State of California
AIR RESOURCES BOARD

PRELIMINARY DISCUSSION PAPER – AMENDMENTS TO CALIFORNIA'S LOW-EMISSION VEHICLE REGULATIONS FOR CRITERIA POLLUTANTS – LEV III

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1. Introduction

Despite great progress in achieving cleaner air in California, major reductions of criteria pollutant emissions are still required to achieve mandated State and federal ambient air quality standards. The majority of California residents live in areas that do not meet permissible air quality levels for regulated air pollutants. Most of these areas of “non-attainment” in California are due to exceedances in atmospheric concentrations of ozone and particulate matter. Figure 1 shows the air basins within California that are in non-attainment due to their atmospheric ozone concentration exceedances. High atmospheric ozone levels in California are predominantly caused by emissions of oxides of nitrogen (NO_x), reactive organic gases (ROG), and carbon monoxide (CO) from both mobile and stationary sources. Light-duty passenger cars and trucks are responsible for a major fraction of these ozone forming emissions: NO_x (15% of California emissions), CO (42%), and ROG (21%). In addition, light-duty vehicles are responsible for lesser portions of California’s overall particulate matter (PM) emissions (2% of PM_{10} and 3% of $PM_{2.5}$).[i]

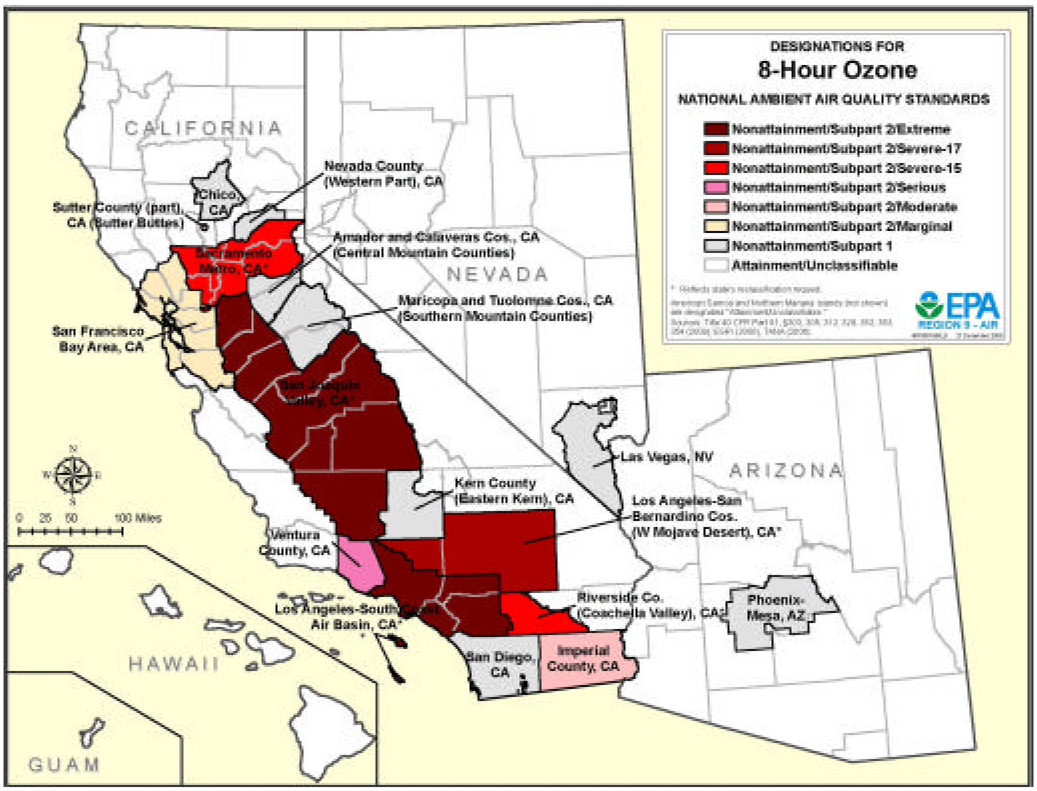

Figure 1. Air quality status for ozone in California air basins[ii]

This report is meant as a summary of major elements of the LEV III standards that are currently under development by ARB staff. The main objective of this report is to provide a brief update on the current status of staff’s work toward developing the technical base for those standards in advance of a public technical workshop in March where there will be an opportunity for stakeholder input.

[i] California Air Resources Board’s *The California Almanac of Emissions and Air Quality - 2009 Edition*

[ii] From U.S. Environmental Protection Agency *http://www.epa.gov/region09/air/maps/images/AIR0901668_9Lg.jpg*

Finally, staff notes that all of the issues discussed in this report are preliminary and are meant to provoke input from all stakeholders before, during, and after the March workshop. In addition to participating in the dialogue at the public workshop, industry groups and environmental stakeholders are invited to discuss the proposed regulatory provisions in private meetings with staff to protect confidential information.

2. Proposed Modifications to Vehicle Criteria Pollutant Exhaust Emission Standards

The proposed modifications discussed in this section are a major part of California's continuing effort to bring California's air quality into compliance with state and federal ambient air quality standards. This new round of more stringent emission standards will be an extension of past vehicle programs, where the automotive industry has achieved very low emission levels from new vehicles in order to meet California's Low-Emission Vehicle program. From the original Low-Emission Vehicle (LEV I) program, introduced in 1990, to the LEV II program that currently regulates new vehicles, the California program has been successful by setting cost-effective, technically feasible standards with long-term goals that provide certainty to the industry. This proposal for new criteria pollutant emission standards in California continues this tradition of applying advanced state-of-the-art emission control technology to regulatory standards for future model years in the interest of protecting public health. This Section provides a brief background of the current LEV II program before summarizing several elements of the proposed LEV III program.

2.1. Background

The existing LEV II program regulates emissions from new light-duty vehicles for sale in California. Vehicle categories covered under the program include all passenger cars, light trucks, and medium-duty passenger vehicles.[iii] The current set of standards includes the emission category designations of Low-Emission Vehicle (LEV), Ultra Low-Emission Vehicle (ULEV), and Super Ultra Low-Emission Vehicle (SULEV). Table 1 summarizes the emission standards for each of these categories. Each certification level has its own permissible emission levels for non-methane organic gases (NMOG), oxides of nitrogen (NO_x), formaldehyde (HCHO), carbon monoxide (CO), and particulate matter (PM). Different emission standards are established for intermediate full useful life (50,000-miles) and full useful life (120,000-miles) durability. Within the cleanest emission standard for vehicles, SULEV, a vehicle that incorporates more effective evaporative controls and a 15 year/150,000-mile emission warranty qualifies as a partial zero-emission vehicle (PZEV), a designation that offers credits within California's Zero Emission Vehicle (ZEV) program.

In addition, NMOG emissions are regulated in a system that allows emissions averaging, trading, and banking to offer additional compliance flexibility for

[iii] The four categories are passenger car ("PC"), light duty trucks at or below 3750 lbs loaded vehicle weight ("LDT1"), light duty trucks with loaded test weights above 3750 lbs and gross vehicle weight (GVW) below 8500 lbs ("LDT2"), and medium-duty passenger vehicles with GVW between 8,500 and 10,000 lbs ("MDPV")

manufacturers. For NMOG emissions, vehicle test groups are certified to 50,000-mile vehicle intermediate useful life as LEV (0.075 g/mi), ULEV (0.040 g/mi), or SULEV (0.010 g/mi), and the sales-weighted average of these emission levels for each manufacturer determines compliance to a fleet average requirement (and emission credits/debits) for each given model year. The target NMOG standard for model year 2008 is 0.040 g NMOG/mile for PC/LDT1 and 0.050 g NMOG/mile for LDT2 and MDPVs. Therefore, average new vehicles in 2008 are approximately regulated at ULEV NMOG levels.

Table 1. LEVII criteria pollutant emission standards (PC/LDT1 and LDT2)

Vehicle emission category	Durability basis (miles)	NMOG (g/mi)	NO_x (g/mi)	CO (g/mi)	HCHO (g/mi)	PM (g/mi)
LEV	50,000	0.075	0.05	3.4	0.015	-
	120,000	0.090	0.07	4.2	0.018	0.01
ULEV	50,000	0.040	0.05	1.7	0.008	-
	120,000	0.055	0.07	2.1	0.011	0.01
SULEV	120,000	0.010	0.02	1.0	0.004	0.01
PZEV [a]	150,000	0.010	0.02	1.0	0.004	0.01

[a] *PZEV has same test emission levels as SULEV but also includes additional evaporative emissions control and a 150,000-mile warranty*

Regarding the national regulatory context, emission standards of approximately the same stringency as LEVII standards have been implemented federally under the U.S. Environmental Protection Agency's Tier 2 emissions program for the national fleet. The federal Tier 2 program has been in the process of phasing in its standards since model year 2004, with 2010 as the final model year of the phase-in period. The federal and California regulatory programs are very similar in structure, although with a number differences regarding overall fleet emission stringency, durability, and categorization of vehicles. For example, one difference in the existing systems is that the federal approach uses eight certification "bins" (e.g., Tier 2 Bin 5 is similar to California's LEV, and Tier 2 Bin 2 is similar to SULEV) to allow averaging across greater emission-level diversification in the fleet. In addition, when fully implemented in 2010, the federal fleet average emission requirement is approximately half as stringent as LEV II (0.075 g/mi NMOG for U.S. Tier 2 vs. 0.035 g/mi NMOG for PC/LDT1 and 0.043 g/mi NMOG for LDT2 for LEV II)

Based on model year 2008 NMOG certification data for vehicles sold in California, 22% of new vehicles are certified as LEV, 55% as ULEV, and 22% as SULEV. Figure 2 shows these data, including a breakdown by the three main vehicle classifications of PC/LDT1, LDT2, and MDV. Generally smaller vehicle models are more likely to be certified to lower emission levels like SULEV than larger vehicle models. For example, as shown, 32% of the PC/LDT1 category achieves SULEV emissions, whereas only 4% of LDT2 and 0% of MDV trucks meet this level of stringency. Of the SULEV-certified vehicles, the vast majority (i.e., 92%) are also PZEV-certified due to their more effective evaporative control systems and 15 year/150,000-mile emission warranty.

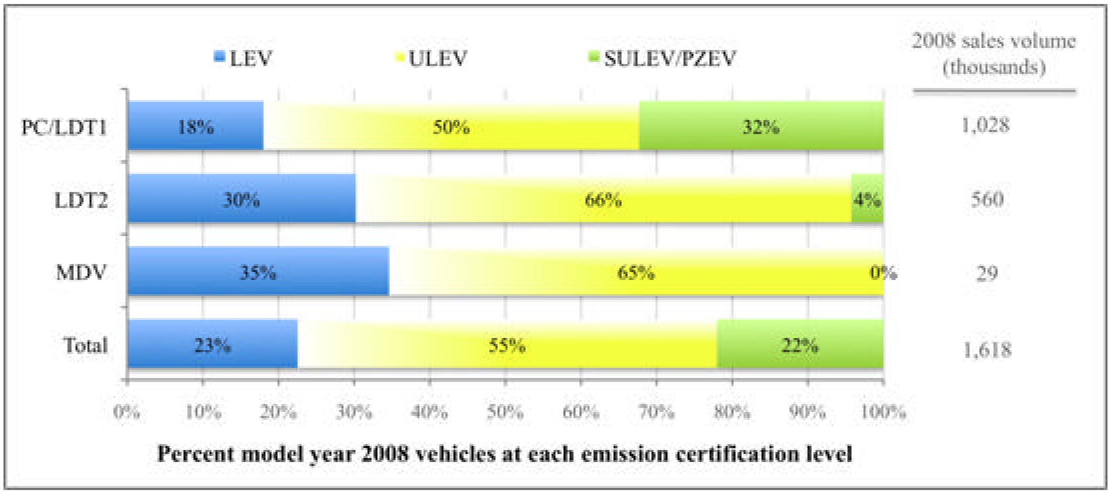

Figure 2. NMOG emission certification levels by vehicle category

2.2. Proposed LEV III Criteria Pollutant Standards

There are several major proposed modifications to the LEV program that are being developed by ARB staff for new LEV III regulations. The main elements of staff's preliminary proposal are summarized in this section. The primary objective of the proposed standards is to require fleet average SULEV-level emissions performance from new vehicles by model year 2022. Among the areas of proposed modifications are increased stringency and restructuring of the NMOG and NO_x standards, increased stringency for PM standards, increased durability requirements for emission control systems, expanded coverage of more restrictive evaporative control requirements, and new requirements for supplemental test procedure emission testing.

2.2.1. NMOG+NO_x standard

The existing LEV II program separately limits per vehicle NMOG and NO_x emissions and sets a fleet average NMOG requirement that decreases each year through 2010 for new vehicles sold in California. This proposal would modify these emission standards in several ways: combine NMOG and NO_x standards into one NMOG+NO_x standard, introduce a more stringent combined NMOG+NO_x fleet average requirement for 2014-2022 model years, add several emission standard bins, and increase the durability requirements for emission control systems.

As noted above, staff is proposing to combine the current separate emission standards for the two major ozone precursors of NMOG and NOx into one NMOG+NO_x standard. The primary logic for combining the two pollutants is to provide greater flexibility for manufacturers to reduce emissions with new emission control technologies. Noting that both pollutants are major contributors to ozone formation, a substantial health concern in California, staff considers both as high priorities for potential reductions. However, staff's technical research and industry input indicate that there are a number of technologies that are more effective in reducing one pollutant than the other, and vice versa. Combining the pollutants into one standard – and allowing averaging, trading, and banking that are currently only allowed for NMOG certification for a combined fleet average standard – would provide significant flexibility for the various industry strategies to substantially reduce those emissions.

Based on the sales share of the model year 2008 fleet (shown above in Figure 2) and the 120,000-mile full useful life emission standards that vehicles are certified to (shown above in Table 1), California vehicles today would have an equivalent NMOG+NO_x level of 0.112 g/mile. ARB staff is proposing that the fleet-wide target for LEV III emissions for model year 2022 be equivalent to the combined NMOG+NOx value of the existing SULEV emission standard. The existing SULEV emission levels are 0.020 g NMOG/mile and 0.01 g NO_x/mile, for a combined emission level of 0.030 g NMOG+NO_x/mile. Therefore, the proposed change from today's fleet average emissions to the fully phased-in fleet-wide SULEV emission level would result in a decrease in NMOG+NO_x emissions from 0.112 to 0.030 g/mi – a 73% reduction.

In order to provide a path for a gradual evolution toward new emission control technology, the existing regulatory system would be expanded from three emission categories (LEV, ULEV, and SULEV) to six emission categories that could be utilized by manufacturers for fleet emission averaging. Table 2 shows the staff proposal for increasing the number of categories, or "bins," that could be utilized for fleet averaging for compliance with the new NMOG+NO_x fleet average requirements. LEV III would add two new categories, ULEV50 and ULEV70, that are between the existing ULEV and SULEV categories and one new sub-SULEV category, SULEV20, that would be the new lowest vehicle emission category. Staff believes that this proposal provides more planning flexibility without compromising the required emission reductions from the overall program.

Table 2. Proposed LEV III NMOG+NOx Emission Standards

Vehicle emission category	Existing NMOG standards [a] (g/mi)	Existing NO_x standards[a] (g/mi)	Combined NMOG+NO_x standards (g/mi)	Proposed NMOG+NO_x emission standards[b] (g/mi)
LEV	0.090	0.070	0.160	0.160
ULEV	0.055	0.070	0.125	0.125
ULEV70	-	-	-	0.070
ULEV50	-	-	-	0.050
SULEV	0.020	0.010	0.030	0.030
SULEV20	-	-	-	0.020

[a] *These emission certification levels are for a 120,000-mile durability basis*
[b] *These proposed emission certification levels are for a 150,000-mile durability basis*

The proposed standards would reduce fleet average NMOG+NO_x emissions from current levels to a fleet-wide average SULEV standard by model year 2022. The proposed phase-in period would be from model years 2014 to 2022. The year 2014 has been selected in order to provide sufficient lead-time for manufacturers to begin deploying improved emission-control technologies across their fleets. Credits will be granted for vehicles certified to the proposed SULEV20 emission standard prior to 2014. Staff believes that it is important to provide a four-year lead-time (2010 through 2013) and the nine-year phase-in period (2014 through 2022) to provide manufacturers with adequate lead time to develop and implement SULEV emission control technologies across their full model lines.

Although the $NMOG+NO_x$ fleet average emission requirements from 2014 through 2022 model years have not yet been determined, staff has conducted a preliminary analysis on this issue. Based on input from industry on plans for implementing various emission control technologies, the two following figures illustrate a possible scenario for compliance with a fleet average requirement of SULEV-level emissions of 0.030 g/mi of $NMOG+NO_x$ emissions by model year 2022. Figure 3 shows the staff assessment for the deployment of vehicles that are certified to the proposed emission categories. Note that the sales share of vehicles is hypothetical and manufacturers can choose different relative percentages to be certified to the applicable emission standards to achieve a fleet average requirement of SULEV. For example, a manufacturer could simply opt to have every vehicle certified at "SULEV." On the other hand, as indicated above, it is more likely that larger vehicles would be certified at higher emission levels (e.g., ULEV70 and ULEV50) while some smaller vehicles would make up for the difference with lower emissions (SULEV20). In the illustrative scenario depicted in Figure 3, the compliant model year 2022 fleet is composed of 4% ULEV70, 13% ULEV50, 47% SULEV, and 37% SULEV20 vehicles.

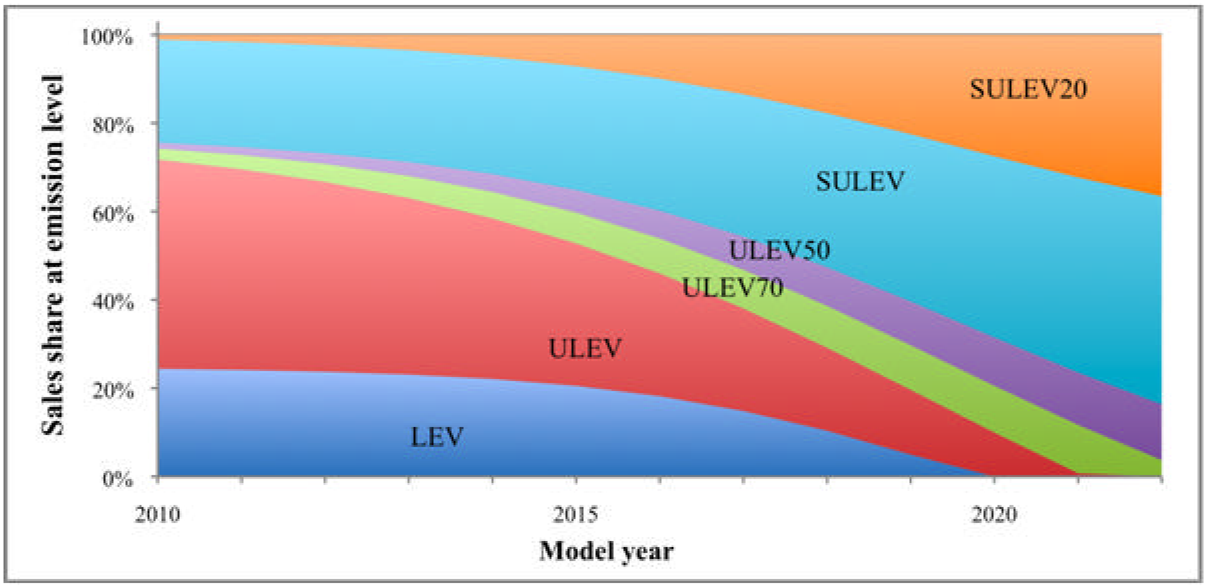

Figure 3. Illustration of sales share of by emission certification level to meet proposed $NMOG+NO_x$ standard

Figure 4 depicts the trajectory of fleet-wide $NMOG+NO_x$ emissions based on the above scenario. This trajectory for emission reduction shows a path that would gradually bring the fleet average emissions for new vehicles in California into compliance with SULEV-level $NMOG+NO_x$ emissions by model year 2022 based on the vehicle sales mix depicted in Figure 3.

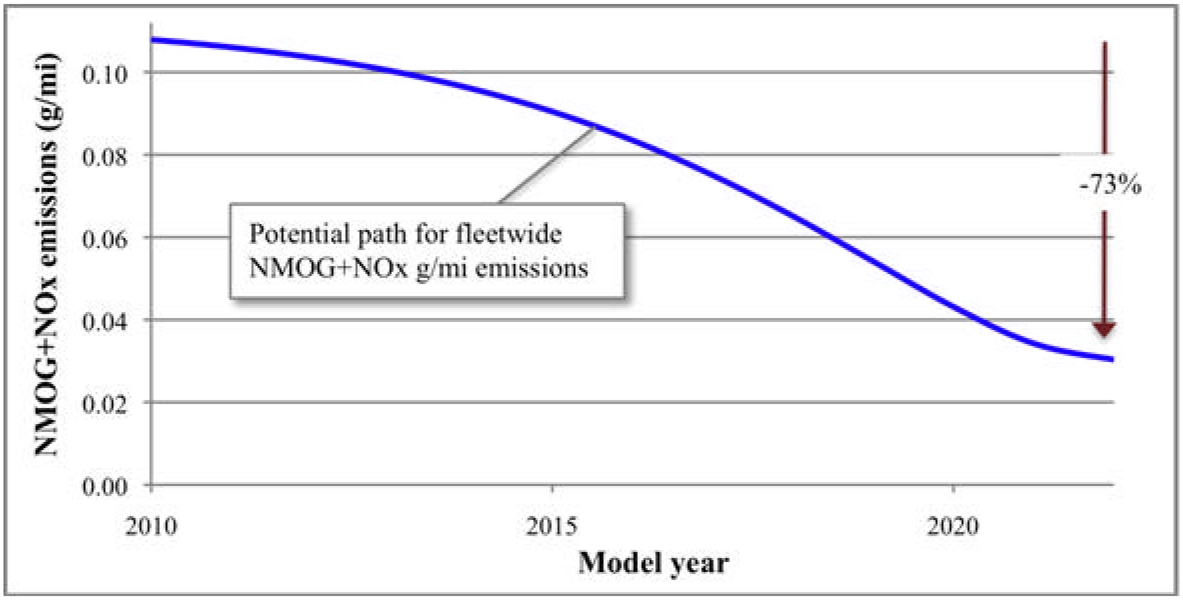

Figure 4. A potential path of fleet-wide $NMOG+NO_x$ emissions for the proposed LEV III standard for model year 2022

ARB staff is currently considering provisions for averaging, early credit, carry-over, and future-year credit discounting for the proposed combined $NMOG+NO_x$ standard. Under consideration is whether the current NMOG emissions provisions should be applied, or whether different schemes would offer an improved structure.

Based on the 22% of the 2008 vehicle fleet that is certified at SULEV-level emissions, a number of emissions control technology options already exist to achieve the proposed emission levels. As was researched extensively by ARB staff for the LEV II rulemaking in 1997, SULEV technology comes at some additional vehicle costs compared to LEV and ULEV emission control technologies. In addition, SULEV emission levels are generally more difficult and costly for larger vehicles with larger engines (e.g., V6 and V8 engines). This proposed regulation, on an average basis, would extend the coverage of SULEV-level emissions control systems across the entire vehicle fleet.

ARB staff finds that the there are a wide variety of available and emerging technologies that can be deployed to bring new vehicles on average from LEV/ULEV levels to SULEV, and thus comply with the proposed $NMOG+NO_x$ emission standards. It is difficult to precisely characterize the current state of emission control technology due to the different engine management and aftertreatment approaches that manufacturers take to achieve SULEV certifications in current vehicles. However, generally 2008 vehicles are equipped with the following equipment: close-coupled three-way catalyst, heated oxygen sensors, sequential fuel injection, and exhaust gas recirculation. Beyond these technologies, a number of additional technologies could be applied to achieve SULEV $NMOG+NO_x$ emission performance for all vehicle models. Table 3 summarizes a number of major SULEV-enabling technologies being used and tested by industry. Many of these technologies are already commercially available, while others are slated for deployment in the next several years.

Table 3. Potential technologies for NMOG+NOx standard compliance

Technology	Description, examples of technology
Secondary air (SAI)	Allowing rich fuel-air mix during cold-start conditions, then adding air to exhaust gases to facilitate catalyst conversion of hydrocarbon and carbon monoxide emissions
Engine management	Preheating cylinder head; lean stratified start-up; ignition retard
Turbocharging system design	For turbocharged engines, use of low thermal mass to reduce warm-up time
Engine design modification	Integration of catalyst into exhaust manifold for fast catalyst warm-up
Three-way catalyst upgrade	Increased catalyst volume, loading, and substrate cell density for increased pollutant conversion
Closed-coupled catalyst upgrade	Lower thermal mass system to reduce warm-up time
Heated catalyst	Electric heating of three-way catalyst during warm-up
Direct ozone reduction (e.g., PremAir ®)	Radiator treatment to facilitate oxidation of atmospheric pollutants; Emission reductions are "real-world" not on emission test cycle; emission reduction credits must modeled/estimated
HC adsorber or trap catalyst	Trap HC emissions temporarily before three-way catalyst is warm; Includes adsorber brick, exhaust diverter valve, and catalyst
Advanced exhaust gas recirculation (EGR)	Variable valve actuation and injection controls for EGR for recirculated exhaust gases for reentry at the engine intake; reduction in combustion temperatures reduces NOx formation
Lean-NOx aftertreatment	Aftertreatment for diesel and future lean gasoline engines; lean NOx trap; urea-based selective catalytic reduction (SCR)

2.2.2. Medium-Duty Vehicles

There are two types of medium-duty vehicles (MDVs) - those that are certified using the chassis dynamometer test procedure and those certified using the engine dynamometer test procedure. Vehicles that are engine certified include incomplete gasoline vehicles[iv] and those powered with diesel engines. There are two weight classes for MDVs, one for vehicles between 8,500 -10,000 lbs. GVW and the other for vehicles between 10,001-14,000 lbs. GVW. Each weight class has distinct emission levels for the emission categories of LEV, ULEV, and SULEV. Unlike light-duty vehicles that must also meet a fleet average requirement, manufacturers are required to certify specific percentages of their MDVs to the applicable emission standards. This is because there are very few MDV emission test groups, making a fleet average requirement difficult to implement. Currently, manufacturers are required to certify 40% of their chassis certified vehicles to the LEV standard and 60% to the ULEV standard. One hundred percent of vehicles certified using the engine dynamometer test procedure must certify to the ULEV standard. Staff is not proposing at this time to modify the

[iv] An incomplete vehicle usually consists of a chassis (and in some instances a cab) minus the cargo container. This allows a chassis/engine combination to be used in a variety of applications ranging from delivery vans, small school buses and motor homes.

emission standards for engine dynamometer certified vehicles.

Because these vehicles are generally used to perform work, they are emission tested at adjusted loaded vehicle weight (ALVW), a higher weight factor than that used to test light-duty vehicles. Adjusted loaded vehicle weight is defined as the average of curb weight and GVW, representing a vehicle that is carrying half its rated payload capacity. A third class of MDVs within the 8,500-10,000 lbs. GVW weight class that are designed primarily to transport passengers, medium-duty passenger vehicles (MDPVs), are required to meet the light-duty vehicle emission standards of the federal Tier 2 program.

Similar to the proposal for light-duty vehicles, for chassis certified MDVs staff is proposing to combine the NMOG+NOx standards and increase the stringency of the emission requirements. Certification emission values for 2010 model year MDVs suggest that improvements in MDV engine and emission control systems have tracked the improvements seen in light-duty vehicles, enabling them to meet more stringent emission standards. The average certification level for model year 2010 chassis certified MDVs in the 8,500-10,000 lbs. GVW weight class is on the order of 0.170 g/mi NMOG+NOx. In the 10,001-14,000 lbs. GVW weight class, they are on the order of 0.190 g/mi NMOG. Accordingly, staff is proposing to eliminate the current LEV and ULEV standards and is proposing the new MDV chassis emission standards listed below in Table 4 for MDVs. Staff is also proposing that all MDVs in the 8,500-10,000 lb. weight class be required to certify to the chassis emission standards to allow better in-use compliance evaluation. This is not expected to present a challenge to manufacturers, since two major manufacturers are currently planning to chassis certify their MDVs in this weight class.

Table 4. Medium-Duty Vehicle Chassis Emission Standards

Emission Category	NMOG+NOx (g/mi) 8,500-10,000 lbs. GVW	NMOG+NOx (g/mi) 10,001-14,000 lbs. GVW
ULEV	0.200	0.317
SULEV	0.145	0.200

Manufacturers have suggested that a fleet average requirement would accommodate the use of engine technologies and fuels anticipated for use in MDVs in the future, thereby providing them with more compliance flexibility. Staff concurs and, therefore, is also proposing a fleet average requirement for MDVs. The new emission standards and fleet average emission requirements (shown in Table 5 below) would be phased-in over time and are listed below in Table 5. Under this regime, manufacturers would certify their vehicles to the emission standards in Table 4 as long as the fleet average emissions of their MDVs meet the requirements listed in Table 5.

Table 5. Medium-Duty Vehicle Chassis Fleet Average Requirement

Weight Class	NMOG+NOx (g/mi)
8,500-10,000 lbs. GVW	0.170
10,001-14,000 lbs. GVW	0.230

2.2.3. PM Standard

The existing particulate matter (PM) standard for LEV, ULEV, and SULEV certification levels is 0.01 g PM/mile, or 10 milligrams/mile (mg/mi). This standard has generally not been a binding constraint for manufacturers, due to gasoline vehicles emitting generally at or below 1.0 mg PM/mi, or about 90% lower than the standard. The primary impact of the 10 mg/mi standard has been to assure the use of particulate filters on diesel-fueled vehicles, which typically have higher levels of engine out particulate emissions[v].

Despite the current situation of overcompliance with the prevailing PM standards, ARB staff is proposing to reduce the permissible PM levels for new vehicles for a number of reasons. First, California's air, due to its annual PM exceedances of federal and state air quality standards, continues to be nonattainment in most population centers (e.g., the Bay Area, Los Angeles, Sacramento, and the San Joaquin Valley)[vi]. As a result, staff considers it necessary to lock in current light-duty vehicle emission levels to ensure PM emissions do not backslide. Second, a number of emerging engine technologies will put an upward pressure on PM emissions, inducing greater risk for increased PM emissions. Federal and California standards that would reduce vehicle greenhouse gas (GHG) emissions will promote deployment of advanced combustion technologies for greater thermodynamic engine efficiency. Some of most the promising efficiency technologies present challenges to simultaneously constrain PM levels to today's levels while also reducing CO_2 emission levels. Examples of some these promising technologies include gasoline direct injection, turbocharging, diesel compression ignition, homogeneous charge compression ignition, and other lean-burn technologies.

The stringency of the proposed PM standard has not been determined; however, staff is interested in ensuring foremost that new vehicle PM emissions levels do not gradually increase due to the emergence of new increased combustion efficiency engines. To ensure that PM emissions do not increase, the new PM standard will likely be between 2 and 4 mg/mile, depending on ongoing ARB emission testing and analysis. One important determination will be whether the proposed PM standard would effectively require particulate filters for gasoline direct injection technology, which is expected to become widespread as manufacturers comply with federal GHG regulations from model years 2012-2016. Staff has received input from a number of manufacturers suggesting that a standard of 3 mg PM/mi can be met for gasoline direct injection engines without requiring the use of particulate filters.

Although ARB staff has done extensive research into the question of a PM particle count or "number" standard, the current proposal does not include a separate mandatory number standard. ARB staff acknowledges that the PM particle count emitted from motor vehicles poses a separate health effect from those of PM mass emissions and that reductions in PM mass have the potential to increase the number of particles emitted. However, issues related to emission testing variability and uncertainty

[v] Diesel vehicles represent less than 1% of light-duty vehicles sold in the U.S. Diesel vehicles that are sold in the U.S. and Europe use diesel particulate filter (DPF) technology to reduce PM emissions from above 10 mg/mi to about 2 mg/mi to comply with prevailing standards.

[vi] U.S. EPA, 2009. 2006 Particulate Matter (PM-2.5) Area Map. *http://www.epa.gov/oar/oaqps/greenbk/ca25b.html*

in the health assessment science make the regulatory assessment for a PM count standard difficult at this time. In addition, because the PM mass and count emissions appear to be correlated, staff finds that establishing the proposed 3 mg/mi PM mass standard will be sufficient to mitigate any potential health effect due to particulate mass and particle number emissions. Although a mandatory number standard is not being considered at this time, an optional PM number standard of about 10^{12} particles/mi is being considered (which could be chosen by manufacturers instead of the PM mass standard). Such an optional approach for the number standard would allow for further research, emission testing, and regulatory assessment by ARB staff and the auto industry.

2.2.4. Durability

ARB staff has a great interest in increasing the durability requirements for vehicle emission control systems to ensure that vehicles maintain their low emissions as long as possible. As noted above, the existing LEVII program has emission standards for 50,000- and 120,000-mile vehicle use. However, average actual vehicle lifetimes in California approach 200,000 miles. To help reduce this gap between the durability requirement and real-world vehicle lifetime, the LEV III proposal would phase-in a new 150,000-mile durability requirement.

After investigating emission data for PZEVs and receiving input from manufacturers, ARB staff finds that this increased durability requirement is technically feasible over the 2014-2022 timeframe. Emission control systems have been developed with greater robustness, thereby increasing their durability. Emission control systems have typically been designed with considerable safety margin, such that vehicle testing at intermediate useful life (50,000 miles) typically show emission levels significantly below the standard. In addition, many manufacturers favor the elimination of the 50,000-mile testing. Therefore, staff is proposing to eliminate the 50,000 mile requirement which would avoid unnecessary compliance testing for manufacturers and emissions monitoring by ARB without compromising fleet emissions.

Along with eliminating the 50,000-mile intermediate useful life standards, staff proposes increasing the 120,000-mile full useful life durability requirement to 150,000 miles to ensure more of the actual vehicle lifetimes are covered by the LEV III regulation. This move is partially motivated by the success of the PZEV-certified vehicles, which are certified with 150,000- mile full useful life durability and extended emission warranties. The durability of PZEV vehicles' emission control systems over the past several years has validated the robustness of SULEV-level emission control systems.

The LEV III proposal is also impacted by the proposed restructuring of the ZEV program[vii]. Under the restructuring of the ZEV mandate, it is expected that the PZEV provisions for partial credits toward each maufacturer's ZEV requirements will no longer be allowed. Removing the PZEV option from the ZEV mandate is being proposed in order to refocus the ZEV program on its main goal of promoting the deployment of electric drivetrains (e.g., plug-in capable hybrid vehicles, battery electric vehicles, fuel

[vii] See California Air Resources Board's "2009 Zero Emission Vehicle (ZEV) Review" at *http://www.arb.ca.gov/msprog/zevprog/2009zevreview/2009zevreview.htm*

cell vehicles) with greater criteria and GHG emission reduction potential. As a result, PZEVs will be shifted into the LEV III program. The proposed LEV III program expands the 150,000-mile useful life for emissions control systems to all vehicles – but in the form of a durability requirement, not an emission warranty.

Staff notes that of the model year 2008 vehicles sold in California, approximately 20% are PZEV vehicles (i.e., 90% of the SULEV-certified vehicles). Because one-fifth of new vehicles have warranties to 15 years/150,000 miles, ARB staff is seeking ways to voluntarily encourage manufacturers to continue the use of extended emission warranties. Accordingly, staff is proposing a 0.005 g/mi credit toward the NMOG+NO_x standard for manufacturers who warrantee their vehicles' emission control systems for the full 15 year/150,000-mile useful life.

2.2.5. Evaporative emissions

In 1998, ARB adopted stringent evaporative emission requirements as an integral part of the LEV II program. Included in the LEV II evaporative regulations was an "optional" zero evaporative standard. Vehicles certified to the zero evaporative standard and the SULEV exhaust standard could receive ZEV credits as a partial ZEV (PZEV). Since 2002, many manufacturers have elected to certify their vehicles as a PZEV in order to garner valuable credits to meet their ZEV obligations. However, over the years the ZEV program has evolved, and it is proposed to no longer allow conventional gasoline vehicles to accrue ZEV credits. Therefore, there is no longer an incentive to certify a vehicle to meet the zero evaporative standard.

To prevent technology backsliding and to expand the use of existing technology, staff proposes to require all light-duty vehicles to comply with the zero evaporative standard. This would result in at least a 30% emission reduction from current evaporative emissions. In addition, as discussed in section 2.2.7 below, staff proposes to update the California certification gasoline specifications to include approximately 10% ethanol by volume (E10), which is representative of what is now sold at the pump. Staff believes the technology required to meet the zero evaporative standard even on arguably a more "severe" fuel such as E10 (i.e., in terms of potentially generating more evaporative emissions) is available and cost-effective.

LEVII evaporative emission requirements consist of compliance over three separate certification standards for the vehicle's useful life: a combined highest three-day diurnal plus high-temperature hot soak emission standard, a combined highest two-day diurnal plus moderate-temperature hot soak standard, and a stand-alone running loss emission standard. These standards are shown below in Table 6. During the evaporative tests, the vehicle is placed inside a sealed enclosure, and the ambient concentration of hydrocarbons in the enclosure is measured to determine the amount of evaporative emissions released by the vehicle. As a result, all vehicle evaporative emissions are measured, including fuel and non-fuel (such as vehicle interior trim, body paint, and tires).

As discussed above, these LEV II evaporative emission standards include a zero-evaporative standard applied to PZEVs. The zero-evaporative standard has two components, with each component requiring a separate test. First, fuel evaporative emissions must be certified to a 0.0 emission level. Second, the whole vehicle must meet a 0.35 grams per test standard for passenger cars, (higher levels are allowed for larger vehicles) when tested in a sealed enclosure, to allow for non-fuel related evaporative emissions. The test procedures currently allow the use of MTBE certification fuel with zero percent ethanol content to demonstrate compliance.

Table 6. LEVII evaporative emission standards

Vehicle class	Hydrocarbon standards		
	Three-day diurnal plus hot soak (grams per test)	Two-day diurnal plus hot soak (grams per test)[a]	Running loss (grams per test)[b]
Passenger car	0.50	0.65	0.05
Light-duty truck under 6,000 lbs. GVWR	0.65	0.85	0.05
Light-duty truck from 6,001-8,500 lbs. GVWR	0.90	1.15	0.05
Medium-duty vehicles (8,501-14,000 lbs. GVWR)	1.00	1.25	0.05
Heavy-duty vehicles (over 14,000 lbs. GVWR)	1.00	1.25	0.05

As noted earlier, over 30% of the 2008 MY vehicles in the PC/LDT1 category are certified as PZEVs, and therefore, certified to the zero-evaporative emission standard. In addition, several LDT2 vehicle models were also certified to the zero-evaporative standard. Expansion of the zero-evaporative emission standard applicable to PZEVs to the remaining categories of vehicles by 2022 would ensure that the most advanced evaporative emission control technologies are used.

However, there is evidence that lower levels of the whole vehicle zero evaporative standard are feasible for the following reasons. First, in an ARB test program completed in 2008, four PC PZEVs were tested over a modified three-day diurnal evaporative test. The test program was designed to explore the evaporative emission effects over extended diurnals. The only modification of the test procedure from the certification three-day diurnal plus hot soak test, besides extending the number of diurnals, is that the running loss test cycle was performed in a standard temperature test cell instead of at 105°F ambient temperature. The test results showed very low evaporative emissions from the tested PZEVs. During the first three diurnals, the average highest diurnal plus hot soak level for the four vehicles was 0.156 grams of hydrocarbon per test, with a range of 0.089 to 0.226 grams per test. These low levels were achieved using summertime commercial fuel with about 6% ethanol content. These test results indicate that the zero-evaporative whole vehicle standard may be reduced to a level lower than the existing 0.35 grams per test standard.

Second, a significant number of certification evaporative families are certified to levels at or below 0.20 grams per test during both the three-day diurnal plus hot soak test and the two-day diurnal plus hot soak test. Current certification data show a range of 0.10 to 0.30 for PC and 0.22 to 0.43 for LDT PZEVs. These vehicles typically utilize a full range of emission control technologies to achieve low evaporative emissions.

Finally, manufacturers have requested ARB staff to remove the fuel evaporative testing portion of the zero-evaporative standard in order to reduce the testing load required for vehicle certification. They argue that the whole vehicle portion of the zero-evaporative standard is low enough to ensure that sufficient control of the fuel evaporative emissions is maintained. However, to ensure sufficient evaporative control, staff maintains that without the fuel evaporative test demonstration, a lower whole vehicle standard is necessary. Based on review of the certification data and test program results, staff has proposed a 0.15 grams per test standard both for the three-day diurnal plus hot soak test and the two-day diurnal plus hot soak test for PCs. Staff acknowledges that numerically higher evaporative standards are likely appropriate for the other evaporative weight categories.

The phase-in period for the LEV III evaporative standards is not yet determined. The same considerations for the LEV III exhaust standards will also be taken when developing the required phase-in period for the proposed evaporative standards. Staff is also considering provisions for early credit and carry-over issues.

A range of various emission control technologies are employed on zero-evaporative emission vehicles, including improvements to the carbon canisters, hoses, seals, and connectors. Table 7 summarizes the major emission control technologies that may be found on zero-evaporative emission vehicles. These and other technologies may be used to bring the emission performance of LEV II vehicles to zero-evaporative emission levels and lower.

Table 7. Emission control technologies on zero-evaporative vehicles

Technology	Description
Carbon canister with hydrocarbon scrubber	Use of scrubber to capture low levels of canister bleed emissions, with deep efficient cleaning during purge
Carbon canister with low-bleed carbon	Use of low-bleed activated carbon to reduce canister bleed emissions
Carbon canister with multi-chambered design	Increased compartmentalization to reduce bleed emissions and inhibit hydrocarbon migration toward the air inlet
Engine intake carbon element	Activated carbon in the engine air induction system to capture evaporative losses from the engine
Improved materials	Reduce permeation emissions by use of better barrier layers, sealing materials, and connectors, and increased use of metal components
Improved design	Reduce permeation emissions by reducing the number of connectors and length of hoses, improved fuel tank design, etc.

Staff has met with several manufacturers and with automotive industry groups. Manufacturers are uniformly of the opinion that the 0.15 grams per test is not doable especially with an E10 fuel. Staff plans to initiate a test program to support the lowering of evaporative standards and demonstrate the feasibility of meeting these standards with E10. In meetings with fuel system industry groups, most have stated that there are fuel components available and in use today that are engineered to minimize the impact of ethanol in the fuel.

2.2.6. Supplemental test procedure

In July 1997, the Board approved new certification tests and standards to control exhaust emissions from aggressive driving and air-conditioner usage for passenger cars, light-duty trucks, and medium-duty vehicles under 8,501 pounds GVWR. The newly adopted test procedures, collectively known as the Supplemental Federal Test Procedures (SFTP) included a high-speed, high-acceleration test known as the US06 test, and the SC03 air-conditioner test. These test procedures were adopted to cover the vehicle operating conditions that are not reflected in the FTP, which is used to certify on-road vehicles. During these operating conditions, emissions can be substantially higher than those measured during the normal FTP driving cycle. The Board adopted the SFTP exhaust emission standards beginning with the 2001 model year to be phased-in over several years. The SFTP standards were to be applicable for a durability period of 4,000 miles. Assurance of SFTP emission durability beyond 4,000 miles was to be indirectly provided by the existence of useful-life FTP emission standards and on-board diagnostics to monitor in-use emissions and ensure proper operation of emission control components.

Since the adoption of the original SFTP regulations, staff believes that it is necessary to propose amendments to the standards and test procedures to ensure that control of off-cycle emissions are extended throughout the full useful life (150,000 miles) of on-road motor vehicles. These more stringent requirements, referred to as SFTP II, would be applicable to vehicles in the passenger car, light-duty truck, and medium-duty vehicle classes up to 14,000 pounds GVW. Additionally, alternative-fueled vehicles, which were previously exempt, would need to comply with the SFTP II regulations.

The proposed SFTP II regulations would be implemented beginning with the 2014 model year for passenger cars and light-duty trucks up to 8,500 pounds GVW with a phase-in through the 2022 model year. Medium-duty vehicles from 8,501 to 14,000 pounds GVW would have a phase-in from 2015 through 2022. These regulations would apply to vehicles during high-speed, high-acceleration modes as contained in the US06 test cycle, and driving with the air conditioner turned on which would be represented by a 10-minute hot start test known as the SC03 test cycle. The regulations would pertain to emissions of non-methane hydrocarbons (NMHC), NO_x, and CO.

Staff initiated a test program in 2006 to aid in the development of appropriate useful life standards. California-registered vehicles were procured by an independent contractor. The vehicles were tested using California certification gasoline fuel on the FTP, US06 and a simulated SC03 test cycle. The tests were run in triplicates. To get an idea of the impact of ethanol in the fuel, the vehicles were also tested on a summertime fuel specification with about 6 percent ethanol. Table 8 details the vehicles procured from the in-use fleet for testing.

Table 8. SFTP II test program vehicles

Test Vehicle	Model	Vehicle	Mileage	Standard	Class
2	2003	Focus	75,000	LEVII SULEV	PC
3	2003	Accord	31,000	LEVII ULEV	PC
4	2003	Camry	60,000	ULEV	PC
5	2003	Corolla	40,000	ULEV	PC
6	2004	Impala	63,000	LEVII LEV	PC
7	2003	CRV	44,000	LEVII LEV	LDT
8	2004	Neon	51,000	ULEV	PC
9	2004	Impala	86,000	LEVII LEV	PC
10	2003	Corolla	47,000	ULEV	PC
11	2006	Silverado	11,000	SULEV	MDV
12	2006	Express	9,000	LEV	MDV
13	2004	Tundra	31,000	ULEV	MDV
14	2005	Focus	30,000	LEVII SULEV	MDV
15	2006	2500 HD*	8,000	ULEV	MDV
16	2006	Impala**	6,000	ULEV	PC
17	2007	Express***	6,000	LEVII LEV	MDV
18	2005	E350***	34,000	LEVII LEV	MDV
19	2005	F-150	34,000	LEVII LEV	LDT
20	2004	Caravan	48,000	LEVII LEV	LDT
21	2002	Crown Victoria	115,000	LEVII ULEV	PC
22	2005	RAM Truck	72,000	LEV	MDV
23	2005	RAM Truck	25,000	LEVII LEV	MDV
24	2008	F-350***	1,000	LEVII ULEV	MDV
25	2006	Impala**	31,000	ULEV	PC
26	2007	Silverado**	27,000	LEVII LEV	LDT

* *Dual Fuel*

** *Flexible Fueled Vehicle*

*** *Above 8,500 pounds*

When evaluating the test results, staff only considered the data from LEV II certified vehicles (since vehicles can no longer be certified to LEV I levels). The average US06 emission levels from the LEV II vehicles are shown in Table 9; Figure 5 averages the results by emission certification level and shows the results graphically.

Table 9. Average vehicle emission results SFTPII test program

Vehicle	Standard	Class	$NMHC+NO_x$ (g/mi)			CO (g/mi)		
			FTP	US06	SC03	FTP	US06	SC03
Focus	LEVII SULEV	PC	0.031	0.010	0.002	0.2	3.3	0.3
Accord	LEVII ULEV	PC	0.042	0.046	0.022	0.6	0.5	0.4
Impala	LEVII LEV	PC	0.092	0.089	0.062	1.1	2.3	0.6
CRV	LEVII LEV	LDT	0.072	0.009	0.014	3.2	0.8	0.1
Impala	LEVII LEV	PC	0.134	0.054	0.039	1.0	1.4	0.2
Focus*	LEVII SULEV	PC	0.137	0.002	0.003	0.6	2.0	0.2
F-150	LEVII LEV	LDT	0.042	0.006	0.008	2.3	2.9	1.8
Caravan	LEVII LEV	LDT	0.061	0.079	0.052	0.6	0.7	0.2
Silverado	LEVII LEV	LDT	0.042	0.026	0.028	1.7	2.7	1.8
Express Van	LEV II LEV	MDV	0.11	0.06	.04	2.4	3.7	1.2
E350	LEV II LEV	MDV	0.08	0.03	0.02	2.3	6.4	1.1
Ram 2500	LEV II LEV	MDV	0.20	0.21	0.14	1.1	1.9	0.2
F-350	LEV II ULEV	MDV	0.10	NA	0.02	1.9	NA	2.3

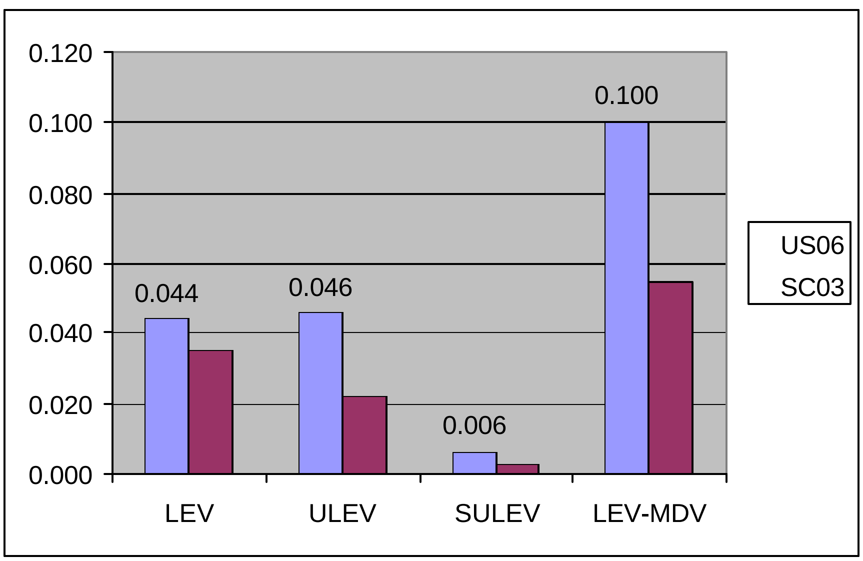

Figure 5. Average US06 and SC03 emission levels ($NMHC+NO_x$) by exhaust category from SFTP test program

In developing the standards, ARB considered data from the test program as well as certification data. Since the majority of the test vehicles were at intermediate useful life, staff projected the observed deterioration rate from the reported 4,000 miles certification level. These deterioration rates were comparable to the FTP deterioration factors. The projected deterioration rates were then applied to the average emissions from the test program for each exhaust category. Staff also added a 50% compliance margin to account for test variability. This methodology was presented at an SFTP II automotive industry meeting held on September 20, 2007. At that time, staff presented proposed SFTP II emission standards as shown in Table 10.

Table 10. Proposed SFTP II US06 and SC03 useful vehicle life standards

Proposed SFTP II Exhaust Emission Standards for New 2014 and Subsequent Model Year LEVs, ULEVs, and SULEVs in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes						
			US06		SC03	
Vehicle type	Mileage for compliance	Vehicle emission category	$NMHC+NO_x$ (g/mi)	CO (g/mi)	$NMHC+NO_x$ (g/mi)	CO (g/mi)
All PCs, LDTs 8,500 lbs. GVW or less Vehicles in this category are tested at their loaded vehicle weight (curb weight plus 300 pounds)	150,000	LEV	0.12	5.6	0.10	1.6
		ULEV	0.10	5.6	0.07	0.9
		SULEV	0.03	5.6	0.02	0.5
MDVs 8,501-10,000 lbs. GVWR Vehicles in this category are tested at their adjusted loaded vehicle weight (curb weight plus ½ payload)	150,000	LEV	0.20	8.8	0.19	2.6
		ULEV	0.16	8.8	0.15	2.0
		SULEV	0.10	8.8	0.10	1.3
MDVs 10,001-14,000 lbs. GVWR Vehicles in this category are tested at their adjusted loaded vehicle weight (curb weight plus ½ payload)	150,000	LEV	0.40	10.0	0.42	6.6
		ULEV	0.32	10.0	0.38	5.9
		SULEV	0.20	10.0	0.21	3.0

Since presenting the proposed standards, staff has had many meetings and conference calls with automotive manufacturers. Of concern is that the proposed standards do not give due consideration to future technologies for compliance with greenhouse gas standards. Manufacturers have also presented data to show that on the US06 drive cycle, the emission results could vary by 2-4 times. In addition, manufacturers believe that use of the US06 test cycle is not appropriate for vehicles over 8,500 pounds GVWR. Based on these and other factors, staff is considering allowing another option where manufacturers can elect to certify to a decreasing US06 fleet average based on a composite emission calculation, as shown by the following equation:

SFTP Composite Standard = 0.28 x US06 + 0.37 x SC03 + 0.35 x FTP

Staff is still working with industry to determine the appropriate fleet average calculation and levels. Staff is also revisiting the original "stand-alone" proposed standards to determine if more flexibility is needed. The original proposed SFTP II exhaust emission standards have been selected to be approximately equal in stringency to the proposed FTP standards for low-emission vehicles (LEV III standards). Reducing a vehicle's FTP emissions to meet the more stringent LEV III exhaust emission standards will likely reduce SFTP emissions as well. This means that most vehicles will not require significant hardware modifications in order to comply with these requirements. Staff currently expects that approximately 70 percent of future vehicles will likely comply with the proposed standards using only calibration changes and minor exhaust gas recirculation (EGR) system upgrades, with the remaining 30 percent requiring catalyst loading and/or volume changes. Staff would welcome presentations from industry outlining possible approaches for the US06 fleet averaging option. In addition, staff is particularly interested in manufacturers providing additional emission data for passenger cars and light-duty trucks using the best available SULEV technology, and additional emission data for medium-duty vehicles using the best available LEV, ULEV, and SULEV technology. Staff is also requesting manufacturers to give their best forecast for future SULEV emission levels that might be achieved in the 2014 to 2022 timeframe.

2.2.7. Proposed certification fuel change

Staff proposes to update the California certification gasoline specifications which currently contain a specification for 10% MTBE. Manufacturers have the option to use California or Federal Tier 2 certification fuel to demonstrate exhaust and evaporative compliance. However, manufacturers typically only use California certification fuel to demonstrate compliance with the zero evaporative standards. Certification fuel specifications are intended to represent the average fuel sold at the pump. However, since the adoption of Phase 3 reformulated fuel in 1999, MTBE was eliminated in the commercial fuel as of December 31, 2002. In addition, the current California certification fuel does not contain any ethanol. Since the elimination of MTBE, California commercial gasoline has contained about 6-7% ethanol by volume. This year, as a result of both the federal renewable fuels standard (RFS2) and the amendments to California's reformulated gasoline (RFG3) regulation, oil companies are making gasoline with 10% ethanol. To account for the increase in ethanol and the elimination of MTBE in commercial gasoline, staff is proposing to modify certification gasoline specifications as shown in Table 11. It should be noted that these proposed specifications are draft and staff is seeking comments on suggested changes.

Table 11. Proposed California certification fuel specifications

Fuel Property	Limit	Test Method
RVP	6.95 psi	TBD
T50	214 oF	TBD
T90	312 oF	TBD
Total Aromatic Hydrocarbons	24 vol. %	TBD
Olefins	7.4 vol. %	TBD
Total Oxygen	3.5	TBD
Sulfur	8 ppm by wt.	TBD
Benzene	0.74 vol. %	TBD
Ethanol	10 vol. %	TBD

2.2.8. 50°F Emission Testing

Current regulations require light-duty vehicles certified to the LEV and ULEV emission standards and medium duty vehicles certified to the LEV, ULEV and SULEV emission standards to be emission tested over the Urban Dynamometer Driving Schedule, or federal test procedure (FTP) at 50°F. Emissions of NMOG and formaldehyde (HCHO) may not exceed a value equal to two times the applicable FTP emission standards for these vehicles when tested at 68° to 86°F. Because fuel properties of E85 present a unique emission challenge at lower temperatures, particularly at SULEV emission levels, staff is proposing that FTP emissions of vehicles tested on E85 fuel at 50°F not exceed 2.5 times the applicable FTP emission standards when tested at 68° to 86°F. The limit of two times the applicable FTP emissions standards for E85 vehicles when tested on gasoline at 50°F would be retained. This modification is being proposed in order to provide an additional compliance margin for vehicles certifying on E85.