

Children's School Bus Exposure Study

The Children's School Bus Exposure Study was conducted to characterize the range of children's exposures to diesel vehicle-related pollutants and other vehicle pollutants during their commutes to school by diesel school buses. The study, conducted by researchers at the University of California Riverside and Los Angeles campuses, measured pollutant concentrations inside five conventional diesel school buses over actual school bus routes in Los Angeles. For comparison, a diesel bus equipped with a particulate trap and a bus powered by natural gas were also included. Other goals of the study were to determine what factors influenced the highest exposures.

The researchers measured multiple diesel vehicle-related pollutants, including black carbon and particle-bound PAHs, and as well as many other exhaust pollutants. A tracer gas was used to determine the bus's own contributions to on-board concentrations. The study measured exposures inside the buses and did not include tail-pipe emissions tests.

Major Findings of the Children's School Bus Exposure Study

The study found that conventional diesel school buses had significantly higher on-board diesel related pollutant (DRP) concentrations than roadway pollutant concentrations alone would indicate.

- **Self pollution is a significant source of exposure** – the study found significantly higher on-board DRP concentrations due to “self pollution”, or the intrusion of the bus' own exhaust into the cabin after leaving the exhaust pipe. The effect was worse when the windows were closed and worse for older buses. DRPs were up to 2.5 times higher when windows were closed.
- **Traffic density is critical to exposure** – the influence of other traffic exhaust emissions is a key determinant of exposure. With the windows open, DRP concentrations were two to three times higher on the primary urban route compared to the suburban or rural route.
- **Cleaner buses have lower in-vehicle exposures** – the CNG-powered bus and the particulate trap-equipped bus showed significantly reduced on-board concentrations of DRPs compared to conventional diesel buses. With the windows closed, the DRP concentrations were two to five times higher on conventional diesel buses compared to the cleaner buses.
- **Most exposure occurs from commuting on the bus, not loading and unloading** – almost all bus-related exposures were due to the time spent commuting on the bus and not the time spent at bus stops or loading and unloading. Idling at schools was not measured and is now not allowed in California as a result of recent ARB regulatory actions to limit school bus idling at schools (<http://www.arb.ca.gov/toxics/sbidling/sbidling.htm>).

How important are the exposures? What are the implications?

- ❖ Increased exposures from commuting by school bus (assuming commutes by bus for 13 years) were estimated to increase a child's lifetime cancer risk due to diesel particulate matter by approximately 4% or an increase of 30 per million lifetime risk. An increased risk of lower respiratory symptoms (~6%) and daily hospitalizations for asthma (~1%) were also estimated.
- ❖ Despite increases in DRP exposures, commuting by school bus is still safer in terms of traffic deaths than commuting by automobile and the results should not be interpreted to remove children from school buses.
- ❖ There is a continuing need to replace older, dirtier buses with cleaner, newer buses to reduce children's exposure to vehicle related pollutants.
- ❖ This study and previous in-vehicle studies provide compelling data that exposures during commutes, whether on buses or cars, are significantly elevated and need to be reduced.
- ❖ There is a continuing need to reduce diesel exhaust pollutant emissions from the overall motor vehicle fleet in order to reduce roadway emissions and exposures.

Researchers Recommendations

The University of California, Riverside and University of California, Los Angeles authors of the study make several other recommendations to reduce impacts of school bus exposures:

- Replace conventional buses with alternate fueled or particulate trap equipped buses to reduce exposures.
- Minimize bus caravanning.
- Use cleaner buses on longer routes.
- Minimize idling time at schools.
- If school buses are not full, children should be encouraged to sit in the front of the bus.
- School districts should maintain their diesel school buses to eliminate visible exhaust.

For More Information

- ❖ For more information on the Children's School Bus Exposure Study, visit the study web site at: <http://www.arb.ca.gov/research/schoolbus/schoolbus.htm>
- ❖ For information on the ARB's Lower-Emission School Bus Program for the acquisition of clean, safe, school buses, visit the web site at: <http://www.arb.ca.gov/msprog/schoolbus/schoolbus.htm>
- ❖ For information on the ARB's School Bus Idling control measure, visit the study web site at: <http://www.arb.ca.gov/toxics/sbidling/sbidling.htm>

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