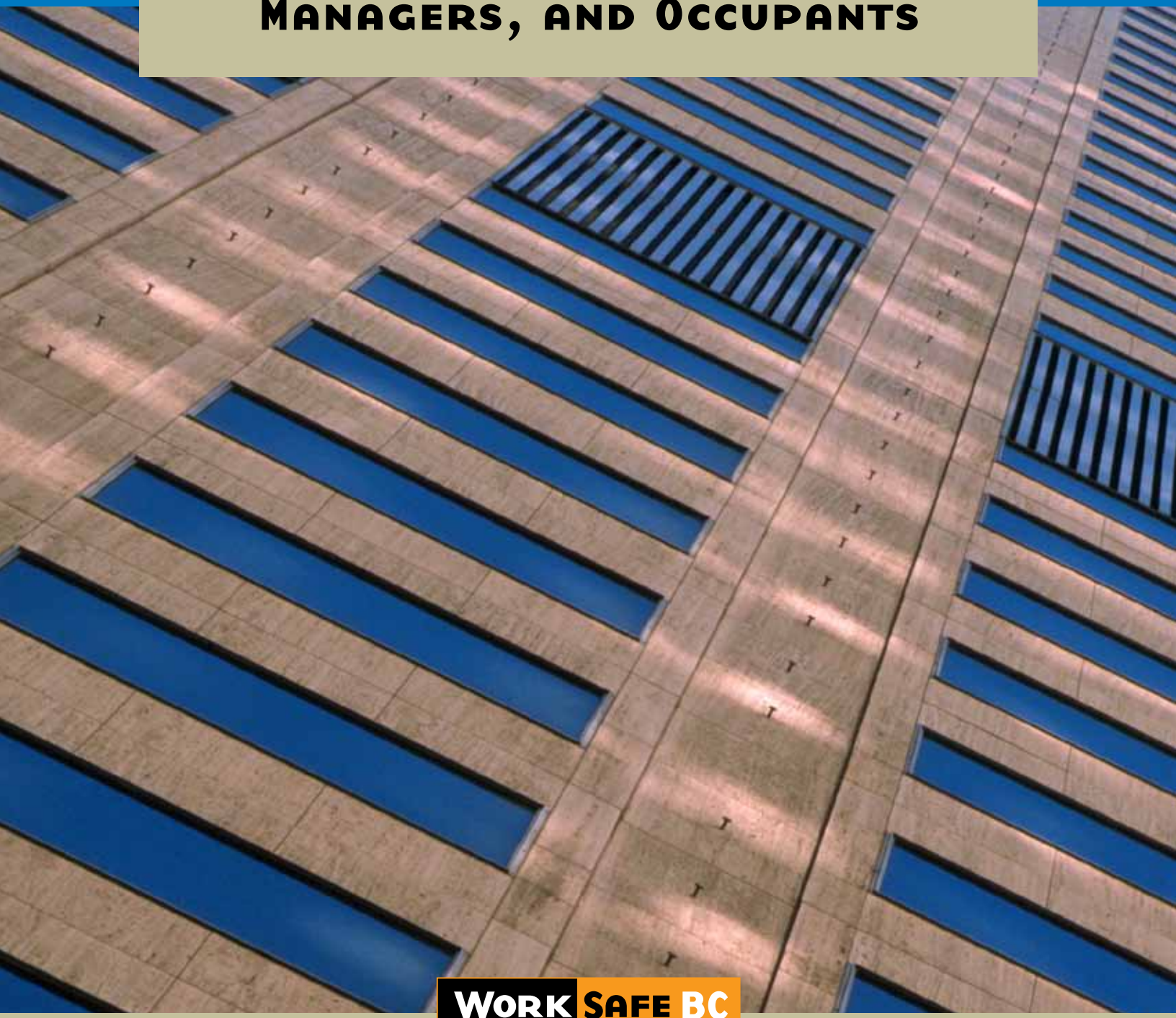
Indoor Air Quality:

A Guide for Building Owners, Managers, and Occupants



WorkSafeBC

About the WCB

The Workers' Compensation Board is an independent provincial statutory agency governed by a Board of Directors. It is funded by insurance premiums paid by registered employers and by investment returns. In administering the *Workers Compensation Act*, the WCB remains separate and distinct from government; however, it is accountable to the public through government in its role of protecting and maintaining the overall well-being of the workers' compensation system.

The WCB was born out of a compromise between BC's workers and employers in 1917 where workers gave up the right to sue their employers or fellow workers for injuries on the job in return for a no-fault insurance program fully paid for by employers. The WCB is committed to a safe and healthy workplace, and to providing return-to-work rehabilitation and legislated compensation benefits to workers injured as a result of their employment.

WCB Prevention Information Line

The WCB Prevention Information Line can answer your questions about workplace health and safety, worker and employer responsibilities, and reporting a workplace accident or incident. The Prevention Information Line accepts anonymous calls.

Phone 604 276-3100 in the Lower Mainland, or call 1 888 621-7233 (621-SAFE) toll-free in British Columbia.

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WorkSafeBC

WCB Publications

Many publications are available on the WCB web site. The Occupational Health and Safety Regulation and associated policies and guidelines, as well as excerpts and summaries of the *Workers Compensation Act*, are also available on the web site: <www.worksafebc.com>

Some publications are also available for purchase in print:

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Contents

Who should use this guide

Read this guide if you own, lease, manage, or operate a building or facility in British Columbia. The information in this guide will help you maintain good indoor air quality in your building, prevent indoor air quality problems, and correct problems that may arise. It will also help you understand the indoor air quality requirements in the Occupational Health and Safety Regulation.

Building occupants, labour unions, environmental consultants, mechanical engineers, and suppliers may also find this guide helpful in understanding typical indoor air quality problems and what can reasonably be done to correct them.

Where do indoor air quality requirements apply?

Sections 4.70 to 4.80 of the Regulation state requirements for indoor air quality in B.C. workplaces. These requirements apply to indoor or enclosed areas that are occupied by workers. For example, the requirements apply to office buildings, portable classrooms, and operators' booths in mills, but they do not apply to vehicles, buses, ferry car decks, barns, and equipment storage trailers.

The requirements do not apply to controlled atmosphere enclosures, such as walk-in freezers or confined spaces. They also do not apply during some construction or renovation projects when it is impractical to implement them (for example, at new construction sites where the ventilation system has not yet been installed or where the system is inoperative during renovations or demolition).

How this guide is organized

In the Regulation

To ensure that you meet specific requirements for indoor air quality, refer to sections 4.70 to 4.80 of the Regulation. If you require assistance applying the Regulation, contact a WCB occupational hygiene officer at your nearest WCB office.

Part 1: The basics (pages 3-12) describes why indoor air quality is important, the effects of poor indoor air quality, factors affecting indoor air quality, responsibilities, ventilation requirements, and design considerations.

Part 2: Preventing indoor air quality problems (pages 13– 22) provides information on managing indoor air quality, operating a ventilation system, controlling temperature and humidity, handling indoor air quality complaints, preventive maintenance, and building modifications.

Part 3: Resolving indoor air quality problems (pages 23–30) provides information on when and how to conduct indoor air quality investigations, walkthrough inspections, assessing indoor air quality, and inspecting the ventilation system. This part also lists common air quality problems and possible causes.

Part 4: Forms, checklists, and other resources (pages 31–42) contains several blank forms and checklists that property managers and building operators can use to handle indoor air quality complaints, document walkthrough inspections, and inspect the ventilation system. A list of other available indoor air quality resources is also included.

This document does not replace the Occupational Health and Safety Regulation or the *Workers Compensation Act*. It is intended only as a general guide and is not meant to be an exhaustive document that addresses every possible indoor air quality issue. In this guide, the word *must* indicates a requirement in the Regulation. The word *should* indicates a recommendation that, while not required by the Regulation, will help to improve workplace health and safety.

1 The basics

This part includes the following sections:

- Why indoor air quality is important
- Effects of poor indoor air quality
- Factors affecting indoor air quality
- Responsibilities
- Ventilation requirements
- Design considerations

Why indoor air quality is important

People spend about 90% of their time indoors. Many people spend their entire working day inside an office, shop, factory, or other facility.

In some indoor environments, poor air quality has been blamed for physical symptoms and complaints such as headaches, eye irritation, and coughs. These physical symptoms and complaints can affect people's health, comfort, job satisfaction, and work performance.

In recent years, people have become more aware of potential health and comfort problems that may be associated with poor indoor air quality. This is partly due to the move to more tightly sealed buildings, the implementation of energy conservation programs, and the growing use of laser printers, photocopiers, and other sources of indoor air contamination. A greater general awareness of environmental issues may also play a part.

Today, people expect healthy, comfortable, productive indoor environments. Workers are likely to complain when they feel the indoor air quality in their building is unsatisfactory. As well, people have varying sensitivities. Some people will react to certain substances (such as pet hair or fragrances) that do not cause a problem for others.

Effects of poor indoor air quality

Poor indoor air quality can lead to a number of physical symptoms and complaints. The most common include:

- Headaches
- Fatigue
- Shortness of breath
- Sinus congestion
- Coughs
- Sneezing
- Eye, nose, and throat irritation
- Skin irritation
- Dizziness
- Nausea

Although these physical symptoms and complaints are often attributed to indoor air quality, it is important to note that indoor air quality is not always responsible. Noise, overcrowding, improper lighting, poor ergonomic conditions, and job stress can also lead to these symptoms and complaints. Frequently, a combination of factors is to blame.

Indoor air contaminants affect some people more seriously, including:

- People with allergies or asthma
- People with respiratory disease
- People whose immune system is suppressed as a result of disease or treatment
- People who wear contact lenses

Factors affecting indoor air quality

A number of factors can affect the indoor air quality of a building or facility, including:

- The physical layout of the building
- The building's heating, ventilation, and air conditioning (HVAC) system
- The outdoor climate
- The people who occupy the building
- Contaminants inside and outside the building

The physical layout of the building and of the building's HVAC system determine how air moves throughout the building and how much fresh air enters the building from outside. For example, changing the layout of a building by erecting walls or dividers inside can change the air circulation patterns and lead to poor air circulation or a concentration of contaminants in certain areas.

The building's HVAC system is designed to distribute outdoor air throughout the building, remove contaminants and odours, and control the indoor temperature and humidity. A poorly designed or poorly maintained system can cause indoor air quality problems.

The outdoor climate can also affect indoor air quality, especially in colder regions. For example, to reduce heating costs many HVAC systems reduce the amount of fresh air brought into the building when the outside air is cold. Also, the humidity level outside the building can make it difficult to control the relative humidity inside the building.

The people who occupy a building also affect indoor air quality. Occupants may affect air quality by smoking, cooking, wearing cosmetics or scents, or producing body odours.

Sources of indoor air contaminants

Indoor air contaminants can originate within a building or be drawn in from outdoors. These contaminants can lead to indoor air quality problems, even if the HVAC system is properly designed, well maintained, and functioning properly.

Sources of contaminants inside the building may include:

- Dust, dirt, or mould in the HVAC system
- Office equipment such as laser printers and copiers
- Personal activities such as smoking or cooking
- Housekeeping activities such as cleaning and dusting
- Maintenance activities such as painting
- Spills of water or other liquids
- Special-use areas such as print shops and laboratories
- Industrial processes such as dry cleaning

Sources of contaminants from outside the building may include:

- Vehicle exhaust
- Pollen and dust
- Smoke
- Unsanitary debris or dumpsters near the outdoor air intake

Environmental tobacco smoke

Second-hand tobacco smoke is a significant workplace hazard in British Columbia. It increases the risks of lung cancer and heart disease, including heart attacks, in otherwise healthy non-smokers. It is estimated that 50 British Columbians die each year of lung cancer caused by exposure to second-hand smoke.

Employers at most B.C. workplaces must control worker exposure to environmental tobacco smoke using one of the following approaches:

- Prohibiting smoking in the workplace
- Restricting smoking to designated smoking areas or by other equally effective means

For more information on environmental tobacco smoke, see sections 4.81 to 4.83 of the Regulation.

Responsibilities

Scent-free environment

Some people are adversely affected by fragances. Today, many workplaces are adopting a scent-free environment policy.

Building owners, employers, property managers, building operators, and occupants all have roles to play in maintaining good indoor air quality in the work environment. Sometimes, joint health and safety committees or labour union representatives may also be involved in investigating and resolving indoor air quality problems or complaints.

Owners and employers

Overall, it is the employer's responsibility to make sure that the workplace meets the indoor air quality requirements stated in the Occupational Health and Safety Regulation. The employer may own the building or facility or, more commonly, will be a tenant operating under a lease agreement with the building owner. Lease agreements help define each party's responsibilities, including who is responsible for maintaining the ventilation system.

Property managers

The property manager is responsible for the day-to-day management of the building on behalf of the building owner. The property manager's responsibilities often include handling indoor air quality complaints, educating occupants about how their activities affect air quality in the building, and overseeing air quality investigations.

Building operators

The building operator is responsible for operating the building's HVAC system. This includes performing preventive maintenance on the system and investigating indoor air quality complaints. The building operator is usually an employee of the building owner or the property manager. Most larger buildings or facilities have a building operator on-site.

Occupants

Building occupants also have responsibilities relating to indoor air quality. For example, building occupants are responsible for avoiding activities that can contaminate the air, such as smoking and cooking. In some buildings, occupants are able to operate zone thermostats to control the temperature or open windows. Occupants should inform the property manager or building operator before modifying an office space or adding new equipment that could affect the indoor environment.

Caution

Portable humidifiers should be used with caution. If not properly maintained, they may become contaminated with mould and bacteria.

Ventilation requirements

Natural ventilation

For some buildings, it is appropriate to use natural ventilation provided through open windows and doors instead of mechanical ventilation provided by an HVAC system. For example, natural ventilation may be appropriate for warehouses with openable windows and no HVAC system.

Good ventilation provides adequate amounts of outdoor air and circulates air in the building to dilute and remove odours and contaminants and keep air temperature consistent within the building. The Occupational Health and Safety Regulation lists a number of requirements for building ventilation systems. Building owners and employers must meet these requirements to protect the health and comfort of people who work in their buildings.

Outdoor air

An adequate supply of outdoor air must be provided to the workplace in accordance with Table 2 of *ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.* The amount of outdoor air required varies according to the type of building or facility, activities, and occupant density. As a general guideline, many workspaces will require between 15 and 20 cubic feet per minute (cfm) of outdoor air per person.

There is an exception to this requirement. If a building ventilation system was installed before 1989, an adequate supply of outdoor air must be provided in accordance with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard in place at the time the ventilation system was designed, not the 1989 standard.

Air distribution and balancing

Outdoor air must be effectively distributed throughout the workplace. The ventilation system must be balanced to ensure that each space within the building receives an adequate amount of outdoor air and to accommodate the normal occupancy of each space.

Ventilation openings

Ventilation systems must not be obstructed by material or equipment placed in front of the ventilation air intakes or discharge points. Obstructions can significantly change airflow patterns or air quantities in a space and prevent proper control of conditions in the space.

Outdoor air intakes must be located so they do not draw in air that is more polluted than the normal air in that locality. In general, outdoor air intakes should not be located in loading bays, parking garages, or cooling tower enclosures.

Discharged air

Ventilation systems that discharge air from work areas must be designed to minimize the likelihood of exposing any worker at a workplace, including an adjacent workplace, to:

- An air contaminant in a concentration that exceeds 10% of its applicable exposure limit or an acceptable ambient air quality standard, whichever is greater
- An objectionable odour, where practicable

This requirement applies to process exhaust and all exhaust from spaces where air contaminants are generated, including combustion products from space and water heaters and tobacco smoke from designated smoking areas. For a complete list of air contaminants and their exposure limits, see the Occupational Health and Safety Regulation.

Air cleaning equipment or exhaust stacks may be used to meet discharged air requirements. Process controls that reduce emissions to below odour thresholds or detection limits may also be used.

A properly functioning HVAC system:

- Provides thermal comfort
- Distributes adequate amounts of outdoor air
- Removes odours and contaminants

ASHRAE

For information on ventilation documentation, see *ASHRAE Guideline 4-1993, Preparation of Operating and Maintenance Documentation for Building Systems.*

As specified in section 4.72 of the Regulation, ventilation systems must be designed, constructed, and operated in accordance with established engineering principles and *ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.* "Established engineering principles" means the information contained in ASHRAE handbooks, standards, and guidelines. For information on ventilation for controlling process contaminants, refer to the current edition of *Industrial Ventilation: A Manual of Recommended Practice,* American Conference of Governmental Industrial Hygienists (ACGIH).

2 Preventing indoor air quality problems

This part includes the following sections:

- Managing indoor air quality
- Operating the ventilation system
- Controlling temperature and humidity
- Handling indoor air quality complaints
- Preventive maintenance
- Building modifications

Managing indoor air quality

Effective management can help avoid many indoor air quality problems. Managing indoor air quality is usually the shared responsibility of the property manager and the building operator.

Follow these basic guidelines for effective indoor air quality management: Keep the HVAC system and controls in proper working order.

- Oversee occupant activities that can affect indoor air quality (for example, smoking, housekeeping, building maintenance, shipping and receiving, and food preparation).
- Communicate with occupants so they know their responsibilities, know how to make an indoor air quality complaint, and understand what can reasonably be done to resolve complaints.
- Manage renovations, remodelling, and construction projects to maintain good indoor air quality.

For more information, see *Building Air Quality: A Guide for Building Owners and Facility Managers,* United States Environmental Protection Agency, and *Managing Indoor Air Quality: A Manual for Property Managers,* National Research Council Canada.

Operating the ventilation system

As specified in section 4.72 of the Regulation, ventilation systems must be operated in accordance with established engineering principles and *ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality.* If the ventilation system was installed before 1989, follow the ASHRAE standard that was in place at the time the ventilation system was designed.

Following these requirements will help to maintain a healthy and comfortable indoor environment, avoid indoor air quality problems, and meet WCB requirements. Also, the efficiencies gained by keeping the HVAC system better controlled can reduce energy costs. For basic information on operating a building's HVAC system, refer to the system's operating manual.

Thermal comfort depends on numerous factors, including temperature and relative humidity. When the relative humidity is high, a person's ability to lose heat through perspiration is reduced. The effect is similar to raising the temperature. Individuals vary in their preferences regarding thermal comfort. For example, what one person finds too warm may be an ideal temperature for another.

Health Canada 93-EHD-166, *Indoor Air Quality in Office Buildings: A Technical Guide*, states that "Relative humidity levels below 25% are associated with increased discomfort and drying of the mucous membranes and skin, which can lead to chapping and irritation. Low relative humidity also increases static electricity, which causes discomfort and can hinder the operation of computers and paper-processing equipment. High humidity levels can result in condensation within the building structure and on interior or exterior surfaces and the subsequent development of moulds and fungi." Note: condensation from high indoor humidity is more likely to occur when it is very cold outside.

As specified in section 4.80 of the Regulation, employers must ensure that indoor temperature and humidity levels are maintained within acceptable comfort ranges, as far is as practicable.

Standard for thermal comfort

ASHRAE Standard 55-1992, Thermal Environmental Conditions for Human Occupancy, specifies conditions or comfort zones in which 80% of sedentary or slightly active persons find the environment thermally acceptable. This standard takes into account the effect of seasonal factors such as temperature, relative humidity, and the type of clothing worn by workers. The table at the top of the next page shows the approximate ranges of temperature and relative humidity found in the standard.

Acceptable ranges of temperature and relative humidity for comfort (adapted from *ASHRAE Standard 55-1992*)

Season	Relative Humidity	Temperature
Summer	30%	23°C to 27°C
	50%	23°C to 26°C
	60%	23°C to 26°C
Winter	30%	20°C to 24°C
	50%	20°C to 24°C
	60%	20°C to 23°C

The values apply to people wearing typical summer or winter clothing while doing light, mostly sedentary, work.

Health Canada 93-EHD-166, *Indoor Air Quality in Office Buildings: A Technical Guide,* states that "In most Canadian cities, ideal indoor relative humidity levels are 35% in the winter and 50% in the summer."

For more detailed information on thermal comfort, see *ASHRAE Standard 55-1992* and *ASHRAE Fundamentals Handbook 2001.*

Definition

On its web site, Environment Canada defines relative humidity: "Relative humidity is the amount of moisture that the air contains compared to how much it could hold at a given temperature. A figure of 100 per cent would mean that the air has become saturated."

In the Regulation

Special requirements apply to the control of hazards of heat and cold where workers work in conditions that could cause heat-related or cold-related disorders or injuries (for example, during a heat wave). For more information, see sections 7.26 to 7.38 of the OHS Regulation.

Handling indoor air quality complaints

The first sign of an indoor air quality problem is often a complaint from a building occupant. The responsibility for handling indoor air quality complaints often falls to the building operator.

It is a good idea to set up a system for handling complaints. Make sure occupants know how to lodge an indoor air quality complaint. For example, they may make complaints to their supervisor, the property manager, a member of the joint health and safety committee, or directly to the building operator. Complaint forms for occupants to fill out can be posted on bulletin boards or left with a supervisor. See the Indoor Air Quality Complaint Form on page 32.

Poor communication can magnify many of the problems associated with indoor air quality problems. Try to respond promptly to every complaint. This will help build trust and reduce occupants' anxiety and frustration.

Keep a record of all indoor air quality complaints. An Indoor Air Quality Complaint Log is provided on page 33. Periodically review the complaint log to determine the nature of the complaints. For example, one particular area of a building may frequently be too warm. Reviewing the log will help identify problems or perceived problems so steps can be taken to remedy them.

For information on investigating indoor air quality complaints and problems, see pages 24-30.

Preventive maintenance

A ventilation system will operate efficiently and ensure good indoor air quality only when it is properly adjusted and maintained. To maintain acceptable air quality, the employer must establish an effective preventive maintenance program for the ventilation system. If the employer is not responsible for system maintenance, the owner or the owner's agent must establish the program. Lease agreements usually indicate who is responsible.

Preventive maintenance program components

In general, a preventive maintenance program should operate in accordance with *CSA Standard Z204-94, Guideline for Managing Indoor Air Quality in Office Buildings.* A preventive maintenance program must include:

- Regular inspections of all critical components of the ventilation system such as dampers, fans, belts, baffles, ductwork, diffusers, and control systems
- Regular inspections for conditions such as water leaks or stagnant water pools that would promote the growth of micro-organisms
- Correction of any deficiencies found during inspections
- Repair or replacement of malfunctioning and consumable components such as filters and belts, and cleaning of air distribution systems, ducts, and dampers when necessary to correct an indoor air quality deficiency
- Adequate treatment of open water systems associated with ventilation equipment, such as cooling towers and humidifiers, to control biological growth
- Maintenance of combustion sources such as furnaces, space heaters, and water heaters to ensure proper burning and exhausting of waste gases so that gases will not be recirculated in the workplace

Preventive maintenance documentation

- It is recommended that a preventive maintenance program be documented. Documentation should include the following:
- A statement regarding the health and safety of workers who are conducting maintenance operations
- The system design parameters, including occupancy, space uses, and conditions anticipated by the designer
- Operating and maintenance manuals for installed equipment, including part numbers for components that require routine replacement
- A description of the intended functioning of system controls

- Inspection reports that state:
  - The date of the inspection
  - Who conducted the inspection
  - The components and conditions inspected
  - The state of the components and conditions when inspected
  - Recommended corrective actions
  - Any corrective actions taken and the dates they were taken
- Specific preventive maintenance procedures and implementation schedules such as instructions for calibration of the HVAC system sensors and a schedule stating when the calibrations are to be conducted

Keep a log of all maintenance activities performed.

Typical preventive maintenance tasks

The following are some typical preventive maintenance tasks. You may wish to include them in your preventive maintenance program. See *CSA Standard Z204-94, Guideline for Managing Indoor Air Quality in Office Buildings* for further details.

- Test the volume of air supplied or returned through diffusers to ensure that the system is balanced.
- Calibrate sensors and devices that control airflow, temperature, and humidity.
- Change air filters, clean dirty air intakes, and prevent leaks.
- Inspect drive belts, bearings, motors, and other moving parts. Replace if necessary.
- Clean ductwork and, where ceiling spaces are used as supply or return air plenums, replace damaged or missing tiles.
- Clean and disinfect components where standing water may have been present for extended periods or where dirt, slime, or mould is observed. This includes humidifiers, electrostatic precipitators, cooling towers, fan coil units, air supply and exhaust ducts, air intakes, cooling coils, condensate drains, radiators, and induction units.
- Make sure drain traps in mechanical rooms do not go dry.
- Maintain shower rooms to minimize moulds and odours.
- Follow proper procedures for housekeeping, handling chemicals, and cleaning up spills.
- Inspect heat exchangers when it is suspected that combustion gases are escaping into the air plenum.

Building modifications

As specified in section 4.73 of the Regulation, the building owner must permit an employer to install a ventilation system if one is required by the Regulation. For example, it may be necessary to install a ventilation system if the building has no existing HVAC system or to upgrade the system if it is inadequate for the occupancy. All such work, however, is subject to the approval of the owner, acting reasonably. The requirements of section 4.73 take precedence over any term of a lease agreement that might be contrary to the responsibility stated by the Regulation.

Factors to consider

Factors to consider when installing or modifying a ventilation system include:

- The effects that the discharged air will have on other tenants or adjacent properties
- The effects that the ventilation system will have on the building's structural integrity, water-tightness, and fire safety
- Whether the ventilation system already complies with all other applicable codes and standards
- Whether the ventilation system will pose a risk to workers or other persons in the building

Changes in use or occupancy

Changes to the building layout, the number of occupants in a space, or the way spaces are used can affect heating, cooling, and ventilation. It may be necessary to rebalance, readjust, or modify the HVAC system any time you:

- Move walls or room dividers
- Increase the number of occupants in a space
- Install or remove equipment that generates heat (for example, photocopiers and computers)
- Change lighting

3 Resolving indoor air quality problems

This part includes the following sections:

- When to conduct an indoor air quality investigation
- How to conduct an indoor air quality investigation
- Walkthrough inspections
- Assessing indoor air quality
- Inspecting the ventilation system
- Common air quality problems and possible causes

When to conduct an indoor air quality investigation

Indoor air quality investigations often begin as the result of occupant complaints. The employer must ensure that indoor air quality is investigated when:

- Complaints are reported
- Occupancy in the space changes substantially
- Renovations are made that involve significant changes to the ventilation system

Some complaints may be related to discomfort (for example, occupants are too hot or too cold) while others may be related to illness (for example, occupants experience nausea or dizziness).

Who takes part in an investigation?

Indoor air quality investigations are often led by the property manager or building operator. Other people involved in an investigation may include:

- The employer
- The building owner
- The supervisor of the area where there is an air quality concern
- Members of the joint health and safety committee
- A union representative

Before an investigation is conducted, it may be helpful to prepare an investigation plan that defines everyone's responsibilities.

What steps should an investigation include?

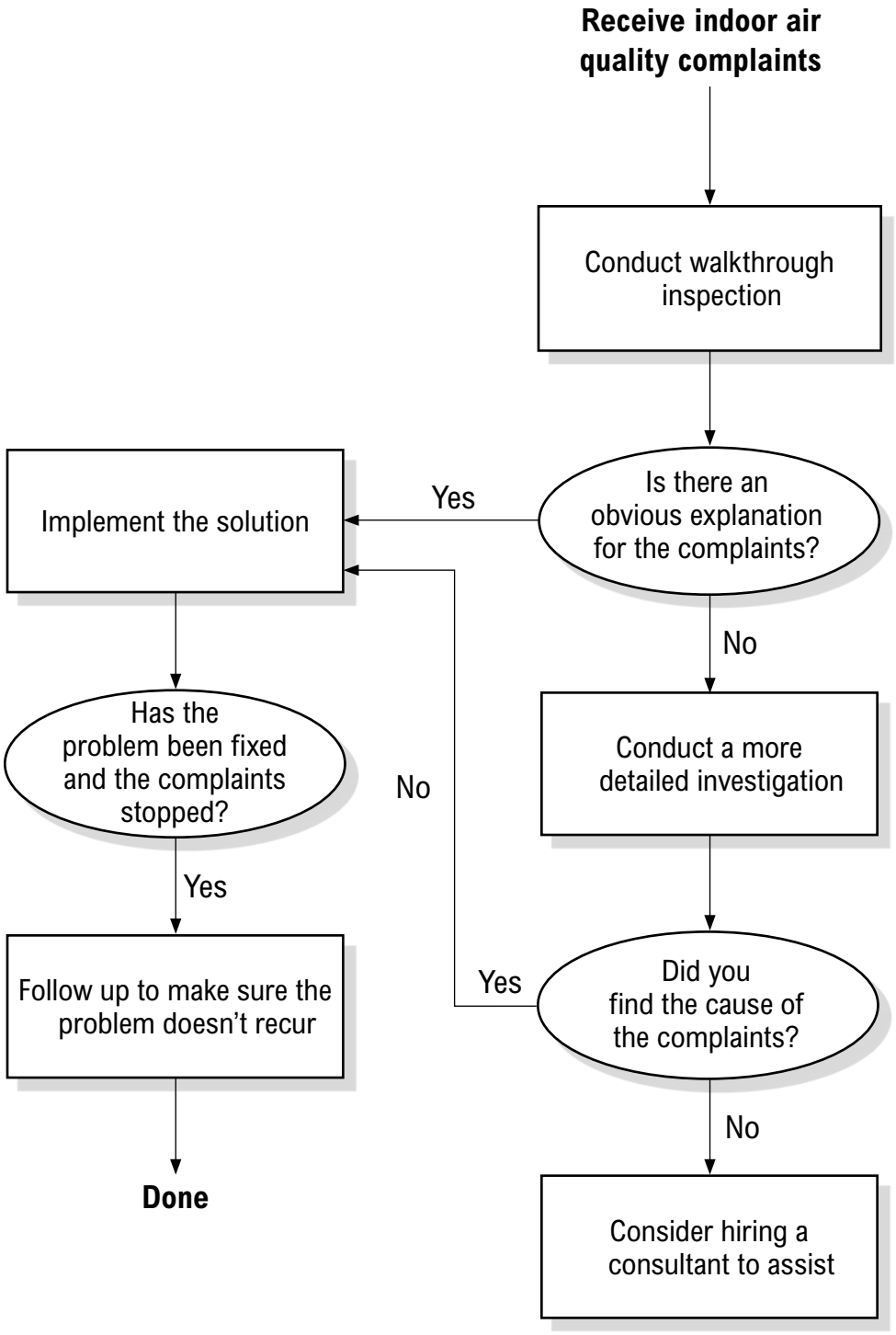
As specified in section 4.79 of the Regulation, an investigation must include the following steps:

- Assess the ventilation rate, unless the indoor carbon dioxide levels is less than 650 parts per million (ppm) above ambient outdoor levels.
- Inspect the ventilation system.
- Sample for airborne contaminants suspected to be present in concentrations associated with the reported complaints.
- Document the complaint, the investigation, and any actions taken.

Carbon dioxide is an indicator of the amount of outdoor air present. Normally, ambient outdoor levels are about 350 ppm, but they may be higher in urban areas or other locations, or during weather conditions such as inversions. Assume that ambient levels are 350 ppm unless sampling establishes otherwise.

Most indoor air quality problems can be resolved in-house. In some cases it may be advisable to hire an outside consultant. The WCB may help employers resolve particularly troublesome indoor air quality problems but does not routinely perform indoor air quality investigations.

The investigation process



Walkthrough inspections

A walkthrough inspection is a good way to begin an indoor air quality investigation. An inspection often reveals an obvious problem that can be easily solved, saving much time and effort. For example, if the complaint is about an unusual odour, the source may be located by first checking possibilities such as odours from cafeterias, outdoor air, or equipment.

Who performs inspections?

Walkthrough inspections are usually performed by the building operator or property manager. Sometimes an area supervisor or a member of the joint health and safety committee may be involved.

What steps should an inspection include?

Talk to the building occupants; they may be able to point to the cause of the problem. Look for things like blocked openings, signs of people interfering with the HVAC system, or obvious internal and external sources of pollution. The Walkthrough Inspection Checklist on page 34 may be helpful.

Some indoor air quality problems are easily identified and remedied. Other problems may be more difficult to pinpoint. The information gathered on the walkthrough inspection can be a starting point for a more detailed investigation, if necessary.

Assessing indoor air quality

When assessing indoor air quality, use thermometers, psychrometers (to measure humidity), and air velocity or flow instruments to verify that systems are operating properly. Also measure carbon dioxide concentrations. In some cases, these widely accepted measures provide all the information needed to assess the performance of an air conditioning system.

Inspecting the ventilation system

When inspecting the ventilation system, check all critical system components, including:

- Dampers
- Fans
- Belts
- Baffles
- Ductwork
- Diffusers
- Control systems

Also look for conditions such as water leaks or stagnant water pools that would promote the growth of micro-organisms. The HVAC Checklist on page 36 can help guide the inspection.

Common air quality problems and possible causes

Problem	Some possible causes to consider
Occupants complain that the building air is too stuffy or dusty.	· Has the HVAC system been properly maintained? · Are any vents blocked? · Is the building being occupied or used differently than originally intended? · Is the air intake located near the air exhaust? · Is the relative humidity too low or high?
Occupants complain that the building air is too warm, cool, dry, or humid.	· Is the relative humidity or temperature too low or high? · Are building controls set properly? · Are building controls operating properly? · Have occupants brought in portable space heaters or humidifiers? · Are there any water leaks?
Occupants complain of headaches, decreased alertness, or nausea after being in the building for a long period.	· Is the building's air intake near a source of carbon monoxide such as a loading dock or parking garage? · Are there any combustion sources in the building?
Occupants complain of eye irritation, dry or sore throats, nosebleeds, or headaches.	· Have there been any recent renovations in the building involving plywood, particleboard, or new furniture? · Are there any other possible sources of formaldehyde? (Formaldehyde, a chemical typically found in the above pressed wood products, can cause the symptoms. Other products exist that can emit formaldehyde.)
Occupants complain of eye, nose, or throat problems; contact lens problems; skin irritation; or respiratory problems.	· Is smoke finding its way into the building? · Is there a dirt buildup around diffusers? · Are filters in the ventilation system changed regularly? · Is the humidity too low?
There has been an increase in the number of illnesses among occupants, especially asthmatic and flu-like illnesses.	· Is there mould or fungal growth on building surfaces or in the ventilation system? · Is there evidence of a water leak in the building?

4 Forms, checklists, and other resources

This part includes the following:

- Indoor air quality complaint form
- Indoor air quality complaint log
- Walkthrough inspection checklist
- HVAC checklist
- Other resources

Indoor air quality complaint form

Fill out this form to make a complaint related to indoor air quality. Indoor air quality complaints include concerns about temperature, ventilation, and air pollutants.

Return the completed form to _____

or call _____ to make your complaint by phone.

We try to respond to indoor air quality complaints as quickly as we can.

Date _____

Name _____ Title _____

Telephone _____

Department and location in building _____

Describe the nature of the complaint and any potential causes. _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Office use only

Complaint # _____ Received by _____ Date received _____

Indoor air quality complaint log

Complaint #	Date received	Date investigated	Location of problem	Description of problem	Action taken and outcome	Initials

Walkthrough inspection checklist

Date _____

Name of inspector(s) _____

_____

Department or location inspected _____

Reason for inspection _____

Inspection activity	Notes
❑ If necessary, include other individuals in the investigation (for example, the supervisor of the area you are investigating or a member of the joint health and safety committee). ❑ Talk to the building occupants who made the complaints. Discuss the nature and timing of their symptoms. Ask them to identify any suspected causes. ❑ Check for obvious pollutant sources such as humidifiers, new furniture, or new carpets. ❑ Check the HVAC system: • Check thermostat settings. • Check that thermostats, diffusers, fans, and dampers are clean and operating properly. • Check the outdoor air intake for mould, stagnant water, blockage, or nearby sources of contaminants. ❑ Take measurements, if necessary, using thermometers, direct reading carbon dioxide meters, or other equipment. ❑ Check records: • When was the system last calibrated and adjusted? • When was preventive maintenance last performed?	

Possible causes of problem

_____

_____

_____

Recommended corrective action

_____

_____

_____

Corrective action taken? ❑Yes ❑No

Additional investigation required? ❑Yes ❑No

HVAC checklist

This checklist is from *Building Air Quality: A Guide for Building Owners and Facility Managers,* December 1991 (EPA Publication No. 400/1-91/003, NIOSH Publication No. 91-114). The full publication, as well as a longer version of the form, is available at: <www.cdc.gov/niosh/baqtoc.html>.

Building name _____ Address _____

Completed by _____ Date _____

Mechanical room

- Clean and dry? _____ Stored refuse or chemicals? _____
- Describe items in need of attention _____

Major mechanical equipment

- Preventive maintenance (PM) plan in use? _____

Control System

- Type _____
- System operation _____
- Date of last calibration _____

Boilers

- Rated Btu input _____ Condition _____
- Combustion air: Is there at least one square inch free area per 2,000 Btu input? _____
- Fuel or combustion odors? _____

Cooling Tower

- Clean? No leaks or overflow? _____ Slime or algae growth? _____
- Eliminator performance _____
- Biocide treatment working? (list type of biocide) _____
- Spill containment plan implemented? _____ Dirt separator working? _____

Chillers

- Refrigerant leaks? _____
- Evidence of condensation problems? _____
- Waste oil and refrigerant properly stored and disposed of? _____

Air handling unit

- Unit identification _____ Area served _____

Outdoor Air Intake, Mixing Plenum, and Damper

- Outdoor air intake location _____
- Nearby contaminant sources? (describe) _____
- Bird screen in place and unobstructed? _____
- Design total cfm _____ Outdoor air (O.A.) cfm _____ Date last tested and balanced _____
- Minimum % O.A. (damper setting) _____ Minimum cfm O.A. = (total cfm X min. % O.A.) ÷ 100 = _____
- Current O.A. damper setting (date, time, and HVAC operating mode) _____
- Damper control sequence (describe) _____
- Condition of dampers and controls (note date) _____

Fans

- Control sequence _____
- Condition (note date) _____
- Indicated temperatures: _____ supply air _____ mixed air _____ return air _____ outdoor air _____
- Actual temperatures: _____ supply air _____ mixed air _____ return air _____ outdoor air _____

Coils

- Heating fluid discharge temperature _____ ΔT _____ cooling fluid discharge temperature _____ ΔT _____
- Controls (describe) _____
- Condition (note date) _____

Humidifier

- Type _____ If biocide is used, note type _____
- Condition (no overflow, drains trapped, all nozzles working?) _____
- No slime, visible growth, or mineral deposits? _____

Distribution system

Zone/room	System Type	Supply Air		Return Air		Power Exhaust		
		ducted/ unducted	cfm	ducted/ unducted	cfm	cfm	control	serves (e.g., toilet)

Condition of distribution system and terminal equipment (note locations of problems)

- Adequate access for maintenance? _____
- Ducts and coils clean and unobstructed? _____
- Air paths unobstructed? supply _____ return _____ transfer _____ exhaust _____ make-up _____

- Note locations of blocked air paths, diffusers, or grilles _____
- Any unintentional openings into plenums? _____
- Controls operating properly? _____
- Air volume correct? _____
- Drain pans clean? Any visible growth or odors? _____

Filters

Location	Type/Rating	Size	Date Last Changed	Condition (give date)

Occupied space

Thermostat types

Zone/Room	Thermostat Location	What Does Thermostat Control? (e.g., radiator, AHU-3)	Setpoints		Measured Temperature	Day/ Time
			Summer	Winter		

Humidistats/dehumidistats type

Zone/Room	Humidistat / Dehumidistat Location	What Does It Control?	Setpoints (%RH)	Measured Temperature	Day/ Time

- Potential problems (note location) _____

  _____

- Thermostat comfort or air circulation (drafts, obstructed airflow, stagnant air, overcrowding, poor thermostat location) _____

  _____

- Malfunctioning equipment _____

- Major sources of odors or contaminants (e.g., poor sanitation, incompatible uses of space) _____

  _____

Other resources

WCB resources

Occupational Health and Safety Regulation

The Occupational Health and Safety Regulation, as well as associated guidelines and policies, is available online at <www.worksafebc.com>.

Indoor air quality web site

More information on indoor air quality is available on the WCB's web site. Go to <www.worksafebc.com> and visit the Health and Safety Centre. Under Health and Safety Topics, click on Indoor Air Quality.

WorkSafe Magazine is a bimonthly WCB publication that informs workers and employers about occupational health and safety issues. It is available online at <www.worksafebc.com>.

Other standards and publications

ASHRAE Fundamentals Handbook 2001

ASHRAE Guideline 4-1993, Preparation of Operating and Maintenance Documentation for Building Systems

ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
Web site: <www.ashrae.org>

Building Air Quality: A Guide for Building Owners and Facility Managers
Available online at: <www.cdc.gov/niosh/baqtoc.html>
United States Environmental Protection Agency (EPA)
Web site: <www.epa.gov>

CSA Standard Z204-94, Guideline for Managing Indoor Air Quality in Office Buildings
Canadian Standards Association (CSA)
Web site: <www.csa.ca>

Indoor Air Quality Health and Safety Guide
Canadian Centre for Occupational Health and Safety (CCOHS)
Web site: <www.ccohs.ca>

Industrial Ventilation: A Manual of Recommended Practice
American Conference of Governmental Industrial Hygienists (ACGIH)
Web site: <www.acgih.org>

Managing Indoor Air Quality: A Manual for Property Managers
National Research Council Canada
Web site: <www.nrc-cnrc.gc.ca>

Office Air: A Worker's Guide to Air Quality in Offices, Schools, and Hospitals, 1995 (PDF document; 3.1 MB)
Available online at: <www.hc-sc.gc.ca/hecs-sesc/air_quality/generalpubs.htm>
Health Canada
Web site: <www.hc-sc.gc.ca>

Indoor Air Quality in Office Buildings: A Technical Guide, 1995 (PDF document; 174 KB)
Available online at: <www.hc-sc.gc.ca/hecs-sesc/air_quality/pdf/93ehd174.pdf>
Health Canada
Web site: <www.hc-sc.gc.ca>

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