CONCEPT PAPER

SUMMARY OF STAFF'S PROPOSED AMENDMENTS TO THE ZERO EMISSION VEHICLE (ZEV) PROGRAM

November 2007

I. INTRODUCTION

In July 2007, Air Resources Board (ARB or Board) staff released a concept paper providing possible options for amending the Zero Emission Vehicle or ZEV Program. Staff presented these options to interested parties during a public workshop on July 24, 2007. After extensive consideration of the comments received, both from the workshop and from dozens of subsequent meetings with stakeholders, staff is now prepared to share more refined proposals as a starting point for further discussions with interested stakeholders and in preparation of the Initial Statement of Reasons and proposed amendments for the ZEV regulation.

We have listed below the original objectives of the ZEV Program, as outlined in the first concept paper and have added a new objective: to simplify the structure of the program:

- Maintain the pure ZEV requirement to achieve our long term public health goals,
- Maintain requirements that accelerate ZEV technology development and deployment,
- Take full advantage of technology options that are available today to achieve air quality improvement and provide a bridge to ZEV commercialization, and
- Provide automakers flexibility in meeting the ZEV Program requirements with a variety of ZEV technologies and fuels.

II. THE PROPOSED ZEV AMENDMENTS

A. ZEV Requirement (Alternative Path)

The Alternative Path (or Alt Path) was incorporated in the 2003 regulatory amendments to establish a path towards increased production of ZEVs. Automakers taking the Alt Path are required to produce their market share of a target number of vehicles during four multi-year implementation phases. Table I below shows the target number of ZEVs for each Phase of the Alternative Path.

Table I: Existing Alt Path Requirement

Phase	I	II	III	IV
Years	2005-2008	2009-2011	2012-2014	2015-2017
Total*	250	2,500	25,000	50,000

* Each automaker is required to produce their sales-weighted share of this total number of vehicles.

The July concept paper presented three options for amending the Alt Path: no change to the original program requirements, a combined Phase II and Phase III requirement, and staff's proposal to maintain the current Phase II requirement and repeat it in Phase III. Further investigation and consideration of stakeholder comments has prompted staff to propose the following:

Phase II (2009 through 2011) – Maintain the 2,500 Alternative Path target for the number of ZEVs to be produced in the phase. Staff believes that automakers can meet the Phase II requirements or chose to comply using the Base Path and using banked credits.

Phase III and beyond (2012 onward) – Maintain the 25,000 vehicle Alternative Path production target for Phase III, and establish a floor of 10 percent of those vehicles, which must be hydrogen fuel cell or battery electric ZEVs while allowing the remainder of the target to be met with a new category of "silver +" vehicles. For Phase IV, the floor would be set at 50 percent of the target of 50,000 ZEVs, and silver + vehicles would be allowed to fulfill the remaining 50 percent of the target. Silver + vehicles are defined as high scoring (greater than one credit per vehicle) AT PZEVs that utilize fuel that can be used in a ZEV. Examples are plug-in hybrid electric vehicles (PHEV) and hydrogen internal combustion engine vehicles.

Staff is suggesting the above described gold and silver+ approach for a number of reasons. Firstly, this is the timeframe where the greatest discrepancy existed between the regulation requirements and the technology readiness as described by the ZEV Expert Panel. As the Board requested, however, if the regulatory numbers are to be adjusted downward, then some form of backfill and a showing of continued progress is needed. For this reason, staff is suggesting the creation of the new silver+ category. These vehicle types are an even more significant technology bridge to ZEVs than conventional AT PZEVs. The requirement that they make use of a ZEV fuel significantly shifts the user towards the ultimate goal of electric drive using either batteries recharged from the grid or hydrogen. This is not an easy offset option for automakers. For most automakers it means an entirely new product that has not yet been demonstrated. In this sense, the silver+ option is highly technology forcing and at the same time incrementally more valuable as a bridge to pure ZEVs than silver vehicles.

"New Path" – A second component of the recommended amendments is to combine the Alternative and Base Paths into a "New Path" for Phase III and beyond that maintains the vehicle numbers. Staff is making this proposal to simplify the regulation, which most stakeholders, including staff and Board Members, are saying has become too complicated. The New Path would return the compliance calculation to an annual percentage requirement for ZEVs with options to comply with percentages of PZEVs, AT PZEVs and a new AT PZEV plus or "silver+" category. Table II below illustrates the New Path percentages. The vehicles per year are calculated by multiplying the total California sales (assumed to be 1.4 million) by the percentage requirement and then dividing that (number of credits needed to fulfill the obligation) by the credit per vehicle.

Table II: Proposed New Path Requirement by Vehicle Category

"NEW PATH"						
Years	2012 – 2014 (12 % Total Requirement)			2015 – 2017 (14 % Total Requirement)		
	Percent	Vehicles Per Year*	Vehicles over period*	Percent	Vehicles Per Year*	Vehicles over period*
Gold	0.18 – 1.79%	840 – 8,353	2,520 – 25,060	1.79 – 3.57%	16,660 – 8,333	25,000 – 50,000
Silver+	0 – 1.61%	Up to 15,000	Up to 45,000	1.78%	Up to 16,600	Up to 50,000
Silver	4.21%	91,000	272,000	4.43%	112,800	338,300
Bronze	6.0%	420,000	1,260,000	6.0%	420,000	1,260,000

* Assumes gold vehicles earning 3 credits, silver+ vehicles earning 1.5 credits, silver vehicles earning 0.65 credits 2012 to 2014 and 0.55 credits 2015 to 2017, with an assumed total California vehicle sales of 1.4 million per year.

The intent of this proposal is to achieve the same outcome from the regulation while simplifying the regulatory structure, returning the program to a more easily described and understood regulation. It results in more easily calculated vehicle numbers, more certainty and transparency about how many vehicles will be produced over the course of years and what impacts the program will have on commercialization and air quality improvement efforts.

ZEV Credits (Carry forward) – Staff also proposes to modify how credits are handled as part of the New Path concept. The ZEV regulation has always allowed banking and trading of credits earned from early or over compliance with the regulation. Because of the lag between early demonstrations and implementation of the regulation, automakers amassed healthy credit accounts with early compliance actions. This has caused problems and further delays in the implementation of the program because of uncertainty about what actions an automaker will take to comply with the requirements given the options available with credits. Therefore, staff is proposing to change how historical banked credits can be used. Starting with credits earned in the 2009 model year and then applying to all pre existing banked gold credits in 2012, credits would only be allowed to be carried forward for three years for application to the gold requirement. Uses of any banked credits for other categories (silver+, silver, bronze) would be unchanged. This change to the use of banked gold credits should alleviate the issue of long black out periods while allowing automakers to build up reserves to choose production demonstration phases that fit their product planning cycles.

Carry Back Provision – The ZEV regulation already includes a one year carry back provision for gold category vehicles, meaning that if an automaker fails to meet their obligation in one year, they may make up their obligation in the next year, after fulfilling that year's compliance obligation. Staff proposes to change the carry back provision to 3 years, meaning that an automaker may fulfill their obligation for year one and/or two after meeting their year three compliance obligation. Like the carry forward provision described above, this provides flexibility to automakers to match their production

development schedules with technology demonstration phases. The stretch from one to three years coincides with the three year windows originally established in the Alternative Path. This carry back provision would apply to the gold category only. The regulation already allows for a 2-year carry back for silver and bronze vehicles and would also cover silver+ vehicles.

B. Use of Battery Electric Vehicles (BEV) after 2008

The current regulation limits how BEVs (Type I and II ZEVs traditionally) can be used to comply within the Alt Path. Table III below lays out the caps and ratios that accompany the use of BEVs within the Alt Path. Staff is proposing to remove the cap for Type II ZEVs and establish new ratios. Table IV provides the proposed numbers.

Table III: Existing Cap and Ratio on Type I & II Vehicles

Type	Cap (percent)	Ratio to Type III (2005-2011)	Ratio to Type III (2012-2017)
I	50	20:1	10:1
II	50	10:1	5:1

Table IV: Proposed Cap and Ratio on Type I & II Vehicles

Type	Cap (percent)	Ratio to Type III (2009-2011)	**2012 and beyond** New Path applies Established credits per vehicle apply to gold obligation
I	50	2:1	
II	0	1.33:1	

Significant progress has been made in battery technology and some automakers are preparing to reintroduce BEVs to the automotive market. The ARB can encourage automakers that chose to produce BEVs to market them in California by providing for even treatment of battery electric vehicles in the Alternative Path. Removal of the Type II cap and adjustment of the Type I and Type II ratios makes it easier for these automakers to attain their volume goals while reflecting the difference in utility between Type I & II vehicles and Type III vehicles. The proposed ratios are based on the credits earned under the current Base Path.

C. Hybrid Electric Vehicles (HEVs):

Staff is proposing several modifications to the hybrid electric vehicle (HEV) AT PZEV requirements, mostly to address plug in HEVs (PHEVs). They include addressing deployment of "blended" PHEVs through an equivalent all electric range credit allowance, adjusting the allowances for advanced components and PHEV low fuel-cycle emissions (LFCE), and phasing out Type C HEV credit.

Blended PHEVs – All Electric Range Allowance - When plug in hybrids were first contemplated by the ZEV regulation, it was envisioned that the vehicle would run off of the battery until it was depleted and then transition to operation on the engine. Since

then, the concept of a blended plug in hybrid has emerged. A blended PHEV is any configuration in which the engine turns on during range testing, but before the charge depletion of the battery is complete. An example is a vehicle where the engine turns on intermittently to accommodate accelerations, top speeds or peak power requirements, but still runs on energy from the battery when the engine is not needed for these requirements, until the battery is depleted to the point where the vehicle switches over to "charge sustaining" operation like a conventional non-plug in hybrid. Staff proposes to retain the same 10 mile minimum AER (now EAER) as in the existing regulation.

The credit allowance for the all electric range of PHEVs is currently calculated using the following equation:

$$\textbf{Allowance} = (33.8 + [0.5 * \text{AER}])/25),$$

where the AER (all electric range) is measured from a city driving cycle test and the test ends when the engine turns on.

Staff is proposing that the AER be replaced with an Equivalent AER or EAER that takes the miles driven by the PHEV in charge depleting mode and then adjusts those miles by the percentage of those miles operated electrically (Equivalent Electric Range Fraction or EERF). Staff further proposes that the EAER credit allowance be adjusted by a utility factor related to miles driven by consumers that normalizes the credit allowance to a maximum of the credit earned by a city electric vehicle. The proposed equations to govern calculation of the EAER credit allowance are:

$$\textbf{EAER} = R_{cd} * \text{EERF}$$

$$\textbf{Allowance}_{AER} = (\text{EAER}/ 50) * [(1-UF_{Rcd})/ (1-UF_{50})] * 1.45$$

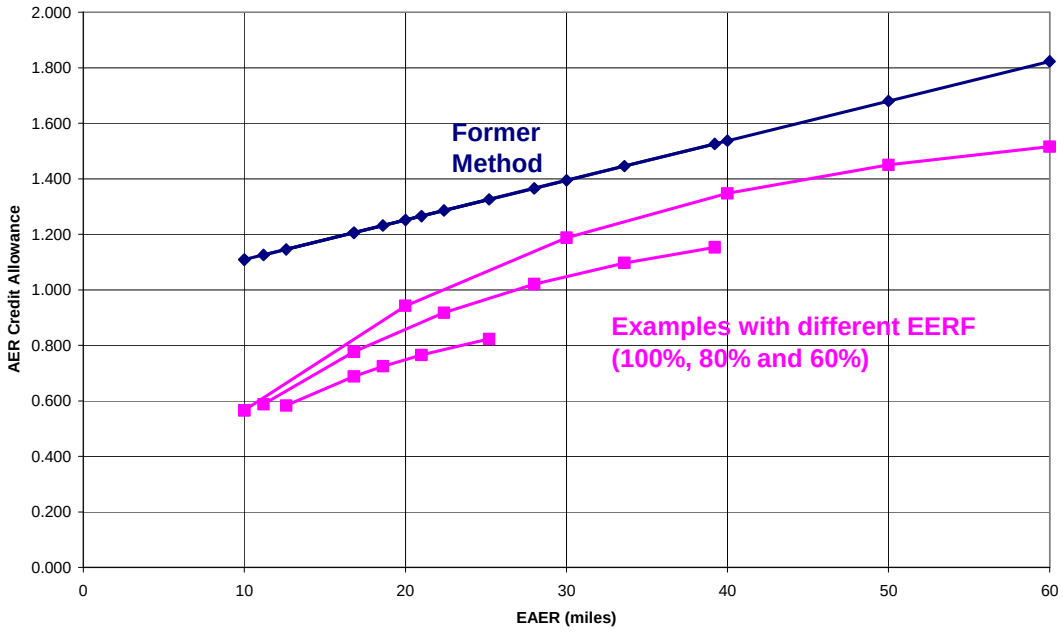
Where:

- R_{cd} is the range of the PHEV in Charge Depleting mode
- EERF is the Equivalent Electric Range Fraction
- $[(1-UF_{Rcd})/ (1-UF_{50})]$ adjusts for the lower probability that the blended PHEV will be driven far enough to make use of it's stored electric energy and is from the *0-100 mile 4th order curve fit from SAE's J1711, March 1999, page 52* which plots the likelihood of a vehicle being used to travel a daily range in miles,
- (EAER/ 50) normalizes the range allowance to a 50 mile range, the same as the minimum range for a Type I or "City EV", and
- 1.45 is the assigned AER credit allowance because this is what a Type I ZEV would earn [2 credits – (0.2 PZEV base) – (0.35 Advanced Componentry allowance)] ≈ 1.45 AER allowance @ 50 miles.

This method results in the AER credit allowance (shown in blue as the "former method) compared to the EAER credit Allowance (shown in pink for three different example equivalent electric range fractions) as shown in figure I below:

Figure I

AER Credit Allowance VS EAER



Advanced Componentry Allowance – Staff proposes to implement a phase-down schedule and extend the allowance sunset for Type C HEVs. Staff also proposes to add a new, higher-power Type F HEV category that would meet a peak power requirement of 100 kW, or alternatively, when installed on AER-type PHEVs, would demonstrate sufficient power capability to propel an HEV through the entire UDDS driving test cycle on electric power alone. The Type C modification is recommended in response to comments that post-2011 hybrids with significant (>10 kW) power capability can still make an important contribution to technology development and electric componentry commercialization and cost reduction even if designed at lower-voltage levels that might not be suitable for full-function ZEVs. This is true because Type C HEVs must also make use of advanced energy storage systems that are expected on full-function ZEVs. Staff believes that Type C HEVs may be well-suited for very high volume markets where tighter cost constraints may restrict other HEV technologies from being deployed. Staff recommends that credit for Type C hybrids be extended indefinitely, but at a reduced credit level relative to other HEV designs. The Type F HEV category is intended to encourage the deployment of HEV drive systems interchangeable with those deployed in full function ZEVs. In this way, design, development, tooling, and other costs will be shared with the systems destined for ZEVs in order to further drive down costs and deploy ZEVs sooner. The allowance schedule proposed is shown in Table V below:

Table V
Proposed HEV Componentry Allowance Schedule

Year	Type C (10 kW)	Type D (10 kW)	Type E (50 kW)	Type F (NEW) (100 kW)
2005-2011	0.2	0.4	0.5	0.85
2012-2014	0.15	0.35	0.45	0.8
2015+	0.1	0.25	0.35	0.7

PHEV Low Fuel-Cycle Emissions Allowance - Staff proposes to eliminate the low fuel-cycle emissions (LFCE) allowance for PHEVs and to increase the credit for AER PHEVs under the advanced componentry provision by at least 0.15 credits to recognize and compensate for the LFCE benefits of electric fuel. As a result, only dedicated LFCE-fueled vehicles will now be eligible for AT-PZEV LFCE allowance (examples include compressed natural gas and hydrogen, depending on its source). The proposed changes would result in PHEVs receiving overall pre-multiplier allowances as shown in the table VI below:

Table VI
PHEV Allowances

PHEV	Type	Rcd	EERF (%)	2011 Allowance	
				Existing	Proposed
B20	Blended PHEV	20	80	0.7	1.45
B30	Blended PHEV	30	80	0.7	1.65
B40	Blended PHEV	40	80	0.7	1.78
P20	AER	20	100	2	1.99
P40	AER	40	100	2.3	2.4
P60	AER	60	100	2.6	2.57

D. Neighborhood Electric Vehicles (NEVs):

Staff proposes to increase the credit for neighborhood electric vehicles to 0.30 credits per vehicle, reflecting the vehicle's positive benefits but limited functionality compared with full function battery electric or fuel cell electric vehicles. Staff is also considering a cap on NEV credit use to ensure that an automaker's Gold credit obligation cannot be met entirely with NEVs prior to 2011. And in the New Path proposal, NEVs would not be allowed to meet the floor gold percentage requirement, but could be used for the silver+, silver or bronze options. These changes are recommended because during the 2003 ZEV amendments, the ARB committed to reviewing the credit value for neighborhood electric vehicles (NEVs). NEVs are low speed vehicles; they have a maximum speed limit of 25 miles per hour (mph) and are only allowed to be driven on roads with a maximum speed limit of 35 mph. These limitations, combined with a

typical driving range of 30 miles per charge and a typical three-year battery durability limit NEV use to a niche market. However, NEVs have positive benefits including: reduced emissions from cold starts, zero tailpipe emissions, and high consumer usage for short trips. They also foster a future market demand for more robust ZEVs. In analyzing the credit value of NEVs, staff is mindful that higher credit values in the past encouraged mass production of low quality NEVs, many of which were only in California for only a short period of time.

E. Intermediate Volume Definition & Ramp Up to Large Volume

Staff is proposing to provide intermediate volume manufacturers (IVMs) six additional years to ramp up vehicle technologies and volumes to large volume manufacturer (LVM) levels. In the first three years of that ramp up phase, new LVMs would have the option to meet the ZEV requirements with PZEVs, of which at least a quarter would have to be AT PZEVs. In the second three years of the ramp up phase, new LVMs would continue to meet the ZEV regulation requirements with PZEVs, of which at least a third would have to be AT PZEVs. And any of their obligation *can* be met with silver+ or gold vehicles. In addition, the NMOG fleet average emissions for the automaker's vehicle fleet could not exceed 0.030 grams per mile during the six year transition phase. Table VII below highlights the proposed requirements.

Table VII: Intermediate Volume Manufacturer Requirements

	Current Regulation Allows		**Proposed Amendment to Allow**		
Years	**3 years of volume in excess of 60,000**	**1-6 Lead Time**	**7-9 AT PZEV Transition 1**	**10-12 AT PZEV Transition 2**	**13 and beyond Full ZEV Requirement**
Status	**IVM**	**LVM**	**LVM**	**LVM**	**LVM**
PZEVs	100 % of ZEV Obligation	100% of ZEV Obligation	75% of ZEV Obligation	67% of ZEV Obligation	Full LVM Obligations as dictated by regulation
AT PZEVs	N/A	N/A	25% of ZEV Obligation	33% of ZEV Obligation	

This new ramp up period is recommended as a way to bridge IVMs into ZEV production and provide additional time to develop full ZEV technologies while bringing them into the AT PZEV market with ZEV enabling technologies.

Staff is also considering a suggestion to redefine IVMs as automakers with sales equal to less than five percent of the total California market. This change would ensure that as the total California sales market changes, IVMs' relative position among automakers would be reflected appropriately.

F. Section 177 Travel Provision

The Travel Provision was incorporated into the ZEV regulation in recognition of the technology development nature of the requirements. It allows ZEVs placed in any state with the ZEV regulation to count in California. The principle underlying this provision is the need to push production of pre-commercial technologies through appropriate demonstration and market ramp up periods. Since these conditions (pre-commercial, technology development) are expected to continue for some technologies through a number of years of implementation, staff is proposing to extend the travel provision for Type I, Type II, and Type III Gold vehicles as described in Table VIII below. Staff is also proposing to make Silver+ vehicles eligible for the travel provision for the very short term. Table VIII lists the existing and proposed schedule for sun-setting the Travel Provision.

Table VIII: Travel Provision Sunset Schedule

Vehicle Type	Silver+	Type I	Type II	Type III
Current:	N/A	N/A	N/A	2011
Extended to:	2011	2014	2014	2017

Ten section 177 states have currently adopted the ZEV regulations and seven states are considering adoption. Thus, the number of ZEVs required across the country more than doubles and is likely to determine the ability of automakers to bring these vehicles to market in the near term.

III. Wrap Up and Next Steps

We encourage stakeholders to meet with us between now and November 28, 2007 to further discuss these proposed amendments. Stakeholders may also provide comments on these topics in writing.

Next Steps:

Deadline for written comments	November 28, 2007
Public release of the Staff Report	January 11, 2008
Board Hearing (Sacramento)	February 28-29, 2008