California Environmental Protection Agency
AIR RESOURCES BOARD

CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2018 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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Amended: December 6, 2012
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Note: The proposed amendments to this document are shown in underline to indicate additions and ~~strikeout~~ to indicate deletions compared to the test procedures as amended May 30, 2014. [No change] indicates proposed federal provisions that are also proposed for incorporation herein without change. Existing intervening text that is not amended in this rulemaking is indicated by "* * * *".

NOTE: This document is incorporated by reference in section 1962.2, title 13, California Code of Regulations (CCR). Additional requirements necessary to complete an application for certification of zero-emission vehicles and hybrid electric vehicles are contained in other documents that are designed to be used in conjunction with this document. These other documents include:

1. "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001~~ and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" (incorporated by reference in section ~~1961(d)~~ 1961.2, title 13, CCR);

2. "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1976(c), title 13, CCR);

3. "California Refueling Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles" (incorporated by reference in section 1978(b), title 13, CCR);

4. OBD II (section 1968, et seq. title 13, CCR, as applicable);

5. "California Environmental Performance Label Specifications for 2009 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Passenger Vehicles" (incorporated by reference in 1965, title 13, CCR);

6. Warranty Requirements (sections 2037 and 2038, title 13, CCR);

7. "Specifications for Fill Pipes and Openings of Motor Vehicle Fuel Tanks" (incorporated by reference in section 2235, title 13, CCR);

8. Guidelines for Certification of Federally Certified Light-Duty Motor Vehicles for Sale in California (incorporated by section 1960.5, title 13, CCR); and

9. "California Non-Methane Organic Gas Test Procedures for 2017 and Subsequent Model Years," (incorporated by reference in section 1961.2(d), title 13, CCR).

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CALIFORNIA EXHAUST EMISSION STANDARDS AND TEST PROCEDURES FOR 2018 AND SUBSEQUENT MODEL ZERO-EMISSION VEHICLES AND HYBRID ELECTRIC VEHICLES, IN THE PASSENGER CAR, LIGHT-DUTY TRUCK AND MEDIUM-DUTY VEHICLE CLASSES

A. Applicability

The emission standards and test procedures in this document are applicable to 2018 and subsequent model-year zero-emission passenger cars, light-duty trucks, and medium-duty vehicles, and 2018 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 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001~~ and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" (hereinafter "LDV/MDV TPs"), and apply except as amended herein.

B. Definitions and Terminology.

1. Definitions.

* * * *

"All-Electric Range" or "AER" means the total miles driven electrically (with the engine off) before the engine turns on for the first time, after the battery has been fully charged. The AER is defined in terms of the Urban All-Electric Range (AER_u) and the Highway All-Electric Range (AER_h).

"All-Electric Range ~~(AER)~~Test" or "AERT" 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 vehicle shall be tested for all-electric range in default mode or in normal mode if the vehicle does not have a default mode. The Urban All-Electric Range Test ($AERT_u$) ~~cycle~~ determines the Urban All-Electric Range (AER_u) and ~~consists of~~ the Highway All-Electric Range ($AERT_h$) determines the Highway All-Electric Range (AER_h) ~~Fuel Economy Schedule and the Urban Dynamometer Driving Schedule~~ (see section ~~E~~G of these test procedures).

"~~Alternate~~ Alternative Continuous Urban Test Schedule" means a series of the following sequence: UDDS, 10 minute key-off hot soak, UDDS, and 10-~~20~~ 30 minute key-off hot soak. This ~~alternate~~ alternative procedure may be substituted for the Continuous Urban Test Schedule when the Continuous Urban Test Schedule cannot be performed.

"~~Alternate~~ Alternative Continuous Highway Test Schedule" means a series

of the following sequence: HFEDS, 15 second key-on pause, HFEDS, and 10-~~20~~ 30 minute key-off hot soak or a 15 second key-on pause. This ~~alternate~~ alternative procedure may be substituted for the Continuous Highway Test Schedule when the Continuous Highway Test Schedule cannot be performed.

"Auxiliary power unit" or "APU" (also referred to as "engine") 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. For the purposes of range extended battery electric vehicles, auxiliary power unit means any device that provides electrical or mechanical energy, meeting the requirements of subdivision C.3.2, to a BEVx, after the zero emission range has been fully depleted. A fuel fired heater does not qualify under this definition for an APU.

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"Charge-depleting net energy consumption" means the net electrical energy, E_{cd}, measured in watt-hours consumed by vehicle over ~~the~~ a charge depleting cycle range, R_{cdc}. E_{cd} can be expressed as AC or DC watt hours, where appropriate.

"Charge-depleting (CD)~~ mode~~ operation" means~~ an operating mode~~ a type of vehicle operation in which the energy storage state-of-charge (SOC) may fluctuate but, on average, decreases while the vehicle is driven. ~~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 depleting actual range, urban" or "R_{cdau}" means the distance traveled on the Urban Charge Depleting Test Procedure at which the state-of-charge is first equal to the average state-of-charge of the two consecutive UDDS cycles used to end the Urban Charge Depleting Test Procedure. This range must be reported to the nearest 0.1 miles. (See section ~~F~~G.11.9.)

"Charge depleting actual range, highway" or "R_{cdah}" means the distance traveled on the Highway Charge Depleting Test Procedure at which the state-of-charge is first equal to the average state-of-charge of the HFEDS cycle used to end the Highway Charge Depleting Test Procedure. This range must be reported to the nearest 0.1 miles.

"Charge depleting cycle range" or "R_{cdc}" means the distance traveled on the Urban or Highway Charge Depleting Test Procedure up to the test cycle prior to where the state-of-charge is above the lower bound state-of-charge tolerance for one test cycle. This range will appear as the sum of a discrete number of test cycle distances. This range shall be reported to the nearest 0.1 miles. (See section F.11.8.)

"Charge-increasing operation" means a type of vehicle operation that occurs when the energy storage SOC may fluctuate but, on average, increases while the vehicle is driven over two or more consecutive UDDS cycles. To test PHEVs with charge-increasing operation, follow the test requirements for charge-sustaining operation in section G.5 with the modifications specific to charge-increasing operation. A charge-increasing driver-selectable mode is not included in this definition but is considered a mode and not an operation.

* * * *

“Charge-sustaining (CS)~~ mode~~ operation” means~~ an operating mode~~ a type of vehicle operation in which the energy storage SOC may fluctuate but, on average, is maintained at a certain level while the vehicle is driven. ~~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).~~

“**Cold start UDDS**” is defined as the first UDDS cycle in which the engine turns on.

* * * *

“Continuous Highway Test Schedule” means a repeated series comprised of four consecutive key-on Highway Fuel Economy Driving Schedules (HFEDS) with a 15 second key-on pause in-between each HFEDS cycle. If this schedule cannot be performed continuously, a key-off soak up to 30 minutes is permitted after every fourth HFEDS cycle.

* * * *

“Default Mode” means the operating mode to which the vehicle automatically reverts after a vehicle is turned off and subsequently turned on. A vehicle with default mode would require the driver to select an alternative mode each time the vehicle is turned on if the driver chooses to use an alternative mode.

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“**Driver-Selectable Mode”** means an operating mode that the vehicle driver can manually engage by means of an instrument panel button, switch, screen menu, etc., anytime the vehicle is activated (e.g., when the key is in the on position).

* * * *

“**Energy storage device**” means a storage device able to provide the minimum power and energy storage capability to enable engine stop/start capability, traction boost, regenerative braking, and (nominal) charge sustaining~~ mode driving capability~~ operation. In the case of TZEVs, a minimum range threshold relative to certified, new-vehicle range capability is not specified or required.

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“Equivalent all-electric range” or “EAER” means the portion of the total charge depleting range attributable to the use of electricity from the battery over ~~the~~ a charge depleting ~~range~~ test.

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"Full State-of-Charge (SOC)" means the energy storage device of an off-vehicle charge capable hybrid electric vehicle is at full energy capacity following a recharging event with an off-vehicle charger.

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"Grid-connected hybrid electric vehicle" means a hybrid electric vehicle that has the capacity for the battery to be recharged from an off-board source of electricity and has some all-electric range. This type of hybrid electric vehicle is also called a plug-in hybrid electric vehicle or PHEV.

* * * *

"Normal Mode" means the operating mode where the vehicle automatically optimizes engine, battery, transmission, and braking operation for the most common driving conditions as determined by the manufacturer. Normal mode would be equivalent to default mode if the vehicle has default mode.

* * * *

"SAE J1634" means the "Battery Electric Vehicle Energy Consumption and Range Test Procedure," as revised by SAE International in October, 2012.

"SAE J1711" means the "Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-in Hybrid Vehicles," as revised by SAE International in June, 2010.

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"State of Charge (SOC) Net Energy Change Tolerance" means the state-of-charge net energy change tolerance that is applied to the SOC Criterion for charge-sustaining hybrid electric vehicles when validating an emission test. See section ~~E~~F.9 and ~~F~~G.10 of these procedures for tolerance specifications.

"State of Charge (SOC) Criterion" means the state-of-charge criterion that is applied to a 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 Energy Change Tolerance shall be applied to the SOC Criterion.

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

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2. Terminology.

	Abbreviation	Units
~~Charge Depleting Actual Range (urban cycle)~~	~~R_{cda}~~	~~mi~~
~~Charge Depleting to Charge Sustaining Range~~	~~R_{cdcs}~~	~~mi~~

* * * *

Highway All-Electric Range	AER_h	mi

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Highway Charge Depleting to Charge Sustaining Range	R_{cdcsh}	mi

* * * *

Urban All-Electric Range	AER_u	mi
Urban Charge Depleting Actual Range	R_{cdau}	mi

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Urban Charge Depleting to Charge Sustaining Range	R_{cdcsu}	mi

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D. Certification Requirements.

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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:

* * * *

2.15 For off-vehicle charge capable hybrid electric vehicles certifying to section ~~F~~G, the manufacturer shall provide the Urban All-Electric Range (AER_u), Urban Charge-Depleting Cycle Range (R_{cdcu}), the Urban Charge-Depleting Actual Range (R_{cdau}), the Urban Charge-Depleting to Charge-Sustaining ~~Urban~~ Range (R_{cdcsu}), the Highway All-Electric Range (AER_h), the Highway Charge-Depleting Cycle Range (R_{cdch}), the Highway Charge-Depleting Actual Range (**(**R_{cdah}), the Highway Charge-Depleting to Charge-Sustaining ~~Highway~~ Range (R_{cdcsh}), the Urban Equivalent All-Electric Range ($EAER_u$), the Highway Equivalent All-Electric

Range (EAER$_h$), the Urban Electric Range Fraction (ERF$_u$), and the Highway Electric Range Fraction (ERF$_h$). In addition, the manufacturer shall provide the following:

(a) all data recorded in accordance with section G.3.1;

(b) worst case emissions from each test cycle used to determine compliance with all applicable emission standards (a manufacturer must clearly indicate where the reported emissions from each of these test cycles are used in the calculations in sections G.8, G.10, G.11, and G.12);

(c) grams per mile emissions of NMOG, NOx, CO, and CO_2 for each test cycle conducted in accordance with sections G.4 (if applicable), G.5, G.6, G.7, and G.8;

(d) end-of-test option(s) selected for the Urban Charge-Sustaining Emission Test and Urban Charge-Depleting Emission Test as described in section(s) G.5.3 and G.5.4.2, respectively;

(e) if the Alternative Urban Charge-Depleting Emission Test was used as described in section G.5.4.5 and if so, the AER/EAER ratio and the attestation that a minimum of four UDDS cycles were driven without any engine startups.

(f) end-of-test option selected for Highway Emission Test as described in section G.6.1;

(g) end-of-test option selected for US06 Test as described in section G.7.1;

~~(g)~~(h) end-of-test option selected for SC03 Test as described in section G.7.2.

* * * *

F. Test Procedures for 2018 and Subsequent Model Zero-Emission Vehicles (including Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles) and All 2018 and Subsequent Model Hybrid-Electric Vehicles, Except Off-Vehicle Charge Capable Hybrid Electric Vehicles.

The "as adopted or amended dates" of the 40 CFR Part 86 regulations and the 40 CFR Part 1066 regulations referenced by this document are the dates identified in the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001~~ and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," unless otherwise noted. Unless otherwise noted, these requirements shall apply to all ZEVs (including fuel cell vehicles and hybrid fuel cell vehicles) and all HEVs, except off-vehicle charge capable HEVs.

Migration of the test procedures for measuring exhaust emissions from 40 CFR Part 86 to 40 CFR Part 1066 and from 40 CFR Part 600 to 40 CFR Part 1066 shall be done in accordance with Part II, Subpart A, section 100.1 and Part I, Subpart B, section 2, respectively, of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles."

A manufacturer of a hybrid vehicle equipped with an energy storage device that is not included in these procedures may request Executive Officer approval to employ an alternative to the SOC Criterion in section F.9. Executive Officer approval of an SOC Criterion alternative shall be conditioned upon the manufacturer providing supporting data and/or engineering evaluation demonstrating the equivalence of the proposed alternative procedure to the SOC Criterion.

1. Electric Dynamometer. ~~All~~ ZEVs and HEVs must be tested using an ~~48-inch single roll~~ electric dynamometer meeting the requirements of 40 CFR Part 1066 Subpart C ~~Subpart B, §86.108-00(b)(2) [October 22, 1996]~~.

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3. All-Electric Range Test for Zero-Emission Vehicles (including Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles). All 201~~2~~8 and subsequent model ZEVs shall be subject to the All-Electric Range Test specified below for the purpose of determining the energy efficiency and operating range of the ZEV.

3.1 **Determination of Urban All-Electric Range for Zero-Emission Vehicles.**

3.1.1 **~~Determination of~~ Urban All-Electric Range Test for Battery Electric Vehicles.**

The urban all-electric range for a battery electric vehicle shall be determined in accordance with this section F.3.1.1. As an option, a manufacturer may elect to determine the urban all-electric range for a battery electric vehicle in accordance with SAE J1634.

(a) **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. Charge time shall not exceed soak time.

(b) At the end of the cold soak period, the vehicle shall be placed or pushed, onto a dynamometer and operated through successive Urban Dynamometer Driving Schedules (UDDS), 40 CFR, Part 86, Appendix I [~~July 13, 2005~~ February 19, 2015], which is incorporated herein by reference. A 10-minute soak shall follow each UDDS.

(c) For vehicles with a maximum speed greater than or equal to the maximum speed on the 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~~78 (b)(1) and (2) ~~[October 22, 1996]~~ or in 40 CFR §1066.425, as applicable, in accordance with 40 CFR §86.101, or the manufacturer determines

that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc.

(d) For vehicles with a maximum speed less than the maximum speed on the UDDS cycle, the vehicle shall be operated at maximum available power (or full throttle) when the vehicle cannot achieve the speed trace within the speed and time tolerances specified in 40 CFR ~~§86.115-00(b)(1) and (2) [October 22, 1996]~~ §1066.425 in accordance with 40 CFR §86.101. The test shall be terminated when the vehicle speed when operated at maximum available power (or full throttle) falls below 95 percent of the maximum speed initially achieved on the UDDS cycle or when the battery state-of-charge is depleted to the lowest level allowed by the manufacturer, or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc., whichever occurs first.

3.1.2 **~~Determination of~~ Urban All-Electric Range Test 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. As an option, a manufacturer may elect to determine the urban all-electric range for a fuel cell vehicle or a hybrid fuel cell vehicle in accordance with section F.3.1.1 above.

3.2 **Determination of Highway All-Electric Range for Zero-Emission Vehicles and Range for Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles.**

3.2.1 **~~Determination of~~ Highway All-Electric Range Test for Battery Electric Vehicles.**

(a) **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. Charge time shall not exceed soak time.

(b) At the end of the cold soak period, the vehicle shall be either placed or pushed onto a dynamometer and operated through Continuous Highway Test Schedules of the Highway Fuel Economy Driving Schedule (HFEDS).

(c) For vehicles with a maximum speed greater than or equal to the maximum speed on the HFEDS 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) [October 22, 1996]~~ 40 CFR §1066.425 in accordance with 40 CFR §86.101, or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc.

(d) For vehicles with a maximum speed less than the maximum speed on the HFEDS cycle, the vehicle shall be operated at maximum available power (or full throttle) when the vehicle cannot achieve the speed trace within the speed and time tolerances specified in ~~40 CFR §86.115-00 (b)(1) and (2) [October 22, 1996]~~ 40 CFR §1066.425 in accordance with 40 CFR §86.101. The test shall be terminated when the vehicle speed when operated at maximum available power (or full throttle) falls below 95 percent of the maximum speed initially achieved on the HFEDS or when the battery state-of-charge is depleted to the lowest level allowed by the manufacturer, or the manufacturer determines that the test should be terminated for safety reasons, e.g. excessively high battery temperature, abnormally low battery voltage, etc., whichever occurs first.

(e) NEVs are exempt from the all-electric range highway test.

3.2.2 **~~Determination of~~ Highway All-Electric Range Test for Fuel Cell Vehicles and Hybrid Fuel Cell Vehicles.**

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3.5 **Measurement Accuracy**. For battery electric vehicles, the overall error in voltage and current recording instruments shall be NIST traceable with an accuracy as specified in 40 CFR §1066.501 subparagraph (a)(iv) [February 19, 2015].~~and accurate to ±1% of the maximum value of the variable (AC/DC volts and amps) being measured. Suggested equipment: amp meter/power meter capable of sampling voltage and current.~~ Instruments measuring ~~V~~voltage and current shall be as specified in 40 CFR §1066.501 subparagraph (a)(iv)(4) [February 19, 2015]~~sampled at a minimum rate of 20 hz~~.

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6. Urban Emission Test Provisions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and 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.

For vehicles with one or more driver-selectable modes (e.g., normal mode, economy mode, performance mode, or any other operating mode available to the driver), emission testing must be done in the one driver-selectable mode that represents the worst case urban NMOG + NOx emissions over the Urban Emission Test set forth in this section F.6. For example, if a vehicle has two driver-selectable modes, the manufacturer shall determine worst case NMOG + NOx emissions by comparing the emission results of the two driver-selectable modes. Compliance with applicable emission standards shall be based on worst case emission testing.

Confirmatory testing and/or in-use compliance testing may be performed in any driver-selectable mode to ensure compliance with emission standards.

6.1 Urban Test Applicability and General Provisions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §1066.801 with the following revisions:

6.1.1 Subparagraphs (a) through (b). [No change.]

6.1.2 Amend subparagraph (c)(1): The Urban Emission Test, which includes the general driving cycle.

6.1.3 Amend subparagraph (c)(1)(i): The Urban Emission Test consists of an engine startup during the first UDDS cycle followed by a 10-minute key-off soak. The first engine startup (with all accessories turned off) that occurs during a UDDS cycle with vehicle shutdown at the end of the UDDS cycle makes a complete cold-start UDDS cycle. Following a 10-minute key-off soak, the subsequent UDDS cycle is a hot-start UDDS cycle. The UDDS cycle can be considered as a two phase cycle where the first 505 seconds of the UDDS cycle is the transient phase, and the remaining 867 seconds of the UDDS cycle is the stabilized phase.

6.1.4 Delete subparagraphs (c)(1)(ii) through (c)(5).

6.1.5 Subparagraph (d). [No change.]

6.1.6 Subparagraph (e). [No change except the hot soak test temperature in the three-day diurnal emission test sequence is 105°F.]

6.~~1~~2 Urban Vehicle Preconditioning for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.

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

6.~~1~~2.1 The vehicle shall be preconditioned in the driver-selectable mode to be tested.~~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.~~

~~6.1.2 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~~2.~~3~~2 ~~After setting battery state-of-charge, t~~The hybrid electric vehicle shall be pushed or towed to a work area for the initial fuel drain and fill according to section III.D.1.~~4~~. of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."

6.~~1~~2.~~4~~3 Following the initial fuel drain and fill, the vehicle shall complete an initial soak period of a minimum of 6 hours. After completing the initial soak period, the vehicle shall be pushed or towed into position on a dynamometer and preconditioned by driving the UDDS cycle. ~~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~~2.~~5~~4 ~~Within five minutes of~~After completing the preconditioning drive, ~~battery~~ initial state-of-charge ~~shall~~ may be set by driving an additional distance on the chassis dynamometer such that the SOC Criterion is satisfied by applying the ±1% SOC Net Energy Change Tolerances in section F.9. However, if the alternative End-of-Test Criterion in section F.6.3.18 is used, then setting initial SOC shall not be permitted due to the larger ±5% SOC Net Energy Change Tolerance provided by the alternative End-of-Test Criterion in section F.6.3.18. ~~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 in section G.10 would be satisfied for the dynamometer procedure (section F.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 the second soak period of 12 to 36 hours.~~

~~(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.~~

6.2.5 A fuel drain and fill shall be performed pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."

6.2.6 The vehicle shall be soaked for 12-36 hours. During this soak period, canister preconditioning shall be performed pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles." Initial SOC may be set during the soak period by discharging or charging the battery such that the SOC Criterion is satisfied when applying the ±1% SOC Net Energy Change Tolerances in section F.9. However, if the alternative End-of-Test Criterion in section F.6.3.18 is used, then setting initial SOC shall not be permitted due to the larger ±5% SOC Net Energy Change Tolerance provided by the alternative End-of-Test criterion in section F.6.3.18.

~~6.2 Urban Dynamometer Procedure for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.~~

~~To be conducted pursuant to 40 CFR §86.135-00 [October 22, 1996] with the following revisions. References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.~~

~~6.2.1 Amend subparagraph (a).~~

~~*Overview*. The dynamometer run shall consist of two tests, a "cold" start test, 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" 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.~~

~~For all UDDS 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). As an alternative, the bag mini-diluter may be used in-lieu of the constant volume sampling (CVS) method for exhaust emission measurement as described below. 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). Part 1065 of the CFR may be used as an optional particulate sampling method. Continuous proportional samples of gaseous emissions are collected for analysis during each test. For hybrid electric vehicles with 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 that are not "off-vehicle charge capable," and are equipped 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, CO_2, CH_4 and NO_x. For hybrid electric 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, CO_2, CH_4 and NO_x. For hybrid electric 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, CO_2, CH_4 and NO_x.~~

~~6.2.2 Subparagraphs (b) through (c). [No change.]~~

~~6.2.3 Subparagraph (d). [No change.]~~

~~6.2.4 Subparagraphs (e) through (g). [No change.]~~

~~6.2.5 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.~~

~~6.2.6 Subparagraph (i). [No change.]~~

6.3 Urban Dynamometer Test Run, Gaseous and Particulate Emissions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR <u>§1066.815</u> ~~§86.137-96 [March 24, 1993]~~ with the following revisions:

6.3.1 Amend subparagraph (a): *General*. <u>The Urban Emission Test consists of a cold-start UDDS cycle and a hot-start UDDS cycle as described in section F.6.1.3. If driver-selectable modes are available, activate the driver-</u>

selectable mode to be tested for the Urban Emission Test to determine worst case emissions as described in the introductory paragraphs of section F.6. ~~The dynamometer run shall consist of two tests, a "cold" start test, 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" and a "hot" start test following the cold start test by 10 minutes. 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 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 vehicle is allowed to stand on the dynamometer during the 10 minute time period between each test.~~

6.3.2 Amend subparagraph (b)~~ as follows.~~: *PM sampling options*. Collect PM using the procedures specified in subparagraphs (b)(1) or (b)(2) or (b)(5) of 40 CFR §1066.815 (subparagraphs (b)(3) and (b)(4) are not applicable) and use the corresponding equation in section F.6.5 to calculate composite PM emissions. Testing must meet the requirements related to filter face velocity as described in 40 CFR §1065.170(c)(1)(vi) [April 28, 2014], except as specified in paragraph (b)(5) of 40 CFR §1066.815. For procedures involving flow weighting, set the filter face velocity to a weighting target of 1.0 to meet the requirements of 40 CFR §1065.170(c)(1)(vi) [April 28, 2014]. Allow filter face velocity to decrease as a percentage of the weighting factor if the weighting factor is less than 1.0. Use the appropriate equations in 40 CFR §1066.610 to show that you meet the dilution factor requirements of 40 CFR §1066.110(b)(2)(iii)(B).

6.3.3 Amend subparagraphs (b)(1): A separate PM sample for transient and stabilized phases of the cold-start UDDS cycle and the hot-start UDDS cycle may be collected. This may be done by sampling with four filters.

6.3.4 Subparagraph (b)(2). [No change.]

6.3.5 Delete subparagraphs (b)(3) and (b)(4).

6.3.6 Subparagraphs (b)(5) through (c)(2). [No change.]

6.3.7 Delete subparagraph (c)(3).

6.3.8 Amend subparagraph (d): *Test sequence*. Follow the exhaust emission measurement procedures specified in 40 CFR §1066.410 through §1066.425, subject to the following exceptions and additional provisions:

6.3.9 Subparagraph (d)(1). [No change.]

6.3.10 Amend subparagraph (d)(1)(i): Precondition the vehicle as described in section F.6.2. Initiate the cold-start UDDS cycle in the driver-selectable mode to be tested for the Urban Emission Test following the 12 to 36 hour soak period.

6.3.11 Subparagraphs (d)(1)(ii) and (d)(1)(iii). [No change.]

6.3.12 Amend subparagraph (d)(1)(iv): Five seconds after the vehicle is turned off, stop all stabilized interval sampling and recording, including background sampling. Stop any integrating devices for the stabilized interval and indicate the end of the stabilized interval in the recorded data. Note that the 5 second delay is intended to account for sampling system transport.

6.3.13 Subparagraph (2). [No change.]

6.3.14 Amend subparagraph (2)(i): Initiate the hot-start UDDS cycle in the same driver-selectable mode as in section F.6.3.10 above (9 to 11) minutes after the end of the sample period for the cold-start UDDS cycle.

6.3.15 Amend subparagraph (2)(ii): Repeat the steps in paragraph (d)(1)(ii) of this section.

6.3.16 Amend subparagraph (2)(iii): For bag 4 measurement or single bag per UDDS cycle measurement, operate the vehicle over the remainder of the UDDS and conclude the testing as described in paragraphs (d)(1)(iii) and (iv) of this section.

6.3.17 Amend subparagraph (3): **End-of-Test Criteria.** A valid test shall satisfy the SOC Net Energy Change Tolerances in section F.9. For HEVs that use a battery as an energy storage device, ($\text{Amp-hr}_{initial}$) is the stored charge at the beginning of the cold-start UDDS cycle, and (Amp-hr_{final}) is the stored battery charge at the end of the subsequent hot-start UDDS cycle. The final stored battery charge, (Amp-hr_{final}), shall not exceed either $(\text{Amp-hr}_{final})_{max}$ or $(\text{Amp-hr}_{final})_{min}$ for a valid test. For HEVs that use a capacitor as an energy storage device, ($V^2_{initial}$) is the square of the capacitor voltage stored at the beginning of the cold-start UDDS cycle, and (V_{final}) is the stored capacitor voltage at the end of the subsequent hot-start UDDS cycle. The final stored capacitor voltage, (V_{final}), shall not exceed either $(V_{final})_{max}$ or $(V_{final})_{min}$ for a valid test. For HEVs that use an electro-mechanical flywheel as an energy storage device, ($rpm^2_{initial}$) is the squared flywheel rotational speed at the beginning of the cold-start UDDS cycle, and (rpm_{final}) is the flywheel rotational speed at the end of the subsequent hot-start UDDS cycle. The final flywheel rotational speed, (rpm_{final}), shall not exceed either $(rpm_{final})_{max}$ or $(rpm_{final})_{min}$ for a valid test

6.3.18 **Additional End-of-Test Criterion.** If the SOC Net Energy Change Tolerance is not satisfied after the hot-start UDDS cycle in section F.6.3.17, then the alternative End-of-Test criterion of ±5% SOC Net Energy Change Tolerance in Appendix C of SAE J1711 may be used to validate an Urban Emission Test with approval from the Executive Officer. Appendix C of SAE J1711 may not be used to correct measured values for any emissions.

~~6.3.2.1 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 alcohol exhaust sample, the formaldehyde exhaust sample, the dilution air sample bag, the alcohol 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.~~

~~6.3.2.2 Delete subparagraph (b)(13).~~

~~6.3.2.3 Amend subparagraph (b)(14): Turn the vehicle off 2 seconds after the end of the last deceleration (at 1,369 seconds).~~

~~6.3.2.4 Amend subparagraph (b)(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 alcohol 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 alcohol 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.~~

~~6.3.2.5 Amend subparagraph (b)(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.~~

~~6.3.2.6 Delete subparagraph (b)(19).~~

~~6.3.2.7 Delete subparagraph (b)(20).~~

~~6.3.2.8 Amend subparagraph (b)(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 in section G.10.~~

~~6.3.2.9 Amend subparagraph (b)(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."~~

6.4 Calculations – Urban Gaseous ~~Exhaust~~ Emissions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §1066.820 [April 28, 2014]~~§86.144-94 [July 13, 2005]~~ with the following revisions:

6.4.1 ~~Amend s~~Subparagraph (a). [No change.]~~For light-duty vehicles and light duty trucks:~~

6.4.2 Amend subparagraph (b): Calculate the final composite gaseous test results as a mass-weighted value, $e_{[\text{emission}]\text{-FTPcomp}}$, in grams per mile using the following equation:

$$e_{[\text{emission}]-\text{FTPcomp}} = 0.43\left(\frac{m_{\text{c}}}{D_{\text{c}}}\right) + 0.57\left(\frac{m_{\text{h}}}{D_{\text{h}}}\right)$$

Where:

m_{c} = the mass emissions determined from the cold-start UDDS cycle, in grams. If the cold-start UDDS cycle consists of phase 1 cold transient emissions and phase 2 cold stabilized emissions, then sum phase 1 and phase 2 emissions to determine m_{c}.

D_{c} = the measured driving distance from the cold-start UDDS cycle, in miles. If the cold-start UDDS cycle consists of phase 1 distance and phase 2 distance, then sum phase 1 and phase 2 distances to determine D_{c}.

m_{h} = the mass emissions determined from the hot-start UDDS cycle, in grams. If the hot-start UDDS cycle consists of phase 3 hot transient emissions and phase 4 hot stabilized emissions, then sum phase 3 and phase 4 emissions to determine m_{h}.

D_{h} = the driving distance from the hot-start UDDS cycle, in grams. If the hot-start UDDS cycle consists of phase 3 distance and phase 4

distance, then sum phase 3 and phase 4 distances to determine D_h.

6.4.3 Subparagraph (c). [Not applicable.]

~~$Y_{wm} = 0.43 * \left(\frac{Y_c}{D_c}\right) + 0.57 * \left(\frac{Y_h}{D_h}\right)$~~

~~Where:~~

~~(1) Y_{wm} = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMOG, 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.~~

~~6.4.2 Subparagraphs (b) through (e). [No change.]~~

6.5 Calculations – Urban Particulate Emissions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §1066.820 [April 28, 2014]~~§86.145-82 [November 2, 1982]~~ with the following revisions:~~. References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.~~

6.5.1 ~~Amend s~~Subparagraphs (a) to (b)~~:~~. [Not applicable.]~~ The final reported test results for the mass particulate (M_p) in grams/mile shall be computed as follows:~~

6.5.2 Amend subparagraphs (c) through (c)(1): Calculate the final composite PM test results as a mass-weighted value, $e_{\text{PM-FTPcomp}}$, in grams per mile as follows:

(1) Use the following equation for PM measured as described in §1066.815(b)(1) or (2):

$$e_{\text{PM-FTPcomp}} = 0.43\left(\frac{m_{\text{PM-cUDDS}}}{D_{\text{c}}}\right) + 0.57\left(\frac{m_{\text{PM-hUDDS}}}{D_{\text{h}}}\right)$$

Where:

$m_{\text{PM-cUDDS}}$ = the combined PM mass emissions determined from the cold-start UDDS cycle (phase 1 and phase 2), in grams, as calculated using Eq. 1066.605-2.

D_c = the measured driving distance from the cold-start UDDS cycle, in miles. If the cold-start UDDS cycle consists of phase 1 distance and phase 2 distance, then sum phase 1 and phase 2 distances to determine D_c.

$m_{PM\text{-}hUDDS}$ = the combined PM mass emissions determined from the hot-start UDDS cycle (phase 3 and phase 4), in grams, as calculated using Eq. 1066.605-2.

D_h = the driving distance from the hot-start UDDS cycle, in grams. If the hot-start UDDS cycle consists of phase 3 distance and phase 4 distance, then sum phase 3 and phase 4 distances to determine D_h.

$$\cancel{M_p = 0.43 * \left(\frac{M_{pc}}{D_c}\right) + 0.57 * \left(\frac{M_{ph}}{D_h}\right)}$$

~~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.~~

~~6.5.2 Subparagraph (b). [No change.]~~

6.5.3 Subparagraph (c)(2). [Not applicable.]

6.5.4 Amend subparagraph (c)(3): Use the following equation for PM measured as described in §1066.815(b)(5):

$$e_{\mathrm{PM-FTPcomp}} = \frac{m_{\mathrm{PM}}}{0.43(D_{\mathrm{c}}) + 0.57(D_{\mathrm{h}})}$$

Where:

m_{PM} = the combined PM mass emissions determined from the cold-start UDDS cycle and the hot-start UDDS cycle (phase 1, phase 2, phase 3, and phase 4), in grams, as calculated using Eq. 1066.605-4.

D_c = the measured driving distance from the cold-start UDDS cycle, in miles. If the cold-start UDDS cycle consists of phase 1 distance and phase 2 distance, then sum phase 1 and phase 2 distances to determine D_c.

D_h = the driving distance from the hot-start UDDS cycle, in grams. If the hot-start UDDS cycle consists of phase 3 distance and phase 4 distance, then sum phase 3 and phase 4 distances to determine D_h.

7. Highway Emission Test Provisions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §1066.801, ~~§600.111-08 [December 27, 2006] with the following revisions~~ except as noted.

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.

For vehicles with one or more driver-selectable modes (e.g., normal mode, economy mode, performance mode, or any other operating mode available to the driver), emission testing must be done in the one driver-selectable mode that represents the worst case highway NMOG + NOx emissions over the Highway Emission Test set forth in this section F.7. For example, if a vehicle has two driver-selectable modes, the manufacturer shall determine worst case NMOG + NOx emissions by comparing the emission results of the two driver-selectable modes. Compliance with applicable emission standards shall be based on worst case emission testing.

~~7.1 Subparagraph (a). [not applicable - delete]~~

~~7.2 Amend subparagraph (b) as follows:~~

~~7.2.1 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. Alcohol and formaldehyde samples are collected and individually analyzed for alcohol-fueled vehicles.~~

~~7.2.2 Amend subparagraph (b)(7)(i): The dynamometer procedure shall consist of two cycles of the Highway Fuel Economy Driving Schedule (§600.109(b)) separated by 15 seconds of idle. The first cycle of the Highway Fuel Economy Driving Schedule is driven to precondition the test vehicle and the second is driven for the fuel economy measurement.~~

~~7.2.3 Amend subparagraph (b)(7)(iii): Only one exhaust sample and one background sample shall be collected and analyzed for THC (except diesel hydrocarbons which are analyzed continuously), CO, CO_2, and NO_x. Alcohol and formaldehyde samples (exhaust and dilution air) are collected and analyzed for alcohol-fueled vehicles.~~

~~7.2.4 Add subparagraph(b)(7)(v): 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.~~

~~7.2.5 Amend subparagraph (b)(9)(v): Operate the vehicle over one HFEDS preconditioning cycle according to the dynamometer driving schedule specified in §600.109-08(b) [December 27, 2006]. 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.~~

~~7.2.6 Amend subparagraph (b)(9)(vi): 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.~~

~~7.2.7 Add subparagraph (b)(9)(viii): 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 in section F.10 is satisfied. If the SOC criterion is not satisfied, then repeat dynamometer test run from subparagraph (b)(9)(vi) and (b)(9)(vii). A total of three highway emission tests shall be allowed to satisfy the SOC criterion.~~

~~(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.~~

~~7.2.8 Delete subparagraph (b)(10).~~

~~7.3 Delete subparagraphs (c) through (e).~~

7.1 Determination of Highway Emissions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §1066.840 with the following revisions:

7.1.1 Amend subparagraph (a): Perform the Highway Emission Test immediately following the Urban Emission Test or a previous Highway Emission Test when this is practical. If the Highway Emission Test starts more than 3 hours after the Urban Emission Test (including evaporative emission measurements, if applicable) or a previous Highway Emission Test, operate the vehicle over one UDDS cycle to precondition the vehicle. If driver-selectable modes are available, activate the driver-selectable mode to be tested for the UDDS preconditioning drive. Additional preconditioning UDDS cycles may be approved in advance by the

Executive Officer if the need for additional preconditioning is demonstrated by the manufacturer.

7.1.2 Amend subparagraph (b): Operate the vehicle over the HFEDS cycle for preconditioning. If driver-selectable modes are available, activate the driver-selectable mode to be tested for the preconditioning drive and for the following HFEDS cycle with emission sampling. Allow the vehicle to idle for 15 seconds (with the vehicle in gear), then start a repeat run of the HFEDS cycle and simultaneously start sampling and recording. **End-of-Test Criterion:** A valid test shall satisfy the SOC Net Energy Change Tolerances in section F.9 for the HFEDS cycle with emission sampling. For HEVs that use a battery as an energy storage device, ($\text{Amp-hr}_{initial}$) is the stored charge at the beginning of the HFEDS cycle with emission sampling, and (Amp-hr_{final}) is the stored battery charge at the end of the same HFEDS cycle with emission sampling. The final stored battery charge, (Amp-hr_{final}), shall not exceed either $(\text{Amp-hr}_{final})_{max}$ or $(\text{Amp-hr}_{final})_{min}$ for a valid test. For HEVs that use a capacitor as an energy storage device, ($V^2_{initial}$) is the square of the capacitor voltage stored at the beginning of the same HFEDS cycle with emission sampling, and (V_{final}) is the stored capacitor voltage at the end of the HFEDS cycle with emission sampling. The final stored capacitor voltage, (V_{final}), shall not exceed either $(V_{final})_{max}$ or $(V_{final})_{min}$ for a valid test. For HEVs that use an electro-mechanical flywheel as an energy storage device, ($rpm^2_{initial}$) is the squared flywheel rotational speed at the beginning of the HFEDS cycle with emission sampling, and (rpm_{final}) is the flywheel rotational speed at the end of the same HFEDS cycle with emission sampling. The final flywheel rotational speed, (rpm_{final}), shall not exceed either $(rpm_{final})_{max}$ or $(rpm_{final})_{min}$ for a valid test.

7.1.3 Amend subparagraph (c): Turn the vehicle off at the end of the HFEDS cycle and stop all sampling and recording, including background. Stop any integrating devices and indicate the end of the test cycle in the recorded data.

7.1.4 **Additional End-of-Test Criterion.** If the SOC Net Energy Change Tolerance is not satisfied for the HFEDS cycle with emission sampling in section F.7.1.2, then the alternative End-of-Test criterion of ±5% SOC Net Energy Change Tolerance in Appendix C of SAE J1711 may be used to validate a Highway Emission Test with approval from the Executive Officer. Appendix C of SAE J1711 may not be used to correct measured values for any emissions.

8. SFTP Emission Test Provisions for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Charge Capable Hybrid Electric Vehicles.

Alternative procedures may be used if approved in advance by the Executive Officer of the Air Resources Board.

For vehicles with one or more driver-selectable modes (e.g., normal mode,

economy mode, performance mode, or any other operating mode available to the driver), emission testing must be done in the one driver-selectable mode that represents the worst case SFTP NMOG + NOx emissions over the SFTP Emission Test set forth in this section F.8. For example, if a vehicle has two driver-selectable modes, the manufacturer shall determine worst case NMOG + NOx emissions by comparing the emission results of the two driver-selectable modes. Compliance with applicable emission standards shall be based on worst case emission testing.

To be conducted pursuant to 40 CFR §1066.801, except as noted.

~~8.1 US06 Vehicle Preconditioning~~

~~To be conducted pursuant to 40 CFR §86.132-00 [October 22, 1996] with the following revisions.~~

~~8.1.1 Subparagraphs (a) through (m). [No change.]~~

~~8.1.2 Amend subparagraph (n): Aggressive Driving Test (US06) Preconditioning.~~

~~8.1.2.1 Amend subparagraph (1) as follows: If the US06 test follows the exhaust emission urban, highway, 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. For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at according to the following conditions:~~

~~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.~~

~~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.~~

~~8.1.2.1.1 Subparagraphs (i) through (iv). [No change.]~~

~~8.1.2.2 Subparagraph (2). [No change.]~~

~~8.1.3 Subparagraph (o). [No change.]~~

8.~~2~~1 US06 Emission Test.

To be conducted pursuant to 40 CFR §1066.831 ~~§86.159-08 [December 27, 2006]~~ with the following revisions~~.~~:

8.1.1 Subparagraphs (a) through (b)(1). [No change.]

8.1.2 Amend subparagraph (b)(1)(i): For aggressive-driving tests that do not follow the Urban Emission Test or the Highway Emission Test.

8.1.3 Amend subparagraph (b)(1)(ii): For a test element that starts more than 72 hours after the most recent Urban Emission Test or Highway Emission Test (with or without evaporative emission measurements).

8.1.4 Amend subparagraph (b)(1)(iii): For testing in which the test vehicle has not remained in an area where ambient temperatures were within the range specified for testing since the previous Urban Emission Test or Highway Emission Test.

8.1.5 Subparagraphs (b)(2) through (b)(3)(i). [No change.]

8.1.6 Amend subparagraph(b)(3)(ii): Operate the vehicle one time over one of the driving schedules specified in this paragraph (b)(3)(ii). A particular preconditioning driving schedule that is related to fuel effects on adaptive memory systems may be requested. If driver-selectable modes are available, activate the driver-selectable mode to be tested for the preconditioning drive and for the following US06 cycle with emission sampling. Sampling equipment may be exercised, but emissions measured during preconditioning may not be used to determine compliance with applicable emission standards. Choose from the following driving schedules:

8.1.7 Subparagraphs (b)(3)(ii)(A) through (b)(3)(ii)(B). [No change.]

8.1.8 Amend subparagraph (b)(3)(ii)(C): The HFEDS cycle.

8.1.9 Subparagraphs (b)(3)(ii)(D) through (e)(2)(iii): [No change.]

8.1.10 Amend subparagraph (e)(3): Turn the vehicle off 2 seconds after the end of the last deceleration. Five seconds after the vehicle stops running, stop all sampling and recording, including background sampling. Stop any integrating devices and indicate the end of the test cycle in the recorded data. Note that the 5 second delay is intended to account for sampling system transport. **End-of-Test Criterion**: A valid test shall satisfy the SOC Net Energy Change Tolerances in section F.9 for the US06 cycle with emission sampling. For HEVs that use a battery as an energy storage device, (Amp-hr$_{initial}$) is the stored charge at the beginning of

the US06 cycle with emission sampling, and ($Amp\text{-}hr_{final}$) is the stored battery charge at the end of the same US06 cycle with emission sampling. The final stored battery charge, ($Amp\text{-}hr_{final}$), shall not exceed either $(Amp\text{-}hr_{final})_{max}$ or $(Amp\text{-}hr_{final})_{min}$ for a valid test. For HEVs that use a capacitor as an energy storage device, ($V^2_{initial}$) is the square of the capacitor voltage stored at the beginning of the US06 cycle with emission sampling, and (V_{final}) is the stored capacitor voltage at the end of the US06 cycle with emission sampling. The final stored capacitor voltage, (V_{final}), shall not exceed either $(V_{final})_{max}$ or $(V_{final})_{min}$ for a valid test. For HEVs that use an electro-mechanical flywheel as an energy storage device, ($rpm^2_{initial}$) is the squared flywheel rotational speed at the beginning of the US06 cycle with emission sampling, and (rpm_{final}) is the flywheel rotational speed at the end of the US06 cycle with emission sampling. The final flywheel rotational speed, (rpm_{final}), shall not exceed either $(rpm_{final})_{max}$ or $(rpm_{final})_{min}$ for a valid test.

8.1.11 Subparagraph (e)(4). [No change.]

8.1.12 **Additional End-of-Test Criterion.** If the SOC Net Energy Change Tolerance is not satisfied for the US06 cycle with emission sampling in section F.8.1.10, then the alternative End-of-Test criterion of ±5% SOC Net Energy Change Tolerance in Appendix C of SAE J1711 may be used to validate a US06 Emission Test with approval from the Executive Officer. Appendix C of SAE J1711 may not be used to correct measured values for any emissions.

~~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 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 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. The US06 cycle after the preconditioning cycle shall be used to calculate emissions and shall meet the state-of-charge net tolerances as calculated in section F.9.~~

~~8.2.2 Amend subparagraph (b) as follows.~~

~~8.2.2.1 Amend subparagraph (b)(2): Position the test vehicle on the dynamometer and restrain.~~

~~8.2.3 Subparagraph (c). [No change.]~~

~~8.2.4 Amend subparagraph (d): Practice runs over the prescribed driving schedule may be performed at test point to permit sampling system adjustment.~~

~~8.2.5 Subparagraph (e). [No change.]~~

~~8.2.6 Amend subparagraph (f) as follows.~~

~~8.2.6.1 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.~~

~~8.2.6.2 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 in section F.10 is satisfied. If the SOC criterion is not satisfied, then repeat dynamometer test run from subparagraph (f)(2)(i) without the preconditioning cycle. A total of three US06 emission tests shall be allowed to satisfy the SOC criterion.~~

~~(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 [October 22, 1996] with the following revisions.~~

~~8.3.1 Subparagraphs (a) through (n). [No change.]~~

~~8.3.2 Amend subparagraph (o): *Air Conditioning Test (SC03) Preconditioning*.~~

~~8.3.2.1 Amend subparagraph (1) as follows: 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. 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:~~

~~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.~~

~~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.~~

~~8.3.2.1.1 Subparagraphs (i) and (ii). [No change.]~~

~~8.3.2.2 Subparagraphs (2) through (3). [No change.]~~

~~8.4~~8.2 SC03 Emission Test.

To be conducted pursuant to 40 CFR §1066.835 ~~§86.160-00 [December 8, 2005]~~ with the following revisions~~.~~:

8.2.1 Subparagraphs (a) through (c)(4). [No change.]

8.2.2 Amend subparagraph (c)(5): Perform a preconditioning drive by operating the test vehicle over the first 505 seconds of the UDDS cycle (phase 1), the last 867 seconds of the UDDS cycle (phase 2), or the SC03 driving schedule. If driver-selectable modes are available, activate the driver-selectable mode to be tested for the preconditioning drive and for the following SC03 cycle with emission sampling. If the air conditioning test sequence starts more than 2 hours after a

different exhaust emission test, the vehicle may be driven over one full UDDS cycle for the preconditioning drive instead of over one of the cycles listed previously in this section (c)(5).

8.2.3 Subparagraphs (c)(6) through (d). [No change.]

8.2.4 Amend subparagraph (d)(1): Place the vehicle in gear 15 seconds after starting vehicle, which is 3 seconds before the first acceleration. If a driver-selectable mode is to be tested, start the vehicle, activate the driver-selectable mode, and place the vehicle in gear 15 seconds after starting vehicle. Follow the SC03 driving schedule.

8.2.5 Amend subparagraph (d)(2): Turn the vehicle off 2 seconds after the end of the last deceleration. Five seconds after the vehicle stops running, stop all sampling and recording, including background sampling. Stop any integrating devices and indicate the end of the test cycle in the recorded data. Note that the 5 second delay is intended to account for sampling system transport. End-of-Test Criterion: A valid test shall satisfy the SOC Net Energy Change Tolerances in section F.9 for the SC03 cycle with emission sampling. For HEVs that use a battery as an energy storage device, ($\text{Amp-hr}_{initial}$) is the stored charge at the beginning of the SC03 cycle with emission sampling, and (Amp-hr_{final}) is the stored battery charge at the end of the SC03 cycle with emission sampling. The final stored battery charge, (Amp-hr_{final}), shall not exceed either $(\text{Amp-hr}_{final})_{max}$ or $(\text{Amp-hr}_{final})_{min}$ for a valid test. For HEVs that use a capacitor as an energy storage device, ($V^2_{initial}$) is the square of the capacitor voltage stored at the beginning of the SC03 cycle with emission sampling, and (V_{final}) is the stored capacitor voltage at the end of the SC03 cycle with emission sampling. The final stored capacitor voltage, (V_{final}), shall not exceed either $(V_{final})_{max}$ or $(V_{final})_{min}$ for a valid test. For HEVs that use an electro-mechanical flywheel as an energy storage device, ($rpm^2_{initial}$) is the squared flywheel rotational speed at the beginning of the SC03 cycle with emission sampling, and (rpm_{final}) is the flywheel rotational speed at the end of the SC03 cycle with emission sampling. The final flywheel rotational speed, (rpm_{final}), shall not exceed either $(rpm_{final})_{max}$ or $(rpm_{final})_{min}$ for a valid test.

8.2.6 Subparagraphs (d)(3) through (f)(3)(iv). [No change.]

8.2.7 **Additional End-of-Test Criterion.** If the SOC Net Energy Change Tolerance is not satisfied for the SC03 cycle with emission sampling in section F.8.2.4, then the alternative End-of-Test criterion of ±5% SOC Net Energy Change Tolerance in Appendix C of SAE J1711 may be used to validate an SC03 Emission Test with approval from the Executive Officer. Appendix C of SAE J1711 may not be used to correct measured values for any emissions.

~~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 simulate testing in an environmental test cell (see §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 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 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. The SC03 cycle after the preconditioning cycle shall be used to calculate emissions and shall meet the state-of-charge net tolerances as calculated in section F.9.~~

~~8.4.2 Amend subparagraph (b) as follows.~~

~~8.4.2.1 Amend subparagraph (b)(2): Position the test vehicle on the dynamometer and restrain.~~

~~8.4.3 Amend subparagraph (c) as follows.~~

~~8.4.3.1 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 (d) as follows.~~

~~8.4.4.1 Amend subparagraph (d)(10): At the conclusion of the SC03 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 in section F.10 is satisfied. If the SOC criterion is not satisfied, then turn off the cooling fan(s), allow the vehicle to soak in the ambient conditions of paragraph (c)(5) of this section for 10 ± 1 minutes, and repeat the dynamometer test run from subparagraph (d). Up to three SC03 emission tests shall be attempted to satisfy the SOC criterion.~~

~~(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 the vehicle two 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 the vehicle two seconds after the end of the last deceleration.~~

~~8.4.5 Subparagraph (e). [No change.]~~

9. State-of-Charge Net <u>Energy</u> Change Tolerances for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle <u>Charge</u> Capable Hybrid Electric Vehicles.

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

* * * *

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

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

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

Where:

$(V_{final})_{max}$ = The <u>maximum</u> stored capacitor voltage allowed at the end of the test

$(V_{final})_{min}$ = The <u>minimum</u> 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 energy change tolerance shall apply:

* * * *

10. 50°F and 20°F Test Provision for All Hybrid Electric Vehicles, Except Hybrid Fuel Cell Vehicles and Off-Vehicle Capable Hybrid Electric Vehicles.

50°F testing shall be conducted pursuant to section F.6 with the modifications in Part II, Section D of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" and the additional following revisions.

20°F testing shall be conducted pursuant to section F.6 with the modifications in Part II Section B or Part II Section C, as applicable, of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" and the additional following revisions.

10.1 To satisfy test requirements for the 50°F emission test, the vehicle shall be emission tested in driver-selectable mode (if available) that represents the worst case urban NMOG + NOx emissions as determined in section F.6. To satisfy test requirements for the 20°F emission test, the vehicle shall be emission tested in the driver-selectable mode (if available) that represents the worst case CO emissions of the urban emission test following the procedure outlined in section F.6. For the 20°F and 50°F emission tests, the vehicle is not required to meet SOC net energy change tolerances.

10.2 One of the following two emission test options must be performed.

(i) A three phase test that includes phase one as the first 505 seconds of the cold-start UDDS cycle, phase two as the remaining 867 seconds of the cold-start UDDS cycle, a 10 minute key-off soak period, and phase three as the first 505 seconds of the hot-start UDDS cycle. Emission weighting is as follows:

$$Y_{wm} = 0.43 * \left(\frac{Y_1 + Y_2}{D_1 + D_2} \right) + 0.57 * \left(\frac{Y_2 + Y_3}{D_2 + D_3} \right)$$

Where:

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

Y_1 = Mass emissions as calculated from phase one of the three phase test.

Y_2 = Mass emissions as calculated from phase two of the three phase test.

Y_3 = Mass emissions as calculated from phase three of the three phase test.

D_1 = The measured driving distance from phase one of the three phase tests, in miles.

D_2 = The measured driving distance from phase two of the three phase tests, in miles.

D_3 = The measured driving distance from phase three of the three phase tests, in miles.

(ii) A two phase test that includes phase one as a UDDS cycle, a 10 minute key-off soak period, and phase two as a UDDS cycle. Emission weighting for the four phase test will follow the procedure outlined in section F.6.4.

G. Test Procedures for 2018 and Subsequent Model Off-Vehicle Charge Capable Hybrid Electric Vehicles.

The "as adopted or amended dates" of the 40 CFR Part 86 regulations and the 40 CFR Part 1066 regulations referenced by this document are the dates identified in the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001~~ and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles," unless otherwise noted.

Migration of the test procedures for measuring exhaust emissions from 40 CFR Part 86 to 40 CFR Part 1066 shall be done in accordance with Part II, Subpart A, section 100.1 of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles."

1. Electric Dynamometer.

All off-vehicle charge capable HEVs must be tested using an ~~48-inch single roll~~ electric dynamometer meeting the requirements of ~~40 CFR Subpart B, §86.108-00(b)(2) [October 22, 1996]~~ 40 CFR Part 1066 Subpart C.

* * * *

3. General Testing Requirements.

3.1 **Recording requirements.**

For off-vehicle charge capable hybrid electric vehicles: The following data shall be recorded for all tests and for each individual test cycle therein, except for the 20°F and 50°F tests, conducted in accordance with section G.8:

* * * *

(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. As an alternative, 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 vehicle may be reported;

* * * *

3.2 **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 for normal driving conditions prior to the commencement of the test. The driving schedule speed and time tolerances specified in ~~this section G~~ 40 CFR §1066.425 shall not be exceeded due to the operation of the regenerative braking system.

3.3 **Measurement Accuracy**. The overall error in voltage and current recording instruments shall be NIST traceable with an accuracy as specified in 40 CFR §1066.501 subparagraph (a)(iv) [February 19, 2015].~~and accurate to ±1% of the maximum value of the variable (AC/DC volts and amps) being measured. Suggested equipment: amp meter/power meter capable of sampling voltage and current.~~ Instruments measuring ~~V~~voltage and current shall be as specified in 40 CFR §1066.501 subparagraph (a)(iv)(4) [February 19, 2015] ~~sampled at a minimum rate of 20 hz~~.

* * * *

5. Urban Emission 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.

For the purpose of determining Urban All-Electric Range and Urban Equivalent All-Electric Range, the vehicle shall be range tested in default mode or in normal mode

if the vehicle does not have a default mode.

For t~~T~~he purpose of demonstrating compliance with exhaust emission standards, ~~criteria~~ a vehicle must be emission tested in the vehicle operation (i.e., either charge-depleting, charge-sustaining, or charge-increasing operation) that represents ~~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~~ urban NMOG + NOx emissions ~~shall constitute the worst case for the urban charge sustaining or charge depleting modes of operation~~.

Vehicles with one or more ~~than one~~ driver-selectable modes ~~of operation of the auxiliary power unit~~ (e.g., normal mode, economy mode, performance mode, battery charging mode, ~~etc.~~or any other operating mode available to the driver) for a given charge-depleting, ~~or~~ charge-sustaining, or charge-increasing ~~test cycle~~operation must be emission tested in the one driver-selectable mode~~(s)~~ and vehicle operation (i.e., charge-depleting, charge-sustaining, charge-increasing) which represents the worst case urban NMOG + NOx emissions ~~of the auxiliary power unit~~. For example, if a vehicle has two driver-selectable modes that can be tested in charge-depleting, charge-sustaining, and charge-increasing operations, the manufacturer shall determine worst case urban NMOG + NOx emissions by comparing the following (1) mode 1 charge-depleting emissions, (2) mode 2 charge-depleting emissions, (3) mode 1 charge-sustaining emissions, (4) mode 2 charge-sustaining emissions, (5) mode 1 charge-increasing emissions, and (6) mode 2 charge-increasing emissions based on the Urban Charge-Depleting Emission Test and Urban Charge-Sustaining Emission Test. The exception to this would be for vehicles qualifying for the Alternative Urban Charge-Depleting Emission Test where the one driver-selectable mode representing the worst case urban NMOG + NOx emissions would be tested only on the Alternative Urban Charge-Depleting Emission Test. In addition, some driver-selectable modes are incompatible with testing of certain vehicle operations. For example, a charge-increasing driver-selectable mode is not compatible with a charge-depleting test.

In lieu of demonstrating the worst case urban NMOG + NOx emissions by certification testing in every urban charge-depleting driver-selectable mode, every urban charge-sustaining driver-selectable mode, and every charge-increasing driver-selectable mode, a manufacturer may determine the worst case operating mode by using non-certification emission data and/or an engineering evaluation. The manufacturer must report the data and/or engineering evaluation used to determine the worst case operating mode. The manufacturer must demonstrate compliance with all applicable emission standards using test data for the worst case operating mode.

For vehicles that qualify for and are tested on the Alternative Urban Charge-Depleting Emission Test in section G.5.4.5, the urban worst case NMOG + NOx emissions may be determined for the Alternative Urban Charge-Depleting Emission Test alone. Therefore, a vehicle qualifying for the Alternative Urban Charge-Depleting Emission Test would not be required to be emission tested in charge-depleting, charge-sustaining, charge-increasing operations. If driver-selectable modes are available, each

driver-selectable mode must still be considered for worst case NMOG + NOx emissions for the Alternative Urban Charge-Depleting Emission Test.

Confirmatory testing and/or in-use compliance testing may ~~also~~ be performed in any driver-selectable mode ~~of operation~~ in charge-depleting, charge-sustaining, or charge-increasing operation to ensure compliance with emission standards. For vehicles that qualify for and are certified on the Alternative Urban Charge-Depleting Emission Test, confirmatory testing and/or in-use compliance testing may be performed in any driver-selectable mode solely using the Alternative Urban Charge-Depleting Emission Test to ensure compliance with emission standards.

For the Urban Charge-Depleting Emission Test in section G.5.4.2, confirmatory and in-use compliance testing shall use two hot-start UDDS cycles to ensure that the vehicle has achieved full warm-up conditions in accordance with section G.5.4.2.1. If, based on the last cycle or series of cycles, the Additional End-of-Test criteria in section G.5.4.3.1 are not satisfied at the end of the second hot-start, then a third hot-start UDDS cycle shall be performed. If criteria are still not satisfied at the end of the third hot-start UDDS cycle, then additional hot-start UDDS cycles shall be performed until:

(1) based on the last cycle or series of cycles, the Additional End-of-Test criteria in section G.5.4.3.1 are satisfied; or
(2) the Additional End-of-Test criteria in section G.5.4.3.2 are satisfied.

For the Alternative Urban Charge-Depleting Emission Test, confirmatory and in-use compliance testing shall use one hot-start UDDS cycle as specified in section G.5.4.6.

5.1 Urban Test Applicability and General Provisions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §1066.801 with the following revisions:

5.1.1 Subparagraphs (a) through (b). [No change.]

5.1.2 Amend subparagraph (c)(1): The Urban Charge-Sustaining Emission Test and the Urban Charge-Depleting Emission Test.

5.1.3 Amend subparagraph (c)(1)(i): The Urban Charge-Sustaining Emission Test consists of an engine startup during the first UDDS cycle followed by a 10-minute key-off soak. The Urban Charge-Depleting Emission Test consists of a series of charge-depleting UDDS cycles each followed by a 10-minute key-off soak until charge-sustaining operation is achieved. The Urban Charge-Depleting Emission Test begins with the vehicle at full state-of-charge with engine startup occurring during the driving of the series of charge-depleting UDDS cycles. The first engine startup (with all accessories turned off) that occurs during a UDDS cycle followed by a vehicle shutdown at the end of the UDDS cycle makes a complete cold-start UDDS cycle. After a 10-minute key-off soak, the subsequent UDDS cycle

is a hot-start UDDS cycle. The UDDS cycle can be considered as a two phase cycle where the first 505 seconds of the UDDS cycle is the transient phase, and the remaining 867 seconds of the UDDS cycle is the stabilized phase. For the Urban Charge-Depleting Emission Test, additional hot-start UDDS cycles each followed by a 10-minute key-off soak may be needed to achieve charge-sustaining operation.

5.1.4 Subparagraphs (c)(1)(ii) through (c)(5). [Not applicable.]

5.1.5 Subparagraph (d). [No change.]

5.1.6 Subparagraph (e). [No change except the hot soak test temperature in the three-day diurnal emission test sequence is 105°F.]

5.~~1~~2 Urban Vehicle Preconditioning for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

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

5.~~1~~2.1 The vehicle shall be preconditioned in charge-sustaining operation with the vehicle in default mode or in normal mode if the vehicle does not have default mode. If, however, the vehicle is to be tested in charge-increasing operation (this does not apply to a driver-selectable charge-increasing mode), then the initial SOC for the preconditioning drive shall be set at the lowest normal SOC level allowed by the vehicle when driving on the UDDS cycle.~~For 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 vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the preconditioning drive.~~

~~5.1.2 For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.~~

5.~~1~~2.~~3~~2 ~~After setting battery state-of-charge, t~~The vehicle shall be pushed or towed to a work area for the initial fuel drain and fill according to section III.D.1~~.4~~.4 of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."

5.~~1~~2.~~4~~3 Following the initial fuel drain and fill, the vehicle shall complete an initial soak period of a minimum of 6 hours.

5.~~1~~2.~~5~~4 After completing the initial soak period, the vehicle shall be pushed or towed into position on a dynamometer and preconditioned.

~~5.1.6 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.~~

5.~~1~~2.~~7~~5 For the Urban ~~c~~Charge-~~d~~Depleting ~~range~~ ~~e~~Emission ~~t~~Test~~,~~ and the Urban ~~c~~Charge-~~s~~Sustaining ~~e~~Emission ~~t~~Test, the preconditioning cycle shall be the UDDS cycle and performed at this time. For the Urban Charge-Sustaining Emission Test, except as noted in sections G.5.2.8.1, G.5.2.8.2, and G.5.2.8.3, the initial SOC may be set after the preconditioning cycle by driving an additional distance on the chassis dynamometer such that the SOC Criterion is satisfied when applying the ±1% SOC Net Energy Change Tolerances in section G.10. ~~The vehicle must be in charge sustaining operation during the preconditioning drive. To determine charge sustaining operation, the vehicle must meet the SOC criterion in section G.10 from the start to the end of the two consecutive UDDSs. As an option, charge sustaining operation can be achieved for a single UDDS if data is provided showing that charge sustaining operation can consistently be maintained over one UDDS. The vehicle must meet the SOC criterion in section G.10 from the start to the end of a single UDDS. Alternative procedures may be used to determine charge sustain operation for the precondition drive if the alternate procedure demonstrates charge sustaining operation based on section G.10 and is approved in advance by the Executive Officer of the Air Resources Board.~~

5.~~1~~2.~~8~~6 A fuel drain and fill shall be performed pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."

5.~~1~~2.~~9~~7 The vehicle shall be soaked for 12-36 hours. During this soak period, canister preconditioning shall be performed pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."

5.~~1~~2.~~10~~8 For the ~~u~~Urban ~~c~~Charge-~~d~~Depleting ~~range~~ Emission ~~t~~Test, ~~the highway charge depleting range test, and the optional cold start US06 range test,~~ charge the vehicle to full state-of-charge as specified by the vehicle manufacturer. For the Urban Charge-Sustaining Emission Test, except as noted in sections G.5.2.8.1, G.5.2.8.2, and G.5.2.8.3, initial SOC may be set during the soak period by discharging or charging the vehicle such that the SOC Criterion is satisfied when applying the ±1% SOC Net Energy Change Tolerances in section G.10. For the Alternative Urban Charge-Depleting Emission Test, only the initial dynamometer run to determine urban all-electric range as described in G.5.4.5 (ii) would require the vehicle to be charged to full state-of-charge prior to testing. For any subsequent dynamometer run to determine urban emissions for the Alternative Urban Charge-Depleting Emission Test, the initial SOC would be set according to G.5.4.5 (iv). The vehicle must be turned off during charging and charge time shall not exceed soak time.

5.2.8.1 If the alternative End-of-Test Criterion in section G.5.3.18 is used, then initial SOC setting shall not be permitted after the preconditioning cycle nor during the soak period prior to the Urban Charge-Sustaining Emission Test.

5.2.8.2 If testing a vehicle in a charge-increasing driver-selectable mode, then initial SOC setting shall not be permitted after the preconditioning cycle nor during the soak period prior to the Urban Charge-Sustaining Emission Test.

5.2.8.3 If testing a vehicle in charge-increasing operation, then the initial SOC for the preconditioning drive shall be set at the lowest normal SOC level allowed by the vehicle when driving on the UDDS cycle.

~~**5.2 Urban Dynamometer Procedure for Off-Vehicle Charge Capable Hybrid Electric Vehicles.**~~

~~To be conducted pursuant to 40 CFR §86.135-00 [October 22, 1996] with the following revisions. References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.~~

~~5.2.1 Amend subparagraph (a).~~

~~*Overview*. The charge depleting range test dynamometer run shall consist of a series of charge depleting UDDSs, each followed by a 10 minute key-off hot soak period until charge sustaining operation is achieved for two consecutive UDDSs. To determine charge sustaining operation, the vehicle must meet the SOC criterion in section G.10 from the start of the first UDDS until the end of the second UDDS. As an option, charge sustaining operation may be achieved for a single UDDS if data is provided showing that charge sustaining operation can consistently be maintained over one UDDS. To determine charge sustaining operation, in this case, the vehicle shall meet SOC criterion in section G.10 from the start to the end of a single UDDS. Emissions are measured for all UDDSs when the auxiliary power unit is operating.~~

~~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. At the end of this cold soak period, the vehicle shall be placed or pushed onto a dynamometer.~~

~~The charge sustaining emission test dynamometer run shall consist of two consecutive UDDSs with a 10 minute key-off hot soak in between. Vehicle emissions shall be measured over two UDDSs during charge sustaining operation, and the vehicle must meet the SOC criterion in section G.10 from the start of the first UDDS until the end of the second UDDS.~~

~~Vehicle charging shall be initiated within three hours after either the charge depleting range test or the charge sustaining emission test pursuant to section~~

~~G.5.4.2 or G.5.4.3, as applicable. During charging, all requirements in section G.3 must be met, and energy consumption shall be calculated pursuant to the requirements in section G.11.7.~~

~~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). As an alternative, the bag mini-diluter may be used in-lieu of the constant volume sampling (CVS) method for exhaust emission measurement as described below. 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). Part 1065 of the CFR may be used as an optional particulate sampling method. 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, CO_2, CH_4 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, CO_2, CH_4 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, CO_2, CH_4 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, CO_2, CH_4 and NO_x.~~

~~5.2.2 Subparagraphs (b) through (c). [No change.]~~

~~5.2.3 Subparagraph (d). [No change.]~~

~~5.2.4 Subparagraphs (e) through (g). [No change.]~~

~~5.2.5 Amend subparagraph (h): The driving distance, as measured by counting the number of dynamometer roll or shaft revolutions, shall be determined for all charge depleting and exhaust emission tests. The revolutions shall be measured on the same roll or shaft used for measuring the vehicle's speed.~~

~~5.2.6 Subparagraph (i). [No change.]~~

5.3 Determination of Urban Charge-Sustaining Emissions – ~~Urban~~ Dynamometer Test Run, Gaseous and Particulate Emissions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §1066.815 ~~§86.137-96 [March 24, 1993]~~ with the following revisions:

5.3.1 Amend subparagraph (a): *General*. The Urban Charge-Sustaining Emission Test consists of a cold-start UDDS cycle and a hot-start UDDS cycle as described in section G.5.1.3. If driver-selectable modes are available, activate the driver-selectable mode to be tested for the Urban Charge-Sustaining Emission Test to determine worst case emissions as described in the introductory paragraphs of section G.5. If a vehicle has a driver-selectable, charge-increasing mode, SOC shall be set in accordance with section G.5.4.5(iv) with the charge-increasing mode activated at the start of the cold-start UDDS cycle. ~~The dynamometer run shall consist of a series of UDDSs, 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." 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 vehicle is allowed to stand on the dynamometer during the 10 minute time period between each UDDS.~~

5.3.2 Amend subparagraph (b) ~~as follows.~~: *PM sampling options*. Collect PM using the procedures specified in subparagraphs (b)(1) or (b)(2) or (b)(5) of 40 CFR §1066.815 (subparagraphs (b)(3) and (b)(4) are not applicable) and use the corresponding equation in section G.5.6 to calculate composite PM emissions. Testing must meet the requirements related to filter face velocity as described in 40 CFR §1065.170(c)(1)(vi) [April 28, 2014], except as specified in paragraph (b)(5) of 40 CFR §1066.815 [February 19, 2015]. For procedures involving flow weighting, set the filter face velocity to a weighting target of 1.0 to meet the requirements of 40 CFR §1065.170(c)(1)(vi) [April 28, 2014]. Allow filter face velocity to decrease as a percentage of the weighting factor if the weighting factor is less than 1.0. Use the appropriate equations in 40 CFR §1066.610 to show that you meet the dilution factor requirements of 40 CFR §1066.110(b)(2)(iii)(B).

5.3.3 Amend subparagraphs (b)(1): A separate PM sample for transient and stabilized phases of the cold-start UDDS cycle and the hot-start UDDS cycle may be collected. This may be done by sampling with four filters.

5.3.4 Subparagraph (b)(2). [No change.]

5.3.5 Delete subparagraphs (b)(3) and (b)(4).

5.3.6 Subparagraphs (b)(5) through (c)(2). [No change.]

5.3.7 Delete subparagraph (c)(3).

5.3.8 Amend subparagraph (d): *Test sequence*. Follow the exhaust emission measurement procedures specified in 40 CFR §1066.410 through §1066.425, subject to the following exceptions and additional provisions:

5.3.9 Subparagraph (d)(1). [No change.]

5.3.10 Amend subparagraph (d)(1)(i): Precondition the vehicle as described in section G.5.2. Initiate the cold-start Urban Charge-Sustaining Emission Test in the driver-selectable mode to be tested following the 12 to 36 hour soak period.

5.3.11 Subparagraphs (d)(1)(ii) and (d)(1)(iii). [No change.]

5.3.12 Amend subparagraph (d)(1)(iv): Five seconds after the vehicle is turned off, stop all stabilized interval sampling and recording, including background sampling. Stop any integrating devices for the stabilized interval and indicate the end of the stabilized interval in the recorded data. Note that the 5 second delay is intended to account for sampling system transport.

5.3.13 Subparagraph (d)(2). [No change.]

5.3.14 Amend subparagraph (d)(2)(i): Initiate the hot-start UDDS cycle (9 to 11) minutes after the end of the sample period for the cold-start UDDS cycle.

5.3.15 Amend subparagraph (d)(2)(ii): Repeat the steps in paragraph (d)(1)(ii) of this section.

5.3.16 Amend subparagraph (d)(2)(iii): For bag 4 measurement or single bag per UDDS cycle measurement, operate the vehicle over the remainder of the UDDS and conclude the testing as described in paragraphs (d)(1)(iii) and (iv) of this section.

5.3.17 Amend subparagraph (3): **End-of-Test Criteria.** A valid test shall satisfy the SOC Net Energy Change Tolerances in section G.10. For PHEVs that use a battery as an energy storage device, ($\text{Amp-hr}_{initial}$) is the stored charge at the beginning of the cold-start UDDS cycle, and (Amp-hr_{final}) is the stored battery charge at the end of the subsequent hot-start UDDS cycle. The final stored battery charge, (Amp-hr_{final}), shall not exceed either $(\text{Amp-hr}_{final})_{max}$ or $(\text{Amp-hr}_{final})_{min}$ for a valid test. For PHEVs that use a capacitor as an energy storage device, ($V^2_{initial}$) is the square of the capacitor voltage stored at the beginning of the cold-start UDDS cycle, and (V_{final}) is the stored capacitor voltage at the end of the subsequent hot-start UDDS cycle. The final stored capacitor voltage, (V_{final}), shall not exceed either $(V_{final})_{max}$ or $(V_{final})_{min}$ for a valid test. For PHEVs that use an electro-mechanical flywheel as an energy storage device, ($rpm^2_{initial}$) is the squared flywheel rotational speed at the beginning of the cold-start UDDS cycle, and (rpm_{final}) is the flywheel rotational speed

at the end of the subsequent hot-start UDDS cycle. The final flywheel rotational speed, (rpm_{final}), shall not exceed either $(rpm_{final})_{max}$ or $(rpm_{final})_{min}$ for a valid test.

5.3.18 **Additional End-of-Test Criteria.** With approval from the Executive Officer, if the SOC Net Energy Change Tolerance is not satisfied after the hot-start UDDS cycle in section G.5.3.17, an Urban Charge-Sustaining Emission Test may be considered valid if:

5.3.18.1 The alternative End-of-Test criterion of ±5% SOC Net Energy Change Tolerance in Appendix C of SAE J1711 is satisfied (Note: Appendix C of SAE J1711 may not be used to correct measured values for any emissions.); or

5.3.18.2 The SOC at the end of the hot-start UDDS cycle is higher than the SOC at the beginning of the cold-start UDDS cycle.

~~5.3.2.1 Amend subparagraph (b)(9): Start the gas flow measuring device, direct the sample flow into the exhaust sample bag, the alcohol exhaust sample, the formaldehyde exhaust sample, the dilution air sample bag, the alcohol dilution air sample and the formaldehyde dilution air sample, 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.~~

~~5.3.2.2 Delete subparagraph (b)(13).~~

~~5.3.2.3 Subparagraph (b)(14). [No change.]~~

~~5.3.2.4 Amend subparagraph (b)(15): Five seconds after the vehicle is shutdown, simultaneously turn off the gas flow measuring device and particulate sample pump. 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 UDDS. Obtain alcohol 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 alcohol 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.~~

~~5.3.2.5 Amend subparagraph (b)(18): Repeat the steps in paragraphs (b)(2) through (b)(17) of this section for the hot start UDDS.~~

~~The steps 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 UDDS.~~

~~5.3.2.6 Delete subparagraph (b)(19).~~

~~5.3.2.7 Delete subparagraph (b)(20).~~

~~5.3.2.8 Amend subparagraph (b)(21): As soon as possible, transfer the particulate filters to the weighing chamber for post-test conditioning, if applicable. For vehicles undergoing a cold start charge sustaining test, a valid test shall satisfy the SOC criterion in section G.10.~~

~~5.3.2.9 Amend subparagraph (b)(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."~~

5.4 Determination of Urban All-Electric Range, ~~and~~ Urban Equivalent All-Electric Range, and Urban Charge-Depleting Emissions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

5.4.1 The **Urban All-Electric Range** shall be ~~shall be~~ defined as the distance that the vehicle is driven from the start of Urban Charge-Depleting ~~Range~~Emission Test until the ~~internal combustion~~ engine first starts in accordance with section G.5.4.2.1. Record the SOC when the engine first starts. The Urban Charge-Depleting Emission Test is performed with the vehicle initially at full state-of-charge. When emission testing a vehicle in a driver-selectable mode other than default mode or normal mode, the distance of the Urban All-Electric Range, which occurs during the first portion of the Urban Charge-Depleting Emission Test, shall not be considered as certification urban all-electric range for the purposes of compliance with the requirements in section C.

5.4.1.1 **Urban Equivalent All-Electric Range** shall be calculated in accordance with section G.11.

5.4.2 **Urban Charge-Depleting ~~Range~~ Emission Test.**

~~(i) **Vehicle preconditioning.** The vehicle shall be preconditioned according to G.5.1.~~

~~(ii) **Dynamometer run.** At the end of the cold soak period, the vehicle shall be placed or pushed, onto a dynamometer and operated through the Continuous Urban Test Schedule until the SOC Net Change Tolerances (specified in section G.10 of these test procedures) that indicate charge sustaining operation are met for two consecutive UDDSs, or a single UDDS if data is provided showing that charge sustaining~~

~~operation can consistently be maintained in one UDDS. If there are no charge depleting hot start cycles, then use the next hot start cycle (after the cold start cycle) in the test sequence for the purpose of determining hot start emissions. For this case (no charge depleting hot start cycle), the manufacturer may optionally add one additional hot start cycle.~~

To be conducted pursuant to 40 CFR §1066.815 with the following revisions:

5.4.2.1 Amend subparagraph (a): *General*. The Urban Charge-Depleting Emission Test consists of the Urban All-Electric Range Test, a cold-start UDDS cycle when the engine starts followed by a 10-minute key off soak and hot-start UDDS cycle(s) as described in section G.5.1.3. The Continuous Urban Test Schedule is used for the Urban Charge-Depleting Emission Test. If driver-selectable modes are available that can be appropriately tested with charge-depleting operation, then test the appropriate driver-selectable mode(s) as required for the Urban Charge-Depleting Emission Test to determine worst case emissions as described in the introductory paragraphs of section G.5. The Alternative Continuous Urban Test Schedule may be substituted for the Continuous Urban Test Schedule if the test facility is unable to perform the Continuous Urban Test Schedule. Refer to sections G.5.5, G.5.6, and G.11, for calculations of urban exhaust emissions, urban particulate emissions, and equivalent all-electric range, respectively. Emissions ~~are~~ shall be measured for all test cycles when the ~~auxiliary power unit~~ engine is operating. For each test cycle ~~for~~ during which emissions ~~were~~ are not ~~measured~~ generated, emissions are not required to be sampled. However, the manufacturer must validate that the ~~auxiliary power unit~~ engine did not turn on at any time during the test cycle. If the engine starts operating toward the end of the cold-start UDDS cycle such that the vehicle does not achieve full warm-up conditions prior to the subsequent hot-start UDDS cycle, an additional hot-start UDDS cycle may be performed following the first hot-start UDDS cycle and be included in the hot-start mass summations Σm_{h} in the equation of section 5.5.1.2 and $\Sigma m_{\mathrm{PM\text{-}hUDDS}}$ of the equation in section 5.6.1.2(1) along with the associated distance summations ΣD_{h}.

5.4.2.2 Amend subparagraph (b): *PM sampling options*. Collect PM using the procedures specified in subparagraphs (b)(1) or (b)(2) or (b)(5) of 40 CFR §1066.815 (subparagraphs (b)(3) and (b)(4) are not applicable) and use the corresponding equation in section G.5.6 to calculate composite PM emissions. Testing must meet the requirements related to filter face velocity as described in 40 CFR §1065.170(c)(1)(vi) [April 28, 2014], except as specified in paragraph (b)(5) of 40 CFR §1066.815. For procedures involving flow weighting, set the filter face velocity to a weighting target of 1.0 to meet the requirements of 40 CFR §1065.170(c)(1)(vi) [April 28, 2014]. Allow filter face velocity to decrease as a percentage of the weighting factor if the weighting factor is less than 1.0. Use the appropriate equations in 40 CFR §1066.610 to show that you meet the

dilution factor requirements of 40 CFR §1066.110(b)(2)(iii)(B).

5.4.2.3 Amend subparagraphs (b)(1): A separate PM sample for transient and stabilized phases of the cold-start UDDS cycle and the hot-start UDDS cycle may be collected. This may be done by sampling with four filters.

5.4.2.4 Subparagraph (b)(2). [No change.]

5.4.2.5 Delete subparagraphs (b)(3) and (b)(4).

5.4.2.6 Subparagraphs (b)(5) through (c)(2). [No change.]

5.4.2.7 Delete subparagraph (c)(3).

5.4.2.8 Amend subparagraph (d): *Test sequence*. Follow the exhaust emission measurement procedures specified in 40 CFR §1066.410 through §1066.425, subject to the following exceptions and additional provisions:

5.4.2.9 Subparagraph (d)(1). [No change.]

5.4.2.10 Amend subparagraph (d)(1)(i): Precondition the vehicle as described in section G.5.2. Initiate the cold-start Urban Charge-Depleting Emission Test in the appropriate driver-selectable mode to be tested following the 12 to 36 hour soak period.

5.4.2.11 Subparagraphs (d)(1)(ii) and (d)(1)(iii). [No change.]

5.4.2.12 Amend subparagraph (d)(1)(iv): Five seconds after the vehicle is turned off, stop all stabilized interval sampling and recording, including background sampling. Stop any integrating devices for the stabilized interval and indicate the end of the stabilized interval in the recorded data. Note that the 5 second delay is intended to account for sampling system transport.

5.4.2.13 Subparagraph (d)(2). [No change.]

5.4.2.14 Amend subparagraph (d)(2)(i): Initiate the hot-start UDDS cycle (9 to 11) minutes after the end of the sample period for the cold-start UDDS cycle.

5.4.2.15 Amend subparagraph (d)(2)(ii): Repeat the steps in paragraph (d)(1)(ii) of this section.

5.4.2.16 Amend subparagraph (d)(2)(iii): For bag 4 measurement or single bag per UDDS cycle measurement, operate the vehicle over the remainder of the UDDS and conclude the testing as described in subparagraphs (d)(1)(iii) and (iv) of this section.

5.4.2.17 Amend subparagraph (3): **End-of-Test Criteria.** A valid test shall satisfy the SOC Net Energy Change Tolerances in section G.10. For PHEVs that use a battery as an energy storage device, $(\text{Amp-hr}_{initial})$ is the stored charge at the beginning of the cold-start UDDS cycle, and (Amp-hr_{final}) is the stored battery charge at the end of the next hot-start UDDS cycle immediately following the cold-start UDDS cycle. The final stored battery charge, (Amp-hr_{final}), shall not exceed either $(\text{Amp-hr}_{final})_{max}$ or $(\text{Amp-hr}_{final})_{min}$ for a valid test. For PHEVs that use a capacitor as an energy storage device, $(V^2_{initial})$ is the square of the capacitor voltage stored at the beginning of the cold-start UDDS cycle, and (V_{final}) is the stored capacitor voltage at the end of the next hot-start UDDS cycle immediately following the cold-start UDDS cycle. The final stored capacitor voltage, (V_{final}), shall not exceed either $(V_{final})_{max}$ or $(V_{final})_{min}$ for a valid test. For PHEVs that use an electro-mechanical flywheel as an energy storage device, $(rpm^2_{initial})$ is the squared flywheel rotational speed at the beginning of the cold-start UDDS cycle, and (rpm_{final}) is the flywheel rotational speed at the end of the next hot-start UDDS cycle immediately following the cold-start UDDS cycle. The final flywheel rotational speed, (rpm_{final}), shall not exceed either $(rpm_{final})_{max}$ or $(rpm_{final})_{min}$ for a valid test.

5.4.3 **Additional End-of-Test Criteria.** With approval from the Executive Officer, if the SOC Net Energy Change Tolerance is not satisfied after the hot-start UDDS cycle in section G.5.4.2.17, an Urban Charge-Depleting Emission Test may be considered valid if:

5.4.3.1 The alternative End-of-Test criteria in Section 3.9 or Section 3.9.1 of SAE J1711 are satisfied; or

5.4.3.2 The SOC at the end of the hot-start UDDS cycle is higher than the SOC at the beginning of the cold-start UDDS cycle.

~~(iii)~~5.4.4 **Vehicle charging after testing.** Vehicle charging shall begin within three hours after ~~either~~ the charge depleting ~~range~~ emission test ~~or the charge sustaining emission test~~, and the vehicle shall be charged to the manufacturer specified full state-of-charge. During charging, all applicable requirements in section G.3 must be met, and energy consumption shall be calculated pursuant to the requirements in section G.11.7.

5.4.5 **Alternative Urban Charge-Depleting Emission Test.**

A vehicle with an Urban All-Electric Range that is equal to or greater than four UDDS cycles and has an AER/EAER ratio that is equal to or greater than 0.98 may demonstrate compliance with applicable exhaust emission standards using this section G.5.4.5 in lieu of sections G.5.3 and G.5.4.2. The AER and EAER values used to calculate the AER/EAER ratio must each contain three significant figures after the decimal point. Rounding the calculated AER/EAER

ratio up to 0.98 is prohibited. Use of the Alternative Urban Charge-Depleting Emission Test must be approved in advance by the Executive Officer.

For the purpose of measuring vehicle emissions, subparagraphs 5.4.5(i) and (ii) must be performed during the initial Alternative Urban Charge-Depleting Emission Test to determine urban all-electric range; these sections may be omitted during any subsequent Alternative Urban Charge-Depleting Emission Tests.

(i) The vehicle shall be charged to full state-of-charge.

(ii) **Dynamometer run to determine Urban All-Electric Range.** The vehicle shall be placed or pushed onto a chassis dynamometer and operated through the Continuous Urban Test Schedule or the Alternative Continuous Urban Test Schedule with the vehicle in default mode or in normal mode if the vehicle does not have default mode. When the engine first starts, record SOC, and continue driving until charge-sustaining operation is achieved. As an option, emissions may be measured so the full Urban Charge-Depleting Emission Test as described in section G.5.4.2 may be used to determine urban charge-depleting emissions for vehicles operating in default or normal mode. If this option is used, vehicle preconditioning according to section G.5.2 must be performed prior to this section G.5.4.5(ii). To determine the Urban Equivalent All-Electric Range for the TZEV Allowance in section C.3.3(a), the full Urban Charge-Depleting Emission Test option shall be performed and the Urban Equivalent All-Electric Range calculated in accordance with section G.11.

(iii) **Vehicle preconditioning.** The vehicle shall be preconditioned according to section G.5.2.

(iv) **Dynamometer run to determine Urban Emissions.** After the cold soak period, using the engine start SOC data from the previous section G.5.4.5(ii), set the SOC so that the engine starts at or before the first 45 seconds of the cold-start UDDS cycle. The SOC shall not be set below the normal operating SOC threshold of the vehicle as observed during the UDDS cycle when driving in default mode or in normal mode if the vehicle does not have default mode. If testing a vehicle in driver-selectable, charge-increasing mode: first set SOC in accordance with the conditions set forth in the first two sentences of this section G.5.4.5(iv) with the vehicle in default mode or in normal mode if the vehicle does not have default mode, then activate the charge-increasing mode at the start of the cold-start UDDS cycle. For all tests, the engine must start at or before the first 45 seconds of the cold-start UDDS cycle to be valid.

(v) The vehicle shall be placed or pushed onto a dynamometer and operated through a cold-start UDDS cycle followed by a 10 minute key-off

soak and then a hot-start UDDS cycle. At the completion of the hot-start UDDS cycle, the test is completed. For additional testing information, the testing parameters for the Urban Charge-Sustaining Emission Test in section G.5.3 are applicable. However, the Alternative Urban Charge-Depleting Emission Test does not require satisfying the SOC Net Energy Change Tolerance to be a valid test.

(vi) Refer to sections G.5.5 and G.5.6, for calculating urban gaseous emissions and urban particulate emissions, respectively.

(vii) **Optional vehicle charging after testing.** Vehicle may be fully charged following the Urban All-Electric Range Test in section G.5.4.5(ii). If this option is performed, vehicle charging shall begin within three hours after completing the Urban All-Electric Range Test in section G.5.4.5(ii), and the vehicle shall be charged to the manufacturer specified full state-of-charge. During charging, all applicable requirements in section G.3 must be met, and energy consumption shall be calculated pursuant to the requirements in section G.11.7.

~~5.4.3 **Urban Charge Sustaining Emission Test.** The Urban Charge Sustaining Emission Test is conducted cold, and after charge sustaining operation has been reached, or an optional charge sustaining test mode has been activated, and no subsequent charge has been performed.~~

~~(i) **Vehicle preconditioning.** If the Urban Charge Sustaining Emission Test is performed within 36 hours after the Urban Charge Depleting Range Test, the vehicle shall be preconditioned pursuant to section G.5.1.9. If the Urban Charge Sustaining Emission Test is performed more than 36 hours after the Urban Charge Depleting Range Test, the vehicle shall be preconditioned pursuant to section G.5.1, except for vehicle charging. Sections G.5.1.1 through G.5.1.4 may be omitted if previously performed.~~

~~(ii) **Dynamometer run.** At the end of the cold soak period, the vehicle shall be placed or pushed onto a dynamometer, and two UDDSs shall be performed during charge sustaining operation, each separated by a 10 minute key-off hot soak period. The vehicle must meet the SOC criterion in section G.10 from the start of the first UDDS until the end of the second UDDS. If the SOC Criterion is not satisfied, the test shall be stopped, the vehicle cold soak shall be conducted again, and the dynamometer test run shall be conducted again.~~

~~(iii) **Vehicle charging after testing.** If the vehicle was not charged after the Urban Charge Depleting Range Test, then vehicle charging shall begin within three hours after the Urban Charge Sustaining Emission Test and the vehicle shall be charged to the manufacturer specified full state-of-charge. During charging, all requirements in G.3 must be met, and energy consumption shall be calculated pursuant to the requirements in section G.11.7.~~

5.5 Calculations – Urban Gaseous ~~Exhaust~~ Emissions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

5.5.1 Urban Charge-Depleting Gaseous Emissions Calculations.

To be conducted pursuant to 40 CFR §1066.820 [April 28, 2014] with the following revisions:

5.5.1.1 Subparagraph (a). [No change.]

5.5.1.2 Amend subparagraph (b): Calculate the final composite gaseous test results as a mass-weighted value, $e_{[\text{emission}]\text{-FTPcomp}}$, in grams per mile using the following equation:

$$e_{[\text{emission}]-\text{FTPcomp}} = 0.43\left(\frac{m_{\text{c}}}{D_{\text{c}}}\right) + 0.57\left(\frac{\Sigma m_{\text{h}}}{\Sigma D_{\text{h}}}\right)$$

Where:

m_{c} = the mass emissions determined from the cold-start UDDS cycle, in grams. If the cold-start UDDS cycle consists of phase 1 cold transient emissions and phase 2 cold stabilized emissions, then sum phase 1 and phase 2 emissions to determine m_{c}.

D_{c} = the measured driving distance from the cold-start UDDS cycle, in miles. If the cold-start UDDS cycle consists of phase 1 distance and phase 2 distance, then sum phase 1 and phase 2 distances to determine D_{c}.

Σm_{h} = the summation of the mass emissions determined from each hot-start UDDS cycle, in grams. If a hot-start UDDS cycle consists of phase 3 hot transient emissions and phase 4 hot stabilized emissions, then sum phase 3 and phase 4 emissions to determine m_{h} for the each hot-start UDDS cycle.

ΣD_{h} = the summation of the driving distances from each hot-start UDDS cycle, in miles. If a hot-start UDDS cycle consists of phase 3 distance and phase 4 distance, then sum phase 3 and phase 4

distances to determine D_{h} for each hot-start UDDS cycle.

5.5.1.3 Subparagraphs (c). [Not applicable.]

5.5.2 Urban Charge-Sustaining Gaseous Emissions Calculations.

To be conducted pursuant to 40 CFR §1066.820 [April 28, 2014] with the following revisions:

5.5.2.1 Subparagraph (a). [No change.]

5.5.2.2 Amend subparagraph (b): Calculate the final composite gaseous test results as a mass-weighted value, $e_{[\mathrm{emission}]\text{-}\mathrm{FTPcomp}}$, in grams per mile using the following equation:

$$e_{[\mathrm{emission}]-\mathrm{FTPcomp}} = 0.43\left(\frac{m_{\mathrm{c}}}{D_{\mathrm{c}}}\right) + 0.57\left(\frac{m_{\mathrm{h}}}{D_{\mathrm{h}}}\right)$$

Where:

m_{c} = the mass emissions determined from the cold-start UDDS cycle, in grams. If the cold-start UDDS cycle consists of phase 1 cold transient emissions and phase 2 cold stabilized emissions, then sum phase 1 and phase 2 emissions to determine m_{c}.

D_{c} = the measured driving distance from the cold-start UDDS cycle, in miles. If the cold-start UDDS cycle consists of phase 1 distance and phase 2 distance, then sum phase 1 and phase 2 distances to determine D_{c}.

m_{h} = the mass emissions determined from the hot-start UDDS cycle, in grams. If the hot-start UDDS cycle consists of phase 3 hot transient emissions and phase 4 hot stabilized emissions, then sum phase 3 and phase 4 emissions to determine m_{h}.

D_{h} = the driving distance from the hot-start UDDS cycle, in grams. If the hot-start UDDS cycle consists of phase 3 distance and phase 4 distance, then sum phase 3 and phase 4 distances to determine D_{h}.

5.5.2.3 Subparagraph (c). [Not applicable.]

~~To be conducted pursuant to 40 CFR §86.144-94 [July 13, 2005] with the following revisions:~~

~~5.5.1 Amend subparagraph (a):~~
~~Gaseous Emissions – Urban Charge Depleting Range Test.~~

~~For light-duty vehicles and light duty trucks:~~

$$Y_{wm} = 0.43 * \left(\frac{Y_c}{D_c} \right) + 0.57 * \left(\frac{\Sigma Y_n}{\Sigma D_n} \right)$$

~~Where:~~

~~Y_{wm} = Weighted mass emissions of each pollutant, i.e., THC, CO, THCE, NMOG, NMHCE, CH_4, NOx, or CO_2, in grams per vehicle mile.~~

~~Y_c = Mass emissions as calculated from the cold start UDDS, in grams per test.~~

~~D_c = The measured driving distance from the cold start UDDS, in miles.~~

~~n = number of hot start UDDSs in Charge Depleting operation~~
~~If there are no charge depleting hot start cycles, then use the next hot start cycle (after the cold start cycle) in the test sequence for the purpose of determining hot start emissions. For this case (no charge depleting hot start cycle), the manufacturer may optionally add one additional hot start cycle for an n=2.~~

~~Gaseous Emissions – Urban Charge Sustaining Emission Test.~~

~~For light-duty vehicles and light-duty trucks:~~

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

~~Where:~~

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

~~Y_c = Mass emissions as calculated from the cold start UDDS, in grams per test.~~

~~Y_h = Mass emissions as calculated from the hot start UDDS, in grams per test.~~

~~D_c = The measured driving distance from the cold start UDDS, in miles.~~

~~D_h = The measured driving distance from the hot start UDDS, in miles.~~

~~5.5.2 Subparagraphs (b) through (e). [No change.]~~

5.6 Calculations – Urban Particulate Emissions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

5.6.1 Urban Charge-Depleting Particulate Emissions Calculations.

To be conducted pursuant to 40 CFR §1066.820 with the following revisions:

5.6.1.1 Subparagraph (a) to (b). [Not applicable.]

5.6.1.2 Amend subparagraphs (c) through (c)(1): Calculate the final composite PM test results as a mass-weighted value, $e_{\text{PM-FTPcomp}}$, in grams per mile as follows:

(1) Use the following equation for PM measured as described in §1066.815(b)(1) or (2):

$$e_{\text{PM-FTPcomp}} = 0.43\left(\frac{m_{\text{PM-cUDDS}}}{D_{\text{c}}}\right) + 0.57\left(\frac{\Sigma m_{\text{PM-hUDDS}}}{\Sigma D_{\text{h}}}\right)$$

Where:

$m_{\text{PM-cUDDS}}$ = the combined PM mass emissions determined from the cold-start UDDS cycle (phase 1 and phase 2), in grams, as calculated using Eq. 1066.605-2.

D_{c} = the measured driving distance from the cold-start UDDS cycle, in miles. If the cold-start UDDS cycle consists of phase 1 distance and phase 2 distance, then sum phase 1 and phase 2 distances to determine D_{c}.

$\Sigma m_{\text{PM-hUDDS}}$ = the summation of the PM mass emissions determined from each hot-start UDDS cycle, in grams, as calculated using Eq. 1066.605-2. If a hot-start UDDS cycle consists of phase 3 hot transient emissions and phase 4 hot stabilized emissions, then sum phase 3 and phase 4 emissions to determine $m_{\text{PM-hUDDS}}$ for the each hot-start UDDS cycle.

ΣD_{h} = the summation of the driving distances from each hot-start UDDS cycle, in miles. If a hot-start UDDS cycle consists of phase 3 distance and phase 4 distance, then sum phase 3 and phase 4 distances to determine D_{h} for each hot-start UDDS cycle.

5.6.1.3 Subparagraph (c)(2). [Not applicable.]

5.6.1.4 Amend subparagraph (c)(3): Use the following equation for PM measured as described in §1066.815(b)(5):

$$e_{\mathrm{PM-FTPcomp}} = \frac{m_{\mathrm{PM}}}{0.43(D_{\mathrm{c}}) + 0.57(D_{\mathrm{h}})}$$

Where:

m_{PM} = the combined PM mass emissions determined from the cold-start UDDS cycle and the hot-start UDDS cycle (phase 1, phase 2, phase 3, and phase 4), in grams, as calculated using Eq. 1066.605-4.

D_{c} = the measured driving distance from the cold-start UDDS cycle, in miles. If the cold-start UDDS cycle consists of phase 1 distance and phase 2 distance, then sum phase 1 and phase 2 distances to determine D_{c}.

D_{h} = the driving distance from the hot-start UDDS cycle, in grams. If the hot-start UDDS cycle consists of phase 3 distance and phase 4 distance, then sum phase 3 and phase 4 distances to determine D_{h}.

5.6.2 Urban Charge-Sustaining Particulate Emissions Calculations.

To be conducted pursuant to 40 CFR §1066.820 with the following revisions:

5.6.2.1 Subparagraphs (a) to (b). [Not applicable.]

5.6.2.2 Amend subparagraphs (c) through (c)(1): Calculate the final composite PM test results as a mass-weighted value, $e_{\mathrm{PM-FTPcomp}}$, in grams per mile as follows:

(1) Use the following equation for PM measured as described in §1066.815(b)(1) or (2):

$$e_{\mathrm{PM-FTPcomp}} = 0.43\left(\frac{m_{\mathrm{PM-cUDDS}}}{D_{\mathrm{c}}}\right) + 0.57\left(\frac{m_{\mathrm{PM-hUDDS}}}{D_{\mathrm{h}}}\right)$$

Where:

$m_{\mathrm{PM\text{-}cUDDS}}$ = the combined PM mass emissions determined from the cold-start UDDS cycle (phase 1 and phase 2), in grams, as calculated using Eq. 1066.605-2.

D_c = the measured driving distance from the cold-start UDDS cycle, in miles. If the cold-start UDDS cycle consists of phase 1 distance and phase 2 distance, then sum phase 1 and phase 2 distances to determine D_c.

$m_{\text{PM-hUDDS}}$ = the combined PM mass emissions determined from the hot-start UDDS cycle (phase 3 and phase 4), in grams, as calculated using Eq. 1066.605-2.

D_h = the driving distance from the hot-start UDDS cycle, in grams. If the hot-start UDDS cycle consists of phase 3 distance and phase 4 distance, then sum phase 3 and phase 4 distances to determine D_h.

5.6.2.3 Subparagraph (c)(2). [Not applicable.]

5.6.2.4 Amend subparagraph (c)(3): Use the following equation for PM measured as described in §1066.815(b)(5):

$$e_{\text{PM-FTPcomp}} = \frac{m_{\text{PM}}}{0.43(D_c) + 0.57(D_h)}$$

Where:

m_{PM} = the combined PM mass emissions determined from the cold-start UDDS cycle and the hot-start UDDS cycle (phase 1, phase 2, phase 3, and phase 4), in grams, as calculated using Eq. 1066.605-4.

D_c = the measured driving distance from the cold-start UDDS cycle, in miles. If the cold-start UDDS cycle consists of phase 1 distance and phase 2 distance, then sum phase 1 and phase 2 distances to determine D_c.

D_h = the driving distance from the hot-start UDDS cycle, in grams. If the hot-start UDDS cycle consists of phase 3 distance and phase 4 distance, then sum phase 3 and phase 4 distances to determine D_h.

~~To be conducted pursuant to 40 CFR §86.145-82 [November 2, 1982] with the following revisions. References to §86.110-94 shall mean §86.110-94 as last amended June 30, 1995.~~

~~5.6.1 Amend subparagraph (a):~~

~~Particulate Emissions – Urban Charge Depleting Range Test.~~

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

$$\cancel{M_p = 0.43 * \left(\frac{M_{pc}}{D_c}\right) + 0.57 * \left(\frac{\Sigma M_{pn}}{\Sigma D_n}\right)}$$

~~Where:~~

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

~~D_c = The measured driving distance from the cold start UDDS, in miles.~~

~~n = number of hot start UDDSs in Charge Depleting operation~~
~~If there are no charge depleting hot start cycles, then use the next hot start cycle (after the cold start cycle) in the test sequence for the purpose of determining hot start emissions. For this case (no charge depleting hot start cycle), the manufacturer may optionally add one additional hot start cycle for an n=2.~~

~~Particulate Emissions – Urban Charge Sustaining Emission Test.~~

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

$$\cancel{M_p = 0.43 * \left(\frac{M_{pc}}{D_c}\right) + 0.57 * \left(\frac{M_{ph}}{D_h}\right)}$$

~~Where:~~

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

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

~~D_c = The measured driving distance from the cold start UDDS, in miles.~~

~~D_h = The measured driving distance from the hot start UDDS, in miles.~~

~~5.6.2 Subparagraph (b). [No change.]~~

~~5.6.3 **Equivalent All-Electric Range** shall be calculated in accordance with section G.11 of these test procedures.~~

6. Highway Emission Test Provisions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §1066.801, except as noted.

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.

For the purpose of determining Highway All-Electric Range and Highway Equivalent All-Electric Range, the vehicle shall be range tested in default mode or in normal mode if the vehicle does not have a default mode.

For the purpose of demonstrating compliance with exhaust emission standards, a vehicle must be emission tested in the vehicle operation (i.e., either charge-sustaining or charge-increasing operation) that represents the worst case highway NMOG + NOx emissions.

Vehicles with one or more ~~than one~~ driver-selectable modes ~~of operation of the auxiliary power unit~~ (e.g., normal mode, economy mode, performance mode, battery charging mode, ~~etc.~~or any other operating mode available to the driver) for a given ~~charge depleting or~~ charge-sustaining or charge-increasing ~~test cycle~~operation (if available) must be emission tested in the one driver-selectable mode~~(s)~~ and vehicle operation (i.e., charge-sustaining, charge-increasing) which represents the worst case highway NMOG + NOx emissions ~~of the auxiliary power unit~~. For example, if a vehicle has two driver-selectable modes that can be tested in charge-sustaining and charge-increasing operations, the manufacturer shall determine worst case highway emissions of NMOG + NOx by comparing the following (1) mode 1 charge-sustaining emissions, (2) mode 2 charge-sustaining emissions, (3) mode 1 charge-increasing emissions, and (4) mode 2 charge-increasing emissions based on the Highway Emission Test.

In lieu of demonstrating the worst case highway NMOG + NOx emissions by certification testing in every highway charge-sustaining driver-selectable mode and every highway charge-increasing (if available) driver-selectable mode, a manufacturer may determine the worst case operating mode by using non-certification emission data and/or an engineering evaluation. The manufacturer must report the data and/or engineering evaluation used to determine the worst case operating mode. The manufacturer must demonstrate compliance with all applicable emission standards using test data for the worst case operating mode.

Confirmatory testing and/or in-use compliance testing may ~~also~~ be performed in any driver-selectable mode ~~of operation~~ charge-sustaining or charge-increasing operation (if available) to ensure compliance with emission standards.

~~The third emission test HFEDS of the Highway Charge Sustaining Test shall be used to calculate highway NOx emissions and must be within the SOC criterion in section G.10. As an option, the manufacturer may perform the Highway Charge Sustaining Test with two emission test HFEDSs provided that the second HFEDS meets the SOC criterion in section G.10. In this case, the second HFEDS shall be used to calculate emissions.~~

~~Highway NOx emissions may be determined from the HFEDS in the Highway Charge Depleting Range Test that demonstrates charge sustaining operation.~~

~~6.1 Vehicle Preconditioning.~~

~~If the Highway Charge Depleting Range Test is performed within 36 hours after completion of either the Urban Charge Depleting Range Test or the Urban Charge Sustaining Emission Test, the vehicle shall be preconditioned pursuant to sections G.5.1.9 through G.5.1.10, without canister preconditioning. If the Highway Charge Depleting Range Test is performed more than 36 hours after completion of either the Urban Charge Depleting Range Test or the Urban Charge Sustaining Emission Test, the vehicle shall be preconditioned pursuant to section G.5.1, without canister preconditioning. Sections G.5.1.1 through G.5.1.4 may be omitted if previously performed.~~

~~If the Highway Charge Sustaining Emission Test is performed within 36 hours after completion of either the Urban Charge Depleting Range Test, the Urban Charge Sustaining Emission Test, or the Highway Charge Depleting Range Test, the vehicle shall be preconditioned pursuant to section G.5.1.9,without canister preconditioning. If the Highway Charge Sustaining Emissions Test is performed more than 36 hours after completion of either the Urban Charge Depleting Range Test, the Urban Charge Sustaining Emission Test, or the Highway Charge Depleting Range Test, the vehicle shall be preconditioned pursuant to section G.5.1 without canister precondition and vehicle charging. Sections G.5.1.1 through G.5.1.4 may be omitted if previously performed.~~

~~6.2 Highway Dynamometer Procedure for Off-Vehicle Charge Capable Hybrid Electric Vehicles.~~

~~To be conducted pursuant to 40 CFR §600.111-08 [December 27, 2006] with the following revisions. This section G.6.2 shall apply during both charge sustaining and charge depleting operation.~~

~~6.2.1 Subparagraph (a). [n/a]~~

~~6.2.2 Amend subparagraph (b) as follows:~~

~~6.2.2.1 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. Alcohol and formaldehyde samples are collected and individually analyzed for alcohol-fueled vehicles.~~

~~6.2.2.2 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 or pushed onto a dynamometer.~~

~~6.2.2.3 Amend subparagraph (b)(7)(i): The Highway Charge Sustaining Emission Test is conducted cold, and after charge sustaining operation has been reached, or an optional charge sustaining test mode has been activated, and no subsequent charge has been performed.~~

~~At the end of the cold soak period, the vehicle shall be placed or pushed onto a dynamometer. A cold start HFEDS followed by three emission measurement HFEDSs, separated by a 15 second key-on hot soak period, shall be performed. The vehicle must meet the SOC criterion in section G.10 for the third emission measurement HFEDS. As an option the manufacturer may perform two emission measurement HFEDS in lieu of three emission measurement HFEDS, if the SOC criterion is satisfied for the second emission measurement HFEDS. If the SOC criterion is not satisfied, the test shall be stopped, and the procedure shall be repeated starting at section G.6.2.2.2.~~

~~6.2.2. 4 Amend subparagraph (b)(7)(iii): One exhaust sample and one background sample per each HFEDS shall be collected and analyzed for THC (except diesel hydrocarbons which are analyzed continuously), CO, CO_2, and NO_x. Alcohol and formaldehyde samples (exhaust and dilution air) are collected and analyzed for alcohol-fueled vehicles.~~

~~6.2.2.5 Add subparagraph (b)(7)(v): For 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 vehicle to operate the auxiliary power unit for the maximum possible cumulative amount of time during the HFEDS preconditioning cycle. For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer.~~

~~6.2.2. 6 Amend subparagraph (b)(9)(v): Operate the vehicle over the continuous highway test schedule, consisting of repeated HFEDS according to the dynamometer driving schedule specified in §600.109-08(b) [December 27,~~

~~2006]. 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.~~

~~6.2.2.7 Amend subparagraph (b)(9)(vi): When the vehicle reaches zero speed between each HFEDS, the driver has 17 seconds to prepare for the HFEDS emission measurement cycle of the test. During the idle period, one of the following conditions shall apply:~~

~~(a) For vehicles that do not allow the auxiliary power unit to be manually activated, the vehicle shall remain turned on during the idle period.~~

~~(b) For 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.~~

~~6.2.2.8 Add subparagraph (b)(9)(viii): At the conclusion of the HFEDS emission test, the following conditions shall apply: For 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 in section F.10 is satisfied. If the SOC criterion is not satisfied, then repeat the dynamometer test run from subparagraph (b)(9)(vi) and (b)(9)(vii). Up to three highway emission tests shall be allowed to satisfy the SOC criterion.~~

~~6.2.2.9 Delete subparagraph (b)(10).~~

~~6.2.3 Delete subparagraphs (c) through (e).~~

6.~~3~~1 Determination of Highway All-Electric Range, ~~and~~ Highway Equivalent All-Electric Range, and Highway Emissions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

6.~~3~~1.1 The **Highway All-Electric Range** shall be defined as the distance that the vehicle is driven from the start of the Highway Charge-Depleting Range T~~t~~est until the ~~internal combustion~~ engine first starts. The Highway Charge-Depleting Range Test is performed with the vehicle initially at full state-of-charge and in default mode or in normal mode if the vehicle does not have a default mode.

6.~~3~~1.2 **Highway Charge Depleting Range Test.**

~~(i) **Vehicle preconditioning.** The vehicle shall be preconditioned pursuant to section G.6.1.~~

(~~i~~i) **Dynamometer run.** ~~At the end of the cold soak period,~~ Starting at full state-of-charge, the vehicle shall be placed or pushed, onto a dynamometer and operated through the Continuous Highway Test Schedule until the ~~State-of-Charge~~ SOC Net Energy Change Tolerances (specified in section G.10 of these test procedures) that indicate charge sustaining operation are ~~is~~ met for one HFEDS cycle. Additional End-of-Test Criteria as provided for in the Urban Charge-Depleting Emission Test in sections G.5.4.3.1 and G.5.4.3.2 may be used for the Highway Charge-Depleting Range Test with approval from the Executive Officer. The Alternative Continuous Highway Test Schedule may be substituted for the Continuous Highway Test Schedule if the test facility is unable to perform the Continuous Highway Test Schedule. ~~Refer to section G.11, for calculations of highway exhaust emissions and equivalent all-electric range, respectively. Emissions are measured for all test cycles when the auxiliary power unit is operating. For each test cycle for which emissions were not measured, the manufacturer must validate that the auxiliary power unit did not turn on at any time during the test cycle.~~ Emissions shall be measured for all test cycles when the engine is operating. For each test cycle during which emissions are not generated, emissions are not required to be sampled. However, the manufacturer must validate that the engine did not turn on at any time during the test cycle.

(~~ii~~i) **Vehicle charging after testing.** Vehicle charging shall begin within three hours after the Highway Charge Depleting Range Test and the vehicle shall be charged to the manufacturer specified full state-of-charge. During charging, all applicable requirements in section G.3 must be met, and energy consumption shall be calculated according to the requirements in section G.11.7. ~~If the manufacturer provides supplemental data demonstrating that the energy required to charge the vehicle from highway charge sustaining operation to full charge is equivalent (within ± 1% of the AC energy) to the energy required to charge the vehicle from urban charge sustaining operation to full charge, then the energy required to charge the vehicle from urban charge sustaining operation to full charge may be used to determine highway energy consumption pursuant to section G.11.7. Data shall be approved in advance by the Executive Officer of the Air Resources Board.~~

6.1.3 **Equivalent All-Electric Range** shall be calculated in accordance with section G.11.

6.~~3.3~~1.4 **Highway ~~Charge Sustaining~~ Emission Test.** ~~The Highway Charge Sustaining Emission Test is conducted cold, and after charge sustaining operation has been reached, or an optional charge sustaining test mode has been activated, and no subsequent charge has been performed:~~

To be conducted pursuant to 40 CFR §1066.840 with the following revisions:

6.1.4.1 Amend subparagraph (a): Perform the Highway Emission Test

immediately following any of the urban emission tests, the Highway Charge-Depleting Range Test, or a previous Highway Emission Test when this is practical. If the Highway Emission Test starts more than 3 hours after any of the urban emission tests (including evaporative emission measurements, if applicable), Highway Charge-Depleting Range Test, or a previous Highway Emission Test, operate the vehicle over one UDDS cycle in charge-sustaining operation to precondition the vehicle. If driver-selectable modes are available, do not activate the driver-selectable mode to be tested for the UDDS preconditioning drive, but set the vehicle in default mode or normal mode for the UDDS preconditioning drive with the vehicle in charge-sustaining operation. Additional preconditioning UDDS cycles may be approved in advance by Executive Officer if the need for additional preconditioning is demonstrated by the manufacturer.

6.1.4.2 Amend subparagraph (b): Operate the vehicle over the HFEDS cycle in charge-sustaining operation for preconditioning. If driver-selectable modes are available, do not activate the driver-selectable mode to be tested for the preconditioning drive, but set the vehicle in default mode or normal mode for the preconditioning drive with the vehicle in charge-sustaining operation. If, however, the vehicle is to be tested in charge-increasing operation (this does not apply to a driver-selectable charge-increasing mode), then the initial SOC shall be set at the lowest normal SOC level allowed by the vehicle when driving on the UDDS cycle. After the preconditioning drive, allow the vehicle to idle for 15 seconds (with the vehicle in gear), then start a repeat run of the HFEDS cycle and simultaneously start sampling and recording. If a driver-selectable mode is to be tested after the preconditioning drive, allow the vehicle to idle for 15 seconds (with the vehicle in gear), activate the driver-selectable mode to be tested, then start a repeat run of the HFEDS cycle and simultaneously start sampling and recording. End-of-Test Criterion: A valid test shall satisfy the SOC Net Energy Change Tolerances in section G.10 for the HFEDS cycle with emission sampling. For PHEVs that use a battery as an energy storage device, ($\text{Amp-hr}_{initial}$) is the stored charge at the beginning of the HFEDS cycle with emission sampling, and (Amp-hr_{final}) is the stored battery charge at the end of the same HFEDS cycle with emission sampling. The final stored battery charge, (Amp-hr_{final}), shall not exceed either $(\text{Amp-hr}_{final})_{max}$ or $(\text{Amp-hr}_{final})_{min}$ for a valid test. For PHEVs that use a capacitor as an energy storage device, ($V^2_{initial}$) is the square of the capacitor voltage stored at the beginning of the HFEDS cycle with emission sampling, and (V_{final}) is the stored capacitor voltage at the end of the same HFEDS cycle with emission sampling. The final stored capacitor voltage, (V_{final}), shall not exceed either $(V_{final})_{max}$ or $(V_{final})_{min}$ for a valid test. For PHEVs that use an electro-mechanical flywheel as an energy storage device, ($rpm^2_{initial}$) is the squared flywheel rotational speed at the beginning of the HFEDS cycle with emission sampling, and (rpm_{final}) is the flywheel rotational speed at the end of the same HFEDS cycle with emission sampling. The final flywheel rotational speed, (rpm_{final}), shall not exceed either $(rpm_{final})_{max}$ or $(rpm_{final})_{min}$ for a valid test.

6.1.4.3 Amend subparagraph (c): Turn the vehicle off at the end of the final HFEDS cycle and stop all sampling and recording, including background. Stop any integrating devices and indicate the end of the test cycle in the recorded data.

6.1.5 **Additional End-of-Test Criterion.** With approval from the Executive Officer, if the SOC Net Energy Change Tolerance is not satisfied for the HFEDS cycle with emission sampling in section G.6.1.4.2, a Highway Emission Test may be considered valid if:

6.1.5.1 The alternative End-of-Test criterion of ±5% SOC Net Energy Change Tolerance in Appendix C of SAE J1711 is satisfied (Note: Appendix C of SAE J1711 may not be used to correct measured values for any emissions.); or

6.1.5.2 The SOC at the end of the HFEDS cycle with emission sampling is higher than the SOC at the beginning of the same HFEDS cycle with emission sampling.

~~(i) **Vehicle preconditioning.** The vehicle shall be preconditioned pursuant to section G.6.1.~~

~~(ii) **Dynamometer run.** At the end of the cold soak period, the vehicle shall be placed or pushed onto a dynamometer. A cold start HFEDS followed by three emission measurement HFEDSs, separated by a 15 second key-on hot soak period, shall be performed. The vehicle must meet the SOC criterion in section G.10 for the third emission measurement HFEDS. As an option, the manufacturer may perform two emission measurement HFEDSs in lieu of three emission measurement HFEDSs, if the SOC criterion is satisfied for the second HFEDS. If the SOC criterion is not satisfied, the test shall be stopped, and the procedure shall be repeated starting at section G.6.3.3.~~

~~6.3.4 **Equivalent All-Electric Range** shall be calculated in accordance with section G.11 of these test procedures.~~

7. SFTP Emission Test Provisions for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

To be conducted pursuant to 40 CFR §1066.801, except as noted.

Alternative procedures may be used if approved in advance by the Executive Officer of the Air Resources Board.

For the purpose of determining US06 all electric range capability as required in section C.3.3(a)(1), a vehicle shall be range tested in default mode or in normal mode if the vehicle does not have a default mode in accordance with section G.7.3.

For the purpose of demonstrating compliance with exhaust emission standards, a vehicle must be emission tested in the vehicle operation (i.e., either charge-sustaining or charge-increasing operation) that represents the worst case SFTP NMOG + NOx emissions.

Vehicles with one or more ~~than one~~ driver-selectable modes ~~of operation of the auxiliary power unit~~ (e.g., normal mode, economy mode, performance mode, battery charging mode, ~~etc.~~or any other operating mode available to the driver) for a given ~~charge depleting, or~~ charge-sustaining or charge-increasing ~~test cycle~~ operation (if available) must be emission tested in the one driver-selectable mode~~(s)~~ and vehicle operation (i.e., charge-sustaining, charge-increasing) which represents the worst case SFTP NMOG + NOx emissions ~~of the auxiliary power unit~~. For example, if a vehicle has two driver-selectable modes that can be tested in charge-sustaining and charge-increasing operations, the manufacturer shall determine worst case SFTP NMOG + NOx emissions by comparing the following (1) mode 1 charge-sustaining emissions, (2) mode 2 charge-sustaining emissions, (3) mode 1 charge-increasing emissions, and (4) mode 2 charge-increasing emissions based on the US06 Emission Test and SC03 Emission Test.

In lieu of demonstrating the worst case SFTP NMOG + NOx emissions by certification testing in every SFTP charge-sustaining driver-selectable mode and every SFTP charge-increasing (if available) driver-selectable mode, a manufacturer may determine the worst case operating mode by using non-certification emission data and/or an engineering evaluation. The manufacturer must report the data and/or engineering evaluation used to determine the worst case operating mode. The manufacturer must demonstrate compliance with all applicable emission standards using test data for the worst case operating mode.

Confirmatory testing and/or in-use compliance testing may ~~also~~ be performed in any driver-selectable mode ~~of operation~~ in charge-sustaining or charge-increasing operation to ensure compliance with emission standards.

~~7.1 US06 Vehicle Preconditioning.~~

~~To be conducted pursuant to 40 CFR §86.132-00 [October 22, 1996] with the following revisions. This section G.1 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed.~~

~~7.1.1 Subparagraphs (a) through (m). [No change.]~~

~~7.1.2 Amend subparagraph (n) *Aggressive Driving Test (US06) Preconditioning*. as follows:~~

~~7.1.2.1 Amend subparagraph (1) as follows: If the US06 test follows the exhaust emission urban, highway, 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. For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer, and the auxiliary power unit shall be manually activated at the beginning of and operated throughout the US06 preconditioning cycle.~~

~~7.1.2.1.1 Subparagraphs (i) through (iv). [No change.]~~

~~7.1.2.2 Subparagraph (2). [No change.]~~

~~7.1.3 Subparagraph (o). [No change.]~~

7.~~2~~1 US06 Emission Test.

To be conducted pursuant to 40 CFR §1066.831 ~~§86.159-08 [December 27, 2006]~~ with the following revisions~~.~~: ~~This section 7.2 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed~~.

7.1.1 Subparagraphs (a) through (b)(1). [No change.]

7.1.2 Amend subparagraph (b)(1)(i): For aggressive-driving tests that do not follow any urban emission test or the Highway Emission Test.

7.1.3 Amend subparagraph (b)(1)(ii): For a test element that starts more than 72 hours after any most recent urban emission test or the Highway Emission Test (with or without evaporative emission measurements).

7.1.4 Amend subparagraph (b)(1)(iii): For testing in which the test vehicle has not remained in an area where ambient temperatures were within the range specified for testing since any previous urban emission test or the Highway Emission Test.

7.1.5 Subparagraphs (b)(2) through (b)(3)(i). [No change.]

7.1.6 Amend subparagraph(b)(3)(ii): Operate the vehicle one time over one of the driving schedules specified in this paragraph (b)(3)(ii). A particular preconditioning driving schedule that is related to fuel effects on adaptive memory systems may be requested. The vehicle shall be in charge-sustaining operation for this preconditioning drive. If driver-selectable modes are available, do not activate the driver-selectable mode to be tested for the preconditioning drive, but set the vehicle in default mode or normal mode for the preconditioning drive with the vehicle in charge-sustaining operation. If, however, the vehicle is to be tested in charge-

increasing operation (this does not apply to a driver-selectable charge-increasing mode), then the initial SOC shall be set at the lowest normal SOC level allowed by the vehicle when driving on the UDDS cycle. Sampling equipment may be exercised, but emissions may not be determined during preconditioning. Choose from the following driving schedules:

7.1.7 Subparagraphs (b)(3)(ii)(A) through (b)(3)(ii)(B). [No change.]

7.1.8 Amend subparagraph (b)(3)(ii)(C): The HFEDS cycle.

7.1.9 Subparagraphs (b)(3)(ii)(D) through (e). [No change.]

7.1.10 Amend subparagraph (e)(1): Following the preconditioning specified in paragraph (b) of this section, place the vehicle in gear and simultaneously start sampling and recording. If a driver-selectable mode is to be tested following the preconditioning, activate the driver-selectable mode, place the vehicle in gear, and simultaneously start sampling and recording. Begin the first acceleration 5 seconds after placing the vehicle in gear.

7.1.11 Subparagraphs (e)(2) through (e)(2)(iii). [No change.]

7.1.12 Amend subparagraph (e)(3): Turn the vehicle off 2 seconds after the end of the last deceleration. Five seconds after the vehicle stops running, stop all sampling and recording, including background sampling. Stop any integrating devices and indicate the end of the test cycle in the recorded data. Note that the 5 second delay is intended to account for sampling system transport. End-of-Test Criterion: A valid test shall satisfy the SOC Net Energy Change Tolerances in section G.10 for the US06 cycle with emission sampling. For PHEVs that use a battery as an energy storage device, ($\text{Amp-hr}_{initial}$) is the stored charge at the beginning of the US06 cycle with emission sampling, and (Amp-hr_{final}) is the stored battery charge at the end of the same US06 cycle with emission sampling. The final stored battery charge, (Amp-hr_{final}), shall not exceed either $(\text{Amp-hr}_{final})_{max}$ or $(\text{Amp-hr}_{final})_{min}$ for a valid test. For PHEVs that use a capacitor as an energy storage device, ($V^2_{initial}$) is the square of the capacitor voltage stored at the beginning of the US06 cycle with emission sampling, and (V_{final}) is the stored capacitor voltage at the end of the same US06 cycle with emission sampling. The final stored capacitor voltage, (V_{final}), shall not exceed either $(V_{final})_{max}$ or $(V_{final})_{min}$ for a valid test. For PHEVs that use an electro-mechanical flywheel as an energy storage device, ($rpm^2_{initial}$) is the squared flywheel rotational speed at the beginning of the US06 cycle with emission sampling, and (rpm_{final}) is the flywheel rotational speed at the end of the same US06 cycle with emission sampling. The final flywheel rotational speed, (rpm_{final}), shall not exceed either $(rpm_{final})_{max}$ or $(rpm_{final})_{min}$ for a valid test.

7.1.13 Subparagraph (e)(4). [No change.]

7.1.14 **Additional End-of-Test Criterion.** With approval from the Executive

Officer, if the SOC Net Energy Change Tolerance is not satisfied for the US06 cycle with emission sampling in section G.7.1.12, a US06 Emission Test may be considered valid if:

7.1.14.1 The alternative End-of-Test criterion of ±5% SOC Net Energy Change Tolerance in Appendix C of SAE J1711 is satisfied (Note: Appendix C of SAE J1711 may not be used to correct measured values for any emissions.); or

7.1.14.2 The SOC at the end of the US06 cycle with emission sampling is higher than the SOC at the beginning of the same US06 cycle with emission sampling.

~~7.2.1 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 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 vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO_2, CH_4 and NO_x. For vehicles with 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. The US06 cycle after the preconditioning cycle shall be used to calculate emissions and shall meet the state-of-charge net tolerances as calculated in section G.10.~~

~~7.2.2 Amend subparagraph (b) as follows.~~

~~7.2.2.1 Amend subparagraph (b)(2): Position the test vehicle on the dynamometer and restrain.~~

~~7.2.3 Subparagraph (c). [No change.]~~

~~7.2.4 Amend subparagraph (d): Practice runs over the prescribed driving schedule may be performed at test point to permit sampling system adjustment.~~

~~7.2.5 Subparagraph (e). [No change.]~~

~~7.2.6 Amend subparagraph (f) as follows.~~

~~7.2.6.1 Amend subparagraph (f)(2)(i): Immediately after completion of the 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 vehicles that do not allow the auxiliary power unit to be manually activated, the vehicle shall remain on during the idle period.~~

~~(ii) For 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.~~

~~7.2.6.2 Amend subparagraph (f)(2)(ix): At the completion of the test US06 cycle, determine if the SOC criterion in section G.10 is satisfied. If the SOC criterion is not satisfied, then repeat the dynamometer test run from subparagraph (f)(2)(i), without the preconditioning cycle. Up to three US06 emission tests shall be allowed to satisfy the SOC criterion. The idle period between multiple test cycles shall not to be less than one minute and not greater than two minutes. For the final test cycle, turn off the vehicle two seconds after the end of the last deceleration. During the idle period between multiple test cycles, one of the following conditions shall apply:~~

~~(i) For vehicles that do not allow the auxiliary power unit to be manually activated, the vehicle shall remain on during the idle period.~~

~~(ii) For 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.~~

~~7.3 SC03 Vehicle Preconditioning.~~

~~To be conducted pursuant to 40 CFR §86.132-00 [October 22, 1996] with the following revisions. This section 7.3 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed.~~

~~7.3.1 Subparagraphs (a) through (n). [No change.]~~

~~7.3.2 Amend subparagraph (o): *Air Conditioning Test (SC03) Preconditioning*.~~

~~7.3.2.1 Amend subparagraph (1) as follows: If the SC03 test follows the exhaust emission urban, highway, 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. For vehicles that allow manual activation of the auxiliary power unit, battery state-of-charge shall be set at the lowest level allowed by the manufacturer, and the auxiliary power unit shall be manually~~

~~activated at the beginning of and operated throughout the SC03 preconditioning cycle.~~

~~7.3.2.1.1 Subparagraphs (i) and (ii). [No change.]~~

~~7.3.2.2 Subparagraphs (2) through (3). [No change.]~~

~~7.4~~7.2 SC03 Emission Test.

To be conducted pursuant to 40 CFR §1066.835 ~~§86.160-00 [December 8, 2005]~~ with the following revisions:~~. This section 7.4 shall apply during charge sustaining operation or at an optional charge sustaining test mode that has been activated, if no subsequent charge has been performed~~. ~~References to §86.162-03 shall mean §86.162-03 as adopted October 22, 1996.~~

7.2.1 Subparagraphs (a) through (c)(4). [No change.]

7.2.2 Amend subparagraph (c)(5): Perform a preconditioning drive by operating the test vehicle in charge-sustaining operation over the first 505 seconds of the UDDS cycle (phase 1), the last 867 seconds of the UDDS cycle (phase 2), or the SC03 driving schedule. If driver-selectable modes are available, do not activate the driver-selectable mode to be tested for the preconditioning drive, but set the vehicle in default mode or normal mode for the preconditioning drive with the vehicle in charge-sustaining operation. If, however, the vehicle is to be tested in charge-increasing operation (this does not apply to a driver-selectable charge-increasing mode), then the initial SOC shall be set at the lowest normal SOC level allowed by the vehicle when driving on the UDDS cycle. If the air conditioning test sequence starts more than 2 hours after a different exhaust emission test, the vehicle may be driven over one full UDDS cycle for the preconditioning drive instead of over one of the cycles listed previously in this section (c)(5).

7.2.3 Subparagraphs (c)(6) through (d). [No change.]

7.2.4 Amend subparagraph (d)(1): Place the vehicle in gear 15 seconds after starting vehicle, which is 3 seconds before the first acceleration. If a driver-selectable mode is to be tested, start the vehicle, activate the driver-selectable mode, and place the vehicle in gear 15 seconds after starting vehicle. Follow the SC03 driving schedule.

7.2.5 Amend subparagraph (d)(2): Turn the vehicle off 2 seconds after the end of the last deceleration. Five seconds after the vehicle stops running, stop all sampling and recording, including background sampling. Stop any integrating devices and indicate the end of the test cycle in the recorded data. Note that the 5 second delay is intended to account for sampling system transport. End-of-Test Criterion: A valid test shall satisfy the SOC Net Energy Change Tolerances in section G.10 for the SC03 cycle with emission sampling. For PHEVs that use a

battery as an energy storage device, (Amp-$hr_{initial}$) is the stored charge at the beginning of the SC03 cycle with emission sampling, and (Amp-hr_{final}) is the stored battery charge at the end of the same SC03 cycle with emission sampling. The final stored battery charge, (Amp-hr_{final}), shall not exceed either (Amp-$hr_{final})_{max}$ or (Amp-$hr_{final})_{min}$ for a valid test. For PHEVs that use a capacitor as an energy storage device, ($V^2_{initial}$) is the square of the capacitor voltage stored at the beginning of the SC03 cycle with emission sampling, and (V_{final}) is the stored capacitor voltage at the end of the same SC03 cycle with emission sampling. The final stored capacitor voltage, (V_{final}), shall not exceed either $(V_{final})_{max}$ or $(V_{final})_{min}$ for a valid test. For PHEVs that use an electro-mechanical flywheel as an energy storage device, ($rpm^2_{initial}$) is the squared flywheel rotational speed at the beginning of the SC03 cycle with emission sampling, and (rpm_{final}) is the flywheel rotational speed at the end of the same SC03 cycle with emission sampling. The final flywheel rotational speed, (rpm_{final}), shall not exceed either $(rpm_{final})_{max}$ or $(rpm_{final})_{min}$ for a valid test.

7.2.6 Subparagraphs (d)(3) through (f)(3)(iv). [No change.]

7.2.7 **Additional End-of-Test Criterion.** With approval from the Executive Officer, if the SOC Net Energy Change Tolerance is not satisfied for the SC03 cycle with emission sampling in section G.7.2.5, an SC03 Emission Test may be considered valid if:

7.2.7.1 The alternative End-of-Test criterion of ±5% SOC Net Energy Change Tolerance in Appendix C of SAE J1711 is satisfied (Note: Appendix C of SAE J1711 may not be used to correct measured values for any emissions.); or

7.2.7.2 The SOC at the end of the SC03 cycle with emission sampling is higher than the SOC at the beginning of the same SC03 cycle with emission sampling.

~~7.4.1 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 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 simulate testing in an environmental test cell (see §86.162-03 (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 vehicles with Otto-cycle auxiliary power units, the composite samples collected in bags are analyzed for THC, CO, CO_2, CH_4 and NO_x. For vehicles with 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. The SC03 cycle after the preconditioning cycle shall be used to calculate emissions and shall meet the state-of-charge net tolerances as calculated in section G.10.~~

~~7.4.2 Amend subparagraph (b) as follows.~~

~~7.4.2.1 Amend subparagraph (b)(2): Position the test vehicle on the dynamometer and restrain.~~

~~7.4.3 Amend subparagraph (c) as follows.~~

~~7.4.3.1 Amend subparagraph (c)(9): Start vehicle (with air conditioning system also running). If the auxiliary power unit of the 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.~~

7.4.4 ~~Amend subparagraph (d) as follows.~~

~~7.4.4.1 Amend subparagraph (d)(10): At the conclusion of the SC03 emission test, one of the following conditions shall apply:~~

~~(i) For vehicles that do not allow the auxiliary power unit to be manually activated and are charge-sustaining over the SC03 test, record the battery state-of-charge to determine if the SOC criterion in section G.10 is satisfied. If the SOC criterion is not satisfied, then turn off the engine and the cooling fan(s), allow the vehicle to soak in the ambient conditions of paragraph (c)(5) of this section for 10 ± 1 minutes, and repeat the dynamometer test run from subparagraph (d). Up to three SC03 emission tests shall be attempted to satisfy the SOC criterion.~~

~~(ii) For vehicles that allow the auxiliary power unit to be manually activated, turn off the vehicle two seconds after the end of the last deceleration.~~

~~7.4.5 Subparagraph (e). [No change.]~~

7.~~5~~3 Optional Cold Start US06 All-Electric Range Test.

7.~~5~~3.1 **Cold soak and vehicle charging.** 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 battery shall be charged to a full state-of-charge. The vehicle must be turned off during charging. Charge time shall not exceed soak time.

7.~~5~~3.2 At the end of the cold soak period with the vehicle in default mode or in normal mode if the vehicle does not have a default mode, ~~the vehicle shall be~~ place~~d~~ or push~~ed~~ the vehicle onto a dynamometer, and ~~shall be driven on~~ drive the vehicle on a continuous US06 test cycle until either:

(a) the auxiliary power unit starts, or

(b) the vehicle can no longer meet the speed trace limits of the US06 driving schedule as specified in CFR 86 Appendix I to within 2 mph higher than the highest point on the trace within 1 second for the upper limit or within 2 mph lower than the lowest point on the trace within 1 second for the lower limit.

When either of these conditions is met, the test shall be ended. The range for this test, in miles, shall be the distant driven from the start of the test to when condition (a) or (b) is met. Emission sampling is not required for this test.

8. 50°F and 20°F Test Provision for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

50°F testing shall be conducted pursuant to section G.5 with the modifications in Part II, Section ~~C~~D of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures ~~for 2001~~ and 2017 and Subsequent Model ~~Year~~ Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" and the additional following revisions.

20°F testing shall be conducted pursuant to section G.5 with the modifications in Part II Section B or Part II Section C, as applicable, of the "California 2015 and Subsequent Model Criteria Pollutant Exhaust Emission Standards and Test Procedures and 2017 and Subsequent Model Greenhouse Gas Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles" and the additional following revisions. ~~and shall include the temperature provisions in 40 CFR Part 86 Subpart C - Emission Regulations for 1994 and Later Model Year Gasoline-Fueled New Light-Duty Vehicles, New Light-Duty Trucks and New Medium-Duty Passenger Vehicles; Cold Temperature Test Procedures.~~

For 50°F and 20°F charge depleting testing, vehicle charging, prior to emissions testing, shall be performed during the soak period at 50°F and 20°F, respectively.

8.1 To satisfy test requirements for the 50°F emission test, ~~the~~ a vehicle shall be emission tested in the vehicle operation and driver-selectable mode (if available) that represents the worst case urban ~~(~~NMOG + NOx~~)~~ emissions ~~of the urban charge depleting range test or urban charge sustaining emission test~~ as ~~defined~~determined in section G.5. To satisfy test requirements for the 20°F emission test, ~~the~~ a vehicle shall be emission tested in the vehicle operation and driver-selectable mode (if available) that represents the worst case ~~(~~CO~~)~~ emissions of the urban charge-depleting ~~range~~ emission test or urban charge-sustaining emission test ~~as defined~~ following the procedure outlined in section G.5. For the 20°F and 50°F emission tests, ~~the~~ a vehicle is not required to meet SOC net energy change tolerances. If a vehicle qualifies for the Urban Alternative Charge-Depleting Emission Test, the 50°F and 20°F emission test shall be performed using the Alternative Charge-Depleting Emission Test in lieu of the urban charge-depleting emission test or urban charge-sustaining emission test.

8.2 If the worst case for emissions is charge sustaining operation, the vehicle shall be preconditioned, and one of the following two emission test options must be performed.

(i) A three phase test that includes phase one as the first 505 seconds of the UDDS cycle, phase two as 506 seconds to the end of the UDDS cycle, a 10 minute key-off soak period, and phase three the first 505 seconds of the UDDS cycle. The first two phases test shall be counted as the first UDDS cycle and the second and third phases will constitute the second UDDS cycle. Emission weighting is as follows:

* * * *

(ii) A two phase test that includes phase one as a UDDS cycle, a 10 minute key-off soak period, and phase two as a UDDS cycle. Emission weighting for the four phase test will follow the procedure outlined in section G.5.5~~.1~~.

8.3 If measurement of worst case emissions requires the urban charge depleting ~~range~~ emission test to be performed, the vehicle shall be preconditioned and fully charged. The continuous urban test schedule shall then be performed. The UDDS cycle, in which the auxiliary power unit first starts, shall be the cold UDDS cycle. Emissions shall be sampled according to one of the options in section G.8.2. For the three phase test option, if the auxiliary power unit starts in phase two of the UDDS cycle, phase one emissions are considered zero for emission calculation purposes. Emissions are weighted according to section G.8.2.

9. Additional Provisions.

9.1 Confirmatory testing may be performed on all tests to establish if higher emissions occur at different states-of-charge in charge depleting mode. This is to ensure that cold start and other emissions standards are not exceeded at other

operating SOCs.

~~9.2 Confirmatory testing may be performed on the US06 test or the manufacturer may provide data to show that potential cold start off-cycle emissions are controlled to the extent that they are controlled for the UDDS.~~

~~9.3 Confirmatory testing may be performed on vehicles equipped with an optional charge sustaining operation mode selector with selector set to simulate charge sustaining operation or in actual charge sustaining operation in accordance with section F of these test procedures.~~

9.4~~2~~ For an example of an off-vehicle charge capable hybrid electric vehicle with all-electric range and blended operation that has charge depleting actual range and charge depleting cycle range, please see section I, Figure 1.

9.~~5~~3 For an example of charge depleting to charge sustaining range with and without transitional range and end of test conditions, please see section I, Figure 2.

9.~~6~~4 When determining the SOC Net Energy Change tolerance during testing, the current drive cycle may be aborted if the SOC Net Energy Change tolerance is met for previous drive cycle.

9.~~7~~5 If the manufacturer determines there is insufficient fuel to run the subsequent test, the manufacturer may perform a fuel drain and fill or add fuel pursuant to the provisions of the "California Evaporative Emission Standards and Test Procedures for 2001 and Subsequent Model Motor Vehicles."

10. State-of-Charge Net Energy Change Tolerances for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

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

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

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

Where:

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

$(\text{Amp-hr}_{\text{final}})_{\text{min}}$ = 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}	=	Open circuit voltage (OCV) that corresponds to the SOC of the target SOC during charge-sustaining operation. This value shall be submitted for testing purposes, and it shall be subject to confirmation by the Air Resources Board.

~~An alternate state-of-charge net tolerance may be used if shown to be technically necessary and if approved in advance by the Executive Officer of the Air Resources Board.~~

10.2 For vehicles that use a capacitor as an energy storage device, the following state-of-charge net energy 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 maximum stored capacitor voltage allowed at the end of the test
$(V_{final})_{min}$	=	The minimum 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

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

* * * *

11. Calculations – Equivalent All-Electric Range for Off-Vehicle Charge Capable Hybrid Electric Vehicles.

11.1 Charge Depleting CO_2 Produced means the cumulative tailpipe CO_2 emissions produced, M_{cd}, in grams per mile during the charge depleting cycle range.

$$M_{cd} = \Sigma Y_i$$

where:

Y_i = The sum of the CO_2 grams per mile in the charge depleting mode from each test cycle (UDDS cycles or HFEDS cycles)

i = Number (UDDS cycles or HFEDS cycles) of the test over the charge depleting cycle range, R_{cdc}

11.2 Charge Sustaining CO_2 Produced - urban means the cumulative tailpipe CO_2 emissions produced, M_{cs}, in grams per mile, during the cold start charge sustaining urban test.

$$M_{cs} = Y_c + Y_h * \left[\frac{(R_{cdcu} - D_c)}{D_c} \right]$$

where:

R_{cdcu} = Urban Charge Depleting Cycle Range, in miles

D_c = The measured driving distance from the cold start UDDS cycle, in miles

Y_c = Grams per mile CO_2 emissions as calculated from the cold start UDDS cycle

Y_h = Grams per mile CO_2 emissions as calculated from the hot start UDDS cycle

11.3 Charge Sustaining CO_2 Produced - highway means the grams per mile tailpipe CO_2 emissions produced, M_{cs}, during the cold start charge sustaining highway test.

$$M_{cs} = \left(\frac{R_{cdch}}{D_h} \right) * Y_h$$

where:

R_{cdch} = Highway Charge Depleting Cycle Range, in miles

D_h = The measured driving distance from the hot start HFEDS cycle, in miles

Y_h = Grams per mile emissions as calculated from the hot start HFEDS cycle

* * * *

11.8 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 cycle prior to where the state-of-charge is above the lower bound state-of-charge tolerance for one test cycle given by:

* * * *

11.9 The Charge Depleting Actual Range, R_{cda}, shall be defined as the range at which the state-of-charge is first equal to the average state-of-charge of the one or two UDDS~~s~~ cycles used to end the Urban Charge Depleting Test. This range must be reported to the nearest 0.1 miles. For an illustration of R_{cda} see section I.

11.10 The Charge Depleting to Charge Sustaining Urban Range shall be defined as the distance driven in miles from the start of the Urban Charge Depleting Test through the UDDS cycle preceding the one or two UDDS~~s~~ cycles used to end the Urban Charge Depleting Test.

11.11 The Highway Charge Depleting Cycle Range, R_{cdch}, shall be defined as the sum of the distance traveled on the Highway Charge Depleting Range Test up to the HFEDS cycle prior to where the state-of-charge is above the lower bound state-of-charge tolerance for one test cycle given by:

* * * *

11.12 The Charge Depleting to Charge Sustaining Highway Range shall be defined as the distance driven in miles from the start of the Highway Charge Depleting Range Test through the HFEDS cycle preceding the final HFEDS cycle.

* * * *

12. The Calculations of the Combined Green ~~H~~house Gas Regulatory Rating of Off-vehicle Charge Capable Hybrid Electric Vehicles

* * * *

12.2 The urban GHG emissions value for off-vehicle charge capable hybrid electric vehicles is calculated using the following equations.

* * * *

12.2.5 The urban or highway charge depleting electricity use is defined by the following formula:

$$E_{cd.AC.i} = \frac{E_{cd.DC.i}}{\sum_{i=1}^{N} E_{cd.DC.i}} * E_{cd.AC.total} \qquad \text{(Eq. 4)}$$

Where,

N = Total number of test cycles in the charge depleting to charge sustaining range (R_{cdtcs}) of the urban or highway charge depleting range test.

$E_{cd.AC.i}$ = AC kWh consumed in the "i"th cycle of the charge depleting test.

$E_{cd.DC.i}$ = Depleted DC energy for the "i"th cycle in the charge depleting test. It is defined in section F.3.4 of these test procedures.

$E_{cd.AC.total}$ = Charge-depleting net AC energy consumption is determined according to section F.3.4 of these test procedures.

12.2.6 The $Y_{cs.urban}$, which is the weighted CO_2 mass emissions of the charge-sustaining test, is determined by the following equation, which can be found in section F.5.5 of these test procedures.

$$Y_{CS.Urban} = 0.43 * \frac{Y_C}{D_C} + 0.57 * \frac{Y_H}{D_H} \qquad \text{(Eq. 5)}$$

Where,

$Y_{CS.Urban}$ = Weighted mass emissions of CO_2 in grams/mi of the charge sustaining test.

Y_C = Mass emissions as calculated from the cold start UDDS cycle, in grams per cycle.

Y_H = Mass emissions as calculated from the hot start UDDS cycle, in grams per cycle.

D_C = The measured driving distance from the cold start UDDS cycle, in miles.

D_H = The measured driving distance from the hot start UDDS cycle, in miles.

* * * *

H. Off-Vehicle Charge Capable Hybrid Electric Vehicle Exhaust Emission Test Sequence.

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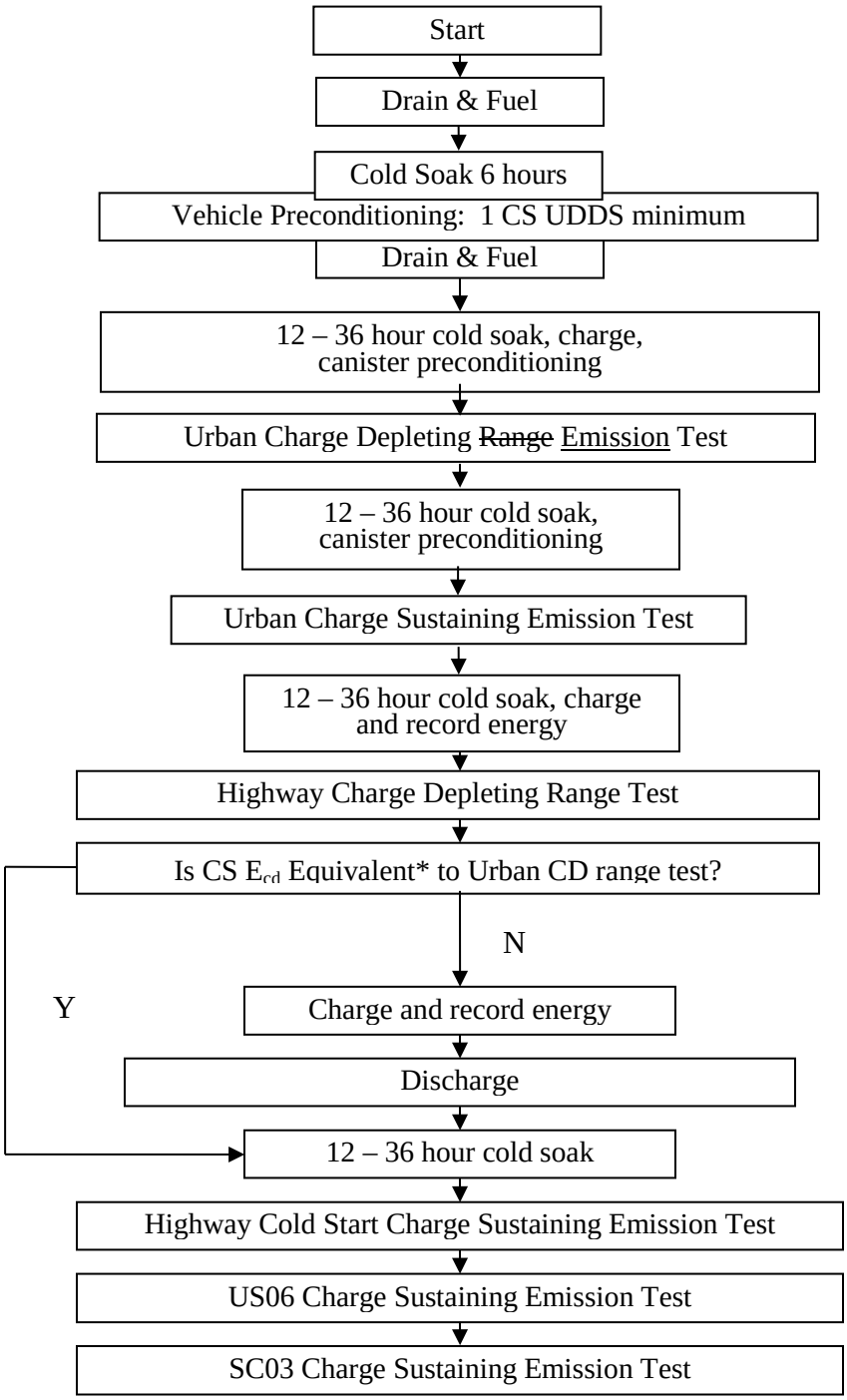
Off-Vehicle Charge Capable HEV Exhaust Emissions Test Sequence

* Equivalent to within ± 1% of AC energy used to charge battery to full state of charge



I. Examples of Off-Vehicle Charge Capable Hybrid Electric Vehicle Terminology.

The figures in this section I are for illustrative purposes only. If any discrepancies exist between the language in the proceeding sections A through H and the figures in this section I, the requirements in sections A through H shall apply. The acronym "NEC" as used in this section I means "Net Energy Change."

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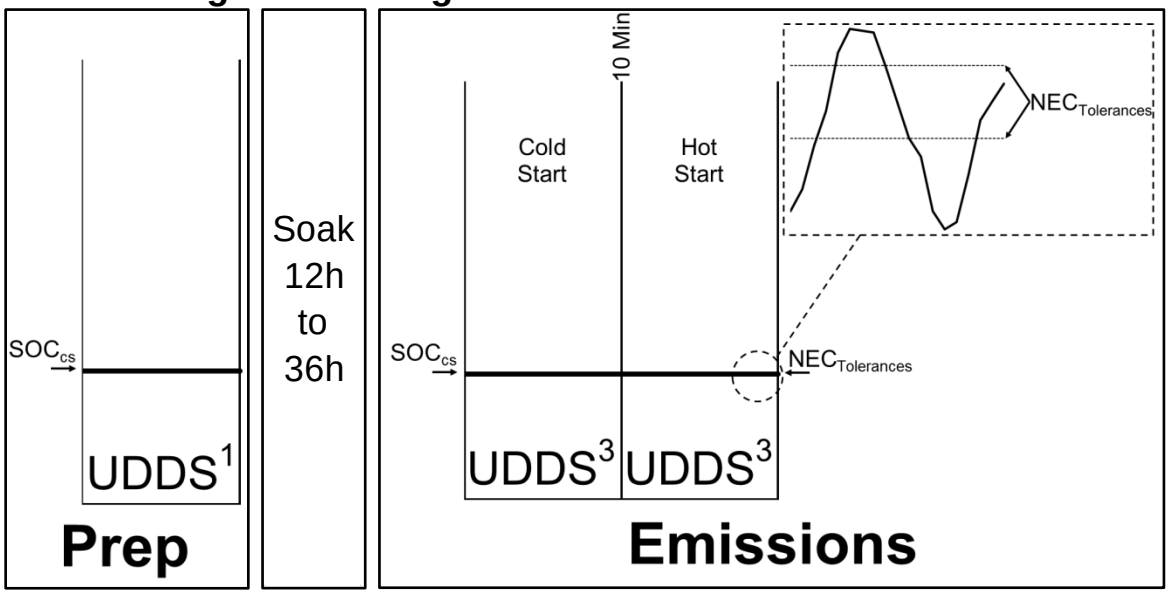
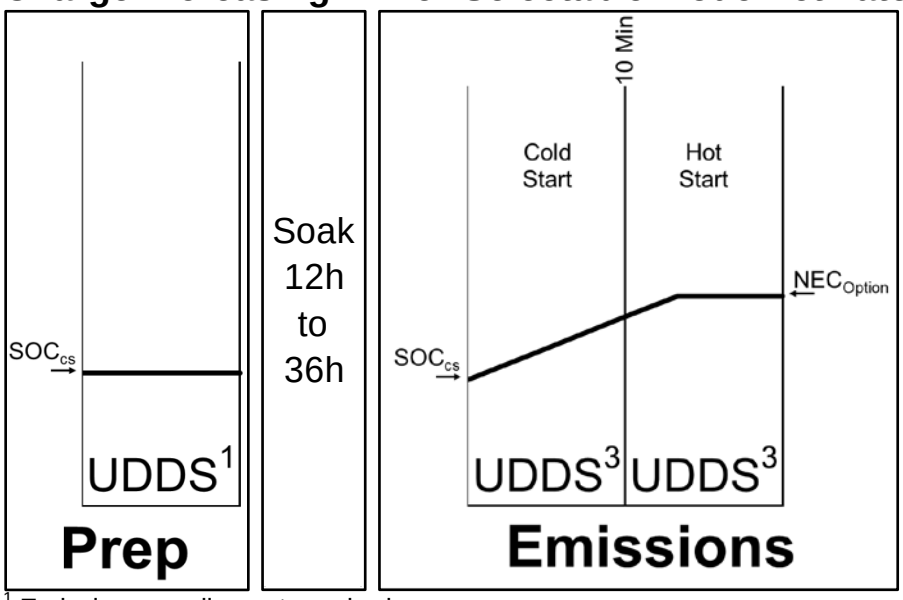
Note: The following Figures 3 – 9 are being added as part of this rulemaking. Since these are pictures, the addition of these figures cannot be shown in underline to indicate additions.

* * * *

Urban Charge-Sustaining Emission Test



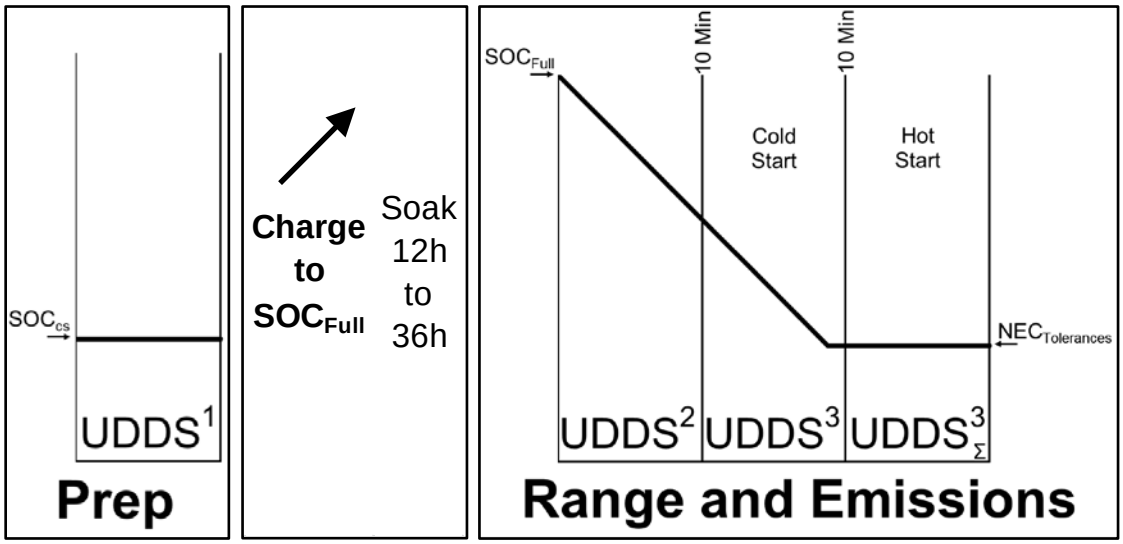
Urban Charge-Sustaining Emission Test with Charge-Increasing Driver-Selectable Mode Activated



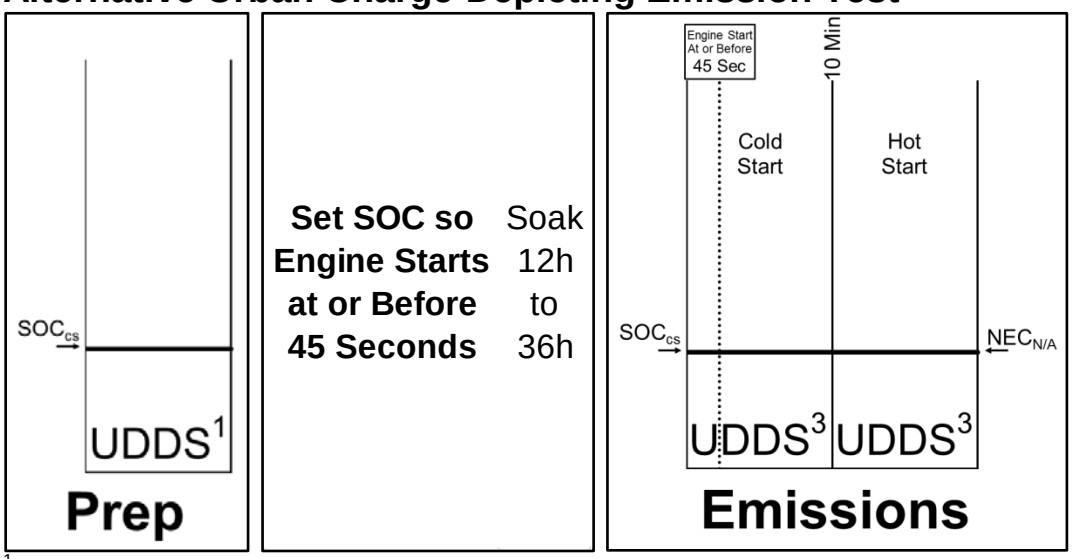
[1] Emission sampling not required
[2] Emission sampling optional
[3] Emission sampling required
SOC_{cs}: State-of-Charge at charge-sustaining level
$NEC_{Tolerances}$: Net Energy Change Tolerances required
NEC_{Option}: NEC Tolerances apply; however, option available to validate test when SOC final > SOC initial.

Figure 3

Urban Charge-Depleting Emission Test with Urban AER and EAER



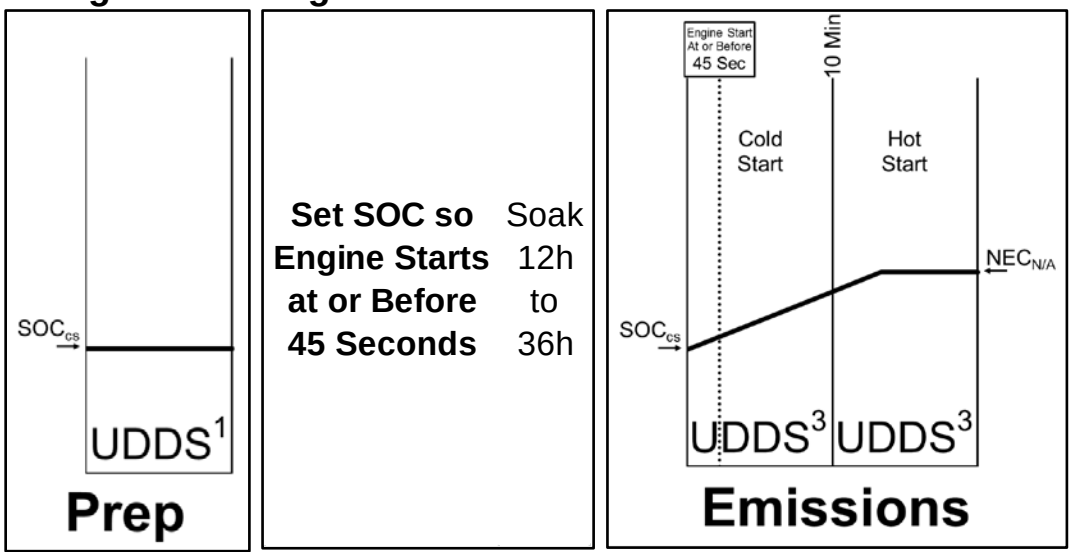
Alternative Urban Charge-Depleting Emission Test



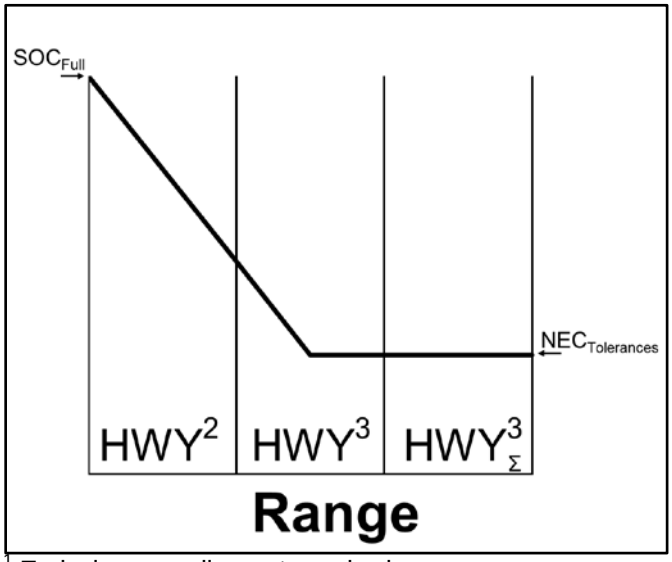
[1] Emission sampling not required
[2] Emission sampling optional
[3] Emission sampling required
UDDS$_\Sigma$: Multiple Hot Start UDDS cycles may be required to satisfy NEC Tolerances
SOC$_{cs}$: State-of-Charge at charge-sustaining level
SOC$_{Full}$: State-of-Charge at full charge
NEC$_{Tolerances}$: Net Energy Change Tolerances required
NEC$_{N/A}$: Net Energy Change Tolerances not applicable

Figure 4

Alternative Urban Emission Test with Charge-Increasing Driver-Selectable Mode Activated



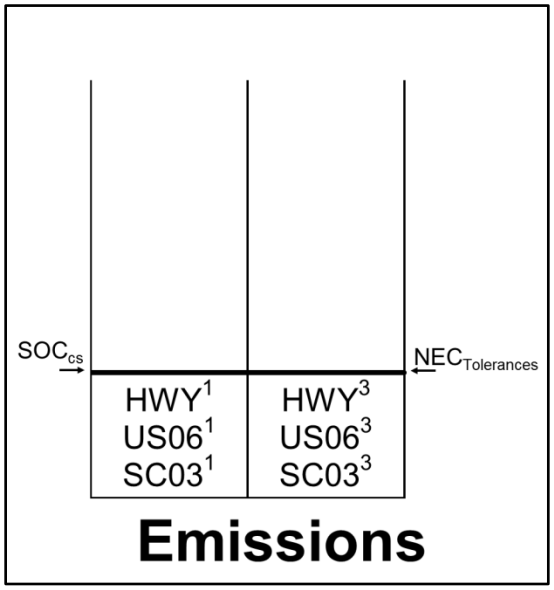
HWY AER and EAER Test



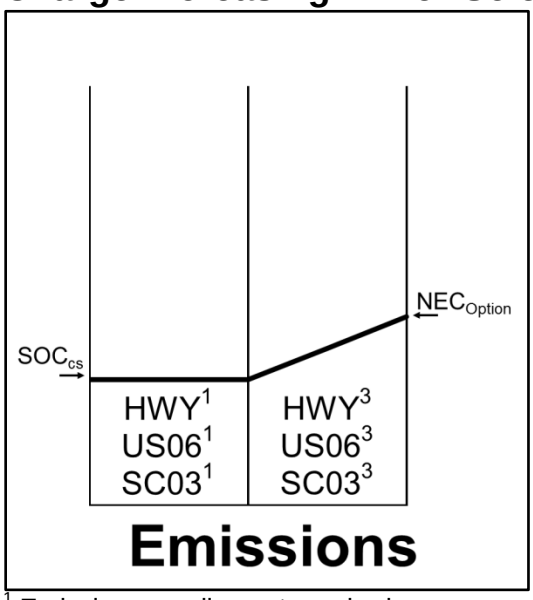
[1] Emission sampling not required
[2] Emission sampling optional
[3] Emission sampling required
HWY_{Σ}: Multiple HFEDS cycles may be required to satisfy NEC Tolerances
SOC_{cs}: State-of-Charge at charge-sustaining level
SOC_{Full}: State-of-Charge at full charge
$NEC_{Tolerances}$: Net Energy Change Tolerances required
$NEC_{N/A}$: Net Energy Change Tolerances not applicable

Figure 5

HWY and SFTP Emission Test



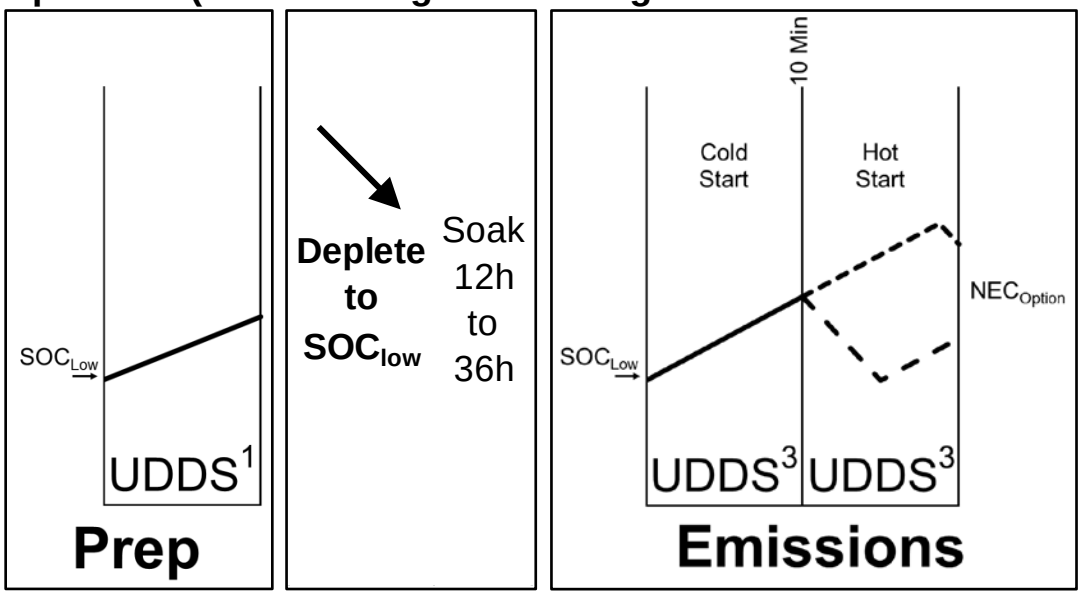
HWY and SFTP Emission Test with Charge-Increasing Driver-Selectable Mode Activated



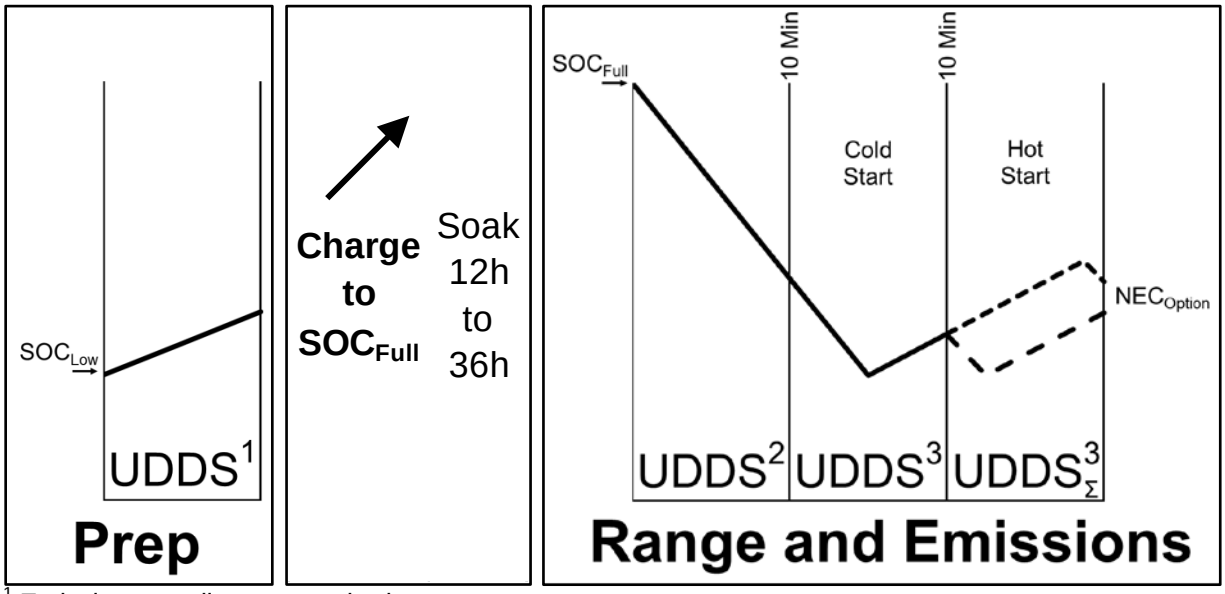
[1] Emission sampling not required
[2] Emission sampling optional
[3] Emission sampling required
SOC_{cs}: State-of-Charge at charge-sustaining level
$NEC_{Tolerances}$: Net Energy Change Tolerances required
NEC_{Option}: NEC Tolerances apply; however, option available to validate test when SOC final > SOC initial.

Figure 6

Urban Charge-Sustaining Emission Test with Charge-Increasing Operation (not for charge-increasing driver-selectable mode testing)



Urban Charge-Depleting Emission Test with Charge-Increasing Operation (not for charge-increasing driver-selectable mode testing) Includes AER and EAER.

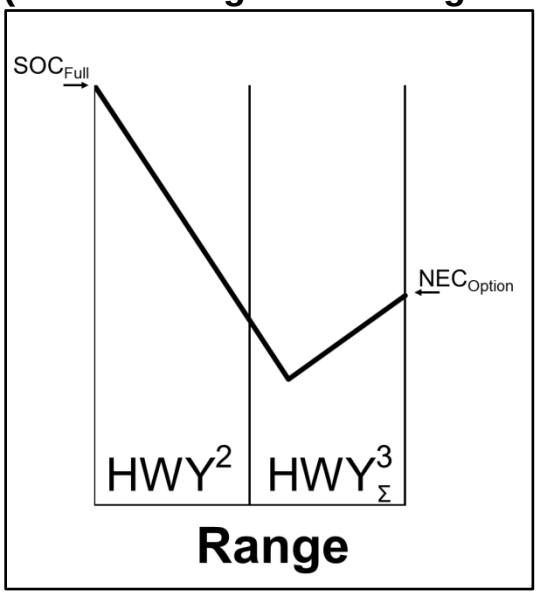


[1] Emission sampling not required
[2] Emission sampling optional
[3] Emission sampling required

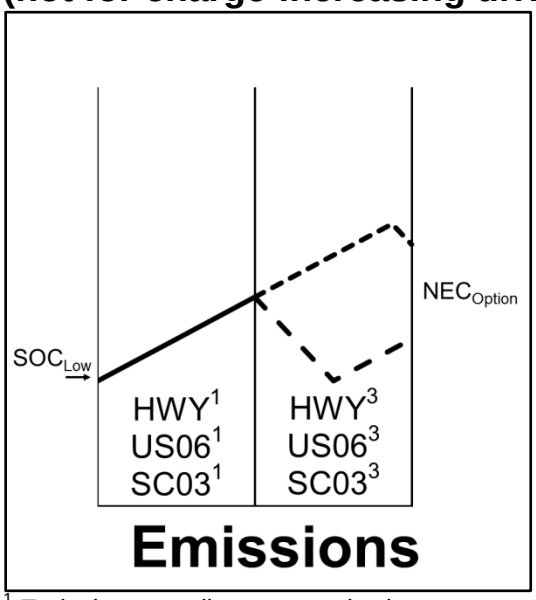
$UDDS_{\Sigma}$: Multiple Hot Start UDDS cycles may be required to satisfy NEC Tolerances
SOC_{Low}: Initial State-of-Charge set at lowest normal SOC allowed by vehicle when driving on UDDS
NEC_{Option}: NEC Tolerances apply; however, option available to validate test when SOC final > SOC initial.

Figure 7

HWY AER and EAER Test with Charge-Increasing Operation (not for charge-increasing driver-selectable mode testing)



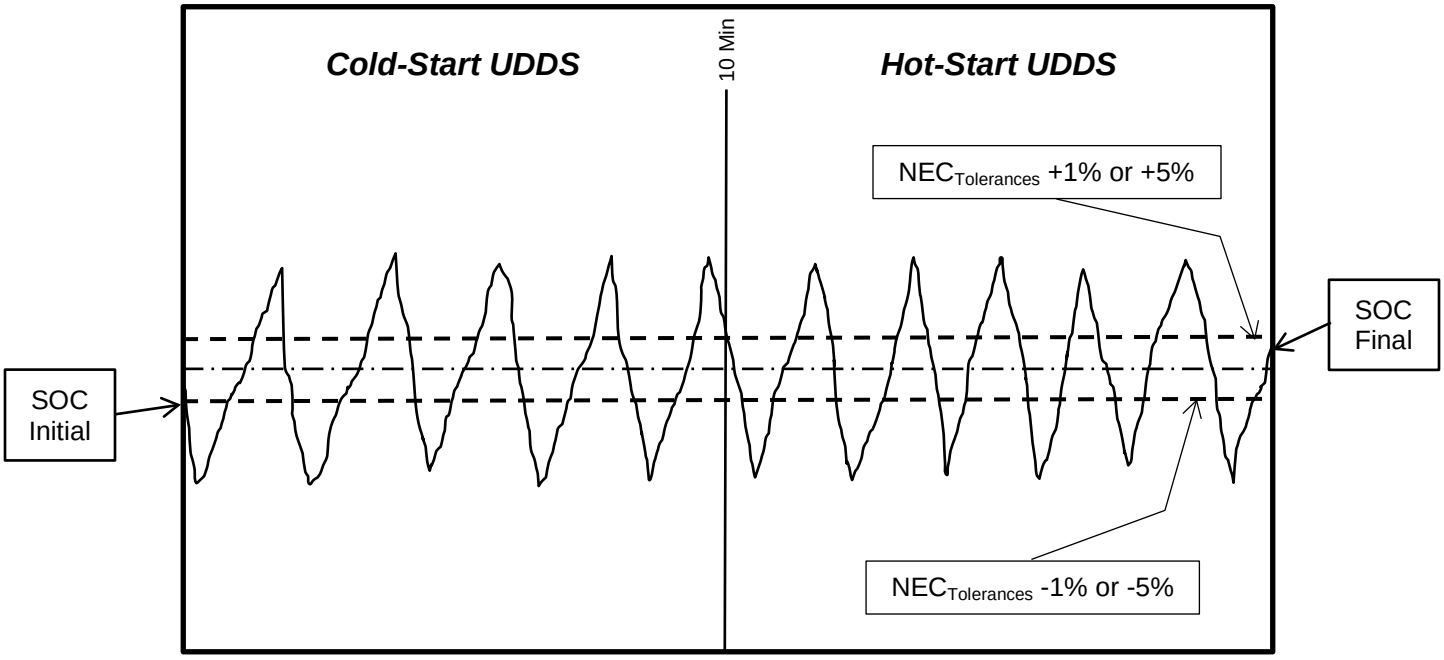
HWY and SFTP Emission Test with Charge-Increasing Operation (not for charge-increasing driver-selectable mode testing)



[1] Emission sampling not required
[2] Emission sampling optional
[3] Emission sampling required
HWY_{Σ}: Multiple HFEDS cycles may be required to satisfy NEC Tolerances
SOC_{Full}: State-of-Charge at full charge
SOC_{Low}: Initial State-of-Charge set at lowest normal SOC allowed by vehicle when driving on UDDS
NEC_{Option}: NEC Tolerances apply; however, option available to validate test when SOC final > SOC initial.

Figure 8

Urban Charge-Sustaining Emission Test – Valid Test



Highway and SFTP Emission Tests – Valid Test

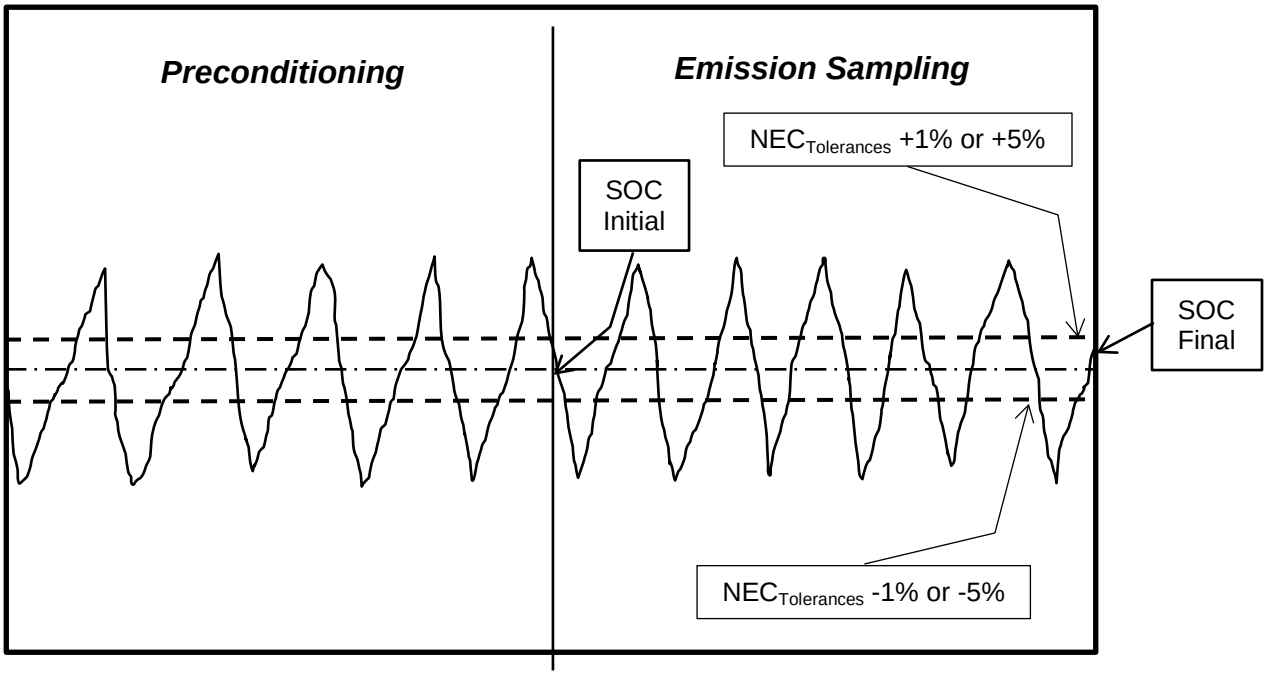


Figure 9

As Amended: September 2, 2015
Date of Hearing: October 23, 2014