APPENDIX E

ALTERNATIVES TO PRIMARY ENGINE IDLING

Alternatives to Primary Engine Idling

When the second phase of the Proposed ATCM takes effect, on January 1, 2009, operators of heavy-duty, diesel-fueled vehicles equipped with sleeper berths will need to consider an alternative to idling the primary engine. An alternative supply of power may be necessary for cab heating and cooling, engine heating, and operating on-board accessories when simply shutting off the engine is not practical. Commercially available alternatives include electronically controlled idle limiters for the main engine, diesel-fired heaters, auxiliary power systems, on- and-off board truck stop electrification, and other miscellaneous devices and software modifications.

A significant amount of idling of heavy-duty diesel vehicles can be eliminated by using currently available alternatives.

A. ELECTRONICALLY CONTROLLED IDLE LIMITERS

Idle limiting devices are software based idle limit controls. They include idle shutdown timers and automatic stop-start systems.

1. Idle Shutdown Timers

Idle shutdown timers are standard features in most modern electronically controlled heavy-duty engines. The system is built into the engine's electronic control software and enables the engine to shutdown automatically if it is left to idle for more than the programmed time. For example, the system can be programmed to shutdown automatically between 2 to 100 minutes in engines made by Detroit Diesel Corporation (DDC), between 2 to 1440 minutes in engines made by Cummins Inc., and 3 to 60 minutes in engines made by Caterpillar Inc. The system can also electronically turn off the ignition to avoid battery discharge that may occur if accessories such as lights and/or the radio, were left in the "on" position during engine shutdown.

2. Automatic Stop-Start Systems

Automatic stop-start systems are predominantly comprised of additional engine software controls that automatically stop and restart the engine as necessary to maintain the engine and cab/sleeper berth temperatures~~,~~ and battery voltage within pre-set limits. Currently several manufacturers, including DDC, Cummins Inc., Caterpillar Inc., and Mack Trucks Inc., offer this feature as a factory option. To date, DDC alone has over 75,000 of these systems installed on its engines nationwide. For safety purposes, the system only works when the parking brake is engaged with the transmission in neutral, the hood engine/compartment closed, and the ignition key in the "on" position. The system is disabled by turning off the ignition or when the vehicle is being driven. An "engine only" mode or a "cab comfort" mode are available. The "engine only" mode monitors engine oil temperature and battery voltage, while the "cab comfort" mode includes monitoring of engine mode parameters as well as sleeper berth temperature. In the cab comfort mode, a thermostat located inside the sleeper berth monitors the inside temperature and sends a signal to the electronic control module (or in some cases a separate control module) when to stop and restart the engine to maintain the sleeper berth temperature in the desired range. The system includes a sensor for monitoring the outside ambient temperature so that under extreme ambient conditions the engine runs continuously.

The amount of idling reduced by the automatic stop-start system varies. Among the major factors influencing the amount of engine run time are the ambient temperature and humidity, drivers preferences of temperature settings, power needs to operate on-board accessories, efficiencies of air conditioning systems, and insulating capabilities of the floor and the sleeper walls. The system does not add weight to the truck and does not require separate maintenance.

A frequently cited drawback of this system is the discomfort it causes to the sleeping driver during the periodic stop and restart of the engine. However, to minimize driver discomfort, the technology has been developed such that the engine speed slowly increases during start-up and slowly decreases before shutdown. Also, this technology still requires the inefficient use of the vehicle engine to meet ancillary needs. Depending on truck manufacturer, the system retails from $800 to $1,200.

B. FUEL-FIRED HEATERS

Fuel-fired heaters provide heat to the cab/sleeper berth and/or to preheat the engine block for easy engine start-up during cold weather. Different models exist for a variety of applications. They run 20 or more hours on a gallon of diesel fuel and typically use the fuel from the truck's fuel tank. The units are relatively small, inexpensive, and consume much less fuel than an idling diesel engine. Diesel fired heating systems provide cab and sleeper heat without idling the trucks. These heaters raise the temperature gradually and evenly. By tapping into the fuel and power supply of the vehicle they avoid the need for external hook ups and can operate anywhere.

The benefits include safety, reliable cold weather starting with no electrical plug-ins, and a warm cab and sleeper without idling the engine. A report by the U.S. EPA shows that diesel fuel-fired heaters reduce NOx emissions by approximately 99 percent and fuel consumption by 50 to 80 percent (U.S. EPA, 2002). The drawbacks of this technology are its inability to provide cooling and its use of the truck's battery power for operation. The cost of fuel-fired heaters ranges from $1,000 to $3,000 per unit (U.S. EPA, 2003).

C. AUXILIARY POWER SYSTEMS

Auxiliary power systems are truck mounted devices that provide electrical, thermal, or mechanical power for some or all of the options that would normally require the truck engine to idle. These devices include Auxiliary Power Units (APU), fuel cells, and battery packs.

1. Auxiliary Power Units

An APU uses a small compression ignition internal combustion engine powering a generator/alternator. The APU may also be equipped with air conditioning unit for cooling the sleeper berth. Often the APU provides electrical power or thermal energy through heat exchangers to heat the sleeper berth and heat to the engine for cold weather starting. The APU may also provide 12-volt DC electrical power to charge the batteries and AC power for on-board accessories such as televisions, microwaves, and computers. The APU typically uses fuel from the vehicle's fuel system. The fuel consumption of diesel fueled APUs range between 0.08 to 0.3 gal/hr (Stodolsky et al., 2000). This is a significant fuel savings compared to the vehicle's engine idling fuel consumption rate of about a gallon or more per hour. NOx emission reductions are also significant ranging up to 70 percent less than the idling primary engine (U.S. EPA, 2002). The drawbacks are their initial cost, additional weight, and maintenance requirements. The cost for an APU averages $8,600.

2. Fuel Cells

An auxiliary power system that has a promising future in eliminating truck idling emissions is the fuel cell. A fuel cell produces electricity by converting the chemical energy of fuel directly to electrical power in a controlled chemical reaction. Fuel cells are clean and efficient. They can provide sufficient power to heat or cool a cab/sleeper compartment and run on-board electrical equipment. Recently, researchers measured the emissions, fuel economy benefits and demonstrated the feasibility of a hydrogen proton exchange membrane (PEM)[1] fuel cell in a Freightliner class 8 truck sleeper cab.

Fuel cells are expected to be commercially viable within ten to fifteen years. However, technical and economic issues, such as availability and infrastructure of a suitable fuel, the production costs of the units, and integration of the units with other on-board truck systems need to be overcome before these systems can become cost-effective for commercial truck operators. While there are technical and economic issues that need to be addressed before these systems become commercially available, this technology holds promise to improve the air quality by reducing emissions.

3. Battery Packs

Manufacturers have developed on board systems for cooling and heating long-haul vehicles without the need to idle the main engine or operate an auxiliary diesel engine. Such systems combine a fully independent air-conditioning system designed to work independently of the main engine. They also include a control system and a power source.

---

[1] Institute of Transportation Studies, University of California, Davis. Diesel Truck Fuel Cell APU. October 2003 www.its.ucdavis.edu/hfcv_openhouse/programspotlights/DieselAPU.pdf

The air conditioning system weighs about 70 pounds and the heating system has a weight of approximately 8 pounds. The self-contained power system includes two deep cycle batteries and has a capacity of 220 amp-hours. The system can be operated up to 10 hours and has a battery life of over two years. The batteries are fully charged after 4-6 hours of main engine operation. The entire system has a total weight of 210 pounds including the two batteries and can be installed under the bunk bed in the sleeper berth.

The estimated cost of this system is $ 3,500. The drawback of this system is that it may not fully meet the ancillary power needs of the sleeper berth.

D. TRUCK STOP ELECTRIFICATION

The development of an electrical power infrastructure is another option to reduce engine idling emissions. This technology provides trucks with AC electrical power to run the air conditioning, heating, and ancillary appliances. Truck stop electrification (TSE) refers to an independent electrical system that provides a vehicle with an alternate source of power eliminating the need to idle the primary engine.

1. On-Board Truck Stop Electrification[2]

The on-board TSE system is an independent system that may supply power without modifying the vehicle or may require that the vehicle comes equipped with three essential components:

- An inverter to charge the truck batteries from grid supplied electricity and to convert the truck batteries' 12-volt DC to 120-volt AC power for all ancillary appliances. Currently, Freightliner, Volvo, and International offer AC power inverters, which are built into the truck as a factory option.

- An electrical HVAC (heating, ventilation, and air conditioning) system to provide heat and air which is powered by electricity.

- Hardware to plug into the electrical outlet.

For the truck stop operator, on-board TSE requires an outlet for the vehicle to plug into. The truck stop operator would regulate its use and charge a fee for the use of this service. A few truck stops currently provide outlets for use. If no electrical outlet is available, battery power can be used to operate the HVAC on some systems.

TSE requires that rest and truck stops be equipped with electrical outlets throughout the parking spaces and that trucks be equipped with inverter-chargers, electrical power connections, and electrically driven air conditioning units.

---

[2]. Truck Stop Electrification EPA-OTAQ-Voluntary Programs -SmartWay Transport. www.epa.gov/ptaq/retrofit/f03020.htm

The drawbacks of this system include the high initial truck stop infrastructure cost, cost for equipment add-ons to trucks, and its availability, which is currently limited to very few truck stops. The cost for inverter/chargers is approximately $1,400 per truck and an AC operated air conditioning unit is approximately $1,350 per unit. A truck stop electrification infrastructure installation cost is approximately $4,000 per truck parking space.

2. Off-Board Truck Stop Electrification

Another truck stop electrification system, which does not require truck modification, has been recently introduced into the market place. The system consists of a structure above the parking spaces with a HVAC unit for each space attached. The system provides 110-volt AC electrical power for on-board appliances, an externally mounted, individual thermostatically-controlled, heating and air conditioning unit, and hook-ups for basic telephone, internet, and television (access to cable/satellite) services at each truck parking space.

The unit is connected to the truck through a console mounted to the truck window using a template insert. The console contains all the necessary connections and controls, including a card reader for the billing system.

Currently, the basic services cost about $1.25 to $1.50 per hour. The drawbacks are the infrastructure installation and maintenance costs, availability is limited to a small fraction of truck stops, and the need for significant government subsidies for more rapid implementation. The potential for diminished parking capacity due to infrastructure space demands may also pose additional issues for truck stop owners and operators. The infrastructure cost is approximately $10,000 per parking space and may vary depending on the number of parking spaces installed.

E. MISCELLANEOUS

For certain drivers who infrequently require sleeping or resting accommodations, additional alternatives to idling may include turning the engine off when weather allows, and staying at hotels or motels. Additionally, equipping the sleeper berth with more insulating blankets may eliminate the need for idling during some inclement weather.

Summary

There are several technologies available to reduce or eliminate idling the primary truck engine for driver comfort in sleeper berths. Table E- 1[3] below provides a comparison of the technologies and estimated cost benefits.

Table E - 1

Technologies and Estimated Cost Benefits

Technology	Initial Cost	Op. charge	Fuel* Saving	Maintenance Saving/yr
Direct fired Heater [1]	$ 1-2K per unit	0	$1,152	$513
Automatic Engine Idle	$ 1-2K per unit	0	$ 1,350	$ 1, 056
APU	$ 5-7 K per unit	0	$ 2,880	$ 1,339
TSE (on-board)	$ 2.5K per parking spot, $ 2.5 K per truck modification	$ 1.00 - 1.50 per hr per truck	$ 3,660	$ 1,539
TSE (off-board)	$ 10K per parking space	$ 1.00 - 1.50 per hr per truck	$ 3,600	$ 1,539

* fuel savings / yr at $ 1.66/gal of diesel (projected price)
[1] Technology can operate to provide heat in cold weather

Table E-2[4]

Comparison of Benefits and Drawbacks of Various Technologies

Technology	Benefits	Drawbacks
Automatic start/stop	Intermittent services anywhere	Uses main engine, noise disrupts rest
Direct fired heater	Heat anywhere , small size and not expensive	Cannot supply cooling, requires battery power
Auxiliary power unit	HVAC and power anywhere	Heavy, large size, more expensive than heater
Truck stop electrification	HVAC and power	Not fully commercial and only available at limited locations

[3] Clean Air Technologies. Alternatives to Idling, August 2003. www.fhwa.dot.gov/environment/cmaqpgs/tseatach.htm

[4] Taken from Technology Options to Reduce Truck Idling. Stodolsky Frank;, Gaines. Linda;, and Vyas. Anant. March , 2001. Argonne National Laboratory, Transportation Technology R&D Center. www.transportation.anl.gov/pdfs/TA/74.pdf

REFERENCES

Institute of Transportation Studies, University of California, Davis. Diesel Truck Fuel Cell APU. October 2003
www.its.ucdavis.edu/hfcv_openhouse/programspotlights/DieselAPU.pdf

U.S. EPA. (2002). Study of Exhaust Emissions from Idling Heavy-Duty Diesel Trucks and Commercially Available Idle-Reducing Devices. EPA420-R-02-025, October 2002.

U.S. EPA. (2003). Currently Available Idle Reduction Technologies. Accessed: November 20, 2003. (http://www.epa.gov/otaq/retrofit/idlingtech.htm)

Truck Stop Electrification EPA-OTAQ-Voluntary Programs -SmartWay Transport. www.epa.gov/ptaq/retrofit/f03020.htm

Stodolsky, F., L. Gaines, A. Vyas. Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks. Argonne National Laboratory. ANL/ESD-43. June 2000. www.transportation.anl.gov/pdfs/TA/15.pdf

Clean Air Technologies. Alternatives to Idling, August 2003. www.fhwa.dot.gov/environment/cmaqpgs/tseatach.htm

Technology Options to Reduce Truck Idling. Stodolsky Frank;, Gaines. Linda;, and Vyas. Anant. March , 2001. Argonne National Laboratory, Transportation Technology R&D Center.
www.transportation.anl.gov/pdfs/TA/74.pdf