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

## Technical Supplement No. 2
## Non-Road Equipment

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**Texas Commission on Environmental Quality (TCEQ)**
**Air Quality Division**
**Implementation Grants Section, MC-204**
**P.O. Box 13087**
**Austin, Texas 78711-3087**
**1-800-919-TERP (8377)**

**www.terpgrants.org**

## Technical Supplement No. 2

## 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 purchases and leases, replacement, repowers, and retrofits/add-ons. Most of the non-road 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 equipment contact TCEQ for eligibility.**

Use the NR-1 worksheet provided at the end of this supplement to calculate the emission reductions and the cost-effectiveness based on annual hours of operation of the activities proposed for your project. You may also go to www.terpgrants.org and download the Microsoft Office non-road equipment (hours) calculator found under Supplemental Activity Application Forms.

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.

***Note – The TCEQ has changed its method of calculating emissions reductions for non-road equipment replacement and repower projects. Unless otherwise specified by the TCEQ, the TCEQ will use a horsepower for the new equipment/engine that is 110% of the old equipment/engine horsepower, regardless of the horsepower listed in the application for the new equipment. Applicants should still list the actual maximum rated brake horsepower for both the old and the new engines in the application, but the TCEQ will calculate the emissions reductions under this new approach.***

**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 $NO_X$ emissions when compared to a baseline emission rate according to the general formula:

*Percent Baseline $NO_X$ Emission Rate Reduction =*
*[(Baseline Emission Rate - Reduced Emission Rate) / Baseline Emission Rate] x 100%*

Use Worksheet NR-1 hour calculator 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 non-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 $NO_X$ emission rate will normally be the federal $NO_X$ emission standard for the model year and horsepower of the baseline (old) engine. The federal $NO_X$ emission standards for non-road equipment are presented in Table 2.1. 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 $NO_X$ + 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 standards.

**TABLE 2.1 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 (19 kW but less than 50hp (37kW) | Tier 0 (uncontrolled) | pre-1999 | 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 | 3.5 |

| | Tier | Model Year | Emissions ($NO_X$) g/bhp-hr | Emissions ($NO_X$ + NMHC) g/bhp-hr |
|---|---|---|---|---|
| Equal to or greater than 50 hp (37 kW) but less than 75 hp (56 kW) | 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 |

| | Tier | Model Year | Emissions ($NO_X$) g/bhp-hr | Emissions ($NO_X$ + NMHC) g/bhp-hr |
|---|---|---|---|---|
| Equal to or greater than 75 hp (56 kW) but less than 100 hp (75 kW) | 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 | 0.30-3.325[1] | N/A |
| | Tier 4 | 2014+ | 0.30 | N/A |

| | Tier | Model Year | Emissions ($NO_X$) g/bhp-hr | Emissions ($NO_X$ + NMHC) g/bhp-hr |
|---|---|---|---|---|
| Equal to or greater than 100 hp (75 kW) but less than 175 hp (130 kW) | 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 | 0.30-2.85[1] | N/A |
| | Tier 4 | 2014+ | 0.30 | N/A |

| | Tier | Model Year | Emissions ($NO_X$) g/bhp-hr | Emissions ($NO_X$ + NMHC) g/bhp-hr |
|---|---|---|---|---|
| Equal to or greater than 175 hp (130 kW) but less than 300 hp (225 kW) | 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 | 0.30-2.85[1] | N/A |
| | Tier 4 | 2014+ | 0.30 | N/A |

| | Tier | Model Year | Emissions ($NO_X$) g/bhp-hr | Emissions ($NO_X$ + NMHC) g/bhp-hr |
|---|---|---|---|---|
| Equal to or greater than 300 hp (225 kW) but less than 600 hp (450 kW) | 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 | 0.30-2.85[1] | N/A |
| | Tier 4 | 2014+ | 0.30 | N/A |

| | Tier | Model Year | Emissions ($NO_X$) g/bhp-hr | Emissions ($NO_X$ + NMHC) g/bhp-hr |
|---|---|---|---|---|
| Equal to or greater than 600 hp (450 kW) but less than 750 hp (560 kW) | 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 | 0.30-2.85[1] | N/A |
| | Tier 4 | 2014+ | 0.30 | N/A |

| | Tier | Model Year | Emissions ($NO_X$) g/bhp-hr | Emissions ($NO_X$ + NMHC) g/bhp-hr |
|---|---|---|---|---|
| Equal to or greater than 750 hp (560 kW) | 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 to over 1200 hp.
3. Applies to all gensets

Reduced $NO_X$ Emission Rate

The reduced $NO_X$ emission rate will normally be the federal $NO_X$ emission standard for the engine model year or a certified emission rate. Certified means certified by the EPA or CARB, or otherwise accepted by the TCEQ. Table 2.1 lists the federal $NO_X$ emission standards by engine model year and by engine horsepower.

- **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 TCEQ.
- **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 TCEQ.
- **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 TCEQ. For a system to convert an existing heavy-duty non-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.

**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 $NO_X$ emissions:** 2.85 g/bhp-hr

**Calculation of baseline emission rate reduction:**
[(4.655 g/bhp-hr - 2.85 g/bhp-hr) / 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) / 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 g/bhp-hr - 6.9 g/bhp-hr) / 9.1 g/bhp-hr] x 100 % = 24.18% baseline emission rate reduction

***Note:*** *This project does <u>not</u> 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 $NO_X$ emissions.

**Engine emission standard without retrofit:** 9.5 g/bhp-hr
**Retrofitted engine certified $NO_X$ emissions:** 5.6 g/bhp-hr

**Calculation of baseline emission rate reduction:**
[(9.5 g/bhp-hr - 5.6 g/bhp-hr) / 9.5 g/bhp-hr] x 100 % = 41.05% baseline emission rate reduction

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

**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 NR-1 for calculations where usage is based in hours of operation.
- Emission reduction represents the difference in the emission level of a baseline (old) 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 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 $NO_X$ 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 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 $NO_X$ 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 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.

Usage based on hours of operation (NR-1)

For calculations based on annual hours of operations (NR-1), the $NO_X$ emission factor will be in grams per hour (g/hr). If given in g/bhp-hr, the engine $NO_X$ emission standard is converted to a $NO_X$ emission factor expressed in g/hr by multiplying it by the engine horsepower (hp). This conversion must be applied to the $NO_X$ emission standard for the baseline engine and for the reduced emission engine.

**Note, for the reduced emission engine a default horsepower value equal to 110% of the baseline engine horsepower is used for the conversion rather than the rated maximum brake horsepower of the new engine.**

An example calculation is provided below the following table.

A default load factor must also be included in the calculation to account for the fraction of available engine's power actually used. Table 2.2 provides load factors by type of equipment and engine horsepower.

**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 |

| SCC Definition | HPMIN | HPMAX | Load Factor | ECF (gal/hp-hr) |
|---|---|---|---|---|
| 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 |
| 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 |

| SCC Definition | HPMIN | HPMAX | Load Factor | ECF (gal/hp-hr) |
|---|---|---|---|---|
| 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 |
| 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 |

| SCC Definition | HPMIN | HPMAX | Load Factor | ECF (gal/hp-hr) |
|---|---|---|---|---|
| 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/Skidders | 25 | 100 | 0.59 | 17.2 |
| Diesel Logging Equip Fell/Bunch/Skidders | 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 $NO_x$ emission factor based on annual hours**

**Activity:** Replacement of a 1988 500-hp diesel crawler tractor with a new 2002 model. Replacement engine horsepower of 550 hp (500 x 1.10 = 550 hp) is used in the calculation.

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
**TxLED Correction factor**: 0.93

TxLED and Baseline $NO_X$ Emission Factor (g/hr)
9.5 g/bhp-hr x 0.93 = 8.835 g/bhp-hr
8.835 g/bhp-hr x 0.59 = 5.2126 g/bhp-hr
5.2126 g/bhp-hr x 500 hp = **2,606.3 g/hr**

Reduced $NO_X$ Emission Factor (g/hr)
4.56 g/bhp-hr x 0.93 = 4.2408 g/bhp-hr
4.2408 g/bhp-hr x 0.59 = 2.502 g/bhp-hr
2.502 g/bhp-hr x **550 hp** = **1,376.1 g/hr**

Part C. Calculate the $NO_X$ 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.

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 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, 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 the use to the TCEQ.

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 five years, including leases.

**TABLE 2.3 MAXIMUM GRANT ACTIVITY LIFE NON-ROAD EQUIPMENT ACTIVITIES**

| | **Minimum** | **Maximum *** |
|---|---|---|
| New | 5 years | 10 years |
| Replacement | 5 years | 7 years |
| Repowers | 5 years | 7 years |
| Retrofit/Add-on (maximum life for dual-fuel conversions is 7 years) | 5 years | 10 years (7 years for dual-fuel conversions) |

*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 types of vehicles by the applicant.

**Example calculation for determining $NO_X$ 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 $NO_X$ emission factor: 2,606.3 g/hr
Reduced $NO_X$ emission factor: 1,376.1 g/hr
Annual hours of operation: 399 hr/yr
Percent time in affected counties: 100 %

2,603.3 g/hr - 1,376.1 g/hr = 1,230.2 g/hr
1,230.2 g/hr x 399 hr/yr = 490,850 g/yr
490,850 g/yr / 907,200 g/ton = **0.5411 ton/yr**

**Step 3: Calculate the Cost Per Ton**

The cost per ton for an activity is 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 NR-1**

**Annual Hours of Operation**

Please fill in the following information. This information will help you with your calculations.
An interactive version of this calculator is available on the TCEQ website at www.terpgrants.org.

**Activity Information**

| Type of activity | | | |
|---|---|---|---|
| ☐ New Purchase/Lease | ☐ Repower | ☐ Replacement | ☐ Retrofit/Add-on |

| | |
|---|---|
| What is the activity life in years? (yr) | |
| What are/how many hours of annual operation for this piece of equipment? (hp) | |
| 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) | |
| Emissions Standard (g/bhp-hr) | |
| Load Factor | |

**Reduced Emission Engine Information**

| | |
|---|---|
| Model Year | |
| Fuel Type | |
| Equipment Type | |
| Horsepower (hp) **<u>Use 110% of the baseline hp for this number</u>** | |
| 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 | 100 (%) |
| = Emission Rate Reduction | |

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

**STEP 2: WHAT ARE YOUR $NO_X$ EMISSION REDUCTIONS?**

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

| | |
|---|---|
| Non Road TxLED Correction Factor *1 - (0.07)* | 0.93 |

**PART B. DETERMINE THE $NO_X$ EMISSION FACTOR**

| **Determine Baseline NOX Emission Factor (g/hr)** | |
|---|---|
| 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 horsepower (hp) | |
| = baseline $NO_X$ emission factor (g/hr) | |
| **Determine Reduced NOX Emission Factor (g/hr)** | |
| **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 110% of baseline engine horsepower (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 [1- 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 | |
| x percent within affected counties (%) | |
| = grams per year reduced (g/yr) | |
| / 907,200 (g/ton) | |
| = estimated annual $NO_X$ emission reduction (tons/yr) | |
| x grant activity life (years) | |
| = 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) | |