

Indoor Air Quality in Buildings (IAQ)

A healthy indoor environment is one in which the surroundings contribute to productivity, comfort, and a sense of health and well-being. The indoor air is free from significant levels of odors, dust and contaminants and circulates to prevent stuffiness without creating drafts. Temperature and humidity are appropriate to the season and to the clothing and activity of the building occupants. There is enough light to illuminate work surfaces without creating glare and noise levels do not interfere with activities. Sanitation, drinking water, fire protection, and other factors affecting health and safety are well planned and properly managed.

The definition of good indoor air quality includes:

- 1- introduction and distribution of adequate ventilation air
- 2- control of airborne contaminants
- 3- maintenance of acceptable temperature and relative humidity

Failure to respond promptly and effectively to IAQ problems can have consequences such as:

- 1- Increasing health problems such as cough, eye irritation, headache, and allergic reactions, and, in some rare cases, resulting in life-threatening conditions (e.g., Legionnaire's disease, carbon monoxide poisoning)
- 2- Reducing productivity due to discomfort or increased absenteeism
- 3- Accelerating deterioration of furnishings and equipment
- 4- Straining relations between landlords and tenants, employers and employees
- 5- Creating negative publicity that could put rental properties at a competitive disadvantage.
- 6- Opening potential liability problems (*Note:* Insurance policies tend to exclude pollution-related claims).

Public and commercial buildings can present a wide range of IAQ problems. The variety of unique features in their design and usage (e.g., apartment buildings, hospitals, schools, shopping malls) make a wide range of IAQ problems possible. In apartment buildings, for example, each residential unit can produce cooking odors and the operation of kitchen exhaust fans.

Factors Affecting Indoor Air Quality

Indoor air quality is a constantly changing interaction of a complex set of factors. Four of the most important elements involved in the development of indoor air quality problems are:

- 1- A source of odors or contaminants;** there is a source of contamination or discomfort indoors, outdoors, or within the mechanical systems of the building.

Indoor air contaminants can originate within the building or be drawn in from outdoors. If contaminant sources are not controlled, IAQ problems can arise, even if the HVAC system is properly designed and well-maintained. It may be helpful to think of air pollutant sources as fitting into one of the categories that follow

Sources Outside Building

Contaminated outdoor air

- 1- pollen, dust, fungal spores
- 2- industrial pollutants
- 3- general vehicle exhaust

Emissions from nearby sources

- 1- exhaust from vehicles on nearby roads or in parking lots, or garages
- 2- re-entrained (drawn back into the building) exhaust from the building itself or from neighbouring buildings
- 3- unsanitary debris near the outdoor air intake

Soil gas

- 1- radon
- 2- leakage from underground fuel tanks
- 3- contaminants from previous uses of the site (e.g., landfills)
- 4- pesticides

Moisture or standing water promoting excess microbial growth

- 1- rooftops after rainfall
- 2- Crawlspace

Equipment HVAC system

- 1- dust or dirt in ductwork or other components
- 2- microbiological growth in drip pans, humidifiers, ductwork, coils
- 3- improper use of biocides, sealants, and/or cleaning compounds
- 4- improper venting of combustion products
- 5- refrigerant leakage

Non-HVAC equipment

- 1- emissions from office equipment (volatile organic compounds, ozone)
- 2- supplies (solvents, toners, ammonia)
- 3- emissions from shops, labs, cleaning processes
- 4- elevator motors and other mechanical systems

Human Activities

Personal activities

- 1- smoking
- 2- cooking
- 3- body odors
- 4- cosmetic odors

- 2-** **A problem with the design or operation of the HVAC system;** the HVAC system is not able to control existing air contaminants and ensure thermal comfort (temperature and humidity conditions that are comfortable for most occupants).

The HVAC system includes all heating, cooling, and ventilation equipment serving a building: furnaces or boilers, chillers, cooling towers, air handling units, exhaust fans, ductwork, filters, steam (or heating water) piping.

A properly designed and functioning HVAC system should:

- 1- provides thermal comfort
- 2- distributes adequate amounts of outdoor air to meet ventilation needs of all building occupants
- 3- isolates and removes odors and contaminants through pressure control, filtration, and exhaust fans

The HVAC system is generally the predominant pathway and driving force for air movement in buildings. However, all of a building's components (walls, ceilings, floors, penetrations, HVAC equipment, and occupants) interact to affect the distribution of contaminants.

- 3-** **A pathway between the source and the location of the complaint;** one or more pollutant pathways connect the pollutant source to the occupants and a driving force exists to move pollutants along the pathway(s).

Airflow patterns in buildings result from the combined action of mechanical ventilation systems, human activity, and natural forces. Pressure differentials created by these forces move airborne contaminants from areas of relatively higher pressure to areas of relatively lower pressure through any available openings. The basic principle of air movement from areas of relatively higher pressure to areas of relatively lower pressure can produce many patterns of contaminant distribution, including:

- 1- local circulation in the room containing the pollutant source

- 2- Air movement into adjacent spaces that are under lower pressure (Note: Even if two rooms are both under positive pressure compared to the outdoors, one room is usually at a lower pressure than the other.)
- 3- recirculation of air within the zone containing the pollutant source or in adjacent zones where return systems overlap
- 4- movement from lower to upper levels of the building
- 5- air movement into the building through either infiltration of outdoor air or re-entry of exhaust air

Air moves from areas of higher pressure to areas of lower pressure through any available openings. A small crack or hole can admit significant amounts of air if the pressure differentials are high enough (which may be very difficult to assess.)

4- The building occupants.

The term “building occupants” is generally used in this document to describe people who spend extended time periods (e.g., a full workday) in the building. Clients and visitors are also occupants; they may have different tolerances and expectations from those who spend their entire workdays in the building, and are likely to be more sensitive to odors.

Groups that may be particularly susceptible to effects of indoor air contaminants include, but are not limited to:

- 1- allergic or asthmatic individuals
- 2- people with respiratory disease
- 3- people whose immune systems are suppressed due to chemotherapy, radiation therapy, disease, or other causes
- 4- contact lens wearers

Some other groups are particularly vulnerable to exposures of certain pollutants or pollutant mixtures. For example, people with heart disease may be more affected by exposure at lower levels of carbon monoxide than healthy individuals. Children exposed to environmental tobacco smoke have been shown to be at higher risk of respiratory illnesses and those exposed to nitrogen dioxide have been shown to be at higher risk from respiratory infections.

Because of varying sensitivity among people, one individual may react to a particular IAQ problem while surrounding occupants have no ill effects.

Types of illnesses systems and complaints contribute to poor IAQ

The effects of IAQ problems are often nonspecific symptoms rather than clearly defined illnesses. Symptoms commonly attributed to IAQ problems include:

- 1- headache
- 2- fatigue
- 3- shortness of breath
- 4- sinus congestion
- 5- cough

- 6- sneezing
- 7- eye, nose, and throat irritation
- 8- skin irritation
- 9- dizziness
- 10- nausea

All of these symptoms, however, may also be caused by other factors, and are not necessarily due to air quality deficiencies. "Health" and "comfort" are used to describe a spectrum of physical sensations. For example, when the air in a room is slightly too warm for a person's activity level, that person may experience mild discomfort. If the temperature continues to rise, discomfort increases and symptoms such as fatigue, stuffiness, and headaches can appear.