California Energy Commission

School Bus Replacement Program/Clean Transportation Program

FINAL PROJECT REPORT

Cajon Valley Union School District Final Report

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July 2026 | CEC-600-2026-029

California Energy Commission

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance, and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

Senate Bill 110 (Committee on Budget and Fiscal Review, Chapter 55, Statutes of 2017) created the School Bus Replacement Program, appropriating up to $75 million from the California Clean Energy Jobs Act (Proposition 39), an initiative that voters approved in 2012. The statute authorizes the CEC to provide school bus replacement grants to school districts, County Offices of Education, and Joint Power Authorities operating the oldest school buses in disadvantaged communities.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued GFO-17-607 to provide funding opportunities under both the School Bus Program to fund projects that replace the oldest diesel school buses in California with electric vehicle school buses and the Clean Transportation Program to fund infrastructure projects that support the electric vehicle school buses. In response to GFO-17-607, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards July 17, 2019 and the agreement was executed as ARV-19-032 on October 14, 2019.

ABSTRACT

Cajon Valley Union School District submitted an application to receive grant funding under the California Energy Commission (CEC) Solicitation GFO-17-607 to replace one old diesel school bus. Cajon Valley Union School District was awarded funding for one vehicle-to-grid ready electric school bus and the supporting electric vehicle charging infrastructure. Cajon Valley Union School District purchased one electric school bus and installed one charger through the CEC. The bus was placed into service January 09, 2024 and districts were offered workforce training to help support the successful deployment of the new electric fleet. The old, diesel-powered buses were also dismantled and removed from service. This project found that the electric school bus reduced greenhouse gas emissions by 0.133 short tons of NOx (oxides of nitrogen), 0.005 short tons of PM2.5., 0.014 short tons of HC, 0.033 short tons of CO and 10.1 short tons of CO_2 and that the electric school bus had a lifetime cost savings of $2,796.52.

Keywords: GFO-17-607, grant funding, electric school bus, diesel, greenhouse gas emissions, cost savings, vehicle-to-grid, electric vehicle charging infrastructure, workforce training.

Please use the following citation for this report:

Brodwolf, Tysen. 2026. *Cajon Valley Union School District Electric Bus and Infrastructure*. California Energy Commission. Publication Number: CEC-600-2026-029.

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EXECUTIVE SUMMARY

The priority of Cajon Valley Union School District has always been student health and educational success. Cajon Valley Union School District embraces continuous improvements to its transportation department and fleet to help keep students safe and healthy. This project sought to replace old diesel school buses with zero-emission electric school buses. The replacement buses will improve air quality and reduce school energy and maintenance costs while providing students with necessary school transportation.

The first stage focused on installation of charging infrastructure. This installation included coordinating with the local utility company, producing engineering and design drawings by subcontractors, purchasing charging equipment, and constructing the charging station. The electric vehicle charging infrastructure is located and maintained at 721 E. Park Avenue, El Cajon, CA 92020, San Diego County.

The second stage dealt with the procurement of electric school buses. Cajon Valley Union School District applied for and was awarded grant funding for the purchase of one new electric school bus. Cajon Valley Union School District selected a school bus manufacturer, placed a purchase order for bus procurement, and placed the bus into service on January 9th, 2024.

The third stage required Cajon Valley Union School District to scrap the old diesel school bus within 12 months from the delivery of the new electric school bus. This disposal is to ensure that the old diesel school bus does not continue to produce emissions.

The final stage involved 12 months of data collection on the electric school buses. These data were used to analyze the economic and environmental impacts that resulted from the electric for diesel school bus replacement.

Cajon Valley Union School District's electric school buses have helped save money on fuel and maintenance costs. The new buses have also improved the health of students by reducing their exposure to toxic air contaminants. Cajon Valley Union School District recommends school districts across the state replace their old diesel-polluting school buses with clean, all-electric school buses.

CHAPTER 1: Introduction

Background

Senate Bill 110 (Committee on Budget and Fiscal Review, Chapter 55, Statutes of 2017) appropriated funds to establish the School Bus Replacement Program at the California Energy Commission (CEC). The CEC provided one-time funding of $75 million from Proposition 39 for the replacement and scrappage of old diesel school buses in disadvantaged and low-income communities throughout California.

To allow wider coverage of the program, the funds were distributed among four regions in California: Northern California, Central California, Southern California, and Los Angeles County. Additional funding of almost $14 million from the CEC's Clean Transportation Program was leveraged to provide schools the necessary charging infrastructure to operate the buses. Also, $1 million in Clean Transportation Program funds were set aside for workforce training and development to ensure proper operation and maintenance of the buses.

The CEC received more than 200 applications for more than 1,600 diesel school buses requested for replacement, some buses as old as 1978. CEC staff then evaluated the buses based on three factors: age of bus, applicant's percentage of free and reduced-price meals recipients, and applicant's disadvantaged community score according to the CalEnviroScreen 3.0. From the applications received, an initial list of ranked buses was released in November 2018.

The second phase of the program included selecting a manufacturer or dealer that could design, construct, and deliver electric school buses. In November 2018, the CEC released a solicitation to establish a bulk purchase price for replacement buses. Applications were evaluated and scored for the technical evaluation portion based on the following criteria:

- Relevant experience and qualifications
- Project readiness and implementation
- Client references
- Battery and fuel range
- Warranty, service, and support
- Innovation
- Economic benefits to California
- Ability to leverage funding

Applications passing the technical evaluation advanced to the next screen, where the lowest-cost bid was selected for each school bus type (Type A[1], Type C[2], Type D[3], and each type with or without chair lifts). The bus bid forms were ranked in order from lowest to highest cost per bus by type. Table 1 shows the manufacturer's awarded bids, which did not include an awarded Type B bus.

Table 1: School Bus Replacement Program Awarded Bids

Applicant	Bus Type	Bid Amount
The Lion Electric Co.	Type A Without Chair Lift	$271,389
A-Z Bus Sales, Inc. – California (Micro Bird)	Type A With Chair Lift	$293,424
The Lion Electric Co.	Type C Without Chair Lift	$321,184
The Lion Electric Co.	Type C With Chair Lift	$329,627
The Lion Electric Co.	Type D Without Chair Lift	$332,009
The Lion Electric Co.	Type D With Chair Lift	$339,370

Source: CEC

Once the manufacturers were selected, CEC staff was able to allocate funding based on bid price, using the rank list to determine which applicants would be awarded buses. From the initial rank list of buses, the CEC was able to fund 228 electric school buses, with an additional $60,000 in infrastructure funding per bus.

Recipients also had the option to procure their bus outside the CEC awarded manufacturer bid, as long as the recipients used their own established procurement procedures while adhering to all applicable state and local laws and terms and conditions of the grant agreement.

School Bus Replacement Program Objectives

The School Bus Replacement Program is helping schools throughout the state transition from old, polluting diesel school buses to electric school buses, reducing exposure to harmful emissions and helping the state reach its climate and air quality goals. This program also supports the state's overall energy goals such as the Low Carbon Fuel Standard (LCFS) target

[1] A Type "A" school bus is a van conversion or bus constructed utilizing a cutaway front section vehicle with a left-side driver's door. This definition includes two classifications: Type A-I, with a Gross Vehicle Weight Rating (GVWR) less than or equal to 14,500 pounds; and Type A II, with a GVWR greater than 14,500 pounds and less than or equal to 21,500 pounds.

[2] A Type "C" school bus is constructed utilizing a chassis with a hood and front fender assembly. The entrance door is behind the front wheels. A "type C school bus" also includes a cutaway truck chassis or truck chassis with cab, with or without a left side door, and with a GVWR greater than 21,500 pounds.

[3] A "type D school bus" is a body installed upon a chassis, with the engine mounted in the front, midship or rear, with a gross vehicle weight rating of more than 10,000, designed for carrying more than ten persons. The engine may be behind the windshield and beside the driver's seat; it may be at the rear of the bus, behind the rear wheels, or midship between the front and rear axles. The entrance door is ahead of the front wheels. A type D school bus has a maximum length of 45 feet.

for 2030 and the Senate Bill 32 (Pavley, Chapter 249, Statutes of 2016) target goal to reduce greenhouse gas emissions 40 percent below the 1990 level by 2030. The agreement objective is to purchase electric school bus to replace diesel buses that will be removed from service and scrapped and install or upgrade electric bus charging infrastructure at grant recipient transportation sites.

CHAPTER 2:
Project Details

Electric School Bus Funding

Cajon Valley Union School District was awarded $492,009 to replace one old diesel school bus with one all-electric school bus, as well as purchase and install the associated charging infrastructure. CVUSD selected a Bluebird Corporation Type D without an optional wheelchair lift based on the following needs:

- Total cost of bus (CEC share)
- Quoted bus range and battery capacity (kWh)
- Bus Route Profiles
- Upgrade Options Available
- Other-None

Cajon Valley Union School District is responsible for transporting between 700-1000 children per year, with an average route distance of 70 miles daily across 29 bus and van routes. Cajon Valley Union School District has a fleet composed of forty-two buses featuring a total of eleven electric school buses and thirty-four diesel buses, zero CNG buses.

Cajon Valley Union School District selected the electric school bus from Blue Bird Corporation because the District required a Type D vehicle with a larger passenger capacity. The purchase also supports long-term operational needs by future-proofing a school bus used to train and test drivers seeking licensing through the California Highway Patrol. The total cost for the new electric school bus was $450,484.50. Of that total, 95.9% percent was covered by the CEC. Figure 1 below shows one of CVUSD's new electric school buses funded by the CEC.

Figure 1: Cajon Valley Union School District Electric School Bus #597E

Source: Cajon Valley Union School District

The replaced diesel bus must be scrapped and removed from service within 12 months from delivery of the new bus. Each district was required to show proof of scrappage, which included photographs of bus/engine destruction, vehicle identification number, engine serial number, and method used to dismantle the engine and non-engine components. Figure 2 illustrates one of the acceptable methods of scrapping the chassis of a vehicle. As of 07/01/2020, one of Cajon Valley Union School District buses has been scrapped.

Figure 2: Chassis Rail Cut in Half

Source: Cajon Valley Union School District

Infrastructure Funding

The CEC's Clean Transportation Program allocated $14 million to the School Bus Replacement Program to fund electric school bus charging infrastructure. The CEC provided up to $60,000 per awarded bus for purchase and installation of the associated infrastructure. This allocation enabled Cajon Valley Union School District to install one ABB Terra DC fast charger. The infrastructure was completed 02/28/2025 and began operating 03/06/2025.

The CEC worked with electric utilities, both public and private, to assist in upgrading electrical infrastructure required to charge the awarded buses while emphasizing the need to plan for future electrical capacity needs. Electric vehicle supply equipment was required to be, at a minimum, a Level 2[4] ENERGY STAR®-certified, networked charger capable of charging a vehicle at a minimum of 6.2 kilowatts (kW); however, the CEC recommended electric vehicle supply equipment capable of charging at 19.2 kW. These high capacity 19.2 kW chargers only require 6–8 hours of charging time to power a school bus battery from 0 to 100 percent, as indicated by the school bus manufacturers selected for the School Bus Replacement Program. Networked electric vehicle supply equipment provides recipients with the ability to set charging for buses to off-peak-demand hours, provide remote diagnostics, and allow remote start of connected vehicles.

Obstacles, Delays, and Lessons Learned

[4] Level 2 Chargers operate between 208 and 240 Volts with output of anywhere between 3 kW and 19 kW of alternating current power.

Vehicle Range Limitations

The electric bus remained assigned to its established AM and PM home-to-school route and was incorporated into regular daily operations whenever feasible.

Throughout the program, Cajon Valley Union School District (CVUSD) intended to continue operating the grant-funded electric school bus to maximize daily vehicle utilization while remaining within the vehicle's available driving range. Transportation staff continuously monitored route assignments, mileage, terrain demands, weather conditions, passenger loads, HVAC usage, and available battery range to ensure the bus could safely complete assigned work. CVUSD learned that real-world operational conditions did not always align with manufacturer-provided range expectations. Route variability, terrain, climate conditions, operational contingencies, and auxiliary power demands all impacted usable range capacity during daily operations of the bus.

While the vehicle successfully supported daily transportation operations at the end of the reporting period, its limited range reduced operational flexibility and restricted CVUSD's ability to use it to is maximum capacity.

Charging Infrastructure and Vehicle Charging Reliability

The original charger assigned to the CEC-funded vehicle experienced ongoing charging reliability issues with both the charging equipment and the vehicle.

On multiple occasions, the electric bus was either not charged or not fully charged prior to morning route deployment, resulting in operational disruptions and the inability to safely place the bus into service.

In 2025, CVUSD utilized CEC infrastructure funding and transitioned the vehicle to an ABB Terra charging system funded by the CEC grant. Following this transition, CVUSD experienced a significant reduction in charger compatibility issues, charging interruptions, and overall charging instability. The ABB charging platform proved to be substantially more reliable and operationally consistent.

Mechanical Reliability and Extended Downtime

The grant-funded electric school bus experienced several significant mechanical issues, resulting in extended periods of downtime and reduced operational availability.

In 2024, the vehicle was removed from service for several months due to a rear suspension issue affecting ride height and vehicle stability. A-Z Bus Sales worked directly with Blue Bird to diagnose and repair the issue. Multiple repair attempts and adjustments were made before the root cause was ultimately identified. The issue was determined to be related to the rear suspension design, which utilized a single rear air bag to independently control ride height on both the driver and passenger sides of the vehicle. This configuration caused the driver's side of the bus to sit noticeably lower than the passenger side.

To correct the issue, Blue Bird installed an air-pressure regulator system that allowed the ride-height support to be independently balanced on both sides of the vehicle. Following completion of the repair, the vehicle was returned to CVUSD. However, the bus arrived in unsatisfactory condition, with excessive dirt and debris throughout the interior and exterior. A-Z Bus Sales subsequently dispatched a detailing team to thoroughly clean the bus before returning it to active service. The bus was again taken out of service due to a power steering pump failure.

Additionally, limited availability of specialized electric-vehicle components, evolving technical support processes, and coordination among multiple support entities occasionally contributed to extended repair timelines and reduced vehicle availability.

These recurring mechanical and support-related issues significantly impacted operational planning and CVUSD's ability to consistently utilize the vehicle for daily transportation services.

Delays Encountered

CVUSD originally secured a Lion Electric Type D school bus as part of the grant award. However, by 2022, the vehicle remained in the research and development phase and was not available for delivery within the originally anticipated project timeline.

Due to these manufacturing and production delays, the CEC granted CVUSD a project extension. In response to the continued delays and uncertainty surrounding vehicle availability, CVUSD elected to transition to a Blue Bird Type D electric school bus in 2022. The replacement vehicle was ultimately delivered to CVUSD in 2023.

While the transition allowed CVUSD to move forward with project implementation, the change in manufacturers resulted in additional coordination, procurement adjustments, charging compatibility considerations, and revised deployment timelines.

Lessons Learned

CVUSD gained valuable operational and infrastructure experience throughout the implementation and operation of the electric school bus project.

One of the primary lessons learned was the importance of charging infrastructure reliability and compatibility. While Vehicle-to-Grid technology presents future opportunities, CVUSD found that maintaining dependable daily student transportation operations requires charging systems that prioritize stability, simplicity, and operational consistency. CVUSD's transition to ABB Terra charging equipment significantly improved charging reliability and reduced operational interruptions.

The project demonstrated that the reliability of charging infrastructure can have a greater operational impact than the vehicle itself. Even when the vehicle was mechanically available, charging instability prevented deployment into daily service.

Additionally, CVUSD learned that emerging technologies, including Vehicle-to-Grid systems, must be evaluated not only for innovation potential but also for operational reliability within a pupil transportation environment where daily service continuity is critical.

The project further demonstrated that electric school buses currently require substantially operational planning and oversight. Route planning, charging schedules, battery management, environmental conditions, vendor coordination, and vehicle availability all require continuous monitoring and operational adjustment to ensure service reliability.

CVUSD also learned that manufacturer support, parts availability, dealer responsiveness, and technical troubleshooting capabilities are critical components of successful electric bus deployment. Extended diagnostic timelines and delays in identifying mechanical issues created operational challenges and reduced vehicle availability. Strong vendor partnerships and responsive technical support are essential to maintaining fleet reliability.

Overall, the project provided CVUSD with valuable real-world experience in operating zero-emission school bus technology and helped identify infrastructure, operational, maintenance, and support considerations that will assist CVUSD in future alternative-fuel fleet planning and deployment efforts.

CHAPTER 3:
Workforce Training Funding

In anticipation of the CEC's School Bus Replacement Program, in 2018 the CEC began to work with California school districts, county offices of education, and joint power authorities to understand the importance and role of school bus training for zero-emission school bus technology. Many school districts expressed the need for training of school bus maintenance and service technicians, as well as training for bus operators for battery-electric technology.

In 2019, the CEC approved a $1 million contract with Cerritos Community College to develop and implement the "Electric School Bus Training Project." Cerritos Community College developed the curriculum with the Southern California Regional Transit Training Consortium and college faculty throughout the state. Faculty from the colleges provided training in the school bus regions through a hybrid of in-person and online training.

The training project included automotive instructor led training to maintenance and service technicians for 96 hours. It also included 12 hours of school bus operator training. The training content consisted of:

- Electric Vehicle School Bus and Charging Infrastructure Familiarization.
- Circuit Diagnostic With Digital Volt Ohm Meter.
- Computerized Engine Management Systems.
- Complexity of the Harness and Computer Functions in the Modern Chassis.
- Programmable Logic Controller Input/Output Systems Diagnostics.
- Network Systems Electronics Diagnosis and Repair
- Electric Bus Driver Training Familiarization.

Workforce training is an important consideration when incorporating zero-emission school buses into a fleet. As with most new technologies, there is a learning curve and operational adjustments the fleet must make to maximize the benefits of the technology. Compared to conventional-fueled school buses, there are differences in zero-emission school bus maintenance and operation. For example, zero-emission school buses have fewer moving parts, do not have an exhaust system, or require oil changes, and the braking systems of these buses last longer. For these reasons, along with many more, electric school buses have proven to be a cost-effective solution.

CHAPTER 4:
Data Collection

12-Month Data Collection

A requirement of the School Bus Replacement Program was to collect 12 months of data and metrics on the usage of the new buses. These data points will be used to determine the financial, environmental, and health benefits of replacement school buses funded by the CEC. Listed below are the specific data points for the one bus funded by the School Bus Replacement Program.

Cajon Valley Union School District Bus 597

When placed into service over a 12-month period, Cajon Valley Union School District's Bus 597, shown in Figure 3, traveled 9,618 miles. The replaced diesel fuel bus had a miles-per-diesel-gallon average of 7. The miles traveled over the reporting period equate to a total reduction of 1,374 gallons of diesel. This reduction in total gallons of diesel equates to a reduction in 899.57 gallons.

The average cost of a gallon of diesel fuel was $3.67 during the reporting period. This equals a diesel cost savings of $3,301.43. The total replaced diesel maintenance cost of the scrapped bus was $1,062.84. Over the 12-month period, the new electric school bus used 8,507.21 kWh. The total cost for this electricity usage was $1,567.75. Total maintenance cost for the new electric school bus amounted to $1,062.84. During this 12-month period alone, Cajon Valley Union School District was able to save $2,796.52.

The CEC's School Bus Replacement Program will help reduce tailpipe emissions of smog-forming nitrogen oxides by 98,000 lbs. and toxic diesel soot by more than 2,500 lbs. Minimizing exposure to hazardous emissions reduces the risk to adolescent bus riders of developing respiratory diseases such as asthma and helps the state achieve emissions reductions goals.

Figure 3: Electric Replacement Bus Number 597

Source: Cajon Valley Union School District

CHAPTER 5:
Conclusion

The School Bus Replacement Program was vital to the long-term success of transporting students to and from school. Not only is the program saving districts time and money, it is also helping reduce the total amount of emissions released into the environment. Cajon Valley Union School District is dedicated to contributing to California's overall goals of decreasing greenhouse gas emissions and improving overall air quality.

District Next Steps Toward California Climate Goals

Cajon Valley Union School District remains committed to supporting California's climate and zero-emission transportation goals through continued fleet modernization, infrastructure investments, and long-term operational planning.

CVUSD will continue to actively pursue grant and funding opportunities to support the transition of the transportation fleet to lower-emission and zero-emission technologies. CVUSD is planning vehicle replacement schedules and procurement efforts to align with California's Advanced Clean Fleets regulation while maintaining safe and reliable student transportation operations.

At the time of this report, CVUSD has four additional electric school buses on order, with delivery anticipated during Quarter 4 of 2026. As electric vehicle technology continues to evolve, CVUSD is evaluating vehicle platforms that offer extended operational range. Increased vehicle range is expected to improve operational flexibility and enable greater integration of zero-emission vehicles into daily route operations, activity trips, and field-trip transportation services.

CVUSD is also continuing to modernize and improve the reliability of charging infrastructure. Based on operational experience and field testing, CVUSD is transitioning away from older Nuvve charging equipment and replacing those systems with ABB Terra charging platforms. The ABB Terra chargers have demonstrated significantly improved charging stability, broader OEM compatibility across multiple vehicle manufacturers, and increased operational reliability within CVUSD's transportation environment.

In addition to expanding zero-emission vehicle deployment, CVUSD will continue replacing older combustion-engine vehicles with newer, more fuel-efficient technologies and zero-emission alternatives whenever operationally and financially feasible. CVUSD recognizes that a successful transition to cleaner transportation technologies requires balancing environmental goals with operational reliability, infrastructure readiness, vehicle capability, and the need for uninterrupted student transportation services.

Through continued investment, operational evaluation, and phased fleet replacement planning, CVUSD intends to further reduce fleet emissions while supporting California's long-term clean transportation and climate objectives.

GLOSSARY

CALIFORNIA ENERGY COMMISSION (CEC) — The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, sections 25000 et seq.) responsible for energy policy. The CEC's seven major areas of responsibilities are:

1. Planning and Policy Development
2. Renewable Energy Growth
3. Energy Efficiency
4. Energy Innovation
5. Cleaner Transportation
6. Responsible Electricity Infrastructure
7. Emergency Response

KILOWATT (kW) — One thousand watts. A unit of measure of the amount of electricity needed to operate given equipment. On a hot summer afternoon, a typical home — with central air conditioning and other equipment in use — might have a demand of 4 kW each hour.

KILOWATT-HOUR (kWh) — The most commonly used unit of measure telling the amount of electricity consumed over time, means 1 kilowatt of electricity supplied for 1 hour. In 1989, a typical California household consumed 534 kWh in an average month.

LOW CARBON FUEL STANDARD (LCFS)—A set of standards designed to encourage the use of cleaner low-carbon fuels in California, encourage the production of those fuels, and therefore reduce greenhouse gas emissions. The LCFS standards are expressed in terms of the carbon intensity of gasoline and diesel fuel and their respective substitutes. The LCFS is a key part of a comprehensive set of programs in California that aim cut greenhouse gas emissions and other smog-forming and toxic air pollutants by improving vehicle technology, reducing fuel consumption, and increasing transportation mobility options.

NITROGEN OXIDES (OXIDES OF NITROGEN, NOx)—A general term pertaining to compounds of nitric oxide (NO), nitrogen dioxide (NO2), and other oxides of nitrogen. Nitrogen oxides are typically created during combustion processes and are major contributors to smog formation and acid deposition. NO2 is a criteria air pollutant and may result in numerous adverse health effects.

PARTICULATE MATTER (PM)—Unburned fuel particles that form smoke or soot and stick to lung tissue when inhaled. A chief component of exhaust emissions from heavy-duty diesel engines.

SHORT TON—An imperial unit of mass equal to 2,000 pounds.