**Indoor Air Quality**
*by Duncan Murray*

Indoor Air Quality or IAQ has a direct relationship on employee health and work performance. IAQ issues tend to be complex in nature:

* Ventilation systems that are not designed to deal with the capacity of the building
* Ventilation system that is in dire need of maintenance
* Building design efficiency does not allow enough ventilation
* Poor location of inlet air ducts that allow exhaust to enter into the building
* Indoor mould growth
* Lack of ventilation of office equipment such as photocopiers, printers etc.

*"With respect to IAQ, Alberta's Occupational Health and Safety (OH&S) legislation requires that workplaces be healthy, but it does not require that workplaces be comfortable. However, there are good reasons, such as enhanced staff moral and productivity, to exceed the legislated minimum requirements."*
(Alberta Human Resources Workplace Health and Safety Bulletin General Health - GH014 September 2003)

As a general guide maintaining IAQ requires adequate ventilation, temperature, humidity and minimum airborne contaminants.

**Adequate Ventilation**
Monitoring carbon dioxide (CO2) is an excellent indicator of air exchange. As the concentration of persons in the building increases so does the concentration of CO2. Outdoor air concentrations contains approximately 300 to 400 parts per million (ppm) CO2. As the "load" or population of the building increases so does the CO2 level and the air begins to get stale. Concentrations of 2,500 ppm to 5,000 ppm can cause headaches. Levels of 100,000 ppm (10 percent) people lose consciousness in ten minutes, and at 200,000 ppm (20 percent) CO2 causes partial or complete closure of the glottis or the space between the vocal cords.

Levels of 2,500 ppm do not normally occur in structures and since CO2 is produced by people this is an excellent indicator on the air quality of a building during the normal workday. Building engineers and operating systems monitor the CO2 content as it increases so does the frequency of air exchange. (See below)

Change to liters per second
The American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc. publishes (ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.) This standard specifies that the minimum ventilation rate per person is 15 cubic feet per minute (cfm) or 7.05 liters per second (lps) of outdoor air. Higher rates are in place for specified applications, i.e., the minimum rate is 60 cfm or 28.2 lps for a smoking lounge, 20 cfm or 9.4 lps for a school training shop, and 30 cfm or 14.1 lps for a hospital operating room. Residential dwellings are covered by a special specification, which is 0.35 air changes per hour, but not less than 15 cfm/person.

To determine ventilation rates, the CO2 levels inside and outside the building must be measured in parts per million (ppm). The ventilation rate is equal to the value 10,500 divided by the difference in indoor and outdoor CO2 concentration. The ventilation rate will be in cubic feet per minute (cfm) per person. In Canada it is liters per second per person where the final figure is multiplied by .47.

Example:

The indoor concentration is 1,000 ppm
Outdoor concentration is 300 ppm
Difference is 700 ppm
10,500 divided by 700 yields 15 or a 15 cfm ventilation rate per person.
15 X .47 = 7.05 lps

It should be noted that this equation assumes that there is a uniform density of persons, no source of combustion and all persons are engaged in light activities.

It is a general guide to attempt not to exceed 1,000 ppm of CO2.

**Air Temperature**
A standard "comfortable" air temperature for most persons is 22 degrees Celsius. Persons involved in physical labour or activity usually desire it cooler whist those in offices prefer it to be slightly warmer. A general guide for office temperatures is 22 Degrees Celsius.

There are six main factors governing perceived temperature:

1. Actual Air Temperature
This is the measurable temperature; it is also the least important under hot conditions.
2. Air Speed
Also known, as wind speed is the movement of air that will cool the skin. Most important during the winter where it can drop the air temperature rather dramatically.
3. Humidity
This deals with the amount of moisture in the air. The higher the humidity the less cooling of the skin during hot weather. Also the higher the humidity the more energy it takes to cool the air and the lower the humidity the more energy it takes to warm the air. That is one reason why some buildings humidify their air during winter months.
4. Physical Activity
Again the more physical a person is the more energy the give off and the more cooling they require. It should also be noted the less movement a person has the cooler they feel and it too can lead to serious medical conditions as well as death in extreme cases. In one instance a lady reported that her office would be very cold early in the afternoon. After placing scientific thermometers in different locations it was found the temperature had not changed. Yet she perceived that it had, upon interviewing her it was noted that she normally worked at her desk and even lunched there. It was recommended that she take a break every couple of hours moving around her department to prevent "blood pooling" after a couple of days she felt better and had no complaints.
5. Radiant Heat
This can be from sunlight, hot water heating system and equipment as well as other people.
6. Clothing
This makes the difference! Layers or type of clothing can trap heat in or keep heat out. If you are too warm then take some off or in the winter dress for the weather.

There are many other factors including health status, body weight, hydration, age, use of prescription and non-prescription drugs as well as fitness can effect how a person may senses or feels temperature.
*Again "With respect to IAQ, Alberta's Occupational Health and Safety (OH&S) legislation requires that workplaces be healthy, but it does not require that workplaces be comfortable. There is currently no legal minimum or maximum limit of air temperature that workers may be exposed to. According to current legislation, an employer is expected to ensure that workers do not experience adverse health effects resulting from heat or cold stress."*
(Alberta Human Resources Workplace Health and Safety Bulletin General Health - GH014 September 2003)

**Humidity**
This is extremely important to the operations of a building and how tenants feel. Comfortable humidification levels range between 30 and 60 percent. During the winter the humidification is raised thru steam injection at the air supply to the building. With raising the humidity it also helps to warm or heat the air. Less humidity in the air requires less energy to cool it and the more humid the air is the less energy is required to heat it.

**Mould**
Small amounts of mould are present most of the time. Normally this is not a problem or hazard however too much exposure to any substance can be harmful. Excessive levels can occur when there has been water damage from flooding, sewer backup or seasonal water leakage or condensation.

There is not currently a specific legal limit of airborne mould that workers may be exposed to. According to current legislation, an employer is expected to ensure that workers do not experience adverse health effects from mould exposure. This general guide is based on Health Canada and New York mould guidelines. See referenced bulletin BH018 for detailed references. (Alberta Human Resources Workplace Health and Safety Bulletin General Health - GH014 September 2003)

**Chemical and particulate Contaminates**
Some of the more common IAQ contaminates are: Carbon Monoxide, Ozone, Cigarette Smoke, Vehicle Exhaust, and Formaldehyde.

Carbon Monoxide is the result of incomplete combustion of fossil fuels. This can come from poorly maintained heating systems, gas fired appliances or exhaust entering the building. Motor vehicle exhaust can enter a building thru loading docks, fresh air inlets. Ozone is produced from electrical equipment such as photocopiers. Formaldehyde is the result of off gassing from new materials such as plastics, carpeting, particleboard even newly printed reports and pamphlets.

*Health Canada has a set guideline limit for Total Volatile Organic Compounds at 5 mg/m3. See:*[*http://www.hc-sc.gc.ca/hecs-sesc/air\_quality/pdf/93ehd166.pdf*](http://www.hc-sc.gc.ca/hecs-sesc/air_quality/pdf/93ehd166.pdf)

**Dust**
There are numerous sources for dust. Dirt being tracked into a building from persons who cannot wipe their shoes, handling paper, poor air filtration as well as other sources. Good housekeeping such as wet mopping, wiping and vacuuming helps to mitigate dust accumulation.

As a general guide total dust for an office environment is not to exceed 100 micrograms per cubic meter of air.

**Allergens**
Allergies or sensitivity to something sometimes bring devastating results. Common substances that may produce allergic reactions include: Perfumes, pollen, animal dander, cigarette smoke even the smell of peanut butter. It is strongly recommended that the use of scented candles, incense as well as cleaning products be kept to a minimum to prevent any reactions.

*There is not currently a specific legal limit of allergens that workers may be exposed to. According to current legislation, an employer is expected to ensure that reasonable and practicable measures are taken to ensure that workers do not experience adverse health effects resulting from exposure to allergens.*
(Alberta Human Resources Workplace Health and Safety Bulletin General Health - GH014 September 2003)

**Lighting**
One of the most important "comfort perceptions" is lighting. This greatly affects a person's perception of IAQ. As a general guide levels between 500 and 750 LUX is required for offices. Computer lighting on the other hand is between 300 and 500 LUX. An architectural design for fluorescent office lighting normally calls for tubes that burn between 3500 and 4100 degrees Kelvin.

Over a period of two years the author has conducted numerous tests. Suffering from migraines he changed some of his lighting to 6500-degree T8 tubes. With the permission of some of his tenants he changed their office lighting using varied configurations and tubes.

After testing it was found that replacing one tube in each fixture with a 5000 K bulb and using two 3500 K bulbs reduced the amount of glare from paper as well as monitor screens. A number of persons who also suffered from eyestrain thru the day also had their lighting changed. They too reported feeling a difference and at the end of the day felt better.

**Noise**
Noise and background noise can also affect a person's perception of IAQ and their comfort.

* General office noise should not exceed 48 dBA
* Private office noise should not exceed 45 dBA
* Board room noise should not exceed 40 dBA

**Employer responsibilities**
Alberta's Occupational Health and Safety Act lays out the employer's responsibility to ensure the health and safety of workers at the work site. Regulations or Codes under this act have been established to define standards related to protections from specific hazards.

In Alberta, workers must not be exposed to airborne levels of chemical contaminants above their Occupational Exposure Limit (OEL) if there is one established, or as low as reasonable practicable if an OEL has not been established. It is important to note that OELs represent minimum standards for worker protection. All reasonable and practical efforts should be taken to keep exposure level as low as possible.

* OELs are reviewed periodically. Please check Alberta's occupational health and safety legislation for the current requirements.

**Worker responsibilities**
The Alberta's Occupational Health and Safety Act places responsibilities on workers for health and safety at the work site. The Act and regulations require workers to take reasonable care of themselves and others at the work site. This includes co-operating with the employer for the purpose of protecting themselves and others."