State of California
AIR RESOURCES BOARD

PRELIMINARY DRAFT STAFF REPORT

PROPOSED AMENDMENTS TO THE LOW-EMISSION VEHICLE REGULATIONS TO ADD AN EQUIVALENT ZERO-EMISSION VEHICLE STANDARD

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TABLE OF CONTENTS

EXECUTIVE SUMMARY i

I. INTRODUCTION 1
- A. Background 1
- B. Description of the Low-Emission Vehicle Program 2

II. PROPOSED REGULATORY AMENDMENTS 4
- A. Proposed EZEV Certification Standards 4
- B. Certifying to EZEV Standards 5
  1. Measuring EZEV Emissions 5
  2. Durability Requirements 7
  3. ZEV Credits and Fleet Average Emission Calculation 7

III. TECHNICAL BASIS FOR THE PROPOSED EZEV STANDARD 7
- A. Quantifying the Power Plant Emissions Associated with EVs in the SCAB 7
- B. CEC Analysis of Marginal EV Emissions in the SCAB 8

IV. ISSUES 15
- A. Out-of-Basin Emissions 15
- B. Fuel-Cycle Emissions 16
- C. EZEV Durability Requirement 16

V. ENVIRONMENTAL AND ECONOMIC IMPACTS 17
- A. Environmental Impacts 17
- B. Economic Impacts 18

VI. HEV TEST PROCEDURES 18
- A. Background 18
- B. Summary of Proposed Changes 19
- C. Overview of HEV Test Procedures 19
- D. Air Conditioning Loading 21
- E. All-Electric Range Testing 22
- F. Exhaust Emission Test 24
- H. Chassis Dynamometer Type 27

VII. ZEV ALL-ELECTRIC RANGE TEST 27

VIII. REFERENCES 28

LIST OF TABLES AND FIGURES

Table 1. Light-Duty Low-Emission Vehicle 50,000-Mile Exhaust Emission Standards 2
Table 2. Fleet Average NMOG Emission Requirements 3
Table 3. Proposed EZEV Certification Standards 5
Table 4. Summary of Key Assumptions Used in CEC Marginal EV Emissions Analysis 9
Table 5. Definition of Scenarios 10
Table 6. Marginal Electric Vehicle In-Basin Emission Rates: Scenario A 11
Table 7. Marginal Electric Vehicle In-Basin Emission Rates: Scenario B 12
Table 8. Marginal Electric Vehicle In-Basin Emission Rates: Scenario C 12
Table 9. Marginal Electric Vehicle In-Basin Emission Rates: Scenario D 13
Table 10. Marginal Electric Vehicle In-Basin Emission Rates: Scenario E 13
Table 11. Marginal Electric Vehicle In-Basin Emission Rates: Scenario F 14
Table 12. Updated CEC Analysis of Marginal EV In-Basin Emission Rates 14
Figure 1. A Comparison of In-Basin EV Emissions to Total EV and ULEV Emissions 15
Figure 2. Test Procedure for 1996 and Subsequent Model Year Hybrid Electric Vehicles 20

LIST OF APPENDICES

APPENDIX A: PROPOSED AMENDMENTS TO THE CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1988 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

EXECUTIVE SUMMARY

The Air Resources Board's (ARB) Zero-Emission Vehicle (ZEV) program will provide significant long-term emission benefits for California. ZEVs have no exhaust, evaporative or refueling emissions and do not have emission control equipment that can deteriorate over time. There are extremely low levels of power plant emissions associated with charging battery-powered electric vehicles, currently the only type of vehicle to qualify as a ZEV. Manufacturers and developers of advanced transportation technologies that have the potential for extremely low emission levels have requested the ARB provide an opportunity for these technologies to demonstrate emission reduction benefits equivalent to ZEVs and receive ZEV credit.

In 1994, the ARB directed staff to evaluate the role of extremely low-emitting vehicles, and in particular hybrid-electric vehicles, within the framework of the ZEV program. In response to the Board's direction, the staff has held meetings with advanced transportation technology developers and conducted two public forums to discuss the technical feasibility of extremely low-emitting vehicles and the policy implications of allowing such vehicles to receive credit toward the ZEV requirement. Based on the information provided to date, the ARB staff is proposing amendments to the regulations that would establish performance-based standards that would reward advanced technologies that provide ZEV-equivalent air quality benefits and provide greater long-term flexibility for manufacturers to meet California's ZEV requirements. The amendments would have no effect on the current ZEV emission standards or the Board's assesment of the unique benefits that battery-electric technology offers.

The proposed amendments would add a new "equivalent zero-emission vehicle" (EZEV) emission standard, which is based on the extremely low level of in-basin power plant emissions of oxides of nitrogen (NOx) and reactive organic gases (ROG) associated with charging battery-powered electric vehicles. Vehicles certifying to the EZEV standard would need to demonstrate exhaust, evaporative and refueling emissions that, in combination, fall below the EZEV certification standards. Vehicles certified to the EZEV standard would be credited toward a manufacturer's ZEV requirement on a one-to-one basis. The proposed certification standards for non-methane organic gas (NMOG), NOx, particulate matter (PM), and carbon monoxide (CO) are:

Proposed Equivalent Zero-Emission Vehicle Certification Standards

Pollutant	Emissions Level (grams per mile)
NMOG	0.004
NOx	0.02
PM	0.004
CO	0.17

I. INTRODUCTION

A. Background

In September 1990, the Air Resources Board (ARB) adopted the Low-Emission Vehicle (LEV) regulations. Beginning with the 1994 model year, auto manufacturers have been required to produce vehicles meeting a fleet average emission level that becomes increasingly stringent each year through 2003. These regulations also required large-volume auto manufacturers to begin introducing zero-emission vehicles (ZEVs) in model-year 1998. Under the LEV regulations, a ZEV is defined as "any vehicle which is certified by the Executive Officer to produce zero emissions of any criteria pollutant under any and all possible operational modes and conditions." Battery-powered electric vehicles (EVs) are currently the only vehicles that fulfill this definition. Although EVs have no exhaust, evaporative or refueling emissions, there are power plant emissions associated with generating the energy needed to charge the EV batteries.

At the time the LEV regulations were adopted, the Board directed the staff to update the Board at least biennially on the status of implementing the regulations and to propose modifications as needed. As a result, the regulations have been updated three times, most recently at the March 1996 hearing when the Board approved regulatory modifications to eliminate the 1998 through 2002 model year percentage ZEV requirements and to add a provision allowing vehicles with longer range or that use advanced batteries to receive multiple ZEV credits. At the May 1994 meeting, the Board directed staff to assess the role of extremely low-emission vehicles, in particular hybrid-electric vehicles (HEVs), within the framework of the ZEV program.

The ARB staff has met with advanced technology developers and other interested parties to discuss the technical feasibility of extremely low-emission vehicles and the policy implications of allowing these vehicles to be credited toward a manufacturer's ZEV requirement. Two public forums were held in 1995. At the August 1995 forum the staff presented a preliminary draft proposal to modify the regulations to 1) add an Equivalent Zero-Emission Vehicle (EZEV) standard, based on the power plant emissions associated with EVs, 2) count EZEVs toward a manufacturers ZEV requirement and 3) provide partial ZEV credit for hybrid-electric vehicles (HEVs) with significant all-electric range. Based on the comments received at the forum, the staff has decided not to further develop regulatory modifications to provide partial ZEV credit for HEVs with significant all-electric range. The regulatory modifications proposed in this staff report focus on the EZEV standard.

Several companies have expressed their intent to develop vehicles that could be certified to an EZEV standard. The staff believes it is important to establish such a standard as a target for technology developers, regardless of whether any technologies could certify to the standard today. Manufacturers would not be required to produce EZEVs. The proposed EZEV standard would be an optional standard that would add flexibility to the existing regulations by making the ZEV requirement more "technology-neutral".

B. Description of the Low-Emission Vehicle Program

The LEV program is a critical component of California's long-term plan for reducing air pollution from light- and medium-duty vehicles. The program requires implementation of advanced emission control strategies to substantially improve California's air quality. The LEV program establishes emission standards for four categories of vehicles, each with increasingly stringent emission requirements: transitional low-emission vehicles (TLEVs), low-emission vehicles (LEVs), ultra-low emission vehicles (ULEVs), and ZEVs. The largest class of vehicles to which the LEV regulations apply is comprised of passenger cars and light-duty trucks (weighing less than 3,750 pounds). The 50,000-mile exhaust emission standards applicable to this class are shown in Table 1.

Table 1. Light-Duty Low-Emission Vehicle 50,000-Mile Exhaust Emission Standards

Vehicle Class[1]	NMOG (grams/mile)	CO (grams/mile)	NOx (grams/mile)
TLEV	0.125	3.4	0.4
LEV	0.075	3.4	0.2
ULEV	0.040	1.7	0.2
ZEV	zero	zero	zero

1 "NMOG" (non-methane organic gas) is comprised of non-methane hydrocarbons and all oxygenated hydrocarbons.

Manufacturers can certify any combination of vehicles meeting the above certification standards as long as a required fleet average NMOG emission level is met. Compliance is determined by calculating the sales weighted average NMOG emissions of a manufacturer's fleet. Additional flexibility is provided through the use of a marketable credit trading system. Manufacturers that exceed the fleet average requirement accumulate credits that can be banked, traded or sold to other manufacturers. The fleet average NMOG emission requirement for passenger cars and light-duty trucks weighing less than 3,750 pounds is shown in Table 2.

Table 2. Fleet Average NMOG Emission Requirements
Passenger Cars and Light-Duty Trucks (0-3750 pounds)

Model Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003 and beyond
Fleet Avg. NMOG (g/mi)	0.250	0.231	0.225	0.202	0.157	0.113	0.073	0.070	0.068	0.062

The requirements for medium-duty vehicles are approached differently. Because of the diversity of vehicle classes in this category, it was not practical to create a fleet average requirement. Instead, manufacturers of medium-duty vehicles are required to meet certain percentage phase-in requirements, but they can accumulate marketable emission credits by exceeding these phase-in percentages. This credit system also affords medium-duty vehicle manufacturers considerable compliance flexibility.

Under the LEV regulations, ZEVs are vehicles that produce zero exhaust or evaporative emissions of any criteria pollutant (or precursor pollutant) under any and all possible operational modes and conditions. The LEV regulations originally required all large-volume manufacturers (those with sales in California exceeding 35,000 vehicles per year) to introduce ZEVs beginning in the 1998 model year. In March 1996, the Board approved modifications to eliminate the 1998 through 2002 model year percentage ZEV requirements. The requirement for large- and intermediate-volume manufacturers to produce 10 percent of their California PCs and LDTs (0-3750 pounds) as ZEVs beginning with the 2003 model year remains unchanged.

Each ZEV that a manufacturer produces and delivers for sale in California is credited toward its ZEV requirement. The modifications approved by the Board at the March 1996 hearing add a provision that allows vehicles with longer range or that use advanced batteries to count as more than one ZEV. If a manufacturer produces more ZEVs than are required in a given year, it earns ZEV credits. The amount of credits generated by an "excess" ZEV is based on the allowable emissions of the average new vehicle it would replace. The credit is expressed in units of grams of NMOG per mile. For each model year, a manufacturer would determine the "excess" number of ZEVs it produced and delivered for sale in California, and multiply that number by the passenger car and light truck grams per mile NMOG fleet average emission level required for that model year. For example, 10 excess ZEVs produced in the 2003 model year would generate ZEV credits of 0.62 grams per mile (10 x 0.062 grams per mile), while 10 ZEVs produced in the 1998 model year would generate ZEV credits of 1.57 grams per mile (10 x 0.157 grams per mile). Credits may be banked for future use or traded to another manufacturer.

II. PROPOSED REGULATORY AMENDMENTS

The ARB staff proposes a new "equivalent zero-emission vehicle" (EZEV) emission standard, based on the power plant emissions associated with charging battery-powered EVs in the South Coast Air Basin (SCAB). The standard is based on the power plant emissions of oxides of nitrogen (NOx) and reactive organic gases (ROG) that are associated with the use of battery-powered EVs, and is 10 times more stringent than the ULEV standard. The new standard is intended to provide a mechanism for advanced technologies that can achieve extremely low emissions to receive credit towards the ZEV requirement. Vehicles certified to the EZEV standard would be credited toward a manufacturer's ZEV requirement on a one-to-one basis.

A. Proposed EZEV Certification Standards

The staff's proposed certification standards for EZEVs are presented in Table 3. The proposed NOx and NMOG standards are based on a marginal power plant emissions analysis conducted by the staff of the California Energy Commission (CEC), which is discussed in section III of this report. The proposed NOx standard of 0.02 grams per mile corresponds to the emission rate estimated for the primary scenario, and also lies at the top of the range of NOx emissions for all six of the scenarios that the ARB staff considered. The proposed NMOG standard of 0.004 grams per mile represents the upper bound of ROG emission rates for all of the scenarios considered. The proposed carbon monoxide (CO) and particulate matter (PM) emission standards correspond to one-tenth of the existing CO and PM standards for ULEVs. These values are not based on power plant emission levels, but are the same percentage of the ULEV standards as the NOx and NMOG EZEV standards. The staff believes that future advanced technology vehicles would be able to achieve the proposed CO and PM emission levels. It is not the staff's intention to have the proposed CO or PM emission standards limit the ability of technology to certify to the EZEV standard. The staff does not propose a separate formaldehyde emission standard as formaldehyde will be counted in the NMOG emissions of the vehicle.

Table 3. Proposed EZEV Certification Standards

Vehicle Type	Loaded Vehicle Weight (LVW) (pounds)	APU Durability Basis	NOx (g/mi)	NMOG (g/mi)	CO (g/mi)	PM (g/mi)
PC[1]	all	vehicle life	0.02	0.004	0.17	0.004
LDT[2]	0-3750					

1 Passenger car
2 Light-duty truck

B. Certifying to EZEV Standards

The staff proposes for a vehicle to certify to the EZEV standards, the sum of its exhaust, evaporative and refueling emissions (with no reactivity adjustments) must not exceed the emission rates in Table 3 for the entire life of the vehicle. Evaporative emissions include hot soak emissions, diurnal emissions, resting losses and running losses. Refueling emissions include only those emissions that occur at the point of vehicle refueling and not other upstream emissions (e.g. fuel production, transportation and distribution emissions).

EZEVs would be required to use an on-board diagnostics system, and would be subject to inspection and maintenance requirements. EZEVs would also be required to meet the general requirements for cold temperature exhaust CO and the 50^{o} F emission test requirements for NMOG, NOx, and CO.

Certified EZEVs would be counted toward a manufacturer’s percentage ZEV requirement on a one-to-one basis. EZEVs would also be treated as having zero exhaust emissions when calculating a manufacturer’s fleet average emission level.

1. Measuring EZEV Emissions

Exhaust: Exhaust certification test procedures for vehicles that intend to certify to EZEV standards will not differ from conventional test procedures currently used. However, as exhaust emissions are reduced below ULEV levels, they will become increasingly difficult to measure using existing test procedures. Therefore some modifications may be needed to make the existing test proceedures applicable to extremely low-emitting vehicles.

Vehicle emission certification is conducted using a dynamometer test cell and a constant volume sampling system to measure emissions. Currently, 100 percent of the vehicle exhaust is captured and diluted with a large quantity of ambient air. A portion of this mixture is analyzed to measure emission levels. This procedure results in a homogenous sample mixture that has pollutant levels within a measurable range. However, ambient air has a comparatively high concentration of pollutants compared to the levels that are produced by clean vehicles. Using ambient air to dilute vehicle exhaust can make it difficult to measure the emissions from very clean vehicles, because the concentration of pollutants present in the ambient air can approach the concentration of pollutants present in the vehicle exhaust sample.

To alleviate problems associated with measuring low emission levels in extremely clean vehicles, modifications such as using reduced dilution rates, purified air for dilution, or more sophisticated measurement equipment, capable of identifying smaller quantities of pollutants, may be needed. A new sampling device currently being developed, the mini diluter, may satisfy these requirements. Using this device, a technician would sample approximately 10 percent of the vehicle exhaust stream and dilute it with purified air.

The ARB staff intends to work with manufacturers to develop procedures for measuring extremely low emission levels as candidate EZEVs are developed and become available for testing, and will propose any necessary changes to the existing test procedures. Because HEVs may be a candidate technology for certifying to the EZEV standard, the ARB staff is proposing changes to the current HEV test procedures to provide a more accurate accounting of emissions produced by HEVs. These proposed changes are discussed in section VI of this report.

Evaporative: Emission certification procedures require a test for evaporative emissions. 1993 and subsequent model year vehicles must meet a hydrocarbon standard of 2.0 grams per test for diurnal plus hot soak emissions and 0.05 grams per mile for running loss emissions. Because the proposed EZEV standard is a combined exhaust, evaporative and refueling emission standard, the results of the diurnal plus hot soak emissions test would need to be converted from a grams per test result to a grams per mile result in order to be combined with the other emissions data and then compared to the proposed EZEV standard, which is expressed in grams per mile. This would involve the application of several assumptions, including the number of daily vehicle starts and the number of periods in which the vehicle is not used. In order to meet the extremely low EZEV standard, vehicles are likely to use a closed fuel system, which are expected to have zero evaporative emissions. To avoid developing a complicated procedure which may or may not need to be used (depending on the type of EZEVs that are developed), the staff proposes to evaluate candidate EZEVs on a case-by-case basis. The staff would use an engineering evaluation to determine if the fuel system of a candidate EZEV has evaporative emissions and, if it does, conduct the evaporative emissions test and apply the necessary assumptions to convert the results to a grams per mile value.

Refueling: For gasoline, the ARB staff has calculated refueling emissions to be equivalent to 0.007 grams ROG per mile. This calculation is based on an uncontrolled emission rate of 8.4 pounds ROG per 1,000 gallons of gasoline dispensed, an assumed control efficiency of 95 percent, and a fuel economy of 27.5 miles per gallon. Because gasoline refueling emissions alone are greater than the power plant emissions of ROG associated with use of EVs, vehicles that use a traditional gasoline fueling system would not be able to certify to the EZEV standard.

Refueling emissions for other fuels are not well quantified at this time. The ARB staff plans to address emissions from other fuels and fueling systems on a case by case basis as vehicles are developed and manufacturers begin the certification process. Manufacturers would need to provide the ARB staff with proposed test procedures for determining refueling emissions from their systems and test data demonstrating compliance.

2. Durability Requirements

In order to certify to the EZEV standard, a manufacturer would be required to demonstrate compliance with the EZEV certification standards based on a 100,000-mile vehicle life. However, manufacturers would be required to guarantee that EZEVs maintain their emissions at or below the EZEV certification standards for the entire life of the vehicle, even beyond 100,000 miles, e.g. through the use of on-board diagnostics and a comprehensive warranty program for the emission control components. In-use vehicle testing would be used to determine compliance. EZEVs that exceed the certification standards would be subject to recall.

3. ZEV Credits and Fleet Average Emission Calculation

Certified EZEVs would be counted toward a manufacturer’s percentage ZEV requirement on a one-to-one basis, i.e. if a manufacturer who is required to produce 15,000 ZEVs in 2003 produces 12,000 ZEVs and 3,000 EZEVs, they will have met their ZEV requirement for that year. Because EZEVs would be required to meet a combined exhaust, evaporative and refueling emission standard, there would be no separate EZEV exhaust standard to use for calculating a manufacturer’s fleet average emission level. For this reason, EZEVs would be counted as having zero exhaust emissions for purposes of calculating a manufacturer’s fleet average emission level. The staff believes this is a reasonable approach because EZEV exhaust emissions will be extremely low.

III. TECHNICAL BASIS FOR THE PROPOSED EZEV STANDARD

A. Quantifying the Power Plant Emissions Associated with EVs in the SCAB

Because of our severe air quality problem, California power plants have been required to significantly reduce emissions. The result is very low levels of emissions compared to other areas of the country. This is especially true in the SCAB, where power plants are subject to increasingly stringent emission requirements through 2010 under the South Coast Air Quality

Management's (SCAQMD's) RECLAIM program. Under this program, power plants are required to reduce emissions of NOx by either controlling emissions at their own facilities or purchasing RECLAIM Trading Credits (RTCs) from other sources.

There are different perspectives on how to appropriately quantify the power plant emissions associated with EVs in the SCAB. The staff has considered these different perspectives and has concluded that EV emissions are most appropriately characterized as a range of emissions estimates. The following sections describe the range of emissions estimates and how these values were derived.

Upper Bound Estimate: Utilities are expected to increase in-basin power generation through 2010 in order to meet the increasing demand for electricity, including demand due to EVs. If utilities exceed their RECLAIM NOx allocations, they are required to purchase RTCs or reduce their own emissions. Some argue that all power plant emissions associated with the increased demand due to EVs should be attributed to EVs, even if those emissions are offset by RTCs. The CEC staff's marginal analysis quantifies these emissions. The ARB staff considers this to be an upper bound to the range of possible emissions that will occur due to EVs. Because this analysis is the most complex of all of the emissions estimates, it is described in more detail in a following section.

Lower-Bound Estimate: Under RECLAIM, total utility power plant NOx emissions will be capped at specified levels, regardless of the amount of electricity the utilities generate in the basin. Because power plant emissions cannot increase beyond what is allowed without being offset by RTCs, the additional demand for electricity created by EVs will not result in a net increase in emissions in the SCAB. For this reason, some argue that the additional power plant emissions associated with EVs will be zero in the SCAB. However, the staff considers this to be a lower bound to the range of possible emissions that will occur due to EVs.

B. CEC Analysis of Marginal EV Emissions in the SCAB

The staff requested the assistance of the California Energy Commission (CEC) staff to analyze the emissions associated with the additional, or marginal, power that will be generated to satisfy EV demand in the SCAB. The ARB staff considers this type of analysis to represent the upper bound of emissions that may occur due to the use of EVs in the SCAB. This is because the CEC staff determined the emissions from power plants without adjusting these emissions for scenarios in which utility NOx emissions were projected to exceed RECLAIM allotments. In such situations, the utility would be required to offset these exceedances by either applying control equipment or by purchasing RTCs from other sources. Using either approach, overall emissions in the SCAB due to EVs would be reduced.

To conduct this analysis, ARB and CEC staff decided on a number of different assumptions (e.g., number of EVs, vehicle efficiency, miles travelled per year) that would characterize the additional demand for electricity due to EVs. The CEC staff then used the Elfin model (Electric Utility Financial and Production Cost Model, owned and maintained by the Environmental Defense Fund) to estimate the amount of additional electricity that would need to be generated under several scenarios, and to predict which power plants would produce this marginal electricity. The NOx and ROG emission factors associated with those plants were used to arrive at the total emissions expected to occur in the SCAB due to the use of EVs. A vehicle emission rate (in grams per mile) was calculated by applying an EV efficiency value.

A draft report describing the marginal power plant emissions analysis was prepared by the CEC staff in June 1995 and was attached as an appendix to the July 14, 1995 HEV/EZEV draft staff report. To save resources, the staff is not reprinting the CEC's report at this time. A copy of the report may be obtained from the CEC staff.

The CEC staff evaluated a number of scenarios. Power plant emissions for the Southern California Edison (SCE) and Los Angeles Department of Water and Power (LADWP) service territories were predicted for two years, 2000 and 2010. For each of these years, two EV charging profiles were examined, using two vehicle efficiency values and assuming three different rates of EV distribution within the SCAB. Table 4 summarizes the key assumptions used in the CEC staff's marginal EV emissions analysis.

Table 4. Summary of Key Assumptions Used in CEC Marginal EV Emissions Analysis

Years Analyzed	Number of EVs Distributed to SCAB in 2010	Miles Driven Per Year	Energy Efficiency (kWh/mi)	Charging Profile
2000 2010	40%[1] = 564,000 55%[1] = 775,000 80%[1] = 1,128,000	10,000	0.24 to 0.35	84% off-peak/16% on-peak 95% off-peak/5% on-peak

1 Represents projected percent distribution of statewide EVs to the SCAB. 70 percent of the SCAB EVs are projected to be charged in SCE territory and 27 percent are projected to be charged in LADWP territory (3 percent are projected to be charged in the municipal utility territories).

The ARB staff has organized the various sets of assumptions used by the CEC staff into six scenarios. These scenarios are summarized in Table 5.

Table 5. Definition of Scenarios

Percent of Statewide EVs Distributed to SCAB	Charging Profile	
	84% Off-Peak 16% On-Peak	95% Off-Peak 5% On-Peak
40%	Scenario A	Scenario D
55%	Scenario B	Scenario E
80%	Scenario C	Scenario F

Scenarios A and D assume that 40 percent (564,000) of the EVs operated statewide in 2010 will be distributed to the SCAB. This figure is based on the ARB's emission inventory data and represents the statewide distribution of all vehicles. Scenarios B and E assume that 55 percent (775,000) of the EVs operated statewide in 2010 will be distributed to the SCAB. This represents a scenario in which the ARB's emission inventory distribution is adjusted so that all EVs are distributed only to four areas of California: South Coast, San Diego, Bay Area and Sacramento. This type of distribution would result in approximately 55 percent of the EVs located in the SCAB. Scenarios C and F assume that 80 percent (1,128,000) of the EVs operated statewide in 2010 will be distributed to the SCAB. This scenario is based on a CEC staff projection that a significant majority of the EVs will be distributed to the SCAB because the SCAB will offer more infrastructure and other incentives to EV owners.

The ARB staff selected Scenario B as the "primary scenario," because the staff believes it represents the most appropriate characterization of EV implementation in the SCAB. This scenario assumes that the number of EVs in the SCAB will be somewhat higher than what would be predicted by the distribution of conventional vehicles (55 percent as opposed to 40 percent). It also predicts that 16 percent of vehicle charging will occur during on-peak hours, accounting for the likelihood that, despite efforts to encourage off-peak charging, some EV owners will need to charge their vehicle during the day. The staff also believes that, within this scenario, a 0.35 kWhr/mi vehicle efficiency in the year 2010 is a conservative prediction, and therefore the values associated with this vehicle efficiency represent a realistic upper bound to the power plant emissions associated with EVs in the SCAB.

The ARB requested that the CEC evaluate two efficiency values, 0.24 kilowatt-hours per mile (kWh/mi) and 0.35 kWh/mi. These values were chosen based on data from ARB tests of

EVs from several manufacturers, including three major manufacturers[1]. The ARB staff believes that this range is realistic, especially considering the technology advancements that are expected to provide significant efficiency improvements by 2010. These efficiency values take into account all energy losses between the wall plug and the vehicle wheels. Transmission line and distribution losses are taken into account by the CEC staff in their calculation of the energy needed to meet EV demand.

The results of the CEC staff's analysis are summarized in Tables 6 through 11.

Table 6. Marginal Electric Vehicle In-Basin Emission Rates: Scenario A (84% Off-Peak/16% On-Peak, 40% SCAB Distribution)

Efficiency (kWhr/mi)	Utility	2000		2010	
		NOx (g/mi)	ROG (g/mi)	NOx (g/mi)	ROG (g/mi)
0.24	SCE	0.022	0.001	0.012	0.002
	LADWP	0.018	0.002	0.012	0.001
	Weighted[1] Avg.	0.021	0.001	0.012	0.002
0.35	SCE	0.026	0.001	0.019	0.004
	LADWP	0.022	0.003	0.018	0.002
	Weighted[1] Avg	0.025	0.002	0.019	0.003

1 Weighted average calculated assuming 72 percent of the EVs used in the SCAB will be charged in SCE service territory, and 28 percent of the EVs used in the SCAB will be charged in the LADWP service territory.

[1]AC efficiency values ("plug to wheels") as determined by ARB testing conducted during 1995 and 1996 of three EVs built by major manufacturers fall within the 0.24 kWh/mi to 0.35 kWh/mi range. ARB tests of the Solectria Sunrise and the U.S. Electricar Prism conducted in 1995 show an AC efficiency of 0.20 kWh/mi and 0.34 kWh/mi respectively. These efficiency results take into account all energy losses that occur between the wall plug and the wheels (e.g. charger efficiency, battery efficiency, battery thermal management and accessory loads).

Table 7. Marginal Electric Vehicle In-Basin Emission Rates: Scenario B (84% Off-Peak/16% On-Peak, 55% SCAB Distribution) ARB's "Primary Scenario"

Efficiency (kWhr/mi)	Utility	2000		2010	
		NOx (g/mi)	ROG (g/mi)	NOx (g/mi)	ROG (g/mi)
0.24	SCE	0.018	0.001	0.012	0.002
	LADWP	0.015	0.002	0.013	0.001
	Weighted Avg.	0.017	0.001	0.012	0.002
0.35	SCE	0.021	0.001	0.021	0.004
	LADWP	0.019	0.002	0.018	0.002
	Weighted Avg	0.020	0.001	0.020	0.003

Table 8. Marginal Electric Vehicle In-Basin Emission Rates: Scenario C (84% Off-Peak/16% On-Peak, 80% SCAB Distribution)

Efficiency (kWhr/mi)	Utility	2000		2010	
		NOx (g/mi)	ROG (g/mi)	NOx (g/mi)	ROG (g/mi)
0.24	SCE	0.014	0.001	0.014	0.002
	LADWP	0.013	0.002	0.013	0.001
	Weighted Avg.	0.014	0.001	0.014	0.002
0.35	SCE	0.018	0.001	0.021	0.004
	LADWP	0.018	0.002	0.023	0.003
	Weighted Avg	0.018	0.001	0.022	0.004

Table 9. Marginal Electric Vehicle In-Basin Emission Rates: Scenario D

(95% Off-Peak/5% On-Peak, 40% SCAB Distribution)

Efficiency (kWhr/mi)	Utility	2000		2010	
		NOx (g/mi)	ROG (g/mi)	NOx (g/mi)	ROG (g/mi)
0.24	SCE	0.023	0.002	0.010	0.004
	LADWP	0.008	0.001	0.016	0.002
	Weighted Avg.	0.019	0.002	0.012	0.003
0.35	SCE	0.027	0.003	0.014	0.005
	LADWP	0.012	0.002	0.022	0.003
	Weighted Avg	0.023	0.003	0.016	0.004

Table 10. Marginal Electric Vehicle In-Basin Emission Rates: Scenario E (95% Off-Peak/5% On-Peak, 55% SCAB Distribution)

Efficiency (kWhr/mi)	Utility	2000		2010	
		NOx (g/mi)	ROG (g/mi)	NOx (g/mi)	ROG (g/mi)
0.24	SCE	0.019	0.002	0.010	0.004
	LADWP	0.008	0.001	0.015	0.002
	Weighted Avg.	0.016	0.002	0.011	0.003
0.35	SCE	0.024	0.003	0.013	0.005
	LADWP	0.012	0.002	0.024	0.003
	Weighted Avg	0.021	0.003	0.016	0.004

Table 11. Marginal Electric Vehicle In-Basin Emission Rates: Scenario F (95% Off-Peak/5% On-Peak, 80% SCAB Distribution)

Efficiency (kWhr/mi)	Utility	2000		2010	
		NOx (g/mi)	ROG (g/mi)	NOx (g/mi)	ROG (g/mi)
0.24	SCE	0.016	0.002	0.009	0.004
	LADWP	0.008	0.001	0.017	0.002
	Weighted Avg.	0.014	0.002	0.011	0.003
0.35	SCE	0.022	0.002	0.015	0.005
	LADWP	0.012	0.002	0.025	0.002
	Weighted Avg	0.019	0.002	0.018	0.004

The CEC staff has updated their analysis to reflect the regulatory modifications approved by the Board at the March 1996 meeting, which result in a lower number of ZEVs required. The CEC staff also added Ventura power plants because these sources have been demonstrated by the ARB to impact SCAB air quality. The modified results for the primary scenario assuming an EV efficiency of 0.35 kWhr/mile are presented in Table 12. Due to time constraints, the CEC was not able to provide estimates for all six scenarios. These may be presented at a later date.

Table 12. Updated CEC Analysis of Marginal EV In-Basin Emission Rates
Scenario B: 84% Off-Peak/16% On-Peak, 55% SCAB Distribution

Efficiency (kWhr/mi)	Utility	2010	
		NOx (g/mi)	ROG (g/mi)
0.35	SCE	0.025	0.004
	LADWP	0.018	0.002
	Weighted Avg	0.023	0.003

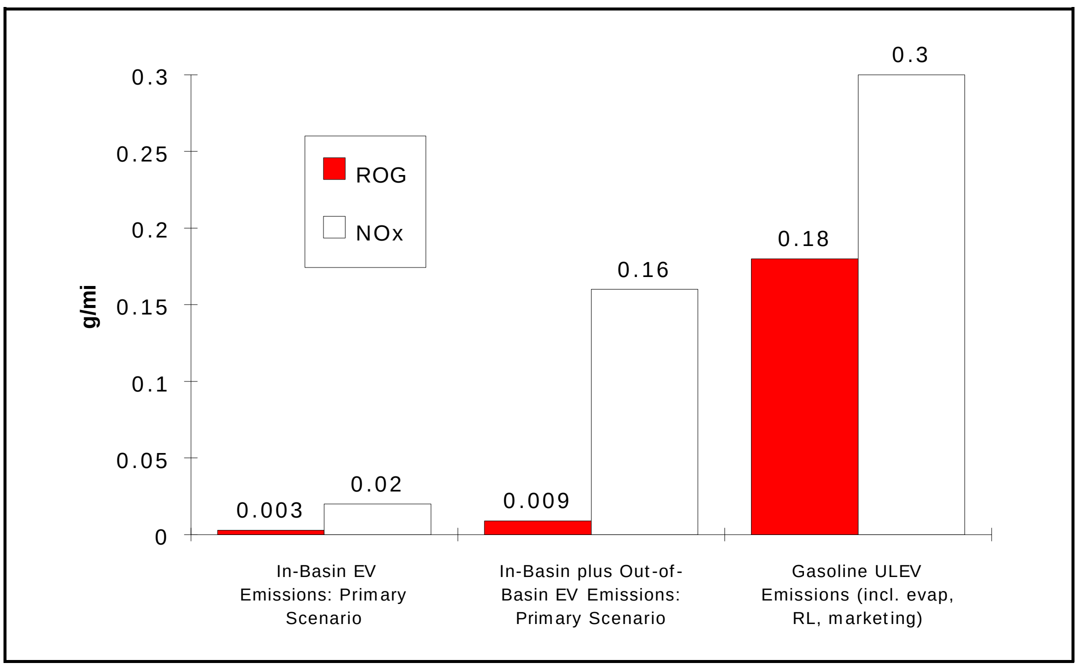
IV. ISSUES

A. Out-of-Basin Emissions

The proposed EZEV certification standards are based on power plant emissions within the SCAB. Some of the electricity used to recharge EVs in the SCAB will be generated out of the basin. Based on the CEC staff's analysis, approximately 55 percent of the energy provided by SCE and about 40 percent of the energy provided by LADWP for use by EVs will be generated out of the basin in 2010. The CEC staff's draft report discusses this out-of-basin power generation in more detail.

Figure 1 compares the in-basin EV emissions associated with the primary scenario to the in-basin plus out-of-basin emissions for the same scenario. The in-basin plus out-of-basin power plant emissions include emissions from relatively dirty coal-fired power plants located outside of California. Emissions, including exhaust, evaporative, and fuel marketing emissions, for a gasoline-powered ULEV are also displayed. Figure 1 shows EVs will be much cleaner than a ULEV, even when the out-of-basin power plant emissions are included.

Figure 1. A Comparison of In-Basin EV Emissions to Total EV and ULEV Emissions



A report conducted by PacifiCorp and Resource Management International, Inc. ("The Environmental Effects of Increased Electrical Generation in the Great Basin to Meet the Electric Vehicle Mandate in California") dated July 1995 found that even if all of the electricity needed to fuel EVs in California were generated in the Great Basin (i.e. Nevada, Utah and Wyoming), the increase in emissions would be less than one percent of existing emissions. This is due to stringent requirements on new generating capacity in the Great Basin. In fact, only a fraction of the total electricity needed to fuel EVs in California will likely be produced in the Great Basin. Therefore the impact on total emissions in the Great Basin will be even lower.

The Los Angeles area has the most severe air quality problem in the United States. Although power plants outside the SCAB, and in particular out-of-state power plants, are allowed to emit at higher levels than those within the SCAB, in-basin power plants have been subject to stringent emissions requirements in order to improve air quality. Because of this, in-basin power plant emissions due to the use of EVs are extremely low. While it is important to recognize the total air quality impact of EVs both within and outside of the SCAB, it would be inappropriate to allow an EZEV to count toward a manufacturer's ZEV requirement if it emits at the higher out-of-basin emission levels while operating in the SCAB, as this would seriously reduce the effectiveness of the LEV regulations.

B. Fuel-Cycle Emissions

An ideal comparison of the environmental effects of various transportation technologies would include an assessment of all emissions associated with fuel use. These emissions, referred to as "fuel-cycle" emissions, result from the production and distribution of fuels and can be significant when compared to direct vehicle emissions, especially for low-emitting vehicles.

In 1993, the ARB contracted with Acurex Environmental Corporation to evaluate the fuel-cycle emissions from conventional and reformulated gasoline, diesel, methanol, ethanol, liquefied petroleum gas, compressed natural gas, liquified natural gas, hydrogen, and electricity. The contract is nearly complete and a final report is expected in the summer of 1996. Because of the enormous amount of detailed information, the inherent uncertainty in many of the estimates, and the numerous interests involved, the preliminary results of this report have created significant debate. Even as the report is being finalized, the staff expects that more review and discussion will be needed. For this reason, the results have not been incorporated into the staff's proposal at this time.

Once the final report is available, the staff plans to evaluate the implications of fuel-cycle emissions as they relate to the proposed EZEV standard and the proposed EZEV certification process. For certain fuels, it is possible that the fuel cycle emissions will be significant when compared to the proposed EZEV standards. If this is the case, then these fuels may not be truly equivalent to the use of electric vehicles.

C. EZEV Durability Requirement

One of the significant benefits of electric vehicles is that they do not experience deterioration of an emissions control system--they are zero-emission vehicles throughout the vehicle life. Because manufacturers would be allowed to use EZEVs to satisfy their ZEV requirement, the EZEV must provide a comparable air quality benefit. If the emissions from an EZEV were to increase beyond the original certification standards over time, the vehicle would no longer provide air quality benefits comparable to a ZEV. In order to ensure that the EZEV emissions remain comparable to the emissions associated with an EV throughout the vehicle's life, the staff believes it is important to require manufacturers to ensure an EZEV's emissions remain at or below the certification standard for the entire life of the vehicle. In practice, however, as vehicles age, it becomes increasingly difficult for the ARB to conduct in-use testing because there are fewer properly maintained vehicles available. One approach may be for manufacturers to provide a comprehensive warranty program for emission control components.

V. ENVIRONMENTAL AND ECONOMIC IMPACTS

A. Environmental Impacts

The ARB staff is proposing a new, optional EZEV emission standard based on the upper bound of the range of power plant emissions estimates for EVs operated in the SCAB. Manufacturers who certify EZEVs could count these vehicles toward their percentage ZEV requirement. To the extent that manufacturers develop and produce EZEVs instead of ZEVs, emissions could increase in some areas for two reasons: 1) utility-allowed emissions under RECLAIM remain constant regardless of the demand for electricity, and 2) EV-related power plant emissions in other areas of California may be lower than SCAB EV-related power plant emissions. These are further explained below. The staff believes the extremely small levels of potential emissions increases are acceptable considering the proposed EZEV standard will provide manufacturers with additional flexibility in meeting the ARB's requirements, thereby encouraging the production of extremely low-emitting vehicles and increasing the overall success of the ARB's motor vehicle program.

Under RECLAIM, a utility's total allowable NOx emissions are capped at a specified level. If a utility can satisfy the demand for electricity without reaching their emission cap, they are allowed to sell emission credits to another entity. If the utility must exceed their emission cap in order to provide the electricity required by their customers, they must purchase emission credits from another entity. Under either scenario, total in-basin RECLAIM NOx emissions remain constant. To the extent that a manufacturer produces EZEVs to satisfy part of their ZEV requirement, the demand for electricity to charge EVs will be somewhat reduced. Utility emissions will remain constant under RECLAIM, while emissions from the motor vehicle fleet will increase slightly. The magnitude of the emissions increase will be extremely small, however, especially in comparison to overall mobile source emissions in the SCAB.

Other areas of California may have EV-related power plant emissions that are different than the proposed EZEV standards, most likely falling within the range determined by the ARB staff. For example, the Sacramento region obtains most of its electricity from sources outside the area. Therefore, the power plant emissions associated with EVs within the Sacramento area are very low. For areas such as Sacramento, the substitution of an EZEV for a ZEV could result in an extremely small increase in localized emissions. Because it would not be practical to establish separate certification standards for each air basin within California, it is logical to base the certification standards on EV-related power plant emissions in the SCAB, the area with the worst air quality problem.

B. Economic Impacts

Section 11346.3 of the Government Code requires that, in proposing to adopt or amend any administrative regulation, state agencies assess the potential for adverse economic impact on California business enterprises and individuals, as well as the ability of California businesses to compete with businesses in other states. This section also requires state agencies to assess the potential impact of their regulations on California jobs and on business expansion, elimination or creation.

The staff's proposal does not place any additional requirements on manufacturers or California businesses. It would provide an optional EZEV standard which would allow vehicle manufacturers additional flexibility in meeting the ARB's requirements. For this reason, the staff finds that the proposed regulatory changes would have no adverse impact on individuals or businesses in California, or on the ability of California businesses to compete with businesses in other states. In developing EZEVs, manufacturers could elect to use advanced emission control technologies and alternative fuel systems produced by California businesses, which would have a positive impact on job creation and the creation or expansion of businesses in California's advanced transportation industry.

Pursuant to Government Code section 11346.5(a)(3)(B), the Board's Executive Officer has determined that the proposed regulatory action will not affect small businesses.

VI. HEV TEST PROCEDURES

A. Background

When the Low-Emission Vehicle regulations were adopted in 1990, no HEVs were available to ARB staff for testing to act as a guide in developing emission test procedures, and even today, this class of vehicle remains in the developmental stage. Therefore, since there are many possible vehicle configurations in terms of battery and auxiliary power unit (APU) operation that can affect HEV emissions, test procedures were adopted to address a range of emission profiles that could be expected from these vehicles. The procedures were also designed to encourage development efforts to minimize HEV emissions and to be similar with procedures for conventional vehicles. Since then, industry and others have suggested changes to the adopted regulatory requirements. At the May 1994 Low-Emission Vehicle Technology Review, the ARB was requested to re-examine the requirements to ensure that HEV emission benefits were properly addressed. As a result, the Board directed staff to re-evaluate all relevant HEV issues and submit a report at the earliest opportunity.

ARB staff, after reviewing the existing HEV test procedures, concluded that with some adjustments, the procedures remained suitable for testing virtually all types of hybrid designs and subsequently proposed modifications to ARB's existing HEV test procedures. In July 1995, a public workshop was held to discuss the proposed changes to the HEV test procedures. As a result of this workshop, ARB staff received additional comments and has further refined the procedures. Consequently, ARB is proposing additional modifications to the HEV test procedures and requirements.

B. Summary of Proposed Changes

Proposed modifications to the current HEV test procedures would revise air conditioning loading, all-electric range testing (AERT) and termination criteria, regenerative braking requirements, exhaust emission testing, certification vehicle condition, and specify use of an electric chassis dynamometer for HEV testing. To account for the particular case of EZEV-qualifying HEVs which increase the state of charge (SOC) of the battery pack during exhaust emission testing, an emission adjustment is now being proposed. Evaporative emission test procedures and other requirements will remain consistent with conventional vehicle requirements.

C. Overview of HEV Test Procedures

The basic elements of ARB's current HEV test procedures are:

(1) an urban AERT and a highway AERT.
(2) APU exhaust emission testing.
(3) an evaporative emission test.

Figure 2 shows the current test sequence for 1996 and subsequent model hybrid electric vehicles. The exhaust test sequence is outlined below:

1. fuel drain and fill
2. AERT or cold soak for a minimum of 6 hours
3. preconditioning drive
4. fuel drained and filled
5. cold soaked for 12 to 36 hours
   - prep canister
6. exhaust emission test
7. evaporative emission test

Figure 2. Test Procedure for 1996 and Subsequent Model Year Hybrid Electric Vehicles

(hard copy only)

The battery must be discharged to the appropriate SOC during the cold soak prior to the beginning of the exhaust emission test.

D. Air Conditioning Loading

Requirements for air conditioning loading are being revised for the purposes of determining all-electric range and exhaust emissions with air conditioning operation. All HEVs and ZEVs which offer air conditioning on 33 percent or more of the model line are affected by these requirements.

Current ARB Requirements:

For HEVs equipped with air-conditioning systems which derive power from the vehicle battery, current regulations require that the chassis dynamometer road load be increased by an incremental horsepower required to simulate air-conditioning operation. The incremental horsepower loading is adjusted to simulate the difference in battery energy consumption required to complete the running loss test fuel tank temperature profile test sequence (as defined in the "California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles") in the all-electric mode with and without air conditioning operation.

Proposed Modifications:

For HEVs certifying to the EZEV standards, it is critical that air conditioning loading be accurately simulated to ensure that APU emissions are equivalent to power plant emissions as required by the EZEV standards. Therefore, the current ARB requirements which determine the air conditioning energy consumption over the running loss test fuel tank temperature profile test sequence shall be retained; however, applying the equivalent road load incremental increase simulating the air conditioning energy consumption shall no longer be required. Instead, the manufacturer shall determine the air conditioning energy consumption rate (kw-hr and kw-hr/mile) during one UDDS in the running loss test sequence. The air conditioning energy consumption rate (ACr) shall be simulated by applying a current load to the HEV battery pack during emission testing. In addition, ACr shall be applied to the emission adjustment credit for certain EZEV-qualifying HEVs as discussed below in the Exhaust Emission Test section.

The ACr term shall be used to adjust the all-electric range for HEVs and ZEVs to account for air conditioning operation. This adjustment is described in the All-Electric Range Test section below.

For HEVs certifying to TLEV, LEV, and ULEV standards, staff is proposing that air conditioning loading for these HEVs should be applied similar to conventional vehicles. Currently, conventional vehicles which offer air conditioning on 33 percent or more of the model line must apply a 10 percent incremental increase in the dynamometer road load power when certifying to the LEV standards. This increase in road load power is meant to represent the additional power load an air conditioning system applies to the engine when the air conditioning is operating. Therefore, for HEVs not certifying to EZEV standards, during exhaust emission testing, dynamometer road load power shall be increased by 10 percent in order to account for air-conditioning operation.

E. All-Electric Range Testing

Current ARB Requirements:

In the current test procedures, the AERT consists of two separate and independent electric range tests. The Urban AERT consists of repeated UDDS cycles separated by soaks which are no longer than 10 minutes in duration. The Highway AERT consists of repeated HFEDS cycles separated by soaks which are also no longer than 10 minutes in duration. The procedure yields separate urban and highway all-electric ranges. Prior to either the Urban or Highway AERT, the HEV is cold soaked for 12 to 36 hours with the battery on a charger and fully charged to 100 percent SOC. Energy consumption of the HEV would be determined following each AERT by measuring the energy consumption (kw-hr) required to fully recharge the battery pack. Regenerative braking is allowed during the test and set according to the manufacturer's specifications. The AERT is terminated when one of the following conditions occurs:

a) vehicle is no longer able to maintain within 5 miles per hour of the speed requirements or within 2 seconds of the time requirements of the driving schedules without the use of the APU.

b) the APU turns ON.

During the test, the battery voltage, battery current, vehicle speed, battery power, total energy used, time, and regenerative energy (if applicable) are recorded. After completion of the test, the vehicle is charged to a full state-of-charge and the energy consumption (kw-hr) used during charging is recorded.

Proposed Modifications:

ARB staff proposes that the conditions for terminating either Urban or Highway AERT be similar to the requirements for conventional vehicles. This would allow the consumer to compare HEV all-electric performance with conventional vehicles on an equal performance basis. In addition, the test is to be terminated should manufacturer-specified operating limits for the battery be exceeded. Therefore, the Urban and Highway AERTs are to be terminated if one or more of the following conditions occurs:

a) the vehicle fails to maintain the speed tolerance as specified in 40 CFR 86.115 which states that the upper limit is 2 mph higher than the highest point on the trace within one second of the given time, and that the lower limit is 2 mph lower than the lowest point of the trace within one second of the given time. Speed variations outside this tolerance are acceptable if they occur for less than 2 seconds on any occasion.

b) the APU turns ON.

c) the battery pack parameters such as battery pack voltage and temperature fall outside the manufacturer's specified operating limits.

Although current regulations allow the use of regenerative braking during testing, it does not address the issue of how to accurately simulate on-road regenerative braking characteristics on chassis dynamometers which engage only two wheels. For two wheel drive HEVs with regenerative braking, all of the inertial braking for the total vehicle is accomplished by only two wheels during chassis dynamometer simulation and not all four wheels which occurs during actual on-road operation. Consequently, the two wheels on the dynamometer are subjected to a higher inertial load during braking than occurs during actual on-road operation, thereby providing excess regenerative braking energy to the batteries. The amount of braking which is normally performed by the wheels not on the dynamometer needs to be taken into account. ARB staff proposes that the manufacturer provide the percentage of braking performed by each axle in order to program the electric dynamometer controller to account for the braking of the wheels not on the dynamometer. For HEVs equipped with an anti-lock braking system (ABS), a modification of the ABS system (e.g. software) may be required to allow the regenerative brake system to operate in a representative manner.

For all HEVs, the all-electric range shall be adjusted to account for air conditioning operation. The battery discharge rate, AERTr (kw-hr/mile), would be determined following each AERT by measuring the electrical energy required to fully recharge the battery pack, AERTc (kw-hr), and dividing by the total miles driven during the AERT.

$$AERTr = \frac{AERTc}{Dtotal}$$

Where:

AERTr = battery discharge rate during AERT (kw-hr/miles)

AERTc = energy required to recharge batteries after AERT (kw-hr)

Dtotal = the total distance driven on all-electric mode (miles)

The air conditioning energy consumption rate, ACr (see Air Conditioning Loading section), shall be added to AERTr. The adjusted all-electric range, AER_{adj} (miles), shall be calculated as follows:

$$AER_{adj} = \frac{AERTc}{(ACr + AERTr)}$$

where: AERTc = energy required to recharge batteries after AERT (kw-hr)

ACr = air conditioning energy consumption rate (kw-hr/mile)

AERTr = battery discharge rate during AERT (kw-hr/mile)

F. Exhaust Emission Test

<u>Current ARB Requirements:</u>

The exhaust emission test is conducted over one CVS-75 Federal Test Procedure (FTP) cycle which includes a cold start phase, a cold stabilized phase and a hot start phase. At the beginning of the exhaust emission test, the battery pack SOC should satisfy one of the following conditions:

1) the SOC is at the lowest level allowed by the control unit of the APU, or

2) the SOC is set such that the APU operation will be at its maximum power level at the beginning of and throughout the emission test.

Such an approach serves to characterize the maximum emissions among possible operating modes. In addition, HEVs are subject to the new, enhanced evaporative emission test and standards similar those that conventional vehicles must meet.

<u>Proposed Modifications:</u>

Prior to the 12 to 36 hour cold soak following preconditioning of the APU, the battery pack shall be discharged to the specified SOC for the exhaust test. The following are the criteria for determining the specified SOC for emission testing:

(1) the APU operation will be at its maximum power output level at the beginning of and throughout the exhaust emission test.

If condition (1) cannot be met, then the battery pack is discharged such that:

(2) the SOC is at the lowest level which causes the APU to turn ON at the start of the test and allows the HEV to just complete two UDDS's in a normal driving mode (i.e., without entering a default operating mode).

At the beginning of the highway exhaust emission test, the SOC of the battery pack is set such that:

(1) the APU operation will be at its maximum power output level at the beginning of and throughout the emission test.

If condition (1) cannot be met, then the battery pack is discharged such that:

(2) the SOC is at the lowest level which causes the APU to turn ON at the start of the test and allows the HEV to just complete two HFEDS's in a normal driving mode (i.e., without entering a default operating mode).

To determine the appropriate battery SOC level for testing, the ARB proposes that manufacturers be required to supply the APU control algorithm and the procedure to accurately drain the battery to the intended SOC at a rate at least equivalent to the C/3 current discharge rate. The C/3 current rate is defined as the constant current discharge rate at which the battery is fully depleted in approximately 3 hours.

Air Conditioning Loading for EZEV Certification

For HEVs certifying to EZEV standards, a current load equivalent to the air conditioning consumption rate, ACr (see Air Conditioning Loading section), shall be applied to the HEV battery pack during exhaust emission testing.

HEV Emission Adjustment (credit) for EZEV Certification

For HEVs certifying to the EZEV standards, emissions shall be adjusted (i.e. credited) to account for any net increase in SOC generated by the APU. Air conditioning loading shall be included in the adjustment calculation for those HEVs which offer air conditioning on 33 percent or more of the vehicle line. The increase in SOC due to APU charging shall be determined for one cold start UDDS and one hot start UDDS separated by a 10 minute soak. The adjusted emissions, FTP_{adj} (g/mi), shall be calculated as follows:

$$FTP_{adj} = \frac{0.43 * (M1 + M2)}{(D1 + D2 + DC1)} + \frac{0.57 * (M2 + M3)}{(D2 + D3 + DC2)}$$

Where: M1 = mass emissions during phase 1 (grams)
M2 = mass emissions during phase 2 (grams)
M3 = mass emissions during phase 3 (grams)

D1 = distance traveled during phase 1 (miles)
D2 = distance traveled during phase 2 (miles)
D3 = distance traveled during phase 3 (miles)

$$DC1 = \frac{SOC1}{(ACr + AERTr)}$$

$$DC2 = \frac{SOC2}{(ACr + AERTr)}$$

SOC1 = [SOC at end of first UDDS] - [SOC at start of first UDDS]

SOC2 = [SOC at end of second UDDS] - [SOC at start of second UDDS]

ACr = air conditioning energy consumption rate (kw-hr/mile)*

AERTr = battery discharge rate during the AERT (kw-hr/mile)

* Note: ACr is equal to 0 for those HEVs which do not offer air conditioning on 33 percent or more of the vehicle line.

G. Vehicle Condition

For certification emission testing, the HEV shall have accumulated 4,000 APU miles on the Durability Driving Schedule or an equivalent cycle. APU miles is defined as those miles accumulated with the APU operating. For electric range testing, the HEV shall have accumulated a minimum of 250 all-electric miles or equivalent. All-electric miles is defined as those mile accumulated with the HEV operating in the all-electric mode.

H. Chassis Dynamometer Type

Current ARB requirements:

The ARB currently allows the use of hydrokinetic chassis dynamometers to be used to test HEVs.

Proposed Modifications:

Due to the unique requirements of testing HEVs (e.g. regenerative braking), the ARB is proposing to allow only electric chassis dynamometers for testing HEVs.

VII. ZEV ALL-ELECTRIC RANGE TEST

Proposed Modifications

The proposed modifications to the AERT for HEVs are also being proposed for ZEVs. Accordingly, a current load equivalent to the air conditioning consumption rate determined over the running loss test sequence shall be applied to the battery pack when performing the AET.

VIII. REFERENCES

1. CEC Staff Report, June 1995, “Electric Vehicles and Powerplant Emissions.”

2. ARB Staff Report, June 1993. "Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations in California."

3. Mills, Dave and Larsen, David et. al. July 1995. "The Environmental Effects of Increased Electrical Generation in the Great Basin to Meet the Electric Vehicle Mandate in California," PacifiCorp, Salt Lake City, Utah and Resource Management International, Inc., Sacramento, California.

APPENDIX A

PROPOSED AMENDMENTS TO THE CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1988 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

State of California
AIR RESOURCES BOARD

PROPOSED

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1988 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES

Adopted: May 20, 1987
Amended: December 20, 1989
Amended: January 22, 1990
Amended: December 26, 1990
Amended: July 12, 1991
Amended: August 12, 1992
Amended: October 23, 1992
Amended: May 28, 1993
Amended: September 17, 1993
Amended: September 22, 1993
Amended: September 22, 1994
Amended: ___________________

NOTE: The regulatory amendments proposed for this workshop are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions from the version of the test procedures adopted on September 22, 1994. Amendments to the standards and test procedures adopted by the Board in two separate rulemaking proceedings (the LDV/MDV rulemaking action heard by the Board on September 28, 1995, and the ZEV rulemaking heard March 28 and 29, 1996) that still need to be submitted for filing with the Secretary of State are incorporated in the underlying text of this document.

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 1988 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS AND MEDIUM-DUTY VEHICLES

The provisions of Subparts A, B, and C, Part 86, Title 40, Code of Federal Regulations as set forth in Appendix I, to the extent they pertain to Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles, are hereby adopted as the California Exhaust Emission Standards and Test Procedures for 1988 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, with the following exceptions and additions.

1. Applicability

No change

2. Definitions

Add the following definition:

"**Equivalent Zero-Emission Vehicle**" or "**EZEV**" means any vehicle which is certified to the EZEV exhaust emission standards.

3. Standards

The following standards represent the maximum projected exhaust emissions for the useful life of the vehicle.

a. [No change]
b. [No change]
c. [No change]
d. [No change]
e. [No change]
f. [No change]

g. The exhaust emissions from new 1992 and subsequent model-year transitional low-emission vehicles, low-emission vehicles, ~~and~~ ultra-low-emission vehicles, equivalent zero-emission vehicles and new 2003 and subsequent model-year zero-emission vehicles shall not exceed:

EXHAUST MASS EMISSION STANDARDS FOR TRANSITIONAL LOW-EMISSION VEHICLES, LOW-EMISSION VEHICLES, ULTRA-LOW-EMISSION VEHICLES, EQUIVALENT ZERO-EMISSION VEHICLES, AND ZERO-EMISSION VEHICLES IN PASSENGER CAR AND LIGHT-DUTY TRUCK VEHICLE CLASSES[6,7,8,9,10]

["grams per mile" (or "g/mi")]

Vehicle Type[1]	Loaded Vehicle Weight (lbs)	Durability Vehicle Basis (mi)	Vehicle Emission Category[2]	Non-Methane Organic Gases[3,4]	Carbon Monoxide	Oxides of Nitrogen[5]
PC and	All	50,000	TLEV	0.125	3.4	0.4
LDT	0-3750		LEV	0.075	3.4	0.2
			ULEV	0.040	1.7	0.2
			EZEV[3]	0.004	0.17	0.02
			ZEV[2.1]	--	--	--
		100,000	TLEV	0.156	4.2	0.6
			LEV	0.090	4.2	0.3
			ULEV	0.055	2.1	0.3
			EZEV[3]	0.004	0.17	0.02
			ZEV[2.1]	--	--	--
LDT	3751-5750	50,000	TLEV	0.160	4.4	0.7
			LEV	0.100	4.4	0.4
			ULEV	0.050	2.2	0.4
			EZEV[3]	0.004	0.17	0.02
			ZEV[2.1]	--	--	--
		100,000	TLEV	0.200	5.5	0.9
			LEV	0.130	5.5	0.5
			ULEV	0.070	2.8	0.5
			EZEV[3]	0.004	0.17	0.02
			ZEV[2.1]	--	--	--

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"LVW" means loaded vehicle weight.
"Non-Methane Organic Gases" or "NMOG" means the total mass of oxygenated and non-oxygenated hydrocarbon emissions.

(2) "TLEV" means transitional low-emission vehicle.
"LEV" means low-emission vehicle.
"ULEV" means ultra-low-emission vehicle.
“EZEV” means equivalent zero-emission vehicle.
“ZEV” means zero-emission vehicle.

(2.1) a. The Executive Officer shall certify as ZEVs vehicles that produce zero exhaust emissions of any criteria pollutant (or precursor pollutant) under any and all possible operational modes and conditions. Incorporation of a fuel fired heater shall not preclude a vehicle from being certified as a ZEV provided the fuel fired heater cannot be operated at ambient temperatures above 40°F and the heater is demonstrated to have zero evaporative emissions under any and all possible operational modes and conditions.

b. Prior to the 2003 model year a manufacturer that voluntarily produces vehicles that meet the ZEV emission standards applicable to 2003 and subsequent model year vehicles may certify those vehicles as ZEVs for the purposes of calculating fleet average NMOG exhaust emission values under note (4) or (5), section h.3. of these test procedures; NMOG credits under section h.3., note(7); and ZEV credits under section h.3., note (9)a.

(3) **Compliance with NMOG Standard**. To demonstrate compliance with an NMOG standard, NMOG emissions shall be measured in accordance with the "California Non-Methane Organic Gas Test Procedures" adopted July 12, 1991 and as last amended ____________.

a. **Reactivity Adjustment**. For TLEVs, LEVs, and ULEVs certified to operate on a fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when certifying on a fuel other than gasoline, manufacturers shall multiply the exhaust NMOG certification levels by the applicable reactivity adjustment factor set forth in Section 13 of these test procedures, or established by the Executive Officer pursuant to Appendix VIII of these test procedures. In addition, natural gas vehicles certifying to TLEV, LEV or ULEV standards shall calculate a reactivity-adjusted methane exhaust emission value by multiplying the methane exhaust certification level by the applicable methane reactivity adjustment factor set forth in section 13 of these test procedures. The product of the exhaust NMOG certification levels and the reactivity adjustment factor shall be compared with the exhaust NMOG mass emission standards established for the particular vehicle emission category and fuel to determine compliance. For natural gas vehicles, the reactivity-adjusted NMOG value shall be added to the reactivity-adjusted methane value and then compared to the exhaust NMOG mass emission standards established for the particular vehicle emission category to determine compliance. EZEVs are prohibited from adjusting exhaust NMOG certification levels by the application of a reactivity adjustment factor.

b. **Fleet Average Requirement**. Each manufacturer shall certify PCs or LDTs to meet the exhaust mass emission standards for TLEVs, LEVs, ULEVs, or to the exhaust emission standards of Sections 3.b., 3.e., or 3.f. of these test procedures, or as Zero-Emission Vehicles, such that the manufacturer's fleet average NMOG values for California-certified PCs and LDTs from 0-3750 lbs. LVW, and LDTs from 3751-5750 lbs. LVW, produced and delivered for sale in California are less than or equal to the requirement for the corresponding Model Year, Vehicle Type, and LVW Class in Section 3.h. of these test procedures.

c. **Requirements for EZEVs.** For vehicles certified to EZEV standards, NMOG shall mean the sum of exhaust, evaporative (including hot soak emissions, diurnal emissions, resting losses and running losses) and refueling emissions.

(4) **NMOG Standards for Fuel-Flexible and Dual-Fuel Vehicles**. Fuel-flexible and dual-fuel PCS and LDTs from 0-5750 lbs. LVW shall be certified to exhaust mass

emission standards for NMOG established for the operation of the vehicle on an available fuel other than gasoline, and gasoline as specified in Section 9.a.1. of these test procedures.

a. **Reactivity Adjustment**. For TLEVs, LEVs, and ULEVs, when certifying for operation on a fuel other than gasoline, manufacturers shall multiply the exhaust NMOG certification levels by the applicable reactivity adjustment factor. In addition to multiplying the exhaust NMOGcertification levels by the applicable reactivity adjustment factor, the exhaust methane certification level for natural gas vehicles shall be multiplied by the applicable methane reactivity adjustment factor and the resulting value shall be added to the reactivity-adjusted NMOG value. The exhaust NMOG certification levels for fuel-flexible or dual-fuel vehicles when certifying on gasoline shall not be multiplied by a reactivity adjustment factor.

b. **Standards for Fuel-Flexible and Dual Fuel Vehicles Operating on Gasoline**. For PCs and LDTs from 0-5750 lbs. LVW, the applicable exhaust mass emission standard for NMOG when certifying the vehicle for operation on gasoline shall be:

Vehicle Type	Weight (LVW)	Emission Category	Durability Vehicle Basis (g/mi)	
			50,000 Mile	100,000 Mile
PCs, LDT	All, 0-3750	TLEV	0.25	0.31
		LEV	0.125	0.156
		ULEV	0.075	0.090
LDT	3751-5750	TLEV	0.32	0.40
		LEV	0.160	0.200
		ULEV	0.100	0.130

(5) **Highway NOx Standard**. The maximum projected emissions of Oxides of Nitrogen (or "NOx") measured on the federal Highway Fuel Economy Test (HWFET; 40 CFR 600 Subpart B) shall not be greater than 1.33 times the applicable light-duty vehicle standards shown in the table. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mi before being compared. <u>For EZEVs, the maximum projected emissions of NOx measured on the federal Highway Fuel Economy Test shall not exceed the applicable light-duty vehicle standards shown in the table.</u>

(6) **Intermediate In-Use Compliance Standards**. The following standards are intermediate in-use compliance standards for 50,000 miles and 100,000 miles for PCs and LDTs from 0-5750 lbs. LVW, including fuel-flexible and dual-fuel vehicles when operating on an available fuel other than gasoline. Intermediate in-use compliance standards shall apply to TLEVs through the 1995 model year as follows:

	NMOG (g/mi)
PCs and LDTs 0-3750 lbs. LVW	0.188

LDTs 3751 - 5750 lbs. LVW 0.238

In-use compliance with standards beyond 50,000 miles shall be waived through the 1995 model year for TLEVs, and through the 1998 model year for LEVs and ULEVs. For LEVs and ULEVs, the following intermediate in-use standards shall apply:

Vehicle Type	**Durability Vehicle Basis**	**LEV (g/mi)**			**ULEV (g/mi)**			
		Model Year	**NMOG**	**NOx**	**Model Year**	**NMOG**	**CO**	**NOx**
PCs, 0-3750 lb. LVW LDTs	50,000	through 1998	0.100	0.3	through 1998	0.058	2.6	0.3
	50,000	1999	0.100	0.3	1999-2002	0.055	2.1	0.3
	100,000	1999	0.125	0.4	1999-2002	0.075	3.4	0.4
3751-5750 lb. LVW LDTs	50,000	through 1998	0.128	0.5	through 1998	0.075	3.3	0.5
	50,000	1999	0.130	0.5	1999-2002	0.070	2.8	0.5
	100,000	1999	0.160	0.7	1999-2002	0.100	4.4	0.7

a. **Reactivity Adjustment**. For TLEVs, LEVs, and ULEVs designed to operate on a fuel other than conventional gasoline, including fuel-flexible and dual-fuel vehicles when operating on a fuel other than gasoline, exhaust NMOG emission results shall be multiplied by the applicable reactivity adjustment factor to determine compliance with intermediate in-use compliance standards for NMOG. In addition to multiplying the exhaust NMOG emission results by the applicable reactivity adjustment factor, the exhaust methane emission results for natural gas vehicles shall be multiplied by the applicable methane reactivity adjustment factor and the resulting value shall be added to the reactivity-adjusted NMOG value. Exhaust NMOG mass emissions from fuel-flexible or dual-fuel vehicles when operating on gasoline shall not be multiplied by a reactivity adjustment factor.

b. **Intermediate In-Use Standards for Fuel-Flexible and Dual-Fuel Vehicles Operating on Gasoline**. For fuel-flexible and dual-fuel PCs and LDTs from 0-5750 lbs. LVW, intermediate in-use compliance standards for NMOG emissions at 50,000 miles when the vehicle is operated on gasoline shall be:

Vehicle Type	Loaded Vehicle Weight (LVW)	Emission Category	Durability Vehicle Basis (g/mi) 50,000 mi
PCs, LDT	All, 0-3750	TLEV	0.32
		LEV	0.188
		ULEV	0.100
LDT	3751-5750	TLEV	0.41
		LEV	0.238
		ULEV	0.128

Intermediate in-use compliance standards shall apply to TLEVs through the 1995 model year, and to LEVs and ULEVs through the 1998 model year. In-use compliance with standards beyond 50,000 miles shall be waived through the 1995 model year for TLEVs, and through the 1998 model year for LEVs and ULEVs.

(7) **Diesel Standards**. Manufacturers of diesel vehicles shall also certify to particulate standards at 100,000 miles. For all PCs and LDTs from 0-3750 lbs. LVW, the particulate standard is 0.08 g/mi, 0.08 g/mi, and 0.04 g/mi for TLEVs, LEVs, and ULEVs, respectively. For LDTs from 3751-5750 lbs. LVW, the particulate standard is 0.10 g/mi, 0.10 g/mi, and 0.05 g/mi for TLEVs, LEVs, and ULEVs, respectively. The particulate standard for EZEVs shall be 0.004 g/mile. For diesel vehicles certifying to the standards set forth in section 3.g. of these test procedures, "NMOG" shall mean non-methane hydrocarbons.

(8) **50ºF Requirement**. Manufacturers shall demonstrate compliance with the above standards for NMOG, carbon monoxide and NOx at 50º F, according to the procedure specified in Section 11k of these test procedures. Hybrid electric, natural gas, and diesel-fueled vehicles shall be exempt from 50º F test requirements.

(9) **Limit on In-Use Testing**. In-use compliance testing shall be limited to vehicles with fewer than 75,000 miles. EZEVs shall be subject to in-use compliance testing for the full life of the vehicle.

(10) **HEV Requirements**. Deterioration factors for hybrid electric vehicles shall be based on the emissions and mileage accumulation of the auxiliary power unit. For certification purposes only, Type A hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors), and demonstrating compliance with 100,000 mile emission standards shall not be required. For certification purposes only, Type B hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 100,000 mile emission standards (using 75,000 mile deterioration factors). For certification purposes only, Type C hybrid electric vehicles shall demonstrate compliance with 50,000 mile emission standards (using 50,000 mile deterioration factors) and 100,000 mile emission standards (using 100,000 mile deterioration factors).

h. The fleet average non-methane organic gas exhaust mass emission values from the passenger cars and light-duty trucks produced and delivered for sale in California by a manufacturer each model year shall not exceed:

FLEET AVERAGE NON-METHANE ORGANIC GAS EXHAUST MASS EMISSION REQUIREMENTS FOR LIGHT-DUTY VEHICLE WEIGHT CLASSES[7,8,9]

[grams per mile" (or "g/mi")]

Vehicle Type[1]	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)[7]	Model Year	Fleet Average Non-Methane Organic Gases[2,3,4,5,6]
PC and LDT	All 0-3750	50,000	1994	0.250
			1995	0.231
			1996	0.225
			1997	0.202
			1998	0.157

			1999	0.113
			2000	0.073
			2001	0.070
			2002	0.068
			2003 and subsequent	0.062
LDT	3751-5750	50,000	1994	0.320
			1995	0.295
			1996	0.287
			1997	0.260
			1998	0.205
			1999	0.150
			2000	0.099
			2001	0.098
			2002	0.095
			2003 and subsequent	0.093

(1) "PC" means passenger cars.
"LDT" means light-duty trucks.
"MDV" means medium-duty vehicles.
"LVW" means loaded vehicle weight.

(2) "Non-Methane Organic Gases" (or "NMOG") shall mean the total mass of oxygenated and non-oxygenated hydrocarbon emissions.

(3) For the purpose of calculating fleet average NMOG values, vehicles which have no tailpipe emissions but use fuel fired heaters and which are not certified as ZEVs shall be treated as Type A Hybrid Electric Vehicles Ultra-Low-Emission Vehicles (or "Type A HEV ULEVs").

(4) **Calculation of Fleet Average NMOG Value (PCs and LDTs from 0-3750 lbs. LVW).** Each manufacturer's fleet average NMOG value for the total number of PCs and LDTs from 0-3750 lbs. LVW produced and delivered for sale in California shall be calculated in units of g/mi NMOG according to the following equation, where the term "Produced" means produced and delivered for sale in California:

{[(No. of vehicles certified to the exhaust emission standards in Section 3.b. of these test procedures and produced) x (0.39)] +
[(No. of vehicles certified to the phase-in exhaust emission standards in Section 3.e. of these test procedures and produced) x (0.25)] +
[(No. of vehicles certified to the phase-out exhaust emission standards in 3.e. of these test procedures and produced) x (0.39)] +
[(No. of vehicles certified to the exhaust emission standards in Section 3.f. of these test procedures and produced) x (0.25)] +
[(No. of TLEVs produced excluding HEVs) x (0.125)] +
[(No. of LEVs produced excluding HEVs) x (0.075)] +
[(No. of ULEVs produced excluding HEVs) x (0.040)] +
(HEV contribution factor)} ÷
[Total No. of vehicles produced, including ZEVs, EZEVs and HEVs].

a. "HEV contribution factor" shall mean the NMOG emission contribution of HEVs to a manufacturer's fleet average NMOG value. The HEV contribution factor shall be calculated in units of g/mi as follows, where the term "Produced" means produced and delivered for sale in California:

HEV contribution factor =

{[No. of "Type A HEV" TLEVs produced] x (0.100) +
[No. of "Type B HEV" TLEVs produced] x (0.113) +
[No. of "Type C HEV" TLEVs produced] x (0.125)**}** +
{[No. of "Type A HEV" LEVs produced] x (0.057) +
[No. of "Type B HEV" LEVs produced] x (0.066) +
[No. of "Type C HEV" LEVs produced] x (0.075)**}** +
{[No. of "Type A HEV" ULEVs produced] x (0.020) +
[No. of "Type B HEV" ULEVs produced] x (0.030) +
[No. of "Type C HEV" ULEVs produced] x (0.040)**}**

b. ZEVs and EZEVs classified as LDTs 3751-5750 lbs. LVW which have been counted toward the ZEV requirement for PCs and LDTs 0-3750 lbs. LVW as specified in note (9) shall be included in the above equation of note (4).

c. Beginning with the 1996 model year, manufacturers that produce and deliver for sale in California PCs and LDTs 0-3750 lbs. LVW that are certified to the Tier I exhaust emission standards in 40 CFR 86.094-8 and 86.094-9 shall add the following term to the numerator of the fleet average NMOG equation in note (4) and calculate their fleet average values accordingly: [(No. of Vehicles Certified to federal Tier I exhaust emission standards and Produced) x (0.25)].

(5) **Calculation of Fleet Average NMOG Value (LDTs 3751-5750 lbs. LVW**.) Manufacturers that certify LDTs from 3751-5750 lbs. LVW, shall calculate a fleet average NMOG value in units of g/mi NMOG according to the following equation, where the term "Produced" means produced and delivered for sale in California:

{[(No. of vehicles certified to the exhaust emission standards in Section 3.b. of these test procedures and produced x (0.50)] +
[(No. of vehicles certified to the phase-in exhaust emission standards in Section 3.e. of these test procedures and produced) x (0.32)] +
[(No. of vehicles certified to the phase-out exhaust emission standards in Section 3.e. of these test procedures and produced) x (0.50)] +
[(No. of vehicles certified to the exhaust emission standards in Section 3.f. of these test procedures and produced) x (0.32)] +
[(No. of TLEVs produced excluding HEVs) x (0.160)] +
[(No. of LEVs produced excluding HEVs) x (0.100)] +
[(No. of ULEVs produced excluding HEVs) x (0.050)] +
(HEV contribution factor)} ÷
(Total No. of vehicles produced, including ZEVs, EZEVs and HEVs).

a. "**HEV contribution factor**" shall mean the NMOG emission contribution of HEVs to a manufacturer's fleet average NMOG value. The HEV contribution factor shall be calculated in units of g/mi as follows, where the term "Produced" means produced and delivered for sale in California:

HEV contribution factor =

{[No. of "Type A HEV" TLEVs Produced] x (0.130) +
[No. of "Type B HEV" TLEVs Produced] x (0.145) +
[No. of "Type C HEV" TLEVs Produced] x (0.160)**}** +
{[No. of "Type A HEV" LEVs Produced] x (0.075) +
[No. of "Type B HEV" LEVs Produced] x (0.087) +
[No. of "Type C HEV" LEVs Produced] x (0.100)**}** +
{[No. of "Type A HEV" ULEVs Produced] x (0.025) +
[No. of "Type B HEV" ULEVs Produced] x (0.037) +
[No. of "Type C HEV" ULEVs Produced] x (0.050)**}**

b. Only ZEVs and EZEVs which have been certified as LDTs 3751-5750 lbs. LVW and which have not been counted toward the ZEV requirements for PCs and LDTs 0-3750 lbs. LVW as specified in note (9) shall be included in the equation of note (5).

c. Beginning with the 1996 model year, manufacturers that produce and deliver for sale in California LDTs 3751-5750 lbs. LVW that are certified to the Tier I exhaust emission standards in 40 CFR 86.094-9 shall add the following term to the numerator of the fleet average NMOG equation in note (5) and calculate their fleet average NMOG values accordingly: [(No. of Vehicles Certified to federal Tier I exhaust emission standards and Produced and Delivered for Sale in California) x (0.32)]

(6) **Requirements for Small Volume Manufacturers**. As used in this section 3.h. of these test procedures, the term "small volume manufacturer" shall mean any vehicle manufacturer with California sales less than or equal to 3000 new PCs, LDTs, and MDVs per model year based on the average number of vehicles sold by the manufacturer each model year from 1989 to 1991, except as otherwise noted below. For manufacturers certifying for the first time in California, model-year sales shall be based on projected California sales. In 2000 and subsequent model years, small volume manufacturers shall comply with the fleet average NMOG requirements set forth below.

a. Prior to the model year 2000, compliance with the specified fleet average NMOG requirements shall be waived.

b. In 2000 and subsequent model years, small volume manufacturers shall not exceed a fleet average NMOG value of 0.075 g/mi for PCs and LDTs from 0-3750 lbs. LVW calculated in accordance with note (4).

c. In 2000 and subsequent model years, small volume manufacturers shall not exceed a fleet average NMOG value of 0.100 g/mi for LDTs from 3751-5750 lbs. LVW calculated in accordance with note (5).

d. If a manufacturer's average California sales exceeds 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall no longer be treated as a small volume manufacturer and shall comply with the fleet average requirements applicable for larger manufacturers as specified in Section 3.h. of these test procedures beginning with the fourth model year after the last of the three consecutive model years.

e. If a manufacturer's average California sales falls below 3000 units of new PCs, LDTs, and MDVs based on the average number of vehicles sold for any three consecutive model years, the manufacturer shall be treated as a small volume manufacturer and shall be subject to requirements for small volume manufacturers as specified in Section 3.h. of these test procedures beginning with the next model year.

(7) **Calculation of NMOG Credits/Debits and Procedure for Offsetting Debits**.

a. In 1992 and subsequent model years, manufacturers that achieve fleet average NMOG values lower than the fleet average NMOG requirement for the corresponding model year shall receive credits in units of g/mi NMOG determined as:

[(Fleet Average NMOG Requirement) - (Manufacturer's Fleet Average NMOG Value)] x (Total No. of Vehicles Produced and Delivered for Sale in California, Including ZEVs, EZEVs and HEVs).

Manufacturers with 1994 and subsequent model year fleet average NMOG values greater than the fleet average requirement for the corresponding model year shall receive debits in units of g/mi NMOG equal to the amount of negative credits determined by the aforementioned equation. For any given model year, the total g/mi NMOG credits or debits earned for PCs and LDTs 0-3750 lbs. LVW and for LDTs 3751-5750 lbs. LVW shall be summed together. The resulting amount shall constitute the g/mi NMOG credits or debits accrued by the manufacturer for the model year.

b. For the 1994 through 1997 model years, manufacturers shall equalize emission debits within three model years and prior to the end of the 1998 model year by earning g/mi NMOG emission credits in an amount equal to their g/mi NMOG debits, or by submitting a commensurate amount of g/mi NMOG credits to the Executive Officer that were earned previously or acquired from another manufacturer. For 1998 and subsequent model years, manufacturers shall equalize emission debits by the end of the following model year. If emission debits are not equalized within the specified time period, the manufacturer shall be subject to the Health and Safety Code section 43211 civil penalty applicable to a manufacturer which sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the emission debits are not equalized by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's emission standards shall be determined by dividing the total amount of g/mi NMOG emission debits for the model year by the g/mi NMOG fleet average requirement for PCs and LDTs 0-3750 lbs. LVW applicable for the model year in which the debits were first incurred.

c. The g/mi NMOG emission credits earned in any given model year shall retain full value through the subsequent model year. The g/mi NMOG value of any credits not used to equalize the previous model-year's debit, shall be discounted by 50% at the beginning of second model year after being earned, discounted to 25% of its original value if not used by the beginning of the third model year after being earned, and will have no value if not used by the beginning of the fourth model year after being earned.

d. In order to verify the status of a manufacturer's compliance with the fleet average requirements for a given model year, and in order to confirm the accrual of NMOG credits or debits, each manufacturer shall submit an annual report to the

Executive Officer which sets forth the production data used to establish compliance by no later than March 1 of the calendar year following the close of the model year.

(8) **Credits for Pre-1994 Model Year Vehicles**. Manufacturers that produce and deliver for sale in California vehicles certified to the phase-in exhaust emission standards in Section 3.e. of these test procedures or vehicles certified to the exhaust emission standards in Sections 3.f. or 3.g. of these test procedures and/or ZEVs in the 1992 and 1993 model years, shall receive emission credits as determined by the equations in notes (4), (5), and (7).

a. For PCs and LDTs from 0-3750 lbs. LVW, the fleet average NMOG requirement for calculating a manufacturer's emission credits shall be 0.390 and 0.334 g/mi NMOG for vehicles certified in the 1992 and 1993 model years, respectively.

b. For LDTs from 3751-5750 lbs. LVW, the fleet average NMOG requirement for calculating a manufacturer's emission credits shall be 0.500 and 0.428 g/mi NMOG for vehicles certified in the 1992 and 1993 model years, respectively.

c. Emission credits earned prior to the 1994 model year shall be considered as earned in the 1994 model year and discounted in accordance with the schedule specified in note (7).

(9) **ZEV Requirements**. While meeting the fleet average requirements, each manufacturer shall certify, produce, and deliver for sale in California at least 10% ZEVs in 2003 and subsequent model years. These percentages shall be applied to the manufacturer's total production of PCs and LDTs 0-3750 lbs. LVW delivered for sale in California.

a. **Calculation of ZEV Credits**. Manufacturers which produce for sale in California more ZEVs than required in a given model year shall earn ZEV credits, which shall be expressed in units of g/mi NMOG. The amount of ZEV credits earned shall be equal to the number of ZEVs required to be produced and delivered for sale in California for the model year subtracted from the number of ZEVs and EZEVs produced and delivered for sale in the model year and then multiplied by the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for that model year.

In calculating the number of ZEV credits under this note (9)a, each ZEV produced and delivered for sale prior to the 2003 model year may be counted as follows:

1. ZEV Credits based on vehicle range:

Number of ZEVs	Vehicle Range (miles)		
	Model Years 1996 and 1997	Model Years 1998 and 1999	Model Years 2000, 2001 and 2002
2	any	$\geq$ 100	$\geq$ 140
3	$\geq$70	$\geq$ 130	$\geq$ 175

Range shall be determined in accordance with section 9.f.(2)(a) of these procedures.

2. ZEV Credits based on the specific energy of the battery:

Number of ZEVs	Specific Energy of Battery (w-hr/kg)		
	Model Years 1996, 1997 and 1998	Model Years 1999 and 2000	Model Years 2001 and 2002
2	any	≥ 50	≥ 60
3	≥40	≥ 60	≥ 90

For model years 1999 through 2002, additional ZEV credits will be determined by linear interpolation between the values shown in the above schedule. Battery specific energy shall be determined in accordance with section 9.g. of these procedures.

3. For purposes of calculating ZEV credits, a ZEV may be counted according to note (9)a.1. or (9)a.2. above, but not both.

4. For purposes of calculating manufacturer's fleet average NMOG value under note (4) or (5), each ZEV shall be counted as one vehicle.

All ZEV credits earned prior to the 2003 model year shall be treated as if earned in the 2003 model year and shall be discounted in accordance with note (7)c.

b. **Submittal of ZEV Credits**. A manufacturer may meet the ZEV requirements in any given model year by submitting to the Executive Officer a commensurate amount of ZEV credits. These credits may be earned previously by the manufacturer or acquired from another manufacturer. The amount of ZEV credits required to be submitted shall be calculated by subtracting the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year from the number of ZEVs required to be produced by the manufacturer for the model year and then multiplying by the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for that model year.

c. **Requirement to Make Up a ZEV Deficit**. Manufacturers which certify, produce, and deliver for sale in California fewer ZEVs than required in a given model year shall make up the deficit by the end of the next model year by submitting to the Executive Officer a commensurate amount of ZEV credits. The amount of ZEV credits required to be submitted shall be calculated by subtracting the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year from the number of ZEVs required to be produced by the manufacturer for the model year and then multiplying by the fleet average requirements for PCs and LDTs 0-3750 lbs. LVW for the model year in which the deficit is incurred.

d. **Penalty for Failure to Meet ZEV Requirements**. Any manufacturer which fails to produce and deliver for sale in California the required number of ZEVs or submit an appropriate amount of ZEV credits and does not make up ZEV deficits within the specified time period shall be subject to the Health and Safety Code section 43211 civil penalty applicable to a manufacturer which sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the ZEV deficits are not balanced by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's standards shall be calculated according to the following equation:

(No. of ZEVs required to be produced and delivered for sale in California for the model year) - (No of ZEVs actually produced and delivered for sale in California for the model year) - [(Amount of ZEV credits submitted for the model year) / (the fleet average requirement for PCs and LDTs 0-3750 lbs. LVW for the model year)].

e. **ZEV Credits for MDVs and LDTs 3751-5750 lbs. LVW**. ZEVs and EZEVs classified as MDVs or as LDTs 3751-5750 lbs. LVW may be counted toward the ZEV requirement for PCs and LDTs 0-3750 lbs. LVW and included in the calculation of ZEV credits as specified in note (9)a., if the manufacturer so designates.

f. Small volume manufacturers as defined in note (6) shall not be required to meet the percentage ZEV requirements. However, small volume manufacturers may earn and market credits for ZEVs they produce and deliver for sale in California.

i. [No Change]

j. [No Change]

k. The cold temperature exhaust carbon monoxide emission levels from new 1996 and subsequent model-year passenger cars, light-duty trucks, and medium-duty vehicles shall not exceed:

1996 AND SUBSEQUENT MODEL-YEAR COLD TEMPERATURE CARBON MONOXIDE EXHAUST EMISSIONS STANDARDS FOR PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES[1,2]

(grams per mile)

Vehicle Type	Loaded Vehicle Weight (lbs.)	Durability Vehicle Basis (mi)	Carbon Monoxide
Passenger Car	All	50,000	10.0
Light-Duty Truck	0-3750	50,000	10.0
Light-Duty Truck	3751-5750	50,000	12.5
Medium-Duty Vehicle	0-3750	50,000	10.0
Medium-Duty Vehicle	3751-8500[3]	50,000	12.5

(1) These standards are applicable to vehicles tested in accordance with 40 CFR Part 86 Subpart C, at a nominal temperature of 20^{o}F (-7^{o}C).

(2) Natural gas vehicles, diesel-fueled vehicles, hybrid electric vehicles, and zero-emission vehicles are exempt from these standards. <u>EZEVs must demonstrate compliance with these standards.</u>

(3) Medium-duty vehicles with a gross vehicle weight rating greater than 8,500 lbs. are exempt from this standard.

4. Initial Requirements

5. Maintenance Requirements

6. Demonstrating Compliance

7. Small-Volume Manufacturer's Certification Procedures

8. Alternative Procedures for Notification of Additions and Changes

9. Test Requirements

10. Optional 100,000 Mile Certification Procedure

11. Additional Requirements

a. - j. [No Change]

k. **50ºF Emission Test Requirement**. Following a 12 to 36 hour cold soak at a nominal temperature of 50º F, emissions of CO and NOx measured on the Federal Test Procedure (40 CFR Part 86), conducted at a nominal test temperature of 50º F, shall not exceed the standards for vehicles of the same emission category and vehicle type subject to a cold soak and emission test at 68 to 86º F. For all TLEVs, emissions of NMOG and formaldehyde at 50º F shall not exceed the 50,000 mile certification standard multiplied by a factor of 2.00. For all LEVs, emissions of NMOG and formaldehyde at 50º F shall not exceed the 50,000 mile certification standard multiplied by a factor of 2.00. For all ULEVs, emissions of NMOG and formaldehyde at 50º F shall not exceed the 50,000 mile certification standard multiplied by a factor of 2.00. <u>For EZEVs, emissions of NMOG at 50º F shall not exceed the NMOG certification standard.</u> Emissions of NMOG shall be multiplied by a reactivity adjustment factor, if any, prior to comparing with the 50,000 certification standard multiplied by the specified factor.

The test vehicles shall not be subject to a diurnal heat build prior to the cold start exhaust test or evaporative emission testing.

i. For the 50º F emission test, the nominal preconditioning, soak, and test temperatures shall be maintained within 3º F of the nominal temperature on an average basis and within 5º F of the nominal temperature on a continuous basis. The temperature shall be sampled at least once every 15 seconds during the preconditioning and test periods and at least once each 5 minutes during the soak period. A continuous strip chart recording of the temperature with these minimum time resolutions is an acceptable alternative to employing a data acquisition system.

ii. The test site temperature shall be measured at the inlet of the vehicle cooling fan used for testing.

iii. The test vehicle may be fueled before the preconditioning procedure in a fueling area maintained within a temperature range of 68 to 86^{o} F. The preconditioning shall be conducted at a nominal temperature of 50^{o} F. The requirement to saturate the evaporative control canister(s) shall not apply.

iv. If a soak area remote from the test site is used, the vehicle may pass through an area maintained within a temperature range of 68 to 86^{o} F during a time interval not to exceed 10 minutes. In such cases, the vehicle shall be restabilized to 50^{o} F by soaking the vehicle in the nominal 50^{0} F test area for six times as long as the exposure time to the higher temperature area, prior to starting the emission test.

v. The vehicle shall be approximately level during all phases of the test sequence to prevent abnormal fuel distribution.

Manufacturers shall demonstrate compliance with this requirement each year by testing at least three PC or LDT and three MDV emission data and/or engineering development vehicles (with at least 4000 miles) which are representative of the array of technologies available in that model year. Only TLEVs, LEVs~~, and~~ ULEVs, and EZEVs, are to be considered for testing at 50^{o} F. It is not necessary to apply deterioration factors (DFs) to the 50^{o} F test results to comply with this requirement. Testing at 50^{o} F shall not be required for fuel-flexible and dual-fuel vehicles when operating on gasoline. Natural gas, hybrid electric and diesel-fueled vehicles shall also be exempt from 50^{o} F testing.

The following schedule outlines the parameters to be considered for vehicle selection:

1. Fuel control system (e.g., multiport fuel injection, throttle body electronic fuel injection, sequential multiport electronic fuel injection, etc.)
2. Catalyst system (e.g., electrically heated catalyst, close-coupled catalyst, underfloor catalyst, etc.)
3. Control system type (e.g., mass-air flow, speed density, etc.)
4. Vehicle category (e.g., TLEV, LEV, ULEV, EZEV)
5. Fuel type (e.g., gasoline, methanol, etc.)

The same engine family shall not be selected in the succeeding two years unless the manufacturer produces fewer than three engine families. If the manufacturer produces more than three TLEV, LEV~~, or~~ ULEV, or EZEV engine families per model year, the Executive Officer may request 50^{o} F testing of specific engine families. If the manufacturer provides a list of the TLEV, LEV, ~~and~~ ULEV, and EZEV engine families that it will certify for a model year and provides a description of the technologies used on each engine family (including the information in items 1 through 5 of the vehicle selection parameters listed above), the Executive Officer shall select the engine families subject to 50^{o} F testing within a 30 day period after receiving such a list and description. The Executive Officer may revise the engine families selected after the 30 day period if the information provided by the manufacturer does not accurately reflect the engine families actually certified by the manufacturer.

l. **Emission Control System Continuity at Low Temperature**. For each engine family certified to TLEV, LEV, ULEV, ~~or~~ SULEV, <u>or EZEV</u> standards, manufacturers shall submit with the certification application, an engineering evaluation demonstrating that a discontinuity in emissions of non-methane organic gases, carbon monoxide, oxides of nitrogen and formaldehyde measured on the Federal Test Procedure (40 CFR Part 86) does not occur in the temperature range of 20 to 86° F. For diesel vehicles, the engineering evaluation shall also include particulate emissions.

12. Identification of New Clean Fuels to be Used in Certification Testing

[No Change]

13. Reactivity Adjustment Factors

[No Change]

14. Cold Temperature Test Procedure

a. General Applicability

In paragraph 86.201-94:

1. Amend subparagraph (a) to read:

(a) This subpart describes procedures for determining the cold temperature carbon monoxide (CO) emissions from 1996 and later model year new passenger cars, light-duty trucks, and medium-duty vehicles (excluding natural gas vehicles, diesel-fueled vehicles, hybrid electric vehicles, and zero-emission vehicles). <u>Vehicles that certify to EZEV standards must demonstrate compliance with these requirements.</u>

b. Equipment Required; Overview

In paragraph 86.206.94:

1. Amend subparagraph (a) to read:

(a) This subpart contains procedures for exhaust emission tests on passenger cars, light-duty trucks, and medium-duty vehicles (excluding natural gas vehicles, diesel-fueled vehicles, hybrid electric vehicles, and zero-emission vehicles.) <u>Vehicles that certify to EZEV standards must demonstrate compliance with these requirements.</u> Equipment required and specifications are as follows:

2. Amend subparagraph (a)(1) to read:

(a)(1) Exhaust emission tests. Exhaust from vehicles (excluding natural gas vehicles, diesel-fueled vehicles, hybrid electric vehicles, and zero-emission vehicles) is tested for gaseous emissions using the Constant Volume Sampler (CVS) concept (Section 86.209). Vehicles that certify to EZEV standards must demonstrate compliance with these requirements. Equipment necessary and specifications appear in 40 CFR Part 86, Section 86.208 through 86.214.

3. Amend subparagraph (a)(2) to read:

(a)(2) Fuel, analytical gas, and driving schedule specifications. Fuel specifications for exhaust emission testing for gasoline-fueled vehicles are specified in 40 CFR Part 86, Section 86.213. Fuel specifications for exhaust emission testing for alcohol-fueled vehicles and liquified petroleum gas vehicles are specified in Section 9.a. of these Test Procedures. Analytical gases are specified in 40 CFR Part 86, Section 86.214. The EPA Urban Dynamometer Driving Schedule (UDDS) for use in emission tests is specified in 40 CFR Part 86, Section 86.215 and Appendix I.

APPENDIX I through VIII

[No Change]