Emission Reduction Analysis Tool for Heavy Duty Diesel Engines

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ABSTRACT

The reduction of emissions from heavy duty diesel engines is of high priority to regulatory agencies and of major concern to the public on account of the adverse effects of these emissions on human health. Fleet managers and government regulators are faced with many emission reduction options including: fuel improvements, engine replacements, and the installation of retrofit controls. To assist in the decision making process, The FLeet Emission Estimation Tool (FLEET) was developed to assist managers of on-road and non-road vehicle fleets, as well as government regulators and policy makers, analyze and compare the performance and cost effectiveness of commercially available emission reduction technologies. FLEET calculates a baseline inventory of emissions of criteria pollutants and greenhouse gases (PM, NOx, SOx, VOC, CO, and CO_2) for both on-road or non-road diesel engine fleets and determines the emission reductions that could be achieved through the use of a variety of fuel improvements, engine/vehicle replacements, and retrofit emission controls. FLEET also calculates the lifetime cost effectiveness (present value/lifetime emissions reduction in tonnes) associated with each emission reduction strategy. US EPA engine certification data are used to estimate emissions from on-road vehicles, while the methods from the 2005 US EPA NONROAD model are used to estimate emissions from non-road vehicles. FLEET offers the user a number of benefits such as the flexibility of estimating emissions from vehicle fleets of any size, the ease of entry of fleet data and selection of one or more emission reduction technologies, and the ability to combine cost effectiveness analysis with calculations of emission reductions. This paper discusses software design, the calculation methods and emission reduction strategies included in the tool.

INTRODUCTION

The human health and air quality impacts of the emissions from heavy duty diesel vehicles (HDDV) are well recognized by regulatory agencies in Canada, the United States, and elsewhere, and of increasing concern to the general public. Canadian regulators are taking steps to implement and promote measures to reduce emissions from on-road and non-road heavy duty diesel vehicles (Environment Canada, 2003, 2005; BC

MOE, 2008; GVRD, 2005). This includes national initiatives to reduce the sulphur content of diesel fuel and implement more stringent emission standards for motor vehicles, in coordination with changes in US emission standards, as well as targeted provincial and regional programs that aim to reduce emissions by promoting retrofitting of emission control equipment, upgrading of vehicles, and the use of lower-emitting fuels. Vehicle fleet managers and regulatory staff are in need of better analytical tools for the assessment of the performance and cost effectiveness of commercial options for reducing emissions from HDDVs in response to regulatory programs, or as a design aid for voluntary initiatives.

The US EPA Retrofit Calculator, which was developed in 2000 to support the Voluntary Retrofit Program, was designed to evaluate the reduction in hydrocarbon, carbon monoxide, nitrogen oxides, and particulate matter emissions that could be achieved using catalytic particulate matter control technologies, or engine upgrade kits. The US EPA has discontinued technical support for the Retrofit Calculator and the performance data it uses for emission reduction estimates has become out of date. The Retrofit Calculator uses the engine manufacturer's certification test data (US FTP emission test), specific to engine families and model years (different from the MOBILE6.2C emission factors) to estimate baseline emissions for the remaining life a fleet of vehicles. Emission reductions are calculated as a percent of baseline emissions, however, baseline emissions are not reported. Moreover, the Retrofit Calculator is not capable of calculating the cost effectiveness of emission reduction technologies or of calculating effects on carbon dioxide emissions.

The FLeet Emission Estimation Tool (FLEET) was developed by Levelton Consultants Ltd. in 2006 for Greater Vancouver Regional District and Environment Canada (Levelton, 2006) for analysis of emission reduction technologies for on-road and non-road heavy duty diesel vehicles. It is a stand-alone computer application that utilizes an approach similar to that used in the Retrofit Calculator, however, with substantial improvements in analytical capabilities and ease of use. The FLEET estimates the baseline emissions and emission reductions likely to be achieved through the implementation of improved or alternative fuels retrofit emission controls, and engine/vehicle replacements. The cost effectiveness of the selected emission reduction options are calculated and compared. A stand-alone platform was preferred, as this option allowed for design of a user-friendly interface, avoided user requirements for other software, such as Microsoft Excel™ or Access™, and facilitates future migration of FLEET to a web-based application.

FLEET analyzes effects of emission reduction technologies on criteria air contaminants (SO_x, NO_x, CO, VOC, and PM), as well as CO_2, the primary greenhouse gas. FLEET calculates baseline emissions using US EPA engine certification program data for on-road vehicles and the 2005 EPA NONROAD model to for non-road vehicle.

SOFTWARE DESIGN

The target audience for use of FLEET consists primarily of managers of fleet vehicle in the public and private sector and staff with government agencies who are involved in air quality planning and regulatory program activities. Simplicity and user friendliness are key design requirements to ensure successful adoption and on-going use of the application. Options for the platform that were considered include Excel, Access, and a stand-alone application. Of the three options considered, a stand-alone application was selected as the most suitable platform for the FLEET Calculator as outlined in Table 1.

Table 1 Platform Options

Platform	Description	Pros	Cons
Excel	Excel model with user-friendly interface Example: School Bus Emissions Calculator (Puget Sound Clean Air Agency)	• Shorter development time	• May pose usability challenges to some users • Will not migrate to a web application • Slow execution when working with larger data sets (emission factors)
Access	Access model with user-friendly interface Example: Marine Emission Calculator (Levelton, 2005)	• Faster execution than Excel model for large data sets	• Need to package the application to run on PC's that do not have Access installed
Stand-Alone Application	Executable file developed in Visual Basic with user-friendly interface Example: Diesel Retrofit Calculator (EPA)	• Will run on user's PC with no dependency on Excel or Access • Greater flexibility in developing a fool-proof user interface • Combines user interface front-end with database back-end • Can migrate to a web based application	• Slightly longer development time

FLEET consists of three components: a graphical user interface written in Microsoft Visual Basic 6.0, a calculation module, and a back-end database created using Microsoft Access, as shown in Figure 1.

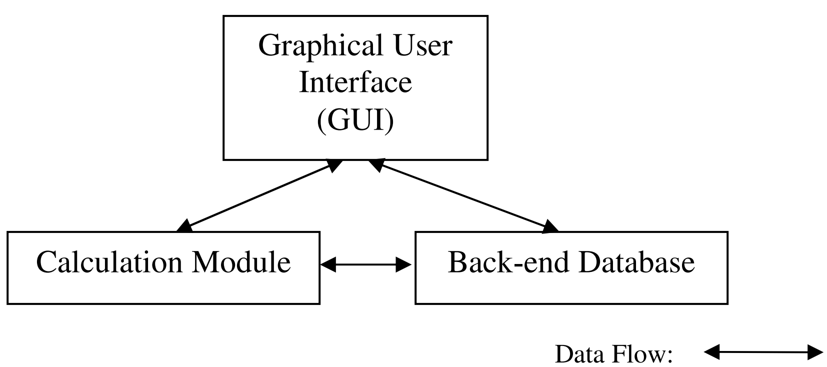


Figure 1 FLEET Components Structure

The primary purpose of the graphical user interface is to provide the user with an easy method to input fleet and emission reduction measures information, and to show emission reductions and cost effectiveness results. Three separate user screens are used for On-Road, Non-Road, and the Emission Reductions & Cost Effectiveness, each accessible by clicking on the tab having the corresponding name. With simple Windows-type screen, input text box and pick-list menus, the user can quickly select reduction scenarios, execute calculations, and view the modeling results. The FLEET also has utilities/functions to let the user import fleet information and export analysis via an Excel spreadsheet.

To input on-road fleet information, the user enters data in the order that is presented on the screen: Sub-Fleet Name, Engine Manufacturer, Model Year, etc. The pick lists are generated dynamically based on previous user selections. The eight data fields are identified in Figure 2; a generic engine family is included in case the engine family code is not known.

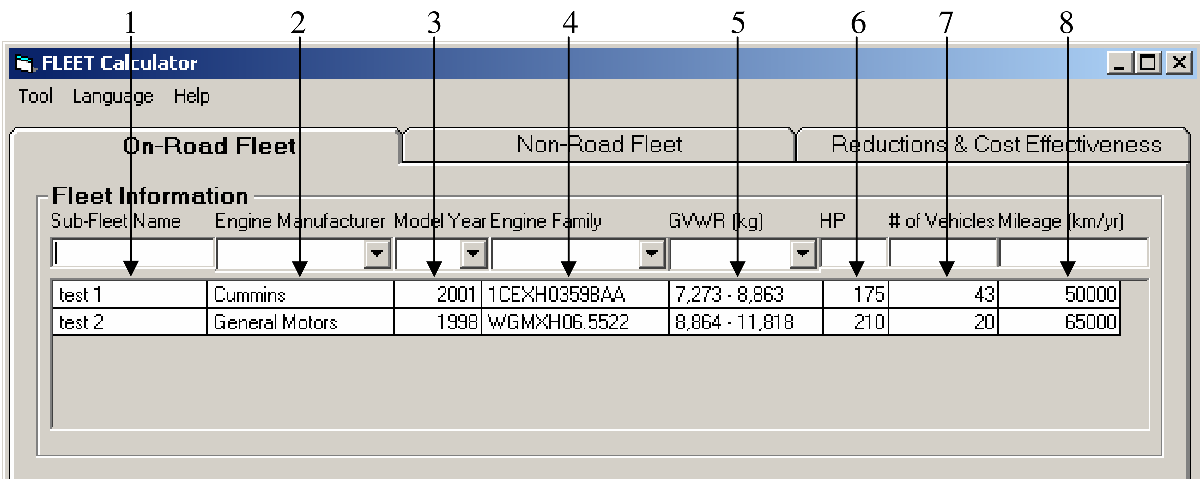


Figure 2 Steps to Input Information

The 'Non-Road Fleet' tab, represented in Figure 3, allows user to input non-road fleet information in the order similar with the on-road fleet input.

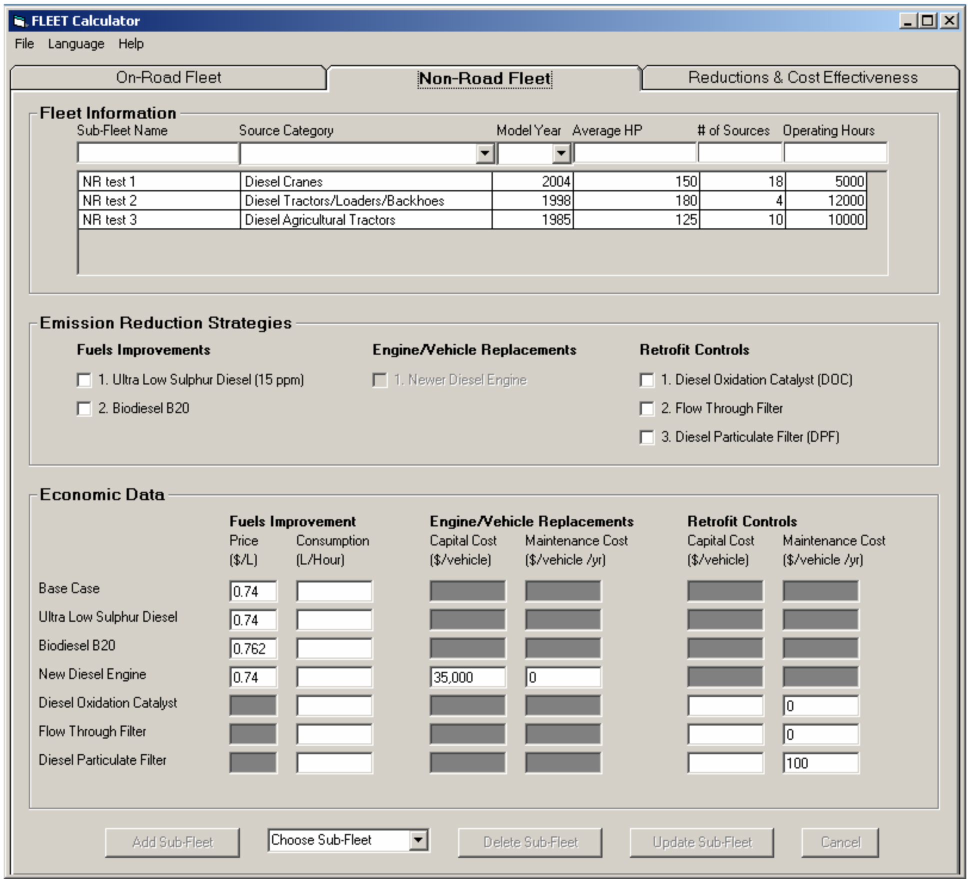
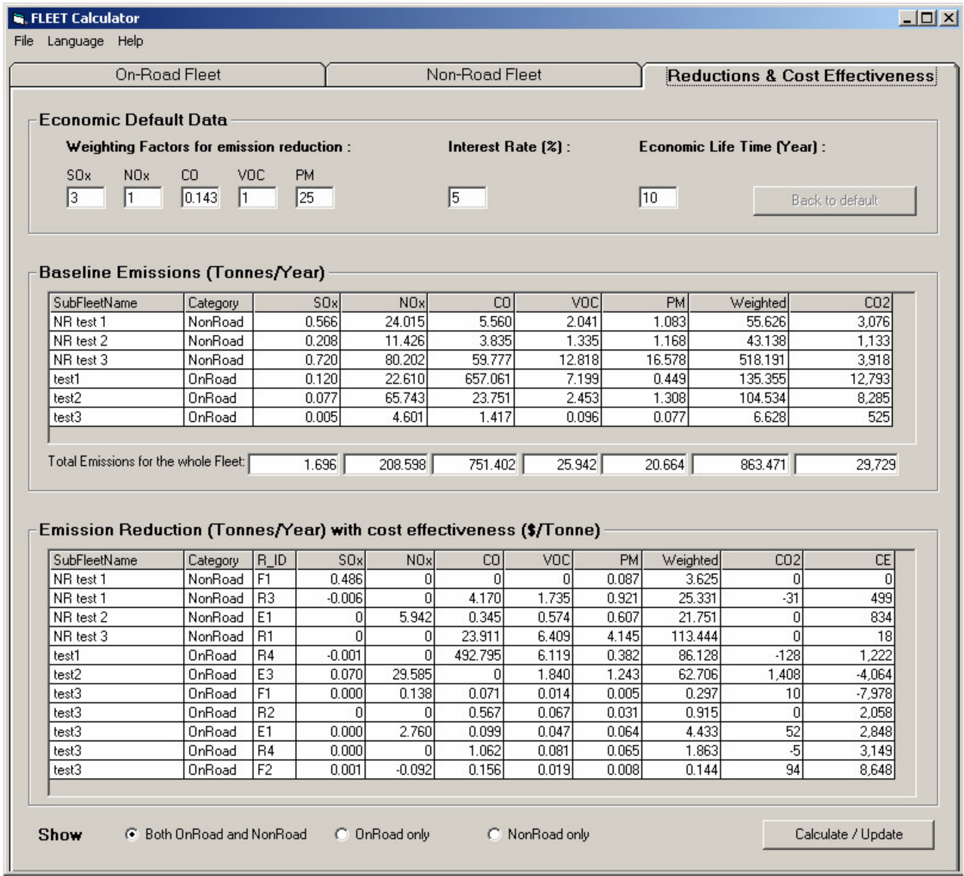


Figure 3 Non-Road Fleet Tab

The 'Reductions & Cost Effectiveness' tab, represented in Figure 4, displays the baseline fleet emissions and the emission reductions and cost effectiveness for the options selected. The results can be toggled to display all fleets, on-road fleets only, or non-road fleets only.



SubFleetName	Category	SOx	NOx	CO	VOC	PM	Weighted	CO2
NR test 1	NonRoad	0.566	24.015	5.560	2.041	1.083	55.626	3,076
NR test 2	NonRoad	0.208	11.426	3.835	1.335	1.168	43.138	1,133
NR test 3	NonRoad	0.720	80.202	59.777	12.818	16.578	518.191	3,918
test1	OnRoad	0.120	22.610	657.061	7.199	0.449	135.355	12,793
test2	OnRoad	0.077	65.743	23.751	2.453	1.308	104.534	8,285
test3	OnRoad	0.005	4.601	1.417	0.096	0.077	6.628	525
Total Emissions for the whole Fleet:		1.696	208.598	751.402	25.942	20.664	863.471	29,729

SubFleetName	Category	R_ID	SOx	NOx	CO	VOC	PM	Weighted	CO2	CE
NR test 1	NonRoad	F1	0.486	0	0	0	0.087	3.625	0	0
NR test 1	NonRoad	R3	-0.006	0	4.170	1.735	0.921	25.331	-31	499
NR test 2	NonRoad	E1	0	5.942	0.345	0.574	0.607	21.751	0	834
NR test 3	NonRoad	R1	0	0	23.911	6.409	4.145	113.444	0	18
test1	OnRoad	R4	-0.001	0	492.795	6.119	0.382	86.128	-128	1,222
test2	OnRoad	E3	0.070	29.585	0	1.840	1.243	62.706	1,408	-4,064
test3	OnRoad	F1	0.000	0.138	0.071	0.014	0.005	0.297	10	-7,978
test3	OnRoad	R2	0	0	0.567	0.067	0.031	0.915	0	2,058
test3	OnRoad	E1	0.000	2.760	0.099	0.047	0.064	4.433	52	2,848
test3	OnRoad	R4	0.000	0	1.062	0.081	0.065	1.863	-5	3,149
test3	OnRoad	F2	0.001	-0.092	0.156	0.019	0.008	0.144	94	8,648

Figure 4 Reduction and Cost Effectiveness Tab

Default economic data is displayed in the first frame, and includes pollutant weighting factors for the cost effectiveness calculation in case the user wishes to weight individual pollutant emissions in a particular way. Emission reducing options reduce and, in some cases, increase individual pollutants to varying degrees, making it difficult to objectively assess which options are better than others from an air quality perspective. To avoid this difficulty for the screening and assessment of the emission reduction options, a set of weighting factors can be applied to the criteria pollutants and the resulting sum of weighted emissions is then used in the calculation of cost effectiveness. The default weighting factors in the FLEET have been applied in some studies of air quality issues in the Lower Fraser Valley in British Columbia (Levelton, 2005). A similar weighting concept was adopted in 2005 by the California Air Resources Board for evaluating cost effectiveness.

The interest rate and economic lifetime needed for the calculation of cost effectiveness can be input by the user and over-ride default values for these parameters. The present value of the initial cost and the series annual costs and benefits over the assumed equipment lifetime are calculated using the specified economic lifetime (typically 10 years) and interest rate.

The second frame titled 'Baseline Emissions (Tonnes/Year)' presents the baseline emissions for all sub-fleets before any emission reductions are applied. A total for the entire group of sub-fleets is also displayed.

The final frame titled 'Emission Reduction (Tonnes/Year) with cost effectiveness ($/Tonne)' presents the reductions in emissions by pollutant. The data is sorted by cost effectiveness (high to low) and grouped by sub-fleet.

The back-end database of the FLEET was designed using Microsoft Access to store large amounts of data, and includes user input data, such as fleet information and the selected emission reduction technologies, engine certification data for on-road vehicles, emission factors for non-road vehicles, and emission reduction rates for different control technologies. Several tables were created to store the emission baseline and emission reduction results data. The back-end database is also designed to store the items for the pick-lists and the text/label in the graphical user interface. The advantage to storing the screen text in the database is that it allows for modification if required in the future. Similarly, future updates can be made in the database to the engine certification data, emission factors and performance characteristics of the emission reduction options. This is possible by updating the database tables linked to the model.

The Calculation Module is developed using a combination of database and Visual Basic programming. It can be triggered by clicking the 'Calculate/Update' button on the 'Reductions & Cost Effectiveness' screen. The module will estimate baseline emissions, emission reductions, and cost effectiveness based on user fleet information and emission reduction options. The estimation result will be stored in the back-end database and showed in the graphical user interface.

CALCULATION METHODOLOGY

The FLEET Calculator estimates emission reductions for both on-road and non-road vehicle fleets. This section will describe the methodologies followed for both types of fleets.

On-Road

For on-road engine model years 1996 to 2006, emission factors were obtained directly from the published EPA Engine Certification Data available on the US EPA's website (http://www.epa.gov/otaq/certdata.htm#largeng). For older engine model years, from 1988 to 1995, US EPA certification data was extracted from the EPA Retrofit Calculator application. The following equations were used to estimate baseline emissions (before reductions are applied):

$$\begin{aligned}\text{BaseEmissions}_{\text{NOx,VOC,CO,PM}} &= \text{EmissionFactor}_{(\text{g/bhp-hr})} \times \text{Conversion}_{(\text{bhp-hr/mile})} \times 1_{(\text{mile})} / 1.6_{(\text{km})} \times \text{Mileage}_{(\text{km/hr})} \\ &\times \#\,\text{Vehicles} \times 1_{(\text{tonne})} / 1{,}000{,}000_{(\text{g})}\end{aligned}$$

Note: The Conversion factor (bhp-hr/mile) was derived by the US EPA (EPA, 2002).

$$CO_2 Emissions = 2730_{(g/L)} \times FuelConsumption_{(L/100km)} \times Mileage_{(km/yr)} / 100 \times \# Vehicles \times 1_{(tonne)} / 1{,}000{,}000_{(g)}$$

$$SO_2 Emissions = FuelConsumption_{(L/100km)} \times FuelDensity_{(kg/L)} \times Mileage_{(km/yr)} / 100 \times \# Vehicles \times S_{(ppm)} / 1{,}000{,}000 \times 64/32$$

The fuel sulphur content for on-road vehicles is assumed to be 15 ppm. Emissions of sulphur oxides (SO_x) and nitrogen oxides (NO_x) are expressed as the equivalent weights of SO_2 and NO_2, respectively. Volatile organic compounds (VOC) are calculated from emissions of total organic hydrocarbons (THC) assuming a nominal VOC/THC emission ratio for diesel engines 1.0; the US EPA suggests a ratio of 1.053 (EPA, 2004).

Non-Road

Emission factors and the calculation methodology for non-road vehicles are based directly on the 2005 US EPA NONROAD model. For a detailed description of the calculation methods used in this model, please refer to the EPA website (EPA, 2004(a)), (http://www.epa.gov/otaq/nonrdmdl.htm).

The fuel sulphur content for non-road vehicles is assumed to be 300 ppm. This assumes a reasonable margin exists between the actual sulphur content and the diesel fuel sulphur regulatory limit of 500 ppm in 2007.

Cost Effectiveness

To provide fleet operators with information that could be used to assess the best option for their own situation and priorities, and to rationalize impacts on multiple pollutants for use in the evaluation of options, the cost effectiveness of each option is estimated. The cost effectiveness of a control option is calculated using the present value method, which divides the present value of the annual stream of costs (net of savings) over an assumed system lifetime by the lifetime reduction in emissions. Cost effectiveness is estimated by applying the following equations:

$$CostEffectiveness = \sum \left[\frac{(\Delta FuelCost + \Delta MaintenanceCost + \Delta CapitalCost)}{WeightedEmissionReduction_{(tonnes/yr)}} \right]$$

Where:

Δ*Fuel Cost = Number of vehicles × (Fuel Price*$_{controlled}$ *– Fuel Price*$_{base}$*) ×Distance*

Δ*Maintenance Cost = Number of vehicles × Maintenance Cost ($/vehicle-yr)*

Δ*Capital Cost = Number of vehicles × A/P Factor × Capital Cost*

Where: A/P Factor (capital recovery factor),(for i>0) = $\frac{i(1+i)^L}{(1+i)^L - 1}$

(for i=0) = 1/L

Where L = economic life

i = discount rate, default 5%

The default values for the economic data for the base case and the various emission reduction options were obtained based on research of current technologies and pricing in Canada. The default fuel consumption data is calculated dynamically based on the Gross Vehicle Weight Rating (GVWR) of each vehicle. The methodology is based on the EPA fuel consumption's calculations used in the MOBILE6.2 model (EPA, 2002(a)). The user may enter more specific data in place of default values. The default retrofit capital cost is calculated dynamically based on engine horsepower.

EMISSION REDUCTION STRATEGIES

The reduction strategies analysed in the FLEET calculator are grouped under three general headings:

1) Fuel Improvements
2) Engine/Vehicle Replacements
3) Retrofit Controls

One or more emission reduction options can be selected for analysis and comparison purposes.

The following emission reduction options are included in FLEET at the present time:

Fuel Improvements

1. Ultra Low Sulphur Diesel Fuel - Fuel with lower sulphur content achieves a reduction in the emissions of sulphur dioxide proportional to the decrease in sulphur burned and a small reduction in emissions of particulate matter amounting to 2-4% of the decrease in sulphur burned. In Canada, the reduction in diesel fuel sulphur content will be extended to off-road vehicles starting in 2007 with a reduction to 500 ppm. The limit will be lowered to 15 ppm in 2012 for rail and marine and in 2010 for all other off-road vehicles.

2. Gasoline Detergents - Gasoline detergents are designed to keep fuel injectors clean and some reduce the build-up of deposits throughout the intake track. Clean engines have been shown to reduce emissions. Detergents can be added to diesel fuel in order to clean-up or keep diesel injectors free of deposits. They perform a similar function to the gasoline detergents that are required by law. The concentration of detergent additives is usually in the 50 to 300 ppm range. Most manufacturers and suppliers of additives have test data that indicates improved fuel economy and reduced emissions with detergent additives.

3. Cetane Additives - The cetane number is a measure of the ignition quality of diesel fuel and it influences the fuel's combustion characteristics. Cetane number is a function of the composition of the diesel fuel but it can also be increased through the addition of cetane improvers. Cetane improvers are routinely added to diesel fuels in Western

Canada and about 90% of the diesel fuel contains some cetane improver. Very little cetane improver is used in the rest of Canada.

4. Biodiesel - It is an alternative fuel for compression ignition engines that can be made from animal fat or vegetable oil. Biodiesel can be used in any diesel engine with few or no modifications and use of the product is growing in on-road and non-road applications worldwide. Biodiesel can be blended with diesel at any level from 2% to 100%, with a 20% blend (known as B20) being common for transportation applications. Biodiesel does not have good cold weather properties and this has the potential to impair the performance of biodiesel-diesel fuel blends in cold weather at high biodiesel levels. Blending biodiesel with petroleum diesel moderates cold flow problems and makes the use of cold flow additives practical, since these are effective in the petroleum portion of the blend. Experience in different regions of North America shows that this concern can be resolved by appropriate testing, consulting with the diesel fuel and biodiesel suppliers and use of cold flow additives, if required. Most engine manufacturers have position statements regarding use of biodiesel in their engines (http://www.biodiesel.org/).

5. PuriNOx™ - This fuel is a microemulsion of water diesel fuel developed by Lubrisol Corporation and marketed in North America and other locations. A similar product has been developed by TotalFinaElf and offered for sale as Aquazole, principally in Europe. PuriNOx™ is a blend of a proprietary additive containing a surfactant to stabilize the emulsion and a cetane improver. PuriNOx is a verified emission reduction technology with the EPA for on-road and off-road diesel vehicles and with the California Air Resources Board for on-road diesel vehicles. CARB verified PuriNOx emission reductions for onroad vehicles as Level 2 according to their evaluation system, indicating a minimum reduction of 50% for particulate matter and 15% for NO_x.

Engine/Vehicle Replacements

1. Engine Replacements - Engine replacements may involve replacing an old high-emitting engine with a newer diesel engine with the same or higher power rating, a complete rebuild of the engine to meet much improved emission standards, or replacing the diesel engine with one that uses an alternative fuel, such as propane or natural gas. The drive train and engine mounting configuration may also need to be replaced or rebuilt, and changes may be needed to the routing and sizing of intake air and exhaust gas ducts and cooling water lines to suit the replacement engine.

Replacement of an old engine or vehicle with a newer one meeting lower emission standards is an assured means of achieving emission reductions. This option is best suited to replacing engines/vehicles manufactured prior to 1994, and more so prior to 1991, when particulate matter and NO_x emission factors were much higher than in 2004 or 2007 model year vehicles. Replacing a pre-1994 model year engine with a 2007 model year engine will achieve over a 95% reduction in PM emissions and over a 75% reduction in NO_x emissions. In addition, the operator will have the benefits of vehicle or engine performance improvements and a reduction in vehicle fuel consumption and greenhouse gas emissions.

2. Compressed Natural Gas (CNG) - Medium and heavy-duty compressed natural gas (CNG) engines are offered by a number of manufacturers. Engines are available from

150 hp to 410 hp. These engines are typically used in transit buses, refuse haulers, delivery trucks, and in some class 8 heavy-duty trucks. The use of natural gas in a portion of the fleet will require the installation of a compressor and refuelling system. The capital cost of this system can be provided by the fuel supplier and amortized over the quantity of fuel used. This option is not suitable for a fleet with one or two vehicles that wish to be converted unless the vehicles can be refuelled at a public refuelling station. Another option for refuelling is to bring the compressed fuel in a tanker truck directly to the vehicle. This could be considered for intermediate fleet sizes too small to financially justify a dedicated refuelling station.

3. High Pressure Direct Injection (HPDI) - Westport Innovations has developed a heavy-duty natural gas engine that allows the full diesel engine compression ratio to be used with the natural gas fuel. A small amount of diesel fuel is injected into the cylinder to assist with the ignition of the natural gas. These natural gas Westport Cycle engines provide the same amount of power and torque as their diesel equivalents, benefiting from essentially the same energy efficiency as diesel. Liquefied natural gas is a more likely fuel for these applications than compressed natural gas because of its higher energy storage density.

4. Vehicle Replacements - Hybrid diesel-electric vehicles are an effective alternative to standard vehicles. These vehicles utilize an electric drive motor to partially, or fully drive the vehicle's wheels and a diesel engine to provide motive power at high speed or to recharge the storage batteries. The capability to generate electricity on-board distinguishes a hybrid-electric vehicle from a dedicated electric vehicle. As a result of their design features, hybrid vehicles can achieve lower emissions and better fuel economy than a conventional vehicle using the same fuel and meeting the same emission control standards.

Retrofit Controls

1. Diesel Oxidation Catalyst (DOC) - These devices use catalysts to combust particulate matter, CO and hydrocarbons present in the exhaust gases. DOCs are more sulphur tolerant and result in a lower exhaust back-pressure and a minimal fuel consumption penalty, but also achieve lower percentage reductions in particulate matter. DOC are similar to the original mufflers on heavy duty diesel vehicles and have been designed to be retrofit to the vehicle without requiring mounting modifications or adjustments to the engine control system. DOCs tend to be heavier than stock mufflers.

2. DOC & Crankcase Vent Filter - Crankcase emissions are a product of the combustion process in reciprocating engines. The emissions include unburned fuel and blow-by gases, hydrocarbon vapour, particulate matter and various engine oil contaminants. Crankcase vent filters reduce crankcase emissions and have the added benefit of reducing oil consumption and underhood fumes and odours.

3. Flow Through Filter - Current designs of flow through filters utilize a wound metal wire mesh that has been treated with a catalyst wash to create an activated filter media. A flow through filter achieves higher percent emission reductions than a DOC because of enhanced filtering and contact with the catalyst, while minimizing filter back-pressure and the associated fuel consumption penalty. Particles that are not oxidized as they pass through the FTF are emitted with the exhaust gases. Therefore, an FTF does not have to cycle through a regeneration sequence to maintain the backpressure across the device at an acceptable level and is therefore suitable for application to a wider range of non-road engines than could be considered for DPF technology. Flow through filters utilize relatively new technology and there is more limited commercial experience with this equipment than either DOC or DPF technology. The filtration efficiency of an FTF is intermediate between the efficiency of a DOC and a DFP, as is the cost and fuel penalty. Verified equipment is available.

4. Diesel Particulate Filter (DPF) - A DPF filters the exhaust gases and catalytically combusts the collected particulate matter as well as CO and hydrocarbons. Diesel fuel having a sulphur content of less than 15 ppm is recommended. DPFs achieve higher percent reductions in particulate emissions that either DOCs or flow through filters, however, there is higher back-pressure on the engine and a fuel consumption penalty of typically about 1%. The effectiveness of DPFs in commercial use on on-road and off-road vehicles has been extensively documented and the particulate matter reduction achieved is normally in the 80-90% range.

CONCLUSTIONS

FLEET can assist the fleet managers as well as the government regulators and policy makers to assess the best options for reducing emissions from on-road and non-road heavy duty diesel vehicles. This tool calculates the baseline emissions and estimates the emissions reduction that could be achieved through the use of a wide variety of commercial emission reduction options, including fuel improvements, engine/vehicle replacements, and retrofit controls. By providing the facility to generate the baseline emission inventories and to carry out the cost effectiveness analysis, it greatly enhances the practical value of the emission reduction estimates.

FLEET is a user-friendly stand alone application and uses current accepted methods for calculating baseline emissions and the emission reductions that could be achieved using commercial emission reduction technologies. The executable file, which was developed in Visual Basic, provides a user friendly interface at the front end, while allowing future updates to be made to the data stored in the Microsoft Access database, such as vehicle emission certification data or the performance and cost of emission reduction options.

FLEET can be run on a desktop PC without the need for knowledge of either Microsoft Excel or Access software, and can be easily migrated to a web-based application in the future. If large volumes of data need to be input for a vehicle fleet, the data can be imported easily from an Excel worksheet. FLEET also allows output of fleet data to an Excel worksheet for ease of conducting further analysis.

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KEY WORDS

Fleet Emission Estimation Tool
On-Road Emissions
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Cost Effectiveness
Fuel Improvements
Engine/Vehicle Replacement
Retrofit Controls.