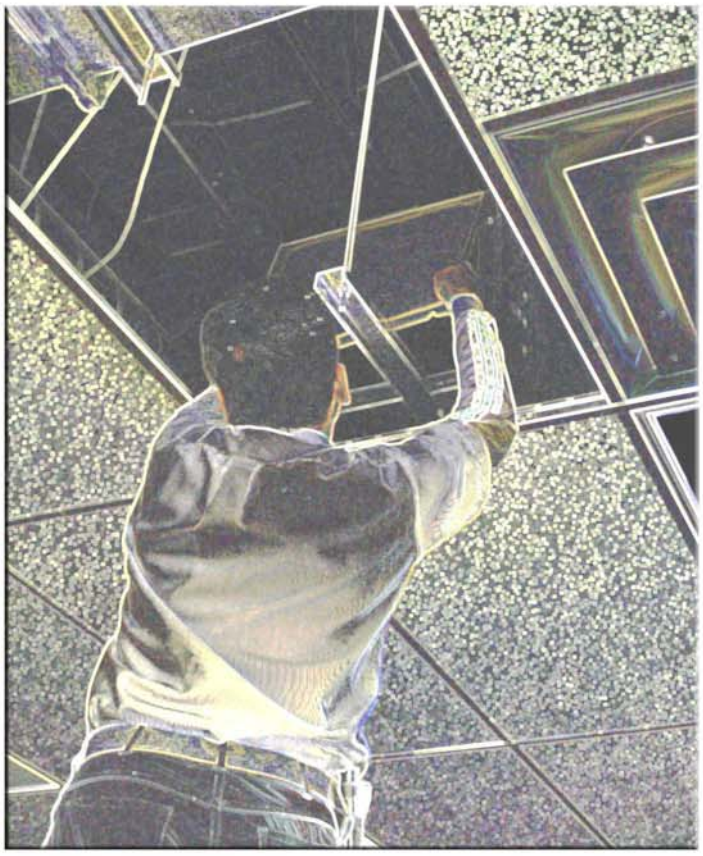
WORK SAFE
ALBERTA

Indoor Air Quality

Tool Kit



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Section 1: Introduction to the IAQ Tool Kit

The goal of this Tool Kit is to help you understand typical indoor air quality (IAQ) issues, and to suggest reasonable solutions to common problems.

While many workplaces can use the Tool Kit, it is written with non-industrial settings in mind – for those working in a building with offices, meeting rooms, some kitchen or lunch room facilities, with basic cleaning activities and a limited number or type of chemicals. The guidance may also apply to home businesses or very light industrial workplaces. Building owners, or those who lease office spaces, employers and workers will benefit from the information in this guide. This guide will help you identify the problem and provide advice about common approaches to recognizing and controlling IAQ problems.

How the Tool Kit is Organized

Section 1	**Introduction to the Tool Kit**
Section 2	**Introduction to IAQ** Why IAQ is important, as well as the typical health concerns of poor IAQ and common causes of IAQ problems.
Section 3	**Identifying and Assessing IAQ Issues** Guidance to help you recognize, identify and assess the extent and nature of IAQ issues. Sample forms and checklists are here too.
Section 4	**Standards and Guidelines** A concise list of IAQ-related regulations, standards and guidelines.
Section 5	**Managing and Correcting IAQ Problems** Common problems and ways to manage and resolve these.
Section 6	**HVAC Primer** Basics of how the HVAC system works, plus maintenance tips.
Appendix A	**Evaluating IAQ Consultants** Guide to hiring an IAQ consultant to resolve workplace issues.
Appendix B	**Air Testing & Sampling Instruments** If you have to test the air, this guide provides information on how it is done.
Appendix C	**Checklists, Forms, Resources**
Appendix D	**Glossary of Terms**
Appendix E	**Bibliography and Web Resources**

Section 2: Introduction to IAQ

Good IAQ helps you provide a healthy and productive environment for all workers 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.

Why IAQ is Important

In the past few decades, energy conservation measures have led to airtight building construction that can create problems with IAQ. Frequently the ventilation systems are set to minimize the amount of fresh air entering and circulating within the building. This restriction impacts indoor air by allowing a build-up of air contaminants within the building that are not properly removed.

IAQ Health Concerns

People spend a lot of time indoors – for example, many office workers will spend their entire working day inside buildings. People who may have concerns about IAQ often mention the following symptoms as health concerns:

- dryness and irritation of the eyes, nose, throat, and skin,
- headache,
- fatigue,
- shortness of breath,
- hypersensitivity and allergies,
- sinus congestion,
- coughing and sneezing,
- dizziness, and/or
- nausea.

You will notice that 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. This fact can make identifying and resolving IAQ problems more difficult.

However, indoor air should be investigated as a cause, especially when people develop these symptoms within a few hours of being at work and they feel better after they have left the building or when they have been away from the building for a weekend or a vacation.

IAQ 'Sensitivity'

Problems with IAQ do not affect all people in the same way. Some people may be more sensitive than others. Some people may be exposed to more contaminants in the building than others and they may experience symptoms earlier than other people. As air quality deteriorates and/or the length of exposure increases, more people tend to be affected and the symptoms tend to be more serious.

It is also possible that some people can become sensitive to certain air contaminants as time passes. Some people may not be susceptible to IAQ problems in the early years of exposure but can become sensitized (react more severely or more often) as exposure continues over time.

What are the Common Causes of IAQ Problems?

IAQ problems can be the result of many factors. Building materials and furnishings, building equipment and activities, outdoor climate, and the building occupants themselves can play a role in IAQ problems. Common areas of concern include:

- Indoor air contaminants - chemicals, cleaners, dusts, moulds, fungi, odours, and vehicle exhaust emissions.
- Not enough outdoor air, poor air quality or poor air circulation.

Is Air Contamination the Only Cause of these Symptoms?

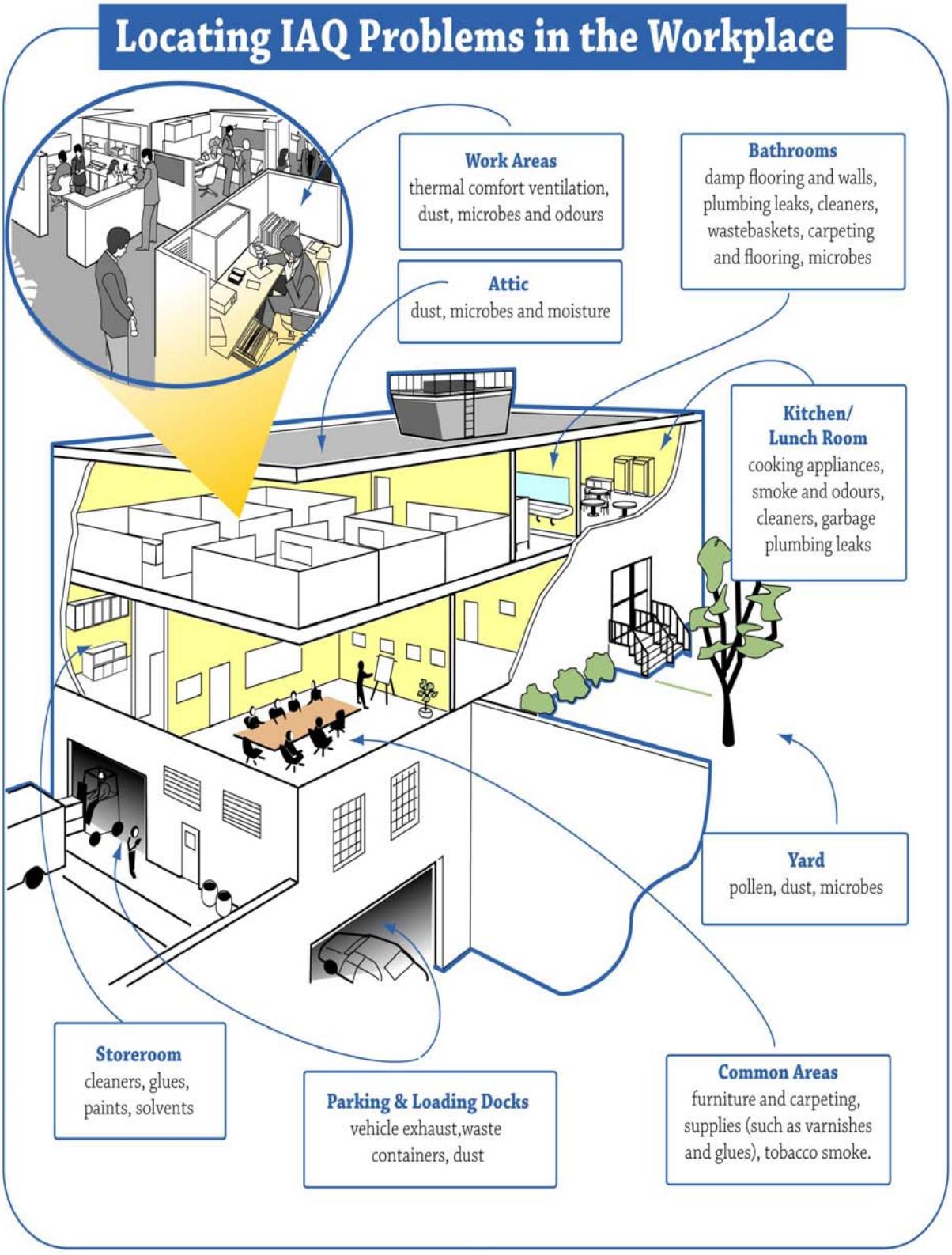
No. Feelings of discomfort and illness may be related to a number of issues in the total indoor environment.

Other common causes may include:

- Noise
- Thermal Comfort (Temperature)
- Humidity / moisture
- Lighting

It is important that these causes be investigated when assessing complaints.

Section 5 on page 18 will help you identify and resolve these issues.


Locating IAQ Problems in the Workplace
Work Areas
thermal comfort ventilation, dust, microbes and odours
Attic
dust, microbes and moisture
Bathrooms
damp flooring and walls, plumbing leaks, cleaners, wastebaskets, carpeting and flooring, microbes
Kitchen/ Lunch Room
cooking appliances, smoke and odours, cleaners, garbage plumbing leaks
Yard
pollen, dust, microbes
Storeroom
cleaners, glues, paints, solvents
Parking & Loading Docks
vehicle exhaust,waste containers, dust
Common Areas
furniture and carpeting, supplies (such as varnishes and glues), tobacco smoke.

Section 3: Identifying and Assessing IAQ Issues

When should I suspect an IAQ problem?

When there is a problem with IAQ, people may experience the health symptoms that are listed in Section 2 on page 2. Since many of the 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 symptoms.

However, it is prudent to investigate IAQ if people:

- develop these symptoms within a few hours of starting work and
- feel better after leaving the building, or after a weekend or vacation.

In addition, if many people report similar symptoms, or if all of the people reporting symptoms work in the same area of a building, air quality issues should be suspected.

Collecting Information on IAQ Problems

There are several ways to collect information about IAQ.

- As a separate inspection, or as part of your **routine workplace inspections**: Incorporating IAQ aspects into the regular inspections by the work site health and safety committee (or representative) is one way to keep alert to potential problems. See Appendix C-3 on page 55 for a sample inspection checklist.
- Using **worker complaint forms:** Establish a reporting procedure that encourages people to report health concerns or unacceptable workplace conditions. A sample complaint form is provided in Appendix C-2 on page 54.
- Conduct a **health survey**: A health questionnaire that targets IAQ issues may be used to gather information about health conditions on a more formal basis. A sample health survey is provided in Appendix C-4 on page 56.

Assessing IAQ Problems

At this stage, you now suspect or think that you may have an IAQ problem, but are wondering how to:

(a) make sure it is an IAQ issue, and

(b) identify what is causing the problem.

It is likely that people have reported symptoms that they believe are related to indoor air problems. Your job is to find out what might be the cause.

Your initial investigation should focus on four main areas:

- Confirm that the ventilation system is operating properly (check the mix of fresh air, proper air distribution, clean filtration systems, humidification systems).

Note: Temperature, humidity and the level of carbon dioxide (CO_2) are generally checked and used as a way to make sure that the HVAC system is in good working order. These factors are a starting point and you may need to assess air contaminants.

- Look for possible sources or causes such as a chemical, renovations, or mould.
- Rule out other possible causes such as noise, temperature, humidity, and/or lighting.
- Conduct a full health survey, if necessary, to help pinpoint sources and causes.
- Consider help and/or air testing by a qualified professional.

There is no one single method that can be recommended that will cover all situations. Often, a common sense approach seems to work best.

Who Should Investigate?

Many people may play a role in helping to resolve an IAQ problem including the building owner, employer, property manager, and occupants. Who conducts your investigation will depend on your workplace, but in general, you should have one person who is the leader, and perhaps a small team, including a representative from the work site health and safety committee, or the union, if appropriate. The expertise of many other people such as health and safety or building maintenance personnel, and the experience of everyone in the workplace will all be important in finding the root cause of your IAQ problem.

Assessment Steps

The first step is to go on a "fact finding" mission. The steps taken may vary from one situation to another. The following 3 steps will help guide you towards a solution.

1. Gather background information and documentation, including:
    - A map of the building layout or floor plans, marking areas with complaints.
    - Complaint forms or other documentation such as records of recent renovations, or minutes from the work site health and safety committee meetings, if available. Complaints received by occupational health, managers or other staff.
    - Maintenance records and design drawings for the HVAC system.
    - Records of recent activities (routine and non-routine) such as cleaning, rug shampooing, painting, renovations, and/or equipment maintenance.

2. Take a walk through the building or area. Get a first hand look at the building design, floor plan, and ventilation system.

    Look for overall cleanliness and the operation of the HVAC system:

    - Are there areas of concern such as improperly stored materials or chemicals?

- Do conditions in any area look like they may cause or promote mould growth including dampness, condensation, moisture or water damage?
- Is there any staining or discolouration of ceiling tiles, walls or carpets?
- Are any supply and exhaust air vents dirty?
- Can you feel the air moving around the supply and exhaust air vents? Are any vents blocked by papers, books or other items?
- Is the area dusty? Unsanitary?
- Do you smell any unusual odours?
- How does this area feel compared to other places you have visited? Is it warmer or colder? More or less humid? Are there drafts?
- Do you hear any unusual equipment noises?
- How many people are regularly in the area?

3. Talk to the people working in the area, and take the time to listen to their concerns.
   - Who has IAQ concerns? Have they reported the symptoms already and to whom?
   - Has someone modified a supply air vent because it was too noisy or drafty?
   - Have there been changes to the ventilation system, renovations, the layout of the area, additional or new furnishing that may not be documented in the official logs and inventories?

Using the Health Survey

You can use the sample heath survey in Appendix C-4 on page 56 to gather more information about who is noticing symptoms and when. Remember to customize the survey, or add questions that are specific to your situation.

You may choose to distribute the survey, or to conduct interviews in person. Interviews should be private, and specific health information about individuals is confidential.

Using Worker Feedback

Information gathered from workers will indicate potential problems as well as possibly highlighting an area where further investigation should be done.

When you are trying to decide if an IAQ problem exists, it is important to remember the following:

- Not everyone will be equally sensitive. Even if only a few people are affected, do not ignore the possibility of a problem.

- Combined exposures may cause health problems even if the level of each of these exposures is below recommended limits.
- Health problems from exposure to a chemical may worsen in the presence of other chemicals.

Defining the Problem

When analyzing the results, compile the information you have gathered. What are:

- The type of complaints?
- The locations of the affected persons on the floor plan?
- The number of people affected?
- The timing of the complaints?
- The deficiencies noted to the HVAC system?
- The possible sources (such as improper storage, unclean areas, water damage)?

When looking at your information, look for patterns in the locations and time of complaints. For example: Compare your findings from the background information and health questions to the floor plan. Are most of the people who have reported symptoms in one area?

Compare your problem pattern information to Checklist C-5 on page 59. Does your IAQ problem fit into any IAQ problem pattern and to any of these causes?

Odours can also be a good indicator of causes of IAQ problems. Review Checklist C-6 on page 61 to consider odours as possible connections to contaminants and health complaints.

It is very likely that you will encounter a range of complaints during your assessment. Review Checklist C-7 on page 62 for common complaints and possible causes.

Other Tips

- Renovations or additional building occupants will impact the ventilation system so compare the original HVAC design to the current use. Overcrowding may mean there isn't enough air exchanges for the increased number of people. Check the carbon dioxide (CO_2) level (or call an air quality professional to do this). CO_2 levels above 1000 ppm will indicate that there are issues with the ventilation system and it is possible that other contaminants are accumulating as well.
- Has a renovation blocked a vent or changed the airflow patterns?
- Is the air intake too close to the air exhaust? There may be a "short circuit".
- Has new equipment been introduced (including photocopiers, printers, humidifiers, dehumidifiers)? Emissions from each piece of equipment can affect the air.

Don't forget! Sometimes the answer can be simple!
Always check the temperature and humidity levels to see if they are in the normal range. Make sure vents and ducts are not blocked.

If you think your initial assessment has identified a cause or problem, work towards resolving the situation. Make the required changes, if you can, and see if the problem is resolved. Specific examples of how to manage and correct IAQ problems are presented in Section 5 on page 18.

Resolving the Problem

At the end of your assessment, you should be able to answer the following questions:

- What are the nature of the complaints?
- How many people are affected?
- Is there a connection to the building that can be related (such as time of day, location)?
- Are there obvious HVAC issues to be considered?
- Are there obvious internal or external sources of contaminants?

If you have identified a potential source for your problems, try to identify a solution. Make the changes required. Evaluate if the change has resulted in better conditions.

If not, are there other solutions that may help? If a solution cannot be found, or if other problems have been identified, you may need to hire the help of a professional.

Monitor the Situation

There are generally two ways to determine if your efforts to solve the IAQ issues have been successful.

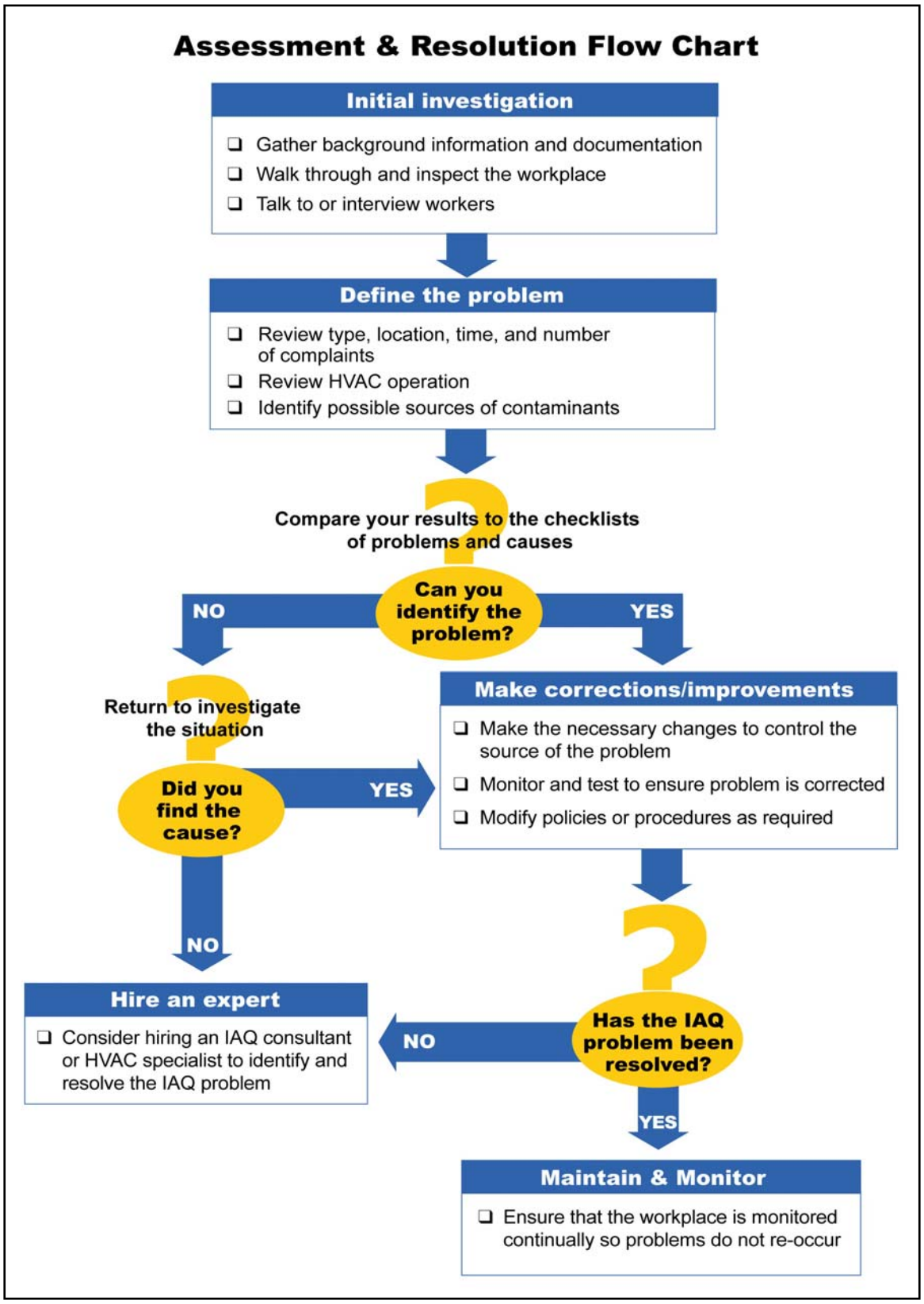
1. Reduced complaints: If complaints are eliminated, or reduced, it may be a sign that the problems have been addressed.
2. Measurement of IAQ: If you are able to compare the properties of the air before and after, these measurements can show what actual changes have been made (includes temperature, humidity, air flow patterns, and air contaminant levels).

Communication is Key

It is a good idea to follow up or continue to monitor the situation, as often people will not make complaints once they realize that their issues are being addressed. On the other hand, people may continue to complain after a situation has been fixed but it may be that they are upset about how the situation was handled. As for any health and safety issue, you should always establish who will respond to the complaint, and how the complaint will be addressed.

To help avoid these situations, it is a good idea to establish procedures for handling complaints and for communication before a situation develops. 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. If the investigation will take a period of time, post updates of any progress. Make the final results available, and encourage feedback. Encourage people to participate in the process.

Refer to the following Assessment & Resolution flow chart as a guide.



Sample Situations to Consider…

Renovation reality…

Business was booming and the marketing firm decided to create a new department. They retrofitted a manager's office into the existing building by adding new walls to one section of the existing cubicle (partition) layout.

After construction was finished, staff in the area complained of headaches, fatigue and muscle aches.

Investigation revealed that the new walls were not allowing air to circulate beyond the manager's office. A HVAC specialist was hired to make adjustments and add new vents. A complete rebalancing was required.

Staff members were resurveyed, and they reported fewer headaches. However, muscle aches were still an issue. The HVAC was rechecked and confirmed to be in acceptable ranges. No other source was discovered.

The manager next looked into the workload of individuals and found that many of those with muscle aches created graphical designs by working at their computers for over 6 hours a day.

Job rotation was introduced as well as encouragement of micro-breaks where possible. Reports of fatigue and muscle aches are now far less frequent.

Still searching…

Fantastic Fran's is a local customized t-shirt shop that does silk screening and embroidering. A few workers often complain about coughing, sneezing and generally not feeling well.

A walk through assessment did not reveal any possible causes or sources. They decided to hire a consultant but while some problems were identified and addressed, some symptoms continued.

While the HVAC system was operating normally, they decided to increase the number of air exchanges and increase the fresh air mixture. Some improvement was noted but still no exact cause was found.

Kind neighbours…

Staff complained about an exhaust smell. It was particularly noticed by staff that started early in the morning.

The HVAC system was checked to see if the air intake was close to the staff parking lot, but it was not. Next, they checked if the HVAC was switching to normal operations from its night reduction mode in time to accommodate staff that worked early hours. The HVAC was operating normally.

A further investigation found that a nearby private school idled their buses in front of the office while waiting for the morning pick up time.

The school was asked if the buses could wait elsewhere. The school was able to relocate the buses and was happy to help.

Sometimes one solution can cause a different problem…

A new office building was receiving complaints that the office spaces were too bright. A lighting expert was hired, and the report indicated that there was too much natural light from the windows. As recommended, new mesh blinds were ordered and installed.

Immediately after installation, many staff members complained of irritated and red eyes and a "chemical" smell. One staff member reported more serious health concerns, including shortness of breath, severe headaches, and other allergy-like symptoms.

The Health and Safety committee met, and since the blinds could not be removed, it was decided that the blinds should be fully extended when the staff left at the end of the day to allow for off-gassing. The HVAC system would run at its maximum air exchange rate and run at this full capacity for 24 hours a day. While more complaints were noticed immediately, after a few days the air quality was improving and no more general complaints where received. After about 2 weeks, the blinds were sufficiently off-gassed, and the HVAC system was returned to its normal settings. The one staff member who was more seriously affected still found it difficult to be in the building, and was allowed to work at home until her condition improved.

To prevent future incidents, it was decided that all new fixtures or furniture would be allowed to off-gas in a separate building before being brought into the office space.

It doesn't add up…

A small accounting office was located in a strip mall complex. The office always had an odd odour – they suspected that it might have something to do with either the bagel shop on one side, or the hair salon on the other. By late afternoon, the accounting office staff often found they were tired and had headaches. Several people reported watery eyes, and a burning in their throat.

No causes were found in their office space, but they were located next to a hair salon that also employed an aesthetician (who mainly applied fingernail polish and decals).

The accounting office requested that the mall owners hire an air quality consultant. The consultant found that there were several problems. The HVAC system was not calibrated to include an appropriate mix of fresh air, nor did it exchange the air adequately. In addition, the two offices shared ducting.

The store owners negotiated with the mall operators to improve the air mixture and increase the number of air exchanges. This change did improve the air quality in both workspaces, but health complaints did not disappear entirely. They are further negotiating with the mall owners to make more substantial improvements to the HVAC system, including an exhaust fan for the aesthetician's work table that exhausts directly outdoors.

Section 4: Standards and Guidelines

This section summarizes the existing regulations, standards and guidelines that can help Alberta workplaces address IAQ issues. It is important to understand that most IAQ standards and guidelines are established to ensure the comfort of workers. So these values tend to be lower than regulatory values that are set to protect workers from possible health based hazards.

Regulations cite values that must be complied with under the law. In Alberta, the regulatory limits are called occupational exposure limits (OELs). OELs are established for health-based reasons.

Standards are set by special organizations with expertise but are not legally binding unless cited within a regulation. The IAQ values cited in standards are useful as a guide for workplaces where IAQ and comfort is a concern.

Guidelines are recommended approaches or values that are useful but not mandatory.

Various air quality resources are cited that relate to either indoor air quality, outdoor environmental standards, or workplace OELs for protecting the health of workers.

Thermal Comfort (Temperature / Humidity)

A common IAQ concern is the 'thermal comfort' of workplace occupants. Thermal comfort means that when surveyed, a substantial majority (greater than 80%) of occupants report that they are "comfortable".

Changes in seasonal outdoor environments and occupant clothing have an impact on perceived comfort levels. ASHRAE recommends the following acceptable temperature values based on occupant clothing and relative humidity levels.

Temperature / Humidity Ranges for Comfort

Conditions	Relative Humidity	Acceptable Operating Temperatures °C	Acceptable Operating Temperatures °F
Summer (light clothing)	**If 30%, then**	24.5 - 28	76 - 82
	If 60%, then	23 - 25.5	74 - 78
Winter (warm clothing)	**If 30%, then**	20.5 - 25.5	69 - 78
	If 60%, then	20 - 24	68 - 75

Source: Adapted from ASHRAE 55-2004 (reference 20)

The Canadian Standards Association (CSA) also recommends similar temperature ranges

for summer and winter. CSA Standard Z412 Guideline for Office Ergonomics [reference 36] recommends that for summer temperatures be from 23-26 °C, while in winter temperatures be from 20-23.5 °C. These temperature ranges are based on a relative humidity of 50%.

Thermal comfort is also affected by drafts and temperature differences. Drafts that are caused by excessive air movement can be minimized by maintaining air velocity below 0.2 m/s (40 fpm) and by directing air supply away from occupants. Maintain workplace airflow so that temperature differences between the head and feet of occupants is not greater than 3°C. ASHRAE 55-2004 - [reference 20]

Humidity/Moisture

Relative humidity levels below 20% are associated with increased discomfort and drying of the mucous membranes and skin, which can lead to chapping and irritation, and increases in static electricity. During very cold outdoor conditions, which are common in Alberta winters, humidity levels need to be reduced below 30% in order to avoid condensation on walls and windows. Condensation can lead to the development of moulds and fungi.

The following table identifies the practical relative humidity level that can be achieved based on various low outdoor temperatures.

Outdoor Temperature °C	Relative Humidity %
- 35	20
>0	30
any	60% maximum
In winter months, humidity may need to be reduced below 30% to avoid condensation.	

Adapted from Indoor Air Quality Guideline, Alberta Infrastructure (reference 18)

Other Parameters

Standards and Guidelines		
IAQ Issue	**Limits or Values**	**Cited**
Carbon Dioxide * (CO_2)	Less than 800 ppm	(1)
	Below 1000 ppm or lower if practical	(2)
	1050 ppm (~300 ppm above outdoor levels)	(4)
	5000 ppm; 9000 mg/m^3 (8-hr)	(3)
Carbon Monoxide	Less than 5 ppm	(1)
	25 ppm or 29 mg/m^3 (8-hr)	(3)

	5 ppm or 6 mg/m^3 (8-hr)	(6)
Vehicle Exhaust	Refer to components such as Nitrogen dioxide, Sulfur dioxide, Carbon dioxide.	
Nitrogen Dioxide	0.3 ppm	(1)
	0.212 ppm or 0.4 mg/m^3	(6)
	3 ppm or 5.6 mg/m^3 (8-hr)	(3)
Sulfur Dioxide	0.3 ppm	(1)
	0.172 ppm or 0.45 mg/m^3	(6)
	2 ppm or 5.2 mg/m^3 (8-hr)	(3)
VOCs	5 mg/m^3	(7)
	Keep specific contaminants below one-tenth of their OEL	(1,2)
Formaldehyde	0.10 ppm	(1,2)
	0.053 ppm (1-hr)	(6)
	0.75 ppm or 0.92 mg/m^3 (8-hr)	(3)
	0.04 ppm or 0.05 mg/m^3	(5)
Dust / particulates	0.1 mg/m^3 total dust	(1,2)
	0.1 mg/m^3 total suspended particulates	(6)
	10 mg/m^3 total particulate 3 mg/m^3 respirable particulate	(3)
	0.015 - 0.050 mg/m^3 respirable fraction of dust (fine)**	(9)
Lighting	Office: 500-750 Lux (maintained) Computer: 300-500 Lux (maintained)	(1,2)
	500-300 Lux horizontal (computer use - intermittent to intensive) 500 Lux (filing or mail sorting rooms) Adjust for aging workers, tasks, reduce glare	(8)
Noise (background)	48 dBA (general office area) 40-45 dBA (board rooms, private offices)	(6)
	50 dBA (call centres) 45-48 dBA (open plan offices, private offices) 35 dBA (conference rooms, executive offices)	(8)
Mould	Indoor air should reflect similar species but lower quantities than outdoor air 150 cfu/m^3 (3+ outdoor fungi species) >50 cfu/m^3 (only 1 species other than Cladosporium or Alternaria) up to 500 cfu/m^3 (summer if species primarily Cladosporium or other tree/leaf fungi)	(7)
Allergens/ Tobacco Smoke	Limit or avoid exposures to fragrances, cigarette smoke, and exposures to dander-producing animals and insects.	(1,2)
Radon	200 Bq/m^3 (proposed)	(10)
Odours	Acceptable to > 80% occupants. Monitor CO_2 concentrations* (alternative to monitoring odours)	(9)

* CO_2 is often used to check the adequacy of the ventilation rate
** Respirable dust particles can be inhaled into the lungs

See Glossary definitions for:

Bq/m^3 – Becquerel per cubic metre of air – a measurement of radioactivity
cfu/m^3 – Colony forming unit of mould per cubic metre of air sampled
dBA – Decibels measure sound levels, with a weighting to approximate human hearing
Lux – A measurement of lighting level. The light of a candle at 1 foot is 10 Lux, while a sunny day outdoors is 32,000 Lux
mg/m^3 – Milligrams per cubic metre of air
OEL – Occupational exposure limit reflects a concentration of a chemical in air
ppm – Parts per million reflecting a concentration of a chemical gas or vapour in air
TWA – Time weighted average for an 8-hour workday

Cited References of Air Quality Information

1. Alberta Infrastructure Indoor Air Quality Guideline

An interdepartmental committee on IAQ chaired by Alberta Infrastructure prepared this guideline for the Government of Alberta facilities. [reference 18]

2. Alberta Workplace Health and Safety Bulletin – Indoor Air Quality

This IAQ bulletin describes IAQ problems in the workplace and provides guidance on the hazard and control measures to minimize these problems. It cites relevant standards and guidelines and sources for related information [reference 2]

3. Alberta Occupational Exposure Limits

The Alberta Occupational Exposure Limits (OEL) cited in the Occupational Health and Safety (OHS) Code (Schedule 1) reflect legal maximum allowable airborne limits for various workplace contaminants. The limits are based in part on the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs)® which are modified from time to time. These limits are based on protecting workers. Especially sensitive individuals may be affected at lower exposure values. [reference 19]

It should be noted that OELs are higher than actual airborne contaminant levels found in most office type workplaces. A common practice cited by the Alberta Indoor Air Quality Guideline is to use one-tenth of the OEL as an air quality guideline for office and related settings. Three types of limits are recommended: limits for 8-hour workdays, short-term exposure limits (15-minutes) or ceiling (not to be exceeded) limits.

4. ASHRAE Standard 55-2004

The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) publish IAQ standards. Thermal Environmental Conditions for Human Occupancy – ASHRAE Standard 55-2004 recommends temperature, relative humidity, air speed and factors such as seasonal clothing. [reference 20]

5. Health Canada Residential Indoor Air Quality Guideline

A recent guideline for formaldehyde is intended for residential exposures that are of a 24-hour nature. It is used for comparison to office workplaces. [reference 25]

6. Alberta Ambient Air Quality Objectives

These outdoor environmental air quality objectives (air concentration values) are established for specific chemicals for 1-hour, 24-hour or annual averaging periods. [reference 16]

7. Health Canada – IAQ in Office Buildings: A Technical Guide

This guide provides important guidance for IAQ and concentration of indoor contaminants. This technical guide was developed with a Federal-Provincial Working Group on IAQ in the Office Environment. [reference 10]

8. CSA Standard Z412 - Guideline for Office Ergonomics

A Standard developed by the Canadian Standards Association to provide minimum requirements for office ergonomic issues such as lighting. [reference 36]

9. ASHRAE Standard 62.1-2004

The American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) publish IAQ standards. Ventilation for Acceptable Indoor Air Quality – ASHRAE Standard 62.1-2004 recommends minimum ventilation rates and IAQ that will be acceptable to human occupants. ASHRAE 62.1 is intended to minimize the potential for adverse health effects. [reference 21]

10. Health Canada - Changes to Canada's Radon Guideline

Health Canada's guideline on Radon is currently being considered for a potential change and this document provides information on the rationale for the new level. [reference 27]

Section 5: Managing and Correcting IAQ Problems

This section provides information on commonly reported indoor air contaminants as well as other IAQ issues. It will help you identify and eliminate IAQ problems. Other workplace factors affecting IAQ such as temperature, humidity and noise are also included.

Outlined for each contaminant or issue are the source, potential health concerns and acceptable levels. Important tips on how to recognize and assess the issue will help pinpoint the root cause(s). Best practices in managing and correcting problems are also covered.

Common Issues	
Carbon dioxide	Humidity/Moisture
Carbon monoxide	Lighting
Vehicle exhaust emissions	Noise
Volatile Organic Compounds (VOCs)	Mould
Formaldehyde	Allergens and Microbes
Dust (particulates)	Odours
Temperature	Tobacco smoke
	Radon

Carbon Dioxide (CO_2)

Source

Carbon dioxide is found naturally in the air. People are also a source of CO_2. When people breathe, oxygen is inhaled and carbon dioxide is exhaled. The carbon dioxide level builds up throughout the day where there are too many people in a poorly ventilated area.

Health Concern

CO_2 is not a toxic gas. It is primarily an indicator of how well the ventilation system is working. People may experience headaches at concentrations above 1000 ppm.

Levels

The recommended CO_2 level is about 1050 ppm or about 700 ppm higher indoors than outdoors (ASHRAE 62.1-2004). To achieve this level in offices, the recommended outdoor air intake is 5 cubic feet per minute (cfm) per person, plus 0.06 cfm per ft^2.

Recognizing and Assessing the Problem

The normal outdoor concentration of carbon dioxide is around 350 ppm. Generally people exhale carbon dioxide at a rate of 0.3 litres per minute (L/min) while doing light work, which means indoor CO_2 levels will rise above outdoor levels. The carbon dioxide level indoors builds up throughout the workday and peaks in the late afternoon especially in areas with too many people. Complaints about "stale" air or "stuffiness" are more frequent when CO_2 concentrations reach above about 1050 ppm.

Managing and Correcting the Problem

The CO_2 level is a common marker of how well the ventilation system is working. The rate of CO_2 removal from an area is related to the rate of air being removed from the space as well as the rate of fresh air entering the ventilation system from outside. The amount of outdoor air needed is based on the occupancy and the size (area) of the room or space. Keep in mind that the ideal airflow rate varies for different types of facilities based upon the level of activity, since greater activity generates higher levels of CO_2.

- Make sure the HVAC system is properly designed for the size of the space, number of occupants, heat sources and amount and location of contaminant releases
- Increase outdoor air intake to offset higher numbers of people and contaminants produced from other sources
- Make sure air supply and intake openings are not blocked
- Ensure fresh air intakes pull in uncontaminated air

Carbon Monoxide (CO)

Source

Carbon monoxide is a colourless, odourless, toxic gas. It is generated from incomplete combustion of fuel-fired equipment, heating or cooking appliances. It may leak from the flue of gas vents of furnaces, hot water heaters or boilers. It can also be found in tobacco smoke and motor vehicle exhaust.

Health Concern

Carbon monoxide interferes with the blood's ability to carry oxygen, and thus can limit a person's oxygen intake. Short-term exposures below 50 ppm normally do not

cause adverse effects in healthy people. Carbon monoxide causes increasingly severe toxic effects as the concentration and duration of exposure increase. The effects include mild headache (50 ppm and above) to severe headache (above 200 ppm); weakness, dizziness, nausea, fainting (above 400 ppm); increased heartbeat, irregular heartbeat (above 1200 ppm); loss of consciousness and finally death (above 2000 ppm). These symptoms are usually seen sooner or at lower concentrations if there is a heavy workload or if the exposed person has heart disease. Some people may be more sensitive than others to CO in the air, for example, if they are pregnant, have cardiovascular problems, or smoke.

Levels

Levels of CO should be 5 ppm or less - well below the levels that cause health effects.

Recognizing and Assessing the Problem

Install and maintain monitors in areas where CO can be generated: furnaces, gas stoves, gas water heaters

Identify CO sources outside the building such as vehicles left running at loading docks, parking garages and industrial activity. Check to see how closely located these potential sources are to air intake and building entry points.

Managing and Correcting the Problem

- Check CO detectors or monitors to ensure that CO is not present. Ensure ventilation systems are well maintained in areas with a potential for generating CO.
- Make sure all fuel-burning devices are properly installed, used and maintained. Never use portable equipment within a building since these are not properly ventilated.
- Make sure that potential pathways of CO to building areas from adjacent parking garages and loading docks are well sealed, and parking garages are well ventilated to control CO concentration.
- Maintain positive air pressure (if possible) in occupied areas.
- Keep areas around fuel burning devices clear of any items that could restrict air circulation.

Vehicle Exhaust Emissions

Source

Cars, diesel-powered vehicles and diesel generators can generate exhaust emissions. These emissions contain a variety of air contaminants, including carbon monoxide, nitrogen oxides such as nitrogen dioxide, sulfur dioxide, coal tar pitch volatiles, polyaromatic hydrocarbons, and more. These exhaust emissions can be generated inside building parking garages or may enter buildings through outdoor intakes that

are close to these sources. They may also be generated by improperly vented sources inside buildings.

Health Concern

Exposure to vehicle exhaust emissions may cause shortness of breath and irritate eyes, nose, throat and respiratory tract.

Levels

Vehicle exhaust emissions contain a wide range of contaminants that should be avoided. Beside carbon monoxide, the two predominant chemicals in these emissions - nitrogen dioxide and sulfur dioxide - should both be kept below 0.3 ppm, carbon monoxide should be kept below 5 ppm.

Recognizing and Assessing the Problem

The smell of diesel exhaust is very distinctive. Check the possibility that emissions from vehicles and combustion sources may be contaminating indoor air. Investigate the path a source may be taking to get into the building.

Managing and Correcting the Problem

- Ensure ventilation systems are operating properly and are well maintained
- Ensure that pathways of vehicle exhaust to building areas are well sealed and building parking garages are well ventilated.
- Reduce vehicle emissions by turning off engines near buildings.
- Make sure all fuel-burning devices are properly installed, used and maintained.
- Keep areas around fuel-burning devices clear of any items that could restrict air circulation.
- Have combustion appliances routinely inspected and serviced by a qualified person.

Volatile Organic Compounds (VOCs)

Source

VOCs are organic chemicals such as alcohols, esters and petroleum distillates. There are many, many different sources of VOCs including cleaning products, paints, coatings, paint removers, paint thinners, glues, caulking, carpets, photocopiers, air fresheners, perfumes, disinfectants, pesticides, and tobacco smoke.

Health Concern

VOCs are consistently present in higher concentrations indoors (up to ten times higher) than outdoors. At low exposure levels, symptoms include fatigue, headache, drowsiness, dizziness, weakness, blurred vision, skin and eye irritation and general

discomfort. As the exposure level increases, people may experience unpleasant odours, respiratory irritation, tightness in the chest, nausea and confusion. Some highly sensitive individuals may be affected at very low concentrations.

Levels

Keep specific chemical contaminants to one-tenth of their occupational exposure level.

Recognizing and Assessing the Problem

Check the following to assess the potential for VOC release:

- Presence of new building materials, furniture or carpets.
- Recent renovations involving paints, glues, and other products.
- Review MSDS of cleaning or other commonly used products.
- Inadequate local exhaust in chemical storage area.
- Possibility of contamination from other areas in the building or outside air through the ventilation system.
- Manufacturer information on emissions from carpets, office furniture and building materials.

Managing and Correcting the Problem

- Select low-VOC materials. When purchasing new products, ask for information from the product suppliers about VOC content and emission rates.
- Allow new building materials and office furniture to “air out” (off-gas) in a well-ventilated storage area before installing them.
- When installing new materials, such as carpets, try to install immediately before an unoccupied period such as a weekend. Maintain a maximum ventilation rate for at least two weeks (24/7) to help “flush out” emissions and odours.
- Store chemicals such as solvents, paints, cleaning liquids, and paint thinners in a separate storage room with a separate exhaust fan. Make sure there is a separate exhaust fan in photographic and printing rooms.
- Keep containers closed when they're not in use.

Formaldehyde

Source

Many building materials, especially new materials and furnishings, are potential sources of formaldehyde. These items include carpets, particleboard furniture, glues and adhesives as well as burning cigarettes and other tobacco products. Slow off-gassing from these materials can cause a build-up of formaldehyde in indoor air. The

rate of build-up depends on the emission source, the rate of outdoor air intake by the ventilation system, the humidity and the temperature.

Health Concern

Formaldehyde gas is an irritant and respiratory sensitizer. Symptoms of exposure include burning eyes, sore nose and throat, nosebleeds, coughing, headaches, nausea, dizziness, and breathlessness. Some sensitive individuals may notice symptoms at concentrations as low as 0.01 ppm. Formaldehyde is considered to be a known or suspected human carcinogen.

Levels

Levels of formaldehyde should be 0.1 ppm or lower as a guideline. Levels of carcinogens should be kept as low as reasonably possible.

Recognizing and Assessing the Problem

Although formaldehyde has a pungent odour, people may not realize they're being exposed to it because they can become accustomed to the smell. The odour of formaldehyde is not a reliable warning signal for exposure as the odour threshold level for many people is higher than the exposure limit. Have adequate ventilation where potential sources of formaldehyde are present to keep the concentration low.

Managing and Correcting the Problem

- Select products with low formaldehyde emission levels if possible.
- Off-gas new building materials in a storage area before installing.
- Increase the amount of fresh air and airflow in areas of new furniture and carpets.
- Seal potential emission sources with a barrier such as polyurethane varnish.
- Do not recirculate formaldehyde-contaminated air.

Dust (Particulates)

Source

Common indoor sources of dust include humidifier additives, poor housekeeping, inefficient vacuum cleaners, scale, rust, building materials, fungal spores, smoke, duct pipe insulation, carpet fibres, and paper fibres. Outdoor sources include airborne pollutants, construction activity, traffic activity, industrial emissions, and releases from fires and accidents.

Health Concern

The health hazard potential of specific dusts depends on their toxicity and on their particle size.

Excessive levels of dust particles can affect the skin, eyes and respiratory system. Symptoms include irritation of the eyes, nose, throat and skin as well as coughing, sneezing, and respiratory problems.

Levels

Alberta IAQ guidelines recommend keeping total dust levels below 0.1 mg per cubic metre of air (mg/m^3). There are also specific OELs for a variety of dusts. IAQ levels should be kept below 10% of the OEL.

Recognizing and Assessing the Problem

There is the potential for dust in indoor air where there is:

- exposed building material (e.g. concrete, insulating material)
- renovation and retrofit activity
- dust in the air intake
- dust and debris in the air delivery and return dampers
- dusty filters
- dust deposits and/or odours around humidifiers
- dust and dirt build-up around diffusers
- use of personal ultrasonic humidifiers
- cigarette smoke
- handling of dusty materials
- paper shredding machines

Managing and Correcting the Problem

- Use appropriate filters for the air handling system.
- Establish a schedule and routine to:
  - Inspect and change air filters
  - Clean air circulation system
  - Clean areas where dust settles
  - Dust surfaces with a damp cloth or cloth-covered duster. Change cloths often.
- Use local exhaust in areas where there is excessive dust from renovations or movement of materials.
- Provide negative air pressure and local exhaust in smoking rooms.
- Do not recirculate air that contains excessive levels of dust.

- Use a vacuum cleaner designed for use with and equipped with a high-efficiency particulate air (HEPA) filter. Change bags before they become full.
- Use entryway mats at all building entrances. A lot of dirt comes in through doorways and a mat to wipe your shoes will help.

Thermal Comfort (Temperature and Humidity)

Source

"Thermal comfort" means that a person feels comfortable - they are neither too cold nor too warm. It can be achieved when the air temperature, humidity and air movement are within the specified range often referred to as the "comfort zone". Even with ideal conditions cold or warm walls, ceilings or floors can cause local air temperature differences that may cause discomfort. Drafts caused by excessive air movement may also be a factor.

Temporary or permanent changes to the original floor plan can affect the performance of the HVAC system. Factors contributing to poor thermal comfort include thermostats that are poorly situated, set too high or too low, and too few for the space. Sources of radiant heat (very warm or very cold surfaces) such as poorly insulated windows, walls and floors can also cause people to feel uncomfortable as they can create air drafts.

Health Concern

In an office that's too warm, occupants may feel lethargic or tire quickly. An office that is too cold causes occupants to feel restless and easily distracted. Even minor deviation from comfort may be stressful and affect performance. Workers already under stress are less tolerant of uncomfortable conditions, and are less productive.

People's age, activity level, health conditions and clothing vary widely and so do personal temperature preferences.

Levels

Ideally, air temperature in an office should be kept at a range that most people find comfortable. The goal should be to maintain an office temperature that will satisfy at least 80% of the occupants.

The season, relative humidity, clothing and activity level of building occupants may factor into the comfort zone. In summer, temperatures of 23-28 °C are recommended for comfort, while in the winter when relative humidity is closer to 30%, recommended temperatures are from 20-25°C.

Temperature / Humidity Ranges for Comfort			
Conditions	**Relative Humidity**	**Acceptable Operating Temperatures**	
		°C	**°F**
Summer (light clothing)	If 30%, then	24.5 - 28	76 - 82
	If 60%, then	23 - 25.5	74 - 78
Winter (warm clothing)	If 30%, then	20.5 - 25.5	69 - 78
	If 60%, then	20 - 24	68 - 75

Adapted from ASHRAE 55-2004 (reference 20)

Drafts that are caused by excessive air movement can be minimized by maintaining air velocity below 0.2 m/s (40 fpm) and by directing air supply away from occupants (ASHRAE 55-2004 see reference 20).

Maintain workplace airflow so that temperature differences between head and feet of occupants is not greater than 3°C.

Recognizing and Assessing the Problem

You have a possible problem with thermal comfort if:

- occupants complain about feeling drafts or being too hot or too cold.
- portable fans or space heaters are being used. Note their location with respect to diffusers and perimeter heaters.
- there is condensation, frosting or other moisture on windows.

Managing and Correcting the Problem

Try to maintain the workplace environment so that at least 80% of the occupants are satisfied. Consider these other factors:

- Check that thermostats and temperature sensors in HVAC system are working properly.
- Check that setback and setup temperatures are correct. Allow sufficient time before workers start work to have warmed/cooled the workspace.
- Use blinds, perimeter heating and well-insulated windows to reduce warm or cool radiant temperature fluctuations.
- Before reconfiguring an office space, consider the impact on diffuser location and airflow volume.
- Before changing the number of occupants in an office, consider the impact on HVAC performance.

- If possible, provide individual control of at least one of these parameters: temperature, air speed or air direction.
- Use workstation panels/dividers with heights of ~ 1.5 m so that air can circulate throughout the area.
- Insulate hot and cold surfaces such as exposed pipes.
- Wear clothing appropriate for the office conditions.
- Have qualified people such as building maintenance engineers maintain the HVAC system.

Humidity/Moisture

Source

Humidity describes the moisture content in air. It is expressed as percent relative humidity (% RH). Relative humidity of 50 % means that the moisture content of air is 50% of the maximum possible moisture (100% RH) that air can hold at a given temperature. Hot air can hold more moisture than cold air. That is why water condenses on cold water glasses, water pipes and cold windows.

Health Concern

When relative humidity is kept at about 50%, office workers have fewer respiratory problems (specifically in the winter) and generally feel better. Higher humidity makes the office feel “stuffy”. More important, it can contribute to the development of bacterial and fungal growth (especially in sealed buildings). Humidity above 60% may encourage mould growth that might cause health problems.

Humidity lower than 20% causes discomfort by drying out the mucous membranes, contributing to skin rashes. Dry conditions also cause static charge on both office equipment and their users.

Levels

Outdoor Temperature °C	**Relative Humidity %**
- 35	20
>0	30
any	60% maximum
In winter months, humidity may need to be reduced below 30% to avoid condensation.	

Alberta Infrastructure Indoor Air Quality Guideline (reference 18)

Recognizing and Assessing the Problem

Stained or discoloured walls, ceilings, ceiling tiles, condensation around windows, pipes, and on inside surface of exterior walls, problems with doors closing properly and mould growth may mean humidity is too high.

Reports of dry throats, dry skin, chapped lips, dry and itchy eyes, static electricity when walking on carpets or when touching metal surfaces such as door handles, may mean humidity is too low.

Managing and Correcting the Problem

- Increase air circulation or reduce relative humidity to eliminate condensation on cold surfaces. During cold or winter months, the relative humidity may need to be reduced to 20% - 30 %.
- Eliminate cold window surfaces by using triple glazed windows.
- Clean and maintain humidifiers and dehumidifiers regularly.
- Repair leaks and clean up spills as quickly as possible. Clean and dry any damp or wet building materials.

Lighting

Source

Office lighting, whether too much or too little, can affect a person's perception of IAQ. Indoor lighting is a combination of overhead lighting, task lighting and natural daylight.

Health Concern

Although office work has not been proven to cause permanent vision or eye problems, many office workers report eyestrain, a burning sensation in the eyes, blurred vision, eye irritation or dryness, dry eyes and headache. Poor lighting can contribute to stiff necks and aches in the shoulder area from poor or awkward postures when trying to read under poor lighting conditions.

NOTE: Generally, older workers need more lighting than younger workers for the same tasks.

Levels

Appropriate light levels depend on visual preferences and type of work. In general work performed in most office buildings requires 300-500 Lux, but the following chart shows that this light level may vary depending on task.

Recommended Light Levels	
Type of Activity	**Lux* Levels**
Public spaces with dark surroundings	30
Simple orientation for short temporary visits	50
Working spaces where visual tasks are only occasionally performed	100
Performance of visual tasks of high contrast or large scale	300
Performance of visual tasks of medium contrast or small size	500
Performance of visual tasks of low contrast or very small size	1000
Performance of visual tasks near threshold of person's ability to recognize an image	3000-10000

Adapted from IESNA Lighting Handbook. (reference 37)

*Lux = Unit of measurement of light in lumens per square metre

Recognizing and Assessing the Problem

Occupant complaints about headaches, dry or irritated eyes may be an indicator of a problem with lighting. You may need to measure light levels as well as identify possible sources of glare, shadows and improper lighting such as extreme contrasts in brightness. A General Lighting Checklist is available in Appendix C-8 on page 64.

Managing and Correcting the Problem

- Preferably, position workstations away from the windows, or alternatively, position desk with window to the side of the worker.
- Position desk to minimize glare. If you can see the image of the light fixture reflecting from your desktop, you have a glare problem.
- Adjust window blinds or drapes to control light and glare.
- Use non-glare finishes and neutral (not too bright) colours on walls and furniture. The colour and finish of a surface determines how much light it reflects.
- Use appropriate lighting fixture for the task and space.
- Use adjustable task lights to increase light levels when needed.
- Check fluorescent lights for flicker. Replace fluorescent tubes regularly and maintain fixtures properly. Update older fixtures as new electronic ballasts have less flicker.
- Ensure that storerooms, corridors and stairways are properly lit.
- Avoid placing a computer monitor so it faces a window.

Noise

Source

The level of noise in an office varies according to the:

- nature of work performed, including the frequency of telephone calls
- operation and condition of equipment such as photocopiers, printers, and ventilation systems
- material used in floor and wall coverings

Noise from external sources or adjacent offices, businesses and the street may also be a concern.

Health Concern

Generally, the noise in an office environment isn't loud enough to cause hearing loss, but it can be disruptive, reduce productivity, and contribute to stress and discomfort. Intermittent noise and varying levels of noise are more disturbing than continuous noise.

Levels

Guidelines for office environments provide a range of recommended noise levels depending upon the type of workplace: open plan offices from 45-48 dBA, private office areas and conference rooms range from 35-45 dBA. In areas such as call centres, recommended levels should not exceed 50 dBA.

The main objectives of office noise guidelines are to:

- prevent disruption of verbal communication
- prevent discomfort and stress
- minimize interference with concentration in the performance of mental work

Recognizing and Assessing the Problem

Have a qualified person conduct a noise survey to determine sources of noise and possible solutions.

Managing and Correcting the Problem

White noise or sound conditioning is constant background noise that may help open plan offices. The noise conceals sounds from adjacent areas and provides privacy for verbal communication across an office desk.

Other ways to manage noise include:

- Select quiet equipment.
- Ensure that equipment is well maintained.
- Isolate noisy equipment from general work areas.
- Use sound-absorbing materials such as carpeting, curtains, and acoustic baffles.
- Encourage workers to use meeting rooms for discussions.

Mould (fungi)

Source

Microscopic fungi are found everywhere indoors and outdoors and they live on plant or animal matter. They need moisture and food to grow. If there is sufficient moisture, mould can easily grow on building materials such as wood, paper, leather, fabric, insulation, paint, grout, cement, and plaster.

Sources of indoor moisture include floods, backed-up sewers, leaky roofs and plumbing, indoor plants, stagnant water in the HVAC system condensate pans, humidifier and filter units, portable humidifiers, and bathrooms and kitchens.

Health Concern

Not all moulds are harmful. Most people exposed to background levels of mould (similar to outdoor mould levels) remain healthy. People may experience adverse health effects from breathing in spores after mould fragments are disturbed and released to the air. Health effects may include irritation, cough, fatigue and other flu-like or allergy-like symptoms such as runny or itchy nose, nasal congestion, and wheezing. People with allergies or suppressed immune systems may have a higher risk of experiencing health effects. Symptoms disappear over a short time when exposure is reduced to background levels.

Levels

When evaluations find moulds at greater concentrations than outdoors or a specific species that is at higher concentrations, this concentration is an indication of indoor growth. Moulds are measured as Colony Forming Units (cfu) per cubic metre of air.

Generally the levels should be:

- 150 cfu/m^3 (for three or more outdoor fungi species)
- >50 cfu/m^3 (for only 1 species other than *cladosporium* or *alternaria*)
- up to 500 cfu/m^3 (in summer if species are primarily *cladosporium* or other tree/leaf fungi).

Recognizing and Assessing the Problem

You have two ways of identifying that you have a mould problem.

- Visual or odour assessment of mould growth such as musty smells or growth stains or dampness on ceilings, walls, carpets. In some cases investigations within wall cavities or in ceiling plenums may be required.
- Sampling: Sampling for airborne mould is generally not effective in identifying mould issues, but can be helpful when assessing a mould issue that has already been identified. Sampling may help identify mould species and quantities present. Only qualified consultants or specialists should do air sampling.

In addition review and record any reported health issues paying close attention to mapping potential problems and health complaints.

Managing and Correcting the Problem

Clean-up

As soon as possible, clean up mould. Contaminated surfaces should be cleaned with a dilute bleach solution (250 mL of bleach in 4 L of water). Depending upon the amount of mould growth, a qualified specialist may be required for assessment, clean-up, and decontamination. Only trained workers with proper equipment, control procedures and personal protective equipment should attempt to clean up mould, as there are potential health hazards from exposure.

Special step-by-step clean-up procedures are available (see Appendix C-1 on page 53 for Mould Cleanup Guidelines). There are four main clean-up phases:

1. Properly train workers doing the clean-up and provide them with appropriate personal protective equipment (e.g. clothing, respirators).
2. Clean or remove contaminated materials, taking precautions to avoid spreading spores and dust to other areas. Dispose properly according to provincial or local guidelines.
3. Decontaminate the HVAC system if necessary.
4. Repair and replace damaged materials such as wallboards, ceiling tiles, baseboards.

Controlling moisture is key to preventing indoor mould growth. Keep relative humidity at 20-30% in winter and no more than 60% the rest of the year.

Eliminate Sources of Moisture

- Stagnant, dirty water in condensate pans, sumps, humidifiers and filter units
- Wet carpets or furnishings resulting from leaks, spills and storm damage
- Areas with mouldy or musty odours, or visible mould growth.
- Condensation on windows/walls from too high humidity, which could occur due to poor air circulation and/or colder walls.

Indoors

- Fix plumbing leaks, drips and “sweating pipes”.
- Limit sources of indoor humidity: dehumidify indoor air.
- Improve air movement in poorly ventilated areas.
- Increase amount of fresh air when outdoor air is not humid.
- Insulate areas where dampness or condensation can occur.
- Warm cold surfaces where condensation may occur.
- Change or wash filters and disinfect or refill water reservoirs regularly.

Outdoors

- Maintain roof and gutter/downspout system.
- Direct runoff away from foundation by grading, drain tiles, and/or landscaping.

- Use air conditioning and keep building closed during high outdoor humidity.
- Prevent leakage around windows, doors, and flashing.
- Waterproof foundations.

Allergens and Microbes

Source

Allergens can include a wide range of items such as microscopic living organisms (including bacteria, viruses, and parasites), or insect and animal allergens (including dust mites, cockroaches, cats, dogs and birds).

Dust mites are part of the spider family. Mites survive and grow in warm and humid areas (RH greater than 60%) with a sufficient supply of food such as human skin scales. Animal dander is loose skin cells (i.e., dandruff) from animals such as dogs and cats. People may bring dander into a workplace on their clothing. In the workplace carpets, fabric and foam chairs provide a source of food for dust mites.

Microbial growth such as fungal spores, moulds, and bacteria can cause respiratory illness and allergies. Wet areas due to leaks or floods—carpets, ceiling tiles, walls, or insulation or sites with high humidity or stagnant water are possible sources of microbial growth. Dirty and dusty areas containing animal (rodent or pigeon) droppings can also be a source of respiratory illness.

Health Concern

Various allergens can cause a range of respiratory problems for those sensitive to them, resulting in allergic and asthma-like reactions. Some individuals are hypersensitive to allergens and show health symptoms at very low exposure levels.

Sensitized building occupants who inhale allergens may experience asthma attacks, sneezing, runny and itchy nose, swelling, coughing, wheezing, or a combination of these symptoms.

Though not common, some microbes such as Legionella bacteria can cause severe respiratory illness such as pneumonia or flu-like fever. Hantavirus from rodent droppings or Psittacosis from bird droppings can also cause severe illnesses.

Levels

Currently there are no specific guidelines outlining an acceptable level of allergens. It is a good practice to keep levels as low as possible. Microbes should be avoided in the workplace.

Recognizing and Assessing the Problem

Check the workplace for cleanliness and for openings in walls where insects and animals may enter. Are dead insects/rodents/birds or their droppings visible?

If building occupants are allergic to cats and dogs, are these animals being brought onto the premises? If these animals were present in the recent past there may still be latent allergens present in carpets and furnishings.

Consider how often allergy-like symptoms are reported and locate possible areas of concern. Determine if the vacuum cleaner used to clean carpeted areas is equipped with a HEPA-type filtration system. If not, it may be spreading dust and dander back into the area with exhaust air.

Check cooling towers and evaporative condensers for cleanliness and water quality. Check that water treatment systems are working effectively. Check that there is no re-entrapment of moisture from air cooling systems back into the fresh air intakes.

Managing and Correcting the Problem

- Thorough housekeeping and routine maintenance programs reduce the likelihood of allergens in the workplace.
- Prevent microbial growth by removing stagnant water, cleaning up spills and leaks and ensuring that wet areas are cleaned up immediately.
- Clean and decontaminate microbial or mould-contaminated sites immediately.
- Change or clean filters in the heating/cooling system regularly according to manufacturer's specifications, usually stated as a pressure drop. Carefully discard disposable filters in sealed bags or containers.
- Ensure that water treatment in cooling towers and condensation units is effective and there is no microbial growth. Monitor water quality regularly. Ensure water systems are flushed regularly to prevent water stagnation.
- Use vacuum cleaners equipped with HEPA-type filtration systems. Clean up dusts, food spills and other waste frequently.
- Ensure that insects and animals are eliminated from building areas. If droppings are visible, avoid dry sweeping or brushing. Vacuum using HEPA filters and ensure all persons involved in the clean up wear gloves and masks.

For more information see resources on:

Hantavirus http://www.ccohs.ca/oshanswers/diseases/hantavir.html

Legionnaires' Disease http://www.ccohs.ca/oshanswers/diseases/legion.html

Psittacosis http://www.ccohs.ca/oshanswers/diseases/psittacosis.html

Odours

Source

Sources include personal care products, perfumes, cleaning products, office products, building materials, food products, body odours and odours from outside sources (air pollution, emissions from neighbouring buildings).

Health Concern

Sensitivities to odours can vary significantly from person to person. Odours can be bothersome and cause discomfort. Some common symptoms include headaches, nausea, loss of appetite and upper respiratory symptoms.

People with allergies and asthma report that certain odours - even in the smallest amounts - can trigger an attack.

The severity of these symptoms can vary. Some people report mild irritation while others are “incapacitated” and/or must give up many “normal” activities to avoid exposure.

Levels

A general guideline to use is that fewer than 20% of workers should find odours objectionable. So if more than 20% of workers surveyed indicate a problem, a solution should be identified.

Recognizing and Assessing the Problem

Conduct a survey of workers to assess the extent that odours and scents cause health concerns.

Managing and Correcting the Problem

- Use scent-free cleaning products and discourage the use of fragrances in the workplace.
- Consider implementing a scent awareness or reduction program in the workplace.
- Encourage people to prepare and/or eat food products in a lunchroom or cafeteria.
- Reduce emissions from building materials and cleaning products.

Tobacco smoke

Source

Cigarettes, pipes, cigars

Health Concern

Tobacco smoke contains a wide range of compounds including toxic dusts, carbon monoxide and volatile organic compounds (VOCs). It is classified as carcinogenic (cancer causing). The effects of environmental tobacco smoke (ETS) on office building workers include:

- Short-term effects include annoyance, discomfort, coughing, sneezing, breathing problems, throat and eye irritation.
- Long-term effects include increased risk of lung cancer.

Levels

As a carcinogen, no level of tobacco smoke is recommended in the workplace. Try to eliminate, or at least keep tobacco smoke as low as possible.

Managing and Correcting the Problem

1. Alberta's Smoke Free Workplace Act requires that many Alberta workplaces be smoke-free if minors are permitted. In addition, local laws may prohibit smoking in certain buildings. In some jurisdictions, law requires designated smoking rooms with separate exhaust to the outdoors. Designated smoking rooms prevent tobacco smoke from mixing with the building's air and reaching all occupants.

   A designated smoking room should also:

   - Have a sign that meets the requirements of the applicable legislation.
   - Exhaust air to the outside without recirculating air to any workspace.
   - Meets design requirements set out in the legislation applicable to your workplace. If there are no regulated requirements, ventilate smoking rooms in accordance with ASHRAE 62.1-2004.
   - Have ashtrays and non-combustible, covered waste containers.
2. Keep smoking room doors closed.
3. Only stay in smoking rooms as long as necessary.

Radon

Source

Radon is an invisible, odourless and radioactive gas. Radon occurs naturally in rock, soil and groundwater. Radon can enter buildings through cracks in the foundation or very slowly through basement walls. Radon can accumulate in indoor areas that have poor air circulation such as basements or crawl spaces.

There is generally a lack of information on radon prone areas in Canada.

Health Concern

Radon breaks down into other radioactive by-products that can be inhaled into the lungs. This exposure can cause an increased risk of lung cancer. Work areas in basements or located on foundations above soil may contain radon gas.

Levels

Health Canada currently has a guideline that recommends remedial action be taken when the air in the living area of a home reaches 800 becquerels per cubic metre (Bq/m^3). Recent scientific evidence has shown that there is a measurable risk of lung cancer at much lower radon levels. Health Canada is currently proposing to lower the action level to 200 Bq/m^3 and extending the guideline to schools, hospitals, and other residential type facilities. [reference 27]

Recognizing and Assessing the Problem

Radon levels are greatly impacted by the presence of uranium in the region and by soil characteristics, foundation conditions and rate of indoor ventilation. Workplaces in buildings that have adequate circulation and are located above ground level would have very low levels of radon. Simple methods for radon testing for homes are described in a guide from the Canada Mortgage and Housing Corporation (CMHC). Only qualified people should conduct air sampling in the workplace. [reference 51]

Managing and Correcting the Problem

A guide from the CMHC provides suggestions on how to manage radon levels. The options are:

1. Close major entry routes in the foundation that allow radon gas to enter, such as open sump pumps, floor drains, exposed soil, and voids in the concrete block walls.
2. Reduce negative air pressure in the building so that gas is not drawn up from the basement into the building. A well-functioning HVAC system can ensure positive pressure in the building.
3. Other methods include:
    a. "Active soil depressurization". This method involves drawing air out from under the foundation, lowering the pressure in the surrounding soil and preventing the soil gas from entering the home. This effective and reliable radon reduction technique may require the assistance of a skilled contractor.
    b. Reduce emission from the ground into the building by caulking and sealing cracks and holes in basement floors and walls. Painting basement floors and wall surfaces using epoxy paints may also minimize cracks.
    c. Increase ventilation in basements and other enclosed areas.

For more information see the CMHC *Radon – A Guide for Canadian Homeowners* – reference 51 and Health Canada's document on *Radon Mitigation* reference 52

Section 6: HVAC Primer

What is HVAC?

HVAC stands for Heating, Ventilation and Air Conditioning system. Office buildings rely on a properly designed and functioning HVAC system to:

- provide temperature and humidity control
- distribute adequate amounts of fresh outdoor air
- control odours and indoor air contaminants

How does HVAC work?

In general, the HVAC system:

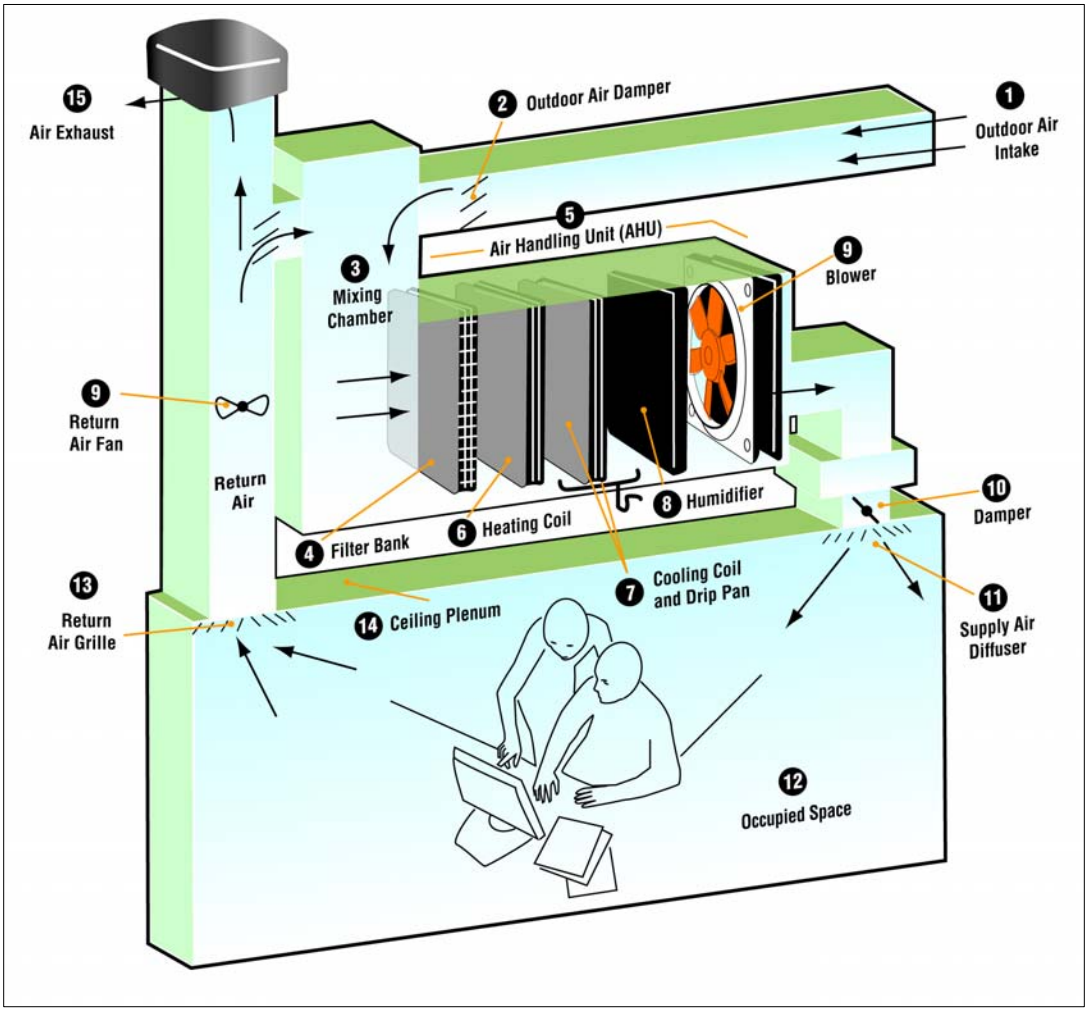
- brings fresh outdoor air into the building
- cleans and filters the air
- heats or cools the air
- humidifies or dehumidifies the air
- distributes an adequate amount of outdoor air to the building
- removes used air from the occupied space
- exhausts a portion of the return air outside the building, recycles the remaining air

What are the main components of an HVAC?

The HVAC system has many interconnected parts throughout a building such as intakes, filters, ducts, and fans that work together to move air into, around and out of rooms. A key feature of the HVAC design is that it delivers the right amount of air to each room in the building to achieve a balanced system.

1. **Outdoor Air Intake** - Where fresh outdoor air enters the building.
2. **Outdoor Air Damper** - Adjustable barrier that limits the amount of air being brought into the building.
3. **Mixing Chamber** - Area where outdoor air is mixed with air returned from the occupied space, and recirculated.
4. **Filter** - Removes large dust particles, bugs, feathers, and leaves from air before the air is distributed to the work areas.
5. **Air Handling Unit (AHU)** - Includes the blower or fan, heating and/or cooling coils, and related equipment such as controls, condensate drain pans, and air filters.
6. **Heating Coil** - Heats the air if needed.

7. **Cooling Coil and Drip Pan** - Cools the air if needed; drip pan catches water that is produced during the air-cooling process, and drains into the wastewater system.



Adapted from the IAQ Investigator's Guide, E.Gunderson 2006

8. **Humidifier or Dehumidifier** - Adds or removes moisture to or from the air as required to adjust the relative humidity of the building.
9. **Blowers or Fans** - Push (supply) or pull (exhaust) air through system; control flow to various parts of the building.
10. **Damper** - Adjustable barrier that limits air flowing into a space.
11. **Supply Air Diffuser** - Distributes the vented air throughout the occupied space.
12. **Occupied Space** - Where people are working or eating.
13. **Return Air Grille** - Removes air from work area and returns it to the system.
14. **Ceiling Plenum** - Space above the suspended ceiling that may be used as a part of the air return system.

15. **Air Exhaust** – A portion of the air removed from the occupied space is exhausted outside the building, while the remaining air is recycled back into the system.

The following practices for your HVAC will help to maintain good IAQ. They are based on IAQ standards for managing IAQ cited in Section 4 on page 13.

Good Practices for Operations and Maintenance of HVAC Systems	
Outdoor air	❑ The building should be kept under a slight positive pressure if possible (draw slightly more outdoor air into the building than escapes or exhausts). Positive pressure limits drafts or intake of contaminants and helps maintain good airflow. ❑ Ensure that at least 15% of air flowing into the system is from outdoor air (set dampers accordingly). ❑ The outdoor air requirement depends in large part upon the number of building occupants. There are guidelines with formulas to determine these requirements and they are expressed as airflow rates of outdoor air. For example, an office space of 100 m^2 containing 5 people requires a minimum of 17 cubic feet per minute of outdoor air per person or 8.5 litres per second per person. HVAC specialists can test and adjust these rates.
Operating schedules	❑ HVAC systems are usually shut down overnight and on weekends to save energy. Before regular work hours a "flushing cycle" operates to remove indoor air contaminants and to bring air to the proper temperature and humidity. The number of air changes depends on the length of the shutdown period and other factors.
Air movement	❑ Four air changes per hour provide gentle air movement and continuous dispersal of contaminants. Excessive air movement may cause people to feel drafts or chills. Maintain air velocity below 0.2 m/s (40 fpm). ❑ Good air circulation helps ensure temperature within a room is consistent (no hot/cold spots); the difference between floor and ceiling temperatures should not be more than 3 °C.
Special areas	❑ Areas with higher contaminant levels should be designed to exhaust air directly outdoors. These areas include photocopy rooms, bathrooms, kitchens, parking garages, loading docks, print shops, janitorial closets, and some storage areas (e.g. for paint or chemicals).
Carbon Dioxide (CO_2)	❑ Indoor carbon dioxide levels at the start of work hours should be close to outdoor levels, about 350 ppm. Adjust the HVAC system during work hours so that CO_2 levels do not exceed 1050 ppm.
Temperature and Humidity	❑ Maintain the indoor temperature between 20-23.5 °C in the winter and 23-26 °C in the summer. ❑ Maintain the relative humidity of indoor spaces between 30% and 60%. ❑ During winter months, humidity levels can be adjusted to about 30% to reduce window condensation. It may be necessary to go as low as 20%.
Balanced system	❑ Ensure the correct volume of air is delivered to all locations in a building to provide adequate air quality.

Thermostats	❑ Ensure that thermostats are functioning, calibrated, correctly located, and not obstructed or enclosed.

Reference: ASHRAE 62.1-2004 [reference 21] and ASHRAE 55-2004 [reference 20]

Tips:

- Zone control to deal with changing temperature and humidity needs is important. For example, a south-facing sunny location can have more cool air supplied to it, or a north-facing one can have more heated air supplied to it.
- There is a fine balance between energy conservation (e.g. keeping electricity costs low) while maintaining good IAQ and being able to provide occupants with a healthy, comfortable, and productive workplace.
- Personal heaters and/or humidifiers at work areas will confuse the HVAC system's sensors and lead to inaccurate adjustments of the temperature and/or humidity in an area.

Did you know?

Legionnaires' disease is caused by *Legionella* bacteria growing in water temperatures of 25-45°C with a nutrient supply (algae and organic matter).

The bacteria can infect people through contaminated water droplets entering the ventilation system.

Prevent this disease through proper HVAC maintenance particularly in cooling towers.

How do I properly maintain the HVAC?

Preventive maintenance and prompt repairs to the HVAC system are important for the system to operate correctly and contribute to good IAQ. A well-implemented preventive maintenance plan improves the functioning of the mechanical systems and saves money over the long term.

HVAC equipment that requires preventive maintenance

- controls and sensors
- outdoor air intake
- damper controls
- air filters
- drip pans
- cooling and heating coils
- humidification equipment and controls
- distribution systems (e.g. air ducts)
- exhaust fans and blowers
- fan belts

Good Maintenance Practices	
General Practices	• Regularly inspect and keep all equipment and controls in proper working order according to manufacturer's recommendations. • Use good quality maintenance equipment and replacement parts that are suitable for the intended function. • Keep interior of equipment and ductwork clean and dry. • Prevent the accumulation of stagnant water anywhere, especially in and around HVAC system mechanical components, such as under the cooling coils of air handling units, condensate drain pans and water towers. • According to manufacturer’s directions, regularly clean and disinfect surfaces that normally become wet to prevent the microbial growth. • Contaminated surfaces should be disinfected while the building is vacant. • Document your preventive maintenance program to ensure that no steps are missed and to have as a reference if IAQ complaints arise. • Have qualified personnel adjust and calibrate control system components (sensors, thermostats, time clocks, dampers and valves).
Cleaning	• HVAC systems should be turned off during cleaning operations, which should be scheduled during weekends and unoccupied periods.
Leaks	• Investigate any dampness on walls, windows and ceiling. • Repair all external and internal leaks promptly and permanently. Dry out area immediately and remove any materials that are wet.
Air Filters	• Replace filters on a regular basis to prevent fungal growth and build-up of dust and particles.
Ceiling Plenum	• Keep space above ceiling tiles clean and free of debris and loose material.

Mechanical room(s)	• Ensure that the mechanical room containing the HVAC system is clean and dry. Dirty conditions are a problem if unducted return air is dumped into and circulated through the mechanical room and then back throughout the building.
Humidifiers	• Drain humidifiers and clean with chlorine bleach at intervals of 2-4 months. Fill humidifiers with drinking water. • Check and repair blocked nozzles and broken pumps. Drain stagnant, dirty water. These conditions can lead to microbial growth. • Remove rust and mineral deposits from HVAC system components once or twice a year.
Drip pan	• Ensure that drip pans under cooling coils have effective drain lines so that water drains completely leaving no standing water.
Ducts	• Ensure ducts are tightly sealed (leakage rate of less than 3%).
Combustion Sources	• Ensure proper burning in stoves and furnaces and exhausting of waste combustion gases so gases are not re-circulated throughout the building.

Common HVAC Problems and Solutions	
Problem	**Possible Solution**
Building air is stuffy or dusty	❑ Ensure sufficient outdoor air is entering building. ❑ Ensure system is mixing air completely and properly distributing air throughout work areas and the HVAC system is properly balanced. ❑ Ensure vents are not blocked and that all dampers work properly to prevent blocked airflow. Replace air filters regularly. ❑ Keep all diffusers and return grilles clean and unblocked, and ensure they are not so close together as to short-circuit air flow in the room. ❑ Ensure office layout is not hindering airflow. ❑ When space is reorganized or number of occupants has changed (e.g., an open common area is converted to offices with many cubicles), re-evaluate the airflow requirements to the redesigned space. ❑ Ensure good workplace housekeeping to maintain airflow around thermostats or wall or floor-mounted registers.
Poor air flow	❑ Ensure filters are cleaned regularly and are never overloaded. ❑ Match filter to equipment recommendations and expected airflows (e.g. low efficiency vs. high efficiency filters). ❑ Check if the design of filtering system matches current use and needs of occupants.
High carbon dioxide levels	❑ Ensure that the flushing cycle is operating to change indoor air prior to work hours. ❑ Ensure sufficient outdoor air is entering building during operating hours. ❑ Evaluate current occupancy rate and determine appropriate air flow rates.
Microbial Growth (mouldy odours, visible mould, bacterial growth)	❑ Remove water sources or accumulations that encourage microbial growth. ❑ Ensure that the vapour barrier on fibreglass used to line ducts and air-handling units is intact, dry and clean. If it is wet or dirty, remove and replace it. ❑ Ensure that fungal growth, if detected, is properly eliminated. ❑ Ensure the humidification system and cooling system are properly cleaned and maintained.

Appendix A: Evaluating IAQ Consultants

It is possible that you may not be able to resolve IAQ complaints on your own. In this case, the next step may be to bring in an IAQ consultant to determine if they can find the source of the problem and a practical solution.

You should know the problem and types of questions that you want answered before talking to an IAQ consultant. Think about your expectations, needs and requirements.

This Appendix will help you select the right IAQ professional for your needs.

Find a Consultant and Examine their Qualifications

To find a consultant, you can contact local area professional associations or use the Work Safe Alberta consultant directory [http://www.hre.gov.ab.ca/whs/network/condir/]. [Note that the presence of a consultant on this list does not mean that they are approved or sanctioned by the Alberta Government.]

Ask these questions:

A. Do they or their staff have certification by a recognized national or international organization? Possible certifications include:

- Registered Occupational Hygienist (ROH)
- Certified Industrial Hygienist (CIH)
- Occupational Health and Safety Technologist (OHST)
- Registered Occupational Hygiene Technologist (ROHT)
- Certified Public Health Inspector of Canada (CPHIC)
- Association of Professional Engineers, Geologists and Geophysicists of Alberta (APEGGA)

B. Do they have appropriate training and project experience? For example, if you need help with mould, do they have training and experience with mould?

C. Ask for references and contact former clients to verify that the consultant helped to resolve their IAQ issue.

D. Does the consultant have a financial or other stake in the results of the testing? Consultants should not be biased towards a solution benefiting new work for their own company.

Select the Consultant and Establish a Plan

Depending on the scope of the IAQ testing you need and your time-frame, you may wish to interview consultants either in person, by phone or by issuing a *Request For Proposal* and establishing a contract.

In establishing a contract you will want to:

- Clarify your needs and expectations
- Discuss the types and locations of tests
- Identify a time schedule and completion date for your report
- Require a project cost or estimates
- Establish reporting requirements, including status reports and final written report
- Ask for a meeting to summarize the results of the work and to ensure that the results of the report are clearly communicated to workplace parties.

Questions to Ask About Air Sampling

You can prepare a checklist of questions about the plan for air testing, the sampling methods and the analysis. The questions listed below are all standard questions for an IAQ consultant and should be easy for them to answer. Review the answers and if you are in doubt about what they mean – ask questions of your consultant until you understand what is being tested and why. The methods, equipment and analysis method should refer to well-established standard sampling procedures (e.g. OSHA, NIOSH).

Many of the questions listed are very technical; however, it is important that the sampling report provide these details for future reference. These details will ensure that the test methods are clearly identified and will help determine that the sampling and testing was done properly and reliably. The report can also be used in the future, or provided to another consultant for a second opinion.

Sample Questions to Ask
The sampling plan • What is being sampled and why? Note: if a particular building area is the problem, ensure that area is identified for testing in the plan. • How will the testing be done? What number of samples will be taken? • Are there any guidelines or limits for these contaminants?
You can ask that the report identify: • Sampling method and equipment being used • Analysis method

After the testing is complete, ensure these details are provided in your report:

Air sampling documentation

- Who did the sampling and analysis? Are there any limitations to these?
- Were true and blank samples used as controls?
- Under what conditions were tests conducted, e.g. crowded office, no ventilation?

Air contaminants

- Are the air contaminants being sampled identified by name?
- Can you match sampling results to workplace locations?

Method

- Is the sampling method an "approved" method (e.g. OSHA, NIOSH)?
- Is the type and model of the equipment identified?
- Is there documented "calibration" before and after the sampling? Calibration ensures that the testing equipment was set up properly.
- Was the sampling time noted?

Analysis

If air sampling for contaminants is done, the analysis has to be done correctly so that contaminants and their concentration in the air are accurately indicated.

- Is the laboratory that did the analysis accredited to analyze this type of contaminant? Accreditation could be by the American Industrial Hygiene Association (AIHA) or the Canadian Association For Environmental Analytical Laboratories (CAEAL) or another organization.
- Is the analytical method an "approved" method (e.g. OSHA, NIOSH)?
- Were true and blanks samples included?
- Are all the results listed in the report and compared to the standards and guidelines?

Note: In situations where direct reading instruments are used to take readings the results of tests will still be reported and analyzed.

Recommendations

Recommendations about taking specific actions are important to correct the workplace problem. Make sure that you understand the sampling results and the recommendations being suggested before taking further actions.

- What future actions are recommended?
- If no 'cause' for your IAQ problem is identified, what are the next steps?

Appendix B: Air Testing & Sampling Instruments

If you have to test the air, this guide provides information on how it is done. There is no single test or instrument that can check for all possible contaminants. In fact different types of air contaminants have specific procedures for their sampling and analysis. The following are some common types of instruments used to take air samples and measurements. You should be aware of issues related to their use and limitations for detecting contaminants. If you have air sampling done, you can compare the results against the levels noted in the standards and guidelines listed in Section 4 (page 13).

Note: Only trained personnel should conduct air sampling and testing.

Direct-reading Colorimetric Tubes 	
Measures	Nitrogen Oxides (NO and NO_2) Carbon Dioxide (CO_2) Carbon monoxide (CO) Formaldehyde Volatile Organic Compounds (VOCs) and others
Process	A quantity of air is drawn by an air pump into a small glass tube. The tube contains a reactive compound that darkens or changes colour with contact with the specific contaminant. The length of coloured stain in the tube (graduated marks on side of the tube) corresponds to the concentration level of the contaminant detected in the air.
Issues	Tubes are inexpensive tools for quick air quality surveys but not reliable for low levels of contamination typical of offices. If air quality contamination is fairly high and are detected by the tubes, the level may be fairly reliable. (+/- accuracy of 25%) Low levels of air contaminants may not be a meaningful result due to inaccuracy of this method for low concentrations (+/- accuracy of 25%).
Tip	Ask if low levels of contaminants will be detected with these tubes. Ask if the “error margin” makes this test unreliable for the amount of contaminant detected?

Direct-reading Portable Monitors	
Measures	Carbon dioxide (CO_2) Carbon monoxide (CO) Volatile Organic Compounds (VOCs) Formaldehyde Temperature Humidity Other substances (such as hydrogen sulphide, lead, or mercury)
Process	A known volume of air is drawn through the equipment. The sensors are capable of detecting specific contaminants in the air. The sensors are also capable of detecting relative humidity and air temperature.
Issues	Expensive equipment that must be in good working condition. Must “calibrate” before and after use or data is useless. Note: Only a trained person should use these instruments.
Tip	Proper calibrations before and after testing ensure the machine is working properly. These calibration tests must be included in the report to ensure accuracy. (Imagine a weigh scale at home that isn’t zeroed, and ends up reading 100 pounds with a 200-pound weight).

Air Samplers	
Measures	Formaldehyde VOCs Other substances
Process	Commonly these samplers capture air contaminants (sometimes with an air pump and sometimes without) into a collection device containing a material that absorbs the contaminant. This material is then analyzed in a laboratory using a standard method to determine the type and amount of contaminant present.
Issues	Very accurate method Analysis of contaminants requires expertise and time.
Tip	Calibration of the volume of air sampled over time must be done before and after sampling or the calculated amounts may be inaccurate. This information should be available in the consultant's report.

Smoke Tube	
Measures	Air motion, circulation
Process	A puff of visible smoke shows air flow and direction.
Issues	Quick and inexpensive test. The test provides 'qualitative' results, allowing a description of air movement not a measurable value. Smoke allows you to visualize air flow patterns in the workplace (e.g. to track where exhaust is moving). If the smoke doesn't move then there is no air flow.
Tip	Do these tests in areas with complaints of poor air circulation or drafts. This test also shows air flow that is 'short-circuiting' (moving from air supply to air return without mixing with room air). Care should be taken in using this tool, as some people are sensitive to the smoke generated from these tubes.

Thermal Anemometer	
Measures	Air speed, air flow and temperature
Process	Air runs across the sensors to give readings.
Issues	Immediate readings. Skill is needed to use this machine properly. Typically it can be used to calculate the number of room air changes and the speed of air flow in various parts of the room.
Tip	A number of measurements must be taken of air flowing into the room from the supply air diffuser to calculate room air changes. Note: Only a trained person should take these measurements.

Direct-reading Dust Sampler	
Measures	Dusts Fumes Smoke Spores Fibres Other substances
Process	Monitors air and measures “particles” with instant results. Inlets can select for different sized particles.
Issues	Good for workplace surveys where there is concern about dust being generated in specific areas. May cost more than other tests. Note: Only a trained person should take these measurements.
Tip	This test is most relevant to areas of the building that have dusty processes. If dust levels are high and the process cannot be modified, a local exhaust system may be a recommended option.

Microbial Sampling	
Measures	Fungal spores Bacteria
Process	A measured amount of air is collected. The microbes collected from the air sample are then grown on specific types of growth media (different food for different microbes). The microbes that grow (colony forming units or CFUs) are expressed as CFUs per cubic metre.
Issues	Proven expertise in microbial sampling and analysis is required. This analysis takes time and results are not always very helpful in determining if there is a problem.
Ask	Does the number and type of indoor microbes resemble outdoor microbes? If they don't, there could be a problem in the building or HVAC system.

Appendix C: Checklists, Forms, Resources

List of Resources in this Appendix

Appendix C-1: Removing Visible Mould

Important:
Only fully trained personnel should proceed to clean up mould, even when growth is in the Minimal to Moderate size areas. Mould growth at levels meeting the Large and Extensive area definitions should be handled by experts only. Control measures and PPE are provided for information only.

Guidelines for Removing Mould Growth in Indoor Areas		
Surface Area Covered by Visible Mould	**Control Measures to Prevent Spread of Dust or Spores**	**Minimum Recommended PPE Use NIOSH-approved PPE**
Minimal Areas up to 1 m^2	Contain mould: Remove contaminated material with minimal disturbance of dusts and spores. Place materials in a plastic bag and seal. Small areas can be cleaned with bleach solutions.	N-95 type respirator, gloves, and eye protection
Moderate Areas of 1 m^2 to 3 m^2	Isolate the work area – stop others from approaching these areas. Wet wipe or mist contaminated surfaces with water containing a surfactant (wetting agent). Remove or clean as necessary. Use drop sheets to limit the spread of dust and spores. Ensure procedures and facilities for decontamination and personal hygiene are planned and implemented.	N-95 type respirator, gloves, and eye protection
Large to Extensive Areas Areas above 3 m^2	**Use trained health and safety professional and trained remediation personnel only.** Experts may be required to fully contain areas and put affected areas under negative pressure to contain the spread of dusts and spores. Decontamination facilities and personal hygiene are also required.	Full-facepiece HEPA filter cartridge respirator, gloves, and disposable coveralls covering head and shoes.

Adapted from: WorkSafe BC OHS Guidelines – Moulds and Indoor Air Quality (reference 50)

Appendix C-2: Sample Worker Complaint Form

Indoor Air Quality - Worker Complaint Form
Name:
Location (department, area, or room):
Reported Health Symptoms:
Time and Frequency of Symptoms:
Suspected Cause(s):
Recommended Action (to be filled in by employer/investigator):

Appendix C-3: Sample Inspection Checklist for IAQ

Inspection Checklist	
Inspector(s)	
Location/Department:	Date:
✓ Satisfactory	**X** Unsatisfactory, requires attention

GENERAL OBSERVATIONS

Walls, Ceilings and Floors

Walls, ceilings and windows free of mould
Indoor plants free of mould and odour
Flat surfaces dust free
Thermostats in enclosed offices
Cleanliness of shower facilities and washrooms

Open-Concept Offices - cubicles

Screen heights (max. 1.5 metres)
Screens do not touch floor

Diffusers

Diffusers are unobstructed
Diffuser condition (mould, dust, dirt)

Air Exhaust Louvers

Louvers are unobstructed
Louver condition clean (mould, dirt, dust)

Pollutant Sources (~3 metres from work areas)

Photocopiers
Chemical storage/handling area
Smoking room
Paper storage and handling areas
Number of building occupants

CARBON MONOXIDE (CO) SOURCES

Air does not enter building from:
parking garage
loading dock
other (describe)

Condition/location of indoor CO sources:

gas stoves, heating and other appliances
gas fired heating system
free standing gas heaters
other (describe)

_____

VOLATILE ORGANIC COMPOUNDS

Cleanliness/condition/location of:
chemical laboratories
chemical storage areas
new plywood, particle board shelving

CIGARETTE SMOKE

Smoking policy in place/enforced

VENTILATION SYSTEM (HVAC)

Adequate outdoor air intake
Air intake clear of pollution sources
Cleanliness of ducts and plenum
Ventilation shut-down (nightly/weekends)
Air filter condition

HUMIDIFIERS

Pans and wetting media are free of slime
Ducts free of mould
Fans free of hard water deposits
Volatile chemicals used for humidifiers

AIR CONDITIONING SYSTEM

Condensate trays free of slime
Cooling coils free of slime
Absence of mouldy odours

GENERAL MAINTENANCE, DESIGN

Windows can be opened
Alterations to ventilation system
Number of occupants in area
Usage/condition of carpeting
Work areas repainted
Presence of odours

Appendix C-4: Sample Health Survey

Health Survey - Confidential	
Name:	Department/Position:
Survey Date:	Interviewer (if applicable):
Work Location / Building Area	
Background Information:	
How long have you been working for your employer? _____ Yrs.	
Where do you spend most of your time at work?	
Have there been any changes in the office recently? E.g.: new location, renovation, cleaning	
Symptoms & Patterns:	
Check all the symptoms or discomfort you are experiencing:	

❑ Headache
❑ Nausea
❑ Dizziness
❑ Tiredness / fatigue
❑ Irritation of eyes, nose, throat
❑ Breathing Problems
❑ Coughing
❑ Sneezing
❑ Wheezing
❑ Shortness of Breath
	❑ Blurred Vision
	❑ Sinus Congestion
	❑ Difficulty in concentrating
	❑ Pain and discomfort of:
	  ❑ Back
	  ❑ Neck
	  ❑ Hands
	  ❑ Wrist
	  ❑ Shoulders
	❑ Other _____

Do you have any other health conditions that may make symptoms worse? E.g.: allergies, immune system disorders, or chronic cardiovascular or respiratory disease	

Health Survey - Confidential

Have you seen a doctor for these symptoms? 1 Yes 1 No

(Do you wish to provide general details?)

Timing:

When do you notice these symptoms and how often do they occur?

On average, when you notice the symptoms, how long have you been at work?

1 Less than 1 hour 1 2-4 hours 1 > 4 hours 1 1 day 1 After __ days

Has there been any change to the symptoms or patterns? 1 Yes 1 No

If yes, please explain:

When do the symptoms go away? 1 Overnight 1 After a week away 1 Rarely/Never

Can you provide more information?

Has the pain or discomfort caused you to take time off work? 1 Yes 1 No

Are you aware of other people with similar symptoms or concerns? 1 Yes 1 No

If yes, can you provide more details?

Suspected or Potential Causes:

Check any of the following that are true:

- ❑ Are there any unusual odours?
- ❑ Does the air seem stuffy?
- ❑ Is the air dry?
- ❑ Is it dusty?
- ❑ Do you get shocks from static electricity?
- ❑ Is the work area too warm?
- ❑ Is the work area too cool?
- ❑ Does the temperature vary from room to room?
- ❑ Are there drafts where you work?

Health Survey - Confidential

Do you think any of the following might be causing problems at your workstation?

- ❑ Air circulation
- ❑ Humidity
- ❑ Dryness
- ❑ Air conditioning
- ❑ Temperature
- ❑ Noise
- ❑ Lighting / glare
- ❑ Odours
- ❑ Air contaminants
- ❑ Machinery or equipment
- ❑ Cigarette smoke
- ❑ Overcrowding
- ❑ Dividers or wall partitions
- ❑ Dusts and particles
- ❑ Pesticide spraying
- ❑ New furnishings / carpet
- ❑ Other _____
- ❑ I don't know

Have you noticed other events (weather, temperature, humidity, or activities in the building) that occur around the same time as your symptoms?

Have there been any changes in the work environment? E.g.: duties, equipment, products

Additional Information:

Please provide any comments or suggestions on how to improve the air quality in the workplace.

Appendix C-5: IAQ Problem Patterns and Causes

Checklist - Patterns and Possible Causes	
Patterns	**Suggestions**
Widespread, no real pattern	❑ Check HVAC for entire building. ❑ Check air intakes for contamination or poor location ❑ Consider sources that are throughout the entire building such as cleaning products ❑ Check for sources that are spread by the ventilation (such as moulds inside the HVAC system) ❑ Consider other causes, such as lighting
Localized – affecting one room, or HVAC zone	❑ Check HVAC for that area ❑ Check for local sources of contamination (such as storage of materials, a cleaning product specific to that area, photocopiers) ❑ Check HVAC for air flow from a remote source to that area
Individuals	❑ Check for drafts, heat loss or gain, or other local temperature or ventilation issues (e.g., a blocked vent) ❑ If individuals have various complaints, consider various causes including known triggers for susceptible individuals
Symptoms begin and/or are worst at start of shift	❑ Review HVAC operation. Source may be building up when building is not occupied or when HVAC is operating on a reduced volume overnight
Symptoms get worse over a period of time (during the day)	❑ Determine if HVAC system is adequately handling routine activities or operations in the building (e.g., not enough fresh air, or not enough air exchanges for the number of people)

Intermittent symptoms	❑ Look for patterns for daily, weekly, or seasonal changes. ❑ Check for other occurrences, such as weather patterns or special activities (such as increased number of people in building, cleaning activities like floor waxing)
Single event	❑ Determine if there was an event, such as a spill or repair to equipment
Symptoms get better when away from the building (either immediately, overnight, or after an extended leave)	❑ Check entire system ❑ Consider other causes such as stress, lighting, and noise
Symptoms are never relieved, even after extended absence	❑ Consider that the problem may not be building related

Appendix C-6: Odours and Common Problems

Odour	Problem	Complaints
Auto exhaust, diesel fumes	Carbon monoxide Nitrogen oxides (diesel)	Headaches, nausea, dizziness, tiredness, irritation
Body odour	Overcrowding, low ventilation rates (high carbon dioxide levels)	Headaches, tiredness, stuffiness
Musty smell	Microbial material, wet areas	Allergy symptoms
Chemical smell	Volatile organic compounds (VOCs)	Odour, allergy symptoms, dizziness, headache
Wet cement, dusty, chalky smells	Particulates, humidification system	Dry eyes, respiratory problems, nose and throat irritation, skin irritation, coughing, sneezing
Sewage gas odour	Water traps are likely dry in floor drains (in washroom or basement)	Foul smell

Adapted from: Indoor Air Quality in Office Buildings: A Technical Guide. Health Canada
[http://www.hc-sc.gc.ca/ewh-semt/pubs/air/office_building-immeubles_bureaux/index_e.html]

Appendix C-7: Health Complaints and Possible Causes

Common Complaints (grouped by causes)	Possible Causes / Items to Check
Air is stuffy or dusty	❑ Check HVAC system maintenance: for example, blocked vents, dirty filters, broken fan belts ❑ Check for changes to the airflow such as new building or HVAC design ❑ Relative humidity - too low or too high
Too warm/cool, or Too dry/ humid	❑ Check controls are set correctly and the system operating properly ❑ Check for water leaks ❑ Relative humidity and/or temperature - too low or too high
Swelling, itching, sneezing, congestion, asthma	❑ Possible allergic or sensitivity reaction – check for common triggers such as mould, dust, dead insects/animals, animal droppings or dander, or scented products (cleaners, perfumes, aftershaves)
Headaches, decreased alertness, or nausea after being in building for a long period of time	❑ Carbon monoxide may be entering the system (via loading dock or parking garage) ❑ Check that combustion sources are effectively exhausting to the outside (such as propane, natural gas, or oil as used in furnaces, fireplaces)
Irritation of eye, nose, throat (watering, burning or dryness), nosebleeds, headaches	❑ Recent renovations or additions (involving new furniture, rugs, window coverings, plywood, particleboard) may introduce volatile chemicals ❑ Check for other sources such as solvents, paints, adhesives, and cleaning products ❑ Relative humidity - too low
Eye, nose or throat problems, skin irritation, respiratory problems	❑ Cigarette smoke may be entering the system ❑ Check that filters are clean and functioning properly ❑ Relative humidity - too low
Increase in asthmatic or flu-like symptoms? (cough, shortness of breath, fever, chills, fatigue)	❑ Possible mould or fungal growth ❑ Check for water leaks

Headaches, loss of memory, tremors	❑ Investigate for any agent that can cause long term nervous system effect such as (some insecticides, pesticides or solvents). Check your MSDSs for health information. Always follow manufacturers directions carefully, including how much to use, and when "re-entry" can occur.
Diagnosed infections such as Legionnaires' disease, Aspergillosis, Psittacosis, or Hantavirus*	❑ Specific microbes (fungi, bacteria or viruses) can cause respiratory or other flu-like infections – check for water misting, and other areas where fungal or bacteria growth can occur such as humidification systems or fountains, check also for bird or rodent droppings
Headaches, fatigue, muscle aches	❑ Check for drafts or air currents in particular areas ❑ Check other factors such as workload, communications, or ergonomics (seating, repetitive motions)
Eyestrain, headaches, poor concentration	❑ Check that the lighting is adequate (not too dull or bright/glare) ❑ Check if the noise level is reasonable for office work

* *Legionella* - bacteria commonly found in any aquatic environment. They can survive for several months in a wet environment and multiply in the presence of algae and organic matter.

Aspergillus - fungi common in soil, decomposing plant matter, household dust, building materials, ornamental plants, items of food, and water.

Psittacosis - bacteria which can occur in the droppings of infected birds and cause respiratory disease

Hantavirus – virus which can occur in the droppings of infected rodents and causes respiratory disease

Appendix C-8: General Lighting Checklist

General Lighting Checklist	
General	
Enough light for the task.	
No troublesome reflections.	
No glare along or near normal line of sight	
No frequent transitions between extremes of light and dark or near and far.	
Lamps covered to diffuse light evenly.	
Adequate lighting of upper walls and ceilings.	
Shadows eliminated.	
Bright shiny objects out of view.	
Office	
Clear and readable images on VDT.	
Well-placed local lighting.	
VDTs positioned parallel to windows or fluorescent light fixtures.	
Flicker-free VDTs and fluorescent lights	
Matte finishes on furniture and equipment.	
Blinds or curtains on windows.	
Brightness and contrast controls properly adjusted on VDTs.	
Appropriate size print, and good contrast on reading materials.	
Maintenance	
Regular replacement of bulbs.	
Regular cleaning of light fixtures.	
Upper walls and ceilings clean.	
Complaints	
Headaches	
Eyestrain, burning or watering eyes	
Glare	

Adapted from http://www.ccohs.ca/oshanswers/ergonomics/lighting_checklist.html

Appendix D: Glossary

- **Acoustic baffles** – Panels attached to walls/ceilings to absorb or diffuse sound.
- **AIHA** - American Industrial Hygiene Association - a non-profit organization of occupational and environmental health professionals practicing industrial hygiene in industry, government, labour and academic institutions.
- **Air exchange rate** - The number of air changes per unit of time. For a building, the air exchange rate is the number of times that the total volume of air in the building is replaced by outdoor air within a certain period of time, e.g. air changes per hour. For a room or area, the rate is the number of times that the ventilation system replaces the air within the room or area.
- **Air motion** - The movement of air by either convection (hot air rises/cool air falls) or mechanical ventilation (old air out/new air in).
- **Ambient air** – Air in the surrounding area outside the building.
- **ASHRAE** - The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. publishes IAQ standards.
- **ASHRAE Standard 55-2004 - Thermal Environmental Conditions for Human Occupancy** - recommends temperature, relative humidity, air speed and factors such as seasonal clothing.
- **ASHRAE Standard 62.1-2004 -Ventilation for Acceptable Indoor Air Quality** - recommends minimum ventilation rates and IAQ that will be acceptable to human occupants. ASHRAE 62.1 is intended to minimize the potential for adverse health effects.
- **Bq/m^3** – A measurement of radioactivity where a radioactive nucleus decays per second. It is used for highly active radioactive materials such as Radon.
- **Calibration** - To establish the accuracy of a machine by comparison with a known standard, e.g. a weigh scale is calibrated by ensuring that known weights are accurately measured on the scale.
- **Carcinogen** - A substance that causes cancer.
- **Ceiling exposure limit** - A ceiling exposure limit is the concentration of a chemical which should not be exceeded at any time.
- **CFM** - Cubic feet per minute. A measure of air volume, in cubic feet, that flows through a given space in one minute.
- **CFU/m^3** - Colony forming units per cubic metre of air sampled. Measurement of microbes in a volume of air which can grow in a laboratory test.
- **CSA** (Canadian Standards Association) - A not-for-profit association that develops standards to address concerns such as enhancing public safety and health, advancing

the quality of life, helping to preserve the environment and facilitating trade. Some jurisdictions have enforced CSA standards in their regulations.

- **Damper -** A physical barrier or partition that controls the air flow through an opening (outlet, inlet or duct) by blocking off all or part of the opening. A damper position may be immovable, manually adjustable, or controlled by an automated control system.
- **dBA** - A sound level in decibels weighted to approximate the response of the human ear with respect to frequencies; used for measuring general sound levels.
- **Diffuser** - A device for distributing the air from the HVAC system widely into work areas, it also reduces the velocity of air flow from the HVAC system. Its shape may be circular or square and it is set in the ceiling at predetermined locations to diffuse air within that space evenly.
- **Ergonomics -** The science that involves fitting the job to the worker and not the worker to the job. It involves adapting workstations, tools, equipment and job practices to be compatible with the capabilities of an individual worker and thus reduce the risk of injury due to risk factors.
- **Exhaust ventilation** – Air that is mechanically removed from an area. Can be part of a local exhaust ventilation system or a general exhaust ventilation.
- **fpm** - feet per minute. A measurement of air velocity (speed).
- **Fungi** - A class of cellular plants that lack chlorophyll and obtain nutrients from dead or living organic matter (mushrooms, toadstools, and moulds are familiar examples).
- **HEPA** – High-Efficiency Particulate Air – a type of air filter that removes at least 99.97% of particulates such as dust, animal dander, smoke, mould and other allergens that are 0.3 microns or larger, from the air.
- **HVAC -** Heating, Ventilation and Air Conditioning system - an interconnected mechanical system of delivering conditioned outside air to a building while removing old air from it.
- **Hypersensitivity** - An exaggerated response by the immune system to a substance.
- **L/m** - Litres per minute. For IAQ, it is a measure of the volume of air entering or flowing in litres that flows through a given space each minute.
- **L/s -** Litres per second. For IAQ, it is a measure of the volume of air entering or flowing in litres that flows through a given space each second.
- **Local exhaust ventilation**: Local exhaust ventilation is a mechanical ventilation system that is used to remove contaminated air directly at its source. Contaminants (such as toxic gases, fumes, dusts and vapours) are captured close to where they are released into the air and exhausted outdoors before they can mix into the room air. Fume hoods are the most commonly used type of local exhaust ventilation.
- **Louver -** A framed opening in a wall, door, or window, fitted with fixed or movable horizontal slats so that air can pass through at various rates. The louvers diffuse the air and can dampen air flow.

- **Lux** - A unit of measurement of light equal to lumens per square metre. 10 lux is the light of a candle at 1 foot, 32,000 lux is the light outside on a sunny day.
- **m/s** - Metres per second. A measurement of velocity (speed).
- **mg/m^3** - Milligrams per cubic metre of air. For IAQ, it refers to a measurement of the amount of particulate (dust or aerosol) in the air.
- **Micron** (μm) - One micron is one millionth of a metre (one thousandth of a millimeter).
- **Microbial** – Living things including bacteria, fungi, mould, and algae that are too small to be seen by the human eye.
- **Mould** - see Fungi
- **MSDS** - Material Safety Data Sheet. MSDSs provide the basic information to help you work safely with a chemical product.
- **Negative air pressure** - More air is exhausted from a building or room than is supplied. This creates a partial vacuum and can cause air to be pulled into the room from opened doors or windows.
- **NIOSH** - National Institute for Occupational Safety and Health - NIOSH is the main United States federal agency responsible for conducting research and making recommendations for the prevention of work-related injury and illness.
- **Occupational Exposure Limit (OEL) -** An exposure limit is the concentration of a chemical in the workplace air to which most workers can be exposed without experiencing harmful effects. Exposure limits should not be taken as sharp dividing lines between safe and unsafe exposures. It is possible for a chemical to cause health effects, in some people, at concentrations lower than the exposure limit.
- **Occupational Hygienist –** A professional trained in assessing and controlling chemical, physical or biological hazards in the workplace that could cause discomfort, injury or disease.
- **Odour threshold level** - The odour threshold is the lowest concentration of a chemical in air that is detectable by smell. In the workplace, the ability to detect the odour of a chemical varies from person to person and depends on conditions such as the presence of other odorous materials. Odour cannot be used as a warning of unsafe conditions since workers may become used to the smell (adaptation), or the chemical may numb the sense of smell, a process called olfactory fatigue. However, if the odour threshold for a chemical is well below its exposure limit, odour can be used to warn of a problem with your respirator.
- **Off-gas -** To give off vapours. For example, allowing new furniture to off-gas (air out) in a separate building or well-ventilated storage area before bringing it into the office space can reduce staff exposure to odours.
- **OSHA** - Occupational Safety and Health Administration - A United States federal agency under the Department of Labor that writes and enforces safety and health regulations for most businesses and industries in the United States.

- **Perimeter heating** - Any system in which the heat registers (e.g. baseboard heaters) are located along the outside walls of a room, especially under the windows.
- **Plenum** - Air compartment connected to a duct or ducts, often used in the return air system.
- **Positive air pressure** - More air is brought into a building (or room) than the amount of air that is exhausted, resulting in excess air leaking out of the space. Buildings in general are often designed to operate under positive pressure to prevent or minimize unconditioned air from leaking into the work area, potentially causing drafts and introducing dust, dirt, and thermal discomfort.
- **PPE** - Personal protective equipment (e.g. respirators, gloves, goggles, apron) - clothing or devices worn to help isolate a person from direct exposure to a hazardous material or situation.
- **ppm** - Parts per million. A common unit of concentration of gases or vapour in air. For example, 1 ppm of a gas means that 1 molecule of the gas is present for every 1 million molecules of air (nitrogen and oxygen).
- **Pressure** (relationships between rooms) - Control pressure between rooms is accomplished by adjusting the air quantities (volumes) that are supplied to and removed from each room. Building areas should be balanced for minimal pressure differences unless required to control contaminants.
- **Rebalancing** (HVAC) - Adjusting the ventilation system e.g. dampers, air flow, ductwork to meet original design specifications or adjusting the ventilation system to meet new ventilation requirements as a result of building renovations (e.g. removing or adding walls).
- **Re-entry time** - The time lapse the manufacturer recommends before re-entering an area after use of a chemical (eg. after applying a pesticide).
- **Relative humidity** (RH) - The percentage of humidity (moisture content) in air. Relative humidity of 50 percent (%) means that the moisture content of air is 50% of the maximum possible moisture (100% RH) that air can hold at a given temperature.
- **Sampling "control"** – A particular sample that is treated the same as all the rest of the samples except it does not contain the substances being tested. It is used for comparison.
- **Sensitization / sensitizer -** Sensitization is the development, over time, of an allergic reaction to a chemical (the sensitizer). The chemical (sensitizer) may cause a mild response on the first few exposures but, as the allergy develops, the response becomes worse with following exposures. Eventually, even short exposures to low concentrations can cause a very severe reaction.
- **Setback / setup temperatures**. Setback = temperature that the office is set to at the end of occupied periods (e.g. nights and weekends). Setup = temperature that the office is set to at the beginning of occupied periods (e.g. days).
- **Spores** (fungal) - Seeds of mould or fungi.

- **Stagnant** - Air or water not circulating or flowing; still and motionless.
- **Susceptible** - Readily affected by a condition or contaminant, as in a susceptible person.
- **Task lighting** – A lamp or light that can be turned on/off at the workstation as required.
- **Thermal comfort** – Thermal comfort is achieved when a substantial majority (greater than 80%) of occupants report that they are "comfortable" in terms of temperature, humidity level and air motion in their work area.
- **Toxic** – Causing harmful effects; poisonous.
- **Toxicity** - The extent, quality or degree of causing harmful effects.
- **TWA** (Time-weighted average exposure limit) - The time-weighted average concentration of a chemical in air for a normal 8-hour work day and 40-hour work week to which nearly all workers may be exposed day after day without harmful effects. TWA means that the average concentration has been calculated using the duration of exposure to different concentrations of the chemical during a specific time period. In this way, higher and lower exposures are averaged over the day or week.
- **Vapour barrier** – A material, usually a plastic or foil sheet, that resists movement of air and moisture through walls, ceilings and floors. It helps protect the walls and insulation from damage by condensation.
- **Velocity** - Speed: distance travelled per unit time. For IAQ, generally refers to the speed of air movement.
- **Ventilation** - The process of supplying and removing air by natural or mechanical means to and from any space. There are different types of ventilation: Dilution or General Ventilation (includes Natural ventilation) and Local exhaust ventilation.
- **Ventilation rate** - The rate at which indoor air enters and leaves a building. Expressed as the number of changes of outdoor air per unit of time (air changes per hour, or in cubic feet per minute (CFM)).
- **Volatile organic compounds (VOCs)** - Certain solids and liquids give off a variety of vapours and gases. These emissions are an assortment of different chemicals and as a group, are called Volatile organic compounds (VOCs). These substances evaporate easily at room temperature. VOCs often have a sharp smell.
- **Work site health and safety committee** – Some Alberta workplaces have a committee made up of workers (employees) and management members who meet on a regular basis to deal with health and safety issues. Consult the Health and Safety legislation applicable to your workplace for more information.

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Top 5 Web Resources for IAQ

Alberta Workplace Health and Safety
[http://www.hre.gov.ab.ca/cps/rde/xchg/hre/hs.xsl/53.html]

Health Canada - Air Quality [http://www.hc-sc.gc.ca/ewh-semt/pubs/air/index_e.html]

Canada Mortgage Housing Corporation (CMHC) - Indoor Air Quality
[http://www.cmhc-schl.gc.ca/en/corp/faq/faq_005.cfm]

WorkSafe Saskatchewan - Indoor Air Quality
[http://www.worksafesask.ca/topics/common_issues/indoor_air.html]

U.S Environmental Protection Agency - Indoor Air Quality
[http://www.epa.gov/iaq/index.html]

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