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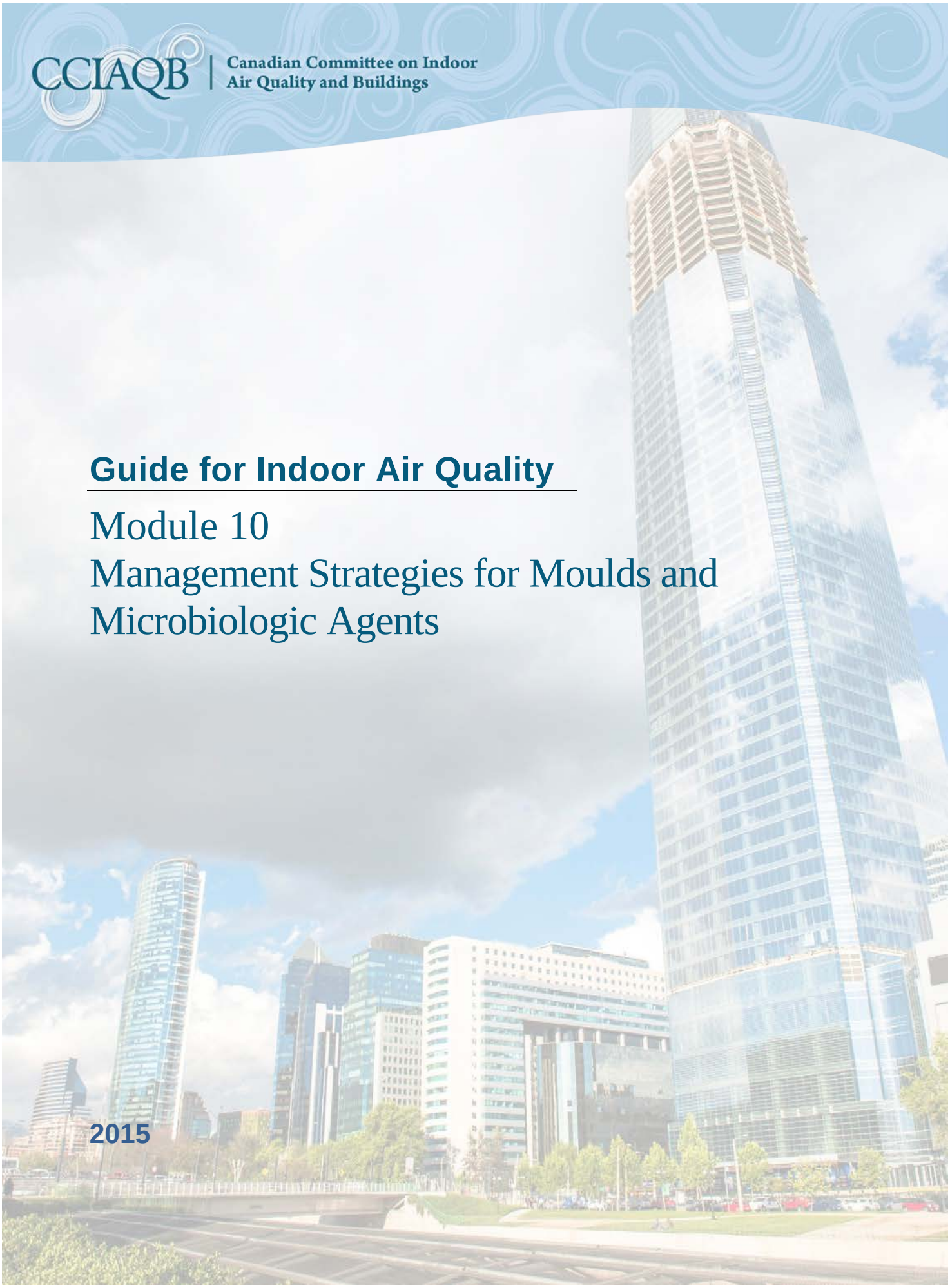

Guide for Indoor Air Quality

Module 10
Management Strategies for Moulds and Microbiologic Agents

2015

Canadian Committee on Indoor Air Quality and Buildings (CCIAQB)

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Indoor air quality is a very complex issue and there is currently a significant gap between knowledge of the effects of indoor air quality on the health of occupants and the effectiveness of various air quality technologies and solutions. User discretion is advised.

Preamble

The objective of the CCIAQB is, ultimately, to improve indoor air quality for all Canadians in every type of building. The CCIAQB has decided that its initial focus should be on buildings where many Canadians spend time outside their home, working, learning, shopping, being entertained, etc. For the most part, these buildings have relatively complex heating, ventilating and air conditioning systems that are operated and managed by knowledgeable persons. The table below gives examples of buildings that are covered using the classification found in the National Building Code of Canada (NBC). Documents produced by the CCIAQB are primarily intended for the use of building operators and facility managers, but the information contained in the guides can be helpful to anyone seeking a general understanding of indoor air quality issues.

The Committee welcomes feedback on the documents as well as ideas for the development of new materials. Contact the CCIAQB Secretary at info@IAQforum.ca or register on the website at www.IAQforum.ca

NBC Classification	**Examples**
Group A, Division 1	Theatres, movie theatres and other facilities for the performing arts
Group A, Division 2	Art galleries, museums, libraries, educational facilities (schools, colleges and universities), gymnasia, air and rail terminals
Group A, Division 3	Arenas and swimming pools
Group C	Apartments, hotels, college residences
Group D	Offices, including medical and dental offices
Group E	Department stores, supermarkets, shops, retail space

Guide for Indoor Air Quality
Module 10: Management Strategies for Moulds and Microbiologic Agents

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1. Purpose of this Guide

The purpose of this Module is to provide building owners and managers with information about the causes, effects and correction of indoor air quality issues resulting from moulds and some common microbiological agents found in the indoor environment. The primary focus of this Module is on moulds and airborne mould spores.

Airborne moulds and microbiological agents are some of the several potential causes of poor indoor air quality. Readers are encouraged to review the other modules that make up the *CCIAQB Guide for Indoor Air Quality* available at www.IAQForum.ca:

Module 1 – Introduction to Indoor Air Quality
Module 2 – Volatile Organic Compounds (VOC) Sampling Methods and Strategies
Module 3 – Custodial Activities, Maintenance, Repair and Renovation
Module 4 – Recognizing and Addressing IAQ Problems
Module 5 – Hygienic Operation of Air-Handling Systems
Module 6 – Scent-Free Buildings

Each of these modules includes general information on the avoidance, recognition, management, and correction of indoor air quality issues pertinent to the challenges posed by moulds and microbiological agents.

2. Moulds and Microbiological Agents

Microbials are microscopic living organisms, such as bacteria, moulds, viruses and dust mites. Microbiological agents are microscopic byproducts, or parts of microbes that are found in the environment. These agents include cat saliva, dust mite feces, byproducts of moulds (mycotoxins, enolases or beta-lactams that come from the cell wall, and spores), endotoxins from bacteria, cockroach antigens (proteins from feces, saliva, eggs, and shed cuticles) and pollens, all of which can be found in house dust. Both microbials and microbiological agents have the potential to provoke adverse health effects.

Mould refers to any fungus that grows on food or damp building materials. In some cases, mould may not be visible and its presence might be indicated only by a musty odour. If it is allowed to grow mould can contribute to poor indoor air quality.

The word mould is a non-scientific term that refers to members of a few dozen filamentous fungi. Mould growth on building surfaces not only damages these surfaces, but may also affect the air quality, as intact mould organisms, as well as their spores and fragments, are dispersed in the air. Prolonged exposure to moisture can result in the deterioration of wood structural members. Depending on the particle aerodynamic diameter (size), building occupants can be exposed to released microbiological agents through inhalation.

When deposited on a building material substrate, mould often has a filamentous growth form, giving rise to “fuzzy”, “cottony”, “woolly” or “powdery” textured colonies or masses (Figure 7-1).


Figure 7-1 Mould

3. Conditions Conducive to Mould Growth

Various respiratory complaints are associated with building-related fungal exposure. Affected individuals often experience relief when they leave an affected building for several days. Fungal spores are common in the outdoor air during the growing season, and the principal fungi that grow on leaves constitute 60-70% of the spores in the air. These fungi can induce allergies, but most people are not affected significantly.

Species of fungi that have the physiological ability to grow and accumulate indoors or in the air handling equipment could be different from the common plant and leaf fungi. Dampness, condensation and water accumulation allow the growth of many fungi that may be associated with allergies and other health problems in exposed individuals.

In order to reproduce, mould releases spores into the air as fine particulate matter, which can be inhaled by people occupying the areas of mould development. Although some levels of airborne mould spores are always present outdoors, a large-surface-area-mould growth indoors may lead to higher concentrations of and exposure to airborne mould spores and fragments.

Indoor environments often have most of the conditions necessary for mould growth: oxygen, carbon-based nutrient sources, and an acceptable temperature range. The only missing and critically important additional requirement for mould growth is moisture. The longer an indoor environment remains damp, the higher the likelihood of mould growth.

Indoor dampness is the result of excess moisture accumulation that is not properly vented outdoors. Poor ventilation contributes to high humidity levels and leads to condensation.

Excessive prolonged dampness, including condensation, can promote mould growth. Dampness may result from various sources including: normal human daily activities (e.g., cooking, showering, laundry); improper or inadequate ventilation; flooding; plumbing leaks; roofs, walls or windows leaks; an excessive number of indoor plants such as those grown illegally (e.g., marijuana); and pet urine.

Contaminated central air handling systems can become breeding grounds for mould and other sources of microbiological contaminants and can distribute these contaminants throughout a building.

4. Health Effects

There is variation in the level of sensitivity to mould both within individuals and within populations. The potential health responses tend to fall into one of the following three categories:
1. Allergic and other hypersensitivity reactions;
2. Infections;
3. Chemically induced effects (toxicity) through exposure to mould by-products such as microbial volatile organic compounds (VOCs) and mycotoxins.

There is increasing concern about the health effects of indoor mould growth because of a possible link to a wide range of respiratory symptoms. North American and European studies have shown a relationship between mould and damp conditions, and an increase in the following symptoms:

- Eye, nose and throat irritation;
- Coughing and phlegm build-up;
- Wheezing and shortness of breath;
- Worsening of asthma symptoms;
- Allergic reactions.

Although it is clear that exposure to mould can worsen the symptoms of asthma, it is still unclear whether or not mould actually *causes* asthma in otherwise healthy people. The risk of health consequences from mould exposures arising from mould-damaged building materials varies with their degree of isolation from the occupied space. Examples of this, in decreasing order of risk potential, are:

- Surfaces exposed to an occupied space;
- Interior walls or floor cavities (especially if there are ducts);
- Exterior walls with poor air barriers;
- Exterior walls outboard of a good air barrier;
- Attic spaces or roof spaces above an air barrier.

If the mould contamination is on the walls, ceilings or floors exposed to an occupied space, immediate steps are required to contain the mould-damaged areas, stop further wetting and arrange for remediation.

5. Prevention Strategies

5.1 Construction and Renovation

Good design detailing, construction material selection and construction practices are needed to ensure that moisture conditions conducive to mould growth are not introduced into a building during construction and renovation.

Construction during damp or rainy periods may result in the exposure of building materials to moisture. Even with a weather-tight building envelope, concrete floor curing or plastering processes, or inadequate temporary building heating, can release excess moisture within a building. When ventilation and drying are not adequate, drywall and wood structures that are particularly sensitive to moisture absorption are likely to promote mould growth. Generally, the earlier the construction schedule requires a contractor to finish the building interior, the greater the risk of trapping moisture in the building materials and assemblies.

Given the growing awareness of the potential hazards of mould contamination in buildings, owners and designers must be 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, which often resulted in mould contamination.

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 mandatory in the maritime climates and are a recommended best practice in other areas to permit the escape of rainwater that penetrates the exterior weather barrier.

Progressive designers will stipulate that builders construct 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 leaks. Mock-ups help to ensure suitable flashing, insulation, caulking, and air barrier installation, and serve as a standard for site installations.

During construction or renovation, the following steps should be taken to reduce the potential for mould growth:

- Develop a strategy for construction sequencing and timing to prevent the formation of environmental conditions conducive to mould development. The sequencing and timing for the installation of vapour barriers, air barriers, insulation and construction materials with low permeability must be carefully considered to ensure that moisture does not become trapped during construction;
- Ensure adequate ventilation and moisture control at all times. Temporary ventilation and dehumidification may be required;

- Minimize the exposure of interior building products to exterior conditions;
- Protect stored materials from moisture;
- Minimize moisture accumulation within the building;
- Prevent spillage of water within the building;
- Maintain the integrity of the building envelope components through ongoing monitoring and inspections;
- Ventilate any gas-fired temporary building heating appliances to the outside;
- Achieve balance control of thermal comfort and relative humidity in the building;
- Check all material deliveries to validate that components are dry and clean;
- Reject wet or mouldy materials;
- Monitor installations to ensure they remain clean and dry (including the heating, ventilation, and air conditioning - HVAC - systems).

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 for interior mould growth during construction or renovation.

Proper design principles can reduce the risk of HVAC systems contributing to mould growth in buildings. Various publications by 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 the ASHRAE publication, “Humidity Control Design Guide for Commercial and Industrial Buildings”).

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 a project permit require the builder to operate the HVAC system during construction, all the HVAC equipment should be turned over upon project completion in clean condition.

5.2 Maintenance

The overall facility maintenance program should promptly address conditions that could result in mould. The most effective way to inhibit mould growth indoors is to find and eliminate the supply of moisture. An effective moisture and mould control program should include:

- Maintaining low indoor humidity, below 60% relative humidity (RH), ideally 30-50%, if possible;
- Preventing condensation by increasing the surface temperature of windows and other places where condensation occurs, reducing the air humidity levels, or increasing the air circulation;
- Eliminating moisture source as soon as possible (i.e., cooling pipes, window panes, roof/wall intersections);

- Fixing plumbing and leaks as soon as possible;
- Fixing roof leaks and other exterior envelope leaks as soon as possible. Leaks in wooden construction can be especially problematic in terms of mould growth.
- Increasing ventilation (if the outside air is cold and dry), or dehumidification (if the outdoor air is warm and humid) to reduce the indoor air moisture level;
- Venting moisture-generating appliances to the outside;
- Keeping the water from entering the foundation by providing proper drainage (weeping tile) and wall damp proofing, and having gutters downspouts and ground surface slopes that guide the roof water away from the foundation.
- Ensuring that a preventive maintenance program is in place with regard to:
  - The exterior envelope including roofs, skylights, walls, doors, windows, foundations and all exterior penetrations.
  - All building systems.
  - Site services such as water mains, sanitary and storm drainage systems.

The foregoing recommendations 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.

If water intrusion occurs, every reasonable effort should be made to dry the wet materials within 24 hours (48 hours maximum) from the time when it is reasonably practical to stop the water intrusion. It should be determined whether the materials can remain on site or must be removed and replaced. 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 in inspection records.

5.3 HVAC Systems

For HVAC systems, the following steps should be taken:

- Perform regular building/HVAC inspections and maintenance as scheduled.
- Provide exhaust ventilation to remove moisture during cold weather in spaces with moderate to high rates of moisture production per unit area (classrooms, kitchens, bathrooms, small apartments, etc.).
- Keep heating, ventilation, and air conditioning (HVAC) drip pans clean, flowing properly, and unobstructed.
- Ensure that air conditioning systems are able to control the humidity in the space and in the ductwork, especially during partial load cooling conditions when the system is on only part of the time (e.g., warm, rainy days).
- Ensure that cooling coil condensate drain pans are in place and sloped in both directions to a drain large enough to avoid clogging from dirt (e.g., min. 3/4” diameter).
- Avoid open, porous insulation inside ductwork intended to control sound levels, which can be a suitable growth media for mould. Although inorganic fibers do not support mould growth, they do collect dust and allow mould growth if the humidity is not controlled. Such insulation is also very difficult to clean.

- Ensure that filters are placed upstream of the cooling coils to keep the coils clean and avoid water dripping down from the coil onto the filter, which supports mould growth on the filter.
- Limiting airflow velocities and designing the cooling coils appropriately can control the blow-through of condensate from the coils. Research has shown that anti-mould treatments on filters have no effect once dirt is deposited.

Checklist 7-1 (Appendix A) lists design, maintenance and administrative measures for reducing mould growth in HVAC systems. Refer to *Module 5 – Hygienic Operation of Air-Handling Systems* for information about the operation, inspection and maintenance of HVAC systems for maximizing the indoor air quality.

5.4 Custodial Practices

Refer to *Module 3 – Custodial Activities, Maintenance, Repair and Renovation,* for information about custodial practices:

- *Section 4.1 Cleaning Procedures*, provides directions for custodial activities; Note that while cleaning can reduce exposure to contaminants, it can also cause pollutants such as mould spores, dust, chemical emissions and other harmful contaminants to be released into the air.
- *Section 6 Maintenance,* provides guidance for HVAC systems cleaning.
- *Section 8.2 Resolving Moisture-related Problems,* notes that the key to preventing mould is preventing excessive moisture through proper maintenance.

6. Recognizing and Assessing Potential Mould Contamination

The presence or suspected presence of mould may become evident as a result of occupant complaints and/or from observations resulting from regular maintenance and custodial work. Once mould presence is suspected, an inspection must be completed as soon as possible.

An accurate survey of the extent of the contamination, moisture or damage is required to document and plan for the remediation of the affected area. A thorough building investigation is sufficient in most cases. However, when mould is suspected but not observed, an understanding of the fundamentals of moisture transport in buildings, materials susceptibility to mould and the likely locations of elevated humidity, condensation and leaks in the building envelope is needed. In some cases, a sampling protocol might also be needed, and in specific situations more intrusive investigations might be appropriate.

6.1 Objectives of a Mould Investigation

The intensity and complexity of mould investigations vary according to the size and nature of the building, as well as to whether an air quality audit is being conducted or whether the investigation is in response to a health complaint. The Committee on Environmental and Occupational Health (Canada), CEOH, provides guidelines for minimizing exposure to mould.

If a complaint was received and the initial evidence shows that mould might be one of the potential issues, the goals of the investigation should be to:

- Establish the cause, nature and extent of mould contamination;
- Assess the risk of adverse effects on the occupants health;
- Manage the microbial problem(s);
- Return the building to a satisfactory level of performance.

It is important to focus on the problem as quickly as possible in order to allow the investigating team to provide clear answers to the building managers/owners and health providers about the state of the building. If the extent of mould is significant, the building occupants should be advised of potential risks without causing undue alarm.

Problems very often result from chronic moisture problems and can reach a point where they result in health complaints. The nature and the extent of the contamination, as well as the occupants who are most likely to be exposed to mould should be promptly identified.

6.2 Documentation

As the nature and the extent of the contamination become known, the information should be communicated to the occupants in order to permit those with sensitivities to mould exposures to consult with a medical professional about whether they should remain in the building.

Thorough documentation is required to: (1) record the inspection and the scope of the mould and/or moisture problem; (2) describe the stages of a destructive inspection, if conducted; (3) support and assist risk management and remediation decisions; (4) record the remediation actions taken and the final state after remediation; (5) assure the quality of the remediation work; and (6) address any legal, health or property claims.

The assessment documentation should include checklists, written notes, and a full set of photographs of the visible damage, taken before, during and after the remediation. The documentation may also include occupant questionnaires, interviews with the building maintenance team regarding the building operations, maintenance and practices, and the history of moisture problems. The documentation should be of sufficient detail so that an individual who has not been involved in the particular project can clearly understand the issue and the basis of the recommended remediation steps.

6.3 Steps

Inspection

The first step for investigating a potential mould problem is to perform a thorough visual inspection to check the building materials and spaces for visible mould growth and signs of

moisture damage, including a history of water leaks, elevated humidity levels, condensation, and musty or mouldy odours.

A thorough inspection should include:

- Examination of the physical structure, maintenance activities and occupancy patterns of the building;
- Examination of the potential sources of biological agents;
- Examination of evidence of current or past water damage and excess moisture;
- Examination of other possible indoor air contaminants;
- A plan of action for the control or the remediation of the problems found.

Investigators must consider whether there is possible hidden contamination, including in the HVAC system or wall cavities. In such cases, air samples are especially useful. Destructive testing such as drilling or coring into cavities, using boroscopes, or inspection using infrared cameras or moisture meters, and a collection of air samples are especially useful.

Regular monthly inspections should be conducted as a preventative measure. Checklist 7-2 (Appendix A) lists specific items that should be addressed during regular inspections for mould.

The components of the building ventilation system should be inspected, with particular emphasis on the filters, cooling coils (if present), the fan chamber and any internal insulation. If mould growth or moisture problems are found, the air pressure differential between the area of growth and the surrounding areas should be determined. The location of the mould and moisture damage should also be indentified to determine its impact on the building and its occupants. The risk of potential health consequences varies depending on the amount of visible mould/moisture damage and the degree of isolation from the occupied space.

If the mould damage is in the ventilation system, immediate steps are required to stop the spread of the contamination. If the contamination is on the surface of the walls, ceilings or floors exposed to an occupied space, prompt steps are required to contain the mould-damaged areas. Arrange for swift remediation because the mould area that is visible is likely just a fraction of the total damage.

When inspecting, if material samples are taken, floors and other surfaces where dust may accumulate should be damp cleaned or cleaned with a high-efficiency particulate air (HEPA) vacuum cleaner. With few exceptions, most exposure to mould spores arises from people stirring up settled dusts.

It is important to clean areas after sampling because inspection activities can cause the release of mould spores. Cleaning will, in most cases, immediately reduce the exposure while the investigation process continues.

6.4 Sampling Methods

Health Canada does not have numerical exposure limits for airborne mould. It does not recommend that indoor air be tested for mould as a first step because, in the absence of a numerical exposure limit to mould in air or a "threshold value", air tests cannot be used to assess the risks to the health of the building residents. Mould is a natural part of the environment and there are always mould spores in the air. Mould becomes a problem only if it finds a prolonged damp area to grow indoors. Simply finding mould spores in an air test does not necessarily mean there is a problem. An air test for mould will not help identify the source of the moisture or indicate how to fix it. Furthermore, one does not need to know the type of mould present in order to remove it.

In some cases, a sampling protocol might be developed to aid the investigation, and there are some specific situations where an air test might be required. For example, testing the air quality for mould could be necessary as part of a post-remediation quality assurance strategy.

Air Sampling

Air sampling is not appropriate unless a thorough building inspection is first done either on a concurrent basis or before sampling. Air sampling can be done to identify contamination that is not visible without destructive testing, and to document the air contamination. Similarly, after the sample results are obtained, the data must be compared with the information obtained during the physical inspections. Specialized equipment and training are required to perform appropriate mould air sampling.

Air samples should be taken during normal activity in the building, while the ventilation system is operational. Factors to consider include taking samples in a given space and allowing one or two hours between duplicates (e.g., go around each floor of the building in one direction, go up each level and then down, morning and afternoon, etc.). This technique takes into consideration the variability of airborne spore concentrations over time and with different activities, as well as varying thermal and wind loads.

Ideally, the number of outdoor air samples should be equal to the number of air samples taken indoors. Since this is seldom practical, at least three to six samples should be taken outdoors during the period(s) when the indoor sampling is under way. The outdoor samples should be collected above grade to avoid the collection of wind-blown soil particles containing fungi, which can affect the indoor-outdoor comparison. Outdoor ambient air samples should not be taken when it is raining. Rain has a transient effect on the microbial populations in outdoor air that can result in a reduction of the sensitivity of the indoor-outdoor comparison.

The advantage of properly collected and analyzed viable air samples is the detection of signs in the early stages of a mould problem, as well as growths in the wall cavities or ventilation ducts (where dilution by outside air limits the sensitivity of the analysis).

Impact Samplers
Impact samplers such as Reuter Centrifugal (RCS) or Anderson samplers can be used to sample for viable mould. Air is drawn through the unit onto growth media, which is then cultivated in a lab setting. RCS samplers use agar strips and Anderson samplers use medium filled Petri-dishes. The test equipment can be bulky and the media must be stored and shipped in a controlled environment. Several days to weeks are needed to culture and analyze the results. Results are provided at the genus or spore level.

Spore traps are small cassettes with a glass slide coating. Air is drawn into the cassette and particles are deposited on the coating. After collection, the cassette is sent to a lab for analysis of viable and non-viable mould and mould fragments. Because the spores are not cultured, the results are only provided at the genus level. The advantage of data from properly collected and analyzed spore trap samples lies in the quick results available within a day, which are useful for initial site testing and after the remediation.

Surface or Bulk Samples
The colonies that first emerge from test samples of mouldy building materials are likely to be the most reflective of those active in the damaged materials.

There are two techniques for sampling surfaces: swab sampling and tape sampling. For swab sampling, a sterile swab is used to wipe a surface. Swab samples can be analyzed for viable or non-viable mould contamination. For tape sampling, a clean piece of clear adhesive tape is used to lift suspect mould materials off a surface. Tape samples are analyzed for non-viable mould contamination.

Bulk samples refer to physical, destructive samples of building materials that are analyzed to determine the diversity of the fungi species present. For bulk sampling a piece of the suspected mouldy material is collected and analyzed in the lab for either viable or non-viable mould contamination.

6.5 Investigation of Suspect Concealed Areas

It is important to note that moulds in wall cavities and enclosed spaces do not present a health risk for the building occupants if there are no possible or reasonably predictable pathways of appreciable exposure indoors. Therefore, in indoor environments, hidden moulds should not be considered to have the same importance as extensive visible mould development, where the occupants could be exposed through both direct physical contact and/or inhalation of viable/non-viable mould spores and disturbed mould fragments.

Visible indoor mould growth – regardless of its extent - should be removed to reduce structural damage and long term health risks. When making a decision to remediate hidden mould, aspects such as potential exposure pathways, effect of the mould on the structural integrity of the building, and the susceptibility or health of the building occupants need to be taken into consideration. The viability and species of mould should not affect this decision.

Hidden mould can grow anywhere under prolonged wet or damp conditions. If concealed mould is suspected, more invasive techniques may be employed to determine its location.

Hidden mould can be expensive and difficult to identify and relies on an inspector's experience, combined with results of visual inspections, knowledge of moisture migration and dynamics, knowledge of mould growth conditions, and appropriate use of instrumentation and testing. Because of the complexity, as well as the additional health risks, investigations for hidden mould must be conducted by qualified environmental professionals.

Identifying mould in hidden areas may require small scale destructive openings in walls or other surfaces, lifting of carpets or vinyl sheet flooring, and removal of wallpaper, drywall or paneling. Signs of possible hidden mould include stains at the base of the walls, on the tack strips under the carpets and, commonly, under possible leak locations such as windows. Testing along the base of the walls using surface moisture meters can be useful in identifying hidden moisture.

More sophisticated methods, such as using hand-held infrared cameras, can also be used to identify locations where unusual moisture may be present. Training is needed since these devices are prone to false positive and false negative readings.

If there is a strong suspicion of hidden mould growth, as a precaution, personal protective equipment should be worn by inspectors conducting invasive inspections. Sensitive individuals should be removed from the premises before invasive or destructive inspections are conducted, as spores and dust may be released into the occupied areas. If mould is disturbed, immediate containment and other engineering controls such as HEPA filtration or negative pressure should be employed.

7. Addressing a Mould Problem

7.1 Communicating with Building Occupants

As applicable to all types of indoor air quality issues, open and ongoing communication with the building occupants is essential for a satisfactory outcome.
Use Form 4-1 IAQ Complaint (*Module 4 – Recognizing and Addressing IAQ Problems*) to document the nature of the occupant complaints.

Refer to *Module 7 – Communicating with Tenant Organizations and Individual Occupants* for additional information.

7.2 In-House vs. Outside Resources

The extent of the mould problem, the health of the building occupants, the degree of intervention needed, the effort required for containment, and the level of personal protection required for workers will determine whether outside expertise is required. If there are no health effects reported, the remediation of small isolated areas (less than 1 m^2) can generally be carried out by

the building maintenance staff, if they are trained in remediation and have no medical record of asthma or other respiratory ailments. Training should include information on proper clean-up methods and disposal, personal protection and potential health hazards. If the building maintenance staff is not adequately trained, the extent of the mould problem is large, or health effects have been reported, qualified mould professionals should be involved.

Refer to Module 2 – Volatile Organic Compounds (VOC) Sampling Methods and Strategies. *Section 8.1 Choosing a Consultant* provides direction on selecting a consultant to address indoor air quality problems.

The mould remediation contractor must have a written remediation plan describing the scope and objectives of the remediation, the areas and components to be remediated, the procedures to be followed, the cleaning agents and waste disposal methods to be used, the criteria that will determine whether the remediation has been successfully completed, and a work schedule outlining the sequence of events and the documentation and inspection procedures.

Environmental control requirements must be clearly stated, including containment, airflow, humidity and ventilation control strategies.

Checklist 7-3 (Appendix A) summarizes the steps for identifying and remediating mould.

8. Contaminant Removal Methods

8.1 General Information

Mould remediations prevent human exposure to mould and damage to building materials and furnishings. It is important to remove the mould contamination, not just to kill the mould. When area sterilization is not possible or desirable, a background level of mould spores will remain in the air (roughly equivalent to or lower than the mould level present in the outside air).

The use of biocides, such as quaternary ammonium compounds, is outside the scope of competence for someone not specifically trained in their use and their potential adverse health effects, and is not recommended as a routine practice for mould remediation. In the event a trained remediation contractor proposes the use of biocides, the advantages and disadvantages should be fully discussed.

The methods used to remediate mould growth depend on the cause and the extent of the growth. A variety of techniques and cleaning procedures are required to minimize the health risks associated with mould exposure and the spread of the contamination.

A variety of mould cleanup methods are available for remediating damage to building materials and furnishings caused by moisture control problems and mould growth. The specific method or group of methods used will depend on the type of material affected. In addition to the methods presented below, professional remediators may use specialized methods.

As noted in *Module 3 – Custodial Activities, Maintenance, Repair and Renovation, Section 5.1 Selection of Cleaning Products*, cleaning involves the removal of physical contaminants and disinfestation, which implies the use of chemicals. For some chemicals there may be limited knowledge about their effects on the indoor air quality and on health, and a balance between effectiveness, effects, labour and cost should be sought. *Table 3-2 Selection of Cleaning Products* provides general guidance for the selection of all-purpose cleaners and general disinfectants suited for mould removal with the lowest overall effect on the indoor air quality.

The scope of the remediation activities depends on the extent of water damage and mould contamination, and may range from surface mould removal by a custodian to an extensive structural renovation requiring a team of skilled professionals. The primary method to ensure that the mould remediation has been done properly is to confirm that the water or moisture sources have been identified and removed.

It is generally not appropriate for spaces to be occupied when mould remediations are actively underway. Containment of the dust and spores using negative pressure and isolation of the remediation area is a prudent practice. During repairs and damp cleaning measures should be taken to protect the building contents from settled dusts, and/or HEPA vacuum cleaning should be done after the repairs are completed.

There is no public health reason to contain the outside of a building when the remediation is done from the exterior. A possible exception is when the exterior walls are in a semi-enclosed space (e.g., a stairwell). However, if there is any potential for exposure of the general public, mould remediation activities should be implemented with measures in place (e.g., dust suppression) to prevent the generation, dispersion and deposition of significant airborne dust/particulate matter in the local environment and the neighbouring properties.

If the remediation consists mainly in demising wall cavities, access to the highly damaged areas of the building should be restricted until the remediation is complete. Additional steps to consider include regular damp cleaning and/or HEPA vacuum cleaning, as well as air monitoring to ensure the effectiveness of the cleaning. A team should be created to manage the remediation and repair process, and to closely monitor the remediation and repair work in order to ensure its effectiveness.

8.2 General Mould Cleaning Methods

Wet vacuuming

Wet vacuum cleaners can be used to remove water from floors, carpets, and hard surfaces where water has accumulated. However, note that wet vacuum cleaners should not be used to vacuum porous materials, such as gypsum board, and should be used only when the materials are still wet, as they may spread spores if sufficient liquid is not present. Tanks, hoses, and attachments of wet vacuum cleaners should be thoroughly cleaned and dried after each use, as mould and mould spores may stick to their surfaces.

Damp Wiping
Mould can generally be removed from non-porous (hard) surfaces by wiping or scrubbing with water, or water and detergent. It is important to dry surfaces quickly and thoroughly to obstruct further mould growth. The instructions found on cleaning product labels should always be read and followed. Wet porous materials may have to be discarded, as mould can infiltrate porous substances and grow in empty spaces or crevices, which may make mould difficult or impossible to remove entirely.

HEPA Vacuuming
HEPA (high-efficiency particulate air) vacuum cleaners are recommended for the final cleanup of the remediation areas, after the materials have been thoroughly dried and the contaminated materials have been removed. HEPA vacuum cleaners are also recommended for cleaning the dust that may have settled on the surfaces located outside of the remediation area. Care must be taken to fit the HEPA filter properly into the vacuum cleaner to ensure that all of the air passes through the filter. When changing the filter, personal protective equipment should be worn to prevent exposure to the mould that had been captured. The filter and the contents of the HEPA vacuum cleaner must be disposed of in well-sealed plastic bags.

8.3 Personal Protective Equipment

If during the remediation work the mould spores become airborne the risk of respiratory exposure increases. Actions that are likely to stir up mould include: breakup of mouldy porous materials such as wallboard; invasive procedures used to examine or remediate mould growth in a wall cavity; actively stripping or peeling wallpaper; and the use of fans to dry items.

The primary function of the personal protective equipment (PPE) is to avoid the inhalation of mould and mould spores and to avoid mould contact with the skin or eyes. The use of certain PPE equipment, such as half-face or full-face respirators, requires training.

Gloves are required to protect the skin from contact with mould allergens and with cleaning solutions. Long gloves that extend to the middle of the forearm are recommended. The glove material should be selected based on the type of materials being handled. When using a mild detergent or plain water, ordinary household rubber gloves may be used. For eye protection properly fitted goggles or a full-face respirator with a P100 filter should be used. Goggles must be designed to prevent the entry of dust and small particles. Safety glasses or goggles with open vent holes are not acceptable.

Respirators protect cleanup workers from inhaling airborne mould spores, mould fragments, and dust. When cleaning a small area affected by mould, use a P100 respirator. This device covers the nose and mouth, will filter out 99.97% of the particulates in the air, and is available at most hardware stores. For larger areas, use a half-face or full-face air purifying respirator (APR) equipped with a P100 filter cartridge. These respirators contain both inhalation and exhalation valves that filter the air and ensure that it is free of mould particles. Note that half-face APRs do not provide eye protection. In addition, HEPA filters do not remove vapours or gases.

In situations where high levels of airborne dust or mould spores are likely, or when intense or long-term exposures are expected (e.g., cleanup of large areas of contamination), a full-face powered air purifying respirator (PAPR) is recommended. Full-face PAPRs use a blower to force air through a P100 filter. The P100-filtered air is supplied to a mask that covers the entire face or a hood that covers the entire head. The positive pressure within the hood prevents unfiltered air from entering through penetrations or gaps. Individuals must be trained to use their respirators before the remediation work begins.

8.4 Disposal of Mouldy Materials

Mouldy construction materials may usually be disposed of as regular garbage in approved landfills. However, federal, provincial, and local regulations must be followed. Debris and waste should be stored in a secure location and transported in a closed container to minimize the possibility of cross-contamination or exposure. Where local legislation requires recycling of materials, mouldy construction materials and, especially, porous materials such as carpets, textiles, insulation and drywall, should not be included.

Checklist 7-4 (Appendix A) provides suggestions for dealing with materials that are or have been wet.

Non-porous materials such as metal, glass, stone, and plastics, and some semi-porous materials such as wood beams and frames, brick and concrete, can be recycled or salvaged for re-use. A professional restoration specialist should be consulted to determine the appropriate cleaning methods and precautions to prevent the spread of contamination.

Remediations should be considered complete only when:

1. The cause of the water or moisture problem has been rectified.
2. The mould has been removed.
3. Visible mould, mould-damaged materials, and mouldy odors are not present.
4. If sampling was conducted, the types and concentrations of mould and mould spores in the building after remediation are similar to those found in the ambient outside air.
5. The site was checked shortly after remediation and showed no signs of water damage or mould growth.
6. The building occupants have no health complaints or report physical symptoms.

9. Levels of Intervention for Surfaces

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

- Level I (small isolated areas): Areas smaller than 1 m^2 (10 ft^2)
- Level II (mid-sized isolated areas): Areas between 1-3 m^2 (10-30 ft^2)

- Level III (large isolated areas): Areas between 3-10 m^2 (30-100 ft^2)
- Level IV (extensive contamination): Areas larger than 10 m^2 (>100 ft^2)

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

9.1 Level I - Remediation of Small Isolated Areas (smaller than 1 m^2) (e.g., ceiling tiles, small areas on walls)

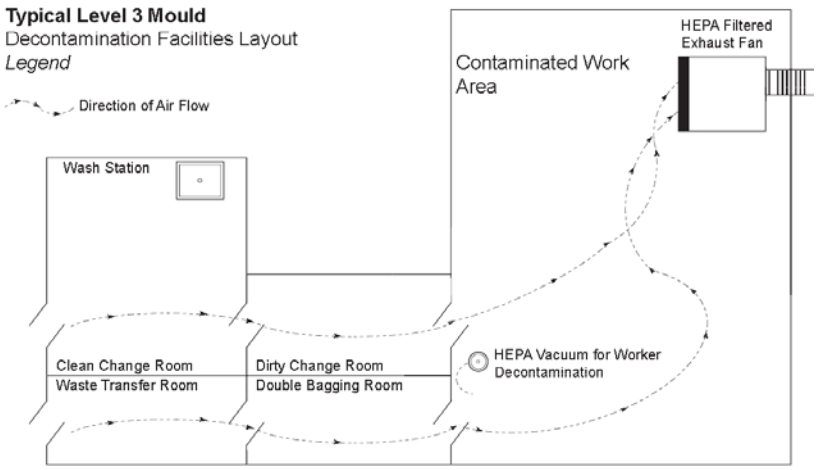
The regular building maintenance staff, provided they are not asthmatic, may perform Level I remediations. Workers should be informed about the risks associated with mould exposure, and their training should include the use of personal protection and proper clean-up methods. Suggested procedures for Level I occurrences are listed in Checklist 7-5 (Appendix A).

9.2 Level II – Mid-Sized Isolated Areas (1 - 3 m^2) (e.g., individual wallboard panels)

The regular building maintenance staff, provided that they are not asthmatic or have any respiratory ailments, can conduct Level II remediations. Such persons should receive training on proper clean-up methods, personal protection, and potential health hazards. Suggested procedures for Level II occurrences are listed in Checklist 7-6 (Appendix A).

9.3 Level III – Large Isolated Areas (3 - 10 m^2) (e.g., several wallboard panels)

A health and safety professional with experience in performing microbial investigations should be consulted prior to remediation activities to provide oversight of Level III remediations. Suggested procedures for Level III occurrences are listed in Checklist 7-7 (Appendix A). Figure 7-2 shows a recommended workflow to contain the contaminated area during Level III mould remediations.



*Note: *HEPA vacumns / exhaust fans should exhaust to outside if practicable.*

Source: The Canadian Construction Association

Figure 7-2 Workflow for Level III mould remediation

9.4 Level IV – Extensive Contamination (areas larger than 10 m²)

A health and safety professional with experience in performing microbial investigations should be consulted prior to remediation activities to provide oversight of Level IV remediations. Suggested procedures for Level IV occurrences are listed in Checklist 7-8 (Appendix A).

10. Levels of Intervention for HVAC Systems

Internal HVAC system components that become contaminated with active mould growth, spores, or associated contaminants must be cleaned or replaced.

10.1 HVAC Level I – Small contamination areas (smaller than 3 m²)

The regular building maintenance staff trained on proper clean-up methods, personal protection, and potential health hazards can remediate small areas of HVAC systems. Suggested procedures for HVAC Level I occurrences are listed in Checklist 7-9 (Appendix A).

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

A health and safety professional with experience in performing microbial investigations should be consulted prior to remediation activities involving more than a small isolated area of an HVAC system. Suggested procedures for HVAC Level II occurrences are listed in Checklist 7-10 (Appendix A).

11. Measures to Prevent Mould and its Recurrence

Vigilance and prompt attention to condensation and water leaks in the building, and wet building materials (resulting from plumbing or other causes such as flood or storm damage) will eliminate the growth of mould and prevent the increase of other contaminants such as house dust mites. Such preventive actions are relatively inexpensive compared to the costs associated with building remediations due to mould.

The intent of a preventative maintenance program is to ensure that the building will continue to provide a healthy environment. A monitoring process provides several opportunities for technical and building maintenance staff to assess the building operating systems and indoor air quality conditions. The principal guideline for microbial control is to keep mould growth in buildings to a minimum. This can be accomplished in a number of ways:

- Be vigilant about moisture sources and remove them immediately. Prevent the accumulation of stagnant water in and around the HVAC system mechanical components, such as the cooling coils of air handling units. Maintain the indoor relative humidity lower than 60%. Repair all external and internal leaks promptly and permanently.
- Remove the mould-contaminated materials. Remove and discard porous organic materials that are obviously contaminated (e.g., mouldy ceiling tiles, mildewed carpets). Any remaining non-porous materials that were in contact with the mould contaminated materials should be washed with diluted 5% bleach (250 mL bleach /4 L water) or other acceptable mould remediation cleaning solution.
- In HVAC systems use steam for humidification rather than recirculated water, or use spray humidifiers where feasible. If spray systems are used, a rigorous preventive maintenance program must be employed, as these systems can easily become contaminated with bacteria and mould. This includes maintenance of slime-free surfaces and the addition of potable water to the reservoir. Humidifiers should be drained and cleaned. Rust and scale deposits should be removed from HVAC system components once or twice a year. HVAC systems should be turned off during cleaning operations, which should be scheduled during weekends and unoccupied periods.
- Porous synthetic insulation is often used to line ducts and air handling and induction units. The vapour barrier on fiberglass should be intact. There should be no standing water or condensation on these surfaces. Dirty, contaminated insulation should be removed, as the effectiveness of cleaning or encapsulation has not yet been verified.
- Personal portable humidifiers should not be allowed, as they are seldom maintained properly and can easily become contaminated.
- The use of efficient filters to control the amount of spores entering the air handling system is important. Use prefilters and extended surface-type secondary filters with dust-spot efficiency ratings higher than 85% when possible. Replace the filters at regular intervals of time. Prefilters are normally changed 4-6 times a year and secondary bag filters once a year, depending on the outside conditions and the retrofit activity.

12. References and Sources of Additional Information

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7. WHO Guidelines for Indoor Air Quality, Dampness and Mould. 2009: http://www.who.int/indoorair/publications/7989289041683/en/
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Appendix A – Checklists

Checklist 7-1 Measures for reducing mould growth in HVAC systems		
Component	Action Type	Measure
1. Outdoor Air Intakes	M	Maintain surfaces clean to prevent the accumulation of moisture or debris
	M	Protect intakes and surrounding area from infestation from birds, bats, rodents, or other animals
	M	Promptly remove all stagnant water, soil, plant, animal, and other debris from adjacent areas
	D	Avoid positioning the intakes down-wind from possible mould sources (e.g., cooling towers, sanitary vents, building exhausts, large bird nests or roosting sites)
2. Filters	D/M	Protect filters from direct wetting via rain, snow, water leaks or flooding to avoid microbial growth on the filter. Replace filters periodically so that they perform to design specifications
	D	Locate duct humidifiers at least 4.6 m (15 ft.) downstream of the final high-efficiency filters
	M	Promptly discard wet filters and insulation from HVAC air-handling and fan-coil units
3. Condenser Units and Vicinity	D	Avoid the use of porous materials on airstream surfaces in persistently wet areas of the HVAC systems
	D/M	Design and operate the cooling coils and spray humidifiers to minimize the carryover of water droplets
4. Drain Pans	D	Slope the pans to drain completely (e.g., a drop of –0.2 cm for every 10 cm of pan length (0.25 in/ft.)). The slope should direct the water toward a drainage point, preferably from the bottom of a pan. Do not insulate the pan with porous materials
	D	To allow the water to drain properly, 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 in centimeters or inches or water gauge).
	M	Keep the drain pans clean to avoid extensive microbial growth. Physically remove the growth that develops. Biocide treatment without the removal of microbial growth is inadequate.
	M	HVAC components, subject to wet or damp conditions, should be inspected monthly and cleaned, if necessary.
5. Humidifiers	D/M	If steam is used, supply “clean steam.” Raw steam from a central boiler may be contaminated.
	A	Discourage the use of console humidifiers or vaporizers in the workplace because they must be thoroughly cleaned and disinfected to eliminate all mould growth.
	A	Avoid water-spray humidifiers and air washers in non-industrial HVAC systems because they require frequent maintenance to prevent microbial growth

	D/M	Avoid exposed insulation and air cleaners (e.g., filters) in HVAC plenums or ductwork downstream of humidifiers. Respect the absorption distance recommended by manufactures to allow complete entrainment of humidifier moisture by the ventilation airstream
6. Plenums and Ducts	D/M	The airstream surfaces of HVAC equipment and ductwork should resist the accumulation of dirt (or be readily cleanable or replaceable), moisture absorption or retention, and bio deterioration
	M	Maintain all surfaces within the HVAC plenum to prevent the accumulation of moisture or debris.
	D/M	Surfaces in the vicinity of moisture-producing equipment should be smooth and non-absorbent. Keep porous insulation in these areas free of dirt and moisture or protect surfaces with a layer that is impermeable to water (e.g., sheet metal).
	A D/M	Check for obstructions or proper operation of HVAC system if areas are poorly ventilated.

Legend: D=Design; M=Maintenance; A=Administrative
Adopted from Mould Guidelines for the Canadian Construction Industry, Canadian Construction Association, 2004

Checklist 7-2 Regular inspections for mould

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

Adopted from Mould in Indoor Environments, Risk Assessment and Management Program Handbook, Alberta Transportation and Infrastructure, 2006

Checklist 7-3 Steps for mould remediation	
	Investigate, evaluate and address moisture and mould problems Assess the size of the mould area(s) (m^2) Consider the possibility of hidden mould Clean up small mould problems and fix moisture problems before they become large problems Select a remediation manager for medium or large size mould problems Investigate the areas associated with occupant complaints Identify the source(s) or the cause of water or moisture problem(s) Note the type of water-damaged materials (wallboard, carpet, etc.) Check inside the air ducts and the air handling unit Throughout the process, consult a qualified professional if necessary
	Communicate with the building occupants at all stages of the process, as appropriate Designate a contact person for questions and comments about medium or large scale remediation as needed
	Plan remediation Consult remediation guidelines Plan to dry wet, non-mouldy materials within 48 hours to prevent mould growth
	Select remediation personnel with experience and training to implement the remediation plan and use Personal Protection Equipment and area containment as appropriate
	Select cleanup methods for mouldy items
	Specify personal protection equipment
	Select containment equipment
	Remediate moisture and mould problems Fix moisture problem, implement repair plan and/or maintenance plan
	Clean and dry mouldy materials
	Discard mouldy porous items that cannot be cleaned

Adapted from Mould Remediation for Schools and Buildings, EPA, 2008.

Checklist 7-4 Actions required for wet materials	
Water-Damaged Material	Actions to be Taken
Books and papers	• Discard damaged books and papers. • Photocopy valuable/important items and discard originals.
Carpet and backing – dry within 24-48 hours	• Remove water with water extraction vacuum cleaner. • Reduce ambient humidity levels with a dehumidifier. • Accelerate drying process with fans.
Ceiling tiles	• Discard and replace.
Cellulose insulation	• Discard and replace.
Concrete or cinder block	• Remove water with water extraction vacuum cleaner • Accelerate drying process with dehumidifiers, fans, and/or heaters.
Fiberglass insulation	• Discard and replace
Hard surface, porous flooring (linoleum, ceramic tile, vinyl)	• Vacuum or damp wipe with water and mild detergent and allow drying; scrub if necessary. • Check under flooring to ensure that it is dry; dry under flooring if necessary.

Adapted from Mould in Indoor Environments, Risk Assessment and Management Program Handbook, Alberta Transportation and Infrastructure, 2006, Table 2.

Checklist 7-5 Remediation of Level I - Small Isolated Areas (Less than 1 m^2)

1. Use respiratory protection (e.g., P100 respirator) in accordance with the respiratory protection standard (CSA Standard Z94.4). Wear gloves and eye protection.
2. Ensure the work area is unoccupied.
3. Consider containing the work area. Use dust suppression methods, such as misting (not soaking) surfaces prior to remediation.
4. Remove contaminated materials that cannot be cleaned in a sealed plastic bag and dispose.
5. Clean the work area used by remedial workers with a damp cloth and/or mop and a detergent solution.
6. Leave all areas dry and visibly free from contamination and debris.

Adopted from Mould in Indoor Environments, Risk Assessment and Management Program Handbook, Alberta Transportation and Infrastructure, 2006.

Checklist 7-6 Remediation of Level II – Mid-Sized Isolated Areas (1 - 3 m^2)
(e.g., individual wallboard panels)

1. Use respiratory protection (e.g., P100 respirator) in accordance with the respiratory protection standard (CSA Standard Z94.4). Wear gloves and eye protection.
2. Ensure the work area is unoccupied.
3. To contain dust/debris, cover the work area with plastic sheet(s) and seal with tape before remediation.
4. Use dust suppression methods, such as misting (not soaking) surfaces, prior to remediation.
5. Remove contaminated materials that cannot be cleaned in sealed plastic bags and dispose.
6. Clean the work area used by remedial workers with a damp cloth and/or mop and a detergent solution.
7. Leave all areas dry and visibly free from contamination and debris.

Adopted from Mould in Indoor Environments, Risk Assessment and Management Program Handbook, Alberta Transportation and Infrastructure, 2006.

Checklist 7-7 Remediation of Level III – Large Isolated Areas (3 - 10 m^2)
(e.g., more than one wallboard panel)

1. Use personnel trained in the handling of hazardous materials, equipped with respiratory protection (e.g., P100 respirator) in accordance with the respiratory protection standard (CSA Standard Z94.4). Wear gloves and eye protection.
2. Cover the areas directly adjacent to the remediation area with plastic sheet(s) and tape before remediation to contain the dust/debris.
3. Seal the ventilation ducts/grills in the work area and areas directly adjacent with plastic sheeting.
4. Ensure the work area and areas directly adjacent are unoccupied. Vacate infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity pneumonitis, and severe allergies).
5. Use dust suppression methods, such as misting (not soaking) surfaces prior to remediation.
6. Remove contaminated materials that cannot be cleaned in sealed plastic bags and dispose. (There are no special requirements for the disposal of mouldy materials. They can be disposed of as common household waste.)
7. Clean the work area and surrounding areas with a HEPA vacuum cleaner and with a damp cloth and/or mop and a detergent solution.
8. Leave all areas dry and visibly free from contamination and debris.
9. If the remediation procedures are expected to generate a lot of dust (e.g. abrasive cleaning of contaminated surface, demolition of plaster walls) or the visible concentration of the mould is heavy (blanket coverage as opposed to patchy), follow the remediation procedures for Level IV.

Adopted from Mould in Indoor Environments, Risk Assessment and Management Program Handbook, Alberta Transportation and Infrastructure, 2006.

Checklist 7-8 Remediation for Level IV – Extensive Contamination (greater than 10 m^2)

1. Use personnel trained in the handling of hazardous materials equipped with:
   a. Full-face respirators with high efficiency particulate air (HEPA) cartridges
   b. Disposable protective clothing covering both head and shoes
   c. Gloves
2. Contain the affected area using:
   a. Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and any other openings)
   b. An exhaust fan with a HEPA filter to generate negative pressurization
   c. Airlocks and decontamination room
3. Ensure the work area and areas directly adjacent are unoccupied. Vacate infants (less than 12 months old), persons having undergone recent surgery, immune suppressed people, or people with chronic inflammatory lung diseases (e.g., asthma, hypersensitivity pneumonitis, and severe allergies).
4. Remove contaminated materials that cannot be cleaned in sealed plastic bags and dispose. Clean the outside of the bags with a damp cloth and a detergent solution or a HEPA vacuum cleaner in a decontamination chamber prior to transportation to uncontaminated areas of the building.
5. Clean the work area and surrounding areas with a HEPA vacuum cleaner and with a damp cloth and/or mop and a detergent solution.
6. Conduct air monitoring prior to occupancy to determine if the area is fit to be reoccupied.

Adopted from Mould in Indoor Environments, Risk Assessment and Management Program Handbook, Alberta Transportation and Infrastructure, 2006.

Checklist 7-9 Remediation of HVAC Level I – Small contamination areas, under 3 m²

1. Use personnel trained in the handling of hazardous materials and equipped with respiratory protection, (e.g., P100 respirator) in accordance with the respiratory protection standard (CSA Standard Z94.4). Wear gloves and eye protection.
2. Shut down the HVAC system prior to any remedial activities.
3. Cover the work area and areas directly adjacent with plastic sheet(s) and tape before remediation to contain the dust/debris.
4. Use dust suppression methods such as misting (not soaking) surfaces prior to remediation.
5. Remove growth supporting materials that are contaminated, such as paper on the insulation of interior lined ducts and filters. Remove the contaminated materials that cannot be cleaned in sealed plastic bags. (There are no special requirements for the disposal of mouldy materials.)
6. Clean the work area and surrounding areas with a HEPA vacuum cleaner and with a damp cloth and/or mop and a detergent solution.
7. Leave all areas dry and visibly free from contamination and debris.
8. Consult the HVAC manufacturers on the products recommended for the cleaning of the HVAC components, such as cooling coils and condensation pans.

Adopted from Mould in Indoor Environments, Risk Assessment and Management Program Handbook, Alberta Transportation and Infrastructure, 2006.

Checklist 7-10 Remediation of HVAC Level II – Larger contamination areas (3 m² or more)

1. Use personnel trained in the handling of hazardous materials equipped with:
    a. Respiratory protection (e.g., P100 respirator), in accordance with the OSHA respiratory protection standard (CSA Standard Z94.4).
    b. Gloves and eye protection
    c. Full-face respirators with HEPA cartridges and disposable protective clothing covering both head and shoes.
2. The HVAC system should be shut down prior to any remedial activities.
3. Contain the affected area using:
    a. Plastic sheeting sealed with tape.
    b. An exhaust fan with a HEPA filter to generate negative pressurization.
    c. Airlocks and a decontamination room.
4. Use sealed plastic bags to remove growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, and other contaminated materials that cannot be cleaned. When a decontamination chamber is present, clean the outside of the bags with a damp cloth and a detergent solution, or a HEPA vacuum cleaner, prior to transportation to uncontaminated areas of the building. (There are no special requirements for the disposal of mouldy materials. They can be disposed of as common household waste.)
5. Clean the work area and surrounding areas with a HEPA vacuum cleaner, and with a damp cloth and/or mop and a detergent solution, prior to the removal of the isolation barriers.
6. Leave all areas dry and visibly free from contamination and debris.
7. Prior to re-occupancy, conduct air monitoring with the HVAC system in operation to determine if the areas served by the system are fit to be reoccupied.
8. Consult the HVAC manufacturers on the products recommended for the cleaning of the HVAC components, such as cooling coils and condensation pans.

Adopted from Mould in Indoor Environments, Risk Assessment and Management Program Handbook, Alberta Transportation and Infrastructure, 2006.