

# Indoor air quality

## Risk Control services

from Liberty Mutual Insurance



### Highlights:

- Contributing factors of poor IAQ
- Assessment strategy
- Preventive measures

Poor indoor air quality (IAQ) is a concern for building managers and occupants. Common complaints include drowsiness, headaches, nausea, eye and throat irritation, and itchy skin – symptoms that can arise from a variety of causes, not just IAQ issues.

IAQ problems are often difficult to solve because workers' symptoms are usually diverse and subjective. In most cases, the health effects of poor IAQ do not result in disabling injuries. Poor IAQ often increases absenteeism, and building-related complaints can convert to real dollar losses in employee downtime, reduced worker morale, lost revenue, business interruption, and depending on the resulting airborne contaminants, potentially high medical costs.

The causes of IAQ problems are even more diverse than the complaints. It's rare that a single, causative factor can be identified, isolated, and eliminated. An effective IAQ evaluation should consider the following factors, which are the most frequent contributors to poor IAQ.

## **Contributing factors of poor IAQ**

### **Inadequate fresh air**

An inadequate amount of clean, outside air in the building is the factor most frequently associated with IAQ problems. A constant infusion of fresh outdoor air serves to dilute building pollutants to acceptable levels. The American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), in their 62.1-2013 Standard, *Ventilation for Acceptable Indoor Air Quality*, provides data detailing the amount of outdoor air that should be brought into a building based on the type of occupancy, the number of occupants within the building (or area of concern), and the overall square footage of building space being serviced by the affected air handler.

### **Biological contaminants**

Biological contamination of air conditioning system components and humidifiers has caused some of the most serious IAQ incidents. Buildings with issues that compromise the building envelope, such as leaky roofs, windows, water intrusion through wall systems, or other types of issues causing water damage, can harbor microbial growth that can cause allergic reactions among persons who are sensitive to mold spores and other microorganisms. Porous water-damaged building materials such as sheetrock, carpet, and ceiling tile provide good mediums for fungal growth. Correctly designed and installed vapor barriers on buildings can help reduce biological contamination potential.

### **Smoking**

Environmental tobacco smoke is typically considered irritating to the nonsmoker. Inadequate control and isolating the smoke from tobacco products can tax an otherwise adequate building ventilation system and cause widespread complaints. Many municipal and state laws now limit where smoking is permitted in indoor environments.

### **Humidity**

ASHRAE 62.1-2013 recommends keeping the relative humidity upper limit below 65 percent indoors. A hot, humid climate may also be a contributor to IAQ symptoms. High humidity (greater than 60 percent) can promote excessive microbial growth in building ventilation systems and may promote mold or mildew growth on walls and other interior surfaces.

## Building pressure

Proper pressurization within a building is a very important factor that needs to be maintained on a consistent basis for consistent and adequate IAQ. Buildings should be designed to be under a slight positive pressure with relation to the outdoors so that any leaks in the structure can migrate from inside to outside. Negative pressure buildings tend to draw un-tempered and unfiltered air into the building walls or envelope, allowing contact with building materials that may cause moisture to condense on building surfaces, potentially resulting in mold growth.

## New furnishings

The contribution of carpeting and room furnishing materials should not be overlooked when investigating IAQ. Initial off gassing of organic volatiles from new furnishings can exacerbate existing IAQ problems, even if they are not primary contributors.

## Cleaning and custodial activities

Solvents, carpet cleaners, insecticides, and other chemicals used inside or immediately outside of buildings can lead to employee complaints. Chemical odors, especially pesticides or solvents, in an office environment are apt to produce strong complaints. Unreported chemical spills or forgotten open containers of chemicals have been known to cause mysterious odors that produce widespread employee complaints. Such materials can also generate complaints if they are used or stored near fresh air or return air intakes.

## Vehicle exhaust

Parking garages and loading docks with idling vehicles (trucks, forklifts, etc.) can send exhaust into buildings, causing subsequent complaints. The carbon monoxide component of engine exhaust is a potentially serious threat to health and should be investigated thoroughly. If engine exhaust is suspected as a source of building air pollution, immediate corrective action is advised. The outside air-intake vent for the HVAC system should be located to minimize the intrusion of contaminated air.

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## Other sources of carbon monoxide (CO)

Natural gas cooking equipment produces carbon monoxide. Buildings with kitchens should have adequate exhaust ventilation to remove the CO that is produced by gas-fired appliances. Portable gasoline or LP-powered equipment can also produce CO gas. Portable generators or fuel burning heaters should be placed in well ventilated areas to avoid introducing CO gas in the building.

## Temperature extremes

Problems related to a too-cool or too-warm building environment are usually the easiest to identify, but they may be difficult to resolve because of disagreements among workers about what constitutes a comfortable temperature. Since climate comfort is a function of both temperature and humidity, complaints related to temperature extremes may, in fact, help identify problems with building humidification.

## Volatile Organic Compounds (VOC), Particulates, formaldehyde, and CO

These should each be maintained below the maximum indoor air concentration levels shown below:

- Formaldehyde: 27 parts per billion
- 10-micron sized particulates (PM10): 50 micrograms per cubic meter
- Total VOC: 500 micrograms per cubic meter
- \*4-Phenylcyclohexane (4-PCH): 6.5 micrograms per cubic meter (\*only required if carpets and fabrics with styrene butadiene rubber, SBR, latex backing are installed as part of these building systems)
- Carbon monoxide: 9.0 parts per million and no greater than 2.0 parts per million above outdoor levels

## Assessment strategy

Following these steps will help you investigate IAQ concerns in many types of work environments.

1. Look for patterns of complaints. The first step in isolating a cause is to isolate the complaints. Patterns may occur in many categories, including these common examples:
  - Physical (work areas)
  - Process (similar machinery or supplies)
  - Chemical (raw materials or products)
  - Time (shift or season)
2. Make observations of areas and processes where complaints are occurring. Eliminate obvious problems and monitor the results.
3. Employees may blame their symptoms on “bad air” when in reality the problems are unrelated to IAQ. Common examples of problems that may mimic IAQ symptoms of drowsiness, headaches, nausea, eye or throat irritation, itchy skin, etc. include the following:

- Glare from computer screens
  - Poor workstation design or layout
  - Building noise and vibration
  - Skin contact with chemicals or physical irritants
  - Common disorders such as colds, flu, or digestive illness
  - Recent changes in diet
  - Industrial relations problems.
4. Evaluate the fresh air infusion. Measure the total amount of fresh air being brought into the building. The ASHRAE 62.1-2013 standard recommends a fresh air intake that accounts for the number of people who occupy the space as well as the overall square footage of the space to which the air handler services for different indoor environments.
  5. Measure carbon dioxide (CO<sub>2</sub>) concentrations. CO<sub>2</sub> concentration in the air is used as an indicator of poor IAQ and inadequate fresh air infusion. ASHRAE 62.1-2013 established a recommended upper control level concentration of CO<sub>2</sub> for indoor environments of 700 ppm above the outdoor concentration. This CO<sub>2</sub> level was established to address odor complaints from human occupants.
  6. Perform an air balance survey. Measure the airflow from each ventilation register. An air balance survey provides a precise idea of how much the airflow must increase to meet ASHRAE ventilation recommendations. Ensure the building is consistently maintained under a slight positive pressure in relation to the outdoor air.
  7. Inspect areas where moisture tends to collect. Visible fungi (mold and mildew) growth is evidence that biological infestation could be contributing to an IAQ problem. Growth can occur in concealed spaces in walls, ceilings, or ventilation systems, and may require diligent searching to locate. Note: Currently there is no widely accepted, absolute standard for the maximum amount of biological agents that should be in the air.

## **Preventive measures**

The most efficient way to control IAQ problems is to prevent them from occurring in the first place. The following guidelines should be addressed to curtail IAQ issues.

### **Provide adequate fresh outdoor air to the building**

HVAC systems recirculate large amounts of air, but recirculated air does not satisfy the fresh air requirement.

### **Inspect the HVAC system for biological contamination**

HVAC systems should be properly designed to minimize entrapment of moisture. For example, condensate from cooling coils should drain away from the system rather than letting it accumulate in pans. Look inside ductwork and HVAC units for any visible mold growth.

### **Avoid humidification systems if possible**

Humidity and moisture provide opportunities for microbial growth. A humidification system may disperse those harmful microbes through the air. If such a system is necessary, a good preventative maintenance (PM) program is needed to keep the system clean and working properly.

### **Inspect the building for leaks**

Fix leaks as soon as possible. Good PM programs are essential to prevent water leaks. When leaks do occur, quick action is needed to stop the leak and begin drying out the affected materials.

### **Schedule contaminant-producing tasks in the building during off hours**

Construction and/or remodeling projects should be carefully planned to minimize IAQ complaints and issues during the project. Schedule these tasks when the number of building occupants is at a minimum, thus controlling the exposure. During these tasks, provide good ventilation in work areas with an independent ventilation system, if possible.

### **Aerate furnishings and carpeting before installation**

The purpose of aeration is to dissipate as much odor as possible before the furnishings are brought into the work area. Many manufacturers are now using low-emission materials or “aging” furnishings in their warehouses.

### **In new buildings, preplan construction to use materials and furnishings that produce the lowest odor and chemical component composition possible**

In addition, plan a preoccupancy “burn-in.” Elevating the building temperature to drive off-odors and chemical releases from new furnishings prior to occupancy, followed by sufficient flushing of the building with fresh outdoor air often helps reduce complaints that often occur after new construction or building renovations.

Keep a log of all complaints and air survey results. Good recordkeeping can document your preventive efforts, help identify patterns, and may be helpful in defending against claims.

Most IAQ problems and complaints can be avoided through a combination of managerial and physical measures. When workers

do complain, take their concerns seriously and investigate. Even a minor irritant in the air can produce lost workdays and lower productivity, and a severe IAQ problem can produce dramatic losses.

## References

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