

## Appendix 3

### Marine Vessels

This appendix outlines the criteria for project eligibility and gives the methods for calculating the reductions in NO<sub>x</sub> emissions for a marine-vessel project. Most of the calculations will require input of an NO<sub>x</sub> emissions factor applicable to the engine. The emissions standards and factors applicable to this program are included in a technical supplement, which will be made available in conjunction with these guidelines at the TERP website, <[www.terpgrants.org](http://www.terpgrants.org)>. Examples of the calculations will also be available in the supplement, along with other materials prepared by the TCEQ. Potential grant applicants may also contact the TCEQ for hard copies of the supplement and for answers to questions about the applicable emissions standards and factors.

In accordance with Texas Health and Safety Code 386.104(j) and TERP program rules, 30 TAC 114.622(g), the executive director or his or her designee has the authority to waive certain eligibility requirements, based on a finding of good cause. Situations where good cause may be determined and a waiver granted are explained in the discussion of eligibility requirements in this appendix.

The executive director may identify other eligibility criteria for which a waiver may be considered, based on a finding of good cause and subject to the statutory and regulatory requirements. Waiver options will be explained in the grant-application materials.

In determining good cause and deciding whether to grant a waiver, the executive director will ensure that the emissions reductions attributable to the project will still be valid and, where applicable, meet the conditions for assignment for credit to the State Implementation Plan.

### Eligible Activities and Costs

The activities and eligible costs under each project category are explained in this section. The TCEQ may further limit the types of eligible activities, and may more narrowly define eligibility requirements, during a particular funding period, as needed to best achieve the goals of the TERP.

The types of vessels that may be eligible for funding are diverse, and may include both oceangoing vessels and harbor craft. However, to be eligible for funding, at least 75% of a vessel's annual use must occur in the bays adjacent to an eligible county or in the Texas Intracoastal Waterway. Therefore, there will probably be few projects involving large oceangoing vessels.

The TCEQ may also consider, case by case, vessels that operate in coastal or international waters, where it can be definitively shown that the emissions from those vessels are included by the TCEQ in the inventory of emissions for an eligible county or area made up of eligible counties. This decision will be solely at the discretion of the TCEQ. It is recommended that potential applicants contact the TCEQ to discuss this type of project before submitting an application.

In addition, many marine vessels will have one or more propulsion engines, as well as one or more auxiliary engines. In most cases, for lease or purchase and replacement projects, the combined NO<sub>x</sub> emissions for both the propulsion and the auxiliary engine will be used to determine the reductions in NO<sub>x</sub> emissions for the project. For engine repower, retrofit, and add-on projects, the NO<sub>x</sub> emissions reductions will be based on the individual engines being replaced or retrofitted.

This section explains the eligible activities and costs under each project category. The TCEQ may further limit the types of eligible activities, and may more narrowly define eligibility requirements under a particular funding round, or by geographic area, as needed to best achieve the objectives of the TERP. Administrative costs, in-house labor costs, and travel costs are not eligible expenses.

### ***Purchase or Lease of Marine Vessels***

This category is for the purchase or lease of new marine vessels. The cost may also include the purchase and installation of a global positioning system, subject to approval by the TCEQ. For this category, the TCEQ does not consider whether the applicant is replacing an existing piece of equipment; the baseline for comparison of emissions is the current NO<sub>x</sub> standard for a marine engine of that horsepower and use. The baseline vessel used for determining the difference in cost must be **new**.

To be eligible for funding, the engine on the new piece of equipment must be certified to emit at least 25% less NO<sub>x</sub> than required (in other words, no more than 75% as much NO<sub>x</sub> as is allowable) under the current standard for that engine.

A *lease* is defined as the use and control of a new marine vessel in accordance with a lease contract for a period of five or more years. The TCEQ will reimburse the incremental costs of the lease—costs above those that would otherwise have been incurred for the lease of a baseline vessel.

The TCEQ will reimburse the incremental cost of the purchase of a new marine vessel subject to cost-effectiveness limits established by the TCEQ. The incremental cost is the difference between the documented dealer price of a baseline vessel or other appropriate baseline cost established by the TCEQ and the actual cost of the cleaner vessel.

## ***Replacement of Marine Vessels***

This category is for the replacement of marine vessels with a new or newer marine vessel. For this category, the applicant must be replacing a vessel with a minimum of five years of remaining useful life. The TCEQ may establish longer activity-life requirements for any grant period. The baseline for comparison of emissions is the difference between the emissions standard (or in some cases, the certified emissions level) for the engine or engines on the vessel being replaced, and the certified emissions level of the engine or engines installed on the vessel being purchased.

For a replacement project, the TCEQ will evaluate whether the vessel being replaced would have otherwise been used in the bays adjacent to the eligible counties or in the Texas portion of the Gulf Intracoastal Waterway for the period within which the emissions reductions will be claimed. Standards that apply include **all** of the following:

1. The owner must have owned the vessel continuously for at least the two years immediately preceding the grant-application date.
2. Unless otherwise approved by the TCEQ, the vessel must have been continuously located and used in Texas over the preceding two years.
3. The vessel must currently be registered for operation in Texas in the applicant's name.
4. The vessel must be in good operating condition and capable of performing its primary function.

The TCEQ may waive the two-year ownership requirement, case by case, where the ownership of the company has changed, the assets of the company have been purchased by another company, or the company has changed its name or incorporation status. The use of the vessels being replaced must not have changed.

The TCEQ may waive the requirement for two years of continuous use for short lapses in operation attributable to economic conditions, seasonal work, or other circumstances, based on a finding of good cause. The historical usage described by the applicant on the grant-application forms must reflect the lapses in use of the vessel in those activities.

In order for a replacement activity to result in creditable emissions reductions, the applicant must intend to continue to use the marine vessel being replaced for the same type of use and amount of use over the same period as the activity life, absent the award of a grant. The TCEQ may require additional assurances, certifications, and documentation to verify that the applicant would continue to use the marine vessel being replaced if the grant is not awarded.

For replacement projects, the emissions reductions are based on replacement of the future use of the original vehicle or equipment with the use of the reduced-emission vehicle or equipment. The estimated future use of the original vehicle or equipment is determined from the recent historical use. Except when a default usage amount is

used for the emissions-reduction calculations, the activity level used for those calculations and the corresponding usage commitment for a replacement project may not exceed the average annual use of the vehicle or equipment being replaced for the two years preceding the application.

The combined NO<sub>x</sub> emissions of the engines on the replacement vessel must be certified to be at least 25% less than (that is, no more than 75% as much as) the combined NO<sub>x</sub> emissions of the engines on the vessel being replaced, based on the emissions standard for those engines. "Certification" means approval by the EPA or the California Air Resources Board (CARB), or acceptance on other grounds by the TCEQ.

The replacement vessel must be of the same type and should be intended for use in the same application or vocation (for example, tug, fireboat, pusher) as the vessel being replaced. The TCEQ may accept, based on the particular case, a vessel of a different type to account for the latest technology used for a specific vocation. In addition, the TCEQ may accept, case by case, the replacement of a multi-engine vessel with a single-engine vessel, or vice versa, as long as the new vessel will have the same use as the vessel being replaced and the emissions reductions can be adequately determined.

The year of manufacture of the engine installed on the replacement vessel may not be more than three years prior to the current calendar year, unless an alternative age limit is established by the TCEQ for a particular grant round. The TCEQ may also waive the age-limit requirements, case by case, where the vessel has a unique or specialized use and where a model with a recently manufactured engine is not available.

The grant recipient may be eligible for reimbursement of up to 80% of the eligible costs for the purchase or lease of the replacement vessel subject to cost-effectiveness limits established by the TCEQ. The TCEQ may further limit the incentive amount to a lower percentage of eligible costs as needed to best achieve the goals of the TERP.

Costs may include the invoice price, including taxes and delivery charges included in the price of the replacement vessel, or the cash basis for the lease charges. The cost may also include the purchase and installation of a global positioning system, subject to approval by the TCEQ. Delivery charges from a third party, not included in the invoice price from the vehicle or equipment vendor, may be included, subject to approval by the TCEQ.

The total incentive amount must not exceed 80% of the cost of the replacement vessel minus the scrappage value received for the old vessel. The TCEQ may establish a default scrappage value.

## ***Repower of Marine Vessels***

This category is for the replacement of an existing engine on a marine vessel with a new, rebuilt, or remanufactured engine, or one or more electric motors, drives, or fuel cells. The upgrade of an engine with an emissions-upgrade kit certified by the EPA or CARB may also be considered under the repower category. The replacement, rebuilt, or remanufactured engine must be certified to emit at least 25% less NO<sub>x</sub> (in other words, no more than 75% as much NO<sub>x</sub>) compared with the engine being replaced, or the engine before rebuilding or remanufacture, based on the standard for that engine. “Certification” means approval by the EPA or the CARB, or acceptance on other grounds by the TCEQ.

Eligible rebuilt or remanufactured engines must use only components from the original engine manufacturer only and be purchased from the OEM or its authorized dealers and distributors. However, the TCEQ may accept engines from suppliers not connected with the OEM, subject to a case-by-case determination.

The grant recipient may be eligible for reimbursement of up to 80% of the incremental cost of the repower subject to cost-effectiveness limits established by the TCEQ. The TCEQ may further limit the incentive amount to a lower percentage of the eligible costs as needed to best achieve the goals of the TERP.

The incremental cost for an engine replacement is the cost to purchase and install the replacement engine and associated equipment minus the scrappage value received for the old engine, if applicable. The TCEQ may establish a default scrappage value. The TCEQ may further limit the incentive amount to a lower percentage of the eligible costs as needed to best achieve the goals of the TERP.

For engine conversions and emissions-upgrade kits certified by the EPA or CARB, the incremental cost is the cost to purchase and install the conversion system or kit, including the new fuel system, if applicable. Other upgrades or modifications to the engine or vehicle that are not necessary for the conversion or upgrade of the engine are not eligible.

Expenses for salaries, travel, and overhead, including indirect costs, will not be covered. Costs that may be reimbursed, subject to approval by the TCEQ, include:

- the invoice cost of the new engine, including sales tax and delivery charges;
- the invoice cost of additional equipment that must be installed with the new engine;
- associated supplies directly related to the installation of the engine;
- costs to remove and dispose of the old engine, if applicable;
- installation costs;
- reengineering costs, if the vessel must be modified for the new engine to fit; and
- other costs directly related to the project, including the purchase and installation of a global positioning system.

## ***Retrofit or Add-on of Emissions-Reduction Technology***

This category is for the retrofit of an existing engine on a marine vessel, or for adding devices onto the vessel. To be eligible for funding, the retrofit or add-on systems must be verified to cause the engine to emit at least 25% less NO<sub>x</sub> (that is, no more than 75% as much NO<sub>x</sub>) compared with emissions prior to the retrofit or add-on. Certification means approval by the EPA or the CARB, or acceptance on other grounds by the TCEQ.

The TCEQ will reimburse the incremental cost of the purchase and installation of the retrofit or add-on technology subject to cost-effectiveness limits established by the TCEQ. If the engine is to be rebuilt to install the emissions-reduction devices, the incremental cost is the difference between the cost of rebuilding the existing engine and the cost of rebuilding the engine to include the retrofit or add-on technology. If the engine does not need to be rebuilt, then the incremental cost will be the full cost of purchasing and installing the technology. The TCEQ may further limit the incentive amount to a lower percentage of the eligible costs as needed to best achieve the goals of the TERP.

Expenses for salaries, travel, and overhead, including indirect costs, will not be covered. Costs that may be reimbursed, subject to approval by the TCEQ, include:

- the invoice cost of the retrofit kit or add-on devices, including sales tax and delivery charges;
- the cost of associated supplies directly related to the installation of the devices;
- installation costs;
- reengineering costs, if the marine vessel must be modified for the retrofit or add-on devices to be installed and used; and
- other costs directly related to the project, including the purchase and installation of a global positioning system.

## **Project Criteria**

In addition to the eligibility criteria previously presented, the following list applies to projects involving marine vessels. The TCEQ may impose additional criteria, and may more narrowly define the criteria established in this guide, under a particular funding round, or by geographic area, as needed to best achieve the goals of the TERP.

- One or more eligible **activities** of the same project type (i.e., on-road, non-road, locomotive, etc.) and that will occur in the same primary area may be included under one project application.
- The applicant must own the vessel being replaced, repowered, or retrofitted.
- Marine vessels used primarily for competition or recreation are not eligible for funding.

- Marine-vessel activities must reduce emissions of NO<sub>x</sub> by at least 25% compared to baseline NO<sub>x</sub> emissions. The NO<sub>x</sub> emissions of engines and retrofit or add-on devices used to achieve the emissions reductions must be certified or verified by the EPA or the CARB, or accepted on other grounds by the TCEQ. Where the model year of the marine vessel and the model year of the existing engine are different—such as in a vessel that has already had its engine replaced with a newer engine—the model year of the engine must be used to determine the baseline emissions standard for emissions-reduction calculations. The application of the 25% reduction criteria for each type of activity is explained below.

**Purchases and leases** are allowed based on what year the purchase or lease is completed. At a minimum, the combined NO<sub>x</sub> emissions of the vessel being purchased or leased must be certified to be at least 25% less than the NO<sub>x</sub> emissions would have been if the engine or engines only met the minimum standard.

**Replacements.** The combined certified NO<sub>x</sub> emissions of the replacement marine vessel must be at least 25% less than the combined NO<sub>x</sub> emissions of the vessel being replaced, based on the emissions standards for those engines.

**Repowers.** The replacement engine must be certified to emit at least 25% less NO<sub>x</sub> than the engine being replaced, based on the federal standard for that engine.

**Retrofits and add-ons.** Emissions standards for retrofit and add-on activities are based on the engine being retrofitted. If an applicant wants to retrofit or add on a device, the technology must be verified to emit at least 25% less NO<sub>x</sub> than the standard for the engine being retrofitted.

**Combined technologies.** Where two technologies (for example, repower plus retrofit) are combined on the same vessel or engine, the TCEQ may consider the combined reductions from the two technologies in meeting the 25% requirements. This decision will be solely at the discretion of the TCEQ, and will be based on a determination that the combination of the two technologies will permanently reduce emissions by at least 25%.

- The cost-effectiveness of a project, other than a demonstration project, may not exceed any limits established by the TCEQ on the cost per ton of NO<sub>x</sub> emissions reduced in the eligible counties for which the project is proposed.
- An activity is not eligible if it is required by any state or federal law, rule, regulation, memorandum of agreement, or other legally binding document. However, this restriction does not apply to an otherwise qualified activity—regardless of the State Implementation Plan’s assumption that the change in equipment, vehicles, or operations will occur—if, on the date the grant is awarded, the change is not yet required by any state or federal law, rule, regulation, memorandum of agreement, or other legally binding document. This restriction also does not apply to a purchase of vehicles or equipment that is required only by local law or regulation or by controlling-board policy of a public or private entity.

Projects used to demonstrate a technology that may be used to comply with an emissions-reduction requirement may be funded, as long as the reductions directly attributable to the project are not used to comply with that requirement.

- Activities for the repower or retrofit of an existing engine that must meet a more stringent emissions standard under state or federal regulations at the time of engine replacement, overhaul, or remanufacture may also be eligible if the requirement does not include a deadline or specific time period for the upgrade. The more stringent standard will be used as the baseline emissions rate in the calculation to determine the emissions reductions and the determination that the activity will reduce NO<sub>x</sub> at least 25%.
- In the areas of the state where Texas Low Emission Diesel (TxLED) is required, the baseline and reduced emissions-rate calculations for diesel engine usage after September 2005 must be adjusted using a correction factor, in addition to any other calculation adjustments.
- An activity involving a new emissions-reduction measure that would otherwise generate marketable credits under state or federal emissions-reduction-credit averaging, banking, or trading programs is not eligible for funding under this program unless:
  - the activity includes the transfer of the reductions that would otherwise be marketable credits to the State Implementation Plan or the owner or operator as provided under Texas Health and Safety Code 386.056; and
  - the reductions are permanently retired.
- The incremental cost of the proposed activity must be reduced by the value of any existing financial incentive that directly reduces its cost, including tax credits or deductions, other grants, or any other public financial assistance.
- For repower activities, eligible rebuilt or remanufactured engines must use only components from the original engine manufacturer and be purchased from the OEM or its authorized dealers and distributors. However, the TCEQ may accept engines from suppliers not connected with the OEM, subject to a case-by-case determination.
- For all activities, the activity life must be a minimum of five years. The TCEQ may establish longer activity-life requirements for each grant period. Not less than 75% of the annual use of the marine vessel must take place in the Texas portion of the Gulf Intracoastal Waterway or in bays adjacent to an eligible county throughout the life of the project. Leases that do not include a binding commitment to purchase must be for the length of the activity life.
- For most marine vessels, annual use must be measured using hours of operation. For vessels with no viable mechanism for measuring the hours of operation, fuel consumption normally should be chosen as the usage factor.
- Applicants should refer to the technical supplement to these guidelines for the maximum acceptable life established by the TCEQ for each type of activity.

### Figure A3.1 Correction Factor for TxLED

The TCEQ adopted rules (30 TAC 114.312–19) requiring that diesel fuel sold or supplied for use in compression-ignition engines in certain counties in Texas must meet low-emission-diesel standards.

The counties affected by the TxLED requirements currently include all those eligible for TERP incentive funding, as listed in Table 3.1, except for El Paso County.

The requirements set a maximum for content of aromatic hydrocarbons of 10% by volume. The requirements also set a minimum cetane number for TxLED of 48.

The TxLED requirements are intended to result in reductions in NO<sub>x</sub> emissions from diesel engines. Currently, reduction factors of **5.7%** (0.057) for on-road use and **7.0%** (0.07) for non-road use have been accepted as estimates for use of TxLED. However, these estimates are subject to change, based on the standards accepted by the EPA for use in the Texas State Implementation Plan. The TCEQ will identify the appropriate reduction factors to use in the technical supplement prepared to support these guidelines.

For activities in the applicable counties, a correction factor will need to be applied when calculating the baseline or reduced emissions for diesel engines.

**On-road:**

$$\text{TxLED correction factor} = 1 - 0.057 = \mathbf{0.943}$$

**Non-road:**

$$\text{TxLED correction factor} = 1 - 0.070 = \mathbf{0.93}$$

- Applicants must agree to monitor the use of grant-funded vehicles, equipment, infrastructure, and fuel, and to report to the TCEQ for the life of each grant-funded activity.
- Applicants must also agree to notify the TCEQ of any changes during the life of the following activities: termination of use; change in use, sale, transfer, or accidental or intentional destruction of grant-funded vehicles or equipment; or change in use of the qualifying fuel.
- Administrative costs and other internal costs of the grant recipient—including but not limited to personnel expenses, internal salaries, indirect costs, and travel—are not eligible. This restriction also applies to situations when the grant recipient delivers the grant-funded vehicle or equipment before or after accepting it.
- Consultant fees for the preparation of a grant application, either directly or as an addition to the cost basis of the grant-funded vehicle, equipment, or engine, are not eligible.
- Fees for a third-party consultant hired by the grant recipient to manage and administer the grant-funded activities, including coordination of the work and submission of reports and paperwork to the TCEQ for the grant recipient, are not eligible. This restriction is not intended to limit the ability of the vehicle or equipment supplier or installer to include reasonable and necessary costs for managing the work to be performed in the price of the vehicle, equipment, or installation. The costs for professional services, including engineering and

technical work, required for completion of the activity may be included, subject to the restrictions pertaining to that type of project. Per the Uniform Grant Management Standards, the “cost plus a percentage of cost” method of contracting for professional services must not be used.

- The TCEQ may impose additional criteria for certain projects and funding periods, consistent with these guidelines.

## NO<sub>x</sub> Emissions Factors

The EPA has adopted exhaust emissions standards for marine diesel engines. These standards apply to the following:

- **Marine diesel engines with displacement at or above 30 liters per cylinder.** These engines are also known as Category 3 marine diesel engines. They range from about 2,500 to 70,000 kilowatts (3,000 to 100,000 hp). These are very large marine diesel engines used for propulsion power on oceangoing vessels such as container ships, oil tankers, bulk carriers, and cruise ships.
- **Marine diesel engines with displacement ranging from 2.5 liters per cylinder to below 30 liters per cylinder.** These engines are also known as Category 1 and Category 2 marine diesel engines. They range in power from about 500 to 8,000 kilowatts (700 to 11,000 hp). These engines are used to propel many kinds of vessels, including tugboats, push boats, supply vessels, fishing vessels, and other commercial vessels in and around U.S. ports. They are also used as stand-alone generators for auxiliary power on many types of vessels.

For purposes of this program, the EPA standards for marine engines are to be used for propulsion engines, where applicable. These standards are included in the technical supplement to these guidelines. To determine the emissions level for an engine manufactured before the EPA standards applied to that engine, the TCEQ will work with the applicant to determine the most appropriate level, based on information supplied by the manufacturer and from other sources.

For new leases and purchases, where the vessel’s NO<sub>x</sub> emissions must be at least 25% less than the current minimum standards, and where the EPA standards do not yet apply to the engines installed on the vessel, the TCEQ will work with the applicant to determine whether the engines meet the requirements for this program.

In most cases, the EPA standards for non-road engines will be used for determining the emissions of auxiliary engines on marine vessels.

For activities involving oceangoing vessels, the TCEQ will work with the applicant to determine the appropriate standards to use, case by case.

## Calculating Reductions in NO<sub>x</sub> Emissions

In general, the emissions-reduction benefit represents the difference in the emissions level of a baseline engine and a reduced-emissions engine. In situations where the model year of the marine vessel and the model year of the current engine are

different, the model year of the engine must be used to determine the baseline emissions for benefit calculations.

The emissions level is calculated by multiplying an emissions factor and an activity level. Because conversion factors and the activity levels may be expressed in different units for the existing and replacement engines, the emissions levels for the baseline and reduced-emissions engines should be calculated separately, and then differences taken to determine emissions reductions.

Emissions factors are generally expressed in terms of grams per brake horsepower-hour (g/bhp-hr), grams per mile (g/mi), or grams per gallon (g/gal). Conversion factors are generally expressed in units of brake horsepower-hour per mile (bhp-hr/mi) or horsepower-hour per gallon (hp-hr/gal).

For most marine applications, the activity level should be established by the annual hours of operation. For engines without an hour meter installed, and no other mechanism to track hours of operation, the activity level should be determined from annual fuel consumption. Emissions-reduction calculations should be consistent with the type of records maintained over the life of each activity.

### ***Calculation of NO<sub>x</sub>-Emissions Reductions Based on Annual Hours of Operation***

The calculation of emissions and emissions reductions using annual hours of operation as the usage factor is determined by the steps shown in Table A3.1.

Appropriate baseline NO<sub>x</sub> emissions factors are included in a technical supplement available from the TCEQ. Use the emissions factors associated with engine horsepower and model year. Potential grant applicants should consult with the TCEQ to ensure they use the appropriate factors.

For retrofit and add-on activities, and other activities where the emissions reductions are based on a percentage reduction from the baseline, the verified percentage-reduction factor can be applied to the baseline emissions factor to determine the reduced NO<sub>x</sub> emissions factor.

Alternatively, for activities where the emissions of the new or replacement engine are certified at a specific emissions level (g/bhp-hr), such as purchases or repowers, that emissions level should be used as the emissions factor.

**Table A3.1**  
**Calculating Reductions in NO<sub>x</sub> Emissions Based on Annual Hours of Operation**

#### ***Applying the TxLED Correction Factor***

The counties affected by the TxLED requirements currently include all those eligible for TERP incentive funding, as listed in Table 3.1, except for El Paso County.	
TxLED correction factor for non-road: <i>1 - 0.07</i>	0.93

**Step 1. Determine the Reduced NO<sub>x</sub> Emissions Factor**

<b>Option A. Reduced-emissions technology verified to achieve a percentage reduction from the baseline</b>	
Baseline NO <sub>x</sub> emissions factor (g/bhp-hr)	
× verified percentage reduction from baseline	
= reduced NO <sub>x</sub> emissions factor (g/bhp-hr)	
<b>Option B. Reduced-emissions engine certified to a specific emissions standard (g/bhp-hr)</b>	
Certified NO <sub>x</sub> emissions (g/bhp-hr)	

**Step 2. Calculate the NO<sub>x</sub>-Emissions Reduction**

Baseline		Reduced Emissions	
NO <sub>x</sub> emissions factor (g/bhp-hr)		NO <sub>x</sub> emissions factor (g/bhp-hr)	
× TxLED correction factor <i>(diesel engines only)</i>		× TxLED correction factor <i>(diesel engines only)</i>	
= corrected NO <sub>x</sub> emissions factor (g/bhp-hr)		= corrected NO <sub>x</sub> emissions factor (g/bhp-hr)	
× horsepower		× horsepower	
= g/hr		= g/hr	
Baseline g/hr - reduced emissions g/hr =			
× annual hours of operation			
× percent within eligible counties (%)			
= g/year			
		÷ 907,200 grams per ton	
= estimated annual NO <sub>x</sub> -emissions reduction (tons/yr)			
× activity life (years)			
= estimated activity-life NO <sub>x</sub> emissions reduction (tons)			

## Calculation of NO<sub>x</sub>-Emissions Reductions Based on Annual Fuel Use

If annual fuel consumption is the basis for the emissions reductions, an energy-consumption factor is used to convert g/bhp-hr to g/gal of fuel used. There are two ways of calculating an engine-specific energy-consumption factor:

1. divide the hp of the engine by the fuel economy in gal/hr; or
2. divide the density of the fuel by the brake-specific fuel consumption of the engine.

While actual fuel receipts or other documentation may support the annual fuel consumption for an engine being replaced, repowered, or retrofitted, the annual fuel consumption of the new vehicle or engine is an estimate, proportional to the change in the energy-consumption factor. Check with your equipment dealer to confirm the fuel economy or fuel consumption of the equipment for the type of application.

Otherwise, there are two ways of calculating an engine-specific energy-consumption factor:

1. divide the hp of the engine by the fuel economy in gal/hr; or
2. divide the density of the fuel by the brake-specific fuel consumption of the engine.

While actual fuel receipts or other documentation may support the annual fuel consumption for a baseline engine, the annual fuel consumption of the new vehicle or engine is an estimated proportion to the change in the energy-consumption factor. For example, a reduced-emissions engine having an energy-consumption factor of 18.5, which replaces a baseline engine that uses 5,000 gallons/year, and that has a factor of 17.8, would have an estimated annual fuel consumption of 5,197 gal/yr.

The calculation of reductions in NO<sub>x</sub> emissions using annual fuel use is outlined in Table A3.2. Applicants should consult with the TCEQ for the appropriate calculations for projects involving non-diesel engines.

**Table A3.2**  
**Calculating Reductions in NO<sub>x</sub> Emissions Based on Annual Fuel Use**

### *Applying the TxLED Correction Factor*

The counties affected by the TxLED requirements currently include all those eligible for TERP incentive funding, as listed in Table 3.1, except for El Paso County.	
TxLED correction factor for non-road: <i>1 - 0.07</i>	0.93

**Step 1. Determine the Reduced NO<sub>x</sub> Emissions Factor**

<b>Option A. Reduced-emissions technology verified to achieve a percentage reduction from the baseline</b>	
Baseline NO <sub>x</sub> emissions factor (g/bhp-hr)	
× verified percentage reduction from baseline	
= reduced NO <sub>x</sub> emissions factor (g/bhp-hr)	
<b>Option B. Reduced-emissions engine certified to a specific emissions standard (g/bhp-hr)</b>	
Certified NO <sub>x</sub> emissions (g/bhp-hr)	

**Step 2. Calculate the NO<sub>x</sub>-Emissions Reduction**

Baseline		Reduced Emissions	
NO <sub>x</sub> emissions factor (g/bhp-hr)		NO <sub>x</sub> emissions factor (g/bhp-hr)	
× TxLED correction factor ( <i>diesel engines only</i> )		× TxLED correction factor ( <i>diesel engines only</i> )	
= corrected NO <sub>x</sub> emissions factor (g/bhp-hr)		= corrected NO <sub>x</sub> emissions factor (g/bhp-hr)	
× energy-consumption factor (hp-hr/gal)		× energy-consumption factor (hp-hr/gal)	
× annual fuel consumption gallons per year (gal/yr)		× annual fuel consumption (gal/yr)	
= g/yr		= g/yr	
Baseline g/yr - reduced emissions g/yr =			
× percent within eligible counties (%)			
= g/yr			
		÷ 907,200 grams per ton	
= estimated annual NO <sub>x</sub> emissions reduction (tons/yr)			
× activity life (years)			
= estimated activity-life NO <sub>x</sub> emissions reduction (tons)			

## Calculating Cost-Effectiveness

Only the amount of incentive funds requested under the program will be used in calculating cost-effectiveness. The incremental costs for each activity must be reduced by the value of any existing financial incentive that directly reduces the cost of the proposed activity, including tax credits or deductions, other grants, or any other public financial assistance.

To determine the cost-effectiveness of an activity—with the exception of qualifying fuel activities—the incentive amount for the activity included in the project must be amortized over the activity life designated by the applicant, at a discount rate of 3%.

The following amortization formula yields a *capital-recovery factor* (CRF).

$$\text{capital-recovery factor} = [(1 + i)^n (i)] / [(1 + i)^n - 1]$$

where  $i$  = discount rate (3%)  
 $n$  = activity life

The discount rate of 3% reflects the opportunity cost of public funds—the level of earning that reasonably could be expected by investing state funds in various financial instruments, such as U.S. Treasury securities.

The incentive amount should be multiplied by the incremental cost or incentive amount requested to determine the annualized cost.

$$\text{incremental cost} \times \text{CRF} = \text{annualized cost}$$

The cost-effectiveness calculations appear in Table A3.3. For use in the calculations, capital-recovery factors for up to 20 years appear in Table A3.4.

For projects that include more than one activity, the total project incentive amount must be used to determine the cost-effectiveness of the project. The applicant may request an incentive amount that is less than the full incremental costs, in order to meet the cost-effectiveness criteria.

*To determine the cost-effectiveness:* First sum all of the annualized costs for the activities included in the project. Also sum the annual emissions reductions from each activity to determine an annual emissions reduction for the project. Then divide the combined annualized costs for all activities included in the project application by the total annual reductions in NO<sub>x</sub> emissions for the combined project activities.

$$\text{total annualized cost} / \text{total annual NO}_x \text{ reductions} = \text{project cost-effectiveness}$$

**Table A3.3**  
**Calculating Cost-Effectiveness**

<b>Step 1. Determine the capital-recovery factor (CRF)</b>	
$CRF = [(1 + i)^n (i)] / [(1 + i)^n - 1]$ $i = \text{discount rate (.03)}$ $n = \text{activity life}$	
Capital-recovery factor:	
<b>Step 2. Determine the annualized cost</b>	
Incentive amount × CRF = annualized cost	
Annualized cost (\$/year):	
<b>Step 3. Determine cost-effectiveness</b>	
$\text{Annualized cost (\$/year)} / \text{annual NO}_x \text{ emissions reduction (tons/year)}$ $= \text{cost-effectiveness (\$/ton)}$	
Cost-effectiveness (\$/ton):	\$

**Table A3.4**  
**Capital-Recovery Factors Using a Discount Rate of 0.03**

<b>Activity Life</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
<b>CRF</b>	1.00	.5226	.3535	.2690	.2184	.1846	.1605	.1425	.1284	.1172
<b>Activity Life</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>	<b>20</b>
<b>CRF</b>	.1081	.1005	.0940	.0885	.0838	.0796	.0760	.0727	.0698	.0672