

Indoor Air Quality:

every breath you take

Laser printers, like those used in offices, can emit as much fine-particle pollution as cigarette smoke. This finding released in a 2007 study by the *Environmental Science & Technology Journal* suggests these particles, if inhaled can pose significant health risks. But this is only one of many sources of indoor pollutants facing workers today.

The issue of indoor air quality (IAQ) became a health and safety concern approximately two decades ago with the advent of sealed buildings. In the name of “energy conservation measures,” buildings were constructed with ventilation systems which restricted the amount of fresh air entering and circulating within the building. These measures have resulted in a host of IAQ problems caused not only by the buildup of indoor contaminants, but also by problems arising from inadequate maintenance of the ventilation system itself.

Most people are unaware of how poor IAQ can affect their health. The United States’ (U.S.) Environmental Protection Agency (EPA) has shown the quality of indoor air can be many times worse than air outdoors. The World Health Organization (WHO) estimates one third of all new and remodeled buildings have unhealthy air. As well the U.S. National Institute of Occupational Safety and Health (NIOSH) reports that between 1980 and 1990, requests for office environment investigation went from 8 to 52 per cent. Poor indoor air quality is especially problematic for Canadians as they spend close to 90 per cent of their time indoors; at home, at work and in recreational environments.

Many Canadian jurisdictions have made recent advances such as the prohibition of smoking in public places including workplaces, but much more progress is needed.

What is IAQ?

IAQ refers to the quality of the air in an indoor environment. Other terms relating to exposure and reactions to indoor air contaminants include:

- Sick building syndrome (SBS) which describes a wide range of health effects linked to time spent in a building. Complaints may be in a particular area or be widespread throughout the building. As well symptoms may be different for each worker; and
- Building related illness which is a term used to describe a diagnosable illness attributed to a specific air borne contaminant. An example is Legionnaire’s Disease, caused by a specific air-borne bacterium.

What factors affect IAQ?

Studies show about half of all IAQ problems are related to deficiencies in the heating, ventilation and air conditioning (HVAC) system. Other factors include contaminants; for example microbiological agents and chemicals; and outdoor sources such as vehicle exhaust, pollen, dust and smoke.

HVAC systems

A properly designed and functioning HVAC system should meet the needs of a specific building based on its design, use and occupant numbers. It should filter the air, isolate and remove odours and contaminants through pressure control, filtration and exhaust fans, circulate the air throughout the building and provide thermal comfort. The system should also introduce clean outdoor air to dilute building contaminants. A poorly maintained HVAC system can allow a buildup of water in the unit, creating a reservoir for biological contaminants. Inadequate systems maintenance can also generate high moisture levels fostering the growth of mould and mildew.

Mould and microbial growth

Moisture-related problems in buildings can result in the growth or amplification of biological or microbial organisms such as mould, mildew, dust mites and bacteria. Exposures to these organisms can increase risk of allergic illness, trigger asthma, cause respiratory infections or have other health effects. Typical sources of moisture are structural leaks, plumbing leaks, flooding, and HVAC-related humidity control problems. Proper cleaning and building maintenance, especially moisture control, are essential to controlling mould and other biological agents.

Volatile organic compounds (VOCs)

Indoor air can contain several hundred different chemicals called VOCs. Sources of VOCs include emissions from paint, solvents, building materials, air fresheners, dry-cleaned clothing, aerosol sprays, adhesives, fabrics, cleaning agents and perfumes and fragrances from personal hygiene products. Some of these chemicals can cause eye, nose and throat irritation; headaches; loss of coordination; nausea, and damage to the liver, kidneys and central nervous system. Others can cause cancer in animals; and some are suspected or known human carcinogens.

One of the more common VOCs found indoors is formaldehyde. Formaldehyde can be found on many products including durable-press drapes and other textiles; particle board products such as paneling and furniture; tobacco smoke; and adhesives.

Exposure to formaldehyde can cause tearing of the eyes, coughing and bronchial spasms. Formaldehyde is listed as a suspected human carcinogen.

Particulates

Sources of airborne particles include combustion products, dust and pollen. Health effects from exposure to respirable-size particles in the air depend on the type and concentrations of particles present, frequency and duration of exposure, and individual sensitivity. Health effects range from irritation of the eyes and/or respiratory tissues to more serious effects, such as cancer and decreased lung function. Biological particles such as animal and insect allergens, viruses, bacteria, and moulds, can cause allergic reactions or infectious diseases.

Environmental tobacco smoke (ETS)

Second-hand smoke or ETS is a mixture of smoke from the burning end of a cigarette, pipe or cigar, and smoke exhaled by the smoker. ETS contains more than 4,000 chemical compounds, approximately 40 of which are known or suspected carcinogens. In Ontario, the *Smoke-free Ontario Act* bans smoking in all workplaces and public places including bars and restaurants. Still it is possible for workers to be affected by second hand smoke if, for example, smoke enters the workplace via the intake air system.

Lead-based paints

Lead is a heavy metal used in the manufacture of paint (before 1978) and other products used in plumbing pipes and solder. When paint containing lead deteriorates, tiny lead particles and dust can contaminate the environment. Regulations now limit the use of lead in paint and other applications. However, because lead lasts a long time, lead pollution remains a health hazard, particularly in older buildings. Lead is a designated substance under the *Ontario’s Occupational Health and Safety Act* (OHS). As such there are specific rules regarding exposure control and handling.

Combustion products

Combustion products, such as carbon monoxide, can cause health concerns ranging from mild health effects to death. Other pollutants, such as nitrogen oxide, can cause breathing problems and can trigger asthma attacks. Sources of combustion products include unvented fossil-fuel, unvented gas stoves and ovens, back-drafting and malfunctioning furnaces and water heaters. All potential sources of combustion pollutants should be properly maintained and vented outside the building to avoid IAQ problems.



Information Bulletins for health, safety and environmental representatives

RESOURCE LINES

Asbestos

Although Canada stopped the wide use of asbestos in buildings in 1973, older buildings may contain asbestos products. Exposure to asbestos causes a number of recognized related health concerns including several forms of cancer. Asbestos is also a designated substance under OHSA.

What are the health effects of poor IAQ?

Health effects associated with contaminated indoor air are vast and varied and depend on factors such as contaminant source(s), length of exposure and in some cases individual reactions. While the health effects of some individual chemicals are well documented, not much is known about the combined effects of two or more IAQ contaminants. This synergistic effect may have consequences far greater than any one contaminant. Regardless, diseases caused by poor indoor air include the following:

- **Legionnaires' disease** is a rare and sometimes severe type of pneumonia caused by the bacteria *Legionella pneumophila*, which is found in water sources. People become infected by breathing in mist or steam that contains the bacteria.
- **Humidifier fever** is a building-related disease caused by breathing in contaminated water droplets from humidifiers or other components of a ventilation system. Humidifier fever produces flu-like symptoms and can cause illnesses such as respiratory infections and asthma.
- **Multiple chemical sensitivity (MCS)** can occur when workers are simultaneously exposed to several chemicals found in indoor air. Health conditions related to MCS include respiratory problems, eye irritation, light-headedness, excessive fatigue and headache.

What is the law?

There are no occupational health and safety regulations that specifically address IAQ. However under OHSA, employers have a general duty to ensure a healthy and safe work environment and workers have the right to investigate and recommend prevention measures. OHSA Regulations also set out exposure limits for certain substances. Most are based on Threshold Limit Values (TLVs) from the American Conference of Governmental Industrial Hygienists (ACGIH). TLVs are based on the assumption there is a level at which nearly all workers may be repeatedly exposed to a substance without adverse effects. However, these limits only apply to industrial environments where control measures may require workers to wear personal protective equipment. They do not address exposure to the same chemicals in workplaces such as offices, schools, hospitals and retail stores. They also do not apply to instances where workers may be exposed to low levels of many contaminants all at the same time.

When enforcing employer general duties, the Canadian and/or Ontario Building Codes come into play.

These codes draw heavily from the American Society for Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) Standard 62.1-2004 *Ventilation for Acceptable Indoor Air Quality* as a guideline for acceptable IAQ.

The Canadian Standards Association's (CSA) guideline Z204-94 *Guideline for Managing Indoor Air Quality in Office Buildings* is also referenced by building codes in Ontario and other Canadian jurisdictions.

It should be noted that building codes based on these standards may only address an acceptable level of "occupant comfort" rather than the health effects of IAQ contaminants. Both the ASHRAE and CSA standards apply to situations in which 80 per cent or more do not express **dissatisfaction**. In some jurisdictions building standards address IAQ issues from the outset. They take an approach that includes health, safety, and the environment as well as occupant comfort.

Toronto's Thomas L. Wells Elementary School which opened in 1995 has adopted this leading approach to IAQ. To reduce the spread of airborne dust and respiratory viral infections, designers installed a displacement ventilation system. They chose porcelain tile floor finishes and anti-microbial treated carpets to eliminate the need for toxic cleaning products. As well toxic fume emissions were reduced or eliminated by the choice of millwork and paint finishes. For their efforts, the school received a silver rating under the Canadian Green Buildings Council's Leadership in Energy & Environmental Design rating system.

How can IAQ be controlled?

In theory, although rarely in practice, the solutions required to eliminate Sick Building Syndrome are relatively straightforward: ensure the HVAC system is working effectively, ensure an adequate supply of fresh, clean air and eliminate or isolate contaminant sources.

Any plans to address IAQ problems should contain several steps. These might include:

- A survey of all workers to determine patterns of specific health effects, such as number of workers affected, symptoms and location
- An evaluation of the HVAC system
- A regular maintenance and cleaning schedule for the HVAC system
- A block diagram of the design and layout of the workplace, including location of all air intake and exhaust vents
- An evaluation of recently renovated areas
- A review of Materials Safety Data Sheets for products found in the workplace
- A search for safer materials and furnishings for new or renovated projects.

Of course at every step the joint health and safety committee (JHSC) or worker health and safety representative must be involved.

In some cases air monitoring and testing may be required to determine specific contaminant source(s) and level of exposure. The *Act* gives JHSCs the right to information about health and safety tests in the workplace. Committees also have the right to be consulted about proposed testing strategies including what to sample for and when, where and how these samples are collected.

If monitoring is required, sampling technique and equipment used must be appropriate for contaminants being tested.

Direct reading calorimetric tubes, for example, are easy to use and provide instant results; however they have a 25 per cent margin of error and are not effective when measuring low levels of contaminants.

It is important to remember that a single air test does not identify all the chemicals, bacteria or other particulates that may be present in the work environment; and therefore does not address possible synergistic exposures.

Also remember, an important factor in preventing IAQ problems is worker education. Quality health and safety training for all workers including health and safety committee members and safety representatives will help workplace parties recognize, assess and control or eliminate IAQ hazards.

NOTE: The Workers Health & Safety Centre has a number of training programs and information products addressing IAQ concerns. Training programs include *Indoor Air Quality and Ventilation*, *Multi Chemical Sensitivity and Asbestos Hazards*. Information includes hazard bulletins for moulds, lead, asbestos, legionella and fragrances. To learn more visit www.whsc.on.ca.

For further discussion on new innovations in building codes and IAQ standards visit British Columbia's (BC) *Light House Sustainable Building Centre's* web site at www.sustainablebuildingcentre.com and take a look at the document entitled *BC Green Building Code, Background Research, Materials Emissions & Indoor Air Quality*.



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