CHILDREN'S EXPOSURES DUE TO SCHOOL BUS COMMUTES: RESULTS FROM THE RECENT ARB-SPONSORED STUDY

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Air Resources Board
California Environmental Protection Agency

Thank you Ms. Witherspoon. Good morning Dr. Lloyd and members of the Board. Today I will be summarizing the results from the recent ARB-sponsored study of children's school bus exposures. The study was conducted by researchers at UCLA and UC-Riverside, with co-funding by the South Coast AQMD and EPA.

STUDY DESCRIPTION

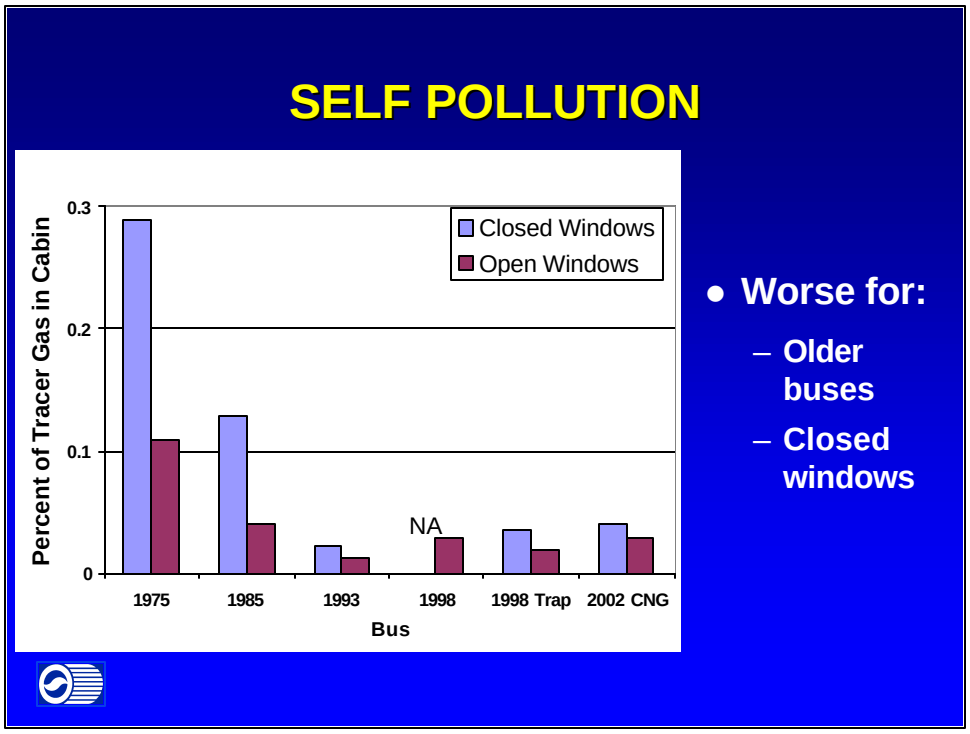
- Goal: characterize children's exposures and high exposure conditions
- Buses: seven total, five uncontrolled diesel, one CNG, one diesel with trap
- Routes: actual school routes in LA, urban and suburban/rural
- April - June, 2002
- Tracer gas in exhaust

The goal of this study was to characterize children's exposures due to school bus commutes with special emphasis placed on characterizing the conditions expected to produce high exposures.

Seven buses were studied in total. These included five uncontrolled diesel buses, that is, buses with no after treatment. Uncontrolled buses ranged in age from 1975 to 1998. Also included were a 1998 bus outfitted with a particulate trap, and a 2002, uncontrolled, natural gas-powered bus.

Actual school bus routes for a magnet school in West LA were followed at normal route times. No children were on board, but all route stops were made in order to simulate the picking up or dropping off of children. The primary urban route was about 60 minutes long, each way, serving residential areas of South Central LA, with significant time spent in slow traffic conditions on the 10 Freeway. A suburban/rural route from UC Riverside to Diamond Bar, east of urban LA, was chosen for its low traffic. The study was conducted mornings and afternoons in the late spring and early summer of 2002.

While many pollutants were measured, a key aspect of this study was adding an inert tracer gas to the bus's exhaust to allow distinguishing the bus's own emissions from that of other vehicles.



The most important result of this study was demonstrating the extent of school bus self-pollution. School buses appear to be especially vulnerable to the re-intrusion of their own exhaust into the bus cabin after it leaves the tailpipe.

This bar chart shows the fraction of the exhaust making it back into the bus cabin, as determined by the tracer gas measurements. The two bar colors are for open and closed window positions, light blue being closed windows. On the x-axis are listed the buses in order of their age, the oldest on the left. Intrusion rates can be seen to generally be higher for older buses, and higher when windows were closed, when cabin ventilation was reduced.

RELATIVE INCREASES IN DIESEL-RELATED POLLUTANTS

- **Closed windows: ~2 times higher than open**

  Uncontrolled buses

- **Dirtier bus emissions: 2 to 5 times higher**

  Uncontrolled vs CNG or trap-equipped bus (windows closed)

- **Higher traffic density: 2 to 7 times higher**

  Urban vs suburban/rural (windows open)

Self-pollution contributed significantly to on-board pollutant concentrations. For example, when windows were closed, concentrations of diesel vehicle-related pollutants were about two times higher on uncontrolled buses, compared to when windows were opened.

Self-pollution was also more pronounced for dirtier buses than for cleaner buses. For the two uncontrolled diesel buses that showed similar low rates of intrusion like the CNG or trap-equipped bus, diesel-related pollutant concentrations were two to five times higher under closed window conditions.

The other primary contributor to on-board pollutant concentrations was other traffic. The congested urban routes caused concentrations of diesel-related pollutants 2 to 7 times higher than on the lightly congested suburban/rural route for the same bus during open window conditions.

RISK COMPARISONS

- **Worst-case commute scenario:**

  4% increase in lifetime lung cancer risk due to diesel exhaust particulate matter (30 in a million)

- **Worst-case passenger car commute:**

  200 in a million increase in crash fatality risk compared to buses

To help determine the importance of these elevated concentrations on-board buses, several commuting scenarios were compared in terms of diesel particulate matter exposure, considered to be the major cancer risk of urban air toxics.

For a worst-case scenario, assuming the relatively long commute measured in this Bus Study was ridden by children twice a day, 200 days per year, for grades K through 12, with diesel particulate concentrations equal to the uncontrolled bus average, a lifetime diesel particulate matter exposure increase of 4% was calculated.

Using the ARB/OEHHA unit risk factor, this increase translates to an increased lifetime risk of lung cancer of 30 in a million.

However, because school buses are significantly safer than other vehicles, these results mean that school bus fleets need to become cleaner, not that children be taken off buses and transported by less safe means. For example, the increased risk of crash fatality for children driven to school over the same commute in passenger cars rather than school buses was 200 in a million, much higher than the increased risk of lung cancer.

RECOMMENDATIONS

- Bus fleet emissions reductions
- Bus impact reductions
  - Newer buses for longer routes
  - Maximize open window time for older buses
  - No caravanning
  - Minimize idling
- Follow up: bus exhaust intrusion study

Our recommendation, first and foremost, is to clean up the school bus fleet through replacing or retiring the older buses as quickly as possible. Replacing diesel buses with natural gas, or retrofitting buses with particulate traps, also appears to be effective in reducing exposures.

In the meantime, other bus activity-related recommendations include using the newest buses on the longest routes, and for older buses, whenever comfort allows, opening the windows.

It is also important to discourage buses following each other, such as occurs during caravanning to after-school events.

Finally, as a follow-up to this study, staff are planning an additional study into the self-pollution phenomenon. This study will determine how and when self-pollution occurs, and whether special inspection or maintenance measures might prove effective in reducing this problem and in reducing bus commute exposures.

Thank you. I'll be happy to answer any questions.