Report to the Legislature

A Pilot Project on the Use of Biodiesel with Ultra Low Sulfur Diesel in School Buses

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December 2005

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SUPERINTENDENT OF PUBLIC INSTRUCTION

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December 15, 2005

TO: Members of the Washington State Legislature

FROM: Dr. Terry Bergeson, State Superintendent of Public Instruction

RE: A Pilot Project on the use of Biodiesel in School Buses

I am submitting this report in response to RCW 28A.160.804. The Office of Superintendent of Public Instruction was required to report to the Legislature by September 1, 2005, the results of a pilot project involving the use of biodiesel with ultra low sulfur diesel in school buses. A draft version of the report was submitted at that time.

The statue required a two year pilot program to determine the impact on the diesel emissions of school buses with the use of ultra low sulfur diesel blended with biodiesel. This pilot program started with the beginning of the 2003–04 school year and continued until the end of the 2004–05 school year in June 2005.

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A Pilot Project on the Use of Biodiesel With Ultra Low Sulfur Diesel In School Buses

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Executive Summary

A two year biodiesel fuel pilot project was initiated by the legislature through House Bill 1243. The Office of Superintendent of Public Instruction (OSPI) was directed to conduct this project on the use of biodiesel with ultra low sulfur diesel.

In the 2003–04 school year, Northshore School District (King County) used ultra low sulfur diesel fuel and in the 2004–05 school year used ultra low sulfur diesel with twenty percent biodiesel added (a B20 blend). Central Valley School District (Spokane County) used a B20 blend of biodiesel and standard highway diesel (low sulfur diesel) for the duration of the two-year project.

Emission testing was performed during all phases of the pilot project. However, the pilot project did not provide the controlled environment necessary to precisely evaluate the impact of the use of a biodiesel blend on diesel emissions. Laboratory tests in controlled environments indicate a reduction in emissions with the use of a biodiesel blend and some buses demonstrated this effect. The lack of a controlled environment probably masked a similar effect in other buses. The ability to evaluate the impact of biodiesel on fuel economy also suffered from a lack of controlled environment.

It was the intent of the legislature that implementation of the pilot project would not produce a significant financial burden on participating school districts. This was accomplished with the help of the Department of Ecology (DOE) and the local clean air agencies. Both districts experienced initial increased maintenance costs in older buses as a result of frequent filter changes, and Northshore experienced advanced deterioration of hoses and lift pump failures attributed to the solvent characteristics of biodiesel. Either the fuel vendors or local clean air agencies offset all associated costs.

School districts should carefully evaluate the technical aspects of implementation prior to making a decision to move to the use of a biodiesel blend. For instance, some industry experts recommend against the use of biodiesel in pre-1992 model year vehicles. School districts wishing to use a biodiesel blend should consult the latest manufacturer's technical guidance for recommendations regarding the vehicles in their fleet. In addition, the district should consult with the manufacturer(s) of the buses in their fleet to determine any impact of various biodiesel blends on engine warranties.

Introduction

Numerous studies have concluded that school buses are significantly safer than any other mode of transportation for getting students to and from school. In particular, students are at much higher risk riding to school in private passenger vehicles. While the pupil transportation industry is proud of their safety record, the industry continually evaluates current research into all potential methods of minimizing any health risk associated with riding school buses.

Within the last few years, there have been studies that have indicated some possible increased long term health risk associated with the exposure to diesel exhaust present on diesel powered school buses. A major factor contributing to the increased risk to students riding school buses is the result of children being more sensitive to pollutants in diesel exhaust than adults. This is because children breathe more air relative to their body weight and because their lungs are not yet fully developed. While the studies have shown various levels of associated risk, the overwhelming majority of the school bus industry in general, and in Washington State in particular, has taken the approach that any risk should be reduced to the greatest extent possible.

Although stringent standards established by the U.S. Environmental Protection Agency for new diesel engines will take effect with the 2007 model year, a significant majority of older diesel-powered school buses now in use in Washington State will continue to be used for many years beyond that date. The 2003 legislature passed a law establishing and funding a voluntary program to reduce air pollution from existing diesel school buses. The legislation, Engrossed Substitute Senate Bill 6072, provides approximately $5 million annually, for five years, primarily to provide for the retrofit of exhaust emission control devices on existing diesel school buses. The Washington State Department of Ecology (DOE) has overseen this effort to retrofit existing school buses with diesel oxidation catalysts (DOCs) and is starting to retrofit buses with closed crankcase ventilation filters. This program has resulted in significant reductions in diesel emissions from school buses.

Engrossed Substitute House Bill 1243 was also passed during the 2003 legislative session, establishing a pilot program for the use of biodiesel in school buses. Biodiesel is a clear amber-yellow liquid made from renewable resources such as vegetable oils or animal fats with a viscosity similar to petroleum diesel. After processing, unlike straight vegetable oil, biodiesel has combustion properties very similar to those of petroleum diesel, and can replace it in most current uses. The industry standard nomenclature for biodiesel blends uses a system for labeling the blend by the percentage of biodiesel. For example, the 20 percent biodiesel blend used in this pilot program is referred to as B20.

Biodiesel is one of the possible candidates to replace a portion of the demand for fossil fuels as the world's primary transport energy source. It has the benefit of being a renewable fuel that can replace petroleum diesel in current engines without significant engine modification. Biodiesel also can be transported and sold using today's infrastructure. Biodiesel use and production is increasing rapidly, though in all markets it still makes up a small percentage of fuel sold. A growing number of fuel stations are making biodiesel available to consumers, and a growing number of large transport fleets use some proportion of biodiesel in their fuel.

Unlike petroleum diesel, biodiesel is biodegradable and non-toxic, and it significantly reduces toxic and other emissions when burned as a fuel, as compared to petroleum diesel. As a result of these characteristics, it is predicted that the use of biodiesel in place of, or blended with, petroleum diesel should reduce school children's exposure levels to carbon monoxide, hydrocarbon particulates, and air toxins while riding on school buses or during the loading and unloading process.

An additional concern with biodiesel is that the characteristics of the fuel vary significantly depending on the source product used. For instance, biodiesel produced from new soy based oil has different characteristics from biodiesel produced from used cooking oil that includes animal fats. The end user should verify the source product of the biodiesel and determine if the fuel characteristics are appropriate for use in pupil transportation.

Ultra low sulfur diesel fuel (ULSD) is a relatively new product. The production process for ultra low sulfur diesel fuel is similar to standard highway petroleum diesel. However, the elimination of the additional sulfur results in a loss of lubricity. The ultra low sulfur diesel used in this study had lubricating agents added at the refinery to offset this loss. ULSD's availability increased during the study period as manufacturers transition to the mandatory production of ultra low sulfur diesel fuel effective June 1, 2006. Although biodiesel and ultra low sulfur diesel availability is on the increase, there are still regions where these fuels are not readily available at the date of this report.

Project Overview

Northshore and Central Valley School Districts volunteered to participate in the pilot program and selected school buses to use the fuels as outlined by HB 1243. The Office of Superintendent of Public Instruction and Regional Transportation Coordinators facilitated the pilot program. Northshore School District participated with 30 out of 133 buses and Central Valley School District completed the program with the entire fleet of 75 buses. Not included in this report are various other school districts such as Kent, Sedro-Woolley, and Everett (pupil transportation contracted through Durham School Services) that were voluntarily using ultra low sulfur diesel or biodiesel fuels within the time period of the project. A close working relationship was developed between the Office of Superintendent of Public Instruction, the Department of Ecology, Puget Sound Clean Air Authority, Spokane County Air Pollution Control Authority, and Spokane County Conservation District.

OSPI found that several school districts were using alternative fuels (including ultra low sulfur diesel and biodiesel blends) prior to the passage of HB 1243. In fact, at least one district was not eligible to participate in the pilot project due to their inability to establish a baseline of emissions, because their fleet was already using ultra low sulfur diesel.

The U.S. Environmental Protection Agency has placed a high priority upon reducing children's exposure to diesel emissions. In 2003, the Washington State legislature passed Engrossed Substitute Bill (ESSB) 6072 to fund development of the “Washington State Clean School Bus Program.” The Department of Ecology and seven local air quality agencies are working together to install emissions control technology on the existing school bus fleet. These retrofit technologies reduce 30 percent to 90 percent of the fine particles, and 70 percent to 95 percent of the toxic emissions. The Washington Clean School Bus Program provided funds to offset the cost differential between B20 and highway diesel fuel.

The biodiesel pilot project was intended to provide cleaner fuels that help reduce children's exposure to toxic emissions and fine particles. The “clean fuels” provided included ultra-low sulfur diesel (ULSD) fuel as well as a B20 blend made up of 20 percent biodiesel and 80 percent low sulfur diesel. ULSD contains15 parts per million sulfur content compared to standard highway diesel fuel that contains up to 500 parts per millions sulfur content. Both ULSD and B20 help to reduce toxic emissions.

The Products

Neither district was involved in the blending process of biodiesel with petroleum diesel. Northshore School District used ultra low sulfur fuel for the first year of the pilot program and a B20 biodiesel - ultra low sulfur diesel blend for the second year of the pilot program. Central Valley used a B20 biodiesel - low sulfur diesel blend for the entire two years of the pilot program. Both Central Valley and Northshore were able to purchase the biodiesel fuel blends at their fuel supplier's local facility.

In Central Valley School District, there was an incident in the winter of the second year with contamination of the biodiesel. Upon investigation, it turned out that the biodiesel was transported from the Mid-West in a contaminated rail car. This contamination resulted in the district having to change the fuel filters on all buses that were using biodiesel, at a cost of approximately $3,000. This cost was picked up by the supplier.

There were no significant cold weather operating incidents in either school district. Fuel suppliers did not modify normal winter petroleum diesel blending procedures during the pilot program (suppliers normally modify the blend of highway diesel during the year as temperatures vary). It is worth noting that during a winter power failure in Central Valley, the district lost the use of engine pre-heaters. This resulted in all buses being difficult to start. The buses that were using B20 blend were reported to start similar to those buses that were using standard highway diesel fuel.

The Equipment

There were several incidences of component degradation on older vehicles equipped with natural rubber components. This is typical during the conversion process to biodiesel, especially in those engines manufactured prior to 1992. This is attributed to the higher solvent properties of biodiesel compared to standard highway diesel. At the beginning of the study, mechanical issues were so prevalent on school buses with GM brand 6.5 liter diesel engines that Northshore suspended the use of biodiesel for a period of time. Vehicles were experiencing power loss and engine failure, which threatened to compromise the safety of students. It was discovered that the engines were shutting down because the fuel pump module sensors were affected by the color of the biodiesel blend. Replacement of the sensors provided a solution that let these buses continue with the pilot project.

One of the costly effects of the transition to the use of biodiesel was the plugging of fuel filters. Typical experience during the test was filters plugging at between 500 miles and 1,000 miles. Currently both districts are on a yearly fuel filter change schedule and have not had to deviate from their schedule except where there have been specific problems with the degraded fuel components. After an initial period of system cleansing (as a result of the solvent nature of biodiesel), and after natural rubber hoses were replaced with synthetic, the school districts were able to return to a more normal cycle of fuel filter replacement. There were no warranty issues reported by either school district due to the use of biodiesel fuel during the test period. Some industry experts recommend against the use of biodiesel in older vehicles to avoid these issues.

The above mentioned clogging of filters resulted in additional on-road service calls. The costs associated with these additional service calls and shop time are difficult to evaluate and the school districts involved did not attempt to be reimbursed for the associated costs.

More serious from a safety perspective is the incident reported by Northshore School District (see Addendum: Email from Northshore School District), on January 11, 2005, where a school bus stalled on railroad tracks in Woodinville. Fortunately, the tracks are not used frequently. The shop was able to respond to the incident and push the bus to a safe location prior to rail traffic. This incident clearly shows the risks involved with a pilot project of this nature. Incidences of loss of steering and brakes also were observed (as a result of loss of engine power), along with buses having engines stalling while on the freeway.

Emission Reduction

The Department of Ecology conducted exhaust opacity-based (SAE J1667 test) inspections on all of the pilot study school buses for the 2003–2004 and 2004–2005 school years. The J1667 test is the industry standard emissions test for diesel vehicles for inspection and maintenance programs. Because the J1667 test is designed to identify gross emitters, the test is a poor predictor of driving cycle particulate emissions. While this test is not the ideal test for measuring fine particulate matter (PM) emission, studies have shown a relationship between opacity and high PM emitters. EPA has determined that using either biodiesel or biodiesel in combination with ULSD can provide a six to ten percent reduction in fine particle emissions.

However, the generation of emissions by engines is subject to a large number of interacting variables. For instance, work load and hours of use will significantly impact engine operating temperature, resulting in variation in emission generation. The Department of Ecology analyzed the opacity emission test results and indicated that the results are in line with the expected level of emission reduction.

Fuel Economy

In response to RCW 28A.160.804 (2)(d), the school districts involved attempted to track fuel economy. Central Valley reported a slight increase in fuel economy of approximately 1.5 miles per gallon across the test fleet. Northshore did not report a change in fuel economy.

This study did not provide for laboratory controls during the pilot project. This lack of control is particularly evident in the measurement of fuel economy. Fuel economy is subject to many interacting effects: driver behavior, temperature, and work load cycle to name just a few. The inability of the pilot project to isolate the cause of change in fuel economy (or the lack thereof) should be kept in mind when evaluating the results reported. The use of laboratory controlled tests would be more appropriate when attempting to evaluate the impact of biodiesel on fuel economy.

It should be noted that during the pilot project time period, the Department of Ecology and the Office of Superintendent of Public Instruction, in association with the various clean air agencies, put particular emphasis on the reduction of idling time for school buses. This is an important effort that reduces diesel emissions in school loading zones, where there are large numbers of diesel powered school buses and large numbers of students. The minimizing of engine idle time can have a significant impact on the amount of exposure to diesel exhaust pollutants by students. The additional benefit of reducing idle time is to increase the fuel economy for these buses. With this effort taking place simultaneously with the biodiesel pilot project, the impact of biodiesel on the fuel economy of these school buses is not possible to accurately evaluate.

Findings and Conclusions

OSPI found that school districts, in general, were very interested in any mechanism to reduce school bus emissions when available at reasonable cost and with no reduction in safety for students.

One of the pilot project objectives was to investigate the ability of biodiesel to provide the lubricity lost by the elimination of sulfur in ultra low sulfur diesel. The project was unable to evaluate this as a result of the refinery adding lubricants to ultra low sulfur diesel prior to delivery.

Another aspect of the pilot project was to evaluate potential fuel savings by the use of biodiesel. Unfortunately, the project was unable to clearly evaluate the fuel economy of the pilot project school buses due to the lack of the laboratory conditions necessary to clearly demonstrate this effect.

Generally, the biodiesel industry does not recommend the use of biodiesel in older vehicles. If a school district is interested in using a biodiesel blend, it should attempt to provide a separate fueling process (using petroleum diesel) for the older buses in the fleet. If a separate fueling system is not feasible, the district should carefully consider the cost impact of additional fuel filters, hose and pump replacement, and possible associated service calls and shop costs due to the use of biodiesel in older vehicles.

Several districts have investigated the use of biodiesel unassociated with the pilot project. As the project progressed, biodiesel became more widely available in the marketplace. Incentive programs could provide additional motivation for districts to continue to investigate the use of biodiesel blends.

There is significant variation in biodiesel fuels that are a result of the product used to manufacture the fuel. Additional industry standardization would provide assurance to end users.

Given the occurrence of the detrimental effects of biodiesel blended fuels during the pilot project, OSPI has concerns that this could have resulted in putting students at unnecessary risk. The incidents of brake system malfunction and loss of steering (as a result of engine dying) are worrisome. The most serious issue was the one incident where a Northshore bus stalled on railroad tracks. It is important to remember that the passengers on these vehicles represent the state's most precious cargo. OSPI recommends that future pilot programs of this nature be conducted on equipment other than school buses.

Addendum 1
Text of RCW 28A.160.800 - 28A.160.806

RCW 28A.160.800 Biodiesel fuel pilot project -- Findings. (Expires September 1, 2005.) The legislature recognizes that:

(1) The use of motor vehicles has a significant impact on the environment and public health of the state of Washington. Motor vehicles account for more than half of all air pollutants, almost sixty percent of total carbon dioxide emissions, and a significant portion of toxic contaminants in Washington state;

(2) Diesel exhaust, in particular, is likely to cause lung cancer in humans, chronic and acute bronchitis, asthma attacks, and respiratory illnesses. Children are particularly at risk. One out of every ten children in our state suffers from asthma. Over four hundred thousand students in the state risk their health breathing exhaust from riding diesel-powered buses to school every day;

(3) Although stringent standards established by the United States environmental protection agency for new diesel engine technology will take effect with the 2007 model year, a significant majority of diesel-powered school buses now in use in the state will continue to be used for the next thirteen or more years;

(4) Using biodiesel in place of, or blended with, petroleum diesel reduces emissions of carbon monoxide, hydrocarbon, particulates, and air toxics from new or existing diesel engines;

(5) Using ultra low sulfur diesel, along with after-market emissions control devices, significantly reduces fine-particle, hydrocarbon, and nitrogen oxide emissions from existing diesel engines;

(6) The United States environmental protection agency's new emission standards requiring the use of ultra low sulfur diesel take effect June 1, 2006, and ultra low sulfur diesel requires the addition of a lubricant to counteract premature wear of injection pumps;

(7) Biodiesel provides the needed lubricity to ultra low sulfur diesel, in addition to reducing harmful emissions;

(8) It is the intent of the legislature to study the effects of using ultra low sulfur diesel with biodiesel.

RCW 28A.160.802 Biodiesel fuel pilot project -- Intent. (Expires September 1, 2005.) It is the intent of the legislature that implementation of this pilot project will not produce a significant financial burden on participating school districts or the state. The legislature calls upon the superintendent of public instruction, the office of community, trade, and economic development, and the department of ecology to explore alternative means of funding this pilot project including the use of state or federal grants but excluding the use of money from the state general fund. In the event of the inability of the participating school districts to fund this project, either from their own operating budget, grants, or other local funding or a combination thereof, the implementation of chapter 64, Laws of 2003 shall be dependent on securing funds that are not from the state general fund.

RCW 28A.160.804 Biodiesel fuel pilot project -- Report. (Expires September 1, 2005.) The superintendent of public instruction shall conduct a pilot project on the use of biodiesel with ultra low sulfur diesel in school buses powered by compression-ignition engines. The pilot project must begin in September of 2003.

(1) The superintendent of public instruction shall select two school districts to participate in the project. School districts located in a geographic area listed by the environmental protection agency as an area of concern for pollution emissions must receive first consideration for the project.

(2) The pilot project shall meet the following requirements:

(a) During the 2003 school year, at least one of the participating school districts shall have at least twenty-five percent of the school bus fleet, or a total of not less than ten buses, fueled with ultra low sulfur diesel. Emissions testing must be conducted before using ultra low sulfur diesel, and again after ultra low sulfur diesel has been in use for at least six months.

(b) During the 2004 school year, not less than seventy percent, or a total of not less than seven, of the buses fueled with ultra low sulfur diesel during the 2003 school year must be fueled with a blend of eighty percent ultra low sulfur diesel, by volume, and twenty percent biodiesel, by volume. Emissions testing must be conducted not less than six months after adding biodiesel to the ultra low sulfur diesel.

(c) A maximum of one of the participating school districts may, for the duration of the project, use a blend of twenty percent biodiesel, by volume, with eighty percent highway diesel, by volume, in at least seventy-five percent of the school bus fleet, or a total of not less than ten buses. Emissions testing must be conducted before use of the biodiesel blend, again not less than six months after the biodiesel blend has been is use, and again at the conclusion of the project.

(d) Issues related to the maintenance, including but not limited to fuel economy, changes in fuel filters, and other maintenance issues related to the use of ultra low sulfur diesel and biodiesel must be recorded.

(3) The superintendent of public instruction shall submit a report of findings to the legislature by September 1, 2005.

RCW 28A.160.806 Biodiesel fuel pilot project -- Definitions. (Expires September 1, 2005.) The definitions in this section apply throughout RCW 28A.160.800 and 28A.160.804 unless the context clearly requires otherwise.

(1) "Biodiesel" means a mono alkyl ester of long chain fatty acids derived from vegetable oils or animal fats for use in compression-ignition engines and that meets the requirements of the American society of testing and materials specification D 6751 in effect as of January 1, 2003.

(2) "Ultra low sulfur diesel" means petroleum diesel in which the sulfur content is not more than thirty parts per million.

(3) "Highway diesel" means petroleum diesel in which the sulfur content is not more than five hundred parts per million.

Addendum 2
Post Project District Questionnaire and Responses

A. PRODUCT

1. Were you involved in the blending process? If so, what were the blending issues such as equipment needed, time involved, etc.?

Central Valley: We did not have any involvement in the blending of the fuel.

Northshore: No (we were not involved).

2. What type of fuel were you blending: ultra low sulfur 15 ppm, or low 500 ppm?

Central Valley: Currently we are using a low sulfur blend.

Northshore: NA (used ultra low sulfur diesel, but did not blend ourselves).

3. How readily available was biodiesel or blend? Describe delivery and supply issues.

Central Valley: Our supplier has not seemed to have any problems obtaining the 100% Bio product. It comes into Kalispell Montana and then is transported by tote to their site in the Spokane Valley.

Northshore: Biodiesel and ultra low sulfur were very available. No issues with arranging supply or delivery.

4. Did you have contamination problems? If so, please describe your process and cost to remedy the situation(s).

Central Valley: There were some issues last winter with contamination of the biodiesel due to a contaminated rail car that came from the Midwest. We had to change all of the fuel filters on all buses that were on B20 at the time. The cost was approx. $3,000 (that cost was paid by City Service Valcon, our supplier).

Northshore: No contamination problems.

5. What was the cost differential between B20 and your standard fuel?

Central Valley: The cost has been consistently $.20 higher.

Northshore: Cost differential between B20 and ULSD ranged between $.40 and $.60 per gallon.

6. Identify any cold weather affects on the B20 blend.

Central Valley: Other than the contamination problem that we had last winter, there have been no significant cold weather problems so far. We did have a problem the first year with buses that wouldn't start on one very cold morning but that was more due to the fact that the power had been off and the engine heaters were not on.

Northshore: None.

7. What is your standard cold weather blend?

Central Valley: Not known.

Northshore: No change to the standard product.

8. Identify any effect on your standard cold weather blend.

Central Valley: Not known.

Northshore: None.

9. Describe the winter temperatures during the project (2003–2005).

Central Valley: The temperature might have been down as low as –20 degrees but that was only for a night or two.

Northshore: Temperatures ranged from 30 degrees F to 50 degrees F with occasional dips into the 20's or below at nights for short periods of time.

B. EQUIPMENT

1. Identify specific effects of biodiesel blend on bus equipment. For example: rubber components, pumps, and ejectors.

Central Valley: We have had some problems with the rubber components on the buses degraded by the biodiesel fuel (i.e., rubber fuel return lines, lift pumps, etc.)

Northshore: We had experienced the deterioration of some of the older buses' suction and return fuel hoses and replaced them with Teflon hoses.

2. Identify any increase or decrease in need for fuel filter change on vehicles. Include number of vehicles, and filter changes in mileage increase/decrease.

Central Valley: We are on a yearly fuel filter change schedule and have not had to deviate from our schedule except where there have been specific problems with the degraded fuel return lines.

Northshore: One of the most costly effects of the biodiesel was the plugging of the filters. Not all the buses were affected equally, some plugged at 1,000 miles, some every 500 miles, and some we just changed at their regular intervals. We began the year with all of our buses on biodiesel. At first the problem was so prevalent we suspended the test because the GM 6.5 diesels were shutting down the engines because they were reading the color of the fuel. We brought the test back after three months with just 30 buses.

3. How many vehicles had DOCs or particulate traps?

Central Valley: None.

Northshore: Eleven factory DOC mufflers out of the thirty test buses.

4. Describe specific effect biodiesel had on DOCs or particulate traps.

Central Valley: NA.

Northshore: No effect.

5. Provide pre and post emission data.

Central Valley: Provided to Department of Ecology.

Northshore: Provided to Department of Ecology.

6. Identify any warranty issues.

Central Valley: We have not had any warranty issues at this time.

Northshore: Most engine manufactures don't have enough data on B20 and, therefore, will not warranty any problems attributed to B20. However, B5 is acceptable to some.

7. Any equipment failure or operation issues observed or reported?

Central Valley: The only failures to this point have been the return lines and the fuel lift rubber diaphragms in the lift pumps.

Northshore: The GM 6.5 diesel engine's driver modules sense the color of fuel. We had three buses that would stall or die at any time because of this. The only repair was to replace the sensing module. Many plugged filters and two electric fuel transfer pumps.

8. What was the effect on fuel economy?

Central Valley: We have had a slight increase in mileage, approx. 1.5 mpg.

Northshore: Fuel economy was the same.

9. Did you experience any problems with the fuel dispensers or filters?

Central Valley: City Service Valcon (the supplier) had to install an inline filter on their fuel pumps.

Northshore: No. We changed our filters from 10 microns to 25 microns, at the advice of the fuel distributor.

Addendum 3
Northshore School District Email

Email Message from Jeff Rembold, Northshore School District, Transportation Shop Supervisor to Tom Hudson of the Puget Sound Clean Air Agency.

From: Jeff Rembold
Sent: Friday, March 04, 2005 8:00 AM
To: Tom Hudson
Subject: Effects of biodiesel

Dear Tom,

I will try to give you a summary of what our buses have been experiencing since we started running biodiesel on 9/1/04.
There are several other complaints (work orders) from our bus drivers that are similar to the ones I have listed in this e-mail, but left out because of too many duplications.
We didn't experience any problems until our tenth day of running the whole district on biodiesel, it only seemed to effect our smaller b-buses with GM 6.5 engines ranging in years from 1991 to 2002.
The symptoms were, would not run cold (stay idling) and engine would die hot or cold without warning, maybe once a day or more, when this would happen the bus would lose power steering and brakes, the bus would always restart and drive back to the shop whether we drove it or the driver did.
The first thing we in the shop would do is inspect and change the fuel filter regardless because were told that biodiesel worked as a cleaning solvent and would plug any of the filters with any sediment in the fuel tanks.
After changing the filters we would always test drive the bus as much as time would allow us and return the bus to service with no problems, then some of those same buses would act up again the next day or maybe two days later and we would repeat the same repair procedures thinking we would eventually clean the system with filter changing.
Some drivers would experience just a quick drop in idle and some would just have their engines die but wouldn't report it to anybody because it wouldn't repeat that same action for a week or so.

Vehicle problems Northshore School district has experienced since using Biodiesel in Chronological order:

9/20/04 B-34 1997 GM 6.5
Died four times when letting off the throttle, she lost steering and brakes every time, on the fourth time the driver refused to drive the bus because of the safety factor. We exchanged the bus with another bus and a mechanic drove the bus back with no problems.
We checked out the entire fuel system, changed the fuel filter (looked okay) then test drove and returned to service.

9/20/04 B-43 2002 GM 6.5
The electric lift pump failed, we opened the access hole to the fuel tank because of the debris that came out of the pump and we found the fuel to be very cloudy and a rusty sludge at the bottom of the tank. We drained and cleaned the fuel tank, blew all the suction/return lines out, replaced the electric fuel pump and filter, test drove the bus and returned to service.
I also took a sample of fuel from both of our in ground tanks and sent them to Rainer Petroleum to have them analyzed for contaminates, they came back negative. Test drove bus and returned to service.

9/22/04 B-24 2002 GM 6.5
While on route the engine shut down for no reason five miles from the shop. When we brought her another bus the mechanic started the bus up and drove it back to the shop with no problems.
We checked and changed the fuel filter, (very clean) and hooked up our engine diagnostic scanner which read no codes. Test drove bus for a very long drive through all types of terrain, “ran great” returned back to service.

9/23/04 B-24 2002 GM 6.5
The bus died three times before ever leaving the bus compound, she was told to take another bus. I personally drove the bus six to ten miles without a single problem. I downed this bus for further studies!

9/23/04 #610 1990 E-350 Warehouse van 7.3 Diesel
Service call to our warehouse for no start situation, I sent two mechanics they reported that the engine would turn over but would not start, but it sounded like it was metal to metal. I suggested that the noise was a fuel knocking sound so the fuel system was bled. After a long period of cranking, it finally started. The van made it to the shop and would not start again. We pulled both fuel filters and found what looked like crystals plugged solid. Bled fuel system with new filters installed. Test drove van and returned to service.

9/23/04
I made the decision to return to ultra low sulfur diesel until we find an answer for all the problems that have occurred on biodiesel.

9/24/04 B-24 2002 GM 6.5
Died one hour forty-five minutes into first run, but restarted.

9/27/04 B-24 2002 GM 6.5
Bus fluttered but never died.

9/28/04 B-24 2002 GM 6.5
Bus fluttered after fueling, seemed to have lost power, but never died.

9/29/04 B-24 2002 GM 6.5
Died two times in the morning, first time this bus died under acceleration. Died two times on the freeway, pulled off to the side, waited three minutes then restarted, got back to shop performed a fuel pressure test, found very low lift pump pressure and sediment in the electric lift pump. Replaced lift pump, test drove, returned to service.

9/30/04
Since switching from the biodiesel, the stalling problem has almost cleared up. However, now the 1995-2002 GM 6.5 B-Buses that were stalling are now setting the "Check engine" light, have a loss of power and the engine flutters sometimes. We have them pull over to a safe location, turn off the bus for three minutes and then restart. This cures the problem 90% of the time till the next time it happens, which could be immediately or up to five days. Our scanner always came up with the same code "Crank Sensor" or "Cam Sensor". We tried changing the sensors and clearing the codes, but always came back with the same symptoms. I contacted our GMC/Workhorse dealer but seemed to get the runaround about using biodiesel. They told me it was not an approved fuel by GM and it would void warranty if it was the cause of the problem, so I asked them to show it to me in writing but they never could.
Even though these buses were under warranty, I didn't want to take the chance of absorbing any costs that I wasn't sure was due to biodiesel.

10/1/04 B-43 2002 GM 6.5
Was taken to Husky GMC for excessive engine noise and loss of power when "Check Engine" light comes on. We left it with them for two weeks and they could not duplicate the problem. Husky returned the bus, we test drove the bus and returned to service.

10/7/04 B-24 2002 GM 6.5
We recently preformed an experiment on this bus which was still dying at will (no engine codes or loss of power). I purchased a stanadyne driver module that bolts to the injector pump. (I had B-22 with the same symptoms the previous year and Husky GMC replaced this same part) This module is what runs the stanadyne electronic fuel injection pump, it senses several sensors, one of them being an optical eye sensor that reads the color of fuel. Biodiesel is a more clear

fuel compared to ultra low or regular low sulfur diesel. Our fuel pump rebuild vendor suspected this was the cause of stalling and loss of power when we switched to Biodiesel. We have not had a single problem with stalling since we installed this module. We also installed two more driver modules in two other buses that were experiencing the same symptoms, it repaired the problem.

1/3/05
I decided to go back to the biodiesel on thirty selected buses because all of the stalling and loss of power problems had disappeared with the changing of diesel or with the replacement of modules.

1/11/05 T-1 1991 8.3 Cummins Engine
Service call. Bus engine lost power and died on rail road tracks at N.E. 195th St. in Woodinville. Sent two mechanics who pushed the bus to a safe location. Bus acted as if it was out of fuel even though it had a full tank. We cracked a couple of injectors and hand primed the fuel system, finally got the bus started but it would not go over 40 MPH with half throttle. If you pushed the throttle to the floor the engine would die. Made it back to the shop. We pulled the fuel filters, one had a black residue the other one looked okay. Then we removed the two rubber suction fuel lines from the tank and found the inner rubber of the hoses had deteriorated and swelled up, restricting fuel flow. Replaced the hoses, fuel filters and lift pump because it was plugged with rubber particles. Test drove “ran great” and returned to service.

1/13/05 B-32 1997 GM 6.5
Service call to Woodinville. Bus would not start. Sent one mechanic who reported that the battery was very low. Tried jump starting but the engine would not crank. The mechanic came back to the shop to exchange the 4D battery and returned to the bus. The bus cranked faster but the engine had a noise of metal to metal. He checked the fuel filter because of possible fuel knock and found a rusty sludge substance. He replaced the filter and the bus started. Drove back to the shop, inspected the inside of the fuel tank and found rust, sludge and fuel was very cloudy. Drained and cleaned fuel tank. Changed filter again, blew out all fuel lines going from the tank to the filter and poured in clean biodiesel. Test drove great with no noise bus after ten miles the engine started to miss slightly and thumped through the intake. It sounded like a collapsed lifter. Preformed a compression test. Found one cylinder 200 psi lower from the rest, pulled head and found two cracked pistons and very deep scratches in several cylinders. Pulled engine and replaced with a remanufactured one on our shelf. Bus had 154,939 miles at the time of engine failure.

1/21/05 T-2 1991 Cummins 8.3
Bus had low power and was acting like it was starving for fuel. I had the driver return the bus to the shop at half throttle because full throttle would make the engine die. First we pulled the fuel filters and found rubber particles. Then we pulled the fuel hoses from the tank to the racor filter and from the racor to the

copper line on the frame and found them deteriorating and swelling inside. Replaced hoses and filters. Test drove bus and returned to service.

2/7/05 T-4 1994 Cummins 8.3
Driver wrote up a work order complaining of low power and hard starting. We changed both fuel filters not seeing any visible sediment. Cured problem. Test drove bus and returned to service.

2/8/05 T-3 / T-45 / T-1 All 1991 Cummins 8.3
Drivers all wrote up work orders complaining of low power, sporadic engine stall and hard starting. After confirming complaints we looked at history of repairs and changed fuel filters. Test drove bus and returned to service.

Biodiesel has worked fine on the majority of our buses, however the problems we have experience seem to possibly be because biodiesel works as a cleaning solvent and deteriorates the older fuel hoses, it also breaks loose any sediment in the fuel tanks, resulting in low power, hard starting, and stalling.
Some of the GM 6.5 diesels with electronic fuel pumps have been effected the most, it seems to play havoc with a fuel pump module (as mentioned earlier in this email) that senses the color of fuel through another sensor, resulting in engine shut down, stalling, and fluttering. The only cure we have found is to replace the module.
Engines in buses that did well with biodiesel were 1998 to 2003 with 3126 Caterpillars, 2000 5.9 Cummins, and 2003 7.3 powerstroke Fords. My opinion of why these buses were not effected is because they have newer fuel hoses which are resistant to biodiesel and the fuel tanks being newer probably have less sediment in them.
We have four months left of running biodiesel, I will continue taking notes and complete this report in June.

Here is a list of most of the expenses we have absorbed:
Excluded is labor and fuel sampling.

10,	FS1295 Fuel Filters	$10.16	ea.=$101.60
5,	2040 Fuel Filters	$7.21	ea.=$36.05
5,	FF5052 Fuel Filters	$4.75	ea.=$23.75
3,	BF856 Fuel Filters	$8.90	ea.=$26.70
2,	Elec. Lift fuel pumps	$75.35	ea.=$150.70
3,	Stanadyne fuel module	$252.97	ea.=$758.91
1,	8.3 Lift pump	$159.26	ea.=$159.26

Sincerely
Jeff Rembold