California Environmental Protection Agency
AIR RESOURCES BOARD

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2003 AND SUBSEQUENT MODEL ZERO-EMISSION VEHICLES, AND 2001 AND SUBSEQUENT MODEL HYBRID ELECTRIC VEHICLES, IN THE PASSENGER CAR, LIGHT-DUTY TRUCK AND MEDIUM-DUTY VEHICLE CLASSES

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A. Applicability

The emission standards and test procedures in this document are applicable to 2003 and subsequent model-year zero-emission passenger cars, light-duty trucks and medium-duty vehicles, and 2001 and subsequent model-year hybrid electric passenger cars, light-duty trucks and medium-duty vehicles. The general procedures and requirements necessary to certify a vehicle for sale in California are contained in the "California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles" (hereinafter "LDV/MDV TPs"), and apply except as amended herein. A manufacturer may elect to certify a 2000 model-year hybrid electric vehicle under these standards and test procedures and the LDV/MDV TPs.

B. Definitions

In addition to the following, these test procedures incorporate by reference the definitions and abbreviations set forth in the Title 40 Code of Federal Regulations §86.1803-01, the definitions and abbreviations set forth in the LDV/MDV TPs, and the definitions set forth in section 1900, title 13, CCR.

"**All-Electric Range Test**" means a test sequence used to determine the range of an electric vehicle or of a hybrid electric vehicle without the use of its auxiliary power unit. The All-Electric Range Test cycle consists of the Highway Fuel Economy Schedule and the Urban Dynamometer Driving Schedule (see Section F of these test procedures).

"**Auxiliary power unit**" means a device that converts consumable fuel energy into mechanical or electrical energy. Some examples of auxiliary power units are internal combustion engines, gas turbines, or fuel cells.

"**Battery or Battery pack**" means any electrical energy storage device consisting of any number of individual battery modules or cells that is used to propel an electric or hybrid electric vehicle. These terms may also generically refer to capacitor and flywheel energy storage devices in the context of hybrid electric vehicles.

"**Battery state-of-charge**" means the quantity of electrical energy remaining in the battery relative to the maximum rated capacity of the battery expressed in percent.

"**Charge-depleting**" means that the battery of a hybrid electric vehicle ultimately fully discharges and impairs vehicle operation as the vehicle continuously operates over a given driving cycle when no off-vehicle charging is performed and the consumable fuel is regularly replenished. Hybrid electric vehicles are required to be classified as either charge-sustaining or charge-depleting over each driving cycle (i.e. UDDS, HFEDS, US06, or SC03).

"**Charge-sustaining**" means that the battery of a hybrid electric vehicle ultimately does not fully discharge and impair vehicle operation as the vehicle continuously operates over a given driving cycle when no off-vehicle charging is performed and the consumable fuel is regularly replenished. Hybrid electric vehicles are required to be classified as either charge-sustaining or charge-depleting over each driving cycle (i.e. UDDS, HFEDS, US06, or SC03).

"**Consumable fuel**" means any solid, liquid, or gaseous matter that releases energy when consumed by an auxiliary power unit.

"**Electric vehicle**" means any vehicle that operates solely by use of a battery or battery pack. This definition also includes vehicles which are powered mainly through the use of an electric battery or battery pack, but which use a flywheel or capacitor that stores energy produced by the electric motor or through regenerative braking to assist in vehicle operation.

"**Fuel-fired heater**" means a fuel burning device that creates heat for the purpose of warming the passenger compartment of a vehicle but does not contribute to the propulsion of the vehicle.

"**Hybrid electric vehicle**" means any vehicle that can draw propulsion energy from both of the following on-vehicle sources of stored energy: 1) a consumable fuel and 2) an energy storage device such as a battery, capacitor, or flywheel.

"**HFEDS**" means highway fuel economy driving schedule. See 40 CFR §600.109(b).

"**Off-vehicle charge capable**" means having the capability to charge a battery from an off-vehicle electric energy source that cannot be connected or coupled to the vehicle in any manner while the vehicle is being driven.

"**SC03**" means the U.S. EPA SC03 driving schedule representing vehicle operation with air conditioning, as set forth in Appendix I of 40 CFR Part 86.

"**SOC Net Change Tolerance**" means the state-of-charge net change tolerance that is applied to the SOC Criterion for charge-sustaining hybrid electric vehicles when validating an emission test. See section 8 of these procedures for tolerance specifications.

"**SOC Criterion**" means the state-of-charge criterion that is applied to charge-sustaining hybrid electric vehicle to validate an emission test. The SOC Criterion requires that no net change in battery energy occurs over a given test cycle, i.e. the final battery state-of-charge that is recorded at the end of the emission test must be equivalent to the initial battery state-of-charge that is set at the beginning of the emission test. The SOC Net Change Tolerance shall be applied to the SOC Criterion.

"**US06**" means the US06 driving schedule for aggressive driving as set forth in Appendix I of 40 CFR Part 86.

"**UDDS**" means urban dynamometer driving schedule as set forth Appendix I of 40 CFR Part 86.

"**Zero-emission vehicle**" or "**ZEV**" means any vehicle certified to zero-emission standards.

"Zero-emission VMT" means the vehicle miles traveled with zero exhaust emissions of any criteria pollutant (or precursor pollutant).

C. Zero-Emission Vehicle Standards.

1. ZEV Emission Standard. The Executive Officer shall certify new 2003 and subsequent model passenger cars, light-duty trucks and medium-duty vehicles as ZEVs if the vehicles produce zero exhaust emissions of any criteria pollutant (or precursor pollutant) under any and all possible operational modes and conditions. Incorporation of a fuel-fired heater shall not preclude a vehicle from being certified as a ZEV provided: (1) the fuel-fired heater cannot be operated at ambient temperatures above 40°F, (2) the heater is demonstrated to have zero fuel evaporative emissions under any and all possible operational modes and conditions, and (3) the emissions of any pollutant from the fuel-fired heater when operated at an ambient temperature between 68°F and 86°F do not exceed the emission standard for that pollutant for a ULEV under section 1961(a)(1), title 13, CCR.

A vehicle that would meet the emissions standards for a ZEV except that it uses a fuel-fired heater that can be operated at ambient temperatures above 40°F, that cannot be demonstrated to have zero fuel evaporative emissions under any and all possible operation modes and conditions, or that has emissions of any pollutant exceeding the emission standard for that pollutant for a ULEV under section 1961(a)(1), title 13, CCR, shall be certified based on the emission level of the fuel-fired heater.

2. Percentage ZEV Requirements. The ZEV requirement for each manufacturer in 2003 and subsequent model years is that at least 10% of the PCs and LDT1s produced by the manufacturer and delivered for sale in California must be ZEVs, subject to the conditions in Section C.2.1 through C.2.4. In applying the ZEV requirement, a PC or LDT1 that is produced by a small volume manufacturer, but is marketed in California by another manufacturer under the other manufacturer's nameplate, shall be treated as having been produced by the marketing manufacturer.

2.1 Basic Requirements for Large, Intermediate, and Small Volume Manufacturers.

(a) **Large Volume Manufacturers**. In 2003 and subsequent model years, a large-volume manufacturer must meet at least 40% of its ZEV requirement with ZEVs, full ZEV allowance vehicles, or ZEV credits generated by such vehicles. The remainder of the large-volume manufacturer’s ZEV requirement may be met using partial ZEV allowance vehicles or credits generated by such vehicles.

(b) **Intermediate Volume Manufacturers**. In 2003 and subsequent model years, an intermediate volume manufacturer may meet its ZEV requirement with up to 100 percent partial ZEV allowance vehicles or credits generated by such vehicles.

(c) **Small Volume Manufacturers**. A small volume manufacturer is not required to meet the percentage ZEV requirements. However, a small volume manufacturer may earn and

market credits for the ZEVs or ZEV allowance vehicles it produces and delivers for sale in California.

2.2 Counting ZEVs and ZEV Allowance Vehicles in Fleet Average NMOG Calculations. Vehicles certified as ZEVs and as full ZEV allowance vehicles shall be counted as ZEVs for the purpose of calculating a manufacturer's fleet average NMOG value and NMOG credits under sections 1961(b) and (c), title 13, CCR. Partial ZEV allowance vehicles shall be counted as SULEVs certified to the 150,000 mile standards for the purpose of calculating a manufacturer's fleet average NMOG value and NMOG credits under sections 1961(b) and (c), title 13, CCR.

2.3 Implementation Prior to 2003 Model Year. Prior to the 2003 model year, a manufacturer that voluntarily produces vehicles meeting the ZEV emission standards applicable to 2003 and subsequent model year vehicles may certify the vehicles to those standards and requirements for purposes of calculating fleet average NMOG exhaust emission values and NMOG credits under sections 1961(b) and (c), title 13, CCR, and for calculating ZEV credits as set forth in section C.4.

2.4 Changes in Small and Intermediate Volume Manufacturer Status. In 2003 and subsequent model years, if a small volume manufacturer's average California production volume exceeds 4,500 units of new PCs, LDTs, and MDVs based on the average number of vehicles produced and delivered for sale for the three previous consecutive model years, or if an intermediate volume manufacturer's average California production volume exceeds 35,000 units of new PCs, LDTs, and MDVs based on the average number of vehicles produced and delivered for sale for the three previous consecutive model years, the manufacturer shall no longer be treated as a small volume or intermediate manufacturer, as applicable, and shall comply with the ZEV requirements for intermediate or large volume manufacturers, as applicable, beginning with the fourth model year after the last of the three consecutive model years. If a manufacturer's average California production volume falls below 4,500 or 35,000 units of new PCs, LDTs, and MDVs, as applicable, based on the average number of vehicles produced and delivered for sale for the three previous consecutive model years, the manufacturer shall be treated as a small or intermediate volume manufacturer, as applicable, and shall be subject to the requirements for a small or intermediate volume manufacturer beginning with the next model year. In determining small volume manufacturer status, vehicles produced by one manufacturer and marketed in California by another manufacturer under the other manufacturer's nameplate shall be treated as part of the California production volume of the sales of the marketing manufacturer.

3. Partial and Full ZEV Allowance Vehicles.

3.1 This section C.3 sets forth the criteria for identifying vehicles delivered for sale in California as partial or full ZEV allowance vehicles. A partial ZEV allowance vehicle is a vehicle that is delivered for sale in California and that qualifies for a partial ZEV allowance of at least 0.2 but less than 1.0. A full ZEV allowance vehicle is a vehicle that is delivered for sale in California and that qualifies for a ZEV allowance of 1.0.

3.2 Baseline Partial ZEV Allowance. In order for a vehicle to be eligible to receive a partial or full ZEV allowance, the manufacturer must demonstrate compliance with all of the following requirements. A qualifying vehicle will receive a baseline partial ZEV allowance of 0.2.

(a) Certify the vehicle to the 150,000-mile SULEV exhaust emission standards for PCs and LDTs in section 1961(a)(1), title 13, CCR;

(b) Certify the vehicle to the evaporative emission standards in section 1976(b)(1)(E), title 13, CCR ("zero" evaporative emissions standards);

(c) Certify that the vehicle will meet the applicable on-board diagnostic requirements in section 1968.1, title 13, CCR for 150,000 miles;

(d) Extend the performance and defects warranty period set forth in sections 2037(b)(2) and 2038(b)(2), title 13, CCR to 15 years or 150,000 miles, whichever occurs first.

3.3 Zero-Emission VMT Partial ZEV Allowance.

(a) A vehicle that meets the requirements of section C.3.2 and has zero-emission vehicle miles traveled ("VMT") capability will generate an additional ZEV allowance, not to exceed 0.6, according to the following equation:

Zero-Emission VMT Partial ZEV Allowance = 0.6 x Zero-Emission VMT Factor

where zero-emission VMT factor is the ratio of the zero-emission miles the vehicle travels to the total miles traveled per trip.

(b) The zero-emission VMT factor in the above equation is to be calculated as follows, with the urban all-electric range determined in accordance with section E.3.(2)(a) of these test procedures:

Urban All-Electric Range	Zero-emission VMT Factors:
< 20 miles	0.0
? 20 miles to < 100 miles	(30 + [0.5 x Urban AER])/80
? 100 miles	1.0

(c) As an alternative to determining the zero-emission VMT factor in accordance with the preceding section C.3.3(b), a manufacturer may submit for Executive Officer approval an alternative procedure for determining the zero-emission VMT potential of the vehicle as a percent of total VMT, along with an engineering evaluation that adequately substantiates the zero-

emission VMT determination. For example, an alternative procedure may provide that a vehicle with zero-emissions of one regulated pollutant (e.g. NOx) and not another (e.g. NMOG) will qualify for a zero-emission VMT factor of 0.5. Upon approval of the alternative procedure, the Executive Officer shall assign a zero-emission VMT factor not to exceed 1.0.

(d) The Executive Officer shall approve an additional 0.1 zero-emission VMT ZEV allowance for an HEV with an all-electric range greater than 20 miles if the manufacturer demonstrates to the reasonable satisfaction of the Executive Officer that the HEV is equipped with software and/or other strategies that would promote maximum use of off-vehicle charging, and that the strategies employed are reasonably reliable and tamper-proof. In no event, however, may the total zero-emission VMT ZEV allowance for an HEV under section C.3.3. exceed 0.6.

3.4 Partial ZEV Allowance for Advanced ZEV Componentry. A vehicle that does not qualify for any zero-emission VMT partial ZEV allowance under section C.3.3. shall qualify for an advanced componentry partial ZEV allowance of 0.1, if the manufacturer demonstrates to the reasonable satisfaction of the Executive Officer that the vehicle is equipped with advanced ZEV componentry such as an advanced battery integral to the operation of the vehicle power-train or an electric power-train.

3.5 Partial ZEV Allowance for Fuel-Cycle Emissions. A vehicle that uses fuel(s) with very low fuel-cycle emissions shall receive a partial ZEV allowance not to exceed 0.2. In order to receive the fuel-cycle partial ZEV allowance, a manufacturer must demonstrate to the Executive Officer, using peer-reviewed studies or other relevant information, that NMOG emissions associated with the fuel(s) used by the vehicle (on a grams/mile basis) are lower than or equal to 0.01 grams/mile. Fuel-cycle emissions must be calculated based on near-term production methods and infrastructure assumptions, and the uncertainty in the results must be quantified. The fuel-cycle partial ZEV allowance is calculated according to the following formula:

Partial ZEV Fuel Cycle Allowance = 0.2 x [(percent of VMT using fuel(s) meeting the requirements of the preceding paragraph)/ 100]

A manufacturer's demonstration to the Executive Officer that a vehicle qualifies for a fuel-cycle partial ZEV allowance shall include test results and/or empirical data supporting the estimate of the relative proportion of VMT while operating on fuel(s) with very low fuel-cycle emissions.

3.6 Calculation of Combined ZEV Allowance for a Vehicle. The combined ZEV allowance for a qualifying vehicle is the sum of:

(a) The baseline ZEV allowance of 0.2 for vehicles meeting the criteria in section C.3.2;

(b) The zero-emission VMT ZEV allowance, if any, determined in accordance with section C.3.3., not to exceed 0.6;

(c) The advanced ZEV componentry ZEV allowance, if any, determined in accordance with section C.3.4 not to exceed 0.1; and

(d) The fuel-cycle emissions ZEV allowance, if any, determined in accordance with section C.3.5, not to exceed 0.2.

4. Generation and Use of ZEV Credits; Calculation of Penalties. A manufacturer that produces and delivers for sale in California ZEVs, full ZEV allowance vehicles, or partial ZEV allowance vehicles in a given model year exceeding the manufacturer's ZEV requirement set forth in section C.2 shall earn ZEV credits in accordance with this section C.4.

4.1 1999-2007 Model Year ZEV Multiplier Calculation for Extended Electric Range Vehicles.

(a) Each ZEV and full ZEV allowance vehicle that is produced and delivered for sale in California in the 1999 to 2007 model years and that has an extended electric range shall qualify for a ZEV multiplier as follows:

All-electric range	MY 1999-2000	MY 2001 -2002	MY 2003-2005	MY 2006-2007
100-175	6-10	4-6	2-4	1-2

ZEV multipliers under the above schedule will be determined by linear interpolation between the values shown in the above schedule. Range shall be determined in accordance with Section E.3.(2)(a) of these test procedures. ZEVs that have a refueling time of less than 10 minutes and a range of 100 miles or more shall be counted as having unlimited all-electric range, and shall consequently qualify for the maximum allowable ZEV multiplier for a specific model year. ZEVs that have a range of 80 to 99 miles shall qualify for ZEV multipliers in 1999-2002 model years in accordance with the following equation:

ZEV multiplier = (minimum allowable ZEV multiplier per above table for a model year) x (AER equivalent to a 10 minute recharge/100) x 0.5.

(b) For purposes of calculating a manufacturer's fleet average NMOG value under sections 1960.1(g)(2) and 1961(b) and (c), title 13, CCR, each extended electric range ZEV shall be counted as one vehicle.

(c) *Effect of ZEV Multipliers.* In calculating the number of ZEVs and full ZEV allowance vehicles produced and delivered for sale in California by a manufacturer in a model year and the ZEV credits from such vehicles, the number of ZEVs and full ZEV allowance vehicles qualifying for a particular ZEV multiplier shall be multiplied by the ZEV multiplier.

4.2 ZEV Credit Calculations.

(a) *Credits from ZEVs and Full ZEV Allowance Vehicles.* A full ZEV allowance vehicle shall be treated as a ZEV in calculating and applying ZEV credits. The amount of ZEV credits earned by a manufacturer in a given model year from ZEVs shall be expressed in units of g/mi NMOG, and shall be equal to the number of ZEVs produced and delivered for sale in California that the manufacturer applies towards meeting the ZEV requirements for the model year (at least 40% of the ZEV requirement for a large volume manufacturer) subtracted from the number of ZEVs produced and delivered for sale in California by the manufacturer in the model year and then multiplied by the NMOG fleet average requirement for PCs and LDT1s for that model year.

(b) *Credits from Partial ZEV Allowance Vehicles.* The amount of ZEV credits from partial ZEV allowance vehicles earned by a manufacturer in a given model year shall be expressed in units of g/mi NMOG, and shall be equal to the total number of ZEV allowances from partial ZEV allowance vehicles produced and delivered for sale in California that the manufacturer applies towards meeting its ZEV requirement for the model year (a number not to exceed 60% of the ZEV requirement for large volume manufacturers) subtracted from the total number of ZEV allowances from partial ZEV allowance vehicles produced and delivered for sale in California by the manufacturer in the model year and then multiplied by the NMOG fleet average requirement for PCs and LDT1s for that model year.

(c) The number of credits from a manufacturer's ZEVs and full ZEV allowance vehicles shall be maintained separately from the number of credits from the manufacturer's partial ZEV allowance vehicles.

4.3 ZEV Credits for MDVs and LDTs other than LDT1s. ZEVs classified as MDVs or as LDTs other than LDT1s may be counted toward the ZEV requirement for PCs and LDT1s, and included in the calculation of ZEV credits as specified in this section C.4 if the manufacturer so designates.

4.4 Submittal of ZEV Credits. A manufacturer may meet the ZEV requirements in any given model year by submitting to the Executive Officer a commensurate amount of ZEV credits consistent with section C.2. These credits may be earned previously by the manufacturer or acquired from another manufacturer. The amount of ZEV credits required to be submitted shall be calculated according to the criteria set forth in this section C.4.

4.5 Requirement to Make Up a ZEV Deficit. A manufacturer that produces and delivers for sale in California fewer ZEVs than required in a given model year shall make up the deficit by the end of the next model year by submitting to the Executive Officer a commensurate amount of ZEV credits. The amount of ZEV credits required to be submitted shall be calculated by (A) adding the number of ZEVs produced and delivered for sale in California by the manufacturer for the model year to the number of ZEV allowances from partial ZEV allowance vehicles produced and delivered for sale in California by the manufacturer for the model year (not to exceed 60% of a large volume manufacturer's ZEV requirement), (B) subtracting that total from the number of ZEVs required to be produced and delivered for sale in California by the

manufacturer for the model year, and (C) multiplying the resulting value by the fleet average requirements for PCs and LDT1s for the model year in which the deficit is incurred.

4.6 Penalty for Failure to Meet ZEV Requirements. Any manufacturer that fails to produce and deliver for sale in California the required number of ZEVs or submit an appropriate amount of ZEV credits and does not make up ZEV deficits within the specified time period shall be subject to the Health and Safety Code section 43211 civil penalty applicable to a manufacturer that sells a new motor vehicle that does not meet the applicable emission standards adopted by the state board. The cause of action shall be deemed to accrue when the ZEV deficits are not balanced by the end of the specified time period. For the purposes of Health and Safety Code section 43211, the number of vehicles not meeting the state board's standards shall be calculated according to the following equation, provided that no more than 60% of a large volume manufacturer's ZEV requirement for a given model year may be satisfied with partial ZEV allowance vehicles or ZEV credits from such vehicles:

> (No. of ZEVs required to be produced and delivered for sale in California for the model year) - (No. of ZEVs produced and delivered for sale in California for the model year) - (No. of ZEV allowances from partial ZEV allowance vehicles produced and delivered for sale in California for the model year) - [(Amount of ZEV credits submitted for the model year) / (the fleet average requirement for PCs and LDT1s for the model-year)].

D. Certification Requirements

1. Durability and Emission Testing Requirements. All ZEVs are exempt from all mileage and service accumulation, durability-data vehicle, and emission-data vehicle testing requirements.

2. Information Requirements: Application for Certification. Except as noted below, the Part I (40 CFR §86.1843-01(c)) certification application shall include the following:

2.1 Identification and description of the vehicle(s) covered by the application.

2.2 Identification of the vehicle weight category to which the vehicle is certifying: PC, LDT 0-3750 lbs. LVW, LDT 3751-5750 lbs. LVW, LDT 3751 lbs. LVW - 8500 lbs. GVW, or MDV (state test weight range), and the curb weight and gross vehicle weight rating of the vehicle.

2.3 Identification and description of the propulsion system for the vehicle.

2.4 Identification and description of the climate control system used on the vehicle.

2.5 Projected number of vehicles produced and delivered for sale in California, and projected California sales.

2.6 Identification of the energy usage in kilowatt-hours per mile from:

(a) the battery output (DC energy) (to be submitted with the Part II certification application (40 CFR 86.1843-01(d));

(b) the point when electricity is introduced from the electrical outlet (AC energy); and

(c) the operating range in miles of the vehicle when tested in accordance with the All-Electric Range Test set forth in Section E, below.

2.7 For those ZEVs and HEVs that use fuel-fired heaters, the manufacturer shall provide:

(a) a description of the control system logic of the fuel-fired heater, including an evaluation of the conditions under which the fuel-fired heater can be operated and an evaluation of the possible operational modes and conditions under which evaporative emissions can exist;

(b) the exhaust emissions value per mile produced by the auxiliary fuel-fired heater operated between 68°F and 86°F; and

(c) the test plan which describes the procedure used to determine the mass emissions of the fuel-fired heater.

2.8 All information necessary for proper and safe operation of the vehicle, including information on the safe handling of the battery system, emergency procedures to follow in the

event of battery leakage or other malfunctions that may affect the safety of the vehicle operator or laboratory personnel.

2.9 Method for determining battery state-of-charge, battery charging capacity and recharging procedures, and any other relevant information as determined by the Executive Officer.

2.10 Battery specific energy data and calculations as specified in Section E.4 of these procedures including the weight of the battery system and the three hour discharge rate (C/3) energy capacity.

2.11 Vehicle and battery break-in period as specified in Section E.2 of these test procedures.

2.12 Labeling shall conform with the requirements specified in section 1965, title 13, CCR and the California Motor Vehicle Emission Control and Smog Index Label Specifications.

E. Test Procedures

The “as adopted or amended dates” of the 40 CFR Part 86 regulations referenced by this document are the dates identified in the “California Exhaust Emission Standards and Test Procedures for 2001 and Subsequent Model Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles” incorporated by reference in section 1961(d), title 13, CCR.

1. Electric Dynamometer. All ZEVs must be tested using a 48-inch single roll electric dynamometer meeting the requirements of 40 CFR Subpart B, §86.108-00(b)(2).

2. Vehicle and Battery Break-In Period. A manufacturer shall use good engineering judgment in determining the proper stabilized emissions mileage test point and report same according to the requirements of Section D.2.11 above.

3. All-Electric Range Test. All 2001 and subsequent ZEVs and only off-vehicle charge capable hybrid electric vehicles shall be subject to the All-Electric Range Test specified below for the purpose of determining the energy efficiency and operating range of a ZEV or of an off-vehicle charge capable hybrid electric vehicle operating without the use of its auxiliary power unit. For hybrid electric vehicles, the manufacturer may elect to conduct the All-Electric Range Test prior to vehicle preconditioning in the exhaust and evaporative emission test sequence specified in the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference in section 1976, Title 13, CCR.

(1) **Cold soak**. The vehicle shall be stored at an ambient temperature not less than 68?F (20?C) and not more than 86?F (30?C) for 12 to 36 hours. During this time, the vehicle's battery shall be charged to a full state-of-charge.

(2) **Driving schedule.**

(a) **Determination of All-Electric Range-Urban.** At the end of the cold soak period, the vehicle shall be placed, either driven or pushed, onto a dynamometer and operated through successive Urban Dynamometer Driving Schedules (UDDS), 40 CFR, Part 86, Appendix I, which is incorporated herein by reference, until the vehicle is no longer able to maintain the speed or time tolerances contained in 40 CFR §86.115-00(b)(1) and (2). A 10-minute soak shall follow each UDDS cycle. This test sequence shall be repeated until the vehicle is no longer able to maintain either the speed or time tolerances in 40 CFR §86.115-00 (b)(1) and (2), or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc. For off-vehicle charge capable hybrid electric vehicles, this determination shall be performed without the use of the auxiliary power unit.

(b) **Determination of All-Electric Range-Highway.** At the end of the cold soak period, the vehicle shall be placed, either driven or pushed, onto a dynamometer and operated through two successive Highway Fuel Economy Driving Schedules (HFEDS),

found in 40 CFR, Part 600, Appendix I, which is incorporated herein by reference the speed or time tolerances contained in 40 CFR §86.115-00(b)(1) and (2). There shall be a 15 second zero speed with key on and brake depressed between two cycles and a 10-minute soak following the two HFEDS cycles. This test sequence shall be repeated until the vehicle is no longer able to maintain either the speed or time tolerances in 40 CFR §86.115-00 (b)(1) and (2), or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc. For off-vehicle charge capable hybrid electric vehicles, this determination is optional and shall be performed without the use of the auxiliary power unit.

(3) **Recording requirements.** Once the vehicle is no longer able to maintain the speed and time requirements specified in (2) above, or once the auxiliary power unit turns on, in the case of an off-vehicle charge capable hybrid electric vehicle, the vehicle shall be brought to an immediate stop and the following data recorded:

(a) mileage accumulated during the All-Electric Range Test;
(b) Net DC energy from the battery that was expended during the All-Electric Range Test (may be reported as the total DC battery energy output and the total DC battery energy input during the All-Electric Range Test);
(c) AC energy required to fully charge the battery after the All-Electric Range Test from the point where electricity is introduced from the electric outlet to the battery charger; and
(d) DC energy required to fully charge the battery after the All-Electric Range Test from the point where electricity is introduced from the battery charger to the battery.

Battery charging shall begin within 1 hour after terminating the All-Electric Range Test.

(4) **Regenerative braking**. Regenerative braking systems may be utilized during the range test. The braking level, if adjustable, shall be set according to the manufacturer's specifications prior to the commencement of the test. The driving schedule speed and time tolerances specified in (2) shall not be exceeded due to the operation of the regenerative braking system.

4. Determination of Battery Specific Energy for ZEVs

Determine the specific energy of batteries used to power a ZEV in accordance with the U.S. Advanced Battery Consortium's Electric Vehicle Battery Procedure Manual (January 1996), Procedure No. 2, "Constant Current Discharge Test Series," using the C/3 rate. The weight calculation must reflect a completely functional battery system as defined in the Appendix of the Manual, including pack(s), required support ancillaries (e.g., thermal management), and electronic controller.

5. Determination of the Emissions of the Fuel-fired Heater

The exhaust emissions result of the fuel-fired heater shall be determined by operating at a maximum heating capacity with a cold start between 68°F and 86°F for a period of 20 minutes and dividing the grams of emissions by 20. The resulting grams per minute shall be multiplied by 3.6 minutes per mile for a grams per mile value.

6. Hybrid Electric Vehicle FTP Emission Test Provisions

Alternative procedures may be used if shown to yield equivalent results and if approved in advance by the Executive Officer of the Air Resources Board.

6.1 Vehicle Preconditioning

To be conducted pursuant to the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference herein with the following supplemental requirements:

6.1.1 Battery state-of-charge shall be set prior to initial fuel drain and fill before vehicle preconditioning.

6.1.2 For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the preconditioning drive.

6.1.3 For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle is charge-sustaining over the UDDS, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

(ii) If the hybrid electric vehicle is charge-depleting over the UDDS, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in urban driving conditions.

6.1.4 After setting battery state-of-charge, the hybrid electric vehicle shall be pushed or towed to a work area for fuel drain and fill according to sections D.1.1. and D.1.2. of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference herein.

6.1.5 Following fuel drain and fill, the vehicle shall be pushed or towed into position on a dynamometer and preconditioned. If the auxiliary power unit is capable of

being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the preconditioning drive.

6.1.6 Within five minutes of completing preconditioning drive, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle does not allow manual activation of the auxiliary power unit and is charge-sustaining over the UDDS, then set battery state-of-charge to a level such that the SOC Criterion (see section B., Definitions, of these procedures) would be satisfied for the dynamometer procedure (section 6.2 of these procedures). If off-vehicle charging is required to increase battery state-of-charge for proper setting, off-vehicle charging shall occur during 12 to 36 hour soak period.

(ii) If the hybrid electric vehicle does not allow manual activation of the auxiliary power unit and is charge-depleting over the UDDS, then no battery state-of-charge adjustment is permissible.

(iii) If the hybrid electric vehicle does allow manual activation of the auxiliary power unit, then set battery state-of-charge to manufacturer recommended level for activating the auxiliary power unit when the hybrid electric vehicle is operating in urban driving conditions.

6.2 Dynamometer Procedure

To be conducted pursuant to 40 CFR §86.135-00 with the following revisions:

6.2.1 Amend subparagraph (a): Overview. The dynamometer run consists of two tests, a "cold" start test, after a minimum 12-hour and a maximum 36-hour soak pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference herein, and a "hot" start test following the "cold" start test by 10 minutes. Vehicle startup (with all accessories turned off), operation over the UDDS and vehicle shutdown make a complete cold start test. Vehicle startup and operation over the UDDS and vehicle shutdown make a complete hot start test. The exhaust emissions are diluted with ambient air in the dilution tunnel as shown in Figure B94-5 and Figure B94-6. A dilution tunnel is not required for testing vehicles waived from the requirement to measure particulates. Four particulate samples are collected on filters for weighing; the first sample plus backup is collected during the cold start test (including shutdown); the second sample plus backup is collected during the hot start test (including shutdown). Continuous proportional samples of gaseous emissions are collected for analysis during each test. For hybrid electric vehicles with gasoline-fueled, natural gas-fueled and liquefied petroleum gas-fueled Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO_2, CH_4 and NO_x. For hybrid electric vehicles with

petroleum-fueled diesel-cycle auxiliary power units (optional for natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled diesel-cycle vehicles), THC is sampled and analyzed continuously pursuant to the provisions of §86.110. Parallel samples of the dilution air are similarly analyzed for THC, CO, CO_2, CH_4 and NO_x. For hybrid electric vehicles with natural gas-fueled, liquefied petroleum gas-fueled and methanol-fueled auxiliary power units, bag samples are collected and analyzed for THC (if not sampled continuously), CO, CO_2, CH_4 and NO_x. For hybrid electric vehicles with methanol-fueled auxiliary power units, methanol and formaldehyde samples are taken for both exhaust emissions and dilution air (a single dilution air formaldehyde sample, covering the total test period may be collected). Parallel bag samples of dilution air are analyzed for THC, CO, CO_2, CH_4 and NO_x.

6.2.2 Delete subparagraph (d).

6.2.3 Amend subparagraph (h): The driving distance, as measured by counting the number of dynamometer roll or shaft revolutions, shall be determined for the cold start test and hot start test. The revolutions shall be measured on the same roll or shaft used for measuring the vehicle's speed.

6.3 Dynamometer Test Run, Gaseous and Particulate Emissions

To be conducted pursuant to 40 CFR §86.137-96 with the following revisions:

6.3.1 Amend subparagraph (a): General. The dynamometer run consists of two tests, a cold start test, after a minimum 12-hour and a maximum 36-hour soak pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference herein, and a hot start test following the cold start test by 10 minutes. The vehicle shall be stored prior to the emission test in such a manner that precipitation (e.g., rain or dew) does not occur on the vehicle. The complete dynamometer test consists of a cold start drive of 7.5 miles (12.1 km) and a hot start drive of 7.5 miles (12.1 km). The vehicle is allowed to stand on the dynamometer during the 10 minute time period between the cold and hot start tests.

6.3.2 Amend subparagraph (b)(9): Start the gas flow measuring device, position the sample selector valves to direct the sample flow into the exhaust sample bag, the methanol exhaust sample, the formaldehyde exhaust sample, the dilution air sample bag, the methanol dilution air sample and the formaldehyde dilution air sample (turn on the petroleum-fueled diesel-cycle THC analyzer system integrator, mark the recorder chart, start particulate sample pump No. 1, and record both gas meter or flow measurement instrument readings, if applicable), and turn the key on. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be activated at the beginning of and operated throughout the UDDS.

6.3.2 Delete subparagraph (13).

6.3.3 Amend subparagraph (14): Turn the vehicle off 2 seconds after the end of the last deceleration (at 1,369 seconds).

6.3.4 Amend subparagraph (15): Five seconds after the vehicle is shutdown, simultaneously turn off gas flow measuring device No. 1 and if applicable, turn off the hydrocarbon integrator No. 1, mark the hydrocarbon recorder chart, turn off the No. 1 particulate sample pump and close the valves isolating particulate filter No. 1, and position the sample selector valves to the "standby" position. Record the measured roll or shaft revolutions (both gas meter or flow measurement instrumentation readings), and reset the counter. As soon as possible, transfer the exhaust and dilution air samples to the analytical system and process the samples pursuant to §86.140, obtaining a stabilized reading of the exhaust bag sample on all analyzers within 20 minutes of the end of the sample collection phase of the test. Obtain methanol and formaldehyde sample analyses, if applicable, within 24 hours of the end of the sample period. (If it is not possible to perform analysis on the methanol and formaldehyde samples within 24 hours, the samples should be stored in a dark cold (4?C to 10?C) environment until analysis. The samples should be analyzed within fourteen days.) If applicable, carefully remove both pairs of particulate sample filters from their respective holders, and place each in a separate petri dish, and cover.

6.3.3 Amend subparagraph (18): Repeat the steps in paragraphs (b)(2) through (b)(17) of this section for the hot start test. The step in paragraph (b)(9) of this section shall begin between 9 and 11 minutes after the end of the sample period for the cold start test.

6.3.4 Delete subparagraph (19).

6.3.5 Delete subparagraph (20).

6.3.6 Amend subparagraph (21): As soon as possible, and in no case longer than one hour after the end of the hot start phase of the test, transfer the four particulate filters to the weighing chamber for post-test conditioning, if applicable. For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit and are charge-sustaining over the UDDS, a valid test shall satisfy the SOC Criterion (see Definitions, section B of these procedures).

6.3.7 Amend subparagraph (24): Vehicles to be tested for evaporative emissions will proceed pursuant to the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" as incorporated by reference herein.

6.4 Calculations - Exhaust Emissions

To be conducted pursuant to 40 CFR §86.144-94 with the following revisions:

6.4.1 Amend subparagraph (a): For light-duty vehicles and light duty trucks:

$$Y_{wm} = 0.43 * \frac{Y_c}{D_c} + 0.57 * \frac{Y_h}{D_h}$$

Where:

(1) Y_{wm} = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMHC, NMHCE, CH_4, NO_x, or CO_2, in grams per vehicle mile.

(2) Y_c = Mass emissions as calculated from the cold start test, in grams per test.

(3) Y_h = Mass emissions as calculated from the hot start test, in grams per test.

(4) D_c = The measured driving distance from the cold start test, in miles.

(5) D_h = The measured driving distance from the hot start test, in miles.

6.5 Calculations - Particulate Emissions

To be conducted pursuant to 40 CFR §86.145-82 with the following revisions:

6.5.1 Amend subparagraph (a): The final reported test results for the mass particulate (M_p) in grams/mile shall be computed as follows:

$$M_p = 0.43 * \frac{M_{pc}}{D_c} + 0.57 * \frac{M_{ph}}{D_h}$$

Where:

(1) M_{pc} = Mass of particulate determined from the cold start test, in grams per vehicle mile. (See §86.110-94 for determination.)

(2) M_{ph} = Mass of particulate determined from the hot start test, in grams per vehicle mile. (See §86.110-94 for determination.)

(3) D_c = The measured driving distance from the cold start test, in miles.

(4) D_h = The measured driving distance from the hot start test, in miles.

7. Hybrid Electric Vehicle Highway Emission Test Provisions

To be conducted pursuant to 40 CFR 600.111-93 with the following revisions:

7.1 Amend subparagraph (b)(2): The highway fuel economy test is designated to simulate non-metropolitan driving with an average speed of 48.6 mph and a maximum speed of 60 mph. The cycle is 10.2 miles long with 0.2 stop per mile and consists of warmed-up vehicle operation on a chassis dynamometer through a specified driving cycle. A proportional part of the diluted exhaust emission is collected continuously for subsequent analysis of THC, CO, CO_2, and NO_x using a constant volume (variable dilution) sampler. Diesel dilute exhaust is continuously analyzed for hydrocarbons using a heated sample line and analyzer. Methanol and formaldehyde samples are collected and individually analyzed for methanol-fueled vehicles.

7.2 Amend subparagraph (f)(3): Only one exhaust sample and one background sample are collected and analyzed for THC (except diesel hydrocarbons which are analyzed continuously), CO, CO_2, and NO_x . Methanol and formaldehyde samples (exhaust and dilution air) are collected and analyzed for methanol-fueled vehicles.

7.3 Add subparagraph (f)(5): Battery state-of-charge shall be set prior to performing the HFEDS preconditioning cycle. For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the HFEDS preconditioning cycle. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle is charge-sustaining over the HFEDS, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

(ii) If the hybrid electric vehicle is charge-depleting over the HFEDs, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions.

7.4 Amend subparagraph (h)(5): Operate the vehicle over one HFEDS preconditioning cycle according to the dynamometer driving schedule specified in §600.109(b). If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the HFEDS preconditioning cycle.

7.5 Amend subparagraph (h)(6): When the vehicle reaches zero speed at the end of the HFEDS preconditioning cycle, the driver has 17 seconds to prepare for the HFEDS emission measurement cycle of the test. Reset and enable the roll revolution counter. During the idle period, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the HFEDS, the vehicle shall be momentarily turned off for 5 seconds and turned back on during the idle period. The battery state-of-charge shall be recorded after the hybrid electric vehicle has fully turned on.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the HFEDS, the vehicle shall remain turned on during the idle period.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

7.6 Add subparagraph (h)(9): At the conclusion of the HFEDS emission test, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the HFEDS, record the battery state-of-charge to determine if the SOC Criterion (see Definitions, section B of these procedures) is satisfied. If the SOC Criterion is not satisfied, then repeat dynamometer test run from subparagraph (h)(6). A total of three highway emission tests shall be allowed to satisfy the SOC Criterion. Manufacturers may elect to repeat dynamometer test run from subparagraph (h)(6) if battery energy level increased significantly relative to the initial battery state-of-charge set at the beginning of the HFEDS emission test.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the HFEDS, the emission test is completed.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the emission test is completed.

8. Hybrid Electric Vehicle SFTP Emission Test Provisions

8.1 US06 Vehicle Preconditioning

To be conducted pursuant to 40 CFR §86.132-00 with the following revisions:

8.1.1 Amend subparagraph (n): Aggressive Driving Test (US06) Preconditioning. (1) If the US06 test follows the exhaust emission FTP or evaporative testing, the refueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer provided that battery state-of-charge has not been set; otherwise, if battery state-of-charge is set prior to securing vehicle on dynamometer, vehicle shall be pushed or towed into position on dynamometer. Battery state-of-charge shall be set prior to performing the US06 preconditioning cycle. For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the US06 preconditioning drive. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle is charge-sustaining over the US06, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.

The auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.

(ii) If the hybrid electric vehicle is charge-depleting over the US06, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.

8.1.2 Delete subparagraphs (n)(1)(i) and (n)(1)(ii).

8.2 US06 Emission Test

To be conducted pursuant to 40 CFR §86.159-00 with the following revisions:

8.2.1 Amend subparagraph (a): Overview. The dynamometer operation consists of a single, 600 second test on the US06 driving schedule, as described in appendix I, paragraph (g), of this part. The hybrid electric vehicle is preconditioned in accordance with §86.132-00, to bring it to a warmed-up stabilized condition. This preconditioning is followed by a 1 to 2 minute idle period that proceeds directly into the US06 driving schedule during which continuous proportional samples of gaseous emissions are collected for analysis. If engine stalling should occur during testing, follow the provisions of §86.136-90 (engine starting and restarting). For hybrid electric vehicles with gasoline-fueled Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO_2, CH_4 and NO_x. For hybrid electric vehicles with petroleum-fueled diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of §86.110. Parallel bag samples of dilution air are analyzed for THC, CO, CO_2, CH_4 and NO_x.

8.2.2 Amend subparagraph (b)(2): Position (vehicle shall be pushed or towed if battery state-of-charge is set prior to securing to dynamometer otherwise vehicle may be driven as well) the test vehicle on the dynamometer and restrain.

8.2.3 Amend subparagraph (d): Practice runs over the prescribed driving schedule may be performed at test point, provided that battery state-of-charge setting is conducted after practice and an emission sample is not taken, for the purpose of finding the appropriate throttle action to maintain the proper speed-time relationship, or to permit sampling system adjustment.

8.2.4 Amend subparagraph (f)(2)(i): Immediately after completion of the US06 preconditioning cycle, idle the vehicle. The idle period is not to be less than one minute or not greater than two minutes. During the idle period, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the US06, the vehicle shall be momentarily turned off for 5 seconds and turned back on during the idle period. The battery state-of-charge shall be recorded after the hybrid electric vehicle has fully turned on.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the US06, the vehicle shall remain turned on during the idle period.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on with the auxiliary power unit operating during the idle period.

8.2.5 Amend subparagraph (f)(2)(ix): At the conclusion of the US06 emission test, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit and are charge-sustaining over the US06, record the battery state-of-charge to determine if the SOC Criterion (see Definitions, section B of these procedures) is satisfied. If the SOC Criterion is not satisfied, then repeat dynamometer test run from subparagraph (f)(2)(i). A total of three US06 emission tests shall be allowed to satisfy the SOC Criterion. Manufacturers may elect to repeat dynamometer test run from subparagraph (f)(2)(i) if battery energy level increased significantly relative to the initial battery state-of-charge set at the beginning of US06 emission test.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the US06, turn off vehicle 2 seconds after the end of the last deceleration.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, turn off vehicle 2 seconds after the end of the last deceleration.

8.3 SC03 Vehicle Preconditioning

To be conducted pursuant to 40 CFR §86.132-00 with the following revisions:

8.3.1 Amend subparagraph (o): Air Conditioning Test (SC03) Preconditioning. (1) If the SC03 test follows the exhaust emission FTP or evaporative testing, the refueling step may be deleted and the vehicle may be preconditioned using the fuel remaining in the tank (see paragraph (c)(2)(ii) of this section). The test vehicle may be pushed or driven onto the test dynamometer provided that battery state-of-charge has not been set; otherwise, if battery state-of-charge is set prior to securing vehicle on dynamometer,

vehicle shall be pushed or towed into position on dynamometer. Battery state-of-charge shall be set prior to performing the SC03 preconditioning cycle. For hybrid electric vehicles that do not allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that causes the hybrid electric vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the SC03 preconditioning drive. For hybrid electric vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at a level that satisfies one of the following conditions:

(i) If the hybrid electric vehicle is charge-sustaining over the SC03, battery state-of-charge shall be set at the lowest level allowed by the manufacturer. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 preconditioning cycle.

(ii) If the hybrid electric vehicle is charge-depleting over the SC03, battery state-of-charge shall be set at the level recommended by the manufacturer for activating the auxiliary power unit when operating in highway driving conditions. The auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 preconditioning cycle.

8.3.2 Delete subparagraphs (o)(1)(i) and (o)(1)(ii).

8.4 SC03 Emission Test

To be conducted pursuant to 40 CFR §86.160-00 with the following revisions:

8.4.1 Amend subparagraph (a): Overview. The dynamometer operation consists of a single, 594 second test on the SC03 driving schedule, as described in appendix I, paragraph (h), of this part. The hybrid electric vehicle is preconditioned in accordance with §86.132-00 of this subpart, to bring the vehicle to a warmed-up stabilized condition. This preconditioning is followed by a 10 minute vehicle soak (vehicle turned off) that proceeds directly into the SC03 driving schedule, during which continuous proportional samples of gaseous emissions are collected for analysis. The entire test, including the SC03 preconditioning cycle, vehicle soak, and SC03 emission test, is either conducted in an environmental test facility or under test conditions that simulates testing in an environmental test cell (see Sec. 86.162-00 (a) for a discussion of simulation procedure approvals). The environmental test facility must be capable of providing the following nominal ambient test conditions of: 95°F air temperature, 100 grains of water/pound of dry air (approximately 40 percent relative humidity), a solar heat load intensity of 850 W/m^2, and vehicle cooling air flow proportional to vehicle speed. Section 86.161-00 discusses the minimum facility requirements and corresponding control tolerances for air conditioning ambient test conditions. The vehicle's air conditioner is operated or appropriately simulated for the duration of the test procedure (except for the 10 minute vehicle soak), including the preconditioning. If engine stalling should occur

during testing, follow the provisions of §86.136-90 (engine starting and restarting). For hybrid electric vehicles with gasoline-fueled Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO_2, CH_4 and NO_x. For hybrid electric vehicles with petroleum-fueled diesel-cycle auxiliary power units, THC is sampled and analyzed continuously according to the provisions of §86.110. Parallel bag samples of dilution air are analyzed for THC, CO, CO_2, CH_4 and NO_x.

8.4.2 Amend subparagraph (b)(2): Position (vehicle shall be pushed or towed if battery state-of-charge is set prior to securing to dynamometer otherwise vehicle may be driven as well) the test vehicle on the dynamometer and restrain.

8.4.3 Amend subparagraph (c)(9): Start vehicle (with air conditioning system also running). If the auxiliary power unit of the hybrid electric vehicle is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 emission test. Fifteen seconds after the vehicle starts, begin the initial vehicle acceleration of the driving schedule.

8.4.4 Amend subparagraph (c)(12): Turn the vehicle off 2 seconds after the end of the last deceleration.

8.4.5 Amend subparagraph (d)(7): Start vehicle (with air conditioning system also running). If the auxiliary power unit of the hybrid electric vehicle is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operated throughout the SC03 emission test. Fifteen seconds after the vehicle starts, begin the initial vehicle acceleration of the driving schedule.

8.4.6 Amend subparagraph (d)(10): At the conclusion of the US06 emission test, one of the following conditions shall apply:

(i) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the SC03, record the battery state-of-charge to determine if the SOC Criterion (see Definitions, section B of these procedures) is satisfied. If the SOC Criterion is not satisfied, then turn off cooling fan(s), allow vehicle to soak in the ambient conditions of paragraph (c)(5) of this section for 10 minutes, and repeat dynamometer test run from subparagraph (d). A total of three SC03 emission tests shall be attempted to satisfy the SOC Criterion. Manufacturers may elect to repeat dynamometer test run from subparagraph (d) following a 10 minute soak in the ambient conditions of paragraph (c)(5) of this section if battery energy level increased significantly relative to the initial battery state-of-charge set at the beginning of SC03 emission test.

(ii) For hybrid electric vehicles that do not allow the auxiliary power unit to be manually activated and are charge-depleting over the SC03, turn off vehicle 2 seconds after the end of the last deceleration.

(iii) For hybrid electric vehicles that allow the auxiliary power unit to be manually activated, turn off vehicle 2 seconds after the end of the last deceleration.

9. State-of-Charge Net Change Tolerances

9.1 For hybrid electric vehicles that use a battery as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(Amp\text{-}hr_{final})_{\max} = (Amp\text{-}hr_{initial}) + 0.01 * \frac{(NHV_{fuel} * m_{fuel})}{(V_{system} * K_1)}$$

$$(Amp\text{-}hr_{final})_{\min} = (Amp\text{-}hr_{initial}) - 0.01 * \frac{(NHV_{fuel} * m_{fuel})}{(V_{system} * K_1)}$$

Where:

$(\text{Amp-hr}_{final})_{max}$	=	Maximum allowed Amp-hr stored in battery at the end of the test
$(\text{Amp-hr}_{final})_{min}$	=	Minimum allowed Amp-hr stored in battery at the end of the test
$(\text{Amp-hr}_{initial})$	=	Battery Amp-hr stored at the beginning of the test
NHV_{fuel}	=	Net heating value of consumable fuel, in Joules/kg
m_{fuel}	=	Total mass of fuel consumed during test, in kg
K_1	=	Conversion factor, 3600 seconds/hour
V_{system}	=	Battery DC bus voltage (open circuit)

9.2 For hybrid electric vehicles that use a capacitor as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(V_{final})_{\max} = \sqrt{(V_{initial})^2 + 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{C}}$$

$$(V_{final})_{\min} = \sqrt{(V_{initial})^2 - 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{C}}$$

Where:

$(V_{final})_{max}$	=	The stored capacitor voltage allowed at the end of the test
$(V_{final})_{min}$	=	The stored capacitor voltage allowed at the end of the test

$(V_{initial})^2$	=	The square of the capacitor voltage stored at the beginning of the test
NHV_{fuel}	=	Net heating value of consumable fuel, in Joules/kg
m_{fuel}	=	Total mass of fuel consumed during test, in kg
C	=	Rated capacitance of the capacitor, in Farads

9.3 For hybrid electric vehicles that use an electro-mechanical flywheel as an energy storage device, the following state-of-charge net change tolerance shall apply:

$$(rpm_{final})_{\max} = \sqrt{(rpm_{initial})^2 + 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{(I * K_3)}}$$

$$(rpm_{final})_{\min} = \sqrt{(rpm_{initial})^2 - 0.01 * \frac{(2 * NHV_{fuel} * m_{fuel})}{(I * K_3)}}$$

Where:

$(rpm_{final})_{max}$	=	The maximum flywheel rotational speed allowed at the end of the test
$(rpm_{final})_{min}$	=	The minimum flywheel rotational speed allowed at the end of the test
$(rpm_{initial})^2$	=	The squared flywheel rotational speed at the beginning of the test
NHV_{fuel}	=	Net heating value of consumable fuel, in Joules/kg
m_{fuel}	=	Total mass of fuel consumed during test, in kg
K_3	=	Conversion factor, $4p^2/(3600\ sec^2\text{-}rpm^2)$
I	=	Rated moment of inertia of the flywheel, in kg-m^2