Diesel School Bus Retrofit Pilot Project

A partnership between Environment Canada, the Fraser Valley Regional District, School District No. 34 (Abbotsford) and School District No. 33 (Chilliwack)

FINAL REPORT

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Background

In the fall of 2004, Environment Canada presented a proposal to the Fraser Valley Regional District to retrofit a small number of school buses in Abbotsford with emission controls to help reduce diesel particulate matter emissions. By partnering with other agencies, the school district could become actively involved in an environmental project that would have a beneficial impact on students, while both the FVRD and Environment Canada could lead an important environmental initiative.

Abbotsford was chosen as the site for this pilot project as it is located in the sensitive Lower Fraser Valley Airshed and as it represents a typical community in the Georgia Basin/Puget Sound Airshed, funding through Environment Canada-EPA Border Air Quality Strategy was available. In its proposal, Environment Canada committed to covering all capital and installation costs, while FVRD staff would provide in-kind services to help administer the pilot project. Once tenders for the original project were received, it became clear that it would be possible to expand the project to a greater number of buses, thereby strengthening the results of the project. In the end, the project was expanded to include both School District No. 34 (Abbotsford) and School District No. 33 (Chilliwack).

The technology

The most efficient and economic way to reduce diesel PM in school buses was deemed to be by retrofitting the vehicles with emission-reducing devices called Diesel Oxidation Catalysts (DOCs). DOCs are a type of muffler that use a chemical process (either catalytic or a filter technology) to break down pollutants in the engine exhaust (including carbon monoxide, hydrocarbon and particulate emissions) into less harmful components. This technology was chosen for this pilot project because:

- It was a proven emission reduction technology, as certified by the U.S. Environmental Protection Agency;
- Needed only a one time investment;
- Had low or no maintenance costs;
- Did not negatively impact fuel economy; and,
- As there was more than one supplier, price competitiveness was ensured.

DOCs are considered one of the most cost effective methods to reduce emissions (U.S. Environmental Protection Agency 2005). This first of its kind school bus project in Canada would demonstrate that DOC technology was effective, and if successful, the program could then be expanded into other school districts in the FVRD.

The procedure

In March 2005, 29 buses were selected to have the DOCs installed (18 in SD #34, 11 in SD #33). These particular buses were chosen because they met Environment Canada's specifications that the buses were built between 1991 and 2002 (i.e. they were older buses with higher emissions and would benefit from the installation of DOCs), and were not being sold or decommissioned within the next 2 years.

The contractor (DOCs supplied by Engine Control Systems; installed by Pacifica) was selected based on their ability to provide hardware and retrofit the buses while ensuring that:

- The hardware was a verified emission reduction technology by the U.S. Environmental Protection Agency or California Air Resources Board;
- It was verified to have no adverse effect on fuel efficiency;
- It did not affect the warranty of the bus; and,
- The product, and installation work would have a warrantee for a minimum period of five years.

The contractor provided all necessary mounting hardware required to install the oxidation catalysts, including the oxidation catalysts themselves.

All 29 buses were retrofitted over the course of the week of March Break 2005, which meant that there was no disruption to students or classes. It took, on average, 1 – 2 hours to remove the muffler and replace it with a DOC on each bus, at a cost of $1,350 per bus (note that cost can vary with engine size and the number of devices purchased, i.e. discount for larger orders). Buses were off the road for no more than 4 hours. Overall, the work went as expected. On a few buses, the in-take port had to be modified but this did not cause any significant delays or problems.

Emissions reduction

Based on the equipment certification and testing done by the U.S. Environmental Protection Agency, Environment Canada projects improvements to bus emissions, as described in the following tables

Table 1. Summary of emissions for existing vs. proposed retrofit bus fleet for School District No. 34 (Abbotsford)

	VOC	CO	PM	NOx
	kg/year			
Existing Fleet Emissions				
Total:	373.8	1,209.3	52.6	4,155.8
Projected Fleet Emissions With Proposed Retrofit Devices				
Total:	37.2	120.7	37.2	4,155.8
Total Emission Reductions from Retrofit Devices				
Emissions Reduced	336.6	1088.6	15.4	0.00
% Reduction	90.0%	90.0%	29.0%	0.0%

Table 2. Summary of emissions for existing vs. proposed retrofit bus fleet for School District No. 33 (Chilliwack)

	VOC	CO	PM	NOx
	kg/year			
Existing Fleet Emissions				
Total:	141.5	453.6	19.1	1,492.3
Projected Fleet Emissions With Proposed Retrofit Devices				
Total:	14.5	45.4	13.6	1,492.3
Total Emission Reductions from Retrofit Devices				
Emissions Reduced	127	408.2	5.5	0.00
% Reduction	90.0%	90.0%	29.0%	0.0%

User perspective

Comments from the school districts regarding the upgrades to the buses were:

- No problems reported by school bus drivers
- No change to performance
- No noticeable negative effect on fuel economy
- No power loss
- A noticeable reduction in visible exhaust smoke.

Other comments

There was only one minor difficulty encountered during the installation process. When the DOCs were to be installed, proper connections were missing for some of the buses. These had to be flown in from Nevada, thereby causing a delay in installation. To avoid this problem in future, buses should be inspected first, to ensure all needed parts are available before the DOC installation is to begin. It is also very important that the facilities designated to be used for installation be clearly identified in order to avoid any installation delays, though this wasn't a problem during this project.

Community outreach

On Clean Air Day 2005, 35,000 informational brochures were distributed to students in the school districts, informing parents of the school bus pilot project. The brochure also encouraged parents not to idle their cars when dropping off or picking up their children. By informing parents of what the school district and its partners were doing and why, the hope was that this would make the idea for 'idle-free' zones around the school more relevant and bring parents into the process.

Health risk background

Fine particulate matter (PM) is microscopic material that is formed from the burning of fossil fuels in cars and trucks, and from large industries. It can also be formed in the air, when other emissions combine through chemical reactions. This material hangs in the air and is a major contributor to smog.

Diesel exhaust generates a significant amount of particulate matter, which is one of the precursors of ozone (Environment Canada 2005). Diesel PM, which comes from all types of diesel engines such as trucks, buses, construction equipment, tractors and ships, is of great concern because of its non-cancer and cancer-related health impacts, in particular since so many people live around the areas where diesel engines typically operate. Diesel PM is the top cancer-causing air toxic of concern in this region (Levelton Consultants Ltd 2005). International organizations around the world have identified diesel PM as a potential carcinogen. In Canada, particulate matter under 10 microns (PM10), including diesel PM, is listed on Schedule 1 of the *Canadian Environmental Protection Act, 1999* as a toxic substance, and is also considered a suspected carcinogen (Bates et al. 2003).

No level of diesel PM is considered safe. Exposure to fine PM has been linked to increased hospital admissions for respiratory complaints, including asthma and bronchitis, emphysema and heart diseases (Environment Canada-PYR 2005). Health Canada estimates that up to 6,000 premature deaths annually can be attributed to air pollution (Health Canada 2005). In Puget Sound, diesel PM is believed to contribute as much as 70% of the cancer risk from air toxics in the Puget Sound area (Keill and Maykuk 2003).

Over the next 20 years, diesel PM will be reduced by 90% due to natural fleet turnover, and the replacement of these vehicles by more efficient ones. New emission standards for diesel engines for the model year 2007, in addition to the introduction of ultra-low sulphur diesel (15 ppm) starting in June 2006, will greatly reduce diesel PM and other toxic emissions from new diesel engines. However, since engines from older, higher-polluting diesel engines could still be on the road for the next 10 – 25 years, and existing diesel engines are quite durable and can be rebuilt several times, another approach is to start retrofitting or replacing engines now so that the benefits of cleaner air will occur sooner.

Protecting children: reducing exposure to diesel PM

Bussing children to school has proven not only to be an effective means of transport, it is also one of the statistically safest ways to move large numbers of children to and from school (U.S. Environmental Protection Agency 2005). However, as children ride on school buses, they are being exposed to diesel PM from the exhaust and this is impacting their health. The risks from exposure to diesel PM are primarily when children are in transit, and to a lesser degree during loading/unloading and at bus stops (Fitz et al. 2003). Exposure is higher when bus windows are closed and on older buses. In addition, school buses often leave their engines idling while waiting for children to get on and off, and this creates both indoor as well as outdoor air pollution. As this idling can occur for longer periods of time near schools, the emissions can be harmful for all students, as it can enter the school through air intake vents (U.S. Environmental Protection Agency 2005).

Children are more likely to suffer from the exposure to fine PM than adults. Children breathe in 50% more air per unit of body weight than do adults and their lung systems are not fully developed, making them more sensitive to the pollutants in diesel exhaust (U.S. Environmental Protection Agency 2003). Long-term exposure can reduce function and growth in the developing lungs of children, and can increase a child's lifetime cancer risk by approximately 4%, or an increase of 30 per million lifetime risk (Fitz et. al 2003). Since in Canada, approximately 2 million children ride over 30,000 school buses every day, the health risk from diesel PM exposure in children is high.

The threat to children's health from diesel PM has pushed the United States to create a school bus emissions improvement program ("Clean School Bus USA"), which is now underway in 22 states. For 2005, the program received approximately $7.5 million for a cost-shared grant program to school districts to upgrade their diesel fleets. Washington State plans to retrofit 7500 school buses with emission reducing devices. Over all, the U.S. program is using three approaches to reduce public school bus emissions: discouraging unnecessary public school bus idling; retrofitting buses that will remain in the fleet with better emission control technologies and/or fuelling them with cleaner fuels; and replacing the oldest buses in the fleet with new, less polluting buses. In Canada, efforts are also underway to improve the air quality on our school buses. To date, some school districts in BC have tested biodiesel as a cleaner fuel. As well, Natural Resources Canada is taking its proven SmartDriver program and expanding it to

school buses, through its SmartDriver for School Bus program, which will be in place in 2006 (Natural Resources Canada July 2005).

Conclusions

The retrofitting of these 29 buses has shown that installing DOCs is an effective emission reduction strategy. The project confirmed that the upgrades could be done quickly, efficiently and at low costs, with the result being significantly lower diesel PM emissions. The next step will be to expand the program into other schools districts in the Fraser Valley. With the success of this partnership, the goal is to bring in new partners, including the provincial government, to provide the technical and financial support to complete the provincial upgrade. Other initiatives underway by Environment Canada include the installation of closed crankcase filters in some buses in the Abbotsford and Chilliwack school districts, which would reduce diesel PM inside buses by 90 – 95%. These efforts to reduce school bus diesel particulate matter will reduce children's exposure to toxic chemicals and further protect their health. It will also provide clean-air benefits to communities throughout the region.

References

Bates, D., Koenig, J., and M. Brauer. May 2003. Health and Air Quality 2002-Phase 1: Methods for Estimating and Applying Relationships between Air Pollution and Health Effects. RWDI West Inc. Prepared for BC Lung Association.

Brauer, M., Brumm, J, and S. Ebelt. July 2000. Evaluation of ambient air pollution in the Lower Mainland of British Columbia: Public health impacts, spatial variability, and temporal patterns. Prepared for Vancouver-Richmond Regional Health Board.

Environment Canada. July 2005. Clean Air Online. http://www.ec.gc.ca/cleanair-airpur/

Environment Canada-PYR. July 2005. Clean Air/L'air Pur. http://www.pyr.ec.gc.ca/air/clean_air_e.htm

Fitz, D.R., Bumiller, K., Pankratz, D., Sabin, L., Behrentz, E., Winer, A.M., Colome, S. (2002). Variables Affecting Children's Exposure to Vehicle-Related Pollutants during School Bus Commutes in Los Angeles. 2002 Joint Conference of the International Society of Exposure Analysis and the International Society for Environmental Epidemiology. Vancouver, BC, August 11-15

Health Canada. April 2005. http://www.hc-sc.gc.ca/ahc-asc/media/nr-cp/2005/2005_32_e.html

Keill and Maykut, Oct. 2003. *Final Report: Puget Sound Air Toxics Evaluation*. Puget Sound Clean Air Agency.

Levelton Consultants Ltd. 2005. Air Toxics Emission Inventory and Evaluation (DRAFT REPORT). Prepared for Greater Vancouver Regional District and Environment Canada

Natural Resource Canada. July 2005. Fleetsmart. http://oee.nrcan.gc.ca/transportation/fleetsmart.cfm

Puget Sound Clean Air Agency. June 2005. Diesel Solutions: cleaner air for tomorrow, today. http://www.pscleanair.org/dieselsolutions/index.shtml

U.S. Environmental Protection Agency. June 2005. Clean School Bus USA. http://www.epa.gov/cleanschoolbus/index.htm

U.S. Environmental Protection Agency. April 2003. What you should know about diesel exhaust and school bus idling. U.S. Environmental Protection Agency. 2 pages.

U.S. Environmental Protection Agency. Health Assessment Document for Diesel Engine Exhaust. 2002. Office of Research and Development, National Center for Environmental Assessment, Washington Office, Washington, DC, EPA/600/8-90/057F