

Fungal Air Testing, Investigation and Reporting Requirements for Extensively Mould-Contaminated Buildings

The following are the fungal air testing, investigation and reporting requirements for owners seeking to have removed a "Repair Order", „Unfit for Human Habitation Order" and/or "Notice of Health Hazard" issued by Alberta Health Services (AHS) on a property due to the presence or potential presence of extensive mould contamination attributable to a large adverse moisture control event, including use as a Marijuana Grow Operation. Although this protocol is intended for buildings with large or potentially large mould contamination issues, the acceptable fungal indoor air quality criteria presented in Table 1, and other information, provide guidance on the interpretation of fungal air monitoring results in any situation.

The owner or the consultant representing the owner is advised to review the Executive Officers Order issued by AHS for clarification on the varied and specific requirements that must be satisfied for the release or removal of the Order.

Failure to adhere to or comply with the requirements set forth below or in the Executive Officer's Order are sufficient causes for AHS to deny the rescinding of the issued Order(s).

1. Consultant and Contractor Qualifications:

Prior to the start of any work specified in the issued Executive Officer Order or in this document, the property owner or their representative shall submit the names of the proposed consultant(s) and contractor(s) for acceptance by AHS. Failure to satisfy any of the relevant submission requirements specified below or failure to demonstrate adequate qualifications in the opinion of the environmental health officer/public health inspector (EHO/PHI) are sufficient grounds for the EHO/PHI to assess the submission as unsatisfactory and to reject the Qualifications.

- a. Corporate resume indicating the work experience and history, education, training, membership in professional associations, attendance and participation in workshops, seminars or conferences and other qualifications of employees. Supporting documentation shall include submission of:
 - i. Employee certificates indicating successful completion of instructional courses that demonstrate competence in built and indoor hazard assessment and mitigation, built environment and indoor air quality testing, sampling, monitoring and assessment for the parameters of concern. Certificates shall.

- indicate the name of the individual taking the course, the name of the course, the duration and year of the course, identify the institution or agency giving the course, and if applicable, the time that renewal is required.
- b. Certificates or registrations demonstrating membership in good standing of any of the following:
- i. Canadian Registration Board of Occupational Hygienists as a Registered Occupational Hygienist (ROH) or Registered Occupational Hygiene Technologist (ROHT) ([http:// www.crboh.ca](http://www.crboh.ca))
 - ii. American Board of Industrial Hygiene (specify area of certification). Full or Associate membership status in industrial hygiene or occupational and environmental health and safety (<http://www.aiha.org>).
 - iii. American Academy of Environmental Engineers in the Industrial Hygiene specialty
 - iv. Designated as a P.Eng. and a Professional Licensee or Corporate Permit to Practice in the required specialty area (e.g., electrical, civil) issued by The Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA) ([http:// www.apegga.com/](http://www.apegga.com/))
 - v. Board of Certified Safety Professionals (BCSP) as a Construction Health and Safety Technician (CHST) or Occupational Health and Safety Technologist (OHST) ([http:// www.bcsp.org/](http://www.bcsp.org/))
 - vi. Equivalencies in credentials or certifications to be determined on a case-by-case basis

2. Assessment and Remediation of Mould Contamination:

The owner shall at a minimum contract a qualified consultant to fully and completely investigate and assess the building, including hidden cavities and surfaces, for signs of water damage and moulds. This shall include intrusive and destructive investigation of hidden cavities and surfaces to the extent considered necessary in the opinion of the expert consultant. Intrusive and destructive testing may include, but is not limited to, cutting access holes in walls and ceilings, lifting carpets or vinyl sheet flooring, and removing wallpaper for investigation purposes.

The consultant contracted by the owner shall ensure and document that any and all completed mould remediation work was thorough and effective. This means that in the opinion of the consultant, the mould remediation work was effectively, thoroughly and satisfactorily completed in accordance with the protocols of New York City Department of Health (2008)¹, United States Environmental Protection Agency (USEPA, 2001)² and Health Canada (1995, 2004, 2007)^{3,4,5}.

The consultant shall document the mould investigation, delineation and remediation work and shall submit the detailed report or reports to Alberta Health Services (AHS).

Mould remediation consisting of treatment only with a biocide or disinfectant (e.g., bleach) is not acceptable. The presence of any mould, whether alive or dead, on visible surfaces or hidden in cavities (e.g. wall cavities) presents an unacceptable situation requiring remediation by mould removal and surface cleaning. In addition, the application of a biocide or disinfectant following the completion of mould remediation, with the intent of inhibiting possible future fungal growth, is not considered effective, necessary or beneficial.

3. Hazardous Materials Audit and Management Plan:

A hazardous materials audit of the building shall be completed by the qualified consultant prior to the start of any mould investigation, remediation or any other building disturbance activities. The hazardous materials audit shall include, but not be limited to, the identification and assessment of the following:

- Asbestos-containing materials (e.g. vinyl floors, plaster, drywall joint compound, insulation and fire proofing)
- Lead-containing surface coatings (e.g. damaged paint or walls; or walls to be demolished)
- Mercury-containing switches (e.g. thermometers, thermostats, etc.) Pesticides
- Poly Chlorinated Biphenyls (PCBs) (e.g., motor transformers and light ballasts)
- Radioisotope-containing smoke detectors
- Refrigerants
- Paints and solvents
- Biological hazards such as bird, bat or mouse droppings⁶

The consultant shall document to the owner in written form, the proper management or disposal of the identified hazards in the building. In addition, as the owner's agent, the consultant shall direct and document that the identified hazards in the building are properly managed or disposed of in accordance with government standards and guidelines and industry codes of practice.

¹New York City Department of Health and Mental Hygiene 2008, *Guidelines on Assessment and Remediation of Fungi in Indoor Environments*.

²US EPA 2001, *Mold Remediation in Schools and Commercial Buildings*;

³Health Canada 2004, *Fungal Contamination in Public Buildings: Health Effects and Investigation Methods*;

⁴Health Canada 1995, *Fungal Contamination in Public Buildings: A Guide to Recognition and Management*;

⁵Health Canada 2007, *Canadian Environmental Protection Act, Residential Indoor Air Quality Guidelines for Moulds*. Canada Gazette

⁶Materials that may be contaminated with bird, bat or mouse droppings must be considered to contain highly infectious agents (e.g. *Histoplasma capsulatum*, *Cryptococcus neoformans*, *Chlamydia psittaci* and Hanta Virus). The consultant must implement practices that minimize dust generation (e.g. wetting of dry material before sweeping or shoveling), proper waste collection and removal. Disinfectants may be used to treat contaminated soil or accumulations of animal droppings as a precaution before starting removal. Formaldehyde solutions are the only disinfectants proven effective for decontaminating soil containing *H. capsulatum* (AIHA 1999)

The findings of the hazardous materials audit, including the management or disposal activities undertaken on the premises, shall be documented and submitted in a report to AHS prior to active remediation work proceeding.

4. Air Sampling Locations:

Following the completion of all mould remediation work, the consultant contracted by the owner shall collect representative air samples from each habitable floor of the building, including basement(s), attic(s), attached garage and crawlspaces. The consultant shall collect a minimum of one (1) air sample per floor for an open concept floor plan or a minimum of two (2) air samples per floor for a compartmentalized floor plan. An open floor plan is where 75% or more of the floor footprint consists of one room. More samples per floor may be collected at the professional discretion of the consultant.

5. Number of Outdoor or Control Air Samples:

The consultant shall collect at least three (3) representative outdoor samples for each day of sampling in accordance with Health Canada (2004) recommendations. Outdoor/control samples shall be collected on the same day as indoor samples. The owner/consultant can store viable test samples for later analysis pending receipt of acceptable results of total fungal particulate samples. The characterization of outdoor variability assists in the assessment of indoor samples.

6. Type of Air Sampling Required (Viable and / or Total):

Fungal air sampling shall preferably consist of both viable fungal air sampling (e.g. culturable sampler such as RCS) and total fungal particulate sampling (e.g. sticky surface sampler such as Air-O-Cell). However, the EHO/PHI has the discretionary ability on a case-by-case basis to declare whether one or both methods of testing are appropriate and acceptable.

- Viable air testing requires speciation of all viable fungi
- At ambient temperatures less than or equal to 0°C, control and indoor samples may be collected using only membrane or grease filters (e.g. Burkard or Air-O-Cell filters) and results analyzed for Total Fungal Particulates. Table 1 Total Fungal Particulate criteria shall apply to interpreting the results. Testing for viable moulds is not required.
- Indoor total fungal particulate sampling may be accepted without outdoor controls and viable testing, if the results satisfy the criteria presented in Section 10e.

The requirement for both viable or total testing is based on a number of considerations.^{7,8} Viable or culturable fungi yield test results that can range from several times to orders of magnitude less than totals due to

- 1) the viability or culturability of spores and hyphae decrease with time and environmental conditions, and
- 2) the choice of agar media selects for different types of fungi, further affecting the reportable concentration. The advantage of viable testing is that it allows for the comparison of indoor and outdoor moulds at the species levels, which is a requirement of the Health Canada protocol. The disadvantage is that if mould reservoirs are qualitatively older, speciation tests may or may not indicate the presence of a reservoir because of the viability limitation, and therefore under-represent indoor levels.

Airborne concentration estimates obtained using total fungal particulate testing are comparatively higher based on the microscopic counting of both viable and nonviable spores and hyphae. The advantage of totals testing is that both viable and nonviable moulds retain allergenic and toxicogenic properties. In addition, it would permit the detection of qualitatively older reservoirs that might not be detected by viable testing. The disadvantage is that the test does not permit assessment at the species level.

Requiring testing using both protocols assists in the detection of both qualitatively “fresh” and “aged” fungal reservoirs, and maintains consistency with the Health Canada protocol. Lee *et al.* (2006) recommended both types of testing to more accurately represent the potential for occupant exposure to moulds.⁹

7. Environmental and Building Conditions for Sampling:

Fungal air sampling shall occur in compliance with Health Canada (2004) *Fungal Contamination in Public Buildings: Health Effects and Investigation Method*, page 41, and requires:

- Ventilation system is operational
- Non quiescent conditions (i.e. sampling following or during quiescent periods is not acceptable – sampling conditions must occur during or simulate disturbance conditions associated with normal occupancy)
- Sampling is not to occur during or immediately following precipitation events. AHS recommends a 24 hour buffer period between the end of a precipitation event and air sampling

⁷AIHA Biosafety Committee 1996. *Field Guide for the Determination of Biological Contaminants in Environmental Samples*.

⁸Godish, Thad. 2000. *Indoor Environmental Quality*. Lewis Publishing.

⁹Lee, Taekhee, 2006. *Culturability and concentration of indoor and outdoor airborne fungi in six single-family homes*. *Atmos Environ*40(16):2902-2910

- Allow one or two hours between start and end of triplicate outdoor control or background air sampling (i.e. one outdoor sample at the start, midway and end of indoor sampling)
- One of the outdoor control samples shall be collected at the furnace outdoor air intake grill. If the air intake grill is not accessible, the test location is at the discretion of the consultant but sampling on the windward side of the structure is recommended

8. Time Limited Acceptance of Air Sampling Results by AHS

Air sample results are valid and will only be accepted by AHS for a 60-day period following sample collection. A report with air sample results received by AHS 60-days after sample collection will not be accepted; resampling will be required.

If an AHS Executive Officer Order declaring a building Closed or Unfit for Human Habitation is not rescinded six months after fungal air sample collection, for whatever reason, then fungal air resampling must occur in accordance with this protocol.

9. Reporting Requirements:

- Forward report(s) and assessment(s) to AHS, Environmental Public Health.
- The consultant and the selected laboratory should provide documentation that demonstrates the chain-of-custody (CoC). Information required for ensuring chain traceability must be collected and be transmitted to the analytical laboratory along with samples. CoC records must be able to track samples from the time of collection, through transport to receipt at a laboratory (ACGIH, 1999). At the laboratory, the CoC continues through the analysis and reporting processes (i.e. preservation and storage, processing, analysis and retention of samples and disposal of environmental microbial samples, etc.)
- The consultant shall document and comment on the mould investigation, assessment, and remediation work undertaken in the building. The consultant shall offer an opinion as to whether or not the mould investigation, delineation and remediation work was effective, thorough, and satisfactorily completed in accord with acceptable guidelines and protocols. Regarding mould air sampling, the consultant report shall include:
 - i. a sampling protocol that specifies the collection address, floor, interior location, sample date, sampling interval time, pump flow rate, sample air volume¹⁰. The protocol should also provide a description of sampler type (e.g. culturable samplers such as RCS or Anderson Sampler, sticky surface samplers such as Air-O-Cell), collection or plate area, sample collection media for viable samples

¹⁰A default sampling volume (e.g. 75 litres or 0.0075 m³) is not acceptable. Pump flow rate and sampling time should be reported.

- (e.g. MEA (Malt Extract Agar), CMA (Cornmeal Agar), TSA (Tryptic Soy Agar), etc).
- i. a comment on the assessment of the building regarding evidence of water damage or signs of mould contamination during air sampling
 - ii. all laboratory test results as provided by the analytical laboratory. The consultant can summarize the findings in the body of the report but must submit laboratory test results showing the mould genus/species breakdown for each sample
 - iii. a description of environmental and building conditions on the day(s) of sampling, including barometric pressure, inside and outside temperatures, humidity and recent precipitation, and the operational status of the ventilation system and the occupancy or disturbance activities prior to and during sampling.
 - iv. if a test of Statistical Significance is used, then the test shall be named, the input parameters tabulated and the results presented
 - v. an interpretation of the air monitoring results and their significance describe sampling locations in the report (e.g. main floor living room)
- Regarding test results, the laboratory should provide AHS with reference citations on the Standard Operating Procedure or test method employed. AHS may request a copy of the cited methodology.

Laboratory test reports provided to the consultant shall include at least the following¹¹:

- a. Counting rules/procedures that were used
- b. Laboratory unique identification/laboratory number, address, telephone number
- c. Client identification and address
- d. Client sample identification
- e. Date and time of sample collection and sample receipt
- f. Condition of sample (i.e. any problems with condition)
- g. Date of analysis
- h. Date of report
- i. Analyst name
- j. Signature and printed name of person taking responsibility for the data in the report
- k. Significant modifications to the Standard Operating Procedure, if any
- l. Page number and total number of pages in the report on each page or other mechanism for identifying each page as part of the report and for indicating the end of the report

11. ASTM Committee D22 on Air Quality. Subcommittee D22.08 Sampling and Analysis of Mold. ASTM D7391-09: Standard Test Method for Categorization and Quantification of Airborne Fungal Structures in an Inertial Impaction Sample by Optical Microscopy.

- m. Statement that the analysis relates only to the items tested
- n. For total fungal particulates (TFP), the following information should be recorded:
 - i. Spell out, debris rating/background characteristics for each sample
 - ii. Raw count and total TFP concentrations (ctns/m³) for each fungal category
 - iii. An indication of the proportion of the trace that was analyzed for each spore category (for example, % of trace read¹², multiplication factor¹³)
 - iv. Lower detection limit (LDL)¹⁴ (ctns /m³) for each spore category reported
- o. For viable fungi the following information should be recorded:
 - i. Air sampling method (e.g., Anderson N6 sampler, RCS sampler)
 - ii. Fungal culturable method including references for isolation, culture and identification methods
 - iii. Culture media and growth condition
 - iv. The LDL¹⁵ of the selected sampling method at selected flow rate and sampling time
 - v. The raw count and total viable counts (CFU/ m³) for each fungal category
- p. Summary of any observations or findings that indicate a compromised sample result such as deviation from sampling, analytical and laboratory methodologies and protocols, including notes on sample condition, broken cassette or substrate, missing cap, out-dated cassette, analytical problem, apparent sampling problem (e.g. overloading), etc

10. Interpretation of Air Quality Results

Acceptable criteria for total fungal particulates and viable fungi are based on Health Canada's statement that „normal“ indoor air mycoflora at the genus and species level is qualitatively similar to and quantitatively lower than outdoor air. This means that the distribution of indoor moulds at the genus or species level is similar to the outdoor distribution and quantitatively lower than outdoors. Alberta Health Services, Environmental Public Health criteria for interpreting the results of fungal air testing are presented in Table 1.

¹² For TFP, AHS recommends at least 30% sample trace to be enumerated. The minimum sample trace percentage is acceptable by AHS is 15%.

¹³ For TFP, an appropriate magnification/resolution should be chosen for enumerating spore categories. Enumerate the spore categories *Aspergillus/Penicillium*-like and *Cladosporium* at magnification/resolution 2 and other spore categories at either magnification/resolution 1 or 2

¹⁴ For TFP, $LDL (ctn/m^3) = \frac{100 \times 1 (\text{the minimum detected raw count})}{\text{Percentage trace scanned (\%)} \times \text{volume (m}^3\text{)}}$

¹⁵ For total viable counts, $LDL (CFU/ m^3) = \frac{100 \times 1 (\text{the minimum detected raw count})}{\text{Volume (m}^3\text{)}}$

Air monitoring is a useful tool, among other tools, in identifying the presence of an indoor fungal amplifier requiring remediation, managing a microbial problem, and returning a building, or portion of, to normal use or occupancy (Health Canada, 2004). In terms of human health risk, Health Canada in 2007 wrote that moulds in residential buildings may present a health hazard and that health risk depends on mould exposure and for asthma symptoms, on allergic sensitization. However, the lack of dose-response relationships for adverse health effects, the large variety of mould species, and the large variation in individual vulnerability, prohibits the use of air sampling to assess human health risk. As a result, Health Canada (2007) recommends thoroughly removing and cleaning all visible and concealed mould growing in residential buildings, regardless of mould species.

In conclusion, air monitoring is a useful tool in identifying the presence of an indoor fungal amplifier as a health concern requiring remediation, managing a microbial problem, and returning a building, or portion of, to normal use or occupancy.

The criteria presented below provide guidance on interpreting test results and remain subject to application and interpretation of the Health Canada criteria¹⁶ by AHS.

- a. Table 1 below presents criteria for acceptable indoor air quality for both Total Fungal Particulates and Viable Fungal Particulates. All viable fungi must be speciated. The criteria apply to the determined concentrations of each mould of each sample. As it is not possible to capture the full scope of variables in the Health Canada criteria in this or any table, the Health Canada criteria must still guide the interpretation of this table and of air monitoring results.

Aspergillus and *Penicillium* are often grouped together as one result for Total Fungal Particulate sampling. As a result, acceptable air testing criteria were developed to address this unique grouping and are presented in Table 1 under “For *Aspergillus* & *Penicillium* measured together (Total Fungal Particulates Sampling Only)”. These criteria should not be used for assessing *Aspergillus* and *Penicillium* species identified and enumerated using viable sampling.

For each mould category, report results no lower than the minimum reporting limit for that category (see below). For mould categories, in which no moulds were counted, report as “n.d.” (not detected) or as “<” minimum reporting limit, which is dependent on sample volume, and for TFP on background debris and the percentage of the trace analyzed.

¹⁶Health Canada. 1995. *Fungal Contamination in Public Buildings: A Guide to Recognition and Management*.

- b. Determine the acceptable criterion by inputting the highest measured level of outdoor mould into the Table 1 equations. If there are no measurable levels of outdoor mould, then the default values provided in the equation are used as the acceptable criteria.
- Example 1: the level of a mould is measurable
Three (3) outdoor sample results for *Penicillium chrysogenum* are 24, 60 and 48CFU/m³ (colony forming units per cubic metre). Input the 60 CFU/m³ value (the highest measured value) into the appropriate Table 1 equation, $50 + 2 \times 60$ CFU/m³, to derive an acceptable criterion of 170 CFU/m³. The indoor level could be compared to the calculated acceptable criterion of 170 CFU/m³.
 - Example 2: the level of a mould is non detectable
The three (3) outdoor sample results for *Penicillium chrysogenum* are “n.d.”, “n.d.” and “n.d.” In this case, use the default value of 50 CFU/m³ provided in the table as the acceptable criterion.

The assumptions and calculation of the default values show in Table 1 are as follows:

(1) Total fungal particulates:

Assuming ~15% of the trace is analyzed, the volume sampled is 75 litres or 0.075 m³ the LDL is calculated to be 90 ctn/m³ (counts per cubic meter) (see below)

$$\text{LDL (ctn/m}^3\text{)} = \frac{100 \times 1}{15 \times (75/1000)\text{m}^3} = 90 \text{ ctns/m}^3$$

AHS accepts as background a maximum of 2 raw counts on the ~30% trace analyzed which is equivalent to 1 raw counts on ~15% of the trace or 6 raw counts on 100% of the trace. The LDL of 90 ctns/m³ is rounded up to 100 ctns/m³ and is used as the default acceptable criterion.

(2) Viable fungi:

The LDL for viable fungal sampling is determined by dividing the laboratory detection limit (1 raw count by default) by the sampling volume (m³).

For example,

For an RCS sampler, the air volume is typically 0.160 m³, the LDL thus equals 6 CFU/m³ (1CFU /0.160m³= 6 CFU/m³).

An RCS strip contains 34 wells. AHS accepts a maximum of 1 raw count on ~15% of the sampling strip (~ 6 wells) as background, which is equivalent to 6 counts or 36 CFU/m³ on ~100% of the total collection area, rounded up to 50 CFU/m³ as the default criterion.

Deviation from these assumptions by the laboratory or consultant may render Table 1 criteria invalid. Under these conditions, the criteria used by AHS to interpret the air monitoring results will be at variance with Table 1.

c. Finding and Implications of an Exceedance

The finding of an exceedance of airborne fungal criterion at a single location shall result only in the declaration of an exceedance for the area represented by that sample. The interpretation of an air monitoring result as an exceedance or not shall also consider the professional consultant's visual assessment, site history presentation, and judgement.

d. Statistical Significance Testing

Statistical significance testing can be used to determine whether the observed measurements in any given indoor sample are significantly different, or the same, as those measured outdoors. The test must include the entire dataset (i.e. all identified moulds) in the indoor and outdoor samples. The distribution in the indoor sample must be compared to the distribution in the outdoor control.

Tests for statistical significance of moulds include Wilcoxon Match-Pairs Signed-Ranks Test (Wilcoxon Signed-Ranks Test for Matched Pairs) and the Spearman Rank-Order Correlation Coefficient.

Excessive presence of fungal mycelial fragments above outdoor background would be cause for declaration of non-acceptable sampling results.

For attics, acceptance of results with marginally elevated levels is possible at the discretion of the EHO / PHI if the consultant thoroughly inspects the space for evidence of mould and water damage, including the conditions of drywall surfaces (including the presence of a vapour barrier overlying the drywall), insulation, exposed attic surfaces, and surfaces around the soffit.

e. Conditions for Acceptance of Total Fungal Particulate Only Test Data:

The results of Total Fungal Particulate sampling will be accepted as the sole and only test method if the following criteria are satisfied for each mould identified for each sample:

- *Penicillium/Aspergillus* ≤ 200 (for attics ≤ 400) counts/m³
- *Cladosporium* species ≤ 300 (for attics ≤ 600) counts/m³
- *Alternaria* species ≤ 100 (for attics ≤ 200) counts/m³
- For each other mould ≤ 100 (for attics ≤ 200) counts/m³

If these conditions are satisfied, then viable mould testing is not required.

Excessive presence of fungal mycelial fragments would be cause for declaration of non-acceptable sampling results.

For attics, acceptance of results with marginally elevated levels is possible at the discretion of the EHO / PHI if the consultant thoroughly inspects the space for evidence of mould and water damage, including the conditions of drywall surfaces (including the presence of a vapour barrier overlying the drywall), insulation, exposed attic surfaces, and surfaces around the soffit.

11. Laboratory Qualifications:

The Laboratory selected by the consultant to do the microbial analysis associated with this protocol shall be a certified environmental laboratory which falls within one of the following categories (Health Canada, 2004):

- The laboratory should be certified under the AIHA (American Industrial Hygiene Association) Environmental Microbiology Laboratory Accreditation Program (EMLAP)(ISO/IEC 17025 Accreditation); or
- The laboratory should demonstrate successful performance in the AIHA Environmental Microbiology Proficiency Analytical Testing (EMPAT) program, be accredited by the Standard Council of Canada (SCC); or
- The laboratory should demonstrate successful performance in the AIHA Environmental Microbiology Proficiency Analytical Testing (EMPAT) program, and have ISO/IEC 17025 or Good Laboratory Practice (GLP) certification.

Documentations of laboratory certification and performance in EMPAT program are to accompany analytical reports and are to be included in reports submitted to AHS.

Table 1: Acceptable Fungal Indoor Air Quality Criteria

Failure of any one indoor mould result to satisfy the criteria for any one sample is an unacceptable result for that sample and the represented area.

| For Each Individual Mould Species/Genus in Each Sample | Acceptable Indoor Criteria for Each Mould Detected in a Sample at the Genus and/or Species Level | |
|------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| | Viable Fungi – Species Level | Total Fungal Particulates – Genus Level |
| | CFU/m ³ per species isolate per sample | ctns/m ³ per genus isolate per Sample |
| LIVING / NON ATTIC SPACES | | |
| Combined <i>Aspergillus</i> & <i>Penicillium</i> measured together (Total Fungal Particulates Sampling Only) | Not applicable | ≤ 200 or (200 + 2x outdoor) or the measured maximum ¹ |
| Each <i>Cladosporium</i> species or at genus level as appropriate ⁵ | ≤ 150 or (150 + 3x outdoor) or the measured maximum or Statistical Test of Significance ² | ≤ 300 or (300 + 3x outdoor) or the measured maximum or Statistical Test of Significance ² |
| Each <i>Alternaria</i> species or genus level as appropriate ⁵ | ≤ 50 or (50 + 3x outdoor) or the measured maximum or Statistical Test of Significance ² | ≤ 100 or (100 + 3x outdoor) or the measured maximum or Statistical Test of Significance ^{1,2} |
| For Each Mould (other than the above) | ≤ 50 or (50 + 2x outdoor) or the maximum measured | ≤ 100 or (100 + 2x outdoor) or the measured maximum ¹ |
| ATTICS | | |
| Attics - For <i>Aspergillus</i> & <i>Penicillium</i> measured together (Total Fungal Particulates Sampling Only) | Not applicable | ≤ 400 or (400 + 2x outdoor) or the measured maximum ^{1,3} |
| Attics – Each <i>Cladosporium</i> species | ≤ 300 or (300 + 5x outdoor) or the measured maximum or Statistical Test of Significance ^{2,3} | ≤ 600 or (600 + 5x outdoor) or the measured maximum or Statistical Test of Significance ^{1,2,3} |
| Each <i>Alternaria</i> species | ≤ 100 or (100 + 5x outdoor) or the measured maximum or Statistical Test of Significance ^{2,3} | ≤ 200 or (200 + 5x outdoor) or the measured maximum or Statistical Test of Significance ^{1,2,3} |
| Attics – Each Mould (other than the above) | ≤ 100 or (100 + 2x outdoor) or the measured maximum ³ | ≤ 200 or (200 + 2x outdoor) or the measured maximum ^{1,3} |

Source references on variability: McGrath et al. 1999 Current Microbiology 38:33-36. Ebner et al. 1992 Mycological Research 96(2):117-124. Verhoeff et al. 1990 Allergy 45:275-284. Shelton et al. 2002 Applied & Environmental Microbiology 68(4):1743-1753. ACGIH1999 Bioaerosols Assessment and Control.

¹ Excessive presence of fungal mycelial fragments beyond outdoor background would be cause for declaration of non-acceptable sampling results.

² Statistical significance testing can be used to determine whether the observed measurements in any given indoor sample are significantly different, or the same, as those measured outdoors. The test must include the entire dataset (i.e., all identified moulds) in an indoor sample. The distribution in the indoor sample must be compared to the distribution in the outdoor control.

³ For attics, acceptance of results with marginally elevated levels is possible if the consultant thoroughly inspects the space for evidence of mould and water damage, including the conditions of drywall surfaces (including the presence of a vapour barrier overlying the drywall), insulation, exposed attic surfaces and surfaces around the soffit.

⁴ The acceptable concentration of *Cryptococcus* and *Histoplasma* in indoor air is zero. In addition to the above, the outdoor control data can be a compilation of the median and maximums recorded in outdoor controls.

⁵ Analysis at the species level is required for Viable Fungi and at the genus level for Total Fungal. Some species level identification, such as for *Stachybotrys*, is available using Total Fungal.

Contact us at 1-833-476-4743 or [submit a request online](#) at ahs.ca/eph.

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