Proposition 1B: Goods Movement Emission Reduction Program
Directions: Benefits Calculators

Heavy Duty Diesel Trucks
Commercial Harbor Craft
Shore Power for Cargo Ships
Cargo Handling Equipment

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To: User

This document, and the corresponding calculators, includes methodologies for estimating the emission benefits and cost effectiveness of projects identified in the "Guidelines for Implementation." If there are additional projects that you would like to estimate benefits for that are not included in the calculators please contact us for guidance.

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We recommend you print out these directions in color.

Heavy Duty Truck Emissions Benefit Calculator (for Drayage and Other Heavy Duty Trucks)

This calculator allows a user to input information about a particular heavy duty truck engine and estimate the emissions benefits of a proposed project funded under the $1B Goods Movement Emission Reduction Program. Included below are the methodology and directions for filling in each field necessary for emissions benefit estimation. Where data is not provided an ARB fleet average default will be used.

Methodology ("Project Calcs")

The methodology presented below comes from EMFAC2007 and the adopted Regulation to Control Emissions from In-Use On-Road Diesel-Fueled Heavy-Duty Drayage Trucks at Ports and Intermodal Rail Yard Facilities. Emissions from heavy duty trucks are the product of population (by model year), annual accrual (miles/year), and pollutant and model year specific emission rates. (grams/mile). To estimate the project emissions benefits the emissions from the existing truck(s) and replacement truck(s) are estimated. The difference between the two is the benefit of that project. See example below:

Calendar Year 2008: Local Agency A proposes to replace 75 1980 diesel heavy duty Port trucks with 2007 diesel heavy heavy duty trucks. Fleet records indicate that the trucks accrue 30,100 miles/year.

PM Emission Rate (1980 Model Year in CY 2008) = 2.58 grams/mile
PM Emission Rate (2007 Model Year in CY 2008) = 0.06 grams/mile

Benefit Calculation for Calendar Year 2008

Emissions (75 1980 Model Year Trucks) = 75*2.58 grams/mile*30,100 miles/year = 5,824,350 grams/year*(1 lb/454 grams)*(1 ton/2000 pounds) = 6.41 tons/year

Emissions (75 2007 Model Year Trucks) = 75*0.06 grams/mile*30,100 miles/year = 135,450 grams/year*(1 lb/454 grams)*(1 ton/2000 pounds) = 0.15 tons/year

Benefits of replacing 75 1980 diesel trucks with 2007 diesel trucks in CY 2008
Benefits = 6.41 tons/year - 0.15 tons/year = 6.26 tons/year

Calendar Year 2012 - Benefits of Local Agency A 75 truck replacement project
PM Emission Rate (1980 Model Year in CY 2012) = 2.79 grams/mile
PM Emission Rate (2007 Model Year in CY 2012) = 0.09 grams/mile

Benefit Calculation for Calendar Year 2012

Emissions (75 1980 Model Year Trucks) = 75*2.79 grams/mile*30,100 miles/year = 6,298,425 grams/year*(1 lb/454 grams)*(1 ton/2000 pounds) = 6.94 tons/year

Emissions (75 2007 Model Year Trucks) = 75*0.09 grams/mile*30,100 miles/year = 203,175 grams/year*(1 lb/454 grams)*(1 ton/2000 pounds) = 0.22 tons/year

Benefits of replacing 75 1980 diesel trucks with 2007 diesel trucks in CY 2012
Benefits = 6.94 tons/year - 0.22 tons/year = 6.72 tons/year

Cost-effectiveness of each project is calculated by dividing the weighted emissions reductions (NOx + 20*PM) over the project life by the State contribution.

Directions

The truck benefits calculator contains the following tabs. Each tab will be described in greater detail below.

Table 1: Summary of all the worksheets in the calculator

TAB	DESCRIPTION
Benefits Summary	This tab contains a summary of the PM and NOX emissions benefit by project ID
Sample Inputs	This tab contains sample projects with sample inputs.
Input Data	In this tab the user will input the data necessary for emissions benefit estimation for each truck project.
Input Data QA	This tab contains a basic check on the validity of project entries. It follows the “Guidelines for Implementation”. If a "NO" appears in the “Is Project Valid?” column then there is an invalid entry. Check the "Guidelines for Implementation" for guidance.
Calc Inputs	This tab organizes the data inputted by the local agencies for emissions benefit calculations.
	Fields left blank that are necessary for benefit calculations will be replaced with default data.
Project Calcs	This tab provides the year by year and total project life benefits for PM and NOX.
Default Data	This tab provides the default data used when the user cannot provide information critical for benefit calculations.
	The data included in the Default Data tab are consistent with EMFAC2007 and the Drayage Truck Rule.
ER Diesel	This tab provides the Calendar/Model Year specific emission rates for other heavy heavy duty diesel trucks and drayage trucks.
ER LNG	This tab provides the Calendar/Model Year specific emission rates for all heavy heavy duty LNG/CNG trucks.

“Input Data” Tab

In order to estimate the emissions benefits of a proposed project information on each project must be entered into the "Input Data" tab of this calculator. These inputs may include: project calendar year, model year, fuel type, annual accrual, project type, and truck type and are

described in Table 2 below. Each user should provide the necessary information for each project. Where no information is available leave the field blank. The "Sample Inputs" tab provides sample proposed projects with the correct inputs for those projects.
ONLY INPUT DATA IN THE "INPUT DATA" TAB.
Inputs in RED must be filled out - inputs in BLUE can be left blank if no information exists.

Table 2: "Input Data" Tab - Input Data Fields and Descriptions

	Project Name	An ID that is unique to each vehicle/engine or each vehicle/engine group. This ID can be any value/character the user chooses. No two projects should have the same ID and each project should be inputted into a single row.
	Project Calendar Year	Project calendar year (valid entries: 2008-2011) - this is the calendar year the project will be in use and operational
	Truck Population	The population of trucks to be retrofit, replaced, or repowered. The project population.
EXISTING TRUCK ENGINE	**Engine Model Year**	Model year of the existing truck engine to be replaced, repowered, or retrofit.
	Fuel Type	Fuel type used for existing truck (valid entry: diesel)
	Annual Accrual (miles/year) per truck	The annual mileage driven per truck (miles/year) for the existing truck.
	Drayage Truck (Y/N)	If the existing truck is a drayage truck select "Yes", otherwise select "No".
	Service Area	If this is a drayage truck, what is the primary service port (valid entries for Port Trucks: LA/LB, Oakland, or Other). If the truck is NOT a drayage truck leave this field blank
	Project Option - Detailed	Select the type of project for the existing equipment. See "Guidelines for Implementation" for details.
REPLACEMENT/ REPOWER TRUCK ENGINE	**Engine Model Year**	If the project is a replacement, repower or a three-way transaction, input the model year for the replacement/repower truck/engine. If the project is a retrofit leave this field blank. Note: For all truck replacements/repowers/3-Way, the truck ENGINE must meet the emissions standards outlined in the "Guidelines for Implementation".
	Fuel Type	Fuel type used for replacement/repowered truck (valid entries: diesel, CNG or LNG)
	Annual Accrual (miles/year) per truck	The annual mileage driven per truck (miles/year) for the replacement/repower truck.
	Drayage Truck (Y/N)	If the replacement/repower truck is a drayage truck select "Yes", otherwise select "No".
	Service Area	If this is a drayage truck, what is the primary service port (valid entries for Port Trucks: LA/LB, Oakland, or Other). If the truck is NOT a drayage truck leave this field blank

Total Project Cost ($)	What is the total cost of the project ($).
Program Investment ($)	The Bond program contribution to the project ($)
Will the project be pro-rated?	If you are choosing the pro-rated option for truck replacements and repowers select "Y", otherwise select "N". (See "Guidelines for Implementation")
Total State Investment ($)	The State contribution to the project ($). This includes the Bond contribution and any other State sources.
Project Life (Years)	The length of time an equipment owner is obligated (under an equipment project contract) to maintain and operate the bond-funded equipment according to the requirements of the program.

Special Note for Three-Way Transactions - For all three-way transactions please list Truck A first, followed by Truck B in the input sheet (see examples). This is critical because cost effectiveness calculations are based on these projects arranged in that manner on the spreadsheet. The cost effectiveness is calculated by adding the benefits from both Truck A and Truck B and dividing by the State contribution for the replacement of Truck A.

"Sample Inputs" Tab

The examples in this tab will provide guidance for inputting data into the "Input Data" tab. Samples and correct inputs are provided in the appendix to this document.

"Input Data QA" Tab

This tab contains a basic check on the validity of project entries. It follows the guidelines set up in the "Guidelines for Implementation". If a "NO" appears in the "Is Project Valid?" column then there is an invalid entry.

"Benefits Summary" Tab

The "Benefits Summary" tab contains an automatically updated table of the PM and NOX emissions benefits and cost effectiveness by project ID, project type, population and state investment for the entire contract life of that project.

Emissions Benefits Summary

This tab provides the emissions benefits (PM and NOX) for each proposed project (by ID and Project Type).
If "FALSE" appears in the table there is an invalid project entry.

OVERALL EMISSIONS BENEFITS AND COST EFFECTIVENESS FOR ALL PROJECTS

Total State Investment ($)	Total PM Benefits (lbs)	Total NOX Benefits (lbs)	Cost Effectiveness NOX+20*PM (lbs/State $)
$ 129,000	2,671	31,766	0.66

EMISSIONS BENEFITS AND COST EFFECTIVENESS FOR ALL PROJECTS

Project Name	Project	Project - Detailed	Population	State Investment ($)	Total PM Benefits (lbs)	Total NOX Benefits (lbs)	Cost Effectiveness NOX+20*PM (lbs/State $) Retrofit, Repower & Replacement	Cost Effectiveness NOX+20*PM (lbs/State $) Three-Way
ExampleC1Reta	Replacement	Replacement	1	$ 50,000	428.02	12,084.16	0.41	
ExampleC1Retb	Retrofit 1	Level 3 PM Retrofit	1	$ 4,500	245.39	0.00	1.09	
ExampleC1Retc	Retrofit 2	Level 3 PM and Level 1 NOX Retrofit	1	$ 4,500	245.39	2,256.54	1.59	
ExampleC1Retd	Replacement	Repower	1	$ 20,000	529.17	10,253.12	1.04	
ExampleB1Repa	Three-Way	3-Way Truck A (Replace with Truck C)	1	$ 50,000	630.22	4,901.20	SEE NEXT COLUMN	0.63
ExampleB1Repb	Three-Way	3-Way Truck B (Replace with Truck A with Level 3 PM Retrofit)	1	$ -	592.46	2,271.27	SEE NEXT COLUMN	SEE TRUCK A DIRECTLY ABOVE

Data Sources

Emission Factors (Diesel)

EMFAC2007

Emission factors for diesel heavy duty trucks are based on in-use testing of heavy heavy duty diesel trucks, which is different than certification data. Since similar data is not available for CNG/LNG heavy heavy duty diesel trucks diesel emission rates will be used for these alternatively fueled engines (model years 2007 and newer). This methodology will still account for the additional benefits of an LNG/CNG heavy duty truck meeting 2010 standards over a diesel heavy duty truck meeting 2007 standards.

Default Data

EMFAC2007

Drayage Trucks

Technical Support Document including Appendix A, Proposed Regulation Order
http://www.arb.ca.gov/regact/2007/drayage07/tsd.pdf
Technical Support Document, Appendices B-F, Proposed Regulation Order
http://www.arb.ca.gov/regact/2007/drayage07/appbf.pdf

Commercial Harbor Craft Emissions Benefit Calculator

This calculator allows a user to input information about a particular harbor craft engine and estimate the emissions benefits of a proposed project funded under the $1B Goods Movement Emission Reduction Program. Included below are the methodology and directions for filling in each field necessary for emissions benefit estimation. Where data is not provided an ARB fleet average default will be used.

Methodology ("Project Calcs")

The methodology presented below comes from the adopted Regulation to Reduce Emissions from Diesel Engines on Commercial Harbor Craft Operating within California Waters and 24 Nautical Miles off the California Baseline. Emissions from commercial harbor craft are calculated by the product of population, annual activity (hours/year), fuel correction factor (FCF), horsepower (HP), load factor (LF), horsepower-model year specific deteriorated emission rate (grams/hp-hr), and percent activity within 25 nautical miles (% Act). Deteriorated emission rates are a function of the zero-hour emission factor, equipment age (Age), useful life (UL) and the deterioration factor (df).
To estimate the project emissions benefits the emissions from the existing harbor craft and replacement harbor craft are estimated. The difference between the two is the benefit of that project. See example below:

Calendar Year 2008: Local Agency A proposes to repower 75 1987 diesel tugs with 2007 model year engines. Fleet records indicate that these 1000 horsepower tugs operate 3,000 hours/year and that there is one engine per vessel.

Deteriorated PM Emission Rate (1987 Model Year in 2008) = EF(zero-hour)*(1+df*age/UL)= 0.3625 g/hp-hr*(1+0.67*21/21)=0.61 g/hp-hr
Deteriorated PM Emission Rate (2007 Model Year in 2008) = EF(zero-hour)*(1+df*age/UL)=0.16 g/hp-hr*(1+0.67*1/21)= 0.17 g/hp-hr

Tug Load Factor = 0.5
Percent of Tug Activity within 25 nm = 49%

Benefit Calculation for Calendar Year 2008
Emissions (75 1987 Model Year Tugs) = 75*1000 hp*0.61 g/hp-hr*3,000 hr/year*0.5*0.49 = 33,626,250 grams/year*(1 lb/454 grams)*(1 ton/2000 pounds) = 37.0 tons/year

Emissions (75 2007 Model Year Tugs) = 75*1000 hp*0.16 g/hp-hr*3,000 hr/year*0.5*0.49 = 8,820,000 grams/year*(1 lb/454 grams)*(1 ton/2000 pounds) = 9.7 tons/year

Benefits of repowering 75 1987 tugs with 2007 engines in CY 2008
Benefits = 37.0 tons/year - 9.7 tons/year = 27.3 tons/year

This means that in the 2008 calendar year the proposed project reduced emissions by tons of diesel PM.

Cost-effectiveness of each project is calculated by dividing the weighted emissions reductions (NOx + 20*PM) over the project life by the State contribution.

Directions

The truck benefits calculator contains the following tabs. Each tab will be described in greater detail below.

Table 3: Summary of all the worksheets in the calculator

TAB	DESCRIPTION
Benefits Summary	This tab contains a summary of the PM and NOX emissions benefit by project ID
Sample Inputs	This tab contains sample projects with sample inputs.
Input Data	In this tab the user will input data necessary for emissions benefit estimation for each harbor craft project.
Input Data QA	This tab provides information on whether the proposed project meets guidelines. See the "Guidelines for Implementation".
Calc Inputs	This tab organizes the data inputted by the user (in the InputData tab) for emissions benefit calculations. Fields left blank that are necessary for benefit calculations will be replaced with default data.
Project Calcs	This tab provides the year by year and total project life benefits for PM and NOX.
Default DFs Spatial	This tab provides the default data used when the user cannot provide information critical for benefit calculations. The data included in the "default_dfs_spatial" tab are consistent with the Harbor Craft Rule
EFs	This tab provides the horsepower/Model Year specific emission rates for all commercial harbor craft.

"Input Data" Tab

In order to estimate the emissions benefits of a proposed project information on each project must be entered into the calculator. These inputs include: project calendar year, model year, horsepower, fuel type, annual activity, project type, number of engines, and vessel type, vessel population and are described in Table 4 below. Each user should provide the necessary information for each project. Where no information is available leave the field blank. The "Sample Inputs" tab provides sample proposed projects with the correct inputs for those projects. These input fields can be found in the "Input Data" tab (yellow tab).

ONLY INPUT DATA IN THE "INPUT DATA" TAB.

Inputs in RED must be filled out - inputs in BLUE can be left blank if no information exists.

Table 4: "Input Data" Tab - Input Data Fields and Descriptions

	Project Name	An ID that is unique to each craft/engine or each craft/engine group. This ID can be any value/character that the user chooses. No two projects should have the same ID and each project should be inputted into a single row.
	Project Calendar Year	Project calendar year (valid entries: 2008-2014) - the year the project will be operational and in-use.
	Vessel Type	The type of harbor craft
	Vessel Population	The population of vessels.
	# propulsion engines per vessel	The number of propulsion engines on each vessel.
	# propulsion engines to be replaced/repowered per vessel	The number of propulsion engines that will be replaced or repowered per vessel.
EXISITING HARBOR CRAFT ENGINE(S)	**Model Year**	Model year of existing harbor craft engine(s)
	Fuel Type	Fuel type used for existing harbor craft (valid entry: diesel)
	Annual Operational Hours (hrs) per vessel	The annual activity per vessel
	HP/engine (old engine)	The average horsepower per engine for the existing engine(s).
	Homeport	Primary hailing port
REPLACEMENT/REPOWER ENGINE(S)	**Model Year**	Model year for the replacement/repowered engine(s).
	HP/engine (new engine)	The average horsepower per engine for the new engine(s).
	Total Project Cost ($)	The total cost of the proposed project ($) - replacement engine plus necessary vessel modifications
	Program Investment ($)	The Bond program contribution ($)

	Will the project be pro-rated?	If you are choosing the pro-rated option for harbor craft projects select "Y", otherwise select "N". (See "Guidelines for Implementation")
	State Investment ($)	The total State contribution to the project ($)
	Project Life (Years)	The length of time an equipment owner is obligated (under an equipment project contract) to maintain and operate the bond-funded equipment according to the requirements of the program.

The “Input Data” tab is where all input data should go. There are drop down menu options for vessel type, fuel type, Port and replacement model year. All other inputs can have any range of values.

“Sample Inputs” Tab

The examples in this tab will provide guidance for inputting data into the “Input Data” tab. Samples and correct inputs are provided in the appendix to this document.

“Benefits Summary” Tab

The “Benefits Summary” tab contains an automatically updated table of the PM and NOX emissions benefits and cost effectiveness by project ID, vessel type, vessel population and state investment for the entire contract life of that project.

Emissions Benefits Summary

This tab provides the emissions benefits (PM and NOX) for each proposed project (by ID and Project Type) for the term of the contract.

OVERALL EMISSIONS BENEFITS AND COST EFFECTIVENESS FOR ALL PROJECTS

Total State Investment ($)	Total PM Benefits (lbs)	Total NOX Benefits (lbs)	Cost Effectiveness NOX+20*PM (lbs/State $)
$ 930,000	259,430	4,677,730	10.61

EMISSIONS BENEFITS AND COST EFFECTIVENESS FOR ALL PROJECTS

Project Name	Vessel Type	Vessel Population	State Investment ($)	Total PM Benefits (lbs)	Total NOX Benefits (lbs)	Cost Effectiveness NOX+20*PM (lbs/State $)
ExampleC1a	TUG	1	$ 155,000	30,599	636,617	8.06
ExampleC1b	TOW	1	$ 95,000	40,970	659,350	15.57
ExampleB1a	COF	1	$ 50,000	1,447	21,543	1.01
ExampleB1c	PILOT	5	$ 210,000	62,138	1,120,073	11.25
sample	PILOT	5	$ 210,000	62,138	1,120,073	11.25

Data Sources

Technical Support Document for the Regulation to Reduce Emissions from Diesel Engines on Commercial Harbor Craft Operating within California Waters and 24 Nautical Miles off the California Baseline - Appendix B: Emissions Estimation Methodology for Commercial Harbor Craft Operating in California http://www.arb.ca.gov/regact/2007/chc07/appb.pdf

Shore Power Emissions Benefit Calculator

This calculator allows a user to input information about vessels visiting berth and estimate the emissions benefits of a proposed project funded under the $1B Goods Movement Emission Reduction Program. Included below are the methodology and directions for filling in each field necessary for emissions benefit estimation. Where data is not provided an ARB fleet average default will be used.

Methodology ("Project Calcs")

The methodology presented below comes from the adopted Regulation to Reduce Emissions from Diesel Auxiliary Engines on Ocean-Going Vessels while at Berth at a California Port. Emissions benefits of a proposed shore power project are a function of the type of vessels that call to the berth and how long they hotel while at the berth. Emissions from ocean-going vessels are calculated by multiplying the population, frequency of berth visits, hotelling time per visit (hours/year), power, load factor and fuel specific emission rates (grams/kW-hr). To estimate the project emissions benefits the emissions from the existing vessels using diesel fuel and the existing vessels using grid/non-grid power are estimated. The difference between the two is the benefit of that project. See example below:

Calendar Year 2008: Local Agency F proposes to install grid power at a particular berth. Local Agency F also proposes to make ship modifications to 2 container vessels.

These container vessels have the following characteristics and are projected to visit the berth 10 times a year in 2011 using grid power.

Container Vessel Size	Total Aux Power (kW) per engine	In-Use Aux Power (kW) per vessel	Fuel Type	Total # Vessel Visits to Berth per vessel	Avg Hotelling Time per visit (hours) per vessel
Container <2000 TEU	5,200	1,000	Marine Distillate @ 0.5% Sulfur	10	40

PM Emission Rate (Marine Distillate Fuel @ 0.5%) = 0.3 g/kW-hr
PM Emission Rate (Grid Power) = 0.11 g/kW-hr
Load Factor = Net Hotelling Load/Total Power

Benefit Calculation for Calendar Year 2008
Emissions (2 Container Vessel at <2000 TEU using Marine Distillate Fuel)
Emissions = 2 vessels*5200 kW*(1000 kW/5200 kW)*10 visits/year*40 hours/visit*0.3 g/kW-hr= 240,000 grams/year*(1 lb/454 grams)*(1 ton/2000 pounds) = 0.26 tons/year

Emissions (2 Container Vessel at <2000 TEU using Shore power (Grid))

Emissions = 2 vessels*5200 kW*(1000 kW/5200 kW)*10 visits/year*40 hours/visit*0.11 g/kW-hr= 88,000 grams/year*(1 lb/454 grams)*(1 ton/2000 pounds) = 0.097 tons/year

Benefits of replacing using Shore power for 2 Container Vessels (<2000 TEU size)
Benefits = 0.26 tons/year - 0.097 tons/year = 0.163 tons/year

Cost-effectiveness of each project is calculated by dividing the weighted emissions reductions (NOx + 20*PM) over the project life by the State contribution.

Directions

The truck benefits calculator contains the following tabs. Each tab will be described in greater detail below.

Table 5: Summary of all the worksheets in the calculator

TAB	DESCRIPTION
Benefits Summary	This tab contains a summary of the PM and NOX emissions benefit by project ID
Sample Inputs	This tab contains sample projects with sample inputs.
Berth Input Data	In this tab the user will input the necessary information for the Berth.
Input Data QA	This tab provides information on whether the proposed project meets compliance or guidelines. See the "Guidelines for Implementation".
Inputs	In this tab the user will input the necessary information for the Vessels visiting the berth. There are vessel inputs tabs for all critical compliance years.
Calc Inputs	These tabs organize the data inputted by the user (in the Vessel Inputs tab) for emissions benefit calculations. Fields left blank that are necessary for benefit calculations will be replaced with default data.
Calcs	These tabs provide the year by year and total benefits for PM and NOX.
Defaults and EFs	This tab provides the information used for emissions benefits calculations including emission factors, load factor, etc. It also contains the default data used when the user cannot provide information critical for benefit calculations. The data included in this tab are consistent with the Shore Power Regulation.

"Berth Input Data" and "Input" Tabs

In order to estimate the emissions benefits of a proposed project information on each project must be entered into the "Inputs" tab (yellow tab) and "Berth Input Data" tabs in this calculator. Each user should provide the necessary information for each project. The necessary inputs are described in Tables 6 and 7 below. Where no information is available leave the field blank. The "Sample Inputs" tab provides sample proposed projects with the correct inputs for those projects.

ONLY INPUT DATA IN THE "Inputs" or the "Berth Input Data" TABS.
ONLY ONE BERTH PER CALCULATOR. ADDITIONAL BERTHS SHOULD BE ON SEPARATE SHOREPOWER CALCULATORS.
Inputs in RED must be filled out - inputs in BLUE can be left blank if no information exists.

Because this calculator is only set up to estimate the emissions benefits of one berth there is one "Berth Input Data" tab. There are multiple "_Inputs" tabs. These tabs correspond to compliance years established in the "Guidelines for Implementation" (2011, 2014, 2017 and 2020 for Grid Power and 2010, 2012 and 2014 for Non-Grid Power). The total benefits for the project life will be estimated by using the Benefits Schedule provided in the "Benefits Summary" tab.

Table 6: "Berth Inputs Data" Tab - Input Data Fields and Descriptions

First Operational Year	The first year the berth will be operational and vessels visiting the berth using shore power
Berth Name	An identification number given to the berth. This ID can be any value/character that the user chooses.
Port	The port where the berth will be located
Replacement Power	The type of shore power project (i.e. grid or non-grid)
If Non-Grid, what is the power of the unit (megawatts)	If the proposed project is for non-grid based power the unit's power, in megawatts, must be inputted here.
Total Project Cost ($)	Total of the covered shoreside costs of installing grid power or purchasing non-grid unit.
If Non-Grid - Will the project funding be pro-rated?	If you are choosing the pro-rated option for the non-grid power projects select "Y", otherwise select "N". (See "Guidelines for Implementation")
Program Investment ($)	The Bond program contribution ($)
State Investment ($)	The State contribution to the project ($)

Current Number of Annual Vessel Visits to Berth:	What is the current number of vessel visits (annually) for berth. This data will be used to check for compliance.
Projected Annual Visits to Berth (Grid Power ONLY)	If choosing Grid power what is the projected number of vessel visits (annual) for berth for calendar years 2011, 2014, 2017 and 2020. This includes both vessels that will be using shore power and those that will not be using shore power.

The following inputs will allow the user to enter information on each unique vessel that visits the berth and uses shore power. If you are a local agency and have not yet identified the existing berth or terminal please input information for the vessels that will likely visit the berth. For this purpose we have added a vessel population input.

Table 7: "Inputs" Tab - Input Data Fields and Descriptions

Vessel Name	An identification number given to the vessel(s). This ID can be any value/character that the user chooses.
Vessel Type	The type of vessel that will be visiting the berth and using shore power
Vessel Population	The population of that vessel type that will be visiting the berth and using shore power
Container Vessel Size	If the vessel is a container, the size of the container vessel (in TEU capacity)
Total Aux Power (kW) per vessel	Total auxiliary power (kW) per vessel
In-Use Aux Power (kW) per vessel	The auxiliary power (kW) **used** per vessel
Fuel Type	Fuel type used for vessel
Total # Vessel Visits to Berth per vessel	The number of times the vessel will visit the berth and use shore power in a given year.
Avg Hotelling Time per visit (hours) per vessel	The amount of time the vessel will spend hotelling per visit (hours/visit). Note this value will be adjusted for the time allowed under the regulation for "limited engine use."

The “Berth Input Data” tab is where all input data on the proposed berth should go. There are drop down menu options for hailing port and replacement power.

The “Inputs” tabs are where all input data on the vessels visiting the proposed berth using shore power should go. There are drop down menu options for vessel type, vessel size, and fuel type. All other inputs can have any range of values. The user is required to input vessel data for all critical compliance years; therefore, there are four tabs for Grid power and 3 for Non-Grid power. These tabs are labeled as follows:

2011 Grid | 2010 Non-Grid Inputs: In this tab the user will input vessel data for the critical compliance year of 2011 for grid power or 2010 for non-grid power.
2014 Grid | 2012 No-Grid Inputs: In this tab the user will input vessel data for the critical compliance year of 2014 for grid power or 2012 for non-grid power.
2017 Grid | 2014 Non-Grid Inputs: In this tab the user will input vessel data for the critical compliance year of 2017 for grid power or 2014 for non-grid power.
2020 Grid Inputs: In this tab the user will input vessel data for the critical compliance year of 2020 for grid power, no information is required for non-grid power.

“Sample Inputs” Tab

The examples in this tab will provide guidance for inputting data into the “Input Data” tab. Samples and correct inputs are provided in the appendix to this document.

"Benefits Summary" Tab

The "Benefits Summary" tab contains an automatically updated table of the PM and NOX emissions benefits and cost effectiveness for the proposed berth for the term of the contract.

Emissions Benefits Summary

This contains an automatically updated table of the PM and NOX emissions benefits and cost effectiveness for the proposed berth for the term of the contract.

Total State Investment ($)	Total PM Benefits (lbs)	Total NOX Benefits (lbs)	Cost Effectiveness NOX+20*PM (lbs/State $)
$ 2,100,000	13,823	1,202,471	0.704

Year	Calendar Year	PM (lb)	NOX (lb)
1	2012	2,765	240,494
2	2013	2,765	240,494
3	2014	2,765	240,494
4	2015	2,765	240,494
5	2016	2,765	240,494
6	2017	-	-
7	2018	-	-
8	2019	-	-
9	2020	-	-
10	2021	-	-
11	2022	-	-
12	2023	-	-
13	2024	-	-
14	2025	-	-
15	2026	-	-
16	2027	-	-
17	2028	-	-
18	2029	-	-
19	2030	-	-
20	2031	-	-

Benefits Schedule - Grid

Compliance Calendar Year	Grid - Applicable Calendar Years	Non-Grid - Applicable Calendar Years	PM (lb)	NOX (lb)
2011 Grid | 2010 Non-Grid	First Operational Year-2013	2010-2011	2,765	240,494
2014 Grid | 2012 Non-Grid	Years 2014-2016	2012-2013	2,765	240,494
2017 Grid | 2014 Non-Grid	Years 2017-2019	2014 and beyond	2,765	240,494
2020	Years 2020 and beyond		2,765	240,494

Data Sources

Technical Support Document for the Regulation to Reduce Emissions from Diesel Auxiliary Engines on Ocean-Going Vessels while at Berth at a California Port - Appendix B: Emission Inventory Methodology
http://www.arb.ca.gov/regact/2007/shorepwr07/appb.pdf

2006 Hotelling Times
Lands Commission and Wharfinger Data

Non-Grid Emission Factors:
Technical Support Document for the Regulation to Reduce Emissions from Diesel Auxiliary Engines on Ocean-Going Vessels while at Berth at a California Port - Appendix B: Emission Inventory Methodology
http://www.arb.ca.gov/regact/2007/shorepwr07/appb.pdf
AP-42, (SCR providing 90% control for NOX)

Cargo Handling Equipment Emissions Benefit Calculator

This calculator allows a user to input information about a particular crane engine and estimate the emissions benefits of a proposed project funded under the $1B Goods Movement Emission Reduction Program. Included below are the methodology and directions for filling in each field necessary for emissions benefit estimation. Where data is not provided an ARB fleet average default will be used.

Methodology ("Project Calcs")

The methodology presented below comes from the adopted Regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards. Emissions from cargo handling equipment are calculated by the product of population, annual activity (hours/year), horsepower, load factor, fuel correction factor, and deteriorated emission factor (grams/hp-hr). Deteriorated emission factors are a function of the zero-hour emission factor, equipment age, useful life and the deterioration factor (df). To estimate the project emissions benefits the emissions from the existing crane and the crane with an energy storage device are estimated. The difference between the two is the benefit of that project. See example below:

Calendar Year 2008: Local Agency A proposes to retrofit 5 1984 rubber-tired gantry cranes (with level 3 VDEC) with energy storage systems. Records indicate that these 750 horsepower cranes operate 5,000 hours/year at the port. No other emission control devices are attached.

Deteriorated PM Emission Rate (1984 Model Year in 2008 with level 3 VDEC) = EF(zero-hour)*(1+df*age/UL)=0.530 g/hp-hr*(1+0.67*24/24)=0.885 g/hp-hr*(1-85% PM reduction)=0.133 g/hp-hr
LF= 0.43
FCF = 0.72

Benefit Calculation for Calendar Year 2008

PM Emissions (5 1984 Model Year Cranes) = 5*5,000 hr/year*750hp*0.43*0.72*0.133 g/hp-hr = 772,065 grams/year*(1 lb/454g)*(1 ton/2000lbs) = 0.850 tons/year
PM Emissions (5 energy storage systems) = 25% PM Reduction*0.850 = 0.213 tons/year

This means that in the 2008 calendar year the proposed project reduced emissions by 0.213 tons of diesel PM.

Cost-effectiveness of each project is calculated by dividing the weighted emissions reductions (NOx + 20*PM) over the project life by the State contribution.

Directions

The truck benefits calculator contains the following tabs. Each tab will be described in greater detail below.

Table 8: Summary of all the worksheets in the calculator

TAB	DESCRIPTION
Benefits Summary	This tab contains a summary of the PM and NOX emissions benefit by project ID
Sample Inputs	This tab contains sample projects with sample inputs.
Input Data	In this tab the user will input data necessary for emissions benefit estimation for each cargo handling equipment project.
Input Data QA	This tab provides information on whether the proposed project meets guidelines. See the "Guidelines for Implementation".
Calc Inputs	This tab organizes the data inputted by the user (in the InputData tab) for emissions benefit calculations. Fields left blank that are necessary for benefit calculations will be replaced with default data.
Project Calcs	This tab provides the year by year and total project life benefits for PM and NOX.
FCF	This tab provides diesel fuel correction factors by model year for NOx and PM
EC Factors	This tab displays NOx and PM benefits for other emission controls.
Default_DFs	This tab provides the default data used when the user cannot provide information critical for benefit calculations. The data included in the "default_dfs " tab are consistent with the Cargo Handling Equipment Rule and OFFROAD2007
emfac diesel	This tab displays zero-hour emission factors based on engine year, size and pollutant.

"Input Data" Tab

In order to estimate the emissions benefits of a proposed project information on each project must be entered into this calculator. These inputs include: project calendar year, model year, horsepower, fuel type, annual activity, project type, equipment type and equipment population and are described in Table 9 below. Each user should provide the necessary information for each project. Where no information is available leave the field blank. The "Sample Inputs" tab provides sample proposed projects with the correct inputs for those projects. These input fields can be found in the "Input Data" tab (yellow tab).

ONLY INPUT DATA IN THE "INPUT DATA" TAB.

Inputs in RED must be filled out - inputs in BLUE can be left blank if no information exists.

Table 9: "Input Data" Tab - Input Data Fields and Descriptions

Project Name	An ID that is unique to each equipment/engine or each equipment/engine group. This ID can be any value/character that the user chooses. No two projects should have the same ID and each project should be inputted into a single row.
Project Calendar Year	Project calendar year - the year the project will be operational and in-use.
Equipment Type	The type of cargo handling equipment (valid entries: Crane with level 3 VDEC, Crane with Tier 4 engine)
Population	Equipment population to be retrofit.
Engine Model Year	Model year of cargo handling equipment
Fuel Type	Fuel type used for existing cargo handling equipment (valid entry: diesel)
Annual Operational Hours per Crane	The annual activity (hours/year) per crane.
HP	The horsepower per crane.
Port or Railyard	The location where the equipment is based (valid entry: Port, Railyard)
Other Emission Control Y/N?	If there additional Emission Control Devices Installed on the existing crane select "Y", otherwise select "N".
Other Emission Control Device	The type of emission control device installed (valid entry:DOC, Emulsified Fuel, DOC + emulsified fuels, DOC+Purin Nox, O2 diesel, DOC+O2 diesel
Total Project Cost ($)	The total cost of the project ($).
Will the project funding be pro-rated?	If you are choosing the pro-rated option for cargo handling equipment projects select "Y", otherwise select "N". (See "Guidelines for Implementation")
Program Investment ($)	The Bond program contribution ($)
Total State Investment ($)	The State contribution to the project ($)

The "Input Data" tab is where all input data should go. There are drop down menu options for equipment type, Port/Rail Yard, fuel type, project type, and additional emission controls. All other inputs can have any range of values.

"Sample Inputs" Tab

The examples in this tab will provide guidance for inputting data into the "Input Data" tab. Samples and correct inputs are provided in the appendix to this document.

"Benefits Summary" Tab

The "Benefits Summary" tab contains an automatically updated table of the PM and NOX emissions benefits and cost effectiveness by project ID, equipment type, equipment population and state investment for the entire contract life of that project.

Emissions Benefits Summary

This tab provides the emissions benefits (PM and NOX) for each proposed project (by ID and Project Type) for the term of the contract.

OVERALL EMISSIONS BENEFITS AND COST EFFECTIVENESS FOR ALL PROJECTS

Total State Investment ($)	Total PM Benefits (lbs)	Total NOX Benefits (lbs)	Cost Effectiveness NOX+20*PM (lbs/State $)
$ 812,000	1,601	-	0.039

EMISSIONS BENEFITS AND COST EFFECTIVENESS FOR ALL PROJECTS

Project Name	Equipment Type	Project Population	State Investment ($)	Total PM Benefits (lbs)	Total NOX Benefits (lbs)	Cost Effectiveness NOX+20*PM (lbs/State $)
ExampleC1a	Crane with Tier 4 Engine	1	$ 160,000	135.65	-	0.017
ExampleC1b	Crane with Level 3 VDEC	1	$ 160,000	225.72	-	0.028
ExampleB1a	Crane with Level 3 VDEC	1	$ 160,000	136.52	-	0.017
ExampleB1c	Crane with Level 3 VDEC	1	$ 12,000	183.19	-	0.305
sample	Crane with Level 3 VDEC	1	$ 160,000	784.29	-	0.098
sample 2	Crane with Tier 4	1	$ 160,000	135.65	-	0.017

Data Sources

Initial Statement of Reasons for the Regulation for Mobile Cargo Handling Equipment at Ports and Intermodal Rail Yards - Appendix B: Emissions Inventory Methodology
http://www.arb.ca.gov/regact/cargo2005/cargo2005.htm

Fuel Correction Factor - OFFROAD Tech Memo
http://www.arb.ca.gov/msei/offroad/techmemo/arb_offroad_fuels.pdf

Deterioration Factors - OFFROAD Documentation
MSC# 99-32

Locomotive Emissions Benefit Calculator

This calculator allows a user to input information about a particular locomotive engine and estimate the emissions benefits of a proposed project funded under the $1B Goods Movement Emission Reduction Program. Included below are the methodology and directions for filling in each field necessary for emissions benefit estimation. Where data is not provided an ARB fleet average default will be used.

Methodology

Emissions from locomotives are calculated by the product of population, annual fuel consumption (gallons/year), a fuel correction factor, an emission factor (grams/hp-hr) and a conversion factor (bhp-hr/gallon).

$$E^i = N * EF^i * FC * F_{gal/yr} * \frac{Bc}{454} * L$$

Where

E^i	project life emissions in pounds (lbs) for NOx or PM
N	number of units
EF^i	Pollutant specific emissions factor in g/bhp-hr
FC	Fuel correction factor
F	annual diesel fuel consumption in gallons/yr per locomotive
Bc	conversion factor from bhp-hr to gallons
1/454	conversion from grams to lbs (NIST, 1995)
L	Equipment project life

To estimate the project emissions benefits (Emissions reduced, $E_{reduced}$) the emissions from the existing locomotives ($E_{baseline}$) and replacement locomotive ($E_{new/upgraded}$) are estimated. The difference between the two is the benefit of that project.

$$E^i_{reduced} = E^i_{baseline} - E^i_{new/upgraded}$$, where i=NOx or PM

Example calculation: Local Agency A proposes to replace 20 uncontrolled switchers with new switchers gensets to be operational in 2008. The estimated total project cost is $30 M and they are requesting $15 M from Bond program funds to partially fund this project. The Local Agency estimates each old/new switcher is using about 50,000 gallons diesel fuel per year per locomotive.

NOX EF(uncontrolled switcher) = 17.4 g/bhp-hr
PM EF (uncontrolled switcher) = 0.44 g/bhp-hr
NOX FC = 0.94

PM FC = 0.86
Bc = 18.5 bhp-hr/gallon
L = 15 years

NOx emissions from existing 20 uncontrolled switchers = (20 uncontrolled switchers)*(17.4 gram/brake horsepower-hr)*(0.94)*(50,000 annual gallons per switcher)(18.5 bhp-hr per gallon)/(454 gram per lb)*(15 years project life) = 9,997,335 lb

PM emissions from existing 20 uncontrolled switchers = (20 uncontrolled switchers)*(0.44 gram/brake horsepower-hr)*(0.86)*(50,000 annual gallons per switcher)(18.5 bhp-hr per gallon)/(454 gram per lb)*(15 years project life) = 231,291 lb

NOx emission benefits of replacing 20 uncontrolled switcher by 20 new switcher gensets= (9,997,335 - 2,010,958) = 7,986,377 lb

PM emission benefits of replacing 20 uncontrolled switcher by 20 new switcher gensets= (231,291 - 57,823) = 173,468 lb

Cost-effectiveness of project is = (7,986,377 + 20*(173,468))/$15 M = (11,455,737 lb/$15 M) = 0.76 lb/$

This means, that for the project life, emissions will be reduced by 3,993 tons for NOx and 86.7 tons for PM with a project cost-effectiveness of 0.76 lbs per State dollar invested.

Locomotive Baseline Emission Factors

USEPA adopted (EPA,1997a) in 1997 Tier 0, Tier1, and Tier 2 NOx and PM emission standards for switcher and line haul locomotives (standards were also adopted for total hydrocarbons and CO but are not included in this discussion). These standards are emission levels that are not to be exceeded by existing locomotives. For those existing uncontrolled switchers and line haul locomotives (i.e. manufactured before 1973) EPA recommended emission factors (EPA, 1997b, 1998, 2007) will be used. Table 10 provides emission factors for existing switchers and line hauls.

Table 10: Baseline Emission Factors (g/bhp-hr)

	NOx	PM
Uncontrolled switcher	17.4	0.44
Tier 0 switcher	14.0	0.72
Tier 1 switcher	11.0	0.54
Uncontrolled Line-haul	13.0	0.32
Tier 0 Line-haul	9.5	0.60
Tier 1 Line-haul	7.4	0.45

Locomotive Fuel Correction Factors

The ARB regulation (Regulatory Amendments Extending the California Standards for Motor Vehicle Diesel Fuel to Diesel Fuel Used in Harbor craft and Intrastate Locomotives) adopted in 2004, requires intrastate locomotives that operate 90% of the time in the state to use only California ultra low sulfur diesel fuel (ULSD). The regulation went into effect on January 1, 2007 and provides, on average, a reduction of 6% in NOx and 14% in diesel PM compared to US EPA on-road and nonroad diesel fuels (ARB, 2004). The fuel correction factors are only applied to switcher locomotives.

Locomotive Replacement Emission Factors

US EPA certified test emissions for switcher gensets and line haul emission factors based on the Tier 2 EPA adopted emission standards (EPA, 1997a) are shown in Table 11.

Table 11: Default New/Upgraded Emission Factors

	Switcher Genset (g/bhp-hr)	Line Haul (Tier 2) (g/bhp-hr)
NOx	3.5	5.5
PM	0.1	0.20

Applicants can use PM and NOx emission factors (equal or lower than those in Table 2) for new/upgraded equipment with proper documentation (EPA engine certification test data with ARB verification). If no emission factors are provided, the default NOx and PM emission factors will be assumed.

Conversion Factors

To express emission rates as grams of pollutant emitted per gallon of fuel consumed (g/gal), a bhp-hr to gallons conversion factor is required. EPA has estimated the following conversion rates for line haul and switcher locomotives, based on test data (EPA, 2007). For multiengine switcher gensets, the Carl Moyer Program (ARB, 2005) conversion factor of 18.5 gal/bhp-hr will be used. Table 12 summarizes the bhp-hr to gallon conversion factors.

Table 12: bhp-hr to Gallons Conversion Factors

Locomotive	Conversion Factor (bhp-hr/gallon)
Line Haul	20.8
Switcher	18.5
Switcher Genset	18.5

Emissions must be converted from grams to pounds in order to calculate total tonnage of emissions:

1 pound (lb) = 453.6 grams (g)
1 ton = 2,000 lbs

Directions

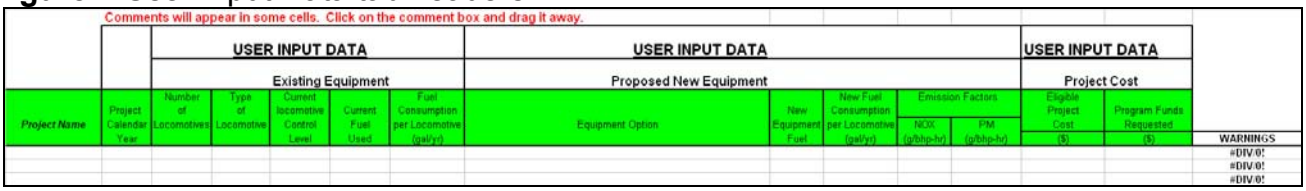
The locomotive benefits calculator contains the following tabs. Each tab will be described in greater detail below.

TAB	DESCRIPTION
Directions	Contains file description and User's instructions
User Input Data	In this tab the user will input data necessary for emissions benefit and cost-effectiveness estimation for each locomotive project.
Benefits Summary	This tab contains an overall summary of the PM and NOX emissions benefits, together with project cost effectiveness (similar summary is also provided for each individual project ID)
Sample Inputs	This tab contains sample projects with sample inputs.
Project Calculations	In this tab the user inputs are used to estimate baseline and replacement project emissions and cost-effectiveness for each project.
Default Emission Factors	This tab contains default NOx and PM Emission factors
Valid Entries	This tab has a list of valid entries used in User Input Data

"User Input" Tab

The "Input Data" tab is where all input data should go. There are drop down menu options for equipment type, existing emission control, project type, and fuel. The inputs are described in Table 13 below.

Figure 1 User Input Data tab headers



The user must enter the required information in each column. The last column labeled WARNINGS, verifies that the requested funding meets Program criteria. For this calculator, locomotives can either be entered individually or grouped based on locomotive type and level of control.

Table 13: User Input Data tab: input fields and field descriptions

Project Name	An ID that is unique to each vehicle/engine or each vehicle/engine group. This ID can be any value/character the user chooses. No two projects should have the same ID and each project should be inputted into a single row.
Project Calendar Year	Project calendar year is the calendar year the project will be operational
Number of Locomotives	The number of switchers, or number of line hauls to be rebuilt,

	repowered or replaced.
Type of Locomotive	Locomotive type (switcher or line haul)
Current Locomotive Control Level	Emission control level of existing locomotives(uncontrolled, Tier 0 or Tier 1)
Current Fuel Used	Fuel used for existing locomotive
Fuel Consumption per Locomotive	Enter the annual diesel-fuel usage per unit (integers only) in gallons per year.
Equipment Option	The proposed equipment option (generator set or Tier 2)
New Fuel Consumption per Locomotive	Enter the projected annual diesel-fuel usage per unit (integers only) in gallons per year. If the annual fuel usage is the same as the existing locomotive enter the same fuel consumption as identified above.
Emission Factors: NOx Emission Factors: PM	Leave blank unless entering PM and NOx emission factors (equal or lower than those in Table 11) for new/upgraded equipment. Proper documentation (EPA engine certification test data with ARB verification) is required to enter emission factors in these fields. If left blank default emission factors will be used.
Eligible Project Cost	Total project cost including matching funds, State funds, and administrative costs ($).
Program Funds Requested	State funds requested for this project, including any administrative costs, from the Bond Program.
WARNINGS	"E R R O R" is displayed if program funds requested exceed Guideline funding criteria.

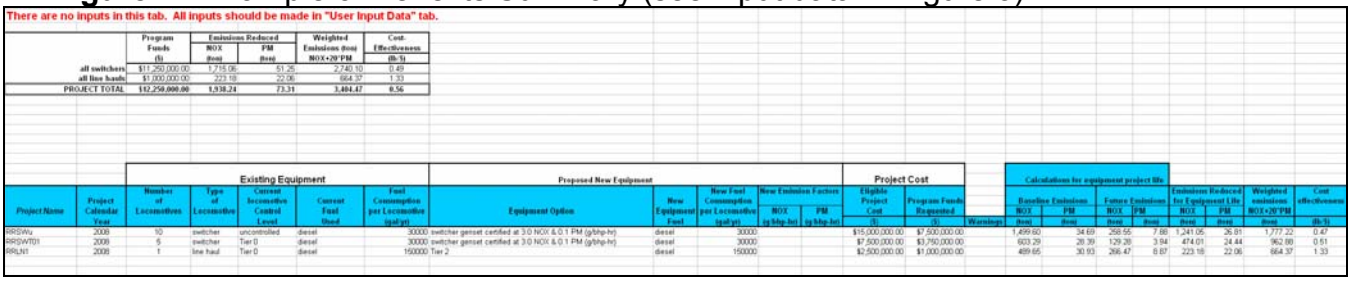
"Sample Inputs" Tab

The examples in this tab will provide guidance for inputting data into the "Input Data" tab. Samples and correct inputs are provided in the appendix to this document.

"Benefits Summary" Tab

The "Benefits Summary" tab contains an <u>automatically</u> updated table of the PM and NOX emissions benefits and cost effectiveness by project type for the entire contract life of that project. After entering valid input data in the "User Input Data" tab. Please check project summary of benefits in the "Benefits Summary" tab.

Figure 4. Example of Benefits Summary (see input data in Figure 3)


There are no inputs in this tab. All inputs should be made in "User Input Data" tab.

	Program Funds ($)	Emissions Reduced NOX (tons)	Emissions Reduced PM (tons)	Weighted Emissions (tons) NOX+20*PM	Cost-Effectiveness ($/lb)
all switchers	$11,250,000.00	1,715.06	51.25	2,740.10	0.49
all line hauls	$1,000,000.00	223.18	22.06	664.37	1.33
PROJECT TOTAL	$12,250,000.00	1,938.24	73.31	3,404.47	0.56

		Existing Equipment					Proposed New Equipment				Project Cost		Calculations for equipment project life							
									New Emission Factors				Baseline Emissions		Future Emissions		Emissions Reduced for Equipment Life			
Project Name	Project Calendar Year	Number of Locomotives	Type of Locomotive	Current Locomotive Control Level	Current Fuel Used	Fuel Consumption per Locomotive (gal/yr)	Equipment Option	New Equipment Fuel	New Fuel Consumption per Locomotive (gal/yr)	NOX (g/bhp-hr)	PM (g/bhp-hr)	Eligible Project Cost ($)	Program Funds Requested ($)	Warnings	NOX (tons)	PM (tons)	NOX (tons)	PM (tons)	NOX (tons)	PM (tons)	Weighted emissions NOX+20*PM (tons)	Cost effectiveness ($/lb)
RRSWu	2008	10	switcher	uncontrolled	diesel	30000	switcher genset certified at 3.0 NOX & 0.1 PM (g/bhp-hr)	diesel	30000			$15,000,000.00	$7,500,000.00		1,499.60	34.69	258.55	7.88	1,241.05	26.81	1,777.22	0.47
RRSWT01	2008	5	switcher	Tier 0	diesel	30000	switcher genset certified at 3.0 NOX & 0.1 PM (g/bhp-hr)	diesel	30000			$7,500,000.00	$3,750,000.00		623.29	20.39	129.28	3.94	474.01	24.44	962.89	0.51
RRLN1	2008	1	line haul	Tier 0	diesel	150000	Tier 2	diesel	150000			$2,500,000.00	$1,000,000.00		489.65	30.93	266.47	8.87	223.18	22.06	664.37	1.33

Data Sources

Air Resources Board. Initial Statement of Reasons for Proposed Rulemaking. Proposed Regulatory Amendments Extending the California Standards for Motor Vehicle Diesel Fuel to Diesel Fuel Used in Harbor craft and Intrastate Locomotives. October 1, 2004. (available at http://www.arb.ca.gov/regact/carblohc/isor.pdf)

Booz-Allen & Hamilton, Inc. Locomotive Emissions Study. January 1991. (available at http://www.arb.ca.gov/research/apr/reports/l343.pdf)

United States EPA, Air and Radiation, Office of Mobile Sources. Regulatory Announcement. Final Emission Standards for Locomotives. EPA-420-F-97-048. December 1997a. (available at http://www.epa.gov/oms/regs/nonroad/locomotv/frm/42097048.pdf)

United States EPA, Air and Radiation, Office of Mobile Sources. Technical Highlights. Emission Factors for Locomotives. EPA-420-F-97-051. December 1997b. (available at http://epa.gov/otaq/regs/nonroad/locomotv/frm/42097051.pdf)

United States EPA. Regulatory Support Document. April 1998. (available at http://www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf)

United States EPA. Draft Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression-Ignition Engines Less than 30 Liter per Cylinder. EPA420-D-07-001. March 2007. (available at http://www.epa.gov/otaq/regs/nonroad/420d07001.pdf)

The Carl Moyer Program Guidelines. Part II of IV. November 17, 2005. (available at http://www.arb.ca.gov/msprog/moyer/guidelines/2005_Carl_Moyer_Guidelines_Part2.pdf)

United State EPA. "Locomotive-Compression-Ignition engines Certification data, 2006&2007 Model Year Family Information, Certification Test Results, Useful Information" (available at http://www.epa.gov/omswww/certdata.htm#locomotive)

Appendix - Examples:

Heavy Duty Truck Emissions Benefit Calculator (for Drayage and Other Heavy Duty Trucks)

Example Project C1
In 2008 Local Agency C proposes to retrofit 150 Port trucks with a retrofit that gets Level 3 PM reductions. 50 of these trucks are model year 2000 and the remaining are model year 1997. These trucks primarily service the Ports of Los Angeles/Long Beach. Fleet records indicate that half of the 2000 model year trucks drive 50,000 miles/year while the other half drive 39,000 miles/year. Fleet records for the 1997 model year trucks indicate that they drive 30,000 miles/year.

Correct Inputs
Project C1

		EXISTING TRUCK						REPLACEMENT/REPOWER TRUCK				
Project Calendar Year	Truck Population	Engine Model Year	Fuel Type	Annual Accrual (miles/year) per truck	Drayage Truck (Y/N)	Service Area	Project Option - Detailed	Engine Model Year	Fuel Type	Annual Accrual (miles/year) per truck	Drayage Truck (Y/N)	Service Area
2008	25	2000	diesel	50,000	Y	LA/LB	Level 3 PM Retrofit	(leave blank)	diesel	50,000	Y	LA/LB
2008	25	2000	diesel	39,000	Y	LA/LB	Level 3 PM Retrofit	(leave blank)	diesel	39,000	Y	LA/LB
2008	100	1997	diesel	30,000	Y	LA/LB	Level 3 PM Retrofit	(leave blank)	diesel	30,000	Y	LA/LB

Example Project B1
In 2008 Local Agency B proposes to retrofit 75 Other Heavy Duty Diesel trucks with a retrofit that gets Level 3 PM and Level 1 NOX reductions, replace 50 Port trucks with 2007 diesel heavy duty trucks and replace 25 Other Heavy Duty Diesel trucks with 2007 CNG trucks. The 75 retrofits are model year 1999 and primarily service the Port of Oakland, but there are no fleet records to determine annual mileage. The only information the local agency has for the 50 Port truck replacements is that the trucks vary in model years from 1980-1990 and belong to the Walmart fleet. The local agency has no information on the 25 trucks to be replaced with 2007 CNG trucks.

Correct Inputs
Project B1

Directions: Proposition 1B GMERP Benefit Calculators

	EXISTING TRUCK						REPLACEMENT/REPOWER TRUCK				
Truck Population	Engine Model Year	Fuel Type	Annual Accrual (miles/year) per truck	Drayage Truck (Y/N)	Service Area	Project Option - Detailed	Engine Model Year	Fuel Type	Annual Accrual (miles/year) per truck	Drayage Truck (Y/N)	Service Area
75	1999	diesel	(leave blank)	N	(leave blank)	Level 3 PM and Level 1 NOX Retrofit	(leave blank)	diesel	(leave blank)	N	(leave blank)
50	1985*	diesel	(leave blank)	Y	Oakland	Diesel Replacement	2007	diesel	(leave blank)	Y	Oakland
25	(leave blank)	diesel	(leave blank)	N	(leave blank)	CNG/LNG Replacement	2007	diesel	(leave blank)	N	(leave blank)

*Take the average of the model year range.

Example Project D1

In 2008 user D proposes to do a Three-Way project. Fleet records for model years and mileage are provided below:

TruckID	Model Year	Fuel	Fleet	Annual Mileage
D1TA1	2003	diesel	Safeway	80,000
D1TA2	1978	diesel	Kroger	40,000

The user would like to replace Truck D1TA1 with a 2007 diesel truck. Truck D1TA1 (including a level 3 retrofit) would be given to the owner of Truck D1TA2 and Truck B would be scrapped.

Correct Inputs

Project D1

		EXISTING TRUCK						REPLACEMENT/REPOWER TRUCK				
Project Name	Truck Population	Engine Model Year*	Fuel Type	Annual Accrual (miles/year) per truck	Drayage Truck (Y/N)	Service Area	Project Option - Detailed	Engine Model Year**	Fuel Type	Annual Accrual (miles/year) per truck	Drayage Truck (Y/N)	Service Area
D1TA1	1	2003	diesel	80,000	N	(leave blank)	Three-Way Truck A (Replace with 2007 or better)	2007	LNG	80,000	N	(leave blank)
D1TA2	1	1978	diesel	40,000	N	(leave blank)	Three-Way Truck B (Replace with Truck A with Level 3 PM Retrofit)	2003	diesel	40,000	N	(leave blank)

*Based on the "Equipment Project Specifications" truck D1TA1 is referred to as Truck A and truck D1TA2 is referred to as truck B. For truck D1TA2 the replacement model year is the model year of truck D1TA1.

** Since truck D1TA1 is being replaced with a 2007 truck, you need to specify whether the replacement truck is a fueled by diesel or CNG.

Commercial Harbor Craft Emissions Benefit Calculator

Project C1

In 2008 User C proposes to replace 5 Tier 0 tugs with 2007 diesel tugs. 3 of these tugs are model year 1980 and the remaining are model year 1990. These tugs primarily service the Ports of Los Angeles/Long Beach. Fleet records indicate that: 1) The 1980 tugs operate 1000 hours/year and the 1990 tugs operate 2000 hours/year, 2) there are 2 engines per vessel, 3) each engine is 1000 hp. The project will replace all engines on each tug.

Correct Inputs

Project C1

				EXISITING HARBOR CRAFT ENGINE(S)					REPLACEMENT/REPOWER ENGINE(S)	
Vessel Type	Vessel Population	# propulsion engines per vessel	# propulsion engines to be replaced/repowered per vessel	Model Year	Fuel Type	Annual Operational Hours (hrs) per vessel	HP/engine (old engine)	Homeport	Model Year	HP/engine (new engine)
Tug	3	2	2	1980	Diesel	1,000	1000	LA/LB	2007	1000
Tug	2	2	2	1990	Diesel	2,000	1000	LA/LB	2007	1000

Homeport: LA/LB

Project D1

In 2008 User B proposes to replace 15 Tier 0 commercial fishing vessels with 2007 diesel vessels. The agency has no fleet records but knows that the vessels range in model year from 1990-1996.

The project will replace one engine on each tug.

Correct Inputs

Project D1

				EXISITING HARBOR CRAFT ENGINE(S)					REPLACEMENT/REPOWER ENGINE(S)	
Vessel Type	Vessel Population	# propulsion engines per vessel	# propulsion engines to be replaced/repowered per vessel	Model Year	Fuel Type	Annual Operational Hours (hrs) per vessel	HP/engine (old engine)	Homeport	Model Year	HP/engine (new engine)
Commercial Fishing	15	(leave blank)	1	1993*	Diesel	(leave blank)	(leave blank)	(leave blank)	2007	(leave blank)

Homeport: (leave blank)

*Take the average of the model year range.

Shore Power Emissions Benefit Calculator

Project B1:
Local agency B proposes to install grid power at a berth and have it operational by 2010.

The local agency projects the following activity for future compliance dates:

CY	Vessel	Size	Population	Fuel Type	Vessel Visits per Vessel
2011	Container	container_<2000	2	Marine Distillate @ 0.5% Sulfur	12
2011	Container	container_4000-4999	3	Marine Distillate @ 0.5% Sulfur	5
2011	Container	container_7000-7999	1	Marine Distillate @ 0.5% Sulfur	8
2011	Reefer		1	Marine Distillate @ 0.5% Sulfur	2
2014	Container	container_<2000	2	Marine Distillate @ 0.5% Sulfur	14
2014	Container	container_4000-4999	3	Marine Distillate @ 0.5% Sulfur	7
2014	Container	container_7000-7999	1	Marine Distillate @ 0.5% Sulfur	9
2014	Reefer		1	Marine Distillate @ 0.5% Sulfur	3
2017	Container	container_<2000	2	Marine Distillate @ 0.5% Sulfur	16
2017	Container	container_4000-4999	3	Marine Distillate @ 0.5% Sulfur	7
2017	Container	container_7000-7999	1	Marine Distillate @ 0.5% Sulfur	10
2017	Reefer		1	Marine Distillate @ 0.5% Sulfur	3
2020	Container	container_<2000	2	Marine Distillate @ 0.5% Sulfur	18
2020	Container	container_4000-4999	3	Marine Distillate @ 0.5% Sulfur	9
2020	Container	container_7000-7999	1	Marine Distillate @ 0.5% Sulfur	10
2020	Reefer		1	Marine Distillate @ 0.5% Sulfur	3

Correct Inputs

The following would be correct berth inputs for Project B1.

First Operational Year	Berth Name	Port	Replacement Power
2010	G23	LB	Grid

The following would be correct "2011" Vessel Inputs" for Project B1.

Vessel Name	Vessel Type	Vessel Population	Container Vessel Size	Total Aux Power (kW) per vessel	In-Use Aux Power (kW) per vessel	Fuel Type	Total # Vessel Visits to Berth per vessel	Avg Hotelling Time per visit (hours) per vessel
C1	Container	2	container_<2000	5,200	(leave blank)	Marine Distillate @ 0.5% Sulfur	12	(leave blank)
C2	Container	3	container_4000-4999	(leave blank)	(leave blank)	Marine Distillate @ 0.5% Sulfur	5	(leave blank)
C3	Container	1	container_7000-7999	(leave blank)	(leave blank)	Marine Distillate @ 0.5% Sulfur	8	(leave blank)
R1	Reefer	1		(leave blank)	(leave blank)	Marine Distillate @ 0.5% Sulfur	2	(leave blank)

See calculator for 2014, 2017 and 2020 correct inputs.

Cargo Handling Equipment Emissions Benefit Calculator

Project A1:

In 2012 Local Agency A proposes to retrofit 10 rubber tired gantry cranes with energy storage systems. 5 of these cranes are model year 2011. The remaining 5 are model year 1995 cranes with Level 3 VDECs. Records indicate that the 2011 model year cranes are used for 500 hours per year, each have a horsepower of 1,030, and operate at the port. Records for the 1995 cranes indicate that usage is 592 hours per year at a railyard, horsepower of 1,030. The 1995 project group has DOC emission control devices installed (DOC).

Correct Inputs

Project Name	Project Calendar Year	Equipment Type	Equipment Population	Engine Model Year	Fuel Type	Annual Operational Hours (hrs)	HP	Port/Railyard	Emission Control Y/N	Emission Control Device
ExampleCHEA1	2012	Crane with Tier 4 Engine	5	2011	diesel	500	1030	Port	No	
ExampleCHEA2	2012	Crane with Level 3 VDEC	5	1995	diesel	592	1030	Rail Yard	Yes	DOC

Locomotives Emissions Benefit Calculator

Example Calculation

To illustrate how to use the locomotive calculator, we will assume a hypothetical example to guide the user.

Local Agency "RR" wants to use the Locomotive Project Benefits calculator (Calculator) to estimate potential emissions reductions and cost-benefit of the following locomotive project:

- Replace 10 uncontrolled switcher locomotives with new switcher gensets certified at 3.0 g/bhp-hr NOx and 0.1 g/bhp-hr PM
- Replace 5 Tier 0 switcher locomotives with new switcher gensets certified at 3.0 g/bhp-hr NOx and 0.1 g/bhp-hr PM
- Replace a Tier 0 line haul locomotive with a new Tier 2 line haul

Each switcher uses 30,000 gallons diesel per year, and the line haul uses 150,000 gallons diesel per year. The agency estimates the total cost for replacement is $15 M, $7.5 M and $2.5 M for the uncontrolled switchers, Tier 0 switchers, and line haul, respectively. Agency RR is requesting Program funds in the amount of $7.5 M, 3.75 and $1 M for uncontrolled and Tier0 switchers and line hauls, respectively, to partially fund these projects.

Figure 2 Example of Agency RR entering Locomotives Projects

Comments will appear in some cells. Click on the comment box and drag it away.

		USER INPUT DATA					USER INPUT DATA				USER INPUT DATA		
		Existing Equipment					Proposed New Equipment				Project Cost		
Project Name	Project Calendar Year	Number of Locomotives	Type of Locomotive	Current locomotive Control Level	Current Fuel Used	Fuel Consumption per Locomotive (gal/yr)	Equipment Option	New Equipment Fuel	New Fuel Consumption per Locomotive (gal/yr)	Emission Factors NOX (g/bhp-hr)	Emission Factors PM (g/bhp-hr)	Eligible Project Cost ($)	Program Funds Requested ($)	WARNINGS
RRSWu	2008	10	switcher	uncontrolled	diesel	30,000	switcher genset certified at 3.0 NOX & 0.1 PM (g/bhp-hr)	diesel				$15,000,000.00	$7,500,000.00	
RRSWT01	2008	5	switcher	Tier 0	diesel	30,000	switcher genset certified at 3.0 NOX & 0.1 PM (g/bhp-hr)	diesel				$7,500,000.00	$4,000,000.00	ERROR
RRLN1	2008	1	line haul	Tier 0	diesel	150,000	Tier 2	diesel				$2,500,000.00	$1,000,000.00	
														#DIV/0!

Note that the second row displays the warning ""ERROR" to warn user that the "Program Funds Requested" exceeds Program criteria. User must enter an amount that meets Program guidelines. Figure 3 shows the corrected version. Note also that no NOx and PM emission factors were inputted for the proposed equipment. In this case the Calculator will select default values.

Figure 3 Corrected Funding Amount

Comments will appear in some cells. Click on the comment box and drag it away.

		USER INPUT DATA					USER INPUT DATA				USER INPUT DATA		
		Existing Equipment					Proposed New Equipment				Project Cost		
Project Name	Project Calendar Year	Number of Locomotives	Type of Locomotive	Current locomotive Control Level	Current Fuel Used	Fuel Consumption per Locomotive (gal/yr)	Equipment Option	New Equipment Fuel	New Fuel Consumption per Locomotive (gal/yr)	Emission Factors NOX (g/bhp-hr)	Emission Factors PM (g/bhp-hr)	Eligible Project Cost ($)	Program Funds Requested ($)	WARNINGS
RRSWu	2008	10	switcher	uncontrolled	diesel	30,000	switcher genset certified at 3.0 NOX & 0.1 PM (g/bhp-hr)	diesel				$15,000,000.00	$7,500,000.00	
RRSWT01	2008	5	switcher	Tier 0	diesel	30,000	switcher genset certified at 3.0 NOX & 0.1 PM (g/bhp-hr)	diesel				$7,500,000.00	$3,750,000.00	
RRLN1	2008	1	line haul	Tier 0	diesel	150,000	Tier 2	diesel				$2,500,000.00	$1,000,000.00	
														#DIV/0!

After entering valid input data in the “User Input Data” tab. Project benefits can be found in the “Benefits Summary” tab.

Figure 4. Example of Benefits Summary (see input data in Figure 3)

There are no inputs in this tab. All inputs should be made in "User Input Data" tab.

	Program Funds ($)	Emissions Reduced NOX (ton)	Emissions Reduced PM (ton)	Weighted Emissions (ton) NOX+20*PM	Cost-Effectiveness ($/lb)
all switchers	$11,250,000.00	1,715.06	51.25	2,740.10	0.49
all line hauls	$1,000,000.00	223.18	22.06	664.37	1.33
PROJECT TOTAL	$12,250,000.00	1,938.24	73.31	3,404.47	0.56

		Existing Equipment					Proposed New Equipment				Project Cost			Calculations for equipment project life							
									New Emission Factors					Baseline Emissions		Future Emissions		Emissions Reduced for Equipment Life		Weighted emissions	Cost effectiveness
Project Name	Project Calendar Year	Number of Locomotives	Type of Locomotive	Current locomotive Control Level	Current Fuel Used	Fuel Consumption per Locomotive (gal/yr)	Equipment Option	New Equipment Fuel	New Fuel Consumption per Locomotive (gal/yr)	NOX (g/bhp-hr)	PM (g/bhp-hr)	Eligible Project Cost ($)	Program Funds Requested ($)	Warnings	NOX (ton)	PM (ton)	NOX (ton)	PM (ton)	NOX (ton)	PM (ton)	NOX+20*PM (ton)	($/lb)
RRSWu	2008	10	switcher	uncontrolled	diesel	30000	switcher genset certified at 3.0 NOX & 0.1 PM (g/bhp-hr)	diesel	30000			$15,000,000.00	$7,500,000.00		1,499.60	34.69	258.55	7.88	1,241.05	26.81	1,777.22	0.47
RRSWT01	2008	5	switcher	Tier 0	diesel	30000	switcher genset certified at 3.0 NOX & 0.1 PM (g/bhp-hr)	diesel	30000			$7,500,000.00	$3,750,000.00		603.29	28.39	129.28	3.94	474.01	24.44	962.68	0.51
RRLN1	2008	1	line haul	Tier 0	diesel	150000	Tier 2	diesel	150000			$2,500,000.00	$1,000,000.00		499.66	30.93	266.47	8.87	223.18	22.06	664.37	1.33

“Project Calculations” tab

Calculations details are shown in the “Projects Calculations” tab. Figure 5 displays this tab for the example used above.

Figure 5 “Project Calculations” tab

There are no inputs in this tab. All inputs should be made in "User Input Data" tab.

				LOCOMOTIVE EMISSIONS ESTIMATES								PROJECT BENEFITS			
		PROGRAM FUND REQUESTED (a warning is displayed if this amount does not meet Guidelines)		Baseline Emission Factors		Baseline Emissions		New Emission Factors		Future Emissions		Emissions Reduced for Equipment Life		Weighted emissions	Cost effectiveness
Project Name	Project Calendar Year		Annual fuel consumption	NOX	PM	NOX	PM	NOX	PM	NOX	PM	NOX	PM	NOX+20*PM	
		($)	(gal/yr)	(g/bhp-hr)	(g/bhp-hr)	(lb/yr)	(lb/yr)	(g/bhp-hr)	(g/bhp-hr)	(lb/yr)	(lb/yr)	lbs	lbs	lbs	($/lb)
RRSWu10	2008	$7,500,000.00	30,000	17.40	0.44	199,946.7	4,625.8	3.000	0.100	34,473.6	1,051.3	2,482,096.9	53,617.4	3,554,444.9	0.47
RRSWT01	2008	$3,750,000.00	30,000	14.00	0.72	80,438.3	3,784.8	3.000	0.100	17,236.8	525.7	948,023.1	48,886.5	1,925,752.2	0.51
RRLN1	2008	$1,000,000.00	150,000	9.50	0.60	65,286.3	4,123.3	5.500	0.200	35,529.5	1,182.0	446,352.4	44,119.8	1,328,748.9	1.33

Directions: Proposition 1B GMERP Benefit Calculators

There are no inputs in this tab. All inputs should be made in "User Input Data" tab.

SUMMARY TABLE

													Calculations for equipment project life							
Number of Locomotives	Project Name	Project Calendar Year	Type of Locomotive	Current locomotive Control Level	Current Fuel Used	Fuel Consumption per Locomotive (gal/yr)	Equipment Option	New Equipment Fuel	Emission Factors NOX (g/bhp-hr)	Emission Factors PM (g/bhp-hr)	Eligible Project Cost ($)	Program Funds Requested ($)	Baseline Emissions NOX (ton)	Baseline Emissions PM (ton)	Future Emissions NOX (ton)	Future Emissions PM (ton)	Emissions Reduced NOX (ton)	Emissions Reduced PM (ton)	Weighted emissions NOX+20*PM (ton)	Cost effectiveness (lb/$)
10	RRSWu10	2008	switcher	uncontrolled	diesel	30,000	switcher genset certified at 3.0 NOX & 0.1 PM (g/bhp-hr)	diesel	0	0	15000000	$7,500,000.00	1,499.6	34.7	258.6	7.9	1,241.0	26.8	1,777.2	$0.47
5	RRSWT01	2008	switcher	Tier 0	diesel	30,000	switcher genset certified at 3.0 NOX & 0.1 PM (g/bhp-hr)	diesel	0	0	7500000	$3,750,000.00	603.3	28.4	129.3	3.9	474.0	24.4	962.9	$0.51
1	RRLN1	2008	line haul	Tier 0	diesel	150,000	Tier 2	diesel	0	0	2500000	$1,000,000.00	489.6	30.9	266.5	8.9	223.2	22.1	664.4	$1.33