Environmental Health
4th Floor, 1509 Centre Street SW
Calgary, Alberta Canada
T2G 2E6
Telephone: (403) 943-8060
Facsimile: (403) 943-8056

calgary health region

Health Effects of Mould Exposure, Interpretation of Air Monitoring Results and Recommendations for Investigation and Remediation

In recent years, the public has becoming increasingly concerned about exposure to moulds and health effects. The following web-accessible resources provide guidance regarding moulds and health effects, identifying and mitigating moulds problems in buildings and on the interpretation of airborne monitoring results.

- The New York City Department of Health (2002), "Guidelines on Assessment and Remediation of Fungi in Indoor Environments." Available at: http://www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html.

- U.S. Environmental Protection Agency (2001), "Mold Remediation in Schools and Commercial Buildings." http://www.epa.gov/iaq/molds/mold_remediation.html

- Health Canada (1995), 'Fungal Contamination in Public Buildings: A Guide to Recognition and Management." Available under the heading "Air Quality" at: http://www.hc-sc.gc.ca/english/search/a-z/a.html

- Health Canada (2004), "Fungal Contamination in Public Buildings: Health Effects and Investigation Methods." Available at: http://www.hc-sc.gc.ca/hecs-sesc/air_quality/publications/fungal_contamination/toc.htm.

- American College of Occupational and Environmental Medicine (2002), Evidence Based Statements, "Adverse Human Health Effects Associated with Molds in the Indoor Environment." Available at: http://www.acoem.org/guidelines/article.asp?ID=52

Moulds are normally found everywhere in indoor and outdoor air; they are natural part of our environment. Everyday we are exposed to these moulds by breathing. Mould health effects research has shown there is a strong association between airborne mould exposure and certain health effects such as irritation of eye, nose, throat and skin including cough and exacerbation of asthma. At least 5% or more of the population may be allergic to moulds. Other commonly reported symptoms include headache, nausea, fatigue and mental confusion. The risk of cancer and damage to the liver, kidneys, immune and nervous systems with mould inhalation exposure are not established and are more speculative. Respiratory infection is not generally a concern unless exposures are extraordinarily high or individuals are immune compromised. Nevertheless, the universal recommendation is to minimize exposure and health risk by eliminating mould reservoirs in indoor environments. Readers should also understand that in water damaged buildings, biological factors other than moulds are a health concern. Those factors can include dust mites and bacteria.

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With reference to interpreting air sampling results, acceptable indoor air quality for moulds is generally defined as having a distribution of mould species that is similar to outdoors and a concentration (colony forming units per cubic meter of air) that is quantitatively lower than outdoors. Guidance on interpreting air monitoring results is provided in a table on page 3.

However, air sampling for moulds is not considered a definitive measure for determining whether there is a mould problem or mould related health concern in a building. Air monitoring can be considered as one of the tools aiding in the assessment of whether a building has a mould problem or not. Other important tools include visual inspection of the building for evidence of water damage and mould growth, understanding the history of the building, such as past flooding events, and identification of other conditions suggesting a moisture control problem, such as the lack of a vapour barrier in wall construction.

The presence of any mould, whether alive or dead, in any area or location within a building, including wall cavities, presents an unacceptable health risk and must be eliminated. The level of risk and mitigation is primarily dependent on the extent of contamination; the presence of potentially toxic moulds is also a consideration. Mitigation consisting of treatment only with a biocide (e.g., bleach) is not acceptable. The contamination must be removed and the underlying moisture control defect responsible for the growth of the mould must be eliminated and corrected. If the moisture control defect is not eliminated, the mould contamination can reoccur.

The following steps outline the basic steps in mould investigation and mitigation:

a. Full delineation of the areas of water damage, mould growth and contamination;
b. Repair of the underlying moisture control defect responsible for the water damage and mould growth;
c. Mitigation (removal) of identified areas of mould contamination and water damage following acceptable procedures
d. Mould remediation should be completed as quickly as possible and for larger areas, by qualified individuals.

The resources provided on page 1 provide guidance on these steps. In addition, The Health Care Health & Safety Association of Ontario (HCHSA) gives practical information summarizing various aspects of mould remediation. For more information on HCHSA, please click on “mould remediation summary chart” at: http://www.hchsa.on.ca/new/MouldV2/START.html

Consultants or contractors with expertise in moulds can be found in the Yellow Pages under the headings “Asbestos Abatement and Removal”, “Environmental Consultants” and “House Cleaners”. Many asbestos contractors and consultants also have expertise with moulds. Laboratories for determination of moulds can also be accessed through the Yellow Pages under “Laboratories”. Calgary Health Region does not endorse or attest to the qualifications or expertise of any of the consultants, contractors or laboratories listed in the Yellow Pages. Potential consultants or contractors should be familiar with the mould remediation protocols referred to on page 1.

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Acceptable Numerical Guidelines for Viable Airborne Moulds Indoors, Related Recommendations and Interpretations

Health Canada: Indoor Air Quality in Office Building (1993) and Fungal Contamination in Public Buildings: A Guide to Recognition and Management (1995)	
40 CFU/m^3	This is the 3 year average number that has been reported for the indoor air of federal government buildings in Canada for *Cladosporium*, *Alternaria* and non-sporulating basidiomycetes. Based on this value, the following recommended limits were devised.
> 50 CFU/m^3	-Cause for concern if present as a single species, other than *Cladosporium* or *Alternaria*, either indoors or outdoors. Further investigation is necessary if a repeat sample confirms the finding and establishes an indoor source. -It should be noted that sampling error is high for low colony counts. Therefore, repeated sampling is necessary to reduce variability in results.
Up to 150 CFU/m^3	Acceptable if there is a mixture of species reflective of outdoor air spores. Higher counts suggest dirty air filters or other problems
Up to 500 CFU/m^3	Acceptable in summer if the species are primarily *Cladosporium* or other tree and leaf fungi. Values higher than this may indicate failure of the filters or contamination of building
Aspergillus fumigatus, *Histoplasma* and *Cryptococcus*	Although, these organisms can't be reliably detected by sampling air or droppings, these pathogenic (e.g. infective) fungi should not be present in indoor air. Bird and bat droppings near air intakes, in ducts or buildings should be assumed to contain these pathogens. The bird droppings should be safely removed.
Stachybotrys chartarum, Toxicogenic *Aspergillus*, *Pencillium* and *Fusarium* species	Persistent presence of significant numbers of these toxicogenic fungi on repeated sampling indicates that further investigation and action is necessary
Fungal amplifier	Confirmed presence of one or more fungal species occurring as a significant percentage of a sample in indoor air samples and not similarly present in concurrent outdoor air samples is evidence for the presence of an indoor fungal amplifier. Therefore, appropriate action should be taken.
Visible fungi in humidifiers, ventilation systems, mouldy ceiling tiles and other indoor surfaces	Immediate investigation and remedial action is necessary regardless of the amount of airborne spore
Unexplained indoor SBS related symptoms	False negative can occur with air sampling, therefore collect dust samples with a vacuum cleaner and analyze them for fungal species and pursue other lines of investigation has outlined in "Fungal Contamination in Public Buildings: A Guide to Recognition and Management" (1995)

Interpretation of Numerical Guidelines:

- The numerical guidelines provided above are based on a large data set collected over a period of several years. A Reuter centrifugal sampler (with a four-minute sampling time) was used.
- Fungal counts should not be interpreted in isolation
- Further investigation or remediation is required if pathogenic and toxicogenic fungi are found in the indoor air
- Detection and observation of fungal counts indoors can be influenced by various factors such as the type of medium, the sampler, sampling time, occupant activities, season, natural ventilation versus HVAC system, and geographic location
- Factors affecting fungal isolates: Usually, the "normal" indoor air mycoflora is qualitatively similar to and quantitatively lower than the outside air. However, sampling techniques, seasonal changes, weather conditions and human activities can influence number of fungal isolates in outdoor air. Published data on the cross Canada variability of "normal" mould concentrations is not available. All these factors should be taken into consideration when comparing fungal colonies in indoor and outdoor air

Source: Indoor Air Quality in Office Buildings: A Technical Guide, Health Canada, 1993 (pages 48-50)
Fungal Contamination in Public Buildings: A Guide to Recognition and Management, Health Canada, 1995 (pages 6-8).