

Indoor Air Quality Investigation Guidelines

General information:

EHS often receives reports of headaches, eye/nose/throat irritation, dry cough, fatigue, etc. which employee (s) relate to the quality of the air in a particular work area. An on-site investigation is generally necessary to address occupant's concerns. Occasionally, the Employee Health Physician requests specialized IAQ sampling based on symptoms or medical issues relating to the affected employee.

Categories of IAQ associated conditions include:

Sick Building Syndrome (SBS) - describe situations in which building occupants experience health and comfort effects that appear to be linked to a building/area, but no specific illness or cause can be identified. Generally, symptoms clear up when employee leaves the building.

Building Related Illness (BRI) – describes situations when a definitive illness can be attributed directly to airborne contaminants within a building. Symptoms have prolonged period of recovery after employee leaves the building.

Multiple Chemical Sensitivity – condition which a person is sensitive to very low levels of a variety of chemicals, but no specific diagnosis can be made.

Sources of IAQ problems

- HVAC system
 - Inadequate ventilation or fresh air
 - Poor distribution (i.e., areas remodeled or sectioned off and HVAC not updated)
- Indoor operations
 - Ozone from copiers/fax machines
 - Cleaning agents
 - Adjacent operations
- Outdoor operations
 - Vehicle exhaust
 - Construction activities
- Building material contamination
 - New furnishings
 - Carpeting
 - Adhesives, paints, etc.
- Biological/microbial contamination
 - Water leaks/sources of on-going moisture
 - Allergens
 - Stagnant water in HVAC system

Response

During initial call or contact, employee “interview” should include a description of:

- the symptoms they are experiencing or concerns they have
- when symptoms began
- when it is worst or if it worsens as the day/week progresses
- when it occurs (i.e., a particular time of day)
- whether the symptoms subside after leaving the building, after work, on weekends
- any other locations where they have similar issues

During the site visit:

NIOSH has determined that inadequate ventilation is the main problem in approximately half of their IAQ investigations. Therefore, ventilation surveys should be conducted during the walk through. This would include:

- noting locations of supply/return grilles
 - check to see if there is any dust near air vents/diffusers
- identifying where the air intake for building is located
- discussing with Facilities staff the proper operation of the HVAC systems and any maintenance

Also during the walk through:

- look for water leaks, sources of moisture (damaged ceiling tiles, walls, or mold growth anywhere)
- note any construction activity in the area or adjacent spaces
- note any new furnishings, carpeting, paint, etc.

IAQ Measurements

Screening:

During the initial site visit, screening measurements for the general IAQ parameters may be taken. These include temperature, humidity, carbon monoxide, and carbon dioxide. Depending on the complaint, VOCs and dust measurements may also be taken during this initial walk-through. Measurements should be taken in a non-complaint area as well as the complaint area.

Datalogging:

Datalogging conditions over the course of several days or a weekend should also be considered in some circumstances. The data that is collected during long duration monitoring provides a more comprehensive look into how the ventilation may be functioning or if there is an episodic event occurring, i.e., if there are times of the day/night when humidity levels are extremely high, if the ventilation does not turn on until after the area is occupied and CO₂ levels climb, if dust levels are higher when the ventilation is on, etc.

IAQ Parameters

Except where noted, the recommended limits listed below are for comfort and are guidelines only.

Carbon Dioxide

Carbon dioxide (CO₂) is used as an indicator to evaluate the performance of ventilation systems. Outside air normally contains about 350 ppm CO₂. ASHRAE standard 62.1-2004 (Ventilation for Acceptable Indoor Air Quality) recommends that office ventilation systems be designed with a minimum of 17cfm of outdoor air per person, which will help achieve their recommendation that CO₂ levels be maintained at 700ppm above outside air levels (~1000 ppm). As levels of CO₂ exceed ~1000ppm, occupants begin to

complain that the office feels stuffy, or they may suffer from headaches, and eye and throat irritation. If CO₂ levels exceed 1000ppm, it does not indicate a hazardous condition; only that occupant discomfort may increase. Increasing fresh air or verifying that the HVAC system is adequately distributed may alleviate the problem.

Note: The OSHA permissible exposure limit for CO₂ is 5000ppm for an 8hr TWA.

Equipment: Q-Trak

Temperature

ASHRAE 55-2010 (Thermal Environmental Conditions for Human Occupancy) recommendations are listed in the following chart. According to ASHRAE, this will produce thermal comfort conditions acceptable to ≥80% of the occupants.

Temperature / Humidity Ranges for Comfort		
Conditions	Relative Humidity	Acceptable Operating Temperatures
		°F
Summer (light clothing)	If 30%, then	76 - 82
	If 60%, then	74 - 78
Winter (warm clothing)	If 30%, then	69 - 78
	If 60%, then	68 - 75

The following is a tabular representation of the University standard temperatures, relative humidity (RH) and central air handling unit operation policy. These standards, along with more information on energy at Yale, can be found at <http://java.facilities.yale.edu/energyGuide.shtml>

	Summer Occupied	Summer Unoccupied	Winter Occupied	Winter Unoccupied	Winter Recess	Relative Humidity	Air Supply
Dormitory	75±	N/A	68±	65-68° F night setback	60° F T-setback	N/A	N/A
Classroom	75±	HVAC-Off Temp. Uncontrolled	68±	65° F night setback	60° F T-setback	N/A	Summer Unoccupied Off
Offices	75±	HVAC-Off Temp. Uncontrolled	68±	65° F night setback	60° F T-setback	N/A	Summer Unoccupied Off
Laboratory As req'd	75±	78-80° F night setback	68±	65° F night setback	60° F T-setback	50% RH	Summer/Winter Unoccupied setback
Library	75±	78-80° F night setback	68±	65° F night setback	60° F T-setback	30-50% RH	Summer/Winter Unoccupied setback
Book stacks	70° F	70° F	68° F	68° F	68° F	50% RH	On
Assembly/ Dining Hall, etc.	75±	HVAC-Off Temp. Uncontrolled	68±	65° F night setback	60° F T-setback	N/A	Summer Unoccupied Off

Equipment: Q-Trak

Relative Humidity

ASHRAE indicates that an acceptable comfort range of humidity is 30 to 60%. When humidity levels are below 20%, they may cause nose, throat or eye irritation in some people. Levels above 60% may accelerate fungal and bacterial growth. Many buildings on campus are not humidified and the levels measured in them reflect outdoor conditions. Generally, EHS does not recommend personal/space humidifiers, because excess moisture can increase the occurrence of mold in the space and there is the potential for mold or bacteria to grow in the unit itself if not properly maintained. People who choose to use them must ensure that they follow the manufacturer's cleaning and maintenance schedule.

Equipment: Q-Trak

Carbon Monoxide

At low levels, carbon monoxide may cause fatigue. Potential sources of CO inside a building include improperly vented furnaces or flues that are blocked or leaking. It may also be introduced from outside vehicle exhaust or cigarette smoke via the air intake. In office areas, levels of CO greater than ~5ppm, although not a dangerous level, should be investigated. The National Ambient Air Quality Standards/Environmental Protection Agency (EPA/NAAQS) recommended guideline for CO is 9ppm for 8 hours.

Note: The OSHA permissible exposure limit for CO is 50ppm for an 8-hour TWA.

Equipment: Q-Trak

VOCs

VOCs may be emitted from furnishings in offices as well as from other potential pollutants such as copiers, cleaners, adhesives, etc. at low levels. Normal office areas will show levels up to 200ppb VOCs on average, but a comparison between a complaint and non-complaint area can often help determine if there is an issue.

Equipment: ppbRae

Particulates/General Dust

Airborne dust may cause nose, eye, and throat irritation in some people. Dust can be caused by nearby construction activities (both indoors and outdoors), as well as from ventilation systems in need of cleaning. Particulates classified as inhalable are those less than 100 μ m and are identified as total dust. Particulates that are less than 10 μ m in diameter are identified as PM10 and are considered the size that can reach the lower levels of the respiratory tract and cause health effects upon inhalation. Particulates that are less than 5 μ m are considered to be respirable by OSHA and have a separate OSHA PEL. Particulates that are sized to be less than 2.5 μ m (PM2.5) are considered to be the most hazardous because they can penetrate deepest into the lungs. There are separate exposure limits and recommendations for each of these particle sizes. NAAQS/EPA (National Ambient Air Quality Standards/Environmental Protection Agency) has recommended a 24 hour exposure limit of 0.15 mg/m³ and a 1 year average of 0.05 mg/m³ for outdoor air PM10, and a 24 hour exposure limit of 0.035 mg/m³ and a 1 year average of 0.012mg/m³ for outdoor air PM2.5.

Note: OSHA regulates total dust and respirable dust, and sets occupational exposure limits of 15 mg/m³ and 5 mg/m³ respectively.

Equipment: DustTrak (add size-selective impactors for PM2.5 or Respirable sized particulate)

Additional potential sources of indoor air quality problems – consult with a subject matter specialist before proceeding with monitoring for these contaminants

Bioaerosol

Some biological contaminants can trigger asthma, allergic reaction or infection (in a susceptible population). Microbial contamination can be fungi, mold, bacterial, and pollen, among other microorganisms. These contaminants can be introduced from air handling system condensate, damp/wet organic materials, outdoor excavations introduced through HVAC, etc. An outdoor reference sample should always be taken when measuring for bioaerosols. In general, an indoor to outdoor ratio greater than 1.0 may be indicative of an indoor source of fungi. However, this is seasonally dependent as there is generally low growth outside in cold temperatures and an indoor/non-complaint area sample may be more applicable during the winter months. In addition, the genus and species in the samples taken in the complaint areas should reflect those in the reference sample.

Note: OSHA does not have an exposure limit for bioaerosols. The AIHA indicates that $>1000\text{cfu}/\text{m}^3$ is atypical.

Equipment: Andersen sampler

Ultrafine particles

These particles are $<100\text{nm}$ in size and can be generated as by-products (printer toner, automobile exhaust). Potential sources are laser printers, fax machines, copiers, and tobacco smoke.

Equipment: P-Trak

Formaldehyde

At low levels, formaldehyde is an irritant and sensitizer. It may be emitted from foam insulation, particle board, plywood, carpeting and fabrics, and glues/adhesives. This can also be emitted from furnishings constructed of any of these materials.

Note: The OSHA PEL is 0.75ppm for an 8-hour TWA. The ACGIH TLV ceiling limit is 0.3ppm.

Equipment: Detector tubes or Gilian low flow sampling pump

Ozone

Ozone is a respiratory irritant produced by equipment that uses high voltage electricity. Photocopiers can release ozone into the indoor environment.

Note: The OSHA PEL for ozone is 0.1ppm for an 8-hour TWA.

Equipment: Detector tubes

After investigation and monitoring:

- If any parameter is exceeded, contact the appropriate people for follow up and mitigation, i.e., high CO_2 : contact Facilities, construction related issue: contact the project manager, etc.
- Write report within 5 business days, unless waiting for analytical/laboratory results.
 - Report should include the reason for the investigation, area description, equipment used for measurements, as well as measurement results and recommended/required limits.
 - Ensure Employee Health Physician is copied on the report, if employee(s) reports health related symptoms.
 - Address report to affected employee and copy managers, supervisors, and others involved in the investigation.

Copy anyone responsible for follow up or mitigation.