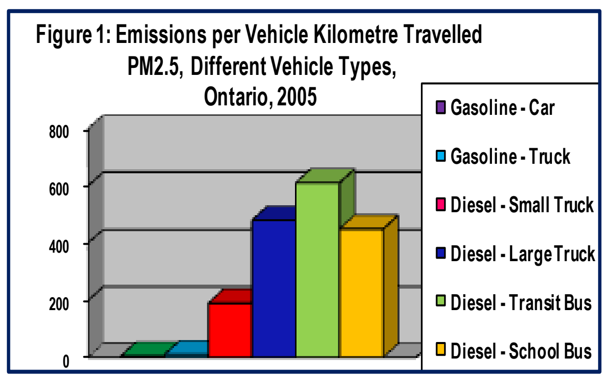
Healthy School Buses for School Bus Operators

School Buses & Air Pollution

School Buses are very safe vehicles. However, most are heavy-duty diesel vehicles that can emit substantial quantities of diesel-related air pollutants such as fine particulate matter (**$PM_{2.5}$**), nitrogen oxides (**NO_x**), and diesel particulate matter (**DPM**) as they travel to and from our children's schools.

They can also be self-polluting vehicles that expose children on-board to elevated levels of $PM_{2.5}$ and DPM. Exposure studies have found that emissions from school bus tailpipes and engine compartments can contribute substantially to levels of air pollutants on-board school buses. Levels of air pollution on-board are also influenced by local air quality, the density of traffic on the roads travelled, wind direction, the position of windows (i.e. open or closed), and idling and queuing patterns.

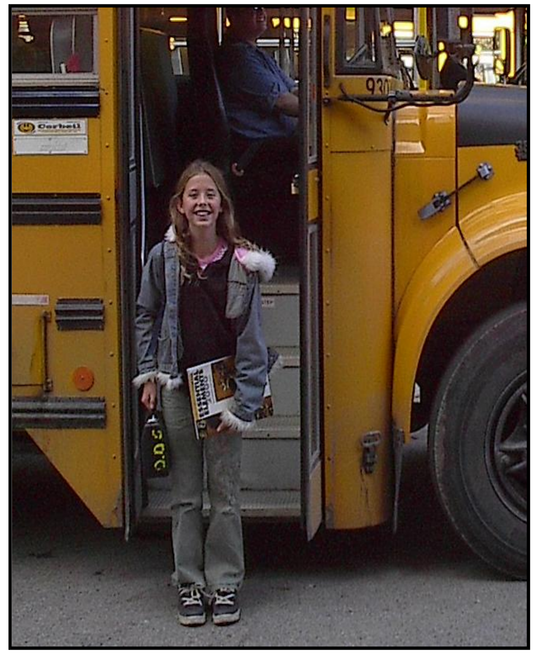


While children may spend only a few hours per day on school buses, the elevated levels of air pollution that can be encountered on-board school buses can add considerably to their daily and annual exposures to $PM_{2.5}$ and DPM. This is a concern because children in many Ontario communities are already exposed to levels of air pollution that are harmful to their health. The Ontario Medical Association estimates that air pollution contributes to approximately 1,829 premature deaths, 16,907 hospital admissions, and 59,696 emergency room visits in Ontario each year.

$PM_{2.5}$ and DPM have been clearly associated with a broad spectrum of acute and chronic impacts. They have been found to:

- ❖ Reduce lung function
- ❖ Aggravate asthma, leading to more frequent and more severe asthma attacks
- ❖ Increase the number of respiratory infections and school and work day absences
- ❖ Aggravate and induce allergies
- ❖ Increase, emergency room visits, hospital admissions, and premature deaths
- ❖ Contribute to chronic heart and lung diseases such as lung cancer and asthma

Children are Sensitive to Air Pollution



With approximately 800,000 Ontario children being transported on school buses each year, school bus exposures represent a substantial public health concern. The respiratory systems of children are sensitive to air pollution. Children with pre-existing respiratory conditions such as asthma are particularly vulnerable. Childhood exposures also influence health in later life. A small shift in the average lung function of a group of children today can translate into a substantial increase in the number of adults who are vulnerable to chronic respiratory diseases such as lung cancer later in life.

Reducing Childhood Exposures

Exposures studies have found that exposures on-board school buses can be significantly reduced, even under idling conditions, by retrofitting school bus tailpipes with emission control devices such as Diesel Particulate Filters (**DPFs**), and school bus engines with Closed Crankcase Ventilation devices (**CCVs**). These studies also suggest that on-board exposures can be reduced by keeping doors and windows closed when buses are idling, avoiding idling when buses are waiting in front of schools, and avoiding caravanning on roadways.

Diesel-Related Air Pollutants

Diesel exhaust is composed of hundreds of different air pollutants. For the purpose of engine emission standards, these air pollutants have been broken into four groups:

- **Carbon Monoxide (CO)** is a gas that can be toxic to humans in high concentrations.
- **Nitrogen Oxides (NO_x)** is a small group of nitrogen-based air pollutants. Nitrogen dioxide **(NO_2)** can be harmful to the lungs in a direct way. All of the NO_x can react with other compounds in the air to create ground-level ozone and/or $PM_{2.5}$. These two air pollutants are harmful to health and trigger most, if not all, of the smog advisories issued in Ontario.
- **Particulate Matter (PM)** is the term for air pollutants that are present in liquid or solid form. A significant portion of diesel exhaust is present as particulate matter (PM). Most of these particles are less than 2.5 microns in size (called $PM_{2.5}$), while a substantial portion are less than 0.1 microns in size (called ultra-fine particles or **UFP**). Because of their small size, $PM_{2.5}$ and UFP can penetrate deep into the lungs, enter the blood stream, and travel throughout the body.
- **Hydrocarbons (HC)** is the term used for a broad group of chemical compounds that includes a number of the toxic contaminants, such as benzene, that are found in diesel exhaust. Many of the hydrocarbons in diesel exhaust adhere to the $PM_{2.5}$ and/or the UFP and are transported into the lungs and throughout the body on these particles.

Newer Buses are Healthier Buses

As can be seen by Table 1, emissions from school buses have declined significantly over the last 20 years as new fuel and engine emission standards have been developed and rolled out by the Government of Canada. Buses built to:

- 1994-2003 standards emit 2.5 times less PM than 1993 buses
- 2004-2006 standards emit 10 times less HC than 2003 buses
- 2007-2009 standards emit 10 times less PM than 2006 buses
- 2010 emission standards emit 6 times less NO_x than 2009 buses.

Table 1: Emission for School Buses by Model Year in Canada			
Model Years	Emissions (g/brake horse power hour)		
	PM	HC	NO_x
< 1991	0.60	1.3	6
1991-93	0.25	1.3	5
1994-03	0.10	1.3	4
2004-06	0.10	0.14	2.25
2007-09	0.01	0.14	1.2
2010	0.01	0.14	0.2

With buses built to 2007 emission standards, it is expected that levels of air pollutants on-board will approach levels in ambient air. These buses, which will be outfitted with DPFs and CCVs, will not be self-polluting. This is great news for children's health and for local air quality. However, for older school buses, concerns remain for on-board exposures and local air quality.

Reducing Emissions & Exposures

School bus operators can adopt a number of practices to reduce emissions and exposures associated with pre-2007 school buses. They can:

1. **Replace Older Buses:** The Model Contract Template developed by stakeholders in Ontario recommends a maximum age limit of 12 years and an average fleet age of 7 years for full-size school buses. **Pre-1994** school buses should not be used at all and pre-1998 school buses should be retired, used for emergency purposes only, or retrofitted with emission control devices.

2. **Assign Routes with an Awareness for Emissions:** Buses should be assigned to routes with an awareness for bus emissions. Buses that do multiple routes in heavily populated areas should be assigned to school buses with **post-2006** model year engines wherever possible to reduce air levels along heavily travelled roads and exposures on-board. Newer buses should also be considered for longer routes in which children spend longer periods of time on-board.

3. **Implement Driver Training:** Drivers should be trained using Natural Resources Canada's SmartDriver Program available from FleetSmart at www.fleetsmart.gc.ca. It covers information about: the health impacts associated with diesel exhaust; the impact of unnecessary idling in school yards and residential neighbourhoods; best operating practices (e.g. to avoid starting the bus until children are on-board and doors are closed); and driving practices that reduce fuel consumption and emissions.

4. **Retrofit with Auxillary Heaters:** In areas where idling is associated with defrosting windows or heating cabins, operators should consider installing auxillary heaters that heat engines and/or

cabins without idling. These devices, which cost about $400 to $1,500, can reduce idling and emissions, while saving fuel and money.

5. **Retrofitting with Closed Crankcase Ventilation Devices (CCVs):** Operators should consider retrofitting all **pre-2007** school buses with CCVs. These devices, which cost about $200 to $1,000, can substantially reduce air levels of $PM_{2.5}$ on-board school buses while also reducing tailpipe emissions. With proper installation and a filter change once or twice a year, these devices can substantially reduce childhood exposure to air pollutants on-board school buses. For optimal operation, installation by the vendor should be considered.

6. **Retrofit with Diesel Oxidation Catalysts (DOCs**): Operators should consider retrofitting **pre-2005** buses that have **> 2 years** of remaining service life with DOCs. At a cost of about $1,100 to $1,400 per bus installed, DOCs can reduce emissions of PM and HC by 40% and 75% respectively. DOCs are easy to install, require no maintenance, do not affect fuel economy, and present no operational problems. These retrofits are particularly important for children who live in communities that experience elevated levels of $PM_{2.5}$.

7. **Retrofit with Flow Through Filters (FTFs):** Operators should consider retrofitting **pre-2005** school buses that have > **5 years** of service life remaining with FTFs. At a cost of $5,700 per bus installed, FTFs can reduce emissions of PM by more than 50% . These devices are sensitive to the temperature of the engine so they should only be installed on buses that have been shown, with data logging, to have the proper duty-cycle. Unlike DPFs, FTFs will <u>not</u> adversely affect the operation of the bus if the duty-cycle and temperature are not well matched. These devices require only a few hours for installation. They do not affect fuel economy. They have no filters to change or clean.

8. **Biodiesel:** In areas that have easy access to biodiesel, operators should consider fuelling buses with a 5 to 20% biodiesel blend (B5 to B20). Biodiesel can produce modest reductions in air pollutants and greenhouse gases. It is a clean fuel that can improve performance on Drive Clean opacity tests. School bus operators in Ontario have had no operational problems when using biodiesel from April to November. Unfortunately, fuel costs continue to be volatile; ranging from $0.01 per litre less than conventional diesel to $0.07 per litre more.

For more information see: http://www.cleanairpartnership.org/schoolbus

Clean Air Partnership

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