

**CHAPTER I**  
**INDOOR AIR QUALITY**  
**EVALUATION METHODS**

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## **I. METHODS**

An initial telephone inquiry is completed to review issues of concern. Once a request is received, staff in the Indoor Air Quality (IAQ) Program gather information from affected parties. Technical assistance via telephone can sometimes solve problems; however, in most cases an on-site assessment is required. IAQ staff contact local Boards of Health/Health Departments (BOH/HD) to notify them of the request and discuss the issues of concern. Note that the IAQ program does not have “right of entry” and needs to be invited in by the local BOH/HD or the owner/operator of the building in question.

IAQ staff assess a variety of factors that can contribute to IAQ complaints: conditions/operation of the heating, ventilating and air-conditioning (HVAC) systems; conditions contributing to moisture and microbial growth; presence of point sources of indoor air pollution (e.g., office equipment, materials used in science classrooms); and the presence of allergens and/or materials known to exacerbate asthma.

An assessment consists of air monitoring using a variety of hand-held equipment and a visual inspection of both inside and outside the building. The duration of an assessment depends on the size of the building and the scope of the problems discovered. Building assessments typically require one full day. IAQ staff meet with local health officials, building management and building occupants and/or other concerned individuals to gather information regarding exposure concerns and symptoms reported by building occupants. IAQ staff collect data on the age of the building, size, specific functions (e.g., shop activities, science labs), population and renovation history. IAQ staff collect testing data in individual rooms and observe conditions

including the presence, condition and operation of HVAC equipment, and sources of pollutants that may contribute to irritation, and record them on a data collection sheets.

## **A. HVAC System Evaluation**

Proper ventilation is a necessity for maintaining IAQ. To determine the status of a ventilation system, both physical and operational factors must be considered. IAQ staff evaluate the physical condition of an HVAC system by examining equipment maintenance conditions (e.g., cleanliness, balancing), filtration, location of air intakes, ability of air handling equipment to supply and return air, any blockages preventing proper airflow, and an examination of the interior of units in contact with moving air. IAQ staff also observe the adequacy of condensation drainage and the location of thermostats. In addition, IAQ staff record factors that determine the requirements for ventilation such as the number of room occupants and the status of portals that allow for airflow (e.g., open/closed windows, doors or transoms).

## **B. Measurable Parameters**

The following indoor environmental parameters may, as applicable, be measured during an assessment:

- Carbon dioxide (CO<sub>2</sub>)
- Temperature
- Relative humidity (RH)
- Carbon monoxide (CO)
- Total volatile organic compounds (TVOCs)
- Airborne particles (AP)

### *1. Carbon Dioxide (CO<sub>2</sub>)*

Measurements for CO<sub>2</sub> are made using a TSI, Q-Trak, IAQ Monitor Model 7565, which is a hand held, direct read instrument. For comparison to indoor levels, an outside CO<sub>2</sub> measurement is taken in an area away from the building. Indoor CO<sub>2</sub> measurements are taken in a neutral airflow area in each room (e.g., center of classroom, away from the direct air stream of the ventilation system). These measurements are generally taken within the breathing zone of building occupants (2 ½ to 5 feet in height above the floor), away from doors and windows. CO<sub>2</sub> samples are taken in as many rooms/areas as feasible under normal operating conditions.

### *2. Temperature*

Temperature readings are made with a TSI, Q-Trak, IAQ Monitor Model 7565 in occupied and unoccupied spaces. Outdoor temperature measurements are recorded in a location away from the building and in a shaded area, away from direct sunlight. Indoor temperature measurements are taken in a neutral airflow area in each room (e.g., center of classroom, outside the direct air stream of the ventilation system). These measurements are generally taken within the breathing zone of building occupants, away from doors and windows. Temperature samples are taken in as many rooms/areas as feasible under normal operating conditions. All heat sources are noted, including computers and monitors, electrical appliances, and combustion sources, such as motor vehicles, gas stoves, propane heaters or water heaters.

### *3. Relative Humidity (RH)*

Relative humidity readings are made with a TSI, Q-Trak, IAQ Monitor Model 7565 in occupied and unoccupied spaces. Outdoor RH measurements are recorded concurrent with

temperature measurement. Indoor RH measurements are taken in a neutral airflow area in each room (e.g., center of classroom, outside the direct air stream of the ventilation system). These measurements are also generally taken within the breathing zone of building occupants, away from doors and windows. RH samples are taken in as many rooms/areas as feasible under normal operating conditions. Sources of airborne water vapor are noted. These sources include unvented restrooms, water penetration into crawlspaces/foundations, unvented kitchens, unvented clothes dryers, unvented pottery kilns, and water heaters.

#### 4. *Carbon Monoxide (CO)*

Carbon monoxide readings are made with a TSI, Q-Trak, IAQ Monitor Model 7565 in occupied and unoccupied spaces. For comparison to indoor levels, an outside CO measurement is taken in an area away from the building. Indoor CO measurements are taken in a neutral airflow area in each room (e.g., center of classroom, outside the direct air stream of the ventilation system). These measurements are generally taken within the breathing zone of building occupants away from doors and windows. CO samples are taken in as many rooms/areas as feasible under normal operating conditions. Sources of CO are noted, including the location of motor vehicles outside the area sampled and combustion sources, such as Bunsen burners, gas stoves, propane heaters, boiler/furnaces, gas-fueled air handling units and water heaters.

#### 5. *Airborne Particulates (AP)*

Measurements of particulate matter are made with a TSI DustTrak (DustTrak 8520 and DustTrak II 8532 models are used). To obtain a comparison sample, an outdoor measurement is

recorded in a location away from the building and operating motor vehicles. Indoor measurements are made in a neutral airflow area in each room (e.g., center of classroom, outside the direct air stream of the ventilation system). These measurements are generally taken within the breathing zone of building occupants, away from doors and windows. If a detectable measurement is obtained in comparison to outdoor measurements, the monitoring equipment is used to identify the source of AP. Such sources may consist of motor vehicles outside the area sampled and combustion sources, such as boiler/furnace chimneys/exhaust vents, non-vented cooking, stoves, propane heaters, boiler/furnaces, gas-fueled air handling units or water heaters. Other sources can include renovation activities, tobacco smoke, carpentry/grinding and other maintenance-related activities.

#### 6. *Ultrafine Particulates (UFP)*

Measurements of ultrafine particulate matter are made with a TSI, P-Trak Ultrafine Particle Counter Model 8525. UFP are defined as “those less than 100 nanometer (nm), so they are nano-sized. However, these ultrafine particles are not purposefully manufactured nor are they necessarily of a constant composition or size. UFP are the result of combustion or friction processes or natural processes in the air or water” (US EPA. 2015. Ultrafine Particle Research. [http://epa.gov/ncer/nano/research/particle\\_index.html](http://epa.gov/ncer/nano/research/particle_index.html)). Due to their small diameter, UFP readily follow airflow and can be used as a means to determine if spaces exist in or around walls separating sources of UFP from other areas of a building.

## 7. *Total Volatile Organic Compounds (TVOCs)*

A Photo Ionization Detector (PID) equipped with a 10.6 (eV) electronic volt lamp is used to detect TVOCs with an ionization potential less than or equal to 10.6 (eV). The MiniRAE 2000 and MiniRAE Lite are used. To obtain a comparison sample, outdoor measurements are taken in a location away from the building and potential TVOC generating sources. Air samples are taken in a neutral airflow area (e.g., center of the room, outside the air stream of the ventilation system). If a detectable measurement above outdoor measurements is obtained, the monitoring equipment is used to identify the source of TVOCs. These sources of TVOCs can be any material that contains petroleum-derived products. Other materials that can be sources of TVOCs can include but are not limited to office products, fuels (e.g., gasoline, heating oil), science chemicals, and materials used during renovations/construction (e.g., paints, adhesives, caulking). IAQ staff look for potential sources of TVOC exposure. These source materials may include but not be limited to:

- rubber cement;
- permanent markers;
- dry erase materials;
- paint;
- duplicating equipment (mimeograph, photocopier);
- hand sanitizer;
- cleaning products;
- air freshener/deodorizers/scented products;
- gasoline-fueled equipment stored in an indoor area lacking a dedicated exhaust ventilation system; and

- petroleum-based products spilled/used in an indoor environment.

## **C. Other Indoor Environmental Data**

IAQ staff also look for other potential point sources within a given building. Sources may include:

- sewer odors;
- moisture and microbial growth;
- animals/pests;
- latex-containing products; and
- alkaline/acidic irritant products.

### *1. Sewer Odors*

If sewer odors are noted, measurements for hydrogen sulfide (HS) are obtained to determine the origin of odor. These measurements are obtained with a four-gas meter. To obtain a comparison sample, outdoor measurements are recorded in a location away from the building and potential HS sources. Indoor air samples are taken in a neutral airflow area in each room (e.g., center of classroom, outside the direct air stream of the ventilation system). These measurements are generally taken within the breathing zone of building occupants, away from doors and windows. If a detectable measurement is obtained, the sampling equipment is used to identify the source of HS. Sources of HS include but are not limited to dry drain traps in sinks, floor drains, HVAC condensation collectors and cracked plumbing pipes.

## 2. *Moisture and Microbial Growth*

IAQ staff look for moisture, water damaged materials, and microbial growth in occupied and unoccupied areas. Materials prone to microbial growth may include plants (e.g., potting soil, leaves, plant debris) and porous materials (e.g., carpeting, gypsum wallboard, cardboard, paper, wallpaper, particle board). Non-porous and semi-porous surfaces (e.g., plaster, brick) can also show signs of water damage (bubbling paint, efflorescence). If building materials are suspected of being moistened, the moisture content of the material is measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe or Tramex Non-invasive Moisture Meter. Occupied and unoccupied areas as well as the building exterior are evaluated for the following:

- Water damage to building materials (i.e., ceiling tiles, gypsum wallboard, carpeting, wall plaster, and window sills);
- Efflorescence or mineral deposits (characteristic sign of water damage to brick and mortar and plaster);
- Sources through which water can penetrate a building, including:
  - poor flashing around building components;
  - mechanical damage/cracking in roof materials;
  - improper maintenance of gutters and downspouts;
  - damage to exterior wall materials, joining materials (e.g., mortar) or joint sealants;
  - poor caulking around windows;
  - poor sealing of exterior door/door frames;

- wet spots or bubbling paint on interior walls (indication of water penetration from exterior sources);
  - poor drainage/water pooling at base of the building;
  - plant growth within 5 feet of foundation (plant roots often create fissures in the building foundation or surrounding grounds, resulting in water movement and penetration to building interiors); and
  - raised water table (water seepage through the foundation, especially after heavy rains and flooding).
- Presence/location of indoor plants and presence/condition of drip pans;
  - Presence of aquariums and terrariums;
  - Presence and condition (i.e. swelling and cracking) of pottery wheels in art rooms; and
  - Presence of mold growth or musty odors.

### *3. Animals/Pests*

IAQ staff look for signs of pest infestation or pets in occupied and unoccupied areas of the building. The location of each observation is noted, including:

- Birds/bats roosting inside the building envelope and/or ventilation system;
- Bird waste in or around HVAC or air-conditioning equipment;
- Mouse droppings indoors;
- Bait traps located indoors;
- Occupant reports of pest presence;
- Reports of pesticide application inside a building; and
- Presence/conditions of animal cages.

#### *4. Latex-Containing Materials*

IAQ staff look for latex-containing materials (e.g., latex gloves, tennis balls to reduce chair/desk noises) in occupied and unoccupied areas of the building. The location of latex-containing materials will be noted in the area observed. Latex is a common allergen.

#### *5. Alkaline/Acidic Products*

IAQ staff look for alkaline and acidic products in occupied and unoccupied areas. The location of each alkaline and acidic product will be denoted in the inspection report in the area observed. The presence, type and location of alkaline or acidic products is noted. Examples of these types of products include: drain clog cleaners, ammonium ion-containing cleaners, bleach-containing cleaners. The conditions of the item (e.g., loose/inappropriate cap or container, inappropriate label) is also noted.