

# Air Monitoring and Indoor Air Quality

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## University of Tennessee Safety Procedure IH-004

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### Purpose

The purpose of these guidelines is to provide a safer working environment for students, staff and faculty. Air monitoring is a recognized method to evaluate and characterize air contaminants that may impact the health of the university community, as well as determine the presence of mold and other air contaminants in the workplace. It shall be the mission of the University of Tennessee to provide a work environment that is safe and reasonably comfortable. Complaints involving indoor air quality shall be investigated to determine the cause and evaluate the risk (if any) to occupants.

Employing safe work practices, as well as using engineering controls, will minimize exposure to hazardous conditions (such as working with volatile chemicals and physical hazards). To confirm that engineering controls and sufficient, EHS conducts air monitoring of work environments and may conduct: sampling for air quality, personnel exposures, and conduct assessments for the presence of mold.

### Scope and Applicability

This procedure shall apply to air monitoring conducted for employee health protection by Environmental Health and Safety (EHS). This procedure shall apply to all faculty, staff and students on the UT Knoxville campus who have the potential for air contaminant exposure.

### Abbreviations and Definitions

#### Abbreviations

**ACGIH:** American Conference of Governmental Industrial Hygienist

**AIHA:** American Industrial Hygiene Association

**EHS:** Environmental Health and Safety

**NIOSH:** National Institute for Occupational Safety and Health

**OSHA:** Occupational Safety and Health Administration

### Roles and Responsibilities

#### Building Occupants

(Including faculty, staff, students, visitors and contractors): University building occupants are expected to maintain the area they occupy in a clean and healthful state. This means that occupants should:

- Properly dispose of unused food and drink, and the associated containers.
- Follow the University's no smoking rules.
- Clean-up or report leaking or spilled liquids.

- Report inadequate ventilation and persistent offensive odors.
- Avoid bringing air pollutants indoors.

**EHS: The Environmental Health and Safety Department is responsible for:**

- Developing and maintaining the Air Monitoring/ Indoor Air Quality guidelines.
- Providing information and guidance to all employees concerning IAQ issues.
- Investigating all reported Indoor Air Quality concerns and if necessary, making recommendations for improvement.
- Maintaining records of employee IAQ concerns and corrective actions.
- Keeping a history of IAQ issues for each campus building for future reference.
- Communicating the status of investigations and corrective action to all concerned.

**Facilities Services is responsible for:**

- Operating and maintaining all building HVAC systems using qualified staff.
- Conducting inspections and maintenance of HVAC systems.
- Notifying EHS of any occupant IAQ concerns or potential projects impacting IAQ.
- Maintaining records of design, installation, inspection, testing, balancing, water treatment, preventative maintenance, repair, replacement and adjustments of HVAC systems.
- Notify EHS and specific campus areas and department managers of projects which may impact IAQ.

## Procedures

### Background Information

Air monitoring may be conducted for a number of reasons listed below:

1. Regulatory compliance (e.g. OSHA)
2. Validation of controls (e.g. properly functioning local exhaust ventilation)
3. Employee concern
4. Characterization of potential exposure to an air contaminant

Results of air monitoring are log-normally distributed and can vary greatly. Professional judgment must be exercised when developing an air monitoring plan and interpreting results.

EHS can conduct live time monitoring or collect samples for laboratory analysis for a myriad of chemicals. These assessments are conducted either qualitatively (to observe for the presence of contaminants) or quantitatively to conduct testing and determine actual concentrations of exposure by an individual.

### Air Sampling

Sampling shall be personal (monitor worn on the employee), in the breathing zone and shall characterize short-duration high-level exposures (ceiling, excursion and short-term exposure limits (STEL)) as well as long duration time-weighted averages where applicable. Some air contaminants list only a short-term or long duration acceptable exposure standard. The monitoring accuracy shall be within 25% of the published standard at the 95% confidence level. In some cases, area monitoring may be conducted to establish background levels, evaluate indoor air quality and validate controls.

The sampling shall accurately characterize all activities (work tasks) where exposure is likely to occur. Where repeated sampling has demonstrated the exposure has fallen below the action level or one-half of any recognized standard, the monitoring may be discontinued. Sampling may be necessary when there is a change in the process, work activity, substance or equipment.

A representative shall periodically check employees who are being monitored. The monitoring shall be conducted to determine that the sampler is being used correctly, not subject to interference and to characterize work activities and exposures.

### **Employee Concerns:**

Indoor air quality problems can come from a variety of sources either inside or outside the building. The agent responsible for the complaint may be transient, intermittent or chronic and it may be chemical, biological or physical in nature.

Individual response to an airborne substance can vary greatly as can an individual's perception of comfort. Other factors can also influence an individual's perception of comfort and should be considered. Allergies (diagnosed or undiagnosed) can be affected by trace amounts of airborne matter. Airborne particulate and biological organisms can represent a serious hazard for individuals who are immune-compromised.

Air monitoring can be expensive, is often inconclusive and must be carefully evaluated when conducted.

1. The person or person who is affected by the indoor air quality or their supervisor should notify EHS or Facilities Services. Notification may be by telephone, e-mail, verbal, written letter or other means. A Request for Service form (Appendix E) can be completed and submitted to EHS. No employee shall be retaliated against for initiating a complaint. However, the person submitting the complaint may remain anonymous if so desired. Individuals wishing to remain anonymous should make this wish known at the initial communiqué. See safety plan GS 100, Reporting Safety Hazards for additional details.
2. The complaint shall be investigated and a corrective action recommended. The complaint may be investigated and resolved by a single department (e.g. EHS). However, it is generally best to take a team approach and involve other departments. When an indoor air quality complaint is complex or the agent(s) is/are unknown, a team approach is certainly warranted. The investigation shall be made in a timely manner based on the perceived degree of hazard.
3. Results of the investigation shall be communicated to the person(s) who initiated the complaint. This shall also apply to cases where the source(s) of the complaint cannot be determined. EHS shall also inform the complainant of the degree of risk (risk communication).
4. Facilities Services shall be responsible for evaluating the building's mechanical systems relative to the indoor air quality complaint.

### **Tools and Techniques Used to Characterize and Evaluate Indoor Air Quality Problems**

In some cases the cause(s) of an indoor air quality complaint are obvious and an exhaustive review of the building is unnecessary. However, often the cause is unknown and a more rigorous approach must be taken to identify the agent(s). Appendix B (Indoor Air Quality Checklist) and Appendix C (Occupant Diary) may be used to identify potential problems. Note that other data collection tools may also be used at the discretion of the investigator.

Air monitoring for mold may be conducted, however, it is generally the responsibility of the department requesting the sampling to pay for this service. EHS can obtain mold sampling equipment, collect samples using recognized protocol and interpret the results, upon request of the department.

### ***Frequency of Air Monitoring***

Air monitoring shall be conducted in accordance with regulatory (e.g. OSHA) requirements and periodically based on professional judgment. Repeat air monitoring shall be conducted when results are equal to or greater than the defined action limit (generally considered to be one-half of the permissible exposure level) accounting for sampling and analytical errors.

### ***Quality Control***

Utmost care shall be taken to ensure that air monitoring is conducted in accordance with accepted industrial hygiene practices. For valid results all aspects of sampling and analysis must be controlled. Sampling protocols for the sampling media and method shall be maintained in the EHS office. Batches of air sampling generally will include a blank. Sample spikes may be used periodically.

### ***Equipment Calibration***

Equipment shall be calibrated as needed. Results of the calibration shall be recorded in the field air monitoring worksheet (Appendix A) and air monitoring database. Calibration standards (e.g. span gas) shall be kept current (e.g. not expired). Instruments may be periodically sent to the factory for calibration, maintenance and repair.

### ***Laboratory Analysis***

Only American Industrial Hygiene Association (AIHA) accredited laboratories shall be used to analyze samples. The type of analysis shall be dictated by regulatory requirements. Professional judgment may be used when no regulatory guidance is available.

### ***Regulatory Standards***

OSHA is usually the primary source of regulations that address air monitoring and worker protection. It should be noted that a number of substances (e.g. formaldehyde and lead) have specific standards, so the applicable section of OSHA must be consulted regarding sampling methodology, frequency, etc. When OSHA does not address a particular substance, other recognized standards such as ACGIH, AIHA, NIOSH or industry standards will be used.

When no recognized standards exist, professional judgment shall be used to evaluate the acceptable exposure level. Factors to weigh include applicable routes of exposure, similarity to other recognized chemical hazards, current research and safety factors. Indoor mold currently has no federal or state regulatory standards.

### ***Regulated Area***

When air monitoring results indicate that an action limit has been routinely exceeded, that area shall be posted. The text of the posting shall be done in accordance with OSHA regulations.

### ***Air Monitoring of Spills and Unplanned Releases***

Chemical spills can result in airborne exposures that substantially exceed published limits. Air monitoring prior to clean up can define the necessary level of personal protective equipment. Monitoring after spill cleanup will provide documentation of safety to re-occupy the space. Employees of EHS may use air monitoring as part of the spill cleanup process to assess the hazard. The preferred method of air monitoring for spills is direct reading equipment.

### ***Notification of Employees and Risk Communication***

All employees shall be notified as soon as possible of the results of their air monitoring, but in no case more than five working days past the date of receipt of the results. The notification shall be done in writing or by posting results. Where the results exceed a regulatory standard, or action level, the notification shall also include the steps to be taken to control the exposure. Included with the results shall be a comparison between the employee's exposure and reference standards such as the OSHA permissible exposure level, ACGIH or the NIOSH. The risk associated with exposure to the contaminants, based on the air monitoring results, shall be explained to the employee.

### ***Limitations of IAQ Investigations***

Sampling methodologies and acceptable exposure limits have been established for many workplace contaminants. However, workers may continue to experience discomfort at contaminant levels below the standards set for occupational exposure. Individual sensitivities vary and the ability to measure possible irritants at low concentrations may be limited by technology. Thus, irritants may be present at low concentrations that are undetected but which may cause health effects in sensitive individuals.

Also, the sampling and measuring of indoor mold contamination in the air and on surfaces is of limited value as mold is found in virtually all environments and because no consensus standards or regulatory standards have been established.

## **Indoor Environmental Quality Checklist**

### ***Building Occupants***

The following list notes items or procedures that should be followed in order to minimize the risk of creating a potential IAQ problem. This list should also be used as a guideline for an initial site- based investigation if an IAQ complaint is reported.

- Clean-up any spills or leaks immediately.
- Eating should be limited to designated areas due to the potential for the development of vermin and cleaning problems.
- Limit the amount of clutter. Excess supplies and personal items stored on the floor or on open shelves make it difficult to adequately clean a room. Closed cabinets are preferable for storage rather than open shelving.
- The use of chemical air fresheners (i.e. "Plug-ins", sprays) should be limited in use, due to their tendency to emit volatile organic compounds (VOC) that may trigger a sensitive individual's asthma or other respiratory condition.
- Do not alter or block air flows to and from air conditioning diffusers without first contacting Facilities Services. Realize that, depending on the type of air conditioning system, it may not be possible to open windows and doors without affecting air flows and temperatures throughout the whole system.
- Do not bring in insecticides from home. Pest control concerns need to be brought to the attention of Pest Management.
- Do not over water potted plants. Eliminate standing water in the bottoms of plant pots. Note that potted plants can be a significant source of mold in an indoor environment.
- Sewer gas odor issues are often due to dried out sink or floor drain traps. Pouring a bucket of water into a floor drain or running the water in a sink for a minute or two will often eliminate the odor.
- Wash hands frequently to help prevent the spread of infectious illnesses such as the flu and colds.

- If an IAQ concern involves some foul odor in a particular room, an inspection should be made for a dead animal, a forgotten lunch or some other possible cause within that room prior to contacting EHS.

## IAQ Concern Resolution

### Overview

The greatest challenge posed by IAQ concerns is that the reported symptoms and health complaints are generally diverse and usually not suggestive of any particular medical diagnosis or readily associated with a causative agent. Typically, physical symptoms includes headaches, unusual fatigue, itching or burning eyes, skin irritation, nasal congestion, dry or irritated throats, and other respiratory irritations. The workplace environment is frequently implicated because workers report that their symptoms diminish or cease once they leave the workplace. In such cases, however, it is often difficult to ascertain causation and/or substantiate a violation.

Strategies for investigating indoor air quality problems can be very straightforward in that relevant information is gathered and conclusions are drawn based on findings. In the absence of specific contaminant sources or obvious ventilation problems, EHS will try to analyze the scope of the problem and systematically identify or eliminate elements which are specifically associated with IAQ episodes. It should be noted that an overwhelming majority of investigations of campus ventilation systems reveal that they are well maintained and operating properly.

When the occupant believes the cause of physical symptoms is the quality of the indoor air, the following typical procedure will be followed by EHS (the scope may vary depending on findings).

### EHS Response

- **Meeting:** an EHS staff person will meet with someone familiar with the problem, usually the affected person(s) or a supervisor, to identify the specific concern.
- **Walk-through:** an initial walk-through will be conducted by EHS to possibly identify immediately correctable causes or to develop a plan for conducting a more thorough investigation.
- **Scope:** strategies/hypotheses are developed to evaluate suspected problems
- **Initial Sampling:** a preliminary IAQ sample may be conducted. An instrument will be used that measures temperature, relative humidity, carbon dioxide and carbon monoxide.
- **Temperature:** ASHRAE recommended ranges of 73° F to 79° F during the winter months and 69 to 75 during summer months will be evaluated. During normal occupied hours, the target indoor air temperature at UTK shall be 68 degrees Fahrenheit for heating and 76 degrees Fahrenheit for cooling. Facilities Services shall ensure that building spaces areas close to these set points as possible. Exceptions to these temperatures must be approved. Please see UTK's Energy Conservation Policy for more information.
- **Relative Humidity:** levels can affect the release rate of many indoor contaminants, their concentrations in the air, and the potential growth of microbial organisms. In ASHRAE 55-1981, an acceptable range of humidity is 20 to 60%.
- **Carbon Dioxide:** is used as an indicator to evaluate the performance of ventilation systems. Ordinary outside air in urban areas normally contain about 300 to 500 parts per million (ppm). ASHRAE standard 62-2001 (Ventilation for Acceptable Indoor Air Quality) recommends that CO<sub>2</sub> levels not exceed 700 ppm above outdoor ambient levels. OSHA limits carbon dioxide concentration in the workplace to 5,000 ppm for prolonged periods, and 35,000 ppm for 15 minutes.



- Carbon Monoxide: indoor levels of CO are generally similar to levels found in the air outside of the occupied building. The current regulatory permissible exposure limit (PEL) as set by TOSHA is 35 ppm.
- Involve Other Department: EHS will call upon Facilities Services for their expertise.
- Evaluate Findings: conditions and measured/monitoring results are compared to criteria established through standards, codes, guidelines and good practice.
- Identify Solutions: the need for corrective actions and controls is identified, and solutions are recommended.
- Correction: controls and recommendations are implemented as necessary.
- Follow-Up: findings and results are communicated to concerned parties.

Investigations will not be initiated over issues of comfort, and such issues normally will not result in a walk-through or follow-up.

## Training and Information

EHS and Facilities Services staff shall be adequately trained to recognize, evaluate and suggest controls for indoor air quality problems.

## Recordkeeping

Records, including the air monitoring field worksheets, and laboratory analytical results shall be permanently maintained in an electronic format or paper copy in the EHS office.

EHS shall document all indoor air quality complaints that they investigate, as well as laboratory testing results (i.e. mold). Records shall be maintained for at least three years.

## References

29 CFR 1910.1000 to .1450

NIOSH REL's

## Appendices

Appendix A: Air Monitoring Field Worksheet

Appendix B: Indoor Air Quality Checklist

Appendix C: Occupant Diary

Appendix D: Occupant Interview

Appendix E: Request for Service Form (see EHS website)

## Disclaimer

The information provided in these guidelines is designed for educational use only and is not a substitute for specific training or experience.

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## Appendix A

## Air Monitoring Field Worksheet

Date	
Location	
Person sampled	
Personnel #	
Job title of employee	
Other job titles with similar exposure	
Department	
Work activity	
Temperature	
Humidity	
Air velocity	
Controls used	
PPE used	
Sample number	
Sample type	
Sampling media	
Media expires	
Substance(s) being sampled	
Interference	
Sampling flow rate	
Sampling start time	
Sampling stop time	
Total sampling time	
Total volume sampled	
Sampling device	
Pre-sampling calibration	
Post-sampling calibration	
Sampled by	
Date sent to lab	
Laboratory	
Analysis protocol used	
Results	
Comments	

## Appendix B

### Indoor Air Quality Checklist

#### HVAC System

*The following items on AC units feeding the area of complaint should be checked.*

- Air flow into the area of complaint.
- Check grilles and registers for buildup of dust, and general cleanliness of the area.
- Check intake dampers and assure that the proper outdoor air quantity is being taken into the system.
- Check area where outdoor air is being obtained for any unusual conditions, pooling of water, biological growth or exhaust fans and roof vents less than 25 feet away.
- Check filters for any biological growth or unusual material captured in the filters.
- Check filters PM records to insure proper changing.
- Check AC unit housing for cleanliness, pooling of water, wet insulation and any biological growth.
- Check coil, drain pan for any biological growth and any unusual pooling of water or leaks into the housing.
- Check condensate drain and trap for operation.
- Check for any dry floor drains that may allow sewer gas into the AC system.

#### ***Factors Inside the Building***

##### Floors

- New carpet
- Soiled or stained carpets
- Signs of water leakage
- Frequency of cleaning

##### Walls

- New paint or sealant
- Signs of water damage
- Visible growth of mold
- New decorations

##### Ceilings

- New paint or sealant
- New ceiling tiles
- Visible signs of water leakage or stain
- Noted condition above drop ceiling
- Missing ceiling tiles

##### General Room Considerations

- Pesticide use
- Plants
- New furnishings

- Use of aerosol chemicals
- Recent maintenance activities
- Construction/demolition activities occurring nearby
- Dust on horizontal surfaces
- Frequency of room cleaning
- Use of chemicals in room, adjacent, above or below
- Windows
- Below grade
- Copy machine
- Chemical spills
- Previous use of room or space
- Is room under positive or negative pressure?
- Length of time space has had its current occupants
- Waste disposal
- Prevalence of diagnosed allergies among workers
- Equipment
- Other

#### ***Factors Outside the Building***

- Roofing work
- Vehicles idling
- Maintenance or construction activities
- Pollen
- Repaving projects
- Smoking
- Loading dock
- Other

#### ***Symptoms***

**Date of first onset**

**Number of individuals affected**

**Location of affected individuals**

Condition

- Transient
- Continual

Trends

- Daily
- Weekly
- Monthly
- Seasonal

Symptoms

- weakness
- numbness
- swelling
- dry throat
- fever
- sleepiness
- coughing
- sneezing
- congestion
- rash
- joint pain
- eye irritation
- dry eyes
- headaches
- dizziness
- blurred vision
- head colds
- feeling cold or chilled
- hot – damp

## Appendix C: Occupant Diary

<b>Occupant Name:</b>	<b>Title:</b>	<b>Phone:</b>
<b>Location:</b>		

On the form below, please record each occasion when you experience a symptom of ill-health or discomfort that you think may be linked to an environmental condition in this building.

It is important that you record the time and date and your location within the building as accurately as possible because that will help to identify conditions (e.g. equipment operation) that may be associated with your problem. Also, please try to describe the severity of your symptoms (e.g., mild, severe) and their duration (the length of time that they persist). Any other observations that you think may help in identifying the cause of the problem should be noted in the "Comments" column. Feel free to attach additional pages or use more than one line for each event if you need more room to record your observations.

<i>Time/ Date</i>	<i>Location</i>	<i>Symptom</i>	<i>Severity/ Duration</i>	<i>Comments</i>

## Appendix D: Occupant Interview

Location: \_\_\_\_\_

Occupant name: \_\_\_\_\_ Date: \_\_\_\_\_

### Symptom Patterns

What kind of symptoms or discomfort are you experiencing? \_\_\_\_\_

Are you aware of other people with similar symptoms or concerns? Yes\_\_\_\_ No\_\_\_\_

If so, what are their names and locations? \_\_\_\_\_

\_\_\_\_\_

Do you have any health conditions that make you particularly susceptible to environmental problems?

\_\_\_\_\_

\_\_\_\_\_ Wear contact lenses                      \_\_\_\_\_ Chronic respiratory problems

\_\_\_\_\_ Allergies    \_\_\_\_\_ Immune system suppressed

### Timing Patterns

When did your symptoms start?

Do they go away? If so, when?

Have you noticed any other events (such as weather events, temperature or humidity changes, or activities in the building) that tend to occur around the same time as your symptoms?

\_\_\_\_\_

### Spatial Patterns

Where are you when you experience symptoms or discomfort?

Where do you spend most of your time in the building/office/lab?

### Additional Information

Do you have any observation about building conditions that might need attention or might help explain your symptoms (e.g., temperature, humidity, drafts, stagnant air, or odors)?

\_\_\_\_\_

Have you sought medical attention for your symptoms?

\_\_\_\_\_

Do you have any other comments? \_\_\_\_\_