



Mould guidelines for the Canadian construction industry

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FOREWORD

Mould is ubiquitous to the natural environment and plays an important part in the natural decomposition (recycling) of organic materials.

In the built environment, mould may damage wood, wallboard and other materials and causes them to rot. The growth of mould on materials in the built environment may affect human health, depending on the extent of growth, the length of exposure, and the health status of the exposed personnel. Many regulatory agencies consider mould growth to be a health hazard; therefore, there has been an increase in litigation in Canada directed to those involved in the construction and maintenance of buildings. In the absence of national guidelines or legislative remedies, courts have been left to define the extent of contractors' and other parties' responsibility concerning mould growth and exposure.

In June 2002, the Canadian Construction Association (CCA) created a mould taskforce to develop national guidelines to assist contractors in minimizing the potential for mould growth and instituting effective remediation practices. A technical review and update of the document was conducted during the first quarter of 2018. This document is the product of that work. These national guidelines provide useful information and step-by-step instructions in the following areas:

- 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.

DISCLAIMER

This guide incorporates technical data and other information relating to mould, which the CCA received from third parties. This guide provides general information only. CCA does not warrant the accuracy of the information, and users of the guide rely upon the information at their own risk. CCA accepts no responsibility for any loss, damage, injury, or consequential damages to persons or property arising out of or connected with the use of this guide. Project construction, building systems, maintenance, and repairs are highly technical, and qualified and trained persons should assess risks and initiate action in accordance with the unique requirements of a project or situation, and in accordance with their own skills and professional judgement.



1.0 INTRODUCTION

Over the past number of years, the private, commercial, industrial, and institutional sectors, as well as the public at large have become increasingly concerned about the potential health risks of mould.

Due to the media's coverage of the possible health risks of mould in schools, courthouses, homes, and other public and private buildings, and the associated legal issues and insurance claims, mould has continued to be a topic of concern.

This has placed increased pressures on building managers, safety committees, directors, contractors, consultants and owners to properly assess the effects of mould and to implement proper prevention, clean-up and remediation practices and procedures.

The scientific and public health communities agree that indoor mould contamination is a health issue for some individuals and, therefore, visible mould growth (of any quantity) should be removed. It is also understood, that it is currently impossible to establish safe mould exposure thresholds for each jurisdiction due to the wide variation in naturally occurring mould spores in the outdoor environment based on ecological zone, temperature, and time of the year.

Incurring mould growth during construction will have a negative consequence on scheduling, costs, client relations and occupancy.

In order to minimize mould growth and associated health risks, all aspects of a construction project should be reviewed. This includes the design, specifications, material selection and handling, construction work practices, scheduling, operations and maintenance.

Minimizing water intrusion during construction and developing a proactive plan to effectively deal with wet construction materials are also important considerations.

As construction professionals, understanding mould related issues is vital to achieving successful projects and minimizing associated liabilities. This document is intended to provide stakeholders with information to assist them in understanding some of the issues associated with mould, as well as their own roles and responsibilities, and the decisions that can significantly increase or decrease associated risk factors.

1.1 Key roles and responsibilities

Design professionals (e.g. architects and engineers) are responsible for the design of a building's envelope, its heating, ventilating and air conditioning (HVAC) system, and other mechanical systems and components, including design details that could potentially promote or limit mould growth.

Construction contractors are responsible for the proper handling and storage of construction materials at the worksite, managing water intrusion episodes, and for monitoring that their employees and subcontractors perform in accordance with the plans, specifications, and other contract requirements. Both design professionals and building owners are responsible for the building materials and systems they select and specify.

Owners are also responsible for the usage, operation and maintenance of a building following its completion.



2.0 LEGAL OVERVIEW

Mould in indoor environments has been compared to the asbestos crises that occurred in the construction and renovation industry years ago. Whether the two are comparable is still open to debate. What is obvious, however, is the media's and legal profession's increasing interest in mould and its possible risks. As a result, people are more aware of their legal rights, and quicker to act on them.

Looking at the U.S. experience with mould claims, it is likely that mould will continue to be a significant legal issue in Canada and will result in a growing number of claims by owners and occupants against those involved in the construction process. Several large actions have occurred involving contractors, subcontractors, design professionals, material suppliers, and maintenance entities.

For federal/provincial regulators, mould is a significant occupational health and safety issue, as well as a public health issue. Most jurisdictions have issued alerts or bulletins concerning the hazards of mould growth in indoor environments. Employers are required to take all reasonable measures to protect the health and safety of their workers, which includes a duty to protect against exposure to potentially harmful substances such as mould. These measures require the immediate and safe removal of any mould growth in buildings, while ensuring the protection of workers, building occupants, and the surrounding environment. Although the health risks of mould exposure are not fully known, scientific and health authorities agree that exposure should be avoided.

Employers must be duly diligent and ensure that their policies and procedures demonstrate full commitment to worker safety. Due diligence is also required to protect the construction industry from the consequences of civil claims relating to mould damage and the potential health risks of mould exposure.

We believe that a proactive response to the issues surrounding mould in indoor environments is appropriate and will assist our industry in managing the legal risks presented by the growing concerns over mould.



3.0 INSURANCE OVERVIEW

3.1 Insurance industry's position

Generally, the insurance industry's position is that mould is not covered under commercial insurance policies. Endorsements specifically excluding mould were added to clarify coverage under Commercial Property and Liability Policies – generally at renewal dates of policies on or after January 1, 2003.

Insurers recognized the need to specifically exclude mould following the outcome of a number of court cases in Canada and the U.S. The courts' interpretation of insurance policy wordings led insurers and their reinsurers to clarify the intent of policies by specifically stating that mould is excluded. Some insurers are more restrictive than others, and each policy should be carefully reviewed to confirm the extent of coverage and exclusions.

3.2 Property and business interruption (e.g., builder's risk, installation floaters, equipment, owned property (such as buildings and contents), extra expense).

The standard mould exclusion used by most insurers:

- Excludes loss or damage consisting of or caused directly or indirectly, in whole or in part, by mould or spores, unless such mould or spores are directly caused by or directly result from a peril otherwise insured and not excluded under the policy.
- Excludes costs or expenses for any testing, monitoring, evaluating or assessing of mould or spores.
- Provides limited coverage for mould and spores if damage results from another insured peril (such as fire).

However, not all insurers provide the limited cover referred to in the third bullet above. Some have ABSOLUTE exclusions. Each insurance policy should be carefully reviewed for mould provisions.

Some insurers may also be willing to pay for expenses incurred for testing following an otherwise insured loss to ensure that remediation work is done properly. Again, it is important to review each policy to determine whether coverage may be available.

3.3 Liability

General liability policies provide insurance to cover the insured's legal responsibility for bodily injury of other people or property damage to other people's property.

Under this type of policy, three options are typically available with respect to mould:

1. Absolute exclusion, using wording such as the following:
Excludes bodily injury, property damage, personal injury or medical payments or any other cost, loss or expense incurred by others, arising directly or indirectly from the actual alleged or threatened inhalation of, ingestion of, contact with, exposure to, existence of, presence of, spread of, reproduction, discharge or other growth of any mould or spores, however caused, including any costs or expenses incurred to prevent, respond to, test for, monitor, abate, mitigate, remove, cleanup, contain, remediate, treat, detoxify, neutralize, assess or otherwise deal with or dispose of mould or spores, or
Any supervision, instructions, recommendations, warnings or advice given, or which should have been given in connection with above, or
Any obligations to pay damages, share damages with or repay someone else who must pay damages because of such injury or damage.



- 2 Limited coverage, possibly with a sublimit and/or annual aggregate limit
Coverage may be provided with respect to products and completed operations as opposed to ongoing work, and for work or operations performed by the insured or on the insured's behalf to premises he/she owns, rents, or occupies.
- 3 No endorsement, that is, the policy is silent with respect to mould.

It is likely that the absolute exclusion will be included in policies for the construction industry.

3.4 Home insurance

Personal insurance for homes, condominiums, or apartments has excluded mould, a few policies may have limited coverage amounts.

3.5 Examples of possible insurance claims

- Contractor completes a building, and two years later, mould develops with no specific incident noted to cause the mould. Building owner sues contractor, and the insurance policy does not respond.
- Plumbing contractor works in new or existing building. Work is not completed correctly (e.g., pipe joints not sealed, etc.). Mould subsequently develops because of leakage. Building owner sues for damage to building, and tenant sues for resulting health problems. Insurance policy does not respond to either claim.
- Fire occurs in a recently-constructed building. Mould develops as the result of water used to put out fire or from improper clean up. Building owner seeks recovery of costs. Building owner's property policy responds because mould developed as a result of the fire (an insured peril under the policy). In the event that the building was not fully complete, the Builders Risk Policy should then respond.

It is also important to note that if the building owner's insurer responded, that insurer might pursue recovery (subrogate) from the contractor if it could be proven that the contractor's negligence had contributed to the cause of the fire. Depending on his / her insurance policies, the contractor may or may not have coverage.

- A condominium corporation hires a building science consultant to assess and provide designs to repair a deteriorated building envelope. The consultant neither assesses for mould nor includes the costs of mould abatement in the repair budget. A contractor is retained to perform the repairs and, early in the project, when hidden mould is identified, the public health office issues orders for extensive abatement. The condominium board is sued by a class of owners over escalating repair costs and reduction in property values; the board in turn sues the consultant. The insurers for both the condominium board and the consultant refuse coverage for legal fees and damages, citing the pollution exclusion clause. (It is important to note that if the property policy had an Absolute Pollution exclusion, the policy would not respond, and again there would be no insurance coverage.)
- A building owner hires a mould remediation contractor to remove mould on one floor of multi-unit building, the contractor provided proof of mould pollution liability coverage at the time the work was completed but ceased operations 2 months after the project was completed. Six months later office workers on the floor above complain of respiratory issues and are unable to work in the space. It is determined the contractor exposed the workers on the above floors to mould because of improper work. The building owner is sued by the occupants for bodily injury and financial losses due to the mould contamination. The building owner looks for the contractor to indemnify and defend them against the lawsuit. The contractor is no longer in business and the contractor's "claim made" mould policy does not respond.

It is important to note that if the property policy had an Absolute Pollution exclusion, the policy would not respond, and again there would be no insurance coverage.



3.6 Recommendations

The prevalence of contractor's pollution insurance has grown since 2003 as building owners have become more aware of the exposure and how inadequate insurance coverage by the contractor in a claims scenario can quickly fall back to the building owner. Most larger public and private sector building owners have been managing the risk of mould remediation project by engaging with professional specialist consultants and contractors.

A contractor or building owner, when hiring a mould remediation contractor or environmental consultant, should determine whether the service provider's insurance includes mould coverage specifically. Pollution liability insurance is not sufficient in its self as most policies require a mould endorsement to be specifically added.

Mould inclusive insurance is recommended for all levels of mould remediation.

The recommended coverage on mould remediation project should always require the remediation contractor to provide mould-specific coverage on an occurrence basis, lesser policies provided on a claims made-basis should be avoided.



4.0 DEFINING MOULD

The term “mould” applies to a large group of microorganisms, which, together with mushrooms and yeast, form the mould kingdom of living matter. Over 100,000 individual species of mould have been identified and biologists estimate there may be over 1.5 million species worldwide. Unlike plants, mould does not produce chlorophyll. They get nutrients from surrounding organic substrates such as wood and wood products, fabrics, foodstuffs, plants and plant debris, and soil. Mould is found everywhere in nature and plays a vital role in balancing ecology. Mould is one of the principal decomposers of organic matter and through the decomposition process, essential nutrients are made available to other organisms. Mildew is a common term applied to a variety of mould that grow on plants or household items under damp conditions.

Most mould reproduce by forming large numbers of spores. Mould spores are always present outdoors and in buildings, and are distributed by wind, insects, floods, animal and human activity. All buildings have a background concentration of settled spores. Three essential conditions for mould growth are a suitable temperature, appropriate substrate, and adequate moisture. Some species of mould grow even in extreme temperatures, for example, just above the freezing point of water and up to temperatures of at least 40 degrees C. Mould will colonize on a wide variety of construction materials and building contents, the most common being drywall, wood and wood products, ceiling tiles, wallpaper, and carpets. Exposed soil within a building (e.g., a dirt crawlspace) is another area of potential mould growth. While some inorganic materials such as fiberglass insulation or plaster and other masonry products may not themselves support mould growth, they may contain dirt or have surface coatings that support growth. The presence of moisture may be due to either flooding (e.g., a rain storm or broken pipe), or conditions of relative humidity and condensation which can result in trapped moisture in a wall cavity, cold sections of air conditioning equipment and ductwork, or cool surfaces in unventilated, unheated areas. By their very nature, construction sites are prone to wetness or uncontrolled humidity.

Mould spores can survive without moisture, when frozen or without a food source. Under favorable conditions, these spores develop into mould colonies that can grow rapidly. The spores first develop a root-like structure called hyphae within hours of wetting. These hyphae grow into an intertwining network called mycelium and finally mould colonies that are visible in as early as 48 hours. Mould growth on building finishes and contents normally appears as a pattern of black, green or grey spotty circular growth or as masses of fine, white, fluffy growth. Generally, once the conditions of adequate moisture have been established, many types of mould may colonize a surface. A musty, earthy odour is often present as the mould grows. Mould growth may produce billions of spores per square metre of visible growth which, when airborne, may pose a potential health risk. Some mould also produces metabolic by-products called mycotoxins. Mycotoxins are known to be acutely toxic and have a wide range of adverse health effects.



5.0 HEALTH RISKS

5.1 General

High-level, short-term exposures and lower-level, long-term exposures can result in adverse health effects. The most common symptoms from exposure to mould in indoor environments are runny nose, eye irritation, cough, congestion, aggravation of asthma, headache, flu-like symptoms, fatigue, and skin rash. In terms of human health risk, Health Canada in 2007 wrote that mould in buildings may present a health hazard and that health risk depends on mould exposure, for asthma symptoms, on allergic sensitization. However, the lack of dose-response relationships for adverse health effects, the large variety of mould species, and the large variation in individual vulnerability, prohibits the use of air sampling to assess human health risk. As a result, Health Canada (2007) recommends removing and cleaning all visible and concealed mould, regardless of mould species.

People with suppressed immune systems, the elderly, and the very young are at the greatest risk to mould infections as a result of exposure to indoor mould.

5.2 Susceptibility to mould exposure

Not everyone experiences allergic reaction; susceptibility varies with the individual's genetic predisposition, age, state of health, and concurrent exposures. Because individual responses vary, it is not possible to establish "safe" or "unsafe" levels of airborne mould spores. Federal and provincial policies have been written to minimize mould exposure and the elimination of mould indoors. Mould in health care and long-term care facilities may pose a greater risk, due to the high proportion of occupants to elevated sensitivities to mould.

People with specific health concerns should consult their doctor if concerned about mould exposure. Symptoms that may appear to stem from mould exposure may be due to other causes.

5.3 Relocation of personnel

Individuals with elevated susceptibility and/or immune-compromised should be removed from the affected and directly adjacent area during remediation to prevent any potential exposure to mould spores. Occupants that have no underlying health issues may remain in areas outside the isolated construction and mould remediation work areas. This should be reviewed by the project team on a project case by case basis.



6.0 CONSTRUCTION PRACTICES TO MINIMIZE MOISTURE INTRUSION

6.1 General

The key to dealing with mould – and with the rising tide of public concern and adverse publicity that surround the issue – lies in prevention. Mould requires three key components to survive, specifically a nutrient source or growth medium, a source of moisture, and the proper environmental conditions (e.g., temperature). Many construction materials contain enough organic material to cultivate mould when wet and within the suitable temperatures. Mould is frequently found on wet paper used in gypsum wallboard and other materials with a high cellulose content.

Although it is not possible to completely eliminate mould spores and nutrients from the construction process, it is possible to control the other element that promotes mould growth - moisture. Mould needs moisture to grow; without excess water or humidity, mould growth will not occur. This is not an easy task; however, controlling moisture during the construction process poses significant challenges to the designers, consultants, contractors, and owners who must work closely together to successfully complete the project.

6.2 Building design considerations

Mould prevention is the joint responsibility of the three key stakeholders in a building project, specifically the designers, builders, and operators/owners. The failure of any stakeholder to exercise due diligence may result in a mould-contaminated facility, with the inherent loss of use, costly remediation, and possible long-term litigation. Guidelines for preventing mould in new construction and in the operation of building systems are discussed in later sections of this document.

Not all contractors operating in the design-build sector have a thorough knowledge of proper design principles, some do not. Nevertheless, builders must be aware of the importance of proper HVAC design, architectural detailing, and the selection of suitable systems and materials in the prevention of mould in a building.

It is unreasonable to expect the builder to carry the entire burden of mould prevention for a project. Builders are responsible for proper material handling and workmanship but should never accept responsibility for inadequate detailing or specification. Designers are duty-bound to provide proper detailing, systems design, and material selection to prevent water intrusion or condensation that results in mould growth and contamination. Building operators must establish, as part of a complete facility operations and maintenance plan, detailed guidelines on maintenance and inspection for the prevention and early detection of mould.

Project or construction managers, whether part of the design team, should give careful consideration to the timing and scheduling of the project, and advise the owner of any increased risks due to accelerated schedules. It is critical to acknowledge that construction during damp / rainy seasons may result in the exposure of building materials to moisture, thereby increasing the potential for mould growth.

Even with a weather-tight completed building envelope, concrete floor curing or plastering processes can release excess moisture within a building. If a suitable ventilation or drying process is not specified, drywall surfaces and wood structures that are particularly sensitive to moisture absorption are likely to facilitate mould growth.

Designers who recognize the risks of exposing materials to moisture during construction or during building operation can make appropriate material choices to reduce the risk of potential mould growth.

In response to industry demands, manufacturers of interior finishing products have developed “mould resistant” materials. Wallboard manufacturers are producing moisture-resistant gypsum board faced with a glass mat instead of paper for use when exposure to moisture can occur. Some ceiling tile manufacturers now offer tiles that incorporate a mould inhibitor, and anti-mould silver ion-based paints are available to coat sheet metal to minimize mould growth in ductwork



Builders have the right to ask designers for details of the project water intrusion and mould prevention plan. If no such plan exists, the builder should inform the designers that mould prevention is a joint responsibility of the designer, builder and owner. Given the growing awareness of the potential hazards of mould contamination in buildings, owners and designers must today be acutely aware of detailing or systems engineering practices that led to mould problems in the past. In the early 1980's, for example, many buildings were made "air-tight" but without the benefit of adequate ventilation to control humidity. The resulting problems due to mould contamination are well documented in industry and legal publications.

6.2.1 Architectural detailing and practices

Many mould-contaminated buildings suffer from chronic leaking through exterior wall and roof systems, sometimes as a result of poor detailing of penetrations or entire assemblies. Proper "rain-screen" design principles and details are essential in the Canadian environment to permit the escape of rainwater that penetrates the exterior surface.

Progressive designers will stipulate that the builder constructs mock-ups of critical assemblies such as windows prior to installation. This is crucial to an effective quality management plan and allows the designer and builder to demonstrate the validity of the design or to expose problems with detailing that might permit a leak. The mock-ups will ensure suitable flashing, insulation, caulking, and air barrier installation; the completed and approved mock-up is then left on the site to serve as the standard for all future installations.

6.2.2 Role of HVAC designer

Proper design principles can reduce the risk of the heating, ventilation, and air conditioning (HVAC) system contributing to mould growth in a building. Various publications by respected industry bodies such as the American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE) outline good practices for ductwork design, cooling for dehumidification, and proper installation of humidification systems to reduce moisture in ductwork and the likelihood of mould growth (see, e.g., the ASHRAE publication, "Humidity Control Design Guide for Commercial and Industrial Buildings-2001").

The HVAC designer should also provide input on the final operation and maintenance guidelines for the specified systems and equipment and should actively participate in the commissioning process, thereby ensuring that building operators understand their role and responsibility in mould prevention.

Should the project permit or require the builder to operate the permanent HVAC system during construction, it must be specified that the equipment be turned over upon project completion in clean condition.

6.3 Construction considerations

6.3.1 General considerations

Construction contractors should follow approved methods, procedures and scheduling best practices to minimize the potential for mould growth. Specifically, contractors should reject wet or mouldy materials, prevent the exposure of clean/dry interior building products to exterior conditions, protect stored/staged materials from moisture and minimize moisture accumulation in built spaces. Contractors should have written plans in place, prepared in consultation with design teams, to prevent water from spilling/accumulating in the building and, once built, should maintain the integrity of building envelope components through ongoing monitoring and regular inspections.

Once the building has been completed and prior to occupancy, the contractor should strive to control the balance of thermal comfort and relative humidity in the building, maintaining both parameters in the range provided by the ASHRAE or equivalent. During commissioning and handover, contractors should monitor installations to ensure no water intrusion and that all areas remain clean and dry, including a final check of the HVAC system after it has been running in a balanced condition.



6.3.2 Administrative controls and record-keeping

Administrative controls and good record keeping provide useful resources for onsite personnel to prevent and address mould growth. In addition to standard safety plans that address responses to observed mould growth, contractors should prepare written environmental/moisture control plans which specify the methods and procedures to be used to prevent water/moisture accumulation and mould growth. Prevention is generally cost-effective, faster and more effective than response actions after water intrusion or mould growth has occurred.

Included in the plan should be a discussion of best practices, forms for documenting water intrusion (incident reports), for rejecting unfit shipments (non-conformance reports), and for documenting routine inspections. Records should be kept in a secure location at the site, and the information contained in the plans and records should be communicated to all site staff during site/worker orientations.

6.3.3 Worker orientations

Worker orientations should be provided for every individual who will be working at the site (e.g., employees, consultants, subcontractors, inspectors), and records maintained to document the content of the orientation and who have been trained. In addition to other health and safety and site-specific issues that should be covered in the orientation, contractors should include information relating to moisture control and mould growth. Generally, the orientation should include a high-level review of the written environmental/moisture control plans including what actions are to be undertaken if mould is discovered. Workers should be informed of the effects of mould exposure and that no wet or mouldy building materials are to be installed.

NOTE: Subcontractors who conduct their own worker orientations must provide a similar review of the information in the environmental/moisture control plan to their workers and must document that the information has been provided.

6.4 Scheduling considerations

To effectively minimize moisture intrusions, owner(s), designer(s), consultants, and construction contractors must work together. It is particularly important that all parties analyze the construction schedule because it dictates the installations for the project and when they are to occur.

Generally, the earlier the construction schedule requires a contractor to begin finishing the interior, the greater the risk of permitting water to enter or accumulate on materials that accommodate mould growth.

There are three stages of construction: the exposed phase, the partially-enclosed phase, and the controlled phase. If the goal is to achieve the lowest level of risk, then the single most important point in the construction schedule may be the point at which the contractor seals the building envelope.

During the exposed and partially-enclosed phases, to minimize the potential for mould growth, it is important to minimize the risk of water damage and wet surfaces due to external factors such as rain, snow, flooding, and high relative humidity. The installation of protective barriers or temporary enclosures across building envelope openings (walls, roof, and basement) and open areas to accommodate construction elevators/hoists, window installation, etc., is recommended. The use of water-resistant materials in areas susceptible to moisture also reduces the risk of mould growth. These decisions affect both the construction cost and schedule and should be fully considered. Wet areas should be reported immediately, and steps taken to dry the materials within 24 hours.

Sequencing of construction and fit-up materials is critical during the controlled phase. Concrete walls, beams and floors, wooden structural components, gypsum moldings, and other materials must be allowed to completely dry without being covered or hidden. Placing a floor or ceiling over a wet concrete floor can result in mould growth. Installation of drywall on or near concrete that is being cured, or adjacent to sprayed-on insulation, or within an area of high relative humidity, will result in water damage.



Drying techniques using fans, natural ventilation, heaters, dehumidifiers, desiccant dehumidifiers, and the HVAC system, if operational, have unique limitations. These methods should be reviewed and used appropriately to reduce the potential of interior mould growth during construction.

6.4.1 General considerations

Construction contractors should consider the following to minimize the potential for mould growth:

- minimizing the exposure of interior building products to exterior conditions;
- protecting stored materials from moisture;
- minimizing moisture accumulation within the building;
- preventing spillage of water within the building;
- maintaining the integrity of the building envelope components through ongoing monitoring and inspections;
- achieving balance control of thermal comfort and relative humidity in the building;
- checking all material deliveries to validate that components are dry and clean;
- rejecting wet or mouldy materials, and;
- monitoring installations to ensure they remain clean and dry (including the HVAC systems).

6.4.2 Administrative controls and record-keeping

Administrative controls and record keeping are useful resources in the prevention of mould growth because they provide working tools for on-site personnel. These may include:

- a written project environment and safety plan which identifies mould prevention practices and procedures;
- incident report forms for documenting water intrusion incidents;
- non-conformance report forms identifying rejected wet materials;
- inspection forms; and
- tailgate meeting forms where topics for water intrusion prevention can be communicated and documented.

6.4.3 Worker orientations

Where construction work is to be performed on any facility, it is extremely important that workers be informed of the following at worker orientation sessions:

- exposure to mould may cause adverse health effects;
- if mould is found, work in the affected area is to be stopped and the worker is to report the mould finding to his/ her supervisor immediately;
- mould must not be disturbed because it may become airborne and contaminate or impact other areas;
- wet construction materials must not be installed unless part of an approved process;
- mouldy construction materials must not be installed; and
- workers must report wet or mouldy construction materials immediately so proper corrective measures (drying, cleaning or replacement) can be implemented.

NOTE: Subcontractors who conduct their own worker orientations must provide the above information to their workers and must document that the information has been provided.



6.5 Subcontractors / suppliers

Contract and purchase order specifications should require that materials be delivered dry and kept clean and dry at all times, including during storage and transportation.

6.6 Drying of wet materials

If water intrusion occurs, every reasonable effort should be made to commence procedures to extract water and dry out wet materials within 24 hours from the time when it is reasonably practical to stop the water intrusion. Drying procedures start with the use of air movement and thermal energy transfer to the wet materials. Dehumidification or ventilation must be in place during the constant rate of evaporation stage to control excess humidity that can trigger mould growth. It should be determined whether materials are permeable and can dry in place or should have holes made to allow air flow in the interstitial spaces. Some materials have coatings or coverings such as oil-based paint or vinyl wall paper that will interfere with the ability to dry materials. Some materials such as absorbent ceiling tiles or fiberglass insulation cannot be effectively dried and should be immediately discarded and replaced. All incidents of wet materials should be documented as part of due diligence. It should also be noted where water is introduced as part of a construction process (e.g., forming drywall curvatures), every reasonable effort should be made to dry out wet materials by introducing airflow within 24 hours.

A moisture sensor will detect hidden wetness and moisture under carpets. Moisture meters are used to detect moisture between interior and exterior walls. Both pin and pinless meters with a variety of attachments are readily available and can be used to compare suspected wet areas with dry areas. Sometimes a carpet “feels” dry to the touch but the underpadding or floor is saturated. A wall may have a wet core or wet fibreglass insulation behind it. Materials such as drywall, carpet, wood, concrete, etc., have an established “equilibrium” moisture content that will not support mould growth.

Airflow is an essential element of drying wet materials because mould will not grow in an environment where there is no stagnant air. Heated air flow will dry materials faster than regular air movement. Humidity control is essential on a water damage site because when the equilibrium relative humidity on the surface of a building material is above 65% an environment conducive for mould growth exists.

These guidelines apply to clean water intrusion incidents only. If the water source is contaminated with sewage, or chemical or biological pollutants, a qualified consultant or contractor should be contacted immediately for advice and/ or assistance. Please refer to ANSI/IICRC S500 Standard and Reference Guide for Professional Water Damage Restoration.



7.0 BUILDING OPERATION AND MAINTENANCE

In addition to the handover and acceptance procedures, it is extremely important that the manufacturer's operational and maintenance procedures for the HVAC system (part of handover package to owner) are reviewed with the owner (for each occupancy) and documented as well. Proper humidity moisture control and good housekeeping within a building are critical to minimizing mould growth.

The HVAC system serves several functions, including providing required ventilation, maintaining desired temperatures, adjusting indoor humidity and establishing desired pressure relationships (air flows) within different portions of a building. The HVAC system components can become a source or disseminator of airborne contamination throughout the building. Figure A shows the general layout of a HVAC system.

Mould may also be introduced through improper positioning of outdoor air intakes. Upwind cooling towers, sanitary vents, and bird-nesting sites are possible mould sources. Stagnant water, soil, plant and animal waste near or in an air intake can support the mould growth, which may subsequently enter a building. It is also important to monitor bird, bat, rodent and other animal infestations in the area, as animal droppings and waste materials harbour pathogenic species. The presence of a particular species depends on the geographic location of the building. For example, *Cryptococcus neoformans* and *Histoplasma capsulatum* are found in Ontario and Quebec.

Filters are traditionally used to protect the heating and cooling coil(s) within the HVAC system, and may become damp when an air intake is not adequately protected from rain or snow. Consequently, mould may grow on a damp filter or on the collected dust. The common filters in building HVAC systems will not remove all particles from the incoming air stream. These particles contain organic matter that can gather on surfaces within the HVAC system, and support mould growth in the presence of moisture.

The air supply is cooled and heated by coils (tubes and fins) within the air-handling unit. Debris and moisture collected on the coils can result in mould growth and contamination of the HVAC system and occupied space. Condensation on the cooling coil and spray from the humidification system can wet system components such as mixing plenums, dampers, floors, fans, and supply ducts. Wet porous insulation and stagnant water can be especially problematic and must be remediated.

Mould can grow in stagnant water that results when drain pans are not properly sloped toward an outlet or when a drain is blocked, so preventative maintenance (detailed in the facility O&M plan) is required. The pressure differential between the inside and outside of a ventilation system may also affect drainage. The presence of a film or foam in standing water is an indication of fouling.

Sumps for air washers and humidification devices that use recirculated cold water require regular cleaning and maintenance. Because these devices generate aerosols, they are considered a potential source of mould growth. Mould growth may also occur in a heat-exchange plenum if the surfaces are sufficiently cool to allow condensation. Although steam humidification systems are preferred over water spray systems, condensation and related mould growth may still occur.

Supply air ducts and return plenums may be lined with glass fibre to reduce noise and minimize heat exchange with surrounding materials. Return air ceiling plenums and risers will also have accumulated dust and debris. Insulation on the exterior of ducts and plenums is preferred and minimizes dust collected and accumulation inside. Sheer, non-porous surfaces are easier to clean and maintain. Any surface within the air supply system can accumulate dirt, which, in the presence of adequate moisture, will promote mould growth. Moisture sources such as condensation on cold air supply ducts and pipes, and leaking drains and roofs must be remediated. Improperly operated and maintained fan-coils, induction units, and heat pumps above the ceiling or along the building perimeter can also be a source of moisture for mould growth.



In most office and institutional buildings, air exits from the occupied space by passing through a common return plenum or an open space above a suspended ceiling. The return air then goes through an air-handling unit for reconditioning. If not effectively filtered, mould from an occupied space may be circulated to other parts of the building. Pressurization, leakage, or backflow from a return or exhaust air system could re-aerosolize particulates and mould. Any water leak in the return air systems can result in mould contamination of the occupied space and HVAC system.

The decontamination of an HVAC system is often costly and time consuming. The key to avoiding remediation is proper system control. Table 1 presents some measures for reducing the risk of mould growth in key HVAC system components.

Figure A
General HVAC system layout

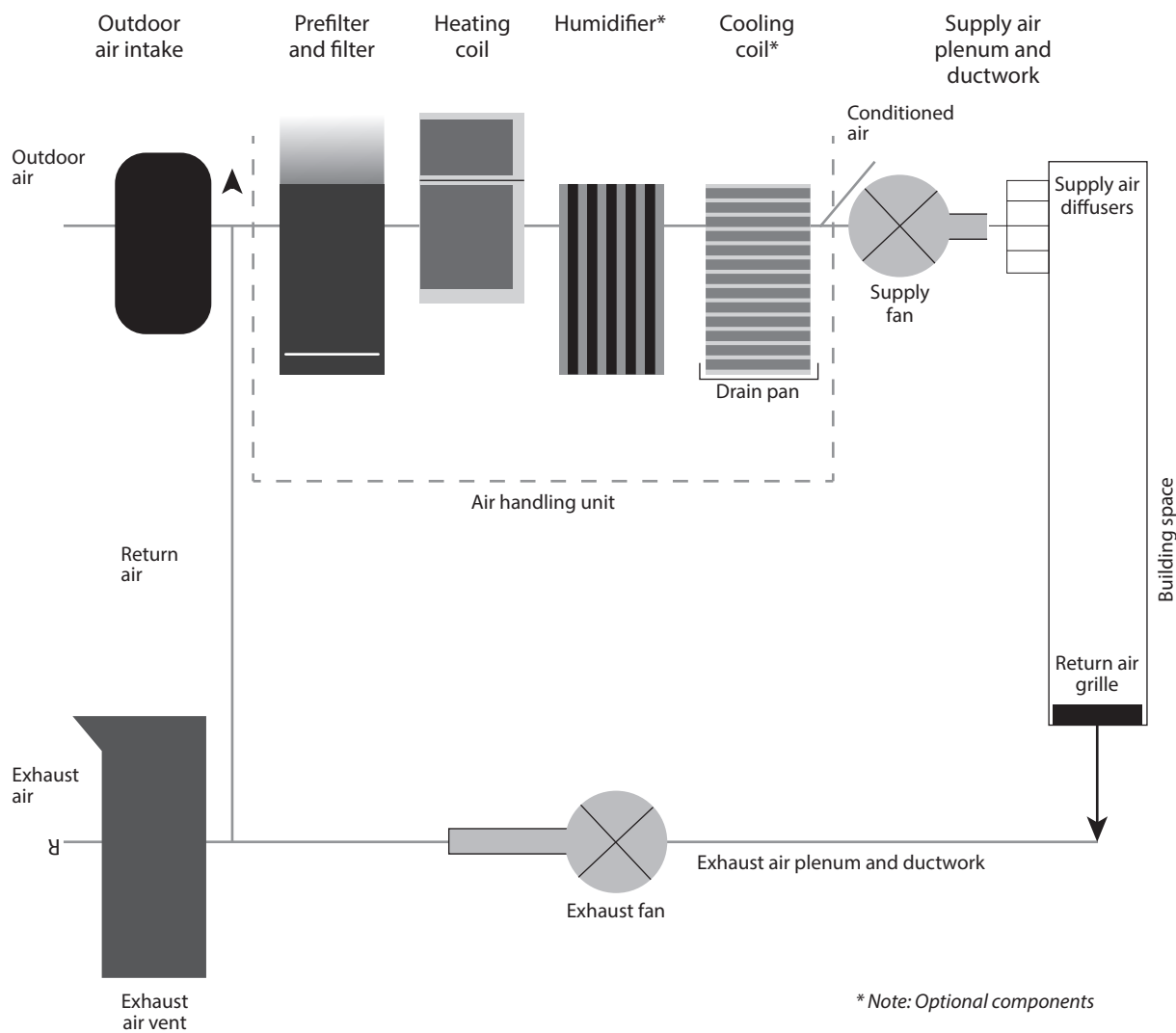


Table 1. Measures for reducing mould growth in HVAC systems

Component	Design	Maintenance	Administrative
Outdoor air intakes	<ul style="list-style-type: none"> Avoid positioning any intake downwind from significant mould/ moisture sources (e.g., cooling towers, sanitary vents, building exhausts, large bird nesting or roosting sites). 	<ul style="list-style-type: none"> Maintain clean surfaces to prevent accumulation of debris. Maintain access to intakes (e.g., snow and debris removal). Protect intakes and surrounding areas from infestations of birds, bats, rodents or other animals. Promptly remove all standing water, soil, plant, animal or other debris from adjacent areas. 	<ul style="list-style-type: none"> Schedule regular inspections of intakes and surrounding areas to document and maintain proper operation.
Filters	<ul style="list-style-type: none"> Protect filters from direct wetting by rain, snow, water leaks or flooding to reduce the likelihood of mould growth on the filter. Locate duct humidifiers at least 4.6m (15ft) downstream of the final, high-efficiency filters. 	<ul style="list-style-type: none"> Replace filters according to design specifications or when dirty. Promptly discard wet filters and insulation from HVAC air handling and fan-coil units. 	<ul style="list-style-type: none"> Adhere to filter replacement schedule. Schedule regular inspections of filters between replacement events.
Condenser units	<ul style="list-style-type: none"> Avoid the use of porous materials on airstream surfaces, particularly in persistently wet areas of HVAC systems. Design cooling coils and spray humidifiers to minimize carry-over of water droplets. 	<ul style="list-style-type: none"> Operate cooling coils and spray humidifiers to minimize carry-over of water droplets. 	<ul style="list-style-type: none"> Schedule regular inspections and cleaning activities to document and maintain proper operation.



Component	Design	Maintenance	Administrative
Drain pans	<ul style="list-style-type: none"> • Slope pans to drain completely. The slope should direct water toward a drainage point, preferably from the bottom of a pan. Do not insulate the pan with porous materials. • Isolate the pressure difference between an air-handling unit under negative pressure relative to a mechanical room by installing a water trap in the drain line. The effective height of the water trap should be 40% greater than the expected peak static pressure of the supply air fan (i.e., 1.4 times the peak static pressure). 	<ul style="list-style-type: none"> • Keep drain pans clean to avoid extensive mould growth. Physically remove any accumulations that develop, biocide additions without removal of bulk material is insufficient. • HVAC components submitted to damp conditions should be cleaned following an approved maintenance schedule 	<ul style="list-style-type: none"> • Schedule regular inspections and cleaning activities to document and maintain proper operation.
Humidifiers	<ul style="list-style-type: none"> • Design for “clean steam”, if steam required. Raw steam from a central boiler may be contaminated. • Avoid water-spray humidifiers and air washers in non-industrial HVAC systems due to increased maintenance requirements. • Avoid exposed insulation and air cleaners (e.g., filters) in HVAC plenums or ductwork downstream of humidifiers within the manufacturer-recommended absorption distance. 	<ul style="list-style-type: none"> • Ensure steam sources are cleaned regularly. • Ensure surfaces in contact with water/ humidity are cleaned regularly 	<ul style="list-style-type: none"> • Discourage the use of console humidifiers or vaporisers in the workplace – adequately cleaning is difficult. • Schedule regular inspections and cleaning activities to document and maintain proper operation.



Component	Design	Maintenance	Administrative
Plenums and ducts	<ul style="list-style-type: none"> • Airstream surfaces of HVAC equipment and ductwork should resist accumulation of dirt and debris (or be easily cleanable or replaceable), moisture absorption or retention and biodegradation. • Surfaces near moisture-producing equipment should be smooth and non-absorbent. 	<ul style="list-style-type: none"> • Maintain all surfaces within the HVAC plenum to prevent the accumulation of moisture or debris. • Check for obstructions and proper operation of HVAC system if areas are poorly ventilated 	<ul style="list-style-type: none"> • Schedule regular inspections and cleaning activities to document and maintain proper operation.



8.0 MOULD ASSESSMENT

During new construction, water intrusion or high relative humidity may lead to mould growth despite prevention efforts. Prior to tendering a construction project involving an existing building, an investigation should be conducted to assess and identify the areas or probable areas of mould growth within the building and HVAC system. In either case, simple inspections can be performed by design professionals, building owners, or construction managers, while more complicated or extensive investigations should be performed by qualified environmental professionals. The extent of the review will depend on the circumstances of the project and building, but will most likely include the following:

- Collection of any available background information (e.g., history of water damage, sequence of renovations or operations, reports of odours or adverse health effects).
- Determination of the water source, which may indicate the need for additional precautions due to contaminated water sources.
- Walkthrough evaluation of the project area and HVAC systems.
- Intrusive inspections into walls or other cavities to detect the presence of hidden mould growth, where information or observations suggest the possibility of mould.
- In some circumstances, collection and testing of air and/or surface samples may be useful to correlate the visual findings and to document current conditions.
- Review existing information regarding hazardous building materials that will be impacted by mould remediation work (for example: asbestos, lead, mercury, silica, PCBs). Additional assessment for these materials may be necessary if an existing survey does not exist, to identify concealed materials, and to comply with local provincial regulations. In most provinces, a survey of this nature is required by regulation prior to any construction project due to the need for unique handling and disposal procedures.

8.1 Visual inspection

A thorough inspection of the project areas and HVAC systems is the most important element of a mould assessment for determining the presence of mould in an existing building. The following tip sheet will assist with determining potential locations of mould contamination.

Signs of water damage can include the following:

- known history of water infiltration or loss;
- visible mould growth;
- water staining;
- water marks;
- discolouration;
- damp or musty odours;
- condensation;
- pooled water;
- corrosion;
- insects;
- relative humidity above 65%.



Inspect building materials, particularly in the following areas, for signs of water damage:

- attic;
- basement;
- crawlspace;
- adjacent to water features;
- adjacent to floor drains or sump pumps;
- adjacent to windows and doors;
- adjacent to plumbing fixtures, water coolers, ice machines, etc.;
- waste storage areas;
- insulation lining air handling equipment, fan coil units, induction units;
- coil or fan surfaces inside air handling equipment;
- condensate pans of air handling equipment.

If water damage is identified, engage a health and safety professional to perform an assessment.

Investigators who may have prolonged exposure to elevated mould concentrations during their inspections and sampling should wear a suitable respirator (minimum of N95 half-facepiece). Disposable coveralls should be used for work in areas that pose a significant risk of contact with mould impacted materials or other contaminants (e.g., investigations in a crawlspace or attic with extensive visible mould growth).

8.2 Intrusive inspections

If the building inspection reveals no obvious mould growth, there may still be growth within the walls, ductwork, or at other hidden locations. Where risk factors for possible hidden mould growth are present (e.g., history of water damage or building envelope failure, surface staining, musty odours), an intrusive inspection is necessary to determine the full extent of contamination. Intrusive inspections may involve peeling back areas of baseboard or vinyl wallpaper, removing sections of carpet or ceiling tiles, cutting holes into wall or ceiling cavities, or inspecting HVAC systems, components, and ductwork.

Prior to performing an intrusive inspection, the investigator should consider and plan for the possible impact on those performing the inspection, and the other building occupants and elements. It is advisable to remove occupants during an intrusive inspection, if possible. The use of dust-controlled tools with exhaust ventilation to a high-efficiency particulate air (HEPA) filtered vacuum are useful options in controlling the spread of contamination. An intrusive inspection should never be performed where building occupants are particularly susceptible to mould (e.g., infants, asthmatics, persons with environmental sensitivities and compromised immune systems). In such cases, the inspection should be performed under isolated conditions and possibly within HEPA- filtered negative pressure enclosures. In addition, the investigators should be protected by disposable coveralls, and suitable respiratory protection. In occupied buildings, the affected area should be cleaned after inspection and holes sealed with tape or other suitable material.

8.3 Surface testing

Mould growth can often be identified by raised, dusty deposits, often in rings or in a spotty leopard-like pattern. Where contamination is evident, it is seldom necessary to test mould-suspect materials. However, where mould growth is suspected and not visible, or not exhibiting obvious characteristics, or where the presence and types of mould must be confirmed for health or legal reasons, then bulk, surface, or air samples should be obtained for laboratory analysis. The collection process should minimize the release and dispersal of any contaminant.



The most common surface samples are bulk or substrate samples, tape-lift samples, and swabs. These samples are analyzed by direct microscopic examination to identify any mould growth and the genus of the mould present. Culturing the samples to identify the species of mould is not necessary.

- Bulk or substrate samples are collected by cutting out a section of mould-suspect material. The sampling tool should be cleaned with a disinfectant wipe prior to obtaining each sample. The material is sealed in a sturdy zip-lock bag and transported to the laboratory.
- Tape-lift samples are useful where the investigator does not want to cut out the mould-suspect material. A piece of clear (not translucent) adhesive tape is pressed lightly against the mould-suspect surface and then stuck onto the surface of a piece of plastic (a clean zip-lock bag is suggested) or waxed paper, with the adhesive side to the bag surface. The adhered tape-lift sample is then placed in a clean zip-lock bag for transport to the laboratory. Prepared, numbered microscope slides with adhesive are also available from several suppliers and provide an easy, consistent method of collecting tape-lift samples.
- Swab samples are taken with dry medical-type swabs or sterile cotton swabs by rolling the swab head against the mould-suspect surface. The sample is returned dry to a clean container and transported to the laboratory.

It is best to consult the accredited laboratory, prior to sampling, for advice on the best type of sample to collect to meet the specific requirements, and for details on sampling methods, handling, and transport.

8.4 Air sampling

The collection and interpretation of mould air samples should be performed by environmental or health and safety professionals experienced in mould and indoor air quality investigations. Air sampling is not typically required in mould investigations, particularly if the extent of mould is readily determined by visual inspection. Air sampling may be useful in cases where hidden mould growth is suspected, and the investigator would limit destructive testing, in cases where mould growth may be present in ventilation units, or for purposes of litigation. Air sampling can also provide information on exposure levels, although the interpretation is complicated by the inability to establish exposure limits, the limitations of short sampling periods, high variability in indoor and outdoor concentrations, and a lack of standardization in sampling methods and equipment. Air sampling may be performed upon completion of mould remediation activities, to confirm that an acceptable condition has been met before the containment barriers are removed. The most common air sampling method is spore trap or non-viable air sampling due to the advantage of immediate analysis. Culture methods are not necessary. A variety of spore trap methods and sampling media are available on the market.

8.5 Laboratory support and sample submission

Prior to mould sampling, it is important to identify an accredited microbiology laboratory with experience and demonstrated performance in the identification of environmental mould. The laboratory can provide advice and references towards the development of the sampling strategy, including test methods, equipment and media, sampling time, transportation, and analysis and reporting period.

When selecting a laboratory, the health and safety professional/consultant who is experienced in performing mould investigations shall ensure it meets the following criteria:

- The laboratory should be accredited by a recognized laboratory accreditation body for the analytical methods in which they are requested to perform;
- The analytical staff should have training and experience in the identification of environmental mould and bacteria and should be able to identify mould to the species level;
- The laboratory should follow current best practices for environmental microbiology;

- The laboratory should be able to demonstrate successful participation in an external proficiency testing program, wherein the laboratory periodically analyses test samples;
- The laboratory should have a comprehensive quality assurance program and designated quality assurance officer.

The person submitting the samples must complete a chain of custody form to accompany all samples. A unique identifier is assigned to each sample and clearly marked on the sample's packaging. Where available, the laboratory's own form should be used. Ensure that all applicable fields are completed, including sample number, type of analysis requested, date of collection and the date by which results are required. The form should be signed and dated every time the sample changes hands.

For further information please refer to Appendix A for a listing of mould remediation resources.



9.0 MOULD REMEDIATION PROCEDURES

9.1 General

The following mould remediation procedures have been developed to assist the construction industry in determining the safest and most effective options for the removal of mould impacted material during a remediation project. In selecting the appropriate abatement procedures, it is important to consider the extent and location of the mould growth, and any particular sensitivities of the occupants. These three factors are interdependent; therefore, they must be considered collectively when determining the appropriate abatement measures.

Two primary principles underscore mould remediation: universal precautions and controlled conditions.

- *Universal precautions* assume that an exposure hazard exists, unless proven otherwise. Therefore, the use of respiratory protection, gloves and eye protection is always recommended.
- *Controlled conditions* include isolation or containment of the affected area in order to prevent the dispersion of mould spore to other areas within the building and into the HVAC system.

The successful remediation of mould contamination includes the following:

- identification and rectification of the underlying cause;
- use of reputable and proven resources;
- development or use of an established remediation methodology; that is, a “standard operating procedure” that includes the use of personal protection, employee training, method of containment, repair, cleaning and disposal, equipment use and decontamination, and isolation of the air-handling system;
- proper hygiene practices - working clean and safeguarding against the spread of dust and debris;
- use of detergents and chemicals that are approved for the specified use;
- establishment of criteria for documentation, task completion and quality assurance; and
- selection of a “contact person” and development of a communication strategy.

Each remediation project has its own unique challenges that may require deviations from these guidelines. Changes to these guidelines should only be made by qualified personnel experienced in mould investigations and remediation. Health Canada, Public Services and Procurement Canada (PSPC), the U.S. Environmental Protection Agency (EPA), the American Industrial Hygiene Association (AIHA), and the American Conference of Governmental Industrial Hygienists (ACGIH), have published documents on this subject. Please refer to Appendix A for specific mould remediation resources.

9.2 Remediation levels

Remediation depends primarily on the scale, or size, of the mould growth. Mould growth is classified as small isolated areas (level 1), medium areas (level 2), or large areas (level 3), 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 1: (small areas) small isolated areas, less than 10 ft² (1 m²) of building materials or clean-up of less than 10 ft² (1 m²) of mould growth in HVAC systems in non-occupied areas.

Level 2: (medium areas) 10 – 100 ft² (1-10 m²) or less than 10 ft² (1 m²) in HVAC systems in occupied areas.

Level 3: (large areas) More than 100 ft² (10 m²), or more than 10 ft² (1 m²) in HVAC systems.

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.

These are arbitrary thresholds and are offered as guidelines only. Again, it is recommended that a qualified health and safety professional be consulted to determine the specific requirements of the project.



High-risk facilities

Mould remediation poses a greater potential risk in facilities such as hospitals, infant daycare centres, medical clinics, and chronic care facilities because of the high proportion of occupants with heightened sensitivities to mould. The remediation manager should consult with the facility operator regarding potential sensitivities to mould. Where sensitivities exist, Level 2 remediation measures should be used, and susceptible occupants should be kept well away from the perimeters of the remediation containment areas.

In health care facilities, infection control personnel should review, approve and monitor the mould remediation procedures. As a minimum, the requirements of the following Health Canada standard must be followed: “Construction-Related Nosocomial Infections in Patients in Healthcare Facilities – Decreasing the Risk of Aspergillus, Legionella and Other Infections,” Canada Communicable Disease Report, Volume 2752, July 2001.

9.2.1 Special risks of mould linked to contaminated water

If mould growth is linked to water sources containing potentially high levels of harmful microorganisms (e.g., sewage, river floods), the remediation worker has the added risk of infectious disease. Sewage water is often contaminated with *Escherichia coli* (e-coli) and its effects on health are acute. In such cases, specific restoration protocols must be followed and additional measures, including isolation of the work area, placing the area under negative pressure, immediate containment of the mould growth until its removed, a higher level of personal protective equipment and disinfection, are required regardless of the level of mould remediation. These projects require the assistance of a qualified restoration contractor or consultant. For more information, see “Remedial Procedures for Water Damage in Buildings,” Public Works and Government Services Canada, 2001.

9.2.2 Mould abatement general safety procedures

Protection of occupants

The project authority should consider whether occupants should be removed from areas adjacent to the work area. The removal of occupants from spaces adjacent to the work area is not necessary in all cases but should be considered in the presence of susceptible occupants including but not limited to infants less than 12 months old, persons having undergone recent surgery, the elderly, immune suppressed people, or people with chronic inflammatory lung diseases.

Worker training and medical pre-screening

Mould abatement workers shall be trained in the hazards of mould abatement and in the procedures to be followed. Training at a minimum shall include classroom and site instruction. Minimum training topics shall include: hazards of mould abatement; use and limitations of personal protective equipment such as respirators and gloves; proper abatement practices including site isolation, removal techniques, proper clean-up and decontamination procedures. General health and safety training should also be provided to workers, as required by the Occupational Health & Safety Act and regulations for construction sites, and waste handling and disposal regulations.

Workers must be fit to work with potential mould or mould exposure. Workers with a history of significant allergic disease (asthma, hay fever, hives, etc.) or with a potential immuno-compromised status (persons with an immune system disease, taking immune system suppression medication, etc.) should consult an experienced physician to determine whether mould removal activities, and the associated potential for exposure to pathogenic materials, would present an unacceptable health risk.

Mould abatement workers who may encounter a risk of infectious disease from unsanitary water sources (sewage, river floods, etc.) should consult with an experienced physician regarding vaccinations to reduce the risk of infectious disease through available immunizations, particularly Hepatitis A and B, tetanus and polio.



Respiratory protection

Workers performing mould abatement must wear a NIOSH-approved respirator with a NIOSH-approved particulate filter appropriate for the level of remediation being executed, and as specified in section 9.2.2.

Workers performing mould abatement using a disinfectant with a volatile hazardous ingredient (e.g., household chlorine bleach) should consult SDS data for specific respiratory protection in relation to specific cleaning products.

Workers should complete respirator pre-screening as detailed in CSA Standard Z94.4-11, Selection, Care and Use of Respirators and, if required, consult with an experienced physician to determine if a respirator can be used without serious difficulty.

Respirator wearers shall be fit-tested for each type of respirator, prior to use, following CSA Standard Z94.4-11, Selection, Care and Use of Respirators.

Follow CSA Standard Z180.1-13 as amended, for testing of breathing air quality for supplied air respiratory protection required for dry ice abrasive blasting.

Clean and maintain the respirator and battery pack (where applicable) in accordance with manufacturer's recommendations.

No facial hair or spectacle side arms, which affect the seal of the respirator to the skin, are allowed.

Dispose of filters daily due to the potential growth of mould spores on damp filter media.

Due to the nature and working conditions of mould abatement, filtering facepiece respirators shall not be utilized for level 2 or level 3 abatement projects.

Personal protection and hygiene

Workers shall wear appropriate eye protection including safety glasses or goggles that provide protection from external debris chemical splashes, impact or dusty environments (unless the worker is wearing a full face negative pressure respirator).

Workers shall wear dust-impermeable gloves appropriate for the work underway and water-impermeable gloves for application of detergent and/or disinfectant. Refer to the MSDS for the detergent and/or disinfectant for glove selection.

Wash face and hands after work at the abatement project each time after exiting the abatement work area.

For all levels of work, eating, drinking or smoking is prohibited in the work area.

Cleaning

Pre-clean any items that will be retained, whether removed from the work area or covered and left in the work area. Use appropriate and effective cleaning methods.

After bulk removal, clean the surrounding areas with a HEPA vacuum. No other type of vacuum can be used. If a HEPA vacuum is not available, wet wiping may be adequate for level 1 work.

Do not dry sweep or dry whisk. Use power tools only if fitted with effective HEPA-filtered dust collection.

Wipe all non-porous surfaces within the removal area with a detergent solution. Rinse with clear water as required.

As an option, a disinfectant solution can be used in place of, or in addition to a detergent. Apply the disinfectant as specified by the manufacturer, maintaining the surfaces wet for the prescribed period. Generally, surfaces to be disinfected must be cleaned of all dust and loose organic material prior to application of the disinfectant. A



disinfectant is required where the work area has been contaminated with a significant pathogenic hazard (i.e., sewage floods).

The project authority should consider the use of a disinfectant in hospital or health care settings, or in other settings where the project authority believes occupants to be significantly immunocompromised. Refer to the Health Canada and CSA guidelines for prevention of mould infections in health care settings, given above.

Use only disinfectants with current Health Canada DIN registration. Apply the disinfectant according to the DIN label, observing requirements for mixing, storage time, worker safety, precleaning, contact time, and any requirements for rinsing.

These cleaning requirements apply to all exposed surfaces within the work area. The project authority will determine if soft goods and porous materials can be adequately cleaned or must be disposed of.

Clean all equipment used in the abatement work area by HEPA vacuuming or wet wiping. Equipment that cannot be readily cleaned shall be HEPA vacuumed and sealed in 6 mil polyethylene bags before removal from the work area.

Post abatement cleanup

Remove polyethylene sheeting used during abatement by carefully rolling towards the centre of the work area. Clean any visible dust and debris using a HEPA vacuum.

Clean all tools, supplies and equipment in the work area using a HEPA vacuum and by wet wiping. Equipment that cannot be readily cleaned (e.g. vacuum hose, wire brushes, etc.) shall be HEPA vacuumed and sealed in 6 mil polyethylene bags or suitable sealed containers before removal from the work area.

Seal the intake and exhaust of HEPA filtered exhaust fans (negative air machines) and clean the cabinet by wet wiping, before removal from the work area.

Leave the work area and surrounding areas dry and visibly free of dust and debris.

Waste disposal

Remove all waste as contaminated material, including but not limited to building debris, disposable coveralls, Respirator filters and/or cartridges, and plastic sheeting. All waste should be immediately double-bagged into two 6-mil polyethylene bags, each individually sealed. If the material cannot be bagged, wrap in 2 layers of 6 mil polyethylene sheeting and seal with tape. Transport and dispose of the waste material in compliance with local, provincial and federal regulations, and any other regulations, which may apply to the mould or the substrate on which the mould was located.

Post-abatement drying

By the completion of the mould abatement, ensure the cause of the mould growth has been identified and an action plan initiated to prevent further mould growth. This action would include mitigation of the original cause of the mould contamination. This would include such factors as past flooding, moisture intrusion or elevated levels of relative humidity. Also, at completion of mould abatement check that the remaining finishes (e.g., concrete, wood framing, sub-floors) have been adequately dried so that mould growth will not re-occur when new finishes are installed. The work area may require further drying efforts before re-construction can commence.

9.2.3 Guidelines for level 1, 2 and 3 mould abatement

Level 1: small isolated areas, less than 10 ft² (1 m²) of building materials or clean-up of less than 10 ft² (1 m²) of mould growth in HVAC systems in non-occupied areas.



Level 1 work procedures are intended for performing abatement of under about 10 square feet of mould growth on building materials or finishes or the abatement of the same extent of mould growth within HVAC equipment in non-occupied areas such as mechanical rooms. Abatement of HVAC equipment in occupied locations shall be performed following a minimum of level 2 procedures (contained mould abatement).

This level of remediation may be performed by regular building maintenance staff; however, only properly trained workers should perform mould abatement. Workers should be well informed in the hazards of mould abatement and in the procedures to be utilized.

Comply with all of the items of section 9.2.1, General safety procedures (protection of occupants, worker training and medical pre-screening, respiratory protection, personal protection and hygiene, cleaning, and waste disposal) while performing this work.

The worker shall wear a half face piece air-purifying respirator fitted with replaceable filters (N95 minimum) or a filtering facepiece respirator (N95 minimum).

Workers shall wear disposable full-body dust-impervious coveralls with attached hoods. Secure the coveralls tight at the ankles and wrists.

Workers shall wear disposable dust-impervious gloves appropriate to the work being performed, and water-impervious gloves when applying detergent or disinfectant. Refer to the safety data sheet (SDS).

Turn off HVAC systems where possible and seal over any system openings (e.g., diffusers and return air openings) within and immediately adjacent to the work area.

Where possible, place a drop sheet below the mouldy materials.

Dust suppression methods should be used where possible, prior to disturbance of the mouldy materials. Tape a section of plastic sheeting or duct tape over the mouldy material, or if this is not feasible, lightly mist the mouldy material with amended water.

Remove any porous substrate materials (ceiling tiles, drywall, etc.) to a point beyond the immediate areas of visible contamination, for a minimum distance of 30 cm in all directions. Clean the work area and dispose of the waste

Level 2: Medium areas, 10 – 100 ft² (1 – 10 m²) or less than 10 ft² (1 m²) in HVAC systems in occupied areas.

Level 2 work procedures are intended for the for performing mould abatement specifically for medium scale projects, or the abatement of less than 10 square feet of mould growth in HVAC equipment in occupied areas.

Comply with all of the items of 9.2.1, General Safety Procedures (protection of occupants, worker training and medical pre-screening, respiratory protection, personal protection and hygiene, cleaning, and waste disposal) while performing this work.

Consult with a qualified health and safety professional prior to remediation work to provide quality assurance for the project and monitoring of compliance with these guidelines. A competent supervisor must be present during all contaminated work.

The worker shall wear full-body dust-impervious coveralls with attached hood. Secure the coveralls tight at the ankles and wrists.

Workers shall wear disposable dust-impervious gloves appropriate to the work being performed, and water-impervious gloves when applying detergent or disinfectant. Refer to the safety data sheet (SDS).

The worker shall wear an elastomeric half face piece air-purifying respirator fitted with 100 series filter cartridges.



Workers shall wear disposable boot covers or separate work boots that can be effectively HEPA vacuumed or wiped clean prior to removal from the work area.

Turn-off HVAC systems where possible and seal over any supply and return openings immediately within and adjacent to the work area. Objective of this engineering control is to maintain negative pressure and prevent the distribution of mould spores and dust from the work area.

The abatement area must be secured and access restricted. Isolate the work area with an enclosure constructed of fibre-reinforced polyethylene sheeting or 6 mil polyethylene sheeting, taped and supported as required. Provide a temporary roof where an existing ceiling does not complete the temporary enclosure. The project authority may require a single chamber decontamination/change room.

A competent supervisor or project authority must inspect the work area for defects in the enclosure, barriers and change room, at the beginning of every shift and at the end of every shift. Records of the inspections should be generated and maintained.

Install signs warning of the exposure hazard. Suggested wording: CAUTION, MOULD EXPOSURE, WEAR ASSIGNED PROTECTIVE EQUIPMENT, AUTHORIZED PERSONNEL ONLY.

Provide continuous negative pressure within the enclosure by drawing air from the work area and exhausting it out of the enclosure, either by use of a HEPA vacuum or a portable HEPA-filtered exhaust fan. Provide a minimum negative pressure of 5 Pascals (0.02 inches of water column) and at least 4 air changes per hour. Discharge the filtered air outside the building and away from persons wherever possible. The project authority may consider on-site leak testing (DOP/PAO testing) of the HEPA filtered equipment if it is not possible to discharge the filtered air outside. Negative pressure must be maintained until the completion of all contaminated work.

Remove any porous substrate materials (ceiling tiles, drywall, etc.) to a point beyond the immediate areas of visible contamination, for a minimum distance of 30 cm in all directions. Clean the work area and dispose of the waste. Before exiting the work area, workers shall fully wipe or vacuum clean all footwear, coveralls and other personal protective equipment and remove and dispose of protective equipment not for re-use. Workers shall then complete personal cleaning as in Section 9.2.1, General safety procedures.

Level 3: Large areas, more than 100 ft² (10 m²), or more than 10 ft² (1 m²) in HVAC systems.

Level 3 work procedures are intended for performing mould abatement specifically for large-scale projects. Comply with all of the items of 9.2.1, General Safety Procedures (protection of occupants, worker training and medical pre-screening, respiratory protection, personal protection and hygiene, cleaning, and waste disposal) while performing this work.

A qualified health and safety professional (qualified by knowledge, training and experience) with experience performing mould investigations and remediation, must be consulted prior to initiating abatement work to develop a site-specific work plan or specification for the project and monitoring of compliance with these guidelines.

The qualified health and safety professional will conduct site inspections prior to abatement, during abatement, after abatement and clearance sampling including air sampling prior to dismantling of the abatement work area. Clearance sampling requirements to be defined by the appointed health and safety professional.

Worker protection

The worker shall wear a tight-fitting full-face piece powered air purifying respirator with high efficiency particulate filters or a non-powered full-face piece air purifying respirator fitted with 100 series filters.



Workers shall wear disposable dust-impervious gloves appropriate to the work being performed, and water-impervious gloves when applying detergent or disinfectant. Refer to the safety data sheet (SDS).

Workers shall wear disposable boot covers or separate work boots that can be effectively HEPA vacuumed or wiped clean prior to removal from the work area.

The worker shall wear full-body dust-impervious coveralls with attached hood. Secure the coveralls tight at the ankles and wrists.

A competent supervisor must be present during all contaminated work.

Site isolation

Turn-off HVAC systems where possible and seal over any supply and return openings immediately within and adjacent to the work area. Isolate the work area with an enclosure constructed of fibre-reinforced polyethylene sheeting or 6 mil polyethylene sheeting, taped and supported as required. Provide a temporary roof where an existing ceiling does not complete the temporary enclosure. Install signs warning of the exposure hazard. Suggested wording: CAUTION, MOULD EXPOSURE, WEAR ASSIGNED PROTECTIVE EQUIPMENT, AUTHORIZED PERSONNEL ONLY.

Provide continuous negative pressure within the enclosure by drawing air from the work area and exhausting it out of the enclosure, either by use of a HEPA vacuum or a portable HEPA-filtered exhaust fan. Provide a minimum negative pressure of 5 Pascals (0.02 inches of water column) and at least 4 air changes per hour. Discharge the filtered air outside the building and away from persons wherever possible. The project authority may consider on-site leak testing (DOP/PAO testing) of the HEPA filtered equipment if it is not possible to discharge the filtered air outside. Negative pressure must be maintained until the completion of all contaminated work.

Negative pressure within the enclosure shall be continuously measured and recorded with a portable monitor located at the entrance to the work area. A competent supervisor and/or the health and safety professional must inspect the work area for defects in the enclosure, barriers and change room, at the beginning of every shift, at the end of every shift where there is no shift beginning immediately following the shift that is ending, and at least once per day on days where there are no shifts. Records of the inspections should be generated and maintained.

Worker and waste decontamination facilities

Provide a worker decontamination facility with a clean change room and a dirty change room. Install flap doors at each opening into and within the decontamination facility. Provide a wash station consisting of at least a basin, fresh water, soap and toweling, in the clean change room. A shower for worker comfort may be provided but is optional. Refer to figure B for a diagram of a typical decontamination facility.

When going into the contaminated work area, the worker will don clean coveralls and a respirator in the clean change room.

Prior to exiting the contaminated work Area, the worker will use a HEPA vacuum in the work area to remove gross contamination from coveralls and boot covers (or separate dirty work boots).

The worker will then enter the dirty change room where the dirty coveralls and boot covers are removed and bagged (to be used only once). Work boots used without boot covers will also be removed and stored in the dirty change room.

The worker will then proceed to the clean change room to complete clean up. The wash station is to be used by each worker on leaving the work area to clean face and hands.



A separate waste decontamination facility consisting of a double bagging room and a waste transfer room should be provided where large volumes of waste will be removed. Seal the waste into bags (or polyethylene sheeting sealed with tape) in the contaminated work area and wipe the exterior of the bags or other containers. Transfer the waste to the double bagging room and place a second bag around bagged waste. Seal the second bag. Transfer the double-bagged waste into the waste transfer room for removal by workers entering from the outside of the decontamination facilities.

Removal, salvage and cleaning

Remove any porous substrate materials (ceiling tiles, drywall, etc.) to a point beyond the immediate areas of visible contamination, for a minimum distance of 30 cm in all directions.

Clean the work area and dispose of the waste. Clean tools and equipment such as vacuums, negative air units or any other items that were exposed during abatement.

Clearance inspection and monitoring

The health and safety professional or representative should inspect the level 3 work area for acceptable completion, by a combination of careful inspection and testing. A site will be considered acceptable and clean when a thorough inspection shows an acceptable state of cleanliness. In addition, clearance air samples are to be taken prior to enclosure tear down to indicate the work area is no longer impacted by the mould contamination abatement process.

Generally, clearance air samples collected within the work area will be compared to samples taken in adjacent areas from where the work area make-up air is being drawn, another suitable location, or to outdoor air samples. An acceptable condition is indicated when:

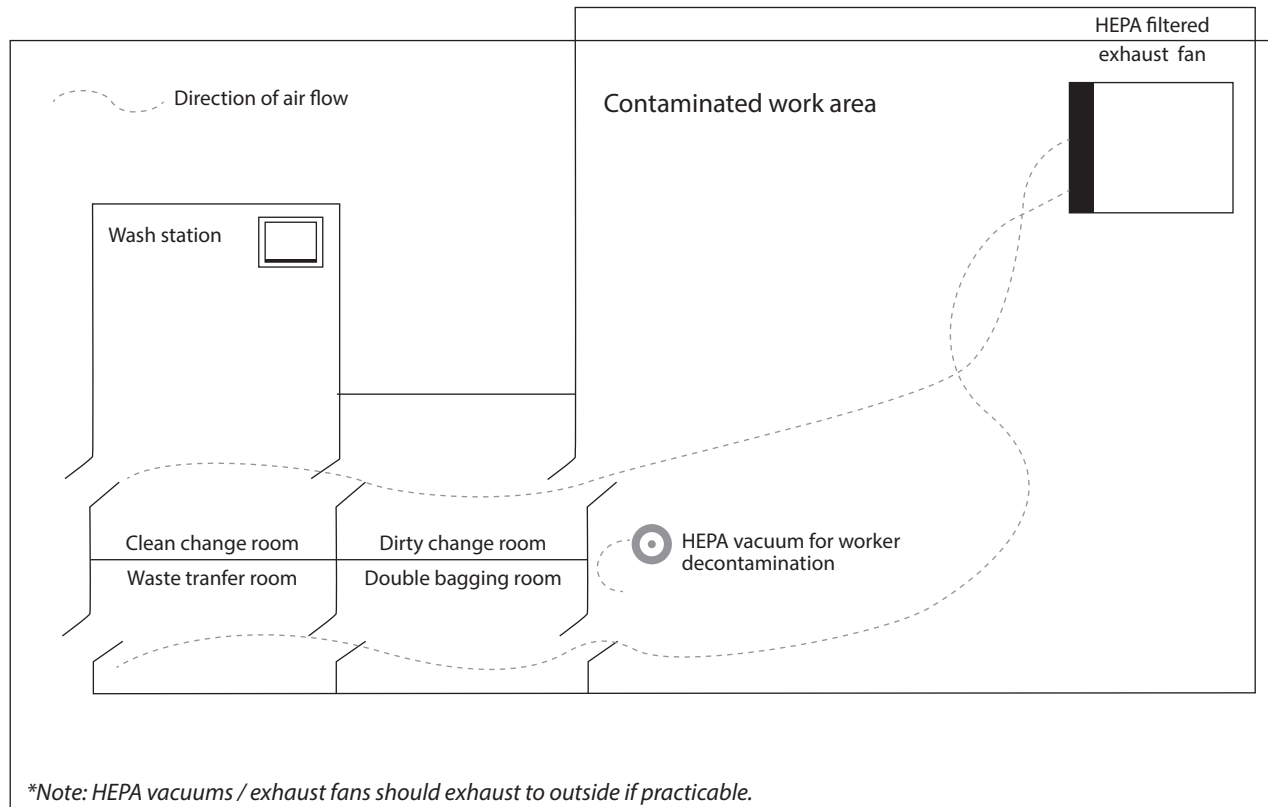
1. Concentrations of airborne mould particles in the work area are not significantly elevated when compared to concentrations in the reference area; and
2. The types of mould particulate present in the work area do not significantly differ from those present in the reference area.

Surface samples should show minimal or no mould growth remaining at completion. Interpretations of sample results are subject to the professional judgment of the health and safety professional with experience performing mould investigation and remediation.



Figure B

Layout of decontamination facilities for level 3 mould remediation



9.3 Conclusion

The objective of mould remediation is not to disinfect or sterilize interior surfaces and components, but rather to restore surfaces to 'normal' conditions. For example, the presence of settled dusts containing spores from outdoor sources is not a problem, while the colonization by any fungus and the predominance of species that do not normally occur outdoors are indicators of unsuccessful cleaning or remediation.

If the occupied space is undergoing mould remediation, the dedicated HVAC system should be inspected and possibly cleaned after this remediation as part of a final commissioning process. While it is good practice to avoid cross-contamination of the HVAC system by sealing off the air return and isolating the remediation zone, it is prudent to verify that both the remediated area and the air supply system are clean before the space is occupied.

The primary response to mould contamination in buildings must be prompt remediation of contaminated material and infrastructure repair. The simplest and most expedient remediation methods that properly and safely remove mould growth from buildings should be used. In all situations, the underlying cause of water accumulation must be rectified, or the mould growth will recur. The focus should be on preventing contamination, through proper building construction practices, maintenance, and prompt repair of water-damaged areas.

10.0 COMMUNICATION

If not properly planned, implemented, monitored, and documented, communicating the potential hazards of mould contamination can become a contentious issue.

When level 1, 2 or 3 remediation is required, there should be a meeting of the major stakeholders, which may include the building owner's representative(s), the general contractor's representative(s), independent environmental consultant and the remediation contractor's representative(s). This meeting should establish what is to be communicated and to whom, a timetable for implementation, a monitoring and feedback plan, follow-up meetings, and a completion report, all of which are to be documented, circulated to affected stakeholders, and maintained as part of the project file.

Communication to tenants should include a description of remedial measures to be undertaken and a timetable for their completion. The following outlines the responsibilities of the various stakeholders, with regard to building occupants, construction workers, public notification, security, meetings / documentation, joint Health and Safety committees, and regulatory compliance.

Building occupants

The owner is responsible for advising the building occupants of the reasonable risks of mould exposure and remediation activities, and for notifying individuals with persistent health problems to seek medical advice.

Construction workers

Contractors are responsible for notifying workers of the remediation activities, the precautions that should be taken, and the personal protection equipment requirements. Contractors must also advise workers of remediation work areas, routes of travel, location of restricted areas, and observance of posted warning signs.

Public notification

Where required, building owners are responsible for posting warning signs at strategic locations to inform the public of remediation activities and necessary restrictions. Through contractual arrangements with the contractor(s), the owner may assign responsibility for public notification to the contractor.

Security

Building owners are responsible for security in the remediation work areas - it is particularly important that no unauthorized personnel enter the remediation areas after work hours. Again, this responsibility can be assigned to the contractor(s) through contractual arrangements.

Meetings / documentation

Building owners and contractors are jointly responsible for scheduling and attending communication meetings, documenting all action and completed items, and circulating the minutes of these meetings to the appropriate stakeholders

Joint health and safety committees

Each stakeholder is responsible for notifying their workplace joint health and safety committee (if this is a jurisdictional requirement) of remediation activities and for submitting the applicable report of findings and procedures.

Regulatory compliance

Whenever, a workplace or public health hazard exists, it is good practice to communicate the potential hazards of mould remediation to impacted parties. In addition, it is important to ensure requirements of federal, provincial and local health and safety regulations are adhered to.



11.0 DECOMMISSIONING / DEMOLITION CONSIDERATIONS

Prior to the decommissioning or demolition of a building, an audit is required to establish the presence of hazardous materials, such as lead (e.g., in paint), asbestos, PCBs, and other materials that require unique handling and disposal procedures. Mould-contaminated materials are not classified as hazardous waste. However, certain precautions should apply to the handling of mouldy materials. Mould should be included in the hazardous materials assessment. During the demolition process worker protection through the implementation of PPE and engineering controls to minimize dust migration should also be considered.

The demolition contractor should inspect the site for visible mould contamination and signs of hidden mould contamination. The latter includes musty odours, visible water damage or dampness, a history of water damage, roof, window, or building envelope failures, and years of non-occupancy, vandalism, and neglect.

When workers enter a mould-contaminated building to disconnect services, prepare the facility for demolition, or to salvage items, or to perform any demolition by hand or with small machinery, industrial hygiene practices similar to level 3 remediation measures, specifically respiratory, eye, and clothing protection, must be followed. During this process and during demolition, it is important to follow work and dust control procedures that eliminate or reduce dust generation.

Dust containing mould can be aerosolized during construction, excavation, or demolition. However, it is important to be aware that air currents can easily carry spores over long distances. Contaminants entering the ventilation system intakes of adjacent buildings (possibly “high risk” facilities such as schools, retirement homes and health care facilities) can cause a serious outbreak of disease.

During windy periods, demolition, removal or disposal of contaminated or dusty materials outdoors should be stopped if dispersion is not controlled.

Educating and training contractors and workers in good work practices will minimize both the risk of exposure and cross-contamination during demolition and handling of mouldy materials. Companies should develop written internal standard operating procedures that mirror the established regulations, standards and guidelines developed by governments and recognized, professional authorities.



12.0 GUIDELINES FOR SELECTING MOULD REMEDIATION CONTRACTORS

12.1 Contractor requirements

Contractors must provide a certificate of liability insurance with a Pollution Liability Policy (containing mould liability).

The contractor should be able to provide confirmation of Workplace Safety and Insurance Board (WSIB).

The mould remediation contractor should be able to provide evidence of experience and references for successful work on equivalent projects.

12.2 Training documentation

The mould remediation contractor must provide proof that supervisors and workers have appropriate training in the hazards of mould remediation and the procedures to be utilized. Contractors should be pre-qualified by submitting training documentation and project experience specific to mould remediation.



APPENDIX A

Mould remediation resources

American Society of Heating, Refrigerating and Air Conditioning Engineers Inc., (ASHRAE)

- Atlanta, Georgia (ashrae.org)
- Standards and handbooks for system design, operation and maintenance. Ventilation and thermal comfort standards. Prevention of mould growth in new construction.

Canada Mortgage and Housing Corporation (CMHC)

- Ottawa, Ontario (cmhc-schl.gc.ca)
- Procedures and guides for inspection, repair, maintenance, mould cleanup, and rehabilitation of homes.

Environmental Abatement Council of Ontario (EACO)

- Ontario (eacoontario.com)
- Guidelines on mould abatement, DOP/PAO Testing, construction worker hygiene, lead and vermiculite.

Health Canada

- Ottawa, Ontario (hc-sc.gc.ca)
- Occupational health and safety, indoor air quality and mould assessment and remediation guidelines.

Institute of Inspection, Cleaning and Restoration Certification (IICRC)

- Vancouver, Washington (iicrc.org)
- Standards for inspection, cleaning and water damage restoration.

National Air Duct Cleaners Association (NADCA)

- Washington, DC (nadca.com)
- Standards and specifications for assessment, cleaning and restoration of HVAC system.

North American Insulation Manufacturers Association (NAIMA)

- Alexandria, Virginia (insulationinstitute.org)
- Practice codes for dealing with cleaning, moisture in building insulation and air transmission systems.

Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

- Chantilly, Virginia (smacna.org)
- Practice codes and construction standards for building and HVAC system works.
- Guidelines for indoor air quality of occupied buildings under construction, duct cleanliness for new construction.

U.S. Environmental Protection Agency (EPA)

- Washington, DC (epa.gov/indoor-air-quality-iaq)
- IAQ and mould guidelines for homes, buildings and schools.



APPENDIX B

Definitions

Term	Definition
Abatement	The process of treating/removing mould growth from a building
Cartridge	A container with a filter, sorbent, or catalyst, or combination of these items, which removes specific contaminants from the air passed through the container.
Clearance tests	Air or surface samples collected after mould abatement to document completion in accordance with established clearance requirements.
Competent person or supervisor	A person who is qualified because of knowledge, training and experience to design the mould abatement program, is familiar with mould abatement procedures, and has knowledge of mould hazards
Contaminated work	Abatement work which includes active disturbance, handling or cleanup of mould-impacted materials
Decontamination facility	A series of two rooms and a shower area constructed in such a way as to allow persons, waste or equipment to be cleaned prior to leaving an abatement to reduce the spread of contaminants
Disinfectant	Anti-microbial substance applied to a surface to destroy microorganisms
Dust suppression	Measures taken to reduce the release of spores and other particulate matter during mould abatement.
Filtering facepiece	Particulate-filtering respirator where the facepiece is also the filter.
Fit-test	A qualitative or quantitative method to evaluate the fit of a specific make, model and size of respirator on an individual.
Health and safety professional	An individual qualified by knowledge, skills, education, training and experience to perform mould assessments, collect samples and interpret analytical reports, develop recommendations for abatement and provide inspection and Quality Assurance services.
HEPA	High efficiency particulate air filter capable of trapping and retaining particles greater than or equal to 0.3 micrometers in diameter, at a minimum efficiency of 99.97%.
HEPA filtered exhaust fan	Portable exhaust fan in sealed cabinet equipped with HEPA filters used to clean and exhaust air out of an enclosed work area and to maintain negative pressure in the work area with respect to surrounding areas.
HVAC	Heating, ventilating and air conditioning (equipment).
Mould	Multi-cellular spore-producing microorganism that obtains nutrients from organic substrates and does not contain chlorophyll.
Microbial	Referring to any micro-organisms.
N95	A particulate filter, 95% efficient at stopping a 0.3 micrometer aerosol, and not resistant to oil, a classification of particulate filters set by NIOSH.
Negative pressure	Lower pressure established inside a work area compared to the surrounding area
NIOSH	National Institute for Occupational Safety and Health, part of the U.S. Centers for Disease Control and Prevention.



Term	Definition
Porous	Permeable, allowing liquids or mould growth to extend below the immediate surface
Project authority	Individual who has overall management responsibility for the project.
Quality assurance	Measures of inspection, testing and documentation to promote confidence that the abatement process will meet the desired goals.
Respirator	A device to protect the user from inhaling a hazardous atmosphere.
SDS	Safety data sheet, required by Workplace Hazardous Materials Information System (WHMIS) 2015 legislation, and giving information on hazardous materials, including properties, hazards, first-aid, emergency response, and personal protection.
100 series filter	Particulate filter, 99.97% efficient at stopping a 0.3 micrometer aerosol. A classification of particulate filters set by NIOSH.



