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BAY AREA
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Section B

Mobile Source Measures

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BAY AREA AIR QUALITY MANAGEMENT DISTRICT

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MSM A-1 - Promote Clean, Fuel-Efficient Light and Medium-Duty Vehicles

Brief Summary:
The Air District, in cooperation with local businesses, city and county governments, and state and federal agencies, will expand the use of Super Ultra-low Emission (SULEV) and Partial-Zero (ZEV) emission light-duty passenger vehicles and trucks within the Bay Area. Emphasis will be placed on vehicles capable of using renewable, low-carbon fuels.

Purpose:
This measure will reduce emissions of ozone precursors, ROG and NOx, and CO2, a key greenhouse gas. It will also support the renewable and low carbon fuel policies and rules established by the State of California, and implemented by the California Energy Commission and the California Air Resources Board.

Source Category:
Passenger Vehicles and Light-Duty Trucks.

Regulatory Context and Background:
The California Air Resources Board's Low Emission Vehicle standards require car manufacturers to meet increasingly more stringent emission standards for their vehicles. The Bay Area benefits from the LEV-II emission standards whenever a new vehicle replaces an old vehicle that is then scrapped. This measure will focus on accelerating these benefits by supporting early turn-over of the vehicle fleet.

Specifically, this measure will focus on the purchase of light-duty vehicles certified by CARB as meeting the Super Ultra Low Emission Vehicle or Partial Zero Emission Vehicle standards. The SULEV and PZEV standards represent the two cleanest standards for light duty vehicle using internal combustion engines. The SULEV and PZEV standards were adopted by CARB as part of the LEV-II program, with both standards applying to MY 2004 and newer vehicles. There is no distinct difference in emissions between gasoline and alternative fuel vehicles rated as SULEV or PZEV. In November 2009, CARB staff released a white paper outlining potential changes to the Zero Emission Vehicle regulation. One potential change relevant to this control measure is the establishment of new MY 2014 light-duty vehicle emission standards using PZEVs as the baseline. CARB staff refers to this proposal as "LEV III – Criteria Pollutants." The Air District will follow the development of the proposed LEV III standards, and may modify the goals of this control measure by increasing support for PZEV vehicles.

The State of California has adopted goals to increase the use of renewable transportation fuels, thereby decreasing petroleum importation and greenhouse gases. This measure supports the statewide goals by making support for renewable-fuel vehicles a high priority for the District's grant programs.

On June 24, 2009, the President signed the *Consumer Assistance to Recycle and Save Act of 2009* into law. In response to the Act, the National Highway Traffic Safety Administration (NHTSA) established the Car Allowance Rebate Program (CARS). This is a $3 billion government program that helps consumers buy or lease a more environmentally friendly vehicle from a participating dealer when they trade in a less fuel-efficient car or truck. Consumers receive a $3,500 or $4,500 discount from a car dealer when they trade in their old vehicle and purchase or lease a new one. While the program is designed to energize the economy by boosting auto sales and put safer, cleaner and more fuel-efficient vehicles on the nation's roadways, many of the eligible new vehicles are certified by CARB at either the SULEV or PZEV emissions levels. The program has been successful; however, it is unclear if this program will continue into 2010. If it does continue, it will contribute a strong early start to this measure.

Implementation Actions:
The BAAQMD and partner agencies will collaborate to:

- Provide incentives for the purchase of SULEV/PZEV or other vehicles.
- Target high-mileage vehicles for fleet turnover, such as delivery vehicles and taxis.
- Initiate and support demonstration projects of renewable fuels from 2010 – 2012, with the goal of wide-spread retail availability by 2020.
- Initiate and support demonstration projects for GHG efficient vehicles and PM emission controls for vehicles.
- Encourage participation in the federal CARS incentive program for light duty vehicles.
- Continue public outreach and education on efficient driving habits and importance of vehicle maintenance for emission controls.

Goals for this measure are as follows:

- By 2012, place up to 10,000 renewable fuel SULEVs and up to 10,000 renewable fuel P-ZEVs into service, primarily in fleets;
- By 2020, place up to 100,000 renewable fuel SULEVs and up to 100,000 renewable fuel P-ZEVs into service, largely in fleets.

Emission Reductions:
This measure will result in the following annual emission reductions (in tons per day) by the end of 2012 and the end of 2020:

Emissions Reductions:

Pollutants (tons per day)	2012	2020
ROG	0.05	0.51
NO_x	0.03	0.29
PM_{10}	0.01	0.20
C02-e	0.00	0.18

In addition to the pollutants shown above, this measure will reduce emissions of the following pollutants by less than 0.01 tons per day: NH3 (ammonia), benzene, 1,3 butadiene, formaldehyde, and acetaldehyde.

Emission Reduction Methodology:
Emission reductions have been estimated by comparing the incremental difference in emissions between a new vehicle meeting the fleet wide average under the LEV-II emissions standards and the zero mile maximum emission allowable emission rate for a new SULEV or PZEV vehicle. There are no appreciable difference in the emission rates of particulate matter between LEV-II compliant vehicles and SULEV or PZEV vehicles. Emission rates developed by CARB were used in this analysis. The new vehicles are assumed to average 12,000 miles of travel per year.

The estimation of reductions in CO2 emissions is highly dependent upon the fuel type of the purchased vehicles. For the purposes of the current plan, it is assumed that 50% of the new vehicles will be fueled by ethanol obtained from a 80%/20% blend of California corn using the dry mill process and from crop and wood waste using cellulosic processes and 50% will be fueled by natural gas recovered from landfills and bio-digesters. Emission factors reflecting the full-fuel cycle developed by CARB for the Low Carbon Fuel Standard were used in this analysis. Vehicles were assumed to achieve an average fuel economy of 30 miles per gasoline gallon equivalent and consume the equivalent of 400 gasoline gallons per year in fuel.

Exposure Reduction:
To the extent that use of more fuel efficient vehicles or combustion of renewable fuels results in lower levels of toxic emissions from light and medium duty vehicles, exposure will be lessened/reduced.

Emission Reduction Trade-offs:
To avoid trade-offs, it will be important to avoid renewable fuels whose full life-cycle impact will result in increased emissions of any criteria pollutant or greenhouse gas.

Cost:
New gasoline and ethanol light duty vehicles certified to the SULEV and PZEV standards generally cost the same as other vehicles on the market. However, vehicles powered by an alternative fuel, such as natural gas, currently sell at a modest price premium. Additionally, an incentive is often required to induce vehicle owners to undertake early replacement of a vehicle. For this measure, it is assumed that an average subsidy of approximately $2,500 per vehicle will be required to accelerate vehicle turnover. The costs of this measure are assumed then to be:

Phase 1: $50 million
Phase 2: $450 million

It is anticipated that the District will provide up to $6 million per year on average towards the accelerated purchase of qualifying vehicles. Additional incentives funds will need to come from state and federal incentive programs, tax refunds and rebates, and private sources.

Because this control measure focuses only on the purchase and deployment of cleaner vehicles, no costs estimates are provide here for necessary infrastructure. The availability of public and private financing for the development of refueling equipment, especially for locally produced, renewable fuels will need to be considered during the implementation phases of this measure.

Monitoring Mechanisms:

- Vehicle registration data from the Department of Motor Vehicles.
- Fuel sales data from the Franchise Tax Board.
- Progress and Final reports from any Air District grants or incentives.
- Progress and Final reports made available from the CEC and CARB for their alternative fuel, technology advancement and climate change programs.

Issues/Impediments:

- Funding for vehicle subsidies.
- Limited availability of SULEV and PZEV vehicles capable of using renewable, low-carbon fuels.
- Limited availability of renewable, low-carbon fuels due to lack of breakthroughs in reducing production costs.
- Local permitting of bio-refineries

Sources:

1. California Air Resources Board, (CARB), Low –Emission Vehicle Program, http://www.arb.ca.gov/msprog/levprog/levprog.htm
2. CARB, Title 17, California Code of Regulations Section 95480 *et seq.*
3. CARB, *Resolution 09-31* (Low Carbon Fuel Standard), April 23, 2009. http://www.arb.ca.gov/regact/2009/lcfs09/res0931.pdf
4. CARB, *Proposed Regulation to Implement the Low Carbon Fuel Standard: Volume 1: Staff Report: Initial Statement of Reason*, March 5, 2009.
5. CARB, *Proposed Environmental Analysis Work plan for the California Low Carbon Fuel Standard*, 2009. http://www.arb.ca.gov/fuels/lcfs/120208lcfs_environ.pdf
6. California Energy Commission, *FINAL Adopted State Alternative Fuels Plan*, December 5, 2007, Publication #CEC-600-2007-011-CMF.
7. California Energy Commission, *Alternative and Renewable Fuel and Vehicle Technology Program Regulations*, May 7, 2008, Publication # CEC-600-2008-013-F.
8. California Energy Commission, Final Regulation Language Alternative and Renewable Fuels and Technologies Program, Title 20, CCR, SECTIONS 3100 – 3108, January 2, 2009.
9. California Energy Commission, *Investment Plan for the Alternative and Renewable Fuels and Technologies Program*, April 2009. Publication #CEC-600-2009-008-CTF.
10. Department of Transportation, National Highway Traffic Safety Administration, *Car Allowance Rebate System (CARS)*, http://www.cars.gov/

MSM A-2 - Zero Emission Vehicles (ZEV) and Plug-in Hybrids

Brief Summary:
The Air District, in cooperation with local businesses, city and county governments, and state and federal agencies, will expand the use of Zero Emission (ZEV) and Plug-in Hybrid (PHEV) passenger vehicles and light-duty trucks within the Bay Area.

Purpose:
This measure will reduce ozone precursors and greenhouse gases.

Source Category:
On-Road Motor Vehicles: Passenger Cars/Light Duty Trucks

Regulatory Context and Background:
In September 1990, ARB adopted a low-emission vehicle regulation whose aim is to drastically reduce pollution from passenger cars and light-duty trucks. As part of the newly created program, the Board included a goal of requiring large auto manufacturers to commercialize vehicles with zero emissions, beginning with 1998 model-year vehicles. The original ZEV program required that 10 percent of new vehicle sales by large manufacturers have zero emissions, starting with 1998 models. The Board modified the program in 1998 and 2001 to allow up to 60 percent of the requirement to be met with vehicles having extremely low emissions and other specific attributes. In 2009 up to 85 percent of the requirements may be met with these vehicles. Vehicles meeting these standards are referred to as “partial zero emission vehicles” (PZEV) and “advanced technology partial zero emission vehicles” (AT-PZEV).

Manufacturers originally planned to meet the ZEV requirements with battery electric vehicles. In 1996, due to cost and performance issues, the ARB eliminated the early (1998) requirements to allow additional time for battery research and development. To ensure a significant market for advanced battery manufacturers, the ARB entered into agreements with manufacturers to place in California roughly 1,800 advanced-battery electric vehicles between 1998 and 2000. The agreements were designed to provide battery developers with the necessary initial production volumes to meet the cost and performance goals needed for commercial production.

CARB’s most recent amendments to the ZEV program in 2008 increased the percentage of ZEVs required to 11 percent starting in 2012, with manufacturers being provided additional flexibility to meet their regulatory obligations through sale of plug-in hybrid vehicles and fuel cell vehicles. The ZEV requirement has been implemented by CARB to catalyze efforts to commercialize sustainable transportation. The program has prompted manufacturers to develop extremely clean conventional and alternative fuel and hybrid electric vehicles. There are currently twenty-one auto manufacturers subject to the ZEV regulation. Six are defined as large volume manufacturers: General Motors, Toyota, Ford, Honda, Chrysler and Nissan. The remaining 15 are intermediate volume manufacturers.

In November 2009, CARB staff released a white paper outlining potential changes to the Zero Emission Vehicle regulation that may be considered by the Air Resources Board. One potential change relevant to this control measure is the establishment of new Green House Gas light-duty vehicle emission standards using AT-PZEVs as the baseline. CARB staff refers to this proposal as "LEV III – Green House Gas." The Air District will follow the development of the proposed LEV III standards, and may modify the goals of this control measure by increasing support for battery electric and fuel cell vehicles.

Implementation Actions:

- Commit motor vehicle grant registration funds towards qualifying vehicle purchases and infrastructure development subsidies.
- Partner with private, local, state and federal programs to promote the purchase of battery-electric and plug-in hybrid electric vehicles.
- Partner with private, local, state and federal programs to install and expand public charging infrastructure. Promote existing charging infrastructure.
- Support research programs advancing technology for plug-in hybrid, battery electric and hydrogen-fueled vehicles.
- Advocate for increased government subsidies and research programs with local businesses, non-profits and governments through the Bay Area Electric Vehicle Initiative.
- Support the use of renewable electricity in both ZEVs and PHEVs, with additional support for low carbon, renewable fuels in the onboard internal combustion engines in PHEVs.

Goals for this measure are as follows:

- By 2012, place 1,000 ZEVs and 5,000 PHEVs into service, primarily in fleets;
- By 2012, expand regional recharging network with 500 new charging stations;
- By 2020, place 10,000 ZEVs and 100,000 PHEVs into service;
- By 2020, expand regional recharging network with 2,000 new charging stations.

Emission Reductions:

Pollutants (tons per day)	2012	2020
ROG	0.01	0.18
NO_x	0.01	0.13
PM10	0.01	0.02
$PM_{2.5}$	0.00	0.01
C02-e	0.00	0.30

In addition to the pollutants shown above, this measure will reduce emissions of the following pollutants by less than 0.01 tons per day: NH3 (ammonia), benzene, 1,3 butadiene, formaldehyde, and acetaldehyde.

Emission Reduction Methodology:
Emission reductions were calculated by assuming that each ZEV and PHEV is in lieu of an average brand new gasoline powered vehicle. For zero emission vehicles, the emission reductions are calculated as the difference between new vehicle emissions and zero emissions in the years 2012 and 2020.

For plug-in hybrid vehicles, it is assumed that the vehicles operate in electric mode for 50% of the annual VMT, or 6,000 miles, and that 75% of the electric power derives from grid supplied electricity stored in batteries, while the remaining 25% of the electricity comes from burning gasoline in the vehicle engine.

Exposure Reduction:
Reduction in the use of gasoline will also reduce public exposure to air toxics, particularly in communities near heavily travelled roads and freeways.

Emission Reduction Trade-offs:
This measure will not increase emissions of any pollutant from motor vehicles; however, to the extent that it helps to increase the number of ZEVs and PHEVs in use within the Bay Area, it may slightly increase emissions of criteria pollutants and greenhouse gases from power plants that generate the required electricity.

Cost:
Cost for the measure is determined by the marginal cost for the cleaner ZEVs and PHEVs over a standard car, plus infrastructure costs. Based on the Air District's 2009 application for federal stimulus funding from the Department of Energy, the marginal or incremental vehicle costs are $12,000 per vehicle and infrastructure is $19,000 per recharging unit on average. Costs to implement are estimated to be:

Phase 1:	Vehicle Costs	$72 million
	Infrastructure	$9.5 million
Phase 2:	Vehicle Costs	$53 million
	Infrastructure	$19 million

It is anticipated that the District will provide up to $6 million per year on average towards the accelerated purchase of qualifying vehicles. Additional incentives funds will need to come from state and federal incentive programs, tax refunds and rebates, and private sources. It is likely that public fleet orders will comprise the bulk of the purchases during the 2010 to 2012 period.

Co-benefits:
The expanded use of newer, cleaner electric powered cars will reduce water pollution and decrease reliance on crude oil for transportation fuel. Benefits of "green" job creation are dependent on commitments to manufacture compliant vehicles within the Bay Area.

Monitoring Mechanisms:
This measure can be monitored via annual vehicle registration data compiled by the DMV, as well as tracking any grant contracts for incentive funding paid out by the Air District.

Issues/Impediments:
- Funding for vehicle subsidies
- Limited availability of ZEV and Plug-in Hybrid vehicles.
- Vehicle price and ongoing maintenance costs
- Battery Technology

Sources:
1. BAAQMD, *Grant Application, U.S. Department of Energy (DOE), National Energy Technology Laboratory, Funding Opportunity: Clean Cities FY09 Petroleum Reduction Technologies Projects for the Transportation Sector, Area Interest #4; Funding Opportunity Number DE-PS26-09NT01236-04; CFDA Number 81.086.* June 2009
2. CARB, *Status Report on the California Air Resources Board's Zero Emission Vehicle Program*, April 20, 2007
3. CARB, *Status and Prospects for Zero Emission Vehicle Technology: Report of the ARB Independent Expert Panel 2007*, April 13, 2007.
4. CARB, *California Hydrogen Highway Network: 2008 Report to the Legislature*, January 2009.
5. CARB*, Preliminary Summary of Air Resources Board Action (3/27/08) – Zero Emission Vehicle (ZEV) Program,* April 2008.
6. For a list of existing public EV charging stations in the Bay Area, see http://www.evchargermaps.com/.

MSM A-3 - Green Fleets

Brief Summary:
This control measure consists of three elements: a) development of a green fleet certification as part of the ABAG Green Business Program; b) the promotion of best practices for green fleets through a dedicated website; outreach to local governments; and outreach to business groups and grant applicants to promote best practices; and c) potential revisions to the District's Transportation Fund for Clean Air (TFCA) and other grant programs to ensure funding is directed towards fleets meeting GHG performance standards.

Purpose:
This measure will further reduce ozone precursors and greenhouse gases, as well as particulate matter and PM precursors.

Source Categories/Travel Markets Affected:
On-Road Light, Medium, and Heavy-Duty Vehicles

Regulatory Context and Background:
There has been little experience to-date with regulatory efforts requiring cleaner, greener fleets. The South Coast AQMD adopted a number of fleet regulations including: Less-Polluting Street Sweepers, Clean On-Road Light- and Medium-Duty Public Fleet Vehicles, Clean On-Road Transit Buses, Clean On-Road Residential and Commercial Refuse Collection Vehicles, Commercial Airport Ground Access Vehicles (Taxicabs, Shuttles, etc.), Clean On-Road School Buses, and Clean On-Road Heavy-Duty Public Fleet Vehicles. These regulations apply to public and private fleets and require the purchase of mostly natural gas powered vehicles. ARB has a number of recently adopted regulations targeting fleet turnover, clean-up of heavy duty trucks, and truck hybridization research programs.

With regards to voluntary efforts, the federal EPA has promoted its SmartWay program as means for reducing energy usage from long-haul trucking operations. ABAG has a Bay Area-wide Green Business Program which uses a checklist for businesses/agencies to complete. ABAG has customized checklists for businesses, such as hotels, printers, and offices. San Francisco uses a customized Green Business checklist with several vehicle related requirements for businesses. Puget Sound Clean Air Agency has an entire website, http://www.psgreenfleets.org/, devoted to assisting agencies and businesses in creating a green fleet. The website contains grant/incentives resources, a green fleet calculator, and regulatory updates.

Implementation Actions:
Green Fleet Certification – The Air District will coordinate with the ABAG/Bay Area Green Business program to explore development of a "green fleet" certification. The Air District and ABAG will encourage public agencies and the private sector to contract with certified green fleets, and with other certified businesses that implement green fleet practices.

Promote best practices – Green fleet best practices include purchasing low emission vehicles, properly maintaining vehicles, minimizing fleet size, reducing reliance on petroleum based transportation fuels, increasing use of locally produced renewable fuels, and encouraging efficient driving habits. The green fleet toolkit developed by Sustainable Earth Initiatives with funding from the Air District's Climate Protection Grant Program, and the San Francisco Department of Environment's Green Fleet calculator represent excellent examples of best practices to promote. The District will consider either developing a specific website or dedicating a page on its website to address green fleet best practices, available incentives, and possibly a green fleet calculator, similar to the webpage developed by the Puget Sound Clean Air Agency.

Incentives/Grants Strategy – Track and assist public agencies in "greening" their fleets. Performance standards for cleaner burning and GHG efficient vehicles may be established for the Air District's grant programs based on ARB's GHG vehicle labeling program and green fleet best practices. The Air District and its partners may utilize the EPA SmartWay program as a source for establishing performance standards for heavy-duty trucks.

Emission Reductions:

Pollutants (tons per day)	2012	2020
ROG	0.02	0.08
NO_x	0.02	0.10
PM10	0.03	0.07
$PM_{2.5}$	0.02	0.05
C02-e	0.00	0.33

In addition to the pollutants shown above, this measure will reduce emissions of the following pollutants by less than 0.01 tons per day: NH3 (ammonia), benzene, 1,3 butadiene, formaldehyde, and acetaldehyde.

Emission Reduction Methodology:
Overall, the Air District will aim to achieve emission reductions from fleets in three ways: increase the use of alternative fuels, increase the use of fuel efficient light duty vehicles, and reduced VMT.

For the purposes of calculating potential benefits under the measure, the Air District will work towards the following goals:

2012

- 1,000 diesel trucks begin using a 20% biodiesel fuel blend.
- 400,000 gallons of gasoline fuel saved from the use of more fuel efficient light-duty vehicles.
- 12 million fewer miles driven by light-duty vehicles.

2020

- 5,000 diesel trucks begin using a 20% biodiesel fuel blend.
- 2 million gallons of gasoline fuel saved from the use of more fuel efficient light-duty vehicles.
- 60 million fewer miles driven by light-duty vehicles.

The increased use of biodiesel will contribute to the reduction of PM2.5 and CO2, while the use of more efficient vehicles and the reduction in VMT will reduce NOx, ROG, PM2.5, PM10 and CO2. Emission factors are derived from work by CARB on the low carbon fuel standard and LEV-II program. It is assumed that heavy-duty trucks switching to biodiesel on average are driven 25,000 miles per year with a fuel economy of 5 miles per gallon (mpg). It was also assumed that gasoline savings by improving vehicle fuel economy from 20 mpg to 30 mpg.

Exposure Reduction:
The adoption of "green" practices by automotive fleet operators will reduce gasoline and diesel usage, which in turn will lower exposure to toxic compounds emitted by light duty gasoline vehicles and medium- and heavy-duty diesel trucks.

Emission Reduction Trade-offs:
None. Adoption of green fleet practices should lead to the reduction of all emissions.

Cost:
The development of a green fleet certification element to the Bay Area Green Business program is estimated to cost $250,000 in staff and consultant fees. The promotion of the Green Fleets Toolkit is estimated to cost $300,000 annually in staff, material and advertising.

Co-benefits:
Promoting a Green Fleets program will help to reduce water and noise pollution. This measure should also reduce petroleum usage in the Bay Area.

Monitoring Mechanisms:

- The annual level of effort by Air District and ABAG Staff to promote Green Fleet best practices.
- The annual increase in fleets making use of the Green Fleets Toolkit.
- Development of green fleet standards and a checklist of robust green vehicle requirements for the Bay Area Green Business certification program.

Issues/Impediments:
The main issues are the availability of resources to implement a Green Fleet certification component of the ABAG/Bay Area Green Business Program, as well as promote "best practices" to fleet operators; and interest/acceptance by fleet operators in changing from current practices.

Sources:

1. Association of Bay Area Governments, *Bay Area Green Business Program*, online at http://www.greenbiz.ca.gov/
2. The Sustainable Earth Initiative, et al*., San Francisco Bay Area Green Fleets Toolkit*, February 2009. Available at http://www.sfenvironment.org/downloads/library/clean_fleets_toolkit__greening_commercial_fleet.pdf
3. CARB, *Subarticle 1, sections 95300 to 95312, title 17, California Code of Regulations*
4. CARB, *Heavy Duty Vehicle Greenhouse Gas Emission Reduction Measure,* 2009, http://www.arb.ca.gov/cc/hdghg/hdghg.htm
5. CARB, *Proposed Regulation to Implement the Low Carbon Fuel Standard: Volume 1: Staff Report: Initial Statement of Reason*, March 5, 2009.
6. CARB, *Detailed California-Modified GREET Pathway for Ultra Low Sulfur Diesel (ULSD) from Average Crude Refined in California*, April 22, 2008.
7. CARB, *Detailed California-Modified GREET Pathway for Biodiesel Produced in California from Used Cooking Oil,* July 20, 2009.
8. EPA, SmartWay Program, http://www.epa.gov/smartway/

MSM A-4 - Replacement or Repair of High-Emission Vehicles

Brief Summary:
This control measure proposes enhancements to three long-running programs to control emissions from in-use light-duty motor vehicles: the Air District's Vehicle Buy Back and Smoking Vehicle complaint programs, and the State's Smog Check program.

Purpose:
The purpose of this measure is to reduce ozone precursors, PM, air toxics, and greenhouse gases from high-emitting vehicles by accelerating the replacement or repair of such vehicles.

Source Category/Travel Market Affected:
On-Road Motor Vehicles Passenger Cars & Light-Duty Trucks

Regulatory Context and Background:
Late-model vehicles that are equipped with recent emission control technologies and properly maintained emit very little ozone precursors or PM. By contrast, older vehicles, or vehicles that are not properly maintained, can emit pollutants at a much higher rate. There are approximately 325,000 pre-1989 model year vehicles on the road in the Bay Area. Although they account for only about 7% of the total vehicle fleet, these older vehicles have much higher emission rates, so that they account for a disproportionate share of total vehicle emissions. Accelerating the replacement or repair of high-emitting vehicles offers a cost-effective strategy to reduce emissions of criteria pollutants and air toxics. In addition, removing older vehicles can help to reduce emissions of CO2.

Vehicle Buy-Back: The Air District has operated a Vehicle Buy-Back (VBB), or scrappage, program since 1996. VBB provides cash to vehicle owners to voluntarily retire old vehicles. Payment per vehicle initially was set at $500; it increased in FY 2006/2007 to $650; and again in 2009 to $1,000. Funding has primarily come from the District's Transportation Fund for Clean Air. This program has led to the early retirement of more than 42,000 older, higher emitting vehicles. The average rate of retirement for the first 10 years of the program was 2,700 vehicles per year; this increased to an average of 7,800 vehicles in the most recent two years, the result of an increased budget and the higher per vehicle payout to vehicle owners and expanded model year eligibility. In February 2009, the Air District also expanded the program to cover model years (MY) 1988 and 1989 vehicles.

The District administers the VBB program based upon guidelines issued by the California Air Resources Board for its Voluntary Accelerated Light-Duty Vehicle Retirement (VAVR) Program. The ARB adopted revisions to the VAVR regulation on December 7, 2006, that incorporate the use of remote sensing devises (RSD) and other technologies to identify high emitting vehicles as possible candidates for voluntary retirement to generate additional emission reductions.

In 2007, the South Coast Air Quality Management District launched its High Emitter Repair or Scrap (HEROS) Program. The HEROS program initially explored the potential benefits of using remote sensing devices to identify gross polluting vehicles operating on local roads and highways, and then offering the vehicles owners cash to either repair or scrap their vehicles. The initial experience with the program has been positive, with the program being expanded in 2009.

Smoking Vehicle Program: The Air District's voluntary program for reporting smoking vehicles began in December 1992. Smoking vehicles are identified and reported to the Air District by Bay Area residents through the *1-800-EXHAUST* phone line and website. After a report is made, the Air District contacts the vehicle owner and encourages them to either have the vehicle repaired or retire it through the Vehicle Buy Back Program. Each year an average of 35,000 calls are received complaining about vehicles emitting excessive visible exhaust.

Smog Check: Motor vehicle emissions have been subject to controls since 1961, when California adopted a regulation that required new cars to have positive crankcase ventilation – the recycling of crankcase emissions back into the engine instead of the atmosphere. Since then, progressively tighter limits on exhaust have spurred the development of a variety of abatement equipment and systems.

In recognition that keeping the abatement equipment and systems operating at peak efficiency ensures the best results from the emissions controls, the Air District in 1980 proposed an inspection and maintenance program. This proposal eventually was adopted in modified form by the California State Legislature and Smog Check was begun in 1984. Enhancements to the program were adopted in 1996 and phased in to many parts of California, with the enhanced program begun in the Bay Area in 2003.

The Smog Check program is operated by the California Bureau of Automotive Repair, with advice from the California Air Resources Board. South Coast Air District required biennial test of motor vehicles to assure they meet applicable emission standards. The Inspection and Maintenance Review Committee monitors and recommends enhancements to South Coast's program.

In November 2008, the State of California's Inspection and Maintenance Review Committee published a draft report on the current status of the Smog Check program. In this draft report, the Review Committee has made several useful suggestions for additional modifications and enhancements to the California Smog Check program. The recommendations in the report serve as the basis for the proposed advocacy plan in this control measure.

Implementation Actions:
The Vehicle Buy-Back, Smoking Vehicle, and Smog Check programs have all helped to improve air quality in the Bay Area. Nonetheless, high-emitting vehicles are still a major contributor to air quality problems. The Air District has recently developed a campaign to help strengthen awareness of and responsiveness to the VBB and Smoking Vehicle programs.

Vehicle Buy Back - The Air District will:

- Consider expanding its marketing of the program through targeted outreach in impacted communities defined through the CARE Program, advertising at Smog Check test sites, specialized or supplemental direct mail solicitation and advertising to owners of pre-1975 vehicles and smog-exempt vehicles, and through the District's Smoking Vehicle program.
- Study the potential for including motorcycles in the District's Vehicle Buy Back program.
- Evaluate the possible benefits of offering a higher incentive for vehicles located in priority communities identified through the CARE program.
- Evaluate South Coast Air Quality Management District's experience with a vehicle repair program –$500 for repairs to a vehicle's emission control systems – as an option for the Bay Area.

Smoking Vehicle Program - The Air District will:

- Continue operation of 1-800-EXHAUST phone line and advertisement campaign;
- Conduct an assessment of the program's effectiveness in reducing emissions. The assessment will consist of follow-up surveys of vehicle owners receiving complaint letters from the Air District; amend the program as warranted.
- Propose program enhancements or revisions as appropriate.

California Smog Check - The Air District will:

- Seek and/or support legislation to enhance the smog check program, e.g., require annual inspections of older model year and of high mileage vehicles, include testing for exhaust particulate matter (PM) in the program; add motorcycles to Smog Check;
- Consider offering incentives to encourage newer model and/or lower mileage vehicle owners to submit their vehicles for annual inspections;
- Consider replicating the SCAQMD's high emitter identification and repair program – HEROS.

Emission Reductions:

Pollutants (tons per day)	2012	2020
ROG	4.37	14.60
NO_x	2.06	6.90
PM10	0.03	0.10
$PM_{2.5}$	0.02	0.07
Benzene	0.09	1.30
1,3 Butadiene	0.02	0.28
Formaldehyde	0.06	0.93
Acetaldehyde	0.04	0.65
C02-e	44.14	147.14

In addition to the pollutants shown above, this measure will reduce emissions of the following pollutants by less than 0.01 tons per day: NH3 (ammonia).

Emission Reduction Methodology:
Emission reduction estimates for this measure are based on past performance of the Vehicle Buy Back and Smoking Vehicle Programs.

Estimates of potential benefits from adding motorcycles to the VBB program and implementing a HEROS style remote sensing and repair program are not included; such estimates will be developed as part of the District's review and consideration of these initiatives.

Exposure Reduction:
In general terms, harmful emissions are at their lowest when abatement equipment on a vehicle is well maintained and operating as designed. Programs that remove the oldest, most-polluting vehicles from operation reduce exposure to toxic air contaminants emitted by gasoline vehicles.

Emission Reduction Trade-offs:
Programs that require the destruction of old vehicles may lead to incremental increases in green house gases; that is, the energy required to destroy the old vehicles may not be offset by the generally higher fuel efficiency of new vehicles. Investigation of this potential trade-off will need to be undertaken during the implementation of this measure.

Cost:
Costs associated with increased frequency of testing under the Inspection & Maintenance program, or inclusion of motorcycles in the program, will be borne by the vehicle owners. There would be some costs to the State of California to update tracking and notification systems.

If the Air District decides to replicate the HEROS program, there will be costs involved in deploying remote sensing equipment to identify gross polluting vehicles, establishing systems for notifying vehicle owners, and the cost of repairing or scrapping vehicles. Costs for this effort will be primarily borne by the Air District, although opportunities exist to utilize funds from private firms or other governmental programs.

The cost for the Vehicle Buy Back Program is $1,000 per vehicle, plus overhead to the car scrapping companies that administer the program. At present, the Vehicle Buy Back Program is funded with Mobile Source Incentive Funds, Carl Moyer Program Funds, and the Air District's Transportation Fund for Clean Air.

The annual budget for the Smoking Vehicle Program is approximately $1 million per year. Funding comes from the Air District's Transportation Fund for Clean Air.

Co-benefits:
Repairing or scrapping gross polluting vehicles will reduce energy consumption, reduce consumer costs, and avoid water pollution (storm water runoff). The expansion of the Smog

Check program to annual inspections and inspections of motorcycles, as well as the implementation of a HEROS type program, may lead to the creation of "green" jobs.

Monitoring Mechanisms:
California Smog Check - The primary means for monitoring progress on this measure will be through the California Legislature, and their effort to expand the Smog Check program.

Vehicle Buy Back and Smoking Vehicles - Monitoring will be accomplished through progress and final reports to the Board of Directors on the initiatives described above, through implementation plans, and budget requests for any expansion of the Vehicle Buy Back and Smoking Vehicle programs.

Expanded use of follow-up surveys for the Smoking Vehicle program will allow the Air District to better assess the on-going need for the complaint line.

Issues/Impediments:
- Changes to the Smog Check program require legislative approval.
- An issue for the Smoking Vehicle program is the declining incidence of vehicles operating with visible exhaust. Tighter emissions controls, higher mileage warranties, advanced engineering, and fleet turnover have all worked to reduce the likelihood for a vehicle to emit visible exhaust, unless there has been a major failure to an engine system.

Sources:
1. State of California, Inspections & Maintenance Review Committee, *IMRC 2008 Smog Check Review Report*, November 18, 2008. http://www.imreview.ca.gov/reports/index_reports.shtml
2. State of California, Bureau of Automotive Repair, http://www.smogcheck.ca.gov/
3. South Coast Air Quality Management District, *High Emitter Repair or Scrap (HEROS) Program*, http://www.aqmd.gov/news1/2007/remotesensingfactsheet.html
4. Bay Area Air Quality Management District, various annual reports & staff reports on the VBB program.
5. South Coast Air Quality Management District, Final 2007 AQMP, Appendix IV-A, pp 148-155, 2007
6. State of California, Air Resources Board, Voluntary Accelerated Vehicle Regulations, http://www.arb.ca.gov/msprog/avrp/avrpfaq.htm

MSM B-1 - Fleet Modernization for Medium- and Heavy-Duty On-Road Vehicles

Brief Summary:
Between 2010 and 2015, the Air District will directly provide, and encourage other organizations to provide, incentives for the purchase of new trucks that meet the California Air Resources Board's 2010 emission standards for heavy-duty engines. This program is designed to assist truck owners/operators to replace pre-2003 heavy-duty diesel trucks (Class 7 and 8) with new diesel-fueled or natural gas-fueled trucks in advance of requirements of CARB's in-use truck regulation.

Purpose:
This measure will reduce ozone precursors and diesel particulate matter emissions.

Source Category/Travel Market Affected:
Medium and Heavy Duty On-Road Vehicles

Regulatory Context and Background:
Emissions from heavy duty trucks account for nearly 24% of NOx emissions in the Bay Area; they are also a significant source of diesel PM. Since 1988, when the first emission standards for trucks came into effect, trucks have become significantly cleaner. Beginning with the model year (MY) 2010 standards adopted by both CARB and the federal EPA, truck emissions for both particulate matter and NOx will be at near-zero levels.

However, because heavy-duty trucks are kept in service for many years and fleet turnover is slow, it can take a long-time to see the air quality benefits of the new engine standards. In 2008, to accelerate the replacement or retrofit of old trucks, CARB adopted a regulation that requires truck fleets to meet progressively more stringent limits as calculated on a fleet-average basis.

The benefits of the fleet-average regulation can be further accelerated by offering financial incentives to truck owners to replace an existing truck 3-5 years in advance of the regulatory requirements. The Air District currently offers incentives for the purchase of MY 2007 and newer trucks as part of the Carl Moyer Program and other grant programs.

Implementation Actions:
Between 2010 and 2015, the Air District will directly provide and/or work with other entities to provide incentives to accelerate the replacement of up to 5,000 heavy-duty on-road diesel engines in advance of requirements for the ARB in-use heavy-duty truck regulation. In order to maximize reductions in green house gases, priority will be given to the purchase of new trucks fueled by natural gas or locally produced bio-fuels.

Emission Reductions:

Pollutants (tons per day)	2012	2020
ROG	0.10	0.25
NO_x	5.00	12.5
PM10	0.11	0.28
$PM_{2.5}$	0.03	0.27
Formaldehyde	0.01	0.02
Acetaldehyde	0.02	0.04
C02-e	0.64	233.24

In addition to the pollutants shown above, this measure will reduce emissions of the following pollutants by less than 0.01 tons per day: NH3 (ammonia), Benzene, and 1,3 Butadiene.

Emission Reduction Methodology:
To estimate the emission reductions from the early replacement of heavy-duty diesel trucks, District staff assumed that on average a model year 2000 truck that travels 50,000 miles per year would be replaced by a model year 2010 CARB/EPA compliant truck. The emission reductions represent the difference in emission rates between the old and new trucks. We assumed that of the 5,000 truck replacements targeted under this measure, 3,000 of the new trucks would be fueled by natural gas. We also assumed that 2,000 truck replacements would occur by 2012, with the balance occurring by 2015. Benefits from the early replacement of the trucks would occur over a 3-5 year period.

Exposure Reduction:
This measure will accelerate the health benefits of an adopted CARB regulation by reducing exposure to diesel PM and by reducing NOx emissions that contribute to regional ozone formation. Impacted communities near freeways and roads with significant truck traffic will benefit.

Emission Reduction Trade-offs:
Exhaust controls on diesel trucks meeting the MY 2010 standards may decrease fuel economy, thereby increasing CO2 emissions.

Cost:
The cost to implement this measure will be determined primarily by the level of financial incentive that will be offered to fleet owners to encourage early compliance with the CARB truck regulations. The incentive amount will be determined during the development of the program. An existing fleet modernization program operated through the Carl Moyer Program provides approximately $35,000 per heavy-duty truck.

Based on the current incentive levels, this measure will potentially cost $175 million to implement. It is anticipated that the District will make available up to $10 million per year in incentives for the purchase of new trucks between 2010 and 2015.

Co-benefits:
To the extent this measure is successful in replacing diesel trucks with natural gas or other alternative fuel trucks, there will be a reduction in petroleum usage in the Bay Area. Reductions in the use of petroleum will help reduce stationary source pollution and water pollution.

Monitoring Mechanisms:
The benefits of the program will be monitored via the contracts for the financial incentives. The District will track emission reductions.

Issues/Impediments:
This control measures sets forth enhancements for an existing program and should not give rise to any new obstacles, as long as funding for the incentives is secured.

Sources:
1. BAAQMD, Carl Moyer Incentive Program, www.baaqmd.gov
2. California Air Resources Board, *2008 Carl Moyer Guidelines*, Chapters III and IV, April 22, 2008

MSM B-2 - Low NOx Retrofits in Heavy-Duty On-Road Vehicles

Brief Summary:
Between 2010 and 2015, the Air District will provide incentives to install CARB-verified abatement equipment to reduce NOx emissions from existing on-road heavy-duty truck engines. Emphasis will be placed on bringing existing engines into early compliance with CARB's in-use truck regulation. The Air District will also continue to require software updates to engine control modules in model year (MY) 1993-1998 diesel trucks to reduce excess NOx emissions as a condition of all heavy-duty vehicle retrofit grants. The Air District will work with CARB to evaluate the feasibility of installing or replacing catalytic convertors on gasoline powered heavy-duty vehicles.

Purpose:
This measure will reduce ozone precursors.

Source Category/Travel Market Affected:
Heavy Duty On-Road Vehicles

Regulatory Context and Background:
Electronic control of the operation of truck engines became commonplace in 1994. Electronics allow for more precise control of engine timing and fuel injection; this has provided significant reductions of NOx and PM emissions. Electronic engine control has also opened up opportunities for integration of exhaust abatement devices, such as lean NOx catalysts, NOx absorbers, exhaust gas recirculation and selective catalytic reduction (SCR) systems. In fact, engine manufacturers will be using SCR systems extensively to comply with ARB's MY 2010 NOx standard for new engines. The increasing availability of retrofit devices to reduce NOx from existing engines provides an opportunity for the Bay Area to achieve benefits in advance of historical fleet turnover rates.

Low NOx software upgrade is computer programming for electronic control modules in certain heavy-duty engines that reduces excess emissions of oxides of nitrogen (NOx). The software upgrades were developed by the engine manufacturers as part of a legal settlement with the federal Environmental Protection Agency and ARB. Installing low NOx software can reduce emissions from most model year 1993-1998 California-registered heavy-duty trucks, school buses, motor homes, and interstate vehicles that visit California, with engines manufactured by Caterpillar, Cummins, Detroit Diesel Corporation, Mack/Renault, Volvo and International. CARB's truck and bus regulation requires replacement of 1994-1999 model engines to reduce NOx emissions by January 1, 2013.

Implementation Actions:
The Air District will either directly provide and/or work with other entities to provide cash incentives for the installation of retrofit devices that reduce NOx emissions from 5,000 MY

1994-2006 engines between 2010 and 2015. Targeted technologies include, but are not limited to, exhaust gas recirculation systems and selective catalytic reduction devices.
As a condition of grant incentives, the Air District will continue to require software upgrades to the engine control modules in any MY 1993-1998 on-road engines to install either diesel PM filters and/or NOx retrofit devices. The Air District will also encourage other providers of incentives to incorporate as similar requirement in their grant programs.
The Air District will work with CARB to evaluate the feasibility of installing or replacing catalytic converters on gasoline powered heavy-duty vehicles.

Emission Reductions:

Pollutants (tons per day)	2012	2020
NO_x	0.99	2.98

In addition to the pollutants shown above, this measure will reduce emissions of the following pollutants by less than 0.01 tons per day: ROG, PM10, $PM_{2.5}$, NH3 (ammonia), Benzene, Formaldehyde, Acetaldehyde, 1,3 Butadiene and CO2-e.

Emission Reduction Methodology:
To estimate the emission reductions from the retrofit of heavy-duty diesel trucks, District staff assumed that on average a model year 2004 truck that travels 50,000 miles per year would be retrofitted with a CARB verified device that achieves sufficient NOx reductions to bring emission levels on par with a model year 2007 diesel engine. The emission reductions represent the difference in NOx emission rates between a MY 2004 and MY 2007 truck. We also assumed that 1,250 truck retrofits would occur by 2012, with the balance occurring by 2015. Benefits from the retrofit of the trucks would occur over a 3-5 year period.

Exposure Reduction:
Efforts to reduce NOx emissions from existing on-road engines will assist in reducing exposure to ozone and secondary particulate matter. Installation of catalytic converters on heavy-duty gasoline engines, if feasible, may reduce exposure to a number of toxic air pollutants present in the exhaust from gasoline engines.

Emission Reduction Trade-offs:
Both the installation of NOx retrofits and the upgrade of the engine control software may reduce the overall efficiency of existing engines, resulting in increases in greenhouse gases, primarily CO2. Additionally, installation of selective catalytic reduction devices could increase emissions of ammonia.

Cost:
The retrofit of heavy duty diesel engines with NOx abatement equipment is estimated to cost $30,000 per engine. District staff anticipates that about 75% of the retrofits will occur between 2013 and 2015 as fleets prepare to comply with NOx requirements in the ARB in-use truck engine regulation. Costs are estimated to be:

Phase 1: $37.5 million
Phase 2: $75 million

It is anticipated that the District will make available up to $3-5 million per year in incentives for the retrofit of existing trucks between 2010 and 2015.

Co-benefits:
This control measure, by focusing on incentives to install retrofit devices, may result in an increase in "green" jobs in the Bay Area, largely at manufacturers of retrofit devices, local truck repair facilities, and diesel engine distributors.

Monitoring Mechanisms:
Progress and Final reports from any Air District grants or incentives.
Progress and Final reports made available from other incentive programs.
Annual reports submitted to ARB under the in-use, on-road truck regulation.

Issues/Impediments:
The main obstacles for this control measure are: a) durability and availability of NOx retrofit devices, and b) ability of retrofit devices to reduce NOx on existing levels to the EPA/CARB 2007 emissions standards.

Sources:
1. California Air Resources Board, Descriptions of various Level 3 Verified Emission Control Devices, http://www.arb.ca.gov/diesel/verdev/level3/level3.htm
2. California Air Resources Board, *Software Upgrade for Diesel Trucks,* http://www.arb.ca.gov/msprog/hdsoftware/hdsoftware.htm
3. Kubsh, Joe, Manufacturers of Emission Controls Association, *Diesel Retrofit Technologies for Combined Reductions of PM and NOx*, November 2008. Available online at http://www.arb.ca.gov/diesel/verdev/wn/jkubsh.pdf
4. Manufacturers of Emission Controls Association, *Emission Control Technologies for Heavy-Duty Trucks and Buses*, 2009. Available online at http://www.meca.org/page.ww?section=Emission+Control+Technology&name=Trucks+%26+Buses
5. Brodrick, C.J., et al., Urea-SCR System Demonstration and Evaluation for Heavy-Duty Diesel Trucks, UCTC No 493, The University of California Transportation Center, Berkeley, November 15, 1999. Available online at http://www.uctc.net/papers/493.pdf.
6. DieselNet, "Johnson Matthey demonstrating retrofit SCR System," posted online on March 26, 2008: http://www.dieselnet.com/news/2008/03jm.php

MSM B-3 - Efficient Drive Trains

Brief Summary:
The Air District will either directly commit and/or work with partner agencies and companies to provide funding to underwrite development and demonstration of hybrid drive trains for medium- and heavy-duty vehicles.

As technologies become commercially available, the Air District will offer cash incentives to accelerate deployment of more efficient vehicles. The Air District will coordinate this effort with the CalStart Hybrid Truck User Group, the California Air Resources Board, the California Energy Commission and other air districts.

Purpose:
This measure will reduce ozone precursors, particulate matter and greenhouse gases.

Source Category/Travel Market Affected:
On-Road Medium and Heavy Duty Vehicles

Regulatory Context and Background:
Since 1988, heavy-duty truck engines have been progressively regulated to reduce harmful emissions of criteria pollutants, such as NOx, PM and ROG. Until recently, however, little effort has been made to reduce greenhouse gas emissions. In response to higher fuel costs, and growing awareness of the need to reduce emissions of CO2 from transportation sources, truck makers, truck owners, and government agencies have been increasing their efforts to develop more efficient drive-trains and power systems for trucks, focusing on electric vehicles, hybrid-electric and hydraulic systems.

In the Bay Area, the Napa Valley Unified School District has been testing a plug-in electric-diesel hybrid system in a school bus; Pacific Gas & Electric has been testing a diesel electric system in maintenance trucks, and others have proposed hybrid systems for transit buses, delivery vehicles and garbage trucks. Freightliner currently offers a diesel electric hybrid for its medium-heavy-duty chassis.

These promising efforts have been fostered largely through the collaborative Hybrid Truck Users Forum operated by the non-profit CalStart consortium. This control measure proposes to build on the existing work by directing financial incentives toward the various field demonstrations being currently operated or proposed by participants in the HTUF program.

Implementation Actions:
The Air District will either directly provide and/or work with partner agencies and companies to provide funding between 2010 and 2015 to underwrite development and demonstration of hybrid drive trains for medium- and heavy-duty vehicles.

As technologies become commercially available, the Air District will either directly and/or work with partner agencies and companies to offer financial incentives to accelerate deployment of more efficient vehicles. The goals for the measure are to place 1000 efficient medium- and heavy-duty trucks on the region's roadways by 2012 and 4000 additional vehicles by 2020.

The Air District will participate in these efforts with the CalStart Hybrid Truck User Forum, the California Air Resources Board, the California Energy Commission, other air districts, local private and public entities and truck manufacturers.

Emission Reductions:

Pollutants (tons per day)	2012	2020
ROG	0.01	0.05
NO_x	0.29	1.44
PM10	0.01	0.01
$PM_{2.5}$	0.01	0.01
C02-e	0.23	1.14

In addition to the pollutants shown above, this measure will reduce emissions of the following pollutants by less than 0.01 tons per day: NH3 (ammonia), Benzene, Formaldehyde, Acetaldehyde, and 1,3 Butadiene.

Emission Reduction Methodology:
To estimate the emission reductions from this measure, District staff has assumed that the efficient drive trains will result in a 30% reduction in fuel usage per truck. The baseline fuel economy is assumed to be 5.6 mpg. It is assumed that each truck will travel 50,000 miles per year. We also assumed that of the 5,000 truck replacements targeted under this measure, 1,000 will occur by 2012 and 4,000 additional trucks by 2020.

Exposure Reduction:
This control measure is focused on the reduction of greenhouse gases from trucks. However, technologies such as hybrid electric power systems that improve energy efficiency also further reduce criteria pollutants. Reductions in both diesel PM and NOx will reduce exposure to toxic pollutants locally and ozone regionally.

Emission Reduction Trade-offs:
None. Improvements in energy efficiency will reduce all pollutants.

Cost:
There are two parts to the costs for this measure. First, there is an un-estimated amount of costs associated with the development of the hybrid technologies that will go into more efficient drive trains for medium- and heavy-duty vehicles. These costs will be borne by a variety of private firms and federal, state and local government agencies. Second, there will be incremental costs associated with the purchase of the vehicles with the advanced drive trains.

For the purposes of discussion, District staff has assumed the incremental costs will average $20,000 per vehicle between 2010 and 2020.

Phase 1: $20 million
Phase 2: $60 million

The District anticipates making available up to $3 million per year towards both the development and deployment of more efficient drive trains for medium- and heavy-duty vehicles, subject to availability of funding and approval of the District governing board.

Co-benefits:
Development and widespread usage of more energy efficient drive-trains and power systems for trucks will reduce water pollution, save fuel, and increase opportunities for "green" jobs. There is also the potential for reduced business and consumer costs, especially in light of rising petroleum fuel costs.

Monitoring Mechanisms:
Progress and Final reports from any Air District grants or incentives.
Progress and Final reports made available from the CEC and CARB for their alternative fuel, technology advancement and climate change programs.
Reports developed as part of the Calstart Hybrid Trucks Users Group's efforts.
Progress and Final reports made available from the federal EPA, DOT and DOE.

Issues/Impediments:
As with all technology advancement efforts, obstacles for this measure revolve around feasibility, durability and cost of hybrid electric and hybrid hydraulic engine systems. However, since this measure is focused on research and development, any efforts to advance the development of more energy efficient systems will be an advantage.

Sources:
1. CalStart/Weststart, Hybrid Truck Users Forum, http://www.calstart.org/Projects/Hybrid-Truck-Users-Forum.aspx
2. Van Amburg, Bill, CalStart, "Emerging Clean Fuel & Vehicle Technology Options for Fleets: How Fleets Can Pepare and Plan for Change," presented to NAFA Conference, New Orleans, LA, April 27, 2009. Available online at http://www.calstart.org/Libraries/Consulting/Emerging_Clean_Fuel_Vehicle_Technology_Options_for_Fleets.sflb.ashx
3. Lowe, Marcy et al., Center on Globalization Governance & Competitiveness, Manufacturing Climate Solutions, Carbon-Reducing Technologies and U.S. Jobs, Chapter 9, Hybrid Drivetrains for Medium- and Heavy-Duty Trucks, June 10, 2009. Available online at http://www.cggc.duke.edu/environment/climatesolutions/greeneconomy_Ch9_HybridDrivetrainsforTrucks.pdf

4. Kenworth Trucks brochure, "Kenworth T270 Class 6 and T370 class 7 Medium Duty HYBRID CONVENTIONAL," 2008. http://www.kenworth.com/brochures/T270T370Hybrid.pdf
5. Slezak, Lee, *Annual Progress Report for Advanced Vehicle Technology Analysis and Evaluation Activities and Heavy Vehicle Systems Optimization Program*, United States Department of Energy, Vehicle Technologies Program, 2009
6. Department of Energy and 21st Century Truck Partnership, *Roadmap and Technical White Papers*, 21CTP-003, December 2006.
7. ARB, "Hybrid Truck and Bus Incentive Program (HTIP) Development: Concepts for HTIP Implementation," January 13, 2009 AQIP Working Group. http://www.arb.ca.gov/msprog/aqip/meetings/hyip_wg_discussion_paper_01_13_09.pdf

MSM C-1 - Construction and Farming Equipment

Brief Summary:
The Air District will work to reduce emissions from construction and farming equipment by pursuing the following strategies: a) expenditure of cash incentives between 2010 and 2020 to retrofit engines with diesel particulate filters or upgrade to equipment with electric, Tier III or Tier IV off-road engines; b) work with the California Air Resources Board, the California Energy Commission and others to develop more fuel-efficient off-road engines and drive-trains; and c) work with local communities, contractors, farmers and developers to encourage the use of renewable electricity and renewable fuels, such as biodiesel from local crops and waste fats and oils, in applicable equipment.

Purpose:
This measure will reduce ozone precursors, diesel particulate matter, and carbon dioxide.

Source Category/Travel Market Affected:
Farm and Construction Equipment

Regulatory Context and Background:
Construction and farming equipment contribute approximately 15% of the regional inventory of NOx emissions, and 5% of PM2.5 emissions. Construction equipment is also a contributor to local exposure of diesel PM. Criteria pollutant emissions from the engines – which are primarily diesel – in construction and farming equipment are subject to control under regulations adopted by both California Air Resources Board and the federal Environmental Protection Agency.

The ARB's control of criteria pollutant emissions from off-road engines used in construction and farming equipment was authorized by the California Clean Air Act as codified in the Health and Safety Code sections 43013 and 43018. In 1992, ARB approved initial regulations to control exhaust emissions from heavy-duty off-road compression ignition (CI) engines 175 horsepower (130 kilowatts) and above. These initial standards are referred to as Tier I standards. In 1994, ARB approved the State Implementation Plan (SIP) for ozone containing measures calling for new state and national emission standards for off-road CI engines beginning in 2005.

U.S. EPA promulgated new emission standards for off-road engines in 1998, with ARB adopting parallel standards in 2000. The standards were progressive and phased in through two additional stages which are referred to as Tiers 2 and 3. In 2004, final Tier 4 emission standards were adopted; Tier 4 standards are scheduled to phase in for new engines between 2011 and 2014. The coordinated efforts of ARB, U.S. Environmental Protection Agency, and the engine manufacturers to introduce lower-emission off-road CI engines nationwide will result in substantial air quality benefits in California and the rest of the country.

However, recognizing that construction and farming equipment are long-lived, with existing

engines remaining in service for many years, ARB adopted in 2007 a regulation to accelerate reductions of NOx and diesel PM from existing off-road engines between 2012 and 2023 by requiring operators to either install abatement equipment, upgrade to Tier 3 and eventually Tier 4 engines, or to retire older equipment with Tier 1 and 2 engines.

ARB's AB 32 Scoping Plan, adopted in 2008, identified a strategy for reducing CO2 from a variety of sources in California, including construction and farming equipment. ARB's strategies include reducing the carbon content of diesel fuel; promoting alternative, renewable diesel fuels, and investigating ways of increasing fuel economy.

Implementation Actions:
This control measure will primarily focus on assisting fleets to achieve early compliance with the ARB in-use off-road engine control measure and supporting research efforts to develop and deploy more efficient engines and cleaner, renewable fuels for construction and farming equipment.

- Between 2010 and 2020 work to either directly and/or encourage partners to provide incentives for the early deployment of 1000 electric, Tier 3 and 4 off-road engines, as well as installation of 500 verified retrofit devices to control diesel PM. The interim goals for 2012 are 200 new engines and 100 retrofits.
- Between 2010 and 2015, coordinate with ARB and the CEC, as well as construction firms, farmers and others, to support field demonstrations of advanced technology for off-road engines and hybrid drive trains. Targeted technology should be those that reduce both criteria pollutants and greenhouse gases at the same time by focusing on fuel economy and renewable fuels.
- Between 2010 and 2015, provide support for the field demonstration of off-road equipment that runs on renewable electricity and diesel, with an emphasis placed on fuels that can be developed and produced locally.

Emission Reductions:

Pollutants (tons per day)	2012	2020
ROG	0.04	0.20
NO_x	0.72	3.60
PM10	0.02	0.09
$PM_{2.5}$	0.02	0.09

In addition to the pollutants shown above, this measure will reduce emissions of the following pollutants by less than 0.01 tons per day: NH3 (ammonia), Benzene, Formaldehyde, Acetaldehyde, and 1,3 Butadiene.

Emission Reduction Methodology:
To estimate emission reductions for this measure, District staff assumed that the typical projects over the next ten years will consist of the replacement of Tier 1 compliant off-road

engines rated at 350 brake horse power-hour with new Tier 4 compliant engines. Each engine is assumed to operate 1,000 hours with an average load factor of 60%. Staff also assumed that for the 2020 goal one-half of the new engines will operate on biodiesel.

Exposure Reduction:
Efforts to reduce diesel PM will reduce exposure of residents and workers in the vicinity of construction sites and farms. Additionally, reduction of NOx emissions will help reduce regional ozone levels/exposure, while reductions in both NOx and diesel PM emissions will contribute to reductions in the directly emitted PM and formation of secondary PM, reducing overall population exposure to fine particulate matter.

Emission Reduction Trade-offs:
The installation of diesel PM filters and other abatement devices generally reduces fuel economy by approximately 3%, and therefore increases emissions of CO2 by a corresponding amount.

Cost:
District staff assumes that the cost of this measure is equal to the incentive amount offered to get a fleet operator to replace a Tier 1 engine with a Tier 4 engine in advance of the CARB regulation. We estimate the average incentive to be $50,000 per engine. We estimate diesel PM retrofit filters to cost $20,000 per engine. Based on these assumptions, this measure will cost approximately:

Phase 1: $12 million
Phase 2: $41 million

It is anticipated that the District will make available up to $3 million per year in incentives for the purchase of new electric, Tier 3 and Tier 4 engines, as well as the installation of verified diesel PM control devices between 2010 and 2020.

Co-benefits:
New engines for construction and farming equipment are incorporating better control of lubricating oils and unburned fuel droplets from crankcases, resulting in less oil leaking on the ground, thereby reducing harmful water pollution. The development of more energy efficient engines and drive-trains, as well as local development of renewable diesel should both result in energy savings and the creation of “green” jobs.

Monitoring Mechanisms:
- Equipment and engine information submitted to CARB as part of the off-road in-use ATCM.
- Progress and Final reports from Air District grants or incentives.
- Progress and Final reports made available from the CEC and CARB for their alternative fuel, technology advancement and climate change programs.

Issues/Impediments:

- Funding for engine subsidies.
- Interest from fleets in early compliance with CARB's off-road in-use engine air toxic control measure.
- Availability of diesel PM retrofit devices for construction and farm equipment.

Sources:

1. BAAQMD, Base Year 2005 Emissions Inventory: Summary Report, December 2008
2. BAAQMD, Base Year 2005 Emissions Inventory: Source Categories, December 2008
3. BAAQMD, Source Inventory of Bay Area Greenhouse Emissions, December 2008
4. State of California, Air Resources Board, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking: Proposed Regulation for In-Use Off-Road Diesel Vehicles*, April 2007.
5. State of California, Code of Regulations, Title 13, Section 2449 et seq., 2009
6. State of California, Air Resources Board, Carl Moyer Program: http://www.arb.ca.gov/msprog/moyer/moyer.htm

MSM C-2 - Reduce Emissions from Lawn and Garden Equipment

Brief Summary:
Use of gasoline lawn mowers and leaf blowers contribute to summertime ozone levels primarily through the release of ROG. While progressively more stringent emission standards have reduced pollution from lawnmowers and leaf blowers, sufficient numbers of older two-stroke and four stroke engines remain in use in the Bay Area to warrant Air District efforts to pursue a clean-up program. The Air District will pursue removal of these older engines through voluntary exchange programs that target residential lawn mowers and backpack-style leaf blowers used by professional gardeners and landscapers.

Purpose:
This measure will reduce ozone precursors, particulate matter, toxic air contaminants and greenhouse gases.

Source Category/Travel Market Affected:
Lawn, Garden & Utility Equipment: Gasoline Lawn Mowers and Leaf Blowers

Regulatory Context and Background:
The lawn, garden & utility equipment category is comprised of a wide variety of small engines used in lawn mowers, leaf blowers, chainsaws, trimmers, shredders, stump grinders, commercial turf equipment and other types of equipment that collectively account for slightly more than 5% of the total ROG inventory in the Bay Area. This equipment primarily uses gasoline engines, although there is some diesel and propane powered equipment. Electric powered equipment has begun to gain market share, particularly with lawnmowers, chainsaws, leaf blowers and other small equipment used by homeowners.

The gasoline engines on such small equipment were first regulated in 1995 by the Air Resources Board, with the newest, most stringent regulations becoming effective with the MY 2008 equipment. Staff currently estimates there to be 1.16 million lawnmowers and leaf blowers in the Bay Area, of which approximately 70,000 are two stroke lawnmowers and 258,000 are two-stroke leaf blowers. Two stroke engines generate significantly more air pollution, especially particulate matter, compared to four stroke engines. The Air District conducted lawn mower exchange programs between 1999 and 2006 by offering cash incentives to consumers to purchase electric or mechanical equipment. Residents exchanged slightly more than 7800 two- and four-stroke lawnmowers for new electrical and mechanical mowers. Estimated emission reductions from the program were 5.3 tons per year of ROG, NOx and PM, at an annualized cost-effectiveness of approximately $7,800 per ton. The Air District expended $780,000 to buy down the cost of the new lawnmowers for the participating homeowners, along with additional funds on administration and advertising by the then Public Information and Outreach Division (now the Communication and Outreach Division).

The South Coast Air Quality Management District periodically conducts exchange programs for "backpack" style leaf blowers used by professional gardeners and landscapers. The program's fourth round of exchanges was conducted in August 2009. Under this program, companies pre-register to exchange up to ten leaf blowers; for each old leaf blower turned in, the company can purchase a new low emission machine at a 50% to 60% discount.

Implementation Actions:
The Air District will:

- Re-establish its exchange program for replacing older gasoline lawnmowers with mechanical push and electrical lawnmowers. The program will target two-stroke engines as an initial priority prior to targeting pre-2008 four-stroke gasoline engines.
- Establish an exchange program for gasoline powered two-stroke "backpack" leaf blowers used by professional gardeners and landscapers.
- Explore options to expand the program to cover chainsaws, trimmers, shredders, stump grinders, commercial turf equipment and other types of lawn mowers. Expansion of the program will depend on the availability of significantly cleaner replacement equipment, costs, equipment turnover rates, and population size.

By 2012: Replace up to 3,000 lawn mowers and up to 5,000 leaf blowers
By 2020: Replace up to 10,000 lawn mowers and up to 50,000 leaf blowers

Emission Reductions:

Pollutants (tons per day)	2012	2020
ROG	0.04	0.26
NO_x	0.01	0.01
PM10	0.01	0.07
$PM_{2.5}$	0.01	0.05
C02-e	0.00	0.64

Emission Reduction Methodology:
For this measure, District staff assumed that the typical project would consist of replacing an existing two-stroke 4 hp lawnmower or leaf blower with a new electric or mechanical push lawnmower or an electric or new Tier 3 compliant, four-stroke gasoline leaf blower. Emission factors were taken from the Air Resources Board OFFROAD2007 emissions model.

Exposure Reduction:
Older gasoline engines emit high levels of hydrocarbons, many species of which are listed as air toxics. Exchanging the older equipment with either electric or low-emission new engines will result in reductions in toxic emissions.

Emission Reduction Trade-offs:
This measure will reduce emissions of NOx, ROG, CO, PM and CO2, but because it replaces a piece of gasoline powered equipment with an electric powered equivalent, it will contribute to

an incremental increase in electricity production, which may cause slight increases in emissions from power plants.

Cost:
The main cost of this measure is the discount for the new electric lawn mowers and leaf blowers that are provided to program participants. The cost of this program will be shared by the Air District, vendors and the equipment owner. The cost of an electric lawn mower ranges from $200 to $300; the cost of a mechanical push mower ranges from $80 to $140; the cost of an electric leaf blower ranges from $30 to $70. The Air District anticipates seeking up to $2 million per year to fund this measure. In addition to direct cost for rebates on new equipment, additional costs would be incurred by the Air District to manage and advertise the program, and to ensure appropriate disposal of the older equipment that will be retired through the replacement program.

Co-benefits:
Use of push lawn mowers, electric lawn mowers and low-emission leaf blowers will result in reductions in water pollution and fossil fuel use. There will also be consumer savings. New leaf-blowers also operate at lower decibel levels, reducing noise impacts.

Monitoring Mechanisms:
Progress will be measured by tracking the number of older gasoline engines that are removed from service in exchange for mechanical and electric powered equipment.

Issues/Impediments:
The main obstacle is the need to secure funding to implement this measure. If funding is secured, then the level of interest from residents and professional gardeners in replacing old equipment with new zero and low-emission equipment could also be a limiting factor.

Experience with the earlier lawn mower exchange program from 1999 to 2006 suggests that a program that focuses on offering rebates through the manufacturers instead of an exchange effort will enhance the program's cost-effectiveness and simplify implementation.

Sources:
1. BAAQMD, Base Year 2005 Emissions Inventory: Summary Report, December 2008
2. BAAQMD, Base Year 2005 Emissions Inventory: Source Categories, December 2008
3. BAAQMD, Source Inventory of Bay Area Greenhouse Emissions, December 2008
4. CARB, *Article 1, Chapter 9, Division 3, Title 13, California Code of Regulations*
5. CARB, Initial Statement of Reasons for Proposed Rulemaking: Exhaust and Evaporative Emission Control Requirements for Small Off-Road Equipment and Engines Less Than or Equal to 19 Kilowatts, August 8, 2003
6. SCAQMD, *Leaf Blower Exchange Program*, http://www.aqmd.gov/tao/leafblowerexchange.htm

MSM C-3 - Reduce Emissions from Recreational Watercraft

Brief Summary:
Use of four-stroke or two-stroke inboard/outboard engines in pleasure craft contribute to summertime ozone levels primarily through the release of ROG. While progressively more stringent emission standards have reduced pollution from these engines, sufficient numbers of older four- and two-stroke engines remain in use in the Bay Area to warrant Air District efforts to pursue a clean-up program. In addition, new inboard/outboard engines are also more fuel efficient.

Purpose:
This measure will reduce ozone precursors, particulate matter and greenhouse gases.

Source Category/Travel Market Affected:
Recreational Watercraft

Regulatory Context and Background:
The recreational vessel category is comprised of relatively small outboard engines that are mounted to the rear or side of small craft and sailboats, as well as larger inboard engines that are mounted within the vessel and connect to propellers via a shaft. This measure focuses on reducing emissions from the small outboard motors.

Outboard gasoline engines were first regulated in 1995 by the Air Resources Board, with the newest, most stringent regulations becoming effective with the MY 2008 equipment. There are currently an estimated 135,500 inboard/outboard engines in the Bay Area, of which approximately 87,000 or 64% are two-stroke, high-emitting outboard engines. Increasingly stringent emission standards and resulting advances in engineering have made four-stroke gasoline inboard/outboard and electric engines readily available.

Implementation Actions:
The Air District will establish a voluntary exchange program to retire older gasoline-powered four-stroke and two-stroke outboard engines used in small pleasure craft. The Air District is focusing on the replacement of outboard engines under this measure because of the lower replacement costs per engines. The goal of the program will be to:

- Replace up to 3,000 outboard motors by 2012.
- Replace up to 10,000 outboard motors by 2020.

Emission Reductions:

Pollutants (tons per day)	2012	2020
ROG	0.06	0.02
NO_x	0.01	0.01
$PM_{2.5}$	0.01	0.01
C02-e	0.42	1.38

Emission Reduction Methodology:
Emission reductions have been estimated by comparing the incremental difference in emissions between a new four-stroke 50 horsepower (HP) engine meeting the lowest emission standards and an average MY 2000 two-stroke 50 hp engine. Emission factors and usage rates are from CARB's OFFROAD model. The outboard engines were assumed to operate approximately 1100 hours per year.

Exposure Reduction:
Older gasoline engines emit high levels of hydrocarbons, many species of which are listed as air toxics. Exchanging the older equipment with either electric or low-emission new engines will result in reductions in toxic emissions.

Emission Reduction Trade-offs:
To the extent electric motors are purchased as replacements there will be an incremental increase in the production of electricity, which may incrementally increase emissions of particulate matter and greenhouse gases from power plants.

Cost:
Costs for this measure may be borne by government agencies in the form vouchers to buy-down the price of new motors, disposal of old engines, and program administration. The main cost for consumers will be the balance of the purchase price for a new engine. The Air District has not identified possible funding sources for this measure, but anticipates seeking up to $2-3 million in funding per year.

Co-benefits:
Use of four-stroke engines will decrease water pollution: Two-stroke engines use a gasoline and oil fuel mixture, with unburned fuel being exhausted directly into the water. The increase use of more fuel-efficient electric and four-stroke gasoline engines will reduce oil consumption; the improved fuel economy of newer engines will also reduce fuel costs for consumers.

Monitoring Mechanisms:
This measure will be monitored via the vouchers awarded to participants to purchase a cleaner outboard motor.

Issues/Impediments:
The main issues for this measure are:
- Interest in the public in participating in the voluntary buy-down/exchange program for new outboard engines;
- Availability of monetary incentives from government agencies to fund the program.

Sources:

1. BAAQMD, Base Year 2005 Emissions Inventory: Summary Report, December 2008
2. BAAQMD, Base Year 2005 Emissions Inventory: Source Categories, December 2008
3. BAAQMD, Source Inventory of Bay Area Greenhouse Emissions, December 2008
4. Air Resources Board, OFFROAD2007 Emissions Model, http://www.arb.ca.gov/msei/offroad/offroad.htm
5. South Coast Air Quality Management District, "SCOFFRD-06 -- Accelerated Turnover and Catalyst Based Standards for Pleasure Craft [VOC, NOx, PM]," FINAL 2007 Air Quality Management Plan, June 2007.