

Indoor Air Quality in Buildings

What is IAQ?

IAQ stands for “Indoor Air Quality”

This term is used to describe the quality of the air inside non-industrial buildings, especially as it relates to health and comfort of building occupants. IAQ can be affected by several factors including temperature, moisture levels, carbon monoxide (CO), carbon dioxide (CO₂), volatile organic compounds (VOC), particulates and microbial contaminants.

What causes poor indoor air quality?

Common air pollutants include:

- CO generated by some machines as they operate both indoors and outdoors (motor vehicles, electric generators, gas powered tools)
- Pollen
- Smog (a combination of smoke and fog)
- VOCs are chemicals that contain carbon and can be introduced into the air as gases. VOCs can be produced by some furnishings, adhesives, paints, and copiers.

What causes poor indoor air quality?

Outdoor sources of pollution, in some cases, can affect IAQ when they migrate indoors thru open doors and windows

Microbial contaminants include molds or fungi, that can come from indoor and outside sources

Other contributors can be nuisance odors:

- Body odor

- Perfumes

- Air fresheners

- Microwave use

What is ventilation?

A process, whereby air is supplied and removed from an indoor space by natural or mechanical means.

Why is ventilation needed indoors?

To remove heat/moisture and to prevent the accumulation of indoor pollutants.

Types of Ventilation

- Natural (primarily used in residential)
- Mechanical (commercial, non-industrial buildings)

Natural Ventilation

Inflow of air: flow of outdoor air through windows, doors and a variety of openings in the buildings.

Exhausted air: movement of air from indoor spaces to outdoors.

Limitation of Natural Ventilation

- Fairly inefficient as it is not uniformly distributed. Air does not circulate evenly and stale air gets collected in some dead end spaces.
- It brings pollen and other pollutants from outside air.

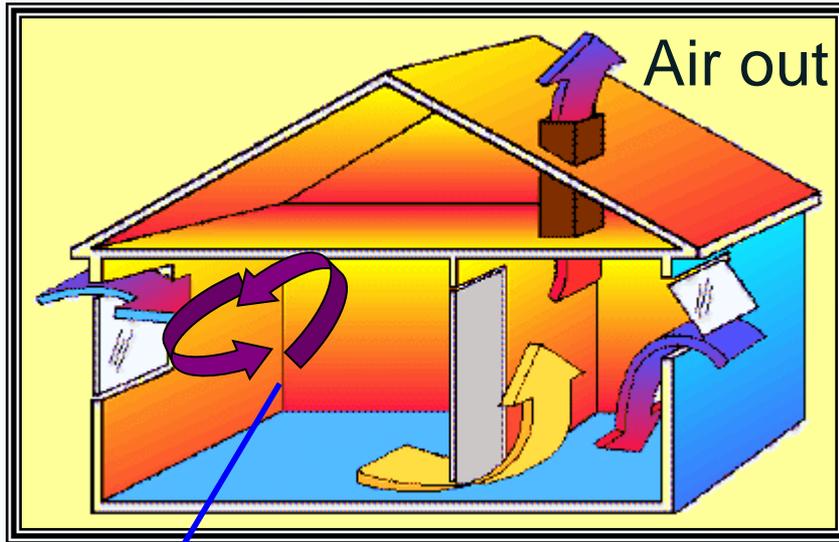
Mechanical Ventilation

Consists of fans, ductwork, heating elements/air conditioning equipment and filters

- Pulling fresh air from outside to indoor spaces
- Exhaust stale air
- Control temperature and humidity inside



Air Flow Inside the Buildings



Air in

Air out

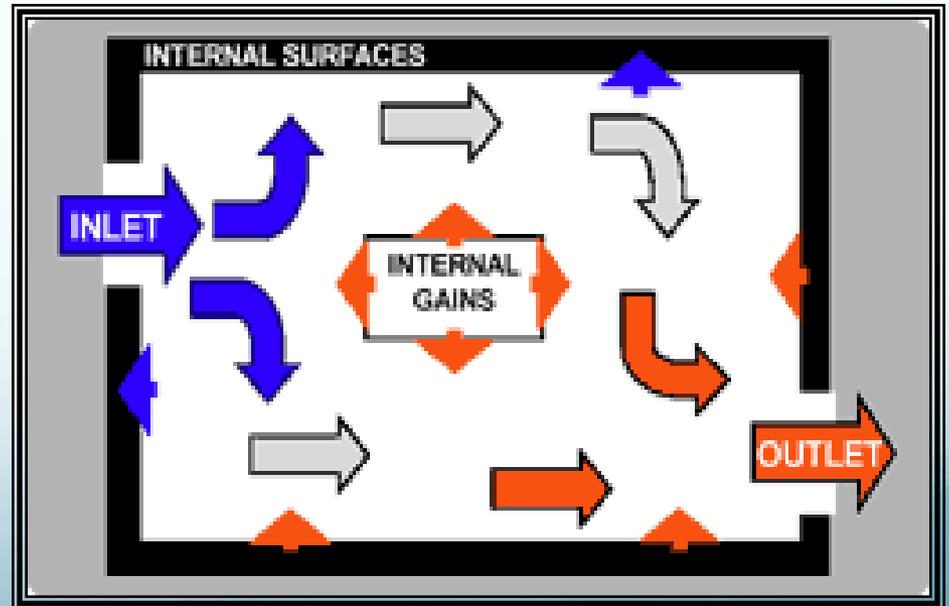
Stagnation zone

Natural Ventilation

Air flow pattern, when natural ventilation occurs



Air flow, when uniform mixing inside (mechanical ventilation)



Energy Efficiency

Energy Efficiency - Starting in the 1970's the cost to heat and air condition buildings increased dramatically. To reduce heating and air conditioning costs, buildings were “sealed-up” and the amount of outside fresh air introduced into the building was drastically reduced.

- Air Contaminants Trapped
- Lack of Outdoor Air

ASHRAE Standard: To allow more outdoor “fresh” air into the building ventilation system, the American Society of Heating, Refrigeration & Air-Conditioning Engineers (ASHRAE) promulgated Standard Number 62.1-2013, which recommends 15 to 20 cubic feet per minute (CFM) of outdoor air per person.

What is a Heating Ventilation Air Conditioning (HVAC) System?

The HVAC system introduces fresh air from the outdoors and uses filters to trap contaminants before re-circulating the air around the occupied spaces. Most deliver air thru vents typically placed in ceilings and walls.

The main function of the system is to provide thermal comfort for occupants, the HVAC also aids IAQ by helping control humidity levels indoors.

Ventilation distributes the air through ducts. **Heating** of the air is provided with the aid of boilers or steam. **Air Conditioning** delivers cool air by removing excessive moisture through the use of chillers or cooling towers.

HVAC Components

Air Intake

An opening that allows fresh air into commercial buildings.



Dampers: valve or plate that stops or regulates the flow of *air* inside a duct.



HVAC System Components

Ducts

The flow of air through a duct work system



HVAC System Components

Filters

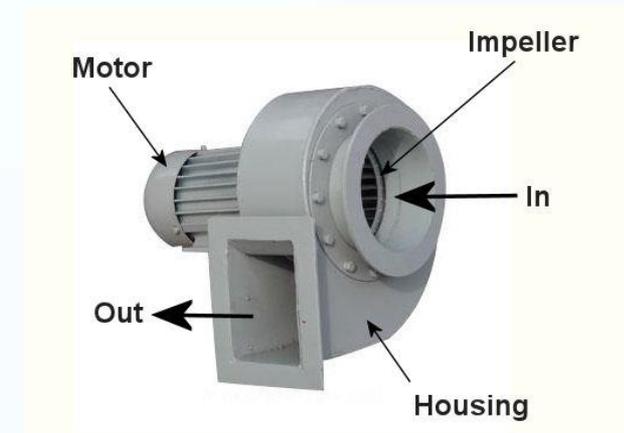
Capture and remove particles, contaminants, vapors and gases from the air.



HVAC System Components

Fans

Aid in the circulation by the forcing the air through the ductwork system



HVAC System Components

Coils and Drain Pans

- Performs heat transfer to air when mounted inside an air handling unit or ductwork. It is heated or cooled by electrical means or by circulating liquid or steam within it.
- Cooling coils dehumidify the air and cause condensation to drip into drain pans.
- Drain pan collects the condensation water from the coils in the HVAC system.



HVAC System Components

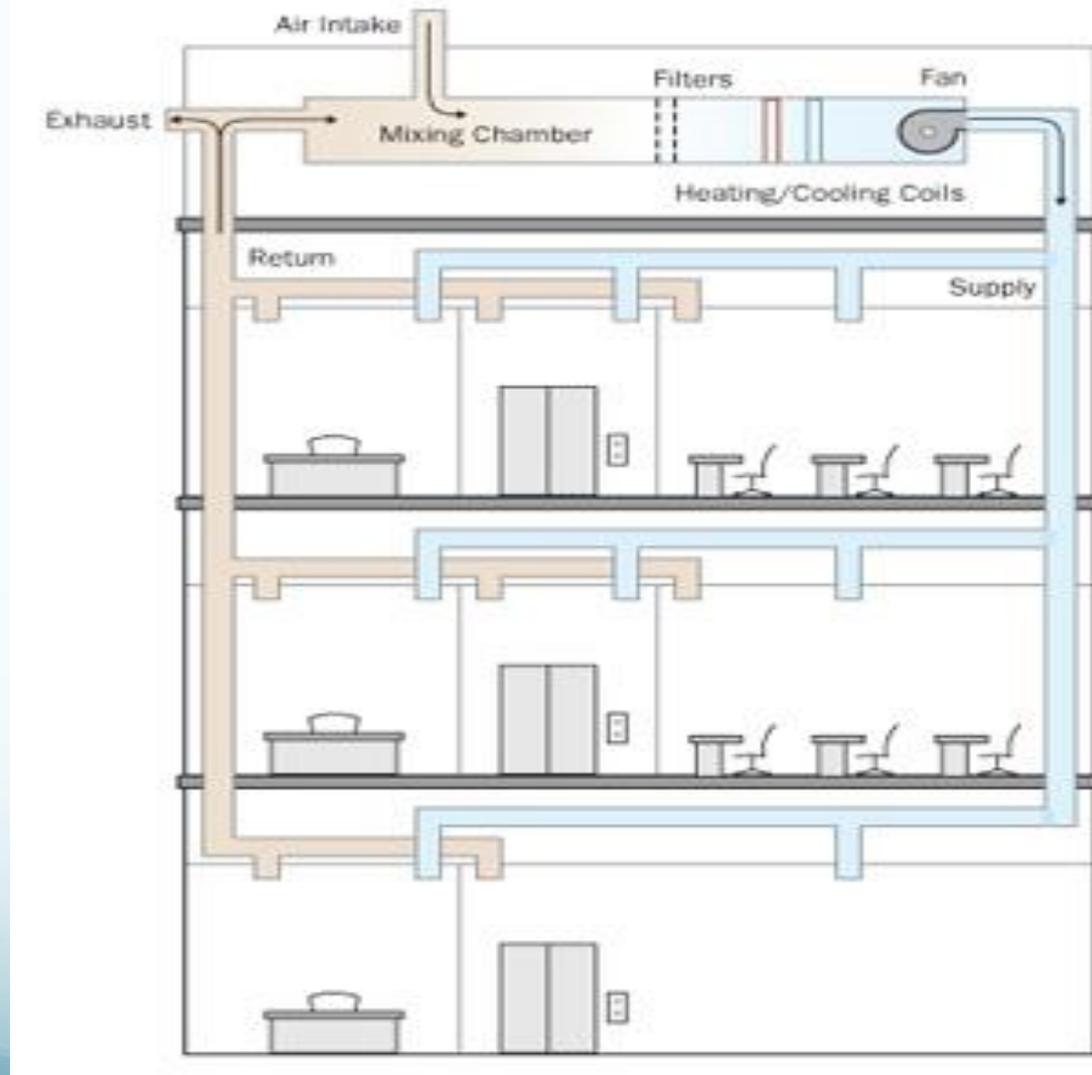
- **Air Exhaust**: Air is removed from a space to be recirculated or exhausted out of the building.
- **Air Supply Vents**: Air is delivered by mechanical ventilation to a space and is composed of outdoor and/or recirculated air.



HVAC Preventive Maintenance

- Building Facilities should develop a preventive maintenance schedule for filter replacement.
- Frequent cleaning of the drain pans is essential to good indoor air quality.

Typical HVAC System Design



HVAC System

HVAC ventilation systems can help with IAQ by bringing in fresh air from outside and exhaust stale air after the air is cleaned by a filtration system.

Air is consistently exchanged during working hours based on type of occupancy, size of space, and number of occupants.

Many HVAC units use air filters. The maintenance of the units and changing of the filters, is an essential part of making sure the HVAC works properly.

IAQ Guidelines

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) sets standards for the proper operation of the HVAC system, and the concentration of oxygen and certain air pollutants that can affect IAQ.

American National Standards Institute (ANSI) oversees the development of standards for products, services, processes, systems, and personnel in the United States. ANSI issues accreditation to ASRAE standards.

Occupational Safety and Health Administration (OSHA)/Public Employee Safety and Health (PESH) established permissible exposure limits.

ASHRAE Guidelines

ASHRAE Recommended Comfort Guidelines:

(ANSI/ASHRAE Standards 55-2013 and 62.1-2013)

Relative Humidity	Winter Temp	Summer Temp
30%	68.5-76.0°F	74.0-80.0°F
40%	68.5-75.5°F	73.5-79.5°F
50%	68.5-74.5°F	73.0-79.0°F
60%	68.0-74.0°F	72.5-78.0°F

- **Acceptable CO₂ Levels**
- Average breathing air contains 20.9% oxygen (O₂)
- **ASHRAE currently set acceptable levels of carbon monoxide at 50 parts per million (ppm) and carbon dioxide at 5000 ppm**

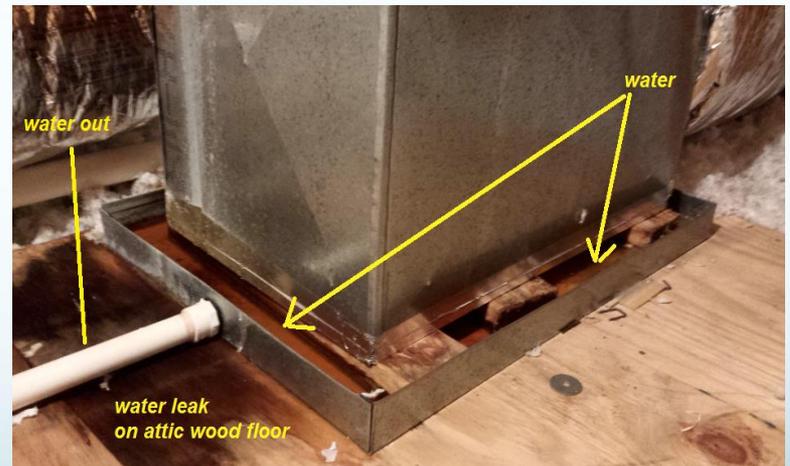
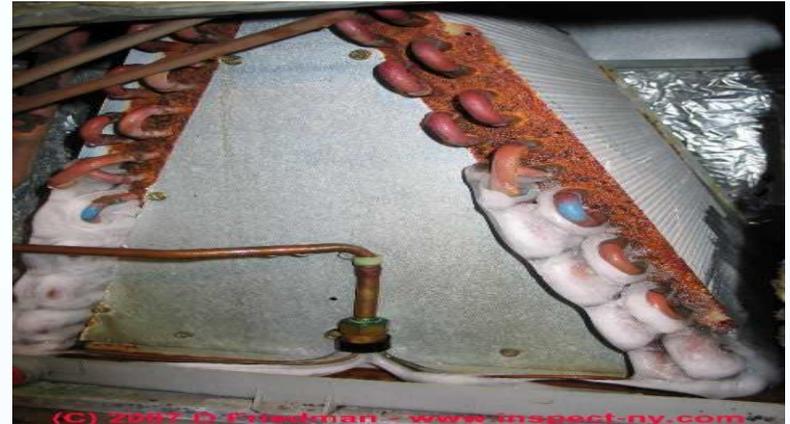
Factors Affecting IAQ

Poor Mechanical Maintenance

Malfunctioning coils, including dirty coils, can waste energy and cause thermal discomfort.

Standing water can accumulate if the drain pan is not properly maintained, creating a microbial habitat.

Dust and dirt build-up of the duct work



Factors Affecting IAQ

Blocked systems



Steps for Investigating IAQ Problems

- Document employee complaints reported / before and during the investigation.
- Examine any practices that can adversely affect air movement and ventilation (workers blocking HVAC vents with cardboard or improper placement of copy machines)
- Reviewing the office layout, for location and use patterns of windows, doors, vents, proximity to kitchens.
- Ventilation and air measurement (multi-gas meters, anemometers, photo ionization detectors PIDs, moisture meters) COSH can conduct testing upon request
- Develop a plan for reducing and eliminating the IAQ problem.

Methods of testing the Air

Multi-Gas meters

oxygen

carbon monoxide



Q-Trak Indoor Air Quality Monitor

- Temperature and Humidity
- Carbon Monoxide
- Carbon Dioxide



Common IAQ Signs and Symptoms

- Eyes: dry, itchy, redness, usually due to low humidity
- Upper respiratory system: wheezing , coughing, sneezing can be due to dust
- Headaches: can be caused by carbon monoxide levels being too high
- Other: although different employees can react to building contaminants differently (due to hyper sensitivity in some of them) drowsiness, nausea, weakness, have also reported as reactions to poor IAQ

Response to IAQ Problems in City Workplaces

The IAQ problems maybe connected to the HVAC system performance.

Steps to take:

Supervisor/Manager 

Building Engineer/Custodian

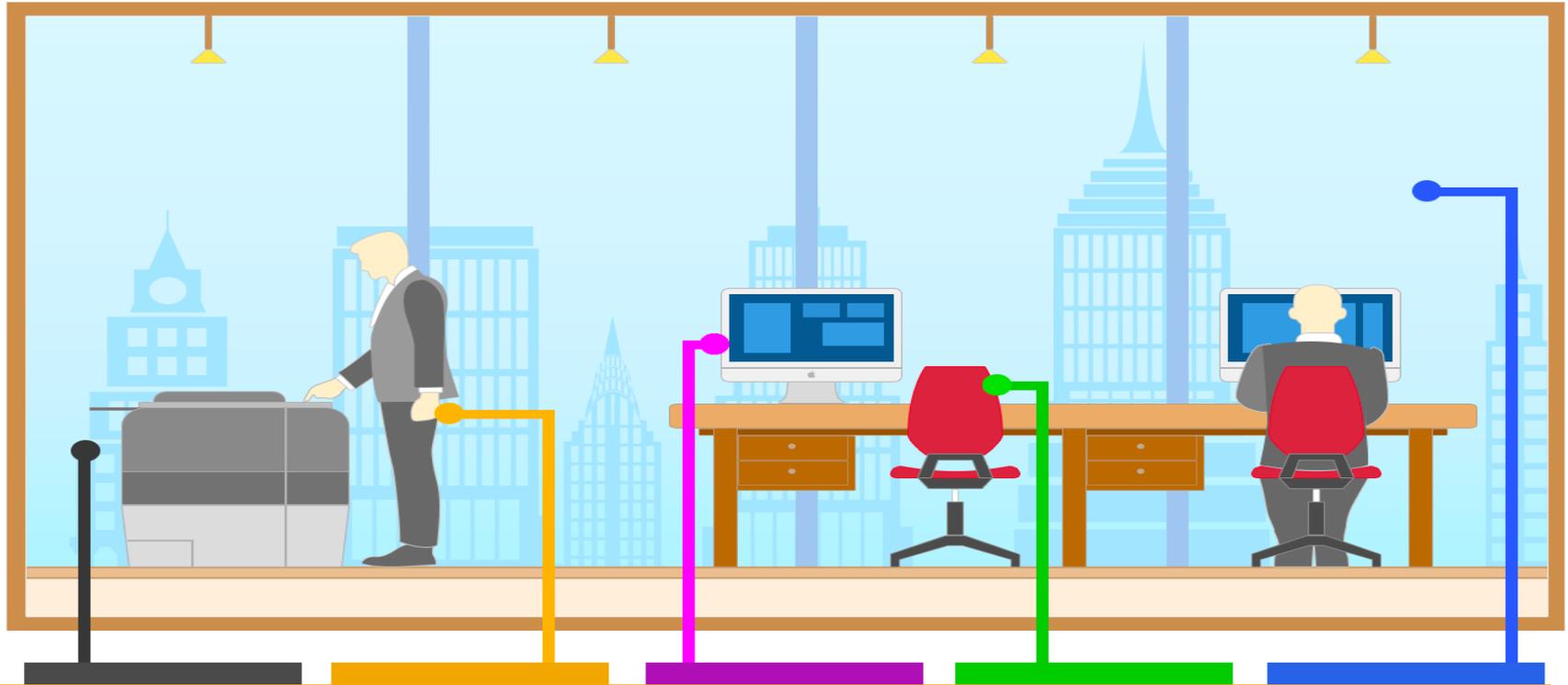
If not solved: 

Agency Safety and Health Coordinator or Agency Facilities Staff/or Lease Enforcement

If not solved: 

Agency Safety & Health Coordinator should contact COSH

Sources of Indoor Air Pollution in a Typical Office Building



CAN YOU NAME SOME FACTORS AFFECTING IAQ THAT CAN BE PRESENT IN THIS OFFICE?