A Supplement on Ventilation

Guidelines on Prevention of Communicable Diseases in Schools / Kindergartens / Kindergartens-cum-Child Care Centres / Child Care Centres

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保障市民健康
Protecting Hong Kong's health

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Department of Health

CONTENT

Foreword

The purpose of this supplement is to provide practical information and develop good practices for Schools / Kindergartens / Kindergartens-cum-Child Care Centres / Child Care Centres to improve ventilation so as to reduce the spread of airborne and droplet-borne infections. This supplement should be read in conjunction with the "Guidelines on Prevention of Communicable Diseases in Schools / Kindergartens cum Child Care Centres / Child Care Centres" and the "Technical Information Checklist for Air-conditioning Installation in Child Care Centre" for registration of a Child Care Centre.

1. Airborne and Droplet Transmitted Communicable Diseases

1.1 Certain infectious diseases are transmitted when susceptible persons are exposed to pathogens contained in droplets. When an infected person talks, sneezes, coughs or vomits, microbe-laden droplets are expelled. These droplets can travel a short distance (1 metre) and infect people within this distance. Examples of diseases which spread in this manner are influenza, rubella, SARS and COVID-19.

1.2 The spread of airborne infectious diseases via droplet nuclei is another important mode of disease transmission. Droplet nuclei are the residuals of droplets where pathogens attached to them remain suspended for a longer time in the air and are transported over longer distances. Meanwhile, it can also be generated through aerosolized oral and nasal secretions from infected persons. Examples of infectious diseases transmitted this way include tuberculosis, chickenpox and measles. Short-range airborne transmission of COVID-19 can occur in poorly ventilated enclosed environments.

1.3 There are three important factors causing the spread of airborne / droplet-borne communicable diseases. They are (1) pathogen, (2) mode of transmission and (3) susceptible host. We can control the spread of communicable diseases by targeting these factors.

Factors of transmission	Examples of control measures
Pathogen	Early detection, isolation and treatment of infected persons
	Cleaning and disinfection
Mode of Transmission	Proper use of face mask and personal protective equipment
	Personal hygienic practices (e.g. hand washing, cough manners)
	Maintenance of good indoor ventilation
Susceptible host	Building up personal immunity
	Receiving immunization

1.4 This supplement focuses on maintaining good ventilation in an indoor environment. Please note that the effective prevention of communicable diseases requires measures targeted at all the above factors to be implemented simultaneously.

2. Understanding Ventilation and its Equipment

2.1 Purpose and Effect

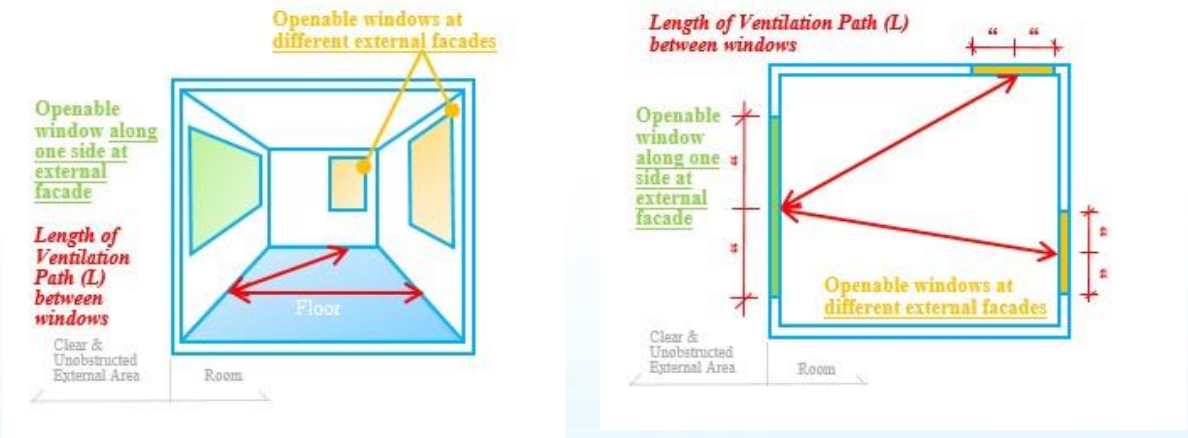
Ventilation is defined as the process of changing air in an enclosed space to maintain good indoor air quality of the following basic components:

- Supply of fresh air to meet the respiratory needs of the occupants;
- Control of indoor temperature and humidity;
- Dilution of any airborne contaminants such as carbon dioxide, dusts, toxic gases and pathogenic microorganisms; and
- Control of air movement to avoid transfer of airborne contaminates from less clean to cleaner zones.

2.2 Natural Ventilation Mode

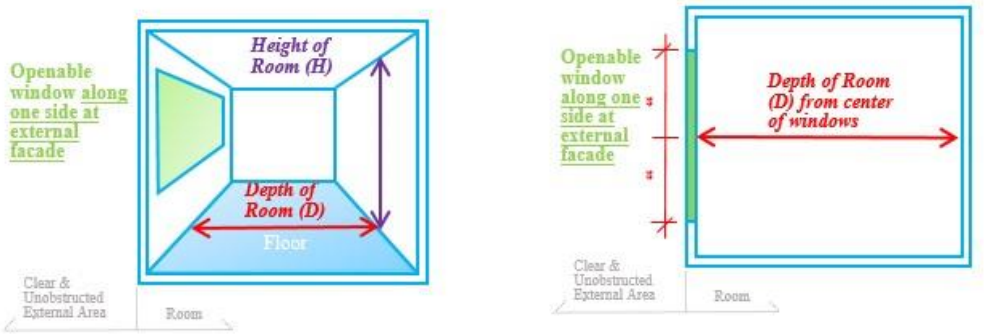
Natural ventilation is the free movement of air into and out of the premises through doors, windows or any openings. The rate of air exchange in this type of ventilation is inherently unstable as it is governed by geographical, meteorological and many other factors. Wind driven cross-ventilation (air pressure) and stack ventilation (heat) are the principal mechanisms for natural ventilation, which employ the difference in air densities to provide air movement across space. Methods to achieve good ventilation may come under two categories:

(i) Cross ventilation (The ventilation path (L) should not exceed 15 metres between two windows/openings at different external facades).



Illustrated diagrams for cross ventilation (L ≤ 15 metres)

(ii) Single-sided ventilation (The windows or any openings are along one side only with room depth (D) not longer than twice the ceiling height (H)).



Illustrated diagrams for single sided natural ventilation (D ≤ 2H)

2.3 Mechanical Ventilation Mode

(l) Fan-assisted movement of air is the basic component of mechanical ventilation. Properly designed and operated mechanical ventilation provides reliable air exchange. Exhaust fan, fresh air supply fan plus exhaust fan, ventilation unit plus individual air conditioner, central mechanical ventilation and air conditioning (MVAC in short) are common mechanical ventilation systems found in Hong Kong.

3. Advice for Good Ventilation

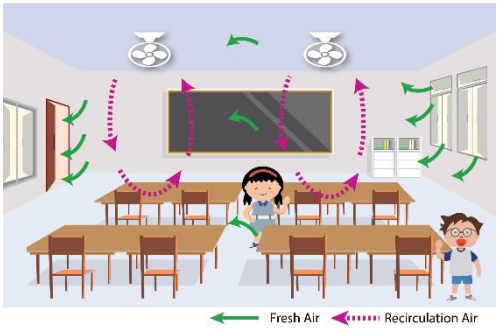
3.1 Eight key points for achieving good ventilation

- The ventilation strategy adopted for schools could be (1) natural mode; (2) mixed mode (natural + mechanical) or (3) mechanical mode. It depends on type of building design, mode of operation and climate conditions. Each occupied space shall be individually assessed to determine the optimal way of ventilation;
- For classrooms or other occupied spaces in schools adopting natural ventilation, the windows or other building openings shall always be kept open before class and over the occupancy period;
- For classrooms or other occupied spaces in schools adopting mechanical ventilation, rate of fresh air supply to attain a minimum of 10L/s/person (i.e. 0.6m^3/min/person) or 6 air change per hour (ACH), whichever is greater, is required. For Child Care Centre (CCC) and Kindergartens with CCC, please follow the stipulation under relevant registration requirement;
- For kitchens / laundry rooms / toilets in schools, a minimum of 15 ACH is required;
- The ventilation of toilets / laundry room / medical rooms / sick bays in schools should be designed with negative pressure via air exhaust system. The exhaust air should be discharged to open air, and far away from adjacent cleaner zones;
- Mechanical ventilation equipment should be kept operating at their full load operation status to ensure that the designed fresh air flow rate or air change per hour could be maintained at all times. If the equipment (e.g. air purifiers) have automatic mode or energy saving mode, to achieve the best effect, such automatic mode or energy saving mode should NOT be used.
- Pathway of air movement should be from clean to less clean areas, then to dirty or potentially contaminated areas; the direction of air inflow and outflow through premises / occupied spaces should be carefully designed; air inlets and exhausts should be at least 5 metres apart to minimize the recirculation of exhausted air back into the premises; and
- Even distribution of sufficient volume of fresh air supply within the occupied space is suggested for effective dilution of contaminants.

3.2 Other considerations for ventilation

- Weather condition;
- The quality of fresh air (outdoor air) - fresh air inlet should not be closed to the pollution sources, e.g.
  - exhaust of other ventilation systems;
  - debris or refuse collection areas;
  - enclosed alleys or poorly-ventilated light wells (including air inlet through gaps of window or doors from these areas);
  - roads and construction sites (dust, or vehicle exhaust);
  - water cooling towers (in respect of Legionnaires' disease); and
  - vent pipe outlets of drainages;
- Water traps at floor drains or washing basins must be filled with water;
- Caution of activities of tenants, e.g.
  - nebulizer use, or other aerosol generating procedures; and
- Other environmental factors, e.g.
  - mosquitoes (avoidable by equipping mosquito screens on windows and doors).

3.3 Practices for classrooms, activity rooms, auditoriums and staff rooms in Schools

Type of Ventilation	Practices
Natural  *Fig1. Natural ventilation—cross ventilation*	Open windows, louvers and doors (premises relying entirely on natural ventilation should have openings of area more than 6.25% of the usable floor area to obtain adequate ventilation). (More information could be found in the Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers APP-130 Lighting and Ventilation Requirements – Performance-based Approach, Buildings Department, December 2016.) • Windows should be opened at least 15 minutes prior to occupancy; • Maximize ventilation efficiency by opening windows, door or louvers located on different external facades (Fig. 1); and • Switch on circulating fans to enhance air movement and reduce the risk of stagnant air within the premises (but avoid blowing air directly from one group of people to another).

Mechanical - Exhaust only

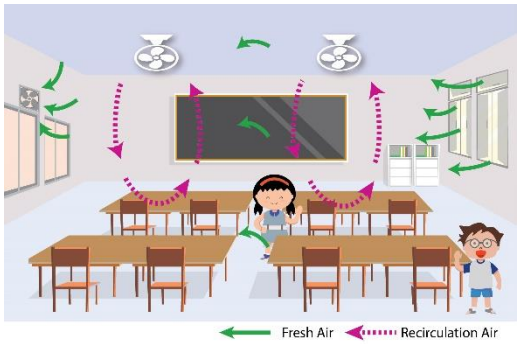
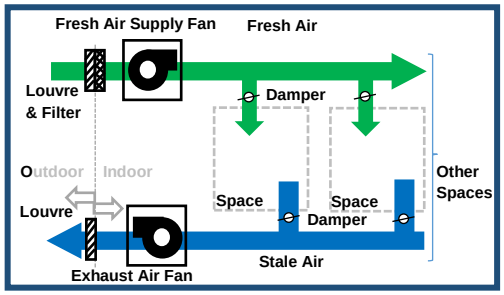


Fig2. Use of exhaust fan to provide adequate and stable ventilation

A propeller fan is installed over an external wall, where indoor air is actively extracted out and outdoor (fresh) air is pulled in from the outside via openings (Fig. 2).

- Extend operation times of mechanical ventilation system such that they are switched on at least an hour before and after the occupancy period;
- Open windows or louvers so that make-up air could be pulled in from outside to replenish the indoor air being extracted out from the space (to prevent short circuit of airflow, open windows or louvers located on different sides and/or located far away from the exhaust fan). The make-up air should be sourced from clear and unobstructed space and its inlet should be far away from any contaminant sources;
- Exhaust fans should not be located close to air-conditioners;
- Switch on circulating fans to enhance air movement and reduce the risk of stagnant air within the premises (but avoid blowing air directly from one group of people to another);
- Remove any obstruction to the ventilation inlets or outlets; and
- Clean and check the exhaust fans regularly.
- Proper maintenance works is required to ensure system performance.

Type of Ventilation	Practices
Mechanical - Fresh Air Supply and Exhaust  *Fig3. Schematic diagram of central ventilation system*	Unlike mechanical exhaust system, both fresh air supply and stale air exhaust are achieved by mechanical means. Both fresh air supply fans and exhaust fans are installed. This system could deliver fresh air evenly in various locations in the premises via properly installed distribution ducts for better control of air movement pathways (Fig 3). • Extend operation times of mechanical ventilation system such that they are switched on at least an hour before and after the occupancy period; • Use in conjunction with the exhaust fans installed in toilets or other areas; • Switch on fresh air supply fans and exhaust fans at the same time; • Switch on circulating fans to enhance air movement and reduce the risk of stagnant air within the premises (but avoid blowing air directly from one group of people to another); • Remove any obstruction to the ventilation inlets or outlets; and • Clean and check the fans and the air filters regularly. • Proper maintenance works is required to ensure system performance.

Mechanical – Ventilation Unit plus Air-conditioning

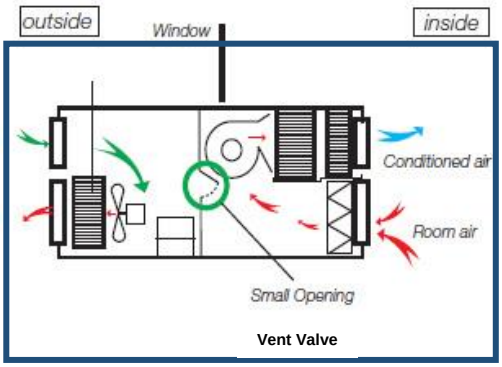
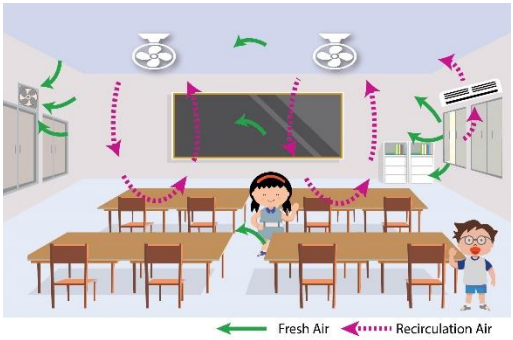
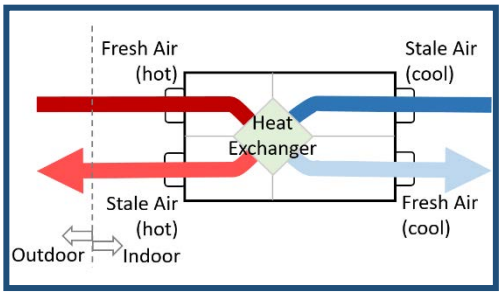
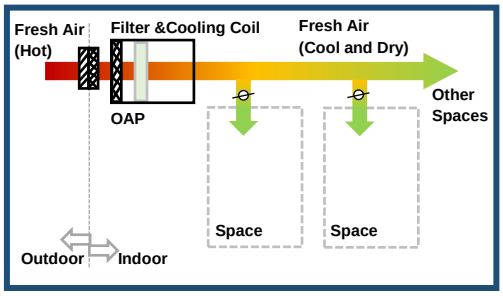


Fig4a. Window -type AC — not a good ventilator

It is an integration of ventilation and cooling into the air-conditioning to control the indoor temperature and humidity as well as to provide fresh air.

- Both window-type and split-type air conditioners could not provide fresh air, as they are designed to condition temperature and humidity of recirculated air primarily. Most window-type air conditioners are equipped with vent valve (Fig 4a), which is recommend to be opened at any times. (Note: The vent valve can provide minimal amount of fresh air only, which cannot meet the fresh air requirement in the enclosed spaces);

Type of Ventilation	Practices
 *Fig4b. Use of exhaust fan to enhance ventilation when using air conditioner*  *Fig4c. Schematic diagram of a energy recovery ventilation unit*  *Fig4d. Schematic diagram of a outside air processing unit*	• Must be complemented by ventilation to provide adequate fresh air. The common ventilation includes: (1) switch on exhaust fans with some opened windows / louvers as make-up air intake to pull in outside air into the enclosed spaces (Fig 4b), (2) switch on the energy recovery ventilation unit (fresh air pre-conditioner (FAP)) to provide adequate fresh air with energy saving feature (Fig 4c) or (3) switch on outside air processing unit (OAP) to provide sufficient fresh air at desired temperature and relative humidity (Fig 4d); • Switch on circulating fans to enhance air movement and reduce the risk of stagnant air within the enclosed spaces (but avoid blowing air directly from one group of people to another); • Remove any obstruction to the ventilation inlets or outlets; • Clean air filters and cooling coils of air conditioner regularly, check condenser water trays and tubes to ensure proper drainage; and • Proper maintenance and repair works is required to ensure system performance.

Mechanical - Central Mechanical Ventilation System (MVAC)

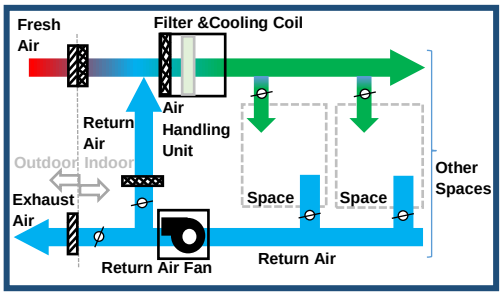


Fig 5. Schematic diagram of mechanical ventilation and air-conditioning system

MVAC System is a centralized mechanical ventilation system plus air-conditioning which is used to off-set generated heat, control humidity, and deliver fresh air into a building or large space area simultaneously (Fig 5).

- Ensure that each occupied space has sufficient fresh air supply from the system (Proper air-balancing works);
- Remove any obstruction to the ventilation inlets and outlets;
- Switch on circulating fans to enhance air movement and reduce the risk of stagnant air within premises (but avoid blowing air directly from one group of people to another);
- Clean or replace air filters and the system regularly; and
- Proper inspection, cleaning, testing and maintenance schedules for the system should be drawn up and followed.
- During the pandemic, the volume of fresh air intake should be maximized, and the volume of return air within central MVAC system serving multiple occupied spaces or zones should be reduced; and
- If necessary, employ qualified technician and contractor, and consult equipment manufacturer for the proper operation and maintenance of central mechanical ventilation system.

3.4 Recommendation on ventilation for toilets

- Must be installed with exhaust fans or have a separate exhaust system to achieve at least 15 ACH;
- Pathway of air movement to toilets should be from clean area. Toilet exhaust should be discharged to areas without crowds of people and unobstructed open air, and its exhaust outlet should be away from other ventilation inlets or windows (Fig 6);
- It is not recommended to use a circulating fan within a toilet, in order not to spread pathogens due to air mixing induced by the circulating fan;
- If windows are closed while in use or there are no windows in the toilet, toilet doors should be installed with vent louvers to avoid drawing in air from dried floor drains / pipes; and
- Inspect drainage pipes regularly. If drainage pipes leak or are blocked, or foul odor comes out from drain outlets, arrange immediate repair by a qualified technician.

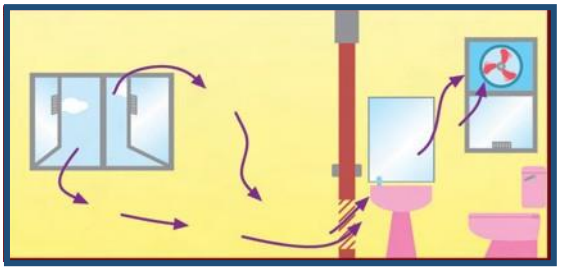


Fig6. Air flow pattern — from clean to less clean area

3.5 Maintenance and repair of ventilation system-

- Regular cleaning of filters, fan's blades, ventilation louvres and safety mesh in ventilation system should be arranged at three months interval. For any defective parts, please replace immediately.
- Annual inspection and cleaning of heat exchange core/element in energy recovery ventilation unit (fresh air pre-conditioner (FAP)) is required. Replace the heat exchange core/element based on the manufacturer's recommended interval.
- Facilities management team of school / kindergarten should employ qualified persons to carry out annual inspection and performance testing of the ventilation system. It should include a functional test, visual inspection of system healthiness, and checking of abnormal sound or vibration during operation of the ventilation system. All inspection records should be properly documented and immediate follow-up rectification works is required for any defect found.
- Ventilation assessment is recommended to be carried out at a regular interval (recommend once every five years) by engineering professionals in relevant trades. The function, safety and performance (including flow rates) of the ventilation system should be thoroughly tested, assessed and recorded. Defective and deteriorated equipment / installation should be identified and included in the improvement works plan. Improvement works (if any) should be arranged immediately after the assessment to restore the performance of the ventilation system back to original design. If there is any alternation works to the existing ventilation system, similar assessment should be conducted immediately.

3.6 Other advices -

- A distance of 5 meters is recommended to be maintained between air exhaust outlets and areas for student's assembly, queuing and activity;
- Insufficient ventilation or overcrowding within an occupied space may be reflected by high levels of carbon dioxide concentration (>0.1%). If so, appropriate follow-up actions must be taken, such as
  - increase ventilation rates (under natural ventilation mode, windows should be opened as far as possible; under mechanical ventilation mode, the system should be running at full load); or
  - limit the number of occupants;
- The ventilation requirement of assembly hall and covered playground is same as that of classroom or other student occupied spaces. However, the number of occupants in these areas vary from time to time, so it is not easy to determine whether the ventilation is sufficient or not. As such, it is recommended to install a carbon dioxide monitoring sensor in assembly hall and covered playground so that the operators / occupants could be alerted if there is overcrowding or insufficient ventilation and take the necessary actions as above;
- For poor ventilated spaces, it is recommended to install air purifiers with high-efficiency particulate air (HEPA) filter to improve the air cleanliness of indoor environment;
- Use only ventilation equipment (Exhaust fan, FAP, OAP, etc.) that comply with appropriate safety standards and follow manufacturer recommendations of operation;
- Maximize the spacing between seats where possible;
- For dormitory of school, adequate spacing between beds should be maintained (if applicable).

3.7 Use of Air Purifiers –

- Air purifiers can be categorized into three types: (1) HEPA cum UV-C device; (2) HEPA device; and (3) UV-C device.
- Air purifiers with high-efficiency particulate air (HEPA) filter could remove most air pollutants (including viruses) by filtration. Air purifiers with ultra-violet-C (UV-C) light could kill viruses via UV-C radiation. However, UV-C radiation is harmful to human skin and eyes. The UV-C device imposes a potential safety hazard to students if there is any leakage of UV-C light. In this regard, it is preferable to use air purifiers with HEPA filters in schools;
- Installation of air purifiers should take the following into consideration:-
  - According to manufacturer's design information, the installation of HEPA air purifier should provide an equivalent clean ACH of at least 6, derived from its Clean Air Delivery Rate ("CADR") and serving area;
  - The air purifiers should be evenly distributed within an occupied space to achieve the best filtration efficiency.
- Air purifiers can improve the indoor air cleanliness only. They cannot provide fresh air and are not a replacement of proper ventilation design;
- The air purifiers are required to comply with relevant international standards, the Consumer Goods Safety Ordinance (Cap. 456) and the Electrical Products (Safety) Regulation (Cap. 406G) under the Electricity Ordinance (Cap. 406). The air purifiers must be properly switched on, operated, maintained and repaired in accordance with the manufacturer manual. The HEPA filter should be replaced regularly according to the recommended interval by the manufacturer.
- Appropriate personal protective equipment should be worn for HEPA filter replacement works (gloves, eye protection and surgical mask). Before replacing the filter, use 1:49 diluted bleach or other equivalent disinfectant to disinfect the surface of the filter. The filter could then be put inside an enclosed plastic bag for disposal.

References

For selection of air purifier, please make reference to the “Information on air purifiers meeting the specified specifications for use in dine-in catering premises”

https://www.fehd.gov.hk/english/licensing/guide_general_reference/Information_air-changes_purification_disclaimer.html