1. What type of ventilation* does the room have?

- ☐ **[1.A] Room with natural ventilation**
  Refer to pages 4-6 for tips on improving indoor air quality.
- ☐ **[1.B] Room with mechanical ventilation**
  - **[1.B.i]** Is the ventilation system set to run continuously while the building is occupied?
    - ☐ **NO**
      Ventilation rate is 0 when system is not running; not in compliance with Ontario Ministry of Education and ASHRAE 62.1; see page 5. Have the ventilation system run continuously when building is occupied.
    - ☐ **YES**
      Great! Go to next question.
  - **[1.B.ii]** When was the ventilation system last checked? _____
    Request proof of inspection. Check for compliance with requirements with Ontario Ministry of Education and ASHRAE 62.1; see page 5.
  - **[1.B.iii]** What type of filter is being used in the ventilation system? _____
    The ventilation system should have the highest rated MERV filter that it can handle; if possible, install a MERV 13 filter.

2. Has there been a recent assessment to determine Air Changes per Hour (ACH) in the room?

- ☐ **NO**
  [2.A] Request an assessment be done as soon as possible. See pages 4-6 for additional information.
- ☐ **YES**
  [2.B] How many ACH can be achieved when the building is occupied? ACH calculation must include outdoor air and total clean air (equal to outdoor air + recirculated filtered air + recirculated disinfected air); ACH = [total airflow rate] / [room volume].
  - 0-2 ACH — Insufficient ventilation. Refer to pages 4-6.
  - 3-4 ACH — More can be done to improve ventilation. Refer to page 4 for tips for improvement.
  - 5-7 ACH — Good ventilation. Refer to page 4 for tips on maintaining this level.

3. Is there an air cleaning device in the room?

- ☐ **NO**
  [3.A] Is there an action plan for harmful outdoor pollutants such as wildfire smoke? _____
  Request an air cleaning device (e.g. HEPA air purifier); use at the highest setting, noise permitting. See pages 4-6 for more tips on usage.
- ☐ **YES**
  [3.B] Is the device turned on and running continuously while the area/room is occupied? _____
  [3.B.i] If the device is an air purifier that filters air:
  - What is the Clean Air Delivery Rate (CADR) for the speed it is being run on? _____
    AHAM recommends 0.32 lps/m^2 (0.67 CFM/ft^2) room size.
  - How many ACH can it provide for the space it is in? _____
    Based on 0.32 lps/m^2 (0.67 CFM/ft^2), this is ~4.5 ACH for a room with 2.7 m (9 ft) ceiling.

  [3.B.ii] If the device contains a UVC lamp:
  - What is the CADR of the device? _____
  - If CADR is not provided, calculate the equivalent CADR: (first pass inactivation rate**) X (air flow rate***) = _____

4. Is CO_2 concentration being monitored in the room?

- ☐ **NO**
  [4.A] Why not? Request to have a CO_2 monitor installed in the classroom. See pages 4-6 for guidance.
- ☐ **YES**
  [4.B] What is the action plan if CO_2 levels go above 1000 ppm? Refer to pages 4-6 for guidance.

Investigating Air Quality at Your Child's School

Use this guide to help you ask the right questions. Contact your school board and principal today!

This guide has been reviewed and endorsed by the Ontario Society of Professional Engineers.

*Schools may have hybrid or partial mechanical ventilation. If this is the case, both options [I.A] and [I.B] may need to be investigated, according to the type of ventilation. Refer to pages 2-3 for definitions of types of ventilation.
**First pass inactivation rate is the percentage of air that is cleaned on a first pass through the device.
***Air flow rate may be given as litres per second (lps), cubic feet per minute (CFM), or cubic metres per hour. ASHRAE 62.1 requires 7-7.5 lps/person (14.8-15.9 CFM/person); ASHRAE 241 requires 20 lps/person (42.4 CFM/person).

Abbreviations: ACH, Air Changes per Hour; AHAM, Association of Home Appliance Manufacturers; ASHRAE, American Society of Heating, Refrigerating and Air-Conditioning Engineers; CADR, Clean Air Delivery Rate; CO_2, carbon dioxide; CFM, cubic feet per minute; ft, foot; ft^2, square foot; HEPA, high-efficiency particulate air [filter]; m^2, square metre; MERV, Minimum efficiency reporting value; ppm, parts per million; UVC, ultraviolet-C.

Investigating Air Quality at Your Child's School

Introduction to Indoor Air Quality (IAQ)

Indoor air quality has a big impact on the people inhabiting that space. Sadly, the air in our school buildings and buses has never been good. The ventilation and air quality in these spaces has been neglected for many years. To find out about air quality at your child's school, it's important to understand how indoor air quality works so you can ask the right questions.

Controlling indoor air quality means ensuring air pollutants are kept below a given level in order to keep people healthy and comfortable. The best way to control indoor air pollution is to control its source. Once pollutants have entered a space, the next step is to remove them from the air.

Useful Terms in IAQ

Ventilation	Supplying outdoor air to an indoor space, while removing indoor air to the outdoors[1]. This is the primary tool for improving indoor air as it reduces the concentration of indoor air pollutants (assuming outdoor air is relatively clean).
Filtration	Involves passing air through a filter to remove polluting particles from the air[1]. This may be necessary if outdoor air supply is polluted (e.g. with wildfire smoke).
Air disinfection	Involves using a method to inactivate infectious particles from the air[1].

Did you know?

Poor ventilation has been associated with more respiratory illnesses and more missed school days[2].

Improving school ventilation will help keep students and educators healthier and at school more often.

This guide has been reviewed and endorsed by the Ontario Society of Professional Engineers (OSPE), and we thank them for their support. Additional information and guidance on safer indoor air may be found in OSPE's Indoor Air Quality Reports.

Abbreviations: IAQ, indoor air quality.

Investigating Air Quality at Your Child's School

Types of ventilation[1]

Mechanical ventilation

Fans are used to control the amount of air supplied to the building. Air is filtered and it can be heated or cooled through the Heating, Ventilation and Air Conditioning (HVAC) system. Schools with mechanical ventilation systems are better equipped to improve air quality.

Hybrid/partial ventilation

- The building switches between mechanical ventilation and natural ventilation depending on the weather conditions.

OR

- The building has an HVAC system for only a section of the building, and the remaining section has natural ventilation.

Natural ventilation

Outdoor air flows into the school through windows, doors, vents, and through leaks within the building envelope, *without* the use of an HVAC system.

Exhaust-only natural ventilation

The building is equipped with exhaust fans to pull air out of the building, which draws in outdoor air through openings such as windows, doors or through leaks in the building envelope.

Abbreviations: HVAC, Heating, ventilation and air conditioning [system].

Investigating Air Quality at Your Child's School

Ways to monitor and improve air quality

Opening Windows

Opening windows can bring in fresh air and help clear indoor air pollutants. Leaving one window open can give **one additional air change per hour (ACH)** into the classroom. Partly opening two windows can also result in a 2.7- to 3-fold decrease in the total concentration of virus particles in a room[3].

Using a CO_2 monitor to assess ventilation

Carbon dioxide (CO_2) is considered an air pollutant[4]; it is exhaled by people and, without adequate ventilation, indoor CO_2 levels will rise due to people breathing in the space. Using a CO_2 monitor in a classroom can help **verify in real time** whether the room is being ventilated properly (i.e. an adequate amount of fresh outdoor air is flowing into the space). When **CO_2 rises above approximately 1000 ppm,** this means not enough fresh air is flowing into the space. We can begin to fix this problem right away by opening windows and/or doors, and by verifying that the HVAC fan is running. Turning on air cleaning devices to the highest setting is also good idea so that any infectious particles in the air can be removed. Studies have shown that using indoor **CO_2 monitoring** with the goal of assessing and improving ventilation and air filtration **can help prevent many illnesses**[5,6].

Air filtration: portable air purifiers and MERV 13

Air filtration units can provide additional clean air. The building's HVAC system should have the highest rated MERV filter it can handle; if possible, a MERV 13 filter should be installed. MERV 13 helps to reduce infectious particles in recirculated air and overall, reduces air pollution.

Commercially available portable air purifiers typically contain a HEPA filter which is capable of filtering nearly all airborne particles. HEPA air purifiers are most effective at a higher speed setting, but this may produce an unacceptable noise level. To reduce noise levels, you can try using two or more units on a lower setting to achieve a similar result. According to research, **one running HEPA unit can be as effective as leaving two windows open all day**. It can also result in a 3-fold decrease in the concentration of virus particles in a room and can result in a **20% decrease in student absence rates**[3,7].

Air cleaning devices: Germicidal UVC

UV air cleaning devices **use ultraviolet light to inactivate viruses, bacteria, and fungi in the air**[8]. Some devices that may currently be used in schools for improving IAQ are UV lamps installed inside air ducts (which help clean recirculated air), and portable standalone units that contain a UV lamp and a fan to draw air through the unit. The effectiveness of these devices depends on how much the air is being cleaned as it passes through the device.

Abbreviations: CH, air changes per hour; CO_2, carbon dioxide; HEPA. high efficiency particulate air [filter]; HVAC, Heating, ventilation and air conditioning [system]; IAQ, indoor air quality; MERV, Minimum efficiency reporting value; ppm, parts per million; UV, ultraviolet; UVC, ultraviolet-C.

Investigating Air Quality at Your Child's School

Current ventilation requirements according to ASHRAE Standard 62.1 and the Ontario Ministry of Education

Ventilation Fan Settings

ASHRAE Standard 62.1 states that the ventilation system should be running while the building is occupied. If the system is not set to run constantly, it is not meeting the minimum ventilation rates in the breathing zone (refer to Page 5 of ASHRAE 62.1 Table 6-1)[9].

The Ministry of Education stated in a memo dated September 5, 2023[10]: "School Boards are expected to: Keep ventilations systems running when buildings are occupied, including by support staff and vendors."

Rooms with only natural ventilation (no HVAC)

The Ministry of Education said in a memo dated September 5, 2023[10]:
"For buildings/rooms that rely on natural ventilation/no HVAC system: [1] Open windows for short times at intermittent intervals, if safe to do so (assess to prevent re-entry of building exhaust). Doing so for a few minutes at a time during the day can still improve air quality, with minimal impact on the indoor temperature. [2] Assess exhaust systems (review to ensure exhaust air is not re-entering the building e.g., windows, science labs, washrooms) and ensure restroom exhaust fans are functional and operating at full capacity when the building is occupied."

MERV 13 filters

The Ministry of Education said in a memo dated September 5, 2023[10]: "School Boards are expected to: Use highest rated Minimum Efficiency Reporting Value (MERV) filter that can be accommodated by the system (MERV 13 if possible) and regularly: [1] inspect filters to make sure they are installed and fit correctly; [2] Replace filters and consider increasing frequency of filter changes to maintain overall performance; [3] Check that sufficient airflow can be maintained based on HVAC design criteria."

Ventilation Inspections

ASHRAE Standard 62.1 states that the ventilation control system should be checked semi-annually and operation of the outdoor ventilation system should be verified annually (refer to ASHRAE 62.1 Table 8-1 on page 5)[9].

The Ministry of Education stated in a memo dated September 5, 2023[10]: "School Boards are expected to: [1] Ensure ventilation systems in all schools are inspected and in good working order for the new school year; [2] Continue inspection and maintenance of ventilation systems throughout the year; [3] Calibrate HVAC systems for maximum air flow and increased fresh air intake, while recognizing specification and limits of existing systems."

Abbreviations: ASHRAE, American Society of Heating, Refrigerating and Air-Conditioning Engineers; HVAC, Heating, ventilation and air conditioning system; MERV, Minimum efficiency reporting value.

Investigating Air Quality at Your Child's School

ASHRAE Standard 241: Control of Infectious Aerosols[11]

ASHRAE 241 was released in June 2023 and provides guidance on controlling airborne infectious diseases in indoor spaces. A key aspect of ASHRAE 241 is the introduction of equivalent clean airflow rates per occupant in a ventilation zone[11].

Comparing ASHRAE 62.1 and ASHRAE 241[12]:

	ASHRAE Standard 62.1 (2022)[9]	ASHRAE Standard 241 (2023)[11]
Equivalent clean air flow rate	**7 - 7.5 lps/person (14.8-15.9 CFM/person)**	**20 lps/person (42.4 CFM/person)**
Calculated Air Changes per Hour* (ACH)**	**2.5 - 3 ACH of outdoor air**	**6.7 - 9.3 ACH of total clean air**

*ASHRAE 62.1 and ASHRAE 241 do not provide calculated ACH; the cited range is based on an assumption of 2.7 m (9 ft) ceiling and occupant density as provided in ASHRAE 62.1, for classrooms (occupants age 5+) and daycares (occupants up to age 4)[12].
**ACH is calculated as follows: ACH = [airflow rate] / [room volume].

A CO_2 monitor placed in each ventilation zone in the school can be used to assess ventilation. If the CO_2 in the space measures below ~1000 ppm, it is likely compliant with ASHRAE 62.1 but the space can be made safer against airborne diseases by increasing the clean air flow rate per person to comply with ASHRAE 241.

In order to improve indoor air quality and safety for the students and school staff, ask your school's building operators to comply with the requirements of ASHRAE 241

Abbreviations: ACH, air changes per hour; ASHRAE, American Society of Heating, Refrigerating and Air-Conditioning Engineers; CFM, cubic feet per minute; CO_2,carbon dioxide; ft, feet; lps, litres per second; m, metre; ppm, parts per million.

Investigating Air Quality at Your Child's School

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