

Appendix 1

On-Road Heavy-Duty Vehicles

This appendix outlines the criteria for project eligibility and gives the methods for calculating the reductions in NO_x emissions for an on-road vehicle project. Most of the calculations will require input of an NO_x emissions factor applicable to the engine, the vehicle, or both. 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>. 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

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 during a particular funding period, as needed to best achieve the goals of the TERP.

Purchase or Lease of On-Road Heavy-Duty Vehicles

This category is for the purchase or lease of **new** on-road heavy-duty vehicles. 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 vehicle; the baseline for comparison of emissions is the current federal NO_x emissions standard for that vehicle. The baseline vehicles used for determining the difference in cost must be **new**.

To be eligible for funding, the new vehicle must be certified as emitting at least 25% less NO_x than required (in other words, no more than 75% of the NO_x allowable) under the current federal standard for that vehicle. "Certification" means approval by the U.S. EPA or the California Air Resources Board (CARB), or acceptance on other grounds by the TCEQ.

A *lease* is defined as the use and control of a new on-road heavy-duty vehicle, in accordance with a lease contract for five or more years. The TCEQ will reimburse the incremental costs of the lease above those that would otherwise have been incurred for the lease of a baseline vehicle.

The TCEQ will reimburse the incremental cost of the **purchase** of a new on-road heavy-duty vehicle subject to cost-effectiveness limits established by the TCEQ. The incremental cost is the difference between the manufacturer's suggested retail price, the documented dealer price of a baseline vehicle, or other appropriate baseline cost established by the TCEQ, and the actual cost of the cleaner vehicle.

Replacement of On-Road Heavy-Duty Vehicles

This category is for the replacement of an on-road heavy-duty vehicle with a new or late-model on-road heavy-duty vehicle. For a replacement project, the TCEQ will evaluate whether the vehicle 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.

- The applicant must be named as the owner on the front of the vehicle title or submit other documentation, as determined by the executive director, that the applicant has authority to dispose of the vehicle and engine being replaced.
- The applicant must have continuously owned, leased, or otherwise commercially financed the vehicle for the two years preceding the grant application.
- The vehicle must currently be registered for operation in Texas in the applicant's name.
- Unless otherwise approved by the TCEQ, the vehicle must have been continuously registered and used in Texas for the two years preceding the application date.
- The vehicle must be in good operating condition and capable of performing its primary function.

- The vehicle must have a current safety inspection (if a safety inspection is required for that vehicle and use) and must have continuously had an up-to-date safety inspection over the preceding two years.

The TCEQ may waive the two-year ownership, lease, or commercial financing 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 or vocation (for example, regional delivery) of the vehicles being replaced must not have changed.

The TCEQ may waive the two-year registration, use, and safety-inspection requirements for short lapses in registration or 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 vehicle in those activities.

For on-road vehicles used exclusively for off-road purposes the TCEQ may, in specific cases, waive the requirements regarding registration and safety inspections. The vehicle must not be subject to state registration and inspection requirements. The historical usage described by the applicant on the grant-application forms must reflect the use of the vehicle for those off-road purposes.

In order for a replacement activity to result in creditable emissions reductions, the applicant must intend to continue to use the vehicle 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 vehicle 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 replacement vehicle must be certified to emit at least 25% less NO_x than the vehicle being replaced. The baseline for comparison of emissions is the difference between the emissions of the vehicle being replaced and the emissions of the vehicle being purchased. "Certification" means approval by the EPA or the CARB, or acceptance on other grounds by the TCEQ.

The replacement vehicle must be of the same type, weight category, and body and axle configuration as the vehicle being replaced. The replacement vehicle must be configured and intended for use in the same application or vocation (for example, regional delivery), as the vehicle being replaced. The TCEQ may accept, in particular cases, vehicles of a different type, weight category, or body and axle configuration to

account for the latest technology used in a specific vocation. In addition, the TCEQ may accept, case by case, the replacement of a multi-engine vehicle with a single-engine vehicle, or vice versa, as long as the new vehicle will have the same use as the vehicle being replaced and the emissions reductions can be adequately determined.

The model year of the replacement vehicle 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 vehicle has a unique or specialized use and where a recently manufactured model 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 vehicle, 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 for particular funding periods, as needed to best achieve the goals of the TERP.

Costs may include the invoice price, with taxes and delivery charges included in the price of the replacement vehicle, 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 also, subject to approval by the TCEQ.

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

Repower of On-Road Heavy-Duty Vehicles

This category is for the replacement of an existing engine on an on-road heavy-duty vehicle 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 25% less NO_x than the engine being replaced, 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.

Repowers resulting in any alteration from an original configuration of a vehicle or engine must comply with the provisions of EPA Memorandum 1A related to ensuring that altered vehicles and engines continue to meet required emissions standards. Copies of Memo 1A are available from the EPA and the TCEQ, and will be made available on the TERP website at <www.terpgrants.org>.

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.

The grant recipient may be eligible for reimbursement of up to 80% of the incremental cost of the repower, subject to the cost-effectiveness limits established by the commission. 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 total incentive amount also must not exceed the cost of the replacement engine.

For certified emissions-upgrade kits, the incremental cost is the cost to purchase and install the conversion system or kit. Other upgrades or modifications to the engine or vehicle that are not necessary for the conversion or upgrade of the engine are not eligible.

Costs that may be reimbursed, subject to approval by the TCEQ, include:

- the invoice cost of the new engine or upgrade, including sales tax and delivery charges;
- the invoice cost of additional equipment that must be installed with the new engine or upgrade;
- associated supplies directly related to the installation of the engine or system;
- the costs to remove and dispose of the old engine, if applicable;
- installation costs;
- reengineering costs, if the vehicle or equipment 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 an on-road heavy-duty vehicle, or adding on devices to the vehicle. To be eligible for funding, the retrofit or add-on systems must be verified to emit at least 25% less NO_x than the engine prior to the retrofit or add-on. "Verification" means approval by the EPA or the CARB, or acceptance on other grounds by the TCEQ.

The conversion of an existing on-road heavy-duty diesel engine to operate under a dual-fuel configuration that uses natural gas and diesel fuel through an alternative-fuel conversion system certified by the EPA or the CARB may also be considered under the retrofit category. Per Texas Health and Safety Code 386.104(f-1), the TCEQ may establish alternative minimum standards for the percentage reduction in NO_x that must be achieved by the conversion of the engine. Under this provision, the

TCEQ will establish any alternative standards on a grant-round basis after considering the effectiveness of available dual-fuel conversion technology in reducing emissions.

Retrofits and add-on activities resulting in any alteration from an original configuration of a vehicle or engine must comply with the provisions of EPA Memorandum 1A, related to ensuring that altered vehicles and engines continue to meet required emissions standards. Importantly, aftermarket systems for converting a vehicle and engines to alternative fuel operation must comply with EPA certification requirements under Memo 1A. Copies of Memo 1A are available from the EPA and the TCEQ, and will be made available on the TERP website at <www.terpgrants.org>.

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 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 for particular funding periods, as needed to best achieve the goals of the TERP.

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,
- 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 on-road heavy-duty vehicle activities. The TCEQ may impose additional criteria, and may more narrowly define the criteria established in this guide, under a particular funding period, 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.) that will occur in the same primary area may be included under one project application.

- The applicant must own the vehicle being replaced, repowered, or retrofitted and the applicant's name must appear on the front of the vehicle title.
- Vehicles and equipment used primarily for competition or recreation are not eligible for funding under any of the project categories.
- On-road heavy-duty vehicle activities must reduce NO_x emissions compared to baseline emissions. The NO_x emissions of vehicles, 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 vehicle and the model year of the existing engine are different, such as in a vehicle 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. How the 25% reduction criterion applies to 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 vehicle and engine being purchased or leased must be certified to emit at least 25% less NO_x than (that is, no more than 75% as much NO_x as) the current federal NO_x emissions standard for that vehicle.

Replacements. The replacement vehicle and engine must have been certified to emit at least 25% less NO_x than (that is, no more than 75% as much NO_x as) the vehicle being replaced. For example, if an applicant wants to replace a 1989 bus with a 1999 bus, the replacement bus and engine must have been certified to emit 25% less NO_x than the 1989 emissions standard.

Repowers. The replacement engine must be certified to emit at least 25% less NO_x than the engine being replaced.

Retrofits and add-ons. Emissions standards for retrofit and add-on activities are based on the model year of the engine being retrofitted. The retrofit or add-on technology must be verified to emit at least 25% less NO_x than the standard for the vehicle and engine being retrofitted. For example, if an applicant wants to retrofit the engine on a bus, and the bus engine was originally manufactured in 1996, then the retrofit kit must have been verified to result in NO_x emissions that are 25% less than the original (1996) certified emissions level of the vehicle and engine. The TCEQ may establish an alternate standard for the conversion of an on-road heavy-duty diesel engine to operate under a dual-fuel configuration that uses natural gas and diesel fuel through an alternative fuel conversion system.

Combined technologies. Where two technologies (for example, repower plus retrofit) are combined on the same vehicle or engine, 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 must not exceed any limits set by the TCEQ on the cost per ton of NO_x 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 those requirements.
- 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.
- In the areas of the state where Texas Low Emission Diesel 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.
- 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 on-road heavy-duty vehicle replacement, purchase, or lease activities, the minimum activity life will be five years or more, or 400,000 miles of operation, whichever occurs earlier. For all other on-road vehicle activities, the activity life must be a minimum of five years. For activities other than an on-road vehicle replacement, purchase, or lease activity, the TCEQ may establish longer activity-life requirements for each grant period. At least 75% of the annual usage of the vehicle must take place in one or more of the eligible counties and designated highways

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, and 75% of the annual usage over the lease period must take place in one or more of the eligible counties and designated highways or roadways. At the executive director's discretion, the TCEQ may require a minimum percentage for use of the vehicle in the eligible counties with any grant-application period.

- For most on-road vehicles, annual usage is to be measured using miles of operation. For refuse vehicles, street sweepers, and other vehicles with substantial power-take-off operations, fuel consumption normally should be used as the usage factor. The TCEQ may consider using either miles of operation or fuel consumption for particular applications, case by case.
- Applicants should refer to the technical supplements to these guidelines available at the TERP website <www.terpgrants.org> for the maximum acceptable activity 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.

Figure A1.1 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 Texas Low Emission Diesel (TxLED) requirements currently include all of the counties 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_x 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:

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

- 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 where the grant recipient acts as a transportation provider for delivery of 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.
- Vehicles used at port facilities and other intermodal delivery and transportation facilities, commonly referred to as *terminal tractors* or *yard trucks*, may have engines certified to either the federal on-road or non-road emission standards. Both the on-road and non-road versions of these vehicles perform the same primary functions; the on-road versions usually travel only limited distances on roads and highways. To account for these similarities in use, the TCEQ may allow, at its discretion, an applicant to apply for a project involving a terminal tractor with an on-road engine under the non-road forms and criteria. This provision does not include any on-road vehicle not designed and manufactured as a terminal tractor, even if the vehicle is being used in that role.
- The TCEQ may impose additional criteria for certain projects and funding periods, consistent with these guidelines.

NO_x Emissions Factors

The baseline NO_x emissions factors for this program will normally be the federal standard for NO_x emissions applicable to the type of engine and model year of vehicle. However, if the baseline engine was certified by the EPA or the CARB to a Family Emissions Limit, the TCEQ may use the FEL for the baseline NO_x emissions factor.

The federal NO_x emissions standards for on-road (highway) heavy-duty engines are listed in the technical supplement that will be made available by the TCEQ during each grant-application period. Potential grant applicants should consult with the TCEQ to ensure they use the appropriate baseline standards. The NO_x emissions factor for the reduced-emission engines will normally be the federal NO_x emissions standard or the FEL to which the reduced-emission engine is certified. For retrofit

and add-on activities verified by the EPA or the CARB to reduce NO_x 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.

Emissions Factors for Retrofits with Dual-Fuel Conversion Systems

The TCEQ may consider alternative information to determine the emissions factors and calculate the emissions reductions for retrofit projects involving the conversion of a heavy-duty on-road vehicle engine to operate under a dual-fuel configuration that uses natural gas and diesel fuel through an alternative fuel conversion system certified by the EPA or the CARB. In particular, if the TCEQ determines it to be necessary and appropriate, the TCEQ may consider certified engine test information that demonstrates reductions of NO_x emissions and other information to determine the emissions reductions.

To be considered under this alternative approach, the TCEQ may require that manufacturers or dealers apply to the TCEQ for a determination of the appropriate emissions factors and reductions that will be accepted for that system. In general, any testing performed to verify the emissions should be performed and certified by an independent testing service or facility. The TCEQ is not required to accept a dual-fuel conversion system under this alternative, and it will be the responsibility of the manufacturer to provide sufficient test data and other information to verify the emissions factors.

The TCEQ may determine an appropriate factor for the percentage reduction in NO_x emissions as a result of the dual-fuel engine conversion. The percentage-reduction factor will be applied to the baseline emissions factor determined by the TCEQ for that engine in order to calculate the emissions reductions. Alternatively, the TCEQ may determine a specific NO_x-emission rate for the converted engine based on the certified test results. In that case, the TCEQ may also consider the certified test results of either the original engine or the converted engine operating in diesel-only mode to determine the baseline emission rate.

In considering certified test information and agreeing to an appropriate percentage reduction in emissions or a specific emission rate, the TCEQ will take into account whether the engine can operate solely on diesel fuel in addition to dual-fuel operation. The TCEQ may adjust the percentage-reduction factor or the specific emission rate to account for the difference in emissions using solely diesel fuel and dual-fuel operation of the engine. In determining appropriate adjustments to the emissions factors, the TCEQ may also take into account the level of confidence that can be given to the test information. In addition, a correction factor may be applied to account for the partial use of TxLED in dual-fuel operation of the engine.

Calculating Reductions in NO_x Emissions

In general, the emissions-reduction benefit represents the difference in the emissions level of a baseline vehicle or engine and a reduced-emissions vehicle or engine. In situations where the model year of the vehicle chassis and the model year of the existing 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 the activity levels may be expressed in different units for the existing and replacement engines, the emissions levels for the baseline and reduced-emissions vehicles or 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).

Different types of on-road vehicles operate very differently. For most on-road applications, the activity level should be established by the annual mileage. Refuse haulers, street sweepers, and other on-road vehicles with significant power-take-off operations are an exception, and the activity level may be determined 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_x-Emissions Reductions Based on Annual Mileage

The calculation of emissions and emissions reductions using annual mileage as the usage factor is determined by the steps in Table A1.1. The applicable NO_x emissions standards are included in the technical supplement available from the TERP Program. For retrofit and add-on activities, as well as 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 applicable emissions factor to determine the reduced NO_x emissions factor.

Table A1.1
Calculating Reductions in NO_x Emissions Based on Annual Mileage

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 on-road: <i>1 - 0.057</i>	0.943

Step 1. Determine the NO_x Emissions Factor

Determine baseline NO_x emissions factor	
Baseline NO _x emissions standard (g/bhp-hr)	
× TxLED correction factor <i>(diesel engines only)</i>	
= correction g/bhp-hr	
× conversion factor (bhp-hr/mi)	
= baseline NO _x emissions factor (g/mi)	
Determine reduced NO_x emissions factor (g/mi)	
Option A. Reduced-emissions technology verified to achieve a percentage reduction from the baseline	
Baseline NO _x emissions factor (g/mi)	
× verified percentage reduction from baseline	
= reduced NO _x emissions factor (g/mi)	
Option B. Reduced-emissions engine certified to a specific emissions standard (g/bhp-hr)	
Certified NO _x emissions (g/bhp-hr)	
× TxLED correction factor <i>(diesel engines only)</i>	
= corrected g/bhp-hr	
× conversion factor (bhp-hr/mi)	
= reduced NO _x emissions factor (g/mi)	

Step 2. Calculate the NO_x-Emissions Reduction

Baseline g/mi – reduced emissions g/mi	
× annual miles of operation	
× percent within eligible counties (%)	
= g/yr	
	÷ 907,200 grams per ton
= estimated annual NO _x -emissions reduction (tons/yr)	
× activity life (years)	
= estimated activity-life NO _x -emissions reduction (tons)	

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, a conversion factor is needed to determine an appropriate emissions factor in grams per mile. Appropriate conversion factors, to convert g/bhp-hr to g/mi, are included in the technical supplement available from the TERP Program.

Calculation of NO_x-Emissions Reductions Based on Annual Fuel Use

The calculation of emissions and emissions reductions using annual mileage as the usage factor is determined by the steps in Table A1.2.

Refuse vehicles, street sweepers, and other on-road vehicles with significant power-take-off operations accrue low mileage, yet intermittently operate at high load during compaction or sweeping mode. Therefore, annual fuel use is a more appropriate emissions factor to use for these vehicles. Alternatively, an applicant may base the emissions reductions on annual mileage for these vehicle uses, provided sufficient supporting documentation is submitted as determined by the TCEQ.

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 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.

Heavy-duty diesel engines typically have a brake-specific energy consumption of 6,500 to 7,000 British thermal units (Btu) per hp-hour on the certification cycle. Diesel fuel has an energy density of about 18,000 Btu/lb and a mass density of 7.0 lb/gal. This results in an energy-consumption factor of about 18.5 hp-hour/gal of fuel consumed, which should be used as the default for vehicles.

In general, the calculation of emissions reductions should be based on the same amount of fuel for the baseline and the reduced-emission vehicle or engine. However, the TCEQ may accept, at its discretion, fuel-economy benefits of the new or repowered vehicle over the baseline unit when calculating emissions reductions.

For example, a new hybrid-electric utility truck may save fuel by powering the non-propulsive systems with a battery. The TCEQ may consider the emissions reductions from this fuel savings based on the particular case.

To use this approach, the application must list the percentage reduction in fuel use expected through use of the reduced-emission vehicle when compared to the baseline. For **replacement activities**, the application should also list the **historical**

average annual fuel use of the old vehicle (the baseline) and commit to an annual fuel use for the new or repowered vehicle.

Documentation must accompany with the application to justify the amount of reduced fuel use. The TCEQ will evaluate the documentation to determine the level of fuel savings that it may accept.

Regardless of the fuel-use baseline listed in the application, the TCEQ will apply an economy factor to the fuel-use commitment for the reduced-emission vehicle and engine. For instance, if the TCEQ agrees that the reduced-emission vehicle will use 30% less fuel than the baseline vehicle for the same amount of work, then the baseline fuel use 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 vehicle. 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.

Table A1.2
Calculating Reductions in NO_x 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 on-road: <i>1 - 0.057</i>	0.943

Step 1. Determine the Reduced NO_x Emissions Factor

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

Step 2. Calculate the NO_x-Emissions Reduction

Baseline		Reduced Emissions	
NO _x emissions factor (g/bhp-hr)		NO _x emissions factor (g/bhp-hr)	
× TxLED correction factor (<i>diesel engines only</i>)		× TxLED correction factor (<i>diesel engines only</i>)	
= corrected NO _x emissions factor (g/bhp-hr)		= corrected NO _x 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 _x -emissions reduction (tons/yr)			
× activity life (years)			
= estimated activity-life NO _x emissions reduction (tons)			

Calculating Cost-Effectiveness

Only the amount of incentive funds requested under the program can be used in the cost-effectiveness calculation for on-road heavy-duty vehicles. 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 A1.3. Capital-recovery factors for use in calculations for up to 20 years appear in Table A1.4.

Table A1.3
Calculating Cost-Effectiveness

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

Table A1.4
Capital-Recovery Factors Using a Discount Rate of 0.03

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

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_x emissions reductions for the combined project activities.

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