Alberta
Infrastructure and Transportation

Mould in Indoor Environments Risk Assessment and Management Program Handbook

Prepared in conjunction with the
Alberta Research Council

June 2006

Program Handbook Contents

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Program Overview

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Program Overview

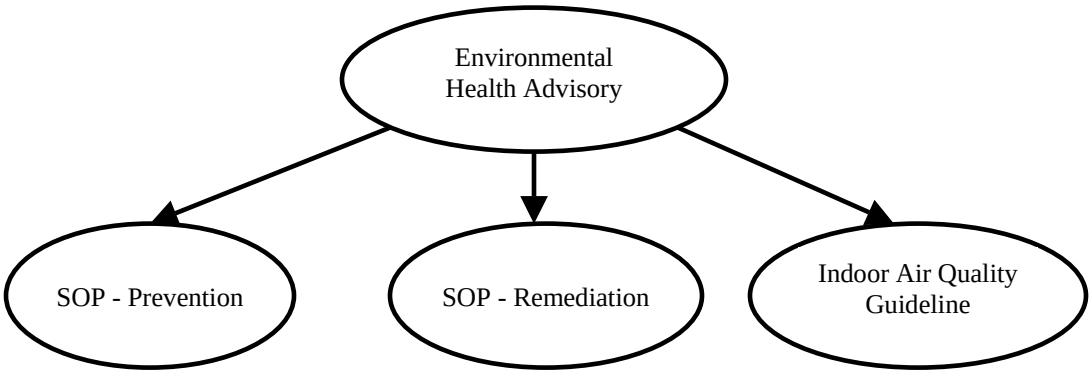
Requirement

In all building infrastructure systems, operators have a growing need to find an effective and efficient way to deal with mould in indoor environments. This has become a public health concern with high profile cases like the Calgary Court of Appeal reinforcing a relatively fearful attitude towards mould. Incidents have become emotionally charged with high media exposure creating a demand for costly solutions, like building new buildings, that greatly exceed the required response.

While Alberta Infrastructure and Transportation (AI&T) had established safe operating procedures (SOPs) to identify and remediate building mould problems, there was a desire to provide better information on the health risks of mould to validate Alberta Infrastructure's SOPs and provide scientific credibility. The Alberta Research Council was engaged to build a Risk Assessment and Management Program for mould in indoor environments.

Risk Assessment and Management Program

The program consists of four basic elements. The core element is an environmental health advisory that summarizes the latest evidence around the health effects associated with building mould, provides an assessment of risk and establishes a set of principles for a risk management program.



Using the environmental health advisory as the guide, three operating procedures complete the program. They include a safe operating procedure for prevention, a safe operating procedure for remediation and an indoor air quality guideline.

Methodology

A multi-disciplinary team composed of ARC staff and Toxcon Health Sciences Research Centre Inc. was used to approach the issue from a holistic point of view. A phased approach was used to build this program to enable the work in future phases to be adjusted, as new information was acquired.

Phase one gathered many kinds of information from multiple sources. The scientific literature search included the Institute of Medicine's 2004 report on damp indoor spaces and health, the latest 2004 Health Canada guidelines and more than 190 references in the scientific literature. Management guidelines included the Canadian Construction Association guidelines of 2004, New York Protocols and 12 other guidelines from around North America. To gain an appreciation of the public's response, media sources, case reviews and personal interviews were conducted.

In the next phase, a draft Environmental Health Advisory was written based on the results of the Phase one report. This draft was circulated to Alberta Health & Wellness, the Calgary and Edmonton regional health authorities and five expert reviewers from outside Alberta to see if the interpretations were reasonable and the management principles sound. Based on their response, the advisory underwent a final technical revision.

Throughout the project a Steering Committee consisting of AI&T staff including members from the Technical Services Branch and Property Management, Capital Projects provided input and guidance to ensure that the program would meet their requirements. As the operating procedures were developed ARC established a methodology that can be used as a base for ongoing technical support and then customized the final program to meet AIT's specific requirements.

While building the program, it became clear that there were a number of research gaps to be filled and that new information would be released regularly. Thus, a research and reference handbook has been created to provide broad coverage in a Q&A format on the latest research results. This will enable the program to be updated and stay current.

Updates and new information will be disseminated on a regular basis through a web-site, training and additional information bulletins. As well, work with building managers, health authorities, contractors and other researchers will continue to build a stronger understanding of mould in the indoor environment across these practice areas.

Conclusion

With this risk management and assessment program, AI&T can be assured that:

1. It is based on the latest scientific information on the health effects of mould in the indoor environment; and
2. The program represents a well thought out, credible approach to risk management that addresses both evidence and uncertainties.

Alberta
Infrastructure and Transportation

ALBERTA RESEARCH COUNCIL
Toxicology Unit

Environmental Health Advisory

Mould in Indoor Environments
Risk Assessment and Management
Program Handbook

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June 2006

ENVIRONMENTAL HEALTH ADVISORY
MOULD IN INDOOR ENVIRONMENTS

April 2005

Introduction – Mould in Indoor Environments as a Public Health Issue

Public concern regarding potential health effects of mould in the indoor environment has increased. In exceptional circumstances, this concern can escalate into a real fear of the risks associated with working in a building's indoor environment. Public opinion on the reasonableness of these fears varies widely. Expert opinions also vary widely on whether indoor mould is toxic. Taken against a backdrop of numerous reports from parents who believe their child's health has suffered from exposure to mould, this issue requires greater clarity and confidence in the information being provided to the public.

When dealing with public health issues, the goal is to "[fulfill] society's interest in assuring conditions in which people can be healthy". The aim of policy, guideline and standards development is "to generate community effort to address the public interest in health by applying scientific and technical knowledge to prevent disease and promote health" (Institute Of Medicine (IOM), 1998).

In this regard, Alberta Research Council's Toxicology Unit has prepared this environmental health advisory based on a review of the latest scientific information, consultation with subject matter experts in Canada and the United States and consultation with public health authorities across Alberta. This advisory aims to provide facility managers, operators, public health personnel, and the general public with an assessment of the risks associated with the health effects of indoor mould exposure. A detailed review of prevention, detection and remediation is outside the scope of this advisory.

Mould Basics

Mould refers to biological organisms from the Botanical Kingdom Fungi that have a filamentous (or "hyphal") growth form, often giving rise to "fuzzy", "cottony", "woolly" or "powdery" textured colonies or masses growing on a substrate.

Fungi compose approximately 25 per cent of the Earth's biomass and can be found almost everywhere naturally, including in soil, on plants, on dead and decaying matter. Mould serves an essential function by decomposing organic matter to provide plants with nutritional elements. Mould metabolism is heterotrophic, i.e. they lack the chlorophyll necessary to produce their own food, so they must live on dead organic matter. For example, moulds play a key role in the breakdown of leaves, wood and other organic debris.

Moulds reproduce by producing large numbers of spores that are poorly visible or not visible at all to the naked eye. In many mould species, these spores can become airborne and disperse widely throughout the environment via wind currents. These same wind currents carry mould spores into buildings where they deposit on surfaces including food, paint, textiles, carpet, drywall, wood flooring, insulation, and furniture. When mould spores encounter a damp spot (e.g. through a water leak), they begin to grow and

eventually destroy the things they grow on by digesting them with powerful enzymes. Mould converts dead matter back into organic matter that can be used again by living organisms.

Thus, in an indoor environment, it is possible for mould to come from two potential sources:

- spores can be generated by outdoor colonies and enter the building's indoor environment; and
- the building can amplify the existence of mould through internal colonies if not properly maintained.

Some of the more common moulds found indoors include species of *Aspergillus, Cladosporium*and *Penicillium. Alternaria*, which is typically an outdoor mould, can be found indoors in some circumstances. Given their universal presence, it is virtually impossible to eliminate mould and mould spores from indoor environments.

Factors Leading to Adverse Health Effects

For mould to present a risk to the health of humans, a number of elements need to exist to create a chain of events that will result in an adverse health effect. These events are highlighted in Table 1 below.

Table 1: Exposure Related Considerations in the Assessment of Environmental Factors Leading to an Adverse Health Effect

Event	**Mould in Indoor Environment**
Existence of a biological agent presenting a potential health risk.	Mould exists in the indoor environment.
Population at risk	General population occupying indoor building environments.
Mode of transmission.	The source fungal spores or related by-products have to be in proximity for direct contact
Portal of entry	The mould must be taken into the body through inhalation, ingestion or skin absorption.
Mode of action	The mould must induce an adverse biological response, which will create a set of associated symptoms.

To conclude that "moulds or their by-products **cause** adverse health effects in humans", a considerable body of scientific evidence needs to be generated and carefully reviewed. This process is usually very lengthy and requires the input of many experts from many scientific disciplines.

In its review, the IOM notes that indoor environments are very complex and that any claim of a link between mould exposure and adverse health effects must be examined carefully against a host of potential confounding factors such as the presence of house dust mites, cockroaches, viruses, endotoxin, gram-negative bacteria, environmental tobacco smoke (ETS), pesticides, nitrogen dioxide (NO_2) from gas appliances, VOC's from furniture off-gassing and consumer products, temperature, RH and ventilation rates as well as socioeconomic status to name only a few. Several of these can produce health effects similar to those reported for moulds and few research studies control for all of these factors. In fact, it is still unknown to what extent ***synergistic effects*** can occur following exposure to more than one chemical or biological agent.

Weighing the Evidence and Assessing Risk

The recent Institute of Medicine Report "Damp Indoor Spaces and Health" (2004) uses a common system to categorize the strength of scientific evidence for assessing the association between exposure to fungal spores or by-products and the development of an adverse health outcome. From the strongest to the weakest, the categories are:

Sufficient Evidence of a Causal Relationship. Evidence is sufficient to conclude that a causal relationship exists between the agent and the outcome, that is, the evidence fulfills the criteria for "sufficient evidence of an association" and in addition, satisfies the following criteria: strength of association, biologic gradient, consistency of association, biologic plausibility and coherence and temporally correct association.

Sufficient Evidence of an Association. Evidence is sufficient to conclude there is an association, that is, an association between the agent and the outcome has been observed in studies in which chance, bias and confounding can be ruled out with reasonable confidence.

Limited or Suggestive Evidence of an Association. Evidence is suggestive of an association between the agent and the outcome but is limited because chance, bias and confounding cannot be ruled out with confidence.

Inadequate or Insufficient Evidence to Determine Whether an Association Exists. The available studies are of insufficient quality, consistency, or statistical power to permit a conclusion regarding the presence of an association. Alternatively, no studies exist that examine the relationship.

The use of this system is important to scientists in deriving conclusions respecting the health risks associated with exposure to moulds.

Based on the scientific literature, four exposure situations can be used as a framework to define the degree of risk for a healthy population.

1. Low Risk Situation. The evidence would need to suggest that mould is unlikely to cause disease.
2. Moderate Risk Situation. The evidence would need to suggest that mould can cause human or animal disease but, under normal circumstances, is unlikely to be a serious hazard.
3. High Risk Situation. The evidence would need to suggest mould could cause serious, chronic human or animal disease, representing a serious hazard to a healthy population through long-term exposure.
4. Critical Risk Situation. The evidence would need to suggest mould could cause serious human or animal disease through a single exposure.

By evaluating the body of scientific evidence and determining an exposure situation, it is possible to select appropriate risk management responses. This should help provide greater clarity and confidence to both building managers and the general public on how mould should be dealt with.

Latest Evidence On Health Effects Associated With Mould in Indoor Environments

General

It is important to recognize that there is a wide degree of sensitivity to moulds both within individuals and in populations. Thus, great care must be taken not to overstate or understate the true risks to individuals. The typical health responses tend to fall into one of three categories:

1. Allergic and other hypersensitivity reactions
2. Infections
3. Chemically induced effects (toxicity) through exposure to mould by-products such as microbial VOCs and mycotoxins.
4. Psychological reactions

The IOM reviewed recent epidemiological studies and found that many of those examining the effects of a particular mold species or strain failed to factor in the possible influence of concomitant exposures to other moulds and bacteria associated with damp indoor environments. In addition, it is important to recognize how difficult it is to test for a specific organism, especially over the long term, given the current lack of reliability and repeatability of such measurements.

The IOM also noted that most of the research examining a link between mould exposure and damp indoor environments was epidemiological research in which the strength of an association was tested between self-reported symptoms or clinical outcomes and the presence of dampness (or visible mould). In many cases, limited or no testing was done for the presence of specific organisms or the degree of exposure was assumed retrospectively.

The body of evidence is still inconclusive, but some trends are expected to emerge, particularly if intensive birth cohort studies are used.

Allergy

Allergy is an immunological reaction. Allergies are caused by increased immune system response to external agents. As part of the immune response, the affected tissues release histamine and other chemicals, which results in symptoms such as swelling, itching, constriction of the airways and rashes.

In 2002, the American College of Occupational and Environmental Medicine (ACOEM) issued an evidence-based statement that stated approximately 10% of the population has allergic antibodies to fungal antigens, and of these, only 5%, would ever show clinical illness at some point in their lives. They further stated that outdoor moulds are more abundant and relevant to the expression of airway allergic disease than those indoors.

The most common allergic responses are allergic asthma and allergic rhinitis (“hay fever”). A rare, but much more serious allergic response is “hypersensitivity pneumonitis” that may follow a number of exposures, such as very high fingal exposures associated with mouldy hay or grain.

Typical Upper Respiratory Tract symptoms associated with allergic rhinitis include nasal congestion, sneezing, and runny, stuffy or itchy nose, while sinusitis is accompanied by symptoms similar to the common cold, including sore or hoarse throat. The eyes may or may not be affected. If so, the individual may report itching, burning, or irritated eyes.

The lower respiratory tract includes the windpipe (trachea), and within the lungs, the bronchi, bronchioles, and alveoli. Typical symptoms by any cause include cough with and without the production of phlegm, wheeze, chest tightness, and shortness of breath (dyspnea).

Allergic responses to fungal proteins can be mediated through the immune system and in particular, immunoglobulin E (IgE) or immunoglobulin G (IgG) antibodies. It is noteworthy that the allergic syndromes, allergic bronchopulmonary asergillosis and allergic fungal sinusitis are very rare and indoor mould exposure has not been implicated in these conditions. Instead, they are triggered by pre-existing disease that prevents normal lung or sinus cavity drainage.

Type I allergy: One common type of allergic response to fungal exposure is "immediate hypersensitivity" or IgE-mediated allergy. Inhaling mould spores or fungal fragments can exacerbate allergic asthma or allergic rhinitis. Usually in this type of reaction, the individual is "atopic", i.e. Affected people have allergic asthma, allergic rhinitis, or atopic dermatitis and respond to a wide range of environmental allergens in addition to fungi, including animal dander, dust mites, and weed, tree and grass pollens.

The IOM (2002) pointed out that finding a widely accepted definition of asthma is difficult. They stated that asthma is a chronic, reversible airway obstructive disease with an inflammatory response where the interaction between mould exposure and asthma is still unclear. Both genetic and environmental factors appear to play important roles in the initiation and continuation of airways inflammation. Although the inflammatory response may vary from one patient to the other, the asthma symptoms are often episodic and usually include wheezing, breathlessness, chest tightness, and coughing. These symptoms are associated with widespread airflow obstruction that is at least partially reversible with medications or time. Asthma cases may show a wide variation in the degree of bronchial hyperresponsiveness over time or under different exposure conditions.

There is sufficient evidence indicating that exposure to fungi can elicit allergic responses in previously sensitized individuals. The degree to which this occurs in the general population is unknown, although the IOM (2000) suggest that about 6 to 10 per cent of the population is sensitized. The IOM (2004) note that the problem of conducting population-based surveys to validate this number is the lack of standardized mould antigens for use in skin prick testing and the method currently used where only a few common mould extracts are tested rather than a broad panel. The problem with this is that it could underestimate the true prevalence of sensitization to moulds in the general population.

In short,

- Only a small segment of the general population will have an allergic reaction to moulds at some point in their lives;
- Growing evidence associates respiratory illnesses with residence in damp or water damaged homes. Mould spores are not the only potential cause of respiratory illness. Dust mites, bacterial growth and other non-fungi allergens may play more important roles in respiratory problems;
- More sensitive individuals (e.g. asthmatics) should take stronger preventive maintenance measures to reduce their exposure.

Infection

For mould to cause an infection, mould must invade the body. A sufficiently large mould dose, an infective dose, is required for mould to cause infection.

The American College of Occupational and Environmental Medicine (2002) concluded that "… exposure to moulds indoors is generally not a specific risk factor in the etiology of mycoses except under specific circumstances…". A very limited number of pathogenic fungi may cause deep tissue infection that may lead to serious illness or death, including *Blastomyces spp.*, *Coccidioides spp.* (soil fungus, especially in the southwest U.S.), *Cryptococcus spp.* (from bird droppings), *Candida spp.* and *Histoplasma spp.* (from bat droppings) and these usually occur in severely immunocompromised individuals such as patients with lymphoproliferative disorders (e.g. acute leukemia), cancer patients receiving intense chemotherapy, persons undergoing bone marrow or solid transplantation who get potent immunosuppressive drugs, uncontrolled diabetics, persons with advanced AIDS, etc. It is for these reasons that such individuals must be very carefully monitored when in or near a health care

facility. Furthermore, it is recognized that outdoor fungi are so diverse and numerous that little can be done to prevent exposure to moulds beyond avoiding known reservoirs of indoor and outdoor fungi (e.g. decaying plants). The U.S. Centers for Disease Control in Atlanta have published extensive guidelines for the protection of specific immunocompromised states (see www.cdc.gov).

Superficial infections of the skin and mucosal surfaces are common in healthy individuals. Infections of the feet (Tinea pedis), finger and toenails *(Tinea onychomycosis)*, groin (Tinea cruris), dry body skin (Tinea corporis), oral and vaginal mucosal surfaces are common. The ACEOM concluded that only individuals with the most severe forms of immunocompromise need to be concerned about the risk of opportunistic fungal infections.

In sum,

- Most fungi are not pathogenic to healthy humans. Superficial infections on the feet, groin, skin and nails are not a serious health threat;
- The "infective dose" of airborne spores for a healthy individual is in the range of thousands to hundreds of thousands of CFU/m^3. Fungal infections are improbable and inconsistent with reported spore concentrations that typically measure in the tens to hundreds of CFU/m^3;
- Fungal infections with deep tissue invasion occur primarily in severely immunocompromised subjects (eg. cancer patients receiving chemotherapy).

Toxicity

Toxicity refers to the degree to which a substance/biological organism or mixture of substances/organisms can harm humans or animals. Acute toxicity involves harmful effects in an organism through a single or short-term exposure, while chronic toxicity involves harmful effects over an extended period of time, usually from repeated or continuous exposure lasting the lifetime of an organism. Subchronic toxicity refers to harmful effects produced by exposure to a substance/biological organism or mixture of substances/organisms for more than one year but less than the lifetime of the organism. With respect to fungi, the concern is usually associated with mould by-products (e.g. mVOC's) and mycotoxins. Not all fungi produce mycotoxins and those that do, do not produce them all the time.

No acute reactions to a single exposure of a mould in indoor environments has been found. Chronic health effects from long-term exposure to moulds or their by-products are difficult to detect since the effects are not readily apparent.

For moulds to be toxic to humans, moulds or their by-products must be available to the human. Mould must enter the lungs or gastrointestinal tract. Mould must contact skin or mucous membranes for infections in these tissues.

The most common chemical by-product of some moulds is secondary metabolites called "mycotoxins". Mycotoxins have been studied for several decades in relation to their effects from oral ingestion with food. It is known that some forms of cancer are caused by some mycotoxins. Cancer has not been associated with skin exposure or inhalation exposures.

In terms of damp buildings, the concern relates more to the inhalation of mycotoxins than ingestion. Little research has been conducted on the inhalation of mycotoxins in both animals and humans resulting in very little evidence for inhalation.

Most evidence is based on large amounts of ingested mycotoxins found on food products and grains. Mycotoxins, however, are not volatile, so mycotoxins do not become airborne on their own. The concept that mycotoxins on mould spores will create clinically significant mycotoxon exposure is unproven.

The IOM (2004) has provided the following findings:

1. Moulds that can produce mycotoxins under appropriate environmental and competitive conditions grow indoors. Little information exists on the toxic potential of chemical releases resulting from dampness-related degradation of building materials, furniture, and the like;

2. Adverse effects, including immunotoxic, neurologic, respiratory, and dermal responses may occur after exposure to specific toxins, bacteria, moulds, or their products;

3. *Stachybotrys chartarum* effects in humans have not been proven;

4. The effects of long term exposure to mycotoxins in humans is not known.

In summary,

- No acute reactions to single exposure of building mould in a healthy population were found. Mould exposure does not appear to be an acute, imminent threat to life for the general population.
- Most evidence of toxic effects is associated with ingestion of mouldy agricultural products, which is inconclusive for assessing the potential effects associated with inhalation.
- The greatest uncertainty exists regarding potential chronic health effects of prolonged exposure to moulds.

Overall Summary

The strength of the evidence for health effects is summarized in Table 2 below:

Table 2: Summary of Findings Regarding the Association Between Health Outcomes and the Presence of Mould or Other Agents in Damp Indoor Environments. (IOM, 2004)

Sufficient Evidence of a Causal Relationship
• None listed
Sufficient Evidence of an Association
• Upper respiratory (nasal and throat) tract symptoms • Cough, Wheeze, Asthma symptoms in sensitized persons • Hypersensitivity pneumonitis in susceptible persons
Limited or Suggestive Evidence of an Association
• Lower respiratory illness in otherwise healthy children

Inadequate or Insufficient Evidence to Determine Whether an Association exists
• Skin symptoms, Fatigue • Dyspnea (shortness of breath), Lower respiratory illness in otherwise healthy adults, Asthma development, Airflow obstruction (in otherwise healthy persons) • Inhalation fevers (nonoccupational exposures), Acute idiopathic pulmonary haemorrhage in infants • Gastrointestinal tract problems, Mucous membrane irritation syndrome • Neuropsychiatric symptoms, Rheumatologic and other immune diseases • Cancer, Chronic obstructive pulmonary disease, Reproductive effects

Lack of sufficient evidence exists for a causal relationship between the development of adverse health effects and the presence of mould in individuals showing no previous symptoms of disease. For a healthy population, concerned about the risks of inhalation of indoor mould, the evidence suggests:

1. **Allergy** – Sufficient evidence exists of an association between mould exposure and allergic reactions in a small segment of the general population, i.e. those already with asthma or allergies.

2. **Infection** – Inadequate or insufficient evidence of infection in a healthy population. Some risk to severely immuno-compromised individuals.

3. **Toxicity** – Inadequate or insufficient evidence of toxicity in a healthy population.

Recommendations

After considering the most recent documentation describing health effects associated with indoor mould exposures, we would classify indoor mould as a low risk situation. The reasons for this include:

- There is no evidence that mould presents an acute, imminent threat to life for healthy adult members of the general population in typical exposure situations;
- Of the general population, only 5% would be expected to show allergic reactions to fungal antigens;
- Recent critical reviews of the literature concluded that a causal relationship has not been established between the presence of indoor microorganisms and the development of disease; and
- Concentrations required to create infection are improbable and inconsistent with reported spore concentrations in buildings.

A low risk situation does not imply that mould issues can be deferred indefinitely. Due to the uncertainty associated with chronic effects from long-term exposure, health concerns require a timely response. Except under excessive contamination, acute health effects and compromised individuals, building evacuations are unwarranted.

A strong management framework should be sufficient to manage mould as part of the overall maintenance program that facility managers use to provide their occupants with a healthy environment. This program should be based on the following principles:

- Prevention is the best form of remediation. An appropriate inspection and maintenance program will inhibit the opportunity for mould to grow and provide early detection.

- Health concerns require investigation of all potential health causes, including building parameters unrelated to mould exposure.
- Use a standard method of investigation and response to health concerns. Regular methods produce predictable activities and responses, which builds confidence among building occupants.
- Qualified professionals should not overstep their area of training and competence. Let experienced medical professionals with expertise in mould effects diagnose the potential causes of health symptoms from building occupants.
- Communicate frequently and consistently. Good communication reinforces good operating practices and builds confidence among building occupants.

Indoor mould is an important public health issue that can be managed to provide people with a healthy indoor environment. To create an adverse human health effect, a complete chain of events needs to occur at sufficient exposure levels. To date, while there are associations between higher mould exposures and allergic reactions in more sensitive individuals (i.e. children, the elderly, those with pre-existing diseases or those whose immune systems are severely compromised), the evidence suggests that mould can be treated as a low health risk for the general population.

For further information

Contact: Dr. Vince Rogers, Business Unit Manager, Toxicology Unit, Alberta Research Council.

Recommended Reading: Some of the more useful summaries include the following. They are peer reviewed and provide extensive reference lists of many of the most significant publications in this field, including those arguing for and against a cause-effect relationship between mould exposure and adverse health effects.

1. American College of Occupational and Environmental Medicine, "Adverse Health Effects Associated with Molds in the Indoor Environment," ACOEM Evidence-based Statement, October 27, 2002.

2. American Industrial Hygiene Association. "Assessment, Remediation, and Post-remediation Verification of Mold in Buildings". 2004. 15 pp.

3. Health Canada. "Fungal Contamination in Public Buildings: Health Effects and Investigation Methods", 2004. 47 pp.

4. Institute of Medicine, "Clearing the Air: Asthma and Indoor Air Exposures". 2000. 438 pp, National Academy Press, Washington, D.C.

5. Institute of Medicine, "Damp Indoor Space and Health". 2004. 355 pp, National Academy Press, Washington, D.C.

6. Kuhn, D.M. and Channoum, M.A., "Indoor Mold, Toxigenic Fungi and Stachybotrys chartarum: Infection Disease Perspective," *Clinical Microbiology Reviews*, Vol 16, No. 1, 2003, pp. 144-172.

Glossary

Atopic

Related to or marked by atopy / allergic.

Atopy

A genetically determined state of hypersensitivity to environmental allergens. Type I allergic reaction is associated with the IgE antibody and a group of diseases, principally asthma, hay fever and atopic dermatitis.

Endotoxin

A microbial toxin not freely liberated into the surrounding medium in contrast to an exotoxin.

Exotoxin

A specific, soluble, antigenic, usually heat labile, injurious substance elaborated by certain Gram-positive or Gram-negative bacteria; it is formed within the cell, but is released into the environment where it is rapidly active in extremely small amounts; most exotoxins are protein in nature (MW 70,000-900,000) and can have a toxic portion of the molecule destroyed by heat, prolonged storage, or chemicals.

Microbial Volatile Organic Compounds (mVOCs)

Small molecular weight volatile substances that are typically released into the atmosphere by growing fungi and bacteria as end products of their metabolism.

Mycotoxins

Toxic compound produced by certain fungi; some are used for medicinal purposes; e.g. muscarine, psilocybin.

Synergism

Coordinated or correlated action of two or more structures, agents or physiologic processes so that the combined action is greater than the sum of each acting separately.

Volatile Organic Compounds VOCs

Volatile organic compounds (VOC) are a principal component in atmospheric reactions that form ozone and other photochemical oxidants. VOCs are emitted from diverse sources, including automobiles, chemical manufacturing facilities, drycleaners, paint shops and other commercial and residential sources that use solvent and paint. VOCs have been found to be a major contributing factor to ozone, a common air pollutant which has been proven to be a public health concern.

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Safe Operating Procedure
Mould Prevention

Mould in Indoor Environments
Risk Assessment and Management
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Safe Operating Procedure – Mould Prevention

Purpose

Managing mould in the indoor environment as part of the overall facility maintenance program will usually be sufficient to provide occupants with a healthy environment. The purpose of this document is to provide preventive measures to inhibit mould growth since prevention is the best form of remediation.

If mould is found another ***Safe Operating Procedure – Mould Remediation*** will provide procedures and measures for the clean up and removal of mould substance. For information on the latest assessment of the health risk associated with mould indoors, refer to the latest ***Environmental Health Advisory – Mould in Indoor Environments*** produced by the Alberta Research Council.

Mould Description

Moulds occur naturally and can be found in soil, on plants, and decaying matter. Since they lack chlorophyll, they need organic material as a source of food to survive. When combined with water, oxygen and the correct temperature, they are able to grow. Moulds reproduce by producing large numbers of spores that are not visible to the naked eye. These spores can be deposited on building materials such as textiles, carpet, drywall, wood, insulation and furniture. When mold spores encounter damp conditions they begin to grow and amplify eventually destroying the things they grow on by digesting them with enzymes.

Health Factors

To date, while there are associations between higher mould exposures and allergic reactions in more sensitive individuals (i.e. children, the elderly, those with pre-existing diseases or those whose immune systems are severely compromised), the evidence suggests that mould can be treated as a low health risk in the general population. Exposure to moulds can be through physical contact and ingestion but the main area of concern is through inhalation. The symptoms of exposure will vary depending on the individual and may include:

1. Decrease health related quality of life (e.g. feelings of well-being; increased stress, increased pain, decreased physical functioning)
2. Reversible loss of lung function in combination with increased presence of health-related or clinical symptoms (e.g. increased bouts of asthma)

Moulds may cause allergic effects depending on the type of mould and the person exposed. Anywhere from 5-15% of the general population with respiratory sensitivities and immune deficiencies may be effected to a larger extent than others. Thus, while mould is a low health risk to the general population, health concerns should be dealt with in a timely manner and prevention is one of the most powerful tools a facility manager can use to manage the issue.

Sources of Mould Generation

Since the nutrients, temperature and oxygen exist in the indoor environment, the most effective way to inhibit mould growth is to cut off the water supply. Thus any condition leading to excessive dampness or sustained water damage creates an opportunity for mould to grow. Some examples include:

- Previously water damaged areas left unattended
- Water damage from renovation of washrooms, shower areas and other plumbing modifications
- Standing water areas in air plenums, cooling coils and filter banks
- Leaks around window and door unit jambs allowing outside water penetration
- Water damaged ceiling tiles
- Roof leaks at wall/roof junctions, around ventilation units and other roof penetrations
- Damp crawl spaces

Mould Prevention

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

The primary prevention strategy for minimizing building inhabitant exposure to mould is moisture control in and around the building site. An effective mould control program requires an integrated approach and includes the following items:

- Fix leaky plumbing and leaks in the building as soon as possible.
- Watch for condensation and wet spots. Fix source(s) of moisture problem(s) as soon as possible (i.e. cooling pipes, windowpanes, roof/wall intersections etc).
- Prevent moisture due to condensation by increasing surface temperature or reducing the moisture level in air (humidity). To increase surface temperature, insulate or increase air circulation. To reduce the moisture level in air, repair leaks, increase ventilation (if outside air is cold and dry), or dehumidify (if outdoor air is warm and humid).
- Keep heating, ventilation, and air conditioning (HVAC) drip pans clean, flowing properly, and unobstructed.
- Vent moisture-generating appliances, such as dryers, to the outside where possible.
- Maintain low indoor humidity, below 60% relative humidity (RH), ideally 30-50%, if possible.
- Perform regular building/HVAC inspections and maintenance as scheduled.
- Clean and dry wet or damp spots within 48 hours.

- Don't let foundations stay wet. Take measures to provide proper drainage below ground at the foundation (weeping tile) and slope the ground away from the foundation wall.

More specifically to HVAC systems the following steps should be taken:

- Mould control can be discussed with an HVAC consultant, the building owner/user and contractor. Explicit moisture control requirements can be given in the project specifications. Exhaust ventilation can be provided to remove moisture during cold weather in spaces with moderate to high rates of moisture production per unit area (classrooms, kitchens, baths, small apartments, etc.).
- Air conditioning systems can be designed to control humidity in the space and in the ductwork, especially during partial load cooling conditions when the system is on only part of the time (e.g., warm, rainy days).
- All cooling coils can have condensate drain pans located under them with bottoms sloped in both directions to a drain large enough to avoid clogging from dirt (e.g., min. 3/4” diameter). Open porous insulation inside ductwork to control sound levels can be a suitable growth media for mould. Although the inorganic fibers do not support mould growth, they do collect dust and allow mould growth if humidity is not controlled. Such insulation is also very difficult to clean.
- Filters can be placed upstream of cooling coils – this keeps the coils clean and avoids water blowing down from the coil and supporting mould growth on the filter. Limiting airflow velocities and designing coils appropriately can control the blow-through of condensate from coils. Research has shown that anti-mould treatments on filters have no effect once dirt is deposited.
- Cool potable water and chilled water lines can allow summertime condensation to form and then drip onto ceiling tiles or within drywall partitions. Such lines can be insulated with closed-cell insulation or at least routed through parts of a building with materials able to withstand occasional wetting (e.g., concrete chase ways).
- Bay windows, alcoves and other susceptible areas with no ventilation can be provided with a means to move air and reduce moisture.
- Some HVAC systems still apply positive pressurizations (i.e., the pressure is acting to drive air outward) to prevent or avoid cold inward drafts. Forcing air out through the building enclosure invites large and damaging amounts of interstitial condensation and is therefore not recommended. Drafts and air leakage should not be controlled by pressurization – a proper air barrier should always be provided.

Specific building structures should be inspected regularly:

- School portables.
- Buildings older than 15 years.

- Buildings with elements of high moisture content (water ponds/pools, laboratories that require high moisture).
- Buildings with a history of roof leaks/water penetration.
- Buildings with poor site drainage away from foundation structures.

A part of normal preventative measures, regular monthly inspections should be conducted with Table 1 providing an example of a sample checklist for inspections.

Table 1: Sample Checklist For Regular Inspections

Inspection Item	**Yes/No**	**Observations**
Are there existing moisture problems in the building?		
Have building materials been wet more than 48 hours?		
Are there hidden sources of water or is the humidity too high (high enough to cause condensation)?		
Are building occupants reporting musty or mouldy odors?		
Are building occupants reporting health problems?		
Are building materials or furnishings visibly damaged?		
Have normal maintenance programs been delayed or the maintenance plan been altered in areas dealing with mechanical systems and building envelope improvements?		
Has the building been recently remodeled or has building use changed?		

During inspection, if materials are found, actions taken with respect to material removal and handling to prevent mould growth in the event of a moisture penetration can be summarized in the table below:

Table 2 – Process for Material Removal and Handling of Wet Materials

Water-Damaged Material	**Actions to be Taken**
Books and papers	• For non-valuable items, discard books and papers. • Photocopy valuable/important items and discard originals. • For non-valuable items, discard books and papers. • Freeze (in frost-free freezer or meat locker) or freeze-dry.
Carpet and backing – 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.
Surfaces	• Accelerate drying process with dehumidifiers, fans, and/or heaters.
Fiberglass 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.

Summary

Prevention is the best form of remediation. An appropriate inspection and maintenance program will inhibit the opportunity for mould to grow and will also provide an early detection for mould growth. This will enable mould to be managed before it becomes a significant problem and contribute to a healthy indoor environment for building occupants.

References

- EPA Mold Remediation in Schools and Commercial Buildings, June 2001

Alberta
Infrastructure and Transportation

Indoor Air Quality Guideline

Mould in Indoor Environments
Risk Assessment and Management
Program Handbook

Prepared in conjunction with the
Alberta Research Council

June 2006
Revised June 2007

Table of Contents

Indoor Air Quality Guidelines

Introduction

The purpose of this guideline is to provide a detailed process to address indoor air quality (IAQ) factors at Government of Alberta occupied facilities. The guideline has been developed by a technical sub-committee of the Interdepartmental Committee on Indoor Air Quality chaired by Alberta Infrastructure and Transportation. It was revised after adoption of a risk assessment and management program for mould in indoor environments, developed by the Alberta Research Council for Alberta Infrastructure and Transportation.

It is recommended that IAQ management programs in Government of Alberta buildings utilize a preventative maintenance routine and an IAQ response process. A preventative maintenance program keeps a building's operating systems at optimal performance. It includes elements such as preventative maintenance of heating, ventilation and air conditioning (HVAC) systems, periodic testing of indoor air quality comfort parameters and reviews indoor air quality associated factors when renovations are undertaken. The Indoor Air Quality (IAQ) response process involves responding to occupant indoor air quality concerns.

Preventative Maintenance Routine

The intent of a preventative maintenance routine is to ensure the building will continue to provide a healthy work environment. A monitoring process provides several opportunities for technical and building maintenance staff to assess the building's operating systems and indoor air quality conditions. A preventative maintenance routine should include the following:

- A regularly scheduled inspection to ensure the heating, ventilation and air conditioning (HVAC) systems operate at design specifications as per Alberta Infrastructure and Transportation's preventative maintenance program.
- Review and evaluation of IAQ and HVAC systems as part of Alberta Infrastructure and Transportation's facility evaluation program.
- Submission of IAQ investigation results to Alberta Infrastructure and Transportation's facility evaluation program.
- Periodic testing for comfort factors as per Appendix 2 – Level 2 by suitably trained building managers. Frequency of this testing is variable, depending on a variety of factors including age, type, and location of the building and history of occupant concerns. Testing frequency to be determined by the building manager.
- Consultation with Alberta Infrastructure and Transportation's Technical Services Branch on design of equipment installations for special processes, major renovations and new construction to address factors that may impact the IAQ of the facility. These factors should include but are not limited to building envelope, HVAC systems, isolation of work area(s) and building materials. This is best done prior to construction or occupancy.
- Periodic inspection by building managers of building cleanliness and review of cleaning products and procedures.

Indoor Air Quality (IAQ) Response Process

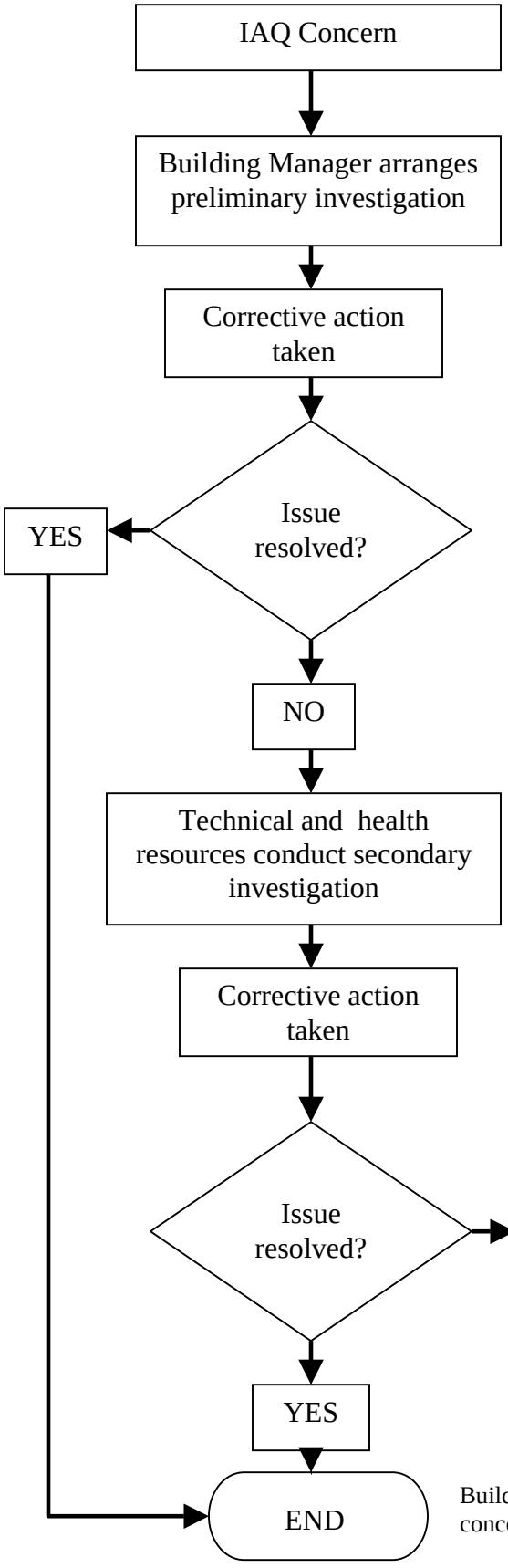
The IAQ response process involves responding to an expressed concern regarding the building's indoor air quality. The concern may be communicated through a variety of channels, but needs to be directed to the building managers for their attention. Appendix 1 provides a flowchart outlining the steps involved in this process.

It is important to understand that there is both a technical component and a health component to IAQ concerns. Addressing only the technical component may result in an occupant's ongoing health worries to cause an IAQ issue to escalate out of control, even when the technical factors appear to be fully satisfactory. Once escalated, resolution can become very costly in time and resources. The Building Manager should establish a contact for building investigations that can help them with both the technical and health components of an investigation when appropriate. The Alberta Infrastructure and Transportation Technical Services Branch, Building Environment Unit, can assist in establishing contacts with supporting professional resources.

The Building Manager will review and investigate an IAQ concern. This would normally include a Level 1 and/or Level 2 investigation as outlined in Appendix 2. Based on the results of the investigation, the building manager would take action to address the concern, and if necessary, proceed to Level 3 Investigation requiring the assistance of technical/professional resources described in Appendix 2.

Throughout the process, timely communication builds trust. It is important that the response and related activities are communicated back to the individual who reported it. It should be made clear that the complaint is taken seriously, action is being initiated and the status toward resolution explained. If the individual continues to express concern, they should be advised to see their family doctor to ensure that all potential factors that could be contributing to their discomfort are evaluated. As the issue is investigated, open communication and information sharing is essential for a successful response.

If, at any point during the IAQ Response Process, a dispute arises, it may be referred to the department's Health & Safety Officer.



Concern expressed by building tenant or representative.

Depending on whether space is owned or leased space, the building manager could be an employee of Alberta Infrastructure and Transportation's Property Management Branch or a contracted building representative. Significant concerns are to be identified to the Alberta Infrastructure and Transportation Property Management Facilities Manager.

Refer to Level 1 and/or Level 2 investigation in Appendix 2.

Building manager to communicate progress to issue originator(s)

Infrastructure Property Management facilities manager to access technical and existing health resources to assist from resources listed in Appendix 2. Refer to Level 3 investigation in Appendix 2. The scope of the secondary investigation will depend on the specific issue at the discretion of the technical and health resources.

Corrective action could involve changes to building environment, workplace arrangements, tenant practices, etc.

Program department's Occupational Health and Safety Officer contacted. If the issue is not resolved by this process, it may be brought to the attention of Workplace Health & Safety (HR&E) or the Regional Health Authoritv.

Building manager communicates findings and corrective measures to the IAQ concern originator (s).

There are three levels of investigation for IAQ concerns, detailed below.

Level 1 – Walk-Through Survey

1. Information Gathering

- Meet with the employee(s) and/or supervisor of the area with the concern and the building operator/facility manager. Gather as much information as possible about the nature of the concern to identify possible sources of concerns.

2. Conduct Physical Inspection

- Identify potential hazards by visual inspection (i.e. sources of airborne contaminants from processes, e.g. blueprinting machines, combustion sources, etc.).
- Look for signs of water leakage and water condensation, as they may be indicators of potential mould contamination. Ask about the history of water leaks/damage. For additional information about mould refer to Appendix 4.
- Look for maintenance and housekeeping deficiencies (e.g. missing fan belts/filters on ventilation systems, humidifiers (drain pans) and cooling systems, boxes stored against cold walls, thermostats set or located improperly, etc.).
- Inspect the air intake and exhaust locations and review the HVAC system operation schedule and minimum outdoor air requirements.

A checklist to assist with the walk-through can be found at the end of this Appendix.

3. Corrective Action

- Take appropriate corrective action to resolve the concern.
- If the results of the walk-through survey do not resolve the issue then proceed to Level 2 investigation

Level 2 – Test For Comfort Factors

If, after the Level 1 investigation, the building manager has not been able to correct or resolve the concern they should arrange for testing of comfort factors. These include carbon dioxide, temperature, relative humidity and in some cases, carbon monoxide. These tests should be conducted by suitably trained individuals and should include the following considerations:

1. Test Plan

- Testing should be conducted in area(s) of concern and area(s) of no concerns (i.e. control sample). A representative number of samples are required to ensure all areas of concern have been addressed. Consult with a technical/professional resource to determine the appropriate number of samples and sampling locations.
- If spot readings are taken, then ensure this is done at different times of the day to capture possible variances.
- Note outdoor weather conditions (temperature, relative humidity) whenever testing for IAQ comfort factors.
- Test for carbon monoxide only if potential sources are identified (e.g. vehicle exhaust, combustion-type heating sources).

- Refer to Appendix 3 for Indoor Air Quality and Comfort Parameters.

Corrective Action

- Based on the results of the investigation, identify corrective action. If you are uncertain, identify corrective action in consultation with the technical/professional resources identified below.
- If the results of Level 2 investigation do not resolve the concern, proceed to Level 3 investigation.

Level 3 – Obtain Assistance From Technical/Professional Resource

If the IAQ issue is not resolved after conducting a Level 2 investigation, obtain assistance from a technical/professional resource listed below.

The type of scenarios where this assistance should be obtained include:

- Interpretation of results from Level 1 & Level 2 investigations.
- Dealing with potential or known existence of mould contamination.
- Further sampling for other possible contaminants such as volatile organic compounds, formaldehyde, particulate, etc.
- Asbestos management/contamination.
- Evaluating the amount of emissions from processes (e.g. blueprinting, drycleaning from nearby commercial operations, etc.).

Technical/Professional Resources

IAQ investigation should be conducted by the following qualified personnel:

Level 1 & Level 2

- Suitably trained individuals (e.g. Property Management Staff) in consultation with those listed below
- Alberta Infrastructure and Transportation Technical Services Branch, Building Environment Unit
- Department Occupational Health and Safety staff
- Private sector Occupational Hygiene and Environmental Consultants.
- Health resources such as occupational health nurses, occupational physicians and family doctors

Level 3

General qualifications for people conducting Level 3 testing would include but not be limited to Certified Industrial Hygienist (CIH), Registered Occupational Hygienist (ROH), Certified Industrial Hygiene Technologist (CIHT), Registered Occupational Hygiene Technologist (ROHT), and Certified Public Health Inspector of Canada CPHI(C).

Health resources include occupational health nurses, occupational physicians and family doctors.

Location: Department:

Completed By: Date:

Item	Y/N	Comments
Occupied Spaces		
Concerns/symptoms from occupants.		
Are there complaints of too hot or too cold?		
Are occupants using portable fans, heater, humidifiers?		
Any noticeable odours?		
Is it stuffy?		
Any obstructions (partitions, screens) blocking ventilation grills, thermostats?		
Any signs of inadequate cleaning?		
Is there any air movement through the supply diffusers?		
Are there dust marks around ceiling diffusers or return air grills?		
Does glare appear to be a problem?		
Any cleaning chemicals? Pesticides/herbicides for indoor plants?		
Any office equipment that may require special ventilation?		
Are there any visible signs of water leakage or condensation?		
Ventilation System		
Air intake locations close to potential contaminant sources, e.g. building, washroom, boiler exhausts, loading dock?		
Humidification system? Drain pans clean?		
Filters in the ventilation system?		
Carbon Monoxide – Combustion Products		
Does the building contain an internal parking garage?		
Does the building contain an internal loading dock?		
Does the building contain a gas-fired heating system?		

Appendix 3 – Indoor Air Quality and Comfort Parameters

These parameters are intended to provide employees with a comfortable and healthy indoor work environment and should be applied by individuals who are trained to conduct IAQ investigations and interpret the results (i.e. technical/professional resources in Appendix 2).

Temperature(1)	22 ^{o}C with a 2 ^{o}C upswing at peak outdoor design temperature (summer) in air-conditioned buildings.
Relative Humidity(1)	20% at outdoor temperature of -35 ^{o}C 30% at outdoor temperature >0 ^{o}C 60% maximum Note: May not be achievable in some buildings due to design limitations.
Carbon Dioxide(1)	800 ppm(2)
Carbon Monoxide(1)	5 ppm(2)
Total Dust	100 ug/m^3 (3)
Total Volatile Organic Compounds	5 mg/m^3 (3)
Formaldehyde	0.10 ppm
Nitrogen Dioxide	0.3 ppm(1)
Asbestos	0.05 f/cc(1)
Ozone	0.01 ppm
Radon	150 Bq/M^3
Office Lighting	500 – 750 Lux (maintained)
Computer Lighting	300 – 500 Lux (maintained)
Background Mechanical Noise Levels - General office area - Private office – Board Rooms	48 dBA 45 dBA 40 dBA
Airborne Fungi (Health Canada Guidelines)	150 CFU/ m^3 (3 or more species reflective of outdoor flora) 50 CFU/ m^3 (only one species other than cladosporium or alternaria) Up to 500 CFU/m^3 (summer if species is primarily Cladosporium or other tree/leaf fungi). **The indoor air should normally be qualitatively similar but quantitatively lower than outdoor air.**

Notes:

(1) Comfort parameters

(2) The above listed levels were developed from the Occupational Exposure Limits. For substances other than those listed above, a level of 1/10th of the Occupational Exposure Limit as identified in Table 2, Schedule 1 of the Alberta Occupational Health and Safety Code, should be used as a guideline.

(3) References used include applicable Health Canada guidelines, comfort levels established by the American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE), Alberta Infrastructure and Transportation's Technical Design Requirements for Alberta Infrastructure Facilities.

(4) Units of measurement:
- ppm = parts per million
- ug/m3 = micrograms per cubic meter
- mg/m3 = milligrams per cubic meter
- f/cc = fibers per cubic centimeter
- Bq/M3 = becquerel per cubic meter of air

Alberta Infrastructure and Transportation has a risk management program handbook providing detailed information on managing mould in indoor environments including an environmental health advisory, a safe operating practice for prevention and a safe operating practice for remediation. The indoor air quality guideline was also revised to reflect the latest information on mould. In particular the use of health resources are encouraged when discomfort persists after corrective action is not able to eliminate the problem.

For concerns about mould in indoor environments, air sampling does not have to be part of a routine assessment. Decisions about appropriate remediation strategies can usually only be made on the basis of a visual inspection. In addition, air sampling methods for some fungi are prone to false negative results and therefore cannot be used to definitively rule out contamination. Finally, interpretation of exposure data is complicated by the limitations of short sampling periods, high variability in indoor concentrations and a lack of standardization in sampling methods and equipment.

Air sampling may be useful as a secondary investigative tool under the following circumstances:

- There is evidence from a visual inspection or bulk sampling that ventilation systems may be contaminated. The purpose of such air monitoring is to assess the extent of contamination throughout a building. It is preferable to conduct sampling while ventilation systems are operating.
- The presence of mould is suspected (e.g. musty odours) but cannot be identified by a visual inspection or bulk sampling (e.g. mould growth behind walls). The purpose of such air monitoring is to determine the location and/or extent of contamination.
- There may be a desire to collect samples for a comparative purpose between the indoor and outdoor environments to see if the building envelope is amplifying the presence of mould. Outdoor air samples should be collected concurrently at an air intake, if possible, and at a location representative of outdoor air.

Personnel conducting the mould sampling must be trained in proper air sampling methods for microbial contaminants. A laboratory specializing in mycology should be consulted for specific sampling procedures and shipping instructions.

Alberta
Infrastructure and Transportation

Safe Operating Procedure
Mould Remediation

Mould in Indoor Environments
Risk Assessment and Management
Program Handbook

Prepared in conjunction with the
Alberta Research Council

June 2006

Safe Operating Procedure – Mould Remediation

Purpose

The purpose of this document is to provide remediation procedures in the event of mould presence. It also serves to mitigate mould exposure by building occupants and protect building maintenance staff where mould exposure may exist when maintenance activities are being performed. Exposure to moulds can be minimized by a combination of awareness of the potential existence of mould, use of personal protective equipment when removing mould and application of good maintenance practices.

Good maintenance practices can inhibit the growth of mould and provide early detection before the issue gets out of hand. Preventative measures are addressed in the ***Safe Operating Procedure – Mould Prevention.*** For information on the latest assessment of the health risk associated with mould indoors, refer to the latest ***Environmental Health Advisory – Mould in Indoor Environments***, produced by the Alberta Research Council.

Mould Description

Moulds occur naturally and can be found in soil, on plants, and decaying matter. Since they lack chlorophyll, they need organic material as a source of food to survive. When combined with water, oxygen and the correct temperatures, they are able to grow. Moulds reproduce by producing large numbers of spores that are not visible to the naked eye. These spores can be deposited on building materials such as textiles, carpet, drywall, wood, insulation and furniture. When mold spores encounter damp conditions they begin to grow and amplify eventually destroying the things they grow on by digesting them with enzymes.

Health Factors

To date, while there are associations between higher mould exposures and allergic reactions in more sensitive individuals (i.e. children, the elderly, those with pre-existing diseases or those whose immune systems are severely compromised), the evidence suggests that mould can be treated as a low health risk in the general population. Exposure to moulds can be through physical contact and ingestion but the main area of concern is through inhalation. The symptoms of exposure will vary depending on the individual and may include:

1. Decrease health related quality of life (e.g. feelings of well-being; increased stress, increased pain, decreased physical functioning)
2. Reversible loss of lung function in combination with increased presence of health-related or clinical symptoms (e.g. increased bouts of asthma)

Moulds may cause allergic effects depending on the type of mould and the person exposed. Anywhere from 5-15% of the general population with respiratory sensitivities and immune deficiencies may be effected to a larger extent than others. Thus, while mould is a low health risk to the general population, health concerns should be dealt with in a timely manner and responsive remediation is an important element a facility manager can use to manage the issue.

Sources of Mould Generation

- Previously water damaged areas left unattended.
- Water damage from renovation of washrooms, shower areas and other plumbing modifications
- Standing water areas in air plenums, cooling coils and filter banks.
- Leaks around window and door unit jambs allowing outside water penetration.
- Water damaged ceiling tiles.
- Roof leaks at wall/roof junctions, around ventilation units and other roof penetrations.
- Damp crawl spaces

Personal Protective Equipment Requirements

1. Wear protective gloves (polyvinyl chloride or latex).
2. Wear P100 respirator in lightly infested areas
3. Wear personal protective half face negative pressure respirator in heavily contaminated areas, in enclosed areas and during clean up.
4. Make sure personal half masks fits ***securely*** and is fit tested and is in good working order.
5. During clean up wear rubber boots or disposable shoe covers, tyvek coveralls and protective goggles and gloves.

Safe Work Practices (Key Steps) for Mould Remediation

The degree of intervention, the effort required for containment, and the level of personal protection required for workers will depend on the area size of the mould present and the health response of the building occupants. If there are no health effects observed, remediation of small isolated areas (less than 1 M^2) can generally be carried out by building maintenance staff if they are trained in remediation and have no medical record of suffering from asthma or other respiratory ailments. Training should include information on proper clean-up methods, personal protection and potential health hazards. If staff are not adequately trained, mould quantities are large, or situations in which health effects have been observed, professional specialists should be involved.

A number of guidelines listed on Page 7 under “References” were reviewed for practice information to ensure this safe operating procedure was based on a review of multiple guidelines approved and in use. The New York Guideline were used as the basis for the remediation levels below. They are divided into four levels for the building envelope and two levels for HVAC systems.

Remediation Levels Within Buildings

Remediation depends primarily on the scale, or size, of the mould growth. Mould growth is classified with appropriate measures or procedures established for each level. For building finishes and components (e.g., drywall, ceiling tile, carpet, etc.) the levels are as follows:

Level I (Small Isolated Areas): Areas less than 1 square metre (10 square feet)*
Level II (Mid-Sized Isolated Areas): Areas between 1-3 square metres (10-30 square feet)*
Level III (Large Isolated Areas): Areas greater than 3-10 square metres (30-100 square feet)*
Level IV (Extensive Contamination): Areas greater than 10 square metres (>100 square feet)*

When determining the appropriate remediation level, it is important to consider both the total area affected (the perimeter of affected materials) and the density of the mould growth.

The use of gaseous, vapor-phase, or aerosolized biocides for remedial purposes is **not** recommended. The use of biocides in this manner can pose health concerns for people in occupied spaces of the building and for people returning to the treated space if used improperly. Furthermore, the effectiveness of these treatments is unproven and does not address the possible health concerns from the presence of the remaining non-viable mould.

Level I - Remediation of Small Isolated Areas (Less than 1 sq.metres (10 sq. feet))

e.g., ceiling tiles, small areas on walls

Regular building maintenance staff, provided they are not asthmatic, may perform remediation. Workers should be well informed about the hazards of mould abatement, and their training should include the use of personal protection and proper clean-up methods. Eating, drinking or smoking is prohibited in the work area.

Such persons should receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the Alberta Occupational Health & Safety Standard.

1. Respiratory protection (e.g., P100 respirator), in accordance with the respiratory protection standard (CSA Standard Z94.4), is recommended. Gloves and eye protection should be worn.
2. The work area should be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons recovering from recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity pneumonitis, and severe allergies).
3. Containment of the work area is not necessary. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
4. Contaminated materials that cannot be cleaned should be removed from the building in a sealed plastic bag. There are no special requirements for the disposal of mouldy materials. They can be disposed of as common household waste.
5. The work area and areas used by remedial workers for egress should be cleaned with a damp cloth and/or mop and a detergent solution.
6. All areas should be left dry and visibly free from contamination and debris.

Level II – Mid-Sized Isolated Areas (1 - 3 sq. metre(10 – 30 sq. feet))

e.g., individual wallboard panels.

Regular building maintenance staff, provided that they are not asthmatic or suffer any type of respiratory ailments, can conduct remediation. Such persons should receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the Alberta Occupational Health & Safety Standard.

1. Respiratory protection (e.g., P100 respirator), in accordance with the OSHA respiratory protection standard (CSA Standard Z94.4), is recommended. Gloves and eye protection should be worn.

2. The work area should be unoccupied. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity pneumonitis, and severe allergies).
3. The work area should be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
4. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
5. Contaminated materials that cannot be cleaned should be removed from the building in sealed plastic bags. There are no special requirements for the disposal of mouldy materials. They can be disposed of as common household waste.
6. The work area and areas used by remedial workers for egress should be HEPA vacuumed (a vacuum equipped with a High-Efficiency Particulate Air filter) and cleaned with a damp cloth and/or mop and a detergent solution.
7. All areas should be left dry and visibly free from contamination and debris.
8. Involve Alberta Infrastructure Building Environment Unit for investigation of areas over one (1) square metre. Contract documents and project management will be directed through this resource.

Level III – Large Isolated Areas (3 - 10 square metres (30 – 100 Sq. Feet))

e.g., several wallboard panels.

A health and safety professional with experience performing microbial investigations should be consulted prior to remediation activities to provide oversight for the project. The following procedures at a minimum are recommended:

1. Personnel trained in the handling of hazardous materials and equipped with respiratory protection, (e.g., P100 respirator), in accordance with the respiratory protection standard (CSA Standard Z94.4), is recommended. Gloves and eye protection should be worn.
2. The work area and areas directly adjacent should be covered with a plastic sheet(s) and taped before remediation, to contain dust/debris.
3. Seal ventilation ducts/grills in the work area and areas directly adjacent with plastic sheeting.
4. The work area and areas directly adjacent should be unoccupied. Further vacating of people from spaces near the work area is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity pneumonitis, and severe allergies).
5. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
6. Contaminated materials that cannot be cleaned should be removed from the building in sealed plastic bags. There are no special requirements for the disposal of mouldy materials. They can be disposed of as common household waste.

7. The work area and surrounding areas should be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
8. All areas should be left dry and visibly free from contamination and debris.
9. If abatement procedures are expected to generate a lot of dut (e.g. abrasive cleaning of contaminated surface, demolition or plaster walls) or the visible concentration of the fungi is heavy (blanket coverage as opposed to patchy), then it is recommended that the remediation procedures for Level IV are followed.

Level IV – Extensive Contamination (greater than 10 contiguous square metres in an area)

A health and safety professional with experience performing microbial investigations should be consulted prior to remediation activities to provide oversight for the project. The following procedures are recommended:

1. Personnel trained in the handling of hazardous materials equipped with:
    a. Full-face respirators with high efficiency particulate air (HEPA) cartridges
    b. Disposable protective clothing covering both head and shoes
    c. Gloves
2. Containment of the affected area:
    a. Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and any other openings)
    b. The use of an exhaust fan with a HEPA filter to generate negative pressurization
    c. Airlocks and decontamination room
3. Vacating people from spaces adjacent to the work area is not necessary but is recommended in the presence of infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity pneumonitis, and severe allergies).
4. Contaminated materials that cannot be cleaned should be removed from the building in sealed plastic bags. The outside of the bags should be cleaned with a damp cloth and a detergent solution or HEPA vacuumed in the decontamination chamber prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of mouldy materials. They can be disposed of as common household waste.
5. The contained area and decontamination room should be HEPA vacuumed and cleaned with a damp cloth and/or mop with a detergent solution and be visibly clean prior to the removal of isolation barriers.
6. Air monitoring should be conducted prior to occupancy to determine if the area is fit to reoccupy.

Remediation of HVAC Systems

HVAC systems include central or main systems, rooftop and compartmental units, ventilators, heat pumps, induction, convection and fan-coil units (within the occupied space or ceiling), air supply ductwork, variable air volume (VAV) boxes, and the return air system. Internal HVAC system components that become contaminated with active mould growth, spores, associated contaminants or must be cleaned or replaced. Two levels are described in the following levels Level I, Level II.

HVAC Level I – Small contamination areas, under 3 m²

The following procedures may be utilized in remediation of small areas within the HVAC system. Regular building maintenance staff can conduct remediation. Such persons should receive training on proper clean up methods, personal protection, and potential health hazards. This training can be performed as part of a program to comply with the requirements of the Alberta Occupational Health & Safety Standard.

1. Respiratory protection (e.g., P100 respirator), in accordance with the OSHA respiratory protection standard (CSA Standard Z94.4), is recommended. Gloves and eye protection should be worn.
2. The HVAC system should be shut down prior to any remedial activities.
3. The work area should be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
4. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
5. Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, should be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. There are no special requirements for the disposal of mouldy materials.
6. The work area and areas immediately surrounding the work area should be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
7. All areas should be left dry and visibly free from contamination and debris.
8. A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as cooling coils and condensation pans. HVAC manufacturers should be consulted for the products they recommend for use in their systems.

HVAC Level II – Larger contamination areas (3 m² or more)

A health and safety professional with experience performing microbial investigations should be consulted prior to remediation activities to provide oversight for remediation projects involving more than a small isolated area in an HVAC system. The following procedures are recommended:

1. Personnel trained in the handling of hazardous materials equipped with:
    a. Respiratory protection (e.g., P100 respirator), in accordance with the OSHA respiratory protection standard (CSA Standard Z94.4), is recommended.
    b. Gloves and eye protection

   c. Full-face respirators with HEPA cartridges and disposable protective clothing covering both head and shoes should be worn if contamination is greater than 3 square metres.
2. The HVAC system should be shut down prior to any remedial activities.
3. Containment of the affected area:
   a. Complete isolation of work area from the other areas of the HVAC system using plastic sheeting sealed with duct tape.
   b. The use of an exhaust fan with a HEPA filter to generate negative pressurization.
   c. Airlocks and decontamination room if contamination is greater than 3 square metres (30 sq. feet).
4. Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, should be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. When a decontamination chamber is present, the outside of the bags should be cleaned with a damp cloth and a detergent solution or HEPA vacuumed prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of mouldy materials. They can be disposed of as common household waste.
5. The contained area and decontamination room should be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution prior to the removal of isolation barriers.
6. All areas should be left dry and visibly free from contamination and debris.
7. Air monitoring should be conducted prior to re-occupancy with the HVAC system in operation to determine if the area(s) served by the system are fit to reoccupy.
8. A variety of biocides are recommended by HVAC manufacturers for use with HVAC components, such as cooling coils and condensation pans. HVAC manufacturers should be consulted for the products they recommend for use in their systems.

References

- New York City Department of Health, Guidelines on Assessment and Remediation of Fungi in Indoor Environments, 2002

- EPA Mold Remediation in Schools and Commercial Buildings, June 2001

- Manitoba Department of Labour, Guidelines for the Investigation, Assessment, & Remediation of Mould, March 2001

- Health Canada, Fungal Contamination in Public Buildings: A Guide to Recognition and Management, June 1995, 2004

- The Canadian Construction Association, Mould Guidelines for the Canadian Construction Industry, 2004