Technical Supplement for On-Road Light-Duty and Heavy-Duty Diesel Vehicles

Texas Commission on Environmental Quality (TCEQ)

Texas Clean Fleet Program (TCFP)

Texas Emissions Reduction Plan (TERP)

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Texas Commission on Environmental Quality (TCEQ)

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Summary

This technical supplement contains instructions for calculating the NO_X emissions reductions and the cost per ton of NO_X reduced for the replacement of on-road light-duty or heavy-duty diesel motor vehicles under the Texas Clean Fleet Program (TCFP). Applicants are not required to calculate these values; however, it is recommended that applicants perform these calculations to have an idea of the score the project may be assigned in the selection process. TCFP is a competitive grant round and projects with the lowest cost per ton of NO_X reduced and the highest NO_X emissions reductions will score more points than other projects. For more details about the scoring criteria, please see the TCFP Request for Grant Applications (RFGA).

The steps in this technical supplement are generally the same steps that will be used by TERP to determine the NO_X emissions reductions and the cost per ton of NO_X reduced by the project. There may be instances where more specific information on emissions and emissions rates are available. In those instances, the TCEQ may use that information instead of the emissions standards listed in this technical supplement.

The calculations are divided into the five main steps listed below.

- Step 1: Determine the NO_X emission rates for the old and new vehicles.
- Step 2: Check the 25% NO_X emissions reduction requirement.
- Step 3: Convert the emission rates to grams per mile (g/mile) and apply the Texas Low Emission Diesel (TxLED) correction factor (where appropriate).
- Step 4: Calculate the NO_X emissions reductions.
- Step 5: Calculate the cost per ton of NO_X reduced.

These steps are explained in the following instructions. Applicants can use the worksheets provided at the end of this technical supplement (Appendix A) in conjunction with these instructions to complete the calculations on their own. Alternatively, applicants can visit www.terpgrants.org for calculator tools that can be used in completing the calculations.

Step 1: Determine the NO_X emission rates for the old and new vehicles

The Texas Emissions Reduction Plan (TERP) uses the Environmental Protection Agency's (EPA) and the California Air Resource Board (CARB) vehicle emissions standards as the basis for emissions reductions standards. In most cases, the provided instructions will help in determining the NO_X emission standard for a vehicle. Should an applicant have any difficulty determining an emission factor, they can contact TERP for assistance.

Applicants will need a few pieces of information about their new and old vehicles to determine the NO_X emissions for each vehicle. Determining emissions factors for light-duty and heavy-duty vehicles is different, and instructions are provided below for each category of vehicle, including what information is needed. For the purposes of determining emissions standards, light-duty vehicles are those with a Gross Vehicle Weight Rating (GVWR) of 10,000 lbs. or less and certified to a light-duty emission standard. Heavy-duty vehicles are those with a GVWR of 8,501 lbs. or more and certified to a heavy-duty emission standard. If an applicant is unsure about the GVWR of their vehicle, the easiest place to locate it is via a sticker placed in the door jamb of the driver's side of the vehicle. Alternatively, this information can be obtained from a vendor, manufacturer, or other resources. If the vehicle's GVWR is between 8,501 lbs. and 10,000 lbs., it may be necessary to check the vehicle's engine plate to determine if the vehicle was certified to a light-duty or heavy-duty standard. Examples of heavy-duty and light-duty engine plates are provided in Appendix C.

Light-Duty Vehicles

Light-duty vehicles have two emissions standard programs for which the complete vehicle (engine and chassis) is certified to operate. The federal standards are known as Tier 0 (historical emissions), Tier 1, Tier 2, and Tier 3. There are also the California standards which are known as LEV I, LEV II, and LEV III. As of 2017, the federal Tier 3 standards and the California LEV III standards are in alignment.

In order to look up which program and subsequently which emission standard to which a vehicle was certified, the following information is needed:

- The vehicle's weight classification or GVWR.
- Model year of the vehicle.
- The engine test group or engine family code, primarily applicable to vehicles produced after 2002.
- For vehicles manufactured for model year 2001 to present, the emissions standard category (e.g., Bin 2, ULEV II).

For vehicles with a model year of 1993 or older, these are Tier 0 vehicles. The only information needed to look up emissions standards for these vehicles is whether the vehicle is a light-duty truck or car, and the model year. Please use Table B.9 in Appendix B to look up the emissions standard.

For vehicles produced on or after the 1994 model year, the process to determine emissions standards is more complex. The simplest method is to locate the Vehicle Emission Control Information (VECI) label. On light-duty vehicles, this label should be located somewhere under the hood of the vehicle such as on the underside of the hood, on the engine, or other flat surface in the engine compartment. It should have the model year of the vehicle on it with the words "Vehicle Emission Control Information." For examples of a VECI label, please see Figure 1 in Appendix C.

Once the label has been located, it should clearly indicate the regulations to which the vehicle conforms (e.g., LEV2, Bin 10 Tier 2). This information may be enough to use the tables in Appendix B to lookup the emissions standard for a vehicle. If not, the label should also provide the engine test group/engine family code. This is a 12-digit code that can be looked up at the following websites to determine which exhaust standard a vehicle was certified to meet. Please be aware that a vehicle may be certified to meet both federal and California standards. In those cases, the applicant should use the lower standard of the two for the emissions reduction calculation.

- EPA Annual Certification Data for Vehicles –

https://www.epa.gov/compliance-and-fuel-economy-data/annual-certification-data-vehicles-engines-and-equipment

Note: Use the vehicle models spreadsheets, not the test data or evaporate emissions spreadsheets.

- California Air Resource Board On-Road New Vehicle & Engine Certification Program –

https://ww3.arb.ca.gov/msprog/onroad/cert/cert.php#6

If a VECI is damaged or missing from an old vehicle, an applicant may need to contact a local dealer or manufacturer for assistance in determining the emission rate of their vehicle. Applicants may also contact TERP for additional assistance.

For new vehicles, applicants should use the emissions standards found in Table B.4, unless a vehicle can meet an alternative NO_X emission standard (e.g., hybrid-electric vehicles). Applicants choosing an alternative NO_X emission standard should check with a vendor to be sure they can purchase a vehicle that can meet that chosen standard. If an applicant is choosing a zero-emission vehicle, a factor of 0 (zero) should be used for the emission rate.

Heavy-Duty Vehicles

Heavy-duty vehicle emissions are regulated by the engine in the vehicle rather than the complete vehicle. This means that in order to lookup the emission standard for an on-road heavy-duty vehicle, information about the engine itself is needed. The federal heavy-duty vehicle emissions standards are primarily designated by the combustion type of a vehicle's engine (spark ignition or compression ignition) and the year of manufacture for that engine. For reference, spark ignition engines are those that use spark plugs to ignite the fuel, such as in gasoline engines or natural gas engines, and compression ignition engines rely solely on the compression of the fuel to ignite it, such as in diesel engines. In some cases, engines are certified to emit a different amount of NO_X than the otherwise applicable standard for that engine. These engines have an EPA-certified Family Emission Limit (FEL).

In order to look up the applicable emission standard for an on-road heavy-duty vehicle, the following information is needed. This information should be readily available on a plate or sticker mounted on the engine. If this plate or sticker is missing or damaged, it may be necessary to contact the engine manufacturer or a local vendor for assistance in obtaining this information.

- Engine manufacture year.
- Fuel type of the vehicle (compression ignition or spark ignition).
- The engine family code, generally applicable to vehicles produced after 2002.

There are two ways an applicant can lookup up the NO_X emission standard for their heavy-duty vehicle's engine: by engine family code or by looking up the default standard for that year. Where possible, applicants should use the engine family code to lookup the emissions standard, as this will provide the most accurate standard for that engine and will reveal if an engine has an FEL. When an engine has an FEL, this is the emissions standard for that vehicle. Please be aware that for engines produced prior to 2003, there may not be an engine family code for that engine.

Applicants can use the following websites to look up the engine family code information for their engine. Please note that these websites are not intuitive, and applicants are encouraged to contact TERP in the event additional assistance is needed.

- EPA Annual Certification Data for Vehicles –

  https://www.epa.gov/compliance-and-fuel-economy-data/annual-certification-data-vehicles-engines-and-equipment

  Note: Use the spreadsheets listed under Heavy-Duty Highway Gasoline and Diesel Engines. These spreadsheets will only demonstrate if an engine family code exists and if there is an FEL. Please follow the instructions in looking up the default emission standard if the engine does not have an FEL.

- California Air Resource Board On-Road New Vehicle & Engine Certification Program – https://ww3.arb.ca.gov/msprog/onroad/cert/cert.php#6

  Note: This site does not contain all engine family codes that the EPA has issued.

If an engine family code is not available, the emission standards for an engine can be looked up in Tables B.10 and B.11 in Appendix B using the engine manufacture year and the fuel type of the vehicle. Please note that for engines manufactured between 2006-2009, the EPA permitted engine manufacturers a period to phase-in a lower emission standard. Engines manufactured during these years will need to be looked up by engine family code as there is not an applicable standard for these years.

For new vehicles, applicants should use the emissions standards found in Tables B.10 and B.11, unless a vehicle can meet an alternative NO_X emission standard such as 0.1 g/bhp-hr, 0.5 g/bhp-hr, or 0.02 g/bhp-hr of NO_X. Applicants choosing an alternative NO_X emission standard should check with a vendor to be sure they can purchase a vehicle that can meet that chosen standard. If an applicant is choosing a zero-emission vehicle, a factor of 0 (zero) should be used for the emission rate.

Step 2: Check the 25% NO_X emissions reduction requirement

The replacement vehicle must be certified to a NO_X emission rate that is at least 25% less than the certified NO_X emissions rate of the vehicle being replaced. Use the worksheets in Appendix A to determine if the activity meets the minimum emission reduction requirements. Provided below are examples of the calculations used to determine if an activity meets a 25% reduction in NO_X emissions.

$$\frac{Old\ Vehicle\ Emission\ Rate - New\ Vehicle\ Emission\ Rate}{Old\ Vehicle\ Emission\ Rate} \times 100 = Emission\ Rate\ Reduction\ (\%)$$

Example calculation for determining 25% NO_X emission rate reduction for replacements

Activity: Replacement of a 1987 diesel heavy-duty vehicle with a 2018 CNG heavy-duty vehicle.

Original engine emission standard: 10.7 g/bhp·hr

Replacement engine emission standard: 0.2 g/bhp·hr

Calculation of emission rate reduction:

$$\frac{\mathbf{10.7}\ \frac{\boldsymbol{g}}{\boldsymbol{bhp \cdot hr}} - \mathbf{0.2}\ \frac{\boldsymbol{g}}{\boldsymbol{bhp \cdot hr}}}{\mathbf{10.7}\ \frac{\boldsymbol{g}}{\boldsymbol{bhp \cdot hr}}} \times \mathbf{100} = \mathbf{98.1\%}\ \boldsymbol{baseline\ emission\ rate\ reduction}$$

Note: This activity would meet the 25% emission rate reduction requirement.

Example calculation for determining 25% NO_X emission rate reduction for replacements

Activity: Replacement of a 1981 light-duty truck with a 2018 Tier 2 Bin 3 model.

Original engine emission standard: 2.3 g/mile

Replacement engine emission standard: 0.03 g/mile

Calculation of emission rate reduction:

$$\frac{\mathbf{2.3}\ \frac{\boldsymbol{g}}{\boldsymbol{mile}} - \mathbf{0.03}\ \frac{\boldsymbol{g}}{\boldsymbol{mile}}}{\mathbf{2.3}\ \frac{\boldsymbol{g}}{\boldsymbol{mile}}} \times \mathbf{100} = \mathbf{98.7\%}\ \boldsymbol{baseline\ emission\ rate\ reduction}$$

Note: This activity would meet the 25% emission rate reduction requirement.

Step 3: Convert the emission rates to grams per mile (g/mile) and apply the TxLED correction factor (where appropriate)

The NO_X emissions of heavy-duty engines are certified in grams per brake horsepower-hour (g/bhp·hr). In order to perform the emissions reduction calculations, the emissions rate in g/bhp·hr must be converted to grams per mile (g/mile). Conversion factors in brake horsepower-hour per mile (bhp·hr/mile) are provided in Table B.12, by model year. If the NO_X emission rate is in g/bhp·hr, the NO_X emission rate must be multiplied by this factor to convert it to g/mile.

For light-duty vehicles, the NO_X emissions are certified in g/mile. No conversion is necessary for emission rates already in g/mile.

The TCEQ adopted rules (30 TAC §114.312 - §114.319) requiring that beginning on October 1, 2005, diesel fuel produced for use in compression-ignition engines in certain counties in Texas must meet new low emission diesel (TxLED) standards. Except for El Paso, Howard, and Hutchinson Counties, the TERP eligible counties are all affected by this standard. To account for the emissions reductions associated with lower emission diesel fuel, a factor of 0.943 should be applied to all diesel emission factors, regardless of when the vehicle came into service or will come into service. For the Texas Clean Fleet Program, this factor should be applied to all the old vehicles as all old vehicles must use diesel fuel.

Provided below are examples of the calculations used to convert g/bhp·hr to g/mile, along with incorporating the TxLED factor where appropriate.

$$Emission\ Rate\ (\frac{g}{bhp \cdot hr}) \times Conv.\ factor\ (\frac{bhp \cdot hr}{mile}) \times TxLED\ factor^{*}\ = Emission\ Rate\ (\frac{g}{mile})$$

$$* TxLED\ factor\ only\ used\ for\ old\ diesel\ vehicles, omit\ otherwise$$

Example calculation for converting g/bhp·hr to g/mile

Activity: Replacement of a 1987 diesel heavy-duty vehicle with a 2024 CNG heavy-duty vehicle.

Vehicle weight rating: 80,000 lbs.

Old vehicle emission standard: 10.7 g/bhp·hr

New vehicle emission standard: 0.2 g/bhp·hr

Old vehicle conversion factor: 3.13 bhp·hr/mile

New vehicle engine conversion factor: 3.03 bhp·hr/mile

TxLED correction factor: 0.943

Old Vehicle NO_X emission factor converted to g/mile:

$$\mathbf{10.7}\ (\frac{\boldsymbol{g}}{\boldsymbol{bhp \cdot hr}}) \times\ \mathbf{3.13}\ (\frac{\boldsymbol{bhp \cdot hr}}{\boldsymbol{mile}}) \times\ \mathbf{0.943}\ =\ \mathbf{31.582}(\frac{\boldsymbol{g}}{\boldsymbol{mile}})$$

New Vehicle NO_X emission factor converted to g/mile:

$$\mathbf{0.2}\ (\frac{\boldsymbol{g}}{\boldsymbol{bhp \cdot hr}}) \times\ \mathbf{3.03}\ (\frac{\boldsymbol{bhp \cdot hr}}{\boldsymbol{mile}}) =\ \mathbf{0.606}(\frac{\boldsymbol{g}}{\boldsymbol{mile}})$$

Step 4: Calculate the NO_X emissions reductions

Calculating the NO_X emissions reductions requires some of the information that has been calculated or gathered in the previous steps plus some additional information. The following is needed to calculate the NO_X emissions reductions.

- The emissions factors calculated in Step 3 for the new and old vehicles in g/mile.
- The default annual mileage for the old vehicle.
    - Use the old vehicle's GVWR to look up the default annual mileage in Table B.13
- The percentage of time in area that the applicant will commit to use the replacement/new vehicle in the Clean Transportation Zone (CTZ) (e.g., 75%, 90%).
- The length of the activity life of the project which is always 5 years for the TCFP.
- A conversion factor to convert grams to tons which is 907,200 grams in a U.S. standard ton.

NO_X emissions reductions are calculated in tons and should be rounded to 4 decimal places at the end of the calculation, should rounding be needed. The formula for the NO_X emissions reduction calculation is shown below followed by an example calculation.

The Texas Clean Fleet Program is a competitive grant round and one of the factors utilized in the grant selection process is total NO_X emissions reductions. The higher the NO_X emissions of the project, the more competitive the grant application may be.

$$Old\ vehicle\ emissions\ factor\ (\frac{g}{mile}) - New\ vehicle\ emissions\ factor\ (\frac{g}{mile}) = Reduced\ emissions\ factor\ (\frac{g}{mile})$$

$$Reduced\ emissions\ factor\ (\frac{g}{mile}) \times Default\ annual\ milage\ (\frac{miles}{year}) = Emissions\ per\ year\ (\frac{g}{year})$$

$$Emissions\ per\ year\ (\frac{g}{year}) \times Usage\ in\ area(\%) = Area\ emissions\ per\ year\ (\frac{g}{year})$$

$$Area\ emissions\ per\ year\ (\frac{g}{year}) \div Conv.\ factor\ (\frac{g}{ton}) = Area\ emissions\ per\ year\ (\frac{tons}{year})$$

$$Area\ emissions\ per\ year\ (\frac{tons}{year}) \times Activity\ life\ (years) = Total\ emissions\ (tons)$$

Example calculation for NO_X emission reductions

Activity: Replacement of a 1987 diesel heavy-duty vehicle with a 2024 CNG heavy-duty vehicle.

Old vehicle NO_X emission factor: 31.582 g/mile

New vehicle NO_X emission factor: 0.606 g/mile

Default mileage: 60,000 miles/year

Percent time in eligible counties: 75%

Unit Conversion Factor: 907,200 g/ton

Activity Life: 5 Years

$$31.582\frac{g}{mile} - 0.606\frac{g}{mile} = 30.976\frac{g}{mile}$$

$$30.976\frac{g}{mile} \times 60,000\frac{miles}{year} = 1,858,560\frac{g}{year}$$

$$1,858,560\frac{g}{year} \times 0.75 = 1,393,920\frac{g}{year}$$

$$1,393,920\frac{g}{year} \div 907,200\frac{g}{ton} = 1.5365\frac{tons}{year}$$

$$1.5365\frac{tons}{year} \times 5\ years = 7.6825\ tons$$

Step 5: Calculate the cost per ton of NO_X reduced

The cost per ton for an activity is determined by dividing the requested grant amount for that activity by the total NO_X emissions reductions. Keep in mind that the requested grant amount is at the discretion of the applicant, but it cannot exceed 80% of the cost of the new vehicle (See Section 3.2 of the TCFP RFGA for details). Since the Texas Clean Fleet Program involves multiple activities in a single application, the cost per ton calculation is based on the aggregate NO_X emissions reductions for all activities divided by the aggregate requested grant amount. The formula for this calculation and some examples of this calculation are provided below. Please note that the cost per ton must be rounded to the nearest cent (i.e., no more than two decimal places).

The Texas Clean Fleet Program is a competitive grant round and one of the factors utilized in the grant selection process is the cost per ton of a project. The lower the cost per ton of the project, the more competitive the grant application may be.

$$\frac{\sum Requested\ grant\ amounts\ for\ all\ vehicles(\$)}{\sum Emissions\ reductions\ for\ all\ vehicles(tons)} = Cost\ per\ ton\ (\frac{\$}{ton})$$

Example calculation for cost per ton

Activity: Replacement of a 1987 heavy-duty vehicle with a 2024 CNG heavy-duty vehicle.

Requested grant amount: $40,000

Total NO_x Reduced: 7.6825 tons

$\$40,000 \div 7.6825\ tons\ =\ \$5,206.64/ton$

Example cost per ton calculation for multiple activities.

Activity: Replacement of ten 1987 diesel heavy-duty vehicles with ten 2024 CNG heavy-duty vehicles.

Requested grant amount: $400,000

Total NO_x Reduced: 76.825 tons

$\$400,000\ \div 76.825\ tons\ =\ \$5,206.64/ton$

Appendix A – Calculation Worksheet

Texas Clean Fleet Program
Worksheet TCFP-1 Heavy Duty

This worksheet is provided to assist applicants in estimating the NO_X emissions reductions and cost per ton of NO_X reduced for each activity. See Worksheet TCFP-3 to calculate these values for the entire project.

Activity Information

What is the default mileage for your vehicle?	
What is the percent of usage in the eligible counties?	
What is the incremental cost of the vehicle?	
What is the requested grant amount for the activity?	
Old Engine Information	
Model Year:	
Gross Vehicle Weight Rating (GVWR):	
Emission Rate (g/bhp·hr):	
Conversion Factor (bhp·hr/mi): Note: If the vehicle certification is in g/mile then a conversion factor is not needed	
New Engine Information	
Model Year:	
Gross Vehicle Weight Rating (GVWR):	
Emission Rate (g/bhp·hr):	
Conversion Factor (bhp·hr/mi): Note: If the vehicle certification is in g/mile then a conversion factor is not needed	
Check the Emissions Rate Reduction	
Old Engine Emission Rate (g/bhp·hr):	
- New Engine Emission Rate (g/bhp·hr):	
= Difference (g/bhp·hr):	
÷ Old Engine Emission Rate (g/bhp·hr):	
x:	100
= Emission Rate Reduction (%): Note: Must be 25% or more	

Determine Old Engine NO_X Emission Rate (g/mile)	
Old Engine NO_X Emission Rate (g/bhp·hr):	
x TxLED Correction Factor:	0.943
= Corrected NO_X Emission Rate(g/bhp·hr):	
x Conversion Factor (bhp·hr/mi):	
= Converted Old Engine NO_X Emission Rate (g/mile):	
Determine New Engine NO_X Emission Rate (g/mile)	
New Engine NO_X Emission Rate (g/bhp·hr):	
x Conversion Factor (bhp·hr/mi):	
= Converted New Engine NO_x Emission Factor (g/mile):	
Calculate the NO_X Emissions Reductions	
Converted Old Engine NO_x Emission Factor (g/mile):	
- Converted New Engine NO_x Emission Factor (g/mile):	
= Grams per Mile Reduced (g/mile):	
x Default Annual Miles:	
x Percent within Eligible Counties (%):	
= Grams per Year Reduced (g/yr):	
÷ 907,200 Grams per Ton	907200
= Estimated Annual NO_X Emission Reduction (tons/yr):	
x Activity Life (years):	5
= Estimated Activity Life NO_X Emission Reductions (tons):	
Requested Grant Amount ($) ÷ NO_X Emission Reductions (tons) = Cost Per Ton ($):	
Eligibility Checks	
Is the requested grant amount less than or equal to 80% of the incremental cost?	
Does the new engine reduce emissions by at least 25%?	

Texas Clean Fleet Program
Worksheet TCFP-2 Light Duty

This worksheet is provided to assist applicants in estimating the NO_X emissions reductions and cost per ton of NO_X reduced for each activity. See Worksheet TCFP-3 to calculate these values for the entire project.

Activity Information

What is the default mileage for your vehicle?	
What is the percent of usage in the eligible counties?	
What is the incremental cost of the vehicle?	
What is the requested grant amount for the activity?	
Old Vehicle Information	
Model Year:	
Gross Vehicle Weight Rating (GVWR):	
Old Emission Rate (g/mile):	
New Vehicle Information	
Model Year:	
Gross Vehicle Weight Rating (GVWR):	
New Emission Rate (g/mile):	
Check the Emissions Rate Reduction	
Old Engine Emission Rate (g/mile):	
- New Engine Emission Rate (g/mile):	
= Difference (g/mile):	
÷ Old Engine Emissions (g/mile):	
x:	100
= Emission Rate Reduction (%): Note: Must be 25% or more	

Determine Old Vehicle NO_X Emission Rate (g/mile)	
Old Vehicle NO_X Emission Rate (g/mile):	
x TxLED Correction Factor:	0.9430
= Converted Old NO_X Emission Rate (g/mile):	
Determine New Vehicle NO_X Emission Rate (g/mile)	
New Vehicle NO_X Emissions Rate (g/mile):	
= Converted New NO_X Emission Rate (g/mile):	
Calculate the NOx Emissions Reductions	
Converted Old NO_X Emission Rate (g/mile):	
- Converted New NO_X Emission Rate (g/mile):	
= Grams per Mile Reduced (g/mile):	
X Default Annual Miles:	
x Percent within Eligible Counties (%):	
= Grams per Year Reduced (g/yr):	
÷ 907,200 Grams per Ton	907200
= Estimated Annual NO_X Emission Reduction (tons/yr):	
x Activity Life (years):	5
= Estimated Activity Life NO_X Emission Reduction (tons):	
Calculate the Cost per Ton	
Requested Grant Amount Activity ($):	
÷ NO_X Emissions Reductions (tons):	
= Cost Per Ton ($/ton):	
Eligibility Checks	
Is the requested grant amount less than or equal to 80% of the incremental cost?	
Does the new engine reduce emissions by at least 25%?	

Texas Clean Fleet Program

Worksheet TCFP-3

Project Cost Per Ton and NO_X Emissions Reductions

This worksheet is provided to assist applicants in calculating their project NO_X emissions reductions and cost per ton.

Activity	NO_x Reductions	Requested Grant Amount
Activity 1		
Activity 2		
Activity 3		
Activity 4		
Activity 5		
Activity 6		
Activity 7		
Activity 8		
Activity 9		
Activity 10		
Total		

Total Requested Grant Amount	Math Function	Total NO_X Reductions	Math Function	Project Cost Per Ton
	÷		=	

Appendix B – Tables

Table B.1 - EPA Light-Duty Vehicle Classifications

LDV	Light-Duty Vehicle	Passenger Car
LDT1	Light-Duty Truck 1	Truck up to 6000 pounds GVWR[1], and 3750 pounds LVW[2]
LDT2	Light-Duty Truck 2	Truck up to 6000 pounds GVWR, and between 3751 and 5750 pounds LVW
LDT3	Light-Duty Truck 3	Truck between 6001 and 8500 pounds GVWR, and between 3751 and 5750 pounds ALVW[3]
LDT4	Light-Duty Truck 4	Truck between 6001 and 8500 pounds GVWR, and over 5750 pounds ALVW

Revised EPA light truck categories for 2004 and later vehicles

LLDT	Light Light-Duty Truck	Truck up to 6000 pounds GVWR; includes LDT1 and LDT2
HLDT	Heavy Light-Duty Truck	Truck between 6001 and 8500 pounds GVWR; includes LDT3 and LDT4
MDPV	Medium-Duty Passenger Vehicle	Vehicle between 8501and 10,000 lbs GVWR used primarily for passengers

[1]GVWR: Gross Vehicle Weight Rating
[2]LVW: Loaded Vehicle Weight
[3]ALVW: Adjusted Loaded Vehicle Weight

Table B.2 - EPA Heavy-Duty Vehicle Classifications

HDDV2b	Heavy-Duty Diesel Vehicle 2b	Vehicle between 8501 and 10,000 lbs GVWR
HDDV3	Heavy-Duty Diesel Vehicle 3	Vehicle between 10,001 and 14,000 lbs GVWR
HDDV4	Heavy-Duty Diesel Vehicle 4	Vehicle between 14,001 and 16,000 lbs GVWR
HDDV5	Heavy-Duty Diesel Vehicle 5	Vehicle between 16,001 and 19,500 lbs GVWR
HDDV6	Heavy-Duty Diesel Vehicle 6	Vehicle between 19,501 and 26,000 lbs GVWR
HDDV7	Heavy-Duty Diesel Vehicle 7	Vehicle between 26,001 and 33,000 lbs GVWR
HDDV8a	Heavy-Duty Diesel Vehicle 8a	Vehicle between 33,001 and 60,000 lbs GVWR
HDDV8b	Heavy-Duty Diesel Vehicle 8b	Vehicle between Greater than 60,000 lbs GVWR
HDDBT	Heavy-Duty Diesel Vehicle	Diesel Transit or Urban Buses
HDDBS	Heavy-Duty Diesel Vehicle	Diesel School Buses

Table B.3 - California Medium-Duty Vehicle Classifications

MDV1	Medium-Duty Vehicle 1	For California standards, an MDV up to 3750 pounds ALVW
MDV2	Medium-Duty Vehicle 2	For California standards, an MDV between 3751 and 5750 pounds ALVW
MDV3	Medium-Duty Vehicle 3	For California standards, an MDV between 5751 and 8500 pounds ALVW
MDV4	Medium-Duty Vehicle 4	For California standards, an MDV between 8501 and 10,000 pounds ALVW
MDV5	Medium-Duty Vehicle 5	For California standards, an MDV between 10,001 and 14,000 pounds ALVW

Table B.4 - EPA Tier 3 (MY 2025+)[1] and California LEV III (MY 2015+) Light-Duty Vehicle Emission Standards

EPA Tier III Emission Standard Category	**California LEV III Emission Standard Category**	**NO_X + NMOG (g/mile)[2]**
Bin 1	N/A	0.00
Bin 20	SULEV20	0.02
Bin 30	SULEV30	0.03
Bin 50	ULEV50	0.05
Bin 70	ULEV70	0.07
Bin 125	ULEV125	0.125
Bin 160	LEV160	0.16

[1]Phase-in of the EPA Tier 3 standards begin with MY 2017.
[2]The EPA issued Tier 3 standards that only have a combined NO_X + NMOG standard. For the purposes of calculating emissions reductions, applicants should consider this standard to be entirely NO_X.

Table B.5 - EPA Tier 2 (MY 2004-2016) Light-Duty Vehicle Emission Standards

Emission Standard Category	Model Year	Vehicle Classification	NO_x (g/mile)
Bin 1	2004+	LDV, LLDT, HLDT, MDPV	0.00
Bin 2	2004+	LDV, LLDT, HLDT, MDPV	0.02
Bin 3	2004+	LDV, LLDT, HLDT, MDPV	0.03
Bin 4	2004+	LDV, LLDT, HLDT, MDPV	0.04
Bin 5	2004+	LDV, LLDT, HLDT, MDPV	0.07
Bin 6	2004+	LDV, LLDT, HLDT, MDPV	0.10
Bin 7	2004+	LDV, LLDT, HLDT, MDPV	0.15
Bin 8a	2004+	LDV, LLDT, HLDT, MDPV	0.20
Bin 8b[1]	2004-2008	HLDT, MDPV	0.20
Bin 9a[1]	2004-2006	LDV, LLDT	0.30
Bin 9b[1]	2004-2006	LDT2	0.30
Bin 9c[1]	2004-2008	HLDT, MDPV	0.30
Bin 10a[1]	2004-2006	LDV, LLDT	0.60
Bin 10b[1]	2004-2008	HLDT, MDPV	0.60
Bin 10c[1]	2004-2008	LDT4, MDPV	0.60
Bin 11[1]	2004-2008	MDPV	0.90

[1]Bin 8b – Bin 11 were part of the Tier 2 Interim Program and are no longer in use. See 40 CFR 86, Subpart S for further details about this program.

Table B.6 - California LEV II (MY 2004-2014) Light-Duty and Medium-Duty Vehicle Emission Standards

Emission Standard Category	Model Year	Vehicle Classification	NO_x (g/mile)
ZEV	2004-2019	LDV, LDT	0.00
PZEV*	2004-2019	LDV, LDT	0.02
SULEV II	2004-2019	LDV, LDT	0.02
ULEV II	2004-2019	LDV, LDT	0.07
LEV II	2004-2019	LDV, LDT	0.07
LEV II option 1	2004-2019	LDV, LDT	0.10
SULEV II	2004-2019	MDV4	0.10
ULEV II	2004-2019	MDV4	0.20
LEV II	2004-2019	MDV4	0.20
SULEV II	2004-2019	MDV5	0.20
ULEV II	2004-2019	MDV5	0.40
LEV II	2004-2019	MDV5	0.40

Table B.7 - EPA Tier 1 (MY 1994-2003) Light-Duty Vehicle Emission Standards

Model Year	Vehicle Classification	NO_x (g/mile)
1994-2003	LDV	0.6
1994-2003	LDT1	0.6
1994-2003	LDV diesel	1.25
1994-2003	LDT1 diesel	1.25
1994-2003	LDT2	0.97
1994-2003	LDT3	0.98
1994-2003	LDT4	1.53

Table B.8 - California LEV I (MY 2001-2006) Light-Duty Vehicle Emission Standards

Emission Standard Category	Model Year	Vehicles	NO_x (g/mile)
ULEV I diesel	2001-2006	LDV, LDT1	0.30
ULEV I	2001-2006	LDV, LDT1	0.30
SULEV I	2001-2006	MDV2	0.30
LEV I diesel	2001-2006	LDV, LDT1	0.30
LEV I	2001-2006	LDV, LDT1	0.60
LEV I	2001-2006	LDV, LDT1	0.30
SULEV I	2001-2006	MDV3	0.45
SULEV I	2001-2006	MDV4	0.50
LEV I diesel	2001-2006	LDT2	0.50
LEV I	2001-2006	LDT2	0.50
ULEV I	2001-2006	MDV2	0.60
TLEV I diesel	2001-2003	LDV, LDT1	0.60
TLEV I	2001-2003	LDV, LDT1	0.60
LEV I	2001-2006	MDV2	0.60
SULEV I	2001-2006	MDV5	0.70
ULEV I	2001-2006	MDV3	0.90
TLEV I diesel	2001-2006	LDT2	0.90
TLEV I	2001-2006	LDT2	0.90
LEV I	2001-2006	MDV3	0.90
ULEV I	2001-2006	MDV4	1.00
LEV I	2001-2006	MDV4	1.00
ULEV I	2001-2006	MDV5	1.50
LEV I	2001-2006	MDV5	1.50

Table B.9 - EPA Tier 0 and Historical Light-Duty Vehicle Emission Standards

Cars		
Model Year	**Vehicle Classification**	**NO_x (g/mile)**
1987-1993	LDV	1.0
1985-1986	LDV	1.0
1984	LDV	1.0
1983	LDV	1.0
1982	LDV	1.0
1981	LDV	1.0
1980	LDV	2.0
1978-1979	LDV	2.0
1977	LDV	2.0
1975-1976	LDV	3.1
1973-1974	LDV	3.0
pre-1968	LDV	3.5
Trucks		
1988-1993	LDT1	1.2
1988-1993	LDT2-4	1.7
1987	LDT	2.3
1984-1986	LDT	2.3
1982-1983	LDT	2.3
1981	LDT	2.3
1979-1980	LDT	2.3
1978	LDT	3.1
1975-1977	LDT	3.1
1973-1974	LDT	3.0
pre-1968	LDT	3.6

Table B.10 - EPA Heavy-Duty Diesel Engine NO_X Emission Standards by Model Year

Diesel Engines Emission Standards

Year of Manufacture	NO_X Only (g/bhp·hr)	NO_X+NMHC (g/bhp·hr)
1989 and earlier	10.7	
1990	6.0	
1991-1997	5.0	
1998-2003	4.0	
2004 -2006	2.375	2.5
2007-2009[1]	2.375 - 0.2	
2010+	0.2	

[1]For these years, a phase-in program was in place to allow manufacturers flexibility in implementing the new 0.2 g/bhp·hr standard. Engines produced during these years will have varying standards.

Table B.11 - EPA Heavy-Duty Spark-Ignition Engine NO_X Emission Standards by Model Year

Spark-Ignition Engines Emission Standards

Year of Manufacture	NO_X Only (g/bhp·hr)	NO_X+NMHC (g/bhp·hr)
1987 and earlier	10	
1988-1990	4.8	
1991-1997	4.0	
1998-2004	3.2	
2005-2007	1	2.5
2008+	0.2	

Table B.12 - Conversion Factors by Model Year and GVWR

Vehicle Class MDPV, MDV4& HDD2b Medium/Heavy-Duty Diesel Vehicles (8,501-10,000 lbs GVWR)		Vehicle Class MDV5 and HDDV3 Medium/Heavy-Duty Diesel Vehicles (10,001-14,000 lbs GVWR)		Vehicle Class HDDV4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs GVWR)		Vehicle Class HDDV5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs GVWR)	
Model Year	**Conversion Factor (bhp·hr/mi)**	**Model Year**	**Conversion Factor (bhp·hr/mi)**	**Model Year**	**Conversion Factor (bhp·hr/mi)**	**Model Year**	**Conversion Factor (bhp·hr/mi)**
2010	1.09	**2010**	1.25	**2010+**	1.46	**2010+**	1.57
2009	1.09	**2009**	1.25	**2009**	1.46	**2009**	1.57
2008	1.09	**2008**	1.25	**2008**	1.46	**2008**	1.57
2007	1.09	**2007**	1.25	**2007**	1.46	**2007**	1.57
2006	1.09	**2006**	1.25	**2006**	1.46	**2006**	1.57
2005	1.09	**2005**	1.25	**2005**	1.46	**2005**	1.57
2004	1.09	**2004**	1.25	**2004**	1.46	**2004**	1.57
2003	1.09	**2003**	1.25	**2003**	1.46	**2003**	1.57
2002	1.09	**2002**	1.25	**2002**	1.46	**2002**	1.57
2001	1.09	**2001**	1.25	**2001**	1.46	**2001**	1.57
2000	1.09	**2000**	1.25	**2000**	1.46	**2000**	1.57
1999	1.09	**1999**	1.25	**1999**	1.46	**1999**	1.57
1998	1.09	**1998**	1.25	**1998**	1.46	**1998**	1.57
1997	1.09	**1997**	1.25	**1997**	1.46	**1997**	1.57
1996	1.09	**1996**	1.25	**1996**	1.46	**1996**	1.57
1995	1.09	**1995**	1.25	**1995**	1.46	**1995**	1.59
1994	1.09	**1994**	1.25	**1994**	1.47	**1994**	1.60
1993	1.09	**1993**	1.25	**1993**	1.47	**1993**	1.61
1992	1.10	**1992**	1.25	**1992**	1.48	**1992**	1.62
1991	1.10	**1991**	1.25	**1991**	1.48	**1991**	1.64
1990	1.10	**1990**	1.25	**1990**	1.49	**1990**	1.65
1989	1.10	**1989**	1.25	**1989**	1.49	**1989**	1.66
1988	1.10	**1988**	1.25	**1988**	1.50	**1988**	1.68
1987	0.92	**1987**	1.76	**1987**	1.76	**1987**	1.76
1986	0.92	**1986**	1.76	**1986**	1.76	**1986**	1.76
1985	0.92	**1985**	1.76	**1985**	1.76	**1985**	1.76
1984	0.92	**1984**	1.76	**1984**	1.76	**1984**	1.76
1983	0.92	**1983**	1.76	**1983**	1.76	**1983**	1.76
1982	0.92	**1982**	1.76	**1982**	1.76	**1982**	1.76
1981	0.94	**1981**	1.76	**1981**	1.76	**1981**	1.76
1980	0.94	**1980**	1.76	**1980**	1.76	**1980**	1.76

Table B.12 Continued

Vehicle Class HDDV6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs GVWR)	Vehicle Class HDDV7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs GVWR)	Vehicle Class HDDV8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs GVWR)	Vehicle Class HDDV8b Heavy-Duty Diesel Vehicles (Greater Than 60,000 lbs GVWR)

Model Year	Conversion Factor (bhp·hr/mi)	Model Year	Conversion Factor (bhp·hr/mi)	Model Year	Conversion Factor (bhp·hr/mi)	Model Year	Conversion Factor (bhp·hr/mi)
2010	1.94	**2010**	2.41	**2010**	2.76	**2010**	3.03
2009	1.94	**2009**	2.41	**2009**	2.76	**2009**	3.03
2008	1.94	**2008**	2.41	**2008**	2.76	**2008**	3.03
2007	1.94	**2007**	2.41	**2007**	2.76	**2007**	3.03
2006	1.94	**2006**	2.41	**2006**	2.76	**2006**	3.03
2005	1.94	**2005**	2.41	**2005**	2.76	**2005**	3.03
2004	1.94	**2004**	2.41	**2004**	2.76	**2004**	3.03
2003	1.94	**2003**	2.41	**2003**	2.76	**2003**	3.03
2002	1.94	**2002**	2.41	**2002**	2.76	**2002**	3.03
2001	1.94	**2001**	2.41	**2001**	2.76	**2001**	3.03
2000	1.94	**2000**	2.41	**2000**	2.76	**2000**	3.03
1999	1.94	**1999**	2.41	**1999**	2.76	**1999**	3.03
1998	1.94	**1998**	2.41	**1998**	2.76	**1998**	3.03
1997	1.94	**1997**	2.41	**1997**	2.76	**1997**	3.03
1996	1.94	**1996**	2.41	**1996**	2.76	**1996**	3.03
1995	1.95	**1995**	2.41	**1995**	2.78	**1995**	3.06
1994	1.95	**1994**	2.41	**1994**	2.81	**1994**	3.09
1993	1.96	**1993**	2.40	**1993**	2.83	**1993**	3.11
1992	1.96	**1992**	2.40	**1992**	2.85	**1992**	3.14
1991	1.96	**1991**	2.40	**1991**	2.87	**1991**	3.17
1990	1.97	**1990**	2.40	**1990**	2.90	**1990**	3.20
1989	1.97	**1989**	2.39	**1989**	2.92	**1989**	3.23
1988	1.98	**1988**	2.39	**1988**	2.95	**1988**	3.26
1987	1.87	**1987**	2.13	**1987**	2.99	**1987**	3.13
1986	1.87	**1986**	2.13	**1986**	2.99	**1986**	3.13
1985	1.88	**1985**	2.14	**1985**	3.01	**1985**	3.14
1984	1.89	**1984**	2.16	**1984**	3.04	**1984**	3.14
1983	1.91	**1983**	2.18	**1983**	3.06	**1983**	3.15
1982	1.93	**1982**	2.19	**1982**	3.09	**1982**	3.15
1981	1.99	**1981**	2.23	**1981**	3.11	**1981**	3.26
1980	2.06	**1980**	2.25	**1980**	3.06	**1980**	3.33

Table B.12 Continued

Vehicle Class HDDBT Heavy-Duty Diesel Vehicles (Diesel Transit or Urban Bus)		Vehicle Class HDDBS Heavy-Duty Diesel Vehicles (Diesel School Buses)	
Model Year	**Conversion Factor (bhp·hr/mi)**	**Model Year**	**Conversion Factor (bhp·hr/mi)**
2010+	4.03	**2010+**	2.99
2009	4.03	**2009**	2.99
2008	4.03	**2008**	2.99
2007	4.03	**2007**	2.99
2006	4.03	**2006**	2.99
2005	4.03	**2005**	2.99
2004	4.03	**2004**	2.99
2003	4.03	**2003**	2.99
2002	4.03	**2002**	2.99
2001	4.03	**2001**	2.99
2000	4.03	**2000**	2.99
1999	4.03	**1999**	2.99
1998	4.03	**1998**	2.99
1997	4.03	**1997**	2.99
1996	4.03	**1996**	2.99
1995	4.02	**1995**	2.93
1994	4.02	**1994**	2.88
1993	4.02	**1993**	2.82
1992	4.01	**1992**	2.77
1991	4.01	**1991**	2.71
1990	4.01	**1990**	2.70
1989	4.01	**1989**	2.69
1988	4.01	**1988**	2.67
1987	3.07	**1987**	1.62
1986	3.07	**1986**	1.62
1985	3.07	**1985**	1.62
1984	3.07	**1984**	1.62
1983	3.07	**1983**	1.62
1982	3.07	**1982**	1.62
1981	3.01	**1981**	1.61
1980	2.91	**1980**	1.60

Table B.13 - Default Annual Mileage

Vehicle Class	Default Miles
LDV, LDT1, LDT2, LDT3, LDT4	10,000
MDPV, MDV4, and HDV2b (8,501-10,000 lb GVWR)	15,000
MDV5 and HDV3 (10,001-14,000 lb GVWR)	15,000
HDV4 (14,001-16,000 lb GVWR)	20,000
HDV5 (16,001-19,500 lb GVWR)	20,000
HDV6 (19,501-26,000 lb GVWR)	20,000
HDV7 (26,001-33,000 lb GVWR)	20,000
HDV8a (33,001-60,000 lb GVWR)	40,000
HDV8b (Greater than 60,000 lb GVWR)	40,000
Haul Truck	60,000
HDBT (Transit or Urban Bus)	35,000
HDBS (School Bus)	10,000

Appendix C – Figures

Figure 1 - Vehicle Emission Control Information (VECI) Labels

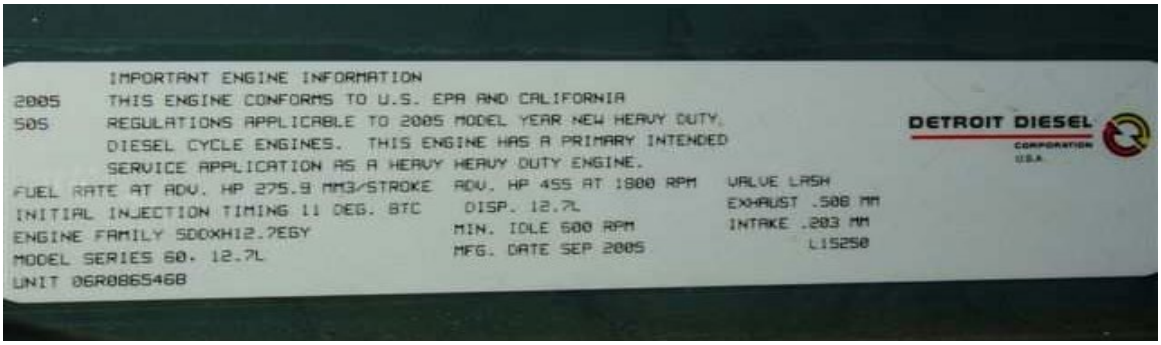
Example Emission Label for Some 2007 and Earlier Model Year Vehicles

Company's Trustmark	Company's Name VEHICLE EMISSION CONTROL INFORMATION		
Conforms to regulations:			2008 MY
U.S. EPA:	IT2B10LDT4	OBD: II	Fuel: Gasoline
California:	LEV II MDV6	OBD: II	Fuel: Gasoline
No adjustments needed.		TWC/HO2S/EGR/SFI	
EVAP:	8VEHR0240ABC 8VEHR0240ABD	Standard Fuel Tank: 26/27 gal Option Fuel Tank: 35.7 gal	
Group 8VEHT05.8ABC		*Part # Bar Code Here*	Label Part Number

Test Group Name

Source: https://www.epa.gov/importing-vehicles-and-engines/locating-vehicle-emissions-label

Figure 2 – Example of a Heavy-Duty Engine Emission Label



Engine: Heavy-duty diesel engine
Engine model year: 2005
Engine family: 5DDXH12.7EGY