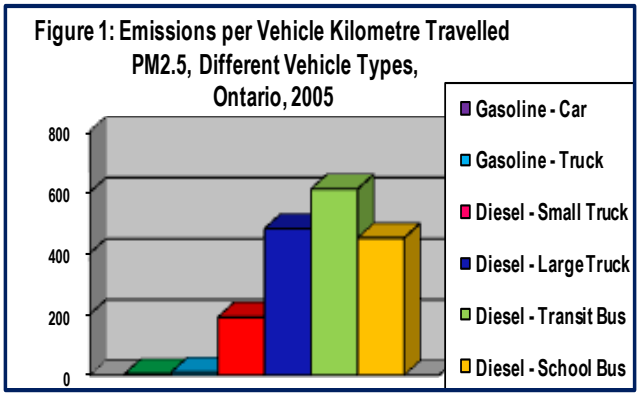
Healthy School Buses: School Board Factsheet

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.

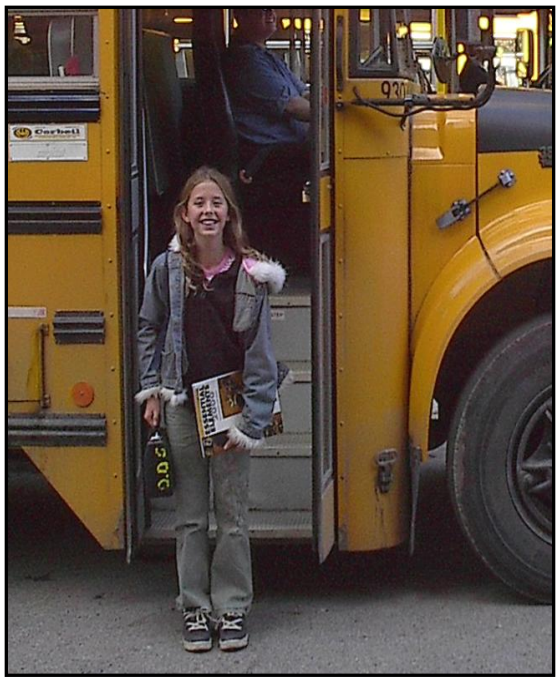


While children may spend only a few hours per day on school buses, the elevated levels of air pollution that can be encountered on-board school buses can add considerably to their daily and annual exposures to $PM_{2.5}$ and DPM. This is a concern because children in many Ontario communities are already 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 including 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 significant public health concern. The respiratory systems of children are sensitive to air pollution, and 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 susceptible 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 $PM_{2.5}$ which are both harmful to health. These two air pollutants 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 that 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 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.

New 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: Emissions from 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 & On-Board Exposures

Student Transportation Boards and Consortia in Ontario can adopt a number of policies to reduce emissions and exposures associated with **pre-2007** model year school buses. They can:

1. **Encourage Replacement of 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. By adopting these age limits in policies and contract language, Student Transportation Boards/Consortia can ensure that the highest emitting school buses are removed from the road as quickly as possible.

2. **Limit the Use of Older School Buses:** For those situations in which older school buses (i.e. >12 years) are retained for emergency purposes, contract language should limit the number of hours and/or days per year that these older buses can be used and/or require that they are retrofitted with Diesel Oxidation Catalysts (DOCs). The contract should, however, make it mandatory to retire all **pre-1994** school buses.

3. **Encourage the Assignment of 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 levels of air pollution 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.

4. **Require Driver Training:** Drivers should be trained using Natural Resources Canada's SmartDriver Program available from FleetSmart at www.fleetsmart.gc.ca. It covers: the health impacts

associated with diesel exhaust; the impact of unnecessary idling in school yards and residential neighbourhoods; best operating practices; and driving practices that reduce fuel use and emissions.

5. **Encourage Retrofitting with Auxillary Heaters:** In areas where idling is associated with defrosting windows and warming bus cabins, contracts can encourage operators to install auxillary heaters that heat engines and/or cabins without idling. These heaters, which cost between $400 and $1,500, can reduce idling and emissions, while saving fuel and money.

6. **Encourage Retrofitting with Closed Crankcase Ventilation Devices (CCV):** Contracts can encourage retrofitting **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.

7. **Encourage Retrofitting with Diesel Oxidation Catalysts (DOCs):** Contracts can encourage operators to retrofit **pre-2005** buses with **> 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 in communities that experience elevated levels of $PM_{2.5}$. They are particularly effective for pre-2004 school buses that emit higher levels of hydrocarbons.

8. **Encourage Retrofitting with Flow Through Filters (FTFs):** Contracts can encourage operators to retrofit **pre-2007** school buses that have **> 5 years** of remaining service life with FTFs. At a cost of $5,750 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 not adversely affect the operation of the bus when temperatures are not maintained.

9. **Encourage Use of Biodiesel:** In areas that have easy access to biodiesel, contracts can encourage operators to fuel buses with 5 to 20% biodiesel blends (i.e. B5 to B20). These blends can produce modest reductions in air pollutants and greenhouse gases. Biodiesel is a clean fuel that can improve performance on Drive Clean opacity tests. School bus operators in Ontario who have used biodiesel blends from April to November have experienced no operational problems.

Clean Air Partnership

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

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