FAILING THE GRADE:

How Diesel School Buses Threaten Our Children's Health.

Mapping the Way to Clean Alternative Fuel School Buses.

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COALITION FOR CLEAN AIR

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About the Coalition for Clean Air

The Coalition is the leading environmental organization dedicated exclusively to restoring clean, healthful air to California and has a long history of working with regulatory agencies in support of responsible, innovative, and effective air quality improvement programs. The Coalition continues to work on the development and implementation of advanced transportation technologies throughout the State of California and beyond.

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TABLE OF CONTENTS

Tables

Figures

Introduction.

School Children at Risk.

It's time for school and as dutiful parents, we carefully escort our children to the curbside to await that yellow school bus to safely deliver our kids to the classroom. We entrust the public school transportation system with our children because we believe it to be safe, reliable and convenient. Although our children return home from school appearing safe and healthy, what we may fail to see is the real, physical damage that can take hold inside the deep recesses of our children's lungs due to diesel exhaust exposure.

Ironically, the very transportation system that carries America's most precious resource - our children - can be characterized as the most aged, least funded, and one of the most polluting fleets in the nation. California lags behind many other states in turning over its school bus fleets. California ranks 47th in the nation with over 4 percent of its bus fleet predating 1977.[1,2]

In 1998, a resolution was adopted by the California Air Resources Board (CARB), the state's air quality agency, prioritizing the replacement of all pre-1977 Type I diesel buses by 2003. The resolution further stated that pre-1977 diesel school buses emit at least three times more smog-forming oxides of nitrogen (NO_x) than clean alternative fuel school buses and approximately four times more particulate matter (PM).[3] Despite the adoption of Resolution 98-49 (see Appendix A), CARB has yet to adopt more stringent air pollution standards for school buses.

The age and diesel dependence of California's school buses is especially troubling because children are more susceptible to the health effects of air pollution than adults. Unlike adults, a child's organs, including the brain, lungs, and reproductive system, are in a constant state of development and do not reach full maturation until well past puberty. Due to the body's immaturity, a child is far less capable of defending herself from airborne pollutants and toxics that can penetrate deep into her respiratory tract and other vital organs. Children also breathe more air per pound of body weight at a rate of two to three times that of an adult. This relatively greater rate of intake combined with the tendency for a child to breathe through the mouth instead of the nose means that children receive higher doses of contaminants present in air, increasing overall exposure. Furthermore, children typically play outdoors during the day when air pollution levels are at their peak. Even a child's height in relation to the ground increases the amount of exposure to airborne particles that may be re-suspended into the air by tires, wind or other sources.

LETTERS TO THE L.A. TIMES
Nov. 22, 1998

School Buses

Driving in the San Fernando Valley on a spectacularly clear afternoon, I passed Birmingham High School at dismissal time. Bus after bus, perhaps a dozen or more, pulled away from the school and emitted massive plumes of dense black smoke that fouled the blue sky and stank up the air inside and outside my car.

To my knowledge, school buses don't have seat belts. They obviously don't have to maintain any emission standards. Do we want our children riding on these dangerous conveyances? Does the Los Angeles Board of Education care?

JUDITH R. BIRNBERG
Sherman Oaks

Because diesel-powered school buses may significantly increase the level of air pollution exposure to a child, parents have a right to know that their children may be boarding a bus that emits exhaust that is classified by state health officials as a toxic air contaminant known to cause cancer. Concerned parents, educators, school administrators and school district general managers must act now to limit the continued use of diesel and accelerate the transition to cleaner alternative fuels in our school transportation system.

Efforts have been made by federal, state and local governments to help public and private fleets purchase and operate clean alternative fuel trucks and buses. However, these limited government funds fail to cover the fueling station and maintenance facility costs required to run a successful clean alternative fuel school bus operation and are generally geared toward fleets that operate more hours per day than a typical school bus fleet. Thus, many school districts throughout the state opt not to apply for government funding programs because they do not believe they are likely to receive government funds. For those school districts that do apply, clean air project dollars are so limited that only a few candidates will be awarded funding. School districts often choose not to initiate clean alternative fuel programs independent of public funds because the costs associated with purchasing clean alternative fueled school buses are higher than the costs associated with today's diesel technologies. This combination of factors largely explains why clean alternative fuels power less than three percent of California's school buses today.

The majority of California's children reside in regions designated by the United States Environmental Protection Agency (U.S. EPA) as "unhealthy." Incidences of childhood asthma and cancer have been nationally on the rise over the past two decades. We know diesel exhaust increases instances of asthma and causes cancer. We know that cleaner alternatives are available and can significantly reduce the health risks posed by diesel to our children. We must move aggressively toward the adoption of clean alternative fuels in our school bus fleets.

Though we believe this to be a national problem, this report focuses on the problems California faces with its diesel school bus fleet. This report is intended to inform parents, educators, school administrators, and state and local policymakers of the dangers both children and the general public face when exposed to diesel exhaust. It is also designed to heighten the public's awareness of the availability of cleaner alternative fuel school bus technologies. It is recommended that school districts immediately phase-out the use of diesel and phase-in the use of clean alternative fuels. This report also recommends that the Governor and members of the California legislature make additional funding available for clean alternative fuel school buses in the state budget.

HIGHLIGHTS.

- Diesel exhaust is harmful to our health. It acts as a respiratory irritant and may cause wheezing, difficulty in breathing, eyes and throat irritation, and chronic bronchitis.[4] Diesel exhaust is believed to increase the risk for asthma attacks, lung cancer and premature death.[5]

- Children respire at a rate twice that of an adult, and are thus more susceptible to the toxicity of airborne diesel particles, vapors and gases.[6] Athletes, the elderly, and those with pre-existing respiratory disease are also at greater risk.

- New cases of childhood asthma nationwide rose nearly 60 percent during the 1980s and early 90s. During this period, the severity of childhood asthma as measured by hospitalizations and childhood deaths also increased.[7]

- Over 69 percent of the 24,372 school buses in California's fleet run on diesel fuel and approximately 4 percent of the fleet predates 1977 model years.[8,9,10] Only 3 percent of California's school buses run on clean alternative fuels.

- Only 2 percent of the vehicles on California's roads are diesel-powered and yet diesel vehicles constitute 31 percent of the total smog-forming oxides of nitrogen and 79 percent of the total particulate matter (PM) emissions produced by on-road vehicles.[11]

- According to the South Coast Air Quality Management District, the average diesel school bus on the road today is 223.5 times more toxic than a new compressed natural gas (CNG) school bus.[12]

- California's school bus fleet ranks 47th in taking pre-1977 school buses off the road.[13] The California Air Resources Board has determined that pre-1977 diesel school buses pollute at least three times more smog-forming oxides of nitrogen and four times more soot than clean alternative fuel school buses.[14]

- Diesel exhaust was listed as a known human carcinogen in October 1990, under California's Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) and was identified as a toxic air contaminant (TAC) by the California Air Resources Board in August 1998.

- According to the California Scientific Review Panel's risk evaluation of diesel exhaust soot, as many as 16,010 Californians may contract lung cancer from diesel exhaust exposure over their lifetime.[15,16]

- There is no such thing as a "clean diesel" engine. The newest diesel engines available on the market today are the most polluting engines for new sale. Unlike clean alternative fuel engines, not one diesel engine is currently certified to the California Air Resources Board's low optional (less polluting) oxides of nitrogen (NO_x) standard.

- Clean alternative fuel school buses are currently available on the market. The phase-out of diesel and the phase-in of clean alternative fuels would provide a clear strategy for school districts to significantly reduce diesel exhaust exposure to our children.

- Approximately sixty California school districts operate more than 650 clean alternative fuel school buses. These buses have traveled more than 64 million miles transporting school children to and from school.[17]

SELECTED POLICY RECOMMENDATIONS.*

- Governor Gray Davis and the California legislature should make it a priority to provide state funds that are exclusively earmarked for the purchase of clean alternative fuel school buses, the costs of refueling and maintenance infrastructure, and training of mechanical personnel.

- The California Air Resources Board (CARB) should live up to its own Resolution 98-49 which supports immediate and continuing efforts to replace diesel-fueled school buses with clean alternative fuel school buses. This resolution also recognized the importance of replacing **all** pre-1977 Type I diesel buses by 2003 because such buses emit three times more NO_x than new alternative fuel school buses and four times more particulate matter (PM).

- CARB should adopt at the earliest feasible time emission standards which reflect the state-of-the-art low emission levels of CNG bus technology for all categories of school buses, with a gradual requirement for school districts to phase in zero emission electric or fuel cell bus technologies.

- The United States Environmental Protection Agency must significantly tighten engine emission standards for heavy-duty vehicle applications, including school buses, and provide increased incentives for technologies that significantly reduce both air pollution and air toxics in our environment.

- School boards should adopt a clean alternative fuels policy similar to the Los Angeles County Metropolitan Transportation Agency's (MTA) Alternative Fuels Initiative (AFI). MTA's AFI policy calls for the purchase of 100 percent clean alternative fuel buses for all future procurements.

- School boards should only employ private contractors that commit to converting their school buses to clean alternative fuels.

- Parent-Teacher Associations and environmental, community, and public health advocacy groups must advocate for federal, state and local strategies that will significantly reduce the level of emissions released by California's school bus fleets. Specifically, these groups should support school bus funding legislation in 2000, urge the California Air Resources Board to make clean school buses a priority, and lobby local school districts to purchase cleaner alternative fuel buses.

- Engine manufacturers must do their part to protect public health by increasing their research and development, marketing, and manufacturing of clean alternative fuel engines.

- The petroleum industry should support the development of alternative fuel infrastructure throughout the state and the nation.

* The complete list of policy recommendations is found in Chapter 6.

CHAPTER ONE.

The Health Effects of Diesel Exhaust on Children.

Our children are our most precious resource. They are also more susceptible than the average adult to the health effects caused by diesel exhaust exposure and are therefore in need of greater protection. Diesel school buses pose an immediate as well as long-term health threat to our children. Not only do diesel exhaust emissions contribute significantly to air pollution levels of ground-level ozone (smog), NO_x, and particulate matter, but diesel exhaust is also the major contributor to ambient levels of air toxics. Although we entrust the public school system to transport our children safely, a school bus that runs on diesel fuel is hazardous to their health and ours.

Air Pollution Is Harmful To Our Health

The harmful nature of air pollution has been recognized for several decades and the emissions from diesel engines are a significant source of California's outdoor air pollution. Studies from as early as the 1930's have documented health effects from increased levels of air pollution, including greater rates of death, especially for children and the elderly.[18,19] Health effects from air pollution can result from both acute (short-term) and chronic (long-term) exposures and can be permanent or temporary. Symptoms of exposure range from mildly irritating to life-threatening. Temporary health effects include coughing, chest tightness, shortness of breath, decreased breathing capacity, shortened ability to exercise, asthma exacerbations, decreased lung clearance of particles and increased pulmonary permeability and inflammation.[20] Permanent effects from exposure to air pollution can result in chronic bronchitis, restricted lung growth in children, greater risk for developing lung cancer, and can lead to premature death.[21] Certain individuals and groups of people are even more sensitive, or susceptible, to the health effects of air pollution and diesel exhaust exposure. These sensitive populations include children, the elderly, those with compromised respiratory systems, and even athletes.

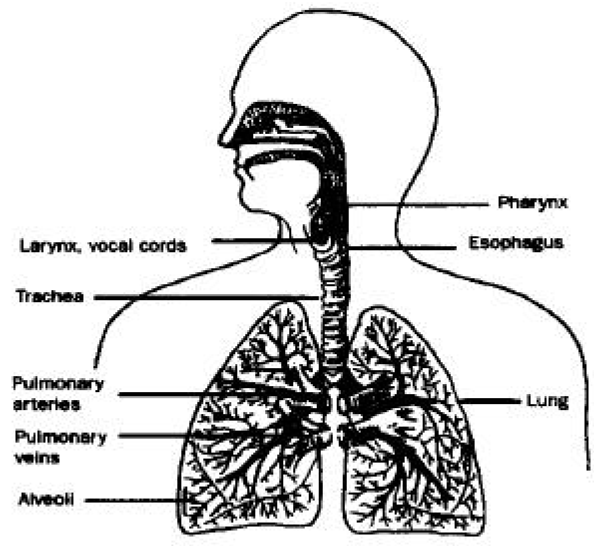
People who live in cities with dirty air have blacker lungs than people who live in rural areas with less air pollution.

Source: Etzel, R.A. U.S. Public Health Service, Washington, D.C.

Diesel Exhaust and Health Effects

Health officials worldwide have recognized for over a decade that diesel exhaust is a respiratory irritant and a human carcinogen. Short-term exposure to diesel exhaust can cause wheezing, headaches, irritation to the eyes and throat, and nausea. These health effects tend to be worsened in those who have compromised respiratory systems, such as people with asthma. Long-term exposure can cause irreversible respiratory damage, permanent structural changes to the pulmonary system, increased risk for developing lung cancer, more frequent hospitalizations and premature death.

Figure 1: The Human Airway



Source: Office of Technology Assessment, Identifying and Controlling Pulmonary Toxicants: Background Paper, OTA-BP-PA-91, June 1992.

In a laboratory experiment conducted on healthy human volunteers, exposure to diesel exhaust while engaged in moderate intermittent exercise resulted an observable inflammatory response.[22] The level of PM exposure was within the high ambient range comparable to levels found in enclosed spaces, such as train stations, bus depots, and in many industrialized cities of developing countries. The authors concluded that even short-term acute exposure to diesel exhaust can result in marked systemic and pulmonary inflammatory responses that may be underestimated by standard lung function tests. Chronic exposure to diesel exhaust has the potential to permanently damage the respiratory system, and lead to the development of chronic bronchitis.[23]

Children are more susceptible to the health effects from diesel exhaust exposure than adults. However, the school buses that transport our children to and from school overwhelmingly run on diesel fuel. Everyday, our children step aboard and ride a school bus that may intensify their exposure to diesel exhaust, a known human carcinogen. This exposure does not end with the bus ride, however. Exposure also occurs in and around the school grounds when school buses park and idle nearby or load and unload students.

Children Are At Greater Risk

A child's body is constantly developing and does not reach full maturation until after puberty. During this time, a child's body is less capable of defending itself from airborne particles and foreign substances that can penetrate the respiratory tract and other vital organs. A child's enhanced susceptibility is compounded by the biological and physical characteristics of her immature body that results in greater exposure. For example, a child has a faster metabolism than an adult as well as a breathing rate typically twice that of an adult. Due to this greater breathing rate relative to body weight and lung surface area, a child's developing lungs receive and retain a greater dose of pollution than that of an adult.[24] Children also have a tendency to breathe through their mouths rather than their nasal passages, which are restricted due to immaturity. Mouth breathing results in an increased deposition of small particles into the deepest regions of the lungs.[25] A child's respiratory passageway is also much narrower than an adult's, and exposure to air pollution can often inflame and irritate the passageways. This can result in greater risk for significant airway obstruction.[26] Even a child's height in relation to the ground increases the amount of exposure to secondary airborne particles re-suspended by tires or natural forces. All of these factors contribute to a child's greater risk from exposure to air pollution.

A child's natural behaviors also puts her at greater risk of exposure to outdoor air pollution. Children spend on average 50% more time outdoors than adults.[27] Furthermore, children tend to engage in play and rigorous activity outside when air pollution levels are at their peak. This increased activity level leads to greater respiratory rates and therefore greater risk from exposure.

Health Effects and Children

Health Effects of Air Pollution in Children

- Increased prevalence of respiratory symptoms;
- Increased acute respiratory disease morbidity;
- Infectious episodes of longer duration;
- Lowered lung function when pollutants increase;
- Lowered lung function in more polluted regions;
- Increased sickness rates;
- Aggravation of asthma;
- Increases in mortality in very severe episodes;
- Increased risk of peri-neonatal mortality in regions with higher pollution;
- Increased general rate of mortality in children.

Source: Dr. Henry Gong. 1999. Presentation to the Clean Transit Workshop in Anaheim, CA.

Numerous studies have documented greater impacts of air pollution on children's health. Air pollution exposure may cause health effects that range from mildly irritating to permanently damaging. For example, increased rates of mortality have been observed in children during intense periods of air pollution and in heavily polluted geographic regions.[28] Air pollution levels have a statistically significant association with increased respiratory symptoms and greater numbers of school absences in children.[29] In a 10-year study on 3,293 southern California schoolchildren living in 12 different communities, the relationship between chronic health effects and air pollution exposure was investigated.[30] Lung function tests indicated that air pollution, including particulate matter (both PM_{10} and $PM_{2.5}$), ozone, and nitrogen dioxide were associated with decreased lung function in girls, especially in those who spent more time outdoors. Decreased lung function was also strongly associated with ozone exposure in boys who spent more time outdoors. In another large study conducted on 1,001 preadolescent children, average growth rate for pulmonary function was found to be significantly lower for children residing in more heavily polluted areas.[31] These findings suggest that the levels of air pollution found in our neighborhoods retards the growth of our preadolescent children's pulmonary function. The effects of exposure to air pollution may well impact these children for the rest of their lives.

The Dangers Of Living In or Near Urban Areas

Many studies have supported the belief that it is unhealthy to live and breathe in or near centers of heavy urban traffic congestion, especially for our children. Diesel exhaust emissions levels are highest near busy streets, highways, truck and bus terminals, and parking areas.[32] Respiratory symptoms including wheezing and asthma have been found to be significantly more common in children living in close proximity to freeways, particularly for girls.[33] Truck traffic density was also related to the respiratory symptoms. Another study examined the effects of air pollution on children living in areas near major motorways and found that lung function was associated with truck traffic density and that the association increased for those children that lived closer to the motorways.[34] Again, associations were stronger for girls. Other studies have discovered positive associations between truck traffic and symptoms of asthma and "hay fever" symptoms.[35, 36] In yet another study, children admitted to the hospital for asthma were significantly more likely to reside in areas near major roads with high flow of traffic.[37]

Ground-level Ozone, Particulates, and Children

In the upper atmosphere the presence of ozone is beneficial and serves to protect us from the deleterious effects of ultraviolet radiation emitted from the sun. However, the ozone gas that forms near the earth's surface, also known as smog, acts as an insidious air pollutant that is harmful to our health and the health of our children. Ground-level ozone is the principal component of outdoor smog, and is formed as a secondary pollutant through the reaction of hydrocarbons with nitrogen oxides (NO_x) in the presence of sunlight. Motor vehicles, such as diesels, represent the major source of emissions of ozone precursors, most of which are NO_x.[38]

Ground-level ozone has long been recognized as a public health problem, but efforts to control its formation and spread have been challenging.[39] Its pervasive nature is due to the fact that ozone formation can take place over very large regions far from the origin of its reactant gases.[40] Ambient levels of ground-level ozone today remain high in most of California's air regions.

The adverse health effects of ozone on health especially for children are well recognized and documented. Unfortunately, ozone pollution levels also tend to be highest in the summer months and during the middle of the day when young children are most often outside at play. Furthermore, children are often not as aware as adults of the warning signs of respiratory distress that result from breathing in ozone.[41] This places them at even greater risk as they continue to play outside. Exposure to ozone is associated with increased lower and upper respiratory symptoms in children. Levels of ambient ozone have been found to cause decreased lung function in healthy children.[42] A study investigating the influence of air pollution on the incidence of acute respiratory wheezing in children documented strong associations between the number of hospital emergency room visits and ozone concentrations.[43]

According to the American Lung Association, the lung damage caused by ozone exposure may be likened to the effects caused by cigarette smoking.

American Lung Association. 1996. Lung Disease Data.

Particulate matter (PM), or soot, consists of very small particles that are easily inhaled into the lungs. Ninety-eight percent of diesel exhaust particles are respirable and toxic.[44] Children's health is at risk from PM exposure from diesel exhaust. For example, increased absences in school children have statistically significant associations with air pollution levels of PM.[45] A two-year study on children investigated daily visits to primary health clinics and found statistically significant associations with PM exposure and increased respiratory symptoms.[46] The association of PM with lung cancer in occupationally exposed workers is cause for concern for children's long-term health.

Asthma And Children

Asthma is the most common chronic disease of children, and the most common cause of childhood hospitalizations in California.

Source: MMWR, 1996 and English et al., 1998 PannAm J Public Health

Asthma is a very common and potentially life-threatening disease with a range of symptoms and degrees of severity. Clinical symptoms of asthma include wheezing, shortness of breath, and difficulty in breathing to such an extent that death may occur. The airways of asthmatics are characterized by constant inflammation and hyper-reactivity.[47] In the United States, over 12 million people are afflicted with asthma and the numbers are rising.[48] Between 1982 and 1994, the prevalence of asthma increased by 61%, with the greatest increases occurring for children.[49] California leads the nation with over 2 million people diagnosed with asthma, and an increased prevalence rate of 75% in the last 15 years.[50,51] This pervasive disease hits children especially hard. Over four million children suffer from asthma in the United States, including 500,000 in California.[52,53]

Many studies have documented greater respiratory problems in children with asthma who are exposed to air pollution, ozone, and particulate matter.[54,55] A recent study found that asthmatic children are particularly sensitive to air pollution health effects.[56] The study focused on more than 3,000 fourth, seventh and tenth graders with asthma and related symptoms from 12 different southern California communities. The study found increased prevalence of chronic phlegm and bronchitis associated with air pollution, especially nitrogen dioxide and particulate matter. In fact, as the particulate matter concentration levels increased among the communities so did the risk of bronchitis. Additional studies have associated relatively low air concentration levels of particulate matter and nitrogen dioxide with decreased breathing capacity (measured as peak expiratory flow, or PEF) in children with asthma, especially those living in urban areas.[57]

Doctors' visits and hospital admissions for asthma-related symptoms have also been repeatedly linked with air pollution exposure. Daily general practitioner consultations for asthma increased with levels of nitrogen dioxide in a study conducted on children over 1992-1994.[58] In another study that focused on daily admissions to acute care hospitals, respiratory and asthma admissions were significantly associated with levels of ozone and sulfur dioxide.[59] A five-year study also found a strong association between house calls for asthma and air pollution levels that was especially strong for children.[60] Recent studies have implicated the products of fossil fuel combustion, such as diesel exhaust, as partly responsible for the increase in prevalence of asthma.[61]

Asthma Affects Family and Society

Children with asthma experience a diminished quality of life. Asthma impacts a child's play, school, and home life. Asthma is a leading cause of absences from school.[62] Both the family of an asthmatic and society at large are also affected by this pervasive disease. No parent wants to see his or her child suffer from the pain of asthma. When an asthmatic suffers an attack, parents often stay home from work to care for their child. Medicines and trips to the doctor are costly, and add up over time. Society as a whole must incur the economic impacts of doctor and hospital bills resulting from asthma. In California, hospitalization costs for asthma alone amounts to over $350 million each year.[63]

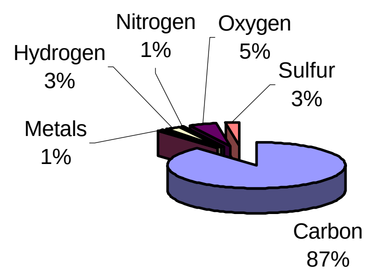
Given that diesel exhaust emissions impart such a significant contribution to our air pollution problem and are known to cause adverse health effects, school districts should make a concentrated effort to reduce this exposure, especially when clean alternatives for school buses are available on the market today. The use of diesel must be reduced and eventually eliminated in our school education system to protect the health of our children.

CHAPTER TWO.
Why it is the End of the Line for Diesel: Exposure and Health Effects.

Most of us have at some point in our lives held our breath as a diesel-powered truck or bus rolled by with its exhaust manifold spewing out foul-smelling black smoke and soot. Not only do diesel exhaust fumes smell bad and significantly contribute to the brownish tinge in our otherwise blue horizon, but breathing these fumes is known to be harmful to our health.

What is Diesel Exhaust?

Figure 2. Diesel Exhaust Particulate

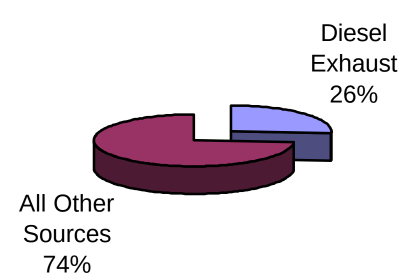


Source: California Environmental Protection Agency. 1998. Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant. Part A. Exposure Assessment. Air Resources Board. P. A-11.

Diesel exhaust is a complex mixture of particles, vapors and gases formed by the combustion process of a diesel-fueled engine. It consists of both a vapor phase and a fine particulate phase. The vapor phase is comprised of a number of different gases including oxides of nitrogen, carbon dioxide and carbon monoxide, sulfur oxides, and a whole host of polycyclic aromatic hydrocarbons (PAHs) and nitro- polycyclic aromatic hydrocarbons (nitro-PAHs). Many of the vapor-phase gases are known to cause harmful health effects including lung cancer. The particulate phase of diesel exhaust consists of a carbon core surrounded by a variety of organic compounds. These organic compounds adsorb onto the particulate core and can include substances that are highly toxic and carcinogenic, such as PAHs and nitro-PAHs. The adsorbed organic compounds of diesel exhaust have been estimated to include approximately 18,000 different substances, many of which are known to cause genetic damage and cancer.[64]

Diesel Exhaust And Air Pollution

Figure 3. 1996 Diesel Exhaust Contribution to National NOx Emisssions



Source: Office of Air Quality Planning and Standards. National Air Pollutant Emission Trends, 1900-1996. U. S. EPA. Appendix A. December 1997.

Vehicles that run on diesel fuel contribute a disproportionate amount of air pollution and toxic risk when compared individually to other non-diesel vehicles on the road. Diesel exhaust emissions significantly contribute to oxides of nitrogen (NO_x), fine particulate matter, and air toxics, all of which are associated with serious adverse health effects. According to CARB, diesel trucks and buses have been estimated to account for 79 percent of the particulate emissions and 31 percent of the smog-forming nitrogen oxides that make up California's total mobile source inventory, while representing only 2 percent of the state's on-road vehicles.[65] Further, California's Scientific Review Panel estimates that 16,010 Californians will develop lung cancer over a lifetime of diesel exhaust exposure.

Diesel Exhaust is Identified as Toxic.

Air toxics are air pollutants that pose a potential hazard to human health, and may contribute to or cause increased illness or death. In California, substances are evaluated for toxic air contaminant (TACs) classification by the Office of Environmental Health Hazard Assessment. After 10 years of thorough review, diesel exhaust was listed as a TAC in August 1998 by the California Air Resources Board (CARB). The listing of diesel exhaust as a TAC was under the advisory of the Scientific Review Panel, an independent group of scientists charged with the task of evaluating the risks of compounds in use throughout the state of California. Diesel exhaust is also subject to regulation under the California's Safe Drinking Water and Toxic Enforcement Act of 1986, also known as Proposition 65. This legislation supports the people's right to know if they are exposed to significant levels of chemicals that are carcinogenic or reproductive hazards. Diesel exhaust was listed as a Proposition 65 chemical on October 1, 1990. On a national level, the regulation of air toxics falls under the "Hazardous Air Pollutant" (HAP) program of the Clean Air Act. Diesel exhaust is currently under review as a potential HAP by the U.S. Environmental Protection Agency (EPA). Furthermore, the U.S. EPA and CARB have already identified at least 40 of the individual substances within diesel exhaust that are probable carcinogens or reproductive hazards.

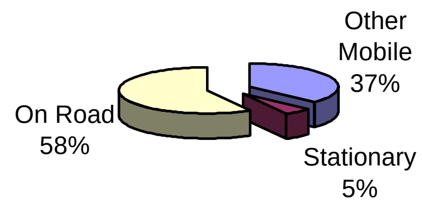
Table 1. Substances in Diesel Exhaust Listed by Cal EPA as Toxic Air Contaminants

Acetylaldehyde	Cobalt compounds	4-Nitrobiphenyl
Acrolein	Creosol isomers	Phenol
Aniline	Cyanide compounds	Phosphorous
Antimony compounds	Dibutylphthalate	Polycyclic organic matter, (polycyclic aromatic hydrocarbons, or PAHs and their derivatives)
Arsenic	Dioxins and dibenzofurans	
Benzene	Ethyl benzene	
Beryllium compounds	Formaldehyde	
Biphenyl	Inorganic lead	Propionaldehyde
Bis[2-ethylhexyl]phthalate	Manganese compound	Selenium compounds
1,3-Butadiene	Mercury compounds	Styrene
Cadmium	Methanol	Toluene
Chlorine	Methyl ethyl ketone	Xylene isomers and mixtures
Chlorobenzene	Napthalene	o-, m-, and p-xylenes
Chromium compounds	Nickel	

The carcinogenic nature of diesel exhaust has been supported by numerous occupational and epidemiological studies on humans and laboratory controlled animal studies.[66] Several occupational studies on workers chronically exposed to elevated levels of diesel exhaust, such as truck drivers and railroad workers, have consistently linked diesel exhaust exposure with an increased risk for developing lung cancer.[67,68] The causal association of lung cancer with diesel exhaust exposure was further substantiated through an evaluation of 29 published occupational studies (a meta-analysis).[69]

Particulate Matter

Figure 4. Sources of Diesel Particle Emissions in California, 1995



Source: California Air Resources Board, Emission Inventory 1995, *Technical Support Division*, October 1997.

Diesel exhaust is a major contributor to particulate matter concentrations in the United States. The particulate matter component of diesel exhaust is responsible for a significant portion of its toxicity. In fact, the overall carcinogenic potential of air pollution is believed to be associated with its particulate fraction.[70]

Respirable particulate matter is categorized according to size, and is subdivided into a coarse size fraction and a fine size fraction. Coarse size particles, or PM_{10}, are generally considered to consist of all particles less than 10 microns in aeronautical diameter. Fine size particles, or $PM_{2.5}$, are those particles equal to or less than 2.5 microns in diameter (equal in size to $1/8^{th}$ of the diameter of a human hair follicle). Fine particles are derived primarily from fossil fuel combustion, but coarse particles (2.5 and 10 microns) are derived from crustal material, or dust. Both PM_{10} and $PM_{2.5}$ are small enough to penetrate deeply into the lungs.[71] The vast majority (approximately 94 percent) of the diesel exhaust PM is fine PM or 2.5 microns or smaller.[72]

Adsorbed to the fine particulate component of diesel exhaust are hundreds of chemicals that include numerous known or suspected mutagens or carcinogens.[73] The toxic nature of diesel exhaust is believed to occur from the harmful chemicals adsorbed to the particles combined with the ease with which these very small particles enter, lodge and are absorbed within the lungs. In fact, virtually all inhaled particles less than 10 microns are deposited within the respiratory tract.[74] The American Lung Association believes that $PM_{2.5}$ represents the most serious threat to our health.

Health Effects of Particulate Matter

Exposure to PM pollution has been associated with a whole host of health effects that include respiratory and cardiac problems, premature death, and lung cancer. PM exposure has been linked with increased prevalence and severity of asthma and allergic rhinitis (hay fever) and greater risk of hospital admissions for heart and lung disease.[75,76] The inflammatory damage to the lungs that results from exposure to fine particulate matter may be responsible for the observed increased risk of hospitalization or premature death.[77]

Increased mortality (deaths) has been directly linked to daily fluctuations in particulate matter concentration.[78,79] In fact, the World Health Organization (WHO) has estimated that half a million premature mortalities each year may be associated with PM pollution.[80] Medical researchers at the American Lung Association followed more than 8,000 persons over a 15-year period of study and found that the risk of premature death in areas with high $PM_{2.5}$ pollution was 26 percent greater than in less polluted areas.[81] In another research study that involved 6,338 nonsmoking Californians from 1977 to 1992, PM_{10} was strongly associated with mortality, as well as with lung cancer deaths in males.[82] In another large study spanning 151 areas within the United States on over half a million people, fine particulate air pollution at levels commonly seen within our cities was associated with elevated levels of cardiopulmonary and lung cancer mortalities.[83]

In a wide-spread study spanning six U.S. cities, exposure to fine particulate matter was significantly correlated with increased acute mortality for both PM_{10} and $PM_{2.5}$, but the strongest association seems to lie with $PM_{2.5}$.[84] Even a small increase $PM_{2.5}$ can cause a significant increase in mortality. In fact, researchers have found that only a 10 microgram per cubic meter (ug/m^3) increase in the two-day average $PM_{2.5}$ was associated with a 1.5 % increase in daily mortality[85]. Other studies have shown that the association of premature death with PM exposure grows stronger as particle size decreases from PM_{10} to $PM_{2.5}$.[86] In other words, the smaller size fraction of particulate matter is believed to be more harmful, in part due to its greater ability to penetrate more deeply into the lungs. Approximately 94% of diesel exhaust PM is less than 2.5 microns in diameter.

Smog-Forming Oxides of Nitrogen

Nitrogen oxides (NO_x) represent another class of pollutants that plague the air we breathe, and are formed in large part through the burning of diesel fuel at high temperatures. A major concern about NO_x centers on its role as a primary precursor ozone formation, which is the major constituent of smog. In addition, NO_x, including nitrogen dioxide (NO_2), contributes to particulate matter formation.

Figure 5. How Photochemical Smog Chemically Forms

NO_x + NMHC + Sunlight = Smog or Tropospheric Ozone

Health Effects of Ozone and Oxides of Nitrogen

Numerous studies have documented the harmful health effects associated with exposure to ozone and oxides of nitrogen. Elevated levels of nitrogen dioxide and ozone have been linked with cardiac disease and respiratory illness, increased hospital admissions for respiratory and cardiac symptoms, and doctor visitations for asthma.[87,88,89] Exposure to nitrogen dioxide as well as to smog (ozone) can also result in reduced immunity leading to a decreased ability to fight off infections. Nitrogen dioxide also acts as a lung irritant, and exposure has been associated with respiratory and cardiac symptoms.

Ozone exposure may cause breathing and respiratory difficulties that may be long-term, increased exercise-related wheezing, coughing and chest tightening, increased hospital admissions and emergency room visits for asthma attacks.[90] Variations in the daily ozone pollution levels have been associated with episodes of acute wheezing, and long-term exposure to ground-level ozone has been linked with the development of asthma in adult males.[91,92] Exposure to ozone while engaged in moderate exercise has been shown to decrease lung function and increase respiratory inflammation.[93] Air concentration levels of ozone have been linked with an increased risk for death, including increased lung cancer mortality in males.[94] The effects of ozone exposure typically cause a gradual decrease in pulmonary function that may persist for several hours after exposure. Health effects from ozone exposure have been found even at levels below those accepted as our national standards.[95]

California At Risk from Diesel Exhaust

To evaluate the risk associated with diesel exhaust exposure, California's Scientific Review Panel (SRP), an independent group of scientists and researchers, determined a best reasonable unit risk estimate at 3×10^{-4} (300 potential cancer cases per 1 million persons exposed over a lifetime to one microgram of diesel exhaust) in April of 1998. This risk estimate was based on the scientific evidence provided by the Office of Environmental Health Hazard Assessment and the California Air Resources Board. Applying this unit risk value to the many regions of California, one can quickly see the significant public health risks posed by the toxicity of diesel exhaust alone.

Table 2. Projected Cancer Cases Caused By Ambient Diesel Exhaust PM_{10} Fraction.

Air Basin Region	Estimated Population in 2000[96]	Estimated PM10 Concentration Levels in 1995 (μg/m3)[97]	Cancer Cases over a 70 year lifetime exposure using the SRP Unit Risk Value[98]
Great Basin Valleys	30,567	0.1	1
Lake County	60,072	0.2	3
Lake Tahoe	48,085	0.5	5
Mojave Desert	852,599	0.6	107
Mountain Counties	427,642	0.4	36
North Central Coast	713,987	1.0	150
North Coast	318,617	0.9	60
Northeast Plateau	91,634	0.8	15
Sacramento Valley	2,334,610	1.6	784
Salton Sea	453,017	1.8	171
San Diego	2,943,001	1.9	1,174
San Francisco Bay	6,763,980	1.9	2,699
San Joaquin Valley	3,246,853	1.7	1,159
South Central Coast	1,420,709	1.2	358
South Coast	14,948,022	2.7	8,476
Statewide	34,653,395	2.2	16,010

The risk for an individual varies, and may be greater for more sensitive members of our population including children, women, the elderly and people with respiratory illnesses (e.g., asthmatics). Risks may also be greater for people who live near freeways, truck or bus yards, urban centers or other areas that experience heavy diesel exhaust congestion, or those who are dependent upon bus systems that operate on diesel fuel.

Armed with the growing knowledge and awareness of the health hazards of diesel exhaust, we must actively take action to protect our children's health and decrease their exposure. Cleaner, less toxic alternatives fuels that are available, safe, and viable should replace diesel fuel in our children's school buses.

Aaron Feuer
Los Angeles, CA

November 16, 1999

Dr. Ruben Zacarias, Superintendent
Los Angeles Unified School District
450 North Grand Avenue, A223
Los Angeles, CA 90012

Dear Superintendent Zacarias:

I am a third grader at Castle Heights Elementary School. I like being at Castle Heights and I love being in the L. A. Unified School District. But I don't like the diesel school buses that come to my school (and to other schools in the District).

One day when I was with a friend coming home from school, we pulled up behind a diesel school bus. We stopped at a traffic light. Then, when the light turned green, we started driving again. A big cloud of exhaust spewed out of the back of the school bus. It really smelled terrible and a lot of soot got on our windshield.

In school we learn that diesel exhaust is bad for our health. If you teach us that, then why at the end of the day do you take kids home in diesel buses?

The bottom line is that I would like for you to change some or all of the school bus fleet to cleaner alternative fueled buses. That would make driving behind a school bus smell better and be better for us and the air we breathe. I am also concerned about what the kids in the school bus breathe. So, please make a change and help us kids breathe cleaner air.

Sincerely,

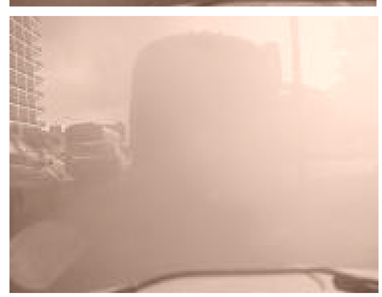
Aaron Feuer

cc: Mr. Louis Carillo, Principal, Castle Heights Elementary School
Howard Miller, Chief Operating Officer, LAUSD
Genethia Hudley Hayes, LAUSD President, District 1
Victoria Castro, LAUSD Board Member, District 2
Caprice Young, LAUSD Board Member, District 3
Valerie Fields, LAUSD Vice President, District 4
David Tokofsky, LAUSD Board Member, District 5
Julie Korenstein, LAUSD Board Member, District 6
Mike Lansing, LAUSD Board Member, District 7

CHAPTER THREE.
The Clean Alternatives to Diesel.

Diesel-fueled engines power at least 69 percent of California's school bus fleets and approximately 4 percent predate 1977 model years.[99,100,101] This does not have to be the case, however, given the clean and reliable alternatives that are available on today's heavy-duty engine market. Clean alternative fuels include natural gas, propane, hybrid-electric, battery-electric, and fuel cells. Clean alternative fuels have been in existence for nearly 100 years, but have only garnered wide acceptance over the past two decades as a strategy to combat air pollution and toxics. A tremendous amount of research and development has gone into clean alternative fuel vehicle technologies to provide us with safe, reliable and low emission alternatives for cars, trucks, transit buses, and, yes, school buses.

Diesel Technology: Will Diesel Engines Clean Up Their Act?



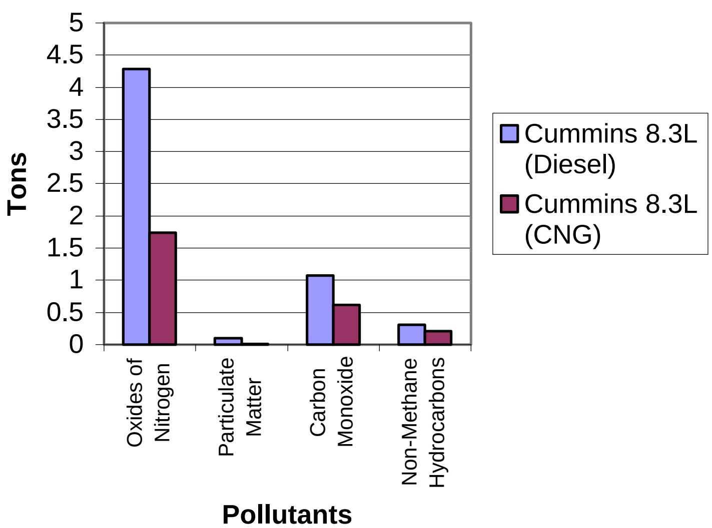
New diesel engines are the dirtiest engines sold on the market today, barely meeting California Air Resources Board's (CARB) four gram per brake horsepower-hour (g/bhp-hr) oxides of nitrogen (NO_x) standard. As part of a settlement agreement with U.S. EPA and CARB, most heavy-duty engine manufacturers will be required to reduce smog-precursor emissions from diesel engines by another 43 percent to 2.5 grams per brake horsepower-hour (g/bhp-hr) for a combined NO_x and non-methane hydrocarbon (NMHC) emissions standard by October 2002. The engine manufacturers have indicated that diesel engines will be able to meet even more stringent emission standards for NO_x and PM. However, it is not clear if they can further reduce toxic emissions.

Natural gas engines, in comparison, already meet the 2002 NO_x emissions target and are significantly less toxic.[102] Clean alternative fuel engines, such as natural gas, are expected to maintain their lead over diesel engine technology as alternative fuels are inherently cleaner and can apply the same advanced emissions control technologies (e.g., sophisticated fuel management, exhaust gas recirculation, and aftertreatment) that are being designed to clean up today's newest diesel engines. Ultimately, with the development and maturation of zero emission vehicles utilizing battery-electric and fuel cell technologies, all vehicles that depend upon a combustion engine for power will likely become obsolete.

So Why is the Diesel Industry Heralding Diesel as a Clean Engine Technology?

Some industry advocates argue that 1996 model year and later diesel engines using 1993 reformulated diesel fuel are "clean diesel" and are not a public health threat. However, diesel engines—new and old—continue to pose serious health threats, including lung cancer. Even the "cleaner," 1999 model year diesel engines emit more smog forming NO_x and PM than comparable clean alternative fueled engines. In fact, all diesel engines currently registered for sale in California are certified to the dirtiest emissions levels allowable under state regulation; unlike natural gas, not one diesel engine is certified to CARB's optional low-NO_x (less polluting) standards. The cleanest diesel engine made for school bus applications is the 1999 Cummins 5.9 liter engine as shown in Appendix B. Yet, the Cummins 5.9 liter engine releases 47 percent (or 1.8 tons) more NO_x and 71 percent (109 pounds) more PM into the air over its useful life when compared against the 1999 Cummins 5.9 liter natural gas engine. The Cummins 8.3 liter diesel engine certified in 1999 emits 58 percent more smog forming NO_x and 89 percent more PM than a Cummins 8.3 liter natural gas engine certified the same year.[103] Although the Cummins 8.3 liter natural gas engine is lower in carbon monoxide (CO) than both its diesel engine counterparts, other natural gas bus engines may experience slightly higher CO, carbon dioxide (CO_2) and Non-Methane Hydrocarbon (NMHC) emissions. The increase in these emissions, however, is small and does not outweigh the significant NO_x and PM benefits achieved with natural gas engines.

Figure 6. Useful Life Emissions for 1999 Certified Cummins 8.3L Engines: Diesel v. CNG



Source: California Air Resources Board 1999 certification numbers for Cummins 8.3L diesel and natural gas engines.

As to reformulated diesel, a recent study comparing emissions from a new diesel engine running on pre-1993 diesel fuel and 1993 reformulated diesel fuel (now required in California) revealed that the newer diesel fuel only slightly reduces emissions of NO_x and PM, and that more than 95 percent of the PM emissions are very fine (less than 1 micron in size). Dioxins were detected in diesel emissions, both with the older and newer fuel. Finally, levels of toxics such as benzene, toluene, 1,3-butadiene, formaldehyde, and polycyclic aromatic hydrocarbons (PAHs) were essentially unchanged by use of the newer diesel fuel.[104] Thus, even the most advanced diesel engine available with California reformulated diesel fuel remains far from clean.

To put it another way, the emissions benefits achieved in NO_x and PM reductions by operating a new natural gas school bus over a new diesel-powered school bus is equivalent to removing 13 to 16 existing cars from the road or keeping 64 to 80 new cars off the road.[105] Advanced diesel technology also under-performs clean alternative fuel technologies on air toxics. The South Coast Air Quality Management District (SCAQMD) estimates that an average diesel school bus emits 223.5 times more air toxics than a school bus that is powered by natural gas. Simply put, clean alternative fueled school buses are much cleaner than diesel school buses.

THE CLEAN ALTERNATIVES OF TODAY

Compressed Natural Gas

Natural gas is a safe alternative fuel technology in widespread use today. It is composed primarily of methane (CH_4), and may be derived from either gas wells or from crude oil production. Natural gas is stored either in a compressed or liquefied form. Compressed natural gas (CNG) has the advantage of being distributed by natural gas pipelines throughout the continental US, and is used extensively in power plants, industry and other domestic uses. Fueling stations may consist of either a slow-fill (5-8 hours) or fast-fill (approximately 10 minutes) compressor. Slow-fill stations are less expensive than fast-fill stations, and are a convenient option for school districts that refuel their fleet overnight. Natural gas burns cleaner than diesel and is less toxic, and its use results in less air pollution than diesel fuel. Finally, because natural gas is lighter than air, there is less potential for ground water contamination.

Alternative Fuel Use Enhances National Security.

In addition to air pollution benefits, clean alternative fuels also reduce our dependence on petroleum products, both domestic and imported. According to the California Energy Commission, California only produces 50 percent of its total petroleum fuel usage. About 40 percent of our petroleum fuel comes from Alaska and the remaining 10 percent comes from foreign sources. As domestic supplies of petroleum approach depletion, US national security may be threatened by a greater dependence on foreign fuels. Although gas prices today are at an all-time low, resource specialists forecast that petroleum prices will rise in the future as U.S. oil reserves near depletion. Thus, alternative fuels offer a clean alternative to diesel fuel and help America become less dependent upon petroleum products. Of course, clean alternative fuel use by school districts also adds insurance against diesel price spikes that could drive up costs and drain much needed school district funds

Liquefied Natural Gas

Liquefied natural gas (LNG) as a fuel of choice is garnering appreciation for its speed of fueling (30 to 60 gallons per minute), fuel storage capacity, lightweight properties, and long-range capabilities. Unlike CNG, LNG is cryogenically stored at temperatures of –260 degrees Fahrenheit under normal atmospheric conditions and, lacking a pipeline infrastructure, is delivered to fleet facilities by truck. Liquefaction stations that liquefy pipelined natural gas on-site are under development, but the technology faces some economic hurdles and the fuel quality may not be suitable for heavy-duty application (e.g., school buses).[108] Nevertheless, on-site liquefaction may mature as the demand for LNG increases for truck and bus fleets throughout the nation. The advantage of LNG lies in its density reducing the volume needed for storage by 60 percent in comparison to CNG. Fuel costs range from approximately 46 to 56 cents per LNG gallon excluding applicable taxes, with a diesel gallon equivalent at about $0.85 to $1.04.[109,110] Because LNG tanks have a tendency to vent if a school bus remains out of use for an extended period of time, the best application for this promising technology may be for school districts that operate year round. LNG is currently not utilized in California school bus fleets at this time.

Propane

Liquefied petroleum gas (LPG) is comprised of a simple mixture of hydrocarbons, mainly propane gas, and is produced as a by-product derived from the processing of natural gas and crude oil mostly in the U.S. According to the Alternative Fuels Data Center, LPG has been used as a transportation fuel for over 60 years around the world. Refueling time is comparable to gasoline. Propane engines also tend to last two to three times longer than diesel or gasoline engines due to less carbon buildup. Propane, however, has not been shown to be as cost-effective as CNG. Although propane is not currently being used in California's school buses, it has been proven to be a viable fuel in transit fleet service in California and nationwide.

THE CLEAN ALTERNATIVES OF TOMORROW

Hybrid-Electric Vehicles

Hybrid-electric vehicle technologies are unique in that they are powered by two distinct sources: a traditional combustion engine powered by a fuel (e.g., CNG, diesel, gasoline, or propane) and an energy reservoir or battery. Thus, unlike technologies that depend upon one dedicated power or fuel source, a hybrid-electric bus alternates its power usage from a smaller combustion engine to a battery pack depending on the vehicle's current mode of operation. The strategy of a hybrid therefore aims to deliver better fuel economy and offer lower emissions. Although hybrid technologies promise lower emissions benefits, the establishment of emissions testing procedures and protocols by U.S. EPA and CARB is required to ensure that emission benefits from hybrid-electric technologies hold. Further, hybrid-electric vehicles do not eliminate the air toxics problem if the combustion engine runs on diesel fuel. Hybrid-electric vehicle technology is a very young technology. It is currently being introduced in the transit bus and passenger vehicle markets but is not expected to enter the school bus market for some time.

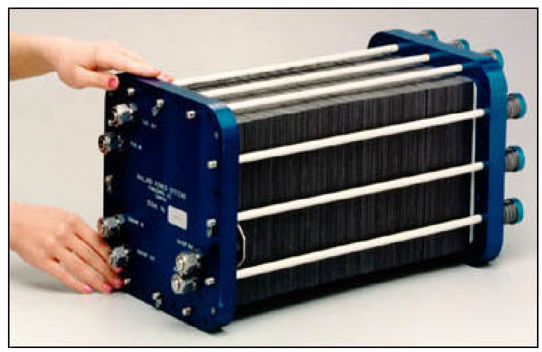
Battery-Electric Vehicles

Battery-electric vehicles are powered exclusively by an energy reservoir or battery. Battery-electric vehicles tend to experience low maintenance and fuel costs, operate quietly, and do not produce tailpipe emissions or air toxics. Hence, battery-electric vehicles are commonly known as "zero emission vehicles." One manufacturer introduced battery-powered school buses as a research and development project in 1996 at a premium price of $230,000 per unit. Despite providing superior emissions benefits and meeting the range needs of most urban school districts, these buses experience limited battery lifetime and high battery replacement costs. Battery technology, however, is advancing in passenger vehicle and transit bus markets (with about 200 thirty-foot battery-electric shuttle buses operating in the US).[111] Given the success of the Santa Barbara Metropolitan Transit District's electric bus program, the South Coast Air Quality Management District partially funded a $400,000 project being conducted by Santa Barbara Electric Bus Work to further advance battery-electric school bus technology and reduce vehicle costs to $146,000-160,000 per unit.[112] Battery-electric school bus purchases should rise as the technology advances.

Bluebird Battery-Electric Bus. ***Courtesy of the California Energy Commission. 1999.***

Fuel Cell Vehicles

There are a number of competing fuel cell technologies out on the market today, but the fuel cell attracting the most interest relies on Proton Exchange Membrane (PEM) technology. PEM fuel cell technology is based on the conversion of chemical energy into a usable form of energy and heat that occurs without any combustion phase. Fuel cell technology results in near-zero emissions, with the potential for zero emissions when pure hydrogen is used. Fuel cells are similar to batteries in their use of chemicals separated by an electrolyte that reacts and produces an electric current.[113] Unlike a battery, fuel cells are not charged. Instead, the reactants are fed continuously to the cell. Fuel cells run on pure hydrogen but have the potential to operate on a variety of other fuel types when reformed into pure hydrogen. These fuel types include methanol, ethanol and natural gas.[114] Automobile manufacturers and oil companies are also researching ways to operate PEM fuel cells that can reform gasoline and diesel fuel into pure hydrogen. Fuel cells were first invented over a century ago and received greater attention following the excitement of the 1960s space program.[115] Although fuel cells are not available on the market today for school bus application, there are demonstration transit buses powered by hydrogen fuel cells operating in several countries. Most of the major automakers[1] have committed to commercializing fuel cell passenger cars within the next five years.



PEM Fuel Cell Stack.
Courtesy of Ballard Power Systems. 1999.

[1] DaimlerChrystler, Ford, General Motors, Honda, Nissan, Toyota and Volkswagen have produced fuel cell prototypes or announced plans to do so.

THE MOST MATURE ALTERNATIVE TODAY

CNG is the Clean Technology of Choice for Today's School Bus Applications

Advantages of Natural Gas Over Diesel.

- ✓ Significant emission reductions improving air quality and lowering human health risks;
- ✓ Less toxic;
- ✓ Less odor;
- ✓ Less noise pollution;
- ✓ Lower fuel costs;
- ✓ Lower maintenance costs;
- ✓ Domestically available and in abundant supply;
- ✓ Increases fuel diversity and enhances national security.

CNG is the most mature of the clean alternative fuel technologies available on the market today. CNG-fueled vehicles are advantageous over diesel-powered school bus from a public health and environmental perspective since CNG school buses produce significantly less NOx, PM and toxics emissions than conventional diesel school buses. CNG technology also has a proven track record in that over 40 school districts currently operate CNG school buses to transport school children to and from school. Unlike most other clean alternative fuel technologies, CNG also has an extensive fueling infrastructure throughout California. Finally, natural gas is believed to be more abundant than petroleum fuels including diesel and is domestically available at affordable prices. In fact, 90 percent of the natural gas used by the US is domestically produced and almost 100 percent is produced in North America.[116]

CNG Fueling Infrastructure

The greatest challenge to widespread adoption of any clean alternative to diesel rests with the need for an existing fueling infrastructure. According to estimates from the Natural Gas Vehicle Coalition, at the end of 1998, there were an estimated 215 natural gas fueling stations in California, with approximately 50 available for public use in southern California. Government funding sources to date have failed to provide the incentives necessary for school bus fleets to make the capital investment required for the construction of a natural gas fueling station. School bus fleets, however, are ideal candidates for fueling infrastructure funding because they fuel in one central location. Furthermore, because a school bus operates fewer hours than its transit bus counterpart, school districts have the option of installing slow-fill stations that are significantly less expensive. However, for those few school districts that may require fast-fill fueling stations for their fleet, they can substantially offset their facility costs by making the facility open to the general public.

Natural gas-powered buses fueling at slow –fill CNG fueling facility. ***Courtesy of California Energy Commission. 1999.***

The Economics Behind CNG

CNG is an economically viable alternative to diesel. Although a CNG school bus costs more that a diesel school bus (roughly $30-40,000 incremental cost), fleet managers who operate CNG fleets report that operational and maintenance costs tend to be less expensive than a similar fleet operating on diesel. This is primarily due to CNG being a clean-burning fuel that requires fewer oil changes and less overall maintenance. Thus, initial investment costs can be recouped over time via CNG's lower operation and maintenance costs.[117] Furthermore, the incremental cost associated with CNG school buses is expected to decrease as the volume of sales increases nationwide. With about 20-23 percent of current school bus sales in California running on CNG, it is likely that the cost differential between CNG and diesel will decrease in the near future.[118] A-Z Bus Sales began the sale of 40-foot (Type I) CNG school buses in 1992 and they have delivered over 600 CNG school buses since that time. In fact, over 30 CNG buses were delivered in July and August of 1999 alone. A-Z's competitor, California Bus Sales, has also entered the clean alternative fuel school market by selling their first round of 50 CNG school buses last year. California Bus Sales expects CNG school bus sales to rise in the coming years.

In addition to the incremental costs associated with CNG technology, another large cost lies with the need to install a new fueling station and the modification of existing maintenance facilities.[2] According to Transit Manager Steve Anthony of the Southern California Gas Company, refueling stations vary in cost and can range from $100,000 to $500,000 depending on whether a slow-fill or a fast-fill fueling station is required. Fast-fill compressors cost substantially more than slow-fill compressors. School districts rarely require fast-fill capabilities because a typical school bus fleet does not operate many hours and can easily rely on an overnight fueling strategy. If the fueling station is to be made open to the public, however, a fast-fill station is required. Compressor costs for fast-fill stations will be higher, but these costs can be offset over time through the sale of natural gas to the general public. The fuel price for CNG is comparable to diesel fuel selling at a rate just below a dollar per gasoline gallon equivalent (GGE) and about $1.05 per GGE for the general public.

Natural Gas and Safety

The same fuel that we use to cook our food and heat our homes also has a proven safety record as a vehicle fuel. According to the Alternative Fuels Data Center of the U.S. Department of Energy, natural gas is neither corrosive nor toxic, and is an inherently safe fuel compared to other fuel types. With its high ignition temperature and narrow ignition range, natural gas is much less likely to ignite than gasoline in the unlikely event of a leak. And natural gas is non-corrosive and lighter than water, so contamination of soil and water sources is unlikely. Natural gas contains a distinctive odorant (mercaptan) that allows natural gas to be detected at a 0.5 percent concentration in air, well below levels that can cause drowsiness due to inhalation and well below the weakest concentration that can support combustion. Although compressed gas in cylinders poses a potential safety risk, natural gas cylinders are designed to withstand extreme pressure and are subjected to rigorous federal testing to ensure their integrity. Natural gas cylinders are designed to contain the fuel at pressures of 3000 or 3600 psig with a large margin of safety. Throughout the 10 years of the California Energy Commission's Safe School Bus Program, there have been no incidents of ruptured cylinders further supporting the technology's safety and reliability.

[2] Maintenance facilities require modification due to CNG's lighter than air properties.

CHAPTER FOUR.
Demonstrated Public School Success Stories.

A number of public school districts both within California and throughout the nation have begun the transition to clean alternative fuels for their school bus fleets, and a California transit fleet has already achieved 100 percent conversion. Approximately 60 California school districts currently operate clean alternative fuel school buses in their fleet. This chapter briefly discusses the California Energy Commission's Safe School Bus Clean Fuel Efficiency Demonstration Program and features the experiences of three school districts in southern, central, and northern California that operate clean alternative fuel school buses.

Table 3. School Districts in California Operating Alternative Fuel School Buses

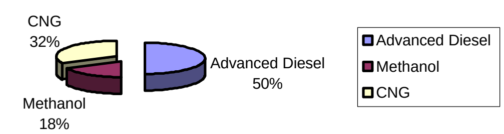
Anderson Union High School	Paris Unified SD
Antelope Valley School Transportation Agency	Paso Robles Public School
Apple Valley Unified SD	Poway Unified SD
Beaumont Unified SD	Pupil Transportation Cooperative (Whittier)
Chula Vista Elementary SD	Redlands Unified SD
Clovis Unified SD	Realto Unified SD
Covina Valley Unified SD	Rincon Valley Unified SD
Elk Grove Unified SD	Rio Linda Unified SD
Folsom/Cordova Unified SD	Sacramento City Unified SD
Fresno Unified SD	Sanger Unified SD
Fullerton Union High SD	San Dieguito Union High School
Grant Union High SD	San Juan Unified SD
Hayward Unified SD	San Luis Obispo Coastal Unified SD
Hemet Unified SD	Sequoia Union High SD
Hesperia Unified SD	Snowline Joint Union SD
Hueneme School District	South Bay Union SD
Jefferson Union High SD	Southwest Transportation Agency
Kern County Supt. of Schools	Sweetwater Union High SD
Kern High School District	Tahoe/Truckee Unified SD
Kings Canyon Unified SD	Tehachaipi Unified School District
Lemoore Union High School District	Torrance Unified School District
Lompoc Unified SD	Tulare County Org. for Vocational Education
Los Angeles Unified SD	Val Verde Unified SD
Lucerne Valley Unified SD	Ventura Unified SD
Montebello	Victor Valley Elementary SD
Moreno Unified SD	Victor Valley Union High SD
Napa Valley Unified SD	Visalia Unified SD
Oceanside Unified SD	Vista Unified SD
Oxnard Union High School	West County Trans. Agency
Paradise Unified SD	

Safe School Bus Clean Fuel Efficiency Demonstration Program.

As a California State Assemblyman, Richard Katz recognized the potential of clean alternative fuels when he authored Assembly Bill 35 (Chapter 1426, Statutes of 1988). This legislation signed into law by Governor George Deukmaejian in 1988 created the most comprehensive clean alternative fuel school bus demonstration project in the nation, and is known as the Safe School

Bus Clean Fuel Efficiency Demonstration Program. The program was funded at $100 million from the Petroleum Violation Escrow Account (PVEA), and managed through the California Energy Commission (CEC). The Safe School Bus Program was established to provide California public school districts with new energy-efficient school buses that met current Federal Motor Vehicle Safety Standards. Prior to 1977, safety standards for school buses were insufficient. CEC's program was pivotal in helping school districts purchase buses that met tougher safety standards and were powered by clean alternative fuels as early as 1989.

Figure 7. CEC Safe School Bus Clean Efficiency Demonstration Program



Source: California Energy Commission. 1999. Safe School Bus Clean Efficiency Demonstration Program, Second Interim Status Report. Transportation Technology & Fuels Office and the Energy Technology Development Division. May. p. 3.

The Safe School Bus Program was implemented in four phases staggered over time to replace pre-1977 school buses with buses that met Federal Motor Vehicle Safety Standards. To use PVEA funds, thirty-five percent of school bus purchases were required to operate on low-emission, clean alternative fuels. CEC opted to make 50% of purchases clean alternative fuels and replaced over 860 pre-1977 school buses. Today, California roughly has 991 pre-1977 buses remaining in service. Over the four phases of the program, 826 new school buses were purchased and distributed to Local Educational Agencies. Approximately half of these school buses operated on alternative fuels, and one third operated on CNG. In the final phase of the program, only CNG school buses were purchased. As the success of the program and the buses was demonstrated, other schools began to purchase and operate clean alternative fuel buses. According to Al Deterville of the California Energy Commission's Transportation Technologies and Fuels Office, one of the goals of the program was to encourage other school systems to convert to clean alternative fuels.

CASE STUDY: Napa Valley Unified School District

CNG School Bus. Courtesy of CEC. 1999.

The Napa Valley Unified School District is located in a region best known as California's "wine country." In this bucolic setting, Napa Valley Unified serves all of Napa Valley and transports approximately 16,000 children to and from school. Back in 1995, Napa Valley's average age school bus age was over 20 years, and all of the buses ran on diesel. Mechanical problems were common and most school buses were in constant need of repair. In 1995 however, clean alternative fuel school buses were added to Napa's fleet with financial assistance from the Bay Area Air Quality Management District (BAAQMD) and the CEC's Safe School Bus Program. By the end of 1999, the average school bus age will be five years, and one-third of Napa Valley Unified's 75 school bus fleet will run on clean alternative fuels.

The success of the clean alternative fuel school bus program has been tremendous. As leaders in clean alternative fuel school bus technologies, the school district expected problems. According to Napa Valley Unified's Director of Transportation Ralph Knight, "the CNG buses run great" and problems have been minimal. Napa's CNG buses require less maintenance, fewer oil changes, get better mileage, and run on less expensive fuel. The school district has also enjoyed visible public support and has been invited to display the CNG buses at fairs and community events. "Switching to CNG has been a very positive experience for Napa Valley Unified and its community," says Knight.

Knight also operates two battery-electric school buses in his fleet. Although the battery-electric school buses initially experienced poor battery performance, both buses have experienced a banner year in 1999 and Knight plans to add two more to his fleet with new nickel-metal hydride batteries.

When asked to discuss obstacles, Knight emphasized the importance of obtaining funding for fueling infrastructure through state and local air district sources. Knight wisely noted that the problems associated with the transition to clean alternative fuels tend to be temporary and are soon offset monetarily by the savings in fuel, performance, maintenance costs, and the ever-increasing availability of fueling stations.

Los Angeles Unified School District

LAUSD is the second largest school district in the nation, second only to the New York City Public School District. LAUSD serves most of Los Angeles County, ranging from the region's beaches to the valleys. LAUSD's school bus fleet size consists of 2,740 buses (1,100 small and 1,640 large buses) and transports 65,000 students. The district owns roughly half of the fleet's school buses and the other half are contracted out.

Out of LAUSD's 1,326 Vehicles, 95 percent of the vehicles are powered by diesel. 37 buses are powered by gasoline and only 33 are powered by CNG. The remaining 1,300 contracted buses are powered by diesel. LAUSD's combined fleet is 99 percent diesel dependent.

According to LAUSD's Director of Maintenance, Antonio Rodriguez, CNG buses are very clean, in both operation and emissions. Fuel costs are also somewhat less expensive for CNG than for diesel and provide better fuel economy (i.e., approximately 6-7 miles diesel gallons equivalent for CNG versus 5 miles for 1 gallon of diesel). Because CNG is relatively new to LAUSD, current maintenance costs for CNG tend to be slightly more than diesel. However, such costs are expected to decline as LAUSD's maintenance crews become more familiar and educated with CNG technology. LAUSD supports its CNG bus fleet with a CNG fueling station in Gardena and is hoping to expand the district's fueling infrastructure soon.

Rodriguez identified the lack of government funding as the biggest obstacle to additional clean alternative fuel procurements.

The Coalition for Clean Air is very concerned about the health effects of diesel exhaust exposure on children in association with LAUSD's school bus fleet. LAUSD operates in urban cores where diesel levels can reach significant levels. The Coalition believes LAUSD should adopt a policy that requires clean alternative fuel procurements only in the future, similar to the policy of the Los Angeles County MTA.

CASE STUDY: Antelope Valley Schools Transportation Agency

Antelope Valley Schools is located in Lancaster, California, and serves about 35,500 students. Prior to 1992, Antelope Valley's school bus fleet was in very bad shape with buses as old as 35 years of age. The school buses emitted so much pollution and black smoke that they accumulated fines of up to $3,000 per day for violations of California's emissions laws. The Chief Executive Officer of Antelope Valley Schools Transportation Agency (AVSTA), Ken McCoy, looked to clean alternative fuels as the solution. Relying heavily on grant funding, the first clean alternative fuel school bus arrived to AVSTA in 1992. Today, they operate 19 CNG buses and plan to increase their clean alternative fuel bus procurements in the future while exploring hydrogen fuel cell options with government agencies.

Table 4: Operating Cost Data for AVSTA

ANTELOPE VALLEY SCHOOLS TRANSPORTATION AGENCY

ARIEL 150 CFM STATION OPERATING COSTS
STATION INSTALLED 1992

DATE	SOCAL FUEL THERMS	SOCAL FUEL COST	SOCAL MAINT COST	EDISON UTILITY COST	AT&T CELL PH COST	FUEL TOTAL COST	FUEL COST PER THERM
Jul-98	5,396	1,713	-	496	30 est	2,239	0.415
Aug-98	7,894	2,625	1,947	410	30 est	5,012	0.635
Sep-98	15,241	4,458	1,128	1,066	30 est	6,682	0.438
Oct-98	13,115	3,947	2,216	1,099	30 est	7,292	0.556
Nov-98	8,998	2,929	1,001	788	30 est	4,748	0.528
Dec-98	9,077	2,986	857	804	30	4,677	0.515
Jan-99	8,465	2,681	837	591	16	4,125	0.487
Feb-99	7,581	2,412	1,760	684	56	4,912	0.646
Mar-99	11,477	3,361	1,021	744	37	5,163	0.45
Apr-99	7,810	2,277	650	735	39	3,701	0.474
May-99	10,556	2,967	1,513	783	43	5,306	0.503
Jun-99	7,483	2,298	702	884	46	3,930	0.525
TOTALS	113,093	34,654	13,632	9,084	417	57,787	
						AVG	0.511[1]

[1] $0.64 gasoline gallon equivalent. 1 GGE=1.25 therms
Source: Kenneth R. McCoy, Chief Executive Officer, Antelope Valley Schools Transportation Agency, September 1999.

But for now, CNG is clearly the fuel of choice for AVSTA. CNG is less polluting, less toxic, and is economically competitive with diesel. Comparable fuel costs and fewer oil changes lead to AVSTA savings. McCoy has found no advantages to diesel over CNG, except for the greater availability of fueling stations. Since AVSTA owns its own fueling station, they are able to keep CNG fuel costs to a minimum. An onsite CNG fueling station and well-trained in-house mechanics contribute to the CNG's low operational costs. McCoy recommends purchasing a CNG fueling station equipped with fast-fill capabilities. This has allowed AVSTA to make their station open to the public, resulting in additional revenue for the school district. McCoy cautions, however, that owning a fast-fill station may not be ideal if there is no public demand for CNG.

From the bus drivers to the students, Antelope Valley's CNG school bus fleet has been met with very positive feedback. Because CNG engines are less noisy than diesel engines, children no longer scream to be heard inside the bus, making the ride more safe and enjoyable for both kids and school bus drivers. Also, there is no longer the terrible odor or copious cloud of smoke typically associated with diesel exhaust. McCoy encourages other districts to talk with fleet managers who operate clean alternative fuel programs and pursue government funding available to school districts.

CASE STUDY: Kern High School District

Kern High School District, with an average daily attendance of 26,000 students, serves 3,200 square miles within Kern County and transports approximately 8,000 students to and from school daily. Kern has acted as one of the pioneers in the clean alternative fuel transition for school buses. However, in 1993, all of the school district's buses ran on diesel fuel and over half were pre-1977 buses. Through funding made possible by the CEC and the local air district, the first CNG school buses were phased-in the Kern High School District in 1993. Today, Kern no longer operates pre-1977 school buses and 44 out of the 94 school buses run on CNG.

Overall, Kern's acquisition of CNG school buses has been a very positive experience. The district has found that the advantages of natural gas extend beyond the positive health benefits; the CNG school buses are cleaner, quieter, and do not have the foul smelling fumes associated with the diesel buses. From an economic standpoint, the CNG fuel costs have been comparable to diesel, and the county expects that the cost of CNG fuel will go down in the future. Furthermore, their John Deere natural gas engines require less maintenance and less frequent oil changes than diesel. School bus drivers also prefer the overnight fueling of the CNG buses compared with the constant daily refueling of the diesel buses.

There were financial challenges with the acquisition of new CNG school buses. There was the initial investment to train drivers and mechanics in the new technology. Furthermore, the CNG school buses cost about $30,000 more than a diesel bus. Often this can be a deterrent to schools located in districts with little funding available. Bud Bankston, Director of Transportation at Kern High School District, points out that CNG would not have been an option for Kern if the financial incentive programs had not been in place by the state and local air district. Bankston recommends that other school districts interested in clean alternative fuels include the need to evaluate refueling options. If funding is available towards the purchase of a fueling station, taking advantage of that money is highly recommended. Kern High School District was able to purchase an onsite CNG fueling station that facilitated overnight fueling with a slow-fill system.

Overall, the program has been "very positive" for Kern County residents and especially for the students who ride on the school buses. Kern hopes to purchase more CNG school buses in the future with the help of state and local government incentive programs.

CHAPTER FIVE.

Funding Opportunities Available for School Districts.

Although this chapter is designed to provide California school districts with information on existing funding sources that have been made available to help finance clean alternative fuel projects and future procurements, the funding sources listed below are either limited in the amount of dollars that can be applied to school district bus fleets or are geared toward fleets that operate more hours per day. If we are ever to successfully convert California's school bus fleet to clean alternative fuels, the Governor and members of the California state legislature must allocate the necessary funding to California's school districts. As for the existing programs, contact information is provided in Appendix C and further information may be obtained by contacting your local air quality or pollution control district.

Carl Moyer Memorial Fund

The Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer Program) is designed to cut emissions from diesel-powered heavy-duty trucks, buses, agricultural and construction machinery and some off-road, marine and airport ground-support equipment. For the FY1998-1999 the program provided $25 million through the state of California in grant funding to participating local air pollution control and air quality management districts. Under the program, grants are provided to cover the incremental costs of purchasing trucks, buses, and other vehicles that cut current nitrogen-oxide (NO_x) emissions by 25-30 percent or more. This program applies to new vehicles or rebuilds for existing engines that can demonstrate cost-effectiveness.

The program has been approved for a second year of funding in the 1999-2000 California State Budget at $19 million. $1 million has been specifically allocated for school buses. Another $1 million has been allocated for fueling and electric charging stations. Funded projects are expected to result in substantial reductions in NO_x and fine particulate emissions associated with diesel. The cost-effectiveness of NO_x reductions will be evaluated for the proposed projects, with a criterion of no more than $12,000 per ton of NO_x reduced.

The local air district must match one dollar for every two dollars granted in Carl Moyer funds. Local air district dollars, unlike state dollars, are not restricted and can offer additional funding to the $1 million already set aside for fuel infrastructure projects. Requests for proposals are available and each local air district sets application deadlines. Air districts must present proposals to CARB by March 2000.

Despite increased demand for Carl Moyer funds, the state government allocated less funding to the program this year and it is not clear where funding will come from in the future.

California Energy Commission

The California Energy Commission (CEC) offers funding to support infrastructure requirements for alternative fuel and electric vehicles and expects approximately $2 million in funds to be distributed to air districts.

Motor Vehicle Registration Fees: AB 2766 (Sher)

Legislative bill AB 2766 (Sher) was signed into law in 1990 and applies a $4 surcharge to motor vehicle registration fees in the state of California. This legislation funds programs that reduce air pollution from motor vehicle emissions and for activities that ensure implementation of the Air Quality Management Plan or the California Clean Air Act of 1988. The monies are distributed by the State Department of Motor Vehicles according to the following breakdown: 30 percent to participating local air districts based on the number of vehicles in the area distributed at their discretion, 30 percent of AB 2766 funds to the Mobile Source Air Pollution Reduction Review Committee (MSRC) enacted to control pollution in the South Coast basin, and the remaining 40 percent of funds, Subvention funds, to local governments on a pro-rated basis to reduce motor vehicle emissions.

Local Government Subvention Funds

Based on population, 40 percent of the AB 2766 funds allocated to local governments, to be used to reduce emissions from mobile sources. Southern California governments receive $16 million annually, in addition to any unused money from previous years that may be available.

Local Air Districts

The State is divided into Air Pollution Control Districts (APCD) and Air Quality Management Districts (AQMD), which are also called air districts. Local air districts receive 30 percent of AB 2766 funds. Contact your local district for more details on these and additional sources of funding.

Mobile Source Air Pollution Reduction Review Committee (MSRC)

Thirty percent of the monies from the California Motor Vehicle Registration Fee from AB 2766 are allocated to the South Coast AQMD under a discretionary fund account. The Mobile Source Air Pollution Reduction Review Committee (MSRC) is responsible for the development and adoption of an annual work program that is subject to approval by the SCAQMD. MSRC discretionary funds may be used for programs to reduce emissions from mobile sources. Funds can only be applied to areas that fail to meet Clean Air Standards, and are intended to help these areas implement the Air Quality Management Plan and the California Clean Air Act. $29.8

million was available for funding over the 1997-1999 fiscal year. Those who apply for vehicle funding may also receive funds for infrastructure support if it can be demonstrated that at least 20 buses and/or trucks will use a particular fueling station. Grants may be given up to $250,000 with a minimum required match of 50 percent. Anyone may apply for funding, and proposals are evaluated in large part based on cost-effective reduction in vehicle emissions.

Compressed Natural Gas School Bus Incentive Program (through MSRC)

The Compressed Natural Gas School Bus Incentive Program is administered through the MSRC and provides $40,000 towards the purchase of a Bluebird or Thomas Built CNG school bus. This program covers the differential cost of purchase of a CNG school bus instead of a diesel bus. In fact, the incentive program often makes the purchase of a CNG bus less expensive than its diesel counterpart. The money is provided at the point of sale through A-Z Bus Sales or California Bus Sales. As of late Spring 1999, $2.8 million was available on a first-come first-served basis.

Clean Fuels Program - South Coast AQMD

The Clean Fuels Program (required by the state under AB 2194) is administered in the South Coast Air Basin by the South Coast AQMD and is designed to increase the use of clean-burning fuels. Funding for this program comes from a $1 vehicle registration that amounts in total to about $10 million annually. Funds are intended to be used to co-sponsor clean alternative fuel vehicles and support fueling stations. In addition, the SCAQMD obtains $4 in matching funds for every $1 from industry and other public agencies, with $1.1 million approved so far.

Transportation Fund For Clean Air (TFCA) – Bay Area AQMD

The Transportation Fund for Clean Air (TFCA) provides funding by public agencies for projects that focus on reducing motor vehicle emissions. In the San Francisco Bay Area, funding for TFCA comes from a $4 surcharge applied to vehicle registration fees that are allocated through the Bay Area Air Quality Management District (BAAQMD). Approximately $20 million per year is generated through the vehicle registration surcharge to be used for TFCA. Designated AB 434 this bill is similar to AB 2766 in that funding comes from a $4 surcharge applied to motor vehicle registration fees in the Bay Area and is intended for use in programs that will reduce pollution emissions from vehicles. Public agencies alone are eligible for TFCA funding, and this includes school districts. Sixty percent of the funds are "Regional Funds" that are available to public agencies on a competitive basis. Projects are selected based on the most cost-effective reduction of air pollutant emissions. Applications that request greater than $150,000 in TFCA Regional Funds must be matched by additional sources to cover at least 20 percent of the entire cost of the project. "Program Manager Funds" comprise the other forty percent of TFCA funding and are distributed to each county's program managers who use their own criteria for project selection. Staff at the Air District is available to assist with the TFCA grants application process.

Congestion Mitigation and Air Quality Improvement (CMAQ)

The Congestion Mitigation and Air Quality Improvement Program, or CMAQ, is a $9.1 billion national program designed to help states control transportation and meet national air quality standards for air criteria pollutants. These monies come from the federal transportation bill TEA-21, the Transportation Equity Act for the 21st Century, signed by President Clinton in June of 1998. TEA-21 authorizes a total of $217 billion in funding over six years for surface transportation, and essentially reauthorizes the initiatives that were originally established in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), including CMAQ. Funds are available to state and local governments for transportation projects and programs that will help meet the requirements of the Clean Air Act, and National Ambient Air Quality Standards.

CMAQ funds are available to areas designated by the U.S. EPA as non-attainment or maintenance areas for ozone or carbon monoxide. Non-attainment areas are regions that exceed federal air quality standards for ozone or carbon monoxide, and maintenance areas include those areas that were once non-attainment areas. CMAQ funds are available to states for spending on projects that will reduce ozone, carbon monoxide, or particulate matter levels. Eligible projects include vehicle refueling, transit improvements, and alternative fuel vehicles. Funds cannot be used if projects are mandated in order to comply with existing federal laws. California will receive about $287 million of CMAQ funds for each year from FY 1998 to 2003, or $1.7 billion over this time period.

CHAPTER SIX.

Conclusions and Policy Recommendations.

Our children's health should be a top priority for policy makers throughout California, from the Governor to the legislature to the local school boards. It is a travesty that the vast majority of California's school buses remain powered by diesel when there are alternatives on the market that are significantly less harmful to the health of school children. A handful of school districts in California today have demonstrated the leadership we need and proven that a cleaner way to travel to school is possible. The following recommendations provide critical steps for a rapid transition to clean alternative fuel school buses.

Governance and Legislation

1. Congress and the state legislature should make clean school buses for our children a priority.

2. Governor Gray Davis and the California legislature should make it a priority to provide state funds that are exclusively earmarked for the purchase of clean alternative fuel school buses, the costs of refueling and maintenance infrastructure, and training of mechanical personnel.

3. The Superintendent of Public Instruction and the State Board of Education should work with the California Department of Transportation to develop a strategy for clean alternative fuel school bus procurements.

Air Regulation

1. The United States Environmental Protection Agency must significantly tighten engine emission standards for heavy-duty vehicle applications, including school buses, and provide increased incentives for technologies that significantly reduce both air pollution and air toxics in our environment.

2. The California Air Resources Board should live up to its own Resolution 98-49 which supports immediate and continuing efforts to replace diesel-fueled school buses with clean alternative fuel school buses, including the provision of necessary infrastructure and technical training. This resolution also recognized the importance of replacing **all** pre-1977 Type I diesel school buses by 2003 because such buses emit three times more NO_x than new clean alternative fuel school buses and four times more particulate matter (PM).

3. CARB should adopt emission standards that reflect the state-of-the-art low emission levels of CNG bus technology for all categories of school buses. A gradual zero emission bus requirement for school district's should also be considered, starting with 5 percent of the fleet for those school districts that operate more than 200 buses directly or indirectly through contract. CARB should include school buses in its proposed transit bus rule this January 2000 as originally intended.

4. Local air districts must work with local school districts to educate, encourage and provide financial incentives for school districts to implement clean alternative fuel school bus programs.

School Districts

1. School boards should adopt a clean alternative fuel policy similar to the Los Angeles County Metropolitan Transportation Agency's (MTA) Alternative Fuels Initiative (AFI). MTA's AFI policy calls for the purchase of 100 percent clean alternative fuel buses for all future procurements.

2. School boards and districts should educate themselves on the dangers of diesel exhaust and explore ways to reduce the levels of pollution that school buses release into our environment.

3. School boards should only employ private contractors that commit to converting their school buses to clean alternative fuels.

Parent-Teacher Associations and Environmental, Community, and Public Health Advocacy Groups

1. Parent-Teacher Associations and environmental, community, and public health advocacy groups must advocate for federal, state and local strategies that will significantly reduce the level of emissions that are released by California's school bus fleets. Specifically, these groups should support school bus funding legislation in 2000, urge CARB to make clean school buses a priority, and lobby local school districts to make real change in their bus fleet procurements.

2. Public advocacy groups should educate our local communities on the dangers associated with diesel exhaust exposure and provide the tools necessary to motivate, organize and empower communities to come to the table with federal, state and local decision makers to better protect our children's lives.

Industry

1. Engine manufacturers must do their part to protect public health by increasing their research and development, marketing, and manufacturing of clean alternative fuel engines.

2. The petroleum industry should support the development of alternative fuel infrastructure throughout the state and the nation.

Appendix A. Board Urges Use of New Federal TEA-21 Funds to Clean California's Transit and School Bus Fleets

State of California
AIR RESOURCES BOARD

Resolution 98-49

September 24, 1998

Agenda Item No. 98-10-04

WHEREAS, Section 39600 of the Health and Safety Code authorizes the Air Resources Board (Board) to take actions as necessary to execute the powers and duties granted to and imposed upon the Board;

WHEREAS, extensive reductions in oxides of nitrogen (NOx) and combustion generated particulates from diesel engines are needed in order to meet California's State Implementation Plan (SIP) commitments for ozone and particulate matter;

WHEREAS, older pre-1977 school buses emit three times more NOx than new alternative fuel school buses and four times more particulate matter (PM10);

WHEREAS, replacement of diesel buses with cleaner alternative-fuel buses has been found to be a cost-effective means of reducing ozone-forming emissions; for example, ARB's evaluations of the use of motor vehicle registration fees have shown that compressed natural gas (CNG) transit and school buses have achieved a cost-effectiveness in the range of $10,000 and $12,000 per ton of emissions of NOx reduced;

WHEREAS, on August 27, 1998, following extensive scientific review and public hearings, and consistent with the Scientific Review Panel and the Office of Environmental Health Hazard Assessment's conclusions, the Board formally identified particulate emissions from diesel-fueled engines as a toxic air contaminant, and has initiated the risk management process to determine how best to reduce exposure to these emissions;

WHEREAS, the Board, through the adoption of Resolution 98-35, has directed its staff to begin the risk management process for particulate emissions from diesel-fueled engines, including convening a Diesel Exhaust Advisory Committee to assist staff in the identification of measures and strategies to reduce these emissions and exposure to them;

WHEREAS, replacing diesel powered school and transit buses with cleaner, alternative fueled buses is a clean air strategy for meeting health-based air quality standards for ozone and particulate matter and has the added benefit of reducing exposure to diesel particulate emissions which have been identified as a toxic air contaminant;

WHEREAS, the United States Congress, with the strong bipartisan support of the California Congressional Delegation, has substantially increased funds available for transportation-related projects and programs that reduce air pollution through the adoption of the Transportation Equity Act for the 21st Century (TEA-21);

WHEREAS, Congress included in TEA-21 several programs that are potential sources of funds for purchase of cleaner alternative-fuel public transit vehicles, including the Congestion Mitigation and Air Quality Improvement Program (CMAQ), the Clean Fuels Formula Grant Program, the Transit Formula Grant Program, the Transit Capital Investment Program, and the Surface Transportation Program;

WHEREAS, California's share of CMAQ funds has been increased under TEA-21 by more than 100 percent, to an average of about $300 million per fiscal year between 1998 and 2003;

WHEREAS, the CMAQ Program is a potential source of funds for purchase of clean-fuel school buses as well as public transit buses;

WHEREAS, potential sources of local and state matching funds for cleaner alternative-fuel bus purchases include motor vehicle fee surcharge funds, State trust funds for heavy-duty vehicle emission reductions; transportation sales tax revenues, school transportation funds and school bus replacement and infrastructure funds;

WHEREAS, technical training, infrastructure development, and commitment to alternative fuel programs are important to their success.

NOW, THEREFORE, BE IT RESOLVED that the Board calls upon State, local and federal agencies, including air districts, regional transportation planning agencies, local governments, public transit agencies, school and community college districts, the California Department of Transportation, the California Transportation Commission, the California Energy Commission, and elected officials to join together with us in actions to "clean the fleet." We support immediate and continuing efforts to replace diesel-fueled school and public transit buses with cleaner alternative-fuel buses, including the provision of necessary infrastructure and technical training. We strongly urge air pollution control districts and air quality management districts to take a leadership role in bringing together affected agencies to agree on steps needed to implement diesel school and public transit bus replacement.

BE IT FURTHER RESOLVED that the Board recommends the following targets for clean fuel bus purchases to take advantage of significant public health benefits available to California through TEA-21 programs:

For school buses, replacement of the remaining 2200 pre-1977 Type 1 diesel buses by 2003, at an approximate annual cost of $60 million in CMAQ funds and $8 million in local/state matching funds. This will be an important step toward the eventual replacement of all diesel-fueled school buses.

For public transit buses, replacement of the remaining 5000 diesel-fueled buses by 2010, and exclusive purchase of alternative fuel buses for fleet expansion, at an approximate annual cost of $180 million in TEA-21 and subsequent federal funds and $40 million in local/state matching funds.

BE IT FURTHER RESOLVED that the Board directs staff to distribute this resolution and its recommendations to County Boards of Supervisors and City Councils, to State, local and federal transportation, education and air quality agencies, and to school and community college districts. The Board further directs staff to work with air districts to engage these parties in discussions to plan and fund the conversion of California's school and public transit bus fleets to cleaner alternative fuels. The Board further directs staff to keep the Diesel Exhaust Advisory Committee apprised of its efforts.

I hereby certify that the above is a true and correct copy of Resolution 98-49, as adopted by the Air Resources Board.

Pat Hutchens, Clerk of the Board

Appendix B.
Emissions Comparisons of Advanced Diesel, CNG and Propane (LPG) School Buses

'99 Certified Emissions (g/bhp-hr) for School Bus Engine[a] and Fuel Type[b]

Pollutants and CA Emission Standards	Cummins 5.9L (Diesel)	Cummins 5.9L (CNG)	Cummins 5.9L (LPG)	John Deere 6.8L (CNG)	John Deere 8.1L (CNG)	Cummins 8.3L (Diesel)	Cummins 8.3L (CNG)	Detroit Diesel Corp. 8.5L (Diesel)
NOx (4.0 g/bhp-hr)	3.4	1.8	2.3	2.4	2.6	4	1.7	4
PM (0.1 g/bhp-hr)	0.07	0.02	0.01	0.04	0.05	0.09	0.01	0.04
CO (15.5 g/bhp-hr)	0.6	2.7	1.0	1.9	2.2	1.0	0.6	0.8
NMHC (1.2 g/bhp-hr)	0.1	0.06	0.8	0.3	0.4	0.3	0.2	0.5

Calculated Emissions Using '99 Cert. Emissions for School Bus Engines[c]

Pollutants (g/mi)	Cummins 5.9L (Diesel)	Cummins 5.9L (CNG)	Cummins 5.9L (LPG)	John Deere 6.8L (CNG)	John Deere 8.1L (CNG)	Cummins 8.3L (Diesel)	Cummins 8.3L (CNG)	Detroit Diesel Corp. 8.5L (Diesel)
NOx in (g/mi)	14.6	7.38	9.43	9.84	10.7	17.2	6.97	17.2
PM (g/mi)	0.301	0.082	0.0533	0.164	0.205	0.387	0.041	0.172
CO (g/mi)	2.58	11.07	4.1	7.79	9.02	4.3	2.46	3.44
NMHC (g/mi)	0.418	0.246	3.28	1.23	1.64	1.25	0.82	2.09

Calculated Useful Life Emissions Using '99 Cert. Data for School Bus Engines[d]

Pollutants (lbs or tons)	Cummins 5.9L (Diesel)	Cummins 5.9L (CNG)	Cummins 5.9L (LPG)	John Deere 6.8L (CNG)	John Deere 8.1L (CNG)	Cummins 8.3L (Diesel)	Cummins 8.3L (CNG)	Detroit Diesel Corp. 8.5L (Diesel)
NOx (tons)	3.64	1.84	2.35	2.45	2.66	4.29	1.74	4.29
PM (lbs)	150.07	40.88	26.57	81.76	102.21	192.95	20.44	85.75
CO (tons)	0.643	2.76	1.02	7.96	2.25	1.07	0.613	0.858
NMHC (tons)	0.104	0.0613	0.818	0.307	0.409	0.312	0.204	0.521

[a] School bus engines typically used in school bus fleets according to A-Z Bus Sales.

[b] Certified emissions data from ARB's *1999 Model Year Heavy-Duty On-Road Certification Listing*. Values are expressed in grams per brake-horsepower-hour (g/bhp-hr), a measure of the mass emissions released per unit of energy consumed by the engine.

[c] Calculated from certified emissions data using ARB conversion factors of 4.3 bhp-hr/mi for diesel engines and 4.1 bhp-hr/mi for CNG and LPG (ARB 1996). Data from the US Environmental Protection Agency suggests that applying the same conversion factor for all pollutants is inappropriate and has identified empirically-derived estimates that would widen the gap between CNG and diesel for particulate emissions (U.S. EPA 1992).

[d] The calculated emissions shown in the above table assume that the useful life of a school bus is equal to 15 years and accumulates approximately 13,300 miles of service per year (SCAQMD 1999).

Appendix C. CONTACTS

POLITICAL CONTACT INFORMATION.

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LOCAL AIR QUALITY MANAGEMENT DISTRICTS OR AIR POLLUTION CONTROL DISTRICTS

Amador County APCD
(209) 223-6406

Antelope Valley APCD
(805) 723-8070

Bay Area AQMD
(415) 771-6000

Butte County APCD
(530) 891-2882

Calaveras County APCD
(209) 754-6504

Colusa County APCD
(530) 458-0590

El Dorado County APCD
(530) 621-6662

Feather River AQMD
(530) 634-7659

Glenn County APCD
(530) 934-6500

Great Basin Unified APCD
(760) 872-8211

Imperial County APCD
(760) 339-4314

Kern County APCD
(805) 862-5250

Lake County AQMD
(707) 263-7000

Lassen County APCD
(530) 251-8110

Mariposa County APCD
(209) 966-5151

Mendocino County APCD
(707) 463-4354

Modoc County APCD
(530) 233-6419

Mojave Desert AQMD
(760) 245-1661

Monterey Bay Unified APCD
(831) 647-9411

North Coast Unified AQMD
(707) 443-3093

Northern Sierra AQMD
(530) 274-9360

Northern Sonoma County APCD
(707) 433-5911

Placer County APCD
(530) 889-7130

Sacramento Metro AQMD
(916) 386-6650

San Diego County APCD
(619) 694-3300

San Joaquin Valley Unified APCD
(559) 497-1000

San Luis Obispo County APCD
(805) 781-5912

Santa Barbara County APCD
(805) 961-8800

Shasta County AQMD
(530) 841-4029

Siskiyou County APCD
(530) 841-4029

South Coast AQMD
(909) 396-2000

Tehama County APCD
(530) 527-3717

Tuolumne County APCD
(209) 533-5693

Ventura County APCD
(805) 645-1400

Yolo-Solano AQMD
(530) 757-3650

GOVERNMENT FUNDING CONTACTS

California Alternative Energy and Advanced Transportation Financing Authority
915 Capitol Mall, Room 466
Sacramento, CA 95814
Tel. (916) 654-5610
Fax. (916) 653-3241
http://www.treasurer.ca.gov/caecon.htm

Carl Moyer Memorial Fund
Contact: Jack Kitowski
CA Air Resources Board
Mobile Source Controls Div.
2020 L Street
Sacramento, CA 95814
Tel. (916) 323-6169
Fax. (916) 322-3923
http://www.arb.ca.gov/

Compressed Natural Gas School Bus Incentive Program
Contact: Raymon J. Gorski
MSRC
21865 East Copley Drive
Diamond Bar, CA 91765
Tel. (909) 396-3682
Fax. (909) 396-3682
http://www.arb.ca.gov/

Local Government Subvention Funds
Contact: Larry Rheinhardt
South Coast AQMD
218865 E. Copley Drive
Diamond Bar, CA 91765
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Mobile Source Air Pollution Reduction Review Committee
Contact: Raymon J. Gorski
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Tel. (909) 396-3682
Fax. (909) 396-3682
http://www.arb.ca.gov/

Petroleum Violation Escrow Account (PVEA)
Contact: Susan J. Brown
California Energy Commission
Transportation Technology and Fuels Office
1516 9th Street, MS 41
Sacramento, CA 95814-5512
Tel. (916) 654-4741
Fax. (916) 653-470
http://www.energy.ca.gov/

South Coast AQMD Clean Fuels Program
Contact: Chung Liu, D. Env.
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Fax. (909) 396-3252
http://www.aqmd.gov/

Transportation Fund for Clean Air (TFCA) – Bay Area
Contact: Michael R. Murphy
Bay Area AQMD
939 Ellis Street
San Francisco, CA 94109
Tel. (415) 749-4644
Fax. (415) 928-8560
http://www.baaqmd.gov/

ENVIRONMENTAL GROUP INFORMATION.

Coalition for Clean Air
10780 Santa Monica Blvd., Ste. 210
Los Angeles, CA 90025
Phone: (310) 441-1544
Fax: (310) 446-4362
http://www.coalitionforcleanair.org/

American Lung Association of CA
921 11th Street, Suite 700
Sacramento, CA 95814-2821
Tel. (916) 442-4446
Fax. (916) 442-8585

CA League of Conservation Voters

10780 Santa Monica Blvd., Ste. 210
Los Angeles, CA 90025
Tel. (310) 441-4162
Fax. (310) 441-1685
http://www.ecovote.org/ecovote

Natural Resources Defense Council
71 Stevenson Street, Suite 1825
San Francisco, CA 94105
Tel. (415) 777-0220
Fax. (415) 495-5996
Tel. (323) 934-6900
http://www.nrdc.org/

Union of Concerned Scientists
2397 Shattuck Avenue, Suite 203
Berkeley, CA 94704
Tel. (510) 843-1872
Fax. (510) 843-3785
http://www.ucs.usa.org/

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Claudia Sherrill, Dir. of Trans & Safety
8421 Gerber Road
Sacramento, CA 95828
Tel. (916) 686-7734
Fax. (916) 682-1224

Kern Union High School Dist.
Jim Shearer, Maint. Sup.
3701 East Belle Terrace
Bakersfield, CA 93307
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Lower Merion Schools
Mike Andre, Dir. of Transp.
301 East Montgomery Ave.
Ardmore, PA 19003
Tel. (610) 645-1945
Fax. (610) 649-6288

Poway Unified School District
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Tim Purvis, Transp. Dir.
13626 Twin Peaks Road
Poway, CA 92064-3098
Tel. (619) 748-0010
Fax. (619) 679-2536

GENERAL BUS SALES INFORMATION.

A-Z Bus Sales
Contact: James O'Connell
1900 S. Riverside Ave.
P.O. Box 700
Colton, CA 92324
Tel. (909) 781-7188
Fax. (909) 781-4905

California Bus Sales
Contact: Arcadio Aguirre
Distributer of Thomas Built CNG School Buses
2716 S. Cherry Avenue
Fresno, CA 93706
Tel. (800) 331-6183
Fax. (209) 266-0832

ELECTRIC BUS CONTACTS

APS Systems
Contact: Ed Atelian
3535 West 5th Street
Oxnard, CA 93030-6498
Phone: (805)984-0300
Fax: (805)984-2100

So. California Edison
Contact: Kyle L. Davis
P.O. Box 800
2244 Walnut Grove Ave.
Rosemead, CA 91770
Tel. (626) 302-8504
Fax. (626) 302-1328

A-Z Bus Sales, Inc.
Contact: George W. Tillery
1900 S. Riverside Avenue
PO Box 700
Colton, CA 92324
Phone: (909)781-7188
Fax: (909)781-4905

Bus Manufacturing U.S.A.
Contact: Yolanda Davis
325-F Rutherford Avenue
Goleta, CA 93117
Phone: (805)964-0970
Fax: (805)683-7765

El Dorado National
Contact: Gentry Shaw
13900 Sycamore Way
Chino CA 91710
Phone: (909)591-9557
Fax: (909)591-5285

Thomas Built Buses
California Bus Sales
Contact: Arcadio Aguirre
2716 S. Cherry Avenue
Fresno, CA 93706
Phone: (209)266-0167
Fax: (209)266-0932

U.S. Electricar
Contact: Rick Duste
5 Thomas Mellon Circle
San Francisco, CA
Phone: (415) 656-2414

Fax: (415) 656-2402

Thomas-Hughes
Hughes Power Control Systems
Contact: Mark Warren
Loc TO, Bldg. 237, MS 1445
3050 Lomita Boulevard
P.O. Box 2923
Torrance, CA 90509-2923
Phone: (310)517-5866
Fax: (310)517-5727

FUEL CELL BUS CONTACTS

Ballard Power Systems
dbb, Fuel Cell Engines Inc.
3900 North Fraser Way
Burnaby, British Columbia
Canada, V5J5G1
Tel. (604) 432-9200

NATURAL GAS VEHICLE CONTACTS

California Natural Gas Vehicle Coalition
Contact: Gregory E. Vlasek
1228 N Street, Suite 19
Sacramento, CA 95814
Tel. (916) 448-5036
www.califngv.org.

Liberty Fuels, Inc.
Youbert Alkhato, Sales Manager
2801 Mission Street
Santa Cruz, California 95060
Tel. (831) 471-1400
Fax. (831) 471-1408
http://www.libertyfuels.com/

Pacific Gas and Electric Company
Contact: Tom Alexander
123 Mission Street, Room 2240-H28L
San Francisco, CA 94177
Tel. (415) 973-0462
e-mail: TPA1@pge.com

Pickens Fuel Corp.
Contact: Andrew J. Littlefair
3030 Old Ranch Parkway, Suite 280
Seal Beach, CA 90740
Tel. (562) 493-2804
Fax. (562) 493-4532

San Diego Gas and Electric
Contact: Joseph Semerad
8306 Century Park Court CP42K
San Diego, CA 92123-1593
Tel. (858) 654-1105
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Southern California Gas Company
Contact: Mitchell W. Pratt
555 W. Fifth Street
Los Angeles, CA 90013-1011
Tel. (213) 244-3601
Fax. (213) 244-5039

Southwest Gas Corporation
Contact: Mark Haught
P.O. Box 98510
Las Vegas, NV 89193
Tel. (702) 364-3255
Fax. (702) 876-4238

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