Advanced Vehicle Testing Activity

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Heavy-Duty Truck Idle Reduction Technology Demonstrations

2005 Status Report

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U.S. Department of Energy
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NOTICE

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Executive Summary

In September 2005, Schneider National completed its project demonstrating engine-off cab heating and cooling. In cold weather testing, trucks using the Webasto cab heater averaged 10% idling time versus 27% for control trucks leading to a 0.158 MPG (or 2.4%) improvement in fuel economy. Based on these results, Schneider National has equipped all of its MY2003 and newer trucks with auxiliary cab heaters. In hot weather, trucks using the Webasto Parking Cooler averaged 20% idling time (20% of the total operation time was spent idling) versus 23% for comparison trucks (without cab coolers) which resulted in no improvements in overall fuel economy. The Bergstrom Nite System for cooling averaged 13% idling versus 16% idling for control vehicles which led to a modest 1.1 % improvement in fuel economy. However, this "actual" data is somewhat questionable as drivers who had lost the financial incentive from Schneider not to idle (due to various reasons) begin to idle at very high rates thereby skewing the data. When this "out of range" data was removed, the Webasto Parking Cooler trucks idled an average of 7% as opposed to 24% for the control vehicles leading to a 3% fuel economy improvement. When "out of range" data was removed the Bergstrom Nite System trucks averaged 7% idling as well as compared to 16% for control vehicles leading to a 2.0% improvement in fuel economy. While these improvements were not good enough for Schneider to adopt the cooling technologies based on cost payback alone, they are still being considered due to potential advantages of driver comfort and an improved sleep environment. Additionally, for fleets that idle at much higher rates more near the trucking industry average of 40+%, Schneider indicated the cooling technologies can provide a payback within two years. Schneider National trucks idle 73% less than the industry average.

Caterpillar is demonstrating its MorElectric™ technology, which applies electrically driven accessories for cab comfort during engine-off stops and for reducing fuel consumption during on-highway operation. Data collection began in the Fall of 2004 and includes compilation of fuel, operation, and maintenance data. Preliminary results show that the MorElectric™ trucks are idling an average of 14% versus 27% for control vehicles leading to a 0.33 MPG improvement in fuel economy. This is equivalent to a savings of approximately 800 gallons of diesel fuel per truck per year. Early systems performance issues have largely been resolved and more recently the MorElectric™ trucks are logging equivalent mileage as control trucks indicating robust technology. A 2-year extension to this project until September 2007 will capture longer term durability information and the effects reduced idling may have on engine and accessory wear.

A project led by Espar Heater Systems is demonstrating combined cab heating and cooling systems. Equipment installation was completed in May 2004 which included installing Bergstrom air conditioners and Espar bunk heaters as a combination package in 20 trucks and installing Tripac auxiliary power units which provides heating, cooling, and accessory power and an Espar bunk heater into an additional 5 trucks. Preliminary results indicate an average idling time of 21% for the test vehicles, and 513 hours of run time for idle reduction technologies per

truck leading to approximately 240 gallons of diesel fuel saved per truck over the first 11 months of the evaluation period ending in April 2005.

International Truck and Engine Corporation is leading a project to complete engineering development activities for the integration of on-board idle reduction technology into heavy-duty trucks as an original-manufacturer, factory installed equipment option. This idle reduction equipment must be offered at an affordable price that provides an economic incentive for truck owners to purchase and use idle reduction equipment at an operating cost savings. Project scope includes 1) the development of idle reduction system and subsystem requirements; 2) the design, fabrication, and testing of APUs and an electric HVAC systems, 3) installation and testing of developed systems and improved cab insulation in a pre-production pilot truck; and 4) the installation and field testing of the idle reduction systems in 5 custom-ordered vehicles allowing for hot and cold season testing to gain customer acceptance. International has announced plans to make available in limited production the integrated factory-installed reduced idle system with the cab and sleeper insulation, fuel fired heater with engine preheat, electric HVAC, and battery system beginning in March 2006 with the APU beginning limited production in May 2006. This project started in August 2005 and is scheduled for completion in July 2007.

In addition to the four demonstration projects, this report briefly describes other idle reduction activities, including those of the DOE State Energy Program, a project to apply thermal management technologies to truck cabs, and the multi-agency National Idle Reduction Plan.

Background

In 2002, the Department of Energy's (DOE's) Advanced Vehicle Technology Activity (AVTA) initiated a study of diesel truck engine idle reduction technologies, which identified several barriers to widespread use of existing technologies. These barriers included initial cost, driver education and receptiveness, reliability, and maintenance requirements. The results of the study were used to develop a demonstration plan that defined a pathway to idle reduction technology implementation. The goal of the demonstration and evaluation effort outlined in the plan was to gather objective in-use information on the performance of available idle reduction technologies by characterizing the cost; fuel, maintenance, and engine life savings; payback; and user impressions of various systems and techniques.

Several phases of the demonstration plan have been completed, including a workshop for gathering industry input, held in April 2003 in Philadelphia. Input from the workshop was used to design a DOE solicitation for technology demonstration projects as well as help prioritize data types for collection and evaluation. A second workshop was held to identify cost reduction strategies; DOE subsequently released a technology introduction plan that outlines a path to implementation of these cost reduction strategies and refines the technology implementation strategies addressed in the earlier demonstration plan. In late 2003, two idle reduction demonstration projects were awarded (Schneider and Caterpillar), a third project was awarded in 2004 (Espar), and a fourth (International) in 2005. This report provides the status of these projects and identifies potential next steps based on results, as well as brief synopsis of other idle reduction activities of the Federal Government.

Demonstration Projects

The four projects consist of teams of a truck fleet, truck manufacturer, and idle reduction technology manufacturer. Including all these major participants on the teams ensures successful implementation and demonstration of the complete onboard idle reduction systems.

The first contract award, to Schneider National Inc., for a project titled "Cab Heating and Cooling," is completed and has demonstrated the Webasto Cab Cooler, which uses a phase change cooling storage technology to cool the truck cab when the engine is off and the Bergstrom Nite System, a 12 volt air conditioning system powered by batteries. This project equipped nineteen Freightliner trucks with the Cab Cooler and Nite Systems, and 100 trucks were equipped with a self-contained diesel-fueled air heater to demonstrate engine-off cab heating.

The second award, to Caterpillar Inc., for a project titled "Demonstration of the New MorElectric™ Technology as an Idle Reduction Solution," is applying electrically driven accessories for cab comfort during engine-off stops and for reducing fuel consumption during on-highway operation. Caterpillar has equipped and is operating five new trucks with the technology in conjunction with International Truck and Engine Corporation and Cox Transfer.

The third award, to Espar Heater Systems, for a project titled "Idle Reduction Technology Demonstration and Information Dissemination," is demonstrating a combined heating and cooling system. Twenty International trucks have been equipped with the Bergstrom Nite system (electric A/C) and Espar bunk heaters for operation by Wal-Mart Transportation, LLC and 5 trucks are also being equipped with Tripac APUs and Espar heaters. Espar engine pre-heaters also are being installed to reduce idling done to avoid cold-start problems. Twenty trucks are being used as control vehicles.

The fourth project with International Truck and Engine Corporation is to complete engineering development activities for the integration of on-board idle reduction technology into heavy-duty trucks as an original-manufacturer, factory installed equipment option. This idle reduction equipment must be offered at an affordable price that provides an economic incentive for truck owners to purchase and use idle reduction equipment at an operating cost savings. This project involves an idle reduction system that has four principal elements: an auxiliary power unit (APU), electric air conditioner, cab and engine preheater, and improved cab insulation. Installation and field testing of the idle reduction system will be in five custom-ordered vehicles, allowing for hot and cold season testing to gain customer acceptance

Schneider National

Schneider National, a Wisconsin-based provider of truckload and intermodal services throughout North America, teamed up with truck manufacturer Freightliner and Webasto Thermosystems and Bergstrom to devise and test truck cab heating and cooling technologies to reduce idling to five percent of total engine operating time. Schneider National has historically taken a proactive stance to reduce idling in its fleet of 15,000 trucks and offered incentives to its drivers to keep idling time to a minimum. Schneider National trucks idle considerably less than the industry average: 480 hours/year vs. 1,830 hours/year for the industry.

For this evaluation, Schneider National chose to demonstrate heating and cooling technologies separately, so as to take advantage of climatic extremes in evaluation and data collection – testing spanned two summers for cooling and two winters for heating applications. All Schneider trucks in this evaluation were equipped with the “Artic” insulation package (a significantly upgraded “Extreme” insulation package is becoming available at Freightliner but was not used in these demonstrations). During the evaluation period, three separate technologies were tested: a Webasto Airtronic diesel fired heater for cold weather operation, a Webasto Parking Cooler phase change storage system, and a Bergstrom Nite System 12 volt electrical air conditioner for cooling applications. Data on system operation were collected using temperature data loggers and driver records. The Schneider project was completed in September 2005.

Hot Weather Testing

Evaluation of the cooling systems was conducted on 19 trucks based out of Schneider National’s Dallas facility, operating primarily in the Southwestern United States.

Webasto Parking Cooler

The first technology evaluated was the Webasto Parking Cooler (Figure 1), retrofitted to existing trucks in Schneider National’s fleet for the summers of 2003 and 2004. The Cab Cooler uses a thermal storage medium to collect cooling energy from the truck’s normal cab air conditioning unit during normal daytime operation, and then provides cooling during non-driving hours via a heat exchanger and blower unit. The Cab Cooler takes up to 6 hours to charge during normal driving, and was designed to provide 10 hours of engine-off cooling. The retrofit also included installation of an insulating curtain to help isolate the sleeper bunk at night.

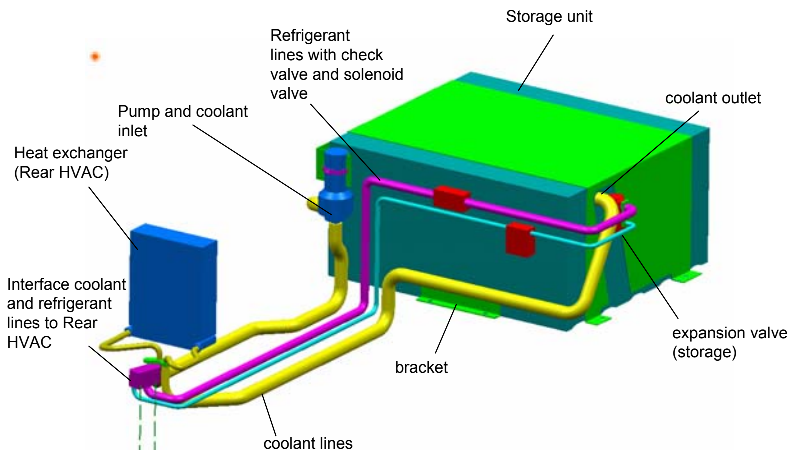

Figure 1. Webasto Parking Cooler

Final Results

The Parking Cooler system performed satisfactorily in ambient temperatures up to 85°F. However, once temperatures exceeded 85°F, the performance degraded; at 90°F, the cooler was only capable of 7 hours of operation, and from there performance declined proportionally as ambient temperature rose. Table 1 below summarizes the idling percentages on a monthly basis for the Webasto Parking Cooler for the summers of 2003 and 2004.

Table 1. Webasto Parking Cooler Idling Test Results

Actual Data

	Test (Idle %)	Control (Idle %)	Difference
May	14.19	15.34	1.15
June	19.81	19.84	0.03
July	20.96	23.84	2.87
August	21.32	10.03	-11.30
September	15.38	17.85	2.46
May	11.77	19.15	7.38
June	19.94	26.26	6.32
July	25.80	34.22	8.42
August	26.40	33.19	6.79
September	24.76	27.48	2.72
Average	20.03	22.74	2.69

Data With Out of Range Removed

	Test (Idle %)	Control (Idle %)	Difference
May	6.30	15.34	9.04
June	8.61	19.84	11.23
July	9.22	23.84	14.62
August	7.46	19.67	12.21
September	7.23	17.85	10.62
May	3.38	19.15	15.77
June	9.88	26.26	16.38
July	11.39	34.22	22.83
August	4.21	33.19	28.98
September	7.25	27.48	20.23
Average	7.49	23.68	16.19

At first blush, the results indicate that idling was only slightly reduced (22.74% for control to 20.03% for test vehicles) with a slightly improved fuel economy (6.91 MPG for test vehicles versus 6.94 MPG for the control vehicles); not the difference expected nor enough to justify purchase. However, when "out-of-range" data is removed, the expected 17% reduction in idle was nearly achieved leading to a 3% improvement in fuel economy – the "out-of-range" data indicates what is possible if drivers used coolers consistently.

While the high idle percentages may indicate that the coolers did not meet performance expectations, Schneider indicated that drivers with very high idle percentages during the period had missed their bonus incentive due to non-related factors, and once a driver fails to achieve a bonus, they tend to increase idle time. Additionally, some drivers assigned to these trucks did not properly employ the units, as those who reported limited unit capacity had high initial bunk temperatures prior to turning on the units – unit instructions specified pre-cooling the bunk area - and drivers who pre-cooled the area then used the system had fewer reports of capacity issues. Accordingly, many issues can be attributed to familiarity with unit operation, since coordination of charging periods with driving time, pre-cooling the sleep area, and understanding of battery capacity limitations were not familiar to the drivers. Overall, drivers were fairly optimistic in surveys completed during the course of the evaluation, and rated the Webasto Parking Cooler 4/5, in a scaled rating. See Appendix A detailing the results of the driver survey for the Schneider National demonstration.

Some additional issues with the system regarded complication of installation. Because this system was installed on existing trucks in operation in Schneider National's fleet, modifications had to be made to accommodate the Parking Cooler. The system had to be integrated with the existing air conditioning system, requiring highly skilled technicians to make the plumbing and electrical connections. According to Schneider National, the average time for an installation exceeded 30 hours (partly due to lack of familiarity with the system).

Because the Cab Cooler did not result in a significant reduction in fuel use (measured as fuel economy) in this test, and the installation (labor) costs were high, the projected payback period for this technology would exceed the industry-accepted 2-year maximum. Additional field testing is required to determine if an increase in fuel economy corresponding to the observed reduction in idling can be achieved. If this could be achieved, and Webasto was able to achieve its target of a $1,200 factory installation price for the Parking Cooler, the payback period could become acceptable for fleets with idle rates closer to the industry average (Schneider National trucks already idle 73% less than the industry average; trucks with higher idle times have higher potential benefits from idle reduction technologies).

Bergstrom Nite System

The Bergstrom Nite System, which came to market after the initial evaluation was started, offers a different approach to cooling. This technology uses a 12 volt air conditioning system powered by a battery pack to cool the sleep area. Similar to the Webasto Parking Cooler, battery capacity is significantly reduced if the system is started with high sleep area temperatures, so it is advantageous to pre-cool the bunk prior to use. The Bergstrom system was ultimately rated as easier to use than the Webasto since the charge mode occurred automatically (the Webasto requires drivers to pre-select the charge mode), though 6 to 8 hours of driving are still required to fully recharge the batteries. Initial units had a power source of two 6-volt AGM batteries in series that were isolated from the tractor batteries. Batteries lasted through the two year evaluation period with no problems.

Final Results

Results for the Bergstrom Nite System were very similar to the Webasto Parking Cooler, including similar driver reactions when they were disqualified for their bonus; the drivers idled as an alternative to using the Nite system. Table 2 illustrates the results during the summers of 2004 and 2005 for the Bergstrom Nite System:

Table 2. Bergstrom Nite System Cooling Idle Test Results

Actual Data:				Data With Out of Range Removed:			
	Test (Idle %)	Control (Idle %)	Difference		Test (Idle %)	Control (Idle %)	Difference
August	7.58	15.20	7.63	August	6.54	15.20	8.66
September	8.87	14.49	5.62	September	2.66	14.49	11.83
May	8.87	8.95	0.09	May	4.33	8.95	4.62
June	16.62	17.34	0.72	June	6.62	17.34	10.72
July	17.47	20.41	2.93	July	10.14	20.41	10.27
August	16.78	20.45	3.67	August	9.20	20.45	11.25
September	17.35	17.55	0.20	September	8.85	17.55	8.70
Average	13.36	16.34	2.98	Average	6.90	16.34	9.44

Again, the "actual" test results were not highly favorable, with only a modest decrease in idling and a 1.1% improvement in fuel economy. When "out-of-range" data is removed, idling reduction is significantly better and leads to a 2.0% improvement in fuel economy. It is important to keep in mind that Schneider National is starting at a very low idling percentage – significantly below the industry average due to driver incentives. This situation makes achieving a reasonable payback for Schneider especially difficult. For more typical fleets (upwards of 45% idling times), Schneider indicated payback is possible in a two year timeframe.

Drivers who consistently used the Nite system were overwhelmingly positive about its performance. One driver in particular achieved an average fuel economy of 7.5 MPG, an idling time of 0.1%, few capacity issues, and was able to maximize system performance. Likewise, drivers who pre-cooled the truck had significantly more capacity than those that started the system with higher internal temperatures, and were much more positive about the system performance in general.

During the second summer of the evaluation two additional batteries were added to two trucks. Drivers of these trucks reported improved performance in higher ambient temperatures and added capacity. Moving forward Schneider would recommend using four batteries.

Common Cooling System Issues

The most frequently reported issue from the drivers was lack of insulation, allowing substantial heat migration through the walls of the truck. On hot days and nights, drivers reported heat coming up through the mattress and the surrounding walls, causing discomfort in the sleeper area. Adding to the discomfort, many drivers also reported a lack of airflow, especially at the head area (where the HVAC and other controls are located). Ducting of cooling air is directed toward the foot end of the bunk and is not evenly distributed.

Cold Weather Testing

Webasto Airtop 2000 Cab Heater

Heating performance evaluations of the Webasto Airtop 2000 Cab Heater were conducted on 100 trucks from various Schneider National operating facilities during the winters of 2003-2004 and 2004-2005. The self-contained diesel-fueled air heater is installed in the existing truck ductwork to circulate heated air (Figure 2), and output is controlled by the driver via a thermostat. The unit draws fuel from the truck's diesel tanks, and operates on a 10-hour timer to prevent continued operation while driving (the timer can be reset for a stay longer than 10 hours). The heater units were retrofitted to existing Freightliner trucks in Schneider National's fleet without any additional modification to the truck cab or sleeper bunk (e.g., no insulating curtain installed).

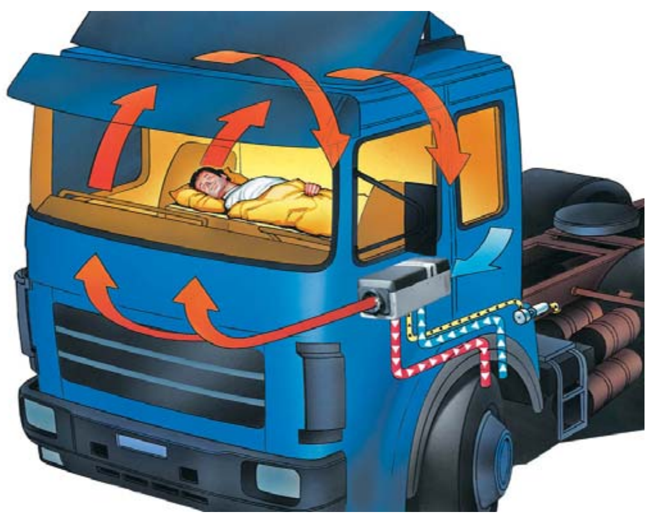

Figure 2. Airtop 2000 Cab Heater Operation

Final Results

The Airtop 2000 Cab Heater can provide equivalent climate control performance as idling the tractor. They are easy to use, small, do not require any additional set up from the drivers, and can easily maintain an interior temperature of 70°F at ambient temperatures down to 10°F. At ambient temperatures below this a diesel engine will not start if it sits for 10 hours or more. If the truck is not plugged in with an engine heater, there is a risk that drivers using the heaters below 10°F could cold soak the engine. However, the test group did not show any difference in jump starts against the control group, and drivers were well versed in following this stance.

During the winter period of operation, cab heaters produced the 17% targeted reduction in idle time. The test trucks averaged 10% idle time and approached the goal of 5% idle time in all but the extreme temperature months of December, January, and February, while a control group of trucks averaged 27% idle time. Table 3 shows the idle times for test and control units and the total idle reduction achieved over the two winter periods. The results show a Net Present Value (NPV) payback of less than two years with fuel pricing above $2.40/gal for cab air heaters.

Table 3. Webasto Airtronic Cab Heater Idling Test Results

	Test (Idle %)	Control (Idle %)	Difference
November	5.921	18.743	12.822
December	8.452	18.743	10.290
January	17.451	33.598	16.146
February	9.613	27.766	18.153
March	5.770	19.740	13.970
November	8.817	21.736	12.919
December	9.764	32.868	23.104
January	16.591	37.182	20.591
February	10.165	32.574	22.409
March	8.997	26.830	17.833
Average	10.15	26.98	16.824

Table 4. Webasto Airtronic Cab Heater MPG Test Results

	Test MPG	Control MPG	Difference
November	6.742	6.678	0.064
December	6.654	6.638	0.016
January	6.453	6.231	0.221
February	6.562	6.384	0.177
March	6.780	6.645	0.135
November	6.833	6.702	0.131
December	6.677	6.311	0.366
January	6.505	6.245	0.260
February	6.690	6.580	0.110
March	6.736	6.638	0.099
MPG Average	6.66	6.51	0.158

Fuel Economy (MPG) also showed improvement (Table 4). The net increase in the test units was .158 MPG, however a portion of this improvement was evident all year long, not just in the winter. While it was never determined why the test group had an overall positive impact throughout the summer months, a comment from one of the drivers may explain why overall results, even in summer, were more positive. He indicated that once you get used to not sleeping with the engine on you only idle when you absolutely need to. Accounting for this difference leads to a fuel economy improvement of .126 MPG. The adjusted actual MPG gain shows a similar payback in less than two years. In the heating evaluation, the correlation between idle reduction and MPG performance was very close.

Based on early cab heater results, Schneider National made a specification change to put diesel fired heaters in all trucks. All trucks purchased since June of 2003 have either been retrofitted with this technology or have been factory installed. Schneider National currently has close to 6,000 trucks with cab heaters installed.

Conclusions for Schneider National Demonstration

1. Diesel fired air heaters are a viable, affordable alternative to winter idle. They maintain a similar temperature environment as idling, are lightweight, durable, easy to use and readily available.
2. Cab insulation is a major issue and recognized by drivers as a limiting factor in cab cooling. Many drivers in their weekly reports indicated heat migration into the sleep area through walls and floor areas. Drivers commented that while the cool air was flowing from the ducts, they could feel heat from the floor and walls coming in at the same time.
3. Drivers have an expectation that the air conditioning system perform similarly to what they experience when idling. Drivers will go back to idling the truck if the anti-idling system is not as effective as idling when the incentive is lost.
4. Minimizing driver interaction with the system and controls will obtain the best results, and less planning prior to use maximizes the chance drivers will get the full benefit of the system. When drivers need to charge the system, pre-cool the sleep area, or be aware of the state of charge of the batteries, the probability of getting optimal performance from the system is decreased.
5. Training of drivers on the use of the system is very important and needs to be followed through with a refresher at the start of each season.
6. Payback on idle reduction air conditioning technologies is an issue. Even at higher fuel prices and idle percentages, the systems cost considerably more than idling the truck for Schneider National fleets. However, at more typical industry average idling percentage (40+%), the cooling system can provide a reasonable payback in two years.
7. Though drivers found ways to accommodate the extra weight of the A/C system by short fueling when hauling heavy loads during the evaluation period, for the long term the additional weight of idle components needs to be addressed nationally. The Webasto Parking Cooler weighs approximately 400 pounds while the Bergstrom Nite System is approximately 250 pounds.

Many limitations were exposed during this test regarding air conditioning, and the lessons learned are already appearing in the marketplace. Both the Parking Cooler and the Nite System have received upgrades due to feedback. OEM's are putting more consideration into tractor insulation and are working closer with the suppliers to integrate engine-off technologies into the truck. While the solutions tested are not quite up to expectations, they are much further along than when the project was started.

Recommendations

1. There is no further need for heating evaluations. The systems are available, affordable, reliable, and provide a reasonable (and in some cases excellent) payback. Demonstration heating results need to be made widely available and an outreach campaign conducted to encourage use of idle reduction heating technologies.
2. More evaluation is needed on cooling technologies, especially incorporating advanced cab insulation. Results indicate that cooling technologies are viable and may provide a reasonable payback for many fleets especially if coupled with improved cab insulation.

Caterpillar

The Caterpillar MorElectric™ technology system, designed to reduce fuel consumption during on-highway truck operation and during rest periods when the truck normally idles, consists of an auxiliary power unit (APU); a heating, ventilating, and air conditioning (HVAC) unit; and a high-efficiency generator that replaces the alternator (Figures 3 and 4). The electrically driven HVAC unit eliminates the need for an engine-driven air conditioning compressor, supplying 24,000 Btu/hr cooling, exhibiting high reliability and durability, and promising up to 2% fuel savings.

Figure 3. Caterpillar MorElectric™ System

During rest periods, the same HVAC unit can be powered by the APU, using only 0.2 gallons per hour of fuel instead of the electrical power coming from the engine-mounted generator. The belt driven generator is high efficiency (79-83% versus 40-55% for an alternator) and can achieve up to a 1% fuel savings. The generator allows the A/C compressor to be removed from the engine, is highly reliable, and demonstrates excellent output (7.5 kW versus 2.3 kW) over its operating range. The HVAC system also can be plugged in at truck stops that have electrical service, thereby eliminating all diesel fuel consumption. The MorElectric™ System and APU option is expected to provide a total fuel economy improvement of up to 8% (2% on road and 6% idle reduction) compared to conventional HVAC systems, and the shore power option can provide up to 10% (2% on road and 8% idle reduction) improvement in fuel economy.

A two-piece HVAC design was used to minimize vehicle modifications and to address weight distribution issues. Use of the standard one-piece HVAC unit would have required relocation of one of the truck fuel tanks, changing the truck weight distribution and reducing trailer payload capacity. To keep the standard tank configuration and minimize truck cab modification, the design team decided to split the HVAC function with air handling done by the standard production fans, ducting, and water heat exchangers.

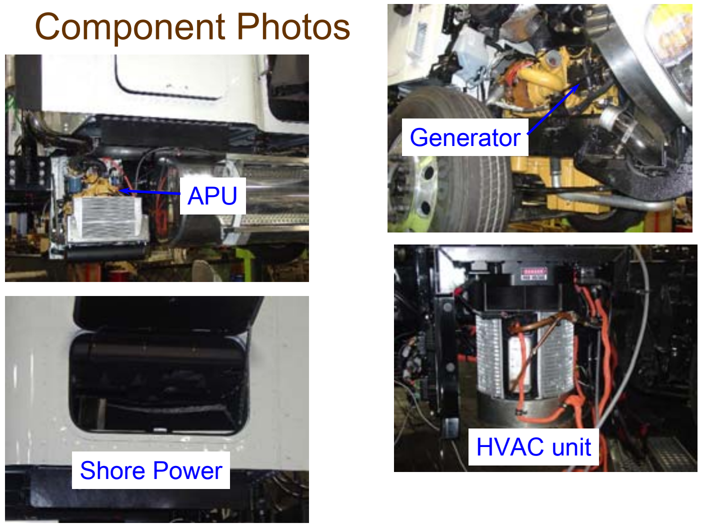

Figure 4. Caterpillar MorElectric™ Technology

DOE Idle Reduction Demonstration

Caterpillar Inc. formed a team with truck manufacturer International and Illinois-based truckload and flatbed common and contract carrier Cox Transfer. The 100-truck fleet for Cox Transfer idles approximately 677 hours/truck per year. For this project, Cox Transfer ordered 10 new trucks from International. Five of the trucks are serving as test vehicles, the other five as a control group. For the first truck (see Figure 5), International installed the MorElectric™ system at its truck engineering center in Fort Wayne, Indiana; for the remaining four trucks, the MorElectric™ systems were installed at International's assembly plant in Chatham, Ontario, Canada.

Figure 5. First Production Caterpillar MorElectric™ Test Truck

This project started in October 2003 and Caterpillar began data collection from the test trucks in the Fall 2004, with all trucks operational since January 2005. Fuel, operation, and maintenance data are being collected regularly from the test and control trucks for direct comparison. Data items such as fuel and oil consumption, preventive maintenance, and repairs will be used to quantify operating costs. Engine and vehicle maintenance data will be collected in addition to idle reduction system maintenance data to quantify any effects the MorElectric™ system may have on reducing truck maintenance from less engine idling.

In the Fall 2004, DOE awarded an extension to the Caterpillar project for 2 additional years, until September 2007, in order to capture longer-term durability information and any effects reduced idling may have on engine or engine accessory wear. The team is also expanding engine oil analysis to help quantify the possible engine effects as well as analyzing the APU oil to help predict the long-term durability and wear of the APU.

Summary of Preliminary Results

Overall driver acceptance of the MorElectric™ Technology is promising, with air conditioning capacity being very good. Initial system problems caused some negative feedback, but they have been corrected. Results from the driver survey are not yet available.

Table 5 below presents the truck usage summary for the MorElectric™ demonstration through early December 2005. As shown, the MorElectric™ trucks are idling 13.8% of the time versus 26.6% for control vehicles. The MorElectric™ System does not require main engine idling to keep the engine from having cold start problems even in the coldest weather, because the APU shares coolant with the main engine. Therefore the 13.8% idling level is largely indicative of idling during loading and unloading conditions and while in traffic. The MorElectric™ fleet is demonstrating a 0.33 MPG improvement over the control vehicles based on fuel receipts through the beginning of 2006, which is equivalent to approximately 800 gallons of diesel fuel saved per truck per year. The control trucks have logged more total mileage than the MorElectric™ trucks due to some system problems on the demonstration trucks early in the demonstration. However, since July 2005 the MorElectric™ trucks have matched the control trucks in accumulated mileage, demonstrating the robustness of MorElectric™ technology.

Table 5. Preliminary Results for the Caterpillar MorElectric™ Truck Demonstration

	MEI System	Control System
Total Mileage	445,161	594,671
High Mileage Truck	124,332	130,720
Engine Hours	9,766	15,735
High Engine Hours	2,468	3,519
APU Hours	4,525	N/A
Mileage/Week Since 1/10/05	8,702	N/A
Mileage/Week Since 1/4/04	N/A	9,556
% Idle Time	13.8%	26.6%

Data analysis comparing the percent idle time and the average ambient temperature showed that both the test and control trucks realized their lowest percentage of idling time when the ambient temperature was in the mid 50's (see Figure 6). Likewise, idle time for both groups of trucks increased in direct relationship to temperature deviations from this mid-50 degree range. The control trucks idle time varied from a low of 18% at the mid-50 degree temperature to a high of about 35-40% as temperatures deviated by 30 degrees either way. The MEI trucks had a low idle time of about 10% at the mid-50 degree temperature and went as high as 20% at the extreme temperature ranges of plus or minus 30 degrees.

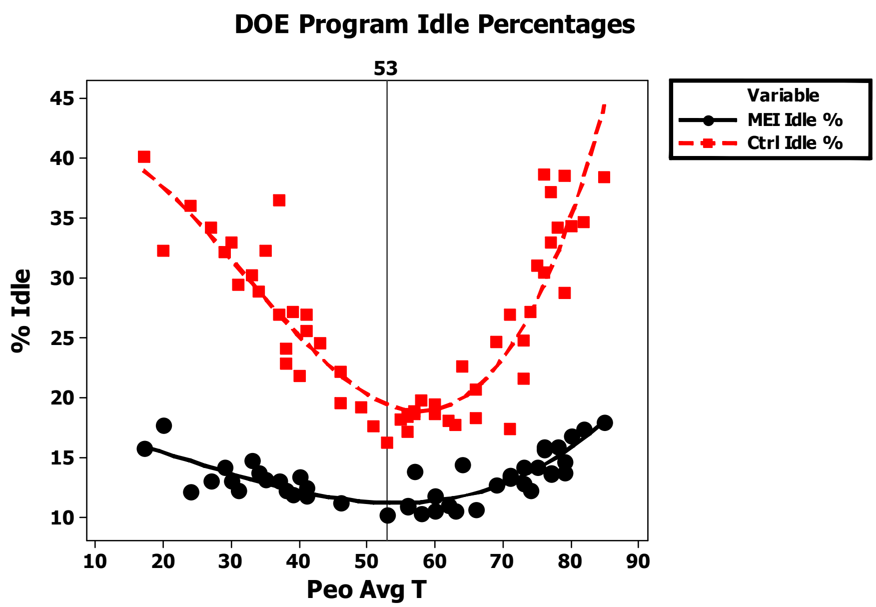

Figure 6. Truck Idle Percentage as a Function of Ambient Temperature

The trend was expected with the control trucks because they are equipped with the Temp-A-Start system, which automatically starts and stops the main engine depending on electrical and cooling/heating needs. At temperature extremes it was anticipated that the percent idle time would increase. A similar effect was also noted on the MEI trucks, although at a much lower percentage. Further follow-up with Cox Transfer revealed that during moderate ambient temperatures, the drivers of both trucks will shut down their main engine instead of idling for short periods while waiting for a load or filling out their log books. The MEI trucks could realize further idle reduction savings by utilizing the APU during those short idle times when ambient temperatures are more towards the extremes.

Systems Issues

The Caterpillar MorElectric™ Truck idle reduction demonstration has addressed several issues relating to the performance of the MorElectric™ Truck technology. The issues have predominately occurred in the early stages of the demonstration and have been largely resolved.

1. Vibration with A/C unit addressed with upgraded HVAC system with new piping design.
2. Periodic generator shut downs resolved with software revisions.
3. Software robustness and reduced electromagnetic interference improved as trucks are receiving a power electronics upgrade.
4. New APU motor mounts installed to avoid potential failure due to excess vibration.

5. APU fuel filter brackets redesigned, validated, and integrated in response to an undesirable vibration response in the APU operating range causing a failure.
6. Five trucks experiencing premature APU muffler failure have received updated design.
7. Several trucks experiencing infrequent dropouts of the downconverter (battery charging). have received a software update that “restarts” the battery charger if it drops off-line.
8. Some reports of difficulty adjusting heat in sleeper addressed through software improvements and updating of all the trucks.
9. Two trucks required change of high voltage converters; investigation is underway to determine the cause.

Recommendations

DOE should consider extending the Caterpillar MorElectric™ idle reduction demonstration project past September 2007 in order to capture longer term data on engine and accessory wear. It would be ideal, although somewhat impractical, to examine engine and accessory wear out to the full ten year, 1 million plus mile lifetime typical of heavy duty trucks. It would be appropriate, however, to examine benefits up to the point of the first major engine overhaul—typically at 5-6 years and 600,000-800,000 miles. Caterpillar vehicles are logging approximately 120,000 miles per year and as such can be expected to reach more than 300,000 miles per vehicle by September 2007. Therefore, extending the project for an additional 3 years to collect engine and accessory wear data would bring most of the vehicles up to the cusp of their first major engine overhaul and to a point where they could readily be evaluated as to the engine and accessory wear benefits of idle reduction. As the most significant engine and accessory wear benefits of idle reduction are likely to manifest themselves most prominently in the vehicle’s middle and later life stages, this would allow for a comprehensive long term wear assessment. This information would be of considerable interest to second tier fleets and owner operators. At present, Cox Transfer (the owner of the trucks) is expected to sell the demonstration vehicles outright. At present rates of mileage accumulation, this project will not capture engine and accessory wear benefits out to even 400,000 miles as the project is scheduled to end in September 2007.

Espar Heater Systems

Espar Heater Systems was awarded the third DOE idle reduction project in Fall 2004 to demonstrate combined cab heating and cooling systems in Class 8 trucks and conduct performance monitoring to demonstrate the potential fuel savings and emissions reductions that can be achieved during normal commercial operation. Engine operating and idling hours along with the operating hours of the idle reduction technologies will be monitored over the course of the 24-month time span, and compared to non-retrofitted trucks to determine subsequent fuel savings and emissions reductions. Maintenance requirements for the idle reduction technologies will be determined.

Equipment installation was completed in May 2004, including installation of Bergstrom air conditioners and Espar bunk heaters as a combination package in 20 trucks (see Figure 7), and Tripac auxiliary power units to provide heating, cooling, and accessory power into an additional 5 trucks. The 25 demonstration trucks and 20 baseline control trucks are being provided and operated by Walmart with International as the participating truck manufacturer. Table 6 provides preliminary results of Espar’s idle reduction technology demonstration.

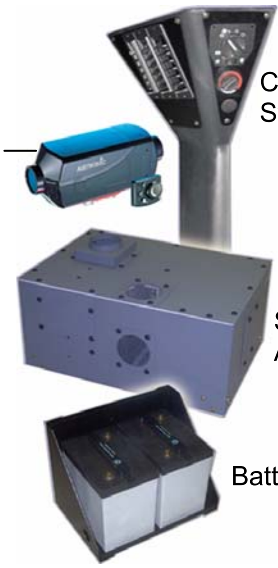

Figure 7. Espar and Bergstrom Idle Reduction Technologies

Table 6. Preliminary Results of Espar Demonstration

	First Data Download April 2005	Second Data Download February 2006	TOTAL
Heater (25 trucks) (hrs)	5,026	7,820	12,896
A/C (20 trucks) (hrs)	5,694	4,130	9,824
Tripac (hrs)	2,114	1,455 (estimate)	3,569
Average Idle Time (%)	20.89	21	
Idle Time Saved (hrs)	12,834	13,405	26,239
Diesel Fuel Savings (gallons)	12,834	13,405	26,239

Based on the data download in April 2005 representing the first eleven months of data collection, the 25 demonstration trucks averaged an accumulated mileage of 183,183 miles, 3,477 hours of main engine run time of which 713 hours represents idle time, and 513 hours of run time of the anti-idling technologies. Main engine idling used on average approximately 0.5 gallons of diesel fuel per hour. Assuming a fuel usage for the bunk heaters of 0.05 gallons per hour over the average use rate of the heaters of 218 hours and no fuel consumption for the air conditioners over the average use rate of 284 hours, approximately 240 gallons of diesel fuel usage was saved per truck over the eleven-month evaluation period. These initial results are expected to improve as drivers become more familiar with the operation of the anti-idling technologies and begin to rely less on main engine idling to maintain cab comfort.

Recommendations

Data on the 20 control vehicles is needed to provide an accurate assessment in comparison to the test vehicles. For example, accumulated mileage, main engine operating time, idle percentages, and fuel economy data is needed. Currently, there is not enough information to accurately assess project progress and achievements.

Wal-Mart to Install Idle-Reduction Technology in Fleet Following Lawsuit

As part of a settlement with the EPA regarding clean-air regulations, Wal-Mart will be outfitting its entire fleet of 6,750 trucks with idle-reducing technology. The settlement is part of a lawsuit by Connecticut and Massachusetts regarding trucks idling outside Wal-Mart stores. Wal-Mart will be installing APUs moving forward into 2007.

International Truck and Engine Corporation

Through the "Factory-Installed Idle Reduction System for International Sleeper Trucks" project, International Truck and Engine Corporation is working to complete engineering development activities for the integration of on-board idle reduction technology into heavy trucks as an OEM, factory-installed equipment option. The proposed idle reduction system consists of four elements; an auxiliary power unit, electric air conditioner, cab and engine heater, and improved cab insulation. This system must be offered at an affordable price that provides an economic incentive for truck owners to purchase and use idle reduction equipment at an operating cost savings. During the project timeframe of August 2005 – July 2007, the scope of work will include:

1. Development of idle reduction system and subsystem requirements
2. Design, fabrication, and testing of selected auxiliary power units (APU) and an electric heating, ventilation, and air conditioning (HVAC) unit to demonstrate component and system capability
3. Installation and testing of the developed systems and improved insulation as a prototype system in a pre-production pilot truck
4. Installation and field testing of the idle reduction system in five custom-ordered vehicles, allowing for hot and cold season testing to gain customer acceptance

Ultimately, production supplier documentation will be released for suppliers to deliver idle reduction system components, and production documentation will be released to aid purchase and installation of the idle reduction system. Two OEM options are planned to be released: a Cold-Cimate version and a Hot and Cold Climate version.

Project Progress

International's program is divided into 8 phases: Specifications and Supplier Selection, Air Cooled APU Development, Water Cooled APU Development, Electric HVAC Development, Truck Integration, Fleet Installation, Fleet Evaluation, and Project Management and Reporting.

Task 1: Specifications and Supplier Selection

International has conducted interviews with customers to identify requirements for idle reduction equipment and is working with suppliers to develop detailed specifications for the performance of the diesel APU, electric HVAC, and cab insulation systems. Suppliers have been contacted to obtain competitive cost quotations and establish commercial agreements for sourcing the idle reduction subsystems.

Mechron was selected as the primary source for APUs, and based upon cost is also being considered with Bergstrom for the HVAC system. A design requirement document was written for the No-Idle Air Conditioning System. Development is continuing with both Bergstrom and Behr/Mechron in an effort to reduce costs.

Task 2: Air-Cooled Diesel APU Development

Mechron has been selected as the primary source for the air-cooled diesel APU and a prototype has been requested. Endurance and performance testing will be conducted, followed by an evaluation report.

Task 3: Water-Cooled Diesel APU Development

Production-intent water-cooled diesel APU samples will be designed and fabricated. Subsequently, endurance and performance testing will be conducted and a validation test report prepared. Currently, definition of validation tests is being conducted and a preliminary validation plan has been developed. Existing tests and test results from Mechron will be examined to determine if they can be used in place of new tests while still ensuring proper validation of the water-cooled diesel APU.

Task 4: Electric HVAC Development

Hot and Cold Climate Air Conditioning Approach

Two versions of the A/C system have been considered. The first is a 120Vac system, recirculation only, to be operated off of shore power or an APU. The second is a 12V system to be run off of battery power. The 120Vac A/C system consists of a single, drop-in module that houses the A/C compressor, evaporator, condenser, condenser fan, plumbing and electrical effects. The module is located on the passenger side under the bunk, installed through the luggage door. Modifications to the footlocker cabinet were made to accommodate a treated air outlet duct. The 120Vac compressor can only function in an on-off fashion, and requires a minimum of six minutes before re-engaging in order to prevent refrigerant slugging and to maintain compressor life. With this operation, and in a moderate ambient temperature setting, the compressor may turn off, whether by the auto temperature control or by internal freeze protection switch. In this case, the temperature within the cab begins to rise, increasing by more than 2^{o}F in six minutes before the compressor re-engages.

The 12Vdc system substitutes a 12Vdc compressor and electronic controller, and as the automatic sleeper control adjusts voltage, the temperature within the cab is maintained. International is working to improve the efficiency of the 12 Vdc system with improvements required in the areas of more efficient A/C operation, better batteries, and improved cab insulation. Either option can be mated with a heater to provide a full, hot/cold weather idle reduction system.

Cold-Climate Heating Approach

A fuel-fired coolant heater has been selected for providing heat for the Cold-Climate option. The coolant heater module provides heated coolant through the existing sleeper HVAC system and/or engine in engine-off conditions. The coolant heater is a 17K BTU unit that is basically off-the-shelf with minor modifications for routing of electrical, coolant, fuel and exhaust. The unit is housed in an enclosure and is mounted on the passenger side frame rail. An electronically controlled solenoid valve controls delivery of the heated coolant to the sleeper HVAC unit and/or to the engine. The coolant heater is powered by diesel fuel and four Decka deep cycle batteries. After 10 hours of coolant heater operation the battery voltage was still in the 12 to 12.5 volt range, indicating sufficient battery state of charge. Table 7 provides a comparison of the No Idle

Table 7. Comparison of No Idle HVAC Systems for International's Series 9000i Sleeper Trucks

Major Items - Similarity or Differences	No Idle Heat (Cold Climate)	APU Systems (Hot and Cold Climate)	
	Fuel Heater	120Vac (AC only)	120Vac (Heat and AC)
Interior Unit	Provides heat to current underseat unit	Additional unit under bunk	Additional unit under bunk includes Electric Grid Heater
Exterior Unit	Frame Rail Mounted Unit, under cab	APU	Mechron CCS APU
Total Batteries	6 deep cycle	No additional	No additional
System Configuration	Used in Battery Only or with Shore Power or APU	APU or Shore Power	APU or Shore Power
Cab Insulation	Premium w/ new Sleeper Curtains	Premium w/ new Sleeper Curtains	Premium w/ new Sleeper Curtains
No Idle Heat	Fuel Fired Heater provides heated coolant to current HVAC unit	Optional Requires Espar Heater	Electric Grid Heater contained in HVAC unit
No Idle AC	N/A	120V ac System, Shore Power or APU compatible	120V ac System, Shore Power or APU compatible
Compressor	N/A	120V ac Sealed Compressor	120V ac Sealed Compressor
Compressor Control	N/A	On/Off only	On/Off only
Run Time	10 hour TMC on Battery	Fuel Limited w/ APU	Fuel Limited w/ APU

HVAC systems for International's series 9000i sleeper trucks. The first option-No Idle Heat - is for strictly cold weather application. The APU options are for hot and cold climates. The column entitled 120Vac (A/C only) was initially considered by International, but is no longer an option as it was felt an APU driven system strictly for A/C was not commercially viable. The 120Vac (Heat and A/C) option will be available in the Spring 2006.

Task 5: Truck Integration

Design installations for the APU, sleeper HVAC, and insulation systems have been developed for the International 9000i sleeper truck products. Production-intent components have been installed into a concept truck to permit vehicle level system testing. Both 110Vac and 12Vdc systems were subjected to on-road A/C testing in Galveston, Texas and Casa Grande, Arizona from August 9 through August 20, 2005.

On road heater testing was conducted in Thompson, Manitoba, Canada from December 1 through December 8, 2005. The testing was conducted on an International 9400 (E600). Different sleeper blower speeds, sleeper temperature settings and heater cores were tested. From the test results in near Truck Maintenance Council (TMC) RP 432 conditions, the coolant heater system provided adequate heating to maintain 68°F for 10 hours. The coolant heater system was also tested as an engine warm-up device.

Testing in the cool room has shown that adding an insulated sleeper curtain improves the sleeper interior temperatures. Under-cab insulation was also developed and testing is underway on determining the impact on the sleeper interior temperature. Testing at Bergstrom commenced on January 30, 2006. Feature Codes were created for the ordering and sale of the heating and air conditioning system. Feature codes have not yet been generated for the APU system.

Task 6: Fleet Installation

Five production-intent prototypes will be completed and a participating fleet will be identified and hot and cold climate idle reduction systems will be installed into five customer-ordered vehicles. The truck purchases will be outside the scope of DOE program and funding. Telematics monitoring equipment will be installed to measure and record the operation of the main engine and idle reduction equipment. Feedback regarding the performance of the system will be solicited. Fleet installation is planned for May 2006.

Task 7: Fleet Evaluation

Fleet evaluation is pending fleet installation of the No Idle systems.

Task 8: Project Management and Reporting

Project management and reporting continue as on-going project activities.

Future Plans

In the winter and spring of 2006, International plans to finalize the HVAC design concept and select the HVAC suppliers. Progress is also targeting component validation and release of the heating system and APU installation to the factory.

International Truck and Engine Corporation has announced plans for its integrated factory-installed reduced idle system to be available in the Spring of 2006. The cab and sleeper insulation, fuel-fired heater with engine preheat, electric HVAC, and battery system will begin limited production in March 2006. The APU will begin limited production in May 2006.

Recommendations

DOE should consider expanding the scope and extending the duration of the International project to examine and capture long-term engine and accessory wear reduction benefits from the use of factory-installed idle reduction technologies. This information is important to mainstream acceptance of idle reduction technologies and has yet to be comprehensively quantified nor accepted by the trucking industry. Presently, only the Caterpillar MorElectric™ project is capturing the benefits of reduced engine and accessory wear from the use of idle reduction technologies. Similar to the recommendations for the Caterpillar project, it would be appropriate for the engine and accessory wear benefits of International's factory-installed idle reduction technologies to be examined out to the point of the first major engine overhaul typically at 5-6 years and 600,000-800,000 miles.

Status of Other AVTA Idle Reduction Activities

Driver Questionnaire

Driver acceptance is crucial for widespread use of technologies that reduce truck idling. In June 2004, the AVTA team developed a driver questionnaire to be administered to truck drivers involved in the idle reduction technology demonstration projects. These 22 questions are intended to help capture user impressions of the various technologies being tested as well as identify specific barriers to acceptance of a particular system or technology. The questionnaire is being used by the DOE idle reduction technology demonstration projects. Appendix A provides the driver survey results from the Schneider demonstration project.

CoolCab

Results from the idle reduction demonstration projects have identified key issues with truck cab insulation that warrant further investigation. Drivers complained of heat penetrating the cab walls, causing discomfort and reducing the effectiveness of the cooling equipment. The heat penetration was most noticeable on sunny days. This insulation issue has been discussed at idle reduction workshops and was identified as a major issue needing further research and development at the National Idling Reduction Planning Conference in Albany, NY in May 2004. Manufacturers claim that improving insulation and reducing the cooling or heating load can substantially decrease the size, cost, and weight of their idle reduction technologies. AVTA is conducting an activity to apply past experience with light-duty vehicle interior thermal management to heavy-duty truck tractor cabs. Called CoolCab, this effort uses a "systems approach" to investigate thermal loads on the vehicle, effective delivery methods, and efficient equipment.

Under the CoolCab effort, DOE is working with Schneider National to identify high energy transfer areas within the truck cab with the greatest potential for improvement. As a first step, infrared imaging is being used to investigate potential areas for improving cab efficiency. Two days of infrared testing on two trucks at ambient temperatures of 0 ^{o}C (32 ^{o}F) has been conducted. Results indicate potential for improvements in the driver and passenger footwells, front overhead storage support, optional sunroof areas and ceiling pad, rear of upper bunk, and underneath the auxiliary heater. Differences in exterior surface temperatures of about 2 ^{o}C indicate the insulation improvements of the super truck. Future plans are to discuss results with Freightliner, test truck-to-truck variability, and establish a protocol for quantifying heat flux through the truck cab.

Next Steps

As final results from the idle reduction technology demonstration projects become available, DOE will publish reports documenting the in-service performance of the tested technologies. These results will quantify the cost and reliability, identify potential barriers to widespread use, and help analyze the payback period for an idle reduction technology installation. The reports will provide information to other truck fleets and owner-operators considering the purchase and use of idle reduction technologies. As preliminary results are received, the AVTA team will continually investigate issues discovered in the demonstration projects to define future activities in support of reducing truck idling and its resulting fuel use.

Other Idle Reduction Activities within the U.S. Government

NYSERDA MorElectric™ Truck Validation and Demonstration

The New York State Energy Research and Development Agency (NYSREDA) is also funding a demonstration of MorElectric™ truck technology utilizing five Peterbilt 387 service trucks powered by Caterpillar C15 engines operated by Schneider National Inc. These trucks use the same Caterpillar MorElectric™ components as the DOE-Caterpillar idle reduction demonstration and have accumulated over 298,000 miles. Though Schneider National already has a driver incentive package based on idle time to save fuel, main engine idling for the MorElectric™ trucks has been further reduced to 5.3% with an average 5.4% fuel savings. On a yearly basis, the APU averaged 1,584 hours of service per truck. The annualized average fuel savings with the APU is 950 gallons per truck.

National Idle Reduction Plan

DOE is working with the Environmental Protection Agency (EPA) and the Federal Highway Administration (FHWA) to develop a national idle reduction plan as a result of consensus reached at the National Idling Reduction Conference in Albany, NY, in May 2004. The goal of this effort is to define activities promoting the introduction of idle reduction strategies and technologies. Clean Cities is also involved to help plan how results from demonstration projects and information from other idle reduction activities get disseminated. A draft of this plan has been developed and includes sections on technology, finance, regulatory activities, and outreach. This plan is being reviewed with an expected limited release in 2006. AVTA is supporting the development of this plan through sharing of information and knowledge gained through the technology demonstration projects.

State Energy Program (SEP) Special Projects

DOE's State Energy Program (SEP) (see www.eere.energy.gov/state_energy_program) provides funding to states for renewable energy and energy efficiency projects. DOE's Office of Energy Efficiency and Renewable Energy (EERE) awards these projects annually to state energy offices through a competitive solicitation. Funding for the projects comes from EERE technology programs and is managed by the State Energy Program. A SEP solicitation issued by DOE's Clean Cities Program included funding opportunities for idle reduction projects. The following three paragraphs discuss 2005 SEP grants for idle reduction technologies.

The New York State School Bus Anti-Idling Program received $75,000 to retrofit 35 buses with ESPAR coolant heaters to reduce the need for idling. Operational and use data on these units were collected to quantify their benefits to the school bus fleet operators. Included in these activities were training and instructional seminars for New York Department of Transportation personnel; these types of technologies are not widely used in New York for school bus applications. This project hopes to gain wider acceptance of such technology from the marketplace, for which New York accounts for 10% nationwide, and change attitudes toward idle reduction technologies.

In Indiana, Styline Transporation was funded $100,000 by SEP to install ProHeat, an on-board idle reduction technology, on 30 of its heavy duty trucks. Using an average diesel fuel price of $2.30 per gallon, Styline Transportation will realize an estimated weekly fuel cost saving of

$6,210; an annual fuel cost saving of $322,000 and a lifetime fuel cost saving of $1,610,000 over the life of the 30 trucks. These bottom line savings will allow the company to install additional idle reduction kits on its remaining 76 trucks.

With $11,656 provided by SEP, the Flatiron Improvement District/Idle Reduction Tech Public Awareness Campaign acquired and installed six engine preheaters (with timers) for diesel-powered passenger shuttles used for the Zip Shuttle System that serves employees and shoppers of the Flatiron Shopping District. The District conducted a public information campaign, using its Web site, local access cable TV, LED "NextBus" signs, destination signs, voice annunciation, and feature articles to reassure patrons that these are clean-burning vehicles and that idle-reduction technologies are used.

In 2004, DOE awarded three truck idle reduction projects through SEP (with funds provided by Clean Cities and AVTA): a shore power project in California, an APU (Pony Pack) data collection project in New Mexico, and an infrastructure deployment project in New York.

Clean Cities

DOE's Clean Cities (http://www.eere.energy.gov/cleancities/) is a deployment activity within the U.S. Department of Energy's FreedomCar and Vehicle Technologies (FCVT) Program (http://www.eere.energy.gov/vehiclesandfuels/) to advance the economic, environmental, and energy security of the United States by supporting local decisions to adopt practices that contribute to the reduction of petroleum consumption in the transportation sector. For idle reduction technologies, Clean Cities strategies include educating stakeholders about available idle reduction technologies; holding workshops for niche market fleets to teach them the benefits of idle reduction, including cost savings in fuel and maintenance; developing outreach documents detailing idle reduction technology options, costs, and benefits; making State Energy Program special project grants available for idle reduction projects; and establishing and tracking national and regional idle reduction goals and impacts.

Through the 2005 State Energy Program (SEP) (http://www.eere.energy.gov/state_energy_program/) Clean Cities Special Projects solicitation, Clean Cities funded 60 projects totaling approximately $5.4 million, which included the following activities for idle reduction technologies:

- Clean Cities funded $20,000 to the Northeast Ohio Clean Cities Coalition Support to accelerate the use of idle reduction technologies in northeastern Ohio, especially among the regions truck transportation industry.
- The Greater Philadelphia Clean Cities Coalition Support received $20,000 to promote idle reduction through the Clean Yellow Bus Association.
- The Clean Cities-Atlanta Idle Reduction Technologies project, funded $48,043, deployed and evaluated on-board auxiliary power units (APUs) to reduce the amount of petroleum fuel used by trucks during idling in a commercial trucking application.
- Clean Cities funded $16,556 to the Clean Cities-Atlanta (CC-A) to develop coalition in the Atlanta region activities, which include idle reduction technologies.
- The Denver Metropolitan Clean Cities Coalition received $20,000 to host successful events to increase the use of alternative fuels and alternative fuel vehicles, including idle-reduction technologies, and expanding the number of stakeholders.
- Northern Colorado Clean Cities (NCCC) was funded $20,000 to hold events, including the promotion of idle reduction strategies in alternating locations around various cities.

- Clean Cities awarded $20,000 to the Oregon Clean Cities Coalition Support, which provided for the Columbia-Willamette Clean Cities Coalition, Inc. coordinator position to organize and host an "Advancing the Choice" event in conjunction with an auto, truck, retrofitter, hybrid or idle reduction manufacturer.
- Norwich Clean Cities Coalition Support of Connecticut, funded $20,000, will organize in FY 2006 and host at least one "Advancing the Choice" event per year in conjunction with an auto, truck, retrofitter, hybrid, or idle reduction manufacturer with the intent to increase sales.
- Alamo Clean Cities Coalition Support helped develop an Early Action Program between local elected officials, the Texas Commission on Environmental Quality, and the EPA. The Clean Cities program funded $20,000 to this coalition to encourage municipalities and industries to participate in the emission reduction effort by promoting alternative fuels, idle-reduction technology, and expansion of alternative fuel station infrastructure.
- Space Coast Clean Cities Coalition Support of Florida accelerated the use of idle reduction technologies through meetings, events, and activities with $20,000.
- Gold Coast Clean Cities Coalition Support of Florida, funded $10,000, supported the introduction and use of idle reduction strategies, and targeted resources specific to idle reduction strategies in niche markets such as area airports and ports, school district buses, transit buses, state and federal fleets, and light and medium duty delivery fleets.
- Clean Cities provided the Maryland Transit Agency (MTA) with $65,301 to install idle reduction devices on transit buses to support the Clean Cities Program. The Maryland Department of the Environment and the MTA retrofitted 100 buses with Clever Devices BusLink Switches, which allow "just-in-time" engine starting and warmup. The switches automatically activate a ProHeat auxiliary heater that will heat the coolant in the engine and allow the vehicle to be at operating temperature when turned on in the morning. A wireless bus communication system was installed at the depot to allow the MTA to remotely operate and communicate with the device. If this project is successful, MTA will incorporate these devices into its entire fleet of 822 transit buses.

Clean Cities and the Propane Education & Research Council (PERC) (http://www.perc.org/) developed and each contributed $100,000 for a total of $200,000 to the Grant Partnership program in order to provide funds for propane deployment projects, which also include activities for idle reduction technologies. In 2005, the program sought projects on power generation at truck stops and delivery locations as well as other idle reduction application utilizing propane. New West Technologies of Landover, Maryland was awarded $30,000 to investigate the market for tractor-installed propane, develop a preliminary design for on-board propane APU system and identify funding resources for a pre-commercial propane-fueled APU and demonstration on long-haul tractors in the mid-Atlantic region.

State Technologies Advancement Collaborative Solicitation STAC Grants

The State Technologies Advancement Collaborative (STAC) (http://www.stacenergy.org/) was formed by an agreement between the U.S. Department of Energy, National Association of State Energy Officials, and the Association of State Energy Research and Technology Transfer Institutions to allow states and territories and the Federal Government to better collaborate and move forward on energy research, development, demonstration, and deployment projects using an innovative project selection and funding process. On May 2, 2005, the STAC Solicitation on "Energy Efficiency Research, Development, Demonstration, Deployment, and Rebuild America Projects (05-STAC-01) made available a minimum of $4.95 million for cost-shared energy efficiency and clean energy projects for advanced technologies in buildings, industry, and transportation, as well as projects in distributed energy resources and Rebuild America. In the transportation technologies area, the solicitation was open to projects that demonstrate and collect data on heavy-duty vehicle idle reduction technologies. Proposed multi-state projects may have included, but were not limited to: on-board technologies for heavy-duty trucks; school, transit, coach, and tour buses; off-road construction; marine; or locomotive technologies, and should have focused on quantifying petroleum usage, environmental impact, and economic impact of idle-reduction technologies. On October 24, 2005, the STAC Executive Committee selected eleven projects, valued at $11.5 million, to cover each of the five technical areas in the solicitation. More than $6.6 million of the selected projects' value represented costs to be shared by non-federal government entities, and approximately $4.9 million funding from the STAC program. However, none of the eleven projects included advancements in idle reduction technology.

EPA SmartWay

The SmartWay[SM] Transport Partnership (http://www.epa.gov/smartway/index.htm) is a voluntary collaboration between U.S. EPA (http://www.epa.gov/) and the freight industry, designed to increase energy efficiency while significantly reducing greenhouse gases and air pollution. On June 10, 2003, in Atlanta, Georgia, EPA launched the National Transportation Idle Free Corridors project under the SmartWay Transport Partnership. The objective of this project is to eliminate all unnecessary long-duration truck and locomotive idling at strategic points along major transportation corridors, which will be achieved by studying, evaluating, and deploying technologies and strategies for trucks, locomotives, truck parking facilities (see interstate highway maps [http://www.epa.gov/smartway/idle-tsemap.htm]), rail yards, and other idling locations. To implement idle reduction projects in a successful and cost-effective manner, EPA will work with a group of key partners and stakeholders, which include state and local air quality planners, state and local transportation officials, state and local energy officials, idle reduction technology manufacturers, trucking fleets and railroad companies, truck stop owners and operators, environmental and community organizations, and other groups interested in reducing idling. On October 11, 2005, EPA awarded $5 million in grant under the SmartWay Transport Partnership, which will help pay for technologies that save fuel and money while also reducing pollution. The SmartWay grants supported a first-of-its kind initiative that deploys a wide variety of idle reduction technologies on trucks and at truck stops and ports across the nation. In addition, the grants will spur development and commercialization of idle-reduction technologies that yield even greater benefits as their use becomes more widespread. The grants were awarded to the following entities:

- Texas Transportation Institute - "Truck Engine Idle Reduction Technology Demonstration Program" $3,000,000
- Ohio Department of Development - "Ohio and Midwest Truck Stop Electrification Corridors Demonstration, Evaluation, and Development Project" $500,000
- Lane Regional Air Pollution Authority (Oregon) - "Everybody Wins - Phase II" $500,000
- American Transportation Research Institute - "Demonstration of Integrated Mobile Idle Reduction Solutions" $500,000
- North Carolina State University - "Truck Original Equipment Manufacturer (OEM) Auxiliary Power Unit (APU) Prep Kit Design and Installation" $500,000

Since 2000, EPA has funded several idle reduction demonstration projects under the authority of the Clean Air Act, Section 103(b). A case study on the "Vancouver, WA Switchyard Locomotive

Idle Reduction Project" (http;//www.epa.gov/smartway/documents/Vancouver-locomotive.pdf) was released on October 2005, which is a final report by Southwest Clean Air Agency on the effectiveness of idle reduction technologies emission reductions on locomotive switch yard engines and fuel savings of a Class I railroad in Vancouver, Washington using a combined auxiliary engine idle reduction technology and automatic shut-down/start-up technology, which EPA funded $85,000 in 2003.

Appendix A: Driver Survey Results – Schneider National

Summary Survey:
Fleet Demonstration of Idle Reduction Technologies

Driver acceptance is critical to successfully encourage the use of idle reduction technologies in heavy duty trucks. This survey was developed to ascertain users' perceptions of idle reduction technologies during fleet demonstrations. The information gathered herein will help to identify any remaining barriers from the users' standpoint and how they may best be overcome.

DRIVER HISTORY PRIOR TO THIS DEMONSTRATION PROJECT FOR IDLE REDUCTION TECHNOLOGIES

1. Prior to this demonstration project, did you track idling time? ❑ Yes 9 ❑ No 9 NA - 1

2. Why historically have you idled your sleeper vehicle? (Please provide ESTIMATED percentage for each of the following. Total should equal 100%.)

39	Heat the cab?	38	Cool the cab?	7	Keep the engine warm?
9	Stopped in traffic?	8	Other? (specify)		No Reason - 1, Freezable Loads – 2, Charge Battery - 1

3. Please ESTIMATE how many hours per year your sleeper vehicle has typically idled for each of the following: Drivers did not quote hours for this and the results are all over the place. Some used percentages like above and many just left this blank.

___ Truck stops? ___ Rest stops? ___ In traffic?

___ Loading/off loading? ___ ___

___ At or Near Customer Locations ___ Other? (specify) ___

4. Prior to this demonstration, have you used idle reduction technologies? ❑ Yes ❑ No

If yes, what type of technology have you used and who was the manufacturer?

		Manufacturer
Automatic engine shutdown	2	DDC
Diesel fired heater	4	Webasto heaters
APU (heating/cooling/electrical)	1	None given
Genset	❑	
Truck stop electrification system	❑	
Other	❑	

If no, why haven't you used idle reduction technologies?

None available in fleet to use other than demonstration projects and newer trucks with Webasto. Prior to this none available.

5. If you answered yes to Question #4, what was your experience with these idle reduction technologies?

Nite System is fantastic, Webasto is great – Cooling needs work,

QUESTIONS REGARDING THIS DEMONSTRATION PROJECT OF IDLE REDUCTION TECHNOLOGIES

6. For this demonstration, what type of idle reduction technology are you using? Who is the manufacturer(s) and how long have you been using it?

		Manufacturer	How Long
Diesel fired heater	7	Webasto Heater	12
APU (heating/cooling/electrical)	❑		
Genset	❑		
Phase change storage system	5	Webasto	12
More electric truck system	❑		
Other Nite System	7	Bergstrom	5

7. This question addresses driver comfort. Has the idle reduction technology during the demonstration:

a) Provided sufficient heat during cold weather. Yes 17 No 2 N/A

If no, please explain. Too Warm

b) Provided sufficient cooling during hot weather? Yes 13 No 3 N/A 3

If no please explain. Only have heater, Fan too low, Outside air gets in

c) Provided reliable heating functions through the year? Yes 16 No 1 N/A 2

If no please explain. Battery Charge

d) Provided reliable cooling functions through the year? Yes 10 No 4 N/A 5

If no please explain. Don't have cooling, Can't use during the day, Need more fan, Not enough battery, Must pre-cool truck or doesn't work

8. What has been the effect of idle reduction technologies during this demonstration on your sleeping in the cab?

   17 Made it better
   0 Made it worse
   2 About the same

   Please explain. Less Fuel, Less engine wear, driver comfot, Can't sleep anymore with engine idling – too noisy, don't wake at night freezing, Slept last two nights with Temps in teens and never noticed

9. Has the idle reduction technology taken up too much space within the cab? 8 Yes 11 No

   If yes, please explain. Need Shelves Back, Should go under bunk, Took refrig space, Takes half of under bunk space, Not enough room for it, Put batteries outside

10. Has the weight of the idle reduction technology impacted your ability to carry a full load?
    1 Yes 18 No

    If yes, please explain. Drivers may not have visibility to this as Customer service works Direct with customers.

11. Has the idle reduction technology provided flexibility for additional driver amenities you find useful? For example, electrical power to run larger refrigerators, microwave, or lap top computer? 0Yes 19 No 0 N/A

    Please explain.

12. In your opinion, can the idle reduction technology provide useful backup power during a failure of the main truck engine? 3 Yes 8 No 8 N/A

Please explain. It drains batteries

13. Was training on the idle reduction technologies for this demonstration project quick and easy? 17 Yes 2 No

If no, please explain. 6 Hours training provided, Don't need any

14. Is the idle reduction technology easy to operate? 18 Yes 1 No

If no, please explain. Never received training

15. Has the idle reduction technology required maintenance on the road? 1 Yes 18 No

If yes, please explain. OTR shop did not have parts

16. What has been your overall experience with idle reduction technology during this demonstration?

Heater excellent, Better rest, No worries whether I am going to be hot or cold, Heat good, Cooling needs work, 100% satisfied & reduced idle, good, Great don't take away, need More vents, I'm warm on cold nights, heating good cooling needs help, easy to get bonus, cooler needs to be more powerful, greatest thing ever, Dropped idle from 20% to 2 %, all trucks should have, Love the cooling system,

17. Would you like to continue to use this idle reduction technology after the conclusion of the demonstration? 19 Yes 0 No

Please explain. Will not give it up

18. If you perceive the following items (or others) as barriers to the adoption of idle reduction technologies, please rank them. Most drivers didn't rank these but chose one or two and marked them. I put checks next to most common ones

X Cost

___ Performance

X Weight

X Maintenance (regularly scheduled)

____ Maintenance (breakdown) X Parts/distribution network

____ Driver training/education/ acceptance ____ Lack of warranty

____ Other ____________________

19. Are there additional comments (positive or negative) you would like to make with regards to idle reduction technologies and this demonstration?

Please elaborate. Some of questions weren't clear, Idle was at 5% now at 0%, I love it If I owned my own truck I would buy it, need more vents, Keep it, Wonderful idea, Need more battery for cooler, temperature control, provides driver with comfort when Really needed, Cooler system is great

20. What information would you personally need to make a decision on using idle reduction technologies? Please mark all that apply.

a) Experience of peer/colleagues?	3
b) Results of long term (2 winters) test for reliability/ durability?	14
c) Cost/payback period?	9
d) Extent of dealer/OEM support network?	0
e) Other? Would buy it myself	2

21. Please check all that apply and rank in order of priority your primary sources of information on truck technology and related areas. Drivers did not rank so I put the areas most often checked

		Rank
❑	Truck manufacturers	9
❑	Federal Government	3
❑	Associations	
❑	Engine manufacturers	2
❑	Industry trade publications	4
❑	Other Sources	8 (SNI)

22. Please check all that apply and rank in order of priority the following means through which you prefer receiving information on truck technologies and related areas.

		Rank
❑	Industry conferences	1
❑	Industry trade publications	10
❑	Government publications	2
❑	Electronic newsletter	0
❑	World wide web/internet	3
❑	Other	6 (SNI)

23. After completing the survey send it in a shuttle envelope to: Dennis Damman/LHS