

**FUNGAL AIR TESTING, INVESTIGATION AND REPORTING REQUIREMENTS FOR
MARIHUANA GROW OPERATIONS**

Revised October 2007

This policy is effective October 9, 2007 and is approved by Robert Bradbury, Director of Health Protection.

The following are the fungal air testing, investigation and reporting requirements for owners seeking to have removed an 'Unfit for Human Habitation Order' and/or Notice of Health Hazard issued by the Calgary Health Region against a property due to recent use as a Marihuana Grow Operation. The owner or the consultant representing the owner is advised to review the Executive Officer's Order issued by the Calgary Health Region for clarification on the varied and specific requirements that must be satisfied for the release of the Order by the Calgary Health Region.

Failure to adhere or comply to the requirements set forth below or in the Executive Officer's Order are sufficient cause for the Calgary Health Region to deny the removal of both the "Unfit for Human Habitation Order" and the Notice of Health Hazard.

1. Consultant and Contractor Qualifications:

The contracted consultant(s) and contractor(s) shall have and demonstrate to Calgary Health Region (1) current and active membership in a related professional organization or certifying body or expertise (ie Environmental Health or Indoor Air Quality), and (2) professional liability insurance, prior to the start of any work on the premises.

2. Delineation 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 the 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 contracted consultant shall ensure and document that any and all mould remediation work completed by a contractor hired by the owner was thorough and effective. That is, that in the opinion of the consultant, the mould remediation work was effectively, thoroughly and satisfactorily completed in accordance with the protocols of New

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York City Department of Health, United States Environmental Protection Agency and Health Canada¹. The consultant shall document the mould investigation, delineation and remediation work and shall submit the detailed report or reports to Calgary Health Region, Environmental Health.

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 remediation or any other building disturbance activities. The hazardous materials audit shall include, but not be limited to, the identification and delineation of the following:

- Asbestos-containing materials
- Lead-containing surface coatings
- Mercury-containing switches, thermometers, etc.
- Pesticides
- Poly Chlorinated Biphenyls
- Radioactive equipment such as some smoke/fire detectors
- Refrigerants

The consultant shall document to the owners 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.

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 Calgary Health Region prior to active remediation work proceeding.

4. Air Sampling Locations:

Following the completion of all 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 1 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

¹ Health Canada 2004, Fungal Contamination in Public Buildings: Health Effects and Investigation Methods; Health Canada 1995, Fungal Contamination in Public Buildings: A Guide to Recognition and Management; US EPA 2001, Mold Remediation in Schools and Commercial Buildings; NY City Dept of Health and Mental Hygiene 2005, Guidelines on Assessment and Remediation of Fungi in Indoor Environments. See also Health Canada 2007, Canadian Environmental Protection Act, Residential Indoor Air Quality Guidelines for Moulds. Canada Gazette.

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 Total):

Fungal air sampling shall consist of both viable fungal air sampling (e.g. Reuter Centrifugal Sampler or similar) and total fungal particulate sampling (e.g., Air-O-Cell).

- Speciation of all viable fungi is required.
- At ambient temperatures $\leq 0^{\circ}\text{C}$, control and indoor samples may be collected using membrane or grease filters (e.g., Burkard or Air-O-Cell filters) and results analyzed for Total Fungal Particulates. Table 2 Total Fungal Particulate criteria shall apply to interpreting the results.
- Indoor total fungal particulate sampling may be accepted without outdoor controls and viable testing if the results satisfy the criteria presented in 9e.

7. Environmental and Building Conditions for Sampling:

Fungal air sampling shall occur in compliance with Health Canada 'Fungal Contamination in Public Buildings: Health Effects and Investigation Methods' (2004), 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).
- Allow one or two hours between duplicate air sampling (i.e., outdoor backgrounds).
- Sampling is not to occur during or immediately following precipitation events. Calgary Health Region recommends a 24 hour buffer period between the end of a precipitation event and air 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. Reporting Requirements:

- Forward report(s) and assessment(s) to Calgary Health Region, Environmental Health
- The consultant shall document and comment on the mould investigation, delineation, 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 (see bullet number 1, page 1).
- Regarding mould air testing, the consultant report shall include:
 - a comment on the assessment of the building regarding evidence of water damage or signs of mould contamination during air sampling.
 - 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.
 - a description of environmental and building conditions on the day(s) of sampling, including outdoor temperature and recent precipitation, the operational status of the ventilation system and the occupancy or disturbance activities prior to and during sampling.

- if a test of Statistical Significance is used, then the test shall be named, the input parameters tabulated and the results presented.
- an interpretation of the air monitoring results and their significance.
- indicate sampling locations in the report (e.g., main floor living room).
- indicate the duration of sampling and volume of air collected for each sample in the report.

9. Interpretation of Air Sampling Results:

Acceptable criteria for total fungal particulates and viable fungi are the Health Canada numeric criteria (Fungal Contamination in Public Buildings: A Guide to Recognition and Management (1995) or Indoor Air Quality in Office Buildings (1993). The criteria 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. In other words, the distribution of indoor moulds at the genus or species level is similar to the outdoor distribution and quantitatively lower than outdoors. Calgary Health Region criteria for interpreting the results of fungal air testing are as follows in Table 2.

The few indoor and outdoor samples collected at a site along with the brief sampling period (i.e., 3-7 minutes) cannot be considered statistically representative sampling (American Industrial Hygiene Association, 1999). Such limited sampling cannot accurately characterize the indoor and outdoor mould population. The lack of statistically relevant sampling makes the direct and simple indoor to outdoor numeric comparison to any guideline, including the Health Canada guideline, difficult. Numerous scientific studies have shown tremendous variability in sequential mould sampling results. The extent of the variability is such that a single indoor sampling result, although quantitatively higher than outdoors, may in fact satisfy the Health Canada requirement of indoor moulds being quantitatively lower than outdoors.

Air monitoring is a useful tool, among other tools, in identifying the presence of an indoor fungal amplifier requiring remediation, assessing potential health risks, managing a microbial problem and returning a building, or portion of, to normal use or occupancy (Health Canada (2004). In 1995, Health Canada wrote that, "Although it is clear that pathogenic and toxigenic fungi can cause disease, the health risks associated with a given measured level are, for the most part, unknown" (page 6). The U.S. National Academy of Science, Institute of Medicine (2004), concluded that exposure to moulds is causally associated with aggravation of asthma in individuals allergic to moulds and increased symptoms of lower and upper respiratory effects. Lower respiratory tract symptoms include increased nasal congestion, increased cough with or without phlegm production, wheeze, chest tightness, shortness of breath, runny or itchy nose and sore throat (Institute of Medicine 2004). However, in reviewing this and other studies, Health Canada (2004) concluded, "Due to limitations in the assessment of exposure and outcomes, and since in almost all studies to date an independent effect of mould could not be isolated from other contaminants associated with dampness, epidemiologic data alone are insufficient to conclude that indoor mold causes respiratory disease. However, such a causal link is highly plausible..." (page 33). Health Canada (2007) says mould exposure is associated with aggravation of asthma, lung inflammation, and may be a risk factor for developing asthma but that the lack of a dose-response prohibits the use of air sampling to assess health risk. Thus 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 criteria by Calgary Health Region.

- a. Fungal indicators of mould damaged buildings are indicated below in Table 1.

Table 1: List of Indoor Indicator Mould Species

Alternaria alternata (tenuis)		
Aspergillus fumigatus	Aspergillus sydowii	Aspergillus versicolor
Chaetomium globosum		
Cladosporium cladosporioides	Cladosporium sphaerospermum	
Cryptococcus neoformans ¹		
Eurotium herbariorum	Eurotium repens	
Histoplasma ¹		
Memnoniella echinata		
Paecilomyces variotii		
Penicillium aurantiogriseum	Penicillium chrysogenum	Penicillium commune
Stachybotrys chartarum		
Ulocladium chartarum		

Source: Health Canada 2004. Health Effects of Fungi; Health Canada 1995

¹The acceptable concentration for these moulds in indoor air is zero.

- b. Table 2 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 inform 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 2 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 viable sampling, the other criteria should be used: "Each Indicator Mould" and "Each Non-indicator Mould".

Determine the acceptable criterion by inputting the highest measured level of a mould into the Table 2 equation. If there are no measurable levels of mould, use the default value provided.

For example, three (3) outdoor sample results for *Penicillium chrysogenum* are 24, 60 and 48 cfu/m³ (colony forming units per cubic metre). Input the 60 cfu/m³ value (the highest value) into the appropriate Table 2 equation, $50 + 2 \times 60 \text{ cfu/m}^3$, to derive an acceptable criterion of 170 cfu/m³. The indoor level could be compared to the calculated acceptable criterion of 170 cfu/m³.

As another example, the three (3) outdoor sample results for *Penicillium chrysogenum* are 0, 0 and 0 cfu/m³. In this case, use the default value of 50 cfu/m³ provided in the table as the acceptable criterion

The assumptions of the default values shown in Table 2 are as follows:

- Total fungal particulates: 1 raw spore count is equivalent to 45 ctns/m³, assuming ~30% of the trace is analyzed. CHR accepts as background a maximum of 2 raw counts on the ~30% trace analyzed, which is equivalent to 6 raw counts on 100% of the trace. Two (2) raw spore counts on the ~30% trace are equivalent to 90 ctns/m³, rounded up to 100 ctns/m³.
- Viable fungi: 1 raw count is equivalent to 6 cfu/m³. Calgary Health Region accepts a maximum of 6 raw counts as background, which is equivalent to 36 cfu/m³, rounded up to 50 cfu/m³.

Deviation from these assumptions by the laboratory or consultant may render Table 2 criteria invalid. Under these conditions, the criteria used by Calgary Health Region to interpret the air monitoring results will be at variance with Table 2.

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

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

Table 2: Acceptable Fungal Indoor Air Quality Criteria for Remediated Marijuana Grow Houses.

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

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	Counts/m ³ per genus isolate per sample
NON ATTIC SPACES		
For Aspergillus & Penicillium measured together (Total Fungal Particulates Sampling Only)	-	≤ 200 or (200 + 2x outdoor) or the measured maximum ¹
Each Indicator Mould (see Table 1)	≤ 50 or (50 + 2x outdoor) or the maximum measured	≤ 100 or (100 + 2x outdoor) or the measured maximum ¹
Cladosporium species (non indicator)	≤ 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
Alternaria species (non indicator)	≤ 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}
Each Non Indicator Mould	≤ 50 or (50 + 2x outdoor) or the measured maximum or Statistical Test of Significance ²	≤ 100 or (100 + 2x outdoor) or the measured maximum or Statistical Test of Significance ^{1,2}
ATTICS		
Attics - For Aspergillus & Penicillium measured together (Total Fungal Particulates Sampling Only)	-	≤ 400 or (400 + 2x outdoor) or the measured maximum ^{1,3}
Attics – Each Indicator Mould	≤ 100 or (100 + 2x outdoor) or the measured maximum ³	≤ 200 or (200 + 2x outdoor) or the measured maximum ^{1,3}
Attics - Cladosporium species (non indicator)	≤ 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}
Attics - Alternaria species (non indicator)	≤ 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 Non Indicator Mould	≤ 100 or (100 + 3x outdoor) or the measured maximum or Statistical Test of Significance ^{2,3}	≤ 200 or (200 + 3x outdoor) or the measured maximum or Statistical Test of Significance ^{1,2,3}

Source material 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. AIHA 1999 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 excluding Table 1 indicator organisms. 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.

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 (non indicators) ≤ 300 (for attics ≤ 600) counts/m³
- Alternaria species (non indicators) ≤ 100 (for attics ≤ 200)
- For each other mould (indicator or non indicator) ≤ 100 (for attics ≤ 200)
- 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 excluding Table 1 indicator organisms. The distribution in the indoor sample must be compared to the distribution in the outdoor control.
- Excessive presence of fungal mycelial fragments beyond outdoor background would be cause for declaration of non-acceptable sampling results.
- For attics, acceptance of results with 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.

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

10. Laboratory Qualifications:

The Laboratory selected by the consultant to do the microbial analysis associated with this protocol shall demonstrate AIHA (American Industrial Hygiene Association) certification as an Environmental Microbiology Accredited Laboratory with a competence in moulds, or other comparable accreditation, or demonstrated routine participation and acceptable performance in an Environmental Microbiology Proficiency Analytical Testing (PAT) program for both culturable and direct examination determination of fungi, or other comparable accreditation. Documentation of laboratory certification or performance in PAT programs is to accompany analytical reports and is to be included in reports submitted to Calgary Health Region. Calgary Health Region understands that PAT programs for direct examination of fungi are anticipated to have begun in 2005.

Approved October 9, 2007



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