



## **WATER INFILTRATION INTO BUILDINGS:**

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Roles & Responsibilities

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and Remediation of Fungi in Indoor Environments

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## PART 1

### Mold in Buildings: General Information

Water damaged building materials and furnishings, if not appropriately handled, can become significant sources of microbiological contamination in building environments. This may lead to health problems for occupants ranging from simple irritation to allergic responses to hypersensitivity diseases.

All buildings during their lifetime will have some form of water problems. Appropriate management of these water problems to prevent or mitigate microbial growth will ensure the health of building occupants.

#### **What are molds?**

Molds are simple, microscopic organisms, found virtually everywhere, indoors and outdoors. Molds can be found on plants, foods, dry leaves and other organic materials. Mold spores are very tiny and lightweight, and this allows them to travel through the air. Mold growths can often be seen in the form of discoloration, ranging from white to orange and from green to brown and black. When molds are present in large quantities, they can cause allergic symptoms.

#### **HEALTH EFFECTS**

Whether or not symptoms develop in people exposed to fungi depends on the nature of the fungal material, the amount of exposure, and the susceptibility of exposed persons. Susceptibility varies with genetic predisposition, age, state of health, and concurrent exposures.

Some of the most common symptoms reported from indoor fungal exposures include:

- Respiratory symptoms (cough, spit, nasal or throat irritation, runny nose, sneezing, wheezing, respiratory problems, thoracic pains)
- Respiratory allergies (runny nose, alveolitis, bronchitis, asthma, hypersensitivity pneumonitis)
- Non-respiratory symptoms (eye irritation, lesions, infection)
- Skin allergies (skin irritation, dermatitis)
- General toxic effects (fever, chills, headaches, nausea, vomiting, diarrhea, immunity deficiency, fatigue, hair loss)

#### Medical Evaluation:

Individuals with persistent health problems that appear to be related to fungal exposures should see their physicians.

Individuals seeking medical attention should be provided with a copy of all inspection results and interpretation to give to their medical practitioners.

#### Health Precautions:

Persons doing the remedial work should follow the procedures outlined in the Guidelines for Facilities Management: methods for the control and remediation of fungi in indoor environments.

#### **PREVENTION**

- As a general rule, water infiltration should be corrected within 24 to 48 hours (Refer to Guidelines for Facilities Management: methods for the control and remediation of fungi in indoor environments).
- Good ventilation and periodic air exchanges are necessary.

#### **DETECTING WATER DAMAGE & MOLD CONTAMINATION**

Replaceable building materials that cannot be thoroughly cleaned, decontaminated and rapidly dried should be discarded. Building materials and furnishing that remain wet for more than 48 hours should be discarded.

Ceilings and walls that have been flooded or that have absorbed water should be inspected either by breaking open the ceiling/wall or with a moisture meter.

Fungi need a source of moisture, a source of nutrients, and a warm environment with a temperature range from 10 to 42°C to grow. Because fungi grow well at room temperature, control is achieved through adequate filtration and control of moisture. Areas that have poor ventilation and a source of moisture are likely sources for fungal amplification.

## PART 2

### Guidelines for Managing Water Infiltration into Buildings: Roles & Responsibilities

#### SCOPE

This procedure will apply to the managing of water infiltration and remediation of water problems in buildings due to floods, roof leaks, potable water leaks, sewage backup, steam leaks and groundwater infiltration.

In addition to remediation measures, water infiltration should always be eliminated **at the source**.

#### RESPONSIBILITIES

##### Building Occupants:

- Report all incidents ASAP (within 24-48 hrs)
- When *water damage* is detected it should be reported to the Service Center at extension 2400 (including water stains on carpets, walls or ceilings)
- If *mold growth* (green or black stains on the surface of walls, ceilings carpets) or a *moldy odor* is detected it should be reported to the Service center at 2400 and Environmental Health & Safety Office (EH&S) at extension 4877.
- Any *health problems* that appear to be associated to the exposure of fungi from the work environment should be reported to EH&S at extension 4877.
- Decontaminate personal effects or dispose them if they cannot be decontaminated (e.g. paper, files, etc.)

##### Facilities Management:

- Conduct environmental assessment (with EH&S) – refer to “Guidelines for Facilities Management: methods for the control and remediation of fungi in indoor environments”
- Handle water damaged building materials (ie. gyproc, ceiling tiles, carpet, electrical units, ventilation systems, etc.)
- Remediation of contaminated materials
- Identify and eliminate source of the problem

## Environmental Health & Safety:

- Conduct environmental assessment (with Facilities Management)
- Investigate health matters
- Coordinate the identification of mold
- Do needed sampling
- Provide information and support to area occupants

## **PROCEDURES**

- Procedures for the proper handling of water damaged items, remediation of contaminated areas, and for the decontamination of ventilation systems refer to: Guidelines for Facilities Management: methods from the control and remediation of fungi in indoor environments.
- Procedure for sampling:

Surface sampling is *not required* to undertake a remediation (surface samples are taken by a tape lift imprint or by submitting a bulk sample of the suspect surface). If there is visual evidence of mold growth, remediation of the contaminated area should proceed without further evaluation. However, if the identification of the fungal species is required (i.e. for medical evaluation), samples should be collected by the industrial hygienists, and the microscopic identification of the fungal spores will be analyzed in an accredited laboratory.

## **TRAINING**

The following personnel should be trained on the detection of water damage and mold growth, how to deal with water damaged materials, and potential health risks:

- Custodial
- Carpenters
- Electricians
- Plumbers
- Power Plant personnel
- Security Agents

Training should be done once every 2-3 years.

The following personnel should also receive training on the proper remediation methods of fungi in indoor environments:

- Custodial
- Carpenters
- Electricians
- Plumbers
- Boiler room operators

## **HAZARD COMMUNICATION**

When fungal growth is found, it should be reported to the departmental supervisor, the Service Center of Facilities Management, and the Environmental Health and Safety Office. Notification to the occupants should include a description of the remedial measures to be taken and a timetable for completion.

Environmental Health and Safety Office will advise based on the following criteria, whether or not to temporarily evacuate an area:

- Extent of contamination
- Location
- Risk of dispersion and propagation
- Personal health risks of occupant population

In the event of an evacuation, group meetings held before and after remediation with full disclosure of plans and results, or a written communiqué will be used.

## **PART 3**

### **Guidelines for Facilities management:** **Methods for the control and remediation of fungi in indoor environments**

In all situations, the underlying cause of water accumulation must be rectified or fungal growth will occur. Any initial water infiltration should be stopped and cleaned *immediately*. An immediate response (within 24 to 48 hours) and thorough clean up, drying, and/or removal of water damaged materials will prevent or limit mold growth. Emphasis should be on ensuring proper repairs of the building infrastructure, so that water damage and moisture build-up does not recur.

#### **ENVIRONMENTAL ASSESSMENT**

The presence of mold, water damage, or musty odours should be addressed immediately. In all instances, any source(s) of water must be stopped and the extent of water damage determined.

Factors that contribute to mold growth are shown in the table below:

<b>FACTOR</b>	<b>CRITERIA FOR GROWTH</b>
MOISTURE	<ul style="list-style-type: none"><li>• Wet materials</li><li>• Humidity of materials reaches 75%</li><li>• Moisture content of wood &gt; 24%</li></ul>
HUMIDITY	<ul style="list-style-type: none"><li>• Greater than 60% relative humidity</li></ul>
NUTRIENTS/SUBSTRATE	<ul style="list-style-type: none"><li>• Organic materials (drywall, adhesives, paper, wood, plaster, leather, cloth)</li><li>• Prefers natural materials to synthetic, but some will grow on plastics and some metals</li></ul>
AIR VELOCITY	<ul style="list-style-type: none"><li>• Stagnant ambient air</li><li>• Air velocity less than 2 feet/second</li><li>• *NOTE: air movers near growth will disperse mold spores</li></ul>
TEMPERATURE	<ul style="list-style-type: none"><li>• 10 – 42°C</li></ul>
LIGHT	<ul style="list-style-type: none"><li>• Darkness, low light</li></ul>
WATER SOURCE CONTAMINATION	<ul style="list-style-type: none"><li>• Direct correlation between previous mold growth and more rapid growth</li></ul>
TIME REMAINING WET	<ul style="list-style-type: none"><li>• Chance of growth greater after 48 hours of saturation</li></ul>
COLD SURFACES (i.e. pipes, walls, ect.)	<ul style="list-style-type: none"><li>• Proper insulation, including a vapour barrier of the cold surfaces will reduce the chances of growth.</li></ul>

#### **TAKING STEPS TO REDUCE MOISTURE**

Mold growth can be reduced if relative humidity is well controlled and condensation on surfaces is prevented. This can be accomplished by:

- Reducing the moisture content of air
- Increasing air movement at the surface
- Controlling air temperature

- Insulation of cold surfaces

*EQUIPMENT NEEDED:*

- Dehumidifiers
- Air-Conditioners (aid in removing humidity from air)
- Ventilation units (fans)
- Psychrometer/Hygrometer
- Shop-vac

**VISUAL INSPECTION**

A visual inspection is the most important initial step in identifying a possible contamination problem; it is necessary to locate the source of the water infiltration and to determine whether mold growth has occurred. The extent of any water damage and mold growth should be visually assessed. This assessment is important in determining remedial strategies. Look for signs of water damage! Inspection should include spaces in **ductwork or behind walls**, and a moisture meter should be used to detect moisture in building materials. This step may be helpful in identifying **hidden sources** of fungal growth and the extent of water damage.

When investigating for water damage look for the following:

- Water damage, flooding, sewage backflow
- Water stains on carpets, walls, ceilings or pipes
- Powdery mineral deposits (remaining after the water has evaporated) on the walls or concrete
- Softened wood or drywall
- Ceiling tiles, gypsum wallboard (sheetrock), cardboard, paper, and other cellulosic surfaces should be given careful attention during a visual inspection.
- Ventilation systems should also be visually checked, particularly for damp filters but also for damp conditions elsewhere in the system and overall cleanliness.

Signs of mold growth include:

- Green or black stains (could also be different colors such as white, pink, yellow or orange) on the surface of walls, ceilings, carpets
- Musty, moldy odours.

**PROCEDURES FOR THE REMEDIATION OF WATER DAMAGED OR FUNGI CONTAMINATED MATERIALS**

<b>Circumstance</b>	<b>Procedure to Follow</b>
If water accumulation is removed and the area can be completely dried within 24 –48 hours.	<b>A) Detailed descriptions on how to deal with specific water-damaged materials.</b>
If the water accumulation has not been cleaned up within 48 hours and/or mold is visually present.	<b>B) Guidelines on the Remediation of Fungi in Indoor Environments.</b>



If fungi and bacteria are detected in ventilation systems.

**C) Fungi and Bacteria in Ventilation Systems.**

## **A) DETAILED DESCRIPTIONS ON HOW TO DEAL WITH SPECIFIC WATER-DAMAGED MATERIALS**

NB. Replaceable building materials that cannot be thoroughly cleaned, decontaminated, and rapidly dried should be discarded.

### **1. Sheetrock /Gyproc/Drywall**

- If water damage has been noted within 48 hours (this includes floods, roof leaks, steam leaks, potable water leaks, and ground water damage) and no previous water damage has occurred:
  - Allow the material to dry and verify the moisture content after 48 hours.
  - Discard and replace all insulation materials.
- If after 48 hours or if materials have been damaged with sewage water:
  - remove and discard all damaged materials. Materials should be removed at least 500 mm (20 inches) above the high-water line. Make sure all wet materials have been removed, including all “hidden” areas (the use of a moisture meter may be helpful in detecting all moist areas). Ensure that the interior cavities of walls and ceilings are completely dry before re-closing and/or rebuilding.

### **2. Ceiling Tile**

- If water damage noted within 48 hours:
  - air-dry and reuse and monitor for future mold growth.
- If after 48 hours or wet with sewage water:
  - remove and dispose.

### **3. Concrete surfaces**

- If water damage noted within 48 hours:
  - Air-dry and vacuum using a HEPA filter.
- If after 48 hours or wet with sewage water:
  - Clean using TSP (trisodium phosphate) solution: 1 cup of TSP in two-2 gallons of warm water. Note – TSP is highly corrosive therefore eye protection and gloves must be worn.

### **4. Wood surfaces**

- Dry wood using fans and by extracting the moisture with a dry/wet vac and clean rags. Once dry the surface should be cleaned with a detergent and water and left to dry. Wood should not remain wet for more than 24 hours.
- If mold develops, wood can be sanded with a vacuum sander, do not sand without simultaneously vacuuming.

## 5. Electrical

Consider all wet wiring, light fixtures, electrical outlets to be shock hazards!

- Have everything checked by electrician.
- Electrician will decide whether to turn power off.
- Electrician should check for visible moisture, and electrical integrity.
- If in doubt, throw it out.

## 6. Furniture

**NB. If mold growth is visible see procedure B.**

For all types of furniture, if water damage noted with 48 hours:

- Clean, and let dry.

If furniture has been wet for > 48 hours or contaminated with sewage water:

- Discard all upholstered furniture.
- Hardwood, intact laminate, particleboard furniture should be sanded until all signs of water damage are no longer visible.

## 7. Carpet

**NB.** Any carpet that has been contaminated with sewage backup should be discarded under controlled conditions and the entire area disinfected with bleach and water.

- If wet for less than 48 hours (this includes floods, roof leaks, steam leaks, potable water leaks, and ground water leaks):
  - Remove all materials (e.g. furniture, file cabinets) from the carpet.
  - Extract as much water as possible from the carpet using wet vacuums.
  - Shampoo and steam clean.
  - Commercial steam cleaning of carpeting can be used in place of bleach.
  - Dry the carpet within 12-24 hours of treatment. After work is completed, increase the room temperature, and use commercial dehumidifiers, floor fans or exhaust fans to aid in drying the carpet.
  
- If wet for more than 48 hours:
  - If winter: disinfect and dry. Discard if cannot dry.
  - If summer (high humidity): discard.

## 8. Paper/Files

- If non-essential: remove and dispose.
- If essential: dry within 24-48 hours, photocopy and then discard.
- If cannot dry within 24-48 hours: clean with water and freeze until proper drying can be completed. Once dry, photocopy and discard. Any paper products that do develop mold will need to be discarded.

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## **B. GUIDELINES ON THE REMEDIATION OF FUNGI IN INDOOR ENVIRONMENTS**

The goal of remediation is to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied or non-abatement area, while protecting the health of workers performing the abatement.

### **For all contaminated sites:**

- Personnel, who will take part in the decontamination process, must receive training on proper clean-up methods, personal protection, and potential health hazards.
- Persons doing the remedial work cannot suffer from severe asthma, chronic respiratory disease, allergies and other hypersensitivity respiratory reactions to bacteria or mold, such as hypersensitivity pneumonitis or humidifier fever; or be immunocompromised (such as persons with HIV or AIDS)
- The spread of dust and debris must be suppressed/avoided.
- All porous, disposable areas with visible mold contamination must be removed.
- All hard surfaces, borders and all non-porous surfaces must be washed with a water-household bleach solution\* (25 % water-bleach solution, rinse, wait 15 minutes, rinse with water again) or TSP (trisodium phosphate) solution: 1 cup in 2 gallons of warm water using the same cleaning procedure as bleach.

\*Caution for Bleach:

**Use bleach in a well-ventilated area. Do not mix bleach with other cleaning chemicals, especially those containing ammonia. Poisonous vapours will result.**

\*Caution for TSP:

**TSP is corrosive and must not come into contact with skin or eyes. Proper Personal Protective equipment must be worn which consists of gloves and eye protection.**

- The work area should remain unoccupied while the decontamination process is in operation.
- If the source of water infiltration was not immediately rectified, monthly visual inspections of the area should be done to make sure that there has not been any new fungal growth. Also a hydrometer should be used to measure the humidity of the building materials.

**Small Isolated Areas** 2 sq. feet or less

Example: ceiling tiles

1. Remediation can be conducted by regular building maintenance staff, which has received proper training by a competent instructor, on the proper clean-up methods, personal protection, and potential hazards.
2. These workers must wear:
  - a. a half-face respirator with P-100 filters
  - b. nitrile gloves
  - c. safety goggles
3. Contaminated materials that cannot be cleaned should be removed from the building in sealed plastic bags.
4. The borders in the contaminated area must be cleaned with a water –household bleach or TSP solution.
5. All areas should be left dry and visibly free from contamination and debris.
6. The work area should be unoccupied. Vacating people from spaces adjacent to the work is not necessary but it is recommended in the presence of infants (less than 12 months old), immune suppressed people, people having undergone recent surgery, or people with chronic inflammatory lung disease (e.g. asthma, and severe allergies)

**Mid-sized Isolated areas** 2 – 30 sq. feet

Example: individual wall panels

1. Remediation can be conducted by regular building maintenance staff, which has received proper training by a competent instructor, on the proper clean-up methods, personal protection, and potential hazards.
2. Personnel trained in handling the contaminated materials must wear:
  - a. half-face respirator with P-100 filters
  - b. nitrile gloves
  - c. safety goggles
  - d. disposable Tyvek coveralls
3. The work area should be covered in plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
4. Ventilation ducts/grills in the work area and areas directly adjacent should be covered with plastic sheeting and sealed with tape.
5. Contaminated areas that cannot be cleaned should be removed from the building in sealed plastic bags.
6. The border of the work areas should be cleaned with a water – bleach solution or TSP solution.
7. All areas should be left dry and visibly free from contamination and debris

**Large Isolated areas** more that 30 sq. feet

*Example:* Area greater than individual wall panel, in direct contact with personnel.

1. Decontamination must be done by specialized personnel trained in handling hazardous materials ( i.e. work similar to that of a high risk asbestos removal project). Concordia personnel should not be decontaminating such areas.
2. The contaminated area must be contained:
  - a. Complete isolation of work area from occupied spaces using plastic sheeting sealed with duct tape (including ventilation ducts/grills, fixtures, and any other openings).
  - b. The use of an exhaust fan with a HEPA filter to generate negative pressurization
  - c. Airlocks and decontamination room should be used to facilitate the exit from the contaminated work area
3. Contaminated materials that cannot be cleaned should be removed from the building in sealed plastic bags.
4. The contaminated area should be HEPA vacuumed prior to the removal of isolation barriers.
5. Personnel trained in the handling of hazardous material must wear:
  - a. Full-face respirators with HEPA cartridges or an air-supplying respirator
  - b. Disposable coveralls with hoods, and shoe coverings and gloves.
6. Air monitoring should be:
  - a. conducted after the decontamination procedure, but before the removal of isolation barriers, to determine whether the fungal spores were dispersed during the cleanup procedure
  - b. conducted after the decontamination, to evaluate the efficiency of the cleanup and to determine whether sensitive persons can reenter the area.

**FURNITURE WITH VISIBLE SIGNS OF MOLD**

- All upholstered furniture must be discarded.
- Hardwood, intact laminate, particleboard furniture should be sanded until all signs of mold growth are no longer visible.

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**C. FUNGI AND BACTERIA IN VENTILATION SYSTEMS**

Fungi and bacteria growing in ventilation systems may contaminate indoor environments and cause various problems. These microorganisms develop in the presence of water, excessive humidity, and in areas of dust accumulation. To avoid the occurrence of these factors it is of extreme importance to eliminate all sources of stagnant water in the ventilation systems (e.g. in humidifiers), immediately clean after a flood or spill, remove all excess dust, and to limit temperatures to a maximum of 30°C.

Filtration has for many years provided the primary defense against spores entering a building ventilation system. HEPA filters are typically used and are capable of intercepting a large number of fungal spores **only** if they are well maintained and tightly installed. Fungi and

bacteria can grow on HEPA filters that are not properly maintained, as well as other ventilation components and, if unchecked, can actually contribute to the problem.

**Likely sources of fungal and bacterial growth include:**

- Cooling coils, drain pans, and water pans for humidifiers (especially when there is standing water).
- **Any duct or other component of the system where condensation can occur.**
- Insulation can absorb and hold moisture, thus it too is a likely source for fungal growth.

**SMALL ISOLATED AREA OF CONTAMINATION (<10 SQUARE FEET) IN THE HVAC SYSTEM**

1. Remediation can be conducted by regular building maintenance staff. Such persons should receive training on proper clean up methods, personal protection, and potential health hazards.
2. Respiratory protection (P100 filters), nitrile gloves and eye protection should be worn.
3. The HVAC system should be shut down prior to any remedial activities.
4. The work area should be covered with a plastic sheet(s) and sealed with tape before remediation, to contain dust/debris.
5. Dust suppression methods, such as misting (not soaking) surfaces prior to remediation, are recommended.
6. Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, should be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. There are no special requirements for the disposal of moldy materials.
7. The work area and areas immediately surrounding the work area should be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution.
8. All areas should be left dry and visibly free from contamination and debris.
9. A variety of biocides are often recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. The Environmental Health and Safety office should be consulted before any biocide is used.

**AREAS OF CONTAMINATION (10-30 SQUARE FEET) IN THE HVAC SYSTEM**

A health and safety professional with experience performing microbial investigations should be consulted prior to remediation activities to provide oversight for remediation projects involving

more than a small isolated area in an HVAC system, and to decide whether any further monitoring is needed. The following procedures are recommended:

1. Personnel trained in the handling of hazardous materials must be equipped with:
  - a. Respiratory protection (1/2 face mask with P100 filters)
  - b. Nitrile gloves and eye protection
  - c. Tyvek suit should be worn

**NB.** If contamination is greater than 30 square feet, it is now categorized as a high-risk situation; thus, specialized personnel will be contacted to conduct the remediation procedures.

2. The HVAC system should be shut down prior to any remedial activities.
3. Containment of the affected area:
  - a. Complete isolation of work area from the other areas of the HVAC system using plastic sheeting sealed with duct tape.
  - b. The use of an exhaust fan with a HEPA filter to generate negative pressurization.
  - c. Airlocks and decontamination room if contamination is greater than 30 square feet.
4. Growth supporting materials that are contaminated, such as the paper on the insulation of interior lined ducts and filters, must be removed. Other contaminated materials that cannot be cleaned should be removed in sealed plastic bags. When a decontamination chamber is present, the outside of the bags should be cleaned with a damp cloth and a detergent solution or HEPA vacuumed prior to their transport to uncontaminated areas of the building. There are no special requirements for the disposal of moldy materials.
5. The contained area and decontamination room should be HEPA vacuumed and cleaned with a damp cloth and/or mop and a detergent solution prior to the removal of isolation barriers.
6. All areas should be left dry and visibly free from contamination and debris.

*If EH & S deems necessary:*

7. Air monitoring should be conducted prior to re-occupancy with the HVAC system in operation to determine if the area(s) served by the system are fit to reoccupy.
8. Disinfection should be done. There are a variety of biocides recommended by HVAC manufacturers for use with HVAC components, such as, cooling coils and condensation pans. HVAC manufacturers should be consulted for the products they recommend for use in their systems.

## REFERENCES:

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