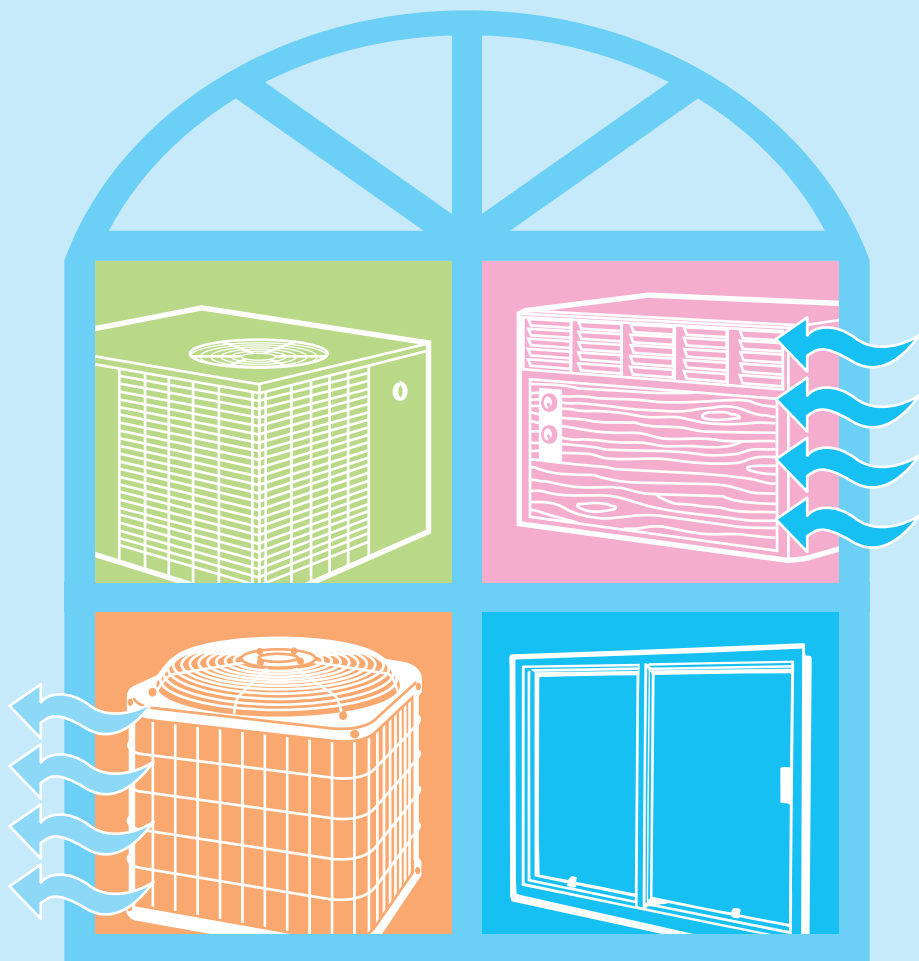


Guidance Notes on Ventilation and Maintenance of Ventilation Systems



Occupational Safety and Health Branch
Labour Department



OCCUPATIONAL SAFETY & HEALTH COUNCIL

**This Guidance Notes is prepared by the
Occupational Safety and Health Branch
Labour Department**

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**Guidance Notes on
Ventilation and Maintenance
of Ventilation Systems**

“Foreword”

Efficient ventilation and proper maintenance of ventilation systems help provide a comfortable working environment for workers and avoid various invisible health hazards in buildings and workplaces. This “Guidance Notes” provides a general reference on ventilation and maintenance of ventilation systems. It helps to comply with the requirements laid down in the Section for ventilation under the Occupational Safety and Health Regulation.

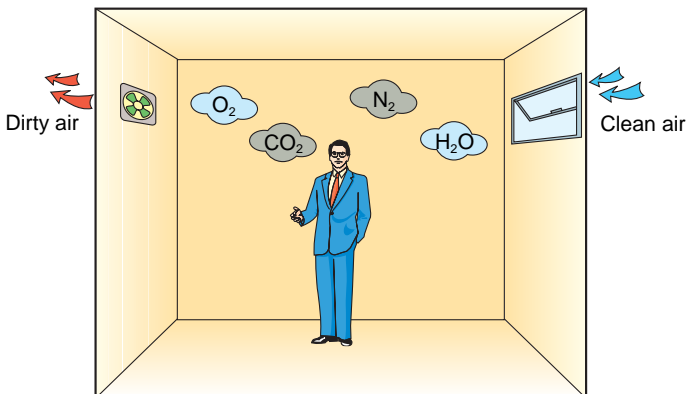
Functions of Ventilation

1. Ventilation is a process by which air is removed from and supplied to premises simultaneously. Its functions are:
 - (a) to supply fresh air to meet the respiratory needs of the occupants;
 - (b) to remove airborne contaminants such as dusts, mists, gases, vapours, tobacco smoke, body odours and bacteria which may pose health hazards or nuisance to the occupants; and
 - (c) to maintain the temperature and humidity within an acceptable range that is appropriate to the activities on the premises.

Fresh Air Composition

2. 'Fresh air' normally means air from outside the building. It should be, as far as possible, free from any contamination. The composition of pure dry air is:

Oxygen	20.94% by volume
Carbon dioxide	0.03% by volume
Nitrogen & inert gases	79.03% by volume

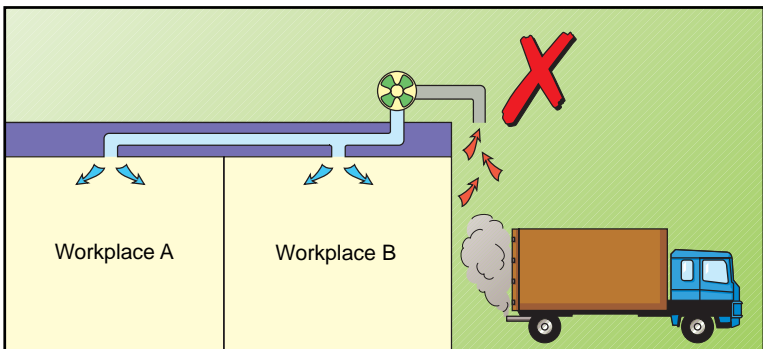


Ventilation Requirement

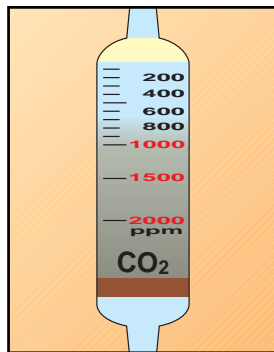
3. Ventilation requirements for different workplaces are varied because of different indoor activities and building designs. The basic methods for control of airborne contaminants are:
- elimination or control of sources of contaminants
 - air filtration (purification)
 - fresh air supply
 - proper air distribution
 - removal of contaminated air



4. Sources of contaminants can be found inside and outside the workplace. Examples of indoor sources are new furniture and fittings which may emit volatile organic compounds, human bodies which give off odours and carbon dioxide, cigarette smoking, renovation work, etc. A no-smoking policy should be implemented in workplaces. Where smoking is allowed, it should be limited to a designated and isolated area which is equipped with an independent exhaust arrangement. Outdoor contaminants, such as dusts and vehicle exhaust, can get into workplaces through fresh air intake points. Thus, the intake points should be away from sources of contaminants, and fresh air should be filtered or cleaned before being supplied to the workplace.



5. For general workplaces where there is no smoking, the fresh air should be supplied at a rate of 0.3 to 0.5 cubic metres per minute per person. Where smoking is allowed, the supply rate should be more than 0.9 cubic metres per minute per person. In workplaces where hazardous air contaminants are produced, fresh air should be supplied and polluted air be removed at rates which can control the contaminant levels to those not causing adverse health effects. Local exhaust is usually recommended. Factors needed to be taken into account in designing the ventilation requirement include:
- the nature of the operations or activities
 - the toxicity and rate of generation of hazardous substances
 - the degree of expected occupancy
 - the design of the premises.
- Readers may find some recommendations of fresh air supply rate for various activities in the appendix.
6. In a workplace without a specific source of contamination, the adequacy of ventilation can be measured indirectly with a carbon dioxide index method. As the concentration of carbon dioxide increases with human activities, background levels of other contaminants also increase. Carbon dioxide level frequently exceeding 1000 ppm (although carbon dioxide at such a level is not a health concern) could be a useful indicator for review of the ventilation supply distribution and the activities going on, especially when there is a complaint.

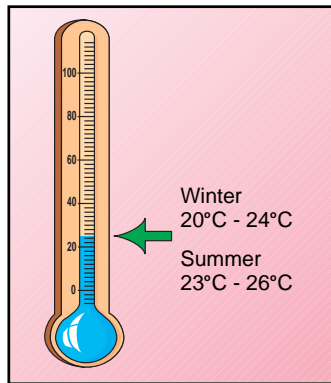


7. Where contaminant sources can be localised, the contaminants should be removed from the location before it spreads into the occupied zone. This can be achieved through control of local air movement by creation of pressure differentials, by exhaust fans or by careful location of inlet diffusers and air return inlets.

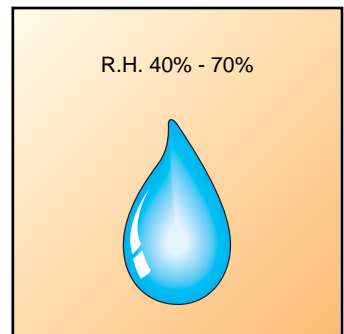
8. A combination of sufficient outdoor air supply, good air distribution, air filtering and contaminated air removal can provide a cost effective means to the control of airborne contaminants.

Thermal Environment

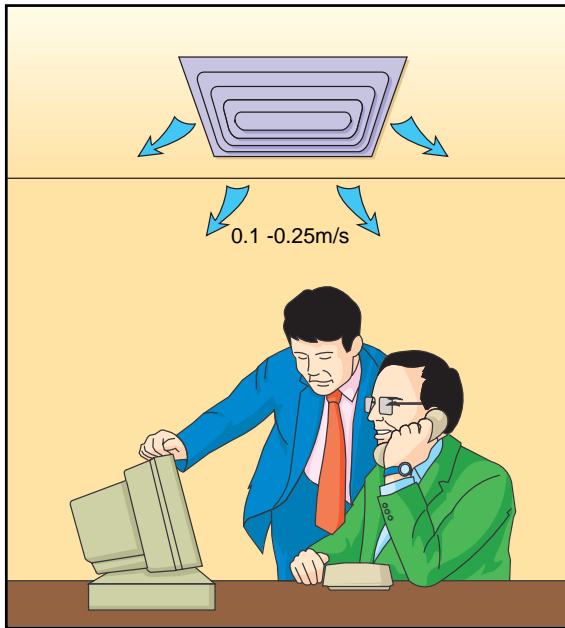
9. Thermal comfort perceived by a person depends on environmental and personal factors. Environmental factors which can be controlled by a ventilation system include air temperature, relative humidity and air speed.
10. In air-conditioned work environments, most workers carrying out light activities may feel comfortable when air temperature is maintained between 20°C to 24°C in the winter and 23°C to 26°C in the summer.



11. People who perform light activities in moderate temperatures can accept a wide range of relative humidity. The indoor relative humidity should be kept between 40 % to 70 % to avoid workers feeling dry eyes and throat at low humidity and prevent flourishing growth of micro-organisms at high humidity.

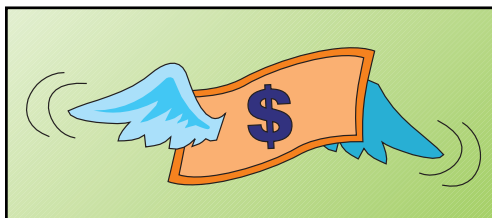


12. Either draught or stagnant air is unsatisfactory. The air speed at workstations should lie between 0.1 to 0.25 metres per second. People in warmer environments can withstand higher air speed.



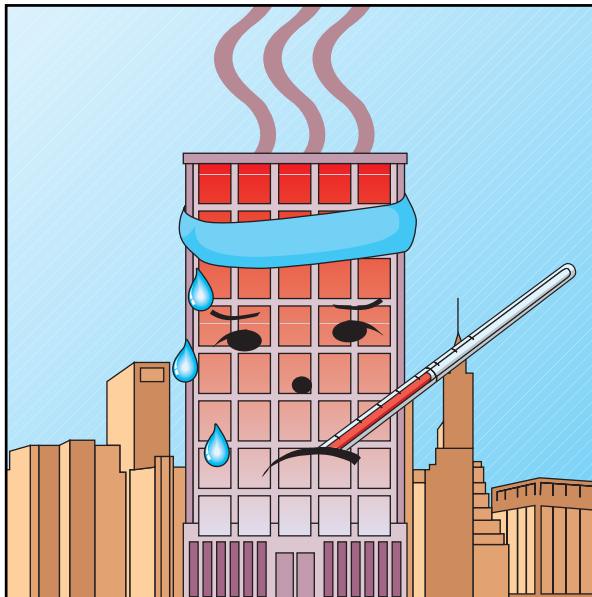
Health Effects

13. A poorly designed ventilation system or inadequate ventilation may induce irritability, impair concentration and performance, and cause fatigue and headache.
14. Poor maintenance of a ventilation system will increase power consumption and running costs, and lower its performance, leading to accumulation of air contaminants and deviation from the optimum indoor environmental conditions.



15. Furthermore, a poorly designed or maintained ventilation system will enhance dispersion of air contaminants, particularly micro-organisms dislodged from the dirty filters or grills of the system. These organisms may cause health hazards to the occupants of the premises. These include:
- (a) Legionnaires' disease
Legionnaires' disease is a type of bacterial infection caused by *Legionella pneumophila*. It may be contracted by inhaling droplets which contain viable legionella bacteria from the fresh water cooling towers of air-conditioning systems. Most reported cases have occurred in the 40 to 70 age group. The symptoms include high fever, chills, headache, muscle pain, and cough. This disease may not always be severe and in community outbreaks, mild cases may be recognised.
 - (b) Humidifier fever
This may be caused by inhaling water droplets from contaminated humidifiers, but the definite pathogen is unknown. It is said to be related to growth of bacteria, fungi or algae in the air filters. These organisms or their associated endotoxins may trigger complaints in sensitive individuals. The symptoms, including fever, general malaise, lethargy and aches, may occur 4 to 8 hours after starting work. After a break away from work, e.g. holiday, these symptoms will generally disappear.

16. Poor ventilation is a significant contributor to a phenomenon, known as 'Sick Building Syndrome'. The occupants of the building may complain of sore throat, headache, sore dry eyes, dry blocked nose, lethargy, general malaise and vague upper respiratory discomfort. There are no definite causes for the syndrome. Many factors have been suggested for the sick building syndrome. Stress may result from psycho-social factors such as poor relationship with colleagues and extremes of workload. Repetitive tasks and boredom are also stressful. Inhalation of solvent vapour from correcting fluid or corresponding thinner and side-stream smoke in a poorly ventilated building may cause vague discomfort. Furthermore, the physical environmental factors including lighting, humidity, noise and office layout may also be the contributing factors to stress and health complaints. Complaints are more likely from locations where population densities are higher, and symptoms are more likely to appear in the afternoon than in the morning. In general, people feel better when they are away from work.

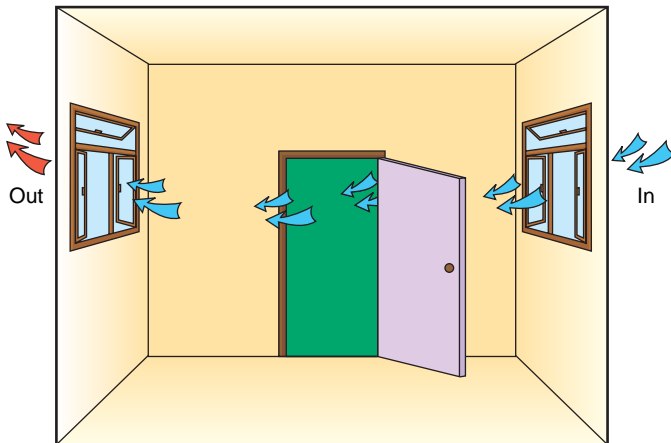


Methods of Ventilation

17. Basically, methods to achieve the ventilation requirements may come under two categories:
- Natural ventilation, and
 - Mechanical ventilation
 - induced dilution ventilation, i.e. stale air is extracted from the premises by exhaust fans whereas outside air infiltrates into the premises through available openings
 - forced dilution ventilation, i.e. where air is forced into the premises by air blowers commonly via ducting systems.

Natural Ventilation

18. Natural ventilation is the movement of air into and out of the premises through windows, doors or any openings without any mechanical aid. The rate of air exchange in this type of ventilation is inevitably unsteady as it is governed by geographical, meteorological and many other factors which are very often beyond the occupants' control. Natural ventilation is suitable only for control of modest heat load and very low emission of less toxic contaminants.



19. Adequacy of air inlets and outlets is of great importance to natural ventilation. As a reference, premises relying entirely on natural ventilation should have openings of at least 5 to 10% of the floor area to obtain adequate ventilation in the summer.

Mechanical Ventilation

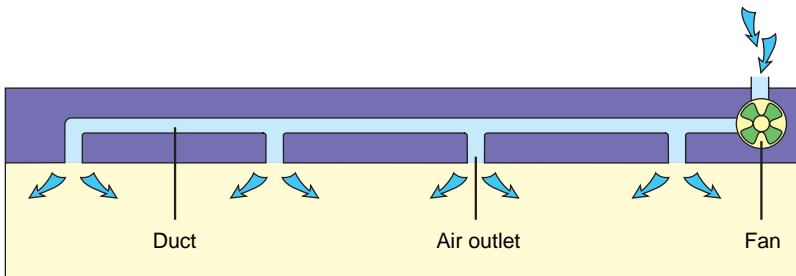
20. Induced dilution ventilation

In this type of ventilation, contaminated air is extracted from the premises by propeller fans. The air pressure inside the premises is lower than outside. Air therefore infiltrates into the premises through openings. Proper arrangements of air inlets and outlets are of vital importance to such systems. In principle, cross ventilation should be effected as far as practicable. Sufficient replacement air is essential in maintaining the efficiency of the exhaust fan and avoiding the indoor air pressure being too negative.



21. Forced dilution ventilation

In this type of ventilation, air (preferably filtered and conditioned) is blown into the premises for ventilation. It is important to site the air inlets away from sources of contaminants. The system usually consists of a fan, a cooling/heating unit and a ducting system by which air is distributed to the required positions.



22. Dilution ventilation together with natural ventilation is suitable for the control of heat load and moderate emission of gases and vapours of low toxicity. It is, however, not advisable to apply this type of ventilation to hazardous operations as the volume of air necessary for dilution may be too high to be practicable.

Maintenance of Mechanical Ventilation Systems

23. In using mechanical systems for ventilation, it is important to minimise any health hazard to the occupants. To achieve this, the following points should be observed:
- Proper inspection, cleaning, testing and maintenance schedules should be drawn up and followed.
 - Replace air filters regularly.
 - Inspect all components of the ventilation system for cleanliness and microbial growth regularly, and clean them as required.
 - Test the performance of the system against the design specifications and make necessary adjustment or repair.
 - If water cooling towers are used, they should be so maintained, e.g. use of biocides as appropriate, as to prevent the growth of micro-organisms.
24. Consult a competent ventilation maintenance agency for the proper maintenance of your ventilation system.

Further Information

If you have any queries about this booklet, please contact the Occupational Health Service of the Labour Department.

Address : 15/F Harbour Building, 38 Pier Road, Central, Hong Kong

Telephone : 2852 4041

Facsimile : 2581 2049

Email : enquiry@labour.gov.hk

Website : <http://www.labour.gov.hk>

Information on the services offered by the Occupational Safety and Health Council can be obtained through hotline 2739 9000.

If you have any complaints about unsafe workplaces and practices, please call the Labour Department's occupational safety and health complaint hotline at 2542 2172.

Appendix

Fresh air supply rate for general work activities in air-conditioned workplaces.

(A) For places where the number of persons present is normally constant.

Types of work activity	Minimum fresh air supply rate ($m^3/min/person$)	Remark
Open plan offices, schools (non-smoking)	0.43	The normal daily working hours or hours of stay are long e.g. 8 hours
Private offices (with moderate smoking), laboratories	0.6	
Conference rooms or offices (with heavy smoking)	1.0	
Canteens, restaurants	0.3 (based on the seating capacity and the number of employees)	On average, people may not stay in the area for a long period

(B) For places where the number of persons may vary from time to time.

Types of work activity	Minimum fresh air supply rate (m^3/m^2 floor area / min.)	Remark
Shops, supermarkets department stores	0.18	Generally no smoking
Kitchen (Restaurants)	1.2	Additional exhaust for working areas are required

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