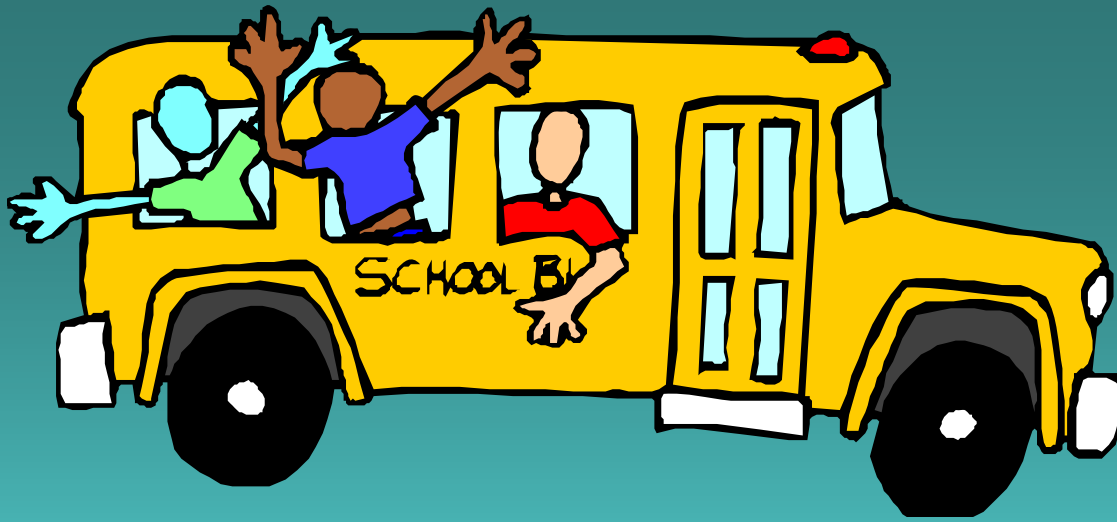


US EPA ARCHIVE DOCUMENT



Characterization of the Fine Particle and Gaseous Emissions from School Bus Idling

What's the question?



Is there a net benefit of anti-idling to emissions reduction?

Or

Should school buses be allowed to idle while waiting for the kids?

What was the study goal?

- The ***goal*** of this research was to quantify and compare the Particulate Matter and gaseous exhaust pollutants emitted from selected diesel school buses which were shut down and ultimately restarted and those which idled continuously.
- EPA and anti-idling advocates are interested in confirming the benefits of idle reduction programs.

What's the existing EPA guidance?

- **Tools for Schools**

- *The easiest way to reduce vehicle idling emissions is to "Just turn it off!"*



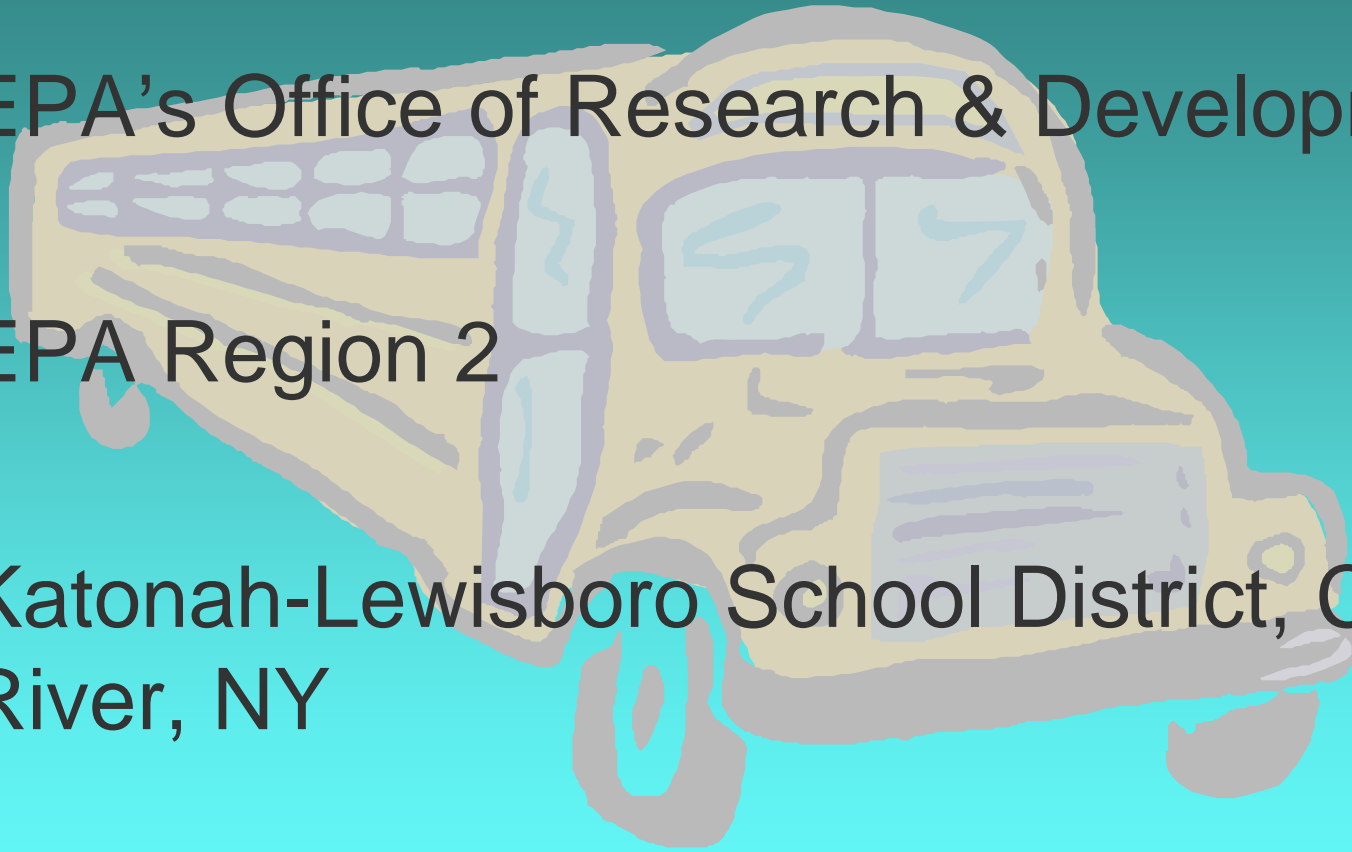
- **Clean School Bus USA**

- *The engine should be turned off as soon as possible after arriving at loading or unloading areas. The school bus should not be restarted until it is ready to depart.*
- *Limit idling time during early morning warm up to what the manufacturer recommends (generally no more than five minutes).*



Who was involved?

- EPA's Office of Research & Development
- EPA Region 2
- Katonah-Lewisboro School District, Cross River, NY



What was tested?

- Six diesel school buses w/ Caterpillar engines and catalytic mufflers
- Simulated loitering during wintertime operation in a northern climate
- Continuous idle, hot restart, post-restart idling
- Fine particulate matter (PM), particulate polycyclic aromatic hydrocarbons (PAHs), carbon monoxide (CO), total hydrocarbons (THC), nitrogen oxides (NO_x), and formaldehyde



Pollutants

- Fine Particulate Matter (PM_{2.5})
 - 2.5 micrometers in diameter and smaller
 - Found in smoke and haze
 - Fine particles are the major cause of reduced visibility (haze) in parts of the United States
- Nitrogen Oxides
 - Form when fuel burns at high temperatures
 - Mobile sources are responsible for more than half of all nitrogen oxide emissions in the United States
 - Contributes to smog and particulate matter formation
- Carbon Monoxide
 - Forms when carbon in fuel doesn't burn completely
 - The main source of carbon monoxide in our air is vehicle emissions
- Polycyclic Aromatic Hydrocarbons (PAHs)
 - Key component of smog
 - Result from incomplete fuel combustion and from fuel evaporation.

What example bus operating scenarios were evaluated using the study results?

- A **20 minute idle** to keep bus warm.
- Bus not started until the children are seated. Then an immediate departure.
Restart and go.
- Bus turned off then restarted 10 minutes before the children board to warm the bus.
Off 10 minutes, restart, on ten minutes.

What did we find?

- **Turning off the engine is the preferred operating choice**
 - There is a short but minor “burst” of emissions when the engine is restarted
 - This emissions burst lasts less than 5 sec for fine particulate matter, carbon monoxide, and nitrogen oxides
 - Idling after the bus is restarted erodes the emissions benefits of shutting it off
 - Different operating scenarios can be evaluated and trade-offs made using the study results

What were the emissions?

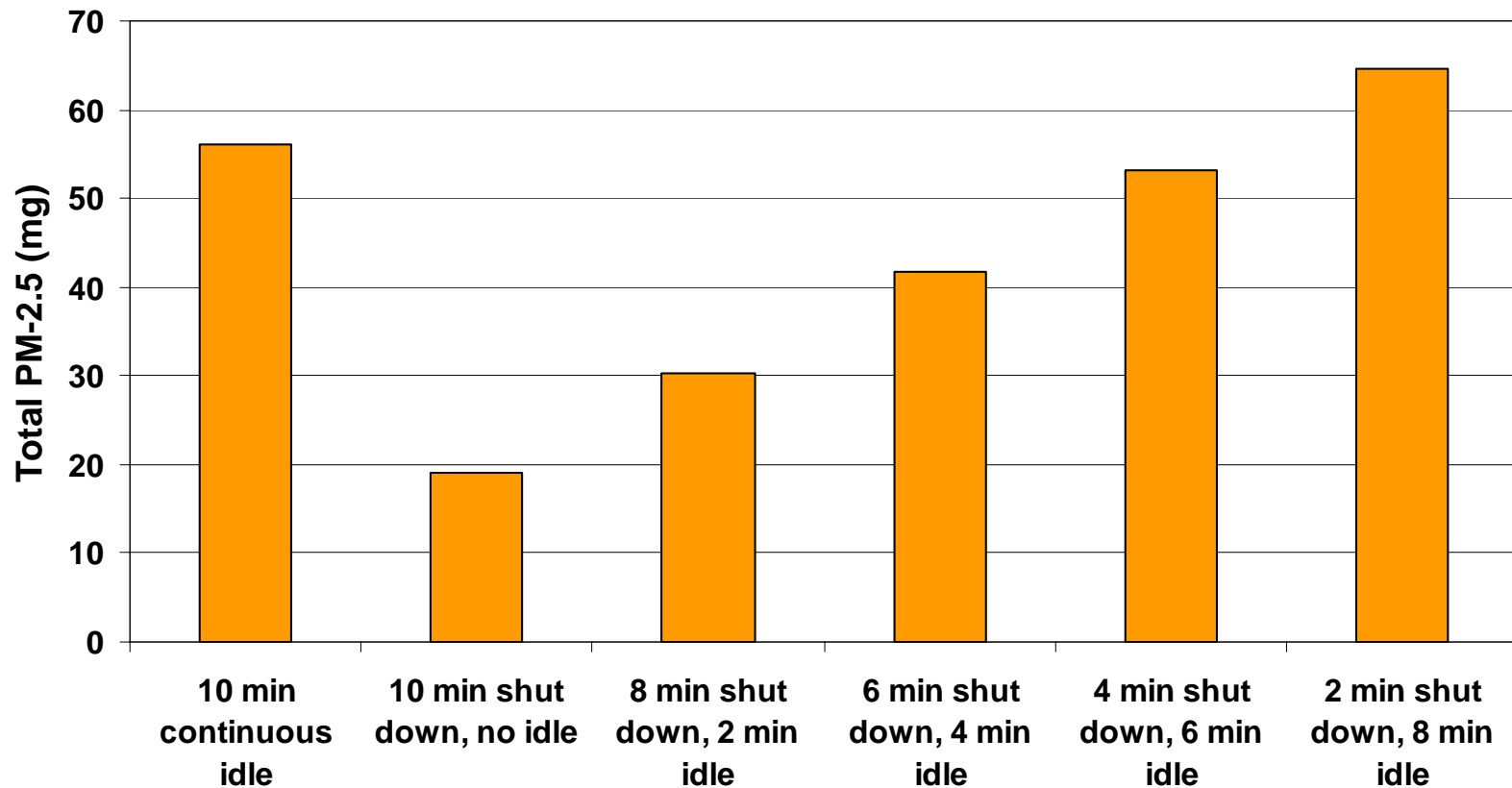
	Bus Operating Conditions¹				
	20 minute idle	Restart and go		Off 10 min, restart, and 10 min idle	
Pollutant			% reduction²		% reduction²
Nitrogen Oxides	24 grams	0.032 grams	99.9	13 grams	45.8
Carbon Monoxide	10 grams	0.081 grams	99.2	5.4 grams	46.0
Particulates	112 milligrams	19 milligrams	83.0	76 milligrams	32.1
Particle Polycyclic Aromatic Hydrocarbons	480 micrograms	7.1 micrograms	98.5	227 micrograms	52.7

¹ Idling emission values were calculated based on results from the study. Restart and go emission values are average values obtained from the measurement results.

² Percent reductions compared to 20 minute idle.

What were the emissions?

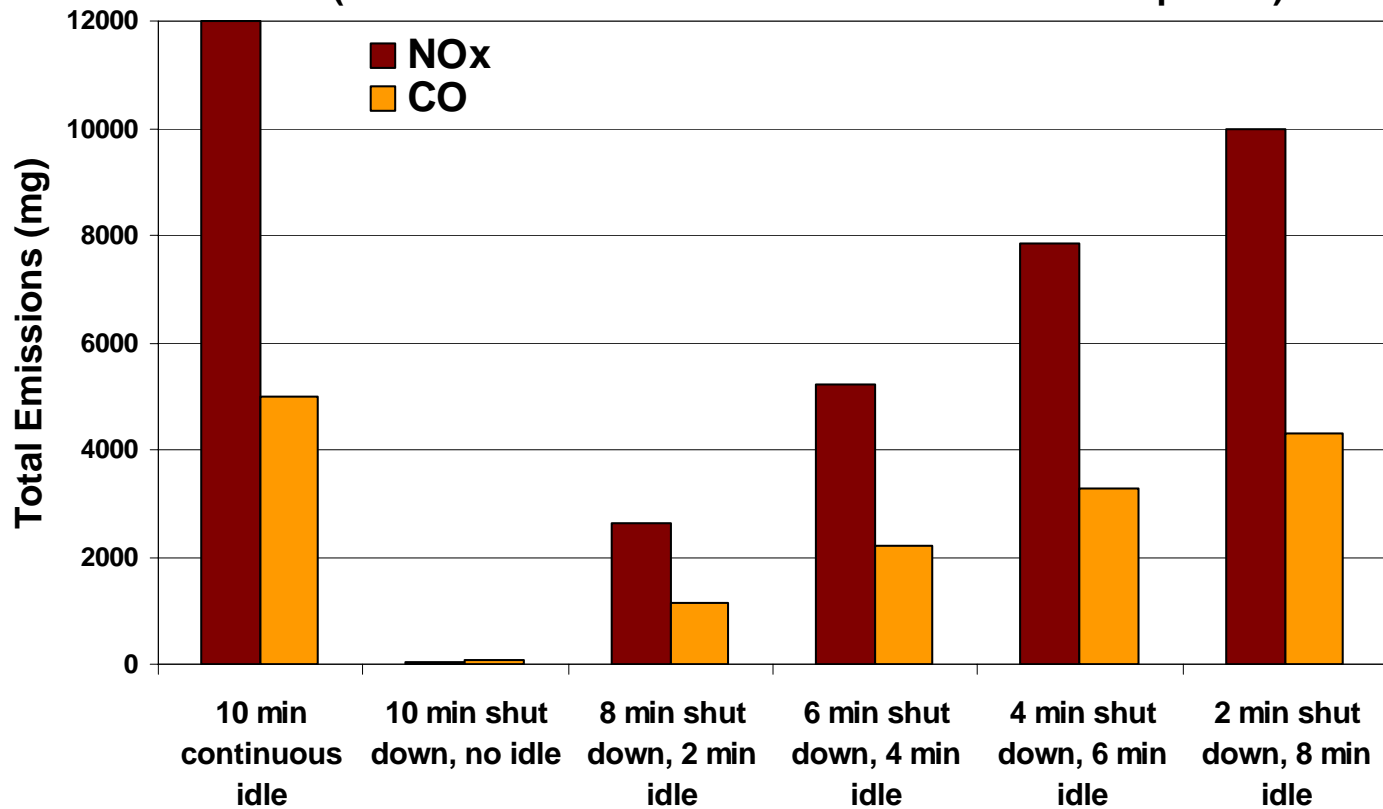
Total Fine Particulate Matter Emissions
Over a 10 Minute Period
(Shut down/idle combinations include restart "pulse")



What were the emissions?

Nitrogen Oxides and Carbon Monoxide Emissions Over a 10 Minute Period

(Shut down/idle combinations include restart "pulse")



What is the “take home” message from this limited study?

Anti-idling can be used to effectively lower emissions and reduce student exposure to air pollutants from diesel engine exhaust

Findings provide additional support to EPA’s Anti- Idling Guidance

For more information visit:

- Tools for Schools (<http://www.epa.gov/iaq/schools/tfs/guidei.html#Anti-Idling>)
- Clean School Bus USA (<http://www.epa.gov/cleanschoolbus/>)