Wissahickon School District

Diesel Retrofit/Clean Air Initiative

1. Overview

> "The fine particles in diesel exhaust (known as particulate matter) can penetrate deep into the lungs and pose serious health risks including aggravated asthma, lung damage, and other serious health problems. In addition, diesel exhaust is a likely human carcinogen. Children are more susceptible to air pollution than healthy adults because their respiratory systems are still developing and they have a faster breathing rate." Source – United States Environmental Protection Agency

In August 2002, the Wissahickon School District located in Montgomery County, Pennsylvania approximately twenty-five miles north of Philadelphia embarked on a diesel retrofit and clean air initiative for its school bus fleet. The school district is 23 square miles in size and serves 4,600 students in seven public schools. The district also transports students to 125 non-public schools. The diesel fleet consists of 75 school buses logging over 900,000 miles a year.

The initiative was funded by a $250,000.00 grant from The Pennsylvania Department of Environmental Protection in partnership with the U.S. Environmental Protection Agency and the 3M Corporation. The project entailed converting the diesel fuel supply to ultra-low sulfur diesel fuel (ULSD) and installing retrofit technology on 41 of the school district's 75 vehicle diesel bus fleet.

The goal of this pilot project was to determine the effectiveness of the retrofit technology and ultra-low sulfur diesel fuel on a suburban school bus fleet in a temperate climate.

2. Project Implementation - Fuel

In March 2002, the school district solicited bids for a two-year contract to supply ultra-low sulfur diesel fuel. The product specifications used for this bid are set forth in Appendix A. The district received one bid from Sprague Energy of White Plains, NY at a bid price of the January 2003 NYMEX future settle price for No. 2 heating oil plus a differential of $0.2440. The contract was awarded on August 27, 2002 at a contract price of $1.0197 per gallon. The award price was a $0.2184 per gallon premium over conventional low sulfur diesel by bid the Montgomery County School Purchasing Consortium.

To transition the new fuel, the school district depleted the current fuel supply in its 15,000 gallon fuel tank to a level of about 400 gallons and then commenced deliveries of the ULSD fuel. The fuel conversion was without incident; no issues surfaced regarding vehicle performance, product lubricity, or maintenance.

In June 2004, the school district solicited bids on behalf of the Wissahickon and North Penn School Districts for a one or two-year contract to supply 315,000 gallons annually of ULSD fuel. Again, the district received one bid from Sprague Energy of White Plains, NY at a bid price of

the January 2005 NYMEX future settle price for No. 2 heating oil plus a differential of $0.2556. A one-year contract was awarded on June 21, 2004 at a contract price of $1.3138 per gallon. The award price was a $0.2507 per gallon premium over conventional diesel again by bid the Montgomery County School Purchasing Consortium. By comparison, the ULSD fuel cost differential in the State of Washington at this time was approximately $0.06 per gallon.

Delivery and limited competition appear to be the continuing challenges with the procurement of this product. Ultra-low sulfur diesel fuel is produced regionally by the Sun Oil and Conoco-Phillips refineries. Both firms expressed interest in participating with the 2004 bid through the use of third-party delivery. However, the Conoco-Phillips contractor could only commit to a fluctuating price and Sun Oil could not guarantee a delivery truck dedicated solely to ultra-low sulfur diesel fuel as specified to ensure product integrity.

3. Project Implementation – Retrofit Technology

Upon review of the fleet composition by the district and grant partners it was determined to install 31 diesel particulate filters, a ceramic device that collects the particulate matter (PM) in the exhaust stream and allows the particles to breakdown into less harmful components, and 14 oxidation catalyst filters as the major and minor retrofits technologies, respectively. According to EPA estimates, the combination of diesel particulate filters and ULSD can reduce emissions of PM, hydrocarbons, and carbon monoxide by 60 to 90 percent.

Bids for emission control devices were solicited in November 2002. Product specifications were developed in large part by the Environmental Protection Agency. The district received bid responses from Cummins Power Systems and Lubrizol/Engine Control Systems. The bid results are set forth below.

	Major Retrofit for 31 Vehicles	**Minor Retrofit for 14 Vehicles**	**TOTAL**
Lubrizol/Engine Control Systems Newmarket, Ontario	**$ 133,864.19**	**$ 10,822.56**	**$ 144,686.75**
Cummins Power Systems, Inc. Bristol, PA	$ 269,293.75	$ 29,568.00	$ 298,861.75

Diesel particulate filters were initially installed on 6 buses with 8.3 liter Cummins engines, 20 buses with Cummins 5.9 liter engines and 1 bus with a DT466 International engine. Oxidation catalysts were installed on 6 buses with 8.3 liter and 8 buses with 5.9 Cummins engines. Vehicles installations are detailed on Appendix B.

Lubrizol technicians with assistance from the school district fleet maintenance staff installed the retrofit equipment and back pressure monitors with installation time ranging from two to four hours per vehicle. Temperature data logging from sample vehicles occurred prior to retrofit installation.

There were early indications that the Cummins 8.3 liter engines were not achieving the temperature goal of 325°C for 25% of the duty cycle needed for the particulate filters to regenerate, or self-clean. These engines were from the 1990 and 1991 model years, just prior to the introduction of a cleaner burning engine. The filters on these buses would begin to clog up within 30 days of use.

Lubrizol conducted additional temperature data logging on these units after insulating blankets were installed on the vehicles manifolds. The blankets failed to provide enough additional temperature for filter regeneration and they continued to prematurely clog. Eventually, the filters were removed from all vehicles with Cummins 8.3 liter engines.

No problems surfaced with the particulate filters installed on the Cummins 5.9 liter or International DT466 engines. The oxidation catalysts also performed problem free.

Vehicle drivers have observed a slight power loss when the particulate filters need to be cleaned. This usually occurs in about six to twelve months depending on the miles driven and the age of the bus. The school district purchased a particulate filter cleaning station to provide a more thorough cleaning of the filters. It takes about eight hours to regenerate and clean a filter. Changing the particulate filters takes about an extra fifteen minutes when servicing a bus.

There has been no noticeable change in fuel consumption on the retrofit vehicles. We experienced both slight increases and decreases in fuel use which can be attributed to other factors such as length of the bus run and individual driving style.

4. Goals

The goal to determine the effectiveness of the retrofit equipment and ultra-low sulfur diesel fuel on a suburban school bus fleet was achieved with great success. The transition to the ULSD fuel was seamless and the retrofit technology, with the exception of one engine size for limited model years, operated as anticipated with no adverse vehicle performance.

The project has been received with enthusiasm by our students, parents and other stakeholders. Community members have commented on the absence of black soot being emitted from our school buses noticeably separates our fleet from other similar diesel powered vehicles.

Estimates provided by the Environmental Protection Agency have determined that over the next seven years we will reduce the emission of hydrocarbons by 1.86 tons, carbon monoxide by 5.4 tons and diesel particulate matter by 0.82 tons. The reduction in pollutants will average over one ton per year.

5. Launch Events/Press/Publicity

The project was recognized by a number of events. On April 7, 2003 EPA Administrator, Christine Todd Whitman launched the Clean School Bus USA program at the Wissahickon High School. The PA Department of Environmental Resource held a subsequent media event where they recognized project partners and developed a videotape for release to all schools in the state.

The project was reported in numerous school board and petroleum industry related publications as well Philadelphia News and National Public Radio. In May 2004, the Wissahickon School District was the first recipient of platinum level recognition by the Philadelphia Diesel Difference Coalition, a status given to select fleets, which have demonstrated outstanding clean diesel technology initiatives.

6. Contacts

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Appendix A

Ultra Low Sulfur Diesel Fuel Specifications

Property	Units	Specification	Method
Appearance:			
Color, ASTM	Rating	Max. 2.0	D-1500
Odor		Satisfactory	
Composition Properties:			
Sulfur	%w	Max. 0.003	D-2622
Parts Per Million			30 ppm
Corrosion (Copper Strip)	Rating	Max. 1.0	D-130
Alkali or Mineral Acids		Neutral	D-974
Volatility:			
Flash Point	Deg. F	Min. 100	D-93
Initial Boiling Point	Deg. F	Min. 325	D-86
Distillation, 90% recovery	Deg. F	Max. 530	D-86
Final Boiling Point	Deg. F	Max. 572	D-86
Recovered Volume	% Min.#	98.0	D-86
Fluidity:			
Cloud Point	Deg. F	Max. -10	D-2500
Viscosity @ 100 Deg. F	CST	1.4-3.6	D-445
Gravity API, 60 Deg. F			D-287
Combustion Properties:			
Cetane Index	Value	Min. 40	D-976
Contaminants:			
Ash, %Max.	%w	0.01	D-482
Carbon Residue % Max. (10% bottom)	%w	0.15	D-524
Water Sediment % Max	%v	Max. 0.05	D-1796
Additives:			
Lubricity, applied load OR	Gram	Min. 3100	D-6078
Lubricity, WSD, @ 60C	MM	Max. 0.45	D-6079

Appendix B

VEHICLES WITH MAJOR RETROFIT

Veh. #	Make	Year	Engine	Make	Install Date	Mileage @ Install	Annual Mileage	MPG	Annual Fuel Consumed
1	Bluebird	2000	5.9	Cummins	Aug-03	57,448	13,926	6.4	2,176
3	Bluebird	1993	5.9	Cummins	Aug-03	115,833	9,993	8.7	1,149
4	Bluebird	1997	5.9	Cummins	Aug-03	88,196	12,088	6.3	1,919
5	Bluebird	1997	5.9	Cummins	Aug-03	82,092	9,429	5.7	1,654
7	Genesis	1997	DT.466	Intl.	Apr-03	57,532	9,167	5.6	1,637
11	Bluebird	1994	5.9	Cummins	Aug-03	92,283	12,358	8.0	1,545
15	Bluebird	1997	5.9	Cummins	Aug-03	89,834	10,850	6.2	1,750
16	Bluebird	2000	5.9	Cummins	Apr-03	46,723	9,973	6.2	1,609
18	Bluebird	1993	5.9	Cummins	Aug-03	94,722	7,148	5.7	1,254
20	Bluebird	1997	5.9	Cummins	Aug-03	76,241	10,535	5.8	1,816
21	Bluebird	1997	5.9	Cummins	Aug-03	74,741	7,560	5.2	1,454
22	Bluebird	1994	5.9	Cummins	Aug-03	79,812	7,058	7.3	967
23	Bluebird	1997	5.9	Cummins	Aug-03	74,769	8,874	5.7	1,557
24	Bluebird	1990	8.3	Cummins	Aug-03	143,997	6,629	4.7	1,410
25	Bluebird	1990	8.3	Cummins	Aug-03	110,257	7,576	5.2	1,457
28	Bluebird	2001	5.9	Cummins	Aug-03	16,752	5,229	5.8	902
30	Bluebird	1997	5.9	Cummins	Aug-03	67,035	7,980	5.5	1,451
31	Bluebird	1997	5.9	Cummins	Aug-03	87,714	10,630	6.2	1,715
41	Bluebird	2001	5.9	Cummins	Aug-03	23,210	17,988	7.6	2,367
42	Bluebird	1991	5.9	Cummins	Aug-03	197,648	13,019	10.3	1,264
43	Bluebird	1993	5.9	Cummins	Aug-03	108,063	8,229	7.2	1,143
44	Bluebird	1993	5.9	Cummins	Aug-03	143,165	13,400	7.4	1,811
66	Bluebird	1998	5.9	Cummins	Aug-03	115,257	23,927	6.4	3,739
67	Bluebird	1994	5.9	Cummins	Aug-03	98,957	9,085	7.5	1,211
68	Bluebird	1998	5.9	Cummins	Aug-03	66,659	12,061	5.2	2,319
69	Bluebird	1997	5.9	Cummins	Aug-03	88,279	9,802	6.0	1,634
73	Bluebird	2000	5.9	Cummins	Aug-03	51,434	11,974	6.4	1,871
							286,488		**44,779**

Count	8.3	2
Count	5.9	24
Count	DT.466	1
	Total	**27**

VEHICLES WITH MINOR RETROFIT

Veh. #	Make	Year	Engine	Make	Install Date	Mileage @ Install	Annual Mileage	MPG	Annual Fuel Consumed
2	Bluebird	1989	5.9	Cummins	Aug-03	131,318	8,739	7.6	1,150
6	Bluebird	1988	5.9	Cummins	Aug-03	156,879	7,606	6.7	1,135
9	Bluebird	1989	5.9	Cummins	Aug-03	136,363	12,847	5.8	2,215
10	Bluebird	1994	5.9	Cummins	Aug-03	96,343	9,714	7.8	1,245
13	Bluebird	1989	5.9	Cummins	Aug-03	136,305	9,500	6.9	1,377
19	Bluebird	1993	5.9	Cummins	Aug-03	90,107	8,129	7.4	1,099
29	Bluebird	1991	5.9	Cummins	Aug-03	154,352	11,085	7.1	1,561
55	Bluebird	1989	8.3	Cummins	Aug-03	150,686	5,484	5.3	1,035
56	Bluebird	1989	8.3	Cummins	Aug-03	175,018	7,882	4.1	1,922
57	Bluebird	1989	8.3	Cummins	Aug-03	169,696	11,788	6.5	1,814
60	Bluebird	1990	8.3	Cummins	Aug-03	164,433	9,765	5.7	1,713
63	Bluebird	1993	8.3	Cummins	Aug-03	101,602	10,722	6.7	1,600
64	Bluebird	1993	8.3	Cummins	Aug-03	113,393	10,701	6.5	1,646
65	Thomas	1995	5.9	Cummins	Aug-03	86,055	8,346	4.9	1,703
							132,308		**21,216**

Count	8.3	6
Count	5.9	8
	Total	**14**

TOTAL RETROFIT	**41**