Best Practices
Mould at the Work Site

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Government of Alberta
Employment and Immigration

ALBERTA

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Scope of this Document

This document describes the principles to be followed when selecting the most appropriate techniques for managing mould and mould-contaminated materials. Mould is a type of fungus and the procedures and guidelines presented in this document apply to all types of fungi. The document also presents basic information on mould, health hazards, requirements for worker protection, safe work procedures, inspection criteria and applicable legislation.

Work practices and precautions vary depending on the amount of mould and the sensitivity of the population group who may be affected if exposed. The objective of this document is to present best practices for mould at the work site that are to be followed in Alberta.

Occupational Health and Safety officers from Alberta Employment and Industry use this document as a guide when reviewing work practices. Practices are assessed against those presented in the document to determine if they meet the intent of the province's occupational health and safety legislation. Alternate practices are acceptable if they provide workers with a level of safety equal to or greater than those practices presented in this document.

Glossary of Terms

Abatement: the process of removing or cleaning an undesired material such as mould.

Aerosolization: the production of an aerosol consisting of either a liquid or other material that has been distributed into the air.

Allergen: a substance that causes an antibody response and is responsible for producing allergic reactions.

Allergy: an inflammatory response to a substance in the environment that your body believes to be a threat to itself.

Amplification: mould spores germinate and create visible mould growth due to optimal growing conditions, such as the presence of elevated moisture in building materials.

Asbestos: a naturally occurring material composed of fibers and used in many building materials.

Asthma: a respiratory disorder that causes narrowing of the lung passageways.

Bioaerosols: airborne particles of biological origin.

Biocide/Fungicide: Chemicals that limit the growth of or kill microorganisms.

"Black mould": This term, which has no scientific meaning (also "toxic black mould"), has been associated with *Stachybotrys*. Not all moulds that are black in colour are Stachybotrys.

CFU/m^3: colony-forming units per cubic meter of air

Colonies: cells from the same organism growing together.

Colony forming units (CFU): a measure or count of living or viable cells that form a colony.

Dew point: is the temperature of a surface at which water vapour in the air will condense out onto that surface.

EPA: Environmental Protection Agency

Enzymes: used by mould to digest nutrients from organic materials.

Filamentous cells: a collection of cells linked together in a long strand. With respect to mould this collection of cells form hyphae.

Fit Check: a check performed each time a respirator is donned to verify that an adequate seal exists.

Fit test: the use of a quantitative or qualitative method to evaluate the fit of a particular model, make and size of respirator on an individual.

Fungal fragments: the vegetative body of mould, the hyphae, or other portions of mould such as pieces of spores.

Fungi: group of organisms that are neither plants nor animals and reproduce sexually and asexually via spores. The fungi kingdom includes a very large group of organisms, including moulds, yeasts, mushrooms, and puffballs.

Genus: is a name given to a group of organisms that are closely related.

GFCI: ground fault circuit interrupters

Ghosting: discolouration or darkening of a wall or surface due to thermal bridging. Often found as dark areas on drywall where the studs are located.

HEPA: high efficiency particulate air filters that remove at least 99.97% of airborne particles down to 0.3 micrometers in diameter.

High Risk Population: populations where the possibility of severe health effects and even death exist when they are exposed to a contaminant because of other pre-existing health conditions.

Hidden mould: mould growth above drop ceilings, within a wall cavity (the space between the inner and outer structure of a wall), inside air handlers, or within the ducting of a ventilation system.

HVAC: heating, ventilation and air-conditioning system.

Hyphal Mass or Mycelium: an interconnection of hyphae that form a mass visible to the eye.

MSDS: Material Safety Data Sheet

Microbial volatile organic compounds (mVOC's): Chemicals produced by fungi as a result of their metabolism. Some of these chemicals are responsible for the mouldy, musty, or earthy smell of fungi.

Mould: A group of organisms that belong to the fungi kingdom (see Fungi). Although the terms mould and fungi are referred to interchangeably, all moulds are fungi, but not all fungi are moulds.

Morphology: the form and structure of an organism.

Mycelium: an interconnection of hyphae that form a mass visible to the eye.

Mycotoxin: toxins produced by some fungi.

NIOSH: National Institute of Occupational Safety and Health

Non-Viable Sampling: sampling that collects living and dead cells, spores, mould fragments, bacteria and dust that are present in the air.

Occupational Exposure Limit: the amount of substance that most workers can be exposed to at a worksite without having adverse health effects.

OV: organic vapour

Ozone: a gas that contains three oxygen atoms and is capable of oxidizing and therefore killing living organisms.

Party walls: a wall located between two or more units in townhouses, duplexes and condominium units for fire rating.

Polyethylene: a type of plastic.

RCS Strips: agar strips used during air monitoring to determine viable concentrations of airborne mould.

Relative humidity: the amount of water vapor in air that is expressed as a percentage relative the temperature of the air.

Remediate: To fix a problem. Related to mould contamination, remediation includes fixing the water/moisture problem and the cleaning, removal, and/or replacement of damaged or contaminated materials.

Respiratory Protective Equipment (RPE): equipment used to protect the user from inhaling hazardous contaminants.

Sensitive population: populations could be sensitive for a variety of reasons such as age, health, politics, building history, location of mould, etc.

Species: a specific organism belongs to a group of organisms referred to as Genus.

Spore: a reproductive structure in fungi.

Spore trap: a mechanical means to separate, identify and count airborne spores.

Stachybotrys: Genus that includes approximately 10 species and is usually not found in indoor environments unless mould contaminated materials are present.

Thermal bridging: heat loss due to a break or a gap in the building insulation.

Toxigenic mould: mould that can produce mycotoxins (see Mycotoxin).

UV: ultraviolet radiation

Water-damage: building materials that have sustained damage as a result of being wet.

Water staining: building materials that are discoloured as a result of being wet.

WHMIS: Workplace Hazardous Materials Information System.

Viable Sampling: sampling which identifies the types and amounts of mould capable of reproduction. Viable sampling does not identify mould that is not capable of reproduction.

Volatile organic compounds (VOC's): a group of chemicals compounds containing carbon atoms that readily evaporate.

Yeasts: unicellular fungi. Typically seen as a slimy pink covering on building materials

Section One: What is Mould?

1.1 What is Mould?

Fungi are found almost everywhere. Fungi cannot produce food. They get nutrients by absorbing them from surrounding materials. Fungi can only thrive in environments where a food source is readily available. Fortunately for fungi, any organic material can be a food source.

Fungi grow through and within the material on which they are feeding. A network of hyphae (long branching filamentous cells) begin to grow and secrete digestive enzymes which break down the food source. The fungus can then absorb the nutrients in the food source.

Fungi are efficient decomposers of dead plant and animal waste. This is critical to the nutrient cycle and prevents the planet from becoming covered in organic waste. Fungi also feed on many building materials and textiles, including gypsum board, insulation, rubber, wood, carpet, adhesives, paper, leather and cardboard. Fungi will grow in paint, solvents, fuel and in many other industrial products.

Mouldy Coffee

Fungi are divided into different phyla groups based primarily on how they reproduce. Indoors, most fungal contamination is from ascomycetes, which are sac fungi such as ergot, yeast and moulds, and, to a lesser extent, basidiomycetes, which are club fungi such as mushrooms, rusts, and smuts. Indoor fungal contamination is referred to as “mould”, but other types of fungi may also be present. In this document the term “mould” is used to refer to indoor fungal contaminants.

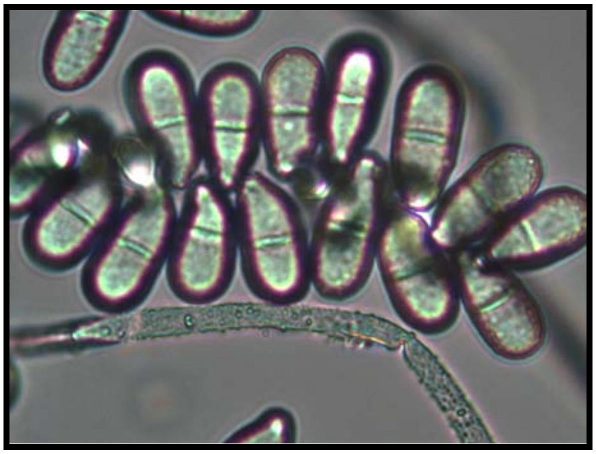
The type of mould found indoors can vary, depending on geographic area, climate and season. Although some moulds can grow at very low, almost freezing temperatures and others will thrive at very high temperatures, the temperature range in occupied buildings is ideally suited to mould growth. Since a food source of some kind is also usually present, the controlling factor for mould growth indoors is the **availability of moisture.**

Moulds can become dormant, producing spores that can survive without moisture, when frozen or without a food source. These spores can develop into mould colonies when the environment becomes favourable.

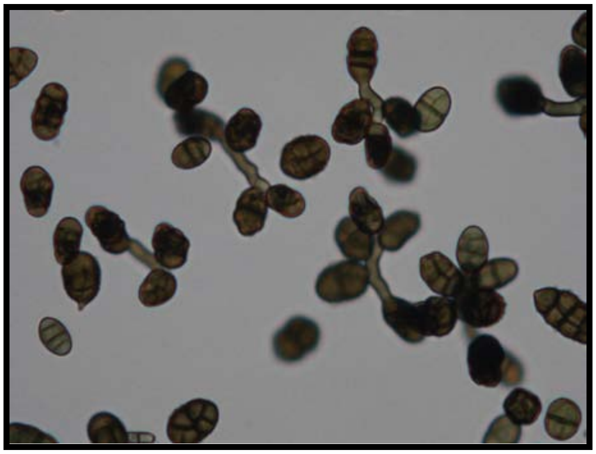
1.2 Structure and Life Cycle of Mould

1.2.1 Spores

Most fungi, including moulds, produce microscopic cells called "spores" that spread easily through the air. Live spores act like seeds, forming new mould growth (colonies) under the right conditions. All of us are exposed to fungal spores daily in the air we breathe.



Spores (*Trichothecium species*)



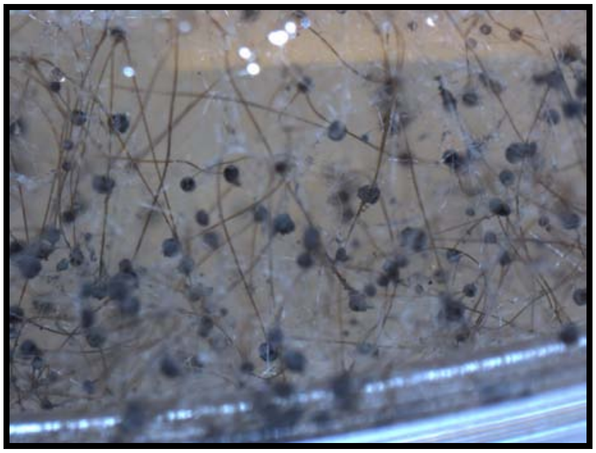
Spores (*Ulocladium species*)

Spores can remain dormant for years until finding themselves in the right environmental conditions. Indoors, these conditions are usually from excess moisture from floods, broken pipes, plumbing and structural leaks or humidity that is too high.

1.2.2 Mycelium

As spores grow, they produce microscopic filamentous cells called hyphae. If the conditions are favourable, hyphae will grow into an intertwining network of cells called a mycelium. The mycelium is what we can see.

Sporangia with spores (*Aspergillus species*)



Hyphae and Sporangia
(*Rhizopus species*, common bread mould)

Life Cycle

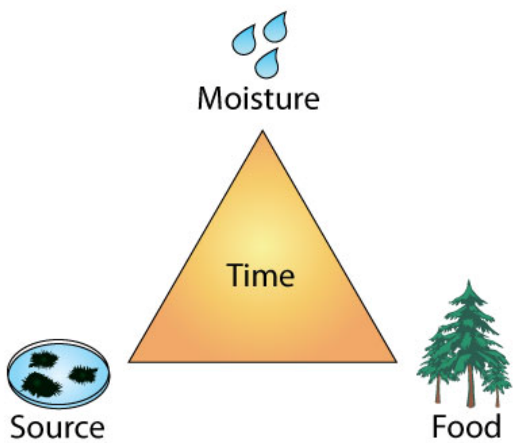
The mould life cycle consists of:

1) spore germination
2) hyphal formation
3) spore generation
4) spore dispersal, death of mycelium

1.3 Conditions Needed for Mould Growth

1.3.1 General Requirements

The basic needs for mould growth are spores, food and moisture.



When a mould spore finds a source of food and there is enough moisture available, mould growth will usually occur.

1.3.2 Spores

Microscopically small dormant cells, called spores, are found on almost every surface. They begin to grow under the right conditions. This process is called "amplification".

Mould is able to adapt to changes in its environment so well that the more stressful the conditions, the more spores will be produced. This ensures that there will be a lot of opportunity for the mould to re-grow in the future.

1.3.3 Food Source

Almost any organic material can be a source of food for mould. Fungi cycle nutrients back into the environment and decompose organic waste. Since waste accumulation is an undesirable and potentially harmful side effect of life, for every kind of organic material there is a species of fungus that can decompose it under the right conditions.

In outdoor environments, moulds are found everywhere, such as on leaves, grass, and trees. There are also moulds that will grow on grains, food crops, animals, sea life, aquatic plants and even insects.
In indoor environments, building materials are a food source for mould. Mould growth can be found on:

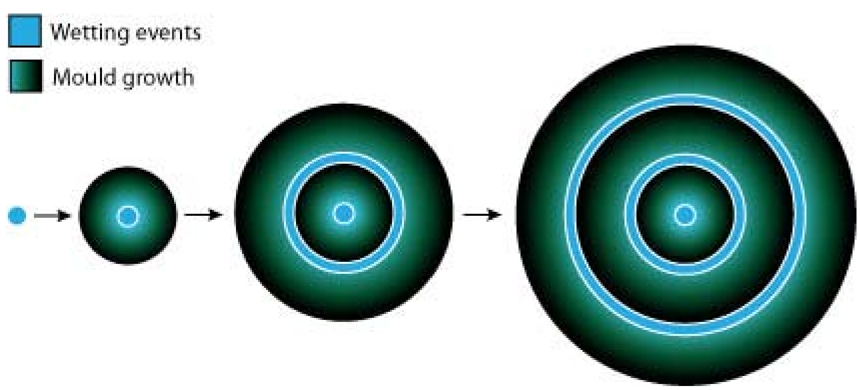
- drywall;
- ceiling tiles;
- glues;
- wood;
- surfaces loaded with dust or other organic materials;
- carpets;
- sealants;
- cellulose insulation;
- cardboard;
- books;
- furniture;
- draperies;
- bedding and other textiles;
- stored food;
- kitchen equipment.

Mould on Dusty Concrete

Mould on Drywall and Mushrooms on Carpet

When there are wetting events, mould can grow from a relatively small area such as the drywall at the base of the wall, to a much larger area such as a significant portion of the drywall surface.

Repeated Wetting and Subsequent Mould Growth



1.3.4 Water and Other Forms of Moisture

Life requires water. The main factor that controls mould growth indoors is the availability of enough water. Spores can travel easily and are found almost everywhere. However, there is not always enough water present for mould growth to occur. This is fortunate for us as it gives us a way to prevent mould growth.

Water sources include:

- rain;
- snow and ice;
- humidity;
- surface water such as oceans, lakes and streams;
- ground water and aquifers; and
- flooding, freeze/thaw cycles, tidal waves, and other forms of mass water movement.

Building water sources include:

- flooding;
- pipe breaks and leaks;
- toilet and sewer back-ups;
- building envelop deficiencies;
- roof leaks;
- HVAC systems;
- exterior deficiencies (through cladding, brick, windows, cement blocks, stucco, or wood);
- site drainage problems (issues with grading, weeping tile, natural obstructions, plant growth);
- condensation (cold surfaces); and
- too much humidity.

Building occupants can also have an effect on moisture levels. Some examples of this include:

- storage of wet materials such as clothing, boots, and rags in a place where they cannot quickly dry;
- use of too much water for cleaning and maintenance;
- drinking fountains, coffee machines, kitchen sinks, and break room use;
- architectural details such as water walls, fountains, and fish tanks;
- inadequate maintenance and repairs; and
- renovations.

1.3.5 Special Conditions

There are also some special conditions that may be needed for mould.

Light:

While some moulds are found in dark locations, others need light for spore ejection. However, direct sunlight may dry out an environment and inhibit mould growth, or increase the temperature to a point where the mould cannot survive.

Temperature:

Moulds have a specific temperature range that they need to grow. This is often the temperature range that is most comfortable for humans. Low temperatures will usually slow mould growth or cause spores to generate and become dormant. Some types do well in extreme temperatures, such as natural hot springs or in ice. These species do not grow well in indoor environments.

Population of Moulds:

Sometimes only a single type of mould will initially grow in an area. This "pioneer mould" may be able to create favourable conditions for the growth of other moulds.

Marijuana Grow Operations:

Marijuana grow operations are a unique environment for excessive mould growth. The activities and building modifications that go with "grow-ops" contribute to building moisture and subsequent mould growth. This includes activities such as:

- crop watering;
- fertilizer application;
- high temperatures from the use of grow lamps;
- storage of waste and soil after harvesting;
- high humidity;
- no permanent occupancy; and
- building modifications.

Grow Operation

Mould Growth Following Grow Operation

1.4 Common Types of Mould

Mould comes from the outdoors. Indoor levels of mould should be similar to those found outside unless excessive mould growth occurs indoors. There are thousands of types of fungi, but there is limited information on all of the species of fungi that exist.

1.4.1 Outdoor Mould Types

Common types of outdoor mould include:

- Ascospores;
- Basidiospores;
- Smuts / myxomycetes;
- *Cladosporium*;
- *Aspergillus*;
- *Penicillium*; and
- *Alternaria.*

1.4.2 Indicator Mould Types

The air in a building comes from outside. It is heated or cooled and filtered and then distributed throughout the building. Certain types of mould are called "indicators". They are usually not found outdoors in significant amounts and therefore their presence indoors is an indication of mould growth. Some examples of these moulds include:

- *Aspergillus;*
- *Penicillium; and*
- *Stachybotrys.*

People often refer to moulds by their colour such as "green mould" or "black mould". However, the same type of mould can be found in a many colours, depending on many factors such as the moisture content and the food source. An example of this is the mould *Aspergillus versicolor*.

People often associate "black mould" with *Stachybotrys*. It is often referred to as "black toxic mould" and is thought to be an indicator of poor indoor air quality. This mould needs a lot of moisture and grows very well in areas where moisture has accumulated inside a building. *Stachybotrys* is often wet and slimy in appearance, and does not produce airborne spores as easily as other moulds. For this reason, *Stachybotrys* is known as an indicator type of mould. Although it can grow well in indoor environments, sampled airborne levels are often low because compared to other types of mould it produces fewer airborne spores. Also, in Alberta, *Stachybotrys* in outdoor air is rare, so the presence of *Stachybotrys* in indoor air is an indication of a potential mould problem.

Section Two: Health Effects Associated with Exposure to Mould

2.1 A Brief History of Fungus

Throughout history, fungi have affected humans. The use of fungus has ranged from food production, health care, textile dyeing and religious experiences.

2.1.1 Positive Effects of Fungi on Humans

2.1.1.1 Food Production

Humans have been using mushrooms and other fungi as a food source since prehistoric times. Women, as the traditional gatherers in a hunter-gatherer society, would collect different types of mushrooms. The pharaohs of Egypt decreed that mushrooms could only be eaten by royalty. Roman emperor had food tasters to taste mushrooms and ensure that they were not poisonous.

Today mushrooms are eaten by people all around the world. Mushrooms are rich in nutrients and are easily dried and preserved, making them useful in winter climates. Some common species of mushrooms are grown, while others, such as truffles, are found only in the wild.

Bread, in one form or another, has been one of the principal forms of food for man from the earliest times. In the Stone Age, people made hard cakes by mixing water with stone-crushed grains like barley and wheat. This is known as “unleavened bread”. Later, people realized that if you knead together flour and water and leave it out for a while it will begin to rise, and was more tasty when baked. This type of bread is known as “leavened”.

The leavening or rising of bread dough is from contamination by the fungus *Saccharomyces cerevisiae* (yeast). Yeast feeds off of sugars in the flour and produces carbon dioxide, which fills thousands of balloon-like bubbles in the dough and gives bread an airy texture. The ability of yeast to convert sugars into carbon dioxide through fermentation is also essential in the production of alcohol.

The process of fermentation is also used to make other food items, such as soy sauce. *Aspergillus oryzae* or *A. soyae* is added to a wheat-soy mixture, along with bacteria.

Many different types of cheese are made using different fungi. Adding *Penicillium* moulds to cheese curds results in the veins found in Stilton, Roquefort, Blue, and Gorgonzola cheeses. Brie and Camembert develop soft insides and edible rinds through the use of moulds.

2.1.1.2 Medical Uses

Antibiotics are one of the main medical uses of fungi. The first and most famous antibiotic is penicillin. In 1928, Sir Alexander Fleming observed that a plate culture of *Staphylococcus aureus* had been contaminated by a blue-green mould, and that the colonies of bacteria were killed. Today, *P. chrysogenum* mould is used to commercially produce penicillin.

The later discovery of the molecular structure of penicillin led scientists to develop other antibiotics, such as cephalosporins, which are made from the *Cephalosporium* fungus.

Fungi are also used to produce immune suppressants. Cyclosporin A is a powerful immune suppressant in mammals, and is a primary metabolite of several fungi. This chemical is widely used during and after tissue and organ transplants.

Statins are used in the control of bad cholesterol levels in blood and for clearing blockages in arteries. Statins are produced by fungi such as *Aspergillus griseus.*

Ergot alkaloids cause the dilation of blood vessels and are used in the treatment of migraines. These alkaloids are produced by species of the fungi *Claviceps.*

2.1.2 Negative Effects of Fungi on Humans

Historically, the most significant negative effect of fungi on humans has been food poisoning, loss of field crops, loss of stored foods and disease.

Many fungi will infect food crops and lower harvestable yields. An example of this is the Great Irish Potato Famine. The famine caused by the infection of Ireland's potato crop by the airborne fungus *Phytophthora infestans*. The infection began mysteriously in late 1845 and lasted for six years, killing over a million men, women and children in Ireland because of starvation and causing another million to flee the country.

Other fungi will also infect food crops. While this may have no effect on the crops themselves, it may cause ill effects when the food is eaten. Ergotamines that are used medically today were historically found as a contaminant of rye and wheat. These and other grains can be contaminated by *Claviceps purpurea*. Eating the contaminated grains can cause an intensely painful burning feeling in the arms and legs. Higher concentrations can also cause hallucinations and a type of dry gangrene.

Another fungal contaminant of cereal grains is *Fusarium*, which infects corn. It produces toxins called fumonisins. If ingested, fumonisins can damage the kidney and liver.

Some diseases are cause by inhalation of moulds. Farmer's lung is an incurable, allergic lung disease caused by the inhalation of spores found in moldy crops, such as hay, straw, corn, silage, grain, and tobacco. *Aspergillus* moulds develop on wet crops during storage. They can be inhaled on dust when the crops dry.

2.2 How Mould Exposure Occurs

The ways for substances to enter the human body include inhalation, ingestion, absorption and injection. For mould, the main ways we are exposed are by inhalation and ingestion. There can also be health effects caused by skin contact, such as Athlete's foot.

Athletes Foot

Health effects from mould and other fungi can be from exposure to living or dead fungal cells, fungal parts such as hyphae or mycelium, fungal spores and mycotoxins.

There is also a relationship between health effects and dose. As Paracelsus said, "All substances are poisons; there is none which is not a poison. The right dose differentiates a poison…."

"All substances are poisons; there is none which is not a poison. The right dose differentiates a poison…."

This means that all substances can cause a toxic effect if there is a large enough dose. The toxicity of a substance is defined by the dose of the chemical that causes response in a biological system, such as people. Groups of the population that will experience toxic effects at lower levels than the average person are referred to as "sensitive individuals".

2.3 Health Effects of Mould Exposure

There is not a lot of documented information on the health effects from exposure to mould. Most is related to ingestion of contaminated materials or poisonous fungi. However, most exposures in the workplace will likely be from inhalation. Also, most studies on the negative health effects are from exposure to high doses, like those experienced by agricultural workers, and not the lower doses found in indoor environments. The differences in short-term exposure and long-term exposure are also not well understood.

2.3.1 Symptoms of Mould Exposure

Most healthy people have little or no reaction when exposed to moulds. If symptoms do occur they are most likely to be:

- runny nose;
- eye irritation;
- respiratory irritations;
- rash or other skin irritations;
- cough;
- congestion;
- aggravation of asthma; and/or
- headache.

These symptoms are usually temporary and will go away when exposure to the mould stops.

2.3.2 Categories of Health Effects

There are four main categories of the health effects caused by exposure to mould: irritation, allergic reaction, infection and toxic response.

2.3.2.1 Irritation

Irritants are biological, physical or chemical substances that cause cellular changes in tissue. Irritation causes symptoms such as burning, itching, inflammation, or redness usually in the eyes, nose, skin, throat, and lungs.

The spores, cell wall constituents, mycotoxins and other metabolites produced by moulds can cause irritation. Of particular interest are microbial volatile organic compounds (mVOCs). Microbial volatile organic compounds are the chemicals responsible for the mouldy or musty odors that go along with mould contamination. Exposure to mVOCs may result in headache, nausea, runny nose, dizziness and fatigue.

2.3.2.2 Allergic Reaction

An allergy is a reaction of the immune system to a substance. Allergies are common and many people have some level of allergic response to one or more materials.

The immune system is the body's defense against invading agents such as bacteria and viruses. Many antibodies are produced when the immune system first senses a foreign object. These antibodies are usually called immunoglobin E, or IgE, and each type produced is specific to one particular type of particle. The next time this same particle type enters the body, it is recognized by the antibody and an immune response is initiated.

For most allergic reactions, the immune system is responding to a false alarm – that is, to a particle or substance that is not harmful to the body. Most allergies are annoying or mildly debilitating. For some substances the immune response can be deadly, such as those seen with severe peanut or seafood allergies.

Sometimes sensitization to a substance can occur. Initially, an individual does not have an allergic reaction when exposed to the substance. Over time or at exposure to a threshold level, a reaction will occur. Once this happens, the individual may have a similar reaction at much lower exposure levels than were needed before.

An allergic response can be triggered by live or dead mould spores, hyphal or mycelial fragments, mycotoxins or other materials produced by the mould.

2.3.2.3 Infection

Fungal infections in healthy individuals are usually rare. Most fungal infections affect the skin or mucous membranes. Different species of *Tinea* can infect the feet, nails, and groin. Athlete’s foot is caused by *Tinea pedis*. *Candida albicans* causes thrush, a common infection of the mouth, as well as vaginal yeast infections. These infections can become common in people who have compromised immune systems and cause more serious health effects.

Aspergillosis is an infectious disease that is caused by exposure to *Aspergillus* species of mould. High concentrations of this mould do not normally cause infection in a healthy person, but individuals with compromised immune systems are more susceptible to the disease.

Conditions such as antibiotic treatment, steroid treatment, chemotherapy, and immune disorders are examples of things that can weaken the immune system. Children, pregnant women, and elderly individuals can also have less developed or weakened immune systems and tend to have greater sensitivity to mould exposure.

A very small number of fungi can infect normal healthy individuals and cause severe and sometimes fatal illness. These fungi include outdoor or environmental species such as *Blastomyces, Coccidioides, Cryptococcus, and Histoplasma.* These species of fungi are found in bird and bat droppings, trees, and soil and are not usually found in indoor environments.

2.3.2.4 Toxic Response

A toxin is a poisonous substance produced by living cells or organisms and can cause disease when body tissues are exposed to it.

There are several reasons that a cell or organism will produce toxins. The production of certain toxins may have evolved as a method to survive predators. Toxins may also be a by-product of an organism's metabolic process and the fact that it is toxic to humans is coincidental.

Many mould species produce cell wall constituents and secondary metabolites that are toxic to humans. Toxins produced by fungi are called mycotoxins. When mycotoxins are produced, they are found in all parts of the fungal colony, including the spores, hyphae, mycelia and the surface that the mould is growing on. The mycotoxins in this material will remain toxic even when the mould cells are dead.

Mycotoxins are relatively large molecules and, unlike mVOCs, do not easily become airborne. Thus, an inhalation exposure will usually require the spores, mould fragments, or the material the mould is growing on to be disturbed. Poisoning from mycotoxins is more often the result of the ingestion of food that has been contaminated with mould.

The production of mycotoxins depends on environmental conditions and the food source or materials that the mould is growing on. Usually if a toxigenic (toxin producing) species of mould is present, then some mycotoxins will also be present. However, the presence of mycotoxins in an indoor environment does not mean that ill-health effects will occur. The health effects from exposure to mycotoxins are usually non-specific and can be difficult to tell apart from exposure to other substances or bacterial and viral infections. Reports of complaints following exposure to toxigenic moulds include headaches, fatigue, nausea, respiratory disorders, depression, fever, numbness, sensitization, nosebleeds, immune system disorders and nervous system disorders.

The most infamous species of toxigenic mould found in indoor environments is *Stachybotrys chartarum* (also known as S. atra). There is much controversy about the health effects from exposure to *Stachybotrys*, and the dose needed for a toxic effect. The most severe health effects have been seen in infants living in extremely contaminated environments. The people who are most likely at risk are infants and children, the elderly and individuals with compromised immune systems.

2.4 What do the Experts Say?

2.4.1 Health Canada

Health Canada carried out two reviews of the scientific literature on the health effects of indoor moulds, one in 1995 and a second in 2004. The major findings of their review are summarized as follows:

- Exposure to indoor mould causes an increase in asthma-related symptoms such as chronic wheezing and irritation.
- Studies on mould exposure and the development of asthma yielded conflicting results. There was not enough evidence for the association between indoor mould exposure and the development of asthma. Indoor mould exposure did cause worse asthma symptoms in mould-sensitized individuals.
- There is evidence that exposure to high levels of airborne fungal spores from environmental disturbances or inadequate control measures are associated with a higher risk of disease in immuno-compromised individuals. The exposure dose necessary for illness to develop is not known.

2.4.2 American College of Occupational and Environmental Medicine (ACOEM)

The ACOEM reviewed the scientific literature on exposure to mould and created the document entitles Adverse Human Health Effects Associated with Molds in the Indoor Environment. This document includes the following points:

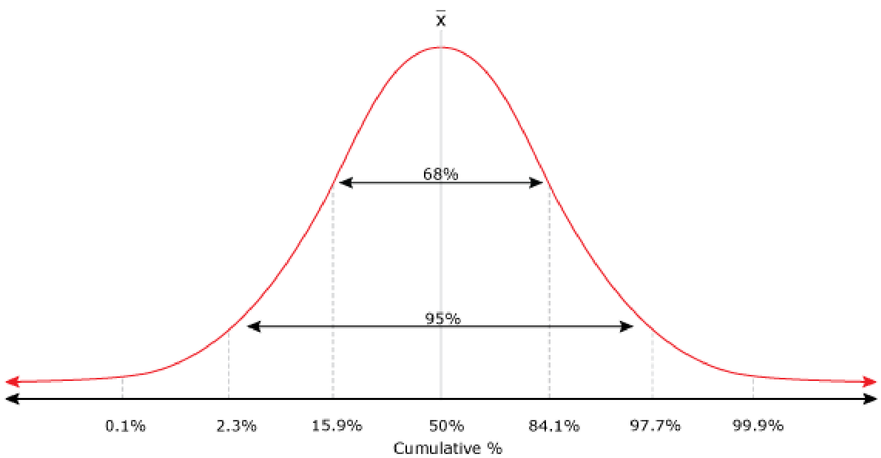
- About 5% of individuals will have some allergic respiratory symptoms from mould exposure. Almost all of these reactions will be limited to runny nose or asthma, and inflammation of the sinuses;
- Outdoor moulds are more allergenic than indoor ones.
- Rarely do sensitized individuals develop the uncommon and more serious conditions from exposure to mould;
- Fungi are rarely significant pathogens for humans. Indoor mould is not a source of fungal infections except for persons with severely impaired immune systems;
- Occupational diseases are also recognized as a result of inhalation exposure to fungi, bacteria, and other organic matter, usually in industrial or agricultural settings. Some believe that moulds growing indoors can cause building-related or IAQ symptoms;
- Some moulds that grow and are amplified indoors may, under some conditions, produce mycotoxins that can have negative health effects on humans;
- Despite a large amount of research on the issue, the association between mould exposure and ill health remains unproven, particularly with respect to mycotoxins. For example, although *Stachybotrys chartarum* is known to produce mycotoxins under appropriate growth conditions, years of intensive study have failed to establish exposure to *S. chartarum* in home, school, or office environments as a cause of adverse human health effects;
- It is unlikely that levels of airborne mycotoxins in indoor environments are high enough to deliver a toxic dose, even for the most vulnerable sub-populations;
- To reduce the risk of developing or aggravating allergies, mould should not be allowed to grow unchecked indoors. Mould growth indoors should be remediated after the source of the moisture that supports its growth is identified and eliminated;
- Uncontrolled mould growth in the home, school, or office environment should not be tolerated. This is because mould destroys the building materials on which it grows, it is unsightly and may produce offensive odours, and may cause allergic responses in sensitive individuals; and
- Current scientific evidence does not support the proposition that human health has been adversely affected by inhaled mycotoxins in home, school or office environments.

2.4.3 Institute of Medicine (IOM), Committee on Damp Indoor Spaces and Health

The Committee on Damp Indoor Spaces and Health has produced an extensive document called Damp Indoor Spaces and Health (2004). The committee conducted a comprehensive review of the scientific literature on the relationship between damp or mouldy indoor environments and the development of adverse health effects. The findings of this review indicated that there was sufficient evidence of an association between the development of upper respiratory tract symptoms (wheezing, cough and asthma symptoms for sensitized persons) and damp indoor spaces. The review also indicated that there was sufficient evidence of an association between the development of upper respiratory tract symptoms and hypersensitivity pneumonitis in susceptible persons in indoor spaces with the presence of mould.

2.5 Special Cases

Some people are more likely to get sick than the general public. This is true for exposure to any substance, including mould. The immune response of a population usually follows a typical bell curve:



If you look at a typical healthy population of 100 people with immune response that fits a typical bell curve, the average response will be at the 50% mark. Sixty-eight of the 100 people will have a response that could be considered "average". On either side of the average population will be populations that have either slightly greater or slightly less immune responses to exposure. A small group of the population will either have almost no immune response or a more dramatic immune response to exposure. This corresponds to approximately 2 to 3 people in 100 when compared to the average population.

Some of the types of people that may fall into the 2% that may have a dramatic immune response to fungi are:

- infants and others with developing immune systems;
- elderly individuals;
- people with suppressed or weakened immune systems;
- pregnant women; and
- individuals with existing respiratory conditions such as asthma.

2.6 Summary

Most healthy people will have little or no reaction when exposed to moulds. However, regardless of their state of health, people have a threshold for pathogen exposure, above which health effects can occur. Mould exposure levels usually have to be very high for healthy individuals to exceed that threshold. Certain groups of people, however, may be affected by lower concentrations.

Allergy and irritation represent the major concerns with respect to mould exposure.

Section Three: Legislation, Standards, Guidelines, and Best Practices

3.1 Introduction

The presence of mould in indoor environments is an unacceptable condition and requires:

- an assessment of the situation;
- correction of the conditions responsible for the mould growth (i.e., water intrusion); and
- abatement of the mould in a controlled manner in accordance with established principles and procedures.

There is both general and specific legislation that is relevant to the abatement of mould as well as many guidelines, best practices, and procedures that are used to ensure that the removal of mould-contaminated materials is carried out safely and effectively.

3.2 Legislation

A safe workplace is mandated by law in Canada. In Alberta, legislation to ensure the health and safety of workers is the *Alberta Occupational Health and Safety (OHS) Act*, *Regulation*, and Code. Workers and work sites in Alberta that are under the jurisdiction of the federal government must follow the legislation in the Canada Labour Code (Part II: Occupational Health and Safety).

Some work sites, where sensitive individuals may be impacted by mould-abatement activities, such as schools and hospitals, will also be regulated under the Canada Public Health Act. Alberta Health Services has jurisdiction with respect to the Canada *Public Health Act.*

There are also the Alberta Building and Fire Codes which regulate building construction and use. Failure to meet these codes can sometimes be the cause of elevated moisture and mould in a building.

This section provides a summary of some of the key requirements in the OHS legislation. For more information on the requirement, refer to the OHS Code Explanation Guide, available online at http://employment.alberta.ca/SFW/3969.html

3.2.1 Alberta Occupational Health and Safety Act

Section 2 of the *Alberta OHS Act* details the general obligations of employers and workers with respect to health and safety at the work site:

- Employers must ensure the health and safety of workers on the work site, as far as it is reasonable to do so. This responsibility includes people completing work for the employer as well as other workers who may be present;
- Employers must ensure that workers are aware of their responsibilities and duties under the law; and
- Workers must take reasonable care and co-operate with their employer to protect the health and safety of themselves, other workers and others present at the work site.

3.2.2 Alberta Occupational Health and Safety Regulation

The *OHS Regulation* provides the general requirements for equipment safety, worker competency and training. Some of the key sections are discussed below:

3.2.2.1 Section 12: Equipment

- All equipment at a work site must be maintained in a condition that is not harmful to workers, will safely perform the function for which it is intended, is of adequate strength for its intended use, and is free from obvious defects; and
- An employer must ensure that the worker uses or wears required equipment at the work site.

3.2.2.2 Section 13: General protection of workers

- Work must be performed by a competent worker or under the direct supervision of a competent worker;
- Workers must be familiar with all work practices and procedures before starting work at each work site;
- Workers who may be required to use safety or protective equipment must be competent in the application, care, use, maintenance and limitations of that equipment; and
- An employer must ensure that worker's perform all duties imposed on the worker by a regulation or code.

3.2.2.3 Section 14: Duties of workers

- A worker must not perform work if they are not competent unless under the direct supervision of a competent worker;
- A worker must immediately report equipment that is in a condition harmful to workers, will not safely perform the function for which it is intended, is not of adequate strength for its intended use, and has an obvious defect; and
- A worker must perform all duties imposed by the regulation or code.

> "Competent in relation to a person, means adequately qualified, suitably trained and with sufficient experience to safely perform work without supervision or with only a minimal degree of supervision."

3.2.2.4 Section 15: Safety training

- Workers must have adequate training on the equipment that they are expected to use.
- Training must include the following topics:

  (a) the selection of the appropriate equipment;
  (b) the limitations of the equipment;
  (c) an operator's pre-use inspection;
  (d) the use of the equipment;
  (e) the operator skills required by the manufacturer's specifications for the equipment;
  (f) the basic mechanical and maintenance requirements of the equipment;
  (g) loading and unloading the equipment if doing so is a job requirement; and
  (h) the hazards specific to the operation of the equipment at the work site.

- If there is the potential for exposure to a harmful substance at a work site, an employer must establish procedures to minimize exposure, train workers on these procedures, ensure that workers apply the training and inform workers of any health hazards related to exposure; and
- A worker must participate in the training provided by an employer and use that training when appropriate.

3.2.3 Alberta OHS Code

The OHS Code does not have specific requirements for mould. However, several parts of the Code are relevant to work sites where workers may be exposed to mould. These parts include Part 2: Hazard Assessment, Elimination and Control and Part 4: Chemical Hazards, Biological Hazards, and Harmful Substances.

3.2.3.1 Part 2, Section 7: Hazard assessment

- A hazard assessment must be completed to identify existing and potential hazards at a work site before work begins;
- A dated report must be prepared containing the results of a hazard assessment and the methods required to control the hazards; and
- The hazard assessment must be repeated at reasonable intervals to prevent the development of unsafe work conditions, when a new process is introduced, when a work process or operation changes or prior to significant alterations to a work site.
- Where reasonably practicable, workers must be involved in the hazard assessment.

3.2.3.2 Part 2, Section 9: Hazard elimination and control

- An existing or potential hazard should be eliminated if reasonably practicable. If not, the hazard must be controlled;
- Hazards must be eliminated or controlled using engineering controls if reasonably practicable;
- If engineering controls do not eliminate or control the hazard, administrative controls must be used to control the hazard to a level that is as low as is reasonably achievable;
- If administrative controls cannot control or eliminate the hazard, appropriated personal protective equipment must be used by workers affected by the hazard; and
- A combination of all three control methods may be necessary on a given work site to provide the required amount of protection.

3.2.3.3 Part 4, Section 16: General Requirements, Worker exposure to harmful substances

- Worker exposure to harmful substances must be kept as low as reasonably achievable, and must not exceed occupational exposure limits (OEL) if they are available; and
- There is no established OEL for mould in the OHS Code. Therefore, worker exposure to mould at a workplace must be kept as low as reasonably achievable.

The *OHS Act* requires that employers ensure, as far as it is reasonably practicable to do so, the health and safety of workers at their work site. In this section, the term "reasonably achievable" is used. Understanding of the term reasonably achievable comes form the Canadian Safety Commission Regulatory Guide (2004, for "*Keeping Radiation Exposures and Doses as Low as Reasonably Achievable* (ALARA)". Though the term reasonably achievable has not been given definite meaning by the Canadian Court system, it is generally accepted in industry and by regulations to encompass the same considerations as the concept of "reasonably practicable".

Reasonably practicable is a concept used by the courts and is assessed using the "reasonable person test". This test asks what a dozen of your peers e.g. twelve workers with equal qualifications and experience, would consider reasonable in a similar set of circumstances. The persons would likely review what happened and compare it against what they do in their own operations. Some of them might do more, others less. The result would be a balanced and wise judgment that could be defended to others. Reasonably practicable is a term that has been tested in the courts and supports a high standard of effective workplace protection for workers.

3.2.3.4 Part 4, Section 43.1: Controlling mould exposure

- The presence of mould at the work site must be controlled in accordance with Section 9 of the OHS Code where mould poses a hazard to workers as determined by the hazard assessment completed as required by Section 7 of the OHS Code.

- The types of controls (engineering, administrative or protective equipment are based on where mould is present and who may be affected by exposure. Employers need to control mould exposure when:

    1. Visible uncontrolled mould growth or elevated airborne mould concentrations (compared to a control area such as outdoors) are present, but cannot be immediately remediated. This may include situations where remediation is planned at a later date or the contamination is not really accessible without significant damage to the building.

    2. Mould cleanup or abatement is actively being controlled in the building.

    3. Workers are medically diagnosed as having adverse health effects consistent with mould exposure at the work site, even though visible mould growth and/or the conditions likely to support mould growth such as damp indoor conditions are not readily apparent .

Workers who have possible mould-related health effects can have many different symptoms. Medical history, specific mould skin testing and indoor mould sampling results reviewed by a physician familiar with mould-associated medical conditions are required to establish a likely causal relationship between reported adverse health effects and a damp indoor work environment with exposure to identified significant mould growth. However, this relationship is often difficult to establish.

3.2.3.4 Additional Sections of the Code

Other sections of the Code should be reviewed to determine whether they are relevant to a particular mould abatement work site. These may include:

- Part 4 Chemical Hazards, Biological Hazards and Harmful Substances;

- Part 5 Confined Spaces;
- Part 7 Emergency Preparedness and Response;
- Part 8 Entrances, Walkways, Stairways and Ladders;
- Part 9 Fall Protection;
- Part 11 First Aid;
- Part 12 General Safety Precautions;
- Part 15 Managing the Control of Hazardous Energy;
- Part 16 Noise Exposure;
- Part 18 Personal Protective Equipment;
- Part 23 Scaffolds and Temporary Work Platforms;
- Part 26 Ventilation Systems;
- Part 29 WHMIS; and
- Part 30 Demolition.

3.2.4 Alberta Environment

Alberta Environment, through the *Environmental Protection and Enhancement Act* and numerous regulations and guidelines, provides information on the disposal of hazardous materials, such as lead, mercury, and asbestos. There are no specific requirements for the disposal of mould, provided that other materials present meet the disposal requirements. For example, if no other controlled contaminants are present, the mould-contaminated waste can be disposed of in a municipal landfill. However, if other hazardous materials are present, the mould-contaminated materials will have to be disposed of in accordance with the regulations specific to that other hazardous material, if those regulations have more stringent disposal requirements.

3.3 Guidelines Related to Mould

3.3.1 Introduction and Some Limitations of Mould Exposure Guidelines

The guidelines for mould exposure are based on following the advice of authorities such as the Federal-Provincial-Territorial Committee on Environmental and Occupational Health (CEOH), the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 62, and the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs).

Exposure limits and guidelines have been established for chemical contaminants at work sites with known or studied effects on humans. It is difficult to assign specific exposure limits to mould. There is a very large number of mould species found in both indoor and outdoor environments. The potential health effects of exposure to moulds fall into the broad categories of irritation, allergic reaction, infection or response to toxins. However, difficulties arise when trying to assess the particular health effects in more detail.

For example, different mould species may be more or less hazardous. In fact, the same mould species may be more or less hazardous under different environmental conditions. Some individuals may be more or less sensitive to the different species of mould than other individuals, even with identical exposures. Other factors may include the general health of the population exposed, the number and types of different moulds present and how they interact, and other toxins or pathogens including bacteria and other chemicals that may be present.

Because of these gaps in knowledge on the health effects of different types of mould in different people and in different situations, it is not possible to set simple numerical exposure limits for mould. This is why it is best to manage mould exposure by preventing it before it occurs.

3.3.2 Health Canada

Health Canada has produced several documents dealing with mould contamination in public, residential, and office spaces.

3.3.2.1 Indoor Air Quality in Office Buildings: A Technical Guide (Revised Edition 1995)

This document makes several recommendations for the interpretation of air sampling data for mould. Primarily, a rank order assessment, which is a comparison of the type and numbers of species present in indoor versus outdoor air, should be used. Numerical data are useful under defined circumstances.

For example, information from a large data set obtained by experienced individuals using the same instrument has practical value. One such set of data collected from federal buildings over a period of years yielded the following conclusions:

- Significant numbers of certain pathogenic fungi should not be present in indoor air (e.g., *Aspergillus fumigatus*, *Histoplasma* and *Cryptococcus*). Bird or bat droppings near air intakes, in ducts or buildings should be assumed to contain these pathogens. Action should be taken as appropriate. Some of these species cannot be measured by air sampling techniques;
- The persistent presence of significant numbers of toxigenic fungi (e.g., *Stachybotrys atra*, toxigenic *Aspergillus*, *Penicillium* and *Fusarium* species) indicates that further investigation and action should be taken;
- The presence of one or more species of fungi indoors, but not outdoors, suggests the presence of an amplifier in the building. Appropriate action should be taken;
- The "normal" air mycoflora is similar in type and lower in quantity than that of outdoor air. In federal government buildings, the 3-year average has been approximately 40 CFU/m^3 for *Cladosporium*, *Alternaria*, and non-sporulating Basidiomycetes;
- More than 50 colony forming units per cubic metre (CFU/m^3) of a single species (other than *Cladosporium* or *Alternaria*) may be reason for concern. Further investigation is necessary;
- Up to 150 CFU/m^3 of mould is acceptable if there is a mixture of species reflective of the outdoor air spores. Higher counts suggest dirty, low efficiency air filters or other problems;
- Up to 500 CFU/m^3 is acceptable in summer if the species present are primarily *Cladosporium* or other tree and leaf fungi. Values higher than this may indicate failure of filters or contamination in the building;
- The presence of visible fungi in humidifiers and on ducts, ceiling tiles and other surfaces requires investigation and remedial action regardless of the airborne spore load; and
- There are certain kinds of fungal contamination not readily detectable by typical sampling methods. If unexplained health symptoms persist, a more detailed assessment is needed.

3.3.2.2 Fungal Contamination in Public Buildings: Health Effects and Investigation Methods (2004)

This guide is designed to "assist in the recognition and management of fungal contamination problems in public buildings. It also strives to further the understanding of the health significance of fungi detected in or during building investigations".

This document concluded that a link between respiratory disease such as irritation, non-specific respiratory symptoms and asthma and exposure to dampness and mould is likely, although studies to date are insufficient to conclude a direct cause and effect relationship. The guide recommends that damp conditions and mold growth should be prevented and fungal contamination in buildings remediated.

3.3.2.3 Residential Indoor Air Quality Guidelines: Moulds (2007)

Health Canada considers mould growth in residential buildings a potential health hazard. Health risks depend on exposure and, for asthma symptoms, on allergic sensitization. Because of the large number of mould species and strains and the large variability in human response to mould exposure, exposure limits cannot be developed. Therefore, Health Canada recommends:

- control humidity and diligently repair water damage in residences to prevent mould growth; and
- clean thoroughly any visible or concealed mould growing in residential buildings.

These recommendations apply regardless of the mould species growing in the building. Further, because there are no exposure limits for mould, results from tests for the presence of fungi in air cannot be used to assess the risk to the health of building occupants from mould exposure in buildings.

3.3.2.4 Indoor Air Quality, Tools for Schools, Action Kit for Canadian School (2003)

This document "provides a process and the tools to help schools prevent, identify, assess, and address the majority of indoor air problems with minimal cost and involvement" to help create a favourable learning environment. This document addresses indoor air quality and potential causes of poor indoor air quality. One of the causes of poor indoor air quality is the presence of mould contamination and therefore mould is mentioned briefly.

3.3.3 NYC Department of Health and Mental Hygiene

In 1993, the New York City Department of Health and Mental Hygiene produced a document on the abatement of mould-contaminated materials, Guidelines on Assessment and Remediation of Fungi in Indoor Environments. This document was used as the basis for mould abatement procedures in many other jurisdictions. This document was updated in 2008.

The main points on the evaluation of the degree of mould contamination are:

- For bulk or surface samples, the presence of few or trace amounts of fungal spores should be considered background. Amounts greater than this or the presence of fungal fragments may suggest fungal colonization, growth, and/or accumulation at or near the sampled location;
- For air samples, contamination should be evaluated by means of comparison (i.e., indoors to outdoors) and by fungal type; and
- In general, the levels and types of fungi found should be similar indoors when compared to the outdoor air. Differences in the levels or types of fungi found in air samples may indicate the presence of moisture sources and amplifiers.

This document also provides recommendations for abatement procedures based on the amount and location of the mould. Mould remediation levels and associated procedures are defined based on the total surface area affected and the potential for exposure. Remediation levels are broken down into small isolated areas (less than 10 square feet), medium sized isolated areas (between 10 and 60 square feet), and large isolated areas (greater than 100 square feet) and remediation of HVAC systems.

3.3.4 American Conference of Governmental Industrial Hygienists (ACGIH)

ACGIH produced the document "Bioaerosols: Assessment and Control" (1999). No exposure guidelines are provided for mould due to the lack of environmental and health data on which to base the guidelines. ACGIH provides the following recommendations:

- Fungal growth in buildings is undesirable and may cause health problems for building occupants. Indoor fungal growth is inappropriate and should be removed. Further steps are needed to correct the conditions that led to the fungal growth;
- The concentration of fungi indoors is usually similar to that seen outdoors (exceptions include enclosed agricultural and other specialized environments. However, the fact that outdoor concentrations exceed those indoors does not mean that indoor growth is not occurring,
- The use of indicator species to evaluate fungal contamination indoors should be done with caution,
- Some fungal pathogens should be assumed to be present when material known to support their growth are found (e.g. Histoplasma capsulatum and Cryptococcus neoformans in bird and bat droppings). Such materials should be removed if they contain pathogenic fungi.

This document also provides information and guidance related to building inspections, sampling, prevention and control of fungal contamination and remediation.

3.3.5 Canadian Construction Association (CCA)

Canadian Construction Association has produced a document Mould Guidelines for the Canadian Construction Industry (CCA-82, 2004). These guidelines are meant to provide useful information and step-by-step instructions for:

- Insurance Considerations;
- Minimizing of Moisture Intrusion;
- Proper Building Maintenance and Operation;
- Mould Assessment;
- Mould Remediation Protocols;
- Proper Disposal of Mouldy Materials; and
- Guidelines for Selecting Mould Remediation Contractors.

3.3.6 Alberta Infrastructure and Transportation

Alberta Infrastructure and Transportation has developed a document entitled Mould in Indoor Environment Risk Assessment and Management Program Handbook (June 2006) to address safe mould assessment and abatement procedures. The handbook recommends following the Health Canada guidelines for mould exposure levels (Section 3.3.2).

3.3.7 United States Environmental Protection Agency (US EPA)

The US EPA has not set standards or exposure limit values for airborne concentrations of mould or mould spores.

The US EPA does provide several bulletins and documents on mould contamination that may be relevant to a mould-abatement project.

3.3.7.1 Mould Remediation in Schools and Commercial Buildings (EPA 402-K-01-001, March 2001)

This document provides guidelines for the remediation and cleanup of mould and moisture problems in schools and commercial buildings. Mould remediation levels and associated procedures are based on the total surface area affected and the potential for exposure. Remediation levels are broken down into small (less than 10 square feet), medium (between 10 and 100 square feet) and large (greater than 100 square feet).

To determine whether remediation or clean up of mould-contaminated materials is complete:

- The water or moisture problem must be completely fixed;
- Mould removal should be completed. Professional judgment should be used to determine if the cleanup is sufficient. Visible mould, mould-damaged materials, and mouldy odours should not be present;
- If sampling has been done, the kinds and concentrations of mould and mould spores in the building should be similar to those found outside once cleanup activities have been completed;
- The site(s) should be re-inspected shortly after remediation, and there should be no signs of water damage or mould growth;
- People should be able to occupy or re-occupy the space without health complaints or physical symptoms; and
- Ultimately, this is a judgment call; there is no easy answer.

3.3.8 Institute of Medicine and the National Academies

The Committee on Damp Indoor Spaces and Health was established, and produced the document entitled Damp Indoor Spaces and Health (2004). This document does not provide guidelines on limits for mould exposure. It does provide information on where more research is needed so exposure limits for mould can be developed, if that is possible.

3.3.9 Calgary Health Region

The Calgary Health Region (CHR) of Alberta Health Services has produced a number of documents on the issue of mould contamination and remediation following the use of a structure to grow marijuana.

The Marijuana Grow Operation Remediation Guidelines were developed to describe the Calgary Health Region's current requirements to return a structure to a habitable state and have an Unfit for Human Habitation Order and Notice of Health Hazard removed from a remediated marijuana grow operation property. Information in the guidelines includes selecting contractors, permitting requirements and document submission, removal of materials, cleaning, air sampling, rebuilding, and inspections.

The Marijuana Grow Operation Checklist was designed to help contractors and owners ensure that the requirements of the remediation guidelines are met.

The Fungal Air Testing, Investigation and Reporting Requirements for Marijuana Grow Operations document details the requirements for air sampling for marijuana grow operations, including:

- consultant and contractor qualifications;
- delineation and remediation of mould contamination;
- hazardous materials audit and management plan;
- air sampling locations;
- number of outdoor or control air samples;
- type of air sampling required (viable and total);
- environmental and building conditions for sampling;
- reporting requirements;
- interpretation of air sampling results; and
- laboratory qualifications.

3.3.10 Alberta Employment and Industry, Workplace Health and Safety - IAQ Toolkit

The Alberta Employment and Industry's document entitled Indoor Air Quality Toolkit is a comprehensive document directed towards understanding, evaluating and correcting indoor air quality issues. The document has a section addressing mould contamination where the basics of mould amplification, assessment and abatement are discussed.

3.4 Summary

Numerous research and regulator bodies have studied mould and some have developed guidelines. The presence of visible mould in a building is an unacceptable condition that could lead to health impacts. The presence of mould warrants an inspection to understand the underlying conditions responsible for mould growth, correction of the underlying conditions and abatement (removal) of the mould in a controlled manner. No specific exposure limits have been set for mould because it exists naturally, outdoor concentrations are prone to wide variability depending on location, time of year and ambient weather conditions and some people are more predisposed to health effects. More scientific study is required to set exposure limits.

Section Four: Assessment of Mould at the Work site

4.1 Introduction

An assessment is used to find the cause, nature, and extent of an air quality issue, and assess how it may affect the health and safety of building occupants and workers.

A request for a mould assessment is usually prompted by indoor air quality (IAQ) complaints, an uncontrolled water intrusion event or observed or suspected mould growth. If there is no specific reason to suspect that mould is the issue, IAQ assessment tools and guidelines should be followed.

IAQ issues include ventilation and air movement, occupant comfort, unpleasant odours, dust and other particulate, noise and lighting and increases in ill-health effects in the workspace that cannot be attributed to other causes. An IAQ assessment will usually include measurements of some or all of the following:

- temperature and relative humidity, as indicators of occupant comfort;
- carbon dioxide, as a measure of the effectiveness of ventilation;
- carbon monoxide, as a measure of the amount and quality of outdoor air entering the space or to detect whether sources of combustion are entering the building;
- volatile organic compounds or VOCs, which can come from building materials, furniture and office equipment such as photocopiers;
- respirable or total particulate, as a measure of air movement, outdoor air intrusion and cleanliness;
- bioaerosols including mould and bacteria;
- noise levels; and
- other issues such as lighting levels and non-ionizing radiation.

The IAQ assessment must be conducted by a competent individual, and there are a number of guidelines that can be followed. Some of these documents are listed in Table 4.1.1.

Table 4.1.1: Guidelines for Indoor Air Quality Assessments

Organization	Guideline
American Society of Heating, Refrigeration, and Air Conditioning Engineers	ASHRAE Standard 55-2004 Thermal Environmental Conditions for Human Occupancy
	ASHRAE Standard 62.1-2007 Ventilation for Acceptable Indoor Air Quality ASHRAE Standard 62.2-2007:Ventilation for Acceptable Indoor Air Quality in Low Rise Residential Buildings
Alberta Employment and Industry – Workplace Health and Safety	IAQ Toolkit
Health Canada	Indoor Air Quality - Tools for Schools Action Kit for Canadian Schools
	Exposure Guidelines for Residential Indoor Air Quality
	Indoor Air Quality in Office Buildings: A Technical Guide
	A Worker's Guide to Air Quality in Offices, Schools, and Hospitals
	Fungal Contamination in Public Buildings**:** Health Effects and Investigation Methods, 2004
Alberta Infrastructure	August 2003 Indoor Air Quality Guideline
Canadian Standards Association	Z204-94 (R1999) Guideline for Managing Indoor Air Quality in Office Buildings
United States – Environmental Protection Agency	EPA Publication No. 400/1-91/003 Building Air Quality: A Guide for Building Owners and Facility Managers (December 1991)
	Tools for Schools Indoor Air Quality Tools for Schools (IAQ TfS) Program
World Health Organization	WHO Regional Publications, European Series, No. 78 Assessment of Exposure to Indoor Air Pollutants
	WHO European Center for Environment and Health WHO Air Quality Guidelines - 2nd Edition (2000)
Sheet Metal and Air Conditioning Contractors National Association	First Edition, 1995 IAQ Guidelines for Occupied Buildings Under Construction
American National Standards Institute	ANSI/IESNA RP-7-01 Recommended Practice for Lighting Industrial Facilities
	ANSI/ASHRAE 62.1-2004 Ventilation for Acceptable Indoor Air Quality
	ANSI/ASHRAE 62.2-2004 Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
	ANSI/IESNA RP-1-04 American National Standard Practice for Office Lighting
	ASTM D6245-98(2002) Standard Guide for Using Indoor Carbon Dioxide Concentrations to Evaluate Indoor Air Quality and Ventilation
National Institute for Occupational Safety and Health	DHHS (NIOSH) Publication No. 91-114 Building Air Quality: A Guide for Building Owners and Facility Managers (December 1991)
	DHHS (NIOSH) Publication No. 98-123 Building Air Quality Action Plan

4.2 Conducting a Mould Assessment

An assessment for mould may be done for a number of reasons:

- Have there been complaints of ill health effects that could be due to mould growth?
- Is there visible mould present?
- Are there elevated levels of spores or other fungal contaminants in the indoor air compared to outside air?
- Are there conditions present which may cause or allow mould growth?
- How big is the problem (area, amount of contamination, type of contamination)?
- Is there a source of water intrusion into the building?
- What conditions or failures have permitted water intrusion?

Experience and knowledge of building systems are needed to answer these questions. Personnel experienced in mould assessment, management and abatement (remediation or removal) should be involved. These may include:

- Certified Industrial Hygienists;
- Registered Occupational Hygienists;
- Building engineers;
- Safety professionals; and
- Academic professionals who study indoor and environmental mould.

The assessment should be conducted in a methodical and unbiased manner. It should include, at a minimum, a visual inspection. During the visual inspection, look for evidence of wetting and the presence of visible mould. The inspection should include the measurement of moisture in building materials. Other aspects of an assessment, such as air sampling, may be required depending on the goals of the assessment and the particulars of the site.

The choice to involve an outside professional should be guided by factors such as the complexity of the situation, size of the assessment area and people involved.

4.3 First Steps in Responding to a Possible Mould Concern

A mould assessment should include occupant interviews, visual inspections, moisture measurements and, in some cases, sampling. The data collected should be analyzed by a competent person.

4.3.1 Occupant Interviews

The first step when responding to a possible mould concern is to interview building occupants. This could include tenants, managers, health and safety specialists, maintenance personnel, cleaning crews, workers and security staff.

Different people will have a different perspective. For example:

- Building Owner – may know that the roof is leaking and needs to be repaired, but not know where and how the water is entering the building;
- Facility Operator – may know where the water is entering the facility via the roof, but not know how it is affecting tenants; and
- Worker– may have health effects or smell odours but may not know why.

The types of questions asked during interviews should be open-ended. Try not to lead the questioning. For example:

"**The Right Way**"
Where did you notice the water in your office?
"**The Wrong Way**"
Did the water leak through the ceiling tile, down the wall and wet the carpet?

Questions should attempt to answer the following:

- Who? (who had the concern, who was affected)
- What? (identify affected materials)
- Where? (location of the affected areas)
- When? (single/multiple events, over a long period of time, date)
- Why? (are repairs needed, undergoing renovations, flooding)

The interviews should focus on when the problem occurred, where the problem is located and who is affected. Some sample questions include:

- Have you seen water leaks?
- Have you seen mould growth?
- Are there strange odours in the workplace? If so, where?
- Have you experienced symptoms or discomfort?
- When did you first notice the water leakage, the mould growth or the odours?
- When did your symptoms start? When are they generally worst? Do they go away? If so, when?
- Have you noticed events, such as weather events, temperature or humidity changes, or activities in the building that occurred around the same time as your symptoms?
- Where are you when you experience symptoms or discomfort?
- Where do you spend most of your time in the building?
- Do you have observations about building conditions that might need attention or might help explain your symptoms (e.g., temperature, humidity, drafts, stagnant air, and odours)?
- Have you sought medical attention for your symptoms?
- Do you have other comments?

Once the information is collected it should be reviewed and grouped. Data should never be disregarded. You should consider how often an observation was made and how many individuals observed the same thing.

The data should help you identify potential areas of concern that need to be investigated further. For example, if the roof or the plumbing leaked, you would check on the type of roof or plumbing, how old it is, what condition it is in, have there been other leaks? You might also ask what the water looked like (fresh, gray, or black). The extent of contamination should be then visually checked, noting the type, size and location of materials that have been affected.

4.3.2 Building Assessment

Following the occupant interviews, the next step is a building assessment.

Elements of an assessment beyond a simple visual inspection should be conducted by skilled personnel with experience in dealing with moisture problems in buildings. The investigation could involve complex situations, inspection of building drawings and construction, interviews with people experiencing negative health effects, sampling and measurement. Architectural and engineering knowledge may also be necessary, depending on the type of building and the extent of the moisture problem.

An assessment checklist is provided to help with completing the assessment. However, each site varies greatly, and therefore the aspects of an assessment vary. This checklist should be used as a starting point.

4.3.3 Visual Inspection

The goal of the visual inspection is to look for signs of mould and the conditions that support mould growth such as moisture.

To control the growth of mould, the source of moisture must be identified. It may be necessary to look in ceiling spaces or plenums, attics and basements and adjacent spaces and floors above and below the area of concern. Look for:

- signs of moisture, including wet materials, water staining or water damage;
- standing water; and
- water accumulation around and under sinks, tubs, drip pans for dehumidifiers, air conditioners, and refrigerators.

Water staining is a discoloration of a building material surface. Examples of water staining are:

- a discoloured spot on a ceiling or wall after drywall has been wet;
- a light or whitish residue on a concrete floor;
- coloured stains from wet carpets, furniture, or draperies; and
- ink stains from papers, boxes, or other printed materials.

Mould Assessment Checklist

(This checklist should be completed prior to remediation work)

Completed by: ____ Date:________________

Location: ____

____

1. Has a hazard assessment been completed for the work site? (If not, complete one before proceeding) Yes ☐ No ☐ N/A ☐

2. Have hazards identified in the hazard assessment been eliminated or controlled? Yes ☐ No ☐ N/A ☐

3. Have owner(s) and appropriate staff been notified and interviewed for background information? Yes ☐ No ☐ N/A ☐

4. Have there been previous water intrusion events? (If so, document date, area impacted and what action was taken at that time.) Yes ☐ No ☐ N/A ☐

   ____

   ____

   ____

5. Have previous water intrusion issues been rectified? Yes ☐ No ☐ N/A ☐

   ____

   ____

   ____

6. Have moisture measurements been made? Yes ☐ No ☐ N/A ☐
   List those measurements:

   ____

   ____

   ____

7. Do moisture measurements indicate that there are wet materials? Yes ☐ No ☐ N/A ☐

8. Have wet materials been identified? Yes ☐ No ☐ N/A ☐
   If so, list the materials, location and how much in square metres.

   ____

   ____

   ____

9. Is visible mould present? Yes ☐ No ☐ N/A ☐
If so, where and on what materials and how much in square metres.

____

____

____

10. Are there hidden contaminated areas which may include HVAC, wall cavities, behind vinyl or carpet coving or baseboards and in attic spaces? Yes ☐ No ☐ N/A ☐

11. Have the appropriate diagrams, photographs and observations been recorded? Yes ☐ No ☐ N/A ☐

12. Site diagram

13. List of photograph numbers, location and descriptions:

Number	Location	Description
1	____________________	____________________
2	____________________	____________________
3	____________________	____________________
4	____________________	____________________
5	____________________	____________________
6	____________________	____________________
7	____________________	____________________

14. Is further expertise required for the mould assessment? Yes ☐ No ☐ N/A ☐

Water-damaged materials will change in appearance, texture or size. You should look for:

- swollen wooden windowsills, door frames, and trim;
- bubbling paint, wall paper, or other wall coverings;
- separation of the leaves or corners in laminate flooring;
- rust on furniture, piping, light fixtures and other metal surfaces; and
- bubbled, creased, or wrinkled paper materials like books or files.

Water-Stained Ceiling Tile

Mineral Deposits (Efflorescence) on Block

Water-Damaged Drywall

Water-Damaged (Rusted) Metal Bottom Plate

When looking for mould, you can use non-destructive methods, semi-destructive or destructive.

Non-destructive methods will uncover contamination on surfaces and easily visible areas. They do not require alteration of building materials and finishes. Non-destructive methods consist of a detailed visual inspection of accessible building materials. You should access unobtrusive or out-of-the-way spaces, such as behind furniture or cupboards or in closets or other storage spaces. Look for:

- discoloration on surfaces, materials black, brown or bluish green,
- raised or furry surfaces;
- a white matting or surface coating;
- other fungi such as mushrooms; and

- yeasts, usually pink in color and slimy.

It is also important to note anything out of the ordinary compared to the rest of the area, such as:

- baseboards that no longer stick to the wall;
- wall paper edges lifting or pieces falling; and
- ghosting on walls, (an outline or image of the nail or screw heads and wall studs can be seen on the drywall or paint surface) although ghosting can occur for other reasons, such as due to particulate deposition.

Mould-Contaminated Oriented Strand Board

Mould Contaminated Drywall Behind Cardboard Box

Semi-destructive methods may be needed to assess water intrusion and mould growth in less easily accessible areas. Mould needs moisture to grow, so areas that remain wet longer are more likely to support mould growth.

Methods that require minimal disturbance of the building finishes can be used to look for moisture and mould behind baseboards, behind wall paper, at the base of a wall cavity, behind drywall or other construction materials and beneath flooring materials. This often involves the use of a utility knife or small pry bar to lift and separate the edges of building finishes to look for visible mould contamination.

View of Mirror

Mould-Contaminated Drywall Behind Mirror

You need to look in areas where water will be retained for an extended period of time. This could include behind furniture, building finishes and in storage areas.

View of Exterior Wall Construction Detail

One location where mould can be found, but is difficult to identify, is where there are more than one layer of drywall. Water can wick up between the drywall layers and mould can grow on the drywall in-between the layers. Often water staining and water damage may be visible with no surface mould. This is one of the reasons why a thorough understanding of the building construction is needed before conducting an assessment.

If there is not enough access to areas of moisture intrusion or mould growth by non-destructive or semi-destructive methods, destructive methods may be required. This can include making holes to gain access to closed-in foundations or crawl spaces, removal of built-in units, cupboards, or fixtures or even removal of flooring, wall, or ceiling material so an enclosed space can be inspected.

It is important to note that semi-destructive or destructive inspection methods may create health and safety hazards. These include the disturbance of mould or other hazardous materials such as asbestos, a decrease in building stability, or damage to building finishes. Care should be taken when conducting destructive testing on exterior walls so as not to compromise the integrity of the vapour barrier system. Whether the testing is for visual inspection or air sampling, holes, drilled through vapour barriers will themselves lead to moisture problems in the future. Small holes can and should be filled with spray foam insulation This must be taken into account, and controls must be put in place, before the inspection begins.

4.3.4 Assessment Tools

Several different types of assessment tools are available to assist in the inspection process. They allow you to collect additional information; however they are not a replacement for well thought-out and detailed interviews and a visual assessment.

4.3.4.1 Relative Humidity Meters

Relative humidity meters are used to measure the relative humidity, or RH, in a space. Relative humidity is used to describe the amount of water vapour in the air at a given temperature. If the RH is high enough, there can be enough moisture for mould growth.

Dew point is also an important measurement that can be measured with an RH meter. The dew point is the temperature where water vapour will condense into water. For example, when the temperature of a cold glass or a window is less than the air in a room, water droplets will begin to form on the surface. The dew point can be reached in a building when outside temperatures are very low, even when there is very little moisture in the air.

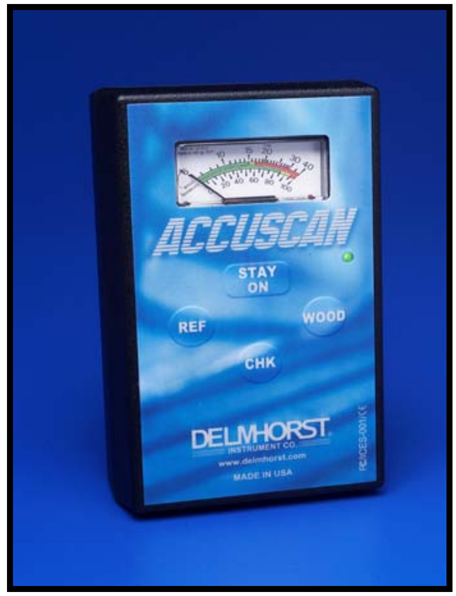
Relative Humidity Meter

Condensation on Cold Glass

4.3.4.2 Moisture Meters

Moisture meters can be used to measure the water content of a porous solid material, such as wood or drywall. This is a non- or semi-destructive tool that will help in characterizing a water source. Wet materials may not have visual mould today, but left alone they may become visibly mouldy in the future.

Pin Moisture Meter



Pinless Moisture Meter

There are two types of moisture meters. A pinless moisture meter reads moisture close to the surface of a material using an electromagnetic field. A pin-type uses two pins that penetrate into a material to determine the moisture content.

The pinless moisture meter is a good meter to use first, as it does not damage the surface and can be easily moved across wall surfaces. This meter is best used for comparisons between impacted and non-impacted areas. The presence of metal in the wall, such as nails, screws and metal studs, can produce false high measurements, and the meter will not work on vinyl covered surfaces.

The pin-type of moisture meter is a more accurate instrument that may have settings for different material types. However, this tool leaves two small holes in the test surface. Although small and relatively unnoticeable, if many measurements must be made, the pin holes become more visible.

4.3.4.3 Boroscopes

A boroscope is an optical device with an eyepiece on one end and a lens and light source on the other, linked by some type of rigid or flexible tubing. The lens end can be inserted in a small hole in a surface and the internal area of the wall or cavity is then magnified and can be viewed through the eyepiece. The lens can be moved around inside the cavity without having to make additional holes in the surface.

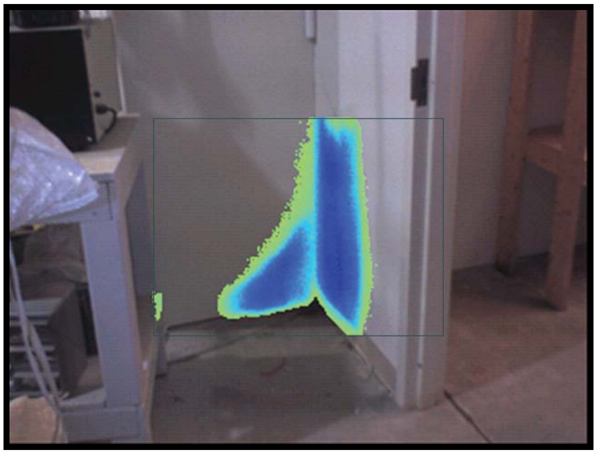
4.3.4.4 Digital Camera

A standard digital camera is invaluable in an assessment. Photographs document the site conditions and often are needed later for other purposes such as insurance claims. Photographs should consist of close-ups of site observations such as mould as well as distant shots to show perspective and location.

4.3.4.5 Infrared Camera

An infrared or IR camera may also be used during a mould or moisture inspection. This camera measures the temperature differences of building materials and creates a thermal image. This is then used to pinpoint leaks or sources or water intrusion. This method is non-destructive and is most effective shortly after a leak has occurred. The camera may also be used in building envelope investigations to find insulation deficiencies such as thermal bridges.

Infrared Camera



Infrared View of Wet Drywall

4.3.5 Sample Collection

Sampling can be done to document the air quality. It can be used to ensure that contamination has not spread to other areas during clean up or to provide evidence that the cleaning process has been successful. Sampling may also be done for legal reasons.

Air sampling is not usually an effective tool for the initial mould assessment. A positive result does not mean there is a mould problem and a negative result does not mean there is no problem. This is because mould is found almost everywhere in our environment.

You must develop a sampling strategy before you begin to collect samples. This strategy should address the questions that you are trying to answer. If you are not sure what those questions are, sampling should not be the first step. Random sampling is not very useful. Sample locations and numbers should be based on the results of the visual inspection. Remember once you know you have mould contaminated materials, they require abatement (removal), and the collection of samples will not change this reality. So, if visible mould has already been identified, air or bulk sampling may not be required.

Mould samples can be viable or non-viable. Viable sampling identifies the types and amounts of mould that are present in living cells or spores. The spores are grown under laboratory conditions so that an analysis can be made. Viable sampling does not identify the types or amounts of non-living mould spores, mycelial fragments and other substances that may produce allergies or irritation. It may not be effective for mould species that do not culture well. Also it is not useful when immediate results are required as it normally takes five to seven days to grow the mould.

Non-viable sampling is where living and dead mould cells and spores, mould fragments and bacteria and dust that are also present are sampled. This provides a better overall view of potential health risks, because it accounts for the dead cells, spores, and mould fragments that may also cause health effects. Species that are not easy to culture will not be missed or undercounted by this type of sampling. However, since the samples are not cultured, the types of mould present must be identified by microscopic assessment. This can be difficult if the species look the same. For example, *Aspergillus sp.* and *Penicillium sp.* are normally reported together due to the similarities in spore shape, size and texture.

4.3.6 Surface or Bulk Sampling

Surface sampling allows you to identify the mould growing on a surface and the mould that has settled out of the air onto the surface. It is of limited value if you already know mould is present but is helpful when you are not sure whether the substance on the surface is mould. Sampling "clean" surfaces is not advised, since mould spores are found everywhere. However, in porous building materials such as dry wall, ceiling tiles or carpets, mould may be present even though it is not visible.

There are two techniques for sampling surfaces: swab sampling and tape sampling.

Swab sampling is where the surface in question is wiped with a sterile swab. The contaminants picked up on the swab are transferred onto a sterile plate filled with media or a liquid solution that will allow for mould growth in the lab. Swab samples can be analyzed for viable and non-viable mould contamination.

Tape sampling is where a clear piece of adhesive tape is used to lift materials off a surface. The tape is then placed on a microscope slide and sent to the laboratory for analysis. Tape sampling is an example of non-viable sampling.

Bulk sampling is where a piece of material is collected. A piece of the drywall, ceiling tile, carpet, wood, or other material is removed using clean tools, placed in a sealable bag, and sent to the laboratory for analysis. At the lab, this sample can be used for either viable or non-viable results.

There are many advantages to the collection of surface and bulk samples:

- a large number of samples can be collected;
- the results can be used to help determine the extent or boundaries of the contaminated area;
- different areas can be easily compared; and
- surface samples are non-destructive.

The limitations of surface and bulk sampling include:

- difficulty in collecting samples on rough surfaces;
- destruction of viable cells during the sampling process;
- difficulties in analysis if the surfaces sampled are very dirty or dusty;
- cross contamination of samples;
- all surface areas cannot be sampled so some contamination may be missed; and
- the results are not representative of the amount of airborne mould.

The use of surface or bulk samples should be driven by the sampling strategy and what questions the samples are intended to answer. If the sample results will not provide additional useful information to the assessment, you should re-evaluate the use and expense associated with the collection of surface or bulk samples. For example, if obvious visible mould is present, sampling is not needed to develop a remediation strategy.

4.3.7 Air Sampling

Air sampling is not always needed. The purpose of air sampling should relate back to the sampling strategy. The results may provide another piece of information for evaluating whether there is a mould problem and may be used to evaluate if mould is potentially affecting air quality in an area where health effects have been identified. Since there are no exposure limits for mould, if sampling is done, samples must be collected from inside/outside the building as well as in clean/dirty areas.

It is most useful to do air sampling when:

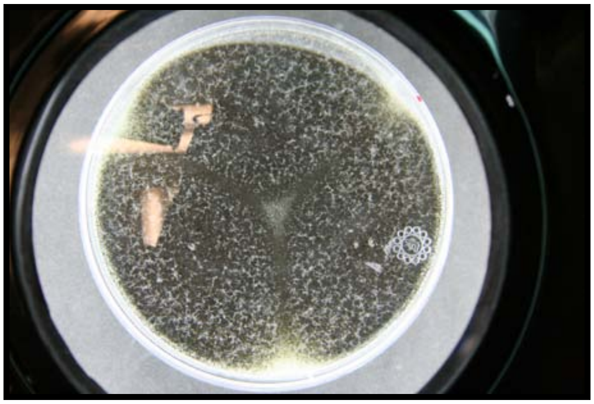
- Evidence such as odours or workers experiencing adverse health effects suggests that mould maybe present but none is found by visual inspection.
- Mould may be having an adverse effect on air quality
- To evaluate if abatement procedures were effective, by comparing airborne levels of mould before, during and after work is completed.

The location of air sample collection depends on the sampling strategy and the questions you are trying to answer. Samples can be collected in occupied spaces, unoccupied spaces such as electrical and mechanical rooms, in HVAC systems and ducting and in wall cavities. Background or "clean air" samples will also have to be collected; usually outdoors or in another area of the building that has not been affected.

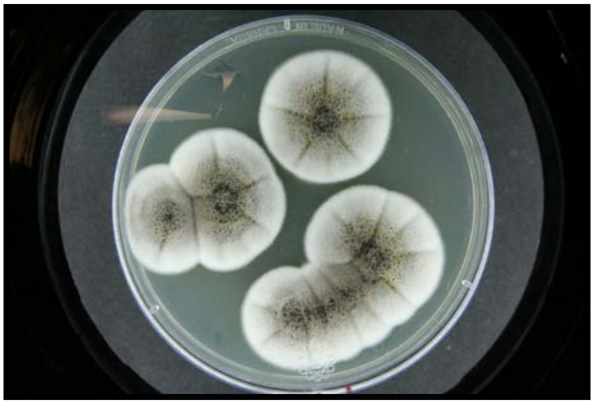
If air sampling will be done on an abatement project, the use of an enclosure or containment around the work area is advisable. This allows for the control of air inside the abatement area so that sampling results outside and inside the enclosure can be compared.

There are several types of air sampling methods used for mould. The simplest and least effective is passive sampling. This involves exposing a dish filled with growth media to the air. Only spores that settle out of the air are collected. The number or type of organisms with spores that have too little mass to settle will not be determined.

Air sampling for bioaerosols such as mould and bacteria can be done using impact samplers, such as Reuter Centrifugal (RCS) and Anderson samplers. Air is drawn through the unit and onto a growth media, which is then cultured in a lab setting. RCS samplers use agar strips and Anderson samplers use medium-filled Petri-dishes.



Petri Dish (Aspergillus niger)



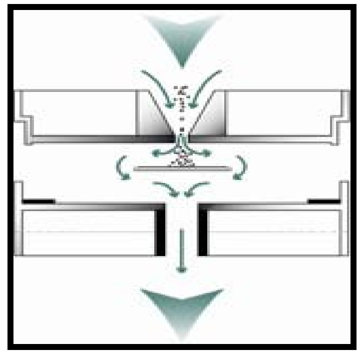
Petri Dish (Aspergillus ustus)

Impact sampling is good when you need to collect viable cells or spores. The method allows for determination of the species of mould present in the test area. However, specific media may be needed to grow different species of mould. Some species of mould may out-compete other species on the growth media. This means that the results may not be representative of the airborne levels. This can result in an under-representation of some species in the final analysis. Also, the equipment can be bulky, the media must be stored and shipped in a controlled environment and several days to weeks are needed to culture and analyze the results.

Spore-trap samplers are another type of sampler used to assess levels of airborne mould. This type of sampling is becoming more common and the results are gaining a more wide-spread acceptance. Spore traps are small cassettes with a glass slide coated in a sampling substrate in the center. Air enters the cassette and travels over the slide, leaving particles on the coating. Particles can include fungal spores, mycelial fragments, pollen, fibres, and dust. After sample collection, the cassette is sent to the laboratory. The glass slide is removed from the cassette and analyzed under a microscope for viable and non-viable mould and mould fragments.

Spore-trap sampling may be useful for initial site testing, especially if mould growth is not visible. It is quick and simple and requires little equipment so many samples can be collected if necessary. The resulting analysis includes both viable and non-viable mould spores and mould fragments. Because spores are not cultured there are no special storage and shipping requirements. The results are provided at the genus level. Culturing is required if the species of mould must be identified.

Spore-trap Cassette



View of Spore-trap Cassette and Impaction

Another type of air sample is for microbial volatile organic compounds (VOCs). These compounds are produced by some types of mould and may cause the characteristic odour of damp areas and mould growth. However, it may be difficult to accurately determine the amount of microbial VOCs in a space, because there are many other VOCs present that are similar to those produced by micro-organisms. Other sources of VOCs can include paints, cleaning materials, solvents, upholstery, carpets, plastics and office machinery.

Microbial VOCs can be collected by whole air sampling or sorbent tube sampling. Whole air sampling involves collecting contaminated air in a vacuum-pressured stainless steel canister which is sent to the lab for analysis. This type of sampling is relatively simple and the air can be analyzed for a large number of different compounds. Sorbent tube sampling involves passing air through a tube filled with a collection media. The contaminants are absorbed by the collection media. The results may be more accurate than with whole air sampling, as larger volumes of air can be sampled. However, the sorbent tube used must be specific to the contaminants that are to be analyzed.

The samples should be collected according to well recognized sampling methods and by competent personnel. The usefulness of sampling data is limited by the sample collection technique, sampling analysis and the interpretation of the results

Sampling for microbial VOCs is expensive. Currently microbial VOCs sampling is of limited use.

4.3.8 Sample Analysis

Some types of mould samples must be preserved, transported and stored under specific environmental conditions to maintain sample integrity. For example, temperatures that are too high may damage spores and prevent them from culturing in the lab. When you contact the lab regarding sample analysis, they can provide you with the requirements for proper handling, storage and transportation of the samples.

Image provided by and with permission of Bio-Chem Consulting Services Ltd.

View of Mould Colonies on RCS Strip and Petri Dish

Laboratories accredited in microbiological and mould assessment should be used to analyze the samples. Accreditation ensures that labs have the necessary equipment and personnel to do the analysis, as well as the ability to do the analysis properly. There are a number of accreditations that are applicable for mould analysis. Two accreditation programs, administered by the American Industrial Hygiene Association (AIHA), are:

- the Environmental Microbiology Laboratory Accreditation Program, or EMLAP, which is specifically for labs identifying microorganisms commonly detected in air, fluids, and bulk samples during indoor air quality studies; and
- the Environmental Microbiology Proficiency Analytical Testing Program, or EMPAT, which was developed for microbiology laboratories specializing in analysis for microorganisms commonly detected in air, fluids and bulk samples collected from schools, offices, hospitals, industrial, agricultural and other work environments.

The laboratory should also have an internal quality control program. This program should include training and experience levels for analysts, quality control checks (field and laboratory blanks, duplicate samples, inter-laboratory analysis) and chain-of-custody procedures to document each step from sample collection to receipt at the laboratory.

4.3.9 Interpretation of Sampling Results

It is much easier to interpret sampling results when the goals of the sampling have been well defined in the sampling strategy. This way the correct type and number of samples are collected,

You must know the terms used in a laboratory analysis report to correctly interpret the results. Some commonly used terms include:

- **colony forming units (CFU):** a mass of mould which often originates from a single spore or hypha;
- **fungal or mould type (genus and species):** the name of the mould found. If sp. or spp. is found after a genus name, the species has not been determined or multiple species are present;
- **spore counts:** the number of spores per area of surface sampled or volume of air sampled;
- **hyphal or fungal fragments**: refers to fragments of the filamentous structures (hyphae) that make up the body of moulds by branching extensively to form a complex network called mycelium; and
- **rank order:** lists the mould species found in order from most abundant to least abundant.

The main difficulty with interpreting the air sampling results for mould is the lack of exposure limits for mould to compare the results to. Indoor mould levels are usually compared to outdoor mould levels so outdoor air samples must be collected as well. Other information that will be important is the seasonal and daily variations in the concentration of mould in the outdoor environment, as well as the weather conditions on the day of sampling.

It is important to keep in mind that air sampling results for mould often may not be representative of the site conditions. Some moulds do not easily become airborne, so if samples are “clean”, it does not necessarily mean that there is no problem. Also, since mould is found everywhere and natural air levels can vary considerably, a “high” sample does not necessarily mean that there is a problem with mould growth. This is why air sampling should only be done in conjunction with a good building inspection and assessment.

To interpret sampling results, you should compare the types and levels of mould measured in different environments, usually indoors versus outdoors or complaint areas versus non-complaint areas. In buildings or areas without mould contamination, the types and amounts of mould present should be similar or less than what is found outside. If there are large numbers of one or two kinds of mould relative to the control samples (outdoor or non-compliant area), this may indicate the presence of mould contamination. However, seasonal variations must be taken into account. For example, in the winter it is not uncommon for mould concentrations outdoors to be significantly lower than those indoors. This is because conditions outdoors are not favourable for mould growth. The consistent presence of *Stachybotrys* is also an indicator that mould contamination exists. *Stachybotrys* is known as an indicator species as it is often found in water-damaged and mould-contaminated buildings and is not commonly found outdoors in Alberta.

4.4 Evaluating the Assessment Results

Once the inspection and sampling data has been collected, it must be evaluated.

The following questions must be answered:

- Were wet materials identified, if so where and how much?
- Was mould identified, is so where and how much?
- Is a more thorough inspection (destructive testing) needed?
- What is the source of the moisture that caused the mould and/or wet materials?
- Can an accurate scope of work for abatement procedures be developed? To answer this question you will need to know the location and extent of the wet and mouldy materials, the type of occupants in the building, whether the materials can be cleaned or will have to be discarded and other considerations discussed in detail in Sections 5.0 and 6.0 of this document.

If the above questions cannot be answered then a more thorough inspection is required. This inspection could involve destructive testing and/or the services of an experienced professional.

When evaluating the findings of an assessment it is important to focus on the details of each area and what those findings tell you, but also to look at the story or big picture of what has and may be happening in the building. Generally, the findings and the story that the findings tell should make sense. If there is data that does not fit, you may have missed something. For example if wet building materials were found on the floor and bottom portions of drywall following a small flood and mould is found on the top portion of one wall. This mould on the upper portion of the wall is likely the result of past wetting events and does not fit with the current flooding and therefore requires additional investigation.

Often the exact building deficiency responsible for the water intrusion and mould growth may not be obvious. A building envelope specialist or an engineer may be needed to evaluate this.

Table 4.4 Interpretation of Air Monitoring Results

Parameter	Description	Action
>50 CFU/m^3	Mould level present as a single species, other than Cladoporium or Alternaria. Sampling error can be high for low colony counts, so repeated sampling is necessary to reduce the variability in results.	Cause for concern. Further investigation is required.
Up to 150 CFU/m^3	Mixture of species, reflective of outdoor air spores.	Acceptable
Up to 500 CFU/m^3	Species primarily Cladosporium or other tree and leaf fungi, summer conditions.	Acceptable. Values higher than this may indicate failure of the filters or contamination of the building.
Aspergillus fumigatus, Histoplasma and Cryptococcus	Pathogenic fungi, not normally found in indoor air.	Should not be present in indoor air.
Stachybotrys chartarum, toxicogenic Aspergillus, Penicillium and Fusarium species	Persistent presence of toxicogenic fungi, not normally found in indoor air, with repeated sampling.	Further investigation and action is required.
Fungal amplifier	Confirmed presence of one or more fungal species occurring as a significant percentage of a sample in indoor air samples and not simply present in concurrent outdoor samples.	Further investigation and action required.
Visible mould		Immediate investigation and remedial action required, regardless of airborne concentrations.
Unexplained adverse health effects, even where air sample results may be low.		Collect bulk/surface samples and analyze for fungal species.

Source: Indoor Air Quality in Office Buildings: A Technical Guide (Health Canada 1993), Fungal Contamination in Public Buildings: A Guide to Recognition and Management (Health Canada 1995)

Notes:

1. Fungal counts should not be interpreted in isolation. A complete IAQ assessment and inspection should be conducted.
2. Detection and observation of fungal counts will be influenced by various factors, such as the type of sample medium, sampler used, sampling time, occupant activities, seasonal variations, ventilation systems present and geographic location. These factors must be taken into account when interpreting sampling results.

Section Five: Management of Mould at the Work Site

5.1 Introduction

Mould removal can be costly and disruptive. Because mould is everywhere and buildings have many potential food sources for mould, the management of moisture is the key to preventing mould growth.

5.2 Prevention of Mould Growth

The prevention of mould growth is the first step to manage mould at the work site. Preventing mould growth from the beginning will save money and there will be fewer complaints and occupant issues. This is because some type of clean-up and abatement will be needed if there is mould growth because, unlike some hazardous materials such as asbestos, managing mould growth in-place (not immediately removing it) is usually not an acceptable option.

Because mould spores can be found almost anywhere, the main key to preventing mould growth is to limit the availability of water. This is accomplished by keeping building materials dry. You can also control the food source to some degree by using materials that provide less nutrients such as mould resistant drywall.

5.3 Developing a Management Plan for Mould

A management plan is an important tool in the control of mould. Uncontrolled water release can happen for many reasons and at any time. Having a plan in place before an event occurs will help minimize the potential for mould growth.

A management plan will have several different parts:

- Assignment of Responsibilities;
- Background Information;
- Ranking of Mould Potential;
- Building Maintenance Procedures;
- Hazard Assessments;
- Emergency Response Procedures;
- Regular Mould Assessments;
- Abatement Plan;
- Re-Assessment of the Management Plan;
- Risk Communication; and
- On-Going Assessment.

5.3.1 Assignment of Responsibilities

The individual or individuals responsible for the various components of the management plan must be clearly identified. This includes responsibilities for plan implementation, development of procedures, scheduling, performance of inspections, emergency response coordination, training development and delivery and regular reassessment of the plan.

5.3.2 Background Information

Background information on the building should be collected. This includes:

- previous uses of the building and renovations completed;
- previous reports on maintenance procedures and repairs;
- surveys for hazardous materials;
- previous reports of mould issues in the building, including water intrusion; and
- tenant activities, processes and materials in the building.

5.3.3 Ranking of Mould Potential

By ranking the potential for an activity, process or material to cause water intrusion or elevated moisture levels, appropriate decisions can be made and controls can be implemented. A blank checklist has been provided to assist in this process. The intent of the checklist is to allow building operators and other personnel to manage conditions that may cause elevated moisture and the potential for mould growth.

Particular attention should be given to:

- buildings that are intended as temporary structures such as school portables and portable offices; especially if they have become a permanent fixture;
- buildings with high moisture content, such as fountains, pools, and ice rinks;
- buildings with a history of roof, window, or foundation leaks;
- buildings with poor site drainage;
- buildings on flood plains, in areas with high water tables or with underground water sources; and
- buildings with underground structures such as parking garages.

Potential Water Events Ranking	
Conducted by:	Site Address:
Date:	

Hazard Priority (Status)

Identification								Controls
Item #.	Description	E	B	AP	Frequency	Severity	Priority	

Identification: Environmental Factor = E, Building Factor = B, Activity or Process Factors = AP
Frequency Ratings: A = High likelihood, B = Medium, C = Low, D = Not Applicable (N/A)
Severity Ratings: 1 = Imminent Contamination, 2 = Serious, 3 = Minor, 4 = Negligible, 5 = Not Applicable (N/A)
Priority Ratings: Highest to lowest priority, 1 = highest, with subsequent numbering being of less priority

*The rating system used here is subjective to different sites and may not apply in all situations. Environmental factors include weather events such as heavy rains and flooding which can contribute to conditions that support mould growth. Building factors may include such events as pipe breaks and roof leaks. Activity or Process factors may include painting, mopping, and occupant use of facility services such as water fountains in a school. Frequency ratings are a relative scale compared to the other building factors based on how often any one particular factor occurs. The more frequent a factor is the greater the likelihood that mould growth will occur. Severity ratings are a relative scale compared to the other building factors based on the extent of possible damaged to building materials. Priority ratings are a relative scale of the combination of frequency and severity ratings so that the factors can be ranked from the highest to the lowest in order to make appropriate decisions.

Examples of how to use the checklist have been provided below:

Example #1: A contractor is using a gas-fired heater to heat a partially enclosed structure under construction in March while some finishing activities (erecting and mudding drywall) are underway.

Gas-Fired Heater

Gas-fired heaters produce more water vapour than fuel consumed. This is because water is a waste product from combustion. Therefore, gas-fired heaters contribute significantly to the relative humidity inside a building. If the outside temperature drops significantly, then the temperature of interior surfaces of a building may reach the dew point and become wet.

The likelihood is high that the outside temperature will drop significantly in Alberta in the spring. So, there is a high potential for wet building materials such as drywall to be present.

In this situation where the frequency or likelihood is high and the severity is high, the situation should be managed to prevent material damage, added costs, construction delays and the potential growth of mould.

Example #2: A new commercial flat-roofed building is located in an older community with large trees. The building's maintenance department is short staffed and has been unable to attend to the building's preventative maintenance. As a result, the roof is not regularly inspected and leaves from the neighbouring trees have plugged many of the roof drains.

The likelihood of a roof leak depends on the likelihood of rain and the presence of leaves. The severity would be a function of how blocked the drains were, how much it rained and the condition of the roof membrane.

Potential Water Events Ranking	
Conducted by: Mr. John Smith and Ms. Carol Schmidt	Site Address:
Date: February 25, 2008	

Hazard Priority (Status)								
	Identification							Controls
Item #.	Description	E	B	AP	Frequency	Severity	Priority	
1	Use of gas-fired heaters in an partially constructed building (Example #1)	X	X	X	A	1	1	Use dry heat in place of gas-fired heaters
2	Roof drains, leaves and the lack of preventative maintenance (Example #2)	X	X		B	2	3	Implement a roof inspection program
3	Water spills at school water fountains		X	X	A	3	5	Install water resistant wall coverings such as ceramic tile in the area of the water fountains
4	Painting walls and the resulting humidity and condensation on the windows during an cold Alberta winter	X	X	X	C	3	4	Use dehumidifiers
5	Occasional pipe valve failure in an old building	F	X		C	1	2	Implement a pipe valve inspection program and replace older components
6	Poor site drainage and water intrusion during the spring melt	X	X		B	2	6	Investigate long-term repair of site drainage short-term controls such as snow removal, sealing building penetrations etc…

Identification: Environmental Factor = E, Building Factor = B, Activity or Process Factors = AP
Frequency Ratings: A = High likelihood, B = Medium, C = Low, D = Not Applicable (N/A)
Severity Ratings: 1 = Imminent Contamination, 2 = Serious, 3 = Minor, 4 = Negligible, 5 = Not Applicable (N/A)
Priority Ratings: Highest to lowest priority, 1 = highest, with subsequent numbering being of less priority

*The rating system used here is subjective to different sites and may not apply in all situations. Environmental factors include weather events such as heavy rains and flooding which can contribute to conditions that support mould growth. Building factors may include such events as pipe breaks and roof leaks. Activity or Process factors may include painting, mopping, and occupant use of facility services such as water fountains in a school. Frequency ratings are a relative scale compared to the other building factors based on how often any one particular factor occurs. The more frequent a factor is the greater the likelihood that mould growth will occur. Severity ratings are a relative scale compared to the other building factors based on the extent of possible damaged to building materials. Priority ratings are a relative scale of the combination of frequency and severity ratings so that the factors can be ranked from the highest to the lowest in order to make appropriate decisions.

5.3.4 Building Maintenance Procedures

Good building maintenance procedures are the most useful tool for preventing mould growth. Good procedures can control the environment and can act as an early warning system. Mould can be managed before it becomes an issue and affects the indoor air quality in a building. Maintenance procedures should be a written part of the mould management plan.

Regularly scheduled inspections of the roof, HVAC systems, plumbing, windows and doors and other building components will help ensure that damage or defects are noticed and repaired quickly. Maintenance of the building infrastructure is very important.

The HVAC system should be assessed and its condition documented on a regular basis. Temperature and relative humidity levels should be watched to make sure that they stay within recommended ranges. Humidity levels should be maintained at levels below 60% to inhibit mould growth.

Additional attention may be necessary for HVAC systems. Insulation and filters in the HVAC system can be sources of food for mould, or can trap dirt and mould spores. Cooling coils, condensate drain pans and the humidity in circulating air can provide the moisture needed for mould to grow. Some of these areas may be inaccessible and very hard to clean.

Other building maintenance procedures that control moisture in and around a building site can include:

- Keep HVAC drip pans clean, flowing properly and unobstructed.
- Vent moisture-generating appliances, such as dryers, to the outside where possible;
- Fix leaks in plumbing as soon as possible;
- Use proper housekeeping techniques to prevent standing water;
- Watch for condensation on plumbing, windows, mirrors, chilled water lines and drinking fountains, cooling pipes and other surfaces. If condensation is found, the surface temperature may need to be increased by insulating or increasing air circulation, or humidity levels decreased by increasing ventilation rates or dehumidifying the air;
- Ensure proper air flow in areas such as bay windows and alcoves to reduce moisture;
- Prevent or minimize the wetting and drying of materials in the building and of soil in crawl spaces during construction; and
- Use air barriers to keep cold air out of the building rather than positive pressurization to prevent condensation build-up in internal building spaces.

When buildings are renovated, the operation of the systems being changed or installed should be assessed. Control of moisture should be made a priority in the project specifications. Small modifications to the floor plan of a building can affect ventilation and result in condensation and subsequent mould growth.

5.3.5 Hazard Assessments

The presence of uncontrolled water and the potential presence of mould on a work site present hazards that require assessment and elimination and/or control. A hazard assessment must be done to determine which hazards are present. This is required under the Alberta OHS legislation. Once the hazards have been identified, control measures must be put in place to protect workers. Refer to Section 7.0 of this document for more detailed discussion on hazard assessment.

5.3.6 Action Plan for Response to Water Leaks or Floods

The actions to be taken when there is an uncontrolled water release should be a part of the management plan. An uncontrolled water release can include a flood, pipe break, sewer backup, heavy rains or snows and heavy and rapid snow melt.

The water release or intrusion must be stopped as quickly as possible. Free-standing water should be collected and removed. Subsequent wetting should be prevented.

Wet building materials need to be cleaned and dried in the first 24 to 48 hours following a wetting event to limit the potential for mould growth. Tools that may be used to do this can include heaters, fans and dehumidifiers. The effectiveness of drying is limited to accessible areas. Wall cavities and other enclosed inaccessible areas cannot be easily dried.

Suggestions for the handling of water-damaged materials after an intrusion event are listed in Table 5.3.6. This table is adapted from information in the Alberta Infrastructure and Transportation document Mould in Indoor Environment Risk Assessment and Management Program Handbook (June 2006) and the USEPA document Mould Remediation in Schools and Commercial Buildings (2001).

The Ontario Safety Association for Community and Healthcare provides practical information on the prevention and remediation of mould growth following a leak or flood. This information is available online at: www.osach.ca/new/Mould2/START.html. The Mould Remediation Summary Chart from this reference is reproduced on the following pages, with the permission of OSACH.

Table 5.3.6: Guidelines for Response to Clean Water Damage within 24-48 Hours to Prevent Mould Growth

Water-Damaged Material	Actions to be Taken
Books and papers	Discard non-valuable items. Photocopy valuable/important items and discard originals. Freeze (in frost-free freezer or meat locker) or freeze-dry.
Carpet, backing, and subfloor – dry within 24-48 hours	Remove water with water extraction vacuum. Reduce ambient humidity levels with dehumidifier. Accelerate drying process with fans.
Ceiling tiles	Discard and replace.
Cellulose insulation	Discard and replace.
Concrete or cinder block	Remove water with water extraction vacuum.
Wallboard (gypsum board)	Best approach is to remove and discard. May be dried in place if there is no obvious swelling and the seams are intact. Ventilate the wall cavity, if possible.
Upholstered furniture	Remove water with water extraction vacuum. Accelerate drying process with dehumidifiers, fans, and/or heaters. It may be difficult to completely dry within 48 hours. If the piece is valuable, you may wish to consult a restoration/water damage professional who specializes in furniture
Fibreglass insulation	Discard and replace.
Hard surface, porous flooring (Linoleum, Ceramic tile, vinyl)	Vacuum or damp wipe with water and mild detergent and allow drying; scrub if necessary. Check to make sure under flooring is dry; dry under flooring if necessary
Non-porous, hard surfaces (Plastics, metals)	Vacuum or damp wipe with water and mild detergent and allow to dry; scrub if necessary.
Window drapes	Follow laundering or cleaning instructions recommended by the manufacturer.
Wood surfaces	Remove moisture immediately and use dehumidifiers, gentle heat, and fans for drying. (Use caution when applying heat to hardwood floors.) Treated or finished wood surfaces may be cleaned with mild detergent and clean water and allowed to dry. Wet paneling should be pried away from wall for drying.
All Surfaces	Accelerate the drying process with dehumidifiers, fans, and/or heaters.

The guidelines in Table 5.3.6 are for damage caused by clean water. If the water source is contaminated with sewage or chemical or biological pollutants, then additional personal protective equipment and procedures will be required and the services of an experienced professional should be consulted. Do not use fans until you have determined that the water is clean and that there are no other hazards present (such as asbestos that could become airborne).

Mould Growth Prevention and Remediation

Actions to take after a leak or flood to prevent or remediate the growth of mould......

The attached sheets contain a chart and the related explanations for the codes used in the chart. The chart indicates how mould growth can be prevented within 48 hours of water damage and also provides general advice on remediation once mould has started.

This information is intended only as a summary of basic procedures and is not intended, nor should it be used, as a detailed guide to mould remediation.

Professional advice should be obtained if the flooding is extensive, the water is contaminated, or mould growth has already become well established. Mould growth generally is not visible for the first 48 hours. If growth is apparent immediately after the flooding it may indicate a more extensive problem or a previously unidentified long-term problem.

HCHSA

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A project of the Occupational Health and Safety Organizations of Ontario sponsored by the Occupational Health and Safety Council of Ontario. April 2002

Instructions for using the Chart......

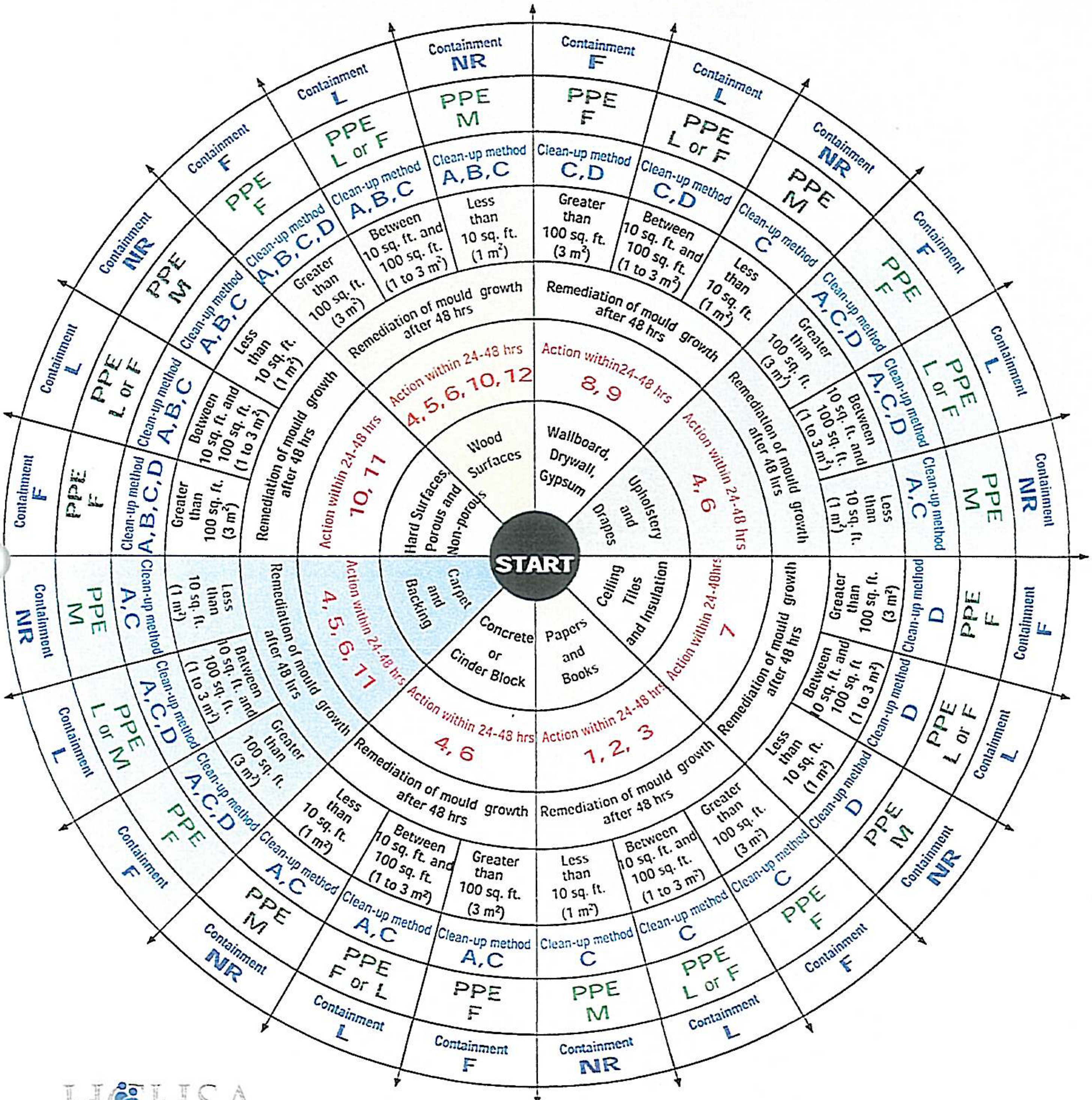
The chart on the next two pages summarizes mould control procedures recommended by the Environmental Protection Agency in the United States.

The chart may look complicated, however it becomes clear and useful when taken one step, or one ring, at a time.

1) Start at the centre.
2) In the first ring, identify the material of concern.
3) In the next ring, find out what actions to take within the first 24-48 hours after CLEAN water damage occurs. Actions are numbered 1, 2, 3, 4, and so on. Each is explained under the Action within 24 - 48 hrs column on page 3.
4) Proceed to the next ring if mould growth is apparent and more than 48 hours have elapsed since the water damage. Determine whether the contaminated area is less than 10 square feet (1 square metre) , between 10 and 100 square feet (1 and 3 square metres) , or greater than 100 square feet (3 square metres).
5) Proceed to the next ring and follow the clean-up method indicated for the size of the contaminated area. Methods are lettered A, B, C, and D. Each is explained under the Clean-up Methods column on page 3.
6) In the next ring, determine the level of personal protective equipment required. This is indicated by M, L, or F under the **PPE** column and explained in the PPE (Personal Protective Equipment) column on page 3.
7) Finally, in the outermost ring, determine whether containment is necessary and, if so, whether it must be L (limited) or F (full). These requirements are explained in the containment column on page 3.

Mould Remediation Process

Select a process based on the type of material and extent of contamination



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Based on information from: Mold Remediation in Schools and Commercial Buildings, United States Environmental Protection Agency, March 2001.

Mould Remediation

Process

Action within 24-48 hours

Actions are for damage caused by clean water. If is is known or suspected that the water is contaminated by sewage or chemical or biological pollutants, consult a professional. Do not use fans unless the water is clean and sanitary. If the mould has grown or materials have been wet for more than 48 hours, consult the chart.

1. Discard non-valuable items.
2. Photocopy valuable items, then discard.
3. Freeze (in frost-free freezer or meat locker) or freeze-dry.
4. Remove water with water-extraction vacuum.
5. Reduce humidity levels with dehumidifiers.
6. Accelerate drying process with fans and/or heaters.
   - Don't use heat to dry carpet.
   - Use caution applying heat to hardwood floors.
7. Discard and replace.
8. May be dried in place, if there is no swelling and the seams are intact. If not, then discard and replace.
9. Ventilate wall cavity.
10. For all treated or finished woods, porous (linoleum, ceramic tile, vinyl) and non-porous (metal, plastic) hard surfaces, vacuum or damp-wipe with water or water and mild detergent and allow to dry; scrub if necessary.
11. For porous flooring and carpets, make sure that subfloor is dry. If necessary clean and dry subfloor material according to chart.
12. Wet paneling should be pried away from walls for drying.

Clean-up Methods

Methods are for damage caused by clean water. If it is known or suspected that the water is contaminated by sewage or chemical or biological pollutants, consult a professional.

These are guidelines only. Other cleaning methods may be preferred by some professionals.

Consult Action within 24-48 hrs in the chart if materials have been wet for less than 48 hours and mould growth is not apparent.

If mould growth is not addressed promptly, some items may be damaged beyond repair. If necessary, consult a restoration specialist.

A. Wet-vacuum the material. In porous material, some mould spores/fragments will remain but will not grow if material is completely dried. Steam cleaning may be an alternative for carpets and some upholstered furniture.

B. Damp-wipe surfaces with water or with water and detergent solution (except wood - use wood floor cleaner); scrub as needed.

C. Use a high-efficiency particulate air (HEPA) vacuum once the material has been thoroughly dried. Dispose of HEPA-vacuum contents in well-sealed plastic bags.

D. Remove water-damaged materials and seal in plastic bags inside containment area, if there is one. Dispose of as normal waste. HEPA-vacuum area once it is dried.

Precautions

PPE (Personal Protective Equipment)

Use professional judgment to determine PPE for each situation, particularly as the size of the remediation site, and the potential for exposure and health effects, increase. Be prepared to raise PPE requirements if contamination is more extensive than expected.

M Minimum - Gloves, N-95 respirator, goggles/eye protection.

L Limited - Gloves, N-95 respirator or half-face respirator with HEPA filter, disposable overalls, goggles/eye protection.

F Full - Gloves, disposable full-body clothing, head gear, foot coverings, full-face respirator with HEPA filter.

Containment

Use professional judgment to determine containment for each situation, particularly as the size of the remediation site, and the potential for exposure and health effects, increase.

NR None Required

L Limited – From floor to ceiling, enclose affected area in polyethylene sheeting with slit entry and covering flap. Maintain area under negative pressure with HEPA-filtered fan. Block supply and return air vents in containment area.

F Full - Use two layers of fire-retardant polyethylene sheeting with one airlock chamber. Maintain area under negative pressure with HEPA-filtered fan exhausted outside of building. Block supply and return air vents in containment area.

Notes

a) Upholstery may be difficult to dry within 48 hours. For items with monetary or sentimental value, consult a restoration specialist.

b) Follow manufacturer's laundering instructions.

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With grateful acknowledgment:
Based on Mold Remediation in Schools and Commercial Buildings, published by the United States Environmental Protection Agency, March 2001.

5.3.7 Regular Mould Assessments

In addition to regular building inspections, mould assessments should be done periodically, for example on an annual basis. These assessments can be conducted by building personnel. However, as experience in mould assessments lend a great deal to the quality of an assessment, the services of an experienced professional may be needed. Areas of concern should be addressed immediately. When wet areas are found, the reason must be determined and control measures established. A re-inspection or follow-up schedule should be developed to ensure that areas of concern are dealt with and do not re-occur.

5.3.8 Abatement Plan

When water-damaged or mouldy materials are found, an abatement plan is needed to ensure that the materials are cleaned or removed as quickly as possible. The plan should include contacts for restoration and abatement contractors, as well as professional mould consultants. It should also outline the training requirements for individuals involved in the abatement process.

More details on mould abatement are discussed in Section 6.0, however in general:

- take appropriate steps to protect workers and occupants;
- control the moisture source and dry wet materials if possible;
- prevent transfer of contaminants to other areas;
- clean or remove damaged materials;
- determine whether the space has been successfully cleaned up; and
- return the space to use in a way to minimize the potential for future water release and mould growth.

5.3.9 Re-Assessment of the Management Plan

A re-assessment of the management plan should be completed annually and after a water intrusion event or mould abatement procedure. This is because:

- The responsibilities for different parts of the management plan may need to be reassigned.
- The mould/moisture hazard assessment may need re-evaluation.
- Changes to activities or materials used may be needed to reduce the potential for wetting events.
- Changes in housekeeping and maintenance activities may be needed.
- Materials less prone to moisture retention and mould growth may be evaluated for use during re-construction or renovation activities.

5.4 Communication

Communication is an important part of managing mould at the work site. It can prevent distrust among workers or tenants and keep them involved in the process. It is important that all parties know that their needs are being met and that their concerns are being taken seriously.

Facts should be distributed in a simple and accurate manner. Mould and related health effects should be discussed. The results of inspections, assessments and sampling should be made available to building occupants in a format that is understandable to everyone involved. The development and presentation of an action plan, including future updates, is useful in maintaining the flow of communication. This plan should be developed with everyone's input, including:

- building occupants;
- workplace health and safety officials;
- building managers and owners;
- employers; and
- health and safety committee representatives.

5.5 On-Going Monitoring and Controls

In some cases, abatement cannot be conducted immediately. This may be because the source of the water has not yet been controlled, the mould growth is in wall cavities, structural materials cannot be removed without the involvement of engineers or other specialists, or due to other restrictions such as contractor availability.

Mould growth in inaccessible areas may be a problem since spores and other mould fragments from the area may migrate through the building. In these cases, on-going air monitoring may be done to ensure that it is acceptable to use the work space.

If air monitoring shows that mould levels are increasing (compared to background levels), action may be needed to control mould exposure until abatement can be done. The actions taken will be determined by factors such as how much mould is present, the indoor air quality and the sensitivity of building occupants. Airborne mould levels may be controlled by:

- housekeeping measures, such as the use of high efficiency particulate air (HEPA)-filtered vacuums;
- increased ventilation to areas affected;
- improvement of the ventilation filtration systems (if possible);
- cleaning or scrubbing of air with HEPA-filtered air units, such as negative air units; and
- restricting access to areas of concern with barriers and signage.

5.5.1 HEPA Filters

HEPA filters are capable of capturing mould spores and mould fragments that would otherwise be recirculated in the air by conventional vacuum cleaners or standard HVAC systems. However, the benefits of HEPA filters are only realized when they are used and maintained properly. HEPA filters are designed to remove 99.97% of particles down to a 0.3 micron diameter (one third of one millionth of a meter). HEPA filters in non-industrial, commercially available vacuum cleaners and HVAC systems do not have the seals to ensure that the air is filtered properly and therefore are not effective.

HEPA filters should be factory tested using a challenge agent such as dioctyl phthalate (DOP). In addition to the factory testing, on-site testing should be done when the equipment is installed and when filters are changed. While there is no requirement for the tester to be certified, they still must be competent to do the testing.

The person performing the test should check and note the physical condition of the equipment, such as electrical connections, wheels, etc., at the time of the test. The equipment must be inspected for sources of leakage such as cracked frames, holes or damage. The filter must be properly installed and meet or exceed the air flow rating of the equipment in which it is installed.

HEPA Vacuum

HEPA Negative Air Unit

Equipment passing the challenge agent test should be labeled with the test date and the name of the tester. A log should be kept for each piece of equipment.

The test equipment should be maintained and factory calibrated at least annually. The person performing the testing should be trained to understand the test procedure and equipment being tested. For more detail please see Section 6.5.1 of this document.

Section Six: Mould Abatement Methods

The goal of abatement is to remove or clean contaminated materials to prevent mould and dust contaminated with mould from leaving a work area and entering an occupied or non-abatement area, while protecting the health of workers doing the abatement.

6.1 Abatement Plan

An abatement plan lays out what the objective is and how it is going to be achieved. You will have to consider whether mould contaminated materials should be cleaned or removed. The potential for future water intrusion and mould contamination should be a factor in determining which abatement activities to use.

An important factor is whether the contaminated materials are non-porous, semi-porous or porous. Non-porous materials such as metal, glass and hard plastics do not absorb and hold water. Mould contamination will be limited to the surface, so cleaning is a good option. Semi-porous materials such as wood, plaster and concrete can absorb and hold water. If mould growth is in the initial stages and has not penetrated the surface of the material, then cleaning may be possible. If water has been absorbed into the material and mould growth is extensive, then the materials may have to be removed. Porous materials such as drywall and insulation will absorb and hold water and the contamination will likely be throughout the material. These materials have to be removed as cleaning is ineffective.

Removal of water-damaged and mould-contaminated materials is usually more effective to prevent re-growth of mould. However, the hazard of inhalation of airborne mould and other health and safety issues during removal must be considered. Removal is a more costly solution; this cost must be weighed against the hazard of remediation activities.

The abatement plan should address four basic principles:

1. Protect workers
2. Isolate the work area
3. Minimize the disturbance and release of mould
4. Ensure proper decontamination and clean-up

Prior to commencing any abatement activities a well thought-out abatement plan must be developed. This plan will include the following:

- select a remediation manager and assign responsibilities where appropriate;
- a communication plan;
- determine the source of water or moisture and the steps required to control it;
- determine who will be involved in the abatement;
- a timeline for the completion of abatement activities;
- procedures to minimize mould disturbance and release;
- proper waste handling and disposal procedures;
- proper decontamination and clean-up procedures;
- a proper air sampling strategy, if appropriate; and
- a re-occupancy strategy.

A pre-abatement checklist is provided to assist in the abatement planning.

Pre-Abatement Checklist

This checklist should be completed prior to any remediation work.

Completed by: ____ Date: ________________

Location:____

____

	YES	NO	N/A
#1: Has a hazard assessment been completed for the work site? (if not, complete one before proceeding)			
#2: Have hazards identified in the hazard assessment been eliminated or controlled?			
#3: Has the level of hazard associated with the mould abatement been determined? (Low-Risk, Moderate-Risk and High-Risk)			
#4: Have roles and responsibilities for the site been established and assigned?			
#5: Has the cause of the moisture been identified and controlled? (No, then how may this impact the abatement and what additional controls are required?)			
#6: Have stakeholders been notified of the abatement process?			
#7: Have workers been appropriately trained?			
#8: Have workers been provided with the appropriate respiratory protection?			
#9: Have workers been fit tested?			
#10: Has HEPA-filtered equipment such as vacuums and negative air units been leak tested with a hot-challenge agent?			
#11: If moderate-risk or high-risk abatement is being conducted, is the containment under a differential negative pressure of 5 Pascals?			
#12: Have the appropriate arrangements been made for air sampling if required?			
#13: Are appropriate signs and barriers in place?			
#14: Have ventilation systems been deactivated and properly sealed?			
#15: Have tag-out and locked-out procedures been developed and implemented? (electical, mechanical and other energized equipment)			
#16: Is all electrical equipment in the work area plugged into a GFCI?			
#17: Have waste storage and disposal been arranged?			
#18: Have appropriate controls been implemented to protect the workers and the building occupants?			
#19: Has an emergency response plan been developed?			
#20: Are the minimum requirements of the Alberta Occupational Health and Safety Act, Regulation and Code being met?			

6.1.1 Wet Building Materials

Following an uncontrolled water release it takes about 48 hours from when the materials become wet before mould growth begins.

If wet building materials are discovered early enough, mould growth may not yet have occurred. Wet building materials can support mould growth and must be dealt with immediately. Water collection, dehumidifiers and fans can help in the drying process; but are most effective for accessible and non-porous materials. Inaccessible materials, such as those inside walls are difficult, if not impossible, to dry. Porous materials such as drywall are also hard to dry. Removal of wet drywall can also have the added benefits of:

- ability to access wall cavities to collect free standing water and conduct drying;
- ability to find out if mould is present on the wall cavity facing sides of the drywall; and
- increased confidence that the situation has been resolved and a mould problem does not exist.

If mould is not present, the drywall can be removed using general construction practices as required for the work area. For example, for removal of wet drywall on some work sites additional controls other than what would already be required for drywall work may not be needed. However, removal of wet drywall in a hospital may require controls to address dust control since the people who could potentially be exposed could be more sensitive.

6.1.2 Extending Abatement Surfaces Beyond the Perimeter of the Mould

In abatement, removal of the mould is the goal. Usually slightly more material than would be required simply by the location of the mould is removed. For example, with respect to drywall, this amounts to an additional 0.6 meters (2 linear feet) of drywall along the perimeter of the mould contaminated material that should be removed. The non-contaminated materials can be inspected to verify that mould contamination is not present on the wall-cavity facing side of the material.

6.2 Hazard Assessment

Before starting any abatement work, a hazard assessment must be done so that appropriate controls can be put in place to protect workers. For a more detailed discussion of potential health and safety hazards on abatement work sites and hazard assessment, refer to Section 7.0 of this document.

6.2.1 Hazard Level of the Abatement Project

Once the hazards identified in the general hazard assessment have been identified and controlled, a more detailed hazard assessment specific to the mould and it's abatement must be conducted.

To assess the level of hazard associated with the mould:

- determine the extent of the wet materials;
- determine the extent of the mould contamination;
- characterize the occupants to assess the potential health risk;
- address the protection of building occupants and general public;
- consider other hazards that may require increased or additional control measures;
- address the protection of the health and safety of workers; and
- consider the need for isolation of the work area.

6.2.1.1 Hazard Algorithm

There are three levels of mould abatement activities, low, moderate and high risk. These are based on the recommendations in the USEPA document Mould Remediation in Schools and Commercial Buildings. The differences in the abatement activity for each level depend on the total area of contamination and worker or other populations that may be exposed.

A hazard algorithm can be used as a simple tool to help select appropriate abatement activities.

Population Type	Risk Level by Affected Surface Area in Square Metres (4)		
	Low	Moderate	High
Healthy Work Force	Less than 1 (10 ft^2)	1 - 10 (10 - 100 ft^2)	Greater than 10 (1) (100 ft^2)
Sensitive Population (2)		1 - 10 10 – 100 ft^2	Greater than 10 (1) (100 ft^2)
Very Sensitive Population (3)			Any Amount (1)

Notes:
(1) Professional involvement and air clearance sampling required
(2) Sensitive Populations – populations could be sensitive for a variety of reasons such as age, health, politics, building history, location of mould (e.g. schools, day cares, senior facilities)
(3) Very Sensitive Populations – populations where the possibility of severe health effects exist because of other pre-existing health conditions such as in a hospital. (e.g. people with chronic inflammatory lung disease, asthma, hyper-sensitivity, pneumonia and severe allergies).
(4) The areas of mould-contaminated materials are based on the total affected surface area.

While this algorithm may be a useful tool, the selection of the level of abatement must also be guided by professional judgment.

6.3 Levels of Abatement Activity

Pre-job planning, personal protective equipment, work procedures, containment and decontamination procedures for low, moderate and high risk work are needed at a minimum. If there are other site variables or other hazards different or higher level controls may be needed.

6.3.1 Low Risk Activities

Low risk activities involve clean up of small mould contaminated areas of 1 m^2 (10 ft^2) or less in size, such as ceiling tiles or small areas on walls.

a) Pre-job Planning

- Establish the work procedures to be followed and assemble the equipment required to perform the job;
- Ensure workers are adequately trained in the work hazards and proper methods of working in mould-contaminated environments;
- Barriers and warning signs should be positioned in areas where access needs to be restricted until the work is completed; and
- Procedures to deal with emergencies such as fire or injury must be developed and in place prior to work starting.

b) Equipment

Required equipment includes:

- polyethylene drop sheets having a minimum 6-mil thickness (0.150 millimeter);
- 6-mil thick disposal bags;
- biocide or mild detergent solution mixed according to the manufacturer's recommendations for use;
- spray bottle or hand pump garden sprayer to wet surfaces;
- barriers and warning signs;
- mops, rags, brushes and clean water for clean-up;
- fire extinguisher; and
- an appropriate first aid kit.

c) Personal protective equipment

Workers performing the clean up or removal must be provided with at least the following: NIOSH approved respirator with N95 cartridge or a NIOSH approved disposable N95 respirator, disposable nitrile or rubber gloves and eye protection. More or a higher level of protective equipment may be needed depending the results of the hazard assessment.

d) Work procedures

Workers doing the mould abatement must receive training on proper clean-up methods, personal protective equipment and potential health hazards before the work begins.

The work area should be unoccupied. People from spaces beside the work area may not need to be moved unless they fall in the sensitive or very sensitive population category.

Place polyethylene sheeting on the ground under the contaminated material to be cleaned or removed. This polyethylene sheeting must be folded in on itself and disposed of with the contaminated debris.

Materials to be removed or cleaned must be misted (not soaked) with a suitable liquid (biocide, mild detergent or water) immediately before removal or cleaning to minimize the release of mould or spores.

The work area and areas used by workers to enter the area should be cleaned with a damp cloth and/or mop and a detergent solution.

e) Cleaning versus Removal

Cleaning of fixed building materials is recommended for non-porous materials because the mould can be effectively wiped or brushed off. Non-porous materials include glass, metal and plastics. Cleaning of semi-porous materials (such as wood and plaster) may be possible, but may not be as effective. Semi-porous materials should be removed and replaced if they cannot be effectively cleaned. Porous materials that are not fixed in place such as curtains and fabrics may be laundered; however depending on the extent of the mould this may have limited success.

If cleaning is done, the surfaces should first be wiped with a clean damp cloth (with biocide, mild detergent or water) so as to not spread the mould contamination. This involves making small wipes with progressive folds of the cloth so that a clean surface of the cloth is used for each new wipe. Once all the available clean surfaces on the cloth are used it should be discarded and a new clean cloth used. Once the majority of the mould contamination has been removed, a more thorough cleaning using a brush is done.

Following cleaning, the surfaces should be dried. Often the cleaning process has to be repeated several times with a drying period between each cleaning period. This is because when the mould is wet it is more difficult to see.

Removal is recommended for porous materials such drywall and ceiling tiles. Additionally, porous materials usually are damaged or fall apart during or after cleaning activities.

If removal is being conducted, cut the affected materials out with hand tools and place in a bag for disposal. Care should be taken to minimize disturbance of the mould.

f) Waste Handling

Contaminated debris, including polyethylene sheeting clothes and used protective equipment should be double-bagged in 6-mil polyethylene bags and immediately sealed tight by twisting the top of the bag and securing with duct tape or other suitably strong material. Waste may also be placed in drums, bins or other containers that are not easily damaged by the waste (e.g. sharp edges).

The waste material must be properly disposed of.

g) Decontamination Procedures

Washing facilities must be available to workers. Workers must remove and dispose of their used protective clothing and wash their hands and face before leaving the work area and before eating, drinking or smoking. Protective clothing should not be laundered at home.

h) Site Inspection

Once the work is done, the work area should be visually inspected to ensure that visible mould contaminated material has been properly cleaned up. The work area should be left dry and free of debris.

6.3.2 Moderate Risk Activities

Moderate risk activities involve clean up or removal of mould contaminated areas of 1 to 10 m^2 (10–100 ft^2) such as individual wallboard panels. Additional factors, such as the presence of a sensitive population in or near the abatement area may also dictate this level of abatement.

a) Pre-job Planning

- Establish the work procedures to be followed and assemble the equipment required to perform the job;
- Ensure workers are adequately trained in the work hazards and proper methods of working in mould-contaminated environments;
- Barriers and warning signs should be positioned in areas where access needs to be restricted until the work is completed;
- Procedures to deal with emergencies such as fire or injury must be developed and in place prior to work starting; and
- The services of an experienced health and safety professional and abatement contractor may be required.

b) Equipment

Required equipment includes:

- polyethylene drop sheets having a minimum 6-mil thickness;
- a polyethylene containment or enclosure may be needed;
- 6-mil thick disposal bags;
- duct tape or an alternative tape with similar or better adhesive qualities;
- biocide or mild detergent solution mixed according to the manufacturer's recommendations for use;
- spray bottle or hand pump garden sprayer to wet surfaces;
- barriers and warning signs;
- HEPA vacuum;
- ground fault circuit interrupter if a containment is used;
- mops, rags, brushes and clean water for clean-up;
- fire extinguisher; and
- an appropriate first aid kit.

c) Personal Protective Equipment

Protective clothing must be worn by workers who may be exposed to mould. This clothing should:

1. be made of a non-porous material such as Tyvek™;
2. cover the body and fit snugly at the neck, wrists, and ankles;
3. cover the head and feet (laceless steel-toed rubber boots are recommended); and
4. be immediately repaired or replaced if torn.

Only persons wearing appropriate protective clothing, including eye protection, disposable nitrile or rubber gloves, and at least a half-face, properly fitted NIOSH approved respirator (with P100 cartridges and appropriate protection for biocides) should be in the contaminated area.

Personal protective equipment such as hard hats or hearing protection may be needed for other hazards at the work site. If other airborne contaminants are also present, respiratory protective equipment appropriate to those hazards may be required.

d) Work Procedures

Where abatement is planned and the walls do not already enclose the contaminated area, a small negative pressure enclosure or containment should be built around the work area. The enclosure should be constructed of one layer of a minimum of 6-mil polyethylene, or other suitable material, with reinforced polyethylene on the floor. The enclosure should be kept at negative air pressure relative to the air pressure outside of the enclosure using a HEPA vacuum cleaner or similar ventilation unit. Refer to Section 6.4 for more details on the set up a containment.

Disable mechanical ventilation in the contaminated area, except that required to maintain the negative pressure in the containment.

Seal openings into or out of the contaminated area with at least one layer of 6-mil polyethylene.

The surfaces of the materials to be removed or cleaned must be misted (not soaked) with a suitable liquid (biocide, mild detergent, or water) immediately before the removal or cleaning to minimize the release of mould or spores.

Contaminated debris, polyethylene and used protective clothing must be cleaned-up during and immediately upon completion of the work.

Surfaces inside the enclosure must be either vacuumed with a HEPA vacuum or wet wiped with an appropriate biocide or a mild detergent solution prior to dismantling.

e) Cleaning versus Removal

Cleaning of fixed building materials is recommended for non-porous materials because the mould can be effectively wiped or brushed off. Non-porous materials include glass, metal and plastics. Cleaning of semi-porous materials (such as wood and plaster) may be possible, but may not be as effective. Semi-porous materials should be removed and replaced if they cannot be effectively cleaned. Porous materials that are not fixed in place such as curtains and fabrics may be laundered; however depending on the extent of the mould this may have limited success.

If cleaning is done, the surfaces should first be wiped with a clean damp cloth (with biocide, mild detergent or water) in a systematic manner as to not spread the mould contamination. This typically involves making small wipes with progressive folds of the cloth so that a clean surface of the cloth is used for each new wipe. Once all the available clean surfaces on the cloth are used, it should be discarded and a new clean cloth used. Once the majority of the mould contamination has been removed, a more thorough cleaning is done with a brush.

Following cleaning ,the surfaces should be dried. Often the cleaning process has to be repeated several times with a drying period between each cleaning period. This is because when the mould is wet it is more difficult to see.

Removal is recommended for porous materials such drywall and ceiling tiles. Additionally, porous materials are usually damaged or fall apart during or after cleaning activities.

If removal is being conducted, cut the affected materials out and place in a bag for disposal. Care should be taken to minimize disturbance of the mould.

f) Waste Handling

- Contaminated debris, polyethylene and used protective clothing should be double-bagged in 6-mil polyethylene bags;
- The outside surface of all polyethylene bags should be either vacuumed with a HEPA vacuum, or wet wiped with a biocide or mild detergent before being removed from the enclosure; and
- The sealed polyethylene bags containing contaminated material should be properly disposed of.

g) Decontamination Procedures

- Protective clothing, must be vacuumed with a HEPA vacuum cleaner or cleaned by wet wiping with a biocide or mild detergent after completing the work and before leaving the contaminated area;
- Contaminated protective clothing and equipment that will not be re-used must be disposed of as contaminated waste; and

- Washing facilities for hand and face must be made available to workers and be located immediately adjacent to the work. This way, workers will not have to walk through clean areas to access the washing facilities. Workers must remove and dispose of their used protective clothing and wash their hands and face before leaving the work area and before eating, drinking or smoking. Protective clothing should not be laundered/cleaned at home.

h) Site Inspection

Once the work is done, the work area must be visually inspected to ensure that visible mould contaminated material has been properly cleaned up. The area should be left dry and free of debris.

i) Air Sampling

Air sampling is not required, but may be useful in some cases. If a containment is used, sampling outside the containment or enclosure during the abatement may be useful to document that the concentrations are similar to outside air or a background sample obtained from an uncontaminated area of the building. This will help evaluate whether controls are effective. Similarly, clearance sampling inside the containment or enclosure once the mould contamination is removed or cleaned can be useful. The concentration of mould inside the enclosure should be similar to that of outside air or a background sample obtained from an uncontaminated area of the building before the enclosure is removed. The selection of a background area can be difficult because it assumes that there is no mould contamination present and this may not be the case. Sampling and the selection and use of background samples for comparison purposes requires the assistance of an experienced professional.

6.3.3 High Risk Abatement Activities

High risk mould abatement activities involve contaminated areas of greater than 10 m^2 (100 ft^2) in size, such as several wallboard panels. Other factors such as the presence of a sensitive population in or near the abatement area, may also dictate this level of abatement.

a) Pre-job Planning

- Obtain building permit(s), if necessary, from the municipality or accredited agency that issues building permits in your area;
- Ensure workers are adequately trained in the work hazards and proper methods of working in mould-contaminated environments;
- Services of an experienced abatement contractor are recommended;
- Services of an experienced health and safety professional are required;
- Ensure that HEPA filtered equipment has been tested before the job starts;
- Ensure that building occupants, trade people, other workers are notified, in advance, of the location, duration and type of work to be done;
- Entry points to the work site must carry prominently displayed warning notices that identify a remediation activity and forbid entry to anyone not wearing appropriate personal protective equipment; and
- Procedures to deal with emergencies, such as a fire or injury, must be developed and in place before work starts. At least one worker, who is appropriately trained, should be stationed outside the containment to respond to emergencies and contact rescue personnel if required.

Have the following documentation available at the work site:

- required permits;
- hazard assessment;
- written lock-out procedures;
- proof of worker training;
- names of supervisory personnel;
- shop drawings of work area layout/decontamination facility;
- construction schedule;
- certification of HEPA filtered equipment; and
- respiratory code of practice.

b) Equipment

The following equipment should be available:

- portable HEPA-filtered exhaust units with extra fuses;
- flexible or rigid ducting;
- HEPA vacuum;
- electrical extension cords;
- portable ground fault circuit interrupter (GFCI);
- biocide or mild detergent solution mixed according to the manufacturer's recommendations for use;
- hand pump garden sprayer to wet surfaces;
- scrapers, nylon brushes, dust pans, shovels, etc.;
- scaffolds with railings as required;
- duct tape or an alternative tape with similar or better adhesive qualities;
- polyethylene sheeting having a minimum 6-mil thickness;
- 6-mil thick disposal bags;
- barriers and warning signs;
- mops and/or rags, clean water and other supplies for clean-up;
- fire extinguisher; and
- appropriate first aid kit.

c) Personal Protective Equipment

Protective clothing must be worn by workers who may be exposed to mould. This clothing should:

1. be made of an impermeable material such as Tyvek™;
2. cover the body and fit snugly at the neck, wrists, and ankles;
3. cover the head and feet (laceless steel-toed rubber boots are recommended); and
4. be immediately repaired or replaced if torn.

Only workers with appropriate protective clothing, eye protection, disposable nitrile or rubber gloves and at least a half-face, properly fitted, NIOSH approved respirator (with P100 cartridges and appropriate protection for biocides) can be inside the contaminated area. Disposable respirators should not be used.

Personal protective equipment such as hard hats or hearing protection, appropriate to other hazards at the work site must be used. If other airborne contaminants are also present, respiratory protective equipment appropriate to those hazards may be required.

d) Work Procedures

- Compressed air must not be used to clean up or remove debris from contaminated surfaces;
- Before enclosure setup, movable, non-porous equipment inside the work area should be cleaned either with a HEPA vacuum or an appropriate biocide or mild detergent and then removed from the work area;
- Fixed non-porous equipment within the work area should be cleaned with a HEPA vacuum or an appropriate biocide or mild detergent and protected from contamination with 6-mil polyethylene during the remediation;
- Porous equipment within the work area must be laundered, steam cleaned or disposed of. If it is cleaned it must be either removed from the work area or protected from contamination during the remediation;
- Electrical circuits inside the contaminated area must be deactivated unless equipped with ground-fault circuit interrupters;
- Ventilation equipment inside the work area or running through the work area must be deactivated and sealed with polyethylene. Simply sealing off air diffuser grills is not enough. The ventilation systems must be deactivated. The deactivation of ventilation systems near the work area may also be needed as a precautionary measure based on the site conditions. It may also be necessary to seal duct openings with plywood or sheet metal, depending on the effectiveness of the HVAC disabling;
- The surfaces of materials to be removed or cleaned must be misted (not soaked) with a biocide or mild detergent to minimize the spread of mould or spores during abatement;
- Contaminated material must be cleaned up frequently and bagged in 6-mil polyethylene bags;
- Workers inside the containment should have some form of communication with the worker outside the containment; and
- Emergency exits should be clearly marked, both inside and outside of the containment.

e) Cleaning vs. Removal

Cleaning of fixed building materials is recommended for non-porous materials because the mould can be effectively wiped or brushed off. Non-porous materials include glass, metal and plastics. Cleaning of semi-porous materials (such as wood and plaster) may be possible, but may not be as effective. Semi-porous materials should be removed and replaced if they cannot be effectively cleaned. Porous materials that are not fixed in place such as curtains and fabrics may be laundered; however depending on the extent of the mould this may have limited success.

If cleaning is done, the surfaces should first be wiped with a clean damp cloth (use biocide, mild detergent or water) so as to not spread the mould contamination. This usually involves making small wipes with progressive folds of the cloth so that a clean surface of the cloth is used for each new wipe. Once all the available clean surfaces on the cloth are used, it should be discarded and a new clean cloth used. Once the majority of the mould contamination has been removed, a more thorough cleaning is done using a brush.

Following cleaning the surfaces should be dried. Often the cleaning process has to be repeated several times with a drying period separating each cleaning period. This is because when the mould is wet, it is more difficult to see.

Removal is recommended for porous materials such drywall and ceiling tiles. Additionally, porous materials are usually damaged or fall apart during cleaning activities.

If removal is being conducted, cut the affected materials out and place in a bag for disposal. Care should be taken to minimize disturbance of the mould.

f) Containment Construction

- Where walls do not already enclose the abatement area or walls cannot be properly cleaned without causing staining or damage, a negative pressure enclosure should be constructed;
- The enclosure should be constructed of one layer of a minimum of 6-mil polyethylene or other suitable material, with reinforced polyethylene sheeting on the floors;
- There must be at least four air changes per hour within the enclosure and it must be kept at negative pressure (at least -5 Pa or -0.02 inches of water gauge) relative to the air pressure outside of the enclosure;
- The enclosure must be kept under negative pressure for the duration of the abatement;
- Air exhausted from the enclosure should pass through a HEPA filter before being vented outside the building. It is preferable not to vent the air back inside the building;
- Openings in the contaminated area, including windows and doors, must be adequately sealed with adhesive tape or with a layer of 6-mil polyethylene sheeting. Additional materials such as multiple layers of polyethylene, reinforced polyethylene, non-clear or opaque polyethylene and plywood may be required; and
- A walk-through decontamination unit should be attached to the entrance of the containment. It should consist of two small rooms separated from the work area and each other by overlapping flaps of polyethylene. The outer most room is referred to as the clean room. The innermost room is referred to as the equipment room. Refer to Section 6.4 for more details on the construction of containments.

g) Waste Handling

- Bags of waste should be removed from the work area through the decontamination unit using the following procedure;
  - remove visible contamination from the bags in the work area by damp wiping or HEPA vacuuming;
  - transfer the sealed bags to the equipment room of the decontamination unit and clean the bags with an appropriate biocide or mild detergent. Place the sealed bag into a second 6-mil polyethylene bag and seal by twisting the bag and securing it with duct tape or other suitable strong material; and
  - transfer the double-bagged waste to the clean room and then out of the decontamination unit.
- Contaminated equipment, tools, and other items used in the work area must be disposed of or cleaned with an appropriate biocide or mild detergent prior to removal from the negative pressure enclosure;
- Used protective clothing and equipment must be cleaned or disposed of as contaminated waste. Used protective clothing must not be taken home for cleaning;
- Surfaces inside the enclosure must be vacuumed with a HEPA vacuum, and or wet wiped with an appropriate biocide or mild detergent;
- Polyethylene sheets used to form the enclosure, the worker decontamination unit and cover openings inside the contaminated area must be removed and double-bagged in 6-mil polyethylene bags, securely tied and disposed of as contaminated waste after the abatement is complete; and
- The sealed polyethylene bags containing contaminated material must be properly disposed of.

h) Decontamination Procedures

- Washing facilities for hand and face must be available to workers. Workers must remove their protective clothing and wash before eating, drinking or smoking and leaving the work area;
- A worker decontamination unit must be connected to the decontamination enclosure;
- The worker decontamination unit must be arranged so that each worker entering or leaving the enclosure must pass through the decontamination unit;
- A decontamination shower, similar to what is used for other hazardous materials such as asbestos is not required because mould spores and fragments are present naturally in our environment. However, the use of a shower may be needed due to other hazards at the work site;
- At the end of work, workers must:
  - remove visible contamination from their protective clothing and respiratory protection in the enclosure by HEPA vacuuming or wet wiping;
  - enter the equipment room of the worker decontamination unit and remove debris from their respiratory protection equipment with HEPA vacuuming or wet wiping;
  - remove boots and other equipment and wet wipe clean;
  - remove disposable clothing and dispose of in waste bags;
  - wash hands, face and respirator with warm water while respirator is being worn; and
  - proceed into clean room, remove respirator, clean and store respirator, dress and leave the decontamination unit.

i) Air Monitoring

Sampling outside the containment or enclosure during the abatement may be useful to document that mould levels in the air are similar to outside air or a background sample from an uncontaminated area of the building. This will help ensure that the controls are effective. Air clearance sampling inside the containment or enclosure, once the mould contamination is removed, and before the enclosure is dismantled is required. The concentration of mould inside the enclosure should be similar to that of outside air or a background sample from an uncontaminated area of the building.

j) Site Inspection

A competent person must inspect the work area for defects in the enclosure, barriers, and worker decontamination unit on a regular basis during the abatement.

- before work begins;
- at the beginning of each shift;
- at the end of each shift; and
- at least once per day.

Defects found must be repaired immediately. No work, other than necessary repair work, should be done in the containment until the repair work is completed.

6.4 Construction of Containments or Enclosures

A containment or enclosure is used to provide a physical barrier around the abatement area to help control air quality within and outside the abatement area. Containment is more effective when the inside of the enclosure is kept at a negative pressure relative to the air outside. This ensures that contaminants will tend to stay inside as air will naturally flow from outside to inside.

Worker Constructing Polyethylene Containment

View of Polyethylene Containment using Orange Re-enforced Polyethylene

Several factors will determine whether containment is required. These factors include the extent of the mould, the type of occupants and the feasibility of conducting the abatement. The decision should be based on an understanding of the full scope of mould contamination, including visible and hidden mould sources.

The first step in building an enclosure is planning. You have to determine what is to be removed and how you will remove it. Then you can decide what to enclose.

Ensure that enclosing wet materials will not increase mould growth. Also, the contaminated materials in the enclosure must be safely accessible for removal or cleaning.

Some practical issues must also be considered, such as:

- Where are the entrance and exit from the containment going to be located?
- How long will the containment be in use?
- What surfaces may have to be protected from damage?
- How is the waste going to be removed from the containment and building?
- How is the waste going to be stored?
- Where is the waste going to be disposed of?
- How will workers decontaminate themselves and their equipment when leaving the enclosure?

The materials required to build an enclosure include:

- timber framing;
- polyethylene sheeting;
- painter's tape and duct tape;

- spray glue; and
- staples.

Polyethylene sheeting comes in different thicknesses and with or without re-enforcement. This affects durability. A minimum of 6-mil thick polyethylene sheeting should be used for containment construction.

There are different grades of duct tape available that have different thicknesses, re-enforcement and adhesive. Industrial grade tape should be used for containment construction.

Joints in the polyethylene should be overlapped a minimum of 15 centimeters (6 inches) and sealed with spray glue and duct tape.

The containment should be constructed to minimize the number of polyethylene joints and be as reasonably free of folds or other obstructions that will restrict cleaning during the abatement.

At entrance and exit locations to the containment, overlapping polyethylene flaps are constructed. These flaps consist of two full length sections of polyethylene that fill the opening at each air lock. One flap is affixed to the top of the doorway and the left side while the other flap is affixed to the top of the door way and the right side. The doorway and polyethylene flaps are not sealed closed, but are free to move, allowing outside air to flow into the containment.

Regular housekeeping must be done in the containment during abatement activities. This should include:

- remove properly bagged waste at the end of each shift;
- keep hand tools and cords neat and stored properly;
- keep exits clear of debris; and
- keep floors as dry as possible, as polyethylene is very slippery when wet.

Proper housekeeping is important to prevent damage to the containment and minimize hazards to workers such as slips, trips and falls.

6.4.1 Inspection and Testing of Containments or Enclosures

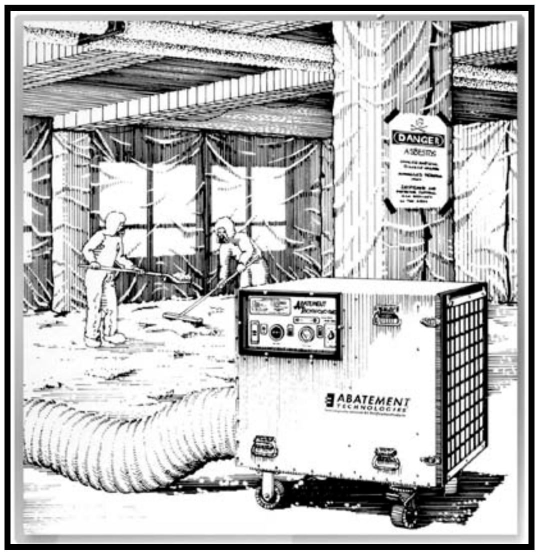
Inspection of the containment is critical in maintaining the protection that containment provides. As time passes, the seals can weaken and give way, resulting in openings in the containment. The polyethylene may also become damaged during abatement activities. To prevent this from occurring, the containment must be regularly inspected. The goal of these inspections is to recognize and correct deficiencies before they compromise the integrity of the containment.

Testing of containments or enclosures usually involves the use of smoke pencils or smoke generators. Testing is done before the removal or cleaning of mould begins. Smoke is introduced into the containment and the perimeter of the containment is checked for the presence of smoke. As leaks are identified, corrections are made to the containment. The use of smoke testing brings with it potential indoor air quality concerns in adjacent areas if and when leaks are encountered and the possibility of setting off fire alarms. For these reasons, the use of smoke testing requires careful planning and may not be suitable for all sites.

6.5 Negative Air Units

Negative air units are used to maintain negative pressure in the containment and filter the air that is exhausted from the containment. A negative air unit is used to create negative pressure inside the containment relative to the air outside. To do this, air is sucked from the containment and exhausted outside by the negative air unit. Clean air will tend to flow from the outside to the inside, rather than air escaping. This helps contain the airborne mould during mould abatement. Clean air flows into the containment through the decontamination unit. Negative air units only create negative pressure inside the containment if exhausted outside the containment. Negative air units should be exhausted outside of the building. Care should be taken to determine the exhaust location to avoid odour and other complaints. It may be useful to conduct confirmatory air sampling at the exhaust outlets to verify the effectiveness of the negative air unit filtration, particularly if the units are not vented outside.

Negative air units also serve to filter the air due to the HEPA filters and seals in them. This continuous filtration helps keep the concentration of airborne mould spores and fragments lower.



View of HEPA Negative Air Unit Inside a Containment

Negative air units should be positioned to achieve good air flow throughout the majority of the containment. Often this involves placing the negative air units at the opposite end of the containment to where the decontamination facility or make-up air location is located.

The negative air units in use must be able to achieve a differential negative pressure of 5 Pascals (gauge) within the containment relative to the surrounding area. At least four complete air changes per hour should be provided

6.5.1 Testing HEPA Filters

HEPA filters must be factory tested using a “hot” challenge agent. In addition to the factory testing, on-site testing should be done. While there is no requirement for the tester to be certified, they still must be competent to do the testing.

The person performing the test should check and note the physical condition of the equipment such as electrical connections, wheels, etc., at the time of the test. The equipment is inspected for potential sources of leakage such as cracked frames, holes or damage. The filter must be properly installed and meet or exceed the air flow rating of the equipment in which it is installed.

When field testing HEPA filters:

(a) filters must be tested at their rated air flow for proper results;
(b) filters should not be used that exceed the labeled air flow rate of the equipment; and
(c) testing is designed to detect leaks in filters, gaskets or related equipment. It will not be as accurate as factory testing since air flow and temperature cannot be controlled as accurately.

Equipment used to test HEPA filters consists of a hot smoke generator capable of generating particles down to 0.3 microns in diameter. A photometer is used on the downstream side of the filter to detect leaking particles. The photometer must be able to detect particles down to 0.3 microns in diameter. In the past, an aerosol of dioctylphthalate (DOP) was used to generate smoke, however, due to the health effects of DOP, other agents may be used if they can produce equivalent results. Poly-alpha olefin type material, approved as a substitute for DOP, is an example of one such agent. The smoke generator must reach the proper temperature to ensure that small range particles are generated.

For draw-through style negative air units (air is drawn through the filter and then blower):

(a) place the photometer probe in the duct, directly in the exhaust of the blower;
(b) control the smoke generated with a hose; and
(c) pass the smoke slowly over the entire filter and gaskets. While doing so, watch the photometer for signs of leakage over 0.03 %.

If a leak is detected, repairs can be made or the filter changed and the equipment retested. No more than 2% of the filter and gasket surface should be affected by the repair.

For blow-through negative air units (air is passed through the blower and then through the filter):

(a) smoke is generated at the air intake where it is misted into the blower unit and dispersed over the filters; and
(b) the photometer probe is passed over the entire area of the gasket and back and forth over the filter.

If leaks in excess of 0.03% are detected, the filter must be repaired or replaced and then re‐tested.

For vacuum cleaners fitted with a HEPA filter, introduce the smoke at the vacuum cleaner’s suction inlet and monitor the exhaust with the photometer probe to detect leaks in excess of 0.03%. If the unit fails, it may be repaired, but no direct repairs to the filter should be done. A new filter should be installed. If exhaust air is used to cool the motor fan, some particulate may be produced from the carbon brushes of the motor and affect the test. Test the vacuum exhaust, not the fan cooling exhaust. (Vacuum cleaners fitted with HEPA filters should be tested each time the filter is replaced and at least once per year if they are only used occasionally.)

Equipment that has passed testing should be labeled with the test date and the name of the tester. A log should be kept for each piece of equipment.

Filter test equipment should be maintained and factory calibrated at least annually. The person performing the testing should be trained to understand the test procedure and equipment being tested.

6.6 Air Sampling

Whether or not air sampling is conducted during or along with abatement activities, an appropriate sampling strategy must be developed.

Air sampling may be required for moderate risk abatement. It is required for high risk abatement. Air sampling should consist of sampling during abatement to ensure that controls are working properly and air clearance testing inside the containment before it is dismantled. Spore-trap sampling should be done. Viable air sampling methods may also be used in addition to spore-trap sampling, if desired.

Air sampling can assist in answering other questions, such as whether the mould was abated. If mould still is present behind walls or otherwise concealed, this mould may cause different results compared to control samples. However, air sampling should not be conducted only for this reason, as a proper assessment should delineate the locations of the mould. Also the air sampling results may not be representative of the conditions ie; a test positive for mould does not mean that there is a problem and a negative test does not necessarily mean that there is no problem. Air sampling results can be used to help assess whether abatement was successful.

The conditions at the time of air sampling will affect the results. Some examples include the presence of mould in other areas of the building that have not yet been abated and the presence of construction and other dust generating activities. Mould present in other areas of the building may affect the air clearance sample results since buildings and walls are not 100% air tight. If this is the case, special considerations are required to prevent this adjacent mould from impacting the air clearance sample results such as sealing the containment and disabling negative air units.

6.7 Surface Sampling

Using surface sampling to confirm the complete abatement of the mould is generally of limited value. It can be useful in a few circumstances, such as when there is a need to determine if remaining materials are mould. Using surface sampling to validate the success of the abatement is of less value because mould spores exist everywhere. Surface sampling also does not replace the need for a good thorough visual inspection following the abatement. If surface sampling is used, it must be part of the abatement plan and sampling strategy. This means that the abatement has been conducted to achieve acceptable surface sample results. What is acceptable? This has to be determined beforehand as well as how many samples are going to be collected, is random sampling or systematic sampling going to be conducted and the type of sampling that is going to be done.

The New York City Department of Health and Mental Hygiene produced a well-recognized document on the abatement of mould-contaminated materials, Guidelines on Assessment and Remediation of Fungi in Indoor Environments. In the document, it recommends that the presence of few or trace amounts of fungal spores should be considered background levels on surface samples. Amounts greater than this or the presence of fungal fragments may be an indication that additional cleaning is required.

6.8 Other Considerations

6.8.1 Moisture Measurements

Moisture measurements should be done on cleaned and remaining materials to ensure that they are dry. Water, detergent and other biocides are used during abatement. Since this can wet building materials, it is important to ensure that the materials are dry once abatement is complete or mould growth will re-occur.

6.8.2 Damp Wiping verses HEPA Vacuuming

In some cases, using a HEPA vacuum to clean dust and/or potential mould spores off non-porous surfaces is more effective then damp wiping. Some spores are hydrophobic (they repel water). For this reason, the use of both damp wiping using water containing surfactants such as mild detergents and HEPA vacuuming is recommended.

6.8.3 Biocides

Biocides are disinfectant chemicals used to kill bacteria, organisms such as viruses and mould. Biocides do not replace thorough cleaning, so have limitations in their use in mould abatement:

- Biocides can kill living cells and viable spores but do not remove allergens or other metabolites that can cause adverse reactions in some people. These substances must be physically removed by either abrasive cleaning such as scrubbing or the complete removal of the affected surface.
- Commonly used biocides are not effective in killing moulds. Spores are very hardy and only a few are needed to cause significant mould growth under the right conditions.
- Biocides may also be harmful or toxic to humans, pets and other animals.

Biocides are useful when used with thorough abrasive cleaning. Many biocides are designed to leave a residue on the surface to help prevent subsequent mould growth if there is a later wetting event.

A mild detergent mixed with water is enough in most cases. It is readily available, of low cost and does not add significant chemical hazards to the work site. Chlorine bleach-water solutions are often also used. However, there are hazards associated with the use of this chemical and it can generate a persistent bleach odour that can be offensive to building occupants long after the abatement is complete.

There has been discussion recently about the use of ultraviolet germicidal light, excessive heat and ozone to kill or inactivate mould. On their own, these methods are not enough, as they do not address the health risks such as allergy and irritation and introduce other hazards into the work environment. However the use of ultraviolet germicidal light with HEPA filtration could be helpful in some cases such as mould abatement near very sensitive population types or abatement where other contaminants such as bacteria from a sewer back-up are present.

Ultraviolet Module for HEPA-Filtered Negative Air Unit

6.8.4 Glue-Fogging Encapsulants

Glue-fogging can assist in achieving acceptable air clearance results inside containment. The glue, a slow drying sealer, is sprayed into the air and onto the surfaces with an airless sprayer. An airless sprayer produces a fine mist of glue that sticks to airborne mould spores and fragments. The mould spores and fragments are deposited onto to horizontal surfaces that are covered in polyethylene sheeting.

Caution is advised with the use of glue-fogging encapsulants as they add some moisture into exposed building materials and the air. Additionally if surfaces are not covered with polyethylene sheeting, the glue can stain building finishes.

The use of glue introduces other potential hazards into the work area and therefore the workers spraying the glue must be properly protected.

6.8.5 Abrasive Blasting

Abrasive blasting is sometimes used to remove embedded mould and staining in semi-porous materials such as wood. Abrasive blasting usually involves the use of dry ice (solid carbon dioxide). Dry ice is used because it can be blown at surfaces and removes a small layer of the affected surface. The dry ice disappears into carbon dioxide gas and therefore the use of dry ice does not create a residue other than the removed layer of the affected material.

The use of dry ice blasting has to be conducted with caution as workers can be exposed to elevated levels of carbon dioxide. Carbon dioxide also displaces oxygen and can create an oxygen deficiency hazard. The dust from the removed affected material such as wood, can also create health and safety hazards.

6.8.6 Post-Cleaning Encapsulants

Encapsulants can be used on building materials that have been thoroughly cleaned but will not be removed. They are coatings that contain antimicrobial agents. They are applied to a surface in a manner similar to paint. Encapsulants can be clear, coloured or tinted.

The use of encapsulants is not a replacement for proper cleaning and/or removal. If the focus of remediation is simply killing the mould, the predominant health risks such as allergy and irritation may not be addressed. Mould can grow on encapsulated surfaces that have not been cleaned, particularly if there is still a water source present. If the surface is clean, however, the antimicrobial agents could inhibit mould re-growth.

6.8.7 Vapour Barriers

Vapour barrier systems will have to be restored after the removal of water damaged or fungal contaminated drywall during abatement. At least 15 mm of the existing vapour barrier should be left intact so the new vapour barrier can be sealed and taped once abatement is completed. Power tools and saws can be used for bulk removal, then scoring and breaking the drywall at the desired dimension should be done by hand to minimize damage to the underlying vapour barrier.

6.8.8 Learn from the Experience

The knowledge gained from every water intrusion and mould abatement event should be used in the development and revision of the mould management plan. This should help prevent future water intrusion. But if it does occur, it can be used to manage mould more effectively.

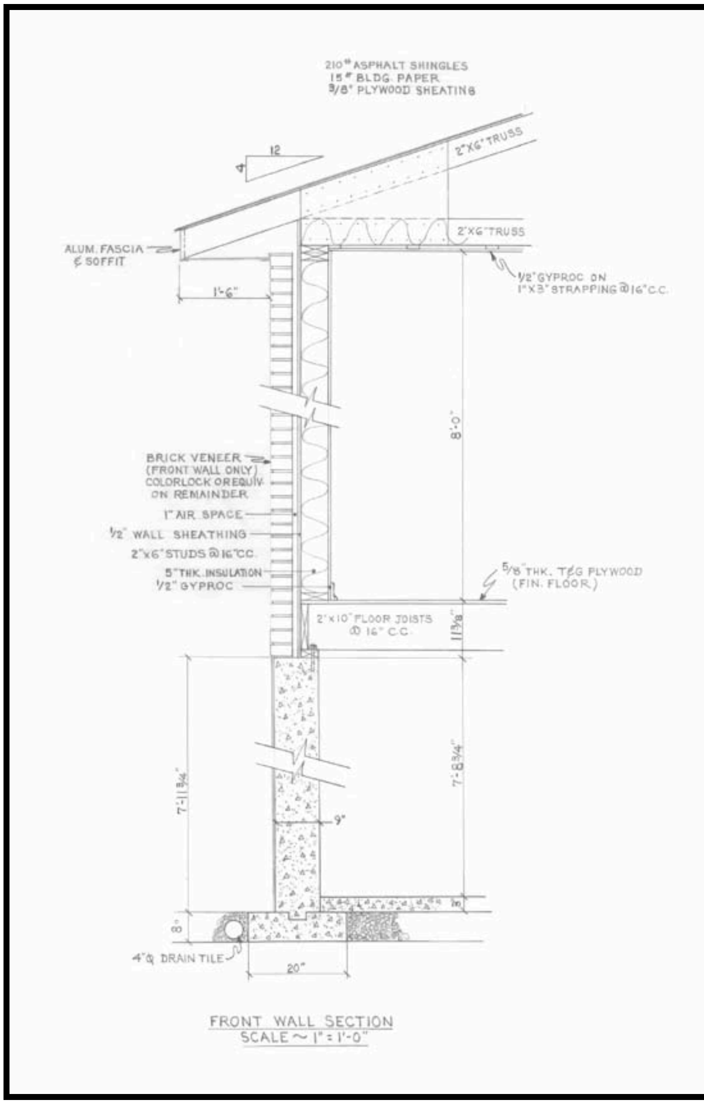
6.9 Special Circumstances

6.9.1 Inaccessible Mould

Gypsum board (drywall) is often used as a component of the exterior wall of buildings. On the exterior-facing side of this board, there may be a water-proof membrane that is next to a brick or other exterior building material.

This type of construction can be an issue because:

- to do an assessment, the removal of the brick or other permanent wall system is necessary;
- exterior-facing side of the gypsum board cannot be accessed without removal of the exterior material; and
- removal of the exterior board from the inside of the building is difficult due to the membrane.



View of Exterior Wall Construction Detail

Because of the difficulties and expense in removing this material, it is sometimes surface cleaned. This is not recommended because:

- you cannot clean behind the wall studs, the top and bottom plates and other inaccessible areas;
- cleaning of porous materials is difficult, less effective and usually damages the material;
- the drywall may deteriorate and need to be replaced; and
- mould and mould fragments may still remain and cause potential health effects for building occupants.

Other examples of inaccessible areas include behind furnaces and between party walls that are in place in townhouses, duplexes and condominium units for fire rating reasons.

Section Seven: Other Health and Safety Considerations

7.1 Introduction

Mould abatement work is potentially hazardous. In addition to mould exposure, potential hazards can include falls, cuts and bruises, electrocution, exposure to chemicals and heat stress. It is important to identify the potential hazards at a work site before work begins. This way, the controls needed to address the hazards can be put in place.

7.2 Hazard Assessment

During the pre-job inspection, work site preparation, containment construction, and removal activities, many potential hazards can be identified and eliminated. Hazards can be physical, chemical or biological in nature. Table 7.1.1 lists some of the common hazards that may be found on a mould-abatement work site in addition to the mould itself.

Table 7.1.1: Potential Work Site Hazards

Potential Physical Hazards	Potential Chemical Hazards	Potential Biological Hazards
•slips, trips and falls •electrical hazards •confined spaces •ladders and scaffolds •heat-related disorders •noise exposure •limb and body injuries •cuts	•asbestos-containing materials •fibreglass and refractory ceramic fibre •carbon monoxide •lead paint •mercury from gauges and switches •PCBs from light ballasts •process chemicals •glues and solvents	•bird droppings (histoplasmosis) •rodent droppings (hantavirus) •sewage •medical wastes

A hazard assessment must be done to determine which hazards are present. This is required by the Alberta OHS legislation. Once the hazards have been identified, control measures must be put in place to protect workers.

Simple tools, such as checklists, can be used in order to help identify hazards at the work site.

7.1.1 Checklists to Identify Hazards

Identifying hazards at a work site can be as simple as filling in a checklist, provided that the checklist asks the right questions. For each hazard, at least one control should be identified. There are many types of hazard assessment checklists, but the best kind is one that has been developed specifically for your workplace. An example checklist has been provided.

Hazard Priority (Status)		**#1 Imminent Danger**	**#2 Serious**	**#3 Minor**	**#4 Negligible**	**#5 Not Applicable (N/A)**
Identification				**Controls** (Engineering, Administrative or PPE Controls)		
Item	Hazard Priority	Hazardous Item	Description	Recommended Control(s)	Action Taken (Date)	By Whom
1		Biological/Chemical Exposure				
2		Cables/Ropes/Chains/Slings				
3		Cold/Heat Exposure				
4		Confined Space				
5		Electrical				
6		Gas (Toxic or Non-Life Supporting)				
7		Flammables (Fire/Explosion)				
8		WHMIS				
9		Ladders/Scaffolding				
10		Machinery and Equipment				
11		Lifting				
12		Noise				
13		Overhead Hazards				
14		Slippery or Unstable Surfaces				
15		Underground Hazards				
16		Working Alone				
17		Working at Heights				
18		Other -				
19		Other -				
20		Other -				

PRECAUTIONS REQUIRED
Personal Protective Equipment
Safe Work Procedures, Job Hazard Analysis Forms or Training

ADDITIONAL INFORMATION and/or CHANGES TO WORK		
TRAINING REQUIREMENTS (please circle relevant items)		
	Training	
• Mould Abatement Training • Asbestos Worker Training • H2S Alive Training	• WHMIS Training • Confined Space Training (8-hour) • CSTS Training	• First Aid Training • Fall Arrest Training • Other (specify)

COMPLETED BY:	Print Name	Date
APPROVED BY:	Print Name	Date
PERSONNEL INVOLVED:	Sign Name	Date
	Sign Name	Date
	Sign Name	Date

Section Eight: Personal Protective Equipment (PPE)

8.1 Introduction to PPE

Personal protective equipment is **not** the first line of defense when minimizing exposure to mould or other harmful substances. Engineering and administrative controls must be used when it is reasonable to do so. Engineering controls can consist of isolating the hazard such as the use of barriers (polyethylene sheeting) or the use of ventilation (HEPA negative air units). Administrative controls can consist of training, limiting exposure time and work procedures (misting of mould containment surfaces prior to removal). When these controls are not practical, or do not protect workers enough, then PPE should be considered.

Engineering controls are often not practical for mould abatement sites. The work sites are usually temporary, may be in remote, awkward, or inaccessible locations, may be in confined spaces, may be in structures occupied by sensitive individuals (such as hospitals and schools) or may be in locations where additional airborne hazards are present (such as asbestos and hazardous chemicals). Therefore, workers at a mould abatement project will need to wear PPE.

If other hazardous materials or chemicals are also present at the work site, and the protective measures for handling these materials are greater than that required for the mould present, the more protective measures must be used.

8.2 Respiratory Protective Equipment

Mould, other hazardous materials and chemicals can become airborne and cause illness and disease if they are inhaled. In these cases respiratory protective equipment (RPE) may be required. Part 18 of the Alberta OHS Code has requirements that apply to the use of RPE at worksites. For more information, refer to the Workplace Health and Safety's bulletin Respiratory Protective Equipment: An Employer's Guide.

8.2.1 RPE Assessment

It is important to select to correct RPE for the work site hazard. To determine whether RPE is required, you must consider:

a) the nature of any contaminants (e.g. type, physical state, how workers will be exposed);
b) the concentration or likely concentration of airborne contaminants;
c) the duration or likely duration of the worker's exposure;
d) the toxicity of the contaminants;
e) the potential for skin or eye absorption and irritation;
f) occupational exposure limit(s), if any;
g) the concentration of oxygen;
h) the potential for oil to be present;
i) warning properties of the contaminants;
j) if conditions are immediately dangerous to life or health (IDLH); and
k) the need for emergency escape.

8.2.2 Code of Practice for RPE

When RPE is used at the worksite, a code of practice describing the selection, use and maintenance of that equipment must be developed. Refer to Workplace Health and Safety's bulletin Guideline for the Development of a Code of Practice for Respiratory Protective Equipment (PPE004) for more information.

The employer must prepare a written respiratory protection program or code of practice. The program should include:

- Definition, intent and general discussion on the need for RPE;
- Company health and safety policy;
- Responsibilities of employer and workers;
- Hazard assessment;
- Selection of appropriate respirator;
- Conditions for RPE use;
- Respirator fit testing;
- Inspection, maintenance, cleaning and storage of respirators;
- Training;
- Health surveillance of respirator users;
- Program evaluation; and
- Record keeping.

8.2.3 Types of Respirators

A respirator protects the wearer from inhaling airborne contaminants. Two types of respiratory protective equipment are available: air purifying and air supplied.

Respiratory protective equipment must be selected, used, maintained and cared for in the proper manner. Only respirators approved by the National Institute for Occupational Safety and Health (NIOSH) or another organization acceptable to a Director of Occupational Hygiene may be used at the worksite. The publication "Respiratory Protective Equipment, An Employer's Guide" provides details about the different types of respirators available and their protection factors.

8.3 Protective Clothing

Protective clothing for mould abatement work usually consists of disposable, impermeable coveralls, gloves and head coverings. Protective clothing reduces contamination of the worker's body and hair and makes decontamination much easier when leaving the work area.

Protective clothing with an attached hood provides the most complete protection. Clothing with attached foot coverings should be avoided because of the associated slipping and tripping hazards. Instead, laceless rubber boots can be worn as long as they are properly decontaminated prior to removal from the work site. Disposable types of protective clothing are made of products such as Tyvek™.

Protective clothing does not include street clothes, shoes, T-shirts, socks, blue jeans, sweat bands, etc. If these items are used inside the work area they must be worn underneath other disposable protective clothing so that they do not become contaminated. If not, they must remain in the work area and be disposed of as mould waste at the end of the job. Protective clothing that is reused must be collected, handled and washed to prevent the spread of mould and ensure that the clothing is free of mould. Workers must never take contaminated clothing home for laundering.

Protective clothing may also be required to protect workers from physical hazards. If the mould-containing materials contain wire mesh or other sharp edges, heavy gloves should be worn to protect workers' hands. Appropriate footwear must also be worn to provide protection from sharp or heavy objects and wet or slippery conditions.

8.4 Eye and Head Protection

Other safety equipment such as eye and head protection should be worn if hazardous conditions requiring their use are encountered. Part 18 of the Alberta OHS Code has the requirements for the use and approval of eye protection and hard hats. For most abatement activities, the use of eye protection is required because of the abrasive cleaning that is conducted and/or the demolition of contaminated building materials.

Head protection, such as the use of hard hats, is required for abatement projects when demolition is occurring or as dictated by the presence of other hazards.

8.5 Hearing Protection

Hearing protection may be required at the work site. Hearing protection comes in the form of plugs and muffs, both of which are grades or classified by CSA. Different grades or classifications afford different levels of protection. If noise levels get to high, a combination of both plugs and muffs is required.

Hearing protection must be used properly, be comfortable, not create other safety problems and be adequate to control the level of noise. For hearing protection to be used properly, the wearer has to be trained in its use and limitations. Often ear plugs are worn improperly. A formalized training program is required by the Alberta OHS legislation.

One of the most common misconceptions concerning the use of hearing protection, is that you cannot communicate while wearing it. This is false, provided that your hearing is not already damaged! It takes the worker a while to adjust to wearing hearing protection and during this adjusted phase, the worker may feel disorientated and experience difficulty interpreting speech. This phase is temporary and will pass allowing the worker to communicate with a fellow worker better than when no protection is worn.

8.6 Other PPE

This is not an exhaustive list of all the types of PPE required. Other equipment may be required for protection against hazards such as radiation, temperature extremes, and working at heights. It is the responsibility of the employer or prime contractor at a work site to ensure that the hazards have been assessed and all necessary PPE is used by workers.

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