

## Appendix 4

# Locomotives

This appendix outlines the criteria for project eligibility and gives the methods for calculating the reductions in NO<sub>x</sub> emissions for a locomotive project. The emissions standards and emissions 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 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.

The granting of a waiver to the eligibility requirements is at the discretion of the executive director or the executive director's designee. In determining good cause and deciding whether to grant a waiver, the executive director shall ensure that the emissions reductions that will be 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

Locomotives are eligible for grants under this program. Most of the engines eligible under this program will be powered by diesel-fueled compression-ignition engines. However, engines powered by other fuels may also be eligible, subject to decisions by the TCEQ for particular funding periods. Eligible activities and 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 under a particular funding round or by geographic area, as needed to best achieve the goals of the TERP. Administrative costs, in-house labor costs, and travel costs are not eligible expenses.

## ***Purchase or Lease of Locomotives***

This category is for the purchase or lease of new locomotives. 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 locomotive, and the baseline for comparison of emissions is the current federal NO<sub>x</sub> emissions standard for that locomotive.

To be eligible for funding, the engine on the new locomotive 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 federal standard for that engine.

A *lease* is defined as the use and control of a new locomotive 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 locomotive.

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

The baseline locomotive used for determining the difference in cost must be a **new** locomotive certified to the current federal NO<sub>x</sub> emission standards.

The EPA has previously defined “new locomotive” to mean a freshly manufactured or remanufactured locomotive, and “remanufacture” of a locomotive as replacement of all the power assemblies of a locomotive engine with freshly manufactured (containing no previously used parts) or reconditioned assemblies. The TCEQ will make the final determination regarding the applicability of a baseline new locomotive.

## ***Replacement of Locomotives***

This category is for the replacement of a locomotive with a new or newer locomotive. For this category, the applicant must be replacing a locomotive with a minimum of five years of remaining useful life. The TCEQ may establish longer activity-life requirements for each grant period. The baseline for comparison is the emissions of the locomotive being replaced and the emissions of the locomotive being purchased.

For a replacement project, the TCEQ will evaluate whether the locomotive being replaced would have otherwise been used in the eligible counties for the period within which the emissions reductions will be claimed. Standards that apply include **all** of the following:

1. The owner must have continuously owned the locomotive for at least the two years immediately preceding the grant application date.

2. Unless otherwise approved by the TCEQ, the locomotive must have been continuously located and used in Texas over the preceding two years.
3. The locomotive 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 locomotives 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 locomotive in those activities.

In order for a replacement activity to result in creditable emissions reductions, the applicant must intend to continue to use the locomotive 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 locomotive 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 the emissions-reduction 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 engine on the replacement locomotive 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. "Certification" means approval by the EPA or the California Air Resources Board (CARB), or acceptance on other grounds by the TCEQ.

The replacement locomotive must be of the same type and should be intended for use in the same application or vocation (for example, switcher) as the locomotive being replaced. The TCEQ may accept, case by case, engines or equipment 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 locomotive with a single-engine locomotive, or vice versa, as long as the new locomotive will have the same use as the locomotive being replaced and the emissions reductions can be adequately determined.

The year of manufacture of the engine installed on the replacement locomotive 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 locomotive 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 locomotive, 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. The cost may also include the purchase and installation of a global positioning system, subject to approval 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.

Costs may include the invoice price, including taxes and delivery charges included in the price of the replacement locomotive, or the cash basis for the lease charges. 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 also must not exceed 80% of the cost of the replacement locomotive minus the scrappage value received for the old locomotive. The TCEQ may establish a default scrappage value.

### ***Repower of Locomotives***

This category is for the replacement of an existing engine on a locomotive 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 engine must be certified to emit at least 25% less NO<sub>x</sub> than the engine being replaced (in other words, no more than 75% of the NO<sub>x</sub> allowable), based on the federal 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 report, subject to the 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. 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 locomotive 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 locomotive, or for adding devices onto the locomotive.

To be eligible for funding, the retrofit or add-on systems must be verified to reduce the NO<sub>x</sub> produced by the engine by 25% or more, compared with the engine 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 in conjunction with installing the new technology, then the incremental cost is 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 vehicle or equipment 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 of criteria applies to projects involving locomotives. The TCEQ may impose additional criteria, and may more narrowly define the criteria established in this guide, during a particular funding period or by geographic area, as needed to best achieve the objectives 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 locomotive being replaced, repowered, or retrofitted.
- Locomotives used primarily for competition or recreation are not eligible for funding.
- An activity must reduce NO<sub>x</sub> emissions compared to baseline emissions. The NO<sub>x</sub> emissions of locomotives, 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 otherwise accepted by the TCEQ. In situations where the model year of the locomotive and the model year of the existing engine are different—such as a locomotive that has already had the 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 25% reduction criterion 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 locomotive and engine being purchased or leased must be certified to emit at least 25% less NO<sub>x</sub> (that is, no more than 75% as much NO<sub>x</sub>) compared with the current federal NO<sub>x</sub> emissions standard for that locomotive.

**Replacements.** The replacement locomotive and engine or engines must have been certified to emit at least 25% less NO<sub>x</sub> than the locomotive being replaced.

**Repowers.** The replacement engine must be certified to emit at least 25% less NO<sub>x</sub> than the engine being replaced.

**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 federal standard for the engine being retrofitted.

**Combined technologies.** Where two technologies (for example, repower plus retrofit) are combined on the same locomotive, engine, or both, the TCEQ may consider the combined reductions from the two technologies in meeting the 25% requirement. This decision will be solely at the discretion of the TCEQ, and will be based on its 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, must 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. Individual activities included under a single project application may exceed that amount, but the combined project must meet the cost-effectiveness standard.
- 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 those requirements.
- 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 emissions standard will be used as the baseline rate in the calculation to determine the emissions reductions and whether the activity will result in at least a 25% reduction in NO<sub>x</sub>.
- 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 the cost of the proposed activity, 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 components 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.
- For all activities, the activity life must be for a minimum of five years. The TCEQ may establish longer activity-life requirements for each grant period. Not less than 75% of the annual usage of the locomotive must take place in one or more of the eligible counties 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.
- Annual use normally should be measured using fuel consumption.

#### Figure A4.1 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 should refer to the technical supplement to these guidelines for the maximum acceptable life established by the TCEQ for each type of activity.
- 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 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 adopted emissions standards for locomotives in December 1997, which took effect in 2000. Federal standards apply to locomotives originally manufactured in 1973 and later, and apply any time they are rebuilt or remanufactured. Not regulated are electric locomotives, historic steam-powered locomotives, and locomotives originally manufactured before 1973.

The baseline NO<sub>x</sub> emissions factors for this program are the federal standards for NO<sub>x</sub> emissions applicable to the type of locomotive and model year. The federal NO<sub>x</sub> emissions standards for locomotives are listed in a technical supplement to these guidelines. Potential grant applicants should consult with the TCEQ to ensure they use the appropriate baseline standards.

The NO<sub>x</sub> emissions factor for the reduced-emission engines will normally be the federal NO<sub>x</sub> emissions standard or the Family Emissions Limit to which the reduced-emission engine is certified. For retrofit and add-on activities verified by the EPA or the CARB to reduce NO<sub>x</sub> emissions by a specified percentage, the verified percentage will be applied to the baseline emissions factor to determine the emissions factor for the retrofitted engine.

## 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. Where the model year of the locomotive 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, an activity level, and a conversion factor, if necessary. Because conversion factors and 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 locomotive applications, the activity level should be based on 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 Fuel Use***

If the annual fuel consumption is used, the activity level should be based on actual annual fuel receipts or other available documentation to estimate the expected annual fuel use of the equipment. An energy-consumption factor will also need to be calculated. This factor converts the emissions factor in terms of g/bhp-hr to g/gal of fuel used. There are two ways of calculating the energy-consumption factor:

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

Check with your equipment dealer to confirm the fuel economy or fuel consumption of the equipment for the type of application.

For most locomotive applications a default fuel-consumption factor of 20.8 bhp-hr/gal should be used. The technical supplement to these guidelines will include the appropriate emissions factors, as well as any alternative fuel-consumption factors.

In general, the calculation of emissions reductions should be based on the same amount of fuel for the baseline and the reduced-emission locomotive or engine. However, the TCEQ may accept, at its discretion, fuel-economy benefits of the new or repowered locomotive engine over the baseline unit when calculating emissions reductions. In general, fuel savings may result from idle-reduction systems that come with the new or repowered locomotive as well as from the enhanced fuel economy of the new engine.

To request the use of this approach, the application must list the percentage reduction in fuel use expected through use of the reduced-emission locomotive when compared to the baseline. For replacement activities, the application should also list the historical average annual fuel use of the old locomotive (the baseline) and commit to an annual fuel use for the new or repowered locomotive.

The TCEQ may consider a fuel-economy benefit based on independent studies and test data. Documentation must accompany the application to justify the reduced fuel amount. The TCEQ will evaluate the documentation to determine the level of fuel savings that it may accept.

Regardless of the baseline fuel-use amount listed in the application, the TCEQ will apply a fuel-economy factor to the fuel-use commitment listed for the reduced-emission locomotive and engine. For instance, if the TCEQ agrees that the reduced-emission locomotive fuel use will be 30% less than the baseline locomotive fuel use for the same amount of work, then the baseline fuel use for the calculation will be the fuel-use commitment times 1.43 (1/0.70). If the historical annual fuel use listed in the application is less than the number derived by applying the fuel economy factor, then that lower baseline number will be used.

The applicant must commit to realistic fuel use for the work expected from the reduced-emission locomotive. If a grant is awarded, the recipient is obligated to use at least that amount of fuel annually in order to meet the grant usage requirements over the activity life.

The calculation of reductions in NO<sub>x</sub> emissions using annual fuel use is outlined in Table A4.1. Applicants should consult with the TCEQ for the appropriate calculations for projects involving non-diesel engines.

## Calculating Cost-Effectiveness

Only the amount of incentive funds requested under the program can 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, the incentive amount for the activity—with the exception of qualifying fuel activities—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.

**Table A4.1**  
**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 (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)			

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 A4.2. For use in the calculations, capital-recovery factors for up to 20 years appear in Table A4.3.

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 NO<sub>x</sub> emissions reductions for the combined project activities.

*total annualized costs / total annual NO<sub>x</sub> reductions = project cost-effectiveness*

**Table A4.2**  
**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 A4.3**  
**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