Indoor Air Quality

It is recognized that good indoor air quality is essential to employees' health and productivity. The purpose of this program is to establish a means for addressing employees' concerns regarding indoor air quality, and to promote good indoor air quality in University buildings.

Investigations of indoor air quality (IAQ) often fail to identify any harmful levels of specific toxic substances. Often employee complaints result from items such as odors, low-level contaminants, poor air circulation, thermal gradients, humidity, job pressures, lighting, work-station design, or noise. In approximately 500 indoor air quality investigations, the National Institute for Occupational Safety and Health (NIOSH) found that the primary sources of indoor air quality pollution problems are:

- Inadequate ventilation 52%
- Contamination from inside building 16%
- Contamination from outside building 10%
- Microbial contamination 5%
- Contamination from building fabric 4%
- Unknown sources 13%

Complaints are often subjective and nonspecific in nature and are associated with the period of occupancy. These symptoms often disappear when the employee leaves the workplace. They include headache, dizziness, nausea, lack of concentration, and eye, nose, and throat irritation.

Investigation of indoor air quality problems can be complicated due to highly charged emotions, the complexity of the buildings themselves, and the fact that standard evaluation techniques may be inconclusive.

Acceptable indoor air quality can be defined as air in which there are no known contaminants at harmful concentrations and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction.

Governing Regulations

There are no federal statutes or regulations regarding indoor air quality.

Florida Department of Business & Professional Regulation: *Regulation of Building Inspection Professionals*; Effective Date: 07/01/2010. Provides for DBPR to certify and license those who do mold assessment and remediation. Exemption: An authorized employee of the US, Florida, any municipality, county, or other political subdivision, or public or private school and who is conducting mold assessment within the scope of that employment, as long as the employee does not hold out for hire to the general public or otherwise engage in mold assessment.

Responsibilities

Environmental Health & Safety will investigate complaints that may be related to indoor air quality problems focusing on their resolution.

Many times **Facilities** and other departments will help facilitate corrective actions.

Typical IAQ Complaint Causes

Investigating IAQ complaints is a process of narrowing down the range of possible problem causes and eliminating them. The six major sources of concern are as follows:

1. **Inadequate Ventilation**: These problems involve lack of fresh air and/or uneven distribution of fresh air in the building.
2. **Temperature and Humidity**: These problems involve temperature and humidity levels outside of the normal comfort range of workers.
3. **Microbiological Contamination**: Generally, this type of problem is associated with the air handler unit and/or ductwork being contaminated with mold. For additional information regarding mold, see Mold FAQ.
4. **Outside contamination**: This is due to re-entrainment of previously exhausted contaminants, generally caused by improper air intake placement or by periodic changes in the wind conditions. One of the most common sources of outside contamination has been vehicle exhaust and emergency generator fumes.
5. **Inside Contamination**: Copy machines and office products have been identified as significant sources.
6. **Building Fabric Contamination**. This is caused by materials off-gassing when the materials are first installed such as carpet and painted surfaces. These problems often resolve with time.

IAQ Complaint Investigations

Generally, there are three steps in a diagnostic process. This problem characterization is intended to solve typical indoor air quality problems that are not emergencies.

1. Determine if the problem is building related.
2. Proceed through a deliberate process of characterizing problems and finding evidence as to causes, and communicating with occupants.
3. Check specific causes until the problem is solved.

An IAQ investigation is like detective work - defining the problem, looking for clues, and finding a solution through a process of narrowing the possible causes, and developing and testing hypotheses.

Clues may be found in basic information about the problem. Seeking the right information from occupants, examining building systems and components, and making simple diagnostic measurements can solve most problems. Occupants helping answer the following questions help determine the problem:

- *What are the symptoms?* What are the symptoms or substance of the complaint?
- *Where is the problem?* Local or widespread, in one part of the building or more, on one side of the building or all sides, one floor/room or throughout the building?
- *When does it occur?* Time pattern, time in relation to individual activities, time in relationship to other activities in the building, time in relation to occupancy in building? Answers can give clues as to whether it is related to the building or elsewhere, and what activities may be associated with the cause and whether the cause is occupant related or building related.
- *Who is the problem experienced by?* An individual or several, just in persons with pre-existing sensitivities or across the board? Answers provide clues as to whether or not the individuals may have special needs that, if accommodated, could solve the problem.

Other questions are provided in the Occupant Health and Comfort Questionnaire.

Typical IAQ investigations will include the review of several items including: a visual inspection of the Heating, Ventilation and Air Conditioning System (HVAC); observation of physical conditions in the area of concern; interviews with the individuals experiencing concerns; and measurements of air temperature, humidity, carbon dioxide and possibly other contaminants. More information on environmental measurements can be found in the appendix. A general walk through of the building is performed to identify potential problems such as:

- Water damaged ceiling, wall, and floor finishes
- Mold growth on building components
- Apparent building use changes
- Recent renovations
- Lingering odors outside air dampers
- Operation of the HVAC system
- Unprotected openings to a crawlspace, basement, or attic
- Dry or rusted out plumbing traps on floor, sink, and tub drains

IAQ Environmental Conditions and Measurements

Measurements of temperature, humidity, carbon dioxide and other contaminants can help in identifying causes of indoor air quality complaints.

Temperature and Humidity

The thermal environment (temperature, relative humidity and airflow) are important dimensions of indoor air quality for several reasons. First, many complaints of poor indoor air may be resolved by simply altering the temperature or relative humidity. Second, people that are thermally uncomfortable will have a lower tolerance to other building discomforts. Third, the rate at which chemicals are released from building materials is usually higher at higher building temperatures. Thus, if occupants are too warm, it is also likely that they are being exposed to higher pollutant levels.

There is no single “ideal” temperature and humidity level suitable for all building occupants. Concerns regarding temperature and humidity can be caused by:

- Poor thermostat location
- Solar radiation
- Improperly designed HVAC system
- Restricted air flow patterns
- Excessive personnel or equipment loading
- Introduction of excessive outdoor/fresh air

As a practical matter, the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) recommends maintaining a building within the following ranges of temperature and relative humidity will satisfy thermal comfort requirements in most cases. These ranges should obtain thermal acceptability of sedentary or slightly active persons. EH&S uses the ASHRAE recommendations when conducting IAQ investigations.

Relative Humidity	Temperature in Winter	Temperature in Summer
@30%	88.5°F - 76.0°F	74.0°F - 80.0°F
@ 50%	68.5°F - 74.5°F	73.0°F - 79.0°F

Carbon Dioxide

Carbon dioxide is a normal constituent of exhaled breath and can be a useful screening technique which is often helpful in determining whether adequate quantities of outside fresh air have been introduced and distributed into the building. Carbon dioxide is measured in parts per million (ppm).

- 250-350 ppm normal outdoor ambient concentrations
- 600 ppm minimal air quality complaints
- 600-1,000 ppm less clearly interpreted
- 1,000+ ppm indicates inadequate ventilation; complaints such as headaches, fatigue, and eye and throat irritation will be more widespread
- 1,000 ppm used as an upper limit for indoor levels

These levels are only guidelines. If carbon dioxide levels exceed 1,000 ppm it does not necessarily indicate that the building is hazardous and should be evacuated. The levels presented above are used as a guideline to help maximize comfort for all occupants.

The carbon dioxide itself is not responsible for the complaints. However, a high concentration of carbon dioxide indicates that other contaminants in the building may also be proportionately increased and could be responsible for occupant complaints.

Well ventilated buildings should have carbon dioxide levels in the range of 600-1000 ppm with a floor or building average of 800 ppm or less. If the average carbon dioxide concentration within a building is maintained below 800 ppm with comfortable temperature and humidity levels, complaints about air quality should be minimal. If carbon dioxide levels are greater than 1000 ppm, widespread complaints may occur.

The recommended ventilation requirements per occupant are lower in classrooms than in office areas. Acceptable carbon dioxide levels for classroom are 800-1200 ppm with a daily average less than 1000 ppm. Carbon dioxide levels in excess of 1200 ppm indicate a need to increase the supply of fresh air to the classroom.

If elevated carbon dioxide levels are detected, the most likely cause is inadequate outside/fresh air being supplied to the space.

Carbon Monoxide

Carbon monoxide is a normal constituent of exhaust gases from internal combustion engines. For office areas, levels of carbon monoxide are normally in the 1 to 5 ppm range and should not exceed 9 ppm.

Exposure to high levels of carbon monoxide causes occupant symptoms such as headaches, drowsiness, and nausea. Areas where there is a combustion source or possible contamination from an outdoor combustion source (e.g. emergency generators) indicates a potential carbon monoxide exposure.

Hydrogen Sulfide

Hydrogen sulfide is a normal constituent of sewer gas. Hydrogen sulfide is a colorless gas that smells like rotten eggs. Sources of hydrogen sulfide in buildings usually arise from dry drain traps or broken sewer lines. Pouring water down drains will usually alleviate the problem of dry drain traps. A rusted out or broken trap will not hold water and requires replacement.

Volatile Organic Compounds (VOC's)

VOCs are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. VOCs are emitted by a wide array of products numbering in the thousands. Examples include: Paints, cleaning products, disinfecting products, pesticides, many common laboratory chemicals, and cosmetics. Fuels are made up of organic chemicals. Photocopying creates VOCs. New furniture, carpet and renovation activities will generate VOCs. All of these products and processes can release organic compounds while you are using them, and, to some degree, when they are stored. Elevated concentrations can persist in the air long after the activity they are used in is completed.

Key signs or symptoms associated with exposure to VOCs include conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, shortness of breath, nausea, fatigue, and dizziness. Health Effects include eye, nose, and throat irritation; headaches; loss of coordination; nausea; damage to liver, kidney, and central nervous system.

Exposure can be reduced by increasing ventilation when using products that emit VOCs or substituting products with less or no VOCs.

Other IAQ Complaint Contributors

Physical and Ergonomic hazards including noise from nearby sources such as air conditioning systems and printers, inadequate lighting, stress from the operation of video display terminals, improper work station design, repetitive tasks, and improper lighting can result in indoor air quality complaints.

Disagreeable employee relationships with supervisors and co-workers can also result in indoor air quality complaints.

The synergistic effect of multiple stressors appears to indicate that building-related problems may be more than an air quality problem. The combined effect of these multiple stressors may interact with employees and could result in acute adverse emotional or physical reactions. In the short term, these reactions may lead to decreased productivity, absenteeism, and high turnover rates and if prolonged can lead to a variety of illnesses including hypertension, coronary heart disease, ulcers, alcoholism and mental illness.

These office-related health problems can be evaluated by a consultation with the FSU Employee Assistance Program (EAP), through employee interviews, and analysis of job demands. The following potential problems may need to be addressed:

- *Physical hazards* include noise from nearby sources such as air conditioning systems and printers, inadequate lighting, vibration sources, extremes of heat, cold and humidity, drafts, and poor air circulation.
- *Ergonomic problems* include inflammatory disorders of the tendons and joints of keyboard operators due to tasks requiring repetitive motions. Proper design of fixed work stations where employees are required to perform repetitive tasks includes proper lighting to prevent glare, maintaining temperature and humidity in a comfortable range with minimum temperature

variations, maximum flexibility in work station design including adjustable chair, keyboard, and screen height, and a work-rest regimen that allows breaks to reduce psychological distress.

- *Job stress* can be reduced by:
    - Adequate flow of information from management to employees
    - Prompt explanation of any changes introduced into the workplace including new chemicals, ventilation, and work schedules
    - Maximizing employee participation in planning and implementing changes
    - Stress reduction techniques including exercise.

References

- Environmental Protection Agency
- Occupational Safety & Health Administration
- American Industrial Hygiene Association
- National Institute for Occupational Health & Safety

Additional Information and Resources

- Mold FAQ
- Occupant Complaint Diary
- Occupant Health and Comfort Questionnaire