TEXAS EMISSIONS REDUCTION PLAN (TERP)
Emissions Reduction Incentive Grants Program (ERIG)

Technical Supplement 1
On-Road Heavy-Duty Vehicles

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TECHNICAL SUPPLEMENT NO. 1 ON-ROAD HEAVY DUTY VEHICLES

Summary

This supplement contains the calculations for activities involving on-road heavy-duty vehicles, including: new purchases and leases, replacement, repower, retrofit, and add-on activities.

For the purposes of the TERP, vehicles equal to or greater than 8,500 lb gross vehicle weight rating (GVWR) are considered to be heavy-duty vehicles. The majority of these vehicles are powered by compression-ignition (CI) internal combustion engines typically using diesel fuel. However, to the extent vehicles using other fuels qualify under the program criteria, those vehicles may also be eligible for funding, subject to decisions by the TCEQ for particular funding periods**. If the project being proposed involves a gasoline, LPG, or CNG powered vehicle, contact TCEQ for eligibility.**

- Use the worksheets provided at the end of this supplement (**OR-1 or OR-2**) to calculate the emission reductions and the cost effectiveness of the activities proposed for your project. Use **OR-1** to do the calculations based on annual miles of operation. Use **OR-2** for calculations based on annual fuel use.

You may also go to www.terpgrants.org and download the Microsoft Office Excel On-road (miles or fuel) calculator. It is found under Supplemental Activity Application Forms.

Please note that in order to qualify using annual fuel, trucks must be equipped with a power take-off (PTO). Examples of trucks that fit in this category would be refuse haulers (garbage trucks), street sweepers, and other vehicles where the PTO is engaged a major portion of the vehicles operation. Contact the TCEQ if you have a question to whether or not your particular vehicles operation meets the fuel use criteria.

The worksheets are divided into three major steps:

a) Step 1: Determining that the activity meets the 25% NO_x emissions reduction requirement.

b) Step 2: Calculating the NO_x Emission Reductions.

c) Step 3: Calculating the Cost Per Ton.

These steps are explained in the following instructions. You should refer to the applicable worksheet and use the instructions to complete each step of the calculations.

Step 1: Determining that the activity meets the 25% NO_x emissions reduction requirement.

All new purchase or lease, replacement, repower, retrofit, and add-on activities must achieve at least a 25% reduction in NOx emissions when compared to a baseline emission rate. Use Worksheet OR-1 or OR-2 to determine if your activity meets the minimum emission reduction requirements. The TCEQ may establish a lower percentage reduction requirement for retrofit systems to convert an existing heavy-duty on-road diesel engine to operate under a dual-fuel configuration that uses natural gas and diesel fuel. The Request for Grant Applications (RFGA) will include any alternative percentage reduction requirements.

Baseline NO_x Emission Rate

For these calculations, the baseline NOx emissions will normally be the federal NO_x emission standard for the model year and gross vehicle weight rating (GVWR) of the baseline vehicle and/or engine. The federal NO_x emission standards for on-road heavy duty diesel vehicles are presented in Table 1.1. In situations where the model year of the vehicle and the model year of the engine are different, the model year of the engine should be used for determining the standard to apply.
For some model years, the EPA began using a combined NO_x + NMHC (non-methane hydrocarbons) standard. For the standards listed in NO_x + NMHC, the TCEQ will use a NO_x fraction of 0.95 for diesel engines and 0.80 for alternative fuel engines to determine the NO_x-only emissions based on the combined standard.

TABLE 1.1 ON-ROAD HEAVY-DUTY CI ENGINES NO_X EMISSION STANDARDS BY MODEL YEAR

Year of Manufacture	Diesel Engines Emission Standard	
	NOx Only (g/bhp-hr)	NOx+NMHC (g/bhp-hr)
1989 and earlier	10.7	
1990	6.0	
1991-1997	5.0	
1998-2001	4.0	
2002	4.0	
2003*	4.0	
2004 -2006	2.375	2.5
2007-2009*	0.2-2.375	
2010+	0.2	

*Some manufacturers were producing 2003 engines that met the more stringent 2.375 g/bhp-hr standard.
Any application request for consideration of a 2003 engine meeting the 2.375 g/bhp-hr standard must include a copy of the official engine certification for the specific engine model or family engine code.

*The 2007 NOx emission standard is 0.20 g/bhp-hr. Manufacturers may phase in their compliance with this new standard over a three-year period. Therefore, it is not guaranteed that a 2007 model year vehicle and engine will meet the lower standard. If an applicant proposes to purchase a 2007 model year vehicle and/or engine, the applicant must certify, in the application, the emission level that the new vehicle and engine will meet. Copies of the form certifying the engine family to the lower emission standard must be provided before any grant expenses are reimbursed. If it is not yet known what emission standard to which the engine will be certified, then use the 2006 standard, 2.375 g/bhp-hr.

Reduced NOx Emission Rate

The reduced NOx emission rate will normally be the certified or verified emissions of the reduced-emission vehicle or engine.

- **New Purchase or Lease.** Use the certified emission rate (g/bhp-hr) of the new vehicle. Certified means certified by the EPA or CARB, or otherwise accepted by the TCEQ.

- **Replacement.** Use the certified emission rate (g/bhp-hr) of the replacement vehicle and engine. In most cases, you should use the federal NO_x emission standard for that model year and GVWR of vehicle. However, if the engine is certified to a lower emissions level, you may use that rate, subject to approval by the TCEQ. Certified means certified by the EPA or CARB, or otherwise accepted by the TCEQ.
- **Repower.** Use the certified emission rate (g/bhp-hr) of the engine installed on the replacement vehicle. In most cases, you should use the federal NOx emission standard for that model year and GVWR of vehicle. However, if the engine is certified to a lower emissions level, you may use that rate, subject to approval by the TCEQ. Certified means certified by the EPA or CARB, or otherwise accepted by the TCEQ.
- **Retrofit/Add-on.** Use the verified or certified emission rate (g/bhp-hr) or emission reduction percentage for the retrofit or add-on device. The emission reductions must be verified or certified by the EPA or CARB, or otherwise accepted by the TCEQ. For a system to convert an existing heavy-duty on-road diesel engine to operate under a dual-fuel configuration that uses natural gas and diesel fuel, the manufacturer may request TCEQ consideration of alternative information, in addition to the emission standard to which an engine is certified by the EPA or CARB, to determine appropriate NO_X emission reduction factors. If the TCEQ has accepted a dual-fuel conversion system under this alternative approach, a letter of acceptance will have been sent to the system manufacturer listing the TCEQ's accepted emissions reduction percentage for the retrofit system on specific engine makes, models, model years, and engine families. If an acceptance letter has been issued by the TCEQ for a particular dual-fuel conversion system, the accepted emission reduction percentage may be used for the calculations.

[(Baseline Engine - Reduced Engine) ÷ Baseline Engine]
x 100 = Baseline Emission Rate Reduction

EXAMPLE CALCULATIONS

Example calculation for determining 25% baseline emission rate reduction for new purchase/lease

Activity: Purchase of a new diesel heavy-duty vehicle.

Current Model Year Engine Emission Standard (MY2005): 2.375 g/bhp-hr

New engine certified NO_x emissions: 1.9 g/bhp-hr (this number came from manufacturer-s certification)

Calculation of baseline emission rate reduction:

[(2.375 g/bhp-hr - 1.9 g/bhp-hr) / 2.375 g/bhp-hr] x 100 % = 20 % baseline emission rate reduction

Note: *This project does not meet the 25% emission rate reduction.*

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

Activity: Replacement of a 1988 heavy-duty vehicle with a 2002 model.

Original engine emission standard: 10.7 g/bhp-hr

Replacement engine emission standard: 4.0 g/bhphr

Calculation of baseline emission rate reduction:

[(10.7 g/bhp-hr - 4.0 g/bhp-hr) / 10.7 g/bhp-hr] x 100 % = 62.62 % baseline emission rate reduction

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

Example calculation for determining 25% baseline emission rate reduction for retrofit/add-on

Activity: Retrofit/add-on device of a 1998 heavy-duty vehicle to switch fuel from diesel to LNG.

Emission standard for existing engine model year: 4.0 g/bhp-hr

Emission with retrofit to LNG use: 2.0 g/bhp-hr (this number came from TCEQ)

Calculation of baseline emission rate reduction:

[(4.0 g/bhp-hr - 2.0 g/bhp-hr) / 4.0 g/bhp-hr] x 100 % = 50 % baseline emission rate reduction

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

Step 2: Calculate the NO_x Emission Reductions

This step is divided into three main parts:

- Part A: Determining the TxLED Correction Factor
- Part B: Determining the NOx emission factors
- Part C: Calculating the NOx emission reductions

Points to remember when performing Emission Reduction Calculations.

- Use Worksheet OR-1 for calculations where usage is based in miles.
- Use Worksheet OR-2 for calculations where usage is based in fuel use.
- The emissions reduction represents the difference in the emission level of a baseline vehicle/engine and a reduced-emission vehicle/engine.
- The emission level is calculated by multiplying an emission factor, an activity level, and a conversion factor, if necessary.
- In situations where the model year of the vehicle chassis and the model year of the existing engine are different, the model year of the engine shall be used to determine the baseline emissions for benefit calculations.
- Because conversion factors and the activity levels may be expressed in different units for the existing and replacement engines, the emission levels for the baseline and reduced-emission vehicles/engines should be calculated separately and then differences taken to determine emission reductions.
- For most on-road applications, the activity level should be established by the annual

mileage.

- Refuse haulers (garbage trucks), street sweepers, and other vehicles where a major use of the propulsion engine is for Apower take-off@ applications, are an exception to using annual miles as the activity level. The activity level should be determined based on annual fuel consumption.
- Emission reduction calculations should be consistent with the type of records maintained over the life of each activity.
- If the vehicle operates in a county or counties that is in the TxLED region the TxLED conversion factor must be applied.

Part A. Determine the TxLED Correction Factor

The TCEQ has 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.

The counties affected by the new TxLED requirements currently include all of the counties eligible for TERP incentive funding, as listed in the *Guidelines*, except for El Paso County.

The new requirements set a maximum aromatic hydrocarbon content standard of 10% by volume per gallon. The requirements also set a minimum cetane number for TxLED of 48. The TxLED requirements are intended to result in reductions in NOx emissions from diesel engines. Currently, a reduction factor of **5.7%** (0.057) for on-road use and **7.0%** (0.07) for non-road use and has been accepted as an estimate for use of TxLED. However, this reduction estimate is subject to change, based on the standards accepted by the EPA for use in the Texas State Implementation Plan (SIP).

For on-road activities in the applicable counties (does not include El Paso County), a correction factor of **0.943** should be applied when calculating the baseline and/or reduced emissions for diesel engines, regardless of when the grant-funded vehicle began or will begin operation.

Part B. Determine the NOx Emission Factors

To complete the calculation of the NO_x emission reductions for the activity, you must convert the NO_x emission rates (g/bhp-hr) to a NO_x emission factor. For most types of vehicles, the NO_x emission reduction factors should be based on annual miles of operation. However, refuse vehicles, street sweepers, and other vehicles with Apower take-off@ uses of the propulsion engine operating predominantly in stop-and- go applications accrue low mileage, yet intermittently operate at high load during compaction or sweeping mode. Therefore, annual fuel use is a more appropriate emission factor to use for these vehicles, although an applicant may base the emission reductions on annual mileage for these types of vehicle uses, provided sufficient supporting documentation is submitted as determined by the TCEQ. You should consult with the TCEQ to determine the factors to use for non-diesel engines, or if you wish to use a different conversion factor.

Usage based on mileage (OR-1)

For calculations based on annual miles of operations (OR-1), the NO_x emission factor will be in grams per mile (g/mile). For calculations based on annual miles of operation, a conversion factor (bhp-hr/mi) is provided to convert the NO_x emission rate (g/bhp-hr) to g/mile. This conversion factor must be applied to the NO_x emission rates (g/bhp-hr) for the baseline vehicle/engine and for the reduced emission vehicle/engine.

Conversion factors by model year for on-road heavy-duty diesel vehicles are provided in Table 1.2 below.

Usage based on fuel consumption (OR-2)

For calculations based on annual fuel use (OR-2), the NO_x emission factor will be in grams per year (g/year). The energy consumption factor (ECF) should be used to convert the NO_x emission rate from g/bhp-hr to g/gal. As shown on the worksheet, because the estimated annual fuel use of the baseline vehicle/engine and the reduced emission vehicle/engine may differ, the g/gal factor is then multiplied by the number of gallons used per year, to determine the estimated g/year to be emitted by both the baseline and the reduced emission vehicle/engine. This factor is used to calculate the NOx emission reductions. Energy consumption factors by model year for on-road heavy-duty vehicles are provided in Table 1.2 below.

Determining the Gross-Vehicle Weight Rating (GVWR) of the Vehicle

The GVWR is the total allowable or recommended vehicle weight, including the loaded weight of the vehicle, driver, passengers, and cargo. The rated weight is usually found on a label affixed to the inside of the door or other area of the vehicle and may also be listed on the vehicle title and registration documents.

If the vehicle is normally operated in combination with a trailer, such as an 18-wheel semi-tractor and trailer rig, use the combined GVWR of both the vehicle and the trailer. However, if a trailer is only attached occasionally, use the GVWR for the vehicle only. Check with TCEQ staff if you are unsure as to which GVWR to use.

TABLE 1.2 ON-ROAD HEAVY-DUTY DIESEL VEHICLE CONVERSION FACTORS BY MODEL YEAR

Vehicle Class HDD2b Heavy-Duty Diesel Vehicles (8,501-10,000 lb GVWR)			Vehicle Class HDDV3 Heavy-Duty Diesel Vehicles (10,001-14,000 lb GVWR)		
Model Year	Conversion Factor (bhp-hr/mile)	Energy Consumption Factor (ECF) (bhp-hr/gal)	Model Year	Conversion Factor (bhp-hr/mile)	Energy Consumption Factor (ECF) (bhp-hr/gal)
2015	1.09	17.1	2015	1.25	18.0
2014	1.09	16.9	2014	1.25	17.8
2013	1.09	16.7	2013	1.25	17.6
2012	1.09	16.6	2012	1.25	17.4
2011	1.09	16.4	2011	1.25	17.2
2010	1.09	16.3	2010	1.25	17.0
2009	1.09	16.1	2009	1.25	16.8
2008	1.09	15.9	2008	1.25	16.7
2007	1.09	15.8	2007	1.25	16.5
2006	1.09	15.6	2006	1.25	16.3
2005	1.09	15.5	2005	1.25	16.1
2004	1.09	15.3	2004	1.25	15.9
2003	1.09	15.2	2003	1.25	15.8
2002	1.09	15.0	2002	1.25	15.6
2001	1.09	14.9	2001	1.25	15.4
2000	1.09	14.7	2000	1.25	15.2
1999	1.09	14.6	1999	1.25	15.1
1998	1.09	14.4	1998	1.25	14.9
1997	1.09	14.3	1997	1.25	14.7
1996	1.09	14.1	1996	1.25	14.6
1995	1.09	14.0	1995	1.25	14.4
1994	1.09	13.9	1994	1.25	14.3
1993	1.09	13.7	1993	1.25	14.1
1992	1.10	13.6	1992	1.25	13.9
1991	1.10	13.4	1991	1.25	13.8
1990	1.10	13.3	1990	1.25	13.6
1989	1.10	13.2	1989	1.25	13.5
1988	1.10	13.0	1988	1.25	13.3
1987	0.92	12.9	1987	1.76	13.2
1986	0.92	12.8	1986	1.76	13.0
1985	0.92	12.7	1985	1.76	12.9
1984	0.92	12.5	1984	1.76	12.8
1983	0.92	12.4	1983	1.76	12.6
1982	0.92	12.3	1982	1.76	12.5
1981	0.94	12.2	1981	1.76	12.3
1980	0.94	12.0	1980	1.76	12.2

TABLE 1.2 ON-ROAD HEAVY-DUTY DIESEL VEHICLE CONVERSION FACTORS BY MODEL YEAR

Vehicle Class HDDV4 Heavy-Duty Diesel Vehicles (14,001-16,000 lb GVWR)			Vehicle Class HDDV5 Heavy-Duty Diesel Vehicles (16,001-19,500 lb GVWR)		
Model Year	Conversion Factor (bhp-hr/mile)	Energy Consumption Factor (ECF) (bhp-hr/gal)	Model Year	Conversion Factor (bhp-hr/mile)	Energy Consumption Factor (ECF) (bhp-hr/gal)
2015	1.46	16.0	2015	1.57	15.8
2014	1.46	15.9	2014	1.57	15.7
2013	1.46	15.8	2013	1.57	15.7
2012	1.46	15.8	2012	1.57	15.7
2011	1.46	15.7	2011	1.57	15.7
2010	1.46	15.7	2010	1.57	15.7
2009	1.46	15.6	2009	1.57	15.7
2008	1.46	15.6	2008	1.57	15.7
2007	1.46	15.5	2007	1.57	15.7
2006	1.46	15.4	2006	1.57	15.7
2005	1.46	15.4	2005	1.57	15.6
2004	1.46	15.3	2004	1.57	15.6
2003	1.46	15.3	2003	1.57	15.6
2002	1.46	15.2	2002	1.57	15.6
2001	1.46	15.2	2001	1.57	15.6
2000	1.46	15.1	2000	1.57	15.6
1999	1.46	15.0	1999	1.57	15.6
1998	1.46	15.0	1998	1.57	15.6
1997	1.46	14.9	1997	1.57	15.6
1996	1.46	14.9	1996	1.57	15.5
1995	1.46	14.8	1995	1.59	15.5
1994	1.47	14.8	1994	1.60	15.5
1993	1.47	14.7	1993	1.61	15.5
1992	1.48	14.6	1992	1.62	15.5
1991	1.48	14.6	1991	1.64	15.5
1990	1.49	14.5	1990	1.65	15.5
1989	1.49	14.5	1989	1.66	15.5
1988	1.50	14.4	1988	1.68	15.4
1987	1.76	14.4	1987	1.76	15.4
1986	1.76	14.3	1986	1.76	15.4
1985	1.76	14.2	1985	1.76	15.4
1984	1.76	14.2	1984	1.76	15.4
1983	1.76	14.1	1983	1.76	15.4
1982	1.76	14.1	1982	1.76	15.4
1981	1.76	14.0	1981	1.76	15.3
1980	1.76	13.9	1980	1.76	15.3

TABLE 1.2 ON-ROAD HEAVY-DUTY DIESEL VEHICLE CONVERSION FACTORS BY MODEL YEAR

Vehicle Class HDDV6 Heavy-Duty Diesel Vehicles (19,501-26,000 lb GVWR)			Vehicle Class HDDV7 Heavy-Duty Diesel Vehicles (26,001-33,000 lb GVWR)		
Model Year	Conversion Factor (bhp-hr/mile)	Energy Consumption Factor (ECF) (bhp-hr/gal)	Model Year	Conversion Factor (bhp-hr/mile)	Energy Consumption Factor (ECF) (bhp-hr/gal)
2015	1.94	18.3	2015	2.41	18.8
2014	1.94	18.2	2014	2.41	18.8
2013	1.94	18.1	2013	2.41	18.8
2012	1.94	18.0	2012	2.41	18.8
2011	1.94	18.0	2011	2.41	18.7
2010	1.94	17.9	2010	2.41	18.7
2009	1.94	17.8	2009	2.41	18.7
2008	1.94	17.8	2008	2.41	18.6
2007	1.94	17.7	2007	2.41	18.6
2006	1.94	17.6	2006	2.41	18.5
2005	1.94	17.6	2005	2.41	18.5
2004	1.94	17.5	2004	2.41	18.5
2003	1.94	17.4	2003	2.41	18.4
2002	1.94	17.3	2002	2.41	18.4
2001	1.94	17.3	2001	2.41	18.3
2000	1.94	17.2	2000	2.41	18.3
1999	1.94	17.1	1999	2.41	18.3
1998	1.94	17.1	1998	2.41	18.2
1997	1.94	17.0	1997	2.41	18.2
1996	1.94	16.9	1996	2.41	18.1
1995	1.95	16.8	1995	2.41	18.1
1994	1.95	16.8	1994	2.41	18.1
1993	1.96	16.7	1993	2.40	18.0
1992	1.96	16.6	1992	2.40	18.0
1991	1.96	16.6	1991	2.40	17.9
1990	1.97	16.5	1990	2.40	17.9
1989	1.97	16.4	1989	2.39	17.8
1988	1.98	16.3	1988	2.39	17.8
1987	1.87	16.3	1987	2.13	17.8
1986	1.87	16.2	1986	2.13	17.7
1985	1.88	16.1	1985	2.14	17.7
1984	1.89	16.0	1984	2.16	17.6
1983	1.91	16.0	1983	2.18	17.6
1982	1.93	15.9	1982	2.19	17.5
1981	1.99	15.8	1981	2.23	17.5
1980	2.06	15.7	1980	2.25	17.4

TABLE 1.2 ON-ROAD HEAVY-DUTY DIESEL VEHICLE CONVERSION FACTORS BY MODEL YEAR

Vehicle Class HDDV8a Heavy-Duty Diesel Vehicles (33,001-60,000 lb GVWR)			Vehicle Class HDDV8b Heavy-Duty Diesel Vehicles (Greater than 60,000 lb GVWR)		
Model Year	Conversion Factor (bhp-hr/mile)	Energy Consumption Factor (ECF) (bhp-hr/gal)	Model Year	Conversion Factor (bhp-hr/mile)	Energy Consumption Factor (ECF) (bhp-hr/gal)
2015	2.76	19.2	2015	3.03	21.2
2014	2.76	19.2	2014	3.03	21.1
2013	2.76	19.1	2013	3.03	20.9
2012	2.76	19.1	2012	3.03	20.8
2011	2.76	19.0	2011	3.03	20.7
2010	2.76	19.0	2010	3.03	20.6
2009	2.76	18.9	2009	3.03	20.5
2008	2.76	18.9	2008	3.03	20.4
2007	2.76	18.8	2007	3.03	20.3
2006	2.76	18.8	2006	3.03	20.2
2005	2.76	18.7	2005	3.03	20.1
2004	2.76	18.6	2004	3.03	20.0
2003	2.76	18.6	2003	3.03	19.9
2002	2.76	18.5	2002	3.03	19.8
2001	2.76	18.5	2001	3.03	19.6
2000	2.76	18.4	2000	3.03	19.5
1999	2.76	18.4	1999	3.03	19.4
1998	2.76	18.3	1998	3.03	19.3
1997	2.76	18.3	1997	3.03	19.2
1996	2.76	18.2	1996	3.03	19.1
1995	2.78	18.2	1995	3.06	19.0
1994	2.81	18.1	1994	3.09	18.9
1993	2.83	18.0	1993	3.11	18.8
1992	2.85	18.0	1992	3.14	18.7
1991	2.87	17.9	1991	3.17	18.6
1990	2.90	17.9	1990	3.20	18.5
1989	2.92	17.8	1989	3.23	18.4
1988	2.95	17.8	1988	3.26	18.3
1987	2.99	17.7	1987	3.13	18.1
1986	2.99	17.6	1986	3.13	18.0
1985	3.01	17.6	1985	3.14	17.9
1984	3.04	17.5	1984	3.14	17.8
1983	3.06	17.5	1983	3.15	17.7
1982	3.09	17.4	1982	3.15	17.6
1981	3.11	17.3	1981	3.26	17.5
1980	3.06	17.3	1980	3.33	17.4

TABLE 1.2 ON-ROAD HEAVY-DUTY DIESEL VEHICLE CONVERSION FACTORS BY MODEL YEAR

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/mile)	Energy Consumption Factor (ECF) (bhp-hr/gal)	Model Year	Conversion Factor (bhp-hr/mile)	Energy Consumption Factor (ECF) (bhp-hr/gal)
2015	4.03	23.0	2015	2.99	24.3
2014	4.03	22.6	2014	2.99	23.9
2013	4.03	22.3	2013	2.99	23.5
2012	4.03	22.0	2012	2.99	23.2
2011	4.03	21.7	2011	2.99	22.8
2010	4.03	21.4	2010	2.99	22.5
2009	4.03	21.1	2009	2.99	22.1
2008	4.03	20.8	2008	2.99	21.8
2007	4.03	20.5	2007	2.99	21.5
2006	4.03	20.3	2006	2.99	21.2
2005	4.03	20.0	2005	2.99	20.8
2004	4.03	19.7	2004	2.99	20.5
2003	4.03	19.5	2003	2.99	20.2
2002	4.03	19.2	2002	2.99	19.9
2001	4.03	18.9	2001	2.99	19.7
2000	4.03	18.7	2000	2.99	19.4
1999	4.03	18.4	1999	2.99	19.1
1998	4.03	18.2	1998	2.99	18.8
1997	4.03	18.0	1997	2.99	18.6
1996	4.03	17.7	1996	2.99	18.3
1995	4.02	17.5	1995	2.93	18.0
1994	4.02	17.3	1994	2.88	17.8
1993	4.02	17.0	1993	2.82	17.5
1992	4.01	16.8	1992	2.77	17.3
1991	4.01	16.6	1991	2.71	17.0
1990	4.01	16.4	1990	2.70	16.8
1989	4.01	16.2	1989	2.69	16.6
1988	4.01	16.0	1988	2.67	16.3
1987	3.07	15.8	1987	1.62	16.1
1986	3.07	15.6	1986	1.62	15.9
1985	3.07	15.4	1985	1.62	15.7
1984	3.07	15.2	1984	1.62	15.5
1983	3.07	15.0	1983	1.62	15.3
1982	3.07	14.8	1982	1.62	15.0
1981	3.01	14.6	1981	1.61	14.8
1980	2.91	14.4	1980	1.60	14.6

Example calculation for determining NOx emission factor based on annual miles

Activity: Replacement of a 1988 heavy-duty vehicle with a 2002 model.

Vehicle weight rating: 20,000 lb

Original engine emission standard: 10.7 g/bhp-hr

Replacement engine emission standard: 4.0 g/bhp-hr

Original engine conversion factor: 1.98 bhp-hr/mile

Replacement engine conversion factor: 1.94 bhp-hr/mile

Annual miles traveled: 50,000 mile/yr

TXLed Correction factor: 0.943

TxLED and Baseline NOx Emission Factor (g/mile)

10.7 g/bhp-hr x 0.943 = 10.0901 g/bhp-hr

10.0901 g/bhp-hr x 1.98 bhp-hr/mile = **19.9784 g/mile**

Reduced NOx Emission Factor (g/mile)

4.0 g/bhp-hr x 0.943 = 3.772 g/bhp-hr

3.772 g/bhp-hr x 1.94 bhp-hr/mile = **7.3177 g/mile**

Example calculation for determining NOx emission factor based on annual fuel use

Activity: Replacement of a 1988 heavy-duty vehicle with a 2002 model.

Vehicle weight rating: 20,000 lb

Original engine emission standard: 10.7 g/bhp-hr

Replacement engine emission standard: 4.0 g/bhp-hr

Baseline energy consumption factor: 16.3 bhp-hr/gal

Reduced energy consumption factor: 17.3 bhp-hr/gal

Annual fuel use (baseline engine): 5,000 gal/yr

Annual fuel use (reduced engine): 5,000 gal/yr

TXLed Correction factor: 0.943

TxLED and Baseline NOx Emission Factor (g/yr)

10.7 g/bhp-hr x 0.943 = 10.0901 g/bhp-hr

10.0901 g/bhp-hr x 16.3 bhp-hr/gal = 164.4687 g/gal

164.4687 g/gal x 5,000 gal/yr = **822,344 g/yr**

Reduced NOx Emission Factor (g/yr)

4.0 g/bhp-hr x 0.943 = 3.772 g/bhp-hr

3.772 g/bhp-hr x 17.3 bhp-hr/gal = 65.2556 g/gal

65.2556 g/gal x 5,000 gal/yr = **326,278 g/yr**

Part C. Calculate the NOx Emission Reduction

Use the factors determined in Part B to calculate the NOx emission reductions for the activity. If you choose to base your calculations on fuel use, you must estimate the annual miles. For calculations that use fuel use as the factor, the annual fuel use determination is in Part B.

The TCEQ may provide the option of using default usage rates for some types of projects in lieu of determining the usage specific to each particular vehicle or piece of equipment. Refer to the Request for Grant Applications (RFGA) for instructions and requirements on the default usage options.

Where a default usage rate option is used, the applicable default usage rates should be used for the emissions reduction calculations. Where a default usage rate is not used, refer to the instructions in the RFGA for determining the usage rate to enter in the application and use for the emissions reduction calculations.

You must also enter the percentage of annual usage that will occur within the eligible counties. To qualify, at least 25% of the annual usage must be projected to occur within those counties. A primary area will need to be identified in the project application form. Activities to be operated in different primary areas will need to be submitted in separate applications.

Finally, to complete the calculations, you must commit to an activity life. This will be the number of years used to calculate the emission reductions. If selected for grant award, you must commit to operating the vehicle within the eligible counties for this time period and to track and report on that use.

The activity life may not exceed the life of the vehicle. Refer to Table 1.3 below, for information on the maximum acceptable activity life for different types of activities. The minimum activity life must be seven years, including leases.

TABLE 1.3 MAXIMUM CONTRACT ACTIVITY LIFE ON-ROAD HEAVY-DUTY VEHICLE ACTIVITIES

	Minimum	**Maximum**
School buses $33,000 GVWR - For new purchase or lease category only	5 years (including lease)	20 years
Other buses $ 33,000 GVWR - For new purchase or lease category only	5 years (including lease)	12 years
New	5 years (including lease)	10 years
Replacement	5 years	7 years
Repowers	5 years	7 years
Retrofit/Add-On **(The maximum life for dual-fuel conversions is 7 years)**	5 years	10 years (7 years for duel fuel conversions)

If an applicant feels that a longer activity life for a new purchase or lease is warranted for school buses or other buses, they should contact the TCEQ to discuss. Any request to use a longer activity life will need to be submitted in writing, and should include complete documentation and records of the historical use of similar vehicles by the applicant.

Example calculation for determining NOx emission rate reduction based on annual miles

Activity: Replacement of a 1988 heavy-duty vehicle with a 2002 model.

Vehicle weight rating: 20,000 lb

Baseline NOx emission factor: 19.9784 g/mile

Reduced NOx emission factor: 7.3177 g/mile

Annual miles traveled: 50,000 mile/yr

Percent time in affected counties: 85%

19.9784 g/mile - 7.3177 g/mile = 12.6607 g/mile

12.6697 g/mile x 50,000 miles = 633,035 grams

633,035 grams x 0.85 = 538,080 g/yr

538,080 g/yr / 907,200 g/tons = **0.5931 ton/yr**

Example calculation for determining NOx emission rate reduction based on annual fuel use

Activity: Replacement of a 1988 heavy-duty vehicle with a 2002 model.

Vehicle weight rating: 20,000 lb

Baseline emission factor: 822,344 g/yr

Reduced emission factor: 326,278 g/yr

Percent time in affected counties: 90 %

822,344 g/yr - 326,278 g/yr = 496,066 g/yr

496,066 g/yr x 0.90 = 446,459 g/yr

446,459 g/yr / 907,200 g/ton = **0.4921 ton/yr**

Step 3: Calculate the Cost Per Ton

The cost per ton for an activity is then determined by dividing the requested grant amount for that activity by the total NOx emission reductions for that activity.

For multi-activity projects, the cost per ton of the complete project is determined by dividing the requested grant amount for the entire project by the total NOx emission reductions for all of the activities included in that project.

Requested Grant Amount / Total NOx Emission Reductions = Cost Per Ton of NOx Reduced

Worksheet OR-1
Annual Miles of Operation

Please fill in the following information. This information will help you with your calculations.

Activity Information

Type of project

☐ New Purchase/Lease ☐ Repower ☐ Replacement ☐ Retrofit/Add-on

What is the activity life, in years?	
How many miles will the vehicle travel annually?	
What is the requested grant amount for the activity?	

Annual Usage Information

(a) What is the percent of time the vehicle will travel in the eligible counties?		
(b) What is the percent of time the vehicle will spend on the designated highways and roadways?		
What is the total percent of time? (a+b)		
What is the percent of time the vehicle will travel in the eligible counties? (a)		

Baseline Engine Information

Model Year	
Fuel Type	
Gross Vehicle Weight Rating (GVWR) (lb)	
Baseline Emission Standard (g/bhp-hr)	
Conversion Factor (bhp-hr/mile)	

Reduced Emission Engine Information

Model Year	
Fuel Type	
Gross Vehicle Weight Rating (GVWR) (lb)	
Reduced Emission Standard (g/bhp-hr)	
Conversion Factor (bhp-hr/mile)	
If the activity is a retrofit/add-on, is there a verified percentage NOx emission reduction?	%

STEP 1. DOES THIS PROJECT MEET THE 25% NOX BASELINE EMISSION RATE REDUCTION REQUIREMENTS?

Baseline Engine Emissions (g/bhp-hr)	
- Reduced Engine Emissions (g/bhp-hr)	
= Difference (g/bhp-hr)	
/ Baseline Engine Emissions (g/bhp-hr)	
x	100
= Emission Rate Reduction	

*The RFGA may authorize a lower percentage reduction requirement for retrofits with dual-fuel conversion systems.

STEP 2. CALCULATE THE NOX EMISSION REDUCTIONS?

PART A. CALCULATE THE TXLED CORRECTION FACTOR (ALL AREAS EXCEPT EL PASO)

On Road TxLED Correction Factor *1 - (0.057)*	0.943

PART B. DETERMINE THE NOX EMISSION FACTOR

DETERMINE BASELINE NOx EMISSION FACTOR (g/mile)	
baseline engine NOx emission standard (g/bhp-hr)	
x TxLED correction factor (diesel engines only)	
= corrected NOx emission factor (g/bhp-hr)	
x conversion factor (bhp-hr/mile)	
= baseline NOx emission factor (g/mile)	
DETERMINE REDUCED NOx EMISSION FACTOR (g/mile)	
OPTION A. REDUCED-EMISSION ENGINE CERTIFIED TO A SPECIFIC EMISSIONS STANDARD (G/BHP-HR)	
reduced engine NOx emissions standard (g/bhp-hr)	
x TxLED correction factor (diesel engines only)	
= corrected NOx emission factor (g/bhp-hr)	
x conversion factor (bhp-hr/mile)	
=reduced NOx emission factor (g/mile)	
OPTION B. REDUCED-EMISSION TECHNOLOGY CERTIFIED/VERIFIED TO ACHIEVE A PERCENTAGE REDUCTION FROM THE BASELINE.	
Baseline NOx emission factor (g/mile)	
x [1-certified/verified percentage reduction from baseline] (%)	
= reduced NOx emission factor (g/mile)	

PART C. CALCULATE THE NOX EMISSION REDUCTION USING ANNUAL MILEAGE

baseline NOx emission factor (g/mile)	
- reduced NOx emission factor (g/mile)	
= grams per mile reduced (g/mile)	
x annual miles of operation	
x percent within affected counties (%)	
= grams per year reduced (g/yr)	
/ 907,200 (g/ton)	
= estimated annual NOx emission reduction (ton/yr)	
x activity life (yr)	
= estimated activity life NOx emission reduction (ton)	

STEP 3: WHAT IS THE ACTIVITY COST PER TON?

requested grant amount for activity ($):	
/ NOx emissions reduction (ton):	
= cost per ton ($/ton)	

Worksheet OR-2
Annual Fuel Use

Please fill in the following information. This information will help you with your calculations.

Type of project	
☐ New Purchase/Lease ☐ Repower ☐ Replacement ☐ Retrofit/Add-on	
What is the activity life, in years? (See table 1.3)	
What is the percent time the vehicle will travel is in the eligible	
counties? What is the requested grant amount for the activity?	

Annual Usage Information

(a) What is the percent of time the vehicle will travel in the eligible counties?		
(b) What is the percent of time the vehicle will spend on the designated highways and roadways?		
What is the total percent of time? (a+b)		
What is the percent of time the vehicle will travel in the eligible counties? (a)		

Baseline Engine Information

Model Year	
Fuel Type	
Gross Vehicle Weight Rating (GVWR) (lb)	
Baseline Emission Standard (g/bhp-hr)	
Annual Fuel Consumption in Gallons (gal/yr)	
Energy Consumption Factor(hp-hr/gal)	

Reduced Emission Engine Information

Model Year	
Fuel Type	
Gross Vehicle Weight Rating (GVWR) (lb)	
Reduced Emission Standard (g/bhp-hr)	
Annual Fuel Consumption in Gallons (gal/yr)	
Energy Consumption Factor (hp-hr/gal)	
If the activity is a retrofit/add-on, is there a verified percentage NOx emission reduction?	%

STEP 1: DOES THIS PROJECT MEET THE 25% NOX BASELINE EMISSION RATE REDUCTION REQUIREMENTS?

Baseline Engine Emission Standard (g/bhp-hr)	
- Reduced Engine Emission Standard (g/bhp-hr)	
= Difference (g/bhp-hr)	
/ Baseline Engine Emission Standard (g/bhp-hr)	
x	100
= Emission Rate Reduction	

STEP 2: WHAT ARE YOUR NOX EMISSION REDUCTIONS?

PART A. CALCULATE THE TXLED CORRECTION FACTOR (ALL AREAS EXCEPT EL PASO)

On Road TxLED Correction Factor *1 - (0.057)*	0.943

PART B. DETERMINE THE NOX EMISSION FACTOR

Determine Baseline NOx Emission Factor (g/year)	
baseline NOx emission standard (g/bhp-hr)	
x TxLED correction factor (diesel engines only)	
= corrected NOx emission factor (g/bhp-hr)	
x energy consumption factor (bhp-hr/gal)	
x annual fuel consumption (gal/yr)	
= baseline NOx emission factor (g/yr)	
Determine Reduced NOx Emission Factor (g/year)	
OPTION A. REDUCED-EMISSION ENGINE CERTIFIED TO A SPECIFIC EMISSIONS STANDARD (G/BHP-HR)	
reduced NOx emissions standard (g/bhp-hr)	
x TxLED correction factor (diesel engines only)	
= corrected NOx emission factor (g/bhp-hr)	
x energy consumption factor (bhp-hr/gal)	
x annual fuel consumption (gal/yr)	
= reduced NOx emission factor (g/yr)	
OPTION B. REDUCED-EMISSION TECHNOLOGY CERTIFIED/VERIFIED TO ACHIEVE A PERCENTAGE REDUCTION FROM THE BASELINE.	
Baseline NOx emission factor (g/yr)	
x certified/verified percentage reduction from baseline	
= reduced NOx emission factor (g/yr)	

PART C. CALCULATE THE NOX EMISSION REDUCTION USING ANNUAL FUEL USE

baseline NOx emission factor (g/yr)	
- reduced NOx emission factor (g/yr)	
= grams per year reduced (g/yr)	
x percent within affected counties (%)	
= grams per year reduced (g/yr)	
/ 907,200 (g/ton)	907200
= estimated annual NOx emission reduction (ton/yr)	
x activity life (yr)	
= estimated activity life NOx emission reduction (ton)	

STEP 3: WHAT IS THE ACTIVITY COST PER TON?

Requested grant amount activity ($):	
/ NOx emissions reductions (ton):	
= cost per ton($/ton):	