

Developing an IAQ Profile

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An IAQ profile is a description of the features of the building structure, function, and occupancy that impact indoor air quality. When you have completed the IAQ profile, you should have an understanding of the current status of air quality in the building and baseline information on the factors that have a potential for causing problems in the future.

The IAQ profile can help building management to identify potential problem areas and prioritize budgets for maintenance and future modifications. Combined with information on lighting, security, and other important systems, it can become an owner's manual that is specific to your building and that will serve as a reference in a variety of situations.

The key questions to answer while developing the IAQ profile are:

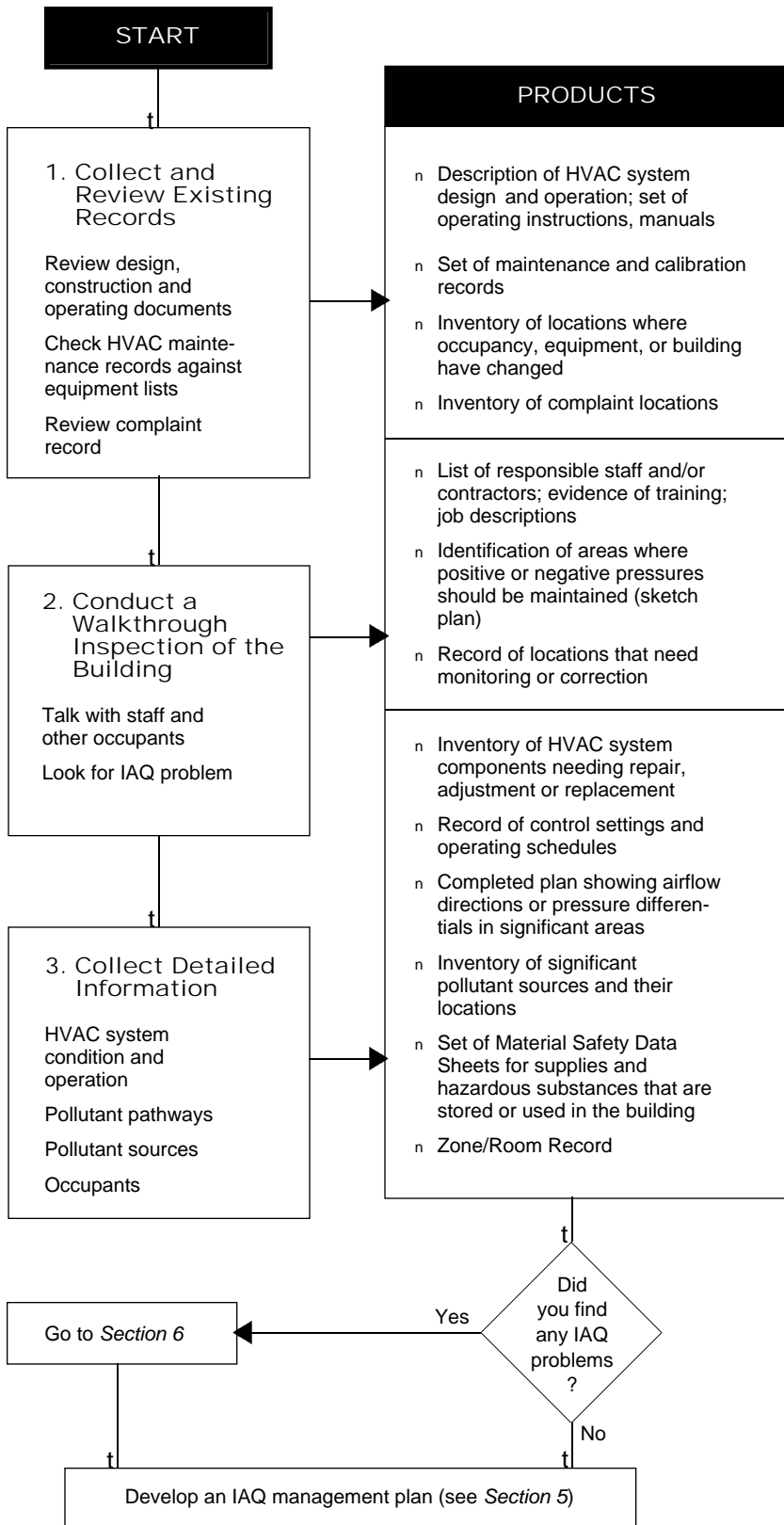
- How was this building originally intended to function? Consider the building components and furnishings, mechanical equipment (HVAC and non-HVAC), and the occupant population and associated activities.
- Is the building functioning as designed? Find out whether it was commissioned. Compare the information from the commissioning to its current condition.
- What changes in building layout and use have occurred since the original design and construction? Find out if the HVAC system has been reset and retested to reflect current usage.
- What changes may be needed to prevent IAQ problems from developing in the future? Consider potential changes in future uses of the building.

After reading this manual to develop a feel for the issues involved in maintaining good indoor air quality in a building, the development of an IAQ profile should become a priority. The process of developing an IAQ profile should require only a modest effort, from a few days to a few weeks of staff time, depending on the complexity of your building and the amount of detailed information collected. The work can be done in pieces over a longer period, if necessary, to fit into a building manager's busy schedule.

Over time, it is desirable to make some actual measurements of airflow, temperature, relative humidity, carbon dioxide (CO₂), and/or pressure differentials (e.g., in each of the air handling zones or other sub-areas of the building). These measurements provide far better information on current conditions than can be obtained from the plans and specifications, even if as-built records are available.

In addition, few buildings have been adequately commissioned, so the system may never have delivered the airflows shown on the design drawings. In the event of litigation around future IAQ complaints, the value of the IAQ profile as a resource document will be enhanced by real-world measurements. (Refer to *Appendix G* and the ASHRAE standard on commissioning. The EPA document on designing for good indoor air quality, which is due to be published in 1992, will contain a more complete discussion of the process of commissioning buildings.)

FIGURE 4-1: Developing an IAQ Profile



SKILLS REQUIRED TO CREATE AN IAQ PROFILE

Many of the resources necessary for the IAQ profile should already be on hand within your organization. Additional information can be collected by the staff person or persons who have the following skills:

- n basic understanding of HVAC system operating principles
- n ability to read architectural and mechanical plans and understand manufacturer's catalog data on equipment
- n ability to identify items of office equipment
- n ability to work cooperatively with building occupants and gather information about space usage
- n ability to collect information about HVAC system operation, equipment condition, and maintenance schedules
- n authority to collect information from subcontractors about work schedules and materials used (particularly cleaning and pest control activities)
- n ability to understand the practical meaning of the information contained in the Material Safety Data Sheets (MSDSs)

If direct measurements are to be included in the IAQ profile, the staff should have the tools and training to make the following measurements (see *Appendix A* for guidance on air sampling):

- n air volumes at supply diffusers and exhaust grilles
- n CO₂ concentration
- n temperature
- n relative humidity
- n pressure differentials
- n assessment of thermal and ventilation load requirements

Section 8 provides guidance on hiring IAQ professionals if you prefer to use outside expertise to develop your IAQ profile.

STEPS IN AN IAQ PROFILE

The information needed for an IAQ profile is similar to that which is collected when solving indoor air quality problems, but includes the entire building rather than focusing on areas that may have caused an identified problem. The IAQ profile should be an organized body of records that can be referred to in planning for renovations, negotiating leases and contracts, or responding to future complaints.

The process of gathering information for the IAQ profile can be divided into three major stages:

1. Collect and review existing records.
2. Conduct a walkthrough inspection of the building.
3. Collect detailed information on the HVAC system, pollutant pathways, pollutant sources, and building occupancy.

The first two stages should be carried out as quickly as possible, but the third stage can be handled as time allows so that it does not interfere with other staff responsibilities.

1. Collect and Review Existing Records

Review construction and operating documents

Collect any available documents that describe the construction and operation of the building: architectural and mechanical plans, specifications, submittals, sheet metal drawings, commissioning reports, adjusting and balancing reports, inspection records, and operating manuals. Many buildings may lack some or all of these documents. If there are no commissioning reports or balancing reports, actual ventilation quantities may be quite different from those indicated on mechanical design

PRODUCTS OF THE REVIEW OF EXISTING RECORDS

- n a description of the HVAC system design and operation (e.g., original plans and specifications with changes indicated or new sketch plans and notes, commissioning reports, testing and balancing reports)
- n a set of operating instructions, maintenance and calibration records for HVAC system components (e.g., fans, dampers, filters, chillers, boilers, and control systems)
- n an inventory of locations where architectural or engineering modifications have taken place
- n an inventory of locations in which current occupancy or HVAC system operation represents a change from the original design
- n an inventory of locations where complaints have been common in the past

drawings. If there are no operating or maintenance manuals for HVAC equipment, it is difficult for staff to carry out an adequate preventive maintenance program.

Study the original architectural and mechanical design so that you understand the building's layout and intended functions. Identify and note locations in which changes in equipment or room usage create a potential for indoor air quality problems and give them special attention during the walkthrough inspection.

Items of interest and the questions they suggest could include the following:

Commissioning reports

- n Was the building properly commissioned when it was first constructed, including testing and balancing of the HVAC system?

Operating manuals

- n Do staff members understand how the HVAC equipment is intended to operate?

Remodeled areas

- n Has the HVAC system layout been changed to accommodate new walls, rearranged partitions, or similar architectural modifications?

Addition, removal, or replacement of HVAC equipment

- n Where the original equipment has been replaced, do the newer units have the same capacity as the originals?
- n Has new equipment been properly installed and tested? Where equipment has been removed, is it no longer needed?

Changes in room use

- n Is there a need for additional ventilation (supply and/or exhaust) due to increased occupant population or new activities within any area of the building?
- n Have new items of equipment (non-HVAC) been provided with local exhaust where needed? Look for unusual types or quantities of equipment such as copy machines or computer terminals.

Check HVAC maintenance records against equipment lists

Collect your existing maintenance and calibration records and check them against the construction documents (e.g., equipment lists and mechanical plans). See whether all components appear to be receiving regular attention. Equipment that

has been installed in inaccessible or out-of-the-way locations is frequently overlooked during routine maintenance. This is particularly true of items such as filter boxes and small capacity exhaust fans.

Review records of complaints

If there is an organized record of past occupant complaints about the building environment, review those complaints to identify building areas that deserve particular attention.

2. Conduct a Walkthrough Inspection of the Building

The intent of the walkthrough inspection is to acquire a good overview of occupant activities and building functions and to look for IAQ problem indicators. No specific forms are suggested for this stage of IAQ profile development. However, the investigator should have a sketch plan of the building, such as a small floor plan showing fire exit, so that his or her notes can be referenced to specific locations.

Detailed measurements of temperature, humidity, airflow, or other parameters are more appropriate to a later stage of profile development. However, chemical smoke can be used to observe airflow patterns and pressure relationships between special use areas or other identified pollutant sources and surrounding rooms. Odors in inappropriate locations (e.g., kitchen odors in a lobby) may indicate that ventilation system components require adjustment or repair. (See *Appendix A* for further discussion of the use of chemical smoke.)

The value of IAQ ventilation measurement tools to your operation will grow as you become more familiar with handling indoor air quality concerns. For example, if you do not own a direct-reading carbon dioxide monitor, it is not necessary to acquire one for the IAQ profile. Those who already have access to this type of instrument can take readings during the walkthrough as a way to obtain baseline

PRODUCTS OF THE WALKTHROUGH INSPECTION

At the end of the walkthrough inspection, you should have:

- n List of staff (and contractors) with responsibilities that could affect IAQ, including contact information:
 - names, telephone numbers job descriptions
 - notes on training and experience of building staff
- n Notes on the schedules and procedures used in:
 - facilities operation and maintenance
 - housekeeping
 - pest control
- n Sketch plan with notes showing:
 - pressure relationships between special use areas and surrounding rooms
 - locations in which general indicators of IAQ problems show the need for close monitoring or corrective action

information about normal operating conditions or identify problem locations. If you begin to suspect that underventilation is a consistent problem, you may decide that it would be helpful to obtain more ventilation monitoring equipment. (See *Appendix A* for further discussion of carbon dioxide and other ventilation measurements.)

Talk with staff and other occupants

A walkthrough inspection provides an opportunity to introduce facility staff and other building occupants to the topic of indoor air quality and to understand current staff (and contractor) responsibilities in relation to housekeeping and maintenance activities. Advance notice of the inspection will make it seem less intrusive and may encourage staff and other occupants to remember important information.

Discussion of routine activities in the building will help to clarify elements that should be included in the IAQ management plan. Ask staff members about their job responsibilities, training and experience. It will be helpful to meet with responsible staff and contractors to discuss:

Facility operation and maintenance (e.g., HVAC, plumbing, electric, interior maintenance)

- n HVAC operating schedule (e.g., occupied/unoccupied cycles)
- n HVAC maintenance schedule (e.g., filter changes, drain pan maintenance)
- n use and storage of chemicals
- n schedule of shipping and receiving, handling of vehicles at loading dock
- n scheduling and other procedures for isolating odors, dust, and emissions from painting, roof repair, and other contaminant-producing activities
- n budgeting (i.e., how do staff members influence budget decisions?)

Housekeeping

- n cleaning schedule



- n trash storage and schedule of refuse removal
- n use and storage of chemicals

Pest control

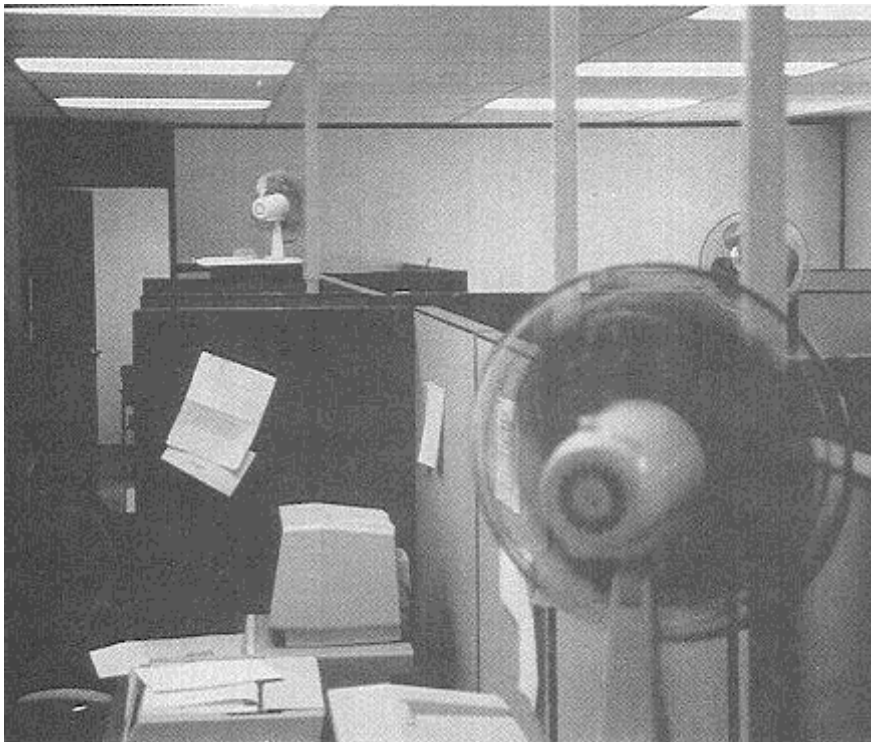
- n schedule and location of pesticide applications
- n use and storage of chemicals
- n pest control activities other than use of pesticides

Look for IAQ problem indicators

The walkthrough inspection can be used to identify areas with a high potential for IAQ problems. The following are general indicators of IAQ problems:

- n odors
- n dirty or unsanitary conditions (e.g., excessive dust)
- n visible fungal growth or moldy odors (often associated with problem of too much moisture)
- n sanitary conditions at equipment such as drain pans and cooling towers

Maintenance is more likely to be performed on a routine basis when there is good access to HVAC equipment such as that shown in this photo.



Building occupants who are uncomfortable may try to improve the situation by themselves. The small fans shown above indicate an air circulation or thermal discomfort problem. The irony of this situation is that the fan motors add heat to the air.

- n sanitary conditions in equipment such as drain pans and cooling towers
- n poorly-maintained filters
- n signs of mold or moisture damage at walls (e.g., below windows, at columns, at exterior corners), ceilings, and floors
- n staining and discoloration (*Note:* Make sure that stains are removed after leaks are repaired so that there will be visible evidence if the leak recurs.)
- n smoke damage (*Note:* If a fire has occurred involving electrical equipment, determine whether PCBs (polychlorinated biphenyls) may have been released from the equipment.)
- n presence of hazardous substances
- n potential for soil gas entry (e.g., unsealed openings to earth, wet earth smells)
- n unsanitary mechanical room, or trash or stored chemicals in mechanical room
- n unusual noises from light fixtures or mechanical equipment

In addition to these general indications, some common problems deserve mention:

Inadequate maintenance: Look for leaks of oil, water, or refrigerants around HVAC equipment. Also be aware of signals such as unreplaced burned-out light bulbs in fan chambers and staff members who have difficulty locating specific pieces of equipment. Dry drain traps can also cause indoor air quality problems. If traps are not kept charged with liquid, they could be allowing sewer gas to enter occupied spaces.

Signs of occupant discomfort: Notice uneven temperatures, persistent odors (including tobacco smoke), drafts, sensations of stuffiness. You may find that occupants are attempting to compensate for an HVAC system that doesn't meet their needs. Look for propped-open corridor doors, blocked or taped up diffusers, popped-up ceiling tiles, people using individual fans/ heaters or wearing heavier (or lighter) clothing than normal.

Overcrowding: Future occupant density is estimated when the ventilation system for a building is designed. When the actual number of occupants approaches or exceeds this occupant design capacity, managers may find that IAQ complaints increase. At that point, the outdoor air ventilation rate will have to be increased. However, the ventilation and cooling systems may not have sufficient capacity to handle the increased loads from the current use of the space.

Blocked airflow: Check for under-ventilation caused by obstructed vents, faulty dampers or other HVAC system malfunctions, or from problems within the occupied space. Furniture, papers, or other materials can interfere with air movement around thermostats or block airflow from wall or floor-mounted registers. If office cubicles are used, a small space (i.e., two to four inches) between the bottom of the partitions and the floor may improve air circulation.

Ceiling plenums: Lift a ceiling tile and examine the plenum for potential prob-

lems. Walls or full-height partitions that extend to the floor above can obstruct or divert air movement in ceiling plenums unless transfer grilles have been provided. If fire dampers have been installed to allow air circulation through walls or partitions, confirm that the dampers are open. Construction debris and damaged or loose material in the plenum area may become covered with dust and can release particles and fibers.

Heat sources: Be aware of areas that contain unusual types or quantities of equipment such as copy machines or computer terminals. Also look for instances of over-illumination. High concentrations of electrical fixtures and equipment can overwhelm the ventilation and cooling systems.

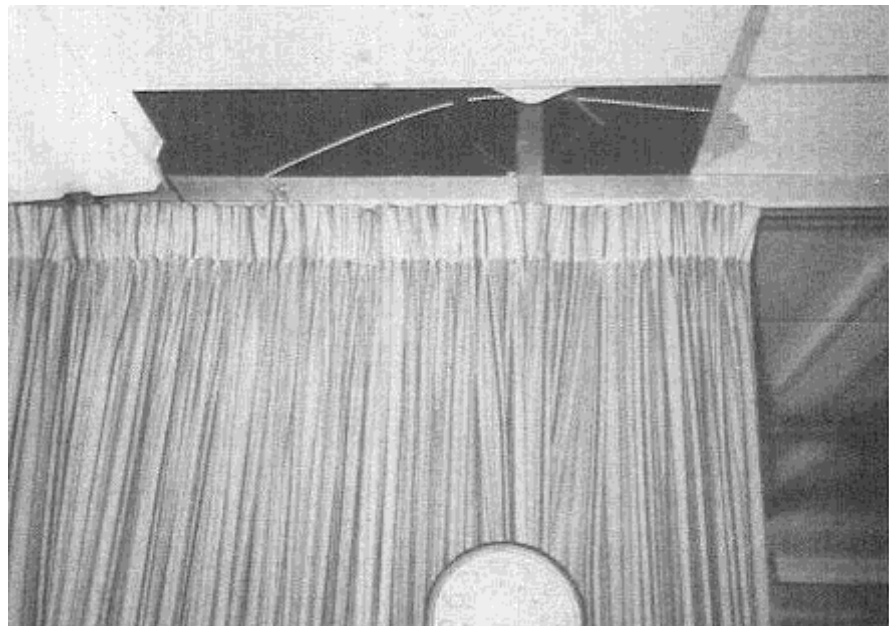
Special use areas: Confirm that the HVAC system maintains appropriate pressure relationships to isolate and contain odors and contaminants in mixed-use buildings and around special use areas. Examples of special use areas include attached parking garages, loading docks, print shops, smoking lounges, janitorial closets, storage areas, and kitchens.

Improperly located vents, exhausts and air intakes: Check the outdoor air intakes to see whether they are located near contaminant sources (e.g., plumbing vents, exhaust outlets, dumpsters, loading docks, or other locations where vehicles idle).

Unsanitary mechanical rooms: See if the space containing the HVAC system is clean and dry. Examples of problems include: cleaning or other maintenance supplies stored in mechanical room; dust and dirt buildup on floors and equipment; moisture in mechanical room because of inadequate insulation, lack of conditioned air, or failure to provide for air movement. Unsanitary conditions in the mechanical room are particularly a problem if unducted return air is dumped into and circulated through the mechanical room.

PRODUCTS OF COLLECTING DETAILED INFORMATION

- n an inventory of HVAC system components that need to be repaired, adjusted, or replaced
- n a current record of control settings and operating schedules
- n a floor plan of the building showing airflow directions or pressure differentials around areas intended to run positive or negative (e.g., special use areas)
- n an inventory of pollutant sources and their locations
- n Material Safety Data Sheets for products used or stored within the building
- n a record of usage for each zone or room, including the source of outside air and the presence of local exhaust (if any)



Collect Detailed Information

The collection of detailed information for the IAQ profile can be handled as time is available. Areas that have been identified as presenting potential IAQ problems should be given the highest priority. You may want to review *Section 2* for background information on the factors that contribute to indoor air quality.

Inspect HVAC system condition and operation

Use your current maintenance records in combination with one or both of the **HVAC Checklists** to inspect HVAC

Occupants or staff sometimes open ceiling tiles into return plenums when attempting to eliminate odors. Building managers should be alert to such signs of occupant dissatisfaction in order to remedy the original problem and prevent additional problems, such as the short-circuiting of supply air.

Sample Form
HVAC Checklist — Short Form

Mechanical Room

▫ Clean and dry? _____
 (describe items in need of attention) _____

▫ Stored refuse or chemicals? _____

Mechanical Equipment

▫ Preventative maintenance (PM) plan in use? _____

Control System Type _____

▫ System operation _____

Sample Form
Pollutant Pathway Record For IAQ Profile

Building Area (zone, room)	Use	Intended Pressure		Needs Attention? (Y/N)	Comments
		Positive (+)	Negative (-)		

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equipment and make sure that it is in good operating condition. A portion of the **HVAC Checklist - Short Form** is shown on this page, with the entire form reproduced in Tab V. The **HVAC Checklist - Long Form** (also reproduced in Tab V) is recommended where a more detailed examination is needed. You may want to create a new form incorporating elements from your existing inspection forms.

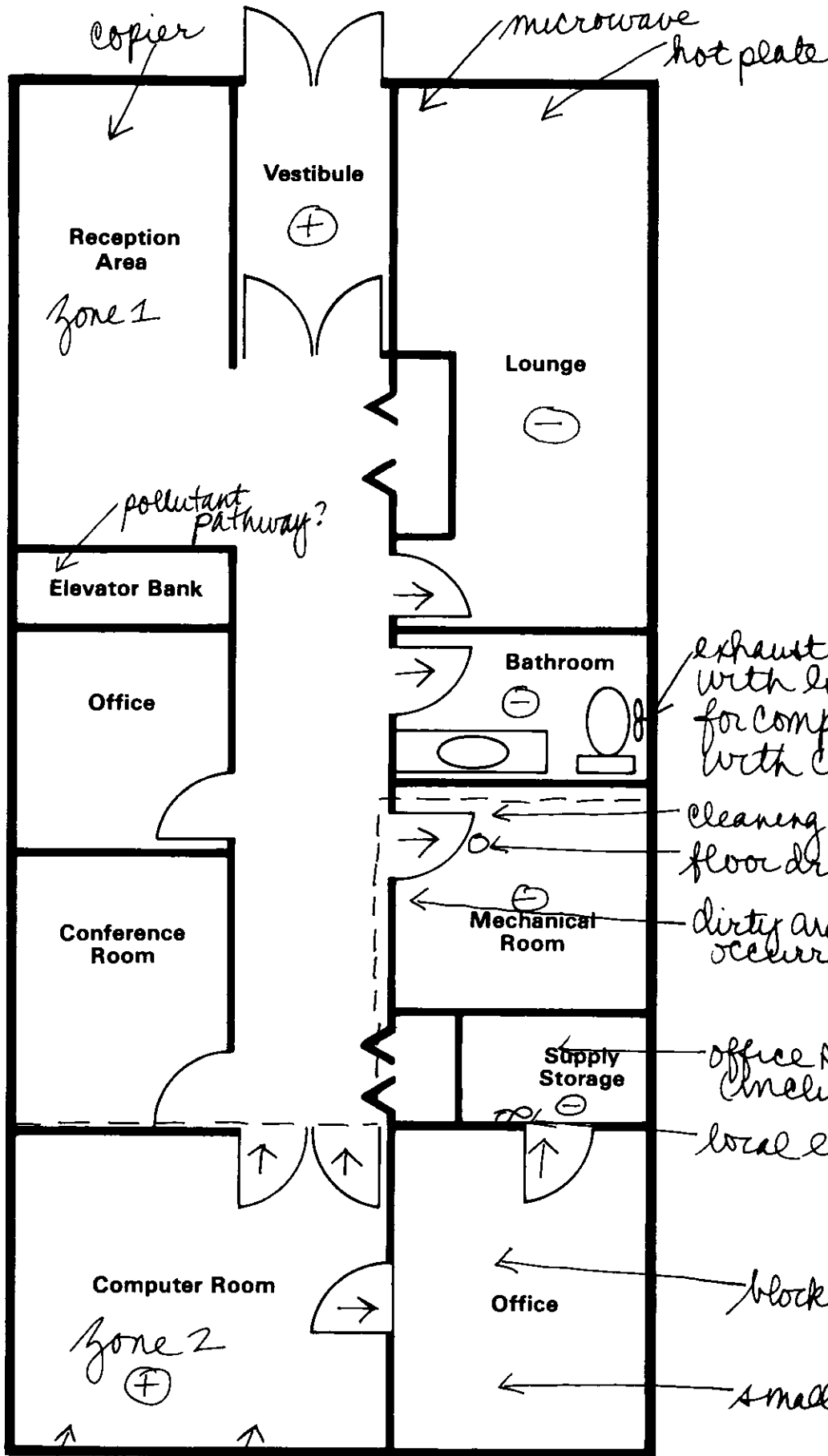
Identify items of equipment that need to be repaired, adjusted, or replaced. Record control settings and operating schedules for HVAC equipment for comparison to occupancy schedules and current uses of space.

Inventory pollutant pathways

Using the sketch plan of the building that was begun during the walkthrough inspection, indicate architectural connections (e.g., chases) and mechanical connections (e.g., ductwork, temperature control zones). Observe and record airflow between spaces intended to run positive or negative and the areas that surround them (including airflow between perimeter rooms and outdoors). Note that hidden pathways such as chases may travel both vertically and horizontally and transport pollutants over long distances. Record the results on the **Pollutant Pathway Record for IAQ Profiles**, the sketch plan, or both. The form is shown at the left (and in Tab V), and a sample sketch plan is shown on the opposite page.

Inventory pollutant sources

Use the **Pollutant and Source Inventory** (shown in part on page 28 and reproduced in full in Tab V) to record potential pollutant sources in the building. As you fill out the inventory form, note the locations of major sources. Major sources such as large items of equipment can be recorded on the floor plan. The **Chemical Inventory Form** (shown on page 28 and reproduced in Tab V) can be used to record the names and locations of chemicals or hazardous substances used or stored within



A fire escape floorplan is very useful for recording information collected during IAQ profile development or while investigating IAQ complaints. The facility manager has begun to identify the areas in which air pressure relationships are (or should be) controlled and some ventilation and has noted source information. Symbols are ⊖ for negative pressure, ⊕ for positive pressure, and ← for observed direction of airflow. Utility chases, tunnels, and suspended ceilings could also be drawn in to show pollutant pathways and driving forces.

exhaust fan switches with light (check for compliance with codes)
 cleaning supply caddy
 floor drain
 dirty area where leak occurred
 office supplies (including solvents)
 local exhaust

blocked ceiling vent
 small space heater

copier fax/modem

Sample Form
Pollutant and Source Inventory Form

Using the list of potential source categories below, record any indications of contamination or suspected pollutants that may require further investigation or treatment.

Source Category	Checked	Needs Attention	Location	Comments
SOURCES OUTSIDE THE BUILDING				
Contaminated Ambient Air				
Pollen, dust				
Industrial contaminants				
General vehicular contaminants				

Sample Form
Chemical Inventory Form

The inventory should include chemicals stored or used in the building for cleaning, maintenance, operations, and pest control. If you have an MSDS (Material Safety Data Sheet) for the chemical, put a check mark in the right-hand column. If not, ask the chemical supplier to provide the MSDS, if one is available.

Date	Chemical/ Brand Name	Use	Storage Location(s)	MSDS on File?

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the building, such as those that may be contained in cleaning materials, biocides, paints, caulks, and adhesives. Ask your suppliers to provide you with Material Safety Data Sheets.

You may be unaware of the potential hazards of some materials that are commonly used in public and commercial buildings. For example:

- n In 1990, EPA eliminated the sale of mercury-containing interior latex paint. (Enamel paints do not contain mercury.) People are urged not to use exterior latex paint indoors, as it may contain mercury. If you have paint in storage that may have been manufactured before August 20, 1990, you may contact the manufacturer, the National Pesticide Telecommunication Network (1-800-858-7378), or your State Health Department for guidance.
- n In 1990, EPA banned the use of hexavalent chromium chemicals in cooling towers, because the chemicals have been shown to be carcinogenic.
- n Heating system steam should not be used in the HVAC humidification system, as it may contain potentially harmful chemicals such as corrosion inhibitors.

Collect information on building occupancy

The **Zone/Room Record** shown on the following page (and also reproduced in Tab V) can be used during IAQ profile development to maintain an up-to-date record of the way each area of the building is used, its source of outdoor air, and whether or not it is equipped with local exhaust. If underventilation is suspected, the form can be used to estimate ventilation rates in cubic feet per minute per person or per square foot floor area, for comparison to guidelines such as design documents, applicable building codes, or the recommendations of ASHRAE 62-1989 (see the table that is reproduced in *Appendix B*).

Sample Form

Zone/Room Record

This form is to be used differently depending on whether the goal is to prevent or diagnose IAQ problems. During development of a profile, this form should be used to record more general information about the entire building; during an investigation, the form should be used to record more detailed information about the complaint area and areas surrounding the complaint area or connected to it by pathways.

PROFILE AND DIAGNOSIS INFORMATION					DIAGNOSIS INFORMATION ONLY		
Building Area (Zone/Room)	Use**	Source of Outdoor Air*	Mechanical Exhaust? (Write "No" or estimate cfm airflow)	Comments	Peak Number of Occupants or Sq. Ft. Floor Area**	Total Air Supplied (in cfm)***	Outdoor Air Supplied per Person or per 150 sq. Ft. Area****

Underventilation problems can occur even in areas where ventilation rates apparently meet ASHRAE guidelines; proper distribution and mixing of supply air with room air are also essential for good ventilation.

If the information collected as you develop the IAQ profile indicates that you have one or more IAQ problems, *Sections 6-8* provide guidance to help you deal with them. If you need to prioritize these problems, consider the apparent seriousness of their consequences. For example, combustion gas odors demand a more rapid response than thermostats that are out of calibration.

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