APPENDIX O

State of California
AIR RESOURCES BOARD

PROPOSED

TECHNICAL SUPPORT DOCUMENT FOR PROPOSED AMENDMENTS TO THE CALIFORNIA SUPPLEMENTAL FEDERAL TEST PROCEDURE EXHAUST EMISSIONS STANDARDS AND TEST PROCEDURES FOR 2015 AND SUBSEQUENT MODEL PASSENGER CARS, LIGHT-DUTY TRUCKS, AND MEDIUM-DUTY VEHICLES UNDER 14,001 POUNDS GROSS VEHICLE WEIGHT RATING

Adopted: [INSERT DATE OF ADOPTION]

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LIST OF ACRONYMS and DEFINITIONS

A/C	Air Conditioner
ALVW	Adjusted Loaded Vehicle Weight, also known as Test Weight
ARB	California Air Resources Board
CFR	Code of Federal Regulations
CNG	Compressed Natural Gas
CO	Carbon Monoxide
Curb Weight	The actual weight of the vehicle (when empty of passengers and cargo)
E85	Ethanol fuel, composed of 85% ethanol and 15% gasoline
EMFAC	ARB's EMission FACtors model, used to calculate emission rates from all motor vehicles operating on highways, freeways and local roads in California
FR	Federal Register
FTP	Federal Test Procedure
GHG	Greenhouse Gas
GPS	Global Positioning System
g/mi	gram per mile
g/s	gram per second
GVWR	Gross Vehicle Weight Rating, the maximum allowable weight when the vehicle is fully loaded
HCCI	Homogeneous Charge Compression Ignition
HEV	Hybrid Electric Vehicle
km	kilometer
km/h	kilometers per hour
lbs	pounds
LEV	Low-Emission Vehicle
LEV II	Currently Adopted Low-Emission Vehicle Regulations
LEV III	Currently Proposed Low-Emission Vehicle Regulations
LDT	Light-Duty Truck
LDV	Light-Duty Vehicle
LVW	Loaded Vehicle Weight, the curb weight of a vehicle plus 300 pounds
MDPV	Medium-Duty Passenger Vehicles. These are heavier vehicles that would fall within the MDV GVWR class but are designed primarily for passenger use. MDPV is defined in 40 CFR §86.1803-01.
MDV	Medium-Duty Vehicle
mph	miles per hour
NHTSA	National Highway Traffic Safety Administration
NMHC	Nonmethane Hydrocarbon
NMOG	Nonmethane Organic Gases
NOx	Oxides of Nitrogen
PC	Passenger Car
PEMS	Portable Emissions Measurement System

PHEV	Plug-in Hybrid Electric Vehicle
PM	Particulate Matter
PZEV	Partial Zero Emission Vehicle
ROG	Reactive Organic Gases
SC03	A test procedure designed to determine emissions associated with the use of an air conditioner; A/C test procedure
SFTP	California Supplemental Federal Test Procedures
SULEV	Super-Ultra-Low-Emission Vehicle
SwRI	Southwest Research Institute
THC	Total Hydrocarbon
TW	Test Weight, or Adjusted Loaded Vehicle Weight, the average of a vehicle's curb weight and GVWR; used for MDV testing
UC	California Unified Cycle (or LA92), dynamometer driving schedule that is similar to the US06 test cycle, but with less aggressive speeds and acceleration
ULEV	Ultra-Low-Emission Vehicle
USEPA	United States Environmental Protection Agency
US06	A high-speed, high-acceleration, test procedure designed to measure off-cycle emissions
US06 Bag 2	A test procedure comprised of the middle portion of the US06 cycle

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I. INTRODUCTION

The California Supplemental Federal Test Procedure (SFTP) was developed to quantify and control motor vehicle emissions not accounted for by the Federal Test Procedure (FTP). Specifically, SFTP captures so-called "off-cycle" emissions resulting from aggressive driving and air conditioner use. The existing SFTP program applies to light-duty vehicles through 8,500 pounds (lbs) gross vehicle weight rating (GVWR) and requires manufacturers to certify applicable vehicles to 4,000-mile SFTP exhaust emission standards.

As summarized in the Initial Statement of Reasons, staff is proposing SFTP amendments primarily to ensure that control of off-cycle emissions is extended throughout the useful life of affected vehicles. These more stringent SFTP requirements would be applicable to vehicles in the passenger car, light-duty truck, and medium-duty vehicle classes through 14,000 lbs GVWR. The proposal would also extend the new proposed requirements to alternative-fueled vehicles. The new SFTP emission standards would be implemented beginning with the 2015 model year for passenger cars, light-duty trucks, and medium-duty passenger vehicles, with a phase-in through the 2025 model year. Medium-duty vehicles from 8,501 through 14,000 lbs GVWR would be phased in from the 2016 through the 2025 model year. The proposed SFTP emission standards would increase in stringency through the phase-in periods and ultimately require Super-Ultra-Low-Emission-Vehicle (SULEV) level emission control.

Staff conducted a research and test program to determine the technological feasibility of the SFTP emission standards being proposed in this rulemaking. Based on their findings, staff believes most vehicles engineered to comply with the proposed Low-Emission Vehicle III (LEV III) FTP emission standards would also meet the proposed SFTP standards without significant hardware modifications. However, since the test program showed that not all vehicles currently in the fleet are optimally calibrated to control emissions during these off-cycle operating conditions, staff believes that the proposed SFTP emission standards are necessary to ensure proper engine calibration and emission control effectiveness during all modes of operation.

Staff does not believe the proposed SFTP requirements would result in any additional hardware cost above what would already be required to produce a vehicle that complies with the proposed LEV III FTP emission standards. However, staff does project an additional testing cost of $300,000 fleet-wide during the phase-in of these requirements. Staff estimates that these regulations would result in 2025 statewide emission reductions of 0.2 tons per day of non-methane organic gases plus oxides of nitrogen (NMOG+NOx), which corresponds to a cost-effectiveness of approximately $0.20 per pound of NMOG+NOx reduced.

This technical support document is an appendix to the Initial Statement of Reasons and includes more detailed discussion on the following:

- Existing SFTP requirements;
- Proposed SFTP requirements;
- SFTP tests;
- Feasibility test program;
- Technological feasibility of the proposed SFTP requirements;
- Alternatives considered; and
- Benefits and cost.

II. EXISTING SFTP REQUIREMENTS

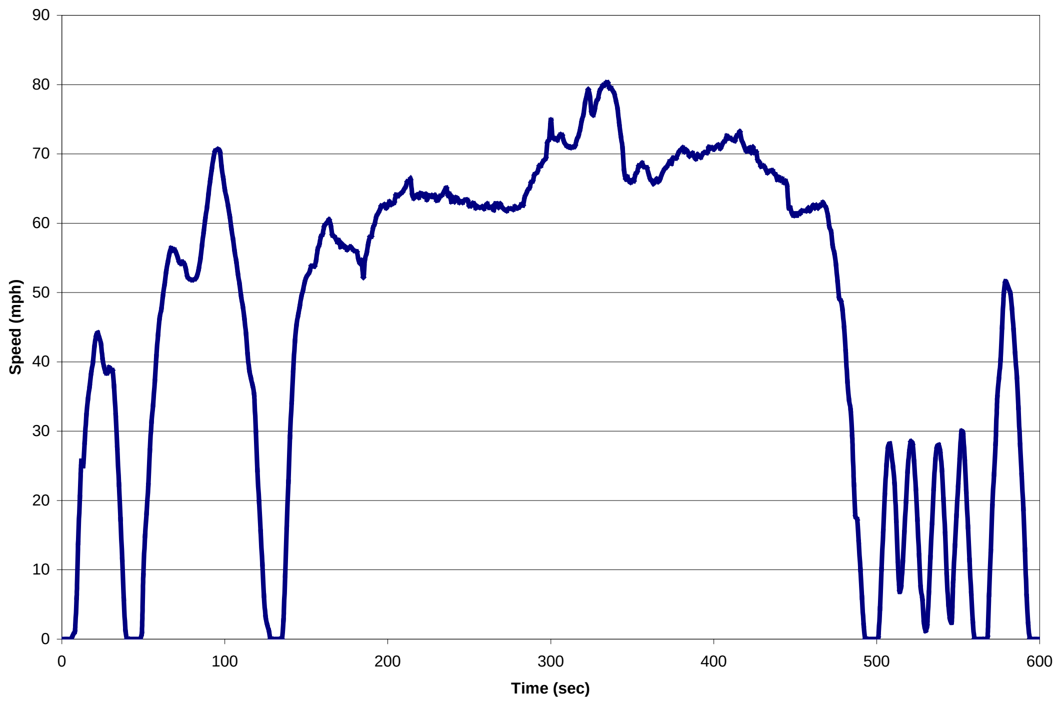
Both the California and Federal FTP exhaust emission standards for motor vehicles apply to emissions that occur when the vehicle is operating through a series of narrowly defined operations. Consequently, the FTP does not accurately reflect aggressive driving and use of the air-conditioner. During these operating conditions, emissions can be substantially increased. Staff from ARB and the United States Environmental Protection Agency (USEPA), in close coordination with motor vehicle manufacturers, agreed upon two supplemental tests (collectively, the SFTP) to measure emissions during off-cycle operations: a high-speed, high-acceleration test known as the US06 test, and the SC03 air-conditioner test. ARB first adopted the SFTP requirements in 1997 and the Initial Statement of Reasons for that rulemaking (ARB, 1997) includes a detailed discussion of the development of these two test procedures. In addition, the test procedures are briefly discussed below.

The US06 driving cycle, shown in Figure O-1, is a high-speed, high-acceleration test cycle that is used to represent aggressive driving behavior, rapid speed fluctuations, and driving behavior following startup of the engine; it has an average speed of approximately 48 miles per hour (mph) and a maximum speed of 80 mph. The SC03 driving cycle, shown in Figure O-2, represents the engine load and emissions associated with the use of air-conditioners; it has an approximate average and maximum speed of 22 mph and 55 mph, respectively. These test procedures are designed to simulate the short-term high loads that occur outside the operating cycle of the FTP, which has an average speed of 21 mph and a maximum speed of 59 mph. Unlike the FTP, the US06 and SC03 driving cycles do not include cold start emissions.

Under the current SFTP regulation, the exhaust emission standards are applied by vehicle weight classification. There are currently five vehicle classifications that fall under the SFTP program: passenger cars (all weights); light-duty trucks 6,000 lbs GVWR and under, and 0-3750 lbs loaded vehicle weight (LVW)[1]; light-duty trucks 6,000 lbs GVWR and under, and 3751-5750 lbs LVW; medium-duty vehicles 6,001-8,500 lbs

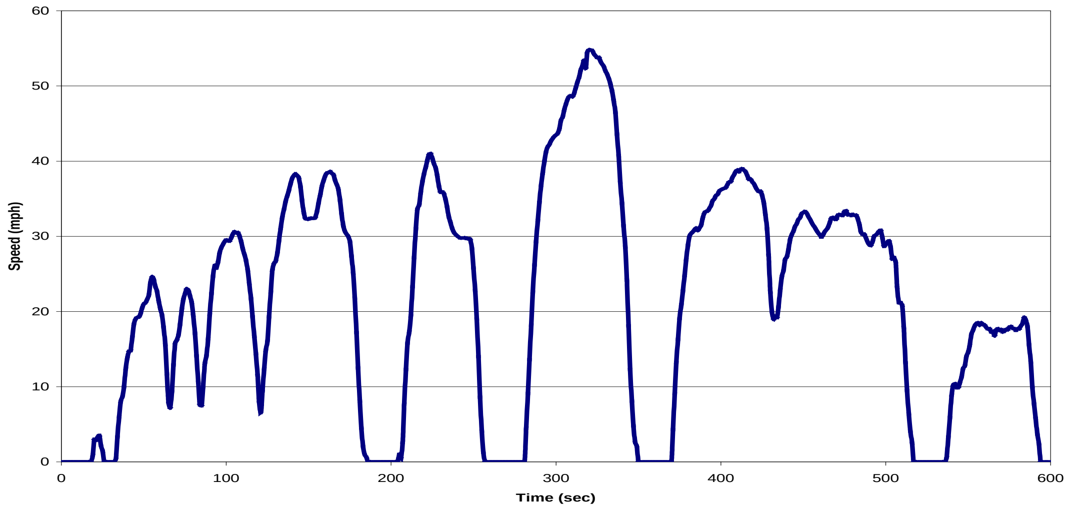
[1] There are several classifications for vehicles based on weight. Curb weight is defined as the actual weight of the vehicle. Loaded vehicle weight (LVW) is defined as the curb weight of the vehicle plus 300 pounds. Light-duty vehicles are often tested at LVW. Gross vehicle weight rating (GVWR) is the curb weight of the vehicle including the full payload. Adjusted LVW (ALVW), or test weight (TW), is the average of a vehicle's curb weight and gross vehicle weight rating, and is generally used for testing medium-duty vehicles.

Figure O-1. SFTP US06 Cycle[1]



[1] The cycle represents an 8.01 mile (12.8 km) route with an average speed of 48.4 mph (77.9 km/h), maximum speed 80.3 mph (129.2 km/h), and a duration of 596 seconds.

Figure O-2. SFTP SC03 Cycle[1]



[1] The cycle represents a 3.6 mile (5.8 km) route with an average speed of 21.6 mph (34.8 km/h), maximum speed of 54.8 mph (88.2 km/h), and a duration of 596 seconds.

GVWR[2], and 3,751-5,750 lbs adjusted LVW (ALVW); and medium-duty vehicles 6,001-8,500 lbs GVWR[3], and 5,751-8,500 lbs ALVW. The SFTP emission standards, shown in Table O-1 below, are applicable to gasoline, diesel, hybrid electric, and partial zero emission vehicles. These emission standards were fully implemented by the 2004 model year.

Table O-1. US06 and SC03 4,000-Mile SFTP Emission Standards for the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes[1]

Vehicle Type	Gross Vehicle Weight Rating (lbs)	Test Weight (lbs)	US06 Test (g/mi)		A/C Test (g/mi)	
			NMHC + NOx	CO	NMHC + NOx	CO
PC	All	All Vehicles in this category are tested at their loaded vehicle weight (curb weight plus 300 lbs)	0.14	8.0	0.20	2.7
LDT	≤ 6,000 lbs	0-3,750 lbs Vehicles in this category are tested at their loaded vehicle weight (curb weight plus 300 lbs)	0.14	8.0	0.20	2.7
		3,751-5,750 lbs Vehicles in this category are tested at their loaded vehicle weight (curb weight plus 300 lbs)	0.25	10.5	0.27	3.5
MDV	6,001-8,500 lbs	3,751-5,750 lbs Vehicles in this category are tested at their adjusted loaded vehicle weight (average of curb weight and GVWR)	0.40	10.5	0.31	3.5
		5,751-8,500 lbs Vehicles in this category are tested at their adjusted loaded vehicle weight (average of curb weight and GVWR)	0.60	11.8	0.44	4.0

[1] See footnotes, Standards and Test Procedures, table entitled “SFTP Exhaust Emission Standards for LEV, ULEV, and SULEV Vehicles in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes”.

III. SUMMARY OF PROPOSAL

Staff is proposing new SFTP emission standards and test procedures to ensure that control of off-cycle emissions is extended throughout the full useful life of on-road motor vehicles. The proposed SFTP emission standards, together with the proposed LEV III FTP emission standards, would require SULEV level emission performance from

[2] Medium-duty vehicles 6,001-8,500 lbs are designated as Light-Duty Trucks 6,001-8,500 in the proposed SFTP requirements.

[3] See footnote 2.

all new vehicles up to and including 14,000 lbs GVWR by the 2025 model year. Staff's proposal would increase the stringency and the emission control durability requirements of the existing SFTP program.

The proposed SFTP emission standards would follow a phase-in schedule similar to that of the proposed LEV III FTP emission standards. This would streamline the certification process and allow manufacturers to calibrate and fine-tune their emission control strategies in meeting both the proposed LEV III FTP and SFTP emission standards on the same certification test groups. In general, emission control strategies that reduce FTP emissions also reduce US06 and SC03 emissions. Thus, as manufacturers make modifications to vehicles in order to comply with the proposed LEV III FTP emission standards, there would likely be a concomitant reduction in SFTP emissions. Some possible technologies to meet the proposed SFTP regulations are discussed in Section V of this report.

The proposed emission standards for ozone precursors are proposed in terms of non-methane organic gases plus oxides of nitrogen (NMOG+NOx) rather than non-methane hydrocarbon plus NOx (NMHC+NOx). A conversion factor of 1.03 would be used to calculate NMOG from NMHC. Carbon Monoxide (CO) emission standards would continue, while emission standards for particulate matter (PM) would be added. The elements of staff's SFTP proposal are detailed in this section.

A. Applicability

The proposed SFTP emission standards and test procedures would be applicable to 2015 and subsequent model year Light-Duty Vehicles (LDVs), 2018 and subsequent model year Medium-Duty Passenger Vehicles (MDPVs), and 2016 and subsequent model year Medium-Duty Vehicles (MDVs) 8,501-14,000 lbs GVWR. Like the LEV III FTP proposal, the SFTP requirements would apply to gasoline, diesel, multi-fueled, alternative-fueled, and hybrid electric vehicles.

Under staff's proposal, SFTP emission standards would continue to be applied by vehicle weight classification. However, the new vehicle weight categories[4] for the SFTP are proposed to be: Passenger Cars (all weights); Light-Duty Trucks 0-8,500 lbs GVWR; MDPVs over 8,500 lbs GVWR; MDVs 8,501-10,000 lbs GVWR; and MDVs 10,001-14,000 lbs GVWR.

[4] Under the existing SFTP program, vehicles from 6,001 through 8,500 lbs GVWR are designated as medium-duty vehicles. Under this proposal, such vehicles would be included in the light-duty truck category and only vehicles above 8,500 lbs GVWR would be designated as medium-duty vehicles.

B. SFTP 150,000-mile Exhaust Emission Standards for Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles

1. NMOG+NOx and CO Emission Standards

Staff is proposing new SFTP full useful life 150,000-mile NMOG+NOx[5] and CO exhaust emission standards for LDVs and MDPVs that would replace the 4,000-mile exhaust emission standards. These new emission standards would align with the FTP LEV III durability period of 150,000 miles. Staff is proposing two pathways to meet the SFTP NMOG+NOx and CO emission standards. Option 1 would use stand-alone emission standards that are similar to those proposed for LEV III FTP certification. Option 2 would use a composite approach for exhaust emissions, with a fleet averaging provision for NMOG+NOx. Staff believes that these options would provide planning flexibility without compromising emission reductions.

Table O-2 shows the staff's proposal for the Option 1 stand-alone NMOG+NOx and CO exhaust emission standards for passenger cars (PCs), light-duty trucks (LDTs), and MDPVs. The standard emission categories are Low-Emission Vehicle (LEV), Ultra-Low-Emission Vehicle (ULEV), and Super-Ultra-Low-Emission Vehicle (SULEV), which are consistent with the FTP emission categories. Additionally, these stand-alone SFTP emission standard categories would each be directly tied to the equivalent emission category in the FTP program, except that the additional ULEV and SULEV subcategories that are being proposed for the LEV III FTP are not being proposed for the SFTP.

For Option 1, a sub-option is being proposed to allow manufactures to certify LDTs 6,001-8,500 lbs GVWR and MDPVs that include a particulate filter to a higher NMOG+NOx emission standard between model years 2015 and 2020 inclusive in exchange for extending the particulate filter emission warranty mileage to 200,000 miles. Manufacturers may find that this option provides them with some additional flexibility for these vehicles. Staff believes that the Option 1 stand-alone SFTP exhaust emission standards provide the best streamlined approach because they are linked directly to the LEV III FTP emission standards and would follow the same phase-in schedule being proposed for 150,000-mile durability requirements.

[5] The combined standard for NMOG and NOx increases compliance flexibility while continuing to address air pollution control goals.

Table O-2. SFTP 150,000-mile NMOG+NOx and CO Stand-Alone Exhaust Emission Standards for New 2015 and Subsequent Model Year LEVs, ULEVs, and SULEVs in the Passenger Car, Light-Duty Truck, and Medium-Duty Passenger Vehicle Classes, Option 1[1,2,3]

			US06 Test (g/mi)		SC03 Test[4] (g/mi)	
Vehicle Type	**Mileage for Compliance**	**Vehicle Emission Category[5]**	**NMOG + NOx**	**Carbon Monoxide**	**NMOG + NOx**	**Carbon Monoxide**
All PCs, LDTs 0-8,500 lbs GVWR, and MDPVs 8,501-10,000 lbs GVWR. Vehicles in this category are tested at their loaded vehicle weight (curb weight plus 300 pounds) on the same fuel used for FTP certification	150,000	LEV	0.140	9.6	0.100	3.2
		ULEV	0.120	9.6	0.070	3.2
		SULEV Option A[6]	0.060	9.6	0.020	3.2
		SULEV	0.050	9.6	0.020	3.2

[1] *Air to Fuel Ratio Requirement*. With the exception of cold-start conditions, warm-up conditions and rapid-throttle motion conditions ("tip-in" or "tip-out" conditions), the air-fuel ratio shall not be richer at any time than, for a given engine operating condition (e.g., engine speed, manifold pressure, coolant temperature, air charge temperature, and any other parameters), the leanest air-fuel mixture required to obtain maximum torque (lean best torque), with a tolerance of three percent of the fuel consumption. The emission control system shall remain in the operating mode producing the best balance of hydrocarbon, CO and NOx catalyst efficiency (e.g., closed loop/ stoichiometric operation on 3-way catalyst system) under all conditions except when required for engine component temperature protection, driver power request, start enrichment requirements, fuel shut-off situations (decelerations, rev limiter, torque management, etc.) or certain component malfunctions preventing safe closed loop operation. The Executive Officer may approve a manufacturer's request for approval to use additional enrichment in subsequent testing if the manufacturer demonstrates that additional enrichment is needed to protect the vehicle, occupants, engine, or emission control hardware.

[2] *"Lean-On-Cruise" Calibration Strategies*. In the Application for Certification, the manufacturer shall state whether any "lean-on-cruise" strategies are incorporated into the vehicle design. A "lean-on-cruise" air-fuel calibration strategy is defined as the use of an air-fuel ratio significantly greater than needed for stoichiometric combustion, during non-deceleration conditions at speeds above 40 mph. "Lean-on-cruise" air-fuel calibration strategies shall not be employed during vehicle operation in normal driving conditions, including when the air conditioner (A/C) is used, unless at least one of the following conditions is met:

1. Such strategies are substantially employed during the FTP or SFTP; or

2. Such strategies are demonstrated not to significantly reduce vehicle NMOG+NOx emission control effectiveness over the operating conditions in which they are employed; or

3. Such strategies are demonstrated to be necessary to protect the vehicle, occupants, engine, or emission control hardware.

If the manufacturer proposes to use a "lean-on-cruise" calibration strategy, the manufacturer shall specify the circumstances under which such a calibration would be used, and the reason or reasons for the proposed use of such a calibration.

The above provisions shall not apply to vehicles powered by "lean-burn" engines or Diesel-cycle engines. A "lean-burn" engine is defined as an Otto-cycle engine designed to run at an air-fuel ratio significantly greater than needed for stoichiometric combustion during the large majority of its operation.

[3] *In-use Compliance Margin for Transitional Vehicles*. Through the 2019 model year, a multiplicative factor of 1.4 shall be applied to the applicable NMOG+NOx or CO certification emission standard in order to derive the in-use emission standard that shall apply during confirmatory testing.

[4] *A/C-on Specific Calibrations*. A/C-on specific calibrations (e.g., air-fuel ratio, spark timing, and exhaust gas recirculation) may be used which differ from A/C-off calibrations for given engine operating conditions (e.g., engine speed, manifold pressure, coolant temperature, air charge temperature, and any other parameters). Such calibrations must not unnecessarily reduce the NMOG+NOx emission control effectiveness during A/C-on operation when the vehicle is operated under conditions which may reasonably be expected to be encountered during normal operation and use. If reductions in control system NMOG+NOx effectiveness do occur as a result of such calibrations, the manufacturer shall, in the Application for Certification, specify the circumstances under which such reductions do occur, and the reason for the use of such calibrations resulting in such reductions in control system effectiveness.

A/C-on specific "open-loop" or "commanded enrichment" air-fuel enrichment strategies (as defined below), which differ from A/C-off "open-loop" or "commanded enrichment" air-fuel enrichment strategies, may not be used, with the following exceptions: cold-start and warm-up conditions, or, subject to Executive Officer approval, conditions requiring the protection of the vehicle, occupants, engine, or emission control hardware. Other than these exceptions, such strategies which are invoked based on manifold pressure, engine speed, throttle position, or other engine parameters shall use the same engine parameter criteria for the invoking of this air-fuel enrichment strategy and the same degree of enrichment regardless of whether the A/C is on or off.

"Open-loop" or "commanded" air-fuel enrichment strategy is defined as enrichment of the air-fuel ratio beyond the stoichiometric ratio for the purposes of increasing engine power output and/or the protection of engine or emissions control hardware. However, "closed-loop biasing," defined as small changes in the air-fuel ratio for the purposes of optimizing vehicle emissions or driveability, shall not be considered an "open-loop" or "commanded" air-fuel enrichment strategy. In addition, "transient" air-fuel enrichment strategy ("tip-in" and "tip-out" enrichment), defined as the temporary use of an air-fuel ratio richer than needed for stoichiometric combustion at the beginning or duration of rapid throttle motion, shall not be considered an "open-loop" or "commanded" air-fuel enrichment strategy.

[5] *Vehicle Emission Categories. S*FTP requirements are linked with LEV III FTP requirements. All FTP LEVs certified to 150,000 mile durability shall comply with the SFTP 150,000 mile LEV standard, all FTP ULEVs certified to 150,000 mile durability shall comply with the SFTP 150,000 mile ULEV standard and all FTP SULEVs certified to 150,000 mile durability shall comply with the SFTP 150,000 mile SULEV standard.

[6] *Optional SFTP SULEV Standard*. A manufacturer may certify its light-duty truck fleet from 6,001-8,500 lbs GVWR and its MDPV fleet to the SULEV, option A, emission standards set forth in Test Procedures, Section E.1.2.3 for the 2015 through 2020 model years only if the vehicle is equipped with a particulate filter and the manufacturer extends the particulate filter emission

warranty mileage to 200,000 miles. Passenger cars other than MDPVs and light-duty trucks 0-6,000 lbs GVWR are not eligible for this option.

Manufacturers expressed some concern over variability in results from the US06 test cycle and requested a composite emission standard option. Therefore, staff is proposing an additional option (Option 2) for PCs, LDTs, and MDPVs, wherein manufacturers could comply with composite emission standards instead of US06-specific emission standards. To demonstrate compliance, manufacturers would calculate composite emission values for each certification test group by weighting the emission test results from the FTP, US06 and SC03 tests, as shown by the following equation:

SFTP Composite Emission Value = 0.28 x US06 + 0.37 x SC03 + 0.35 x FTP [Eq. 1]

This is the same equation currently used for federal SFTP compliance determination. If no vehicles in a test group have air conditioning units, the FTP cycle emission value can be used in place of the SC03 cycle emission value in Equation 1.

For NMOG+NOx, manufacturers would demonstrate compliance through a sales-weighted fleet average for any given model year instead of meeting the composite emission standard with each individual test group. Specifically, manufacturers would certify vehicles to “bins”, each with a testing-based NMOG+NOx composite emission value serving as the emission standard for that bin, analogous to an FEL, or family emission limit. These bins would be valued in 0.010 g/mi increments[6] and, starting with the 2018 model year, vehicles would not be able to certify to bins with a composite emission value above 0.180 g/mi. Once separated into bins, manufacturers would weight, by sales, the composite emission value of each bin to determine compliance with the proposed NMOG+NOx composite emission standard for that model year. Beginning with the 2015 model year, the NMOG+NOx composite emission standard would gradually become more stringent through model year 2025, when the composite emission standard would reach 0.050 g/mi NMOG+NOx, as shown in Table O-3. The sales-weighted fleet-average NMOG+NOx composite emission value for each model year would be calculated using a combination of carryover SFTP composite emission values (adjusted to 120,000-miles and converted to NMOG+NOx) and 150,000-mile SFTP composite emission values. Since MDPVs do not have existing SFTP requirements, they would not be included in the fleet average calculation until they are required to certify to FTP emission standards at 150,000-mile durability.

Under this option, there is no fleet averaging proposed for CO; CO emissions would be capped and each individual certification test group would be required to comply with the CO composite emission standard.[8]

[6] During the phase-in period, for the first two model years after a test group is certified to a new bin, in-use test results up to 1.4 times the appropriate certified bin would be accepted.

[8] During the phase-in period, for the first two model years after a test group is certified to SFTP 150,000-mile durability requirements, in-use test results up to 1.4 times the CO emission standard would be accepted.

Table O-3. SFTP NMOG+NOx and CO Composite Exhaust Emission Standards for New 2015 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles (Option 2) [1,2,3,4]

Model Year	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
All PCs, LDTs 0-8,500 lbs GVWR, and MDPV 8,501-10,000 lbs GVWR. Vehicles in this category are tested at their loaded vehicle weight (curb weight plus 300 pounds) on the same fuel used for FTP certification	**NMOG+NOx Sales-Weighted Fleet Average Composite Exhaust Emission Standards (g/mi)** [5,6,7,8]										
	0.140	0.110	0.103	0.097	0.090	0.083	0.077	0.070	0.063	0.057	0.050
	CO Composite Exhaust Emission Standard (g/mi) [9]										
	4.2										

[1] *Air to Fuel Ratio Requirement. S*ee footnote 1, Table O-Table O-2.
[2] *"Lean-On-Cruise" Calibration Strategies*. See footnote 2, Table O-2.
[3] *A/C-on Specific Calibrations*. See footnote 4, Table O-2.
[4] MDPV test groups would neither be subject to these emission standards nor be included in the NMOG+NOx fleet average until they certify to FTP emission standards at 150,000-mile durability.
[5] For carry-over test groups not certified to LEV III FTP emission standards on a 150,000-mile durability basis, SFTP emission values shall be projected out to a 120,000-mile durability basis. Deterioration factors or aged parts may be used to determine individual composite emission values for these test groups.
[6] Test groups shall certify to bins in increments of 0.010 g/mi. Beginning with the 2018 model year, vehicles would not be able to certify to bin values above a maximum of 0.180 g/mi.
[7] *Calculating the sales-weighted fleet-average.* For each model year, the manufacturer shall calculate its sales-weighted fleet-average NMOG+NOx composite emission values as follows:

$$\frac{\sum_{i=1}^{n}[(\text{number of vehicles in test group})_i \times (\text{Composite Emission Value of Bin})_i]}{\sum_{i=1}^{n}(\text{number of vehicles in test group})_I} \quad \text{[Eq. 2]}$$

where "n" = a manufacturer's total number of certification bins in the PC, LDT 0-8,500 lbs GVWR, and MDPV (if applicable) categories for a given model year, including carryover certification bins;
"number of vehicles in test group" = the number of vehicles produced and delivered for sale in California in the certification test group;
"Composite Emission Value of Bin" = the numerical value selected by the manufacturer for the test group that serves as the emission standard for the vehicles in the test group with respect to all testing, instead of the emission standard specified.

MDPVs will be excluded from the sales-weighted average until they are certified to LEV III FTP 150,000-mile durability requirements.
[8] *Calculation of Fleet Total NMOG+NOx Credits or Debits. A* manufacturer shall calculate the total NMOG+NOx credits or debits as follows:

[(NMOG+NOx Composite Emission Standard) – (Manufacturer's NMOG+NOx Composite Emission Value)] x (Total Number of Vehicles Produced and Delivered for Sale in California in the 0-8,500 lbs GVWR plus MDPV classes) [Eq. 3]

A negative number constitutes total NMOG+NOx debits, and a positive number constitutes total NMOG+NOx credits accrued by the manufacturer for the given model year. Total NMOG+NOx credits earned in a given model year retain full value through the fifth model year after they are earned. At the beginning of the sixth model year, the total NMOG+NOx credits have no value. A manufacturer shall equalize total NMOG+NOx debits by earning total NMOG+NOx credits in an amount equal to the total NMOG+NOx debits within three model years after they have been incurred. Manufacturers would be allowed to trade credits with other manufacturers. If total NMOG+NOx debits are not equalized within the three model year 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 total 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 debits for the model year by the fleet average emission standard for the model year in which the debits were first incurred.

[9] *CO requirement.* The proposed CO composite emission standard applies to each individual test group. Compliance would be demonstrated using a weighted composite emission value of FTP, US06, and SC03 test results, calculated in accordance with Equation 1. There are no fleet averaging provisions. MDPVs are excluded from the composite CO requirements until they are certified to LEV III FTP 150,000-mile durability requirements.

2. PM Emission Standards

Staff also is proposing new SFTP full useful life PM exhaust emission standards for LDVs and MDPVs. As vehicles age, oil consumption tends to increase. Engine oil consumption is correlated with PM generation. By controlling PM, staff believes that efforts will be made to control oil consumption in older vehicles. The proposed standards begin with the 2017 model year, and are presented in Table O-4.

Table O-4. SFTP PM Exhaust Emission Standards for New 2017 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles[1]

Vehicle Type	Test Weight	Mileage for Compliance	Test Cycle	PM mg/mi
PCs 0-8,500 lbs GVWR; LDTs 0-6,000 lbs GVWR	Loaded vehicle weight	150,000	US06	10.0
LDTs 6,001-8,500 lbs GVWR; MDPVs 8,501-10,000 lbs GVWR	Loaded vehicle weight	150,000	US06	20.0

[1] Requirements apply to all PCs, LDTs, and MDPVs certified to 150,000-mile durability FTP PM emission standards of 3 mg/mi or 1 mg/mi.

C. SFTP 150,000-mile Exhaust Emission Standards for Medium-Duty Vehicles

Staff is proposing new SFTP full useful life exhaust emission standards for MDVs from 8,501-14,000 lbs GVWR (MDPVs would certify under the LDV standards). These new emission standards would be phased in at the same model year percentages as the LEV III FTP useful life mileage requirement of 150,000 miles. Consistent with the LEV III FTP phase-in schedule, MDV requirements would not effectively begin until the 2016 model year.

1. NMOG+NOx and CO Emission Standards

Medium-duty vehicles would be subject to composite emission standards for NMOG+NOx and CO, tied to the LEV III FTP. The proposed standards are presented in Table O-5. The MDVs in this class often carry significantly heavier payloads than their light-duty counterparts. Therefore, staff set the proposed US06 standards based on ALVW to account for the extra payload and associated excess emissions. This is also consistent with the treatment of these vehicles in the proposed LEV III FTP program.

SC03 Air-Conditioner Simulation. Because MDVs have significantly larger displacement engines, and more power and torque, compared to LDVs, the effect on emissions of using the air conditioner for this class appears to be less significant. Medium-duty vehicles using the latest air conditioner technology should have no difficulty complying with the proposed SC03 emission standards. However, manufacturers expressed some concern about costs associated with the SC03 test for MDVs, noting that significant upgrades would be required for their environmental test cells to handle MDVs. Manufacturers proposed, and staff agreed, that an engineering evaluation be accepted when certifying these vehicles to the proposed SC03 emission standards. Manufacturers opting to submit engineering analyses in lieu of actual test results for the SC03 cycle would use FTP results instead of the SC03 results when calculating the composite emission values for the applicable test group.

Table O-5. SFTP NMOG+NOx and CO Exhaust Emission Standards for New 2016 and Subsequent Model Year Medium-Duty Vehicles[1,2,3,4]

Vehicle Type	Mileage for Compliance	Hp/GVWR[6]	Test Cycle[7]	Vehicle Emission Category	SFTP Composite Emission Standard[5] (g/mi)	
					NMOG + NOx	Carbon Monoxide
MDV 8,501-10,000 lbs GVWR	150,000	≤ 0.024	US06 Bag 2, SC03, FTP	ULEV	0.550	22.0
				SULEV	0.350	12.0
		> 0.024	Full US06, SC03, FTP	ULEV	0.800	22.0
				SULEV	0.450	12.0
MDV 10,001-14,000 lbs GVWR	150,000	n/a	UC (LA92), SC03, FTP	ULEV	0.550	6.0
				SULEV	0.350	4.0

[1] *Air to Fuel Ratio Requirement. S*ee footnote 1, Table O-2.
[2] *"Lean-On-Cruise" Calibration Strategies*. See footnote 2, Table O-2.

[3] *A/C-on Specific Calibrations*. See footnote 4, Table O-2.
[4] *MDV Model Year Phase-in. F*or each model year, the number of MDVs from 8,501-10,000 lbs GVWR certified to a 150,000-mile SFTP emission category must be equal to or greater than the number certified to the FTP ULEV250, ULEV 200, SULEV 170, and SULEV 150 emission categories and the number certified to a 150,000-mile SFTP SULEV emission category must be equal to or greater than the number certified to FTP SULEV 170 and SULEV 150 emission categories. Additionally, for each model year, the number of MDVs from 10,001-14,000 lbs GVWR certified to a 150,000-mile SFTP emission category must be equal to or greater than the number certified to the FTP ULEV400, ULEV 270, SULEV 230, and SULEV 200 emission categories and the number certified to a 150,000-mile SFTP SULEV emission category must be equal to or greater than the number certified to SULEV 230 and SULEV 200 emission categories.
[5] SFTP Composite Value for MDVs 8,501-10,000 lbs GVWR = 0.28 x US06 (or US06 Bag 2, as appropriate) + 0.37 x SC03 + 0.35 x FTP, in g/mi.
SFTP Composite Value for MDVs 10,001-14,000 lbs GVWR = 0.28 x UC + 0.37 x SC03 + 0.35 x FTP, in g/mi.
[6] *Power to Weight Ratio*. If all vehicles in a test group have a power to weight ratio at or below a threshold of 0.024, they may opt to run the US06 Bag 2 in lieu of the full US06 cycle. The cutoff is determined by using a ratio of the engine's horsepower to its GVWR in pounds and does not include any horsepower contributed by electric motors in the case of hybrid electric or plug-in hybrid electric vehicles. The standards presented for Bag 2 are equivalent in stringency to the full US06 cycle standards, and manufacturers may opt to test to the full cycle regardless of the calculated ratio. In that case, manufacturers shall meet the requirements under the >0.024 provision.
[7] Vehicles in this category are tested at their adjusted loaded vehicle weight (average of curb weight and GVWR).

2. PM Emission Standards

Staff also is proposing new SFTP full useful life PM exhaust emission composite standards for MDVs, as shown in Table O-6. These proposed standards may appear more stringent than those for the light-duty fleet shown in Table O-4 because the PM standards for the MDV fleet are a composite standard, weighting the FTP, US06 (or equivalent) and SC03 cycles, whereas the light-duty standards are presented in terms of the US06 cycle only.

Table O-6. SFTP PM Composite Exhaust Emission Standards for New 2017 and Subsequent Model Year Medium-Duty Vehicles[1]

Vehicle Type	Test Weight	Mileage for Compliance	Hp/GVWR[2]	Test Cycles	PM[3] mg/mi
MDVs 8,501-10,000 lbs GVWR	Adjusted loaded vehicle weight	150,000	≤ 0.024	FTP, US06 Bag 2, SC03	7.0
			> 0.024	FTP, US06, SC03	10.0
MDVs 10,001-14,000 lbs GVWR	Adjusted loaded vehicle weight	150,000	n/a	FTP, UC (LA92), SC03	7.0

[1] Requirements apply to all MDVs certified to 150,000-mile durability FTP PM emission standards of 8 mg/mi or 10 mg/mi.

[2] *Power to Weight Ratio*. See footnote 6, Table O-5.
[3] See footnote 5, Table O-5.

D. Test Procedures

Compliance with the existing SFTP emission standards is determined using the US06 and SC03 test procedures, as previously discussed. For the light-duty fleet, these test procedures would continue to be used to determine compliance with the proposed 150,000-mile SFTP emission standards. Where feasible, MDVs would also use these test procedures.

However, as discussed with manufacturers, while most MDVs can and do operate in the US06 domain[7], some MDVs in the 8,501-10,000 lbs GVWR class have difficulty following the US06 trace, particularly where the power-to-weight ratio is low. As noted in footnote 6 of Table O-5, manufacturers of these vehicles have the option to assess only bag 2 of the US06 cycle when the ratio of the engine's horsepower to the vehicle's GVWR in pounds is 0.024 or less. The US06 Bag 2 cycle, presented in Figure O-3**,** does not include the frequent accelerations and decelerations at the beginning and end of the full US06 cycle which could cause overheating problems and be particularly troublesome for low-powered MDVs to follow. However, it still reaches the same maximum speed of 80.3 mph as the full US06 cycle. The emission standards have been adjusted to reflect the abridged cycle and are equivalent in stringency to the full US06 emission standard. In addition, MDV testing is performed at ALVW to account for the extra payload and associated excess emissions as well as to streamline the 150,000-mile SFTP test procedures with the FTP test procedures for LEV III vehicles.

Medium-duty vehicles greater than 10,000 lbs GVWR also may have difficulty following the US06 driving trace. Therefore, staff is proposing to allow the use of the California Unified Cycle (UC) for these vehicles, presented in Figure O-4. The UC is a dynamometer driving schedule that is similar to the US06 test cycle, but with less aggressive speeds and acceleration. Overlapping the US06 and UC test cycles, as illustrated in Figure O-5, shows that the UC test cycle is 58 percent longer in duration, but only achieves about half the average speed. Its peak speed is 16 percent lower, at 67.2 mph, while the US06 test cycle's peak speed is 80.3 mph. The maximum acceleration is 6.9 mph/s^2 for the UC test cycle compared to 8.4 mph/s^2 for the US06 test cycle. Although designed as a cold start cycle, staff proposes to require preconditioning for the cycle such that the UC test cycle is performed as a hot-start test cycle like the US06. Again, testing of these heavier MDVs is performed at ALVL. An MDV 10,001-14,000 lbs GVWR operating over the UC test cycle should experience comparable engine loads to a lighter MDV operating over the US06 cycle. The proposed emission standards have been adjusted to reflect the different emission result that would be obtained under the UC as opposed to the US06 test cycle. This is why

[7] Real-world driving patterns of MDVs are discussed in the next chapter.

the heavier MDVs in Table O-5 appear to have more stringent requirements than the lighter MDVs.

Figure O-3. US06 Bag 2 Test Cycle

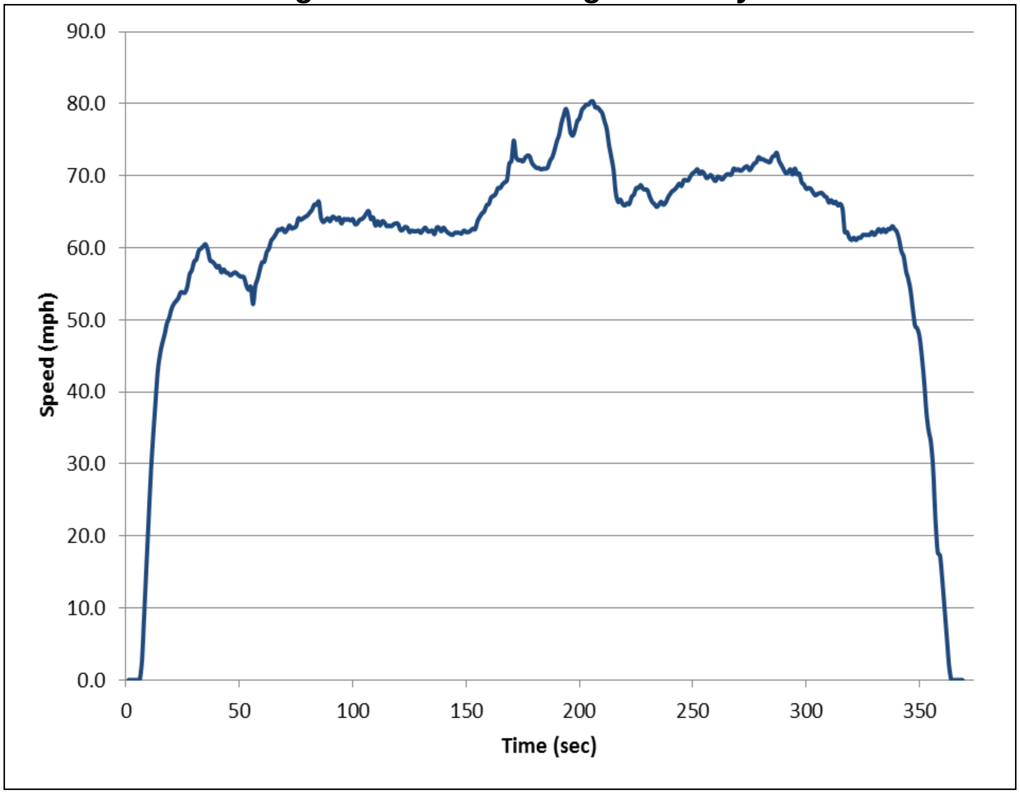
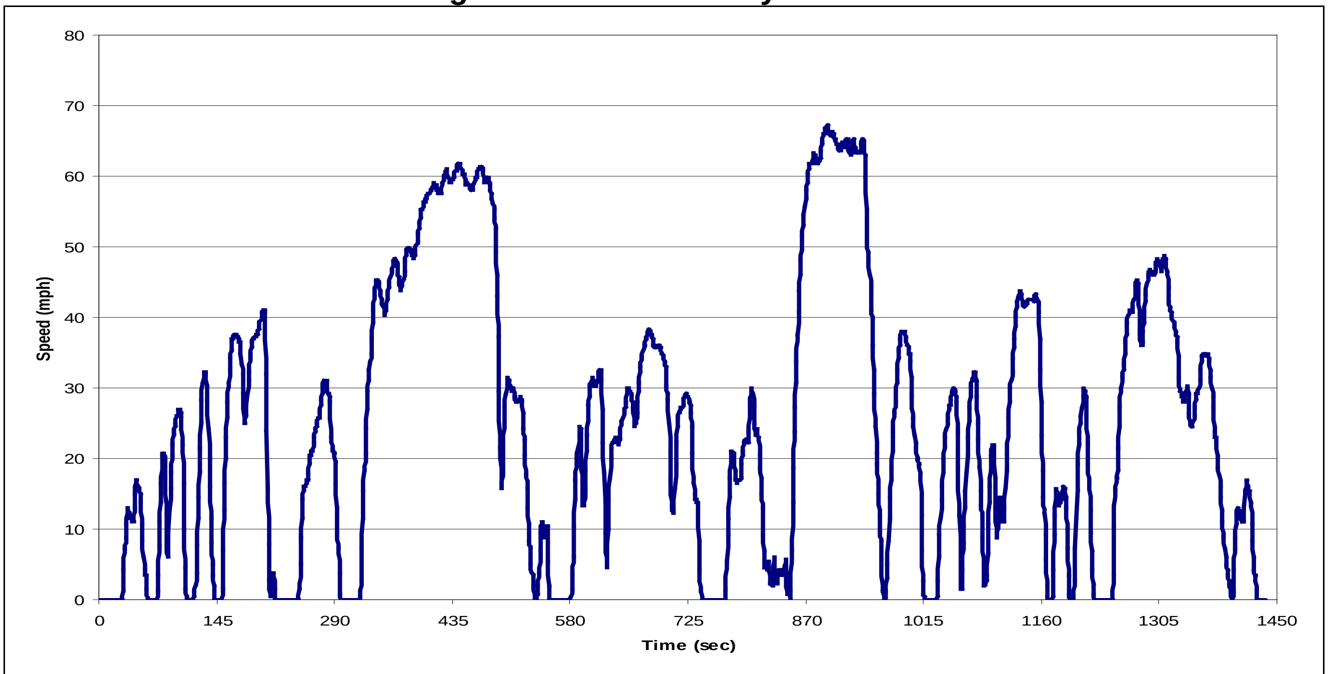
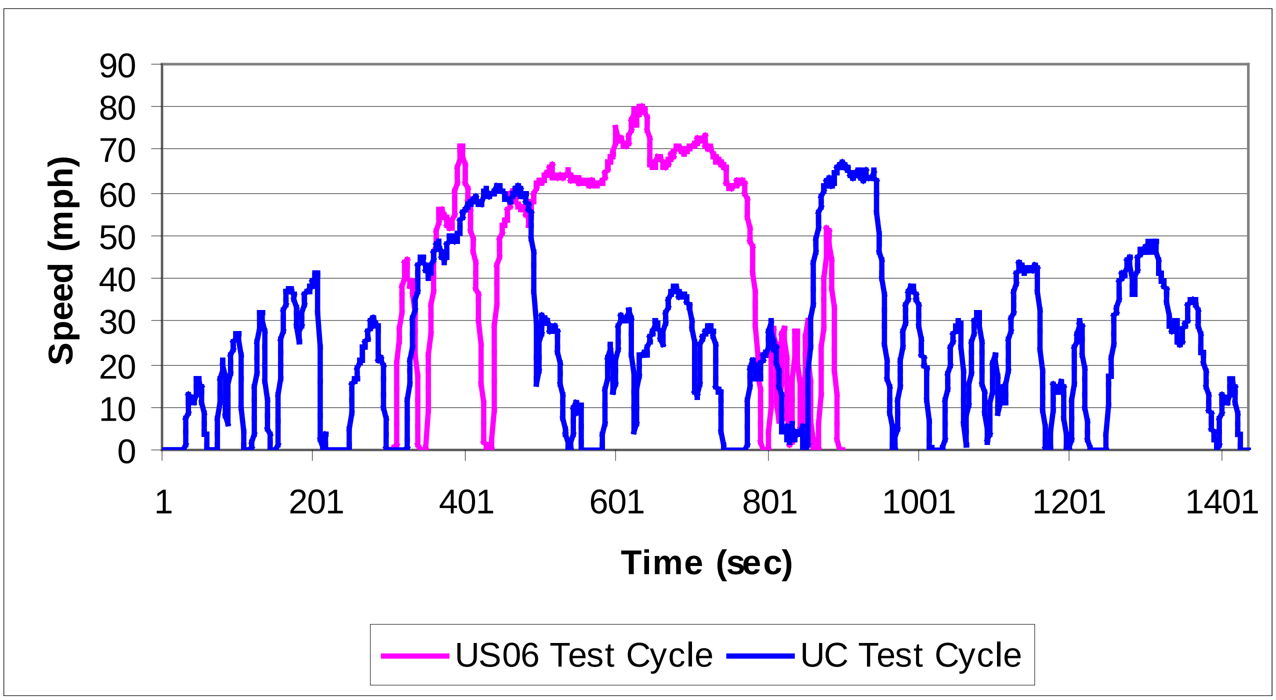


Figure O-4. UC Test Cycle[1]



[1]The cycle represents a 9.8 mile (15.7 km) route with an average speed of 24.6 mph (39.6 km/h), maximum speed of 67.2 mph (108.14 km/h), and a duration of 1435 seconds.

Figure O-5. US06 and UC Test Cycles Comparison



The use of the UC test cycle for MDVs 10,001-14,000 lbs GVWR in lieu of the US06 test cycle should provide more flexibility to manufacturers in meeting the proposed SFTP emission standards while still accounting for off-cycle emissions throughout the useful life of the vehicle.

E. Change from a NMHC to a NMOG-based Standard

The LEV III FTP program sets hydrocarbon emission standards on an NMOG basis. The existing 4,000-mile SFTP requirements base hydrocarbon emission standards on NMHC. Since NMOG includes photochemically-reactive oxygenated hydrocarbons that NMHC does not, it more accurately represents total ozone-forming hydrocarbons. Therefore, staff proposes to use an NMOG basis for the proposed 150,000-mile SFTP emission standards, which is consistent with the emission standards of the LEV III FTP program.

However, since option 2 for the light-duty fleet is a fleet average compliance approach, and since during the phase-in period, there would be many 4,000-mile certifications included in the fleet-average calculations, there is a need to convert these carryover SFTP emission values to NMOG-based emission values. Although it was suggested that the conversion factor should be a function of the ethanol content of the fuel, tests run by USEPA[8] on LA92 bag 2, a warmed-up cycle, showed no direct or indirect correlation between ethanol content and the NMOG/NMHC ratio. To determine an appropriate conversion factor, staff averaged the NMOG/NMHC ratios obtained over the entire range of different ethanol levels evaluated by USEPA. Since US06 is also a hot-start test, staff expects an NMOG/NMHC ratio similar to that derived from the LA92 bag 2 tests. Based on this analysis, staff is proposing to use a conversion factor of 1.03 to convert SFTP NMHC to NMOG. Thus, to demonstrate compliance with SFTP option 2, manufacturers would be required to convert NMHC to NMOG, where applicable, using the 1.03 conversion factor. Staff believes that setting the standards using NMOG instead of NMHC would not be a significant burden for manufacturers.

IV. TEST PROGRAMS

A. NMHC+NOx and CO Test Program

Staff began a test program in 2006 to (1) evaluate the feasibility of updating the existing SFTP exhaust emission standards to full useful life 150,000-mile emission standards, (2) provide a basis for adopting more stringent SFTP emission standards to reflect newer technology, (3) support the harmonization of vehicle weight categories among state and federal FTP and SFTP programs, and (4) evaluate the feasibility of requiring medium-duty and alternative-fueled vehicles to meet SFTP emission standards. A summary of the results follows.

California-registered vehicles, listed in Table O-7, were procured by an independent contractor. The gasoline vehicles were tested in triplicate using California

[8] Personal Communication, Aron Butler, USEPA to David Eiges, ARB, June 23, 2011

certification gasoline fuel on the FTP, US06 and the SC03 test cycle. To assess the impact of ethanol in the fuel, the gasoline vehicles were also tested on commercial summertime gasoline with about 6 percent ethanol. The diesel vehicle was tested in triplicate using ultra low sulfur diesel fuel.

1. Evaluating Gasoline-Fueled Vehicles

When evaluating the test results from conventionally-fueled vehicles, staff only considered the data from LEV II certified vehicles since vehicles can no longer be certified to LEV I levels. Thirteen in-use LEV II gasoline-fueled vehicles were evaluated in this test program. These test vehicles were representative, in terms of weight, of the mix of LEV II vehicles presently in the California fleet.

Table O-8 shows the in-use LEV II certified vehicles that staff tested using California Phase 2 certification test fuel on the FTP, US06, and SC03 test cycles. Similar results were obtained using commercial fuel, as shown in Table O-9.

Table O-7. ARB SFTP Test Program Vehicles

Test Vehicle[1]	Model Year	Vehicle	Mileage	Emission Standard Category	Vehicle Type
1	2006	Chevrolet Box Van	400	ULEV	MDV 10,001-14,000 lbs
2	2003	Ford Focus 1	75,000	LEVII SULEV	PC
3	2003	Honda Accord	31,000	LEVII ULEV	PC
4	2003	Toyota Camry	60,000	ULEV	PC
5	2003	Toyota Corolla 1	40,000	ULEV	PC
6	2004	Chevrolet Impala 1	63,000	LEVII LEV	PC
7	2003	Honda CRV	44,000	LEVII LEV	LDT ≤ 8,500 lbs
8	2004	Dodge Neon	51,000	ULEV	PC
9	2004	Chevrolet Impala 2	86,000	LEVII LEV	PC
10	2003	Toyota Corolla 2	47,000	ULEV	PC
11	2006	Chevrolet Silverado 1	11,000	SULEV	LDT ≤ 8,500 lbs
12	2006	Chevrolet Express 1	9,000	LEV	LDT ≤ 8,500 lbs
13	2004	Toyota Tundra	31,000	ULEV	LDT ≤ 8,500 lbs
14	2005	Ford Focus 2	30,000	LEVII SULEV	PC
15	2006	Chevrolet 2500 HD (dual fuel)	8,000	ULEV	LDT ≤ 8,500 lbs
16	2006	Chevrolet Impala 3 (flex fuel)	6,000	ULEV	PC
17	2007	Chevrolet Express 2	6,000	LEVII LEV	MDV 8,501-10,000 lbs
18	2005	Ford E350	34,000	LEVII LEV	MDV 8,501-10,000 lbs
19	2005	Ford F-150	34,000	LEVII LEV	LDT ≤ 8,500 lbs
20	2004	Dodge Caravan	48,000	LEVII LEV	LDT ≤ 8,500 lbs
21	2002	Ford Crown Victoria (CNG)	115,000	LEVII ULEV	PC
22	2005	Dodge RAM Truck 1	72,000	LEV	LDT ≤ 8,500 lbs
23	2005	Dodge RAM Truck 2	25,000	LEVII LEV	MDV 8,501-10,000 lbs
24	2008	Ford F-350	1,000	LEVII ULEV	MDV 8,501-10,000 lbs
25	2006	Chevrolet Impala 4 (flex fuel)	31,000	ULEV	PC
26	2007	Chevrolet Silverado 2 (flex fuel)	27,000	LEVII LEV	LDT ≤ 8,500 lbs
n/a	2011[2]	Mercedes-Benz Sprinter 2500 (diesel fuel)	125,000	LEVII ULEV	MDV 8,501-10,000 lbs

[1] Vehicle 1 had a GVWR of 12,000 lbs. ARB's laboratory lacked the needed equipment to run the US06 cycle on this heavy vehicle and this vehicle was excluded from further analysis.
[2] This vehicle was a prototype.

Table O-8. ARB SFTP Test Program: FTP, US06, and SC03 Emission Results from Gasoline-Fueled LEV II Vehicles, Certification Fuel

Test Vehicle	Vehicle	Standard	NMHC+NOx			CO		
			FTP	US06	SC03	FTP	US06	SC03
2	Focus 1	LEVII SULEV	0.031	0.010	0.002	0.2	3.3	0.3
3	Accord	LEVII ULEV	0.042	0.046	0.022	0.6	0.5	0.4
6	Impala 1	LEVII LEV	0.092	0.089	0.062	1.1	2.3	0.6
7	CRV	LEVII LEV	0.072	0.009	0.014	3.2	0.8	0.1
9	Impala 2	LEVII LEV	0.134	0.054	0.039	1.0	1.4	0.2
14	Focus 2[1]	LEVII SULEV	0.137	0.002	0.003	0.6	2.0	0.2
19	F-150	LEVII LEV	0.042	0.006	0.008	2.3	2.9	1.8
20	Caravan	LEVII LEV	0.061	0.079	0.052	0.6	0.7	0.2
11	Silverado 1	LEVII LEV	0.042	0.026	0.028	1.7	2.7	1.8
17	Express Van 2[2]	LEVII LEV	0.11	0.06	0.04	2.4	3.7	1.2
18	E350[2]	LEVII LEV	0.08	0.03	0.02	2.3	6.4	1.1
23	Ram 2500[2]	LEVII LEV	0.20	0.21	0.14	1.1	1.9	0.2
24	F-350[2]	LEVII ULEV	0.10	n/a[3]	0.02	1.9	n/a	2.3

[1] This vehicle had a hard start issue which can be seen in the cold start portion of the FTP test. Although presented in the table for completeness, the FTP results were omitted from further analyses.
[2] MDV SC03 results are simulated using the procedure described in CFR 40 §86.162-00.
[3] The Ford F350 is in the 10,001-14,000 lbs GVWR weight class. Due to difficulties completing a valid US06 trace for this vehicle, US06 results from this vehicle are not available.

Table O-9. ARB SFTP Test Program: FTP, US06, and SC03 Emission Results from Gasoline-Fueled LEV II Vehicles, Commercial Fuel[1]

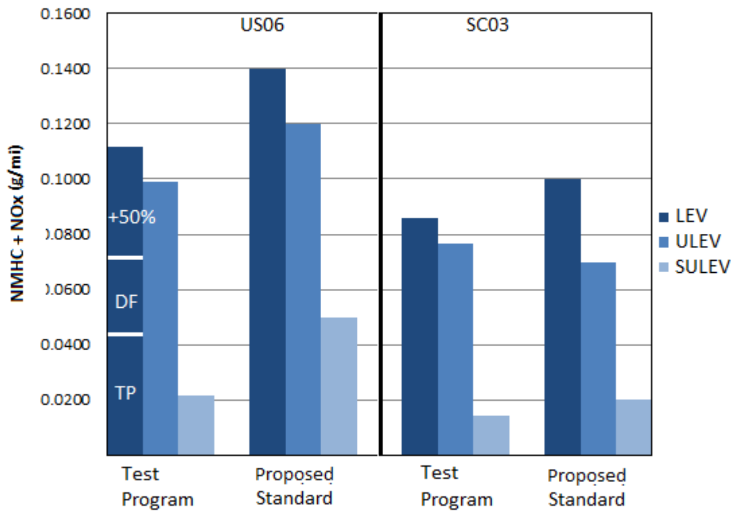
Test Vehicle	Model Year	Vehicle	Standard	NMHC+NOx			CO		
				FTP	US06	SC03	FTP	US06	SC03
2	2003	Focus 1	LEVII SULEV	0.032	0.008	0.002	0.3	2.4	0.2
3	2003	Accord	LEVII ULEV	0.037	0.044	0.031	0.6	0.9	0.4
6	2004	Impala 1	LEVII LEV	0.085	0.107	0.058	0.9	2.0	0.5
7	2003	CRV	LEVII LEV	0.066	0.011	0.005	0.7	7.0	0.1
9	2004	Impala 2	LEVII LEV	n/a	n/a	n/a	n/a	n/a	n/a
14	2005	Focus 2	LEVII SULEV	0.346	0.003	0.003	0.4	2.4	0.2
19	2005	F-150	LEVII LEV	0.039	0.006	0.003	1.3	6.1	1.3
20	2004	Caravan	LEVII LEV	0.059	0.132	0.042	0.6	0.7	0.2
11	2007	Silverado 1	LEVII LEV	0.039	0.022	0.024	1.5	3.6	1.7
17	2007	Express Van 2	LEVII LEV	0.096	0.052	0.053	2.1	1.5	0.8
18	2005	E350	LEVII LEV	0.084	0.017	0.024	2.1	6.8	1.8
23	2005	Ram 2500	LEVII LEV	0.173	0.217	0.133	1.2	5.0	0.3
24	2008	F-350	LEVII ULEV	n/a	n/a	n/a	n/a	n/a	n/a

[1] See footnotes 1-3, Table O-8

Staff used the results to determine the emission control capabilities of these vehicles. Since the test vehicles were not at full useful life, staff projected the observed emission values out to 150,000 miles by extrapolating from the reported 4,000-mile certification level and using FTP deterioration factors. The projected deterioration factors were applied to the average emissions from the test program for each exhaust category. Staff also added a 50 percent (1.5 times) compliance margin to account for test variability. This process is shown in Figure O-6 for NMHC+NOx where the average test results have been adjusted upwards by applying the deterioration factors and compliance margin. The adjusted test program emission levels formed the basis for the proposed emission standards. The proposed standards are slightly higher than the test program results in order to accommodate the potential downsizing of engines anticipated to occur due to the proposed greenhouse gas emission standards.

The proposed CO emission standards are intended to be capping standards to control potentially increased CO emissions due to HC- and NOx-reducing strategies. Similar adjustments were made to the CO test results to determine appropriate CO emission standards.

Figure O-6. Average NMHC+NOx Test Program Results Vehicles ≤ 8,500 lbs GVWR, Adjusted with Deterioration Factors and Compliance Margins



2. Evaluating Alternative-Fueled Vehicles

When the existing SFTP program was adopted, staff had intended to include alternative-fueled vehicles. However, staff was not able to test these vehicles at the time and consequently did not set emission standards for them. Table O-10 shows emission results from the 2006 ARB test program from three E85 flex-fuel vehicles. With deterioration factors and compliance margins applied, these flex-fuel vehicles appear to be well-positioned to comply with the proposed SFTP requirements.

ARB staff tested two CNG vehicles, also shown in Table O-10. The 2500 truck was certified to the older LEV I ULEV emission standards. The test results appear to show low enough emissions to meet the proposed SFTP SULEV emission standards for CO and the proposed SFTP LEV emission standards for NMOG+NOx. In contrast, the Crown Victoria, which is certified as an LEV II ULEV, experienced high US06 and FTP emissions. Staff is aware that it is not uncommon for many CNG Crown Victorias to have relatively high emissions towards the end of their useful lives. This observation has not been similarly made for other CNG vehicles.

Automobile manufacturers have indicated that the proposed SFTP standards would not be a burden for alternative-fueled vehicles. LEV III FTP-certified vehicles should be able to meet the proposed SFTP emission standards without additional hardware or hardware modifications. Based on the findings of this test program, staff is proposing that alternative-fueled vehicles be required to meet the SFTP exhaust emission standards.

Table O-10. ARB SFTP Test Program: Light-Duty Emission Results for In-Use Vehicles Tested on E85 and on CNG (g/mi)

Test Vehicle	Model	Vehicle	Standard	Class	NMHC+NOx			CO		
					FTP	US06	SC03	FTP	US06	SC03
16	2006	Chevrolet Impala 3[1]	LEVI ULEV	PC	0.048	0.019	0.018	1.0	0.5	1.0
25	2006	Chevrolet Impala 4[1]	LEVI ULEV	PC	0.061	0.056	0.027	1.2	0.4	0.4
26	2007	Chevrolet Silverado 2[1]	LEVII LEV	LDT	0.025	0.028	0.005	1.4	2.2	1.4
15	2006	Chevrolet 2500 HD[2]	LEVI ULEV	LDT	0.034	0.108	0.012	0.5	2.3	0.4
21	2002	Ford Crown Vic.[2,3]	LEVII ULEV	PC	0.116	2.49	0.513	1.0	1.0	0.7

[1] E85 flex fuel vehicles. These vehicles are LEV I certified due to a shortage of mid-life LEV II certified alternate fuel vehicles.
[2] CNG vehicles.
[3] The Crown Victoria failed applicable emission standards.

3. Evaluating Diesel Vehicles

In 2010, Mercedes Benz loaned a 2011 diesel Sprinter 2500 MDV to ARB for testing. The Sprinter had a GVWR of 8,550 lbs and was representative of a relatively low power-to-weight ratio MDV. In order to complete SFTP testing, the engines of low-powered MDVs typically run very near to their maximum torque capacity, and thus low power-to-weight ratio MDVs are expected to have higher SFTP emissions than high power-to-weight ratio MDVs. The purpose of these tests was to aid in developing MDV SFTP emission standards and to assess the feasibility of having MDVs run the full US06 test cycle. The results of the emission tests are shown in Table O-11. The emission results indicate that this Sprinter would likely comply with the proposed LEV III ULEV standards.

Table O-11. ARB SFTP Test Program: Medium-Duty Diesel Vehicle Emission Results for Mercedes-Benz Sprinter Testing (g/mi)

Vehicle Model	Standard / Class	Mileage	NMHC+NOx				CO			
			FTP	US06	SC03	Composite	FTP	US06	SC03	Composite
2011 Sprinter	LEVII ULEV/MDV	125,000	0.23	1.32	0.50	0.64	0.141	0.009	0.010	0.06
Proposed SFTP MDV ULEV Standard		150,000	n/a			0.800	n/a			22.0
Proposed SFTP MDV SULEV Standard		150,000	n/a			0.450	n/a			12.0

4. Evaluating Hybrid Electric Vehicles

Since the California vehicle fleet will likely contain a significant number of Hybrid Electric Vehicles (HEVs) and Plug-in HEVs (PHEVs) in the future due to current and proposed GHG standards and federal efficiency mandates, staff also analyzed exhaust emission data from the 2006 HEV Test Program (ARB Project No. 2R0611). Table O-12 provides the average US06 exhaust emission test results for the four PHEVs tested. Note that emissions from all four vehicles were lower than the proposed stand-alone SFTP LEV and ULEV emission standards, but three exceeded the proposed SULEV requirements listed in the table. These PHEVs appear to be calibrated for zero or near-zero NMHC and CO exhaust emissions. The proposed standards for LEV III FTP and STFP combine NMOG and NOx, where previously, LEV II FTP had separate emission standards for hydrocarbons and NOx. In order to meet the proposed SULEV emission standards, staff expects that manufacturers would further design and calibrate their PHEVs for an optimal balance between NMHC+NOx and CO emissions and vehicle performance to meet the 150,000-mile useful life requirement. For example, by running at a richer air to fuel ratio, additional CO and NMHC would be generated but the lower temperatures in the combustion chamber would decrease NOx emissions. With proper control of combustion chamber and catalytic converter conditions, the increase in NMHC emissions due to fuel enrichment can be smaller in magnitude than the corresponding decrease in NOx emissions. Therefore, staff anticipates that hybrid vehicles could meet the proposed SFTP SULEV emission standards through calibration adjustments only.

Table O-12. ARB US06 Plug-in Hybrid Evaluation Test Program (g/mi)

Vehicle Model[1]	Standard / Class	Mileage	NMHC	CO	NOx	NMHC+NOx
Prius	LEVII SULEV / PC	4,300	0.000	0.1	0.040	0.040
Prius	LEVII SULEV / PC	10,000	0.000	0.0	0.061	0.061
Prius	LEVII SULEV / PC	4,600	0.000	0.0	0.082	0.082
Prius	LEVII SULEV / PC	9,300	0.000	0.0	0.095	0.095
Proposed SFTP Option 1 SULEV Standard		150,000		9.6		0.050[2]

[1] 2006 hybrid vehicles with aftermarket Plug-in Hybrid Electric Vehicle kit
[2] The standard is in terms of NMOG+NOx instead of NMHC+NOx, but the value would be numerically very similar.

B. Manufacturer Test Program

Data from light-duty test programs conducted by automobile manufacturers shared with ARB staff show similar trends to the ARB test program, but with higher variability. As an example, Mercedes-Benz submitted exhaust emission test results, summarized below in Table O-13. The data show that these currently certified SULEVs have the capability of meeting the proposed SFTP SULEV emission standard of 0.050 g/mi NMOG+NOx.

Table O-13. Useful Life Tests: FTP and US06 Emission Results from Gasoline-Fueled LEV II Vehicles (g/mi)

Vehicle	Standard	Mileage	Class	NMHC+NOx (g/mi)	
				FTP	US06
Class C	LEVII SULEV	156,000	PC	0.019	0.010
Class C	LEVII SULEV	151,000	PC	0.021	0.025
Class C	LEVII SULEV	152,000	PC	0.021	0.025
Class C	LEVII SULEV	152,000	PC	0.018	0.027
Class C	LEVII SULEV	156,000	PC	0.018	0.024
Class C	LEVII SULEV	151,000	PC	0.027	0.033
Class C	LEVII SULEV	151,000	PC	0.029	0.038
Class C	LEVII SULEV	152,000	PC	0.018	0.028
Class C	LEVII SULEV	156,000	PC	0.021	0.031
Average	LEVII SULEV	153,000	PC	0.021	0.027

Source: Courtesy of Daimler AG, 2010.

Data from medium-duty test programs conducted by automobile manufacturers were also shared with ARB staff. As a result of these test programs, manufacturers expressed a few concerns regarding MDVs and the SFTP. First, anticipated engine downsizing to comply with the proposed GHG emission standards could cause increases in SFTP emissions because vehicles would be running nearer to their maximum load during SFTP cycles. Second, manufacturers expressed concern about perceived lab-to-lab and driver-to-driver variability when testing MDVs over the US06 cycle. In addition, manufacturers also contend that diesel vehicles would need a larger percent reduction in emissions to achieve the proposed exhaust emission standards (further discussed in Section V below). Staff considered these issues along with the available test data when determining the proposed emissions standards.

C. PM Test Program

Staff assessed PM emissions using the US06 cycle for seven late-model PCs (2007-2010 MY), one 2009 MY LDT (GMC Hummer 3) and one 2007 MY MDV (Ford E250). Results of the PM test program are presented in Table O-14.

Emissions of PM from the tested PCs were consistently below 3 mg/mi. Testing of the GMC Hummer 3 showed emissions well below the proposed US06 PM emission standard of 20 mg/mi. Staff recognizes that with increased mileage, the PM emission values could increase. However, staff believes that with proper calibration, the Hummer would still meet the proposed standard at high mileage. The Ford E250, which had approximately 52,000 miles on the odometer, had PM emissions below 1 mg/mi using the proposed phase 3 certification E10 fuel.

Based on these test results, staff believes that the proposed SFTP PM standards as presented in Table O-4 and Table O-6 are feasible capping standards and should not pose a significant burden on manufacturers.

Table O-14. ARB SFTP PM Test Program

Vehicle	Mileage	Weight Class	US06 E6 Fuel (mg/mi)	US06 Phase 2 Cert Fuel (mg/mi)	US06 E10 Fuel (mg/mi)
2009 BMW 335i	2000	≤ 8,500 lbs	1.29	1.57	n/a
2008 VW Jetta	2700	≤ 8,500 lbs	0.14	n/a	n/a
2010 VW Jetta	4000	≤ 8,500 lbs	1.38	0.96	1.20
2008 Lexus IS350	11,000	≤ 8,500 lbs	0.82	n/a	n/a
2009 GMC Acadia	11,000	≤ 8,500 lbs	2.70	n/a	n/a
2009 Nissan Altima	29,000	≤ 8,500 lbs	0.72	n/a	0.93
2007 Kia Spectra EX	34,000	≤ 8,500 lbs	0.28	n/a	n/a
2009 GMC Hummer 3	21,000	≤ 8,500 lbs	7.68	3.42	n/a
2007 Ford E250	52,000	8,501-10,000 lbs	n/a	n/a	0.85

D. Operation of Medium-Duty Vehicles

Included in staff's proposal is a provision to extend the applicability of the SFTP emission standards and test procedures to MDVs 8,501 to 14,000 lbs GVWR. Some manufacturers maintain that MDVs should be exempt from the SFTP emission standards because they contend that MDVs are not normally driven aggressively. Staff disagrees. As discussed below, MDVs can and do operate in the full US06 test cycle domain and therefore, staff is proposing to add MDV applicability to the SFTP program.

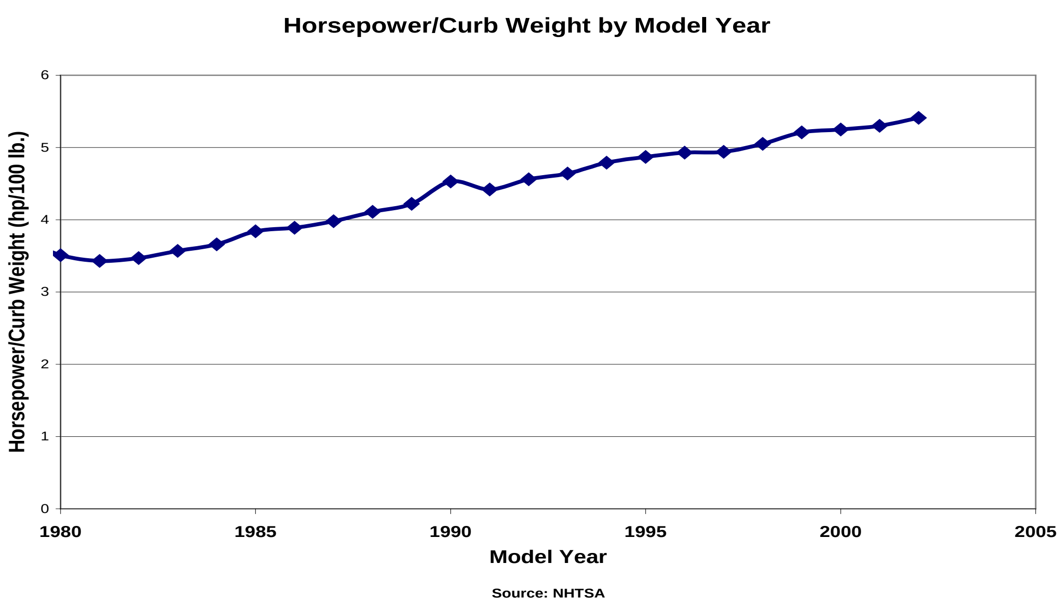
This class of vehicles was previously exempted from SFTP requirements due to their primary use in heavier work applications at lower speeds. Now, however, MDVs include large sport-utility vehicles, passenger vans and other types of "crossover" multipurpose vehicles that operate more like passenger cars. Advanced technology has given MDVs better emission control capabilities, horsepower, and performance compared to previous model years. Current MDVs have much greater power for a given curb weight than was seen in the past, and real world data, such as those discussed below, show that these vehicles do operate in the domain covered by the US06 cycle.

1. MDV Driving Tests

The latest Insurance Institute for Highway Safety research reveals that travel speeds have generally risen on interstate highways and arterial roads. The majority of vehicle highway miles are driven at speeds well above the legal limit. Although larger trucks do tend to drive slower than passenger cars, they generally have much higher power and torque available and the US06 cycle is well within their operating capabilities. Data from NHTSA, as shown in Figure O-7, indicate that today's vehicles have greater power for a given curb weight compared to the vehicles manufactured during the early 1990's when the original SFTP rulemaking was being developed.

Many MDVs are used as both a work truck and a family truck, particularly in the 8,501-10,000 lbs GVWR class. Those in the 10,001-14,000 lbs GVWR class are generally designed as a dedicated work vehicle with higher load carrying capacities. These MDVs typically have powertrains with high power and torque to drive within normal traffic conditions while carrying heavier loads as needed. However, staff agrees with manufacturer input that these vehicles do not typically drive in the full US06 regime and that the LA92 (UC) test, a less aggressive test cycle, sufficiently covers all conditions driven by these vehicles.

Figure O-7. Vehicle Model Year Horsepower by Weight



2. Demonstrating acceleration and speed capabilities

In order to demonstrate that medium-duty vehicles 8,501-10,000 lbs GVWR operate within the domain of the US06 cycle, staff conducted some simple driving tests.

The initial set of driving tests was performed in late 2006, using two MDVs that were instrumented with a GPS[9] to allow data to be collected while driving on California freeways. The objective of this first set of driving tests was to test the acceleration and speed capabilities of MDVs. A 2007 Chevrolet Express and a 2005 Ford E-350, both in the 8,501-10,000 lbs GVWR weight class and LEV II certified, were tested.

Each vehicle was driven for approximately one hour during non-traffic hours on California freeways. The test consisted of mostly freeway driving with some accelerations and decelerations occurring on freeway on-ramps and off-ramps. The driver intentionally drove aggressively to include high accelerations and speeds to test each vehicle's capabilities. Each vehicle had enough horsepower to handle high speeds above 65 miles per hour and aggressive accelerations with no running problems.

Based on the findings of this test program, staff believes MDVs 8,501-10,000 lbs GVWR are capable of operating in off-cycle regimes similar to those found in the US06 driving cycle.

3. Demonstrating "real world" driving conditions

The second set of driving tests was performed to evaluate how MDVs operate in the real world. These tests were conducted over a 3-day period from April 18-20, 2007, using a 2007 Chevrolet Express driven from Stockton, California to Livermore, California. The on-road tests were conducted under normal traffic conditions including accelerations and grade tests over Interstate 5, P-580, and Patterson Pass. The MDV was tested in loaded and unloaded conditions and equipped with a Portable Emissions Measurement System[10] to measure emissions over the driving route. The test protocol is presented in Table O-15. Figure O-8 shows a sample of the test data generated by the PEMS unit.

The results from the on-road portion of the test were obtained through normal driving patterns while following the flow of traffic. As shown in Table O-16, the average speeds were comparable to those in the US06 test cycle. In addition, emissions from the vehicle were consistently higher when it was loaded than when it was unloaded. Thus, staff believes it is necessary to test MDVs at ALVW so that the SFTP testing accurately reflects emissions from real-world driving.

[9] The GPS used was a GST DL2 (GST Tracker for Data Logger) equipped with a SiRF Star I GPS engine board with a position accuracy of 10 meters or less 2D RMS at a spherical probability of 95 percent. The speed accuracy was 1 meter per second under normal conditions with a minimum of one valid position reading per second. 2D RMS represents the radius of a circle containing 95 percent of the GPS readings.

[10] Portable Emissions Measurement System (PEMS) from SEMTECH-DS Mobile Emission Analyzer

Table O-15. "Real World" Driving Tests: Test Protocol

Vehicle	2007 Chevrolet GM Chevy Express EO A-006-1401 Test group - 7GMXK06.0388 LEV II MDV Class – 8,501-10,000 lbs GVW Gasoline-fueled
First Day	Rack fabrication and installation PEMS installation and training Discussing routes and adjustment to the test plan
Second Day	Completing PEMS installation Vehicle unloaded (empty plus driver, copilot and PEMS) Test drive Driving under accelerations Driving on high grades, over the P-580 freeway, maximum 5% grade with an average 2% grade towards Livermore Driving on high grades, over the Patterson Pass, maximum 6% grade with an average of 5% grade towards Livermore
Third Day	Vehicle Loaded (Simulated passengers, 1000 lb mix of weights and bottled water, plus driver, copilot and PEMS) Driving on high grades, over the P-580 freeway, maximum 5% grade with an average 2% grade towards Livermore Driving under accelerations Driving on high grades, over the Patterson Pass, maximum 6% grade with an average of 5% grade towards Livermore

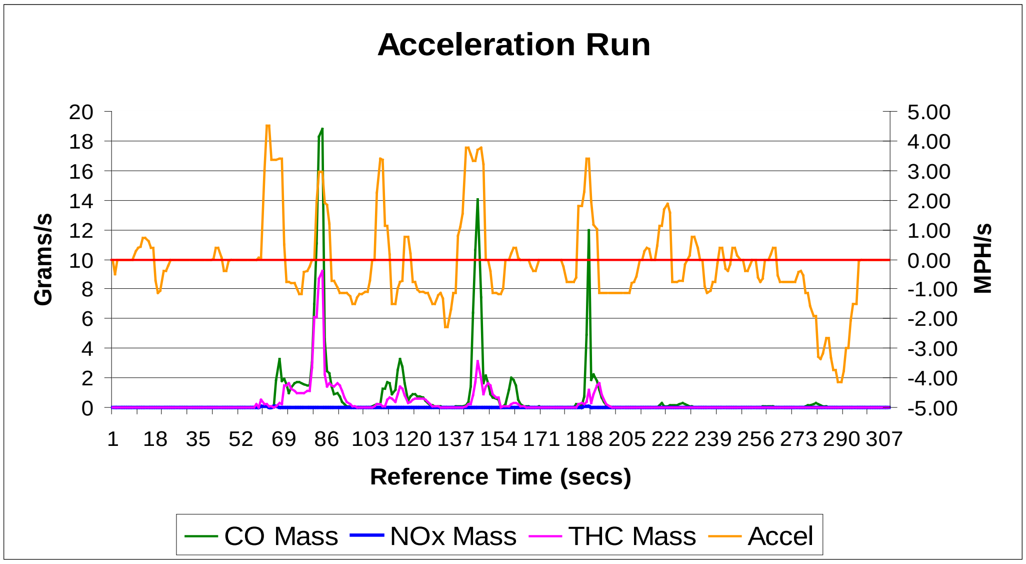
Table O-16. PEMS Emission Test Results

		Average Speed (mph)	Max Accel. (mph/s)	CO (g/mi)	NOx (g/mi)	THC (g/mi)
On-Road Testing	PEMS					
Acceleration Test	Unloaded*	47.4	4.5	51.7	0.164	0.245
P-580	Unloaded	61.1	1.5	0.6	0.084	0.000
P-580	Loaded	62.9	4.2	16.3	0.099	0.004
Patterson Pass	Unloaded	30.8	2.7	1.0	0.060	0.000
Patterson Pass	Loaded	28.1	5.3	3.6	0.023	0.001
Dyno Testing	CVS					
FTP**	Bag2	16.1	3.3	0.8	0.000	0.002
US06**		47.9	8.5	1.5	0.049	0.007

*The baseline NOx was corrected from 0.005 to 0.0 g/s

**Performed at Haagen-Schmidt Laboratory, El Monte, Dyno 1 Phase III summer fuel

Figure O-8. Acceleration portion of Unloaded MDV Test



4. Low Power-to-Weight Ratio Diesel Sprinter

The Mercedes-Benz Sprinter 2500 used for emission testing was also used as a basis for developing the power-to-weight ratio cutoff for MDVs only having to run Bag 2 of the US06 cycle. In our labs, the inertial weight on the dynamometer was adjusted to simulate testing at ALVW of a Sprinter with a GVWR of 8,550 lbs (0.022 HP/GVWR) as well as a Sprinter with a GVWR of 9,900 lbs (0.019 HP/GVWR). When the simulated 9,900 lbs GVWR Sprinter was tested, the test driver had difficulty following the full US06 trace and frequently had trace violations that would invalidate the test during certification. However, when the 8,550 lbs GVWR Sprinter was tested, the test driver was almost always able to follow the full US06 trace without violations. Based on these findings, staff is proposing to set the HP/GVWR cutoff at 0.024, and only vehicles with a power-to-weight ratio equal to or less than 0.24 would be eligible for the less aggressive test cycle under the US06 Bag 2 provision.

V. EMISSION CONTROL TECHNOLOGIES

Staff believes the technologies that would be employed to enable light- and medium-duty vehicles to meet the proposed LEV III FTP requirements would generally also allow these vehicles to meet the SFTP requirements, with minor adjustments only. For a full discussion of those technologies, see the LEV III Initial Statement of Reasons and associated documents.

The LEV II regulations brought forth the current SULEV technologies that we see today. About 22 percent of the 2008 vehicle fleet was certified to SULEV emission standards. These vehicles use a variety of emissions control technologies. It is difficult to precisely characterize the current state of emission control technology due to the different engine management and aftertreatment approaches that manufacturers have taken to reduce emissions. However, 2008 model year vehicles are generally equipped with close-coupled three-way catalysts, heated oxygen sensors, sequential fuel injection, and exhaust gas recirculation. Beyond these technologies, a number of additional technologies, listed in Table O-17, could also be applied to help achieve SULEV-level emission performance on the FTP and SFTP cycles for all vehicle models. Of the technologies used for FTP emission reductions, advanced exhaust gas recirculation and catalyst upgrades, would also significantly help with reductions of SFTP emissions. Therefore, staff believes that manufacturers would only need to use enhanced calibration and advanced software control strategies for the majority of their vehicles to comply with the proposed SFTP emission standards.

Table O-17. Potential Emission Control Technologies for Meeting the Proposed LEV III FTP and SFTP Emission Standards

Technology	Description, examples of technology
Engine management	Lean stratified start-up; ignition retard; and other advanced combustion control strategies
Three-way catalyst upgrade	Increased catalyst volume, loading, and substrate cell density for increased pollutant conversion
Advanced exhaust gas recirculation (EGR)	Variable valve actuation and injection controls for better combustion management
Lean-NOx aftertreatment	Aftertreatment for diesel and lean-burn gasoline engines; lean NOx trap; urea-based selective catalytic reduction (SCR)

A. Motor Vehicles 0-8,500 lbs GVWR

The light-duty fleet in California contains the cleanest certified vehicles (i.e., SULEVs). The cleaner SULEV technologies were initially introduced in the smaller displacement passenger car segment, but over time this technology has gradually been added to the larger displacement light-duty vehicle classes as well. These advanced technologies would allow these vehicles to meet the proposed SFTP emission standards.

Automobile manufacturers have indicated that they will be downsizing their engines as one strategy to meet GHG regulations. Staff expects that these manufacturers would retain the same sized catalyst for the downsized (smaller displacement) engine to help with meeting the LEV III FTP and SFTP emission standards. The most common method to reduce emissions for the US06 test is to increase catalyst loading in the primary or under-floor catalyst, which could generally be upgraded to meet LEV III SULEV and ULEV levels at 150,000-mile useful life.

Based on meetings with the automotive industry, ARB staff expects that by 2025, most, if not all, passenger cars would be using LEV III SULEV emission control technology. The SFTP test data, certification data and in-use data have shown that light-duty gasoline vehicles are very capable of meeting the proposed SFTP emission standards.

B. Motor Vehicles 8,501-14,000 lbs GVWR

8,501-10,000 pounds GVWR

Vehicles in the 8,501 to 10,000 lbs GVWR weight class would also be required to meet the LEV III ULEV and SULEV emission levels. Staff expects that this class of vehicles would also experience engine downsizing, but expects the catalyst sizes to remain roughly the same for purposes of useful life emission control. Staff expects that advanced EGR control systems would continue to be improved upon and be used as one of the control technology choices for meeting the proposed emission standards. Some of the vehicles may require minor hardware upgrades to meet the proposed off-cycle emissions standards such as additional catalyst loading in the early years. However, staff expects advanced technology that is currently being developed to eventually dominate.

10,001-14,000 pounds GVWR

Vehicles in this weight class would be able to use the same emission control strategies listed above to comply with LEV III FTP and SFTP emission standards. However, automobile manufacturers currently have the choice to certify these vehicles to either heavy-duty engine emission standards or LEV II emission standards; most are currently certified to heavy-duty engine standards.

C. Diesel-fueled Motor Vehicles

Over the last decade, diesel vehicles have made significant progress and continue to develop at a rapid pace. Many manufacturers as well as organizations such as Southwest Research Institute (SwRI) have been and are continuing to develop cleaner diesel vehicles. Looking back just five years, diesel catalyst technology has improved significantly. Previously, many manufacturers noted that diesels could not meet LEV II emission standard levels, but beginning with the 2007 model year, manufacturers began to certify newer technology diesel vehicles to LEV II LEV and ULEV chassis emission standards in California.

Table O-18 lists some models of certified LEV II diesel vehicles.

Table O-18. LEV II Diesel Vehicles

LDVs	Standard	MDVs	Standard
AUDI A3, VW Jetta	LEV II ULEV	Dodge Ram	LEV II LEV/ULEV
Audi Q7/VW Touareg	LEV II ULEV	Ford F- 250, 350, 450	LEV II ULEV
BMW 335d	LEV II LEV	GM Sierra/Silverado	LEV II ULEV
BMW X5 xDrive35d	LEV II LEV	Mercedes Sprinter	LEV II ULEV
Mercedes E320	LEV II LEV		
Mercedes ML 350/GL 350	LEV II ULEV		
Mercedes ML 320/R 320	LEV II ULEV		
Mercedes GL 320	LEV II ULEV		

In meeting future emission standards, staff expects step-by-step technology improvements to fuel management, in-cylinder combustion, and post-combustion emission control, along with increased turbocharging, advanced EGR, and better catalysts. Diesel vehicles have improved significantly in the area of emission control, but NOx still poses a significant challenge in meeting the proposed US06 emission standards. However, staff expects future diesel vehicles to have the ability to meet LEV III SULEV emission levels by the 2025 model year. In fact, BMW has certified a 335d diesel passenger car to 0.02 grams per mile NMHC+NOx at 4,000 miles for the 2009 model year. Depending on how this vehicle deteriorates as it ages, it may already be able to meet the proposed SFTP SULEV useful life emission standard today. With some of the improvements noted above and overall durability improvements to the engine and aftertreatment technology, staff believes that this vehicle model would achieve full useful life SULEV-level emission control capability.

VI. ALTERNATIVE SCENARIOS

Staff developed the proposed regulation in an open public process. During the proposal's development, the scope, structure, and requirements of the regulation evolved based on information staff gained both through ARB's own research and test program and through information exchanged at public workshops and separate meetings with individual automobile manufacturers and interested stakeholders.

Ideas that were formulated during the development process and incorporated in the final proposed regulation include: 1) adding a second option to meet SFTP requirements through a declining fleet-average composite emission standard that ultimately reaches SULEV emission level by model year 2025; 2) allowing later implementation for MDVs; 3) allowing SC03 compliance through engineering evaluation for MDVs; 4) increasing the compliance margin for stand-alone US06 CO standards; 5) incorporating in-use compliance standards; 6) defining an overall compliance schedule that extends over multiple years; and 7) allowing a less aggressive test cycle (UC/LA-92) for MDVs 10,001-14,000 lbs GVWR.

When determining whether a suggested change should be incorporated into the proposed regulation, staff considered the impact the proposed change would have on reaching the following goals:

- Achieve benefits primarily through enhanced calibration strategies;
- Base SFTP requirements primarily on technologies that would already be employed in order to comply with LEV III FTP requirements;
- Account for the employment of GHG reduction technologies and other technologies that could impact SFTP emissions; and
- Achieve cost-effective emission reductions on a dollar per ton basis.

One alternate approach is the “do-nothing” approach. Under this approach, LEVIII would be adopted, but SFTP requirements would remain at the 4,000-mile levels. This approach is not being proposed because staff believes high-mileage engine and aftertreatment deterioration could significantly impact emissions under SFTP operating conditions, which tend to stress components more than conditions experienced under other operating modes. Current SFTP emission standards do not go far enough to ensure effective, long-term control of SFTP emissions, so staff believes it is necessary to propose more stringent, full useful life standards to ensure software calibration responds to component deterioration.

In addition, many manufacturers have indicated that engine downsizing is expected to occur for the reduction of CO_2. As previously discussed, engine downsizing could potentially increase SFTP emissions. Staff believes the proposed US06 standards and new durability requirements would help prevent potential backsliding on SFTP emissions by ensuring that aftertreatment devices are not de-contented, or downsized, along with the engines themselves.

Another approach considered was to require only the proposed stand-alone emission standards. While such an approach is relatively simple to develop and enforce, it does not provide the flexibility for manufacturers that a fleet-average approach does. The fleet-average standards do not have the same level of stringency as the stand-alone standards, but the stand-alone approach was left in because it would benefit small volume manufacturers that would only have to certify to ULEV emission standards during the phase in of LEV III and manufacturers that may simply prefer not to use the fleet-average approach.

VII. BENEFITS, AND COSTS

A. US06 and SC03 Emission Benefits

To determine the emission reductions due to the proposed SFTP emission standards, staff used emission test results from ARB's SFTP Test Program, ARB's emission modeling program, EMFAC2007 (ARB, 2006), and certification data. To estimate light-duty emissions reduction, the certification database was filtered to identify only light-duty SULEV vehicles. These SULEV vehicles were assumed to be representative of a future fleet in which there are no updated SFTP standards. The SFTP full useful life emission values were projected out from 4,000 miles and it was determined that SULEV vehicles would likely not need additional emission control hardware beyond what is needed to comply with LEV III SFTP in order to meet the proposed SFTP Option 2 standards. The goal of SFTP is to ensure that software calibrations will be made so that vehicles remain at low emissions levels through their useful life and that SFTP emission performance does not backslide relative to the SULEV SFTP emission performance of today. For this reason, staff did not calculate a benefit for the proposed light-duty SFTP regulations since the emission benefit is expected to be almost entirely due to the proposed LEV III FTP regulations.

Data from EMFAC and MDV testing programs conducted by manufacturers were used to estimate MDV emission benefits. A statistical distribution of SFTP emissions was created based on full useful-life MDV SFTP data submitted from auto manufacturers. The percentage of MDVs at different SFTP emissions levels was estimated using this distribution and was used to calculate the average amount MDVs emissions would be above the proposed standards.

The emissions benefit for the fleet was estimated by multiplying the average benefit per MDV on US06 by EMFAC's annual vehicle miles traveled and using a factor of 0.28 to account for the percentage of driving that is in SFTP conditions. Compared to the baseline LEV III FTP vehicle configuration, staff estimates that the SFTP MDV vehicle configuration would result in fleetwide decrease in NMOG+NOx emissions of 0.2 tons per day, resulting in additional reductions beyond the LEV III FTP proposal.

Staff is proposing to set SC03 emission standards with the primary purpose of maintaining proper calibration of the air conditioning system to control any potential emission increases. Additionally, staff is proposing to set US06 CO and PM capping standards solely to prevent emission increases. Staff is not quantifying any emission reductions for the proposed SC03 emissions or US06 CO and PM emissions.

B. US06 and SC03 Cost Impact Summary

Most of the vehicle design and associated costs are covered in the proposed LEV III FTP regulations. The proposed SFTP regulation is primarily an enhanced calibration and software upgrade regulation. For the light-duty fleet, the proposed SFTP emission standards are set such that vehicles should not require additional hardware, catalyst loading, or testing requirements not already required in order to comply with LEV III FTP requirements. The sales-weighted fleet average option for the light-duty fleet would allow manufacturers to average some higher-emitting vehicles with cleaner vehicles to meet the fleet-average SULEV emission levels.

For MDVs and MDPVs, staff projects an additional testing cost of $10,000 per engine family. This is due to additional testing required and testing facility upgrades that may be needed since this weight class does not have current SFTP requirements. Based on certification data from years past, there would be approximately 30 new engine families in the affected weight classes, thus yielding a $300,000 fleet wide cost for SFTP. As noted previously, staff projects that these regulations would result reductions from the MDV fleet of 0.2 tons per day of NMOG+NOx. Therefore, the estimated cost-effectiveness of the proposed SFTP revisions is approximately $0.20 per pound of NMOG+NOx reduced.

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