



**North Central Texas  
Council of Governments**

**TEXAS EMISSIONS REDUCTION PLAN (TERP)**

**NORTH TEXAS EMISSIONS REDUCTION GRANT**

**Technical Supplement for**

**Non-Road Equipment**

**Revised – June 27, 2006**

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(Based on the TCEQ Emissions Reduction Incentive Grants Program Technical Supplement No. 2)  
**Technical Supplement for Non-Road Equipment**

## Summary

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

Non-road equipment equal to or greater than 25 horsepower (hp) are eligible for grants under this program for new purchase and lease, replacement, repower, and retrofit/add-on. Diesel-fueled compression-ignition (CI) engines will be power most of the non-road engines eligible under this program. However, engines powered by other fuels may also be eligible, subject to decisions by the NCTCOG for particular funding periods and geographic areas. **If the project being proposed involves a gasoline, LPG, or CNG powered equipment contact NCTCOG for eligibility.**

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

This workbook is divided into three major steps.

- Step 1: Determining that the activity meets the 25% NOx emissions reduction requirement.
- Step 2: Calculating the NOx Emission Reductions.
- 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% NOx emissions reduction requirement.**

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

#### **Baseline NOx Emission Rate**

For these calculations, the baseline NOx emission rate will normally be the federal NOx emission standard for the model year and horsepower of the baseline engine. The federal NOx emission standards for non-road equipment are presented in Table 3.1. 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.

In some model years, the EPA used a combined NOx + NMHC (non-methane hydrocarbons) standard. For the standards listed in NOx + NMHC, the NCTCOG will use a NOx fraction of 0.95 for diesel engines and 0.80 for alternative fuel engines to determine the NOx-only emissions based on the combined standards.

**Table 3.1 Non-Road Diesel (CI) Engines NOx Emission Standards by Model Year**

Engine Power (HP)	Tier	Model Year	Emissions (NOx) g/bhp-hr	Emissions (NOx + NMHC) g/bhp-hr
25<hp<50  19<kW<37	Tier 0 (uncontrolled)	pre-1999	7.2	N/A
	Tier 1	1999-2003	6.745	7.1
	Tier 2	2004+	5.32	5.6

Engine Power (HP)	Tier	Model Year	Emissions (NOx) g/bhp-hr	Emissions (NOx + NMHC) g/bhp-hr
50<hp<100  37<kW<75	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+	3.325	3.5

Engine Power (HP)	Tier	Model Year	Emissions (NOx) g/bhp-hr	Emissions (NOx + NMHC) g/bhp-hr
100<hp<175  75<kW<130	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+	2.85	3.0

Engine Power (HP)	Tier	Model Year	Emissions (NOx) g/bhp-hr	Emissions (NOx + NMHC) g/bhp-hr
175<hp<300  130<kW<225	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+	2.85	3.0

Engine Power (HP)	Tier	Model Year	Emissions (NOx) g/bhp-hr	Emissions (NOx + NMHC) g/bhp-hr
300<hp<600	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
225<kW<450	Tier 3	2006+	2.85	3.0

Engine Power (HP)	Tier	Model Year	Emissions (NOx) g/bhp-hr	Emissions (NOx + NMHC) g/bhp-hr
600<hp<750	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
450<kW<560	Tier 3	2006+	2.85	3.0

*Note: Beginning January 2005, some manufacturers of engines in the 300 < hp < 750 hp range will be required to produce Tier 3 engines; thus, these will not be eligible as new purchase activities. Such engines may still qualify for funding consideration as replacement or repower activities.*

Engine Power (HP)	Tier	Model Year	Emissions (NOx) g/bhp-hr	Emissions (NOx + NMHC) g/bhp-hr
hp>750	Tier 0 (uncontrolled)	pre-2000	9.1	N/A
	Tier 1	2000-2005	6.9	N/A
	Tier 2	2006+	4.56	4.8
kW>560	Tier 3	N/A	N/A	N/A

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

### Reduced NOx Emission Rate

The reduced NOx emission rate will normally be the federal NOx certified or verified emissions standard in the model years and horsepower of the reduced-emission equipment or engine (see Table 3.1).

- **New Purchase or Lease.** Use the certified emission standard (g/bhp-hr) of the new equipment. Certified means certified by the EPA or CARB, or otherwise accepted by the NCTCOG.
- **Replacement.** Use the certified emission standard (g/bhp-hr) of the replacement

equipment and engine.

- **Repower.** Use the certified emission standard (g/bhp-hr) of the engine installed on the replacement equipment. Certified means certified by the EPA or CARB, or otherwise accepted by the NCTCOG.
- **Retrofit/Add-on.** Use the verified or certified emission standard (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 NCTCOG.

$$\frac{(\text{Baseline Engine} - \text{Reduced Engine})}{\text{Baseline Engine}} \times 100 = \text{Baseline Emission Rate Reduction}$$

### Example Calculations

#### Example calculation for determining if activity meets 25% baseline emission rate reduction for new purchase/lease

**Activity:** Purchase of a new non-road 125 hp piece of equipment.

**Engine emission standard for current year model:** 4.655 g/bhp-hr

**New engine certified NOx emissions:** 2.85 g/bhp-hr

**Calculation of baseline emission rate reduction:**

(4.655 g/bhp-hr - 2.85 g/bhp-hr) divided by 4.655 g/bhp-hr x 100 = 38.78% baseline emission rate reduction

*Note: This project does meet the 25% baseline emission rate reduction requirement.*

#### Example calculation for determining if activity meets 25% baseline emission rate reduction for repowers

**Activity:** Repower of a 1991 550 hp non-road piece of equipment with 1997 engine.

**Original engine emission standard:** 9.5 g/bhp-hr

**Replacement engine emission standard:** 6.9 g/bhp-hr

**Calculation of baseline emission rate reduction:**

(9.5 g/bhp-hr - 6.9 g/bhp-hr) divided by 9.5 g/bhp-hr x 100 = 27.37% baseline emission rate reduction

*Note: This project does meet the 25% baseline emission rate reduction requirement.*

**Example calculation for determining if activity meets 25% baseline emission rate reduction for replacements**

**Activity:** Replacement of a 1979 750 hp piece of equipment with a 2001 model.

**Original engine emission standard:** 9.1 g/bhp-hr

**Replacement engine emission standard:** 6.9 g/bhp-hr

**Calculation of baseline emission rate reduction:**

$(9.1 \text{ g/bhp-hr} - 6.9 \text{ g/bhp-hr}) \text{ divided by } 9.1 \text{ g/bhp-hr} \times 100 = 24.18\% \text{ baseline emission rate reduction}$

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

**Example calculation for determining if activity meets 25% baseline emission rate reduction for retrofit/add-on device**

**Activity:** Retrofitting a 1995 450 hp piece of equipment with a device that reduces the NOx emissions.

**Engine emission standard without retrofit:** 9.5 g/bhp-hr

**Retrofitted engine certified NOx emissions:** 5.6 g/bhp-hr

**Calculation of baseline emission rate reduction:**

$(9.5 \text{ g/bhp-hr} - 5.6 \text{ g/bhp-hr}) \text{ divided by } 9.5 \text{ g/bhp-hr} \times 100 = 41.05\% \text{ baseline emission rate reduction}$

*Note: This project does meet the 25% baseline emission rate reduction requirement.*

## Step 2: Calculate the NOx Emission Reductions

This step is divided into three main parts:

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

### Points to remember when performing Emission Reduction Calculations

- Use Worksheet NR-1 for calculations where usage is based in hours of operation.
- 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 non-road applications, the activity level should be established by the annual hours of operation.
- Usage amounts for the emission reduction calculations should be consistent with the anticipated grant life of each activity.
- If the equipment operates in a county or counties that is in the TxLED region the TxLED conversion factor must be determined

### Part A. Determine the TxLED Correction Factor

The Texas Commission on Environmental Quality (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 percent 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 percent** (0.057) for on-road use and **7.0 percent** (0.07) for non-road use 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 non-road activities in the applicable counties (does not include El Paso County), a correction factor of **0.93** should be applied when calculating the baseline and/or reduced emissions for diesel engines, regardless of when the grant-funded equipment began or will begin operation.



## Part B. Determine the NOx Emission Factors

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

You should consult with the NCTCOG to determine the factors to use for non-diesel engines, or if you wish to use a different conversion factor.

### Hour of operation based usage (NR-1)

For calculations based on annual hours of operations (NR-1), the NOx emission factor will be in grams per hour (g/hr). Load factor is provided to convert the NOx emission standard (g/bhp-hr) to g/hr. The horsepower of the engine must also be included in the calculation. This load factor must be applied to the NOx emission standard (g/bhp-hr) for the baseline vehicle/engine and for the reduced emission vehicle/engine. Load factors, by type of equipment and horsepower are provided in Table 2.2 below.

### Fuel use based usage (NR-2)

For calculations based on annual fuel use (NR-2), the NOx emission factor will be in grams per year (g/year). The energy consumption factor (ECF) should be used to convert the NOx emission standard (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 2.2 below.

**Table 2.2 Factors for Non-Road Equipment**

SCC Definition	HPMIN	HPMAX	Load Factor	ECF (gal/hp-hr)
Diesel Specialty Vehicle Carts	25	100	0.21	14.8
Diesel Specialty Vehicle Carts	100	1500	0.21	16.4
Diesel Pavers	25	100	0.59	17.2
Diesel Pavers	100	600	0.59	19.1
Diesel Rollers	25	100	0.59	17.2
Diesel Rollers	100	600	0.59	19.1
Diesel Scrapers	50	100	0.59	17.2
Diesel Scrapers	100	750	0.59	19.1
Diesel Paving Equipment	25	100	0.59	17.2
Diesel Paving Equipment	100	600	0.59	19.1
Diesel Surfacing Equipment	25	100	0.59	17.2
Diesel Surfacing Equipment	100	600	0.59	19.1
Diesel Signal Boards	25	100	0.43	17.4
Diesel Signal Boards	100	300	0.43	19.3
Diesel Trenchers	25	100	0.59	17.2
Diesel Trenchers	100	1500	0.59	19.1
Diesel Bore/Drill Rigs	25	100	0.43	17.4
Diesel Bore/Drill Rigs	100	1500	0.43	19.3
Diesel Excavators	25	100	0.59	17.2
Diesel Excavators	100	3000	0.59	19.1
Diesel Concrete/Industrial Saws	25	100	0.59	17.2
Diesel Concrete/Industrial Saws	100	175	0.59	19.1
Diesel Cement & Mortar Mixers	25	100	0.43	17.4

SCC Definition	HPMIN	HPMAX	Load Factor	ECF (gal/hp-hr)
Diesel Cement & Mortar Mixers	100	750	0.43	19.3
Diesel Cranes	25	100	0.43	17.4
Diesel Cranes	100	1000	0.43	19.3
Diesel Graders	50	100	0.59	17.2
Diesel Graders	100	750	0.59	19.1
Diesel Off-highway Trucks	175	3000	0.59	19.1
Diesel Crushing/Proc. Equipment	25	100	0.43	17.4
Diesel Crushing/Proc. Equipment	100	750	0.43	19.3
Diesel Rough Terrain Forklifts	25	100	0.59	17.2
Diesel Rough Terrain Forklifts	100	600	0.59	19.1
Diesel Rubber Tire Loaders	25	100	0.59	17.2
Diesel Rubber Tire Loaders	100	3000	0.59	19.1
Diesel Tractors/Loaders/Backhoes	25	100	0.21	14.8
Diesel Tractors/Loaders/Backhoes	100	300	0.21	16.4
Diesel Crawler Tractors	50	100	0.59	17.2
Diesel Crawler Tractors	100	1500	0.59	19.1
Diesel Skid Steer Loaders	25	100	0.21	14.8
Diesel Skid Steer Loaders	100	175	0.21	16.4
Diesel Off-Highway Tractors	175	3000	0.59	19.1
Diesel Dumpers/Tenders	25	100	0.21	14.8
Diesel Dumpers/Tenders	100	175	0.21	16.4
Diesel Other Construction Equipment	25	100	0.59	17.2
Diesel Other Construction Equipment	100	1000	0.59	19.1
Diesel Aerial Lifts	25	100	0.21	14.8
Diesel Aerial Lifts	100	175	0.21	16.4
Diesel Forklifts	40	100	0.59	17.2
Diesel Forklifts	100	600	0.59	19.1
Diesel Sweepers/Scrubbers	25	100	0.43	17.4
Diesel Sweepers/Scrubbers	100	300	0.43	19.3
Diesel Other General Industrial Equipment	25	100	0.43	17.4
Diesel Other General Industrial Equipment	100	750	0.43	19.3
Diesel Other Material Handling Equipment	40	100	0.21	14.8
Diesel Other Material Handling Equipment	100	600	0.21	16.4
Diesel AC\Refrigeration	25	100	0.43	17.4
Diesel Terminal Tractors	50	100	0.59	17.2
Diesel Terminal Tractors	100	600	0.59	19.1
Diesel Front Mowers (Commercial)	25	100	0.43	17.4
Diesel Lawn & Garden Tractors (Commercial)	40	100	0.43	17.4
Diesel Chippers/Stump Grinders (Commercial)	25	100	0.43	17.4
Diesel Chippers/Stump Grinders (Commercial)	100	1000	0.43	19.3
Diesel Commercial Turf Equipment (Commercial)	25	100	0.43	17.4
Diesel Commercial Turf Equipment (Commercial)	100	600	0.43	19.3
Diesel Other Lawn & Garden Equipment (Commercial)	40	100	0.43	17.4
Diesel Other Lawn & Garden Equipment (Commercial)	100	175	0.43	19.3
Diesel Agricultural Tractors	25	100	0.59	17.2
Diesel Agricultural Tractors	100	750	0.59	19.1
Diesel Combines	50	100	0.59	17.2
Diesel Combines	100	600	0.59	19.1
Diesel Balers	40	100	0.59	17.2
Diesel Balers	100	300	0.59	19.1
Diesel Sprayers	25	100	0.59	17.2
Diesel Sprayers	100	600	0.59	19.1

SCC Definition	HPMIN	HPMAX	Load Factor	ECF (gal/hp-hr)
Diesel Switchers	50	100	0.59	17.2
Diesel Switchers	100	175	0.59	19.1
Diesel Hydro Power Units	25	100	0.43	17.4
Diesel Hydro Power Units	100	600	0.43	19.3
Diesel Other Agricultural Equipment	25	100	0.59	17.2
Diesel Other Agricultural Equipment	100	600	0.59	19.1
Diesel Irrigation Sets	25	100	0.43	17.4
Diesel Irrigation Sets	100	600	0.43	19.3
Diesel Light Commercial Generator Sets	25	100	0.43	17.4
Diesel Light Commercial Generator Sets	100	600	0.43	19.3
Diesel Light Commercial Pumps	25	100	0.43	17.4
Diesel Light Commercial Pumps	100	600	0.43	19.3
Diesel Light Commercial Air Compressors	25	100	0.43	17.4
Diesel Light Commercial Air Compressors	100	600	0.43	19.3
Diesel Light Commercial Gas Compressors	50	100	0.43	17.4
Diesel Light Commercial Welders	25	100	0.21	14.8
Diesel Light Commercial Welders	100	175	0.21	16.4
Diesel Light Commercial Pressure Washer	25	100	0.43	17.4
Diesel Light Commercial Pressure Washer	100	750	0.43	19.3
Diesel Logging Equip Fell/Bunch/Skidlers	25	100	0.59	17.2
Diesel Logging Equip Fell/Bunch/Skidlers	100	750	0.59	19.1
Diesel Airport Support Equipment	25	100	0.59	17.2
Diesel Airport Support Equipment	100	750	0.59	19.1
Diesel Other Oil Field Equipment	25	100	0.43	17.4
Diesel Other Oil Field Equipment	100	3000	0.43	19.3

### Example calculation for determining NOx emission factor based on annual hours

**Activity:** Replacement of a 1988 500hp diesel crawler tractor with a new 2002 model.

**Equipment horsepower:** 500 hp.

**Original engine emission standard:** 9.5 g/bhp-hr

**Replacement engine emission standard:** 4.56 g/bhp-hr

**Load factor:** 0.59

**Annual hours of operation:** 700 hours

**TxLED Correction factor:** 0.93 (based of off an activity life of 5 years)

#### TxLED and Baseline NOx Emission Factor (g/hr)

9.5g/bhp-hr x 0.93 = 8.835g/bhp-hr

8.835g/bhp-hr x 0.59 = 5.2126 g/bhp-hr

5.2126 g/bhp-hr x 500hp = **2,606.3 g/hr**

#### Reduced NOx Emission Factor (g/hr)

4.56g/bhp-hr x 0.93 = 4.2408 g/bhp-hr

4.2408 g/bhp-hr x 0.59 = 2.502g/bhp-hr

2.502 g/bhp-hr x 500hp = **1,251 g/hr**

**Part C. Calculate the NOx Emission Reductions**

Use the factors determined in Part B to calculate the NOx emission reductions for the activity. To complete the calculations, you will need to determine the estimated annual hours of operation. Use historical records and other information, where possible. Note that the usage estimates entered onto the application and used to calculate the emission reductions, will be entered into the grant contract.

You must also enter the percentage of annual usage that will occur within the eligible counties. To qualify, at least 75 percent 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 will need to designate a grant activity life. 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 to the NCTCOG.

Activity life may not exceed the life of the piece of equipment. Refer to Table 2.3 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 2.3 Maximum Grant Activity Life Non-Road Equipment Activities**

	Minimum	Maximum *
<b>New</b>	5 years (1 year for lease)	10 years
<b>Replacement</b>	5 years	7 years
<b>Repower</b>	5 years	7 years
<b>Retrofit/Add-on</b>	5 years	10 years

If an applicant feels that a longer activity life is warranted, they should contact the NCTCOG 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 types of vehicles by the applicant.

**Example calculation for determining NOx emission rate reduction based on annual hours of operation**

**Activity:** Replacement of a 1988 500 hp diesel crawler tractor with a new 2002 model.

**Equipment horsepower:** 500 hp  
**Baseline NOx emission factor:** 2,606.3 g/hr  
**Reduced NOx emission factor:** 1,251 g/hr  
**Annual hours of operation:** 700  
**Percent time in affected counties:** 100%

2,603.3 g/hr -1,251 g/hr = 1,352.3 g/hr  
 1,352.3 g/hr x 700hours = 946,610 g/yr  
 946,610 g/yr x 1.00 = 946,610 g/yr  
 946,610 g/yr ) 907,200 g/ton = **1.0434 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.

$$\text{Requested Grant Amount} \div \text{Total NOx Emission Reductions} = \text{Cost Per Ton of NOx Reduced}$$

## Worksheet NR-1 Annual Hours of Operation

Please fill in the following information. This information will help you with your calculations.  
Also, a link is available at [www.nctcog.org/NTERG](http://www.nctcog.org/NTERG) to an online calculator to assist you.

### Activity Information

Type of activity	
<input type="checkbox"/> New Purchase/Lease <input type="checkbox"/> Repower <input type="checkbox"/> Replacement <input type="checkbox"/> Retrofit/Add-on	
What is the activity life in years? (See table 2.3)	
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	
Emissions Standard (g/bhp-hr)	
Load Factor	

### Reduced Emission Engine Information

Model Year	
Fuel Type	
Equipment Type	
Horsepower	
Emissions Standard (g/bhp-hr)	
Load Factor	
If the activity is a retrofit/add-on, what is the 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 for El Paso County)**

Non Road TxLED Correction Factor 1 - (0.07)	<b>0.93</b>
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**Part B. Determine the NOx Emission Factor**

<b>Determine Baseline NOx Emission Factor (g/hour)</b>	
baseline engine NOx emission standard (g/bhp-hr)	
x TxLED correction factor (diesel engines only)	
= corrected NOx emission factor (g/bhp-hr)	
x load factor	
x horse power	
= baseline NOx emission factor (g/hr)	
<b>Determine Reduced NOx Emission Factor (g/hour)</b>	
<b>Option A. Reduced-emission engine certified to a specific emissions standard (g/bhp-hr)</b>	
reduced engine NOx emissions (g/bhp-hr)	
x TxLED correction factor (diesel engines only)	
= corrected NOx emission factor (g/bhp-hr)	
x load factor	
x horse power	
=reduced NOx emission factor (g/hr)	
<b>Option B. Reduced-emission technology certified/verified to achieve a percentage reduction from the baseline.</b>	
baseline NOx emission factor (g/hr)	
x certified/verified percentage NOx emission reduction from baseline	
= reduced NOx emission factor (g/hr)	

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

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

**Step 3: What is the activity cost per ton?**

Grant activity amount (\$):	
NOx emission reductions (tons):	
= cost per ton (\$/ton)	

## Worksheet NR-2 Annual Fuel Use

Please fill in the following information. This information will help you with your calculations.  
Also, a link is available at [www.nctcog.org/NTERG](http://www.nctcog.org/NTERG) to an online calculator to assist you.

### Base Information

Type of project	
<input type="checkbox"/> New Purchase/Lease <input type="checkbox"/> Repower <input type="checkbox"/> Replacement <input type="checkbox"/> Retrofit/Add-on	
What is the activity life, in years? (See table 2.3)	
What is the percent time the equipment will operate in the eligible counties?	
What is the requested grant amount for the activity?	

### Baseline Engine Information

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

### Reduced Emission Engine Information

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

**Instructions for Determining Annual Fuel Consumption**

1. In most cases, it would be appropriate to use historical records to determine the annual fuel use estimates.
  - However, for all but *Replacement* projects, if you expect to use the reduced-emission engine more than the baseline engine, then the fuel use estimates for both the baseline and reduced-emission engine should be based on the expected future usage level (i.e., amount of work performed).
  - For *Replacement* projects, the emission reductions must be based on the lesser of either the average annual usage level over the previous 24 months (12 months for Small Business Grants) or the expected future annual usage.
2. If the fuel use characteristics of the baseline and reduced-emission engine are similar, then the annual fuel use estimated for both the baseline and the reduced-emission engine may be the same.
3. In some cases, the reduced-emission engine may be more (or less) fuel-efficient than the old (baseline) engine. In that case, you will need to determine the difference in the fuel use characteristics between the engines, so that you can accurately estimate the annual fuel use for the reduced-emission engine. Again, the annual fuel use for both the baseline and reduced-emission engine should be based on the same annual usage level (i.e., the same amount of work performed), and for Replacement projects, it must also be based on the lesser of either the previous 24 months of use or the expected future use.

**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 for El Paso County)**

Non Road TxLED Correction Factor 1 - (0.07)	<b>0.93</b>
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**Part B. Determine the NOx Emission Factor**

<b>Determine Baseline NOx Emission Factor (g/year)</b>	
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	
= baseline NOx emission factor (g/yr)	
<b>Determine Reduced NOx Emission Factor (g/year)</b>	
<b>Option A. Reduced-emission engine certified to a specific emissions standard (g/bhp-hr)</b>	
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	
= reduced NOx emission factor (g/yr)	
<b>Option B. Reduced-emission technology certified/verified to achieve a percentage reduction from the baseline.</b>	
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 grams per ton	
= estimated annual NOx emission reduction (tons/yr)	
x activity life (years)	
= estimated activity life NOx emission reduction (tons)	

**Step 3: What is the activity cost per ton?**

requested grant amount activity (\$):	
NOx emissions reductions (tons):	
= cost per ton (\$/ton)	