Alberta
Infrastructure

Indoor Air Quality

Guide to Indoor Air Quality Management of Government Owned and Supported Infrastructure

July 2019

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Indoor Air Quality

Introduction

The purpose of this document is to provide a detailed process to address Indoor Air Quality (IAQ) concerns within Government of Alberta occupied facilities. The intent of this document is to provide guidance for those personnel responsible for performing IAQ assessments in Government Owned and Supported Infrastructure. It will assist them in determining the cause of the IAQ concern, in establishing at what point specific professional services are required, and in defining the sample methods and scope of a particular IAQ assessment. The document has been developed by the Building Environment Unit within the Alberta Infrastructure Technical Services Branch.

Background

In some indoor environments, occupant concerns about the air quality has resulted in physical and psychological symptoms and complaints such as headaches, nausea, eye and throat irritation and coughs. These symptoms and complaints can affect occupants health, comfort, job satisfaction and work performance. Occupants expect healthy, comfortable indoor environments. Therefore occupants are more likely to report a concern or express discomfort when they feel or perceive the indoor air quality in their building to be unsatisfactory.

IAQ concerns do not affect people in the same way. People may be more or less sensitive to a building IAQ than others. Generally as indoor air quality deteriorates, more people tend to be affected and the symptoms tend to be more serious.

Typical symptoms caused by air quality problems vary greatly according to an individual's sensitivity and may include chills, sweating, eye irritation, allergies, coughing, sneezing, nausea, fatigue, skin irritation, breathing difficulty and others. In extreme cases, personal reactions actually reach the point where an individual cannot function, when exposed to adverse air conditions.

An IAQ assessment attempts to isolate and mitigate one or more problems of the building environment. The approach is solution oriented and systematically narrows the range of possibilities. Qualified personnel responsible for performing IAQ assessments must search through the indicators carefully to solve the problem. Most complaints, especially in smaller buildings, can be handled on site by a person who understands the building operation and the technical framework of IAQ issues. The assessment generally proceeds from simple consultation and observation through a cycle of information gathering, hypothesis formation, and testing until a solution is obtained.

Many IAQ concerns can be prevented by ensuring ventilation is adequate, temperatures and humidity levels are comfortable and airborne contaminants are minimized. Training, educating and communication with occupants about events that could affect the building indoor air quality may also alleviate concerns.

Types of Pollutants

General pollutant types that affect air quality include:

1. Biological - bacteria, fungi, viruses, molds, pollen, animal hair, dander and excrement are examples of common biological pollutants that can impact air quality.
2. Chemical - cleaners, solvents, fuels, adhesives, various combustion by-products and emissions from furnishings and floor and wall coverings are typical examples of airborne chemicals.
3. Particles and Aerosols - solids or liquids that are light enough to be suspended in air. Particles are classified in three general categories (coarse, fine and ultrafine) and are derived from dust, construction activities, printing, photocopying, manufacturing processes, combustion and some chemical reactions in which vapors condense to form particles. These can be categorized as dust, smoke, mist, fume and condensates.

Factors that Influence Indoor Air Quality

To address IAQ problems and solutions, it is important to use strategies that address the factors that influence IAQ. These factors include the:

1. Building occupants;
2. Sources of indoor air pollutants; and
3. Heating, ventilation, and air conditioning (HVAC) systems.

Building Occupants

Building occupants have a responsibility related to indoor air quality and are responsible for avoiding activities that can contaminate the air such as smoking, cooking, wearing cosmetics or scents or by producing body odours. One of the first steps is to interview the affected occupant or occupants. A key question to ask is if their symptoms improve when they are away from work over a weekend, vacation or another type of leave.

A review of the interview responses can provide clues as to the cause of their concerns. For example, the source of an IAQ concern may be identified by looking at where most of the concerns originate relative to local conditions, or relative to the source and pathways of possible contaminants. The source may also be revealed by considering when the concerns occur relative to interior or exterior activities such as renovations, cleaning and pesticide applications.

It is important to have written documentation of IAQ concerns. Occupants can use a complaint log to record days when they felt the indoor air quality was unsatisfactory and to describe the conditions on those days, such as unusual activities (e.g. construction), events or weather.

The solution may depend on how widespread the concerns are. If only one occupant has an IAQ concern it may be more appropriate to accommodate their individual working conditions and not those of all occupants. If an occupant that has a confirmed medical condition that results in a sensitivity or unusual response to a building substance, there is a responsibility to provide additional protection to that occupant, or at their request, assign them to work that is available and less hazardous to them. Additional protection may include eliminating certain chemicals from the workplace, introducing a scent-free policy or relocating the occupant.

Possible Sources of Indoor Contaminants

In a typical building, pollutants fall into two source categories: those that enter the building from the outside and those generated within the building itself. Both include a wide variety of types and origins. When assessing the potential sources of indoor air contamination conduct a qualitative walkthrough inspection and consider pollutant sources such as the following:

- Water-damaged/discolored building materials;
- Visible mould;
- Spills of water or other liquids;
- Dust, dirt or debris located in the HVAC system;
- Off-gassing from new paint, furniture, carpeting or structural materials;
- Office equipment such as laser printers, copiers, paper shredders;
- Housekeeping activities such as cleaning and dusting;
- Maintenance activities such as painting, renovations and construction;
- Industrial type processes such as dry cleaning, cooking and printing;
- Scented products;
- Plants;
- Garbage, recycling or composting containers;
- Food and beverage odours; and
- Personal humidifiers, heaters and air cleaners.

Outdoor sources of contaminants which may be entrained into the building may include:

- Vehicle exhaust;
- Debris or garbage near an outdoor air intake;
- Pollen, dust or smoke;
- Contaminants from processes conducted by adjacent businesses and contractors;
- Exhausted air re-entering the building;
- Soil gases; and
- Materials tracked in or carried in by occupants.

Source management is the most effective method to control or avoid indoor air contamination. Source removal means preventing unnecessary pollutants from entering the building. Pollutant sources must be located and controlled to ensure good indoor air quality; however, it is important to note that both sources and pathways are essential components that must be well understood for effective problem solving. Pathways are created as pollutants travel by air movement or from relative positive to relative negative pressure areas, through a path of least resistance.

Health Concerns

It is common for people to report one or more of the following symptoms:

- Dryness and irritation of the eyes, nose, throat, and skin;
- Headache;
- Fatigue;
- Shortness of breath;
- Hypersensitivity and allergies;

- Sinus congestion;
- Coughing and sneezing;
- Dizziness;
- Nausea;
- Anxiety or irritability; and
- Foul smells.

People generally notice these symptoms after several hours at work and feel better after they have left the building or when they have been away from the building for a weekend or a vacation.

Many of these symptoms may also be caused by other health conditions including common colds or the flu, and are not necessarily due to poor IAQ. Since many of the above symptoms are very similar to what we feel like when coming down with a cold or the flu (influenza), it is often difficult to say for sure if indoor air is the cause of the symptom. This fact can make identifying and resolving IAQ problems more difficult.

Good IAQ helps provide a healthy and productive environment for all occupants and others who occupy the area. There are many ways to help maintain and achieve good air quality, and to improve poor air quality. Most IAQ problems can be prevented with good maintenance, and resolved with simple and inexpensive measures.

Preventative Maintenance Routine

It is recommended that IAQ management programs in Government of Alberta buildings utilize a preventative maintenance routine and an IAQ response process. A preventative maintenance program keeps a building's operating systems at optimal performance. It includes elements such as preventative maintenance of heating, ventilation and air conditioning (HVAC) systems, periodic testing of indoor air quality comfort parameters and reviews indoor air quality associated factors when renovations are undertaken. The Indoor Air Quality (IAQ) response process involves responding to occupant indoor air quality concerns in a timely manner.

The intent of a preventative maintenance routine is to ensure the building will continue to provide a healthy work environment. A monitoring process provides several opportunities for technical and building maintenance staff to assess the building's operating systems and indoor air quality conditions.

A preventative maintenance routine should include the following:

- A regularly scheduled inspection to ensure the heating, ventilation and air conditioning (HVAC) systems operate at design specifications as per Alberta Infrastructure's preventative maintenance program.
- Review and evaluation of IAQ and HVAC systems as part of Alberta Infrastructure's facility evaluation program.
- Submission of IAQ investigation results to the Alberta Infrastructure facility evaluation program.

- Periodic testing for comfort factors as per Appendix 2 – Level 2 by suitably trained Building Managers. Frequency of this testing is variable, depending on a variety of factors including age, type, and location of the building and history of occupant concerns. Testing frequency to be determined by the Building Manager.
- Consultation with Alberta Infrastructure's Technical Services Branch on design of equipment installations for special processes, major renovations and new construction to address factors that may impact the IAQ of the facility. These factors should include but are not limited to building envelope, HVAC systems, isolation of work area(s) and building materials. This is best done prior to construction or occupancy.
- Periodic inspection by building managers of building cleanliness and review of cleaning products and procedures.

Indoor Air Quality (IAQ) Response Process

The IAQ response process involves responding to an expressed concern regarding the building's indoor air quality. The concern may be communicated through a variety of channels, but needs to be directed to the Building Managers for their attention. Appendix I provides a flowchart outlining the steps involved in this process.

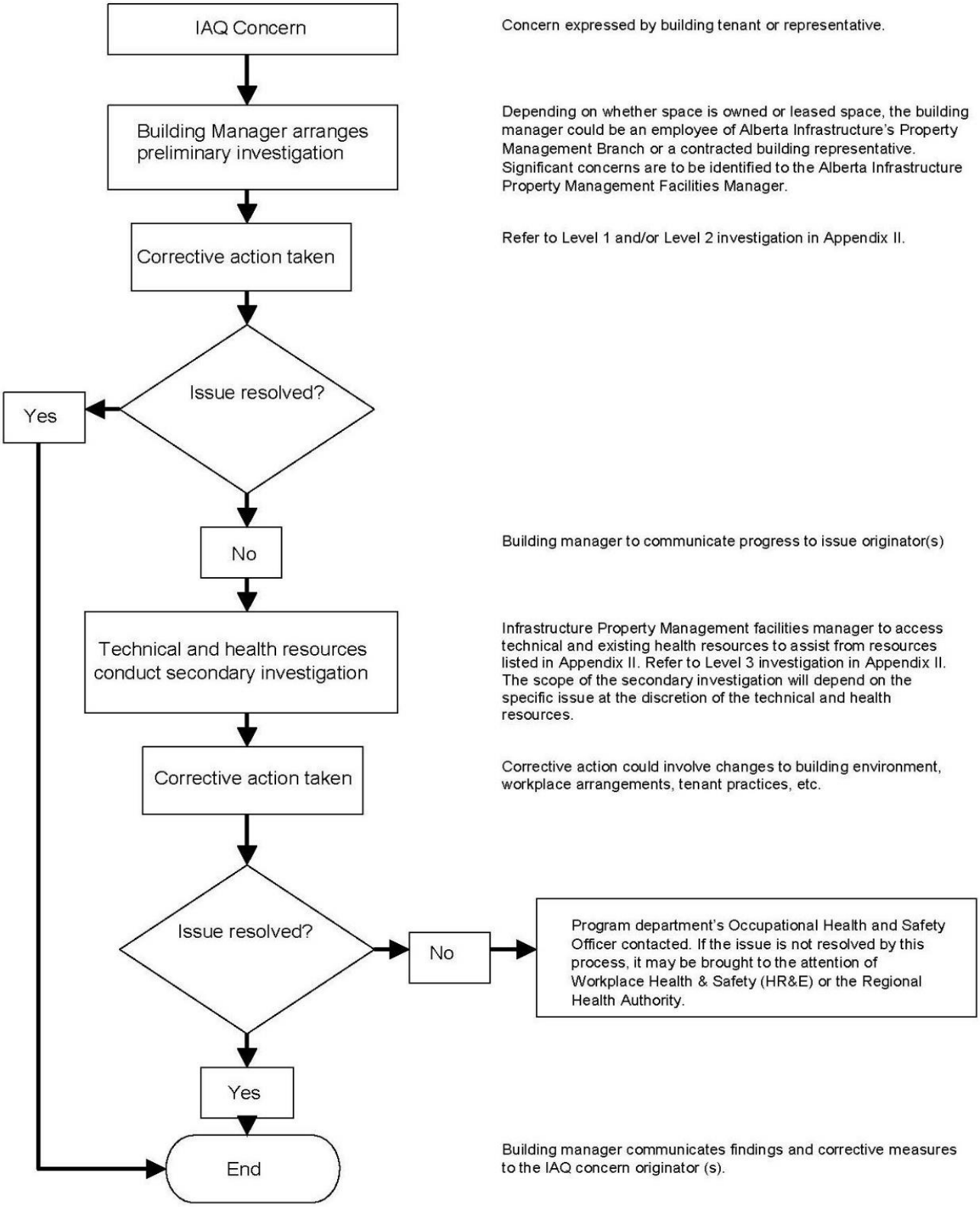
It is important to understand that there is both a technical component and a health component to IAQ concerns. Addressing only the technical component may result in an occupant's ongoing health worries to cause an IAQ issue to escalate out of control, even when the technical factors appear to be fully satisfactory. Once escalated, resolution can become very costly in time and resources. The Building Manager should establish a contact for building investigations that can help them with both the technical and health components of an investigation when appropriate. The Alberta Infrastructure Technical Services Branch, Building Environment Unit, can assist in establishing contacts with supporting professional resources.

The Building Manager will review and investigate an IAQ concern. This would normally include them arranging or conducting a Level 1 and/or Level 2 investigation as outlined in Appendix II. Based on the results of the investigation, the Building Manager would take action to address the concern, and if necessary, proceed to Level 3 Investigation requiring the assistance of technical/professional resources described in Appendix II.

Throughout the process, timely communication builds trust. It is important that the response and related activities are communicated back to the individual who reported it. It should be made clear that the complaint is taken seriously, action is being initiated and the status toward resolution explained. If the individual continues to express concern, they should be advised to see their family doctor to ensure that all potential factors that could be contributing to their discomfort are evaluated. Establishing a procedure for handling complaints and for communication before a situation develops is vital. Be clear about how people can voice their concerns, and the steps that will be taken to investigate the issue. Let people know the purpose and scope of any investigation. As the issue is investigated, open communication and information sharing is essential for a successful response. If the investigation will take a period of time, post updates of any progress.

If, at any point during the IAQ Response Process, a dispute arises, it may be referred to the department's Occupational Health and Safety Advisor.

Appendix I - Indoor Air Quality (IAQ) Response Process



Appendix II – Investigation Levels

There are three (3) levels of investigation for IAQ concerns, detailed below.

Level 1 – Walkthrough Survey (Qualitative Assessment)

1. **Information Gathering**
   - Meet with the employee(s) and/or supervisor of the area with the concern and the building operator/facility manager. Gather as much information as possible about the nature of the concern to identify possible sources of concerns.
   - Establish a reporting procedure that encourages people to report health concerns or unacceptable workplace conditions.

A form to assist with the information gathering can be found at the end of this Appendix.

2. **Conduct a Physical Inspection**
   - Identify potential hazards by visual inspection (i.e. sources of airborne contaminants from processes, e.g. blueprinting machines, combustion sources, etc.).
   - Do you smell any unusual odours. When? Where?
   - Look for signs of water leakage and water condensation, as they may be indicators of potential mould contamination. Ask about the history of water leaks/damage or previous IAQ concerns in the area.
   - Rule out other possible causes such as noise, temperature, humidity, and/or lighting.
   - Look for maintenance and housekeeping deficiencies (e.g. missing fan belts/filters on ventilation systems, humidifiers (drain pans) and cooling systems, boxes stored against cold walls, thermostats set or located improperly, etc.).
   - Can you feel the air moving around the supply and exhaust air vents? Are any vents blocked by papers, books or other items.
   - Inspect the air intake and exhaust locations and review the HVAC system operation schedule and minimum outdoor air requirements. Ask about air filters?
   - Assess how does the area of concern feel compared to other non-problematic areas within the space.

A checklist to assist with the walk-through can be found at the end of this Appendix.

3. **Corrective Action**
   - Take appropriate corrective action to resolve the concern. If corrected, inform occupants.
   - If the results of the walk-through survey and interviews do not resolve the issue, then proceed to Level 2 investigation.

Level 2 – Test for Comfort Factors (Quantitative Assessment)

If, after the Level 1 assessment, the building manager or operator has not been able to correct or resolve the concern they should arrange for testing of comfort factors using calibrated spot testing or long term handheld IAQ testing equipment. These include carbon dioxide, carbon monoxide, temperature, relative humidity and in some cases, total volatile organic compounds (TVOCs) and air motion from supply and return vents. Each parameter investigated may provide the assessor with an indication of the ventilation performance within the space, the quality of air being delivered to the area, and occupant comfort.

Carbon dioxide is commonly used as a surrogate indicator for assessing indoor air quality (IAQ) and ventilation efficiency. The measurement and analysis of the average indoor CO_2 concentration is useful to understand the performance of a ventilation systems' air delivery, distribution, and circulation within a space.

Carbon monoxide is measured as an indicator of the quality of outside air being introduced into the building and to address the performance of any combustion devices which may impact indoor air quality.

Temperature and *relative humidity* are comfort parameters which are important in that maintaining comfortable thermal and moisture conditions that generally improve occupant perception of good indoor air quality.

TVOCs is measured as an indicator of off-gassing which can be released from new furniture, fabrics, chemicals, carpets and paints and can assist in identifying the presence of unusual odours.

These tests should be conducted by suitably trained individuals and should include the following considerations:

1. **Test Plan**
   - Testing should be conducted in area(s) of concern and area(s) of no concerns (i.e. control sample). Consult with a technical/professional resource to determine the appropriate number of samples and sampling locations.
   - If spot readings are taken, then ensure this is done at different times of the day to capture possible variances. A representative number of samples in the morning and afternoons on various workdays are required to ensure all areas of concern have been addressed.
   - If continuous measurement readings are taken, then sampling over a 48-hour period will obtain sufficient data for a range of activities and changes to the ventilation operation. Please note when interpreting the data, that the first ten minutes of the sampling periods should been omitted to allow time for the equipment sensors to stabilize.
   - Note outdoor weather conditions (temperature, relative humidity) whenever testing for IAQ comfort factors.
   - Conducting a visual inspection of the HVAC system servicing the locations being assessed shall include an inspection of the supply and return inlets, exhaust locations, filters and coils.
   - Refer to Appendix III for Indoor Air Quality and Comfort Parameters.

2. **Corrective Action**
   - Based on the results of the investigation, identify corrective action. If you are uncertain, identify corrective action in consultation with the technical/professional resources identified below.
   - If the results of Level 2 investigation do not resolve the concern, proceed to Level 3 investigation.

Level 3 – Obtain Assistance From Technical/Professional Resource

If the IAQ issue is not resolved after conducting a Level 2 investigation, obtain assistance from a technical/professional resource listed below.

The type of scenarios where this assistance should be obtained include:

a) Interpretation of results from Level 1 & Level 2 investigations.
b) Dealing with potential or known existence of mould contamination.
c) Further sampling for other possible contaminants such as volatile organic compounds, formaldehyde, particulate, etc.
d) Asbestos management/contamination.
e) Evaluating the amount of emissions from processes (e.g. blueprinting, dry-cleaning from nearby commercial operations, etc.).

IAQ assessments and associated testing should be conducted by a competent individual. All personnel performing IAQ testing and participating in the interpretation of test results and in the evaluation of information should have a good understanding of the methodologies and procedures involved in air quality assessment work in buildings.

All equipment utilized in testing shall be calibrated according to manufacturer's specifications and be in good working order. All personnel participating in the operation of the specified types of air monitoring equipment shall have adequate experience in the operation of the equipment.

Technical/Professional Resources

IAQ investigation should be conducted by the following qualified personnel:

Level 1 & Level 2

- Individuals with proven competency in conducting IAQ investigations and interpretation of results.
- Alberta Infrastructure Technical Services Branch, Building Environment Unit.
- Department Occupational Health and Safety staff.
- Private sector Occupational Hygiene and Environmental Consultants.
- Health resources such as occupational health nurses, occupational physicians and family doctors.

Level 3

General qualifications for people conducting IAQ investigations would include but not be limited to:

- Certified Industrial Hygienist (CIH);
- Registered Occupational Hygienist (ROH);
- Certified Industrial Hygiene Technologist (CIHT);
- Registered Occupational Hygiene Technologist (ROHT);
- Canadian Registered Safety Professional (CRSP); and
- Certified Public Health Inspector of Canada CPHI(C).

IAQ Complaint Form Log

Location: _____ Department: _____

Completed by: _____ Date: _____

Date	Time (am/pm)	Description of Complaint	Describe Symptoms	Outdoor Weather

IAQ Walkthrough Checklist

Location: _____ Department: _____

Completed by: _____ Date: _____

Item	Y/N	Comments
Occupied Spaces		
Concerns/symptoms from occupants.		
Are there complaints of too hot or too cold?		
Are occupants using portable fans, heater, humidifiers?		
Any noticeable odours?		
Is it stuffy?		
Any obstructions (partitions, screens) blocking ventilation grills, thermostats?		
Any signs of inadequate cleaning? Check high and low surfaces.		
Is there any air movement through the supply diffusers?		
Are there dust marks around ceiling diffusers or return air grills?		
Does glare appear to be a problem?		
Any cleaning chemicals? Pesticides/herbicides for indoor plants?		
Any office equipment that may require special ventilation? (printers, plotters, fume hoods)		
Are there any visible signs of water leakage or condensation?		
Ventilation System		
Air intake locations close to potential contaminant sources, e.g. building, washroom, boiler exhausts, loading dock?		
Humidification system? Drain pans clean?		
Filters in the ventilation system?		
Do filters have a MERV rating?		
Carbon Monoxide – Combustion Products		
Does the building contain an internal parking garage?		
Does the building contain an internal loading dock?		
Does the building contain a gas-fired heating system?		

Appendix III – Indoor Air Quality and Comfort Parameters

These parameters are intended to provide occupants with a comfortable and healthy indoor work environment and should be applied by individuals who are trained to conduct IAQ investigations and interpret the results (i.e. technical/professional resources in Appendix II).

Temperature(1)	22 °C with a 2 °C upswing at peak outdoor design temperature (summer) in air-conditioned buildings.
Relative Humidity(1)	20% at outdoor temperature of -35 C 30% at outdoor temperature >0 °C 60% maximum
Carbon Dioxide	1,000 ppm(4) (office and school environments)
Carbon Monoxide	5 ppm
Total Suspended Particulate (PM_{10})	50 ug/m^3 (0.050 mg/m^3) (4)
Fine Suspended Particulate ($PM_{2.5}$)	25 ug/m^3 (0.025 mg/m^3)
Total Volatile Organic Compounds	3 mg/m^3 (1.3 ppm using direct reading PID)(2)
Formaldehyde	0.10 ppm
Nitrogen Dioxide	53 ppb
Sulphur Dioxide	20 ppb
Asbestos	0.01 f/cc(4)
Ozone	0.01 ppm
Radon	200 Bq/m^3(4)
Office Lighting	200 - 500 Lux (maintained)
General Office Area - Private Office	40 - 45 dBA(4)
Board Rooms	40 - 45 dBA
Surface Mould	Presence or absence
Airborne Viable Fungi (Health Canada Guidelines)	150 CFU/ m^3 (3 or more species reflective of outdoor flora) 50 CFU/ m^3 (only one species other than *Cladosporium* or *Alternaria*) Up to 500 CFU/m^3 (summer if species is primarily *Cladosporium* or other tree/leaf fungi). **The indoor air should normally be qualitatively similar but quantitatively lower than outdoor air**.
Airborne Non-Viable Fungi (Alberta Health Services)	*Aspergillus/Penicillium* max is 200 Cts/m^3 + 2x outdoor *Cladosporium* max is 300 Cts/m^3 + 3x outdoor *Alternaria* max is 100 Cts/m^3 + 3x outdoor Other moulds max is 100 Cts/m^3 + 2x outdoor

Notes:

1. Comfort parameters
2. Photo Ionization detector calibrated to isobutylene.
3. The above listed levels were developed using a level of 1/10th the Occupational Exposure Limits as identified in Table 2, Schedule 1 of the Alberta OHS Code. For substances other than those listed above, a level of 1/10th of the OEL as identified in Table 2 should be used as a guideline.
4. Units of measurement:
   - ppm - parts per million
   - ug/m^3 - micrograms per cubic meter
   - mg/m^3 - milligrams per cubic meter
   - f/cc - fibers per cubic centimeter
   - Bq/M^3 - becquerel per cubic meter of air
   - CFU/m^3 - colony forming units per cubic meter of air
   - Cts/m^3 – counts per cubic meter of air
   - dBA - refers to A-weighted decibels
   - Lux - light in lumens per square metre

Appendix IV – Bibliography and Resources

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