

ITEM 09-1-8

**Adoption of Test Procedure Modifications and Aftermarket Parts Certification
Requirements for Plug-In Hybrid Electric Vehicles**

Staff's Proposed Regulatory Text Modifications

California Environmental Protection Agency
AIR RESOURCES BOARD

**CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR
2009 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**

Adopted: [Insert date of adoption]

Amended: [Insert date of amendment]

Note: The proposed amendments to this document are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions proposed by staff in the Notice of Public Hearing released December 5, 2008. The document in which the amendments are being shown is a version that was initially approved by the Board on March 27, 2008 for adoption as part of the "Rulemaking to Consider Adoption of the 2008 Amendments to the California Zero-Emission Vehicle Regulation." That rulemaking is not yet final. For that reason, the document text also includes two sets of proposed changes that the Board authorized staff to offer for public comment as part of the March 27, 2008 rulemaking. The first set of changes noticed as 15-day changes to the March 27, 2008 rulemaking version are indicated by double underline to indicate additions and ~~double strikeout~~ to indicate deletions compared to the test procedures issued with the 45-day notice for the Board hearing. The second set of 15-day changes to the March 27, 2008 rulemaking version are indicated by dotted underline to indicate additions and ~~italics double strikeout~~ to indicate deletions. Existing intervening text that is not amended is indicated by "** * * *". Page numbers in the table of contents will be amended in the final rulemaking if the proposal is approved by the Board.

Staff's draft proposed modifications are discussed but not shown in regulatory language. Staff will propose draft modifications to the amendments in the formal 15 day modification process.

Proposed Modifications to PHEV Exhaust Test Procedures

Section D2.6 Staff's proposal will add clarifying language to kwh/mi to state that it is based on EAER for the city and highway tests

- D2.6 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. For off-vehicle charge capable hybrid electric vehicles certifying to section F, the manufacturer shall provide the energy usage in kilowatt hours per mile from the Urban Equivalent All-Electric Range and the Highway Equivalent All-Electric Range.

Section D2.11, E2, F2 – Staff's proposal will provide language to eliminate unnecessary cross-references.

D2.11 Vehicle and battery break-in period as specified in section E.2 of these test procedures.

E2. 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.

F2. 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.

Section E3.3 and F3.1 – Staff's proposal will clarify the precision for DC and AC measurements.

E3.3 Recording requirements.

For all battery electric vehicles and hybrid electric vehicles, except off-vehicle charge capable hybrid electric vehicles: Once the vehicle is no longer able to maintain the speed and time requirements specified in E.3.1 or E.3.2 above, the vehicle shall be brought to an immediate stop and the following data shall be 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.

F3.1 Recording requirements.

For off-vehicle charge capable hybrid electric vehicles: The following data shall be recorded for all charge depleting range and exhaust tests and for each individual test cycle therein:

(a) mileage accumulated during the All-Electric Range portion of the test, where applicable;

(b) Net DC energy from the battery that was expended during the test (may be reported as the total DC battery energy output and the total DC battery energy input);

(c) AC energy required to fully charge the battery after a charge depleting or charge sustaining test from the point where electricity is introduced from the electric outlet to the battery charger;

(d) DC energy required to fully charge the battery after a charge depleting or charge sustaining test from the point where electricity is introduced from the battery charger to the battery; and

(e) Net DC amp-hrs from the battery that was expended during the test (may be reported as the total DC amp-hrs output and the total DC amp-hrs input)

Section E3.5 and F3.3 – Staff will propose changes that clarify accuracy requirements for all measurements including DC and AC.

E3.5 Measurement Accuracy. For battery electric vehicles, the overall error in voltage and current recording instruments shall be NIST traceable and accurate to $\pm 1\%$ of the maximum value of the variable being measured. Suggested equipment: amp meter/power meter capable of sampling voltage and current. Voltage and current shall be sampled at a minimum rate of 20 hz.

F3.3 Measurement Accuracy. The overall error in voltage and current recording instruments shall be NIST traceable and accurate to $\pm 1\%$ of the maximum value of the variable being measured. Suggested equipment: amp meter/power meter capable of sampling voltage and current. Voltage and current shall be sampled at a minimum rate of 20 hz.

Section E3.1.2 and 3.2.2 – Staff's proposal will provide language for the testing FCVs per SAE J2572 to show it as an option.

E3.1.2 Determination of Urban All-Electric Range for Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles.

(a) The urban all-electric range for a fuel cell vehicle and a hybrid fuel cell vehicle shall be determined in accordance with SAE J2572.

E3.2.2 Determination of Highway All-Electric Range for Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles.

(a) The highway all-electric range for a fuel cell vehicle and a hybrid fuel cell vehicle shall be determined in accordance with SAE J2572.

Section F5 – Staff's proposal will clarify the language to define the mode of operation (to include economy mode, performance mode, etc) and change the "maximum operation of the auxiliary power unit" to "worst-case emissions mode of operation."

F5. Urban Test Provisions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

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.

The criteria certification emissions for the Urban test shall be the worst case emissions of NMOG, CO, NOx, and PM from either the charge depleting or charge sustaining tests. The sum of NMOG + NOx emissions shall constitute the worst case for the charge sustaining or charge depleting modes of operation and determine the operation mode for US06 and SC03 emission tests.

Vehicles with more than one mode of operation for a given charge depleting or charge sustaining test cycle must be tested in the mode(s) which represents maximum operation of the auxiliary power unit. Confirmatory testing may also be performed in any mode of operation to ensure compliance with emission standards.

Section F5.1.4 – Staff's proposal will create a separate section for last sentence

5.1.4 Following the initial fuel drain and fill, the vehicle shall complete an initial soak period of a minimum of 6 hours. After completing the soak period, 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.

Section F5.2.1 – Staff’s proposal will clarify this section to allow use of the bag mini-diluter as an alternative to the CVS for emission measurement.

F5.2.1 Amend subparagraph (a).

Overview. The dynamometer run shall consist of a series of charge depleting tests, after a second fuel drain and fill and a 12 to 36 hour soak period performed pursuant to the provisions of the “California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles.” Each charge depleting test shall consist of one UDDS followed by a 10 minute hot soak period until charge sustaining operation is achieved for two consecutive UDDSs. Once charge sustaining operation is achieved over two consecutive UDDSs, or a single UDDS if data is provided showing that charge sustaining operation can consistently be maintained over one UDDS, the vehicle shall be turned off and 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. If the energy required to charge the vehicle from urban charge sustaining operation to full charge is not equivalent (within ± 1% of the AC energy) to the energy required to charge the vehicle from highway charge sustaining operation to full charge, the vehicle must be recharged. If the energy required to charge the vehicle from urban charge sustaining operation to full charge is equivalent (within ± 1% of the AC energy) to the energy required to charge the vehicle from highway charge sustaining operation to full charge, the vehicle may be recharged. The vehicle must be turned off during recharging. At the end of this cold soak period, the vehicle shall be placed or pushed onto a dynamometer. Vehicle emissions shall be measured over two UDDSs during charge sustaining operation, each separated by a 10 minute key-off hot soak period. The vehicle must meet SOC criterion in section F.10 from the start of the first UDDS until the end of the second UDDS.

For all exhaust emission tests, the exhaust emissions are diluted with ambient air in the dilution tunnel as shown in Figure B94-5 and Figure B94-6 (§86.110-94). A dilution tunnel is not required for testing vehicles waived from the requirement to measure particulates. For UDDSs, particulate samples are collected on filters for weighing during each UDDS. Each sample plus backup is collected during each UDDS (including shutdown). Continuous proportional samples of gaseous emissions are collected for analysis during each UDDS. For vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO₂, CH₄ and NO_x. For vehicles with petroleum-fueled diesel-cycle auxiliary power units (optional for natural gas-fueled, liquefied petroleum gas-fueled, and alcohol-fueled diesel-cycle vehicles), THC is sampled and analyzed continuously pursuant to the provisions of §86.110-94. Parallel samples of the dilution air are similarly analyzed for THC, CO, CO₂, CH₄ and NO_x. For vehicles with natural gas-fueled, liquefied petroleum gas-fueled, and alcohol-fueled auxiliary power units, bag samples are collected and analyzed for THC

(if not sampled continuously), CO, CO₂, CH₄ and NO_x. For vehicles with alcohol-fueled auxiliary power units, alcohol 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, CO₂, CH₄ and NO_x.

Section F6.2.2.2. Staff's proposal will eliminate the word "driven" from cold start highway charge sustaining emission test. The vehicle needs to be pushed to the dynamometer.

F6.2.2.2 Replace subparagraph (b)(6) with: 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. At the end of the cold soak period, the vehicle shall be placed, either driven or pushed onto a dynamometer.

Section F8.1 Staff's proposal will correct the errors in this section. The references to "urban charge sustaining range test" will be changed to "urban charge depleting range test" and "urban charge sustaining test" will be changed to "urban charge sustaining emissions test".

8.1 To satisfy test requirements for the 50°F emission test, the vehicle shall be tested in the worst case (NMHC + NO_x) of the urban charge sustaining range test or urban charge sustaining test as defined in section F.5. To satisfy test requirements for the 20°F emission test, the vehicle shall be tested in the worst case (CO) of the urban charge sustaining range test or urban charge sustaining test as defined in section F.5. For the 20°F and 50°F emission tests, the vehicle is not required to meet SOC net tolerances.

Section E9.1 and F11.8 – Staff's proposal will be to align the definition of V_{system} as identified by the SAE J1711 committee.

E9.1 For hybrid electric vehicles that use a battery as an energy storage device, the following state-of-charge net change tolerance shall apply:

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

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

Where:

(Amp-hr_{final})_{max} = Maximum allowed Amp-hr stored in battery at the end of the test

<u>(Amp-hr_{final})_{min}</u>	=	<u>Minimum allowed Amp-hr stored in battery at the end of the test</u>
<u>(Amp-hr_{initial})</u>	=	<u>Battery Amp-hr stored at the beginning of the test</u>
<u>NHV_{fuel}</u>	=	<u>Net heating value of consumable fuel, in Joules/kg</u>
<u>m_{fuel}</u>	=	<u>Total mass of fuel consumed during test, in kg</u>
<u>K₁</u>	=	<u>Conversion factor, 3600 seconds/hour</u>
<u>V_{system}</u>	=	<u>Average charge sustaining battery DC bus voltage (open circuit) during charge sustaining operation. This value shall be submitted for testing purposes, and it shall be subject to confirmation by the Air Resources Board.</u>

F11.8 The Urban Charge Depleting Cycle Range, R_{cdcu}, (see section H for an illustration of R_{cdcu}) shall be defined as the distance traveled on the Urban Charge Depleting Procedure up to the UDDS prior to where the state-of-charge is above the lower bound state-of-charge tolerance for one test cycle given by:

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

Where:

<u>(Amp-hr_{final})_{min}</u>	=	<u>Minimum allowed Amp-hr stored in battery at the end of the test</u>
<u>(Amp-hr_{initial})</u>	=	<u>Battery Amp-hr stored at the beginning of the test</u>
<u>NHV_{fuel}</u>	=	<u>Net heating value of consumable fuel, in Joules/kg</u>
<u>m_{fuel}</u>	=	<u>Total mass of fuel consumed during test, in kg</u>
<u>K₁</u>	=	<u>Conversion factor, 3600 seconds/hour</u>
<u>V_{system}</u>	=	<u>Average charge sustaining battery DC bus voltage (open circuit) during charge sustaining operation. This value shall be submitted for testing purposes, and it shall be subject to confirmation by the Air Resources Board.</u>

Date of Hearing: January 23, 2009
Date of 15-Day Notice: TBD

State of California

AIR RESOURCES BOARD

**CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES
FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES**

Adopted: August 5, 1999
Amended: June 22, 2006
Amended: October 17, 2007
Amended: [insert amended date]

Note: Proposed amendments to this document are shown in underline to indicate additions and ~~strikeouts~~ to indicate deletions compared to the test procedures as last amended October 17, 2007. The text of modifications made subsequent to the January 23, 2009 Board Hearing, and described in the Notice of Availability of Modified Text (15-day Notice), is shown in double-underline to indicate additions and ~~double-strikeout~~ to indicate deletions. Existing intervening text that is not amended is indicated by a row of asterisks (* * * *).

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CALIFORNIA EVAPORATIVE EMISSION STANDARDS AND TEST PROCEDURES FOR 2001 AND SUBSEQUENT MODEL MOTOR VEHICLES

The provisions of Title 40, Code of Federal Regulations (CFR), Part 86, Subparts A and B (as adopted or amended as of July 1, 1989); Subpart S (as adopted or amended on May 4, 1999); and, such sections of these Subparts as last amended on such other date set forth next to the 40 CFR Part 86 section title listed below, insofar as those subparts pertain to evaporative emission standards and test procedures, are hereby adopted as the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Years," with the following exceptions and additions:

* * * *

PART III. EVAPORATIVE EMISSION TEST PROCEDURES FOR LIGHT- AND MEDIUM-DUTY VEHICLES

* * * *

C. Road Load Power, Test Weight, Inertia Weight Class, and Running Loss Fuel Tank Temperature Profile Determination

Amend 40 CFR §86.129-80 to include an additional subsection III.C.1. to read:

* * * *

1.3. The vehicle fuel tank shall be drained and filled to 40 percent of the nominal tank capacity with fuel meeting the requirements of paragraph section III.D.1. of these procedures. For all hybrid electric vehicles, except for 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, the battery state-of-charge shall be set at a level such that the auxiliary power unit would be activated by the vehicle's control strategy within 30 seconds of starting the first UDDS of the fuel tank temperature profile determination test sequence. If the auxiliary power unit is capable of being manually activated, the auxiliary power unit shall be manually activated at the beginning of and operating throughout the fuel tank temperature profile determination. For 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, the battery state-of-charge shall be set at the level that results when the battery state-of-charge is initially set at the highest level allowed by the manufacturer and then decreased, as applicable, by the performance of a standard three-phase exhaust test. The vehicle shall be moved to the location where the driving cycle is to be conducted. It

may be driven a maximum distance of 5.0 miles, longer distances shall require that the vehicle be transported by other means. For 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, the vehicle shall be either only pushed or towed to avoid disturbing the battery state-of-charge setting. The vehicle shall be parked for a minimum of 12 hours in an open area on a surface that is representative of the test road. The orientation of the front of the vehicle during parking (N, SW, etc.) shall be documented. Once the 12-hour minimum parking time has been achieved and the ambient temperature and weather conditions and track surface temperature are within the allowable ranges, the vehicle engine shall be started. The vehicle air conditioning system (if so equipped) shall be set to the "NORMAL" air conditioning mode and adjusted to the minimum discharge air temperature and high fan speed. Vehicles equipped with automatic temperature controlled air conditioning systems shall be operated in "AUTOMATIC" temperature and fan modes with the system set at 72°F. The vehicle may be operated at minimum throttle for periods up to 60 seconds prior to beginning the first UDDS cycle in order to move from the parking location onto the road surface. The driver's aid shall be started and the vehicle operated over one UDDS cycle, then two NYCCs, and another UDDS cycle. The end of each UDDS cycle and the end of the two NYCCs shall be followed by an idle period of 120 seconds during which the engine shall remain on with the vehicle in the same transmission range and clutch (if so equipped) actuation mode as specified in 40 CFR §86.128-79 except for the following:

* * * *

D. Test Procedure

The test sequence described in 40 CFR §86.130 through §86.140 shall be performed with the following modifications:

1. General Requirements

* * * *

4.2-1.5. For 2001 through 2010 model-year vehicles, the vehicle preconditioning drive shall be performed in accordance with 40 CFR §86.132-90, except that following the initial fuel drain and fill step in this test sequence, vehicle fueling step at, as specified in 40 CFR §86.132-90(a)(1), an initial preconditioning minimum-soak period of a minimum of 6 hours shall be provided to allow the vehicle to stabilize to ambient temperature prior to the preconditioning drive. Vehicles performing consecutive tests at a test point with the same fuel specification and while remaining under laboratory ambient temperature conditions for at least 6 hours, may eliminate both the initial fuel drain and fill and vehicle soak. In such cases, each subsequent test shall begin with the preconditioning drive. For 2011 and subsequent model-year vehicles, the vehicle preconditioning drive shall be performed in accordance with 40 CFR §86.132-00.

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4.31.6. Except for 2011 and subsequent model-year off-vehicle charge capable hybrid electric vehicles that are equipped with non-integrated refueling canister-only systems, following the vehicle preconditioning drive, a second fuel drain and fill step shall be performed, in which the fuel tank is drained and then filled to in accordance with 40 CFR §86.132-90(a)(1). The fuel tank shall be filled to the prescribed tank fuel volume of 40 percent of the manufacturer's nominal fuel tank capacity, as specified in 40 CFR §86.1803-01, the fuel tank shall be drained and then filled to 40 percent capacity.

* * * *

1.12.5. For 2009 and subsequent model-year hybrid electric vehicles, except for 2011-2004 and subsequent model-year off-vehicle charge capable hybrid electric vehicles, battery state-of-charge setting prior to the standard three-phase test shall be performed pursuant to the supplemental requirements specified in section E.6.1.5 of the "California Exhaust Emission Standards and Test Procedures for 2009 and Subsequent Model Zero-Emission Vehicles and Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck, and Medium-Duty Vehicle Classes."

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1.19.3. At any level in-between the levels indicated by sections III.D.1.19.1. and III.D.1.19.2. ~~II.B.1.19.2.~~, above, if applicable.

* * * *

3. Vehicle Preconditioning

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3.2. The following language shall be applicable in lieu of 40 CFR §86.132-90(a)(4) for 2001 through 2010 model-year vehicles; and, in lieu of 40 CFR §86.132-96(e) for 2011 and subsequent model-year vehicles:

* * * *

3.3. The following language shall be applicable in lieu of 40 CFR §86.132-90(b) for 2001 through 2010 model-year vehicles; and, in lieu of 40 CFR §86.132-96(f) for 2011 and subsequent model-year vehicles:

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State of California
AIR RESOURCES BOARD

CALIFORNIA CERTIFICATION AND INSTALLATION PROCEDURES
FOR OFF-VEHICLE CHARGE CAPABLE CONVERSION SYSTEMS FOR 2000
AND SUBSEQUENT MODEL YEAR HYBRID ELECTRIC VEHICLES

[Note: All text is proposed for adoption. As permitted by section 8, title 2, California Code of Regulations, the proposed text is not underlined for ease of review. Single underlined text is staff's draft proposal of 15 day modifications.]

Adopted: [INSERT DATE OF ADOPTION]

Note: These procedures are incorporated by reference into section 2032, title 13, California Code of Regulations (CCR).

7. California Certification and Installation Procedures for Off-Vehicle Charge Capable WARRANTY REQUIREMENTS

(a) *Requirements of Manufacturers:*

Each manufacturer of a conversion system shall warrant to the person having the vehicle converted and to each subsequent purchaser of the vehicle that the conversion system is designed and manufactured to conform with the applicable requirements of these Procedures without causing damage to any part on the converted vehicle, and is free from defects in materials and workmanship which cause the conversion system to fail to conform with the applicable requirements of these Procedures or cause damage to any part on the converted vehicle. This warranty requirement will be effective for the applicable warranty period specified in section 2037(b), title 13, CCR, from the date of installation if the conversion system is installed on the vehicle within four years of the date the vehicle is first acquired by an ultimate purchaser. If the conversion system is installed on the vehicle after four years of the date the vehicle is first acquired by an ultimate purchaser, the warranty period will be three years or half the applicable warranty period mileage specified in section 2037(b), title 13, CCR, whichever occurs first from the date of installation. For PZEVs, this warranty requirement will be effective for the applicable warranty period specified in section 1962(c) or section 1962.1(c), title 13, CCR, from the date of installation if the conversion system is installed on the vehicle within six years of the date the vehicle is first acquired by an ultimate purchaser. If the conversion system is installed on the PZEV after six years of the date the vehicle is first acquired by an ultimate purchaser, the warranty period will be five years or half the applicable warranty period mileage specified in section 1962(c) or section 1962.1(c), title 13, CCR, whichever occurs first from the date of installation. This warranty shall cover customer service and the full repair or replacement costs including the costs of diagnosis, labor, and parts, including any part on the converted vehicle that is damaged due to a defect in the conversion system.