A Simple Guide to Health Risk Assessment

Office Environment Series OE 4/2004

Ventilation



Occupational Safety and Health Branch
Labour Department

Safety at work

Occupational Safety & Health Council



Contents

Introduction 1

Ventilation of a building 1

Purposes of ventilation 2

Risk assessment 2

Problems and solutions 5

Appendix 1 14

Appendix 2 14

Appendix 3 15

Appendix 4 16

Air conditioning system 17

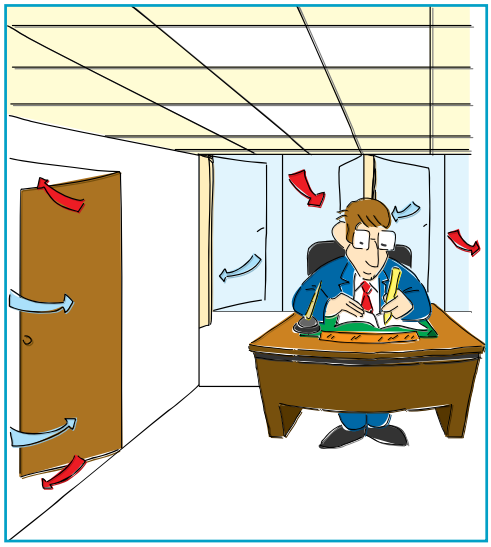
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Introduction

This guide is intended to help employers and employees assess the health risks associated with ventilation systems in their workplace. Such assessments can be no more than an examination of what, in the course of work, could possibly cause harm to people. With the help of this guide, you may identify hazards, the degree of risk and the possible solutions.

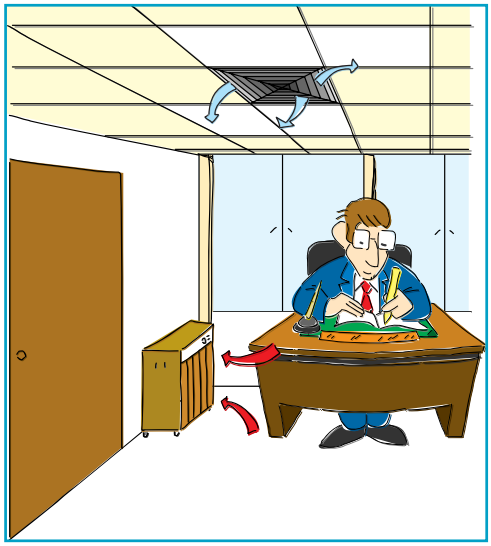
Ventilation of a Building

Ventilation is the process of supplying and removing air by natural or mechanical means to and from a building. The design of a building's ventilation system should meet the minimum requirements of the Building (Ventilating Systems) Regulations.



Natural Ventilation

"Natural ventilation" covers uncontrolled inward air leakage through cracks, windows, doorways and vents (infiltration) as well as air leaving a room (exfiltration) through the same routes. Natural ventilation is strongly affected by weather conditions and is often unreliable.

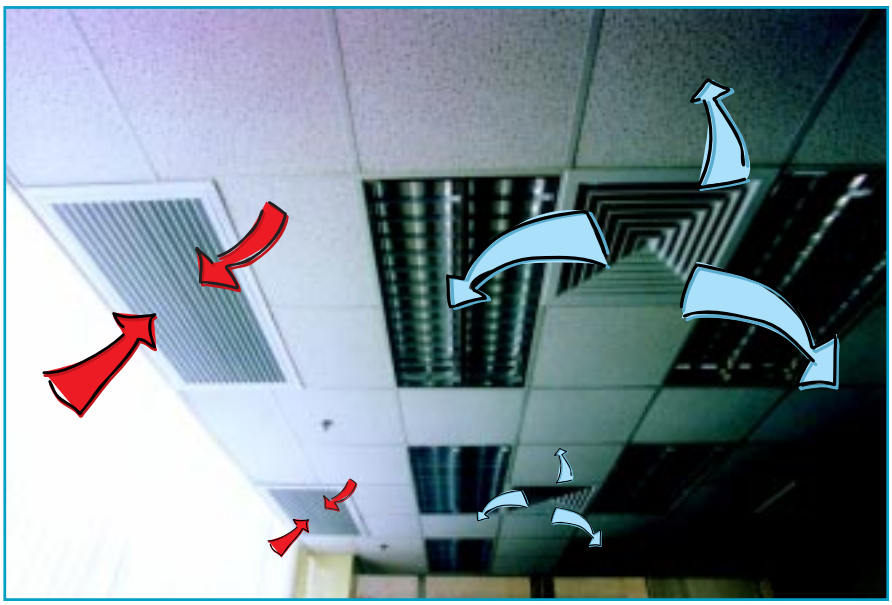


Mechanical Ventilation

Mechanical or forced ventilation is provided by air movers or fans in the wall, roof or air-conditioning system of a building. It promotes the supply or exhaust air flow in a controllable manner.

Purposes of Ventilation

Ventilation in a building serves to provide fresh and clean air, to maintain a thermally comfortable work environment, and to remove or dilute airborne contaminants in order to prevent their accumulation in the air. Air-conditioning is a common type of ventilation system in modern office buildings. It draws in outside air and after filtration, heating or cooling and humidification, circulates it throughout the building. A small portion of the return air is expelled to the outside environment to control the level of indoor air contaminants.



An air-conditioning system

The efficiency of a ventilation system can be evaluated through investigation of environmental factors such as the quality of supply air, the thermal comfort conditions of the occupied space and the level of airborne contaminants therein.

Risk Assessment

The following checklist is designed to help you examine the environmental factors and assess the health risks in your workplace. Answer all the questions and if your answer(s) is the same as that indicating "potential hazards", there are deficiencies in the safety management system or the ventilation is inadequate . You are advised to go through the guidance materials presented in the following sections and apply suitable solutions to eliminate or reduce the health hazards. Should you get matched answers in question marked with ☞, health risks are imminent and immediate remedial actions are required.

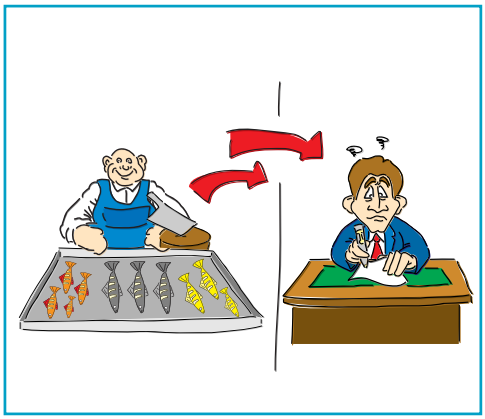
The checklist may not cover all the situations in your workplace. You are free to add more questions or modify them to suit your specific needs.

Design and General Operation

Answers indicating potential hazards

1. Do people complain that the indoor air is stuffy? — Yes

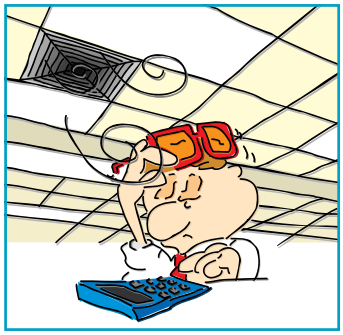
2. Do people notice unusual odour from the ventilation duct which is not related to activities in the office (e.g. cooking odour) or from outdoor sources? — Yes



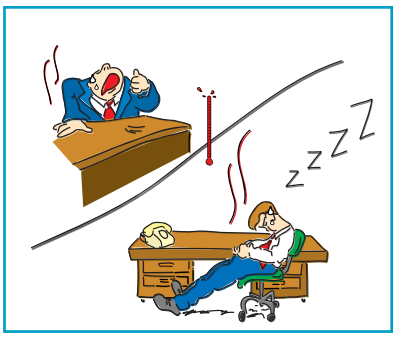
Effect of unrelated activity
e.g. food odour, or fishy smell.

3. Do people complain that the indoor air is too dry, too humid, hot or cold? — Yes

☞ 4. Do people complain that the indoor air is draughty or stagnant? — Yes



Draughts may cause discomfort.



Stagnant air may cause drowsiness

5. Is there a regular maintenance programme for the ventilation system? — No

6. If the building's original design has been changed by the addition of walls or temporary room partitions, has the ventilation system been adjusted and tested to accommodate the new environment? — No

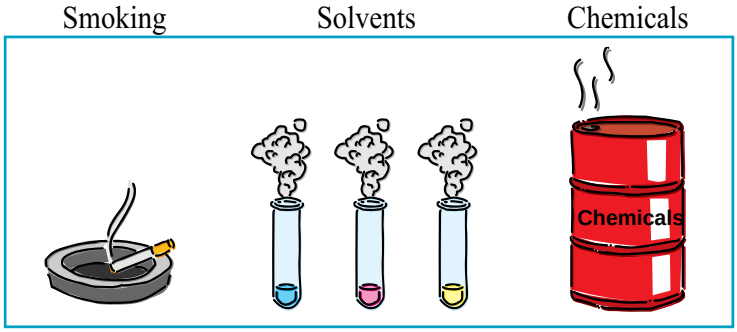
Effects of Renovation Works

☞ 7. Is there any renovation work going on in a nearby location or in a location such that the air quality of your office is affected? — Yes

Specific Contaminant Sources

☞ 8. Do people complain of headaches, decreased alertness or nausea after spending some time in the workroom and yet often no particular odour is detected? — Yes

☞	9. Do people complain of eye irritation, dry or sore throats, nosebleeds or headaches? (These are often associated with a pungent odour.)	Yes
☞	10. Do people complain of having eye, nose or throat discomfort, contact lens problems, skin irritation or respiratory difficulties?	Yes
☞	11. Do people complain of solvent or chemical odours from unknown activities/sources?	Yes



Some potential sources of complaints

☞	12. Is there visible dust or dirt build-up around diffusers, ducting, air handling units or cooling towers?	Yes
	13. Is smoking prohibited in the office or allowed only in a room with an independent ventilation system?	No
☞	14. Is there evidence of mould growth on structural materials or inside the ventilation system?	Yes
	15. Has there been a recent increase in the number of illnesses among people, especially asthma and flu-like illnesses?	Yes
	16. Is the air conditioning system equipped with freshwater cooling tower?	Yes



A water cooling tower

Problems and Solutions

Design and General Operation

1. Good air flow in a workplace is very important for productive and healthy work. Adequate ventilation can maintain the freshness of air, prevent accumulation of heat and control the level of airborne contaminants. When there is a lack of air movement, or over-crowding, people often feel stuffy. (See also Appendix 1)

   Solutions

   - Reduce activities in a location, if it is too crowded.
   - Check the adequacy of ventilation by measuring the indoor carbon dioxide level. If its level is usually greater than 1000 ppm, this may indicate a problem with the ability of the ventilation system to remove normal contaminants from human occupants and to satisfy comfort (odour) criteria. Further investigation is necessary to decide what improvement measures will be required. If there are strong sources of certain contaminants, a comprehensive assessment is required.
   - Increase the supply of fresh air to the building. The rate required depends on the number of occupants and the nature of the indoor activities. See Appendix 2 for fresh air supply rate for general work activities in air-conditioned offices.

2. Unusual odour can emanate from internal or external sources. However, odour from the ventilation system is often associated with problems at the intake points. Intake points too close to an exhaust outlet should be avoided. See Appendix 3 for odours as indicators.

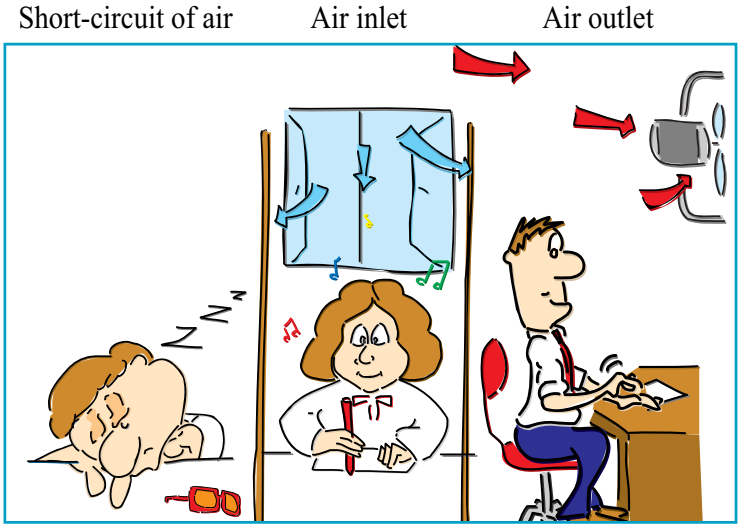


Intake points should not be too close to exhausts

Solutions

- Relocate air intake points away from pollutant sources, including building and automobile exhausts. They are better located at an elevated position.
- Install filters with odour absorbers (e.g. activated carbon) to remove the odour.

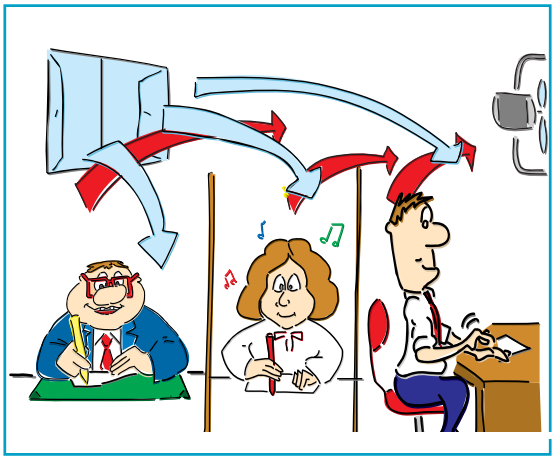
3. A comfortable environment may improve productivity and reduce errors and accidents. Excessive heat can strongly influence working capacity. Ventilation is essential for maintaining an acceptable environment in terms of humidity, heat or cold. In a normal air-conditioned workplace, temperature and humidity can be controlled - ***the optimum temperature range is 20°C - 26°C and relative humidity 40% - 70%***. A poorly designed ventilation system may cause uneven distribution of the supply air, resulting in cooler environment at the front part of the ventilation line, and warmer at the back.



Air inlet and air outlet are too close causing air short-circuiting and poor distribution of air

In general, you may consider the following options to improve the situation:

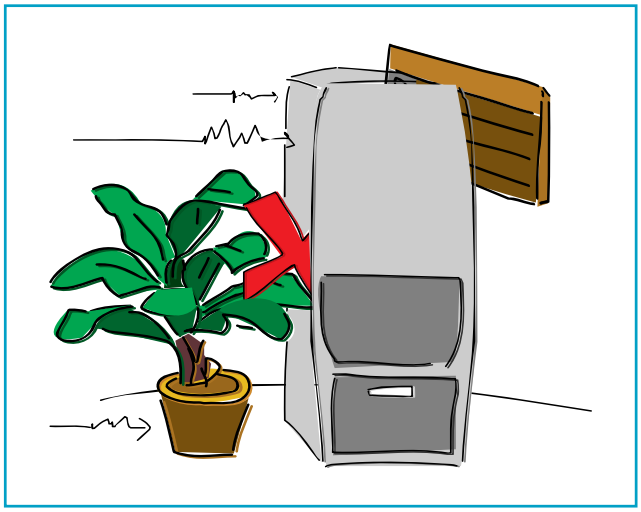
- Provide shielding from solar heat/sunshine by screens or external louvers at the window sides.
- Use insulation material under roofs or on walls to keep the heat away.
- Use light colour paint for decoration of the building's external walls.
- Isolate heat-generating machines and processes.
- Increase natural ventilation with fans and ventilators.



Natural ventilation supplemented with ventilators can improve air circulation.

If an air-conditioning system is installed, the following points may also be considered:-

- Ensure occupants are clothed appropriately.
- Check that thermostats are working properly, calibrated and not obstructed by objects.



Avoid blocking air flow

- Remove obstructions that block air flow, and unlock diffusers and return air grilles.
- Flow system rebalancing and redesign of the distribution system may be necessary.

4. Air motion in a room is an important comfort factor. Too much air movement causes draughts which are annoying. If there is little air movement, people may complain of stuffiness.

Solutions

- Adjust diffusers and return air grilles where necessary.
- Rearrange movable partitions to avoid unwanted air currents or blockage of air flow.



Unbalanced ventilation may disturb the room temperature and air distribution. Tampering with an air outlet may further upset the balance

- Flow system rebalancing or redesign of the distribution system may be necessary.

5. Regular maintenance helps to keep the ventilation system clean and functioning properly. A responsible person should be assigned to oversee the maintenance programme and to keep records.



Poor maintenance may create an ideal breeding ground for micro-organisms.

Solutions

- Draw up a maintenance/repair programme for detecting and fixing problems, including leakage and cleaning of dirt.
- Assign a responsible person to take care of the system.

6. It is not unusual that alteration of the interior structure has not taken into account the potential impact on the ventilation. Partition walls, dividers, cabinets or even stacked boxes could block ventilation duct inlets or outlets. Reassessment is required if the occupied building is to be used differently from the way it was originally planned (for instance if an open-plan office is to be changed into closed offices).

Solution

- Ask a ventilation engineer to check and redesign the system.

Effects of Renovation Work

7. Renovation work is a common source of problems in an office building with limited open windows for natural ventilation. The activities give out dust, solvent vapour, dirt, noise, vibration and the annoying conditions can extend to the surrounding offices. The situation may get worse if they share the same ventilation system. It may lead to complaints.

Solutions

- Isolate the renovation site by physical barrier or have the work done outside office hours.
- Provide exhaust ventilation and fresh air supply, and maintain negative pressure in the renovation area.
- Only have essential work done on site; avoid painting furniture or movable parts in the area. This should be carried out in a workshop rather than the office.

Specific Pollutant Sources

8. Headaches, decreased alertness and nausea are non-specific symptoms but when they occur frequently, are likely to be associated with the presence of air contaminants from a definite source(s) which the existing ventilation is not capable of controlling. Carbon monoxide is a colourless, odourless toxic gas usually produced by incomplete combustion. Symptoms of low-level exposure to carbon monoxide are very similar to those described.

   Solutions

   - Check whether there are combustion sources, such as stoves burning fossil fuel or exhaust from engines located inside the building. Remove or relocate any sources of combustion.
   - Check whether the ventilation air inlets are close to any car parks or major traffic lanes. Relocate the inlets if necessary.
   - Increase exhaust ventilation to the problem area.

9. Eye irritation, dry and sore throats, nosebleeds and headaches are symptoms of exposure to formaldehyde vapour, a colourless irritating gas with a pungent odour. It is also a sensitiser. Building materials or new furniture, carpets and fabrics are the most common sources of the vapour. Low level exposure to the vapour is possible when slight off-gassing happens. It may last for years if the ventilation is poor. Care must be taken with it from the earliest stage of building design.

   Solutions

   - Do not select any building material, furniture or fixture that may emit formaldehyde. If you do, allow off-gassing before installation.
   - Improve fresh air supply by opening windows.
   - Remove or reduce the source by relocating to a better ventilated space.
   - Seal off the gassing material with a suitable substance such as polyurethane varnish.

10. The signs and symptoms referred to in question 10 are associated with exposure to dust and particulates. The particles may originate from external or internal sources and both synthetic and natural fibres that are used in building insulation may cause problems. A detailed investigation is needed to tackle the problem.

Solutions

- Check any damage to insulation along ducting or in air handling units. Repair immediately if necessary.
- Upgrade the filters.

11. Thousands of organic chemicals and solvents are in common use. Volatile compounds from them are collectively known as Volatile Organic Compounds (VOCs). A large variety of VOC sources, such as plastics, floor wax, furniture, structural materials, printers, copiers or stationery could be found in an office. Some of the common VOCs are tabled in Appendix 4. Poor ventilation may aggravate the effects of VOCs causing eye irritation and other symptoms. (Please refer to "Use of Chemicals" in the same series).

Solutions

- Eliminate all potential sources of VOCs as far as possible.
- Provide extra ventilation or separate ventilation in areas where large amounts of VOCs are being emitted, e.g. from a process involving the use of organic solvents.
- Install local exhausts for specific processes that generate large amounts of VOCs, e.g. printing machines, blueprinters.

12. Dirt or dust built-up around diffusers, ducting, etc. indicates that the ventilation system has not been adequately maintained, or that the air from inlets is not clean. Health of the workers may be affected.

Solutions

- Check the ventilation system and remove any dirt that has accumulated in the air circulating units and the ducting.
- Review the maintenance programme and ensure cleaning is carried out more frequently.
- Eliminate or relocate the air intake points so that clean air is supplied.
- Install more effective filters to the ventilation system.

13. Smoking produces an offensive odour and harmful substances.It can adversely affect health and relationships at work. A workplace should have a smoking policy in order to limit the effects of environmental tobacco smoke.

Solutions

- Identify and physically separate smoking and non-smoking areas. Provide them with independent ventilation systems.
- Supply more fresh air to the smoking area but keep it under negative pressure compared with surrounding occupied rooms. As a rule of thumb, the recommended fresh air supply should usually be more than double the normal requirement.



Smoking affects health and may damage office relationships.

- Avoid recirculation of air that contains contaminants.
- The best solution is to ban smoking inside offices.



Adopt a non-smoking policy

14. Micro-organisms, such as mould or fungi, bacteria, viruses, protozoa, can be found indoors. Mould or fungal growth on structural materials is a sign that biological growth in the area is flourishing. High air humidity, stagnant water, filters packed with dusts and building structures that have been damaged by moisture all provide favourable conditions for biological growth.



Mould growth on dirty filters

Solutions

- Remove potential water sources that may encourage fungal growth, especially stagnant water in ventilation systems.
- Repair and maintain all water pipes and drainage systems.
- Repair areas that have been affected by flood or seepage as soon as possible.
- Remove and replace contaminated porous materials, such as heavily deposited ventilation unit filters, mouldy ceiling tiles and mildewed carpets.



Mildewed carpets

- Disinfect all smooth surfaces (such as wall tiles) that have been contaminated by fungi.
- Provide dehumidifier units for control of humidity within the optimum range.

15. Micro-organisms like viruses, bacteria, rickettsia, and chlamydia can cause diseases and may be transmitted by air. Exposure to fungi or spores of micro-organisms can induce allergic reactions such as allergic rhinitis or asthma.



Micro-organisms may cause diseases.

Solutions

- Use efficient filters in ventilation units to remove airborne particulates and spores of micro-organisms from the ventilation system. This will help to prevent the spread of diseases.
- People who do not feel well should seek for medical treatment.

16. Legionnaires' Disease is caused by the bacteria, Legionella pneumophila and is typically manifested as severe pneumonia often culminating in respiratory failure. Cooling towers, evaporative condensers and hot water systems can become their growth and distribution sites. They flourish well in stagnant and contaminated freshwater sources of ventilation units.

Solutions

- Remove all potential nourishing water sources for Legionella, such as stagnant water in drip pans, cooling coils and sumps.
- Clean humidifiers or ventilation units regularly (e.g. bimonthly or quarterly).
- Use air cooled condensers instead of freshwater cooling towers as far as possible in the design of air-conditioning systems.
- If freshwater cooling tower is used, effective dosage of chemicals and biocides should be added regularly to the water tank of the cooling tower to prevent rusting and growth of algae and bacteria.

Appendix 1

General Indicators to Call Attention to Pollutant Sources

1. Visible dust or deposits on surfaces, such as desk, top of a cupboard.
2. Overcrowding in the office.
3. Unsanitary conditions - such as visible dirt, littering.
4. Odours including body odour, solvent or chemical smell.
5. Moisture problems, as indicated by visible fungal growth in corners.
6. Staining and discolouration of false ceilings, walls or carpets.
7. Presence of chemical substances in work areas.
8. Smoking in the office.

Appendix 2

Fresh air supply rate for general work activities in air-conditioned offices

Types of work activity	**Minimum fresh air supply rate** (m^3/min/person)
Open plan office (non-smoking)	0.43
Private office (with moderate smoking)	0.6
Conference rooms or offices (with heavy smoking)	1.0

Note: Local exhaust should be provided if harmful substances are generated.

Appendix 3

Odours as Problem Indicators in Office Buildings

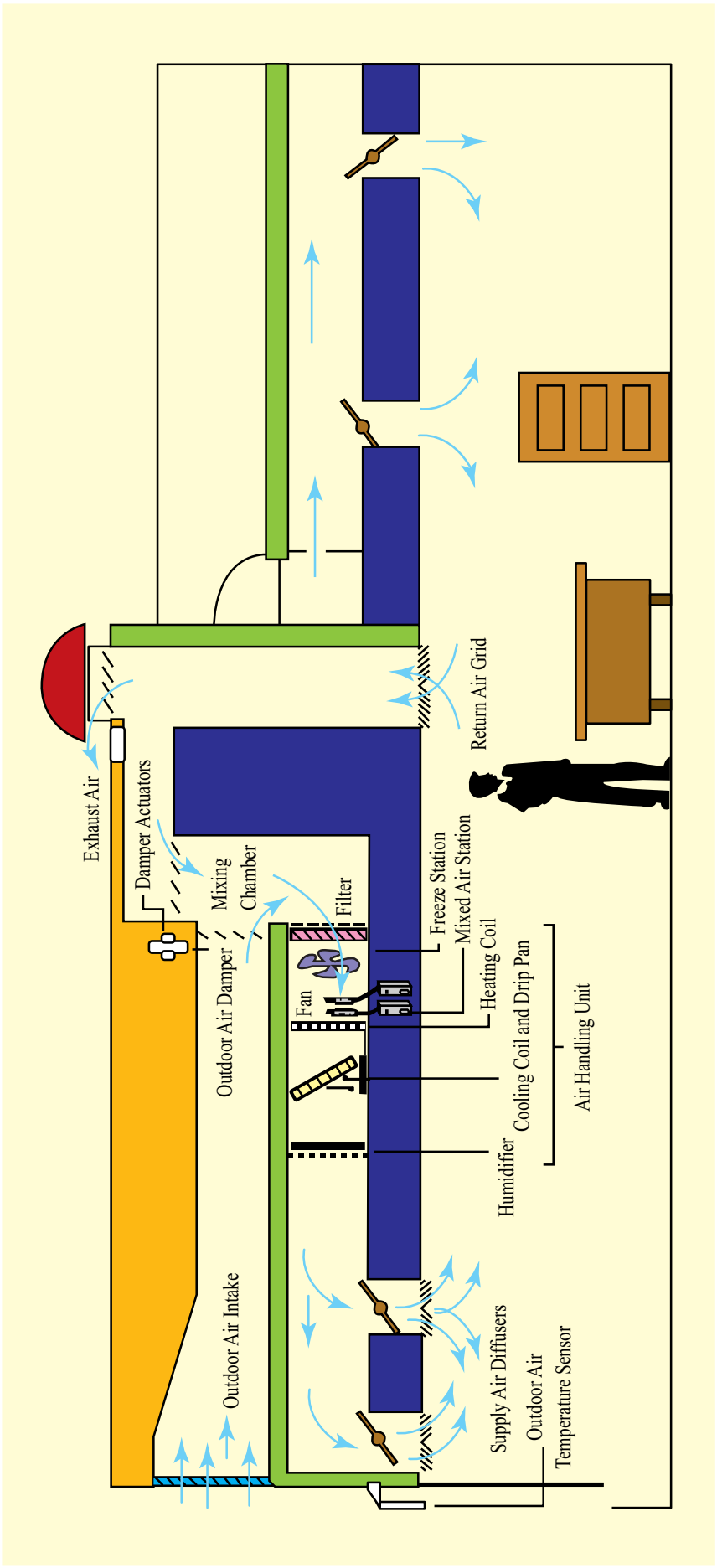
Description Problems	Complaints	
Auto exhaust, diesel fumes	Vehicles or engine (high carbon monoxide* level)	Headaches, nausea, dizziness, tiredness
Body odour	Overcrowding, low ventilation rate (high carbon dioxide level)	Headaches, tiredness, stuffiness
Chlorine odour	Leakage of cleaning agent	Eye, nose and throat irritation
Musty smell	Microbial material, wet surfaces	Allergic symptoms like eye itchiness, watering eyes, sneezing, cough
Chemical smell	Formaldehyde, pesticides, other chemicals	Eye, nose, and throat irritation
Solvent smell	VOCs, emission from furniture, etc.	Odour, allergic symptoms, dizziness, headaches
Wet cement, dusty, chalky smell	Particulates, humidification system	Dry eyes, respiratory problems, nose and throat irritation, skin irritation, coughing, sneezing
Sewage gas odour	Floor drain water-traps in washrooms or basement dry up	Foul smell, bad egg smell

* Carbon monoxide itself is odourless and colourless.

Appendix 4

Commonly Encountered VOCs and Their Sources in Offices

Chemicals	Sources
Acetone	Paint, coatings, finishers, paint remover and thinner, caulking compound, correction fluids
Aliphatic hydrocarbons (octane, decane, undecane, hexane, isodecane, mixtures)	Paint, adhesive, gasoline, combustion sources, liquid process photocopier, carpet, linoleum,caulking compound
Aromatic hydrocarbons (toluene, xylenes, ethylbenzene, benzene)	Combustion sources, paint, adhesive, gasoline, linoleum, wall coating
Chlorinated solvents (dichloromethane or methylene chloride, trichloroethane)	Upholstery and carpet cleaner or protector, paint, paint remover, lacquers, solvents, correction fluids, dry-cleaned clothes
n-Butyl acetate	Acoustic ceiling tile, linoleum, caulking compound
Dichlorobenzene	Carpet, moth crystals, air fresheners
4-Phenyl-cyclohexene (4-pc)	Carpet, paint
Terpenes (Limonene, a-pinene)	Deodorizers, cleaning agents, polishes, fabrics, fabric softener, cosmetics, burning cigarettes



Air conditioning system



Further Information

For further assistance or information about the subject, you can contact

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THIS GUIDE IS

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