



Improving Indoor Air Quality Where You Work

Indoor Air Quality

Indoor air quality (IAQ) in the workplace is the subject of much attention these days, and for good reason. The air quality of the indoor environment can profoundly affect the health, comfort, and productivity of building occupants. Although serious health problems related to IAQ are rare, the perception of endangered health is increasingly common among building occupants. This brochure deals with non-industrial workplaces, such as office buildings and schools.

The causes and consequences of poor IAQ are complex and not completely understood, but there are some basic factors that building owners, managers, employers, and occupants should know in order to address IAQ concerns. The American Industrial Hygiene Association (AIHA) has developed this document to summarize the current state of knowledge on IAQ. It is our goal to inform the reader, so that you can make intelligent decisions to improve the quality of the indoor environment in your building. What is good indoor air quality?

Most occupants will agree that indoor air quality is good when it is free of odors and dust, does not contain harmful contaminants, is neither too still nor too drafty, and is a comfortable temperature and humidity. General guidelines for achieving good indoor air quality include:

- Ventilation is in accordance with the guidelines established in the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 62.1.
- Comfort (temperature, humidity, air movement) factors are acceptable to most occupants or meet consensus standards, such as ASHRAE 55.
- Mechanical equipment and building surfaces are maintained in sanitary condition.
- Significant emission sources are isolated from occupied spaces.
- Major sources of contamination are promptly controlled.
- Occupied areas are regularly cleaned and good housekeeping practices are in place.
- Operations, maintenance, and construction activities are performed in a manner that minimizes occupant exposure to airborne contaminants.

What are common complaints about IAQ?

The most common complaint is related to temperature: the air is either too hot or too cold. The second most common complaint is about air movement: the air is too drafty or too still. Other common comfort-related complaints involve humidity: the air is too dry or too muggy.

Some health-related complaints associated with poor air quality mimic those of the flu or a cold: headaches, sinus problems, congestion, dizziness, nausea, fatigue, and irritation of the eyes, nose, or throat. Such symptoms are often difficult to associate with the workplace. The indoor environment is usually not the suspected cause of occupant symptoms unless the symptoms are shared by a number of occupants; found to be unreasonably persistent; or there is a distinct and suspect odor or other unusual quality to the air.

Health-related complaints may be due to allergic reactions. In the presence of allergens (substances or particles that cause allergic reactions), 10 percent or more of a given population may exhibit symptoms including sneezing, swollen airways, and asthma-like attacks. Individuals with a building-related allergy will experience similar symptoms in other environments if the particular allergen is present (dust mites, cat dander, or mold spores).

When are IAQ complaints most likely?

Factors associated with an increased likelihood of complaints include the installation of new furnishings, uncontrolled renovation activities, poor air circulation, and persistent moisture. Complaints may also increase when there is a stressful work environment, such as impending layoffs, a great deal of overtime, or an ongoing employee/employer conflict.

What are common sources of IAQ problems?

Contaminants may originate from a variety of sources on the inside or outside of a building. Airborne chemicals, bacteria, fungi, pollen, and dust may all contribute to the problem. Although they are not indoor pollutants, factors such as temperature, humidity, lighting, noise, personal and work-related stress, and pre-existing health conditions can affect occupants' perceptions of indoor air quality.

Potential sources of contaminants in office buildings include dust; inadequate design or maintenance of heating, ventilation and air-conditioning (HVAC) systems; cleaning chemicals; pesticides; building materials; furnishings; occupant metabolic wastes (respiration and perspiration); fragrances/cosmetics; and tobacco smoke. Of course, virtually all of these are present to some degree in every building. They cause serious IAQ problems only when concentrations become excessive.

Dusty surfaces, stagnant water, and damp materials provide an environment ripe for microbial growth. When mold spores, odorous compounds resulting from microbial growth, and other microbial particles become airborne, some building occupants may experience symptoms including allergic reactions. One potential, but extremely rare infection is caused by Legionella bacteria. Exposure to the Legionella bacteria can produce a building related illness (Legionnaire's Disease or Pontiac Fever) that can be diagnosed through medical tests. Cases of building related illness are rare, however.

Cigarette smoke contains fine particulate matter, carbon monoxide, formaldehyde, and thousands of other chemicals. It presents a serious health risk to those exposed. Studies have shown that exposure to secondhand tobacco smoke may result in inner ear infections, asthma, and lung cancer in nonsmokers. The U.S. EPA has listed tobacco smoke as a confirmed cancer-causing agent. With more restricted smoking regulations in public areas and workplaces, this exposure has decreased greatly.

Contaminants may also originate outside the building and enter via the outdoor air intakes or, when more air is removed by the HVAC system from the building than is supplied, allowing air to flow into the building through any available gap. When this occurs, the building is said to be operating under negative pressure differential with respect to the outdoor air.

Occupants may also unknowingly bring potential contaminant sources into the building, including dust, consumer products (cleaners, air fresheners, personal hygiene products, etc.), and allergenic particles from their homes, such as cat or dog dander. What occupants do may also affect IAQ, such as blocking air ventilation grills, overusing office chemical products, and improperly storing food, which may lead to odors and vermin infestation.

Why is ventilation important?

Poor IAQ may develop when not enough fresh air is introduced to reduce contaminant concentrations. In addition, the HVAC system must not only control contaminants, it must provide a comfortable environment. The perception of still or stale air, odor, draftiness, or errant temperature and humidity leads to discomfort; and discomfort, however subtle, can be the beginning of IAQ complaints. Many IAQ complaints originate with the HVAC system failing to meet occupants' comfort needs, either by not controlling temperature and humidity or not delivering outside air evenly to occupants.

Studies have shown that communicable diseases, like the common cold, influenza, and tuberculosis, spread more efficiently in poorly ventilated buildings. Proper air filtration is also important. However, most of these kinds of illness are passed from person to person through the air or from contacting viruses or bacteria on surfaces, and thus are largely beyond the control of the building owners. Nevertheless, steps can be taken to limit the spread of serious communicable diseases – for example, pandemic flu. Resources can be found at www.pandemicflu.gov and www.aiha.org/Content/Topics/Pandemic/.

What can be done about IAQ complaints?

First, the occupant concerns should be taken seriously and responded to quickly. Visit the area of concern and determine the following, preferably through personal interviews with individual occupants.

- What are the specific complaints?
- Where in the building are similar concerns about IAQ occurring?
- When does the problem occur?
- When and where did it first occur?
- Who is affected? Is it isolated, or over a large area?
- What health effects or discomfort are occupants experiencing?
- Do the health effects cease soon after leaving the building, or over the weekend?
- Have those affected seen a physician and, if so, what were the diagnoses?

- Is there any environmental condition (e.g., weather) or activity (e.g., remodeling, use of the photocopier, spraying of pesticides) inside or outside the building associated with occurrence of the problem?
- Has the building engineer or HVAC contractor evaluated the area(s) and, if so, what were their conclusions?

Second, evaluate the information. Determine if there is a time or space pattern to the complaints. Conduct a walk-through of the area to identify potential sources of contamination or unusual conditions. Also, consider whether the problem may be linked with an activity or condition inside or outside the building, or a malfunctioning HVAC system. In many cases, the source of the complaints may be readily apparent upon investigation, such as HVAC system air intakes next to an exhaust or a loading dock, the recent addition of large photocopiers in a small room without ventilation system modification, an incorrectly set or broken thermostat, or recent remodeling.

When should air testing be done?

Carbon dioxide testing is often performed during the early stages of an IAQ investigation because people exhale carbon dioxide and if there is not enough outdoor ("fresh") air in a space, the indoor levels will increase. Elevated carbon dioxide concentrations in a building reflect insufficient exchange of "fresh" outdoor air for "spent" interior air, allowing the accumulation of human-source odors, and possibly other contaminants. ASHRAE recommends that the indoor levels of carbon dioxide should be controlled to reduce occupant complaints of human-source body odors. When sufficient outdoor air is supplied in keeping with the ASHRAE recommended ventilation levels, the ventilation is generally considered to be adequate. If it is not possible to directly measure the rate of outdoor air supply, an industrial hygienist can measure the indoor and outdoor levels of CO₂ and estimate the adequacy of the ventilation.

It should be emphasized that this approach does not work in all cases. If a particularly irritating or toxic contaminant is present, the problem can only be resolved through control of the contaminant at its source.

Testing for other contaminants (e.g., particulates, volatile organic compounds, microbes, formaldehyde, and pesticides) may provide valuable information but is recommended only if there is good reason to believe that a contaminant is present (a source has been identified, or medical evaluation of occupants so indicates). Air testing for a broad spectrum of potential contaminants is generally unproductive. Carbon monoxide (CO) testing or continuous monitoring, on the other hand, is relatively inexpensive and is strongly recommended if there is any reason to doubt the proper venting of indoor combustion sources, such as natural gas furnaces or water heaters.

Usually the greatest value of air testing is in the comparison of the results in different locations within a building, indoors versus outdoors, and at different times. The data generated may yield information about the origin of the problem and possible solutions.

How can IAQ problems be prevented?

Three fundamental measures that will greatly reduce the likelihood of IAQ problems are: (1) good building design, (2) effective building maintenance (particularly of the HVAC system), and (3) intelligently designed and executed remodeling projects. Every building manager should develop a performance profile of the building ventilation system, including analyses of comfort, ventilation, and sanitation. This is accomplished by:

- Inspecting accessible areas of the system for obvious malfunction, bad design, or contamination; and
- Determining airflow, temperature, humidity, carbon dioxide concentrations, and air balance (pressure differentials) in representative areas (zones or rooms) of the building.

The information developed:

- May reveal problems with the building's HVAC system – that is, areas in which the system is clearly not performing on par with the remainder of the building; and
- Allows comparison with building design parameters, building codes, and guidelines established in the ASHRAE Standard 62.1. However, ASHRAE 62.1 has undergone many changes over the years, and older buildings may have been designed to an earlier version of the standard. Upgrading existing ventilation systems to meet the newest 62.1 design recommendations may be cost prohibitive, or otherwise infeasible.

Beyond the initial system profile, it is crucial that the HVAC system be routinely inspected and maintained. Maintaining good IAQ in a building also requires careful managing of custodial, pest control, and building engineering or contractor maintenance activities.

Prior to initiating remodeling activities, discuss IAQ concerns with architects and contractors. Require that the materials and procedures used minimize airborne contaminants. Select materials and products that are low-emitting or environmentally friendly when possible. Where feasible, schedule work to minimize the impact on air quality (e.g., perform painting on weekends) and arrange for the ventilation system serving the area to be isolated from the remainder of the HVAC system. If walls are being added or moved in the project area, or the number or distribution of occupants is to be greatly changed, modify the ventilation system to meet the new requirements.

What you can do to control indoor air contaminants?

The best method to control indoor air contaminants depends on the source or sources causing the complaints. Source control is generally the most cost-effective solution to the problem. For example, environmental tobacco smoke-related complaints have been eliminated in many municipalities by prohibiting smoking within buildings, or by isolating designated smoking areas and providing them with independent ventilation.

Modification of the ventilation system may also be an effective method of resolving IAQ complaints. Contaminants can be diluted with outdoor air, or contaminants such as radon can be isolated or removed by changing air pressure relationships between adjoining areas. Increasing the outdoor air supply to meet the criteria of ASHRAE 62.1 may require design and installation of additional heating, cooling, or dehumidification to prevent comfort or moisture-related problems. However, a well designed and maintained HVAC system may be able to improve work environment enough to pay for itself through improved occupant productivity.

Air cleaning may also be used to control indoor air contaminants, particularly when the contaminant source is outside the building. For example, occupants may experience allergic reactions to pollen drawn into the building with outside air. Typically, air cleaning is performed by high efficiency air filters installed in existing HVAC systems and is used in conjunction with source control or other ventilation system changes.

During renovation activities, avoid running combustion appliances, such as propane heaters or fuel-fired generators indoors. Carbon monoxide exposure can be fatal. Refer to the AIHA brochure "Carbon Monoxide – The Silent, Cold Weather Killer," listed toward the end of this brochure.

Occupants can help by 1) promptly reporting unusual odors or discomfort, 2) being aware of weather conditions or other factors associated with periods when IAQ concerns appear, 3) using chemical formulations sparingly and only where dedicated ventilation is provided, 4) not taping off air supply diffusers (since it disrupts proper mixing and distribution of air), and 5) minimizing use of perfumes or colognes that may trigger a co-worker's discomfort.

When should I seek outside help?

If the problem persists even after you have identified and rectified obvious sources, you may want to seek outside assistance. You may also require outside help if the problem requires immediate attention and your resources are limited, or your preliminary investigation reveals little of significance and you don't know what to do next.

Sources of professional help include the yellow pages (under "industrial hygiene" and "engineers-ventilation") or local, state, or federal agencies, such as local or state health departments. For a list of industrial hygiene consultants published semiannually in the *Consultants Listing*, please call AIHA at (703) 849-8888 or visit www.aiha.org. In certain cases, assistance from specialists in medicine, lighting, acoustic design, or psychology may be needed.

When evaluating consultants, pay particular attention to their professional background in terms of education, professional credentials, the reputation of their firm, and, most important, demonstrated success in resolving similar situations. Ask for references. Hiring someone to perform a poorly conceived study is worse than a waste of money and time: it may lead to erroneous conclusions and costly remedial efforts of no intrinsic worth. If a consultant proposes elaborate and expensive air monitoring without demonstrating to your satisfaction that the resulting data will be meaningful, look elsewhere for assistance. There is a helpful brochure listed below on how to select an IAQ consultant.

There are also written references that you may find useful:

- The EPA/NIOSH publication titled *Building Air Quality—A Guide for Building Owners and Facility Managers*. It may be downloaded from the NIOSH website, <http://www.cdc.gov/niosh/baqtoc.html>.
- ANSI/ASHRAE standards 62.1 and 55 are available from ASHRAE (www.ashrae.org)

- The AIHA publication *The IAQ Investigator's Guide*, 2nd edition (AIHA, 2006) gives practical information and guidance for IAQ investigations. Available from AIHA (www.aiha.org).

AIHA has developed several brochures for the public. These brochures are available online at <http://www.aiha.org/Content/AccessInfo/consumer/>.

- “Carbon Monoxide–The Silent, Cold Weather Killer”
- “Facts About Mold”
- “Guidelines For Selecting An Indoor Air Quality Consultant”
- “Is Indoor Air Quality a Problem in My Home?”
- “Is Lead a Problem in My Home?”

In Summary

Indoor air quality concerns are a fact of life for building owners, business owners, managers, and occupants. It is not possible to satisfy every occupant at all times, particularly in the case of thermal comfort. However, it is possible and necessary to provide a work environment that is healthy and safe. A building managed with an eye for preventing IAQ problems may not guarantee that occupants will not occasionally complain about IAQ, but it does greatly reduce the likelihood of chronic discomfort and will likely increase building occupants' productivity.

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