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

Technical Supplement No. 5
Stationary Equipment

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TECHNICAL SUPPLEMENT NO. 5

STATIONARY EQUIPMENT

Summary

This supplement contains the calculations for activities involving stationary equipment, including: new purchases and leases, replacement, repower, retrofit, and add-on activities.

Stationary engines equal to or greater than 25 hp may be eligible for grants under this program. Most of the stationary engines eligible under this program will be powered by diesel-fueled compression-ignition (CI) engines. However, engines powered by other fuels may also be eligible, subject to decisions by the TCEQ for particular funding periods and geographic areas. **If the project being proposed involves a gasoline, LPG, or CNG powered engine contact TCEQ for eligibility.**

Use the worksheets provided at the end of this chapter to calculate the emission reductions and the cost-effectiveness of the activities proposed for your project. Use SE-1 to do the calculations based on annual hours of operation. Use SE-2 for calculations based on annual fuel use.

This workbook is divided into three major steps.

a) Step 1: Does the activity meet the 25% NO_x emissions reduction requirement?

b) Step 2: Calculate the NO_x Emission Reductions.

c) Step 3: Calculate 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: Does the activity meet the 25% NO_x emissions reduction requirement?

All new purchase or lease, repower, retrofit, and add-on activities must achieve at least a 25% reduction in NO_x emissions when compared to a baseline emission rate. Use Worksheet SE-1 or SE-2 to determine if your activity meets the minimum emission reduction requirements.

Baseline NO_x Emission Rate

For these calculations, the baseline NO_x emissions will normally be the federal NO_x emission standard for the model year and horsepower of the baseline equipment and/or engine. The federal NO_x emission standards for non-road engines are presented in Table 5.1. The standards for engines certified for heavy-duty on-road use are presented in Table 5.2. In situations where the model year of the equipment 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 emissions.

TABLE 5.1 NON-ROAD DIESEL (CI) ENGINES NO_X EMISSION STANDARDS BY MODEL YEAR

Engine Power (hp)	Tier	Model Year	Emissions (NO_x) g/bhp-hr	Emissions (NO_x + NMHC) g/bhp-hr
equal to or greater than 25hp (19kW) but less than 50hp (37kW)	Tier 0 (uncontrolled)	pre-1998	7.2	N/A
	Tier 1	1999-2003	6.745	7.1
	Tier 2	2004-2012	5.32	5.6
	Tier 4	2013+	3.325	5.6

Engine Power (hp)	Tier	Model Year	Emissions (NOx) g/bhp-hr	Emissions (NOx + NMHC) g/bhp-hr
equal to or greater than 50hp (37kW) but less than 75hp (56kW)	Tier 0 (uncontrolled)	pre-1998	8.8	N/A
	Tier 1	1998-2003	6.9	N/A
	Tier 2	2004-2007	5.32	5.6
	Tier 3	2008-2013	3.325	3.5
	Tier 4	2013+	3.325	3.5

Engine Power (hp)	Tier	Model Year	Emissions (NO_x) g/bhp-hr	Emissions (NO_x + NMHC) g/bhp-hr
equal to or greater than 75hp (56kW) but less than 100hp (75kW)	Tier 0 (uncontrolled)	pre-1998	8.8	N/A
	Tier 1	1998-2003	6.9	N/A
	Tier 2	2004-2007	5.32	5.6
	Tier 3	2008-2012	3.325	3.5
	Tier 4 (Phase-In)	2012-2013	0.30-3.3251	N/A
	Tier 4	2014+	0.30	N/A

Engine Power (hp)	Tier	Model Year	Emissions (NO_x) g/bhp-hr	Emissions (NO_x + NMHC) g/bhp-hr
equal to or greater than 100hp (75kW) but less than 175hp (130kW)	Tier 0 (uncontrolled)	pre - 1997	9.5	N/A
	Tier 1	1997-2002	6.9	N/A
	Tier 2	2003-2006	4.655	4.9
	Tier 3	2007-2011	2.85	3.0
	Tier 4 (Phase-In)	2012-2013	0.30-2.851	N/A
	Tier 4	2014+	0.30	N/A

Engine Power (hp)	Tier	Model Year	Emissions (NO_x) g/bhp-hr	Emissions (NO_x + NMHC) g/bhp-hr
equal to or greater than 175hp (130kW) but less than 300hp (225kW)	Tier 0 (uncontrolled)	pre-1996	9.3	N/A
	Tier 1	1996-2002	6.9	N/A
	Tier 2	2003-2005	4.655	4.9
	Tier 3	2006-2010	2.85	3.0
	Tier 4 (Phase-In)	2011-2013	0.30-2.851	N/A
	Tier 4	2014+	0.30	N/A

Engine Power (hp)	Tier	Model Year	Emissions (NO_x) g/bhp-hr	Emissions (NO_x + NMHC) g/bhp-hr
equal to or greater than 300hp (225kW) but less than 600hp (450kW)	Tier 0 (uncontrolled)	pre-1996	9.5	N/A
	Tier 1	1996-2000	6.9	N/A
	Tier 2	2001-2005	4.56	4.8
	Tier 3	2006-2010	2.85	3.0
	Tier 4 (Phase-In)	2011-2013	0.30-2.851	N/A
	Tier 4	2014+	0.30	N/A

Engine Power (hp)	Tier	Model Year	Emissions (NO_x) g/bhp-hr	Emissions (NO_x + NMHC) g/bhp-hr
equal to or greater than 600hp (450kW) but less than 750hp (560kW)	Tier 0 (uncontrolled)	pre-1996	9.7	N/A
	Tier 1	1996-2001	6.9	N/A
	Tier 2	2002-2005	4.56	4.8
	Tier 3	2006-2010	2.85	3.0
	Tier 4 (Phase-In)	2011-2013	0.30-2.851	N/A
	Tier 4	2014+	0.30	N/A

Engine Power (hp)	Tier	Model Year	Emissions (NO_x) g/bhp-hr	Emissions (NO_x + NMHC) g/bhp-hr
equal to or greater than 750hp (560kW)	Tier 0 (uncontrolled)	pre-2000	9.1	N/A
	Tier 1	2000-2005	6.9	N/A
	Tier 2	2006-2010	4.56	4.8
	Tier 4 (Phase-In)	2011-2014	2.6/0.50[2]	N/A
	Tier 4	2015+	2.6/0.50[3]	N/A

Note: **For calculations use the NO_x g/bhp-hr column.** NO_x + NMHC g/bhp-hr column is listed for reference only.

[1] These standards are phased-in during the indicated years. At least 50% of a manufacturer's engine production must meet these standards during each year of the phase-in. Therefore, it is not guaranteed that a Tier 4 (Phase-In) equipment and/or engine will meet the lower standard. If an applicant proposes to purchase a Tier 4 (Phase-In) equipment and/or engine, the applicant must certify, in the application, the emission level that the new equipment and/or engine will meet. Copies of the form certifying the engine family to the lower emission standard must be provided. If it is not yet known what emission standard to which the engine will be certified, then use the Tier 3 standard.

[2] The 0.50g/bhp-hr standard applies to gensets over 1200 hp

[3] Applies to all gensets

Table 5.2 On-Road Heavy-Duty CI Engines NO_x Emission Standards by Model Year

Year of Manufacture	Diesel Engines Emission Standard	
	NO_x Only (g/bhp-hr)	**NO_x + NMHC (g/bhp-hr)**
1989 and earlier	10.7	
1990	6.0	
1991-1997	5.0	
1998-2001	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 NO_x Emission Rate

The reduced NO_x emission rate will normally be the certified or verified emissions of the reduced-emission equipment/engine.

- **New Purchase or Lease.** Use the certified emission rate (g/bhp-hr) of the new equipment. 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 equipment/ engine. 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 equipment. 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.

[(Baseline Engine - Reduced Engine) / Baseline Engine]

x 100 = Baseline Emission Rate Reduction

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

Activity: Purchase of a new 125-hp engine that is equivalent to a non-road engine.

Engine emission standard for current year model: 4.655 g/bhp-hr
New engine certified NO_x emissions: 2.66 g/bhp-hr

Calculation of baseline emission rate reduction:
[(4.655g/bhp-hr - 2.66 g/bhp-hr) / 4.655 g/bhp-hr] x 100 % = 42.86% baseline emission rate reduction

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

Activity: Repower of a pump that has a 100-hp piece of equipment built in 1991 with a rebuilt 1999 engine.

Original engine emission standard: 8.1 g/bhp-hr
Replacement engine emission standard: 6.9 g/bhp-hr

Calculation of baseline emission rate reduction:
[(8.1 g/bhp-hr - 6.9 g/bhp-hr) / 8.1 g/bhp-hr] x 100 % = 14.81% baseline emission rate reduction

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

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

Activity: Replacement of a 1985 550-hp generator with a 2002 500hp generator.

Original engine emission standard: 9.5 g/bhp-hr
Replacement engine emission standard: 4.56 g/bhp-hr

Calculation of baseline emission rate reduction:
[(9.5 g/bhp-hr - 4.56 g/bhp-hr) / 9.5 g/bhp-hr] x 100 % = 52% baseline emission rate reduction

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

Activity: Retrofit of a 2001 250-hp pump to accept LPG as a fuel.

Engine emission standard for existing model year: 6.9 g/bhp-hr
New engine certified NO_x emissions: 4.5 g/bhp-hr

Calculation of baseline emission rate reduction:
[(6.9 g/bhp-hr - 4.5 g/bhp-hr) / 6.9 g/bhp-hr] x 100 % = 34.78% baseline emission rate reduction

Step 2: Calculate the NO_x Emission Reductions

This step is divided into three main parts:

- Part A: Determine the TxLED Correction Factor
- Part B: Determine the NO_x emission factors
- Part C: Calculate the NO_x emission reductions

Points to remember when performing Emission Reduction Calculations

- Use Worksheet SE-1 for calculations where usage is based in hours of operation.
- Use the emission standard of the original design of the engine. If the engine is an on-road engine use the on-road standard. If the engine is non-road use the non-road standard.
- Emission reduction represents the difference in the emission level of a baseline engine and a reduced-emission 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 equipment 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 engines should be calculated separately and then differences taken to determine emission reductions.
- For most stationary applications, the activity level should be established by the annual hours of operation.
- Emission reduction calculations should be consistent with the type of records maintained over the life of each activity.
- If the equipment operates in a county or counties that is in the TexLED region the TexLED 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 sold or 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 NO_x 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 an 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 stationary equipment activities in the applicable counties (does not include El Paso County), a correction factor of either **0.943** for on-road engines or **0.93** for non-road engines should be applied when calculating the baseline and/or reduced emissions for diesel engines.

Part B. Determine the NOx Emission Factors

To complete the calculation of the NO_x emission reductions for the activity, you must convert the NOx emission rates (g/bhp-hr) to a NO_x emission factor. For most types of equipment, the NO_x emission reduction factors should be based on annual hours of operation.

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.

Activity level based on hours of operation - Worksheet (SE-1)

For calculations based on annual hours of operations (SE-1), the NO_x emission factor must be in grams per hour (g/hr). If given in (g/bhp-hr), multiply the NO_x emission standard by the engine's horsepower in order to convert it to (g/hr). It is recommended that certified manufacture emission factors are used. A load factor must also be applied to the NO_x emission standard for the baseline engine and for the reduced emission engine. The default load factor for stationary diesel engine applications is 0.43. For cases when activity level records are kept as fuel usage, e.g., annual gallons of fuel used (gal/yr), use an Energy Conversion Factor (ECF) to convert fuel usage (gal/yr) to engine's work output (bhp-hr/yr). The default ECF for stationary diesel engine operations is 18.5 bhp-hr/gal.

Part C. Calculate the NOx Emission Reductions

Use the factors determined in Part B to calculate the NO_x emission reductions for the activity. To complete the calculations, you will need to determine the estimated annual hours of operation, if needed. Annual fuel use determination is in Part B for calculations that use fuel use as the determining factor.

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. At least 75% 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, an activity life must be designated. This will be the number of years used to calculate the emission reductions. If awarded the grant, you must commit to operating the equipment within the eligible counties for this time period, and to track and report on that use.

Activity life may not exceed the life of the piece of equipment or the maximum useful life. Table 5.3 lists the maximum and minimum activity life acceptable for stationary engines. For example a generator that is purchased new and has documentation that the generator has a useful life of 15 years is only eligible for 10 years of TERP NO_x reductions calculations and for cost-effectiveness. The applicant must also commit to using the vehicle in the eligible counties during the active life of the piece of equipment. The minimum activity life must be seven years, including leases.

Table 5.3 Maximum Contract Activity Life of Stationary Equipment Activities

	Minimum	**Maximum***
New	5 years	10 years
Replacement	5 years	7 years
Repowers	5 years	7 years
Retrofit/Add-on	5 years	10 years

*If an applicant feels that a longer activity life is warranted, 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 these similar types of equipment by the applicant.

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 NO_x 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 NO_x emission reductions for all of the activities included in that project.

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

Worksheet SE-1
Annual Hours of Operation

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

Activity Information

Type of activity ☐ New Purchase/Lease ☐ Repower ☐ Replacement ☐ Retrofit/Add-on	
What is the activity life in years?	
What are/how many hours of annual operation for this piece of equipment?	
What is the percent time the equipment is operated in the eligible counties?	
What is the requested grant amount for the activity?	

Baseline Engine Information

Model Year	
Fuel Type	
Equipment Type	
Horsepower (hp)	
Emission Standard (g/bhp-hr)	
Load Factor	

Reduced Emission Engine Information

Model Year	
Fuel Type	
Equipment Type	
Horsepower (hp)	
Emissions Standard (g/bhp-hr)	
Load Factor	
If the activity is a retrofit/add-on, what is the verified percentage NO_x emission reduction?	

STEP 1: DOES THIS PROJECT MEET THE 25% NO_X 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	
= Percent Emission Rate Reduction	

STEP 2: WHAT ARE YOUR NO_X EMISSION REDUCTIONS?

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

On-road engines (*1 - 0.057)*	0.943
Non-road engines (1-0.07)	0.97

PART B. DETERMINE THE NO_X EMISSION FACTOR

Determine Baseline NOx Emission Factor (g/hour)	
baseline engine NO_x emission standard (g/bhp-hr)	
x TxLED correction factor (diesel engines only)	
= corrected NO_x emission factor (g/bhp-hr)	
x load factor	
x engine power (hp)	
= baseline NO_x emission factor (g/hr)	
DETERMINE REDUCED NO_X EMISSION FACTOR (G/HOUR)	
Option A. Reduced-emission engine certified to a specific emissions standard (g/bhp-hr)	
reduced engine NO_x emissions (g/bhp-hr)	
x TxLED correction factor (diesel engines only)	
= corrected NO_x emission factor (g/bhp-hr)	
x load factor	
x horse power (hp)	
=reduced NO_x emission factor (g/hr)	
Option B. Reduced-emission technology certified/verified to achieve a percentage reduction from the baseline.	
baseline NO_x emission factor (g/hr)	
x certified/verified percentage NO_x emission reduction from baseline	
= reduced NO_x emission factor (g/hr)	

Part C. Calculate the NO_x Emission Reduction Using Annual Hours of Operation

baseline NO_x emission factor (g/hr)	
- reduced NO_x emission factor (g/hr)	
= grams per hour reduced (g/hr)	
x annual hours of operation (hr/yr)	
x percent within affected counties (%)	
= grams per year reduced (g/yr)	
÷ 907,200 (g/ton)	907,200
= estimated annual NO_x emission reduction (ton/yr)	
x grant activity life (yr)	
= estimated grant activity life NO_x emission reduction (ton)	

Step 3: What is the activity cost per ton?

Grant activity amount ($):	
/ NO_x emission reductions (ton):	
= cost per ton ($/ton)	