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U.S. Department of Energy
FreedomCAR & Vehicle Technologies Program
Advanced Vehicle Testing Activity

Plug-in Hybrid Electric Vehicle (PHEV)

Integrated Test Plan and Evaluation Program

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INTRODUCTION

U.S. DEPARTMENT OF ENERGY INTEGRATED TEST AND EVALUATION PROGRAM FOR PLUG-IN HYBRID ELECTRIC VEHICLES

The U.S. Department of Energy (DOE) Advanced Vehicle Testing Activity (AVTA) performs closed track, dynamometer, and fleet testing of onroad light-duty vehicles that feature one or more advanced technology energy storage systems and/or propulsion systems. To date, the AVTA has tested and validated the performance and operations of various classes of pure electric, hybrid electric, and hydrogen-fueled internal combustion engine vehicles.

Continuing the trend of testing vehicles that introduce new technologies, the AVTA has initiated the testing of plug-in hybrid electric vehicles (PHEV). Results of this testing are provided to vehicle modelers and manufacturers to assess technical progress and resolve operational issues. The results are also widely distributed to government and private fleets using printed data sheets and via the Internet. The public data dissemination supports fleet managers with the introduction of emerging vehicle technologies into their fleets. All established testing procedures and completed vehicle testing results can be found at either of the AVTA's WebPages at http://avt.inl.gov or http://www1.eere.energy.gov/vehiclesandfuels/avta/.

This document contains PHEV specifications as well as test procedures designed specifically for the AVTA's evaluation of PHEVs. Test procedures for vehicle technologies other than PHEVs can be found on the AVTA WebPages.

For readers unfamiliar with the AVTA's testing history, a brief background by vehicle technology follows. These test activities have been and continue to be conducted for DOE's AVTA led by the Idaho National Laboratory (INL). AVTA testing is conducted by Electric Transportation Applications (ETA), with ETA also conducting all vehicle field and infrastructure testing, and Argonne National Laboratory (ANL) performing dynamometer testing. The DOE, INL, ETA, and ANL collaborate on the selection of vehicles and technologies for testing.

AVTA TESTING BACKGROUND

Pure Electric Vehicles: The AVTA has tested over fifty pure electric vehicle (EV) models, ranging in size from neighborhood EVs to full-size passenger sedan and van EVs. Battery systems tested include flooded lead-acid, valve regulated lead-acid, nickel cadmium, nickel metal hydride, and lithium polymer batteries. Test protocols include the conduct of baseline performance testing using closed test tracks and chassis dynamometers as well as accelerated testing using fleet and dedicated test drivers for onroad testing. Over five million miles of fleet testing has provided validation of EV performance and operating cost as well as identified strengths and weaknesses of specific vehicle designs.

Hybrid Electric Vehicles: The AVTA has tested twelve production hybrid electric vehicle (HEV) models offered by original equipment vehicle manufacturers. Test protocols include the conduct of baseline performance testing using closed test tracks and chassis dynamometers as well as accelerated testing using fleet drivers for onroad testing. To date, over 2.5 million miles has been accumulated to validate the performance and economics of HEVs.

Hydrogen-Fueled Internal Combustion Engine Vehicles: The AVTA has tested 100% hydrogen-fueled vehicles as well as vehicles fueled with blends of hydrogen and compressed natural gas. This testing has included delivery vans, passenger vans and pickup trucks using four- and eight-cylinder internal combustion engines. Testing has provided data on the correlation between performance, emissions and hydrogen content in blended fuel vehicles, as well as performance and emissions data for 100% hydrogen fueled engines. These vehicles are fueled at the Arizona Public Service Alternative Fuel (Hydrogen) Pilot Plant, which has been operating since June, 2002. Additionally, safety and user acceptance of hydrogen fuel has been validated.

PLUG-IN HYBRID ELECTRIC VEHICLE TESTING

With the emergence of PHEV propulsion and energy storage systems, DOE's AVTA has developed this Integrated Test Plan to govern the testing and evaluation of PHEVs. This plan includes Baseline Performance Testing, Accelerated Testing, and Fleet Testing.

Procedures governing PHEV testing have been drafted and reviewed with technical contributors. These procedures are presented herein for comment by a wide range of stakeholders. Procedures are divided into Administrative Control Procedures, Quality Assurance Procedures and Vehicle Test Procedures; including Baseline Performance, Accelerated, and Fleet Test Procedures. A PHEV Vehicle Specification, documenting detailed requirements for PHEVs, has also been developed and is included in this document.

Administrative Control Procedures

The AVTA Administrative Control Procedures control the conduct of testing and associated activities. These procedures define qualifications and training for personnel conducting tests, and requirements for the control of test documents as well as for the control of measuring and test equipment. There are also procedures for the control of testing, review of test results, and preparation of test reports.

Quality Assurance Procedures

The Quality Assurance Program for the AVTA establishes quality requirements governing the conduct of testing and the collection and dissemination of test data. The effectiveness of the Quality Assurance Plan is assured by conducting audits in accordance with Quality Assurance Audit procedures.

Baseline Performance Test Procedures

To govern the conduct of Baseline Performance Testing and to ensure that requirements of the PHEV Vehicle Specification are met, a set of highly repeatable test procedures have been developed in conjunction with vehicle manufacturers and industry stakeholders (such as fleet managers), with the objective of measuring real-world vehicle performance. Individual procedures are prepared to define the requirements for each test or series of related Baseline Performance Tests. A Test Sequence defines the order in which procedures are to be executed for Baseline Performance Testing. This testing is conducted on dynamometers and closed-track environments. PHEVs are evaluated using these Baseline Test Procedures in the following areas:

- Fuel consumption
- Acceleration
- Gradeability
- Road load coefficients (to support dynamometer testing)

- Vehicle durability
- Charger performance.

Testing is conducted in Normal Operation mode that is most appropriate for fleet operations. When all-electric operation is possible (Rechargeable Energy Storage System Only mode), testing is conducted beginning at 100% state-of-charge (SOC) and 50% SOC. Drive-cycle dynamometer testing includes the Urban Dynamometer Driving Schedule (UDDS), the Highway Fuel Economy Driving Schedule (HWFEDS), and the Supplemental Federal Test Procedure US06 (US06). Track testing is conducted at automotive proving grounds near Phoenix, Arizona. Dynamometer testing is conducted at Argonne National Laboratory's Advanced Powertrain Test Facility outside Chicago, Illinois. Test results are presented in test reports and summarized for wide dissemination in one-page data sheets.

Accelerated Test Procedures

Accelerated Testing rapidly provides performance and reliability data for PHEVs by using dedicated drivers to drive PHEVs on fixed routes in and around Phoenix, Arizona. This allows the accumulation of fuel economy data for trips of diverse lengths. The PHEV trips are organized as shown in the following table.

Cycle (mi)	Urban (10 mi)	Highway (10 mi)	Charge (Hr)	Repetitions (N)	Total (mi)	Repetitions (%)	Miles (%)	Cumulative (mi)
10	1	0	4	60	600	45%	14%	600
20	1	1	8	30	600	23%	14%	1200
40	4	0	12	5	200	4%	5%	1400
40	2	2	12	5	200	4%	5%	1600
40	0	4	12	5	200	4%	5%	1800
60	2	4	12	10	600	8%	14%	2400
80	2	6	12	8	640	6%	15%	3040
100	2	8	12	6	600	5%	14%	3640
200	2	18	12	3	600	2%	14%	4240
Total	1740	2500	984	132	4240			4240
Average	41%	59%	7.5	32.1				

At a minimum, fuel consumption, maintenance requirements and operating anomalies are recorded for all trips.

Fleet Test Procedures

During Fleet Testing, PHEVs are monitored as they operate in commercial and government vehicle fleets. Operating mission selection is carefully performed to maximize the benefits associated with the performance characteristics of PHEVs. The PHEVs are operated, by one or more fleet drivers, for two years and 24,000 miles. Data is collected for fuel use, maintenance costs and vehicle reliability. Selected PHEVs are equipped with an onboard data acquisition system designed specifically to collect supplemental operating data from vehicles during Fleet Testing.

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ACRONYM LIST

4WD	Four Wheel Drive
A/C	Air Conditioning
Ah	Ampere-hours
ANL	Argonne National Laboratory
ANS	American Nuclear Society
ASME	American Society of Mechanical Engineers
AVTA	Advanced Vehicle Testing Activity
BMS	Battery Management System
BOD	Bottom of Discharge
BS	Bachelor of Science
CARB	California Air Resources Board
CD	Compact Disc
CFCs	Chlorofluorocarbons
CFEC	Consumable Fuel Energy Converter
CFR	Code of Federal Regulations
CNG	Compressed Natural Gas
CT	Current Transformer
CVT	Continuous Variable Transmission
DAS	Data Acquisition System
DC	Direct Current
DOD	Depth of Discharge
DOE	Department of Energy
DOT	Department of Transportation
EMS	Energy Management System
EODV	End-of-Discharge Voltage
EPA	Environmental Protection Agency
ETA	Electric Transportation Applications
EV	Electric Vehicle
FCC	Federal Communications Commission
FMVSS	Federal Motor Vehicle Safety Standards
GAWR	Gross Vehicle Axle Weight Ratings

GVWR	Gross Vehicle Weight Rating
HEV	Hybrid Electric Vehicle
HPPC	Hybrid Pulse-Power Characterization
HWFEDS	Highway Fuel Economy Driving Schedule
INL	Idaho National Laboratory
ISO	International Standard Organization
LEL	Lower Explosive Limit
M&TE	Measuring and Test Equipment
mA	Milliamp
MIU	Measurement Indication Unit
MPH	Miles per Hour
MSDS	Material Safety Data Sheet
N/A	Not Applicable
NBS/HB	National Bureau of Standards Handbook
NEC	National Electrical Code
NFPA	National Fire Protection Association
NHTSA	National Highway Transportation Safety Administration
NIST	National Institute of Standards and Technology
OCV	Open-Circuit Voltage
OEM	Original Equipment Manufacturer
OJT	On-the-Job-Training
PHAC	Plug-in Hybrid Administrative Control
PHEV	Plug-in Hybrid Electric Vehicle
PHQA	Plug-in Hybrid Quality Assurance
PHQP	Plug-in Hybrid Quality Procedures
PHTP	Plug-in Hybrid Test Procedures
PT	Potential Transformer
QA	Quality Assurance
QAM	Quality Assurance Management
QAP	Quality Assurance Plan
RESS	Rechargeable Energy Storage System
S/N	Serial Number
SAE	Society of Automotive Engineers

SOC	State of Charge
TER	Test Exception Report
THD	Total Harmonic Distortion
TOCV	Top-of-Charge Voltage
TP	Test Procedure
TRRT	Test Results Review Team
UDDS	Urban Dynamometer Driving Schedule
UL	Underwriters Laboratory
VAC	Volts Alternating Current
VDC	Volts Direct Current
VIN	Vehicle Identification Number

Chapter I: PHEV Vehicle Specification

Section I: PHEV Vehicle Specification

PHEV VEHICLE SPECIFICATION

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APPENDICES

1 MINIMUM VEHICLE REQUIREMENTS

The Plug-In Hybrid Electric Vehicle (PHEV) Integrated Test and Evaluation Program is sponsored by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA) to provide for independent assessment of PHEVs. Vehicles tested under this program are evaluated against specific qualitative and quantitative metrics. The results provide potential users a method for comparing various PHEVs against consistent standards and against each other, comparisons that might not otherwise be possible.

For a PHEV to be considered qualified for testing by the AVTA, it must meet the minimum criteria defined by "shall" terminology utilized in this specification. [For clarity, the use of the word "shall" defines the minimum requirements, whereas the use of the word "should" defines design and performance objectives.] Vehicles that do not or cannot meet all of the "shall" requirements will be considered Prototypes, and will not be considered as having successfully completed the Program. The following requirements have been extracted from the body of the Plug-In Vehicle Specification for convenience and clarity. The term "Supplier" refers to the vehicle manufacturer or converter in these requirements and in the Plug-In Vehicle Specification. All of the following requirements must be met before any vehicle can successfully complete testing conducted by the AVTA.

Vehicles to be tested to these Specifications shall be PHEVs which are defined as road vehicles that can draw propulsion energy from both of the following sources of stored energy 1) a consumable fuel and 2) a rechargeable energy storage system (RESS) that is recharged by an electric motor-generator system, and an off-vehicle electric energy source. PHEVs tested to these Specifications shall not be tested for capability to return electrical energy off-vehicle.

(1) Vehicles shall comply with Federal Motor Vehicle Safety Standards applicable on the date of manufacture and such compliance shall be certified by the manufacturer in accordance with 49 CFR 567. Suppliers shall provide a completed copy of Appendix A and Appendix B with their proposal, providing vehicle specifications and the method of compliance with each required section of 49 CFR 571. If certification includes exemption, the exemption number issued by the National Highway Transportation Safety Administration (NHTSA), the date of it's publication in the Federal Register, and the page number(s) of the Federal Register acknowledging issuance of the exemption shall be provided along with Appendix B. Exemptions for any reason other than non-applicability shall not be allowed.

(2) Vehicles shall be certified under current California Air Resources Board (CARB) or Environmental Protection Agency (EPA) regulations.

(3) Suppliers shall supply Material Safety Data Sheets (MSDS) for all unique hazardous materials the vehicle is equipped with, including RESS batteries or capacitors, and auxiliary batteries.

(4) Suppliers shall provide recycling plans for batteries and other vehicle hazardous materials including how the plan has been implemented.

(5) All vehicles shall comply with the FCC requirements for unintentional emitted electromagnetic radiation, as identified in 47 CFR 15, Subpart B, "Unintentional Radiators."

(6) Vehicles shall have a minimum payload of at least 400 pounds.

(7) For conversion vehicles, OEM GVWR shall not be increased. For conversion vehicles, Suppliers shall specify the OEMs gross vehicle weight rating (GVWR).

(8) For conversion vehicles, OEM Gross Vehicle Axle Weight Ratings (GAWR) shall not be increased. Suppliers shall provide axle weights for the vehicle as delivered, and at full-rated payload.

(9) Tires shall be subject to the following requirements:

- Tires provided with the vehicle shall be the standard tire offered by the PHEV Supplier for the vehicle being proposed.
- Tires shall correspond to the requirements of the placard installed in accordance with 49 CFR 571.109, 110, 119 and 120, as applicable.
- Suppliers shall specify manufacturer, model and size of the standard tire.
- Tires sizes and inflation pressures shall be in accordance with the requirements of the placard.
- At no time shall the tire's inflation pressure exceed the maximum pressure imprinted upon that tire's sidewall.
- The tire shall be operable across the entire operation/load range of that vehicle.
- Replacement tires shall be commercially available to the end user in sufficient quantities to support the purchaser's needs.
- Tires provided as original equipment by the PHEV manufacturer shall not have warranty restrictions in excess of those of the tire's manufacturer, unless the Supplier is the sole warrantor for the tires.
- If the vehicle may be equipped with more than one standard tire, this information shall be provided for each type/manufacturer of each standard tire.

(10) Seating capacity shall be a minimum of 1 driver and 1 passenger. Suppliers shall specify seating capacity (available seat belt positions) for their vehicle. For conversion vehicles, if the vehicle's seating capacity is changed from that specified by the OEM on their FMVSS placard, the seat(s) being added or abandoned shall be modified as required by 49 CFR 571.207, et al, and a new FMVSS placard installed as required by 49 CFR 567, 568 or 571, as applicable.

(11) For conversion vehicles, the OEM passenger space shall not be intruded upon by the Rechargeable Energy Storage System (RESS), or other conversion materials.

(12) Vehicles shall have a parking mechanism.

(13) The controller/inverter shall limit the minimum RESS battery discharge voltage to prevent degradation of battery life, and should limit the maximum regeneration voltage to prevent external gassing of the batteries.

(14) Vehicles shall comply with the requirements of 49 CFR 571.105.S5.2.1, or alternatively, 49 CFR 571.105.S5.2.2 for parking mechanisms.

(15) Vehicles shall be capable of completing procedure AVTA-PHTP05, including (1) driving through standing water without damage and without battery to chassis leakage current exceeding 0.5 MIU per UL Standard 2202, and (2) standing for extended periods in extreme temperatures without damage to, or failure of, the vehicle or its systems.

Vehicles shall be capable of completing all AVTA tests without repairs exceeding a cumulative total of 72 hours.

(16) Suppliers should provide a detailed description of the RESS battery pack, battery pack voltage, number of battery modules and summary of previous performance tests. If different, customer available and battery available DOD ratings shall both be provided.

(17) Batteries shall comply with the requirements of SAE J1718.

Vehicles shall not auto-start the engine to charge the batteries while the vehicle is parked and the key switch is in the OFF position.

RESS batteries shall meet the requirements of NEC 625-29(c) or (d) for charging in enclosed spaces without a vent fan. The vehicle shall be labeled as not requiring ventilation for charging (or have the appropriate classification label from a UL-recognized Testing Laboratory).

(18) For vehicles with RESS system voltages of 48 volts and higher, batteries or capacitors and their enclosures shall be designed and constructed in a manner that complies with 49 CFR 571.305. For vehicles with RESS system voltages below 48VDC, batteries or capacitors, and their enclosures, shall be designed and constructed in accordance with the requirements of SAE J1766. Further, irrespective of RESS system voltage, batteries or capacitors, and electrolyte will not intrude into the passenger compartment during or following FMVSS frontal barrier, rear barrier and side impact collisions, and rollover requirements of 49 CFR 571.301. Suppliers shall provide verification of conformance to this requirement.

(19) Concentrations of explosive gases in the battery box shall not be allowed to exceed 25% of the Lower Explosive Limit. Suppliers shall describe how battery boxes will be vented, to allow any battery gases to escape safely to atmosphere during and following normal or abnormal charging and operation of the vehicle. Battery gases shall not be allowed to enter the occupant compartment.

(20) Batteries shall comply with the requirements of SAE J1718, and at a minimum shall meet the requirements of NEC 625-29(c) or (d) for charging in enclosed spaces without a vent fan.

(21) If a Supplier provides a vehicle with parallel battery packs, the Supplier shall provide detailed information on the equipment and charging algorithms required to prevent the parallel strings from becoming unbalanced.

(22) Vehicle suppliers shall provide the battery warranty provided including the procedures for making a warranty claim to the end user.

(23) If a Battery Management System (BMS) is provided, the Supplier shall provide a description of the BMS operation.

(24) For vehicles using fuels other than gasoline, manufacturers shall indicate compliance with appropriate and applicable standards from SAE, NFPA, etc. [e.g., for vehicles using Compressed Natural Gas as fuel, manufacturers should indicate compliance with NFPA 52, "Compressed Natural Gas (CNG) Vehicular Fuel Systems Code," as well as 49 CFR 571.303 and 304.].

(25) Rechargeable Energy Storage Systems (RESS) shall be battery or capacitor based as defined in SAE J1711.

(26) Vehicles shall not contain exposed conductors, terminals, contact blocks, or devices of any type that create the potential for personnel to be exposed to 60 volts or greater (the distinction between low-voltage and high voltage, as specified in SAE J1127, J1128, et al.). Access to any high voltage components shall require the removal of at least one bolt, screw, or latch. Devices considered being high voltage components shall be clearly marked as HIGH VOLTAGE. These markings should be installed at any point the voltage can be accessed by the end user. Additionally cable and wire marking shall consist of orange wire and/or orange sleeving as identified in SAE-J1127.

(27) For propulsion power systems with voltages, which may equal or exceed 60 VDC, the system shall be isolated from the vehicle chassis such that leakage current does not exceed 0.5 MIU.

Charging circuits for RESS battery systems with voltages, which may equal or exceed 60 VDC, shall be isolated from the vehicle chassis such that ground current from the grounded chassis does not exceed 5 mA at any time the vehicle is connected to an off-board power supply.

(28) The automatic disconnect for the RESS batteries shall be capable of interrupting maximum rated controller/inverter current. The Supplier shall describe the automatic disconnect provided for the main propulsion batteries.

(29) The vehicle shall be prevented from being driven with the key turned on and the drive selector in the drive or reverse position while the vehicle's charge cord is attached. Additionally, the following interlocks shall be present:

- The controller shall not initially energize to move the vehicle with the gear selector in any position other than "PARK" or "NEUTRAL."
- The start key shall be removable only when the "ignition switch" is in the "OFF" position, with the drive selector in "PARK."
- With a pre-existing accelerator input, the controller shall not energize or excite such that the vehicle can move under its own power from this condition.
- Vehicles capable of grid connection shall be prevented from being driven with the key turned on and the drive selector in the drive or reverse position while the vehicle's charge cord is attached.

(30) The grid-connected charger shall be capable of recharging the RESS to a state of full charge from any possible state of discharge in less than 12 hours, at temperatures noted in Section 6.5, as applicable.

The charger shall be fully automatic, determining when “end of charge” conditions are met and transitioning into a mode that maintains the main propulsion battery at a full state of charge while not overcharging it, if continuously left on charge.

(31) The RESS charger shall be onboard the vehicle and shall use 120V or 208/240V single-phase 60-Hertz alternating current service, with an input voltage tolerance of ±10% of rated voltage. Input current for charges operating at 120 V shall be compatible with 15-ampere circuit breakers. Input current for chargers operating at 208V and 240V shall be compatible with 40-ampere circuit breakers.

Charger personnel protection systems shall be in accordance with the applicable sections of UL Standards 2231-1 and 2231-2. Equipment external to the vehicle shall comply with NEC 625.

(32) The RESS charger shall have a true power factor of 0.95 or greater and a harmonic current distortion of ≤20% (at rated load).

(33) Regardless of the charger used, the charger shall conform to the requirements of UL Standard 2202.

(34) Suppliers shall specify all optional equipment required to meet the requirements of the PHEV Vehicle Specification. The installation of options shall not relieve Suppliers of meeting other “shall requirements.”

(35) Vehicles shall be accompanied by non-proprietary manuals for parts, service, operation and maintenance, interconnection wiring diagrams and schematics.

The following sections constitute the Technical Requirements of the PHEV Vehicle Specification. Information has been categorized according to component and/or function. These sections provide an overview of the requirements and recommendations for Suppliers to use. This Vehicle Specification establishes the minimum requirements for successful completion of the AVTA Plug-In Hybrid Electric Vehicle Integrated Test and Evaluation Program, as well as identifying design and performance objectives.

No inference should be drawn by Suppliers or any other person that the measures listed in this specification are sufficient to ensure vehicle safety. The Supplier is solely responsible for determining whether each vehicle offered for sale is safe, and must not rely on this PHEV Vehicle Specification as a measure of vehicle safety.

2 REGULATORY REQUIREMENTS

2.1 FMVSS CERTIFICATION

Vehicles shall comply with Federal Motor Vehicle Safety Standards applicable on the date of manufacture and such compliance shall be certified by the manufacturer in accordance with 49 CFR 567. Suppliers shall provide a completed copy of Appendix A and Appendix B for PHEV America review, providing vehicle specifications and the method of compliance with each required section of 49 CFR 571. If certification includes exemption, the exemption number issued by the National Highway Transportation Safety Administration (NHTSA), the date of it’s publication in the Federal Register and the page number(s) of the Federal Register acknowledging issuance of the exemption shall be provided along with Appendix B. Exemptions for any reason other than non-applicability shall not be allowed.

2.2 VEHICLE EMISSIONS CERTIFICATION

Vehicle emissions shall be certified under current California Air Resources Board (CARB) or Environmental Protection Agency (EPA) regulations.

2.3 SAFETY FEATURES

Suppliers should describe safety measures and safety-related design features included in their vehicle design and provide an explanation of the purpose and anticipated effect on vehicle reliability and performance of any such safety measure or design feature.

2.4 MATERIAL SAFETY DATA SHEETS

Suppliers shall supply Material Safety Data Sheets (MSDS) for all unique hazardous materials the vehicle is equipped with, including RESS batteries or capacitors, and auxiliary batteries.

2.5 BATTERY AND HAZARDOUS MATERIALS RECYCLING PLANS

Suppliers shall provide recycling plans for batteries and other vehicle hazardous materials including how the plan has been implemented. This plan should also identify post-purchase costs associated with recycling that will be passed on to the vehicle purchaser.

2.6 FEDERAL COMMUNICATIONS REQUIREMENTS

All vehicles shall comply with the FCC requirements for unintentional emitted electromagnetic radiation, as identified in 47 CFR 15, Subpart B, and “Unintentional Radiators.”

2.7 ELECTROMAGNETIC FIELD MINIMIZATION

Vehicles should be designed to minimize occupant exposure to electromagnetic fields generated by the propulsion system.

3 CHASSIS

3.1 RATED PAYLOAD

Vehicles shall have a minimum payload of at least 400 pounds.

3.2 CURB WEIGHT AND GROSS VEHICLE WEIGHT RATING (GVWR)

For conversion vehicles, OEM GVWR shall not be increased. Suppliers should provide the curb weight and rated payloads of their vehicles. Suppliers shall specify the OEMs GVWR.

3.3 VEHICLE WEIGHT DISTRIBUTION

For conversion vehicles, OEM Gross Vehicle Axle Weight Ratings (GAWR) shall not be increased. Suppliers shall provide axle weights for the vehicle as delivered, and at full rated payload.

3.4 SPEEDOMETER AND ODOMETER

Vehicles shall have a speedometer and an odometer. Speedometers and odometers should have an accuracy of at least ± 5%.

3.5 BRAKING AND STEERING PERFORMANCE

For conversion vehicles, braking and steering efforts should be similar to OEM models of comparable size and weight.

3.6 TIRES

Tires shall be subject to the following requirements:

- Tires provided with the vehicle shall be the standard tire offered by the Supplier.
- Tires shall correspond to the requirements of the placard installed in accordance with 49 CFR 571.109, 110, 119 and 120, as applicable.
- Suppliers shall specify manufacturer, model and size of the standard tire.
- Tires sizes and inflation pressures shall be in accordance with the requirements of the placard.
- At no time shall the tire’s inflation pressure exceed the maximum pressure imprinted upon that tire’s sidewall.
- The tire shall be operable across the entire operation/load range of that vehicle.
- Replacement tires shall be commercially available to the end user in sufficient quantities to support the purchaser’s needs.
- Tires provided as original equipment by the Supplier shall not have warranty restrictions more restrictive than those of the tire’s manufacturer, unless the Supplier is the sole warrantor for the tires.
- If the vehicle may be equipped with more than one standard tire, the above listed requirements shall apply to each type/manufacturer of each standard tire.

3.7 GROUND CLEARANCE

Vehicles should have a ground clearance of at least five (5) inches to all sprung portions of the vehicle, with the vehicle loaded with rated payload (e.g. to GVWR).

4 VEHICLE CHARACTERISTICS

4.1 SEATING CAPACITY

Seating capacity shall be a minimum of 1 driver and 1 passenger. Suppliers shall specify seating capacity (available seat belt positions) for their vehicle. For conversion vehicles, if the vehicle's seating capacity is changed from that specified by the OEM on their FMVSS placard, the seat(s) being added or abandoned shall be modified as required by 49 CFR 571.207, et al, and a new FMVSS placard installed as required by 49 CFR 567, 568 or 571, as applicable.

4.2 PASSENGER AND CARGO SPACE

For conversion vehicles, the OEM passenger space shall not be intruded upon by the Rechargeable Energy Storage System (RESS), or other conversion materials. Suppliers should specify interior passenger and cargo dimensions and volumes.

4.3 ELECTROMAGNETIC SUSCEPTIBILITY

Vehicles should comply with the relevant sections of SAE J551 for electromagnetic radiated fields. Vehicles should not be susceptible to externally generated electromagnetic radiation from an on-board transmitter (i.e., interaction will not preclude operation of any system(s) required for proper operation of the vehicle).

5 DRIVE SYSTEM

5.1 TRANSMISSION

The vehicle should utilize a single speed, multi-speed automatic, or a Continuously Variable Transmission (CVT), and shall have a parking mechanism.

5.2 REGENERATIVE BRAKING SYSTEM

Regenerative braking should not adversely impact the vehicle's braking ability on varying road surfaces. Suppliers should describe the operation of the regenerative braking system and its interface with braking and anti-lock brake systems.

5.3 OVERHEATING

The vehicle drive-train system should be capable of continuous operation at maximum vehicle speed and/or sustained grades without overheating or loss of component life over the range of ambient temperatures specified in Section 6.5.

5.4 BATTERY VOLTAGE LIMITS

The controller/inverter shall limit the minimum RESS battery discharge voltage to prevent degradation of battery life, and should limit the maximum regeneration voltage to prevent external gassing of the batteries. Suppliers should specify the voltage limits and describe how these limits are implemented.

5.5 DRIVE TRAIN

Drive train components should not produce or develop unusual vibrations over the entire design speed range of the vehicle.

5.6 PARKING MECHANISM

Vehicles shall comply with the requirements of 49 CFR 571.105.S5.2.1, or alternatively, 49 CFR 571.105.S5.2.2 for parking mechanisms.

6 VEHICLE PERFORMANCE

Vehicle performance is divided into separate categories depending upon vehicle overall design and available operating modes. Vehicles, which are capable of driver selectable modes, have performance goals for each of those modes. The performance goals apply only if the vehicle is capable of operation in the mode stated [e.g., vehicles that cannot be operated in RESS Only mode will not be tested in that mode]. Normal operation for a PHEV begins after off-board charging at 100% RESS state-of-charge (SOC), then operates in a charge depleting mode (hybrid or all electric) until the RESS attains its minimum operating SOC, at which time the vehicle operates in a hybrid charge sustaining mode.

6.1 ACCELERATION

The vehicle should have a 0-60 mph acceleration time of 13.5 seconds or less with the vehicle loaded to its design curb-weight plus 300 pounds in each of the selectable modes of operation, as applicable.

6.1.1 Normal Operation mode starting with the RESS at 100% SOC

6.1.2 Normal Operation mode starting with the RESS at the SOC at which the vehicle enters charge-sustaining mode

6.1.3 Consumable Fuel Energy Converter (CFEC) mode only

6.1.4 Rechargeable Energy Storage System Only (RESS Only) mode, starting at 100% SOC

6.1.5 Rechargeable Energy Storage System Only (RESS Only) mode, starting at 50% SOC

6.1.6 All other possible HEV modes that are specified as user-selectable in the vehicle’s operating manual, and starting with the RESS at 100% SOC

6.2 MINIMUM TOP SPEED

The vehicle should have a minimum top speed of 90 mph with the vehicle loaded to its design curb-weight plus 300 pounds in each of the selectable modes of operation, as applicable.

6.2.1 Normal Operation mode starting with the RESS at 100% SOC

6.2.2 Normal Operation mode starting with the RESS at the SOC at which the vehicle enters charge-sustaining mode

6.2.3 Consumable Fuel Energy Converter (CFEC) mode only

6.2.4 Rechargeable Energy Storage System Only (RESS Only) mode, starting at 100% SOC

6.2.5 Rechargeable Energy Storage System Only (RESS Only) mode, starting at 50% SOC

6.2.6 All other possible HEV modes that are specified as user-selectable in the vehicle's operating manual, and starting with the RESS at 100% SOC

6.3 HIGH SPEED GRADEABILITY

Vehicles should achieve a minimum sustainable speed of 55 mph on a 3% grade, and 45 mph on a 6% grade, with the vehicle loaded to its design curb-weight plus 300 pounds, in each of the selectable modes of operation, as applicable.

6.3.1 Normal Operation mode starting with the RESS at 100% SOC

6.3.2 Normal Operation mode starting with the RESS at the SOC at which the vehicle enters charge-sustaining mode

6.3.3 Consumable Fuel Energy Converter (CFEC) mode only

6.3.4 Rechargeable Energy Storage System Only (RESS Only) mode, starting at 100% SOC

6.3.5 Rechargeable Energy Storage System Only (RESS Only) mode, starting at 50% SOC

6.3.6 All other possible HEV operating modes that are specified as user-selectable in the vehicle's operating manual, and starting with the RESS at 100% SOC

6.4 LOW SPEED GRADEABILITY

Vehicles should be capable of starting and ascending a 25% grade with the vehicle loaded to its design curb-weight plus 300 pounds in each of the selectable modes of operation, as applicable.

6.4.1 Normal Operation mode starting with the RESS at 100% SOC

6.4.2 Normal Operation mode starting with the RESS at the SOC at which the vehicle enters charge-sustaining mode

6.4.3 Consumable Fuel Energy Converter (CFEC) mode only

6.4.4 Rechargeable Energy Storage System Only (RESS Only) mode, starting at 100% SOC

6.4.5 Rechargeable Energy Storage System Only (RESS Only) mode, starting at 50% SOC

6.4.6 All other possible HEV operating modes that are specified as user-selectable in the vehicle's operating manual, and starting with the RESS at 100% SOC

6.5 DURABILITY

Vehicles shall be capable of completing procedure AVTA-PHTP05, including (1) driving through standing water without damage and without battery to chassis leakage current exceeding 0.5 MIU per UL Standard 2202, and (2) standing for extended periods in extreme temperatures without damage to or failure of the vehicle or its systems. This includes ambient air temperatures of -20°F to +120°F, paved surface temperatures of 150°F, and occupant compartment temperatures of 170°F. Vehicles should be capable of completing procedure AVTA-PHTP05, without becoming inoperable. Vehicle shall be capable of completing all tests without repairs exceeding a cumulative total of 72 hours.

6.6 WATER DURABILITY

Vehicles should be capable of driving through two (2) inches of standing water at a speed of 20 mph without damage, without becoming inoperable, and without battery to chassis leakage current exceeding 0.5 MIU per UL Standard 2202.

Vehicles should be capable of setting in eight (8) inches of standing water for 15 minutes without damage, becoming inoperable, and without battery to chassis leakage current exceeding 0.5 MIU per UL Standard 2202.

6.7 ENERGY EFFICIENCY DRIVE CYCLES

Vehicles should be able to complete two (2) Urban Dynamometer Driving Schedules (UDDS) followed by two (2) Highway Fuel Economy Driving Schedules (HWFEDS) in all charge depleting modes to obtain fuel/energy efficiency. Testing will be conducted with the vehicle loaded to its design curb-weight plus 300 pounds.

7 RECHARGEABLE ENERGY STORAGE SYSTEM (RESS)

7.1 BATTERY TYPE

Suppliers should provide a detailed description of the RESS battery pack including: specific energy, specific power and discharge capacity to 80% depth of discharge (DOD) at the one-hour rate, battery pack voltage, number of battery modules, and a summary of previous performance tests. If different, customer available and battery available DOD ratings shall both be provided.

7.2 BATTERY CHARACTERISTICS

Batteries shall comply with the requirements of SAE J1718. For valve regulated batteries, the internal pressure level at which batteries vent should be specified. Suppliers should describe projected life (in cycles) at a specified level of discharge, how battery life is maximized, how end of life of each battery module and of the full battery pack is determined, and how battery temperature gradients are minimized.

Vehicles shall not auto-start the engine to charge the batteries while the vehicle is parked and the key switch is in the OFF position.

RESS batteries shall meet the requirements of NEC 625-29(c) or (d) for charging in enclosed spaces without a vent fan. The vehicle shall be labeled as not requiring ventilation for charging (or have the appropriate classification label from a UL-recognized Testing Laboratory).

7.3 MAXIMUM STATE OF DISCHARGE

Suppliers should indicate the level of charge below which the batteries should not be discharged. This should include the specific parameters the BMS utilizes to prevent over-discharge. At a minimum, battery capacity ratings, module voltage(s), and battery pack voltage(s) should be provided. Further, this should be consistent with information provided in the Owner's Manuals.

7.4 BATTERY PACK

Suppliers should specify the weight of each battery module, and the weight of the battery pack (including removable pack structures). Suppliers should describe how batteries are installed in the vehicle (including details of module connection), the method of installation and removal of the batteries (and the battery box, if required) for maintenance and repair, the time required for battery removal, and any special training, tools or equipment required for battery removal.

7.5 ELECTROLYTE CONTAINMENT

For vehicles with RESS system nominal voltages of 48 volts and higher, batteries or capacitors and their enclosures shall be designed and constructed in a manner that complies with 49 CFR 571.305. For vehicles with RESS nominal system voltages below 48VDC, batteries or capacitors, and their enclosures, shall be designed and constructed in accordance with the requirements of SAE J1766. Further, irrespective of RESS system voltage, batteries or capacitors, and electrolyte shall not intrude into the passenger compartment during or following FMVSS frontal barrier, rear barrier and side impact collisions, and rollover requirements of 49 CFR 571.301. Suppliers shall provide verification of conformance to this requirement.

7.6 BATTERY BOX

Concentrations of explosive gases in the battery box shall not be allowed to exceed 25% of the Lower Explosive Limit. Suppliers shall describe how battery boxes will be vented, to allow any battery gases to escape safely to atmosphere during and following normal or abnormal charging and operation of the vehicle. Battery gases shall not be allowed to enter the occupant compartment.

Batteries shall meet the requirements of NEC 625-29(c) or (d) for charging in enclosed spaces without a vent fan.

7.7 PARALLEL BATTERY PACKS

If a Supplier provides a vehicle with parallel battery packs, the Supplier shall provide detailed information on the equipment and charging algorithms required to prevent the parallel strings from becoming unbalanced.

7.8 BATTERY MAINTENANCE

Maintenance requirements for the RESS batteries should be described and any associated cost(s) to the consumer/end user should be clearly defined.

7.9 ADDITIONAL RESS COMPONENT MAINTENANCE

Maintenance requirements for other RESS components (e.g., flywheels, ultra capacitors) should be described and any associated cost(s) to the consumer/end user should be clearly defined.

7.10 BATTERY CHARGING ALGORITHM

Vehicle suppliers shall provide the battery warranty provided to the end user, including the procedures for making a warranty claim.

7.11 BATTERY MANAGEMENT SYSTEM

The vehicle should be equipped with a BMS. This system should control propulsion battery pack and module voltages, temperatures and state of charge during both charge and discharge. Further, the BMS should automatically limit battery discharge below a pre-determined minimum level. If a BMS is provided, the Supplier shall provide a description of the BMS operation. This description should be consistent with that provided in the owner's manual.

7.12 FUEL SYSTEMS

For vehicles using fuels other than gasoline, manufacturers shall indicate compliance with appropriate and applicable standards from SAE, NFPA, etc. [e.g., for vehicles using Compressed Natural Gas as fuel, manufacturers should indicate compliance with NFPA 52, as well as 49 CFR 571.303 and 304.] For pressurized fuel systems, Suppliers should provide expected refueling times.

7.13 RESS ENERGY SOURCE

Rechargeable Energy Storage Systems (RESS) shall be battery or capacitor-based as defined in SAE J1711.

8 ELECTRICAL

8.1 ELECTRICAL SAFETY

Vehicles shall not contain exposed conductors, terminals, contact blocks, or devices of any type that create the potential for personnel to be exposed to 60 volts or greater (the distinction between low-voltage and high voltage, as specified in SAE J1127, J1128, et al.). Access to any high voltage components shall require the removal of at least one bolt, screw, or latch. Devices considered having high voltage components shall be clearly marked as HIGH VOLTAGE. These markings should be installed at any point the voltage can be accessed by the end user. Additionally, cable and wire marking shall consist of orange wire and/or orange sleeving as identified in SAE-J1127.

8.2 ELECTRICAL ISOLATION

For propulsion power systems with voltages, which may equal or exceed 60 VDC, the system shall be isolated from the vehicle chassis such that leakage current does not exceed 0.5 MIU.

Charging circuits for RESS battery systems with voltages, which may equal or exceed 60 VDC, shall be isolated from the vehicle chassis such that ground current from the grounded chassis does not exceed 5 mA at any time the vehicle is connected to an off-board power supply. Supplier should provide details on grounding and isolation methods.

8.3 BATTERY DISCONNECT[3]

Vehicles should be equipped with an automatic disconnect for the RESS batteries which operates to isolate the propulsion circuits any time the chassis becomes energized from contact with the propulsion battery or its associated circuits. This disconnect shall be capable of interrupting maximum rated controller/inverter current. The Supplier shall describe the automatic disconnect provided for the main propulsion batteries.

A manual service disconnect should also be present. This disconnect should be operable with the following capabilities:

- Manual action to break the connection
- The disconnection is physically verifiable
- The disconnection does not create exposed conductors capable of becoming energized while exposed.

[3] Manufacturers may choose to install over-ride features to allow vehicles to move under their own power in situations where occupant safety is the primary concern (e.g., following a collision where moving the vehicle off the roadway is determined necessary to prevent injury/further injury or additional damage.)

The key-switch may be used to satisfy the operability portion of the manual service disconnect requirement, if it interrupts all control power going to the controller and the main battery contactor(s). This disconnect is not required to operate under load.

8.4 SAFETY INTERLOCK SYSTEM

The vehicle shall be prevented from being driven with the key turned on and the drive selector in the drive or reverse position while the vehicle's charge cord is attached. Additionally, the following interlocks shall be present:

- The controller shall not initially energize to move the vehicle with the gear selector in any position other than "PARK" or "NEUTRAL"
- The start key shall be removable only when the "ignition switch" is in the "OFF" position, with the drive selector in "PARK"

8.5 OPERATION OF HAZARD LIGHTS

Hazard lights should be capable of at least one hour of continuous operation in the event of shutdown or isolation of the main battery pack, or failure of the DC/DC converter system.

8.6 STATE OF CHARGE INDICATOR

The vehicle should include a state of charge indicator for the RESS batteries. Indications should be accurate to ± 5% of full scale.

8.7 CONNECTORS

Low voltage connectors should meet the requirements of applicable SAE Standards, including J163, J561, J858, et al. High voltage connectors should utilize locking devices, should be keyed to prevent misconnection, and should be moisture proof.

9 GRID-CONNECTED CHARGING SYSTEM

9.1 CHARGER OPERATION

The grid-connected charger shall be capable of recharging the RESS to a state of full charge from any possible state of discharge in less than 12 hours, at temperatures noted in Section 6.5, as applicable. The preferred recharge time should be less than eight (8) hours.

The charger shall be fully automatic, determining when "end of charge" conditions are met and transitioning into a mode that maintains the main propulsion battery at a full state of charge while not overcharging it, if continuously left on charge. The charger should also minimize the energy required to maintain the main propulsion battery in a fully charged state, particularly during extended periods on charge.

9.2 CHARGING INPUT POWER

The RESS charger shall be onboard the vehicle and shall be powered from 120V or 208/240V single-phase 60-Hertz alternating current, with an input voltage tolerance of ±10% of rated voltage. Input current for chargers operating at 120V shall be compatible with 15-ampere circuit breakers. Input current for chargers operating at 208V/240V shall be compatible with 40-ampere circuit breakers.

Charger personnel protection systems shall be in accordance with Standards 2202 and the applicable sections of UL Standards 2231-1 and 2231-2. Equipment external to the vehicle shall comply with NEC 625.

Any conductive or inductive type charging systems should be in accordance with the requirements of SAE J1772 or J1773.

9.3 POWER QUALITY

The RESS charger shall have a true power factor of 0.95 or greater and a harmonic current distortion of ≤ 20% (at rated load).

9.4 VEHICLE CHARGER CONNECTIONS

Suppliers should describe the type, size and location of the point of the vehicle charging port. The charge connector should comply with the requirements of SAE J1772 or SAE J1773, as appropriate.

10 ADDITIONAL VEHICLE SYSTEMS

Suppliers shall specify all optional equipment required to meet the requirements of the PHEV Vehicle Specification. Suppliers should describe the following options, if available. The installation of options shall not relieve Suppliers of meeting other “shall” requirements. Suppliers should specify the impact on range and payload for each option.

10.1 AIR CONDITIONING SYSTEM

Suppliers should describe the design of the air conditioning system and verify that it uses no chlorofluorocarbons (CFCs).

10.2 OCCUPANT COMPARTMENT PRE-HEATING AND COOLING SYSTEM

Suppliers should briefly describe the design of a pre-heating and pre-cooling system that allows passenger compartment temperatures to be maintained while the vehicle is on charge.

11 DOCUMENTATION

11.1 SERVICE MANUALS

Vehicles shall be accompanied by non-proprietary manuals for parts, service, operation and maintenance, interconnection wiring diagrams and schematics. Manuals should include details on the design and operation of vehicle systems, as well as a list of additional or special maintenance tools required.

11.2 TRAINING PROGRAM

Suppliers should offer a training program for the purchaser's maintenance personnel covering vehicle safety and proper operation and maintenance of vehicles.

Appendix A – Vehicle Data & Submittals

PERFORMANCE (in Normal Operation mode)

Time required to accelerate from 0-60 mph on a level grade(s) ____________________
Maximum speed on a 3% grade(s) ____________________
Maximum speed on a 6% grade(s) ____________________
Maximum speed attainable on a level grade (mph) ____________________
Maximum grade attainable from a standing start at GVWR (%) ____________________

PERFORMANCE (in RESS Only mode starting at 50% SOC)

Time required to accelerate from 0-60 mph on a level grade(s) ____________________
Maximum speed on a 3% grade(s) ____________________
Maximum speed on a 6% grade(s) ____________________
Maximum speed attainable on a level grade (mph) ____________________
Range at a constant speed of 45 mph (miles) ____________________

BATTERY RESS CHARACTERISTICS (referenced to 25˚C)

Manufacturer ____________________
Model ____________________
Type ____________________
Description ____________________
Number of cells/modules in the pack ____________________
Arrangement (series or parallel) ____________________
Battery cell/module voltage (VDC) ____________________
Battery pack voltage (VDC) ____________________
Battery cell/module weight (kg) ____________________
Battery pack weight (kg) ____________________
Battery capacity to 100% Manufacturer’s DOD, 1 hour rating (Ah) ____________________
Battery energy to 100% Manufacturer’s DOD, 1 hour rating (Wh) ____________________
Expected life of battery to a Manufacturer’s DOD of:
50% DOD (cycles) ____________________
80% DOD (cycles) ____________________
Charge sustaining mode (cycles) ____________________
Time required to recharge from maximum allowable vehicle DOD (hr:min): __________

Appendix A (continued)

CHARGER CHARACTERISTICS

Manufacturer ____________________
Model ____________________
UL file number ____________________
Description ____________________
Location ____________________
Charger efficiency (%) ____________________
Charger input voltage(s) (VAC) ____________________
Charger input current(s) (A) ____________________
Charger input power factor (%) ____________________
Charger input total harmonic current distortion (%) ____________________
Maximum charger current output (A) ____________________

MOTOR CHARACTERISTICS

Manufacturer ____________________
Model ____________________
Description ____________________
Type (AC, DC, Brushless, etc.) ____________________
Rated efficiency ____________________ % @ ____________________kW
Operating range (RPM) ____________________
Maximum intermittent power ____________________kW for ____________________ minutes
Maximum continuous power (kW) ____________________
Cooling medium and method ____________________

CONTROLLER CHARACTERISTICS

Manufacturer ____________________
Model ____________________
Description ____________________
Type and Phase ____________________
Input voltage range ____________________
Maximum input current (A) ____________________

HEAT ENGINE CHARACTERISTICS

Model ____________________
Configuration ____________________
Displacement (liters) ____________________
Number of cylinders ____________________
Power (hp@rpm) ____________________
Torque (lb-ft@rpm) ____________________
Recommended fuel (all types) ____________________
Fuel storage capacity (gge) (specify for each fuel type) ____________________

Appendix A (continued)

TRANSMISSION CHARACTERISTICS
Type ____________________
Model ____________________
Description ____________________

CHASSIS CHARACTERISTICS - Pre-Conversion

Make, year and model ____________________
Gross vehicle weight rating (kg) ____________________
Gross axle weight rating (kg) __________ front __________ rear
Curb weight (kg) ____________________
Drive wheels (F/R) ____________________
Weight distribution __________ % front __________ % rear
Payload capacity (kg) ____________________
Ground clearance from lowest point on chassis at GVWR (cm) __________
Wheelbase ____________________ inches
Track __________inches front __________inches rear

CHASSIS CHARACTERISTICS - Post-Conversion
Gross vehicle weight rating (kg) ____________________
Gross axle weight rating (kg) __________ front __________ rear
Curb weight (kg) ____________________
Drive wheels (F/R) ____________________
Weight distribution __________ % front __________ % rear
Payload capacity (kg) ____________________
Ground clearance from lowest point on chassis at GVWR (cm) __________
Wheelbase ____________________ inches
Track __________inches front __________inches rear

BRAKES

Type front ____________________
Type rear ____________________
Power source, if used ____________________
Average power, if used (W) ____________________
Maximum regenerative braking (kW) ____________________

Appendix A (continued)

TIRES

Manufacturer ______________________________
Model ______________________________
Description ______________________________
Size and profile ______________________________
Pressure (psi) ______________ front ______________ rear
Weight capacity (lbs) ______________________________

SUSPENSION

Type front ______________________________
Type rear ______________________________
Modifications made during conversion, if any ______________________________
____

STEERING

Type ______________________________
Description ______________________________
Power source, if used ______________________________
Average power, if used (W) ______________________________

AIR CONDITIONING

Model ______________________________
Description ______________________________
Compressor type ______________________________
Maximum cooling output (BTU/hr) ______________________________
Motor type ______________________________
Maximum power required (kW) ______________________________

HEATING SYSTEM

Model ______________________________
Description ______________________________
Heat source/fuel ______________________________
Fuel consumption (gge/kW) ______________________________
Certified under CARB ZEV requirements Yes ☐ No ☐ N/A ☐
EPA ZEV Certificate of Conformity Yes ☐ No ☐

EPA/CARB Certification

Emissions rating (LEV II classification) ______________________________

Appendix A (continued)

REQUIRED SUBMITTALS

The following submittals are required from the Supplier prior to vehicle delivery.

- Suppliers shall provide a completed copy of Appendix B indicating the method of compliance with each required section of 49 CFR 571. If certification includes exemption, the exemption number issued by the National Highway Transportation Safety Administration (NHTSA), the date of it's publication in the Federal Register and the page number(s) of the Federal Register acknowledging issuance of the exemption shall be provided along with Appendix B.
- Suppliers should describe safety measures and safety-related design features included in their vehicle design and provide an explanation of the purpose and anticipated effect on vehicle reliability and performance of any such safety measure or design feature.
- Suppliers shall supply Material Safety Data Sheets (MSDS) for all unique hazardous materials the vehicle is equipped with, including RESS batteries or capacitors, and auxiliary batteries.
- Suppliers shall provide recycling plans for batteries and other vehicle hazardous materials including how the plan has been implemented. This plan should also identify post-purchase costs associated with recycling that will be passed on to the vehicle purchaser.
- Suppliers should specify interior passenger and cargo dimensions and volumes.
- Suppliers should describe the operation of the regenerative braking system and its interface with braking and anti-lock brake systems.
- Suppliers should specify the RESS battery discharge voltage limits and describe how these limits are implemented.
- Vehicles should be accompanied with fuel economy data from Manufacturer's testing.
- Suppliers should provide a detailed description of the RESS battery pack (including specific energy, specific power and discharge capacity to 80% DOD at the one-hour rate), battery pack voltage, number of battery modules, and a summary of previous performance tests. If different, customer available and battery available DOD ratings shall both be provided.
- Suppliers should describe battery pack projected life (in cycles) at a specified level of discharge, how battery life is maximized, how end of life of each battery module and of the full battery pack is determined, and how battery temperature gradients are minimized. Suppliers should specify maximum normal and abnormal gassing rates for the battery pack.
- Suppliers should indicate the level of charge below which the batteries should not be discharged. This should include the specific parameters the Battery Management System utilizes to prevent over-discharge. At a minimum, the Ah rating(s), module voltage(s), and battery pack voltage(s) should be provided. Further, this should be consistent with information provided in the Owner's Manuals.
- Suppliers should specify the weight of each battery module, and the weight of the battery pack (including removable pack structures). Suppliers should describe how batteries are

installed in the vehicle (including details of module connection), the method of installation and removal of the batteries (and the battery box, if required) for maintenance and repair, the time required for battery removal, and any special training, tools or equipment required for battery removal.

- Suppliers shall describe how battery boxes will be vented, to allow any battery gases to escape safely to atmosphere during and following normal or abnormal charging and operation of the vehicle.
- Suppliers should describe the methods used to prevent or accommodate condensation in the battery box, and the quantity and maximum rate of explosive gas generation, by gas type, under normal and abnormal charging conditions.
- If a Supplier provides a vehicle with parallel battery packs, the Supplier shall provide detailed information on the equipment and charging algorithms required to prevent the parallel strings from becoming unbalanced.
- Maintenance requirements for the RESS batteries should be described and any associated cost(s) to the consumer/end user should be clearly defined.
- Maintenance requirements for other RESS components (e.g., flywheels, ultra capacitors) should be described and any associated cost(s) to the consumer/end user should be clearly defined.
- If a BMS is provided, suppliers should provide a description of the BMS' operation. This description should be consistent with that provided in the owner's manual.
- If the vehicle is not equipped with a BMS, manufacturers should provide information on how charging of the RESS batteries/energy storage components is accomplished.
- For pressurized fuel systems, Suppliers should provide expected refueling times at various system fuel pressures and tank fills.
- Supplier should provide details on grounding and isolation methods.
- Suppliers should describe the type, size and location of the point of the vehicle charging port.
- Suppliers should describe the following options (if available):
    - Air conditioning system
    - Occupant compartment pre-heating and pre-cooling system.
- Vehicles shall be accompanied by non-proprietary manuals for parts, service, operation and maintenance, interconnection wiring diagrams and schematics.

Appendix B – FMVSS Certification Methodology

49 CFR 571.100 SERIES	OEM Certified	Analysis Only	Test Only	Test & Analysis	Not Required	Not Certified
101 - Controls and Displays	☐	☐	☐	☐	☐	☐
102 - Transmission Shift Lever Sequence, Starter Interlock & Transmission Braking	☐	☐	☐	☐	☐	☐
103 - Windshield Defrosting and Defogging Systems	☐	☐	☐	☐	☐	☐
104 - Windshield Wiping and Washing Systems	☐	☐	☐	☐	☐	☐
105 - Hydraulic Brake Systems	☐	☐	☐	☐	☐	☐
106 - Brake Hoses	☐	☐	☐	☐	☐	☐
107 - Reflecting Surfaces	☐	☐	☐	☐	☐	☐
108 - Lamps, Reflective Devices, and Associated Equipment	☐	☐	☐	☐	☐	☐
109 - New Pneumatic Tires	☐	☐	☐	☐	☐	☐
110 - Tire Selection and Rims	☐	☐	☐	☐	☐	☐
111 - Rearview Mirrors	☐	☐	☐	☐	☐	☐
113 - Hood Latch System	☐	☐	☐	☐	☐	☐
114 - Theft Protection	☐	☐	☐	☐	☐	☐
116 - Motor Vehicle Brake Fluids	☐	☐	☐	☐	☐	☐
117 - Retread Pneumatic Tires	☐	☐	☐	☐	☐	☐
118 - Power Operated Window, Partition, and Roof Panel Systems	☐	☐	☐	☐	☐	☐
119 - New Pneumatic Tires for Vehicles Other Than Passenger Cars	☐	☐	☐	☐	☐	☐
120 - Tire Selection and Rims for Motor Vehicles Other than Passenger Cars	☐	☐	☐	☐	☐	☐
121 - Air Brake Systems	☐	☐	☐	☐	☐	☐
124 - Accelerator Control Systems	☐	☐	☐	☐	☐	☐
125 - Warning Devices	☐	☐	☐	☐	☐	☐
126 - Truck-Camper Loading	☐	☐	☐	☐	☐	☐
129 - New Non-Pneumatic Tires for Passenger Cars	☐	☐	☐	☐	☐	☐
135 - Passenger Car Brake Systems	☐	☐	☐	☐	☐	☐

Appendix B (continued)

	OEM Certified	Analysis Only	Test Only	Test & Analysis	Not Required	Not Certified
49 CFR 571.200 SERIES						
201 - Occupant Protection in Interior Impact	☐	☐	☐	☐	☐	☐
202 - Head Restraints	☐	☐	☐	☐	☐	☐
203 - Impact Protection for the Driver from the Steering Control System	☐	☐	☐	☐	☐	☐
204 - Steering Control Rearward Displacement	☐	☐	☐	☐	☐	☐
205 - Glazing Materials	☐	☐	☐	☐	☐	☐
206 - Door Locks and Door Retention Components	☐	☐	☐	☐	☐	☐
207 - Seating Systems	☐	☐	☐	☐	☐	☐
208 - Occupant Crash Protection	☐	☐	☐	☐	☐	☐
209 - Seat Belt Assemblies	☐	☐	☐	☐	☐	☐
210 - Seat Belt Assembly Anchorages	☐	☐	☐	☐	☐	☐
212 - Windshield Mounting	☐	☐	☐	☐	☐	☐
213 - Child Restraint Systems	☐	☐	☐	☐	☐	☐
214 - Side Impact Protection	☐	☐	☐	☐	☐	☐
216 - Roof Crush Resistance - Passenger Cars	☐	☐	☐	☐	☐	☐
219 - Windshield Zone Intrusion	☐	☐	☐	☐	☐	☐
225 - Child Restraint Anchorage System	☐	☐	☐	☐	☐	☐
49 CFR 571.300 SERIES						
301 - Fuel System Integrity	☐	☐	☐	☐	☐	☐
302 - Flammability of Interior Materials	☐	☐	☐	☐	☐	☐
305 - EV: Electrolyte Spillage and Shock Protection	☐	☐	☐	☐	☐	☐
49 CFR 581						
Bumper Standard Requirements - All Sections	☐	☐	☐	☐	☐	☐
49 CFR 565						
Vehicle Identification Number Requirements	☐	☐	☐	☐	☐	☐

Chapter II: Administrative Control Procedures

Section I: AVTA-PHAC01 – Control, Closeout and Storage of Documentation

TABLE OF CONTENTS

APPENDICES

1 Objective

The objective of this procedure is to identify proper methods for the control of records during and subsequent to testing activities. These methods are not meant to supersede those of any testing facility, nor of any regulatory agency who may have or exercise control over the covered activities.

2 Purpose

This procedure identifies acceptable methods for the development, use, completion and retention of documents prepared in support of performance testing of vehicles provided for testing by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA).

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation shall contain enough information to “stand alone”; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation.

4 Initial Conditions and Prerequisites

4.1 All documentation required to complete the testing identified in the technical requirements of the PHEV Vehicle Specification shall be completed, approved and issued prior to commencing the testing it addresses.

4.2 A system for storage of records during testing activities shall be identified and completed prior to starting testing.

4.3 A system for the permanent storage of records, if different than that presently in place, shall be identified and completed prior to the need becoming evident.

4.4 Personnel who have cognizance over this system shall be familiar with the system prior to it becoming "operational.”

4.5 A Program Manager or Test Manager shall be assigned overall responsibility for retention of any documents that will be retained pursuant to this procedure.

5 Activity Requirements

5.1 Temporary Storage

Temporary storage is defined as safekeeping or storage of records that are still active, either because they are in process and not yet complete, or because the process they are associated with has been suspended. If the suspension period is greater than thirty (30) days, the record shall be considered closed, the document completed and forwarded for permanent storage per section 5.2 of this procedure.

5.2 Permanent Storage

Permanent storage is defined as retention of records for one (1) year beyond their final signature date, or the end of the test program, whichever is later. All formal documents generated as a result of testing will be permanently retained according to this procedure, unless otherwise controlled.

All documents that fall under this procedure shall be handled according to the following requirements:

5.2.1 Following completion of a document, it shall be forwarded to the Document Administrator for processing and close-out.

5.2.2 The Document Administrator shall review the document for the following:

5.2.2.1 All blanks and spaces requiring an input are filled out. Where no entry is required, an "N/A" shall be inserted.

5.2.2.2 All corrections have been effected by single strike-through, initialing and dating, and there are no erasures or whiteouts.

5.2.2.3 All signatures have been affixed.

5.2.2.4 All entries are legible, and dark enough to support reproduction.

5.2.3 Any submitted document that does not meet these requirements shall be returned to the submitter for correction, prior to being either reproduced or placed into permanent storage.

5.2.4 Document retention may be in any of several formats, including, but not limited to:

5.2.4.1 Original document hard copy

5.2.4.2 Microfiche copy of the original document

5.2.4.3 Microfilm copy of the original document

5.2.4.4 Computer disc of the original data, as long as the original signatures associated with the document are retained in hard copy or film format.

6 Supplemental Activity Requirements

6.1 Distribution

6.1.1 Distribution of the original documents or copies of the documents should be controlled to ensure that only appropriate individuals receive them.

6.1.2 Individuals not associated with the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA), either directly or indirectly (such as by contract or sub-contract), shall not have access to incomplete documents.

6.1.3 Supplier's representatives shall not be provided with or given access to incomplete documents.

6.1.4 Subsequent to a document's completion (including signatures, as required), the document may be released to non-involved parties if agreed to by all parties so contractually bound.

6.2 Destruction

Destruction of original documents is not permitted. The Program Manager will be solely responsible for authorizing exceptions, as stipulated by this procedure. Exceptions will not be granted unless: specific approval has been given, the documents have been completed, and the following conditions also exist:

6.2.1 The original documents have been successfully copied into another medium, and the original signature pages are being retained. OR

6.2.2 One year has passed since the contract expired (section 5.2). AND

6.2.3 One year has passed since the completion of the document (section 5.2).

In addition, the Administrator shall note that the record was no longer needed and that destruction of the original was justified. Any time a question exists as to the need to retain a document, an exception WILL NOT be granted.

Appendix A – Document Close-out/Retention Rider

(Page 1 of 1)

DOCUMENT CLOSE-OUT/RETENTION RIDER

Document Name/Title:

Document Number:

Receipt Date:

____
Y Y M M D D

Original Attached:	**Yes** ☐	**No** ☐
Original Destroyed:	**Yes** ☐	**No** ☐

Retention Format:

Hard Copy	**Yes** ☐	**No** ☐
Computer Disk	**Yes** ☐	**No** ☐
Microfilm	**Yes** ☐	**No** ☐

Close-out Date:

____
Y Y M M D D

Close-out Performed By:

____________________ (Printed Name)

____________________ (Signature)

Comments:

Section II: AVTA-PHAC02 – Control of Test Conduct

TABLE OF CONTENTS

APPENDICES

1 Objective

The objective of this procedure is to identify a common protocol for the conduct of test activities for plug-in hybrid electric vehicles (PHEV) evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA).

2 Purpose

This procedure establishes acceptable methods for the development, use and completion of processes used in support of performance testing of PHEVs provided to the AVTA for testing. It also provides a means to document deviations from approved test procedures when such deviations are necessary and appropriate.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation shall contain enough information to “stand alone”; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Storage and retention of records shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

4.1 All documentation required to complete the testing identified in the technical requirements of the PHEV Vehicle Specification shall be completed, approved and issued prior to commencing the testing it addresses.

4.2 Individuals assigned as Test Engineers shall be familiar with all phases and portions of the tests for which they have responsibility, and should be familiar with the entire Test Program.

4.3 Prior to commencing any test, a meeting of the test team shall be held to discuss the following requirements:

4.3.1 Test purpose and requirements

4.3.2 Test methodologies

4.3.3 Personnel requirements

4.3.4 Expected contingencies and exceptions, including reasons and justifications

4.3.5 Safety requirements.

5 Personnel Qualifications

5.1 All individuals involved in covered test activities shall be trained and certified in accordance with the requirements of procedure AVTA-PHAC05.

5.2 All individuals involved in covered test activities shall receive a briefing on the hazards associated with PHEV propulsion batteries, including:

5.2.1 Type of traction batteries

5.2.2 Location of traction batteries

5.2.3 Voltage of traction battery

5.2.4 Location of traction battery emergency disconnect switch

5.2.5 Basic hazard communication information particular to the traction battery on-board.

5.3 All individuals involved in covered test activities shall receive a briefing on the hazards associated with PHEV fueling, including:

5.3.1 Type of fuel used

5.3.2 Vehicle fueling procedures

5.3.3 Emergency and spill (for liquid fuels) procedures

5.3.4 Basic hazard communication information particular to the vehicle fuel.

5.4 All individuals involved in covered test activities shall receive a briefing on the hazards associated with PHEV accessory batteries, including:

5.4.1 Type of accessory battery

5.4.2 Location of accessory battery

5.4.3 Voltage of accessory battery

5.4.4 Basic hazard communication information particular to the accessory battery on-board

5.4.5 Location of accessory battery emergency disconnect switch, if so equipped.

6 Activity Requirements

6.1 Test Activities

Testing shall be conducted by the Test Engineer under the supervision of the Test Manager and/or the Test Director. All testing shall be conducted in accordance with AVTA administrative, quality and test procedures. The results of testing shall be documented in a final report in accordance with the requirements of procedure AVTA-PHAC03.

During testing activities, if a vehicle fails to meet any "shall" requirement of the then effective PHEV Vehicle Specifications for any reason other than a propulsion battery reaching its design DOD limit, the vehicle shall be removed from the Test Program until such time as the manufacturer can repair it. The failure shall be documented by the Test Engineer using a Non-Conformance Report (Procedure AVTA-PHTP11, Appendix B). The Non-Conformance Report shall be transmitted to the vehicle supplier for resolution of the non-conformance. Vehicles which are removed from testing due to a failure as stated above shall not be subject to further testing until repairs are complete. Once repairs have been completed, every effort shall be made to complete as much of the remaining tests as possible. Vehicles not repaired in a cumulative total of 72 hours shall be considered to have failed the AVTA Test Program, and shall be removed from the program.

Non-Conformance Reports shall also be used to document any vehicle condition or test result which the Test Engineer considers unusual and requires response from the vehicle supplier. The Test Engineer shall complete the Non-Conformance Report and transmit it to the vehicle supplier, requesting response as soon as possible. The Test Engineer shall make a determination as to the need to halt testing of the vehicle pending resolution of the Non-Conformance Report by the vehicle supplier.

Activities related to specific Performance Testing are addressed by procedures specific to those test activities.

6.1.1 For any testing activity, all personnel assigned test team activities shall be familiar with the following:

- 6.1.1.1 The test being conducted
- 6.1.1.2 The parameters being measured
- 6.1.1.3 The anticipated results of the test
- 6.1.1.4 The metrology used in the conduct of the test
- 6.1.1.5 Contingency actions, in case of test/equipment failure
- 6.1.1.6 Emergency response actions in case of equipment damage (specifically battery damage, or failure of the battery and battery compartment)
- 6.1.1.7 Safety requirements.

6.1.2 Data sheets shall be filled out as the data is collected, unless the data must be downloaded from a Data Acquisition System (DAS).

6.1.3 If a DAS is used, the data shall be recorded on the data sheets as soon as practicable. At a minimum, all data transcription should be completed no later than seven (7) days following test completion, and verified by the Test Manager or Test Engineer.

6.1.4 Data sheets may be filled out by any member of the test team; however, the Program Manager, Test Manager or Test Engineer shall sign the completed data sheet attesting to the validity of the data collected.

6.2 Test Exceptions

Deviations from approved test methods, requirements and/or procedures shall not be permitted without approval of the Program or Test Manager. All exceptions shall be noted on Test Exception Report (TER), Appendix A. The following requirements apply to TERs:

6.2.1 All Test Exceptions shall be numbered.

6.2.2 The number shall use the format TER-PHTPXXX-YYYYY-ZZZ, where:

6.2.2.1 XXX indicates the procedure number being excepted

6.2.2.2 YYYYY indicates the last 5 digits of the vehicles VIN

6.2.2.3 ZZZ is the sequential number of all TERs written for that vehicle during the test program.

6.2.3 The number will be issued by the Test or Program Manager at the time of his/her signature.

6.2.4 All Test Exceptions shall be maintained with the Test Manager's Log, and shall be a permanent part of the Test Record.

6.2.5 TERs shall contain the following minimum information:

6.2.5.1 The procedure for which the TER is being written

6.2.5.2 The specific step being excepted

6.2.5.3 Why the exception is necessary

6.2.5.4 The justification for the exception

6.2.5.5 The date and time of the exception

6.2.5.6 The printed name and signature of the person requesting the exception

6.2.5.7 The printed name and signature of the person approving the exception, and the date of the approval.

6.2.6 If a deviation is taken and subsequently disallowed by the Program Manager or Test Manager, the original step shall be re-performed (as allowed by contract terms and conditions), within the requirements of the applicable Test Procedure, and so documented.

6.2.7 The Program Manager or Test Manager shall notify the test vehicle Supplier (as soon as practical) of deviations resulting from mechanical or electrical failure of the test vehicle. Time required for the Supplier to remedy the failure shall be tracked and recorded on the Test Exception Report. Repair time shall be logged in 24 hour increments and shall begin when the Supplier takes custody of the vehicle. Repair time shall end when the Supplier returns custody of the vehicle to the Program Manager or Test Manager. All work performed by the Supplier to repair the test vehicle shall be recorded on the Test Exception Report. Only work required to restore the vehicle to its pre-failure state shall be performed by the Supplier.

7 Supplemental Activity Requirements

7.1 Distribution

Distribution of documents shall be in accordance with procedure AVTA-PHAC01.

7.1.1 Distribution of the original documents or copies of the documents shall be controlled to ensure that only appropriate individuals receive them.

7.1.2 Subsequent to a documents completion (including signatures, as required), the original shall be transmitted in accordance with procedure AVTA-PHAC01.

7.2 Destruction of Documents

Destruction of original documents shall not be allowed. All test documents, including those for tests, which were either suspended or failed, shall be retained as part of the test record. Retention of documents shall be in accordance with procedure AVTA-PHAC01. Any exceptions shall be approved per the requirements of that procedure.

Appendix A – Test Exception Report

(Page 1 of 1)

TER # ______________________________

Procedure Being Excepted:	**Step Being Excepted:**
Requested by: Printed Name	Signature
Date of Request:	**Time of Request:**
Numbered by: Printed Name	Signature
Approval: (Circle ONE) YES NO	Signature

Reason for Request:

____
____
____
____
____

Impact to Test Procedure and/or Test Program:

____
____
____
____
____

Reason for Approval or Denial:

____
____
____
____
____

Additional Requirements due to Approval/Denial:

____
____

Reviewed By:		
(Printed Name)	(Signature)	(Date)
Approved By:		
(Printed Name)	(Signature)	(Date)

Section III: AVTA-PHAC03 – Preparation and Issuance of Test Reports

TABLE OF CONTENTS

1 Objective

The objective of this procedure is to identify the proper methods for the preparation of reports during and subsequent to U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA) testing activities. These methods are not meant to supersede those of the testing facility, nor of any regulatory agency who may have or exercise control over the covered activities.

2 Purpose

This procedure identifies acceptable methods for the development, use, completion and retention of reports prepared in support of performance testing of plug-in hybrid electric vehicles tested by the AVTA.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. Reports shall contain enough information to "stand alone"; that is, they shall be self-contained to the extent that all individuals expected to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

4.1 All relevant testing activities for the subject vehicle have been completed (as described in procedure AVTA-PHAC02) prior to the report being formally issued.

4.2 All necessary test documentation has been completed, reviewed and approved per the requirements of procedure AVTA-PHAC04, prior to the report being issued.

4.3 The method for distribution of the subject Report(s) shall be agreed upon prior to any report being formally issued.

4.4 Personnel who prepare Test Report(s) shall be familiar with the contents of this procedure as required by procedure AVTA-PHAC05.

5 Activity Requirements

A test report shall be issued for any vehicle submitted for AVTA testing, regardless of whether the vehicle is actually tested. Test reports should be issued within 30 days of the completion of testing. This section provides additional requirements for the formal Test Report.

5.1 Test Reports shall be the preferred mechanism for the objective reporting of data collected during AVTA testing.

5.2 These reports may utilize a variety of media and formats, including text, data file, graphical depiction, film/video tape and oral presentation.

5.3 The material for each vehicle shall be presented in a stand-alone format.

5.4 Data/test results shall not be provided in a comparative format. That is, each vehicle's data shall be presented independent of the data of other tested vehicles.

5.5 Report preparation shall include the following:

5.5.1 A Table of Contents

5.5.2 An Executive Summary

5.5.2.1 Vehicle Description

5.5.2.2 Test Conduct Summary

5.5.2.3 Summary Data Sheet

5.5.3 Test Program Summary

5.5.3.1 Test Sequence

5.5.3.2 Test Exception Reports (Procedure AVTA-PHAC02, Appendix A)

5.5.3.3 Non-Conformance Reports

5.5.4 Vehicle description

5.5.4.1 Vehicle inspections sheets

- Procedure AVTA-PHAC06, Appendix B
- Procedure AVTA-PHTP11, Appendix A

5.5.4.2 Vehicle supplier submittals required by PHEV Vehicle Specification, Appendix A

5.5.4.3 Appendices/Submittals

- Vehicle Specification, Appendix A
- Vehicle Specification, Appendix B

5.5.5 Test Results (one section for each Test Procedure) containing:

5.5.5.1 Test summary

5.5.5.2 All test procedure data sheets

5.5.5.3 Test Results Review check-sheet

5.5.5.4 Graphical information list (charts, graphs, plots, etc.).

5.5.6 Appendices

5.5.6.1 Appendix 1 - Vehicle photographs

5.5.6.2 Appendix 2 - Supplier's correspondence

5.5.6.3 Appendix 3 - Test Manager's Log

5.5.7 Exhibits

5.5.7.1 Exhibit A - PHEV Vehicle Specifications

5.5.7.2 Exhibit B - Supplier's Technical Submittal

5.5.7.3 Exhibit C - Supplier's FMVSS Submittal

5.5.7.4 Exhibit D - RESS Charge Log

5.6 The Test Report shall include any exceptions or deviations from the Supplier's proposal taken by the supplier.

5.7 The Test Report shall not be provided/made available to the Supplier for comment, prior to it's issuance except as noted in 5.9.

5.8 Test Reports should not contain raw data sheets.

5.9 Test Reports shall include a Summary Data Sheet. The Summary Data Sheet shall be provided to the vehicle supplier for comment prior to issuance of the Test Report.

5.10 At least one representative of each organization involved in testing activities shall sign the final report(s). This signature indicates their organization's concurrence with the data contained in the report. At a minimum, the Final Test Report for each vehicle shall be signed by the Test Manager.

5.11 Following completion, the Test Report shall be provided to the Supplier, the U.S. Department of Energy (if co-funding the testing) and to the manufacturer of the vehicle (if different than the Supplier and authorized by the Supplier).

5.12 All original test documents, including data sheets and files, shall be incorporated into the Test Report maintained in accordance with procedure AVTA-PHAC01.

Section IV: AVTA-PHAC04 – Review of Test Results

TABLE OF CONTENTS

APPENDICES

1 Objective

The objective of this procedure is to identify a common protocol for the review of test data obtained during conduct of U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA) test activities.

2 Purpose

This procedure establishes acceptable methods for the development, implementation and completion of test result processes used in conjunction with the performance testing of plug-in hybrid electric vehicles tested by the AVTA for testing.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Storage and retention of records shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

4.1 All documentation associated with the test under review shall have been completed by the test personnel, and signed by the applicable Test Manager or Test Engineer.

4.2 Individuals assigned to review test results shall be familiar with all phases and portions of the tests they are reviewing.

4.3 Prior to commencing test results review, a meeting of the personnel signing for the test completion shall be held to discuss the following:

4.3.1 Test requirements

4.3.2 Expected test results

4.3.3 Actual test results

4.3.4 Actual test methodologies

4.3.5 Test Exceptions, including reasons and justifications

4.3.6 Safety requirements.

4.4 A Team Leader with overall responsibility for test results review shall be assigned.

5 Personnel Qualifications

5.1 All individuals involved in covered test activities shall be trained and certified in accordance with the requirements of procedure AVTA-PHAC05.

5.2 All individuals involved in the review of test results shall be cognizant of the tests being reviewed and the methodologies involved, and shall be familiar with normal and accepted test conduct practices.

5.3 All individuals involved in the review of test results shall have a basic understanding of the metrology used in that testing.

5.4 For all test results review activities, assigned personnel shall be familiar with the following:

5.4.1 The test conducted

5.4.2 The parameters which were being measured

5.4.3 The anticipated results of the test

5.4.4 Allowable exceptions and their bases.

6 Activity Requirements

NOTE:
Test result documentation is controlled by this and other procedures. If a conflict arises between this and other procedures, this procedure shall take precedence for issues relating to test results. For conflicts in other areas, procedures which control those specific activities shall take precedence. Should the conflict not be clearly definable, the Program Manager shall be responsible for final resolution.

Activities related to specific Performance Testing will be addressed by procedures specific to those test activities (e.g., AVTA-PHTP01 is the specific procedure for controlling the requirements and methodologies necessary to implement testing per SAE J1263).

6.1 Data sheets shall be completely filled out. If a Data Acquisition System (DAS) was used to record part of the data, the data shall be down-loaded and charted, graphed, etc., prior to review.

6.2 Data sheets may have been filled out by any member of the test team. However, the Test Manager or Test Director shall sign the completed data sheet attesting to the validity of the data collected in accordance with procedure AVTA-PHAC02.

6.3 Deviations from approved test methods, requirements and/or procedures shall not be permitted unless approved by the Test Manager or Test Director, in accordance with procedure AVTA-PHAC02. All exceptions shall be noted in the comments section of the applicable test data sheet. For each exception taken, at a minimum, the following information must be present:

6.3.1 The specific step exception

6.3.2 Why the exception was necessary

6.3.3 The justification for the exception

6.3.4 The date and time of the exception

6.3.5 The printed name of the person who requested the exception, and their signature

6.3.6 The printed name of the person who approved the exception, their signature, and the date of the approval.

6.4 If a deviation was taken and subsequently disallowed by the Program Manager or Test Manager, the original step shall be re-performed, within the requirements of the applicable Test Procedure, and documented as such.

6.5 A Test Results Review Team (TRRT), comprised of at least one representative of each test organization shall review the test results.

6.6 One member of the TRRT shall be assigned as the Team Leader. This should normally be the Program Manager or the Test Manager.

6.7 The TRRT shall review test data for each test of each vehicle. The following reviews shall be completed:

6.7.1 Does the data collected appear reasonable to the requirements of the test conducted?

6.7.2 Is comparative data available?

6.7.3 Does the data correlate?

6.7.4 Does any test exceptions impact the validity of data?

6.8 When the test results review is complete, each member of the TRRT shall sign and date the Test Results Approval Form (Appendix A).

6.9 If any member of the review team takes exception to the results, those exceptions shall be noted. Every attempt to resolve the exceptions shall be made.

6.10 If the exceptions noted in Step 6.9 cannot be resolved, then one of two actions shall be taken:

6.10.1 If, in the opinion of the Team Leader, the results in question do not materially affect the test results, the exception shall be noted, and the test results approved.

6.10.2 If, in the opinion of the Team Leader, the test results in question materially or adversely affect the outcome of the test or the test results, then the results shall not be approved until the exception has been resolved. This may require re-performance of the test in question.

7 Supplemental Activity Requirements

7.1 Distribution of documents will be in accordance with the applicable revision of procedure AVTA-PHAC01.

7.1.1 Distribution of the original documents or copies of the documents shall be controlled to ensure that only appropriate individuals receive them.

7.1.2 Subsequent to a document's completion (review and approval, and signatures as required), the document shall be transmitted in accordance with procedure AVTA-PHAC01.

7.2 Destruction of Documents

Destruction of original documents is not allowed. All test documents, including those for tests which were either suspended or failed, shall be retained as part of the test record. Retention of documents shall be in accordance with procedure AVTA-PHAC01. Any exceptions shall be approved per the requirements of that procedure.

Appendix A – Test Results Review and Approval Form

(Page 1 of 2)

Procedure Reference:	Requirement:	Requirement Met:		Initials:	Date:
		Yes	No		
4.0	Initial Condition / Prerequisites have been met?				
5.0	Personnel meet the minimum qualifications?				
6.1	Data sheets are completely filled out?				
6.2	Test Manager / Test Engineer signatures are present?				
6.3	Were there any deviations from approved test methods?				
6.3.1	Which specific step was excepted: ___________				
6.3.2	Was the explanation for the exception noted?				
6.3.3	Was the justification for the exception noted?				
6.3.4	Were the date and time of the exception noted?				
6.3.5	Is the name of the person who requested the exception noted?				
6.3.6	Is the name of the person who approved the exception noted?				
6.4	Was the original step re-performed within test protocol requirements?				
6.7.1	Does the data collected appear reasonable to the requirements of the test conducted?				
6.7.2	Is comparative data available?				
6.7.3	Does the data correlate?				
6.7.4	Do any test exceptions impact the validity of the data?				
6.8	Test Results Review Team (TRRT) signatures are present?				
6.9	Does each member of the TRRT concur with the test results?				
6.9	Are the TRRT exceptions noted?				
6.10	Did any TRRT exceptions materially affect test results?				
6.10.2	Did any TRRT exceptions result in test re-performance?				

Appendix A - Test Results Review and Approval Form
(Page 2 of 2)

General Comments (initials / date):

Team Leader:	(Organization)	(Printed Name)	(Signature)	(Date)
Team Member:	(Organization)	(Printed Name)	(Signature)	(Date)
Team Member:	(Organization)	(Printed Name)	(Signature)	(Date)
Team Member:	(Organization)	(Printed Name)	(Signature)	(Date)

Section V: AVTA-PHAC05 – Training and Certification Requirements for Personnel Utilizing AVTA Procedures

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APPENDICES

1 Objective

The objective of this procedure is to assure that personnel conducting testing using U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA) procedures are qualified and trained to perform in a technically competent and safe manner. This procedure shall not supersede other training requirements that may be imposed by a contract or subcontract facility (e.g., location-specific Hazard Communication training). Rather, this procedure shall supplement those requirements.

2 Purpose

The purpose of this procedure is to identify minimum requirements for the certification and training of personnel performing activities directed by AVTA procedures.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Storage and retention of records shall be completed as described in procedure AVTA-PHAC01.

4 Prerequisites

4.1 All documentation required to document the training required by this or other procedures shall be completed, approved and issued prior to the testing it addresses being commenced. At no time shall these procedures be utilized prior to their noted effective date.

4.2 Individuals assigned to perform an activity controlled by an AVTA procedure shall have the background necessary to support the particular activity. This background may be through formal education, training, or "on-the-job" training.

4.3 Individuals assigned to perform an activity controlled by an AVTA procedure shall have received training and/or indoctrination in that activity. This applies to all personnel, including contract and subcontract.

4.4 Prior to commencing any activity, a meeting of the personnel involved in the activity shall be held to discuss the following:

4.4.1 Test purpose

4.4.2 Test requirements

4.4.3 Personnel requirements

4.4.4 Test methodologies

4.4.5 Expected contingencies and exceptions, including reasons and justifications

4.4.6 Methods required ensuring safety.

4.5 Individuals involved in activities that include the potential for exposure to hazardous materials or substances shall receive specific training for those hazards.

5 Personnel Requirements

5.1 Individuals involved in an activity controlled by an AVTA procedure shall understand the activity, the methodologies involved, and the normal and accepted practices associated with that activity. These individuals shall also be cognizant of requirements to mitigate off-normal occurrences that may become manifest during the covered activity.

5.2 Individuals involved in an activity controlled by an AVTA procedure shall participate in a briefing or training in that activity prior to their participation in the activity. This requirement may be met by group briefings, lectures, training sessions or one-on-one discussions.

5.3 Briefings will normally be performed by the Program Manager, Test Manager, or the appropriate Test Engineer. At a minimum, assigned personnel shall be briefed on the following:

5.3.1 The test being conducted

5.3.2 The specific steps of the procedure

5.3.3 The parameters which are being measured

5.3.4 The anticipated results of the test

5.3.5 Allowable exceptions, if any, and their bases

5.3.6 Safety requirements.

5.4 If the potential for exposure to hazardous materials exists, a briefing shall be held which addresses the specific materials and their associated hazards. This shall include, but not be limited to, hazard communication training.

5.5 Individuals conducting briefings/training sessions will normally be the Program Manager, Test Manager or the appropriate Test Engineer. This individual shall be familiar with the procedure in question.

5.6 Whenever a briefing or training session is conducted, a briefing form (Appendix A) shall be filled out, and signed by the individual conducting the session, and each individual who was in attendance.

5.7 One briefing form (Appendix A) shall be completed for each subject area addressed, even if multiple topics are covered at the same briefing session. [Example: If one group of individuals receives briefings on two unrelated topics at the same session (e.g., Handling Test and Rough Road Course Test), two briefing sheets shall be completed, one for each topic.]

5.8 These briefing forms noted in 5.6 and 5.7 shall be retained in accordance with procedure AVTA-PHAC01.

Appendix A – Training/Briefing Attendance Sheet

(Page 1 of 2)

Name of Training Lesson: ____

Instructor's Name: ________________________________ Date: ____________

PRINTED NAME	SIGNATURE	COMPANY	DATE

Appendix A – Training/Briefing Attendance Sheet
(Page 2 of 2)

Name of Training Lesson: ____

Instructor's Name: ______________________________ Date: ___________

PRINTED NAME	SIGNATURE	COMPANY	DATE

Section VI: AVTA-PHAC06 – Receipt Inspection

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APPENDICES

1 Objective

This procedure identifies a common protocol for the collection of verification data for each vehicle evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA). These activities shall be completed in conjunction with procedure AVTA-PHTP11 and prior to commencement of testing activities performed in accordance with the AVTA PHEV test procedures.

2 Purpose

This procedure identifies the verification parameters that shall be recorded prior to testing any plug-in hybrid electric vehicle (PHEV) provided to the AVTA. Additional verification requirements are addressed in procedure AVTA-PHTP11.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Storage and retention of records shall be completed as described in procedure AVTA-PHAC01.

4 Prerequisites

4.1 Individuals assigned to complete this procedure will be knowledgeable of the PHEV Vehicle Specification.

4.2 Individuals assigned to complete this activity will have received the appropriate training in accordance with procedure AVTA-PHAC05.

4.3 Prior to commencing this activity, a meeting of the involved personnel will be held to discuss the following:

- 4.3.1 Data required
- 4.3.2 Data available
- 4.3.2 Data sources
- 4.3.4 Contingencies
- 4.3.5 Safety requirements

4.4 Verification of all mandatory requirements presented herein must be completed prior to conduct of other testing, unless specifically exempted herein.

4.5 All documentation required to document the activities addressed by this procedure shall be completed, approved and issued prior to commencing the testing it addresses.

5 Verification Requirements

This procedure shall be completed for each vehicle, which is scheduled to be received for evaluation by the AVTA. The vehicle must be present to obtain some of the required information (curb weight, vehicle heights, ground clearance, etc.) However, a significant amount of information concerning the vehicle may be obtained from data provided by the Supplier prior to receipt of the vehicle. As such, this procedure may be implemented upon receipt of the Supplier's information, but shall not be completed prior to actual inspection of the vehicle.

5.1 Review the Supplier's provided documentation. Make a copy of the PHEV Vehicle Specification Appendices A and B, which the manufacturer has completed. Review these documents for the following:

5.1.1 All blanks have been filled in.

5.1.2 All required data has been provided.

5.1.3 For blanks, which have either no entry or an "N/A" (or similar notation), note the specific entry which is incomplete and the reason the entry is incomplete (if known).

5.1.4 The Program Manager or the Test Manager shall be notified of any missing data. They shall notify the Supplier's representative of the missing data, and request their assistance in obtaining it. All requests for data from the Supplier shall be made in writing, through the Program/Project Manager.

5.2 Upon receipt of the vehicle, the following information and "should" requirements shall be obtained by inspection of the vehicle and recorded in Appendix A.

5.2.1 Vehicle year, make and model

5.2.2 Vehicle manufacturer

5.2.3 Number of occupants

5.2.4 Amount of payload beyond passengers

5.2.5 Design curb weight

5.2.6 Design rated payload

5.2.7 The standard tire manufacturer

5.2.8 The standard tire model and size

5.2.9 Charger manufacturer

5.2.10 Motor manufacturer

5.2.11 Controller manufacturer

5.2.12 Heat engine configuration

5.2.13 Heat engine displacement

5.2.14 Heat engine fuel type

5.2.15 Vehicle is a conversion to PHEV

5.2.16 Type of transmission: [e.g., single speed, multi-speed automatic, manual or continuous variable transmission (CVT)]

5.2.17 Battery module weight

5.2.18 Battery pack weight

5.2.19 Battery pack(s) voltage

5.2.20 Number of modules in the battery pack

5.2.21 Battery one-hour rate discharge capacity.

5.3 Upon receipt of the vehicle, complete the Vehicle Receipt Checklist (Appendix B) by recording the required information. Measurements shall be taken and calculations made as required to complete the Vehicle Receipt Checklist. When complete, the Vehicle Receipt Checklist shall be compared with the information provided by the vehicle supplier (where available) and any discrepancies noted. If discrepancies are significant to test conduct, a Non-Conformance Report (Procedure AVTA-PHTP11, Appendix B) shall be issued and the discrepancy resolved with the vehicle supplier.

5.4 Take receiving pictures of the vehicle as required by Appendix B.

5.5 Using the data obtained in Sections 5.1 through 5.3, determine the potential vehicle operating modes. Determine the vehicle configuration, which will be tested as the Normal Operation mode. Determine if the vehicle is configurable in the RESS Only mode. If it is capable of RESS Only mode operation, determine the vehicle configuration, which will be tested as the RESS Only mode.

5.6 Appendix C identifies all optional (should) requirements of the PHEV Vehicle Specification. Most optional requirements can be verified by a physical inspection or document review. However, some optional requirements require measurement or dynamic test for validation. The methods for conduct of these measurements or dynamic tests are listed in this Section. Conduct testing to verify the following optional requirements of the PHEV Vehicle Specification not verified by specific Performance Test Procedures. Record the results of these tests in Appendix B. These tests may require installation of instrumentation. Testing with installed instruments may be delayed and conducted under a separate test procedure.

5.6.1 Verify that the speedometer is accurate to ± 5% of full scale and the odometer is accurate to ± 5% by conducting Section 5.3 of procedure AVTA-PHTP04.

5.6.2 Verify that the vehicle has a ground clearance of at least five (5) inches to all sprung portions of the vehicle by setting a 5-inch cubic go/no-go block, with the vehicle loaded to GVWR and standing on a flat surface. When the block is in contact with the flat surface and passed beneath the sprung portions of the vehicle, verify that the block does not contact any of the sprung portions of the vehicle.

5.6.3 During conduct of procedure AVTA-PHTP03, qualitatively verify compliance with the relevant sections of SAE J551 for electromagnetic radiated fields by operating the following devices to determine if any interference is being generated from the vehicle:

5.6.3.1 Cellular telephone

5.6.3.2 Mobile radio scanning over the 70 cm and 2M bands

5.6.3.3 Citizen band radio

5.6.3.4 Portable compact disc player

5.6.3.5 Notebook computer

5.6.3.6 Onboard audio equipment (AM/FM radio, cassette, CD.)

Devices and/or their antennae shall be located in a manner to maximize their potential for interference. [Prior to testing the initial vehicle, these devices shall be operated in the dynamometer with the dynamometer operating to verify there is no background interference.]

5.6.4 During conduct of procedure AVTA-PHTP06, verify that regenerative braking does not adversely impact the vehicle's braking ability by noting any unusual application of regenerative braking including, rapid application or release of regenerative braking and oscillation of regenerative braking force.

5.6.5 During conduct of procedures AVTA-PHTP02, and AVTA-PHTP05, verify that the vehicle drive-train system is capable of continuous operation at maximum vehicle speed and/or sustained grades without overheating or loss of component life by noting any abnormal operation resulting from overheating. If the vehicle is operable in the RESS Only mode, also conduct Section 5.2 of procedure AVTA-PHTP04.

5.6.6 During conduct of procedures, AVTA-PHTP02 and AVTA-PHTP05 verify that the vehicle drive train components do not produce or develop unusual vibrations over the entire design speed range of the vehicle by noting any unusual vibrations.

5.6.7 During conduct of procedure AVTA-PHTP02, Section 5.1, verify acceleration times of 13.5 seconds or less.

5.6.8 During conduct of procedure AVTA-PHTP02, Section 5.1, verify a minimum top speed of 90 mph.

5.6.9 During conduct of procedure AVTA-PHTP02, Section 5.3, verify a minimum sustainable speed of 55 mph on a 3% grade, and 45 mph on a 6% grade.

5.6.10 During conduct of procedure AVTA-PHTP02, Section 5.2, verify the vehicle is capable of starting and ascending a 25% grade.

5.6.11 During conduct of procedure AVTA-PHTP05, verify that the vehicle is capable of standing for extended periods in extreme temperatures without damage to or failure of the vehicle or it's systems by noting any failures during this test procedure.

5.6.12 During conduct of procedure AVTA-PHTP05, verify that the vehicle is capable of driving through two (2) inches of standing water at a speed of 20 mph without damage, without becoming inoperable, and without battery to chassis leakage current exceeding 0.5 MIU per UL Standard 2202 and is capable of setting in eight (8) inches of standing water for 15 minutes without damage, becoming inoperable, and without battery to chassis leakage current exceeding 0.5 MIU per UL Standard 2202.

5.6.13 Verify that hazard lights are capable of at least one hour of continuous operation in the event of shutdown or isolation of the main battery pack or failure of the DC/DC converter system by disconnecting the main propulsion battery from the auxiliary battery, then turning on the emergency flashers, and verifying that they operate for at least one hour.

5.6.14 Verify that the State of Charge indicator is accurate to ±5% of full scale by conducting Section 5.1 of procedure AVTA-PHTP04.

5.6.15 Verify that the recharge time with the grid connected charger is less than eight (8) hours by conduct of Section 6.7 of procedure AVTA-PHTP03 for vehicles not capable of operation in RESS Only mode or by conduct of Section 5.1 of procedure AVTA-PHTP04, for vehicles capable of RESS Only operation.

5.6.16 Measure the energy required to maintain the main propulsion battery in a fully charged state during extended periods on charge by conduct of Section 5.4.3 of procedure AVTA-PHTP08.

Appendix A – Vehicle Supplier Review Check List

(Page 1 of 2)

Vehicle Number: ___________________

PHAC06 Ref.	Parameter	Data
5.2.1	Vehicle year of manufacture:	
5.2.1	Vehicle make and model:	
5.2.2	Vehicle manufacturer:	
5.2.3	Number of occupants:	
5.2.4	Amount of payload beyond passengers:	
5.2.5	Design curb weight:	
5.2.6	Design rated payload:	
5.2.7	The standard tire manufacturer:	
5.2.8	The standard tire model and size:	
5.2.9	Charger manufacturer:	
5.2.10	Motor manufacturer:	
5.2.11	Controller manufacturer:	
5.2.12	Heat engine configuration:	
5.2.13	Heat engine displacement:	
5.2.14	Heat engine fuel type:	
5.2.15	Vehicle is a conversion to PHEV:	
5.2.16	Type of transmission:	
5.2.17	Battery module weight:	
5.2.18	Battery pack weight:	
5.2.19	Battery pack(s) voltage:	
5.2.20	Number of modules in the battery pack:	
5.2.21	Battery one-hour rate discharge capacity:	

Appendix A – Vehicle Supplier Review Check List
(Page 2 of 2)

General Comments (initials/date):

Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix B – Vehicle Receipt Check List

(Page 1 of 3)

VIN Number: ________________________

Date Received:				Odometer (miles):			
Vehicle Year:	Vehicle Make:				Vehicle Model:		
Vehicle Body Style:					Vehicle Color:		
GVWR (lbs):		Front GAWR (lbs):			Rear GAWR (lbs):		
Installed Tire Size – F/R:							
Sidewall Tire Pressure - F/R:							
Traction Motor Type:				Traction Motor Rating:			
Designated Seating - Front: Rear:				Front Seat Type:			
RESTRAINT SYSTEM DESCRIPTION							
Driver:		C.F. Pass:			R.F. Pass:		
L.R. Pass:		C.R. Pass:			R.R. Pass:		
VEHICLE CONDITION AND INSTALLED OPTIONS							
Air Conditioning		Power Steering		Power Brakes		Power Windows	
Power Door Locks		Cruise Control		Spare Tire		Front Wheel Drive	
Telescoping Wheel		Tilt Wheel		Front Disk Brakes		Rear Disk Brakes	
Power Seats		4 Wheel Drive		Anti-Lock Brakes		Regenerative Braking	
Additional Significant Options / Accessories:							
Significant Body Damage / Corrosion:____							
VEHICLE WEIGHTS AS RECEIVED (WITH MAX. FLUIDS)							
Left Front (lbs):		Right Front (lbs):		Total Front (lbs):		Percent Front:	
Left Rear (lbs):		Right Rear (lbs):		Total Rear (lbs):		Percent Rear:	
				Total Weight (lbs):			
VEHICLE HEIGHT AS RECEIVED (WITH MAX. FLUIDS)							
Left Front (in): at				Right Front (in): at			
Left Rear (in): at				Right Rear (in): at			
VEHICLE WEIGHTS WITH PAYLOAD (RECEIVED CURB + 300 POUNDS)							
Left Front (lbs):		Right Front (lbs):		Total Front (lbs):		Percent Front:	
Left Rear (lbs):		Right Rear (lbs):		Total Rear (lbs):		Percent Rear:	
				Total Weight (lbs):			
VEHICLE HEIGHT WITH PAYLOAD (RECEIVED CURB + 300 POUNDS)							
Left Front (in): at				Right Front (in): at			
Left Rear (in): at				Right Rear (in): at			

Appendix B – Vehicle Receipt Check List
(Page 2 of 3)

VEHICLE RECEIVING PHOTOGRAPHS							
Eight-Point Walk-Around:							
Front		Rear		Right Profile		Left Profile	
Right Front		Right Rear Quarter		Left Front		Left Rear Quarter	

Additional Misc:					
Instrument Cluster		VIN		Tire Placard	
Console Instrument Cluster		FMVSS Label		Battery Container	
Battery Charger (Off-board)		Drive System Components		Battery Charger (On-Board)	
Controller		Charger Connection		Misc. Placards	
Misc. Labels		Misc.( )		Misc.( )	
Misc.( )		Misc.( )		Misc.( )	

MISCELLANEOUS
Vehicle/Truck Trunk/Bed Space or Volume Encroachment: Yes ______ No ______
Using a 5-inch cubic go/no-go block, with the vehicle loaded to GVWR and standing on a flat surface, when the block is in contact with the flat surface and passed beneath the sprung portions of the vehicle, the block does not contact the sprung portions of the vehicle. CLEARANCE (inches) ________________
Disconnect the main propulsion battery from the auxiliary battery. Turn on the emergency flashers, and verify that they operate for at least one hour. This will verify loss of the main battery pack and a failure of the DC/DC converter. ACCEPTABLE______ UNACCEPTABLE______
Verify that the State of Charge indicator is accurate to ± 2% of full scale ACCEPTABLE______ UNACCEPTABLE______
Verify that the battery system voltage indicator is accurate to ± 2% of full scale. This can be completed by comparing the indication of this meter to the indication of a calibrated meter attached to the same voltage source. ACCEPTABLE______ UNACCEPTABLE______
Verify that the kilowatt-hour indicator is accurate to ± 5% of full scale. ACCEPTABLE______ UNACCEPTABLE______

Appendix B – Vehicle Receipt Check List
(Page 3 of 3)

General Comments (initials/date):			
Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix C – Vehicle Requirement Checklist

(Page 1 of 7)

Vehicle Number: __________

PHAC06 Reference	Vehicle Spec	Requirement	Requirement Met			Initial	Date
5.6	2.3	Suppliers should describe safety measures and safety-related design features included in their vehicle design and provide an explanation of the purpose and anticipated effect on vehicle reliability and performance of any such safety measure or design feature.	Yes	No	N/A		
5.5	2.5	Recycling plans for batteries and other vehicle hazardous materials should identify post-purchase costs associated with recycling that will be passed on to the vehicle purchaser.	Yes	No	N/A		
5.6	2.7	Vehicles should be designed to minimize occupant exposure to electromagnetic fields generated by the propulsion system.	Yes	No	N/A		
5.6.1	3.4	Speedometers and odometers should have an accuracy of at least ± 5%.	Yes	No	N/A		
5.6	3.5	For conversion vehicles, braking and steering efforts should be similar to OEM models of comparable size and weight.	Yes	No	N/A		
5.6.2	3.7	Vehicles should have a ground clearance of at least five (5) inches to all sprung portions of the vehicle, with the vehicle loaded with rated payload (e.g. to GVWR).	Yes	No	N/A		
5.6	4.2	Suppliers should specify interior passenger and cargo dimensions and volumes.	Yes	No	N/A		

Appendix C – Vehicle Requirement Checklist
(Page 2 of 7)

Vehicle Number: __________

PHAC06 Reference	Vehicle Spec	Requirement	Requirement Met			Initial	Date
5.6.3	4.3	Vehicles should comply with the relevant sections of SAE J551 for electromagnetic radiated fields. Vehicles should not be susceptible to externally generated electromagnetic radiation from an on-board transmitter (i.e., interaction will not preclude operation of any system(s) required for proper operation of the vehicle).	Yes	No	N/A		
5.6	5.1	The vehicle should utilize a single speed, multi-speed automatic, or a Continuous Variable Transmission (CVT)	Yes	No	N/A		
5.6.4	5.2	Regenerative braking should not adversely impact the vehicle's braking ability on varying road surfaces.	Yes	No	N/A		
5.6		Suppliers should describe the operation of the regenerative braking system and its interface with braking and anti-lock brake systems.	Yes	No	N/A		
5.6.5	5.3	The vehicle drive-train system should be capable of continuous operation at maximum vehicle speed and/or sustained grades without overheating or loss of component life over the range of ambient temperatures specified in the PHEV Vehicle Specification Section 6.	Yes Yes	No No	N/A N/A		
5.6	5.4	Suppliers should specify the voltage limits and describe how these limits are implemented.	Yes	No	N/A		
5.6.6	5.5	Drive train components should not produce or develop unusual vibrations over the entire design speed range of the vehicle.	Yes	No	N/A		

Appendix C – Vehicle Requirement Checklist
(Page 3 of 7)

Vehicle Number: __________

PHAC06 Reference	Vehicle Spec	Requirement	Requirement Met			Initial	Date
5.6.7	6.1	The vehicle should have a 0-60 mph acceleration time of 13.5 seconds or less with the vehicle loaded to its design curb-weight plus 300 pounds in each of the selectable modes of operation, as applicable.	Yes	No	N/A		
5.6.8	6.2	The vehicle should have a minimum top speed of 90 mph with the vehicle loaded to its design curb-weight plus 300 pounds in each of the selectable modes of operation, as applicable.	Yes	No	N/A		
5.6.9	6.3	Vehicles should achieve a minimum sustainable speed of 55 mph on a 3% grade, and 45 mph on a 6% grade, with the vehicle loaded to its design curb-weight plus 300 pounds, in each of the selectable modes of operation, as applicable.	Yes	No	N/A		
5.6.10	6.4	Vehicles should be capable of starting and ascending a 25% with the vehicle loaded to its design curb-weight plus 300 pounds in each of the selectable modes of operation, as applicable.	Yes	No	N/A		
5.6.11	6.5	Vehicles should be capable of completing the Rough Road Test (Procedure AVTA-PHTP05) without becoming inoperable.	Yes	No	N/A		
5.6.12	6.6	Vehicles should be capable of driving through two (2) inches of standing water at a speed of 20 mph without damage, without becoming inoperable, and without battery to chassis leakage current exceeding 0.5 MIU per UL Standard 2202.	Yes	No	N/A		

Appendix C – Vehicle Requirement Checklist
(Page 4 of 7)

Vehicle Number: __________

PHAC06 Reference	Vehicle Spec	Requirement	Requirement Met			Initial	Date
5.6.12	6.6	Vehicles should be capable of setting in eight (8) inches of standing water for 15 minutes without damage, becoming inoperable, and without battery to chassis leakage current exceeding 0.5 MIU per UL Standard 2202.	Yes	No	N/A		
5.6	7.1	Suppliers should provide a detailed description of the RESS battery pack (including specific energy, specific power and discharge capacity to 80% DOD at the one-hour rate), battery pack voltage, number of battery modules, and a summary of previous performance tests.	Yes	No	N/A		
5.6	7.3	Suppliers should indicate the level of charge below which the batteries should not be discharged.	Yes	No	N/A		
5.6		This should include the specific parameters the Battery Management System utilizes to prevent over-discharge.	Yes	No	N/A		
5.6		At a minimum the Ah rating(s), module voltage(s), and battery pack voltage(s) should be provided.	Yes	No	N/A		
5.6		Further, this should be consistent with information provided in the Owner's Manuals.	Yes	No	N/A		
5.6	7.4	Suppliers should specify the weight of each battery module, and the weight of the battery pack (including removable pack structures).	Yes	No	N/A		

Appendix C – Vehicle Requirement Checklist
(Page 5 of 7)

Vehicle Number: __________

PHAC06 Reference	Vehicle Spec	Requirement	Requirement Met			Initial	Date
5.6	7.4	Suppliers should describe how batteries are installed in the vehicle (including details of module connection), the method of installation and removal of the batteries (and the battery box, if required) for maintenance and repair, the time required for battery removal and any special training, tools or equipment required for battery removal.	Yes	No	N/A		
5.6	7.8	Maintenance requirements for the RESS batteries should be described and any associated cost(s) to the consumer/end user clearly defined.	Yes	No	N/A		
5.6	7.9	Maintenance requirements for other RESS components (e.g., flywheels, ultra capacitors) should be described and any associated cost(s) to the consumer/end user should be clearly defined.	Yes	No	N/A		
5.6	7.11	The vehicle should be equipped with a BMS. This system should control propulsion battery pack and module voltages, temperatures and state of charge during both charge and discharge.	Yes	No	N/A		
5.6		Further, the BMS should automatically limit battery discharge below a pre-determined minimum level.	Yes	No	N/A		
5.6		The description of the BMS operation should be consistent with that provided in the owner's manual.	Yes	No	N/A		
5.6	8.1	Markings for HIGH VOLTAGE devices should be installed at any point the voltage can be accessed by the end user.	Yes	No	N/A		
5.6	8.2	Supplier should provide details on grounding and isolation methods.	Yes	No	N/A		

Appendix C – Vehicle Requirement Checklist
(Page 6 of 7)

Vehicle Number: __________

PHAC06 Reference	Vehicle Spec	Requirement	Requirement Met			Initial	Date
5.6	8.3	Vehicles should be equipped with an automatic disconnect for the RESS batteries which operates to isolate the propulsion circuits any time the chassis becomes energized from contact with the propulsion battery or its associated circuits.	Yes	No	N/A		
5.6		A manual service disconnect should also be present. This disconnect should be operable with the following capabilities: • Manual action to break the connection • The disconnection is physically verifiable • The disconnection does not create exposed conductors capable of becoming energized while exposed.	Yes	No	N/A		
5.6.13	8.5	Hazard lights should be capable of at least one hour of continuous operation in the event of shutdown or isolation of the main battery pack or failure of the DC/DC converter system.	Yes	No	N/A		
5.6.14	8.6	The vehicle should include a state of charge indicator for the RESS batteries. Indications should be accurate to ± 5% of full scale.	Yes	No	N/A		
5.6	8.7	Low voltage connectors should meet the requirements of applicable SAE Standards, including J163, J561, J858, et al. High voltage connectors should utilize locking devices, should be keyed to prevent misconnection, and should be moisture proof.	Yes	No	N/A		

Appendix C – Vehicle Requirement Checklist
(Page 7 of 7)

Vehicle Number: __________

PHAC06 Reference	Vehicle Spec	Requirement	Requirement Met			Initial	Date
5.6.15	9.1	The preferred recharge time with the grid connected charger should be less than eight (8) hours.	Yes	No	N/A		
5.6.16		The charger should also minimize the energy required to maintain the main propulsion battery in a fully charged state, particularly during extended periods on charge.	Yes	No	N/A		
5.6	9.2	Any conductive or inductive type charging systems should be in accordance with the requirements of SAE J1772 or J1773.	Yes	No	N/A		
5.6	9.4	Suppliers should describe the type, size and location of the point of the vehicle charging port.	Yes	No	N/A		
5.6		The charge connector should comply with the requirements of SAE J1772 or SAE J1773, as appropriate.	Yes	No	N/A		
5.6	10.1	Suppliers should describe the design of the air conditioning system and verify that it uses no chlorofluorocarbons (CFCs).	Yes	No	N/A		
5.6	10.2	Suppliers should briefly describe the design of a pre-heating and pre-cooling system that allows passenger compartment temperatures to be maintained while the vehicle is on charge.	Yes	No	N/A		
5.6	11.1	Manuals should include details on the design and operation of vehicle systems, as well as a list of additional or special maintenance tools required.	Yes	No	N/A		
5.6	11.2	Suppliers should offer a training program for the purchaser's maintenance personnel covering vehicle safety and proper operation and maintenance of vehicles.	Yes	No	N/A		

Section VII: AVTA-PHAC07 – Control of Measuring and Test Equipment

TABLE OF CONTENTS

APPENDICES

1 Objective

The objective of this procedure is to assure that Measuring and Test Equipment (M&TE) used for U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA) testing is properly functioning and accurately calibrated. These methods are not meant to supersede those of the testing facility, those specifically mandated by governmental regulations, nor of any regulatory agency who may have or exercise control over the covered activities.

2 Purpose

The purpose of this procedure is to identify acceptable methods for the control of M&TE. This includes requirements for calibration of M&TE, control of the standards, services and resources needed for the calibration processes and the use of external resources for calibration activities. This procedure also satisfies the requirements for these activities as specified in procedure AVTA-PHQP01.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, it will be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities will be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

4.1 This program is applicable to all M&TE utilized for data collection purposes, modified as follows:

4.1.1 Vendor’s M&TE that meets the requirements of a formal program administered by that vendor and subject to audit under the requirements of procedure AVTA-PHQA01, shall be considered to meet the requirements of this procedure.

4.1.2 Devices such as rulers, tape measures, laboratory glassware, volumetric transfer equipment, and other similar devices used in applications where normal commercial accuracy is acceptable shall be accepted at face value. There shall be no further requirement for control of these items as long as they are controlled in a manner that precludes their use in conditions other than as noted.

4.1.3 Equipment that is permanently installed and used in applications not requiring other than normal commercial accuracy (similar to that noted in 4.1.2).

4.1.4 Equipment controlled or regulated by agencies outside the control of the AVTA (such as the equipment regulated by the Federal Communications Commission).

4.2 All calibration activities and resources shall be traceable to the National Institute of Standards and Technology (NIST), or to standards nationally recognized and commensurate with the desired usage. If an appropriate standard exists, calibration bases shall be identified and documented.

5 Activity Requirements

The requirements of this procedure apply to the activities listed here and to the personnel responsible for implementing them. Activities that are not listed or identified herein shall not be considered exempted by their absence, as long as their required function or use is controlled by this activity.

5.1 Equipment Indexing

5.1.1 All equipment maintained for use and data collection and/or processing by Electric Transportation Applications shall be formally identified, numbered and indexed.

5.1.2 Equipment shall be cross referenced to other associated equipment (e.g., calibrated meter probes shall reference the meter with which they are used and calibrated).

5.1.3 Cross references shall contain the applicable Certificates of Conformance, and identify the calibration standards and associated M&TE, when appropriate.

5.2 Calibration Labeling

5.2.1 M&TE equipment shall be labeled, tagged or otherwise controlled to indicate its calibration status and ensure its traceability to calibration test data.

5.2.1.1 Labeling shall be plainly visible and as a minimum should contain:

- The equipment serial number
- The most current calibration date
- The next required calibration due date.

5.3 Intervals of Calibration

5.3.1 Measuring and test equipment (M&TE) should be calibrated at specified intervals, or should be based on the items:

5.3.1.1 Required accuracy

5.3.1.2 Intended use

5.3.1.3 Frequency of use

5.3.1.4 Stability characteristics

5.3.1.5 Any other conditions affecting its performance.

5.3.2 Calibration shall be according to pre-planned equipment schedules based upon an annual/biannual cycle. Frequencies may be increased dependent upon equipment sensitivity and use.

5.3.3 An Instrument Calibration list shall be maintained and shall contain the following minimum information:

5.3.3.1 Equipment type

5.3.3.2 Equipment description

5.3.3.3 Manufacturer

5.3.3.4 Manufacturer's model number

5.3.3.5 Manufacturer's serial number

5.3.3.6 Electric Transportation Application's index number

5.3.3.7 Calibration status

5.3.3.8 Calibration due date

5.4 Calibration Requirements

5.4.1 M&TE shall be calibrated against standards which provide accuracy closer than the required tolerances of the equipment being calibrated. [If a meter has a stated accuracy of 0.5% of full scale, the calibration standard shall not have the result of reducing that stated accuracy.] If nationally recognized standards exist, calibration standards shall be traceable to such standards.

5.5 Documentation Requirements

5.5.1 Documents related to calibration activities shall be maintained and controlled in accordance with the requirements of procedure AVTA-PHAC01.

5.6 Personnel Qualifications

5.6.1 Personnel who perform calibrations or review and/or approve calibrations shall be certified in accordance with procedure AVTA-PHAC05.

5.7 Environmental Controls

5.7.1 All calibration standards shall be maintained, calibrated, transported, used and stored in environments required by the calibration standards governing the particular calibration requirements (e.g., NIST, QAM, ISO-900X), which will not adversely affect their accuracy.

5.7.2 All M&TE shall be maintained within the environmental parameters specified by the particular manufacturer. This applies to calibration, storage and use.

5.8 Non-Conforming Equipment

5.8.1 When M&TE is found to be out of tolerance during its periodic calibration or it is not possible to determine the calibration status due to equipment condition or location, a Non-Conforming Condition is said to exist.

5.8.1.1 The condition type and apparent cause shall be documented.

5.8.1.2 The condition shall be evaluated to determine the impact on tests completed using the non-conforming equipment since the previous calibration.

5.8.1.3 The non-conforming equipment shall be removed from further service (red tag) until the cause of the non-conformance has been corrected or the non-conforming equipment has been recalibrated.

5.9 Vendor's M&TE

5.9.1 M&TE controlled by a vendor's M&TE program need not be subject to this procedure if all of the following are met:

5.9.1.1 The vendor's M&TE is controlled by an approved calibration program that incorporates requirements equivalent to the requirements in this program and associated practices.

5.9.1.2 The vendor maintains documentation controls for the calibration status and records of tools and gauges utilized.

5.9.1.3 The vendor's program and records are available for audit.

5.9.1.4 The scope of the vendor's work is clearly defined and controlled by a purchase order or contract.

5.10 Procurement of Outside Services

5.10.1 Outside services may be utilized for equipment calibration/re-calibration. Should outside facilities be utilized for the calibration of equipment controlled by this program, those facilities shall provide a calibration certificate or data sheet for each item calibrated which contains, at a minimum, the following information:

5.10.1.1 Name of the item

5.10.1.2 Manufacturer's serial number of item

5.10.1.3 Date of the calibration

5.10.1.4 A statement indicating the standards used in calibration, test numbers or other means of documenting traceability

5.10.1.5 A statement of calibration accuracy ratio(s) or a statement of the accuracy of the standard(s) used and the M&TE calibrated

5.10.1.6 A statement of the facility's calibration standards and their traceability to NIST or other nationally recognized standards

5.10.1.7 A statement of equipment conformance to the calibration specifications in the "as found" or pre-calibration condition

5.10.1.8 In the event that the M&TE did not conform to the calibration specifications in the "as found" condition, a statement shall be written containing one of the following:

5.10.1.8.1 A statement specifically defining the out-of-tolerance condition

5.10.1.8.2 A statement specifically identifying the cause of the out-of-tolerance condition

5.10.1.8.3 A statement specifically identifying all of the work performed to correct the out-of-tolerance condition, including components/parts replaced.

5.10.2 Procurement activities for M&TE calibration standards and equipment shall be completed by personnel familiar with metrology requirements and who are certified to procedure AVTA-PHAC05.

5.10.3 Procurement of external services for calibration and/or repair services for M&TE shall be only from vendors who have been subjected to or agreed to an audit under the requirements of procedure AVTA-PHQA01.

Appendix A – Metrology Setup Sheet

(Page 1 of 1)

Instrument/Device:	Calibration Due Date:	Initials / Date:
Fifth Wheel S/N:		
Fifth Wheel Calibrator S/N:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Tire Pressure Gauge S/N:		
Misc:		
Misc:		
Misc:		
Misc:		
Comments (initials/date):		
Completed By: (Printed Name)	(Signature)	(Date)
Reviewed By (QA): (Printed Name)	(Signature)	(Date)
Approved By: (Printed Name)	(Signature)	(Date)

Appendix B – Instrument Calibration List Annual/Semi-Annual Calibration

(Page 1 of 1)

Equipment Type:	Equipment Description:	MFG:	Model No:	Serial No:	AVTA No:	Status:	Cal Loc:	Last Cal:	Cal Due:

Exhibit A – Instrument Calibration Label (Sample)

Company Name

Serial Number:
0001

CALIBRATION DUE DATE:
01/01/08

Chapter III: Quality Procedures

Section I: AVTA-PHQA01 – Audit of the Quality Assurance Program for the Control and Use of Measuring and Test Equipment

TABLE OF CONTENTS

APPENDICES

1 Objectives

The objective of an audit is to verify the adequacy of the operational characteristics of a facility's quality assurance practices, specifically as they relate to the control of metrology.

2 Purpose

The purpose of the audit is to ensure that the Quality Assurance Program requirements which address the control of metrology, or Measuring and Test Equipment (M&TE), are used at facilities which may be subcontracted to perform testing for the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA) program. This includes control measures for all aspects of the calibration and use processes, repair and rework of defective instrumentation. The Audit Plan shall include, but not be limited to, one or more aspects of the following:

- Control of the facility's metrology calibration processes
- Control of the facility's metrology calibration standards
- Control of the facility's metrology procedures
- Control of the facility's metrology records, including retention requirements
- Control and reporting of defective metrology
- Rework/repair of defective metrology
- Rework/repair of metrology which fails in service.

3 Requirements

The Quality Assurance (QA) Plan being audited shall be developed in accordance with the requirements of The National Bureau of Standards Handbook (NBS/HB)-145, or another similar document. The QA Plan is required to contain controls for those items specified as necessary by the NBS/HB-145. For those items required by the NBS/HB but not specifically contained in the QA Plan, the NBS requirements for alternatives must be followed.

4 Personnel

Personnel who conduct the audit shall either be trained or have experience in this type of activity. Training may be formal, such as through post-secondary or post-graduate studies, or through an approved or generally accepted Industry or Corporate Training Program. Experience should be gained through actual auditing of QA Activities or Plans at other facilities or companies, which may include those controlled by Federal or State Governments. Individuals should be capable of being certified as an auditor to the requirements of the QA standard used as the basis for the QA Plan being audited.

Personnel who are assigned as members of the audit team shall have the experience, training or educational background, as identified in Section 8.7, necessary for them to participate as audit team members.

5 Documentation

The documentation used and generated during the Audit Process should be retained as a permanent part of the audit package. Copies of the completed audit, including all checklists and reports, noted deficiencies and any corrective action activity reports, shall be made available to all members of the audit team, as well as to the management of the facility being audited. The audited facility shall maintain the results of the Audit in accordance with the external auditing requirements of their QA Plan, if so stipulated. If not otherwise stipulated, the results of the audit shall be maintained until the date of completion of all activities addressed by the governing contract.

All documents shall be signed by the person completing the document and the Audit Team Leader. The names of the audit team members shall be listed in the document. The final Audit Package will be signed by all members of the Audit Team, and signed by the Manager of the facility or group being audited, or a designated representative. These final signatures shall be attached following completion of the exit meeting process, and will signify that all signers have been made aware of the audit findings, and have received a copy of the final report. Signatures of additional facility personnel, as required by NBS/HB-145 or the facility's QA plan or audit program, shall be affixed as appropriate.

6 Process

The audit shall utilize checklists and interviews to obtain data. Procedures and controls specified by NBS/HB-145 and others as may be specified by the Facility's QA plan are subject to review. Only data which is relevant to the particular process under review shall be collected. Every attempt shall be made to keep the identity of interviewees confidential, as individual reproach is not the intent of this effort. Audit findings, in the opinion of the audit team, which are considered or judged to be unsafe, or could be reasonably expected to jeopardize the safety of the interviewee, other individuals or equipment, or which in turn could jeopardize the safety of subsequent individuals, shall be reported to a senior member of the Subcontractor’s organization.

7 Protocol

Audit activities shall take place at the sub-contractor’s facilities, unless otherwise agreed to in advance. Activities are limited to those activities identified in this Plan. Activities not under the scope of this Plan should not be audited, but may be otherwise noted or reported. Personnel conducting an audit at a subcontractor’s facility are required to follow the confidentiality guidelines and the security and safety requirements of that subcontractor.

All findings of the Audit shall be maintained confidential until the report has been completed, reviewed and signed by all members of the Audit team or their designated representative. The final report should be maintained as previously stipulated. It may be maintained for longer periods, as directed by the facility's requirements for record retention.

8 Activities

8.1 Quality Assessment

Quality Assessment is the term that describes those activities and procedures utilized to monitor the effectiveness of the quality control program and to evaluate the quality of the data output. Such an assessment can be from either an internal or external approach. Because this assessment is intended to quantify the reviewed activities as satisfactory or unsatisfactory only as they relate to the U.S. Department of Energy Advanced Vehicle Testing Activity Performance Test Program, it will be implemented using an external approach. This Plan could be utilized in either manner, however. Appendices C through G shall be used to document the results of the assessment.

8.2 Quality Assurance Program Document

The various aspects of the QA practices should be developed and described in a QA program document. This document should describe the maintenance procedures for facilities and equipment, the control charts to be maintained and "out-of-control" records that should be kept. [As used here, out-of-control means that the records in question have been removed from controlled status, either by time frame or super cession.] This program is only as effective as it is systematically implemented. This means that the QA Program shall have been formally established, and that it documents the policy and procedures to be followed.

8.3 Documentation

All data shall be technically sound and supportable by evidence of unquestionable reliability. Requirements for specific activities and personnel qualification are set forth in Sections 8.4 through 8.7. At a minimum, records shall be both adequate and accurate, and should contain the following items:

8.3.1 What measurements are being performed

8.3.2 Name of the individual(s) performing the measurement

8.3.3 What time the measurements are made.

8.3.4 How measurements are made:

8.3.4.1 The kinds of equipment being used

8.3.4.2 Calibrated or not calibrated and any supporting data

8.3.4.3 Methodology for measurement.

8.3.5 The data obtained

8.3.6 Calculations used to collect or quantify the data

8.3.7 Quality assurance support

8.3.8 Reports.

8.4 Laboratory Administration

The following administrative practices have been identified as necessary for providing proper management of a metrology laboratory and to facilitate good measurement. These items may be duplicates of those listed previously. Maintenance of Standards and Instruments

8.4.1 Maintenance of a proper laboratory environment, including:

8.4.1.1 Laboratory temperature

8.4.1.2 Laboratory humidity

8.4.1.3 Laboratory air flow/currents

8.4.1.4 Vibrations

8.4.1.5 Restricted access

8.4.1.6 Cleanliness.

8.4.2 Filing Systems, including the following separate categories:

8.4.2.1 Reference materials

8.4.2.2 Annual data sheets and reports

8.4.2.3 Reference standards, reports of calibrations and tests

8.4.2.4 Reports of calibrations and tests

8.4.2.5 Correspondence.

8.4.3 Numbering Systems for Tests, including:

8.4.3.1 Calibration tests and tests with the year and sequence number

8.4.3.2 State name (abbreviation or initials)

8.4.3.3 Master record of all test numbers, items, dates, submitters.

8.4.4 Training programs and records, including:

8.4.4.1 Records of a continuous educational program

8.4.4.2 Participation in NBS training Programs (required).

8.5 Laboratory Records

8.5.1 All data should be recorded in notebooks or on data sheets specifically designed for the purpose.

8.5.2 All entries shall be dark and clear enough for photocopy.

8.5.3 Erasures (including the use of whiteout or any similar substance) are not permitted in notebooks or data sheets. If an error is made, it shall be crossed out with a single line, and the correct data recorded. The initials of the person who made the change, along with the date of the change shall be recorded in the margin at the point of error.

8.5.4 Clear identification of what was tested, how the measurements were made and by whom are prime requirements. Any deviations from standard practices shall be documented.

8.5.5 The identity of the sample or item tested must be unquestionable. This may require a chain-of-custody, providing evidence of positive and unbroken custodial action for the sample or test item. There should be no gaps of custody, unless such gaps can be identified as having been due to locked storage or shipping container.

8.6 Calibration/Test Report Preparation

Test reports are the viable output of the laboratory/facility. They should be prepared with the utmost care to ensure they accurately convey all of the pertinent information of the testing activity. A properly prepared test report can be considered a "stand-alone" document, one which contains or refers to all of the information necessary to justify the data therein. It may contain fill-in blanks, a detailed narrative, or both. Appendices A and B contain recommended formats for these processes. Regardless of the final form, the following information shall be included:

8.6.1 Client

8.6.2 Purpose of the test (or reference to a "motherhood" document)

8.6.3 Description of the test/calibration item, including:

8.6.3.1 Manufacturer's name

8.6.3.2 Manufacturer's model number

8.6.3.3 Manufacturer's serial number

8.6.3.4 Laboratory number.

8.6.4 Test Method, including how the test was done, explicit reference to another document, or narrative descriptions of the test activity

8.6.5 Test Results

8.6.6 Limits of uncertainty

8.6.7 Traceability/In-Tolerance, including:

8.6.7.1 Reference standards used

8.6.7.2 Traceability to national standards

8.6.7.3 Whether or not the instrumentation used was/was not in tolerance at the time of calibration.

8.6.8 References

8.6.9 Signatures

8.6.9.1 The laboratory director or designated alternate shall sign all laboratory test reports.

8.6.9.2 Other signers may be required, at the direction of the Laboratory Director.

8.6.10 Conclusions of the test, especially when the test is of more than routine significance. This is especially true when the conclusions drawn can result in limitations on the results, whether necessary or desirable.

8.6.11 Each Test Report shall:

8.6.11.1 Be given a unique characteristic identification number according to the system developed by the Laboratory

8.6.11.2 Be filed according to the Test Report Number

8.6.11.3 Retain copies of the test reports for a minimum of five years, until superseded by a subsequent report, or until deemed by the laboratory director as having no future value.

8.7 Personnel

A competent staff is an absolute necessity for quality measurements. Each member shall have an educational background, supplemented with specific training and experience, sufficient for the duties to be performed. Each person shall be aware of and understand the responsibilities of their position (which can be accommodated by suitable position descriptions and indoctrination) and must have the personal desire to perform them at a high level of competence. Further, these individuals are critical factors in the operational aspects of quality assurance. They must perform technical operations intelligently and skillfully, and in the full spirit of quality assurance requirements. To this end, the following should be verified:

8.7.1 Educational background of each individual

8.7.2 Supplemental training of each individual

8.7.3 A position description for each individual

8.7.4 An indoctrination record for each individual.

Appendix A – Recommended Format for Routine Test Report

Test Report
Issued by
(Name of Testing Laboratory)
Laboratory Report Number ____________

Test Item(s)/Lab No(s): ____
____

Submitted by: ____
Date: ____
Purpose of Test: ____
____
____
____

Test Results*:

As-Found **After Adjustment**

Reference Information:

Test Method: ____
Traceability: ____
Data Reference: ____
Test Results Certified by (Name, Title, Date): ______________________________
____
____
____

***See Test Report, if appropriate**

Appendix B – Recommended Format for Certificate of Traceability

Company Name

Company
Address

CERTIFICATE OF TRACEABILITY

Name of Device:

Model: **Serial Number:**

Submitted By:

The calibration was performed on (date) ______________________. The ambient conditions were ______ °C and ______ % relative humidity. The item tested was/was not in tolerance at the time of calibration. Any out of tolerance data are attached.

Data:

The primary standards to which the above data are traceable are identified in this report. The calibration of these standards is traceable to the National Bureau of Standards. The cycling and certification of all standards of measurement at this facility meet the requirements of MIL-STD-45662.

Name of Standard	NBS Report	Date Calibrated	Date Due

Test Results Certified by (Name, Title, Date): ______________________________
____
____
____

Appendix C – Checklist #1, Documentation

Sect.	Requirement	Acceptable Yes No	Initials/Date
8.3.1	What measurement is being performed	__________	______/____
8.3.2	Who performed the measurement is noted	__________	______/____
8.3.3	Time of measurement is recorded	__________	______/____
8.3.4	How measurements are made	__________	______/____
8.3.4.1	What kind of equipment is being used	__________	______/____
8.3.4.2	Data supporting calibrated/not calibrated is noted	__________	______/____
8.3.4.3	Methodology for measurement is noted	__________	______/____
8.3.5	The data obtained is noted and relevant	__________	______/____
8.3.6	Calculations used to collect or quantify the data	__________	______/____
8.3.7	Quality assurance support is noted	__________	______/____
8.3.8	Reports are issued and complete	__________	______/____

Comments, Exceptions, Corrective Actions, Etc. ______________________________

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Checklist Completed by (name, title, Company) ______________________________

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Date Initiated______________________ **Date Completed** ____________________

Reviewed By (Name, Title, Company)/Date ________________________________

Approved by (Name, Title, Company)/Date ________________________________

Appendix D – Checklist #2, Administration

Sect.	Requirement	Acceptable Yes No	Initials/Date
8.4.1	Laboratory environment is properly maintained	__________	______/_____
8.4.1.1	Laboratory temperature is controlled (± 1° C)	__________	______/_____
8.4.1.2	Laboratory humidity is controlled (35-55%)	__________	______/_____
8.4.1.3	Laboratory air flows/currents are dampened	__________	______/_____
8.4.1.4	Facility is free of vibrations	__________	______/_____
8.4.1.5	Facility has restricted access	__________	______/_____
8.4.1.6	Facility is clean	__________	______/_____
8.4.2.1	Reference Materials Files exist	__________	______/_____
8.4.2.2	Annual data sheets and reports files exist	__________	______/_____
8.4.2.3	Reference standards files exist	__________	______/_____
8.4.2.4	Reports of Calibrations and Tests files exist	__________	______/_____
8.4.2.5	Correspondence files exist	__________	______/_____
8.4.3.1	Documents have a sequence number, with year	__________	______/_____
8.4.3.2	Sequence number uses State name (abbr./initials)	__________	______/_____
8.4.3.3	Master record exists with appropriate data	__________	______/_____
8.4.4.1	Continuous educational program records exist	__________	______/_____
8.4.4.2	NBS Training Program Participation is evidenced	__________	______/_____

Comments, Exceptions, Corrective Actions, Etc. ______________________________

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Checklist Completed by (name, title, Company) ______________________________

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Date Initiated______________________ **Date Completed** _____________________

Reviewed By (Name, Title, Company)/Date ________________________________

Approved by (Name, Title, Company)/Date ________________________________

Appendix E – Checklist #3, Laboratory Records

Sect.	Requirement	Acceptable Yes No	Initials/Date
8.5.1	Data recorded in notebooks or data sheets	__________	______/____
-	Documents specifically designed for this purpose	__________	______/____
8.5.2	Entries are dark and clear enough for photocopy	__________	______/____
8.5.3	No erasures or whiteouts are present	__________	______/____
-	All changes are lined out, initialed and dated	__________	______/____
8.5.4	Deviations from standard practices are noted	__________	______/____
8.5.5	Sample or item tested identity known	__________	______/____
-	Was a chain-of-custody used	__________	______/____
-	Was locked storage or a shipping container used	__________	______/____

Comments, Exceptions, Corrective Actions, Etc. ______________________________

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Checklist Completed by (name, title, Company) ______________________________

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Date Initiated______________________ **Date Completed** ____________________

Reviewed By (Name, Title, Company)/Date ________________________________

Approved by (Name, Title, Company)/Date ________________________________

Appendix F – Checklist #4, Calibration & Test Reports

Sect.	Requirement	Acceptable Yes No	Initials/Date
8.6.1	Client is clearly identified	________	______/____
8.6.2	Purpose of the test is described	________	______/____
8.6.3.1	Tested item's manufacturer's name	________	______/____
8.6.3.2	Tested item's manufacturer's model number	________	______/____
8.6.3.3	Tested item's serial number	________	______/____
8.6.3.4	Testing laboratory's number	________	______/____
8.6.4	Test method(s) identified	________	______/____
8.6.5	Test results are included and complete	________	______/____
8.6.6	Limits of uncertainty are stated	________	______/____
8.6.7.1	Reference standards used are appropriate	________	______/____
8.6.7.2	Traceability of reference to national standards	________	______/____
8.6.7.3	Test instrument in/not in tolerance at time of test	________	______/____
8.6.8	References listed, as applicable	________	______/____
8.6.9	Required signatures affixed	________	______/____
8.6.10	Test conclusions are included and complete	________	______/____
8.6.11.1	Report has a unique identification number	________	______/____
8.6.11.2	Test Reports are filed according to Appendix D	________	______/____

Comments, Exceptions, Corrective Actions, Etc. ______________________________
____
____
____

Checklist Completed by (name, title, Company) ______________________________
____
____
____

Date Initiated______________________ **Date Completed** ____________________

Reviewed By (Name, Title, Company)/Date ________________________________
Approved by (Name, Title, Company)/Date ________________________________

Appendix G – Checklist #5, Training Records

Sect.	Requirement	Acceptable Yes No	Initials/Date
8.4.4.1	Continuous educational program records exist	__________	______/____
8.4.4.2	NBS Training Program Participation is evidenced	__________	______/____
8.7.1	Individuals have appropriate education	__________	______/____
8.7.2	Individuals have supplemental training	__________	______/____
8.7.3	Position descriptions exist	__________	______/____
8.7.4	Indoctrination records exist	__________	______/____

Comments, Exceptions, Corrective Actions, Etc. ______________________________

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Checklist Completed by (name, title, Company) ______________________________

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____

Date Initiated______________________ **Date Completed** _____________________

Reviewed By (Name, Title, Company)/Date __________________________________

Approved by (Name, Title, Company)/Date __________________________________

Appendix H – Blank Comment Sheet

Additional Comments for Appendix

Section II: AVTA-PHQP01 – Quality Program

TABLE OF CONTENTS

1 Objective

The objective of this procedure is to develop and maintain a program that provides guidance for the quality requirements and aspects of work performed for the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA).

2 Scope

This program applies to all activities in support of performance testing of plug-in hybrid electric vehicles performed pursuant to the requirements of the AVTA. This program may also apply to other activities, if it is specifically invoked by the documents controlling those other activities.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. Documents shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals expected to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Prerequisites

4.1 Personnel conducting work under this program or in accordance with the procedures associated with the AVTA shall be aware and trained/certified as to its contents.

4.2 All procedures controlling work or program related activities shall be subject to the requirements of this program.

4.3 All personnel within the cognizance of this program shall be responsible for its implementation.

4.4 All personnel within the cognizance of this program shall be responsible for the quality of their work activities and products. These products may be tangible or otherwise.

4.5 All personnel are responsible for identifying conditions adverse to quality and if possible, correcting those conditions.

4.6 Conditions adverse to quality will be reported to management, regardless of whether they were corrected.

5 Exclusions

5.1 This Program does not apply to activities outside of those specifically addressed by the programs and procedures developed and associated with the AVTA.

5.2 Should this program be applied to other activities it shall be invoked by those activities without the necessity to revise this document.

5.3 Specific exclusions from this program should be made within the document requiring the exclusion.

6 Quality Assurance Criteria

6.1 Program

This document functions as the written Quality Assurance Plan. It will describe, as necessary, the functional responsibilities, levels of authority (as appropriate) and interface requirements for individuals managing, assessing or performing work. The program has or directs the establishment of specific attributes. These may be included in other approved procedures or programs under the control of Electric Transportation Applications. The program should include the following attributes:

6.1.1 A formal Quality Assurance Plan (QAP) (This document is that Plan.)

6.1.2 Management retention and responsibility for an effective QAP (Each individual is responsible for the quality of his/her work.)

6.1.3 The promotion of effective achievement of the performance objectives.

6.2 Requirements

6.2.1 The QAP is binding on all personnel completing work under any AVTA procedures.

6.2.2 The quality of processes, ensured to an extent consistent with their risk.

6.2.3 A description of or reference to the organizational structure, functional responsibilities, levels of authority and interfaces.

6.2.4 A common vocabulary along with key terminology. Personnel indoctrination should include appropriate definitions.

6.2.5 Work assigned or contracted outside of the organizations should be identified, along with any required management controls, such as responsibilities and lines of communication.

6.2.6 Readiness reviews should be completed for all projects prior to initiation.

6.2.7 Responsibility and authority for the stoppage of unsafe or unsatisfactory work should be assigned and clearly denoted for each task or project.

6.3 Personnel Training and Qualification

6.3.1 Personnel performing work should be capable of performing their assigned tasks. Qualification requirements should be established for specific job categories. Training includes both education in principles and enhancement of skills and practices.

6.3.2 Training should emphasize correct performance of work and provide an understanding of the fundamentals of quality, safety and the importance of "doing work right the first time."

6.3.3 Training plans should address and stimulate professional development.

6.3.4 Personnel performing work that requires special skills or abilities should be qualified prior to performing work. Qualification should require demonstrated proficiency of each candidate.

6.3.5 The following job categories will have the noted minimum requirements:

6.3.5.1 The Program Manager shall have a minimum of a BS Degree in Engineering or Technology, and four (4) years of electric vehicle experience and/or four (4) years of Program Management experience. A master's degree may be considered as fulfilling the requirements for one of those years of experience.

6.3.5.2 The Test Director shall have a minimum of a BS Degree in Engineering or Technology, and four (4) years of electric vehicle experience and/or four (4) years of Project Management experience. A master's degree may be considered as fulfilling the requirements for one of those years of experience.

6.3.5.3 The Test Manager shall have a minimum of a BS Degree in Engineering or Technology, two (2) years of Program/Project Management experience and two (2) years of test experience in a professional commercial industrial or government setting. A Master's degree may be considered as fulfilling the requirements for one of those years of experience.

6.3.5.4 The Test Engineer should have a BS Degree in Engineering or Technology and two (2) years of test experience in a professional commercial industrial or government setting.

6.3.6 Certification of personnel shall be completed in accordance with the requirements of the specific test procedure or program.

6.4 Quality Improvement

6.4.1 Processes should be established and implemented with the objective of preventing problems and improving quality. These processes can include peer review, design review, probabilistic risk assessment, etc.

6.4.2 Information collected during various processes should be analyzed for trend identification.

6.4.3 All individuals covered by this policy should foster a no-fault attitude.

6.4.4 Non-conforming items and processes should be controlled to prevent their inadvertent use.

6.5 Documents and Records

6.5.1 Documents

6.5.1.1 Processes should be established and implemented to control the preparation, review, approval, issuance, and revision of documents.

6.5.1.2 The scope of document control should be defined, and should include procedures, test results, procurement documents, audit reports, findings, vendor supplied data, etc.

6.5.1.3 The same organizations and levels that reviewed and approved the original document should review revisions to controlled documents.

6.5.1.4 Controlled documents should be distributed to and used by personnel performing the work.

6.5.1.5 Record copies should be marked as such, and maintained for a specified period of time.

6.5.2 Records

6.5.2.1 A process should be established to ensure that sufficient records are specified, prepared, reviewed, approved and maintained to accurately reflect completed work.

6.5.2.2 A process should be established which specifies the minimum period for storage, as well as the requirements for storage.

6.6 Work Processes

6.6.1 Work

6.6.1.1 Personnel performing work are responsible for the quality of that work.

6.6.1.2 Review personnel are responsible for ensuring that personnel performing work are adequately trained and certified to complete the assigned work.

6.6.1.3 Work should be planned and accomplished in a controlled manner using approved standards and/or procedures.

6.6.1.4 Work-related instructions and procedures should be developed, verified, validated and approved by technically competent personnel.

6.6.2 Calibration and Maintenance of Monitoring and Data Collection Equipment

6.6.2.1 A process should be established or verified to be established which controls the calibration maintenance and use of measuring and test equipment used for monitoring and data collection.

6.6.2.2 This equipment should be suitable for the use intended, and should have calibration certifications and standards traceable to national standards, where possible.

6.7 Design

6.7.1 A process should be established for the design process which uses sound engineering/scientific principles and appropriate standards.

6.7.2 Changes to final design, whether prior to installation or use or not, should have the same restrictions and review processes that the original design was subjected to.

6.7.3 Verification processes should be consistent for all design levels, and should be accomplished by individuals technically competent in the field the design is in.

6.7.4 Testing to verify or validate the design or protocol should be accomplished prior to a production use of the design or protocol.

6.8 Procurement

6.8.1 A process should be established and implemented to ensure that purchased items and services meet the established requirements and perform as expected.

6.8.2 Prospective suppliers should be evaluated to ensure only qualified suppliers are selected.

6.8.3 Actual performance of items should be compared with original performance criteria.

6.8.4 The quality of purchased items and services should be verified at intervals consistent with the item’s complexity, service conditions and risk.

6.9 Inspection and Acceptance Testing

6.9.1 Inspection

6.9.1.1 A process should be established and implemented to specify when and what type of inspections are required.

6.9.1.2 Inspections may be implemented by or for the organization performing the work to be inspected. Personnel shall not inspect their own work.

6.9.1.3 When acceptance criteria is not met, deficiencies should be resolved and re-inspection occur, as required.

6.9.2 Acceptance Testing

6.9.2.1 Testing processes should be established and implemented to demonstrate that items and processes will perform as intended.

6.9.2.2 Testing may be implemented by or for the organizations performing the work to be tested.

6.9.2.3 Item and process test requirements and acceptance criteria should be provided by or approved by the organization responsible for the activity.

6.9.2.4 Test procedures should be developed and include the following:

6.9.2.4.1 Instructions and prerequisites to perform the test

6.9.2.4.2 Completeness and accuracy of data

6.9.2.4.3 Use of test equipment

6.9.2.4.4 Acceptance criteria (if applicable)

6.9.2.4.5 Inspection points, as required

6.9.2.4.6 Test article configuration.

6.9.2.5 Retesting of items or processes to determine that they meet acceptance criteria is required after deficiencies have been corrected.

6.9.3 Measuring and Test Equipment

6.9.3.1 A process should be established and implemented or verified to be present which controls the calibration, maintenance, accountability and use of equipment used to control any process or data collection system.

6.9.3.2 The types of equipment to be used, such as instruments, tools, gages, reference and transfer standards, and non-destructive examination equipment, should be defined.

6.9.3.3 Measuring and test equipment (M&TE) should be calibrated at specified intervals on the basis of the item's required accuracy, intended use, frequency of use, stability characteristics, and other conditions affecting it's performance.

6.9.3.4 M&TE should be labeled, tagged or otherwise controlled to indicate its calibration status and ensure its traceability to calibration test data.

6.9.3.5 M&TE should be calibrated against standards having an accuracy that will ensure that equipment being calibrated will be within required tolerances. If nationally recognized standards exist, calibration standards should be traceable to such standards.

6.9.3.6 M&TE found out-of-calibration or out-of-tolerance should not be used until it is successfully recalibrated. The acceptability of items inspected, tested or measured with an out-of-calibration device should be determined.

6.10 Management Assessment

6.10.1 Planned and periodic management assessments should be completed as a way to improve quality.

6.10.2 Results of management assessments should be documented. Recommendations resulting from the assessments should be promptly acted upon, and the results of those actions noted as appropriate.

6.10.3 This process should involve all levels of management.

6.11 Independent Assessment

6.11.1 A process of planned periodic independent assessments should be established as required, and should focus on improving items and processes by emphasizing achievement of quality.

6.11.2 Personnel performing independent assessments should act in a management advisory function, with responsibilities including monitoring of work performance, potential problems, problem precursors and opportunities for improvement.

6.11.3 Personnel performing independent assessments should be technically knowledgeable and focus on improving the quality of the processes being evaluated.

6.11.4 Personnel performing independent assessments should not have direct responsibilities in the area they are assessing.

6.11.5 These assessments should be conducted using criteria that describe acceptable work performance and promote improvement.

6.11.6 The management having responsibility in the area assessed should resolve assessment results. Follow-up review of the deficient areas should be initiated as necessary.

6.11.7 Responses to assessments should include the following, as applicable:

6.11.7.1 Action to correct the deficiency

6.11.7.2 Cause identification

6.11.7.3 Actions taken to prevent recurrence

6.11.7.4 Lessons learned

6.11.7.5 Actions to be taken for improvement.

Chapter IV: Test Procedures

Section I: PHEV Baseline Test Sequence

1 PHEV PERFORMANCE TEST PROCEDURE SEQUENCE

The following test sequence shall be used for conduct of PHEV Baseline Performance Testing. This sequence of testing confirms vehicle conformance with all "shall" statements contained in the PHEV Vehicle Specifications. Additionally, submittal of all information required by the PHEV Vehicle Specifications is verified and selected "should" statements are verified.

1.1 Procedure AVTA-PHAC06, Receipt Inspection

Conduct of this test procedure accomplishes the following test requirements.

- Should data submittal verification
- Should data submittal accuracy verification by inspection
- Should data submittal accuracy verification by vehicle measurement
- Testing for selected should requirements not verified by specific Performance Test Procedures (AVTA-PHTPXXX)
- Determination of vehicle operating modes and selection of operating modes for testing

1.2 Procedure AVTA-PHTP11, Vehicle Verification (Initial Phase)

Conduct of this test procedure is accomplished in two phases. The initial phase accomplishes the following test requirements.

- Shall data submittal verification
- Shall data submittal accuracy verification by inspection
- Testing for shall requirements not verified by specific Performance Test Procedures

The final phase of this procedure is conducted in Section 1.9.

NOTE:
Portions of the following procedure are applicable only to vehicles tested in RESS Only mode.

1.3 Procedure AVTA-PHTP04, PHEV RESS Only Mode Constant Speed Range Test

Conduct of this test procedure accomplishes the following test requirements.

- Determination of RESS Only mode range
- In conjunction with procedure AVTA-PHTP08, determination of charging time
- Determination of durability at maximum speed
- Speedometer accuracy should requirement verification
- Odometer accuracy shall requirement verification

- SOC meter accuracy should requirement verification
- In conjunction with procedure AVTA-PHTP12, maximum RESS discharge shall requirement and RESS durability data collection
- Depth of discharge calibrations for subsequent RESS Only mode tests

NOTE:
Portions of the following procedure are applicable only to vehicles tested in RESS Only mode.

1.4 Procedure AVTA-PHTP05, PHEV Rough Road Course Test

Conduct of this test procedure accomplishes the following test requirements.

- Rough road completion shall requirement verification
- Rough road impairment should requirement
- RESS leakage current to chassis shall requirement data collection
- Charger leakage current to ground shall requirement data collection for vehicles capable of grid connection
- In conjunction with procedure AVTA-PHTP08, charging efficiency data collection

NOTE:
For vehicles tested in RESS Only mode, the following testing is performed in RESS Only mode at RESS Initial SOCs of 100% and 50%.

1.5 Procedure AVTA-PHTP02, PHEV Acceleration, Gradeability and Deceleration Test

Conduct of this test procedure accomplishes the following test requirements.

- Acceleration should requirement verification
- Gradeability should requirement verification

NOTE:
The following procedure is conducted for all vehicles that will be tested using procedure AVTA-PHTP03.

1.6 Procedure AVTA-PHTP01, Road Load Measurement Using Onboard Anemometry and Coastdown Techniques

Conduct of this test procedure accomplishes the following requirements.

- Develop road load coefficients for use in procedure AVTA-PHTP03 dynamometer testing

NOTE:
The following procedure is conducted for all vehicles in the Normal Operation mode.

1.7 Procedure AVTA-PHTP06, Braking Test

Conduct of this test procedure accomplishes the following test requirements.

- Regenerative braking interaction shall requirement verification
- Braking distance data collection

1.8 Procedure AVTA-PHTP10, PHEV RESS Charger Performance

Conduct of this test procedure accomplishes the following test requirements.

- Maximum RESS discharge shall requirement data collection

NOTE:
This testing requires a separate RESS discharge to verify repeatability of the discharge limiter data collected by procedure AVTA-PHTP04 using AVTA-PHTP11.

- Charge time shall requirement verification
- Automatic termination shall requirement verification
- Charger input voltage shall requirement verification
- Charger operating data collection
- Charger ground leakage current data collection
- Charging efficiency data collection and calculation

1.9 Procedure AVTA-PHTP11, Vehicle Verification (Final Phase)

Conduct of this test procedure accomplishes the following test requirements.

- Verification of maximum depth of discharge limit repeatability (using procedure AVTA-PHTP04) for vehicles capable of grid connection or operation in RESS Only mode
- Repair time shall requirement verification (using Non-Conformance Reports)
- Charger leakage current verification for vehicles capable of grid connection

NOTE:
Vehicles operable only in the Normal Operation mode shall be tested in accordance Section 1.10 (AVTA-PHTP03), below. Vehicle capable of operation in RESS Only mode shall additionally be tested in accordance with Section 1.11 (AVTA-PHTP07), below.

1.10 Procedure AVTA-PHTP03, SAE J1711 Dynamometer Testing

Conduct of this test procedure accomplishes the following requirements for vehicles tested in the Normal Operation mode.

- Determine hybrid vehicle fuel efficiency without air conditioning loads
- Determine hybrid vehicle fuel efficiency with air conditioning loads

This procedure is conducted over five days with tests accomplished each day as follows.

Day 1

- Vehicle setup
- Coastdowns with 2 HWFEDS
- 2 US06 (charge depleting)
- 2 US06 (charge sustaining)

Day 2

- HWFEDS Cold Start (charge depleting)
- HWFEDS Hot Start (charge depleting)
- 2 HWFEDS (charge depleting)
- 2 HWFEDS (charge sustaining)

Day 3

- UDDS Cold Start (charge depleting)
- UDDS Hot Start
- 2 UDDS (charge depleting)
- 2 UDDS (charge sustaining)

Day 4

- UDDS Cold Start (charge sustaining)
- UDDS Hot Start (charge sustaining)
- 2 HWFEDS (charge sustaining)
- 2 US06 (charge sustaining)

Day 5

- UDDS Air Conditioning (A/C) Cold Start (charge depleting)
- UDDS A/C Hot Start (charge depleting)
- 2 HWFEDS A/C (charge depleting)
- 2 UDDS A/C (charge sustaining)
- 2 HWFEDS A/C (charge sustaining)

1.11 Procedure AVTA-PHTP07, SAE J1634 Dynamometer Testing

Conduct of this test procedure accomplishes the following requirements for vehicles tested in the RESS Only mode.

- Determine RESS Only mode drive cycle energy efficiency

- Determine RESS Only mode drive cycle range

1.12 Procedure AVTA-PHTP14, Evaluation of PHEV Battery Packs

Conduct of this test procedure accomplishes the following requirements.

- Determine C1 battery capacity
- Determine battery pulse power capability

2 PHEV CONDUCT OF RESS CHARGING PROCEDURES

During conduct of testing, the vehicle RESS shall be charged using the following procedures.

NOTE:
The following procedure provides guidance for determination of 100% RESS Initial SOC for all vehicles, regardless of operating mode capabilities.

2.1 Procedure AVTA-PHTP08, RESS Charging

Conduct of this test procedure accomplishes the following test requirements.

- Provides guidance for RESS charging activities using Level I or II off-board or onboard charging
- Determination of RESS 100% SOC
- Determination of charging efficiency

NOTE:
The following procedure provides guidance for determination of PHEV energy management systems for all vehicles, regardless of operating mode capabilities.

2.2 Procedure AVTA-PHTP12, Evaluation of PHEV Energy Management System

Conduct of this test procedure accomplishes the following test requirements.

- Evaluation of the effectiveness of the PHEV energy management system throughout the conduct of testing.

Section II: AVTA-PHTP01 – Road Load Measurement Using Onboard Anemometry and Coastdown Techniques

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APPENDICES

1 Objective

The objective of this procedure is to provide methods for obtaining road load coefficients of vehicles evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA). Testing is conducted in accordance with recommended practice SAE J2263, "Road Load Measurement Using Onboard Anemometry and Coastdown Techniques." These methods are not meant to supersede those of the testing facility, those specifically addressed by SAE Test Standards, nor of any regulatory agency, which may have or exercise control over the covered activities.

2 Purpose

The purpose of this procedure is to identify acceptable methods for the implementation of the test requirements of SAE J2263, and to provide a common format for the collection and retention of data for further use with procedure AVTA-PHTP07. This procedure collects and retains this data to complete testing as specified in the PHEV Vehicle Specification.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation contains enough information to "stand alone"; in other words, it is self-contained to the extent that all individuals qualified to review it could reasonably be expected to reach a common conclusion, without the need to review additional documentation. If review of outside documents is required, then it is reasonable to expect that all individuals would need to review those documents. Review and approval of test documents shall be in accordance with procedure AVTA-PHAC04. Close-out and storage of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

Prior to conduct of any portion of the testing, the following initial conditions and prerequisites should be met. Satisfactory completion of these items should be verified as complete and recorded on the PHEV Road Load Test Data Sheet (Appendix A).

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05, and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 Tests should be conducted at ambient temperatures between 32°F (0°C) and 100°F (38°C).

4.3 Tests shall not be run during foggy conditions.

4.4 Tests shall not be conducted when wind speeds average more than 10 mph (16 km/h) or when peak wind speeds are more than 12.3 mph (20 km/h). The average of the component of the wind velocity parallel to the test road shall not exceed 5 mph (8 km/h). Tests should always be conducted during periods of minimum wind velocity.

4.5 Roads shall be dry, clean, smooth, and must not exceed 0.5% grade. In addition, the grade should be constant and the road should be straight since variations in grade or straightness can significantly affect results. [The road surface should be concrete or rolled asphalt (or equivalent) in good condition since rough roads can significantly affect rolling resistance.]

4.6 The range of speeds over which the vehicle is coasted should be as wide as possible considering the length of the straightaway. The speed interval shall include 65 mph (80 km/h) and should include the range of 80-5 mph (128 km/h to 8 km/h)

4.7 Vehicles should have accumulated a minimum of 300 miles (500 km) prior to this testing. Actual mileage shall be recorded prior to starting testing.

4.8 Supplier's recommended tires shall be used. Tires should have accumulated a minimum of 100 miles (160 km) and shall have at least 75% of the original tread depth remaining. All tire break-ins shall be performed on the test vehicle. Tread depth will be recorded in 1/32 inch increments prior to start of test.

4.9 Vehicle tires shall be inflated to the Supplier's recommended cold inflation pressure as specified on the tire placard, corrected for the difference between ambient temperature and tire temperature. The actual inflation pressure and preparation area temperature will be recorded in Appendix A. [Tire pressures will be increased 1 psi for each 13°F, the preparation area is higher than the test area (or 1 kPa for each 1°C).]

NOTE:

Tire sizes and inflation pressures shall be in accordance with the requirements of the placard. At no time shall the tire's cold inflation pressure exceed the maximum pressure imprinted upon the tire's sidewall.

4.10 Instrumentation

4.10.1 All instrumentation used during testing shall be calibrated. Information for all instrumentation used and their calibration dates shall be recorded on the Metrology Setup Sheet(s) contained in Appendix B.

4.10.2 All instrumentation shall have the accuracies and resolutions noted. Unless specifically accepted, at a minimum the following instrumentation shall be installed and employed during the testing:

4.10.2.1 Speed-time

Accuracy ± 0.1% of total coast down time

Resolution of 0.1s

Accuracy of ± 0.25 mph (0.4 km/h)

Resolution of 0.1 mph (0.2 km/h)

4.10.2.2 Temperature

The temperature indicating devices must have a resolution of 2°F (or 1°C) and an accuracy of ± 2°F (or ± 1°C). The sensing element shall be shielded from radiant heat sources.

4.10.2.3 Atmospheric Pressure

A barometer with an accuracy of ± 0.2 inches Hg or ± 0.7 kPa is necessary.

4.10.2.4 Wind

Wind measurements should permit the determination of average longitudinal and cross wind components to within ± 1 mph (±1.6 km/h).

4.10.2.5 Vehicle weight

Accuracy requirement is ± 10 lb (± 5 kg) per axle

4.10.2.6 Tire Pressure

Accuracy requirement is ± 0.5 psi (± 4 kPa).

4.11 Upon receipt of the vehicle for coast down testing, it should be "checked in.” The following items shall be compared to Supplier's recommendations prior to the test:

4.11.1 Tire type, size, and cold inflation pressure as specified on the tire placard

4.11.2 Wheel size, conditions, and presence of wheel covers

4.12 The speed-time measuring device and other necessary equipment must be installed so that they do not hinder vehicle operation or alter the operating characteristics of the vehicle. Mounting shall be accomplished so as to not interfere with the tow vehicle (nominally at the rear of the vehicle).

4.13 Vehicles shall be tested at delivered curb weight plus 300 pounds.

NOTE:
This is a deviation from SAE Standard J2263.

4.14 During the coast down portion of the test, lane changes shall be avoided. If a lane change occurs, it should be achieved over at least one-half mile, and should be noted in the comments section of the test record.

4.15 If the vehicle is equipped with regenerative braking, it should be disengaged from service for the duration of the testing. The manner in which it is disengaged should be noted in Appendix A.

4.16 All protocols, procedures and attendant documentation required to conduct this testing shall be completed, approved and issued prior to commencing the testing it addresses.

5 Test Activity Requirements

Activities necessary to complete the test are identified in the following sections. All items should be completed, whether they are required by J2263 or not. Any section which cannot be completed should be annotated as required by procedure AVTA-PHAC02, along with the appropriate justification, in Appendix A. Data collection may be via a Data Acquisition System (DAS), in lieu of hand-written entries. Such data shall be transcribed in accordance with the requirements of procedures AVTA-PHAC02.

NOTE:
A minimum of twelve runs shall be completed in alternating directions. The runs shall be paired in order to reduce error during data reduction. A pair consists of two consecutive runs in opposite directions.

NOTE:
Unless otherwise noted, the following steps may be completed in any order.

5.1 Record the mileage from the odometer in Appendix A.

5.2 Verify the vehicle windows are closed. Record in Appendix A.

5.3 Verify that regenerative braking has been disengaged. This may require special service settings for the vehicle controller. Note the method by which this was done and record in Appendix A.

NOTE:
If the vehicle's regenerative braking cannot be disengaged, obtain the concurrence of the Program or Test Manager prior to continuing. This shall be noted as a Test Exception.

5.4 Verify that the vehicle's drive train has been disengaged from the drive axle during the coast down. Note method of disengagement (clutch, electrical or mechanical neutral, etc.). Record in Appendix A.

NOTE:
If the drive train cannot be disengaged from the drive axle, obtain the concurrence of the Program or Test Manager prior to continuing. This shall be noted as a Test Exception.

5.5 Verify vehicle tires are inflated to the Supplier's recommended cold inflation pressure as specified on the tire placard, corrected for the difference between ambient temperature and tire temperature. Record the actual inflation pressure and preparation area temperature in Appendix A. [Tire pressures shall be increased 1 psi for each 13°F if the preparation area is higher than the test area (or 1 kPa for each Celsius degree).]

CAUTION:
Tire sizes and inflation pressures shall be in accordance with the requirements of the placard. At no time shall the tire's inflation pressure exceed the maximum pressure imprinted upon that tire's sidewall.

5.6 Verify and record the speed that the DAS will be engaged at. This speed should be 5 mph (8 km/h) higher than the maximum desired coast down speed. At a minimum, record the following data in Appendix A:

5.6.1 Sequence (run) number/computer file number of each run

5.6.2 Direction of each run

5.6.3 Vehicle speed as a function of time

5.6.4 Total wind, and either the wind direction or the cross-wind component of the total wind. Wind quantities shall be recorded, screened for gusts exceeding the ambient condition limits in section 4.4, and averaged.

5.7 At the start of each run, accelerate the test vehicle to 80 mph (128 km/h) or a speed of 5 mph (8 km/h) above the high point of the coast down speed range. Record in Appendix A.

5.8 Each run may be considered complete after the vehicle has decelerated to a speed of less than 5 mph (8 km/h). If the vehicle's speed will not decrease to less than this point, contact the Test Manager for assistance.

5.9 After completion of the test runs, collect the following data:

5.9.1 The ambient temperature at the end of the test

5.9.2 Verify the vehicle weight package is still in place, and equal to 300 pounds including the driver and instrumentation.

5.10 After completing the final run, record the odometer reading in Appendix A.

5.11 Calculate the vehicle's deceleration function over the coastdown by choosing a minimum of three different test run pairs.

5.12 Multiply the deceleration function by the vehicle test mass (including the additional 300 pounds) to obtain the force over the vehicle coastdown.

5.13 Graph the vehicle force vs. velocity and apply a quadratic curve fit to the data. Record the three coefficients from the quadratic equation, as they will be used for modeling force vs. velocity during fuel efficiency dynamometer testing AVTA-PHTP03.

6 Data Reduction and Acceptability Criteria

6.1 The requirements for data reduction are specifically addressed in Section 10 of SAE J2263. Refer to this standard when clarification utilizing these techniques is required.

6.2 Upon calculating the coastdown coefficients, obtain the EPA coefficients (if available) for this make and model of vehicle and graph the EPA coefficients and the calculated coefficients from the coastdown together. If an excessive amount of deviation is present, an inquiry as to the cause of this deviation shall be undertaken and tests shall be re-run, if necessary.

6.3 The acceptability requirements presented in Section 10.4 of SAE J2263 shall be used.

6.4 Distribution, retention and destruction of all test documents shall be in accordance with the requirements identified in procedure AVTA-PHAC01.

Appendix A – PHEV Road Load Test Data Sheet

(Page 1 of 6)

VIN Number: ____________________

Project No.:	Test Date(s):
Data File Name:	
Test Driver: (Initials) (Date)	
Test Engineer: (Initials) (Date)	

Vehicle Setup

VEHICLE WEIGHTS AS TESTED WITH DRIVER & INSTRUMENTATION (Curb weight plus 300 pounds)			
Left Front: (lbs or kg)	Right Front: (lbs or kg)	Total Front: (lbs or kg)	Percent Front: %
Left Rear: (lbs or kg)	Right Rear: (lbs or kg)	Total Rear: (lbs or kg)	Percent Rear: %
		Total Weight: (lbs or kg)	
Preparation Area Temperature: (°F or °C)			
Left Front		Right Front	
Pressure: (psi or kPa)	Tread Depth: (>75% of original depth (in or mm)	Pressure: (psi or kPa)	Tread Depth: (>75% of original depth (in or mm)
Left Rear		Right Rear	
Pressure: (psi or kPa)	Tread Depth: (>75% of original depth (in or mm)	Pressure: (psi or kPa)	Tread Depth: (>75% of original depth (in or mm)

APPENDIX A – PHEV Road Load Test Data Sheet
(Page 2 of 6)

VIN Number: ____________________ **Track/Weather Conditions**

Test Track Location:	Track Grade: % (< 0.5%)
Ambient Temperature (initial): (30-90°F or -1-32°C)	Ambient Temperature (final): (30-90°F or -1-32°C)
Track Temperature (initial): (°F or °C)	Track Temperature (final): (°F or °C)
Wind Velocity (initial): (Average: <10 mph or 16 km/h)	Wind Velocity (final): (Average: <10 mph or 16 km/h)
Cross Wind Component: (Average: <5 mph or 8 km/h)	Cross Wind Component: (Average: <5 mph or 8 km/h)
Wind Direction (initial): °	Wind Direction (completion): °
Barometric Pressure (initial): (nigh)	Barometric Pressure (completion): (nigh)

Test Data "Coast Down Characteristics from 75-5 mph (120-8 km/h)"

Odometer (initial): (miles or kilometers)		Odometer (final): (miles or kilometers)	
Vehicle windows closed:	(Yes)	(No)	
Regenerative breaking disabled:	(Yes)	(No)	
Drive train is disengaged:	(Yes)	(No)	
Sequence No: 1	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 2	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 3	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 4	File No.:	Time:	Direction of Travel:
Comments (initials/date):			

APPENDIX A – PHEV Road Load Test Data Sheet
(Page 3 of 6)

VIN Number: ________________________________ **Test Data (continued)**

Sequence No: 5	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 6	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 7	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 8	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 9	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 10	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 11	File No.:	Time:	Direction of Travel:
Comments (initials/date):			

Appendix A – PHEV Road Load Test Data Sheet

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VIN Number: ________________________ **Test Data (continued)**

Sequence No: 12	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 13	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 14	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 15	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 16	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 17	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 18	File No.:	Time:	Direction of Travel:
Comments (initials/date):			

Appendix A – PHEV Road Load Test Data Sheet
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VIN Number: ____________________ **Test Data (continued)**

Sequence No: 19	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No: 20	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No:	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No:	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No:	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No:	File No.:	Time:	Direction of Travel:
Comments (initials/date):			
Sequence No:	File No.:	Time:	Direction of Travel:
Comments (initials/date):			

Appendix A – PHEV Road Load Test Data Sheet
(Page 6 of 6)

VIN Number: ___________________

General Comments (initials/date):

Completed By:

(Printed Name) (Signature) (Date)

Reviewed By (QA):

(Printed Name) (Signature) (Date)

Approved By:

(Printed Name) (Signature) (Date)

Appendix B – PHEV Metrology Setup Sheet

(Page 1 of 1)

VIN Number: ___________________

Instrument/Device:	Calibration Due Date:	Initials / Date:
Fifth Wheel S/N:		
Fifth Wheel Calibrator S/N:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Tire Pressure Gauge S/N:		
Misc:		
Misc:		
Misc:		
Misc:		

Comments (initials/date):

Completed By:

(Printed Name) (Signature) (Date)

Reviewed By (QA):

(Printed Name) (Signature) (Date)

Approved By:

(Printed Name) (Signature) (Date)

Section III: AVTA-PHTP02 – Plug-in Hybrid Electric Vehicle Acceleration, Gradeability, and Deceleration Test

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APPENDICES

1 Objective

The objective of this procedure is to provide methods for the testing of acceleration and gradeability of plug-in hybrid electric vehicles (PHEV) evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA). Testing is conducted in accordance with SAE J1666, "Electric Vehicle Acceleration, Gradeability and Deceleration Test Procedure," as the methods can be applied to PHEVs. Vehicles are tested in Normal Operation mode and, where applicable, in RESS Only mode. These methods are not meant to supersede those of the testing facility, those specifically addressed by SAE Test Standards, nor of any regulatory agency, which may have or exercise control over the covered activities.

2 Purpose

The purpose of this procedure is to identify acceptable methods for the implementation of the test requirements of SAE Standard J1666. The SAE-J1666 Recommended Practice establishes uniform procedures for testing electric battery-powered vehicles as a total system rather than its individual subsystems. This procedure collects and retains test data as specified in the PHEV Vehicle Specification.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

Prior to conduct of any portion of the testing, the following initial conditions and prerequisites shall be met. Satisfactory completion of these items should be verified as complete and recorded on the PHEV Acceleration Test, Test Data Sheet (Appendix A).

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05, and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 PHEV Test Modes

Vehicles shall be tested in the Normal Operation mode. Vehicles capable of operation in RESS Only mode shall also be tested in RESS Only mode. RESS initial SOC for each test shall be as follows:

4.2.1 Normal Operation mode, starting with the RESS at 100% SOC

4.2.2 Normal Operation mode, starting with the RESS at the SOC at which the vehicle enters charge-sustaining mode

4.2.3 RESS Only mode, starting at 100% SOC

4.2.4 RESS Only mode, starting at 50% SOC

4.3 Road Testing

4.3.1 Road tests shall be performed on a road or test track, which is level to within 1%.

4.3.2 RESS temperatures at the beginning of the test shall be greater than 40˚F (5˚C), shall be less than 120°F (49°C) and should be less than 100˚F (38°C).

4.3.3 Ambient temperature during road testing shall be within the range of 32°F (0˚C) to 100°F (38°C).

4.3.4 The average wind speed at the test site during the test shall not exceed 10 mph (16 km/h). Wind gusts shall not exceed 12.3 mph (20 kph).

4.4 Vehicles shall be tested in its normal configuration with normal appendages (mirrors, bumpers, hubcaps, etc.). Certain items (hub caps, etc.) may be removed where necessary for safety on the dynamometer.

4.5 Vehicles shall be tested at curb weight plus 300 pounds. Consideration should be given to how adding instrumentation will affect the test weight and balance of the vehicle.

4.6 Supplier's recommended tires shall be used.

4.7 Normal Supplier's recommended lubricants shall be employed.

4.8 Accessories shall not be used during testing.

4.9 Rechargeable Energy Storage System (RESS) shall be charged in accordance with procedure AVTA-PHTP08.

4.10 For testing of vehicles in a Normal Operation mode, the required initial RESS SOC shall be established as follows:

4.10.1 For tests requiring an initial RESS SOC of 100%, the RESS shall be charged to 100% SOC in accordance with procedure AVTA-PHTP08.

4.10.2 For tests requiring the initial RESS SOC be that SOC at which the vehicle enters charge-sustaining mode, the required SOC shall be established in accordance with procedure AVTA-PHTP08.

4.11 For testing of vehicles in RESS Only mode, the required initial RESS SOC shall be established as follows:

4.11.1 The RESS shall be charged to 100% SOC in accordance with procedure AVTA-PHTP08.

4.11.2 The RESS capacity (mileage based) shall be obtained from the Constant Speed Range Test completed as part of procedure AVTA-PHTP11, and in accordance with procedure AVTA-PHTP04.

4.11.3 To achieve X% SOC, the RESS shall be discharged, by driving the vehicle on a test track at a constant speed of 45 mph until Y% capacity, has been removed from the RESS. [Where X+Y = 100% capacity]

4.11.4 Tests conducted with the RESS partially discharged at the test start should be initiated no more than 10 minutes after the desired initial state-of-discharge is reached.

4.12 For tests conducted in the RESS Only mode, testing required at an initial RESS SOC of 100% shall be initiated with the RESS at >90%. Testing required at an initial RESS SOC of 50% shall be initiated with the RESS at 50% ±10%.

4.13 The following data shall be collected during conduct of the various tests specified by this procedure. Overall error in recording or indicating instruments shall not exceed ±2% of the maximum value of the variable being measured, unless otherwise noted. Periodic calibration shall be performed and documented in accordance with procedure AVTA-PHAC07, to ensure compliance with this requirement.

4.13.1 RESS voltage versus time

4.13.2 RESS current versus time

4.13.3 Vehicle speed versus time

4.13.4 Distance versus time

4.13.5 RESS temperature versus time

4.13.6 RESS power versus time.

4.14 Environmental conditions during the testing shall be recorded and include, at a minimum:

4.14.1 Range of ambient temperature during the test

4.14.2 Range of wind velocity during the test

4.14.3 Range of wind direction during the test.

4.15 The running surface upon which the test is being conducted shall be noted.

4.16 A description of the test route, road surface type and condition (SAE J688, "Truck Ability Prediction Procedure") and lengths and grades of test route shall be recorded.

4.17 The date, starting time and ending time of the test shall be recorded.

4.18 All instrumentation used in the test shall be listed in Appendix D and attached to the test data sheets/results and shall include the following information:

4.18.1 Manufacturer

4.18.2 Model number

4.18.3 Serial number

4.18.4 Next calibration date

4.19 Any deviation from the test procedure and the reason for the deviation shall be recorded in accordance with procedure AVTA-PHAC02.

4.20 The speed-time measuring device and other necessary equipment shall be installed so that they do not hinder vehicle operation or alter the operating characteristics of the vehicle.

4.21 All documentation required to complete testing shall be completed, approved and ready for issue prior to commencing the testing it addresses.

4.22 Complete or verify complete procedure AVTA-PHAC06 and AVTA-PHTP11 for the vehicle being tested.

5 Test Activity Requirements

This section addresses all test types required to meet the stated purpose and objectives of this procedure. To this end, it selectively implements portions of SAE J1666. For ease of use and consistency of format with other Test Procedures, this section is divided into subsections for each major test. Unless otherwise noted, each section may be completed independent of all the other sections.

NOTE:
Activities necessary to complete the test are identified in the following sections. All items shall be completed, whether they are required by J1666 or not. Any section, which cannot be completed, shall be so annotated along with the appropriate justification in accordance with procedure AVTA-PHAC02, Appendix A.

NOTE:
The following sections may be completed in any order. However, the steps within each section shall be completed in the order written. Deviations shall have the approval of the Program Manager or Test Manager in accordance with procedure AVTA-PHAC02.

NOTE:
Vehicle odometer readings shall be recorded within the appropriate test appendices upon initiation and completion of testing.

5.1 Acceleration and Maximum Speed Test

The purpose of this section is to measure the vehicle acceleration and determine the maximum speed the vehicle can achieve within one mile. This testing is to be completed subject to the initial conditions and prerequisites stated in Section 4 of this procedure. Testing shall be completed for each of the following operating modes, as applicable:

5.1.1 Normal Operation mode starting with the RESS at 100% SOC

5.1.2 Normal Operation mode starting with the RESS at the SOC at which the vehicle enters charge-sustaining mode

5.1.3 RESS Only mode, starting at 100% SOC

5.1.4 RESS Only mode starting at 50% SOC

NOTE:
Vehicles should have a minimum top speed of 90 mph with the vehicle loaded to its design curb-weight plus 300 pounds in each of the selectable modes of operation, as applicable.

NOTE:
Vehicles should have a 0-60 mph acceleration time of 13.5 seconds or less with the vehicle loaded to its design curb-weight plus 300 pounds in each of the selectable modes of operation, as applicable.

NOTE:
A level grade, paved test route upon which the vehicle can be safely accelerated to speeds near its peak speed shall be selected. Note location in Appendix B.

5.1.5 Verify the RESS is at the required Initial SOC. Charge/discharge the RESS, as required, to achieve an Initial SOC in accordance with Section 4.10

(Normal Operation mode) or 4.11 and 4.12 (RESS Only mode). Record the % SOC (in kilowatt-hours) and miles driven, if applicable, in Appendix B.

5.1.6 The vehicle shall be tested at curb weight plus 300 pounds, including the weight of the driver.

NOTE:
The last 3000 feet of track length for this test shall be straightaway.

5.1.7 From a standing start, accelerate the vehicle at its maximum attainable acceleration until the vehicle has traveled one mile or the vehicle has attained 100 mph. Note the speed achieved at one mile in Appendix B. If greater than 100 mph, note "Greater than 100 mph."

5.1.8 Reverse the direction of travel on the test track.

5.1.9 Verify the RESS SOC is within limits for Initial SOC in accordance with Section 4.10 (Normal Operation mode) or 4.11 and 4.12 (RESS Only mode). The maximum time interval between completion of the acceleration portion of one run and the beginning of the next successive run shall be minimized. Record the elapsed time in Appendix B. If the data is being accumulated into a Data Acquisition System (DAS), this time interval may be transcribed subsequent to the data download.

5.1.10 From a standing start, accelerate the vehicle at its maximum attainable acceleration until the vehicle has traveled one mile or the vehicle has attained 100 mph. Note the speed achieved at one mile in Appendix B. If greater than 100 mph, note "Greater than 100 mph."

5.1.11 Repeat Sections 5.1.9 through 5.1.12 to obtain two additional sets of data (one set of data comprises two acceleration runs, one in each direction).

5.1.12 Record the completion of this section in Appendix B.

5.2 Gradeability Limit

The purpose of this test is to determine the maximum grade on which a vehicle can start and move forward. Because the discharge rates associated with the constant low speed pulls are high, it is possible to obtain gradeability limits, which are lower than what might actually be experienced by a vehicle operator. An alternative method is to determine the tractive force from the data obtained during the maximum acceleration tests using *EQ.1*. After calculating this force, implement this value into *EQ.2* to calculate the maximum gradeability.

5.2.1 Determine the maximum acceleration value from Section 5.1. This acceleration should be the average of the maximum acceleration achieved in all tests within an operating mode.

5.2.2 Obtain the vehicle weight used during Section 5.1 testing.

5.2.3 Using the formula *EQ.1*, determine the maximum force available:

Force = (mass) x (acceleration) *EQ.1*

5.2.4 Insert this value into EQ.2, as value P:

$$\text{Percent Gradeability Limit} = 100 \tan\left(\sin^{-1} \frac{P}{W}\right) \qquad \textit{EQ.2}$$

where: P = Tractive force, lb
W = Vehicle mass, lb

5.2.5 Solve for the Maximum Gradeability Limit.

NOTE:
Vehicles should be capable of starting and ascending a 25% grade with the vehicle loaded to its design curb-weight plus 300 pounds in each of the applicable modes of operation shown in Section 5.1.

5.3 Gradeability at Speed

This test determines the maximum speed achievable on roads with 3% and 6% grades.

5.3.1 3% Grade

Using the speed-time data from the road tests of Section 5.1 for each operational mode tested, the vehicle's acceleration characteristics shall be plotted. Data for successive time intervals shall to be used to determine the vehicles average acceleration during the nth time interval,

$$\bar{a} = (V_n - V_{n-1})/(t_n - t_{n-1}) \qquad \textit{EQ.3}$$

when the vehicle has reached the average speed.

$$\bar{V} = (V_n + V_{n-1})/2 \qquad \textit{EQ.4}$$

The data derived from these calculations shall be plotted as average acceleration versus speed as a smooth curve through the calculated points. (If the vehicle is equipped with a recording accelerometer, the acceleration curve information shall be obtained directly.) The percent grade the vehicle is able to traverse at any selected speed is now to be calculated using the following relationship:

$$\text{Percent Gradeability at Speed} = 100 \tan (\sin^{-1} 0.0455a) \qquad \textit{EQ.5}$$

where:

a = Vehicle acceleration at the selected speed, mph/s

(The constant 0.0455 in this equation becomes 0.0283 when acceleration is in units of km/h-s.)

NOTE:
Vehicles should achieve a minimum sustainable speed of 55 mph on a 3% grade, with the vehicle loaded to its design curb-weight plus 300 pounds in each of the applicable modes of operation shown in Section 5.1.

5.3.2 6% Grade

Using the speed-time data from the road tests of Section 5.1 for each operational mode tested, the vehicle's acceleration characteristics shall be plotted. Data for successive time intervals are to be used to determine the vehicles average acceleration during the nth time interval,

$$\bar{a} = (V_n - V_{n-1}) / (t_n - t_{n-1}) \qquad EQ.3$$

when the vehicle has reached the average speed.

$$\bar{V} = (V_n + V_{n-1})/2 \qquad EQ.4$$

The data derived from these calculations shall be plotted as average acceleration versus speed as a smooth curve through the calculated points. (If the vehicle is equipped with a recording accelerometer, the acceleration curve information shall be obtained directly.) The percent grade the vehicle is able to traverse at any selected speed shall now be calculated using the following relationship:

$$\text{Percent Gradeability at Speed} = 100 \tan(\sin^{-1} 0.0455a) \qquad EQ.5$$

where:

a = Vehicle acceleration at the selected speed, mph/s

(The constant 0.0455 in this equation becomes 0.0283 when acceleration is in units of km/h-s.)

5.3.3 Record test section completion in Appendix C.

NOTE:
Vehicles should achieve a minimum sustainable speed of 45 mph on a 6% grade, with the vehicle loaded to its design curb-weight plus 300 pounds in each of the applicable modes of operation shown in Section 5.1.

Appendix A – PHEV Acceleration Test, Test Data Sheet
(Page 1 of 5)

VIN Number: ______________________

Project Name:	Test Date(s):
Data File Name:	
Test Driver: (Initials) (Date)	
Test Engineer: (Initials) (Date)	

Vehicle Setup

VEHICLE WEIGHTS AS TESTED WITH DRIVER & INSTRUMENTATION (Curb weight plus 300 pounds)			
Left Front: (lbs or kg)	Right Front: (lbs or kg)	Total Front: (lbs or kg)	Percent Front: %
Left Rear: (lbs or kg)	Right Rear: (lbs or kg)	Total Rear: (lbs or kg)	Percent Rear: %
		Total Weight: (lbs or kg)	

INSTALLED TIRES (Placard or sidewall whichever is less)			
Preparation Area Temperature: °F (or °C)			
Left Front		Right Front	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	
Left Rear		Right Rear	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	

Track/Weather Conditions

Test Track Location:	Track Grade: % (Within 1%)
Ambient Temperature (initial): (40-90°F or 5-32°C)	Ambient Temperature (final): (40-90°F or 5-32°C)
Track Temperature (initial): (°F or °C)	Track Temperature (final): (°F or °C)
Wind Velocity (initial): (<10 mph or 16 km/h)	Wind Velocity (final): (<10 mph or 16 km/h)
Wind Direction (initial): °	Wind Direction (final): °

Appendix A – PHEV Acceleration Test, Test Data Sheet
(Page 2 of 5)

VIN Number: ________________________ Operating Mode: _____________________________

Sequence No: 1	File Name:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC; kWh; Ah)	State of Charge (final): (SOC; kWh; Ah)	
RESS Temp (initial): (°F or °C)	RESS Temp (final): (°F or °C)	
Comments (initials/date):		

Sequence No: 2	File Name:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC; kWh; Ah)	State of Charge (final): (SOC; kWh; Ah)	
RESS Temp (initial): (°F or °C)	RESS Temp (final): (°F or °C)	
Comments (initials/date):		

Appendix A – PHEV Acceleration Test, Test Data Sheet
(Page 3 of 5)

VIN Number: ________________________ Operating Mode: ____________________________

Sequence No: 3	File Name:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC; kWh; Ah)	State of Charge (final): (SOC; kWh; Ah)	
RESS Temp (initial): (°F or °C)	RESS Temp (final): (°F or °C)	
Comments (initials/date):		

Sequence No: 4	File Name:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC; kWh; Ah)	State of Charge (final): (SOC; kWh; Ah)	
RESS Temp (initial): (°F or °C)	RESS Temp (final): (°F or °C)	
Comments (initials/date):		

Appendix A – PHEV Acceleration Test, Test Data Sheet
(Page 4 of 5)

VIN Number: ________________________ Operating Mode: ______________________________

Sequence No: 5	File Name:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC; kWh; Ah)	State of Charge (final): (SOC; kWh; Ah)	
RESS Temp (initial): (°F or °C)	RESS Temp (final): (°F or °C)	
Comments (initials/date):		

Sequence No: 6	File Name:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC; kWh; Ah)	State of Charge (final): (SOC; kWh; Ah)	
RESS Temp (initial): (°F or °C)	RESS Temp (final): (°F or °C)	
Comments (initials/date):		

Appendix A – PHEV Acceleration Test, Test Data Sheet
(Page 5 of 5)

VIN Number: ________________________ Operating Mode: _____________________________

General Comments (initials/date):

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Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix B – PHEV Gradeability Limit, Test Data Sheet
(Page 1 of 2)

VIN Number: ______________________ **Operating Mode:** ___________________________

Project No.:	Test Date(s):
Data File Name:	
Test Driver: (Initials) (Date)	
Test Engineer: (Initials) (Date)	

Vehicle Setup

VEHICLE WEIGHTS AS TESTED WITH DRIVER & INSTRUMENTATION (Rated vehicle GVWR)			
Left Front: (lbs or kg)	Right Front: (lbs or kg)	Total Front: (lbs or kg)	Percent Front: %
Left Rear: (lbs or kg)	Right Rear: (lbs or kg)	Total Rear: (lbs or kg)	Percent Rear: %
		Total Weight: (lbs or kg)	
INSTALLED TIRES (Placard or sidewall whichever is less)			
Preparation Area Temperature: °F (or °C)			
Left Front		Right Front	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	
Left Rear		Right Rear	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	

Track/Weather Conditions

Test Track Location:	Track Grade: % (Within 1%)
Ambient Temperature (initial): (40-90°F or 5-32°C)	Ambient Temperature (final): (40-90°F or 5-32°C)
Wind Velocity (initial): (<10 mph or 16 km/h)	Wind Velocity (final): (<10 mph or 16 km/h)
Wind Direction (initial): °	Wind Direction (completion): °

Appendix B – PHEV Gradeability Limit, Test Data Sheet
(Page 2 of 2)

VIN Number: ________________________ Operating Mode: ____________________________

Sequence No: 1	File Name:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC; kWh; Ah)	State of Charge (final): (SOC; kWh; Ah)	
RESS Temp (initial): (°F or °C)	RESS Temp (final): (°F or °C)	
Comments (initials/date): Force Reading: _________________ Time Duration: ________________ Vehicle Speed: _________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________		
Completed By: (Printed Name)	(Signature)	(Date)
Reviewed By: (Printed Name)	(Signature)	(Date)
Approved By: (Printed Name)	(Signature)	(Date)

Appendix C – PHEV Gradeability at Speed Test Data Sheet (Analytical Method)

(Page 1 of 1)

VIN Number: ________________________ **Operating Mode:** ____________________________

Speed Calculated for 3% Grade		
General Comments (initials/date):		
Speed Calculated for 6% Grade		
General Comments (initials/date):		
Completed By: (Printed Name)	(Signature)	(Date)
Reviewed By: (Printed Name)	(Signature)	(Date)
Approved By: (Printed Name)	(Signature)	(Date)

Appendix D – PHEV Metrology Setup Sheet

(Page 1 of 1)

VIN Number: ________________________ Operating Mode: ____________________________

Instrument/Device:	Calibration Due Date:	Initials / Date:
Fifth Wheel S/N:		
Fifth Wheel Calibrator S/N:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Tire Pressure Gauge S/N:		
Scales S/N:		
Misc:		
Misc:		
Misc:		

Comments (initials/date):

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Completed By:

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(Printed Name) (Signature) (Date)

Reviewed By (QA):

____

(Printed Name) (Signature) (Date)

Approved By:

____

(Printed Name) (Signature) (Date)

Section IV: AVTA-PHTP03 – Implementation of SAE J1711 MAR99, "Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles"

TABLE OF CONTENTS

APPENDICES

1 Objective

The objective of this procedure is to provide methods for the testing of fuel economy of plug-in hybrid electric vehicles (PHEV) evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA). Testing is conducted in accordance with SAE Standard J1711, "Recommended Practice for Measuring Fuel Economy and Emissions of Plug-in Hybrid Electric and Conventional Heavy-Duty Vehicles" and includes tests both with and without air conditioning loads. These methods are not meant to supersede those of the testing facility, those specifically addressed by SAE Test Standards (except as noted) nor of any regulatory agency, which may have or exercise control over the covered activities.

2 Purpose

The purpose of this procedure is to identify acceptable methods for the implementation of the test requirements of SAE J1711. SAE J1711 establishes uniform procedures for testing plug-in hybrid electric vehicles through a variety of drive cycles. This procedure provides specific guidance for testing plug-in hybrid electric vehicles (classified as off-vehicle-charge capable in SAE J1711) capable of operating in a mode which the consumable fuel energy converter (CFEC) and rechargeable energy storage system (RESS) are automatically controlled to supply energy independently or in combination (Normal Operation mode). Vehicles tested in an operating mode in which the CFEC is disabled and the vehicle operates solely on energy from the RESS (RESS Only mode) are tested in accordance with procedure AVTA-PHTP07. Minimum test requirements include the Urban Dynamometer Driving Schedule (UDDS), Highway Fuel Economy Driving Schedule (HWFEDS) and Supplemental Federal Test Procedure US06. This procedure establishes some requirements that deviate from the guidance of that SAE J1711. These deviations are necessary to assure that relative performance between vehicle types can be assessed. Deviations from SAE J1711 are clearly noted where they occur.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

Prior to conduct of any portion of the testing, the following initial conditions and prerequisites should be met. Satisfactory completion of these items should be verified and recorded on the Test Data Sheet.

4.1 Personnel conducting the testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05, and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 Ambient temperature within the dynamometer cell during testing shall be 77°F ± 9°F (25˚C ± 5˚C).

4.3 RESS and engine temperatures at the beginning of testing shall be established by soaking the vehicle at 77°F ± 9°F (25˚C ± 5˚C) for a minimum of 12 hours in accordance with SAE J1711 Section 4.3.1.4.a.

4.4 Tire Preparation

4.4.1 Tire pressures shall be set at the values used during coastdown testing conducted in accordance with procedure AVTA-PHTP01.

4.4.2 Suppliers recommended tires shall be used. Tires shall have a tread depth of at least 50% when new.

4.5 Dynamometer

4.5.1 This test procedure is predicated on the use of a 48” Four Wheel Drive (4WD) dynamometer which meets current EPA guidelines established in 40 CFR Part 86.108-00, for this type of dynamometer.

4.5.2 Road load power settings shall be based upon coefficients developed using procedure AVTA-PHTP01.

4.5.3 Inertia settings shall be made based on the vehicle curb weight as determined by procedure AVTA-PHAC06 weight plus 300 pounds. This is a deviation from the requirements of SAE J1711.

4.6 During dynamometer operation, a fixed-speed cooling fan shall be positioned so as to direct cooling air in an appropriate manner to cool the engine. The fan shall not develop an air flow in excess of 5,300 cubic feet per minute (2.5 m^3/s).

4.7 The vehicle shall be tested in its normal configuration with normal appendages (mirrors, bumpers, hubcaps, etc.). Certain items (hub caps, etc.) may be removed where necessary for safety on the dynamometer.

4.8 Normal Supplier's recommended lubricants shall be employed.

4.9 Prior to dynamometer testing, vehicles shall have accumulated a minimum of 1,000 miles. The vehicles shall be operated a sufficient number of miles to use at least two gallons of "EPA certification fuel" and shall have completed the requirements of procedures AVTA-PHTP04 and AVTA-PHTP05**.** This is a deviation from the requirements of SAE J1711.

4.10 RESS initial SOC shall be established in accordance with procedure AVTA-PHTP08, Section 5.

4.11 The following data shall be collected using a DAS during conduct of the various tests specified by this procedure. Overall error in recording or indicating instruments shall not exceed ±2% of the maximum value of the variable being measured or as specifically excepted elsewhere. Periodic calibration shall be performed and documented to ensure compliance with this requirement.

4.11.1 RESS voltage versus time

4.11.2 RESS current versus time (RESS current shall be collected at a frequency of at least 20 Hz)

4.11.3 Vehicle speed versus time

4.11.4 Distance versus time

4.11.5 RESS temperature versus time

4.11.6 RESS power versus time

4.11.7 Fuel flow (fuel flow shall be collected at a frequency of at least 20 Hz)

4.12 The range of ambient temperature during the testing shall be recorded.

4.13 A description of the dynamometer shall be recorded, including:

4.13.1 Drum or roll diameter and number of tire contact points

4.13.2 Road load power set points

4.13.3 Dynamometer inertia weight

4.13.4 Confirmation that the dynamometer conforms to EPA guidelines as specified in 40 CFR Part 86.108-00.

4.14 The date, starting and ending times shall be recorded.

4.15 The beginning and ending vehicle odometer readings shall be recorded.

4.16 All instrumentation used in the test shall be listed in Appendix A and attached to the test data sheets/results and shall include the following information:

4.16.1 Manufacturer

4.16.2 Model number

4.16.3 Serial number

4.16.4 Next calibration date

4.17 Any deviation from the test procedure and the reason for the deviation shall be recorded in accordance with procedure AVTA-PHAC02.

4.18 All documentation required to complete the testing shall be completed, approved and issued prior to commencing the testing it addresses.

4.19 A copy of test documentation and methodologies/instructions used for testing shall be included in the final test documentation program. This is in accordance with procedure AVTA-PHAC02.

4.20 Verify that procedures AVTA-PHAC06 and AVTA-PHTP11 have been, or are being completed and that the operating modes in which the vehicle will be tested have been determined. If the vehicle is to be tested in RESS Only mode, procedure AVTA-PHTP07 shall be used for such testing.

4.21 The volume of fuel consumed shall be determined using one or more of the following measurement methods:

4.21.1 The volume of liquid fuels consumed shall be determined by electronically integrating the output of a calibrated fuel flow meter. Accuracy of the meter in the range of measurement shall be at least 2% as required by Section 4.11. The vehicle shall be operated using "EPA Certification Fuel" during all testing.

4.21.2 Fuel consumption shall be determined by the gravimetric method. The test vehicle shall be supplied from an external fuel tank. The tank shall be weighed immediately before and immediately after testing. The quantity of fuel consumed shall be calculated using the density of the fuel (as obtained from the provider of the EPA Certification Fuel) and the weight of the fuel consumed during testing. The scale used for gravimetric testing shall have an accuracy of at least 1% of the weight of the fuel tank after testing. The vehicle shall be operated using "EPA Certification Fuel" during all testing.

4.21.3 Fuel consumption shall be determined using an emissions bench meeting the requirements of 40 CFR Part 86.106, and capable of measuring carbon emissions species (CO, CO_2, THC) to an accuracy, in the range of measurement, of at least 2%. The vehicle shall be operated using "EPA Certification Fuel" during all testing.

4.21.4 When completing the data sheet in Appendix C, the “Fuel Measurement” blanks should contain either the flow meter values or the weight measurements before and after the test. Emission results may be recorded in the comments section of the data sheet.

5 Dynamometer Setup

The purpose of this section is to prepare the dynamometer for use in testing PHEVs to the requirements of SAE J1711 as described in Section 6.

CAUTION:
In this procedure, the dynamometer is started and run. ALL personnel shall exercise appropriate cautions while in the vicinity of both the Power Absorption Unit and the Roller Section.

NOTE:
Activities necessary to complete the test are identified in the following sections. All items shall be completed, whether they are required by J1711 or not. Any section which cannot be completed shall be so annotated, along with the appropriate justification in accordance with procedure AVTA-PHAC02.

5.1 Establish the initial condition applicable to the Normal Operation mode as determined in procedure AVTA-PHAC06.

5.1.1 Place the vehicle in the Normal Operation mode and, for tests to be conducted beginning at 100% initial RESS SOC, establish the RESS at 100% initial SOC in accordance with procedure AVTA-PHTP08.

NOTE:
Establishing the appropriate RESS initial SOC may require charging the test vehicle or operating the vehicle on the dynamometer. Requirements for verification of the proper RESS initial SOC are presented in procedure AVTA-PHTP08.

5.1.2 Soak the vehicle in the dynamometer test cell for at least 12 hours at 77°F ± 9°F (25˚C ± 5˚C) before performing the UDDS test. Do not remove the vehicle from the dynamometer during this time.

NOTE:
Do not operate the vehicle propulsion system during dynamometer warm-up and calibration.

5.2 Conduct an initial warm-up of the dynamometer in accordance with facility procedures.

5.3 Conduct and complete speed calibration of the dynamometer in accordance with facility procedures.

5.4 Conduct and complete torque arm calibration of the dynamometer in accordance with facility procedures.

5.5 Conduct and complete Data Acquisition System (DAS) calibration (including the emissions bench) in accordance with facility procedures.

5.6 Set the dynamometer with the coastdown coefficients and inertia settings determined in procedure AVTA-PHTP01. Record the settings in Appendix B as "Target" settings.

5.7 Prepare the vehicle to be tested as follows:

5.7.1 Record tire inflation pressures in Appendix B.

5.7.2 Place the test vehicle on the dynamometer roll(s), and center it on the roll(s) using facility procedures.

5.7.3 Attach tie-down straps to the vehicle.

5.7.4 Place wheel chocks at the non-driving wheels.

5.7.5 Place fan appropriately to cool the engine, open the engine compartment cover and turn the fan on. Fans should be placed to simulate road air flow in accordance with Section 4.6.

CAUTION:

High voltage may be present. To prevent personnel injury or equipment damage, use extreme caution when connecting instrumentation leads.

5.7.6 Connect vehicle instrumentation leads to the DAS.

5.8 Determination of Dynamometer and Tire Parasitic Losses for Single Roll Dynamometer

5.8.1 Conduct back-to-back HWFEDS drive cycles.

5.8.2 Measure tire temperatures after the HWFEDS drive cycles and immediately before conducting the coastdown and record in Appendix B.

5.8.3 Place the vehicle in neutral or "dynamometer mode" if such mode is applicable based on vehicle manufacturer's supplied data.

5.8.4 Using the dynamometer motor, accelerate the vehicle to 80 mph.

5.8.5 Coast the vehicle to 5 mph, while recording speed vs. time.

5.8.6 Immediately after completion of step 5.7.5, record tire temperatures in Appendix B.

5.8.7 Save the DAS data and determine coastdown times from 75 to 5 mph in 10 mph increments.

5.8.8 Repeat steps 5.8.4 through 5.8.6 a minimum of three times.

5.9 Set up the dynamometer to achieve the desired coast-down times.

5.9.1 Compare the coastdown times obtained in step 5.8 with the coastdown times expected based upon the coastdown coefficients determined in procedure AVTA-PHTP01.

5.9.2 If measured coastdown times are not within 1.5% of the desired coastdown times, adjust road load coefficients and inertia settings as necessary. Record the final road load and inertia settings in Appendix B as "Dyno" settings.

5.10 If the adjustment to road load and inertia settings are greater than 3% from the initial calibration (the initial conduct of step 5.8 for the vehicle), an attempt to determine the cause of the “drift” shall be undertaken. This evaluation shall include both the vehicle and the dynamometer. Results of the investigation shall be noted in Appendix B and reviewed with the Test Director or Program Manager.

5.11 Record the applicable EPA coastdown coefficients and inertia settings in Appendix B. If the EPA settings deviate more significantly from the "Dyno" settings, an attempt shall be made to reconcile this deviation. Results of the investigation shall be noted in Appendix B and reviewed with the Test Director or Program Manager.

6 Road Load Simulation

The purpose of this section is to determine the fuel efficiency of a PHEV vehicle when subjected to the test schedules identified in SAE J1711 and operated both with and without air conditioning loads. This section selectively implements portions of SAE J1711 in support of this purpose. This is a deviation from the requirements of SAE J1711.

Dynamometer operating instructions developed by the entity operating the dynamometer shall be used in conjunction with this procedure. Road load simulation testing shall be conducted in the Normal Operation mode, starting with the RESS at 100% SOC, as determined by procedure AVTA-PHAC06. The vehicle shall be tested in the Normal Operation mode, using the UDDS, HWFEDS and US06 driving schedules without the air conditioning operating. Additionally, the vehicle shall be tested in the Normal Operation mode, starting with the RESS at 100% SOC, using the UDDS and HWFEDS driving schedules, with the air conditioning operating. The vehicle may be tested using other drive cycles defined in SAE J1711 as required to gather data required for evaluation of the vehicle.

Road load simulation testing is typically conducted over a period of five days in the order presented in Sections 6.1 through 6.5. Testing may be completed on a different schedule; however, the RESS shall be at the proper SOC for the beginning of each test. At the beginning of each test day, the dynamometer shall be prepared for operation in accordance with Sections 5.1 through 5.5.

6.1 Testing Day One

NOTE:
The Dynamometer Setup described in Section 5 is typically conducted at the beginning of Test Day One, rather than preceding Test Day One.

NOTE:
Do not operate the vehicle propulsion system during dynamometer warm-up and calibration.

6.1.1 Vehicle setup

6.1.1.1 Prepare the dynamometer in accordance with Sections 5.1 through 5.5.

6.1.1.2 Verify that the required ambient temperature exists in the dynamometer test cell and that the vehicle has been at the required ambient temperature for at least 12 hours.

6.1.1.3 Verify that the DAS instrumentation is connected.

6.1.1.4 Turn on the cooling fan(s).

6.1.1.5 If fuel economy is to be determined by gravimetric means in accordance with Section 4.22.2, weigh the external fuel tank filled with "EPA Certification Fuel" and record in Appendix B.

6.1.1.6 If fuel economy is to be determined by use of a fuel flow meter in accordance with Section 4.22.1, ensure the fuel flow integrator is set to zero and ready to begin operation.

6.1.1.7 If fuel economy is to be determined using an emissions bench in accordance with Section 4.22.3, ensure the emissions bench is ready to begin operation.

NOTE:
During conduct of US06 fuel economy testing, it will be necessary to determine when the vehicle has entered charge sustaining mode. The criteria to make this determination should be specified prior to the initiation of testing and may include calculating the energy represented by the change from initial RESS SOC to final RESS SOC over the drive cycle and comparing such energy to the total energy represented by the fuel consumed over the drive cycle.

6.1.2 US06 Drive Cycle

6.1.2.1 Verify that all accessories are off.

6.1.2.2 Ensure all dynamometer recording systems are operating.

6.1.2.3 Record the vehicle operating mode and the following initial parameters in Appendix C for a US06 drive cycle from a cold start.

6.1.2.3.1 Time of day

6.1.2.3.2 Odometer reading

6.1.2.3.3 SOC indicator reading

6.1.2.3.4 Ambient temperature

6.1.2.3.5 Tire temperatures

6.1.2.3.6 Fuel weight or fuel meter reading (as applicable)

6.1.2.3.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.1.2.4 Conduct a US06 drive cycle from cold start conditions.

6.1.2.5 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.1.2.6 Upon completion of the US06 drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following final cold start US06 parameters. At the end of the ten minute period, begin the next US06 drive cycle. This will be considered a US06 hot start drive cycle.

6.1.2.6.1 Time of day

6.1.2.6.2 Odometer reading

6.1.2.6.3 SOC indicator reading

6.1.2.6.4 Ambient temperature

6.1.2.6.5 Tire temperatures

6.1.2.6.6 Fuel weight or fuel meter integrator reading (as applicable)

6.1.2.6.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.1.2.7 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.1.2.8 Upon completion of the US06 drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin another US06 drive cycle.

6.1.2.8.1 Time of day

6.1.2.8.2 Odometer reading

6.1.2.8.3 SOC indicator reading

6.1.2.8.4 Ambient temperature

6.1.2.8.5 Tire temperatures

6.1.2.8.6 Fuel weight or fuel meter reading (as applicable)

6.1.2.8.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.1.2.9 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.1.2.10 Upon completion of the US06 drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following information:

6.1.2.10.1 Time of day

6.1.2.10.2 Odometer reading

6.1.2.10.3 SOC indicator reading

6.1.2.10.4 Ambient temperature

6.1.2.10.5 Tire temperatures

6.1.2.10.6 Fuel weight or fuel meter reading (as applicable)

6.1.2.10.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.1.2.11 Repeat US06 drive cycles as directed by Sections 6.1.2.7 and 6.1.2.8 a maximum of three times (6 US06 tests) until two drive cycles are completed in the charge sustaining mode as indicated by the criteria specified prior to commencing road load simulation testing, then complete US06 drive cycle tests by recording the following information:

6.1.2.11.1 Total distance for all US06 cycles conducted

6.1.2.11.2 If an emissions bench and carbon species measurement was used to determine fuel use, isolate the bags used for the US06 drive cycle testing and tag them for analysis

6.1.2.11.3 Conduct analysis of the US06 drive cycle emissions bench bags in accordance with facility procedures to determine the quantity of fuel used for each US06 drive cycle.

6.1.2.12 Secure the dynamometer.

6.1.2.13 Recharge the RESS to 100% in accordance with procedure AVTA-PHTP08. This may be done in the dynamometer test cell or in another area. However, no propulsion system power shall be used in moving the vehicle. Record the AC and DC energy returned to the RESS in Appendix D.

6.2 Testing Day Two

NOTE:
Do not operate the vehicle propulsion system during dynamometer warm-up and calibration.

6.2.1 Vehicle setup

6.2.1.1 Prepare the dynamometer in accordance with Sections 5.1 through 5.5.

6.2.1.2 Verify that the required ambient temperature exists in the dynamometer test cell and that the vehicle has been at the required ambient temperature for at least 12 hours.

6.2.1.3 Verify that the DAS instrumentation is connected.

6.2.1.4 Turn on the cooling fan(s).

6.2.1.5 If fuel economy is to be determined by gravimetric means in accordance with Section 4.22.2, weigh the external fuel tank filled with "EPA Certification Fuel" and record in Appendix B.

6.2.1.6 If fuel economy is to be determined by use of a fuel flow meter in accordance with Section 4.22.1, ensure the fuel flow integrator is set to zero and ready to begin operation.

6.2.1.7 If fuel economy is to be determined using an emissions bench in accordance with Section 4.22.3, ensure the emissions bench is ready to begin operation.

NOTE:
During conduct of HWFEDS fuel economy testing, it will be necessary to determine when the vehicle has entered charge sustaining mode. The criteria to make this determination should be specified prior to the initiation of testing and may include calculating the energy represented by the change from initial RESS SOC to final RESS SOC over the drive cycle and comparing such energy to the total energy represented by the fuel consumed over the drive cycle.

6.2.2 HWFEDS Drive Cycle

6.2.2.1 Verify that all accessories are off.

6.2.2.2 Ensure all dynamometer recording systems are operating.

6.2.2.3 Record the vehicle operating mode and the following initial parameters in Appendix C for a HWFEDS drive cycle from a cold start.

6.2.2.3.1 Time of day

6.2.2.3.2 Odometer reading

6.2.2.3.3 SOC indicator reading

6.2.2.3.4 Ambient temperature

6.2.2.3.5 Tire temperatures

6.2.2.3.6 Fuel weight or fuel meter reading (as applicable)

6.2.2.3.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.2.2.4 Conduct a HWFEDS drive cycle from cold start conditions.

6.2.2.5 Monitor the driver’s performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.2.2.6 Upon completion of the HWFEDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following final cold start HWFEDS parameters. At the end of the ten minute period, begin the next HWFEDS drive cycle. This will be considered a HWFEDS hot start drive cycle.

6.2.2.6.1 Time of day

6.2.2.6.2 Odometer reading

6.2.2.6.3 SOC indicator reading

6.2.2.6.4 Ambient temperature

6.2.2.6.5 Tire temperatures

6.2.2.6.6 Fuel weight or fuel meter integrator reading (as applicable)

6.2.2.6.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.2.2.7 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.2.2.8 Upon completion of the HWFEDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin another HWFEDS drive cycle.

6.2.2.8.1 Time of day

6.2.2.8.2 Odometer reading

6.2.2.8.3 SOC indicator reading

6.2.2.8.4 Ambient temperature

6.2.2.8.5 Tire temperatures

6.2.2.8.6 Fuel Weight or fuel meter reading (as applicable)

6.2.2.8.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.2.2.9 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.2.2.10 Upon completion of the HWFEDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following information:

6.2.2.10.1 Time of day

6.2.2.10.2 Odometer reading

6.2.2.10.3 SOC indicator reading

6.2.2.10.4 Ambient temperature

6.2.2.10.5 Tire temperatures

6.2.2.10.6 Fuel weight or fuel meter reading (as applicable)

6.2.2.10.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.2.2.11 Repeat HWFEDS drive cycles as directed by Sections 6.2.2.7 and 6.2.2.8 a maximum of three times (6 HWFEDS tests) and any additional vehicle specific charge depleting drive cycles as required until two HWFEDS drive cycles are completed in the charge sustaining mode as indicated by the criteria specified prior to commencing road load simulation testing, then complete HWFEDS drive cycle by recording the following information:

6.2.2.11.1 Total Distance for all HWFEDS cycles conducted

6.2.2.11.2 If an emissions bench and carbon species measurement was used to determine fuel use, isolate the bags used for the HWFEDS drive cycle testing and tag them for analysis

6.2.2.11.3 Conduct analysis of the HWFEDS drive cycle emissions bench bags in accordance with facility procedures to determine the quantity of fuel used for each HWFEDS drive cycle.

6.2.2.12 Secure the dynamometer.

6.2.2.13 Recharge the RESS to 100% in accordance with procedure AVTA-PHTP08. This may be done in the dynamometer test cell or in another area. However, no propulsion system power shall be used in moving the vehicle. Record the AC and DC energy returned to the RESS in Appendix D.

6.3 Testing Day Three

NOTE:
Do not operate the vehicle propulsion system during dynamometer warm-up and calibration.

6.3.1 Vehicle setup

6.3.1.1 Prepare the dynamometer in accordance with Sections 5.1 through 5.5.

6.3.1.2 Verify that the required ambient temperature exists in the dynamometer test cell and that the vehicle has been at the required ambient temperature for at least 12 hours.

6.3.1.3 Verify that the DAS instrumentation is connected.

6.3.1.4 Turn on the cooling fan(s).

6.3.1.5 If fuel economy is to be determined by gravimetric means in accordance with Section 4.22.2, weigh the external fuel tank filled with "EPA Certification Fuel" and record in Appendix B.

6.3.1.6 If fuel economy is to be determined by use of a fuel flow meter in accordance with Section 4.22.1, ensure the fuel flow integrator is set to zero and ready to begin operation.

6.3.1.7 If fuel economy is to be determined using an emissions bench in accordance with Section 4.22.3, ensure the emissions bench is ready to begin operation.

NOTE:
During conduct of UDDS fuel economy testing it will be necessary to determine when the vehicle has entered charge sustaining mode. The criteria to make this determination should be specified prior to the initiation of testing and may include calculating the energy represented by the change from initial RESS SOC to final RESS SOC over the drive cycle and comparing such energy to the total energy represented by the fuel consumed over the drive cycle.

6.3.2 UDDS Drive Cycle

6.3.2.1 Verify that all accessories are off.

6.3.2.2 Ensure all dynamometer recording systems are operating.

6.3.2.3 Record the vehicle operating mode and the following initial parameters in Appendix C for a UDDS drive cycle from a cold start.

6.3.2.3.1 Time of day

6.3.2.3.2 Odometer reading

6.3.2.3.3 SOC indicator reading

6.3.2.3.4 Ambient temperature

6.3.2.3.5 Tire temperatures

6.3.2.3.6 Fuel weight or fuel meter reading (as applicable)

6.3.2.3.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.3.2.4 Conduct a UDDS drive cycle from cold start conditions.

6.3.2.5 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.3.2.6 Upon completion of the UDDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following final cold start UDDS parameters. At the end of the ten minute period, begin the next UDDS drive cycle. This will be considered a UDDS hot start drive cycle.

6.3.2.6.1 Time of day

6.3.2.6.2 Odometer reading

6.3.2.6.3 SOC indicator reading

6.3.2.6.4 Ambient temperature

6.3.2.6.5 Tire temperatures

6.3.2.6.6 Fuel weight or fuel meter integrator reading (as applicable)

6.3.2.6.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.3.2.7 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.3.2.8 Upon completion of the UDDS drive cycle, wait 10 minutes ($\pm$ 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin another UDDS drive cycle.

6.3.2.8.1 Time of day

6.3.2.8.2 Odometer reading

6.3.2.8.3 SOC indicator reading

6.3.2.8.4 Ambient temperature

6.3.2.8.5 Tire temperatures

6.3.2.8.6 Fuel weight or fuel meter reading (as applicable)

6.3.2.8.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.3.2.9 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.3.2.10 Upon completion of the UDDS drive cycle, wait 10 minutes ($\pm$ 1 minute) with the vehicle and its accessories off. During this period, record the following information:

6.3.2.10.1 Time of day

6.3.2.10.2 Odometer reading

6.3.2.10.3 SOC indicator reading

6.3.2.10.4 Ambient temperature

6.3.2.10.5 Tire temperatures

6.3.2.10.6 Fuel weight or fuel meter reading (as applicable)

6.3.2.10.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.3.2.11 Repeat UDDS drive cycles as directed by Sections 6.3.2.7 and 6.3.2.8 a maximum of three times (6 UDDS tests) and any additional vehicle-specific charge-depleting drive cycles as required until two HWFEDS drive cycles are completed in the charge sustaining mode as indicated by the criteria specified prior to commencing road load simulation testing, then complete UDDS drive cycle by recording the following information:

6.3.2.11.1 Total Distance for all UDDS cycles conducted

6.3.2.11.2 If an emissions bench and carbon species measurement was used to determine fuel use, isolate the bags used for the UDDS drive cycle testing and tag them for analysis

6.3.2.11.3 Conduct analysis of the UDDS drive cycle emissions bench bags in accordance with facility procedures to determine the quantity of fuel used for each UDDS drive cycle.

6.3.2.12 Secure the dynamometer.

6.3.2.13 Do not recharge the RESS, as testing in Day 4 will commence in charge sustaining mode.

6.4 Testing Day 4

NOTE:
Do not operate the vehicle propulsion system during dynamometer warm-up and calibration.

6.4.1 Vehicle setup

6.4.1.1 Prepare the dynamometer in accordance with Sections 5.1 through 5.5.

6.4.1.2 Verify that the required ambient temperature exists in the dynamometer test cell and that the vehicle has been at the required ambient temperature for at least 12 hours.

6.4.1.3 Verify that the DAS instrumentation is connected.

6.4.1.4 Turn on the cooling fan(s).

6.4.1.5 If fuel economy is to be determined by gravimetric means in accordance with Section 4.22.2, weigh the external fuel tank filled with "EPA Certification Fuel" and record in Appendix B.

6.4.1.6 If fuel economy is to be determined by use of a fuel flow meter in accordance with Section 4.22.1, ensure the fuel flow integrator is set to zero and ready to begin operation.

6.4.1.7 If fuel economy is to be determined using an emissions bench in accordance with Section 4.22.3, ensure the emissions bench is ready to begin operation.

6.4.2 UDDS Drive Cycle (charge sustaining)

6.4.2.1 Verify that all accessories are off.

6.4.2.2 Ensure all dynamometer recording systems are operating.

6.4.2.3 Record the vehicle operating mode and the following initial parameters in Appendix C for a UDDS drive cycle from a cold start.

6.4.2.3.1 Time of day

6.4.2.3.2 Odometer reading

6.4.2.3.3 SOC indicator reading

6.4.2.3.4 Ambient temperature

6.4.2.3.5 Tire temperatures

6.4.2.3.6 Fuel weight or fuel meter reading (as applicable)

6.4.2.3.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.4.2.4 Conduct a UDDS drive cycle from cold start conditions.

6.4.2.5 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.4.2.6 Upon completion of the UDDS drive cycle, wait 10 minutes ($\pm$ 1 minute) with the vehicle and its accessories off. During this period, record the following final cold start UDDS parameters. At the end of the ten minute period, begin the next UDDS drive cycle. This will be considered a UDDS hot start drive cycle.

6.4.2.6.1 Time of day

6.4.2.6.2 Odometer reading

6.4.2.6.3 SOC indicator reading

6.4.2.6.4 Ambient temperature

6.4.2.6.5 Tire temperatures

6.4.2.6.6 Fuel weight or fuel meter integrator reading (as applicable)

6.4.2.6.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.4.2.7 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.4.2.8 Upon completion of the UDDS drive cycle, wait 10 minutes ($\pm$ 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin a HWFEDS drive cycle.

6.4.2.8.1 Time of day

6.4.2.8.2 Odometer reading

6.4.2.8.3 SOC indicator reading

6.4.2.8.4 Ambient temperature

6.4.2.8.5 Tire temperatures

6.4.2.8.6 Fuel weight or fuel meter reading (as applicable)

6.4.2.8.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.4.3 HWFEDS Drive Cycle (charge sustaining)

6.4.3.1 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.4.3.2 Upon completion of the HWFEDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin another HWFEDS drive cycle.

6.4.3.2.1 Time of day

6.4.3.2.2 Odometer reading

6.4.3.2.3 SOC indicator reading

6.4.3.2.4 Ambient temperature

6.4.3.2.5 Tire temperatures

6.4.3.2.6 Fuel weight or fuel meter reading (as applicable)

6.4.3.2.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.4.3.3 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.4.3.4 Upon completion of the HWFEDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin a US06 drive cycle.

6.4.3.4.1 Time of day

6.4.3.4.2 Odometer reading

6.4.3.4.3 SOC indicator reading

6.4.3.4.4 Ambient temperature

6.4.3.4.5 Tire temperatures

6.4.3.4.6 Fuel weight or fuel meter reading (as applicable)

6.4.3.4.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.4.4 US06 Drive Cycle (charge sustaining)

6.4.4.1 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in

Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.4.4.2 Upon completion of the US06 drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin another US06 drive cycle.

6.4.4.2.1 Time of day

6.4.4.2.2 Odometer reading

6.4.4.2.3 SOC indicator reading

6.4.4.2.4 Ambient temperature

6.4.4.2.5 Tire temperatures

6.4.4.2.6 Fuel weight or fuel meter reading (as applicable)

6.4.4.2.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.4.4.3 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.4.4.4 Upon completion of the US06 drive cycle, record the following information:

6.4.4.4.1 Time of day

6.4.4.4.2 Odometer reading

6.4.4.4.3 SOC indicator reading

6.4.4.4.4 Ambient temperature

6.4.4.4.5 Tire temperatures

6.4.4.4.6 Fuel weight or fuel meter reading (as applicable)

6.4.4.4.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.4.4.5 Complete Day 4 testing by recording the following information:

6.4.4.5.1 Total Distance for all drive cycles conducted

6.4.4.5.2 If an emissions bench and carbon species measurement was used to determine fuel use, isolate the bags used for drive cycle testing and tag them for analysis

6.4.4.5.3 Conduct analysis of drive cycle emissions bench bags in accordance with facility procedures to determine the quantity of fuel used for each drive cycle.

6.4.4.6 Secure the dynamometer.

6.4.4.7 Recharge the RESS to 100% in accordance with procedure AVTA-PHTP08. This may be done in the dynamometer test cell or in another area. However, no propulsion system power shall be used in moving the vehicle. Record the AC and DC energy returned to the RESS in Appendix D.

6.5 Testing Day 5

NOTE:
Do not operate the vehicle propulsion system during dynamometer warm-up and calibration.

6.5.1 Vehicle setup

6.5.1.1 Prepare the dynamometer in accordance with Sections 5.1 through 5.5.

6.5.1.2 All testing in Day 5 shall be conducted with the air conditioning on. Open as many vehicle doors and windows as can be safely done on the dynamometer and place the air conditioning temperature at the lowest possible setting, the air conditioning fan on the highest possible setting and the air supply to outside air (if selectable).

6.5.1.3 Verify that the required ambient temperature exists in the dynamometer test cell and that the vehicle has been at the required ambient temperature for at least 12 hours.

6.5.1.4 Verify that the DAS instrumentation is connected.

6.5.1.5 Turn on the cooling fan(s).

6.5.1.6 If fuel economy is to be determined by gravimetric means in accordance with Section 4.22.2, weigh the external fuel tank filled with "EPA Certification Fuel" and record in Appendix B.

6.5.1.7 If fuel economy is to be determined by use of a fuel flow meter in accordance with Section 4.22.1, ensure the fuel flow integrator is set to zero and ready to begin operation.

6.5.1.8 If fuel economy is to be determined using an emissions bench in accordance with Section 4.22.3, ensure the emissions bench is ready to begin operation.

NOTE:
During conduct of fuel economy testing it will be necessary to determine when the vehicle has entered charge sustaining mode. The criteria to make this determination should be specified prior to the initiation of testing and may include calculating the energy represented by the change from initial RESS SOC to final RESS SOC over the drive cycle and comparing such energy to the total energy represented by the fuel consumed over the drive cycle.

6.5.2 UDDS Drive Cycle

6.5.2.1 Verify that all accessories are off (except air conditioning when testing with air conditioning on).

6.5.2.2 For testing with air conditioning operable, open as many vehicle doors and windows as can be safely done on the dynamometer and place the air conditioning temperature at the lowest possible setting, the air conditioning fan on the highest possible setting and the air supply to outside air (if selectable).

6.5.2.3 Ensure all dynamometer recording systems are operating.

6.5.2.4 Record the vehicle operating mode and the following initial parameters in Appendix C for a UDDS drive cycle from a cold start.

6.5.2.4.1 Time of day

6.5.2.4.2 Odometer reading

6.5.2.4.3 SOC indicator reading

6.5.2.4.4 Ambient temperature

6.5.2.4.5 Tire temperatures

6.5.2.4.6 Fuel weight or fuel meter reading (as applicable)

6.5.2.4.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.5.2.5 Conduct a UDDS drive cycle from cold start conditions.

6.5.2.6 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.5.2.7 Upon completion of the UDDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following final cold start UDDS parameters. At the end of the ten minute period, begin the next UDDS drive cycle. This will be considered a UDDS hot start drive cycle.

6.5.2.7.1 Time of day

6.5.2.7.2 Odometer reading

6.5.2.7.3 SOC indicator reading

6.5.2.7.4 Ambient temperature

6.5.2.7.5 Tire temperatures

6.5.2.7.6 Fuel weight or fuel meter integrator reading (as applicable)

6.5.2.7.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.5.2.8 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.5.2.9 Upon completion of the UDDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin a HWFEDS drive cycle.

6.5.2.9.1 Time of day

6.5.2.9.2 Odometer reading

6.5.2.9.3 SOC indicator reading

6.5.2.9.4 Ambient temperature

6.5.2.9.5 Tire temperatures

6.5.2.9.6 Fuel weight or fuel meter reading (as applicable)

6.5.2.9.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.5.3 HWFEDS Drive Cycle

6.5.3.1 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.5.3.2 Upon completion of the HWFEDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin another HWFEDS drive cycle.

6.5.3.2.1 Time of day

6.5.3.2.2 Odometer reading

6.5.3.2.3 SOC indicator reading

6.5.3.2.4 Ambient temperature

6.5.3.2.5 Tire temperatures

6.5.3.2.6 Fuel weight or fuel meter reading (as applicable)

6.5.3.2.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.5.3.3 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.5.3.4 Upon completion of the HWFEDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following information:

6.5.3.4.1 Time of day

6.5.3.4.2 Odometer reading

6.5.3.4.3 SOC indicator reading

6.5.3.4.4 Ambient temperature

6.5.3.4.5 Tire temperatures

6.5.3.4.6 Fuel weight or fuel meter reading (as applicable)

6.5.3.4.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.5.3.5 Repeat UDDS and HWFEDS drive cycles (all hot starts) as directed by Sections 6.5.2.5 through 6.5.3.4 a maximum of two times (4 UDDS and 4 HWFEDS tests) until two drive cycles are completed in the charge sustaining mode as indicated by the criteria specified prior to commencing road load simulation testing. No fuel weight, fuel metering or carbon species measurement is required for this testing.

6.5.4 UDDS Drive Cycle (charge sustaining)

6.5.4.1 Record the vehicle operating mode and the following initial parameters in Appendix C for a UDDS drive cycle from a cold start.

6.5.4.1.1 Time of day

6.5.4.1.2 Odometer reading

6.5.4.1.3 SOC indicator reading

6.5.4.1.4 Ambient temperature

6.5.4.1.5 Tire temperatures

6.5.4.1.6 Fuel weight or fuel meter reading (as applicable)

6.5.4.1.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.5.4.2 Conduct a UDDS drive cycle with the RESS at an initial RESS SOC of charge sustaining.

6.5.4.3 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.5.4.4 Upon completion of the UDDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following final cold start UDDS parameters. At the end of the ten minute period, begin the next UDDS drive cycle.

6.5.4.4.1 Time of day

6.5.4.4.2 Odometer reading

6.5.4.4.3 SOC indicator reading

6.5.4.4.4 Ambient temperature

6.5.4.4.5 Tire temperatures

6.5.4.4.6 Fuel weight or fuel meter integrator reading (as applicable)

6.5.4.4.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.5.4.5 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.5.4.6 Upon completion of the UDDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin a HWFEDS drive cycle.

6.5.4.6.1 Time of day

6.5.4.6.2 Odometer reading

6.5.4.6.3 SOC indicator reading

6.5.4.6.4 Ambient temperature

6.5.4.6.5 Tire temperatures

6.5.4.6.6 Fuel weight or fuel meter reading (as applicable)

6.5.4.6.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.5.5 HWFEDS Drive Cycle (charge sustaining)

6.5.5.1 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.5.5.2 Upon completion of the HWFEDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following. At the end of the ten minute period, begin another HWFEDS drive cycle.

6.5.5.2.1 Time of day

6.5.5.2.2 Odometer reading

6.5.5.2.3 SOC indicator reading

6.5.5.2.4 Ambient temperature

6.5.5.2.5 Tire temperatures

6.5.5.2.6 Fuel weight or fuel meter reading (as applicable)

6.5.5.2.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.5.5.3 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1711 Section 3.5.1. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.5.5.4 Upon completion of the HWFEDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following information:

6.5.5.4.1 Time of day

6.5.5.4.2 Odometer reading

6.5.5.4.3 SOC indicator reading

6.5.5.4.4 Ambient temperature

6.5.5.4.5 Tire temperatures

6.5.5.4.6 Fuel weight or fuel meter reading (as applicable)

6.5.5.4.7 If an emissions bench and carbon species measurement is used to determine fuel use, switch the emissions bench to a fresh collection bag.

6.5.5.5 Complete Day 5 testing by recording the following information:

6.5.5.5.1 Total Distance for all drive cycles conducted

6.5.5.5.2 If an emissions bench and carbon species measurement was used to determine fuel use, isolate the bags used for drive cycle testing and tag them for analysis

6.5.5.5.3 Conduct analysis of drive cycle emissions bench bags in accordance with facility procedures to determine the quantity of fuel used for each drive cycle.

6.5.5.6 Recharge the RESS to 100% in accordance with procedure AVTA-PHTP08. This may be done in the dynamometer test cell or in another area. However, no propulsion system power shall be used in moving the vehicle. Record the AC and DC energy returned to the RESS in Appendix D.

6.5.5.7 Secure the dynamometer and dismount the vehicle.

6.6 Fuel Efficiency Calculations

NOTE:
RESS energy supplied and vehicle fuel efficiency shall be calculated for the combined UDDS-HWFEDS (Day 5), each UDDS, HWFEDS and US06 cycle. The equation is the same, but only the energy supplied and distance traveled during the test being evaluated should be used.

6.6.1 If the gravimetric method was used for determination of fuel economy (Section 4.22.2), calculate the vehicle fuel efficiency in mi/gal using the following equation and record the fuel economy and method of calculation (gravimetric) in Appendix E.

$$\text{Fuel Economy (mpg)} = \frac{\text{Dynamometer Distance (miles)} * \text{Fuel Density (lbs/gal)}}{[\text{Initial Fuel Weight (lb)} - \text{Final Fuel Weight (lb)}]}$$

Fuel Density shall be corrected to the average temperature of the test chamber for the 12 hours prior to testing.

6.6.2 If the fuel flow meter method is used for determination of fuel economy (Section 4.22.1) calculate the vehicle fuel efficiency in mi/gal using the following equation and record the fuel economy and method of calculation (fuel flow) in Appendix E.

$$\textit{Fuel Economy (mpg)} = \frac{\textit{Dynamometer Distance (miles)} * \textit{Fuel Density (lbs/gal)}}{\textit{Fuel Used (lb)}}$$

Fuel used shall be determined by integrating the fuel flow meter in accordance with Section 4.11. The Dynamometer Distance shall be the total miles traveled to the point of test termination.

6.6.3 If the carbon species method is used for determination of fuel economy (Section 4.22.3) process the emissions bench data in accordance with facility procedures and record the fuel economy and method of calculation (carbon species) in Appendix E.

6.6.4 The RESS should not have a change in energy over the charge sustaining driving schedules greater than 1% of the total fuel energy consumed. If the net change in RESS energy over a driving schedule is greater than 1% of the total fuel energy consumed for that driving schedule, a correction shall be made for the electric energy consumed during the driving schedule. This is a deviation from the requirements of SAE J1711.

6.6.4.1 The change in RESS energy shall be determined using the following equation.

$$\Delta\ \textit{RESS Energy (Wh)} = [\textit{RESS}_{initial}\ \textit{(Ahr)} - \textit{RESS}_{final}\ \textit{(Ahr)}] * \textit{RESS}_{average\ voltage}\textit{(V)}$$

The change in RESS energy shall be less than 1% of the total fuel energy consumed as calculated using the following equation.

$$\textit{Fuel Energy (Wh)} = \frac{\textit{Net Fuel Heating Value (J/kg)} * \textit{fuel consumed (kg)}}{3600}$$

If change in RESS energy is less than 1% of the total fuel energy consumed, note such in Appendix E. In this case the RESS Correction is zero.

6.6.4.2 If change in RESS energy is greater than 1% of the total fuel energy consumed, note such in Appendix E and calculate the RESS Correction using the following equation. The RESS correction shall be added to the AC recharge energy.

$$\textit{RESS Correction (AC kWh)} = \frac{\Delta\ \textit{RESS Energy (Wh)}}{\textit{Charger Efficiency (DC-Wh/AC-Wh)}}$$

NOTE:

Charger Efficiency shall be obtained using procedure AVTA-PHTP10, Section 5.4.2.16. Net Fuel Heating Value shall be obtained for the "EPA Certification Fuel" from the fuel data sheet.

6.7 RESS Capacity and Energy Supplied Calculations

6.7.1 Calculate the capacity supplied by the RESS (Ahr/mi) during charge depletion and the percentage of RESS capacity supplied by the RESS (%/mi) during charge depletion using the following equations and record in Appendix D:

$$\textit{RESS Capacity (Ahr/mi)} = \frac{[\,RESS_{enter\ sustaining}\,(Ahr) - RESS_{initial}\,(Ahr)]}{\textit{Dynamometer Distance (miles)}}$$

$$\textit{RESS Capacity (\%/mile)} = \frac{100 * [RESS_{enter\ sustaining}\,(Ahr) - RESS_{initial}\,(Ahr)]}{\textit{Dynamometer Distance (miles)} * \textit{RESS Capacity (Ahr)}}$$

The $RESS_{initial}$ and $RESS_{enter\ sustaining}$ shall be determined by integrating the ammeter in accordance with Section 4.11. The $RESS_{enter\ sustaining}$ shall be the total ampere-hours out of the RESS to entry into charge sustaining mode. The Dynamometer Distance shall be the total miles traveled to the point of entry into charge sustaining mode. The *RESS Capacity (Ahr)* shall be the nominal capacity of the RESS as determined in procedure AVTA-PHAC06.

6.7.2 Calculate the DC energy supplied by the RESS (Wh/mi) using the following equation and record in Appendix D:

$$\textit{DC Energy Supplied (DC-Wh/mile)} = \frac{RESS_{DC\ energy}\,(Wh)}{\textit{Dynamometer Distance (miles)}}$$

The DC energy shall be determined by integrating the product of the ammeter and voltmeter in accordance with Section 4.11. The DC energy supplied by the RESS shall be the total energy out of the RESS to the point of test termination. The Dynamometer Distance shall be the total miles traveled to the point of test termination.

6.8 Calculation of RESS AC Electrical Recharge Energy Consumed

6.8.1 Electric energy (AC) used to recharge the RESS shall be calculated in accordance with procedure AVTA-PHTP08.

6.8.2 Record the AC recharge energy for each Test Day the vehicles are charged in Appendix D.

Appendix A – PHEV Metrology Setup Sheet

(Page 1 of 1)

VIN Number: __________

Instrument/Device:	Calibration Due Date:	Initials / Date:
Fifth Wheel S/N:		
Fifth Wheel Calibrator S/N:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Tire Pressure Gauge S/N:		
Fuel Scale/flow Meter S/N:		
Emissions Bench ID:		
Misc:		
Misc:		
Comments (initials/date):		
Completed By: (Printed Name)	(Signature)	(Date)
Reviewed By (QA): (Printed Name)	(Signature)	(Date)
Approved By: (Printed Name)	(Signature)	(Date)

Appendix B – SAE J1711 Test Data Sheet

(Page 1 of 2)

VIN Number: ______________________ Operating Mode ______

Project No.:	Test Date(s):
Data File Name:	
Test Driver: (Initials) (Date)	
Test Engineer: (Initials) (Date)	

Vehicle Setup

TIRE TEMPERATURE			
Initial L/F: (˚F or ˚C)	Initial R/F: (˚F or ˚C)	Final L/F: (˚F or ˚C)	Final R/F: (˚F or ˚C)
Initial L/R: (˚F or ˚C)	Initial R/R: (˚F or ˚C)	Final L/R: (˚F or ˚C)	Final R/R: (˚F or ˚C)

COLD TIRE PRESSURE (Shaved ☐ Yes ☐ No)	
Left Front: (psig or kPa)	Right Front: (psig or kPa)
Left Rear: (psig or kPa)	Right Rear: (psig or kPa)

Determination of Dynamometer and Tire Parasitic Losses

Coefficients	Target	Dyno	% Deviation
Inertia			
A			
B			
C			

EPA Coefficient Comparison

Coefficients	EPA	Dyno	% Deviation
Inertia			
A			
B			
C			

Appendix B – SAE J1711 Test Data Sheet
(Page 2 of 2)

VIN Number: ______________________ Operating Mode ______

General Comments (initials/date):		
Completed By: (Printed Name)	(Signature)	(Date)
Reviewed By: (Printed Name)	(Signature)	(Date)
Approved By: (Printed Name)	(Signature)	(Date)

Appendix C – SAE J1711 Driving Schedule

DAY ONE

VIN Number: ______________________ Operating Mode ______

TIRE PRESSURE	
Left Front: (psig or kPa)	Right Front: (psig or kPa)
Left Rear: (psig or kPa)	Right Rear: (psig or kPa)
Fuel Density: (lbs per gallon)	
Inertial Weight Setting: (la_b)	

US06 Cold Start

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

1st US06 Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th US06 Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th US06 Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th US06 Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th US06 Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

Appendix C – SAE J1711 Driving Schedule

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VIN Number: ______________________ Operating Mode ______

__ th US06 Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th US06 Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

2nd US06 Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

3rd US06 Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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DAY TWO
VIN Number: ______________________ Operating Mode _______

TIRE PRESSURE	
Left Front: (psig or kPa)	Right Front: (psig or kPa)
Left Rear: (psig or kPa)	Right Rear: (psig or kPa)
Fuel Density: (lbs per gallon)	
Inertial Weight Setting: (la_b)	

HWFEDS Cold Start:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: _________	Fuel Weight: ________(kg/lbs) Fuel Meter: _________
Ambient Temperature: ___________ (˚F/˚C)	Ambient Temperature: ___________ (˚F/˚C)

1st HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: _________	Fuel Weight: ________(kg/lbs) Fuel Meter: _________
Ambient Temperature: ___________ (˚F/˚C)	Ambient Temperature: ___________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

2nd HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

3rd HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

1st HWFEDS (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

2nd HWFEDS (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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DAY THREE

VIN Number: ______________________ Operating Mode ______

TIRE PRESSURE	
Left Front: (psig or kPa)	Right Front: (psig or kPa)
Left Rear: (psig or kPa)	Right Rear: (psig or kPa)
Fuel Density: (lbs per gallon)	
Inertial Weight Setting: (la_b)	

UDDS Cold Start:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

1st UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

2nd HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

3rd HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

1st UDDS (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

2nd UDDS (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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DAY FOUR

VIN Number: ______________________ Operating Mode ______

TIRE PRESSURE	
Left Front: (psig or kPa)	Right Front: (psig or kPa)
Left Rear: (psig or kPa)	Right Rear: (psig or kPa)
Fuel Density: (lbs per gallon)	
Inertial Weight Setting: (la$_b$)	

UDDS Cold Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

UDDS Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

1st HWFEDS Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: _________	Fuel Weight: ________(kg/lbs) Fuel Meter: _________
Ambient Temperature: ___________ (˚F/˚C)	Ambient Temperature: ___________ (˚F/˚C)

2nd HWFEDS Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: _________	Fuel Weight: ________(kg/lbs) Fuel Meter: _________
Ambient Temperature: ___________ (˚F/˚C)	Ambient Temperature: ___________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

1st US06 Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

2nd US06 Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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DAY FIVE

VIN Number: ______________________ Operating Mode ______

TIRE PRESSURE	
Left Front: (psig or kPa)	Right Front: (psig or kPa)
Left Rear: (psig or kPa)	Right Rear: (psig or kPa)
Fuel Density: (lbs per gallon)	
Inertial Weight Setting: (la_b)	

UDDS A/C Cold Start:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: _________	Fuel Weight: ________(kg/lbs) Fuel Meter: _________
Ambient Temperature: ___________ (˚F/˚C)	Ambient Temperature: ___________ (˚F/˚C)

1st UDDS A/C Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: _________	Fuel Weight: ________(kg/lbs) Fuel Meter: _________
Ambient Temperature: ___________ (˚F/˚C)	Ambient Temperature: ___________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

1st HWFEDS A/C Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

2nd HWFEDS A/C Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th HWFEDS Hot Start (charge depleting): :

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th HWFEDS Hot Start (charge depleting): :

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th UDDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

__ th HWFEDS Hot Start (charge depleting):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__ th HWFEDS Hot Start (charge depleting): :

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

1st UDDS A/C Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

2nd UDDS A/C Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

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VIN Number: ______________________ Operating Mode ______

1st HWFEDS A/C Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

2nd HWFEDS A/C Hot Start (charge sustaining):

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Fuel Weight: ________(kg/lbs) Fuel Meter: ________	Fuel Weight: ________(kg/lbs) Fuel Meter: ________
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

Appendix C – SAE J1711 Driving Schedule
(Page 31 of 31)

VIN Number: ______________________ Operating Mode ______

Time:	Speed:	Distance:	Comments:	Initials:

Appendix D – SAE J1711 Energy Efficiency

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VIN Number: ______________________ Operating Mode ______

DAY ONE

Fuel Economy

Drive Cycle Description	Fuel Economy	Δ RESS Energy/ Fuel Energy	RESS Correction
US06 Cold Start (charge depleting)	______mpg Method ____	_____ (J) / _____ (J)	___________ (gal)
1st US06 Hot Start (charge depleting)	______mpg Method ____	_____ (J) / _____ (J)	___________ (gal)
2nd US06 Hot Start (charge depleting)	______mpg Method ____	_____ (J) / _____ (J)	___________ (gal)
3rd US06 Hot Start (charge depleting)	______mpg Method ____	_____ (J) / _____ (J)	___________ (gal)

RESS Energy

Drive Cycle Description	RESS Capacity Supplied (Ah/mi)	RESS Capacity Supplied (%/mi)	DC Energy Supplied (kWh/mi)
US06 Cold Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st US06 Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
2nd US06 Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
3rd US06 Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)

Charger

AC into the Charger: _____________ (kWh)	DC into the RESS: _____________ (kWh)

Approval

Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix D – SAE J1711 Energy Efficiency

(Page 2 of 8)

VIN Number: ______________________ Operating Mode ______

DAY TWO

Fuel Economy

Drive Cycle Description	Fuel Economy	Δ RESS Energy/ Fuel Energy	RESS Correction
HWFEDS Cold Start	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
1st HWFEDS Hot Start (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
2nd HWFEDS Hot Start (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
3rd HWFEDS Hot Start (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th HWFEDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th HWFEDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th HWFEDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th HWFEDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th HWFEDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th HWFEDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
1st HWFEDS Hot Start (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
2nd HWFEDS Hot Start (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)

Appendix D – SAE J1711 Energy Efficiency

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VIN Number: ______________________ Operating Mode ______

DAY TWO

RESS Energy

Drive Cycle Description	RESS Capacity Supplied (Ah/mi)	RESS Capacity Supplied (%/mi)	DC Energy Supplied (kWh/mi)
HWFEDS Cold Start	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st HWFEDS Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
2nd HWFEDS Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
3rd HWFEDS Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th HWFEDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th HWFEDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th HWFEDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th HWFEDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th HWFEDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th HWFEDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st HWFEDS Hot Start (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
2nd HWFEDS Hot Start (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)

Charger

AC into the Charger: _____________ (kWh)	DC into the RESS: _____________ (kWh)

Approval

Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix D – SAE J1711 Energy Efficiency

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VIN Number: ______________________ Operating Mode ______

DAY THREE

Fuel Economy

Drive Cycle Description	Fuel Economy	Δ RESS Energy/ Fuel Energy	RESS Correction
UDDS Cold Start	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
1st UDDS Hot Start (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
2nd UDDS Hot Start (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
3rd UDDS Hot Start (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th UDDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th UDDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th UDDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th UDDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th UDDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
__th UDDS (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
1st UDDS Hot Start (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
2nd UDDS Hot Start (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)

Appendix D – SAE J1711 Energy Efficiency

(Page 5 of 8)

VIN Number: ______________________ Operating Mode ______

DAY THREE

RESS Energy

Drive Cycle Description	RESS Capacity Supplied (Ah/mi)	RESS Capacity Supplied (%/mi)	DC Energy Supplied (kWh/mi)
UDDS Cold Start	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st UDDS Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
2nd UDDS Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
3rd UDDS Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th UDDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th UDDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th UDDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th UDDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th UDDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
__th UDDS (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st UDDS Hot Start (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
2nd UDDS Hot Start (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)

Approval

Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix D – SAE J1711 Energy Efficiency

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VIN Number: ______________________ Operating Mode ______

DAY FOUR

Fuel Economy

Drive Cycle Description	Fuel Economy	Δ RESS Energy/ Fuel Energy	RESS Correction
UDDS Cold Start (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
1st UDDS Hot Start (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
1st HWFEDS (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
2nd HWFEDS (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
1st US06 (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
2nd US06 (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)

RESS Energy

Drive Cycle Description	RESS Capacity Supplied (Ah/mi)	RESS Capacity Supplied (%/mi)	DC Energy Supplied (kWh/mi)
UDDS Cold Start (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st UDDS Hot Start (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st HWFEDS (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
2nd HWFEDS (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st US06 (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
2nd US06 (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)

Charger

AC into the Charger: _____________ (kWh)	DC into the RESS: _____________ (kWh)

Approval

Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix D – SAE J1711 Energy Efficiency

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VIN Number: ______________________ Operating Mode ______

DAY FIVE

Fuel Economy

Drive Cycle Description	Fuel Economy	Δ RESS Energy/ Fuel Energy	RESS Correction
UDDS Cold Start (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
1st UDDS Hot Start (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
1st HWFEDS Hot Start (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
2nd HWFEDS Hot Start (charge depleting)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
UDDS-UDDS HWFEDS-HWFEDS Charge Depletion			
1st UDDS Hot Start (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
2nd UDDS Hot Start (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
1st HWFEDS (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)
2nd HWFEDS (charge sustaining)	______mpg Method _____	_____ (J) / _____ (J)	___________ (gal)

Appendix D – SAE J1711 Energy Efficiency

(Page 8 of 8)

VIN Number: ______________________ Operating Mode ______

DAY FIVE

RESS Energy

Drive Cycle Description	RESS Capacity Supplied (Ah/mi)	RESS Capacity Supplied (%/mi)	DC Energy Supplied (kWh/mi)
UDDS Cold Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st UDDS Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st HWFEDS Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
2nd HWFEDS Hot Start (charge depleting)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
UDDS-UDDS HWFEDS-HWFEDS Charge Depletion			
1st UDDS Hot Start (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
2nd UDDS Hot Start (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
1st HWFEDS (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)
2nd HWFEDS (charge sustaining)	_______ (Ah/mi)	________ (%/mi)	_______ (DC kWh/m)

Charger

AC into the Charger: _____________ (kWh)	DC into the RESS: _____________ (kWh)

Approval

Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Section V: AVTA-PHTP04 – Plug-in Hybrid Electric Vehicle RESS Only Mode Constant Speed Range Tests

TABLE OF CONTENTS

APPENDICES

1 Objective

The objective of this procedure is to provide methods for the constant speed range testing of vehicles capable of operation in a mode utilizing energy only from the rechargeable energy storage system (RESS Only mode), which are evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA). Testing is conducted in accordance with procedures similar to SAE-J227a. These methods are not meant to supersede those of the testing facility, those specifically addressed by SAE Test Standards, nor of any regulatory agency who may have or exercise control over the covered activities. This procedure also provides methods for verifying the accuracy of the vehicle speedometer, odometer and SOC meter.

2 Purpose

The purpose of this procedure is to identify acceptable methods for the implementation of a RESS Only Mode Constant Speed Range Test, similar to that identified in SAE J227a, for vehicles operable in RESS Only mode. The SAE J227a Recommended Practice, although canceled, established uniform procedures for testing electric battery-powered vehicles as a total system rather than a collection of its individual subsystems. This procedure shall collect and retain test data as specified in the PHEV Vehicle Specifications.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

Prior to conducting any portion of the testing, the following initial conditions and prerequisites shall be met. Satisfactory completion of these items shall be verified as complete and recorded on the Constant Speed Range Test Data Sheet as contained in Appendix A.

4.1 Personnel conducting the testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05 and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 Road Testing

4.2.1 Road tests shall be performed on a road or test track, which is level to within 1%.

4.2.2 RESS temperatures at the beginning of the test shall be greater than 40˚F (5˚C), shall be less than 120°F (49°C) and should be less than 100˚F (38°C).

4.2.3 Ambient temperature during road testing shall be within the range of 32°F (0˚C) to 100°F (38°C).

4.2.4 The average wind speed at the test site during the test shall not exceed 10 mph (16 km/h). Wind gusts shall not exceed 12.3 mph (20 km/h).

4.3 The vehicle shall be tested in its normal configuration with normal appendages (mirrors, bumpers, hubcaps, etc.) Certain items (hub caps, etc.) may be removed where necessary for safety.

4.4 Vehicles shall be tested at curb weight plus 300 pounds. Consideration should be given to how adding instrumentation will affect the test weight and balance of the vehicle.

4.5 Tires provided with the vehicle shall be the standard tire offered by the Vehicle Supplier, and shall be inflated to the Supplier's (placard) recommended cold inflation pressures. This pressure shall not exceed the maximum allowable pressure imprinted upon the tire's sidewall.

4.6 Normal Supplier's recommended lubricants shall be employed.

4.7 Accessories shall not be used during testing activities.

4.8 Full charge conditions for the RESS shall be established using the Supplier's recommended charging procedure and equipment in accordance with procedure AVTA-PHTP08.

4.9 Testing required at an initial RESS SOC of 100% shall be initiated with the RESS at >90%. Testing required at an initial RESS SOC of 50% shall be initiated with the RESS at 50% ±10%.

4.10 The following data shall be collected during conduct of the various tests specified by this procedure. Overall error in recording or indicating instruments shall not exceed ±2% of the maximum value of the variable being measured. Periodic calibration shall be performed and documented to ensure compliance with this requirement.

4.10.1 RESS voltage versus time

4.10.2 RESS current versus time

4.10.3 Vehicle speed versus time

4.10.4 Distance versus time

4.10.5 RESS temperature versus time

4.10.6 RESS watts versus time.

4.11 Environmental conditions during the testing shall be recorded and include, at a minimum, the following:

4.11.1 Range of ambient temperature during the test

4.11.2 Range of wind velocity during the test

4.11.3 Range of wind direction during the test.

4.12 Complete or verify complete procedure AVTA-PHAC06 and AVTA-PHTP11 for the vehicle being tested.

4.13 A description of the test route, road surface type and condition (SAE J688, "Truck Ability Prediction Procedure") and lengths and grades of test route shall be recorded.

4.14 The date and starting and ending times shall be recorded.

4.15 The starting and ending vehicle odometer readings shall be recorded.

4.16 All instrumentation used in the test shall be listed in Appendix D, attached to the test data sheets/results, and shall include the following information:

4.16.1 Manufacturer

4.16.2 Model number

4.16.3 Serial number

4.16.4 Next calibration date

4.17 The speed-time measuring device and other necessary equipment shall be installed so that they do not hinder vehicle operation or alter the operating characteristics of the vehicle. Mounting is nominally at the rear of the vehicle.

4.18 Any deviation from the test procedure and the reason for the deviation shall be recorded in accordance with procedure AVTA-PHAC02.

4.19 All documentation required to complete the testing shall be completed, approved and issued prior to commencing the testing it addresses.

4.20 During data reduction, the actual distance traveled and the corresponding DC kilowatt-hour and ampere-hour consumption shall be determined. These values provide the 100% depth of discharge mileage and kWh or Ah value. These values shall be used throughout the remainder of testing, and shall be the basis for determining SOCs less than 100%.

4.21 In addition to the formal completion of all sections of this procedure, Section 5.1 may be completed additional times as requested by the AVTA Program Manager or AVTA Test Manager. [Additional tests may be completed to determine changes to the range capability of a vehicle, or if a vehicle's permanently installed instrumentation is suspected of incorrect operation.]

4.22 Each range test shall be terminated when the specific requirements of the procedure have been reached. However, if the Supplier's instructions provide guidance concerning when to stop driving the vehicle, the vehicle's range will be the range achieved when the conditions meeting that guidance have occurred. [Example: If the owner's manual/driver's instructions provided with the vehicle provide direction to stop driving upon receipt of a specific telltale or other indication normally available to the driver, the vehicle will be stopped and the test terminated when that telltale/indication has occurred.]

NOTE:
Only test vehicles that are capable of being driven in RESS Only mode shall be range tested using this procedure. Vehicles, which are not capable of being tested in a RESS Only mode, will not be range tested in this procedure.

5 Testing Activities Requirements

NOTE:
All steps shall be completed in the order written. Deviations from any step or requirement shall have the approval of the Program Manager or Test Manager in accordance with procedure AVTA-PHAC02.

5.1 Range at 45 mph Constant Speed

The purpose of this section is to: (1) determine the maximum range the vehicle can achieve with the Rechargeable Energy Storage System (RESS) starting at 100% State of Charge (SOC), the vehicle loaded at curb weight plus 300 pounds, and operated at a constant speed; and (2) determine the correlation between the RESS SOC and the mileage driven (which will be used to establish partial SOC conditions in other protocols).

This testing shall be completed subject to the initial conditions and prerequisites stated in Section 4 of this procedure. Testing shall be conducted at a constant speed of 45 mph whenever possible. If the vehicle is not capable of operation in the RESS Only mode at 45 mph, then the maximum possible RESS Only speed shall be used for testing.

NOTE:
Constant speed testing is only conducted for vehicles operable in RESS Only mode.

5.1.1 Instrument the vehicle to obtain, at a minimum, the data identified in Section 4.10. Calibrate the fifth wheel, as necessary.

5.1.2 Verify the RESS is fully charged (100% SOC) in accordance with procedure AVTA-PHTP08 and the vehicle is in the RESS Only mode.

5.1.3 Record time and the vehicle's odometer reading in Appendix A.

5.1.4 Adjust the vehicle's cold tire pressures to match the Supplier's placard value, or the maximum cold inflation pressure imprinted upon the tire's sidewall, whichever is less.

5.1.5 From a standing start, accelerate the vehicle under its own power to a speed of 45 mph (72 km/h), or the maximum RESS Only speed as determined in Section 5.1, ±1 mph (±1.6 km/h). Speed and time may be recorded via a Data Acquisition System (DAS).

5.1.6 Each time the vehicle passes the lap marker, record the SOC meter reading and the odometer reading in Appendix A. Each reading shall be recorded in the smallest increment displayed by its respective indicator.

NOTE:
All vehicles tested will be operated in accordance with the requirements of the Supplier's operating manuals/instruction cards/placards. Should the Supplier's requirements for stopping the vehicle be met prior to reaching the criteria in Step 5.1.7, the test shall be terminated. The official range will be the range achieved at that point, regardless of remaining capability.

5.1.7 Maintain this speed without interruption until an average vehicle lap speed within 2 mph (3.2 km/h) of the target speed cannot be maintained.

5.1.8 Pull the vehicle off to the side of the test track. Record the final speed, time, mileage, SOC meter and odometer reading in Appendix A. (This may be recorded via a DAS.)

5.1.9 The mileage achieved during this test shall be recorded as the official range mileage for the vehicle being tested.

5.1.10 Within two hours, recharge the vehicle in accordance with procedure AVTA-PHTP08, Section 5, to obtain the time to fully recharge the RESS.

5.1.11 Any abnormalities in either discharge or charge shall be noted in accordance with procedure AVTA-PHTP12.

5.1.12 Using the SOC meter data in Appendix A determine the following:

5.1.12.1 Vehicle range to full RESS discharge

5.1.12.2 Vehicle range to 50% RESS SOC

5.1.12.3 Accuracy of the SOC meter

NOTE:
SOC meter accuracy should be ± 5% of full scale.

5.2 Range at Maximum Achievable Speed

The purpose of this section is to determine the maximum range the vehicle can achieve after the vehicle has been soaked for four hours at a minimum ambient temperature of 100°F. The RESS shall have been fully charged (100% SOC) prior to the soak period. The vehicle shall be loaded at curb weight plus 300 pounds and operated at the vehicle's maximum achievable speed, or 65 mph, whichever is less. This testing shall be completed subject to the initial conditions and prerequisites stated in Section 4 of this procedure, as amended by this section.

NOTE:
Range at maximum speed testing is only conducted for vehicles operable in RESS Only mode and with a maximum speed greater than 50 mph in RESS Only mode.

5.2.1 The vehicle does not require instrumentation for this test. Odometer readings shall be sufficient to determine range.

5.2.2 Verify the RESS is at fully charged (100% SOC) in accordance with procedure AVTA-PHTP08 and the vehicle is in the RESS Only mode.

5.2.3 Record odometer reading and time in Appendix B.

5.2.4 Adjust the vehicle's cold tire pressures to match the Supplier's placard value, or the DOT sidewall pressure, whichever is less.

5.2.5 Identify the maximum speed the vehicle achieved when tested to procedure AVTA-PHTP02. Record the lesser of this value or 75 mph in Appendix B.

NOTE:
The vehicle shall be operated at the lower of the two speeds in Step 5.2.5. Transitory operation above 75 mph due to track attitude is allowed.

5.2.6 From a standing start, accelerate the vehicle at wide open throttle to the maximum speed determined in Step 5.2.5 (above). Speed and time may be recorded via a Data Acquisition System (DAS.)

5.2.7 Each time the vehicle passes the lap marker, record the SOC meter reading and the odometer reading. Each reading shall be recorded in the smallest increment displayed by its respective indicator.

NOTE:
All vehicles tested will be operated in accordance with the requirements of the Supplier's operating manuals/instruction cards/placards. Should the Supplier's requirements for stopping the vehicle be met prior to reaching the criteria in Step 5.2.8, the test shall be terminated. The Official Range will be the range achieved at that point, regardless of remaining capability.

5.2.8 Maintain this speed without interruption until a minimum vehicle speed of at least 40 mph cannot be maintained, or Supplier's requirements for stopping the vehicle are met. Record the final speed, odometer reading and time in Appendix B. (This may be recorded via a DAS.)

5.2.9 Pull the vehicle off to the side of the test track. Record the time, miles traveled, and odometer reading in Appendix B. (This may be recorded via a DAS.)

5.3 Calibration of the Vehicle Speedometer and Odometer

This section should be completed in conjunction with procedure AVTA-PHTP06 as well as in conjunction with Sections 5.1 and 5.2 of this procedure. It may also be implemented any time the speedometer is suspected of incorrect operation.

5.3.1 Ensure the vehicle is instrumented with a DAS.

5.3.2 With the vehicle stopped, record the odometer reading.

5.3.3 Accelerate the vehicle to 20 mph. Record the speedometer reading and the DAS speed readout.

5.3.4 Increase vehicle speed in 5 mph increments, recording the speedometer and DAS speed read-out at each speed. Continue this until the vehicle has achieved 80 mph, or maximum achievable speed, whichever is less.

5.3.5 Reduce speed to a nominal 40 mph and proceed for at least 10 miles.

5.3.6 Develop a speedometer calibration reference table, Appendix C, for the speedometer and a correction factor for the odometer.

5.3.7 Mount the calibration reference table in the subject vehicle adjacent to the speedometer.

5.3.8 Verify that the speedometer accuracy is at least ± 5% of full scale.

5.3.9 Verify that the odometer accuracy is at least ± 5%.

Appendix A – Constant Speed Range Test Data Sheet

(Page 1 of 2)

VIN Number: ______________________________ Test Speed: ________________ mph

Project No.:	Test Date(s):
Data File Name:	
Test Driver: (Initials) (Date)	
Test Engineer: (Initials) (Date)	

Vehicle Setup

VEHICLE WEIGHTS AS TESTED WITH DRIVER & INSTRUMENTATION (Test Weight is Curb Weight plus 300 pounds)			
Left Front: (lbs or kg)	Right Front: (lbs or kg)	Total Front: (lbs or kg)	Percent Front: %
Left Rear: (lbs or kg)	Right Rear: (lbs or kg)	Total Rear: (lbs or kg)	Percent Rear: %
		Total Weight: (lbs or kg)	

INSTALLED TIRES (Placard or sidewall whichever is less)			
Preparation Area Temperature: °F (or °C)			
Left Front		Right Front	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	
Left Rear		Right Rear	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	

Track/Weather Conditions

Test Track Location:	Track Grade: %
Ambient Temperature (initial): (32-100°F or 0-38°C)	Ambient Temperature (final): (32-100°F or 0-38°C)
Track Temperature (initial): (°F or °C)	Track Temperature (final): (°F or °C)
Wind Velocity (initial): (<10 mph or 16 km/h)	Wind Velocity (final): (<10 mph or 16 km/h)
Wind Direction (initial): °	Wind Direction (completion): °

Appendix A – Constant Speed Range Test Data Sheet
(Page 2 of 2)

VIN Number: ______________________________ Test Speed: ________________ mph

Sequence No:	File Name:		Direction of Travel:
Time (initial):		Time (final):	
Odometer (initial): (miles or kilometers)		Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC,kWh,Ah)		State of Charge (final): (SOC,kWh,Ah)	
RESS Temp (initial): (°F or °C)		RESS Temp (final): (°F or °C)	
Comments (initials/date):			
Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix B – Maximum Achievable Speed Range Test Data Sheet

(Page 1 of 2)

VIN Number: ______________________________ Test Speed: ________________ mph

Project No.:	Test Date(s):
Data File Name:	
Test Driver: (Initials) (Date)	
Test Engineer: (Initials) (Date)	

Vehicle Setup

VEHICLE WEIGHTS AS TESTED WITH DRIVER & INSTRUMENTATION (Test Weight is Curb Weight plus 300 pounds)			
Left Front: (lbs or kg)	Right Front: (lbs or kg)	Total Front: (lbs or kg)	Percent Front: %
Left Rear: (lbs or kg)	Right Rear: (lbs or kg)	Total Rear: (lbs or kg)	Percent Rear: %
		Total Weight: (lbs or kg)	

INSTALLED TIRES (Placard or sidewall whichever is less)			
Preparation Area Temperature: °F (or °C)			
Left Front		Right Front	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	
Left Rear		Right Rear	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	

Track/Weather Conditions

Test Track Location:	Track Grade: %
Ambient Temperature (initial): (32-100°F or 0-38°C)	Ambient Temperature (final): (32-100°F or 0-38°C)
Track Temperature (initial): (°F or °C)	Track Temperature (final): (°F or °C)
Wind Velocity (initial): (<10 mph or 16 km/h)	Wind Velocity (final): (<10 mph or 16 km/h)
Wind Direction (initial): °	Wind Direction (completion): °

Appendix B – Maximum Achievable Speed Range Test Data Sheet

(Page 2 of 2)

VIN Number: ______________________________ Test Speed: ________________ mph

Sequence No:	File Name:	Direction of Travel:
Time (initial):		Time (final):
Odometer (initial): (miles or kilometers)		Odometer (final): (miles or kilometers)
State of Charge (initial): (SOC,KWH,AH)		State of Charge (final): (SOC,KWH,AH)
RESS Temp (initial): (°F or °C)		RESS Temp (final): (°F or °C)

Comments (initials/date):

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Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix C – Calibration of Vehicle Speedometer Test Data Sheet

(Page 1 of 1)

VIN Number: ______________________________

Sequence No:	File Name:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC,KWH,AH)	State of Charge (final): (SOC,KWH,AH)	

DAS Heads-up Display:	Vehicle Speedometer:
20 mph	
25 mph	
30 mph	
35 mph	
40 mph	
45 mph	
50 mph	
55 mph	
60 mph	
65 mph	
70 mph	
75 mph	
80 mph	

Comments (initials/date):

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Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix D – PHEV Metrology Setup Sheet
(Page 1 of 1)

VIN Number: ________________________________

Instrument/Device:	Calibration Due Date:	Initials / Date:
Fifth Wheel S/N:		
Fifth Wheel Calibrator S/N:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Tire Pressure Gauge S/N:		
Misc:		
Misc:		
Misc:		
Misc:		

Comments (initials/date):

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Completed By:

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(Printed Name) (Signature) (Date)

Reviewed By (QA):

____
(Printed Name) (Signature) (Date)

Approved By:

____
(Printed Name) (Signature) (Date)

Section VI: AVTA-PHTP05 – Plug-in Hybrid Electric Vehicle Rough Road Course Test

TABLE OF CONTENTS

APPENDICES

1 Objective

The objective of this procedure is to provide methods for evaluating the durability of plug-in hybrid electric vehicles (PHEV) evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA). These methods are not meant to supersede those of the testing facility, those specifically addressed by SAE Test Standards, nor of any regulatory agency which may have or exercise control over the covered activities.

2 Purpose

The purpose of this test is to (1) accumulate standardized test-mileage on each vehicle over a test track that includes rough road, water hazard and smooth track; and (2) test the vehicles ability to endure extreme conditions over a short time frame. This test is not intended to determine range or speed capabilities of any vehicle. No inferences concerning a vehicle's speed, range or gradeability characteristics should be drawn from this test. This activity is meant to test the vehicle as a total system. Tests of specific subsystems or portions of individual subsystems are addressed by other Test Procedures. This testing and data acquisition meets the requirements specified in the PHEV Vehicle Specification.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone." That is, to be self-contained to the extent that all individuals qualified to review it could reasonably be expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

Prior to conducting any portion of the testing, the following initial conditions and prerequisites shall be met. Satisfactory completion of these items shall be verified as complete and recorded on the Test Data Sheet.

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05 and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 Ambient temperature during road testing shall be within the range of 32°F (0˚C) to 100°F (38°C).

4.3 RESS temperatures at the beginning of the test shall be greater than 40˚F (5˚C), shall be less than 120°F (49°C) and should be less than 100˚F (38°C).

4.4 The average wind speed at the test site during the test shall not exceed 10 mph (16 km/h). Wind gusts shall not exceed 12.3 mph (20 kph).

4.5 Testing shall be completed over a "rough road" course which contains smooth asphalt, potholes, cobblestones, washboard and standing water. The test facility utilized by the AVTA at Exponent Failure Analysis in Phoenix, Arizona incorporates such features.

4.6 Speeds identified for each hazard have been determined to be the optimum speed for testing the vehicle at that hazard. Attempting to negotiate a hazard at a speed different than that identified should be avoided.

4.7 Vehicles shall be tested in their normal configuration with normal appendages (mirrors, bumpers, hubcaps, etc.). Certain items (hub caps, etc.) may be removed where necessary for safety.

4.8 Vehicles shall be loaded at curb weight plus 300 pounds.

4.9 Tires provided with the vehicle shall be the standard tires offered by the Supplier. Tires shall be inflated to the Supplier’s recommended (placard) cold inflation pressure.

4.10 Supplier's recommended lubricants shall be employed.

4.11 Verify the RESS is at 100% SOC in accordance with the requirements of procedure AVTA-PHTP08.

4.12 Overall error in recording or indicating instruments shall not exceed ±2% of the maximum value of the variable being measured unless otherwise accepted. Periodic calibration shall be performed and documented to ensure compliance with this requirement.

4.13 Complete or verify completed procedures AVTA-PHAC06 and AVTA-PHTP11 for the vehicle being tested.

4.14 The road surface type and condition as defined in SAE J688, "Truck Ability Prediction Procedure,” and lengths and grades of test route shall be noted.

4.15 Instrumentation used in the test shall be identified in Appendix B, and attached to the test results. It shall include the following information:

4.15.1 Manufacturer

4.15.2 Model number

4.15.3 Serial number

4.15.4 Calibration date

4.16 Any deviation from the test procedure and the reason for the deviation shall be approved in advance and so noted on the appropriate data sheet(s).

4.17 Any necessary equipment shall be installed in a manner that does not hinder vehicle operation or alter the operating characteristics of the vehicle.

4.18 Accessories shall not be used during the rough road testing.

4.19 Speeds for each hazard or groups of hazards shall be posted on the test track to allow the driver(s) to achieve the required speed prior to encountering the hazard.

4.20 Prior to the initial test sequence, the vehicle’s underside shall be inspected to identify any pre-existing damage. Any damage shall be recorded in writing. Photographs shall be taken to document the conditions.

4.21 Subsequent to each completed test cycle, the vehicle’s underside shall again be inspected to ascertain any additional damage resulting from the conduct of the test. Any additional damage shall be photographed and recorded in the comments section.

5 Rough Road Testing

This procedure was written specifically for implementation at the Test Track at Exponent in Phoenix, Arizona. Hazards and appropriate speeds for negotiation of those hazards are specific to this facility.

CAUTION:

Deviations from the speeds prescribed can present a safety issue for vehicles. All vehicles should maintain posted speed. If any vehicle cannot maintain or achieve speed, it shall be removed from the course.

CAUTION:

Should any vehicle become disabled during testing, it shall be immediately removed from the test course.

NOTE:
Conduct of this procedure should be coordinated with efficiency testing of the grid-connected charger in accordance with procedure AVTA-PHTP08.

<u>FRONT SIDE</u>	
3" Deep Random Chuck Holes	5 mph (8 km/h)
Sine Wave	10 mph (16 km/h)
Railroad Crossing	15 mph (24 km/h)
Perpendicular Dip	15 mph (24 km/h)
Diagonal Dip	15 mph (24 km/h)
Single Wheel Dip	15 mph (24 km/h)
1" Deep Random Chuck Holes	20 mph (32 km/h)
Adjustable Irregularities (tar strips)	25 mph (40 km/h)
Road Crown	30 mph (48 km/h)
<u>BACK SIDE</u>	
1" Deep Random Chuck Holes	25 mph (40 km/h)
Belgian Blocks (cobblestone)	25 mph (40 km/h)
Railroad crossing	25 mph (40 km/h)
2" Standing Water	20 mph (32 km/h)

5.1 Record the VIN/Test number of the vehicle being tested in Appendix A.

5.2 Record the vehicle's cold inflation tire pressure. Adjust the cold inflation tire pressure to meet the requirements of the Supplier's placard, if necessary.

5.3 Verify the RESS is at 100% SOC in accordance with the requirements of procedure AVTA-PHTP08 and place the vehicle in the Normal Operation mode.

5.4 Record the following environmental conditions:

5.4.1 Ambient temperature

5.4.2 RESS temperature (at the discretion of the Test Manager)

5.4.3 Wind velocity

5.4.4 Wind direction

5.4.5 Record vehicle odometer reading

NOTE:
If more than one vehicle is being tested, test vehicles shall maintain a nominal safe distance between themselves and the vehicle in front of them, in accordance with accepted standards.

NOTE:
During this testing, if a vehicle fails electrically or mechanically for any reason, that vehicle shall be removed from this testing scheme until such time as the Supplier can repair it. See procedure AVTA-PHAC02 for additional details.

NOTE:
The test sequence for this procedure will be to complete a 4-hour soak; complete ten stop/start evolutions; complete five laps through the rough road course, and then complete 20 laps at 55 mph. Specific direction is provided below.

NOTE:
When instructed to decelerate in Steps 5.4 through 5.23, the driver shall begin the deceleration approximately 135 feet prior to the stop sign. These deceleration points shall be marked on the test track.

NOTE:
Vehicle odometer readings shall be recorded in Appendix A upon initiation and also completion of testing.

5.5 Move the vehicle to the handling pad (Exponent) or similar area. The vehicle's windows shall be completely closed, except for the driver's and front passenger's windows, which may each be left open no more than one-half ($^1/_2$) inch. The vehicle shall be parked with the windshield facing South.

5.6 The vehicle shall be soaked for at least four hours, during which time it shall have been exposed to a minimum ambient temperature of at least 100°F (38˚C) for at least one hour of the four-hour soak. If ambient temperatures will not reach 100˚F, the vehicle may be soaked in a suitable soak chamber at a minimum of 100˚F for four hours before being moved to the handling pad in lieu of performing a soak on the handling pad. At the completion of this soak period, immediately move the vehicle to the test track starting point.

5.7 From the starting point, smoothly accelerate the vehicle at maximum achievable acceleration to 45 mph, and continue approximately one (1) mile to the stop sign.

5.8 Decelerate the vehicle and bring it to a complete stop at the stop sign.

5.9 From the stop sign, rapidly accelerate the vehicle to 45 mph and continue approximately one (1) mile to the next stop sign.

5.10 Decelerate the vehicle and bring it to a complete stop at the stop sign. The first lap is complete.

5.11 From the stop sign, rapidly accelerate the vehicle to 45 mph and continue approximately one (1) mile to the next stop sign.

5.12 Decelerate the vehicle and bring it to a complete stop at the stop sign.

5.13 From the stop sign, rapidly accelerate the vehicle to 45 mph and continue approximately one (1) mile to the next stop sign.

5.14 Decelerate the vehicle and bring it to a complete stop at the stop sign. The second lap is complete.

5.15 From the stop sign, rapidly accelerate the vehicle to 45 mph and continue approximately one (1) mile to the next stop sign.

5.16 Decelerate the vehicle and bring it to a complete stop at the stop sign.

5.17 From the stop sign, rapidly accelerate the vehicle to 45 mph and continue approximately one (1) mile to the next stop sign.

5.18 Decelerate the vehicle and bring it to a complete stop at the stop sign. The third lap is complete.

5.19 From the stop sign, rapidly accelerate the vehicle to 45 mph and continue approximately one (1) mile to the next stop sign.

5.20 Decelerate the vehicle and bring it to a complete stop at the stop sign.

5.21 From the stop sign, rapidly accelerate the vehicle to 45 mph and continue approximately one (1) mile to the next stop sign.

5.22 Decelerate the vehicle and bring it to a complete stop at the stop sign. The fourth lap is complete.

5.23 From the stop sign, rapidly accelerate the vehicle to 45 mph and continue approximately one (1) mile to the next stop sign.

5.24 Decelerate the vehicle and bring it to a complete stop at the stop sign.

5.25 From the stop sign, rapidly accelerate the vehicle to 45 mph and continue approximately one (1) mile to the next stop sign.

5.26 Decelerate the vehicle and bring it to a complete stop at the stop sign. The fifth lap is complete.

5.27 Stop-Start Portion of the test is complete.

5.28 From the Stop sign, accelerate the vehicle to 5 mph and negotiate the 3" Deep Random Chuck Holes.

5.29 After completing negotiation of the 3" Deep Random Chuck Holes, smoothly accelerate the vehicle so as to enter the Sine Wave at 10 mph.

5.30 After completing negotiation of the Sine Wave, smoothly accelerate the vehicle so as to enter the Railroad Crossing at 15 mph.

5.31 After completing negotiation of the Railroad Crossing, maintain the vehicle speed so as to enter the Perpendicular Dip at 15 mph.

5.32 After completing negotiation of the Perpendicular Dip, maintain the vehicle speed so as to enter the Diagonal Dip at 15 mph.

5.33 After completing negotiation of the Diagonal Dip, maintain the vehicle speed so as to enter the Single Wheel Dip at 15 mph.

5.34 After completing negotiation of the Single Wheel Dip, smoothly accelerate the vehicle speed so as to enter the 1" Deep Random Chuck Holes at 20 mph.

5.35 After completing negotiation of the 1" Deep Random Chuck Holes, smoothly accelerate the vehicle speed so as to enter the Adjustable Irregularities (Tar Strips) at 25 mph.

5.36 After completing negotiation of the Adjustable Irregularities (Tar Strips), smoothly accelerate the vehicle speed so as to enter the Road Crown Intersection at 30 mph.

5.37 After completing negotiation of the Road Crown Intersection, maintain speed at 30 mph and negotiate the transition to the back side of the track.

5.38 Smoothly decelerate the vehicle so as to enter the 1" Deep Random Chuck Holes at 25 mph.

5.39 Maintain speed so as to negotiate the Belgian Block section at 25 mph.

5.40 Maintain this vehicle speed so as to negotiate the Railroad Crossing section at 25 mph.

5.41 Smoothly decelerate the vehicle to achieve a speed of 20 mph through the 2-inch Standing Water Bath.

5.42 After completing negotiation of the 2-inch Standing Water Bath, smoothly accelerate the vehicle to 45 mph [55 mph if completing for the fifth (5th) time]. Maintain this speed through the back turn.

5.43 Decelerate the vehicle to 5 mph so as to enter the 3" Deep Random Chuck Holes at 5 mph.

5.44 Repeat steps 5.28 through 5.42, IN ORDER, until the vehicle has traveled five (5) laps (approximately 10 miles).

5.45 Accelerate the vehicle to 55 mph.

5.46 Drive the vehicle at 55 mph for 20 Laps (approximately 40 miles). If this is the first test sequence, continue to step 5.47. If this is the second test sequence, skip to Step 5.48.

5.47 When the vehicle has completed 20 Laps at 55 mph, the first phase of this test is complete. Move the vehicle to the garage area and record the following:

5.47.1 Record the RESS leakage current (RESS-to-chassis). Current shall be less than 0.5 MIU.

5.47.2 Place the vehicle on charge in accordance with procedure AVTA-PHTP08. Within 5 minutes of placing the vehicle on charge (if applicable), read and record the charger leakage current (chassis to ground). Current shall be less than 5 mA.

5.48 Record or verify as recorded the following data in Appendix A:

5.48.1 Date and time of test phase completion

5.48.2 SOC reading (kWh consumed and percent)

5.48.3 Miles traveled / laps completed

5.48.4 Equipment failures, if any

5.48.5 Equipment abnormalities, if any

5.48.6 Damage to vehicle underside

5.48.7 Damage to any vehicle components

5.48.8 RESS leakage current

5.48.9 Driver notes, if any.

5.49 Move the vehicle to the charging station and recharge the RESS to 100% SOC in accordance with procedure AVTA-PHTP08. Record the AC energy used for this charge in accordance with procedure AVTA-PHTP08 for use in determining charging efficiency.

5.50 Repeat steps 5.2 through 5.49.

Appendix A – PHEV Rough Road Test Data Sheet
(Page 1 of 2)

VIN Number: ________________________

Project No.:	Test Date(s):
Data File Name:	
Test Driver: (Initials) (Date)	
Test Engineer: (Initials) (Date)	

Vehicle Setup

VEHICLE WEIGHTS AS TESTED (Curb weight plus 300 pounds)			
Left Front: (lbs or kg)	Right Front: (lbs or kg)	Total Front: (lbs or kg)	Percent Front: %
Left Rear: (lbs or kg)	Right Rear: (lbs or kg)	Total Rear: (lbs or kg)	Percent Rear: %
		Total Weight: (lbs or kg)	

INSTALLED TIRES (Placard or sidewall whichever is less)			
Left Front		Right Front	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	
Left Rear		Right Rear	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	

VEHICLE SOAK
Vehicle Soaked Minimum of Four (4) Hours at 100°F (initial)

Track/Weather Conditions

Test Track Location:	Track Grade: %
Ambient Temperature (initial): (32-100°F or 0-38°C)	Ambient Temperature (final): (32-100°F or 0-38°C)
Track Temperature (initial): (°F or °C)	Track Temperature (final): (°F or °C)
Wind Velocity (initial): (<10 mph or 16 km/h)	Wind Velocity (final): (<10 mph or 16 km/h)
Wind Direction (initial): °	Wind Direction (completion): °

Appendix A – PHEV Rough Road Test Data Sheet
(Page 2 of 2)

VIN Number: ________________________

Sequence No: 1	File Name:	Direction of Travel:
Soak Time (initial):		Soak Time (final): (Minimum 8 hours)
Range Time (initial):		Range Time (final):
Odometer (initial): (miles or kilometers)		Odometer (final): (miles or kilometers)
State of Charge (initial): (SOC,kWh,Ah)		State of Charge (final): (SOC,kWh,Ah)
RESS Temp (initial): (°F or °C)		RESS Temp (final): (°F or °C)

Comments (initials/date):

Completed By: ______________________________
(Printed Name) (Signature) (Date)

Reviewed By: ______________________________
(Printed Name) (Signature) (Date)

Approved By: ______________________________
(Printed Name) (Signature) (Date)

Appendix B – PHEV Metrology Setup Sheet
(Page 1 of 1)

VIN Number: ____________________

Instrument/Device:	Calibration Due Date:	Initials / Date:
Fifth Wheel S/N:		
Fifth Wheel Calibrator S/N:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Tire Pressure Gauge S/N:		
Misc:		
Misc:		
Misc:		
Misc:		

Comments (initials/date):

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Completed By: ____
(Printed Name) (Signature) (Date)

Reviewed By: ____
(Printed Name) (Signature) (Date)

Approved By: ____
(Printed Name) (Signature) (Date)

Section VII: AVTA-PHTP06 – Braking Test

AVTA-PHTP06

TABLE OF CONTENTS

APPENDICES

1 Objective

This procedure identifies methods for evaluating the braking performance of vehicles evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA). These methods are not meant to supersede those of the testing facility, those specifically addressed by SAE Test Standards, nor of any regulatory agency, which may have or exercise control over the covered activities.

2 Purpose

The purpose of this test is to qualitatively evaluate the controllability of a vehicle during braking. Both the stopping distance and the ability to maintain the vehicle in control (defined as staying in the course lane) are tested. This test is not intended to satisfy the requirements of Section 105 of 49 CFR 571. [For example, the vehicle is tested with dry brakes on a wet surface.] This activity is meant to test the vehicle as a total system. Tests of specific subsystems or portions of individual subsystems are addressed by other Test Procedures, as appropriate. This testing and data acquisition meets the requirements specified in the PHEV Vehicle Specification.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

Prior to conduct of any portion of the testing, the following initial conditions and prerequisites shall be met. Satisfactory completion of these items shall be verified as complete and recorded in Appendix A.

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05 and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 Ambient temperature during road testing shall be within the range of 32°F (0˚C) to 100°F (38°C).

4.3 RESS temperatures at the beginning of the test shall be greater than 40˚F (5˚C), shall be less than 120°F (49°C) and should be less than 100˚F (38°C).

4.4 The average wind speed at the test site during the test shall not exceed 10 mph (16 km/h). Wind gusts shall not exceed 12.3 mph (20 kph).

4.5 Testing shall be completed on a rolled asphalt "braking course" defined by the AVTA at the test facility of Exponent Failure Analysis Associates (or equivalent).

4.6 Vehicles shall be tested in their normal configuration with normal appendages (mirrors, bumpers, hubcaps, etc.). Certain items (hubcaps, etc.) may be removed where necessary for safety.

4.7 Vehicles shall be tested at delivered curb weight plus 300 pounds.

4.8 Tires provided with the vehicle shall be the standard tires offered by the Supplier.

4.9 Supplier's normal recommended lubricants shall be employed.

4.10 Accessories shall not be used or operated during testing.

4.11 Vehicles shall be tested in the Normal Operation mode. Verify the vehicle is in the Normal Operation mode.

4.12 Verify the RESS is at an initial state of charge at charge-sustaining mode in accordance with Section 5.1 of procedure AVTA-PHTP08.

4.13 The overall error of recording or indicating instruments shall not exceed ±2% of the maximum value of the variable being measured. Periodic calibration shall be performed and documented to ensure compliance with this requirement.

4.14 Complete or verify completed procedures AVTA-PHAC06 and AVTA-PHTP11 for the vehicle being tested.

4.15 The road surface type and condition as defined in SAE J688, "Truck Ability Prediction Procedure," and lengths and grades of test route shall be noted.

4.16 For instrumentation used in the test, at a minimum, record the following information for each instrument in Appendix B:

4.16.1 Manufacturer

4.16.2 Model number

4.16.3 Serial number

4.16.4 Next calibration date

4.17 Any deviation from the test procedure and the reason for the deviation shall be recorded in accordance with procedure AVTA-PHAC02.

4.18 Speed-time measuring devices and other necessary equipment shall be installed in a manner that does not hinder vehicle operation or alter the operating characteristics of the vehicle.

4.19 All steps shall be completed in the order written. Deviations from any step or requirement must have the prior written approval of the Program Manager, Test Director or Test Manager in accordance with procedure AVTA-PHAC02.

4.20 All documentation required to complete the testing identified in the technical requirements of the PHEV Vehicle Specification shall be completed, approved and issued prior to the effective date of the procedure. In no case shall the procedure be utilized for official testing or data collection prior to its effective date.

4.21 Testing may take place over the course of several days. Page 1 of Appendix A shall be completed for each day testing is commenced.

5 Testing Activity Requirements

This test qualitatively evaluates the controllability of a vehicle when attempting to stop from 60 mph on a dry asphalt surface. It objectively measures the distance required to do so. Sections 5.1 and 5.2 apply to the entire test sections identified.

An asphalt vehicle dynamics pad shall be assembled as a straight path with a nominal length of 400 feet. The width of the lane should be at least 12 feet. Lane width shall be marked by the use of traffic cones or similar devices. Markers shall be a soft resilient material, which can withstand a vehicle impact, without damaging the vehicle.

NOTE:
During this testing, if a vehicle fails electrically or mechanically for any reason, testing of the vehicle shall be halted, and the vehicle removed from the test program until the Supplier has completed repairs. See procedure AVTA-PHAC02 for additional details.

NOTE:
If the vehicle is equipped with regenerative braking, the regenerative braking system shall be engaged during this test. If the level of regenerative braking can be adjustable by the driver, the setting with the highest level of regenerative power shall be employed.

5.1 Instrument the vehicle to obtain the following data:

5.1.1 Speed versus time

5.1.2 Distance versus time

5.1.3 RESS temperature versus time

5.2 Record the following environmental conditions in Appendix A:

5.2.1 Range of ambient temperature during the test

5.2.2 Range of wind velocity during the test

5.2.3 Range of wind direction during the test

5.3 Testing

5.3.1 Verify vehicle is in Normal operation mode.

5.3.2 Move the vehicle to the start area, and record the vehicle odometer reading.

5.3.3 Record the following information:

5.3.3.1 Initial RESS SOC indicator reading

5.3.3.2 Ambient temperature

5.3.3.3 Wind speed and direction

5.3.4 Engage the fifth wheel.

5.3.5 Accelerate the vehicle to at least 60 mph (96 km/h) and enter the stopping lane.

5.3.6 From a speed of 60 mph +2/-0 mph, decelerate the vehicle in a controlled manner as rapidly as possible to a complete stop.

5.3.7 Measure the total distance required to stop the vehicle. Record in Appendix A.

5.3.8 Note any test deficiencies, moved or dislodged cones/markers, and any driver comments, in Appendix A.

5.3.9 Return the vehicle to the start/staging area, and allow at least 15 minutes to pass before proceeding. Note the actual time duration in Appendix A.

5.3.10 Record the RESS SOC indicator reading in Appendix A.

5.3.11 Accelerate the vehicle to at least 60 mph (96 km/h) and enter the stopping lane from the opposite direction.

5.3.12 From a speed of 60 mph +2/-0 mph, decelerate the vehicle in a controlled manner to a complete stop as rapidly as possible.

5.3.13 Measure the total distance required to stop the vehicle. Record in Appendix A.

5.3.14 Note any test deficiencies, moved or dislodged cones/markers, and any driver comments, in Appendix A.

5.3.15 Record the following information in Appendix A:

5.3.15.1 Date and time of test completion

5.3.15.2 Equipment failures, if any

5.3.15.3 Equipment abnormalities, if any

5.3.15.4 Final RESS SOC Indicator reading

5.3.15.5 Driver notes, if any.

Appendix A – Braking Test Data Sheet

(Page 1 of 3)

VIN Number: ________________________

Project No.:	Test Date(s):
Data File Name:	
Test Driver: (Initials) (Date)	
Test Engineer: (Initials) (Date)	

Vehicle Setup

VEHICLE WEIGHTS AS TESTED WITH DRIVER & INSTRUMENTATION (Curb weight plus 300 pounds)			
Left Front: (lbs or kg)	Right Front: (lbs or kg)	Total Front: (lbs or kg)	Percent Front: %
Left Rear: (lbs or kg)	Right Rear: (lbs or kg)	Total Rear: (lbs or kg)	Percent Rear: %
		Total Weight: (lbs or kg)	

INSTALLED TIRES (Placard or sidewall whichever is less)			
Left Front		Right Front	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	
Left Rear		Right Rear	
Pressure: (psi or kPa)		Pressure: (psi or kPa)	

Track/Weather Conditions

Test Track Location:	Track Grade: %
Ambient Temperature (initial): (32-100°F or 0-38°C)	Ambient Temperature (final): (32-100°F or 0-38°C)
Track Temperature (initial): (°F or °C)	Track Temperature (final): (°F or °C)
Wind Velocity (initial): (<10 mph or 16 km/h)	Wind Velocity (final): (<10 mph or 16 km/h)
Wind Direction (initial): °	Wind Direction (completion): °

Appendix A – Braking Test Data Sheet
(Page 2 of 3)

VIN Number: ______________________

Sequence No: 1	File No.:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC,kWh,Ah)	State of Charge (final): (SOC,kWh,Ah)	
RESS Temp (initial): (60-120°F or 16-49°C)	RESS Temp (final): (°F or °C)	
Comments (initials/date): Speed at the Start of Braking: __________ Distance Required to Stop Vehicle: __________		
Sequence No: 2	File No.:	Direction of Travel:
Time (initial):	Time (final):	
Odometer (initial): (miles or kilometers)	Odometer (final): (miles or kilometers)	
State of Charge (initial): (SOC,kWh,Ah)	State of Charge (final): (SOC,kWh,Ah)	
RESS Temp (initial): (°F or °C)	RESS Temp (final): (°F or °C)	
Comments (initials/date): Speed at the Start of Braking: __________ Distance Required to Stop Vehicle: __________		

Appendix A – Braking Test Data Sheet
(Page 3 of 3)

VIN Number: ___________________________

General Comments (initials/date):

Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix B – PHEV Metrology Setup Sheet

(Page 1 of 1)

VIN Number: ______________________

Instrument/Device:	Calibration Due Date:	Initials / Date:
Fifth Wheel S/N:		
Fifth Wheel Calibrator S/N:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Tire Pressure Gauge S/N:		
Misc:		
Misc:		
Misc:		
Misc:		

Comments (initials/date):

Completed By:

(Printed Name) (Signature) (Date)

Reviewed By (QA):

(Printed Name) (Signature) (Date)

Approved By:

(Printed Name) (Signature) (Date)

Section VIII: AVTA-PHTP07 – Implementation of SAE J1634 May1993 - "Electric Vehicle Energy Consumption and Range Test Procedure"

TABLE OF CONTENTS

APPENDICES

1 Objective

The objective of this procedure is to provide methods for the testing of energy efficiency and range of plug-in hybrid electric vehicles (PHEV) participating in PHEV America which are operable in Rechargeable Energy Storage System Only mode (RESS Only mode). Testing is conducted in accordance with SAE Standard J1634, "Electric Vehicle Energy Consumption and Range Test Procedure" and includes tests both with and without air conditioning loads. These methods are not meant to supersede those of the testing facility, those specifically addressed by SAE Test Standards (except as noted) nor of any regulatory agency, which may have or exercise control over the covered activities.

2 Purpose

The purpose of this procedure is to identify acceptable methods for the implementation of the test requirements of SAE-J1634. SAE-J1634 establishes uniform procedures for testing battery-powered electric vehicles through the Urban Dynamometer Driving Schedule (UDDS) and Highway Fuel Economy Driving Schedule (HWFEDS). This procedure provides specific guidance for testing plug-in hybrid electric vehicles (PHEV) capable of operating in a mode which the Consumable Fuel Energy Converter (CFEC) is disabled and the vehicle operates solely on energy from the RESS (RESS Only mode). Vehicles tested in an operating mode in which the CFEC and RESS are automatically controlled to supply energy independently or in combination (Normal Operation mode) are tested in accordance with procedure AVTA-PHTP03. The requirements for this procedure deviate from some of the test requirements of SAE J1634. These deviations are necessary to accomplish this test for plug-in hybrid electric vehicles and to assure that relative performance between vehicle types can be assessed. Deviations from SAE J1634 are noted where they occur.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

Prior to conducting any portion of the testing, the following initial conditions and prerequisites should be met. Satisfactory completion of these items should be verified as complete and recorded on the Test Data Sheet.

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05 and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 Ambient temperature within the dynamometer cell during testing shall be 77°F ± 9°F (25˚C ± 5˚C).

4.3 RESS temperature at the beginning of testing shall be established by soaking the vehicle at 77°F ± 9°F (25˚C ± 5˚C) for a minimum of 12 hours in accordance with SAE J1711 Section 4.3.1.4.a.

4.4 Tire Preparation

4.4.1 Tire pressures shall be set at the values used during coastdown testing conducted in accordance with procedure AVTA-PHTP01.

4.4.2 Suppliers recommended tires shall be used. Tires shall have a tread depth of at least 50% when new.

4.5 Dynamometer

4.5.1 This test procedure is predicated on the use of a 48" 4WD dynamometer which meets current EPA guidelines established in 40 CFR Part 86.108-00, for this type of dynamometer.

4.5.2 Road load power settings shall be based upon coefficients developed using procedure AVTA-PHTP01.

4.5.3 Inertia settings shall be made based on the vehicle curb weight as determined by procedure AVTA-PHAC06 plus 300 pounds. This is a deviation from the requirements of SAE J1711.

4.6 During dynamometer operation, a fixed-speed cooling fan shall be positioned so as to direct cooling air to the front of the vehicle. The fan shall not develop an air flow in excess of 5,300 cubic feet per minute (2.5 m^3/s).

4.7 Vehicle shall be tested in its normal configuration with normal appendages (mirrors, bumpers, hubcaps, etc.) Certain items (hub caps, etc.) may be removed where necessary for safety on the dynamometer.

4.8 Normal Supplier's recommended lubricants shall be employed.

4.9 Prior to dynamometer testing, vehicles shall have accumulated a minimum of 1,000 miles. The vehicles shall be operated a sufficient number of miles to use at least two gallons of "EPA certification fuel" and shall have completed the requirements of procedures AVTA-PHTP04 and AVTA-PHTP05. This is a deviation from the requirements of SAE J1634.

4.10 RESS initial SOC shall be established in accordance with procedure AVTA-PHTP08, Section 5.

4.11 The following data shall be collected using a DAS during conduct of the various tests specified by this procedure. Overall error in recording or indicating instruments shall not exceed ±2% of the maximum value of the variable being measured or as specifically excepted elsewhere. Periodic calibration shall be performed and documented to ensure compliance with this requirement.

4.11.1 RESS voltage versus time

4.11.2 RESS current versus time (RESS current shall be collected at a frequency of at least 20 Hz)

4.11.3 Vehicle speed versus time

4.11.4 Distance versus time

4.11.5 RESS temperature versus time

4.11.6 RESS power versus time

4.12 The range of ambient temperature during the testing shall be recorded.

4.13 A description of the dynamometer shall be recorded, including:

4.13.1 Drum or roll diameter and number of tire contact points

4.13.2 Road load power set points

4.13.3 Dynamometer inertia weight

4.13.4 Confirmation that the dynamometer conforms to EPA guidelines as specified in 40 CFR Part 86.108-00.

4.14 The date, starting and ending times shall be recorded.

4.15 The beginning and ending vehicle odometer readings shall be recorded.

4.16 All instrumentation used in the test shall be listed in Appendix A and attached to the test data sheets/results and shall include the following information:

4.16.1 Manufacturer

4.16.2 Model number

4.16.3 Serial number

4.16.4 Next calibration date

4.17 Any deviation from the test procedure and the reason for the deviation shall be recorded in accordance with procedure AVTA-PHAC02.

4.18 All documentation required to complete the testing shall be completed, approved and issued prior to commencing the testing it addresses.

4.19 A copy of test documentation and methodologies/instructions used for testing shall be included in the final test documentation program. This is in accordance with procedure AVTA-PHAC02.

4.20 Verify that procedures AVTA-PHAC06 and AVTA-PHTP11 have been, or are being, completed and that the requirements for operating in the RESS Only mode have been determined.

5 Dynamometer Setup

The purpose of this section is to prepare the dynamometer for use in testing PHEVs to the requirements of SAE J1711 as described in Section 6.

CAUTION:
In this procedure, the dynamometer is started and run. ALL personnel shall exercise appropriate cautions while in the vicinity of both the Power Absorption Unit and the Roller Section.

NOTE:
Activities necessary to complete the test are identified in the following sections. All items shall be completed, whether they are required by J1634 or not. Any section which cannot be completed shall be so annotated, along with the appropriate justification in accordance with procedure AVTA-PHAC02.

5.1 Establish the initial condition applicable to the RESS Only mode as determined in procedure AVTA-PHAC06.

5.1.1 Place the vehicle in the RESS Only mode and, for tests to be conducted beginning at 100% initial RESS SOC, establish the RESS at 100% initial SOC in accordance with procedure AVTA-PHTP08.

NOTE:
Establishing the appropriate RESS initial SOC may require charging the test vehicle or operating the vehicle on the dynamometer. Requirements for verification of the proper RESS initial SOC are presented in procedure AVTA-PHTP08.

5.1.2 Soak the vehicle in the dynamometer test cell for at least 12 hours at 77°F ± 9°F (25˚C ± 5˚C) before performing the UDDS test. Do not remove the vehicle from the dynamometer during this time.

NOTE:
Do not operate the vehicle propulsion system during dynamometer warm-up and calibration.

5.2 Conduct an initial warm-up of the dynamometer in accordance with facility procedures.

5.3 Conduct and complete speed calibration of the dynamometer in accordance with facility procedures.

5.4 Conduct and complete torque arm calibration of the dynamometer in accordance with facility procedures.

5.5 Conduct and complete Data Acquisition System (DAS) calibration (including the emissions bench) in accordance with facility procedures.

5.6 Set the dynamometer with the coastdown coefficients and inertia settings determined in procedure AVTA-PHTP01. Record the settings in Appendix B as "Target" settings.

5.7 Prepare the vehicle to be tested as follows:

5.7.1 Record tire inflation pressures in Appendix B.

5.7.2 Place the test vehicle on the dynamometer roll(s), and center it on the roll(s) using facility procedures.

5.7.3 Attach tie-down straps to the vehicle.

5.7.4 Place wheel chocks at the non-driving wheels.

5.7.5 Place fan appropriately to cool the engine, open the engine compartment cover and turn the fan on. Fans should be placed to simulate road air flow in accordance with Section 4.6.

CAUTION:

High voltage may be present. To prevent personnel injury or equipment damage, use extreme caution when connecting instrumentation leads.

5.7.6 Connect vehicle instrumentation leads to the DAS.

5.8 Determination of Dynamometer and Tire Parasitic Losses for Single Roll Dynamometer

5.8.1 Conduct back-to-back HWFEDS drive cycles.

5.8.2 Measure tire temperatures after the HWFEDS drive cycles and immediately before conducting the coastdown and record in Appendix B.

5.8.3 Place the vehicle in neutral or "dynamometer mode" if such mode is applicable based on vehicle manufacturer's supplied data.

5.8.4 Using the dynamometer motor, accelerate the vehicle to 80 mph.

5.8.5 Coast the vehicle to 5 mph, while recording speed vs. time.

5.8.6 Immediately after completion of step 5.8.5, record tire temperatures in Appendix B.

5.8.7 Save the DAS data and determine coastdown times from 75 to 5 mph in 10 mph increments.

5.8.8 Repeat steps 5.8.4 through 5.8.7 a minimum of three times.

5.9 Set up the dynamometer to achieve the desired coast-down times.

5.9.1 Compare the coastdown times obtained in step 5.8 with the coastdown times expected based upon the coastdown coefficients determined in procedure AVTA-PHTP01.

5.9.2 If measured coastdown times are not within 1.5% of the desired coastdown times, adjust road load coefficients and inertia settings as necessary. Record the final road load and inertia settings in Appendix B as "Dyno" settings.

5.10 If the adjustment to road load and inertia settings are greater than 3% from the initial calibration (the initial conduct of step 5.8 for the vehicle), an attempt to determine the cause of the “drift” shall be undertaken. This evaluation shall include both the vehicle and the dynamometer. Results of the investigation shall be noted in Appendix B and reviewed with the Test Director or Program Manager.

5.11 Record the applicable EPA coastdown coefficients and inertia settings in Appendix B. If the EPA settings deviate more significantly from the "Dyno" settings, an attempt shall be made to reconcile this deviation. Results of the investigation shall be noted in Appendix B and reviewed with the Test Director or Program Manager.

6 Road Load Simulation (Without Air Conditioning Loads)

The purpose of this section is to determine the fuel efficiency of a PHEV vehicle when subjected to the test schedules identified in SAE J1634 (May 93) and operated without air conditioning loads. This section selectively implements portions of SAE J1634 in support of this purpose. The actual dynamometer instructions are developed by the entity operating the dynamometer and shall be used in conjunction with this procedure. As such, this procedure may be used at any facility utilizing an electric dynamometer capable of simulating road load.

This procedure performs SAE Standard J1634 testing at an ambient temperature of 77°F ± 9°F. The load cycles shall follow the combined UDDS/HWFEDS road load schedule contained in SAE Standard J1634, May 1993. Test room temperatures shall be controlled in accordance with facility procedures.

Road load simulation testing shall be conducted as soon as practical after completion of Section 5. The vehicle shall not be removed from the dynamometer between completion of Section 5 and start of Section 6 testing.

NOTE:
Do not operate the vehicle propulsion system during dynamometer warm-up and calibration.

6.1.1 Vehicle setup

6.1.1.1 Prepare the dynamometer in accordance with Sections 5.1 through 5.5.

6.1.1.2 Verify that the required ambient temperature exists in the dynamometer test cell and that the vehicle has been at the required ambient temperature for at least 12 hours.

6.1.1.3 Verify that the DAS instrumentation is connected.

6.1.1.4 Turn on the cooling fan(s).

6.2 Determine the energy efficiency and range without A/C.

NOTE:
The SOC indicator reading shall be recorded at each significant datum readable on the SOC meter.

NOTE:
The minimum allowable RESS voltage shall not be violated during testing. If the minimum voltage is reached, testing shall be stopped.

6.2.1 Verify that all accessories, including air conditioning, have been turned off.

6.2.2 Record the following in Appendix C:

6.2.2.1 Time of day

6.2.2.2 Odometer reading

6.2.2.3 SOC indicator reading

6.2.2.4 Ambient temperature

6.2.2.5 Tire temperature

6.2.3 Conduct a UDDS drive cycle, immediately followed by a second UDDS drive cycle, immediately followed by a HWFEDS, followed by a HWFEDS after a 15 second pause with the vehicle key on and brake applied.

6.2.4 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1634. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.2.5 Upon completion of the combined UDDS/HWFEDS drive cycle, wait 10 minutes ($\pm$ 1 minute) with the vehicle and its accessories off. During this period, record the following parameters. At the end of the ten minute period, begin the next combined UDDS/HWFEDS drive cycle.

6.2.5.1 Time of day

6.2.5.2 Odometer reading

6.2.5.3 SOC indicator reading

6.2.5.4 Ambient temperature

6.2.5.5 Tire temperature

6.2.6 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1634. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

6.2.7 Upon completion of the second combined UDDS/HWFEDS drive cycle, wait 10 minutes (± 1 minute) with the vehicle and its accessories off. During this period, record the following parameters.

6.2.7.1 Time of day

6.2.7.2 Odometer reading

6.2.7.3 SOC indicator reading

6.2.7.4 Ambient temperature

6.2.7.5 Tire temperature

6.2.8 Repeat combine UDDS/HWFEDS drive cycle tests until the following test termination criteria are reached.

6.2.8.1 Test termination criteria contained in SAE J1634 shall be the official method of determining vehicle distance traveled. However, this is not necessarily the criteria for terminating the test cycle. Testing shall be terminated based on traction battery voltage, or battery capacity as indicated by the sustained inability of the vehicle to attain or maintain speed, as opposed to the criteria contained in SAE J1634. This is a deviation from the requirements of SAE J1634.

6.2.8.2 Terminate the test based on the depletion of the vehicle batteries. Battery depletion shall be based on the manufacturer's specification of minimum voltage identified in AVTA-PHAC06.

6.2.9 Upon completion of the test, record the following in Appendix C:

6.2.9.1 Time of day

6.2.9.2 Test time

6.2.9.3 Odometer reading

6.2.9.4 Dynamometer distance

6.2.9.5 Total distance

6.2.9.6 Distance to SAE J1634 cutoff criteria

6.2.9.7 Final SOC indicator reading

6.2.9.8 Final tire temperatures.

6.3 Recharge the RESS to 100% in accordance with procedure AVTA-PHTP08. This may be done in the dynamometer test cell or in another area. However, no propulsion system power shall be used in moving the vehicle. Record the AC and DC energy returned to the RESS in Appendix C.

6.4 Secure the dynamometer.

NOTE:
RESS energy supplied may be calculated for the combined UDDS-HWFEDS, a UDDS cycle or a HWFEDS cycle. The equation is the same, but only the energy withdrawn during the test being evaluated should be used.

6.5 RESS Capacity and Energy Supplied Calculations

6.5.1 Calculate the capacity supplied by the RESS (Ahr/mi) during charge depletion and the percentage of RESS capacity supplied by the RESS (%/mi) during charge depletion using the following equations and record in Appendix D:

$$\textit{RESS Capacity (Ahr/mi)} = \frac{[\ \textit{RESS}_{\textit{enter sustaining}}\ \textit{(Ahr)} - \textit{RESS}_{\textit{initial}}\ \textit{(Ahr)}\ ]}{\textit{Dynamometer Distance (miles)}}$$

$$\textit{RESS Capacity (\%/mile)} = \frac{100 \ * [\textit{RESS}_{\textit{enter sustaining}}\ \textit{(Ahr)} - \textit{RESS}_{\textit{initial}}\ \textit{(Ahr)}]}{\textit{Dynamometer Distance (miles)} * \textit{RESS Capacity (Ahr)}}$$

The $RESS_{initial}$ and $RESS_{enter\ sustaining}$ shall be determined by integrating the ammeter in accordance with Section 4.11. The $RESS_{enter\ sustaining}$ shall be the total ampere-hours out of the RESS to entry into charge sustaining mode. The Dynamometer distance shall be the total miles traveled to the point of test termination. The *RESS Capacity (Ahr)* shall be the nominal capacity of the RESS as determined in procedure AVTA-PHAC06.

6.5.2 Calculate the DC energy supplied by the RESS (Wh/mi) using the following equation and record in Appendix D:

$$\textit{DC Energy Supplied (DC-Wh/mile)} = \frac{\textit{RESS}_{\textit{DC energy}}\ \textit{(Wh)}}{\textit{Dynamometer Distance (miles)}}$$

The DC energy shall be determined by integrating the product of the ammeter and voltmeter in accordance with Section 4.11. The DC energy supplied by the RESS shall be the total energy out of the RESS to the point of test termination. The Dynamometer Distance shall be the total miles traveled to the point of test termination.

6.6 Calculation of RESS AC Electrical Recharge Energy Consumed

6.6.1 Electric energy (AC) used to recharge the RESS shall be calculated in accordance with procedure AVTA-PHTP08.

6.6.2 Record the AC recharge energy for each test day in Appendix C.

7 Road Load Simulation (With Air Conditioning Loads)

The purpose of this section is to determine the fuel efficiency of a PHEV vehicle when subjected to the test schedules identified in SAE J1634 (May 93) and operated with air conditioning loads. This section selectively implements portions of SAE J1634 in support of this purpose. The actual dynamometer instructions are developed by the entity operating the dynamometer and shall be used in conjunction with this procedure. As such, this procedure may be used at any facility utilizing an electric dynamometer capable of simulating road load.

This procedure performs SAE Standard J1634 testing at an ambient temperature of 77°F ± 9°F. The load cycles shall follow the combined UDDS/HWFEDS road load schedule contained in SAE Standard J1634, May 1993. Test room temperatures shall be controlled in accordance with facility procedures.

Road load simulation testing shall be conducted as soon as practical after completion of Section 6. The vehicle shall not be removed from the dynamometer between completion of Section 6 and start of Section 7 testing.

NOTE:
Do not operate the vehicle propulsion system during dynamometer warm-up and calibration.

7.1.1 Vehicle setup

7.1.1.1 Prepare the dynamometer in accordance with Sections 5.1 through 5.5.

7.1.1.2 Verify that the required ambient temperature exists in the dynamometer test cell and that the vehicle has been at the required ambient temperature for at least 12 hours.

7.1.1.3 Verify that the DAS instrumentation is connected.

7.1.1.4 Turn on the cooling fan(s).

7.2 Determine the energy efficiency and range with A/C.

NOTE:
The SOC indicator reading shall be recorded at each significant datum readable on the SOC meter.

NOTE:
The minimum allowable RESS voltage shall not be violated during testing. If the minimum voltage is reached, testing shall be stopped.

7.2.1 Verify that all accessories, except the air conditioning, are off.

7.2.2 Record the following in Appendix C:

- 7.2.2.1 Time of day
- 7.2.2.2 Odometer reading
- 7.2.2.3 SOC indicator reading
- 7.2.2.4 Ambient temperature
- 7.2.2.5 Tire temperature
- 7.2.2.6 Fuel weight (if applicable)

7.2.3 Conduct a UDDS drive cycle, immediately followed by a second UDDS drive cycle, immediately followed by a HWFEDS, followed by a HWFEDS after a 15 second pause with the vehicle key on and brake applied.

7.2.4 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1634. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

7.2.5 Upon completion of the combined UDDS/HWFEDS drive cycle, wait 10 minutes ($\pm$ 1 minute) with the vehicle and its accessories off. During this period, record the following parameters. At the end of the ten minute period, begin the next combined UDDS/HWFEDS drive cycle.

- 7.2.5.1 Time of day
- 7.2.5.2 Odometer reading
- 7.2.5.3 SOC indicator reading
- 7.2.5.4 Ambient temperature
- 7.2.5.5 Tire temperature

7.2.6 Monitor the driver's performance and note the time, odometer reading, speed and distance at which an excursion from the drive cycle occurs, as well as the reason(s) for any such excursions in Appendix C. The speed tolerance at any given time on the driving schedule is defined by SAE J1634. The upper limit is 2 mph (3.2 km/h) higher than the highest point on the trace within 1 second of the given time. The lower limit is 2 mph (3.2 km/h) lower than the lowest point on the trace within 1 second of the given time.

7.2.7 Upon completion of the second combined UDDS/HWFEDS drive cycle, wait 10 minutes ($\pm$ 1 minute) with the vehicle and its accessories off. During this period, record the following parameters.

- 7.2.7.1 Time of day
- 7.2.7.2 Odometer reading
- 7.2.7.3 SOC indicator reading
- 7.2.7.4 Ambient temperature
- 7.2.7.5 Tire temperature

7.2.8 Repeat combine UDDS/HWFEDS drive cycle tests until the following test termination criteria are reached.

- 7.2.8.1 Test termination criteria contained in SAE J1634 shall be the official method of determining vehicle distance traveled. However, this is not necessarily the criteria for terminating the test cycle. Testing shall be terminated based on traction battery voltage, or battery capacity as indicated by the sustained inability of the vehicle to attain or maintain speed, as opposed to the criteria contained in SAE J1634. This is a deviation from the requirements of SAE J1634.
- 7.2.8.2 Terminate the test based on the depletion of the vehicle batteries. Battery depletion shall be based on the manufacturer's specification of minimum voltage identified in AVTA-PHAC06.

7.2.9 Upon completion of the test, record the following in Appendix C:

- 7.2.9.1 Time of day
- 7.2.9.2 Test time
- 7.2.9.3 Odometer reading
- 7.2.9.4 Dynamometer distance
- 7.2.9.5 Total distance
- 7.2.9.6 Final SOC indicator reading

7.3 Recharge the RESS to 100% in accordance with procedure AVTA-PHTP08. This may be done in the dynamometer test cell or in another area. However, no propulsion system power shall be used in moving the vehicle. Record the AC and DC energy returned to the RESS in Appendix C.

7.4 Secure the dynamometer and dismount the vehicle.

8 Data Reduction and Acceptability Criteria

NOTE:
RESS energy supplied may be calculated for the combined UDDS-HWFEDS, a UDDS cycle or a HWFEDS cycle both with and without air conditioning operating. The equation is the same, but only the energy withdrawn during the test being evaluated should be used.

8.1 RESS Capacity and Energy Supplied Calculations

8.1.1 Calculate the capacity supplied by the RESS (Ahr/mi) during charge depletion and the percentage of RESS capacity supplied by the RESS (%/mi) during charge depletion using the following equations and record in Appendix D:

$$\textit{RESS Capacity (Ahr/mi)} = \frac{[RESS_{enter\ sustaining}\ (Ahr) - RESS_{initial}\ (Ahr)]}{\textit{Dynamometer Distance (miles)}}$$

$$\textit{RESS Capacity (\%/mile)} = \frac{100 * [RESS_{enter\ sustaining}\ (Ahr) - RESS_{initial}\ (Ahr)]}{\textit{Dynamometer Distance (miles)} * \textit{RESS Capacity (Ahr)}}$$

The $RESS_{initial}$ and $RESS_{enter\ sustaining}$ shall be determined by integrating the ammeter in accordance with Section 4.11. The $RESS_{enter\ sustaining}$ shall be the total ampere-hours out of the RESS to the point of test termination criteria as defined in SAE J1634. The Dynamometer Distance shall be the total miles traveled to the point of to the point of test termination criteria as defined in SAE J1634. The *RESS Capacity (Ahr)* shall be the nominal capacity of the RESS as determined in procedure AVTA-PHAC06.

8.1.2 Calculate the DC energy supplied by the RESS (Wh/mi) using the following equation and record in Appendix D:

$$\textit{DC Energy Supplied (DC-Wh/mile)} = \frac{RESS_{DC\ energy}\ (Wh)}{\textit{Dynamometer Distance (miles)}}$$

The DC energy shall be determined by integrating the product of the ammeter and voltmeter in accordance with Section 4.11. The DC energy supplied by the RESS shall be the total energy out of the RESS to the point of test termination. The Dynamometer Distance shall be the total miles traveled to the point of test termination.

8.2 Calculation of RESS AC Electrical Recharge Energy Consumed

8.2.1 Electric energy (AC) used to recharge the RESS shall be calculated in accordance with procedure AVTA-PHTP08.

8.2.2 Record the AC recharge energy for each test sequence in Appendix D.

Appendix A – Vehicle Metrology Setup Sheets

(Page 1 of 1)

VIN Number: __________

Instrument/Device:	Calibration Due Date:	Initials / Date:
Fifth Wheel S/N:		
Fifth Wheel Calibrator S/N:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Tire Pressure Gauge S/N:		
Misc:		
Misc:		
Misc:		
Misc:		
Comments (initials/date):		
Completed By: (Printed Name)	(Signature)	(Date)
Reviewed By (QA): (Printed Name)	(Signature)	(Date)
Approved By: (Printed Name)	(Signature)	(Date)

Appendix B – SAE J1634 Test Data Sheet
(Page 1 of 2)

VIN Number: ______________________ Operating Mode ______

Project No.:	Test Date(s):
Data File Name:	
Test Driver: (Initials) (Date)	
Test Engineer: (Initials) (Date)	

Vehicle Setup

TIRE TEMPERATURE			
Initial L/F: (˚F or ˚C)	Initial R/F: (˚F or ˚C)	Final L/F: (˚F or ˚C)	Final R/F: (˚F or ˚C)
Initial L/R: (˚F or ˚C)	Initial R/R: (˚F or ˚C)	Final L/R: (˚F or ˚C)	Final R/R: (˚F or ˚C)
COLD TIRE PRESSURE (Shaved ☐ Yes ☐ No)			
Left Front: (psig or kPa)		Right Front: (psig or kPa)	
Left Rear: (psig or kPa)		Right Rear: (psig or kPa)	

Determination of Dynamometer and Tire Parasitic Losses

Coefficients	Target	Dyno	% Deviation
Inertia			
A			
B			
C			

EPA Coefficient Comparison

Coefficients	EPA	Dyno	% Deviation
Inertia			
A			
B			
C			

Appendix B – SAE J1634 Test Data Sheet
(Page 2 of 2)

VIN Number: ______________________ Operating Mode ______

General Comments (initials/date):		
Completed By: (Printed Name)	(Signature)	(Date)
Reviewed By: (Printed Name)	(Signature)	(Date)
Approved By: (Printed Name)	(Signature)	(Date)

Appendix C – SAE J1634 Driving Schedule (without A/C) Data Sheet (Page 1 of 4)

VIN Number: ______________________ Operating Mode _______

TIRE PRESSURE	
Left Front: (psig or kPa)	Right Front: (psig or kPa)
Left Rear: (psig or kPa)	Right Rear: (psig or kPa)
Fuel Density: (lbs per gallon)	
Inertial Weight Setting: (la_b)	
Minimum Allowable RESS Voltage: (volts)	

1st Combined UDDS/HWFEDS:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Ambient Temperature: ___________ (˚F/˚C)	Ambient Temperature: ___________ (˚F/˚C)

2nd Combined UDDS/HWFEDS:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Ambient Temperature: ___________ (˚F/˚C)	Ambient Temperature: ___________ (˚F/˚C)

Appendix C – SAE J1634 Driving Schedule (without A/C) Data Sheet (Page 2 of 4)

VIN Number: ______________________ Operating Mode ______

__th Combined UDDS/HWFEDS:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__th Combined UDDS/HWFEDS:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

Appendix C – SAE J1634 Driving Schedule (with A/C) Data Sheet (Page 3 of 4)

VIN Number: ______________________ Operating Mode _______

TIRE PRESSURE	
Left Front: (psig or kPa)	Right Front: (psig or kPa)
Left Rear: (psig or kPa)	Right Rear: (psig or kPa)
Fuel Density: (lbs per gallon)	
Inertial Weight Setting: (la_b)	
Minimum Allowable RESS Voltage: (volts)	

1st Combined UDDS/HWFEDS:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (°F/°C) R/F______ (°F/°C) L/R______ (°F/°C) R/R______ (°F/°C)	Tire Temperatures: L/F______ (°F/°C) R/F______ (°F/°C) L/R______ (°F/°C) R/R______ (°F/°C)
SOC: %	SOC: %
Ambient Temperature: ___________ (°F/°C)	Ambient Temperature: ___________ (°F/°C)

2nd Combined UDDS/HWFEDS:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (°F/°C) R/F______ (°F/°C) L/R______ (°F/°C) R/R______ (°F/°C)	Tire Temperatures: L/F______ (°F/°C) R/F______ (°F/°C) L/R______ (°F/°C) R/R______ (°F/°C)
SOC: %	SOC: %
Ambient Temperature: ___________ (°F/°C)	Ambient Temperature: ___________ (°F/°C)

Appendix C – SAE J1634 Driving Schedule (with A/C) Data Sheet (Page 4 of 5)

VIN Number: ______________________ Operating Mode ______

__th Combined UDDS/HWFEDS:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

__th Combined UDDS/HWFEDS:

Initial	Final
Time:	Time:
Odometer: mi	Odometer: mi
Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)	Tire Temperatures: L/F______ (˚F/˚C) R/F______ (˚F/˚C) L/R______ (˚F/˚C) R/R______ (˚F/˚C)
SOC: %	SOC: %
Ambient Temperature: __________ (˚F/˚C)	Ambient Temperature: __________ (˚F/˚C)

Appendix C – SAE J1634 Driving Schedule (with A/C)
Excursions from Drive Cycle
Data Sheet (Page 5 of 5)

VIN Number: ________________________ Operating Mode ______

Time:	Speed:	Distance:	Comments:	Initials:

Appendix D – SAE J1634 Energy Efficiency Calculation

(Page 1 of 2)

Without Air Conditioning

VIN Number: ______________________ Operating Mode ______

AC into the Charger: (kWh)	DC into the RESS: (kWh)

Distance traveled to SAE J1634 termination criteria: (miles)
Distance Traveled in Sequence 1 (miles)
Distance Traveled in Sequence 2 (miles)

RESS Capacity Used per Mile = RESS Capacity Out / Dynamometer Distance (miles)
(Ah per mile)

RESS Capacity Used per Mile Sequence 1 = ________________ =
(Ah per mile)

RESS Capacity Used per Mile Sequence 2 = __________________ =
(Ah per mile)

Average Sequence 1 and Sequence 2 for final Percent RESS Capacity Used per Mile.

Percentage RESS Capacity Used = 100 * Amp-hours out from RESS While Driving / RESS Manufacturer Battery Capacity
(%)

Percentage RESS Capacity Used per Mile = Percentage RESS Capacity Used / Dynamometer Distance (miles)
(% per mile)

Percentage RESS Capacity Used per Mile Sequence 1 = ________________ =
(% per mile)

Percentage RESS Capacity Used per Mile Sequence 2 = __________________ =
(% per mile)

Average Sequence 1 and Sequence 2 for final Percent RESS Capacity Used per Mile.

Average DC Energy Supplied (DC Wh/mile) = Total DC Energy supplied by RESS (Wh) / Distance Traveled (miles)

Average DC Energy Supplied Sequence 1 = ________________________ =
(DC Wh/mi)

Average DC Energy Supplied Sequence 2 = ________________________ =
(DC Wh/mi)

Average Sequence 1 and Sequence 2 for final Average DC Energy Supplied.

Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Appendix D – SAE J1634 Energy Efficiency Calculation

(Page 2 of 2)

With Air Conditioning

VIN Number: ______________________ Operating Mode ______

AC into the Charger: (kWh)	DC into the RESS: (kWh)

Distance traveled to SAE J1634 termination criteria: (miles)
Distance Traveled in Sequence 1 (miles)
Distance Traveled in Sequence 2 (miles)

RESS Capacity Used per Mile = RESS Capacity Out / Dynamometer Distance (miles)
(Ah per mile)

RESS Capacity Used per Mile Sequence 1 = _________________ =
(Ah per mile)

RESS Capacity Used per Mile Sequence 2 = __________________ =
(Ah per mile)

Average Sequence 1 and Sequence 2 for final Percent RESS Capacity Used per Mile.

Percentage RESS Capacity Used = 100 * Amp-hours out from RESS While Driving / RESS Manufacturer Battery Capacity
(%)

Percentage RESS Capacity Used per Mile = Percentage RESS Capacity Used / Dynamometer Distance (miles)
(% per mile)

Percentage RESS Capacity Used per Mile Sequence 1 = _________________ =
(% per mile)

Percentage RESS Capacity Used per Mile Sequence 2 = __________________ =
(% per mile)

Average Sequence 1 and Sequence 2 for final Percent RESS Capacity Used per Mile.

Average DC Energy Supplied (DC Wh/mile) = Total DC Energy supplied by RESS (Wh) / Distance Traveled (miles)

Average DC Energy Supplied Sequence 1 = ________________________ =
(DC Wh/mi)

Average DC Energy Supplied Sequence 2 = ________________________ =
(DC Wh/mi)

Average Sequence 1 and Sequence 2 for final Average DC Energy Supplied.

Completed By:	(Printed Name)	(Signature)	(Date)
Reviewed By:	(Printed Name)	(Signature)	(Date)
Approved By:	(Printed Name)	(Signature)	(Date)

Section IX: AVTA-PHTP08 – Rechargeable Energy Storage System (RESS) charging

TABLE OF CONTENTS

APPENDICES

1 Objective

This procedure identifies the method for charging the Rechargeable Energy Storage System (RESS) installed in plug-in hybrid electric vehicles evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA). It shall not supersede the charging protocols of the vehicle's Supplier, nor is it meant to supersede those specifically addressed by SAE Test Standards, nor of any regulatory agency, which may have or exercise control over the covered activities.

2 Purpose

The purpose of this procedure is to provide specific and repeatable guidance for charging the RESS of vehicles participating in the AVTA. This guidance applies to vehicles in any operating mode. This procedure is also used to calculate charging efficiencies during the performance of procedure AVTA-PHTP05.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05 and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 Charging of vehicle RESS shall be in accordance with the requirements of the vehicle/battery supplier as stated in the Owner/Operators manual.

4.3 Ambient temperature during charging shall be within the range of 32°F (0˚C) to 100°F (38°C) at the commencement of charging, or the maximum allowed by the Supplier.

4.4 RESS temperatures at the beginning of charging shall be greater than 40˚F (5˚C), shall be less than 120°F (49°C) and should be less than 100˚F (38°C).

4.5 All personnel conducting charging of RESS shall observe proper safety precautions at all times.

4.6 Charging rates shall not exceed the maximum recommended by the Supplier.

4.7 Grid charging the RESS should be accomplished at the highest voltage (e.g. 240 VAC vs. 120 VAC) allowed.

4.8 All documentation required to complete the charging activities shall be completed, approved and issued prior to commencing any charging activities.

4.9 Record the required data for all metrology used in Appendix B.

5 Charging Requirements

The following instructions apply to charging activities for all plug-in hybrid electric vehicles. They shall not replace or supersede the requirements of any specific Supplier. Should a conflict arise, the requirements of the Vehicle/RESS Supplier shall take precedence.

5.1 Setting Initial SOC At Charge-Sustaining Mode

A RESS Initial State of Charge entering charge-sustaining mode shall be achieved by operating the vehicle in the Normal Operation mode at a constant speed of 35 mph (56 km/h) for at least 25 miles (40 kilometers) or 5 miles (8 kilometers) past the Supplier's stated charge depleting range, whichever is greater. Alternatively, for vehicles operating on a dynamometer, a RESS Initial State of Charge entering charge-sustaining mode shall be achieved by operating the vehicle in the Normal Operation mode on the dynamometer through two UDDS cycles and two HWFEDS cycles in accordance with Section 6 of procedure AVTA-PHTP03, except that data recording shall not be required. After completion of this operation, care shall be exercised not to allow significant changes in the RESS SOC prior to commencement of testing requiring an Initial State of Charge at charge-sustaining mode.

NOTE:
If the vehicle will not deplete RESS charge operating at a constant speed of 35 mph, the operating speed shall be modified to allow charge depletion.

5.2 Setting Initial State of Charge At 100%

An RESS Initial State of Charge at 100% shall be achieved by grid charging the test vehicle in accordance with Section 5.3. Verify that the charger terminated charge without indicated faults. After completion of this operation, care shall be exercised not to allow significant changes in the RESS SOC prior to commencement of testing requiring an Initial SOC at charge-sustaining mode.

5.3 Grid Charging

Vehicles shall not be charged from any outlet except the outlet specifically designated for that vehicle at its designated Charge Station Location. The following steps assume the vehicle is parked in the charging area, and is capable of being charged from its dedicated Charge Station Location.

5.3.1 Verify by physical inspection that there is no damage to the RESS or charging system.

5.3.2 Determine and select the proper cable and connector type for the specific vehicle being charged. This shall be determined by visual inspection of the charger connector.

5.3.3 Read and record the RESS State of Charge (SOC) indicator reading prior to commencing the charge in Appendix A.

5.3.4 If an onboard kilowatt-hour meter reading is available, this should also be recorded in Appendix A.

5.3.5 Select the appropriate Charging Station Location and record in Appendix A.

5.3.6 Read and record the watt-hour meter reading at the charging station in Appendix A.

5.3.7 Verify that the electrical disconnect supplying power to the charger is closed.

5.3.8 Connect the charging cable to the vehicle.

5.3.9 Read and record the time that charging is starting in Appendix A.

5.3.10 If available, read and record the initial DC charging current and voltage in Appendix A.

5.3.11 Verify that the kilowatt-hour meter or the data logger is operating.

5.3.12 Allow the charger to continue charging until the charge is automatically terminated by the charger.

5.3.13 When the charge has completed (as determined by automatic termination of the charger), verify the charger is not indicating a charging fault. If a fault has occurred, the reason for the fault shall be recorded in accordance with procedure AVTA-PHAC02 and the Supplier notified to perform necessary repairs.

5.3.14 If the charger has automatically terminated without fault, record the following information:

5.3.14.1 Time

5.3.14.2 Final voltage (if available)

5.3.14.3 Final charging current (if available)

5.3.14.4 Charging station location energy meter reading

5.3.14.5 Vehicle SOC reading

5.3.14.6 Vehicle kilowatt-hour reading (if equipped)

5.3.14.7 Kilowatt-hour meter or data logger information

5.3.14.8 Vehicle odometer reading

5.3.15 If so equipped, depress the "STOP" button on the charger.

5.3.16 Disconnect the charging cable from the vehicle.

NOTE:
Completion of charge by automatic termination of the charger, without an indicated fault, shall be considered 100% SOC for the RESS.

5.4 Charging Efficiency

Charging efficiencies shall be calculated based upon conduct of rough road testing conducted in accordance with procedure AVTA-PHTP05. The charging efficiency test shall be conducted over a two-day period. One complete rough road test shall be completed each day in accordance with procedure AVTA-PHTP05.

5.4.1 Day One Testing

5.4.1.1 Ensure the vehicle is fully charged in accordance with Section 5.3.

5.4.1.2 Record vehicle mileage prior to conduct of procedure AVTA-PHTP05.

5.4.1.3 Record charger kWh prior to conduct of procedure AVTA-PHTP05.

5.4.1.4 Conduct procedure AVTA-PHTP05.

5.4.1.5 Upon completion of testing, return the vehicle promptly to its designated Charge Station Location and place it on charge in accordance with Section 5.3.

5.4.2 Day Two Testing

5.4.2.1 Ensure the vehicle is fully charged in accordance with Section 5.3.

5.4.2.2 Record vehicle mileage prior to conduct of procedure AVTA-PHTP05.

5.4.2.3 Record charger kWh prior to conduct of procedure AVTA-PHTP05.

5.4.2.4 Conduct procedure AVTA-PHTP05.

5.4.2.5 Upon completion of testing, return the vehicle promptly to its designated Charge Station Location and place it on charge in accordance with Section 5.3.

NOTE:
The kilowatt-hour meter reading taken in accordance with Section 5.4.3 is taken on day three and should be taken as near as practical to the time that the vehicle was taken off the charger on day one for conduct of rough road testing.

5.4.3 Charging Efficiency Calculation

5.4.3.1 Verify the vehicle is fully charged in accordance with Section 5.3.

5.4.3.2 Record vehicle mileage in Appendix A.

5.4.3.3 Record charger kWh in Appendix A.

5.4.3.4 Calculate the miles traveled during the two rough road tests.

5.4.3.5 Calculate the kWh consumed during the two rough road tests.

5.4.3.6 Calculate the vehicle charging efficiency as follows:

$$\text{Vehicle Charging Efficiency} = \frac{\text{Miles Traveled (5.4.3.4)}}{\text{Kilowatt-hours Consumed (5.4.3.5)}}$$

5.4.3.7 Using the Miles per kWh-AC calculated in Step 5.4.3.6, and a given rate of 10¢ per kWh-AC (an average daily rate sans demand charges), calculate the cost per mile to charge as follows:

Cost per Mile = (10¢ per kWh-AC / Miles per kWh-AC)

Appendix A – RESS Charging Log

(Page 1 of ___)

Charging Station Location No. ___	Vehicle:	VIN:

Date	Time	Connect/ Disconnect	Onboard SOC Indicator Status	Vehicle Odometer Reading	Battery Temp (°F)	Charger kWh Meter Reading	Comments	Initials

Appendix B – PHEV Metrology Setup Sheet

(Page 1 of 1)

VIN Number: ______________________

Instrument/Device:	Calibration Due Date:	Initials / Date:
Off-board kWh Meter:		
Volt Meter:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Misc:		
Misc:		
Misc:		
Misc:		
Misc:		

Comments (initials/date):

Completed By:

(Printed Name) (Signature) (Date)

Reviewed By (QA):

(Printed Name) (Signature) (Date)

Approved By:

(Printed Name) (Signature) (Date)

Section X: AVTA-PHTP09 – Reserved for Future Use

Section XI: AVTA-PHTP10 – Measurement and Evaluation of Plug-in Hybrid Electric Vehicle RESS Charger Performance

TABLE OF CONTENTS

APPENDICES

1 Objective

This procedure provides methods for the evaluation of Rechargeable Energy Storage System (RESS) charger performance for plug-in hybrid electric vehicles (PHEV).

2 Purpose

The purpose of this procedure is to provide a quantitative method for determination of key RESS charger performance parameters, including the chargers ability to return the RESS to 100% SOC from any depth of discharge in less than 12 hours. This testing and data acquisition meets the requirements specified in the PHEV Vehicle Specification.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Prerequisites

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05 and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 The following data shall be collected during conduct of the various tests specified by this procedure. Overall error in recording or indicating instruments shall not exceed ±2% of the maximum value of the variable being measured, unless otherwise noted. Periodic calibration shall be performed and documented in accordance with procedure AVTA-PHAC07 to ensure compliance with this requirement.

4.3 A list of all instrumentation used in the test shall be identified in Appendix A, and attached to the test results. It shall include the following information:

4.3.1 Manufacturer

4.3.2 Model number

4.3.3 Serial number

4.3.4 Next calibration date

4.4 Any deviation from the test procedure and the reason for the deviation shall be approved in advance by the Program Manager or Test Manager in accordance with procedure AVTA-PHAC02 and so noted on the appropriate data sheet(s).

4.5 Necessary recording equipment shall be installed in a manner that does not hinder vehicle operation or alter the operating characteristics of the vehicle.

4.6 Ambient temperature during charging shall be within the range of 32°F (0˚C) to 100°F (38°C) at the commencement of charging, or the maximum allowed by the Supplier, whichever is less.

4.7 RESS temperatures at the beginning of charging shall be greater than 40˚F (5˚C), shall be less than 120°F (49°C) and should be less than 100˚F (38°C).

5 Measurement of RESS Charger Parameters

The Rechargeable Energy Storage System (RESS) off-board chargers shall be evaluated for their ability to recharge the RESS in less than twelve hours, their power factor, their effect on supply line power quality, and the Total Harmonic Distortion (THD) introduced by the charger. Several of these evaluations are completed concurrently, and are described in the following sections:

5.1 Measured Parameters

5.1.1 AC input voltage

5.1.2 AC input current

5.1.3 RESS voltage

5.1.4 DC current

5.2 Measurement System Components

5.2.1 Sensors, including potential transformers, and AC and DC current transformers

5.2.2 Signal conditioners, including isolation amplifier and attenuator

5.2.3 Data acquisition system (LabVIEW)

5.3 Measurement of AC Input Parameters

The input AC parameters shall be measured using a potential transformer and current transformer. The potential transformer (PT) shall have a ratio of 4:1 to reduce the line-to-neutral voltage. The voltage signal shall be further reduced using attenuation through an isolation amplifier. The output of the amplifier shall then be fed to the acquisition system. The AC line current shall be measured using a clamp-on current transformer (CT), with a ratio of 1000:1 and a frequency response of DC to 400Hz.

On the secondary side of the CT, a resistor with a value of 10 ohms, 100 ohms, or 1000 ohms shall be connected, in order to obtain a measurable voltage drop. This voltage will be proportional to the line current and will be fed to the data acquisition system.

5.4 Measurement of DC Output Parameters

5.4.1 The DC voltage of the RESS shall be measured using the proper attenuation in the isolation amplifier. The DC current shall be measured using an AC/DC CT. The CT shall have a ±2V analog output, which will be directly fed to the acquisition system, with a frequency response of 0 to 2 kHz. The signals are first passed through a signal conditioning and amplifier unit which provides the necessary signal levels for compatibility with the AC/DC converter. The program shall sample at a frequency of at least 21.6 kHz, acquiring at least 720 points per channel, and covering at least two cycles of the 60 Hz waveform. This sampling frequency will ensure adequate resolution for the power quality measurements.

5.4.2 Using the collected samples, the required parameters shall be calculated every 30 seconds and stored in a data file. The following parameters shall be calculated:

5.4.2.1 Vrms of the AC input voltage

5.4.2.2 Irms of the AC input voltage

5.4.2.3 THD of the AC input voltage

5.4.2.4 THD of the AC input current

5.4.2.5 AC active power

5.4.2.6 Harmonic power

5.4.2.7 Total apparent power

5.4.2.8 Harmonic apparent power

5.4.2.9 True power factor

5.4.2.10 Displacement power factor

5.4.2.11 RESS voltage

5.4.2.12 DC value of the charging current

5.4.2.13 Ripple factor of the charging current

5.4.2.14 Ampere-hours

5.4.2.15 Watt-hours

5.4.2.16 Charger efficiency (DC power out / AC power in)

NOTE:

This data shall be saved in columns along with the time stamp, to be used to plot the required waveforms as a function of time. Power quality calculations use the fundamental components of the voltage and current. These fundamental components shall be calculated using the Fourier series expansion. Through operator control, the acquired data shall also be saved in a separate file to allow plotting of the input voltage and current waveforms. This function should be performed at various times in the charging cycle, including the beginning, mid-point and end.

6 RESS Charger Evaluation

The RESS Initial State of Charge shall be set prior to evaluation of the grid-connected charger.

6.1 Normal Operation mode

For vehicles without an RESS Only mode, the time to recharge the RESS from full discharge shall be determined after placing the RESS at an Initial SOC entering charge-sustaining mode in accordance with Section 5.1 of AVTA-PHTP08.

6.2 RESS Only Mode

For vehicles operable in the RESS Only mode, the time to recharge the RESS from full discharge shall be determined after completion of the range at constant speed test conducted in accordance with procedure AVTA-PHTP04.

6.3 RESS Charging

Within two hours of placing the RESS at the appropriate Initial SOC, return the vehicle to its Charge Station Location. Charge the vehicle in accordance with Section 5.3 of procedure AVTA-PHTP08 and collect data in accordance with Section 5 of this procedure.

6.4 Data Collection and Analysis

6.4.1 Monitor the AC and DC parameters during the entire charge period.

6.4.2 Charge for 13 hours or until the charger has automatically terminated as determined from the Owner's/Operator's Manual.

6.4.3 Plot the parameters listed in Section 5.4.

6.4.4 Note the time the RESS is fully charged. The PHEV Vehicle Specification requires that the RESS charger to automatically terminate charge when the RESS has reached 100% SOC. This automatic termination point shall be used to determine when the RESS has reached 100% SOC.

6.4.5 Note the maximum AC current.

NOTE:
The grid-connected charger shall fully recharge the Rechargeable Energy Storage System (RESS) from any state of discharge in less than 12 hours.

NOTE:
The maximum AC current shall be less than 32 amperes for a 208/240 volt grid connection and shall be less than 12 amperes for a 120 volt grid connection.

Appendix A – PHEV Metrology Setup Sheet

(Page 1 of 1)

VIN Number: ______________________

Instrument/Device:	Calibration Due Date:	Initials / Date:
Current Clamp S/N:		
Voltmeter S/N:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Misc:		
Misc:		
Misc:		
Misc:		
Misc:		

Comments (initials/date):

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Completed By:

____

(Printed Name) (Signature) (Date)

Reviewed By (QA):

____

(Printed Name) (Signature) (Date)

Approved By:

____

(Printed Name) (Signature) (Date)

Section XII: AVTA-PHTP11 – Vehicle Verification

TABLE OF CONTENTS

APPENDICES

1 Objective

The objective of this procedure is to identify a common protocol to verify mandatory (shall) requirements for vehicles evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA).

2 Purpose

This procedure identifies mandatory vehicle requirements contained in the PHEV Vehicle Specification which shall be verified as part of AVTA testing. Vehicles submitted for testing must meet all of these requirements.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. Basis documents are referenced where appropriate. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Storage and retention of records shall be completed as described in procedure AVTA-PHAC01.

4 Prerequisites

4.1 Individuals assigned to complete this procedure will be knowledgeable of the PHEV Vehicle Specification.

4.2 Individuals assigned to complete this activity will have received the appropriate training in accordance with procedure AVTA-PHAC05.

4.3 Prior to commencing this activity, a meeting of the involved personnel will be held to discuss the following:

4.3.1 Data required

4.3.2 Data available

4.3.3 Data sources

4.3.4 Contingencies

4.3.5 Safety requirements

4.4 Verification of all mandatory requirements presented herein must be completed prior to conduct of other testing, unless specifically exempted herein.

4.5 All documentation required to document the activities addressed by this procedure shall be completed, approved and issued prior to commencing the testing it addresses.

5 Verification Requirements

The requirements in Section 5 are derived from the PHEV Vehicle Specification. Vehicles participating in AVTA testing shall meet these requirements. Vehicles which cannot meet these requirements can be accepted for testing but only as a Prototype (non-Production) Vehicle.

Should a vehicle participate in AVTA testing more than once, a new check-sheet shall be completed each time it is presented. The Test Manager may choose not to re-verify all items. Items not re-verified shall be documented in a Test Exception Report in accordance with AVTA-PHAC02.

Appendix A identifies all mandatory requirements of the PHEV Vehicle Specification. Some mandatory requirements can be verified by a physical inspection or document review as described in Section 5.1. However, many mandatory requirements require measurement or dynamic test for validation. The methods for conduct of these measurements or dynamic tests are listed in Section 5.2.

5.1 Minimum Vehicle Requirements

Vehicle compliance with mandatory requirements of the PHEV Vehicle Specification listed in Appendix A which are verifiable by inspection shall be recorded in Appendix A. Any requirements not fully met shall be indicated in Appendix A by marking “No” and completing a Non-Conformance Report, Appendix B. The Non-Conformance Report shall be transmitted to the vehicle supplier within two business days of issuance. Further verification of mandatory vehicle requirements verifiable by inspection (Section 5.1) may continue while a Non-Conformance Report is unresolved. However, no testing (Section 5.2) shall proceed until all Non-Conformance Reports concerning mandatory vehicle requirements verifiable by inspection (Section 5.1) are resolved such that Appendix A can be marked “Yes” for all such requirements.

5.2 Dynamic Verification Requirements

The following tests shall be conducted to verify mandatory requirements of the PHEV Vehicle Specification listed in Appendix A which are not verifiable by inspection and require measurement or dynamic testing. The results of such measurement or testing shall be recorded in Appendix A. Any requirements not fully met shall be indicated in Appendix A by marking “No” and by completing a Non-Conformance Report, Appendix B. The Non-Conformance Report shall be transmitted to the vehicle supplier within two business days of issuance.

5.2.1 Verify the compliance of the vehicle to the requirements of the FMVSS applicable on the date of manufacture by conducting the following:

5.2.1.1 Locate the FMVSS Certification Label(s) on the vehicle

5.2.1.2 Verify that the label(s) indicates the vehicle is fully certified

5.2.1.3 If the vehicle is a conversion, verify that both the OEM FMVSS label and the Converter's FMVSS label are present. The Converter's FMVSS label SHALL NOT be installed in a manner that precludes full view of the OEM label.

5.2.2 During conduct of procedure AVTA-PHTP03, qualitatively verify compliance with FCC requirements for unintentional emitted electromagnetic radiation, as identified in 47 CFR 15, Subpart B, "Unintentional Radiators." by operating the following devices to determine if any interference is being generated from the vehicle:

5.2.2.1 Cellular telephone

5.2.2.2 Mobile radio scanning over the 70 cm and 2M bands

5.2.2.3 Citizen band radio

5.2.2.4 Portable compact disc player

5.2.2.5 Notebook computer

5.2.2.6 Onboard audio equipment (AM/FM radio, cassette, CD)

Devices and/or their antennae shall be located in a manner to maximize their potential for interference. [Prior to testing the initial vehicle, these devices shall be operated in the dynamometer with the dynamometer operating to verify there is no background interference.]

5.2.3 Verify the payload capability of at least 400 pounds as follows:

5.2.3.1 Upon receipt, the vehicle shall be weighed to determine the vehicle's standard (as-delivered condition) curb weight.

5.2.3.2 Obtain the GVWR rating from the FMVSS label affixed to the vehicle.

5.2.3.3 Subtract the curb weight determined in Step 5.2.3.1 from the GVWR determined in 5.2.3.2.

5.2.3.4 The calculated difference shall be considered the vehicle's payload capability.

5.2.4 If the vehicle is a conversion, it shall not have a GVWR or GAWR greater than the OEM specified values. This shall be verified as follows:

5.2.4.1 Locate the OEM FMVSS label. Note the GVWR and GAWRs. Record these values.

5.2.4.2 Locate the Converter's FMVSS label. Note the GVWR and the GAWRs.

5.2.4.3 Compare the two GVWRs and verify that the GVWR listed on the Converter’s FMVSS label is not greater than that listed by the OEM.

5.2.4.4 Compare the two GAWRs and verify that the GAWRs listed on the Converter’s FMVSS label are not greater than the OEM’s listed GAWRs.

5.2.5 Verify that the tires supplied with the vehicle being inspected are commercially available by conducting the following:

5.2.5.1 Identify the manufacturer, type and size of the tire. Verify that the tire size is the same as that on the placard installed in the driver side "B" pillar.

5.2.5.2 Verify that the tire is marked as "DOT rated."

5.2.5.3 Determine the maximum inflation pressure. Verify that the recommended inflation pressure is less than or equal to that on the placard installed in the driver side "B" pillar.

5.2.5.4 Obtain the load rating from the tire sidewall. Verify that this load rating is greater than one-half of the GAWR for both the front and rear axles.

5.2.5.5 Obtain the phone number of three dealers that are authorized dealers for the tire in question.

5.2.5.6 Call those dealers and verify that the tires are available for purchase. Make this verification for quantities of one and four tires. If available, obtain the price of the tire, excluding amounts for taxes, mounting, balancing, road hazard insurance and all other fees and costs.

5.2.6 Verify that the passenger space is not intruded upon by the Rechargeable Energy Storage System (RESS) or other conversion materials, as follows:

5.2.6.1 The RESS cannot be accessed by a vehicle occupant.

5.2.6.2 The RESS enclosure cannot be opened from inside the passenger compartment.

5.2.6.3 The RESS enclosure does not intrude into the space normally occupied by an individual while that individual is occupying a seat formally defined as such.

5.2.6.4 Conversion materials do not intrude into the space normally occupied by an individual while that individual is occupying a seat formally defined as such.

5.2.7 Verify that maximum RESS discharge is controlled for vehicles capable of operation in RESS Only mode by testing in accordance with procedure AVTA-PHTP04, Section, 5.1. Verify that maximum RESS discharge is controlled for vehicles capable of operation only in the Normal Operation mode by testing in accordance with procedure AVTA-PHTP12.

5.2.8 Confirm compliance with 49 CFR 571.105.S5.2.1 or 49 CFR 571.105.S5.2.1.2 by placing the vehicle in neutral and engaging the parking brake on a 30% grade for at least 5 minutes and ensuring that the vehicle does not move. The vehicle shall be loaded to GVWR including the driver. Perform this test with vehicle facing forward on the slope and repeat the test with the vehicle facing backward on the slope.

5.2.9 Verify successful completion of procedure AVTA-PHTP05 without damage to or failure of the vehicle or its systems.

5.2.10 Verify vehicle repair time shall requirement in accordance with procedure AVTA-PHAC02, Section 6.1.

5.2.11 Verify with the vehicle operator's manual that the vehicle is not designed to auto start with the key in the off position (or the vehicle in a de-energized state for "keyless" ignitions). Additionally, vehicles shall be observed throughout the testing program to verify that there are no auto start operations with the key in the off position (or the vehicle in a de-energized state for "keyless" ignitions).

5.2.12 A Test Engineer qualified in accordance with procedure AVTA-PHAC05 to review UL 2202 and UL 2231 shall verify conformance with NEC625-29(c) or (d).

5.2.13 Verification that vehicles do not contain exposed conductors, terminals, contact blocks or devices of any type that create the potential for personnel to be exposed to low voltage and high voltage, (as specified in SAE J1127, J1128, et al.) shall be conducted as follows:

5.2.13.1 Each exposed conductor, terminal contact block and device shall have its potential to ground measured with a voltmeter (digital or analog) verifying that voltage present at the exposed area is less than 60 volts.

5.2.13.2 Any device exhibiting a non-compliance (a voltage of 60V or greater) shall be clearly identified on a comment sheet and by a "NO" in Appendix A.

5.2.14 Verify that access to high-voltage components requires the removal of at least one bolt, screw, or latch as follows:

5.2.14.1 Locate all high-voltage components using the maintenance manual.

5.2.14.2 Verify that each of these components is fully enclosed and requires the removal of at least one bolt, screw, or latch for access to high voltage.

5.2.14.3 Verify that each of these components is clearly marked as "HIGH VOLTAGE" at any point that it can be accessed.

5.2.15 Verify that cable and wire marking consist of orange wire and/or orange sleeves as identified in SAE-J1127 as follows:

5.2.15.1 Locate all high-voltage cable using the maintenance manual.

5.2.15.2 Verify that each of these cables has an orange jacket or is marked with an orange tracer.

5.2.16 Isolation of the RESS from the vehicle chassis such that leakage current is less than 0.5 MIU shall be verified in accordance with procedure AVTA-PHTP05, Section 5.47.1.

5.2.17 Isolation of the RESS charger from the vehicle chassis such that charger leakage current is less than 0.5 MIU shall be verified in accordance with procedure AVTA-PHTP05, Section 5.47.1.

CAUTION:

Verification of Section 5.2.18 may result in movement of the vehicle. Personnel must anticipate inadvertent vehicle movement and exercise extreme caution when performing the tasks required by Section 5.2.18.

5.2.18 Verify the “NEUTRAL” and “PARK” lockout as follows:

5.2.18.1 Place the vehicle transmission in a position other than “PARK” or “NEUTRAL.”

5.2.18.2 Energize the vehicle.

5.2.18.3 Attempt to move the vehicle by depressing the accelerator.

5.2.18.4 If the vehicle moves under power, complete a Non-Conformance Report and notify the Supplier in accordance with Section 5.2.

5.2.19 Verify that the start key is removable only in the “OFF” position with the drive selector in “PARK” as follows:

5.2.19.1 With the drive selector in the “PARK” position, verify that the key can be inserted and removed without problem.

5.2.19.2 Turn the key to the “ON” position. Attempt to remove the key. If the key can be removed, complete a Non-Conformance Report and notify the Supplier in accordance with Section 5.2.

5.2.19.3 Repeat this for each available key position. If the key can be removed in any position other than “OFF,” complete a Non-Conformance Report and notify the Supplier in accordance with Section 5.2.

5.2.19.4 If the key cannot be removed except when in the “OFF” position, circle “Yes” in Appendix A for section 5.2.19.

CAUTION:
Verification of Step 5.2.20 may result in movement of the vehicle. Personnel must anticipate inadvertent vehicle movement and exercise extreme caution when performing the tasks required by Section 5.2.20.

5.2.20 Verify the pre-existing accelerator input lockout as follows:

5.2.20.1 Place the vehicle drive selector in the "PARK" position.

5.2.20.2 Verify the vehicle is not energized.

5.2.20.3 Depress the accelerator.

5.2.20.4 Energize the vehicle. If the vehicle moves under power, complete a Non-Conformance Report and notify the Supplier in accordance with Section 5.2.

5.2.20.5 Place the vehicle drive selector in the "NEUTRAL" position.

5.2.20.6 Verify the vehicle is not energized.

5.2.20.7 Depress the accelerator.

5.2.20.8 Energize the vehicle. If the vehicle moves under power, complete a Non-Conformance Report and notify the Supplier in accordance with Section 5.2.

5.2.20.9 Place the vehicle drive selector in the "DRIVE" position.

5.2.20.10 Verify the vehicle is not energized.

5.2.20.11 Depress the accelerator.

5.2.20.12 Energize the vehicle. If the vehicle moves under power, complete a Non-Conformance Report and notify the Supplier in accordance with Section 5.2.

5.2.20.13 Place the drive selector in the "REVERSE" position.

5.2.20.14 Verify the vehicle is not energized.

5.2.20.15 Depress the accelerator.

5.2.20.16 Energize the vehicle. If the vehicle moves under power, complete a Non-Conformance Report and notify the Supplier in accordance with Section 5.2.

5.2.20.17 If the vehicle did not move in any of Section 5.2.20.1 through 5.2.20.16, circle "Yes" in Appendix A for Section 5.2.20.

5.2.21 Verify charge cord interlock as follows:

5.2.21.1 With the charge cord inserted and the drive selector in the "PARK" position, attempt to energize the vehicle, select "DRIVE" and move the vehicle under power.

5.2.21.2 If the vehicle moves under power, complete a Non-Conformance Report and notify the Supplier in accordance with Section 5.2.

5.2.21.3 Repeat Section 5.2.21.1 selecting "REVERSE" and attempting to move the vehicle under power.

5.2.21.4 If the vehicle moves under power, complete a Non-Conformance Report and notify the Supplier in accordance with Section 5.2.

5.2.21.5 If the vehicle did not move in any of Sections 5.2.21.1 through 5.2.21.4, circle "Yes" in Appendix A for Section 5.2.21.

5.2.22 Verify the RESS charger is capable of recharging the RESS to a state of full charge from any possible state of discharge in less than 12 hours by completing procedure AVTA-PHTP10, Section 6.4. Testing shall be initiated following completion of a 45 mph Constant Speed Range Test conducted in accordance with procedure AVTA-PHTP04.

5.2.23 Verify automatic charger termination in accordance with procedure AVTA-PHTP10.

5.2.24 Verify charger input parameters in accordance with procedure AVTA-PHTP10.

5.2.25 A Test Engineer qualified in accordance with procedure AVTA-PHAC05 to review UL 2202 and UL2231 shall review the charger and charger data submittal to determine conformance with the personnel protection requirement. If access is available to the UL file for the onboard charger, this file may alternatively be examined for conformance to UL2202 and 2231.

5.2.26 Verify charger power quality in accordance with procedure AVTA-PHTP10.

Appendix A – Vehicle Minimum Requirements Review Check List

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VIN Number: ____________________

PHTP11 Ref:	V/S Ref:	Requirement:	Requirement Met:			Initials:	Date:
5.2.1	2.1	Vehicle shall comply with Federal Motor Vehicle Safety Standards applicable on the date of manufacture. Such compliance shall be certified by the Supplier in accordance with 49 CFR 567.	Yes	No	N/A		
5.1	2.1	Suppliers shall provide a completed copy of Appendix A and Appendix B with their proposal, providing vehicle specifications and the method of compliance with each required section of 49 CFR 571.	Yes	No	N/A		
5.1	2.1	If certification includes exemption, the exemption number issued by the National Highway Transportation Safety Administration (NHTSA), the date of it's publication in the Federal Register and the page number(s) of the Federal Register acknowledging issuance of the exemption shall be provided along with Appendix B. Exemptions for any reason other than non-applicability shall not be allowed.	Yes	No	N/A		
5.1	2.2	Vehicles shall be certified under current California Air Resources Board (CARB) or Environmental Protection Agency (EPA) regulations	Yes	No	N/A		
5.1	2.4	Suppliers shall supply Material Safety Data Sheets (MSDS) for all unique hazardous materials supplied with the vehicle	Yes	No	N/A		
5.1	2.5	Suppliers shall provide recycling plans for batteries and other vehicle hazardous materials including how the plan has been implemented.	Yes	No	N/A		
5.2.2	2.6	All vehicles shall comply with the FCC requirements for unintentional emitted electromagnetic radiation, as identified in 47 CFR 15, Subpart B, "Unintentional Radiators."	Yes	No	N/A		
5.2.3	3.1	Vehicle shall have a minimum payload of 400 pounds.	Yes	No	N/A		
5.2.4	3.2	For conversion vehicles, OEM GVWR shall not be increased.	Yes	No	N/A		
5.1		Suppliers shall specify the OEMs GVWR.	Yes	No	N/A		
5.2.4	3.3	For conversion vehicles, OEM Gross Vehicle Axle Weight Ratings (GAWR) shall not be increased.	Yes	No	N/A		
5.1		Suppliers shall provide axle weights for the vehicle as delivered, and at full rated payload.					

Appendix A – Vehicle Minimum Requirements Review Check List
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VIN Number: ____________________

PHTP11 Ref:	V/S Ref:	Requirement:	Requirement Met:			Initials:	Date:
	3.6	Tires shall be subject to the following requirements:					
5.1		• Tires provided with the vehicle shall be the standard tire offered by the PHEV Supplier for the vehicle being proposed.	Yes	No	N/A		
5.2.5		• Tires shall correspond to the requirements of the placard installed in accordance with 49 CFR 571.109, 110, 119 and 120, as applicable.	Yes	No	N/A		
5.1		• Suppliers shall specify manufacturer, model and size of the standard tire.	Yes	No	N/A		
5.2.5		• Tires sizes and inflation pressures shall be in accordance with the requirements of the placard.	Yes	No	N/A		
5.2.5		• At no time shall the tire's inflation pressure exceed the maximum pressure imprinted upon that tire's sidewall.	Yes	No	N/A		
5.2.5		• The tire shall be operable across the entire operation/load range of that vehicle.	Yes	No	N/A		
5.2.5		• Replacement tires shall be commercially available to the end user in sufficient quantities to support the purchaser's needs.	Yes	No	N/A		
5.2.5		• Tires provided as original equipment by the PHEV manufacturer shall not have warranty restrictions in excess of those of the tire's manufacturer, unless the Supplier is the sole warrantor for the tires.	Yes	No	N/A		
5.1		• If the vehicle may be equipped with more than one standard tire, this information shall be provided for each type/manufacturer of each standard tire.	Yes	No	N/A		

Appendix A – Vehicle Minimum Requirements Review Check List
(Page 3 of 8)

VIN Number: ____________________

PHTP11 Ref:	V/S Ref:	Requirement:	Requirement Met:			Initials:	Date:
5.1	4.1	Seating capacity shall be a minimum of 1 driver and 1 passenger. Suppliers shall specify seating capacity (available seat belt positions) for their vehicle.	Yes	No	N/A		
5.1	4.1	For conversion vehicles, if the vehicle's seating capacity is changed from that specified by the OEM on their FMVSS placard, the seat(s) being added or abandoned shall be modified as required by 49 CFR 571.207, et al, and a new FMVSS placard installed as required by 49 CFR 567, 568 or 571, as applicable.	Yes	No	N/A		
5.2.6	4.2	For conversion vehicles, the OEM passenger space shall not be intruded upon by the Rechargeable Energy Storage System (RESS) or other conversion materials.	Yes	No	N/A		
5.1	5.1	The vehicle shall have a parking mechanism	Yes	No	N/A		
5.2.7	5.4	The RESS battery discharge voltage shall be limited to prevent degradation of battery life.	Yes	No	N/A		
5.2.8	5.6	Vehicles shall comply with the requirements of 49 CFR 571.105.S5.2.1, or alternatively, 49 CFR 571.105.S5.2.2 for parking mechanisms.	Yes	No	N/A		
5.2.9	6.5	Vehicles shall be capable of completing procedure AVTA-PHTP05, including (1) driving through standing water without damage and without battery to chassis leakage current exceeding 0.5MIU per UL Standard 2002 and (2) standing for extended periods in extreme temperatures without damage to or failure of the vehicle or its systems.	Yes	No	N/A		
5.2.10	6.5	Vehicles shall be capable of completing all PHEV America tests without repairs exceeding a cumulative total of 72 hours.	Yes	No	N/A		
5.1	7.2	Batteries shall comply with the requirements of SAE J1718.	Yes	No	N/A		

Appendix A – Vehicle Minimum Requirements Review Check List
(Page 4 of 8)

VIN Number: ______________________

PHTP11 Ref:	V/S Ref:	Requirement:	Requirement Met:			Initials:	Date:
5.2.11	7.2	Vehicles shall not auto-start the engine to charge the batteries while the vehicle is parked and the key switch is in the OFF position.	Yes	No	N/A		
5.1	7.2	RESS batteries shall meet the requirements of NEC 625-29(c) or (d) for charging in enclosed spaces without a vent fan. The vehicle shall be labeled as not requiring ventilation for charging (or have the appropriate classification label from a UL-recognized Testing Laboratory).	Yes	No	N/A		
5.1	7.5	For vehicles with RESS nominal system voltages of 48 volts and higher, batteries or capacitors and their enclosures shall be designed and constructed in a manner that complies with 49 CFR 571.305. For vehicles with RESS nominal system voltages below 48VDC, batteries or capacitors, and their enclosures, shall be designed and constructed in accordance with the requirements of SAE J1766. Further, irrespective of RESS system voltage, batteries or capacitors, and electrolyte will not intrude into the passenger compartment during or following FMVSS frontal barrier, rear barrier and side impact collisions, and rollover requirements of 49 CFR 571.301. Suppliers shall provide verification of conformance to this requirement.	Yes	No	N/A		
5.1	7.6	Concentrations of explosive gases in the battery box shall not be allowed to exceed 25% of the Lower Explosive Limit (LEL.)Suppliers shall describe how battery boxes will be vented, to allow any battery gases to escape safely to atmosphere during and following normal or abnormal charging and operation of the vehicle.	Yes	No	N/A		
5.1		Battery gases shall not be allowed to enter the occupant compartment.	Yes	No	N/A		
5.2.12	7.6	Batteries shall meet the requirements of NEC 625-29(c) or (d) for charging in enclosed spaces without a vent fan.	Yes	No	N/A		

Appendix A – Vehicle Minimum Requirements Review Check List
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VIN Number: ______________________

PHTP11 Ref:	V/S Ref:	Requirement:	Requirement Met:			Initials:	Date:
5.1	7.7	If a Supplier provides a vehicle with parallel battery packs, the Supplier shall provide detailed information on the equipment and charging algorithms required to prevent the parallel strings from becoming unbalanced.	Yes	No	N/A		
5.1	7.10	Suppliers shall provide the battery warranty to the end user, including the procedures for making a warranty claim.	Yes	No	N/A		
5.1	7.11	If a BMS is provided, the Supplier shall provide a description of the BMS operation.	Yes	No	N/A		
5.1	7.12	For vehicles using fuels other than gasoline, manufacturers shall indicate compliance with appropriate and applicable standards from SAE, NFPA, etc. [e.g., for vehicles using Compressed Natural Gas as fuel, manufacturers should indicate compliance with NFPA 52, 49 CFR 571.303 &304.	Yes	No	N/A		
5.1	7.13	Rechargeable Energy Storage Systems (RESS) shall be battery or capacitor-based as defined in SAE J1711.	Yes	No	N/A		
5.2.13	8.1	Vehicles shall not contain exposed conductors, terminals, contact blocks or devices of any type that create the potential for personnel to be exposed to 60 volts or greater (the distinction between low-voltage and high voltage, as specified in SAE J1127, J1128, et al.).	Yes	No	N/A		
5.2.14	8.1	Access to any high voltage components shall require the removal of at least one bolt, screw, or latch.	Yes	No	N/A		
5.2.14	8.1	Devices considered to be high voltage components shall be clearly marked as HIGH VOLTAGE. These markings should be installed at any point the voltage can be accessed by the end user.	Yes	No	N/A		
5.2.15	8.1	Cable and wire marking shall consist of orange wire and/or orange sleeving as identified in SAE-J1127.	Yes	No	N/A		

Appendix A – Vehicle Minimum Requirements Review Check List
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VIN Number: _____________________

PHTP11 Ref:	V/S Ref:	Requirement:	Requirement Met:			Initials:	Date:
5.2.16	8.2	For propulsion power systems with voltages, which may equal or exceed 60 VDC, the system shall be isolated from the vehicle chassis such that leakage current does not exceed 0.5 MIU.	Yes	No	N/A		
5.2.17	8.2	Charging circuits for RESS battery systems with voltages, which may equal or exceed 60 VDC, shall be isolated from the vehicle chassis such that ground current from the grounded chassis does not exceed 5 mA at any time the vehicle is connected to an off-board power supply.	Yes	No	N/A		
5.1	8.3	The automatic disconnect for the RESS batteries shall be capable of interrupting maximum rated controller/inverter current	Yes	No	N/A		
5.1		The Supplier shall describe the automatic disconnect provided for the main propulsion batteries.	Yes	No	N/A		
5.2.21	8.4	The vehicle shall be prevented from being driven with the key turned on and the drive selector in the drive or reverse position while the vehicle's charge cord is attached.	Yes	No	N/A		
		The following interlocks shall be present:					
5.2.18		• The controller shall not initially energize to move the vehicle with the gear selector in any position other than "PARK" or "NEUTRAL."	Yes	No	N/A		
5.2.19		• The start key shall be removable only when the "ignition switch" is in the "OFF" position, with the drive selector in "PARK."	Yes	No	N/A		
5.2.20		• With a pre-existing accelerator input, the controller shall not energize or excite such that the vehicle can move under its own power from this condition.	Yes	No	N/A		
5.2.22	9.1	The grid-connected charger shall be capable of recharging the RESS to a state of full charge from any possible state of discharge in less than 12 hours, at temperatures noted in PHEV Vehicle Specification Section 5.5, as applicable.	Yes	No	N/A		

Appendix A – Vehicle Minimum Requirements Review Check List
(Page 7 of 8)

VIN Number: ____________________

PHTP11 Ref:	V/S Ref:	Requirement:	Requirement Met:			Initials:	Date:
5.2.23	9.1	The charger shall be fully automatic, determining when "end of charge" conditions are met and transitioning into a mode that maintains the main propulsion battery at a full state of charge while not overcharging it, if continuously left on charge.	Yes	No	N/A		
5.2.24	9.2	The RESS charger shall be onboard the vehicle and shall be powered from 120V or 208/240V single-phase 60-Hertz alternating current, with an input voltage tolerance of ±10% of rated voltage.	Yes	No	N/A		
5.2.24	9.2	Input current for chargers operating at 120V shall be compatible with 15-ampere circuit breakers. Input current for chargers operating at 208V/240V shall be compatible with 40-ampere circuit breakers.	Yes	No	N/A		
5.2.25	9.2	Personnel protection systems shall be in accordance with the applicable sections of UL2231-1 and 2231-2. Equipment external to the vehicle shall comply with NEC 625.	Yes	No	N/A		
5.2.26	9.3	The RESS charger shall have a true power factor of 0.95 or greater and a harmonic current distortion of ≤ 20% (at rated load).	Yes	No	N/A		
5.1	10.0	Suppliers shall specify all optional equipment required to meet the requirements of the PHEV Vehicle Specification.	Yes	No	N/A		
5.1		The installation of options shall not relieve Suppliers of meeting other "shall" requirements.	Yes	No	N/A		
5.1	11.1	Vehicles shall be accompanied by non-proprietary manuals for parts, service, operation and maintenance, interconnection wiring diagrams and schematics.	Yes	No	N/A		

Appendix A – Vehicle Minimum Requirements Review Check List
(Page 8 of 8)

VIN Number: ______________________

General Comments (initials/date):		
Completed By:		
(Printed Name)	(Signature)	(Date)
Reviewed By:		
(Printed Name)	(Signature)	(Date)
Approved By:		
(Printed Name)	(Signature)	(Date)

Appendix B – Vehicle Non-Conformance Form (Page 1 of 1)

PHEV **NON-CONFORMANCE REPORT** *(PLEASE PRINT USING A PEN OR TYPEWRITER)*	NCR Number:

DESCRIPTION OF NONCOMPLIANCE:

____
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REFERENCES:			STEP DISCOVERED IN NONCOMPLIANCE:
DISCOVERY DATE:	TIME:	Vehicle VIN:	
ORIGINATOR'S NAME: (Printed) (Signature)		DATE:	TIME:
TEST MANAGER'S NAME: (Printed) (Signature)		DATE:	TIME:
MANUFACTURER'S REPRESENTATIVE'S NAME: (Printed) (Signature)		DATE:	TIME:

DISPOSITION

DESCRIPTION OF RESOLUTION (INCLUDE THE ACTIONS TAKEN TO BRING THE VEHICLE INTO PROGRAM REQUIREMENTS):

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MANUFACTURER'S REPRESENTATIVE'S NAME: (Printed) (Signature)	DATE:	TIME:
TEST MANAGER'S NAME: (Printed) (Signature)	DATE:	TIME:

Section XIII: AVTA-PHTP12 – Evaluation of Plug-in Hybrid Electric Vehicle Energy Management System(s) [EMS]

TABLE OF CONTENTS

APPENDICES

1 Objective

This procedure provides a consistent method for the evaluation of the performance of the RESS Energy Management System (EMS) of vehicles evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA).

2 Purpose

The purpose of this procedure is to provide a qualitative method for the collection and evaluation of EMS data and observations**.** This activity is meant to quantify results obtained from the operation of the EMS during conduct of AVTA testing. Although it is necessary to test and monitor vehicle performance to ensure the successful operation of the EMS, vehicle tests are addressed by other test procedures. This testing and data acquisition meets the requirements specified in the PHEV Vehicle Specification specific to the EMS.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation shall contain enough information to “stand alone”; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Prerequisites

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05 and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 Any deviation from the test procedure and the reason for the deviation shall be approved in advance by the Program Manager or Test Manager in accordance with procedure AVTA-PHAC02 and so noted on the appropriate data sheet(s).

4.3 Necessary recording equipment shall be installed in a manner that does not hinder vehicle operation or alter the operating characteristics of the vehicle.

5 Measurement of Energy Monitoring System (EMS) Performance

This procedure is designed as a non-intrusive, qualitative evaluation tool to assist the Test Manager in determining if the EMS is operating correctly. Based upon the Supplier’s submittal, the vehicle will be assumed to contain an EMS unless otherwise noted. The EMS (if installed) shall be evaluated to ensure it is capable of properly maintaining the Rechargeable Energy Storage System (RESS).

The vehicle should be equipped with an RESS EMS. This system should control RESS voltages, temperatures and state of charge. Further, the EMS should automatically limit RESS discharge below a pre-determined minimum level. The charger system should include equipment to maintain each component in the RESS at equal temperature and within the allowed temperature range of the RESS throughout each charge-discharge cycle.

There are several methods of verifying the EMS is operating correctly. Record all comments made on a copy of Appendix A, and include in the Test Report.

5.1 Evaluation of RESS Temperature(s)

RESS temperature affects RESS capacity and life. Unequal module temperatures within the RESS can result in uneven charging and discharging and even premature failure. High RESS temperature can significantly increase charging times and reduce maximum charging rates. Indications of erratic or inconsistent RESS temperatures may be a sign that the EMS is not operating correctly. This condition warrants further discussion with the vehicle Supplier.

5.2 Evaluation of RESS Performance on Charge

The ability of a RESS to recharge in a consistent manner (based upon temperature, State of Charge (SOC), etc.) can be used to identify problems with the RESS or the EMS. RESS charging in a consistent manner following similar discharges indicate the EMS and the RESS are operating appropriately. Inconsistent recharge times, relatively short or long charge times, or erratic performance during or following a charge, are indications the RESS or EMS may not be operating properly. This condition warrants further discussion with the vehicle Supplier.

5.3 Evaluation of RESS Performance on Discharge

The ability of a RESS to discharge in a consistent manner (based upon temperature, SOC, etc.) can be used to identify problems with the RESS or the EMS. RESS discharging in a consistent manner following full charges indicate the EMS and the RESS are operating appropriately. Inconsistent discharge capabilities (as measured by kWh or Ah out), high or low RESS temperatures or erratic charge performance following a discharge, are indications the RESS or EMS may not be operating properly. This condition warrants further discussion with the vehicle Supplier. [Note that a faulty or disabled charger may also cause improper charging for vehicles capable of grid charging.]

5.4 Evaluation of RESS System Voltages

The EMS should control propulsion RESS pack and component voltages to preclude conditions, which may be detrimental to the RESS. Voltage, which changes rapidly on discharge, is an indication that one or more components may have failed. A sudden decrease in RESS voltage should trigger the EMS to control discharge rates. This may be evidenced by a premature loss of power or tell-tales illuminating out of sequence, or not at all. These conditions warrant further discussion with the vehicle Supplier.

5.5 Evaluation of Tell-Tales

Tell-tales are normally provided to alert the operator/driver that RESS limits are being approached. There is usually a specific sequence of illumination, starting with the illumination of an information tell-tale and culminating with the illumination of a final tell-tale concurrent with a power restriction or limiting feature (initiated by the EMS). Illumination of these tell-tales out of sequence or not at all may indicate the EMS is operating incorrectly, or the RESS is operating erratically. These conditions warrant further discussion with the vehicle Supplier.

Appendix A – Energy Management System (EMS), Comment Sheet

(Sheet 1 of 1)

VIN Number: ______________________________

Section XIV: AVTA-PHTP13 – Reserved for Future Use

Section XV: AVTA-PHTP14 – Evaluation of Plug-in Hybrid Electric Vehicle Battery Packs

TABLE OF CONTENTS

APPENDICES

1 Objective

This procedure identifies methods for evaluating the batteries of plug-in hybrid electric vehicles (PHEV) evaluated by the U.S. Department of Energy Advanced Vehicle Testing Activity (AVTA). These methods are not meant to supersede those of the testing facility, those specifically addressed by SAE Test Standards, nor of any regulatory agency which may have or exercise control over the covered activities.

2 Purpose

The purpose of this procedure is to identify acceptable methods for the implementation of the test requirements of the *FreedomCAR Battery Test Manual for Power-Assist Plug-in Hybrid Electric Vehicles*. This test establishes methods to quantitatively evaluate the capacity of the battery as well as the battery's power capability over its usable range of current and voltage. This procedure may be used at any time during the battery life to assess battery condition.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with procedure AVTA-PHAC04. Storage and retention of records during and following testing activities shall be completed as described in procedure AVTA-PHAC01.

4 Initial Conditions and Prerequisites

Prior to conduct of any portion of the testing, the following initial conditions and prerequisites shall be met. Satisfactory completion of these items shall be verified as complete and recorded on the appropriate Test Data Sheet.

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, shall be trained in accordance with the requirements of procedure AVTA-PHAC05 and be certified by the Program Manager or the Test Manager prior to commencing any testing activities.

4.2 Tests shall be conducted a temperature of 77°F ± 9°F (25˚C ± 5˚C).

4.3 Vehicles should have completed test procedure AVTA-PHTP03 and the current data should be available for analysis.

4.4 The tests and conditions outlined in Section 5 are based on the manufacturer's specifications of the battery pack. Hence, the following information must be obtained from the manufacturer:

4.4.1 Battery capacity at the C1 rate (i.e., the capacity of the battery when discharged at the 1 hour rate)

4.4.2 The end-of-discharge voltage (EODV) when performing a test discharge at the C_1 rate

4.4.3 EODV during the hybrid pulse-power characterization (HPPC, see Section 5.4, below) schedule

4.4.4 Top-of-charge voltage (TOCV) limit when charging the battery after a C_1 discharge

4.4.5 TOCV when charging after a discharge pulse within the HPPC (see Section 5.4 below) schedule.

4.5 The following data shall be collected during conduct of the various tests specified by this procedure. Overall error in recording or indicating instruments shall not exceed ±2% of the maximum value of the variable being measured. Periodic calibration shall be performed and documented to ensure compliance with this requirement.

4.5.1 Rechargeable Energy Storage System (RESS) voltage versus time

4.5.2 RESS current versus time

4.5.3 RESS watts versus time

4.5.4 RESS amp-hours versus time

4.5.5 RESS temperature versus time

4.5.6 Ambient temperature versus time.

4.6 All protocols, procedures and attendant documentation required to conduct this testing shall be completed, approved and issued prior to commencing the testing it addresses.

4.7 Any deviation from the test procedure and the reason for the deviation shall be approved in advance by the Program Manager or Test Manager in accordance with procedure AVTA-PHAC02 and so noted on the appropriate data sheet(s).

5 Testing Activity Requirements

Battery testing shall be conducted at the beginning of vehicle life and at the end of vehicle accelerated testing in accordance with procedure AVTA-PHTP01. Beginning and end of life tests shall be presented and compared in accordance with Sections 5.6 and 5.7.

NOTE:
Vehicle Supplier and battery manufacturer limits on battery performance shall not be violated during testing.

5.1 General Test Conditions

5.1.1 Units of charge and discharge

The charge and discharge of batteries in all test profiles will be based on current. Negative current will correspond to a charge and a positive current will relate to a discharge.

5.1.2 Ambient temperature control

The ambient temperature for all testing shall be controlled at a nominal temperature of 77°F ± 9°F (25˚C ± 5˚C). All tests shall be preceded by an eight-hour soak at this temperature.

5.1.3 Battery temperature control

The battery temperature must be monitored and test stopped if the battery temperature rises above the manufacturer recommended maximum charging temperature. If no maximum charging temperature is available, a reasonable temperature for the type of battery being charged shall be chosen. It is recommended to cause air to flow across or through the battery pack as is typically done by the vehicle during normal driving.

5.1.4 Scaling

The goal of the procedure is to test complete packs of batteries from PHEVs. If a full battery pack is not available or impractical to test, the power required for a charge or discharge will be scaled according to the number of modules, so that individual modules experience the same duty as modules in a full battery pack.

5.2 Battery Charging

The conditions for battery charging shall be defined using the manufacturer's recommended procedure. If no manufacturer specifications are available, the battery will be recharged based on literature data specific to the battery technology under test.

5.2.1 Charging procedure

5.2.1.1 Charge the RESS battery to a 100% Initial State of Charge using the grid-connected charger in accordance with procedure AVTA-PHTP08.

5.2.1.2 Record the number of ampere-hours (Ah) returned and the top of charge voltage in Appendix A.

5.3 Static Capacity Test

This test measures the capacity of the battery pack in Ahs at a constant discharge rate that corresponds to the manufacturers rated C1 capacity (i.e., if the rated C1 is 10 Ah, the discharge current will be 10 A). If no capacity is available, a C1 discharge current shall be estimated based on the weight, volume, and typical energy density of the specific technology under test. Discharge is terminated when the battery voltage has decreased to the manufacturer's specified discharge voltage limit. If the manufacturer does not supply a value, a limit shall be derived from literature data specific to the battery technology under test. Battery capacity and discharge voltage limit shall be recorded in Appendix A.

It should be noted that while the C1 capacity does not necessarily reflect the performance of the battery pack under plug-in hybrid vehicle conditions, it does provide baseline data on battery change/degradation during battery lifetime.

A Static Capacity Test is to be conducted prior to each set of hybrid pulse-power characterization measurements.

5.3.1 Capacity test sequence

5.3.1.1 The battery shall be charged to 100% Initial State of Charge in accordance with 5.2.1. Upon completion of charging, the battery shall be allowed to soak for at least 8 hours at 77°F ± 9°F (25˚C ± 5˚C).

5.3.1.2 Ah replaced shall be recorded in Appendix A.

5.3.1.3 After the soak, the battery shall be discharged at a constant C1 current until the minimum discharge voltage is reached.

5.3.1.4 Ah removed shall be recorded in Appendix A.

5.3.1.5 Repeat steps 5.3.1.1 through 5.3.1.4 until the Ah removed from three consecutive capacity cycles are within 3% of the lowest Ahs removed.

5.3.1.6 If the number of cycles exceeds 8 before three consecutive cycles are within 3%, stop the test to evaluate the cause of divergence.

5.3.1.7 Record the average Ah removed of the three consecutive capacity cycles within 3% as the capacity of the battery in Appendix A.

5.4 Hybrid Pulse-Power Characterization Test

Use of the hybrid pulse-power characterization (HPPC) test is intended to provide an estimate of the power capability (charge and discharge) of a specific battery in a specific vehicle under normal driving conditions.

The primary objective of this test is to establish, as a function of depth of discharge (DOD), the following:

i) the V_{min} discharge power capability at the end of a 10 second discharge current pulse

ii) the V_{max} regeneration power capability at the end of a 10 second regeneration current pulse.

5.4.1 Hybrid pulse-power characterization test profile

The objective of this profile is to demonstrate the discharge pulse and regeneration pulse power capabilities at various DOD. The HPPC test profile uses a 10 second constant-current discharge pulse, followed by a 40 second rest at open circuit, followed by a 10 second constant-current charge pulse.

5.4.1.1 The first 10 second pulse is termed Idismax and the second 10 second pulse is referred to as Ichmax. These values are 5 times the C1 capacity of the battery.

5.4.1.2 The HPPC cycle profile is shown in Table 1 and Figure 1, and is referred to as the HPPC test profile (note, the discharge and charge currents are positive and negative, respectively).

Table 1 - HPPC test profile

Time Increment (s)	Cumulative Time (s)	Current
10	10	I_{dismax}
40	50	0
10	60	I_{chmax}

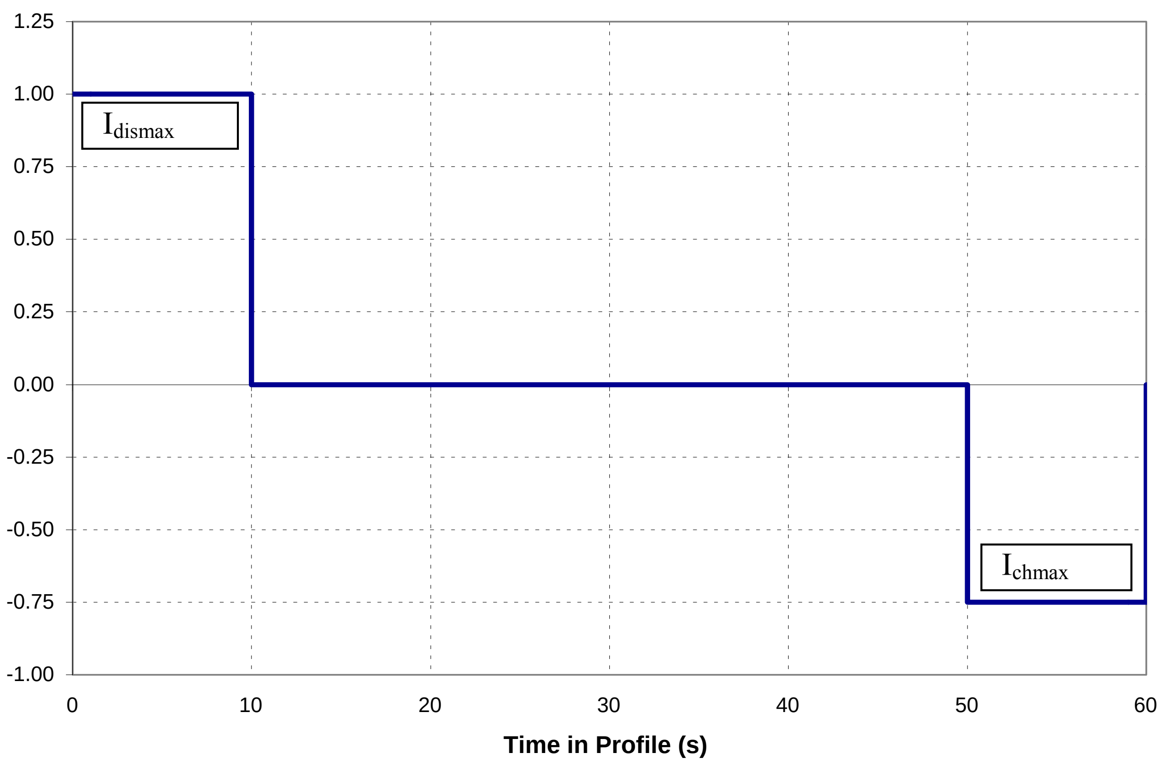


Figure 1 - HPPC test profile

[Courtesy of US Department of Energy FreedomCAR Battery Test Manual}

5.4.2 HPPC test procedure

The HPPC test procedure incorporates the HPPC test profile as defined in Section 5.4.1. This procedure incorporates constant-current steps based on I_{dismax} and I_{chmax}. The complete test procedure is made of single repetitions of the HPPC test profile, separated by 10% DOD constant-current C_1 discharge segments[4], with each of these C_1 discharge segments followed by a 1 hour rest period to allow the cells to return to an electrochemical and thermal equilibrium condition. C_1 discharge segments followed by a 1 hour rest period to allow the cells to return to an electrochemical and thermal equilibrium condition. The test begins with a full cycle of the battery followed by a 1 hour rest, and terminates with the final repetition of the HPPC test profile to 90% DOD, followed by a complete discharge to 100% DOD then a 1 hour rest at open circuit[5]. The test will also terminate when the battery voltage reaches the pre-determined V_{min} during a C1 discharge. If at any point during an I_{dismax} pulse the battery voltage drops to V_{min}, the battery will be held at that voltage until the discharge pulse is complete and the HPPC test profile will continue.

The voltages during each rest period at open circuit are recorded to establish the cell's open-circuit voltage (OCV) behavior. The sequence of rest periods, pulse profiles, and C_1 discharge segments are illustrated in Figures 2 and 3. These figures also illustrate a C_1 cycle to be executed just prior to conduct of the HPPC procedure.

[4] The energy of the pulse profile must be accounted for in determining the actual state-of-charge (SOC) at which the profile was performed. The profile in Table 1 may remove several percent of the capacity from a typical device. The test should be programmed such that 10% of the rate capacity is removed in each test segment, including that removed by the pulse power profile itself.

[5] Note that the manufacturer's limits must be observed during all test procedures. If the discharge voltage limit is reached during the actual pulse profiles, stop the pulse but continue through to the end of the test allowing the each pulse to occur until the limit is reached

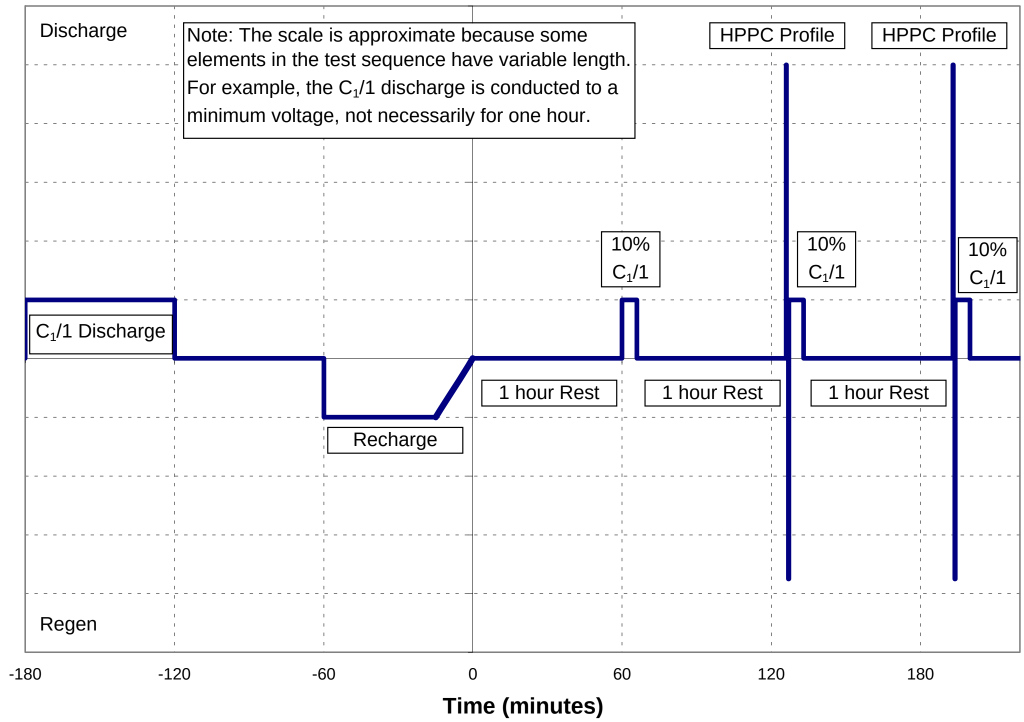


Figure 2 - HPPC test profile (start of procedure only)

[Courtesy of US Department of Energy FreedomCAR Battery Test Manual]

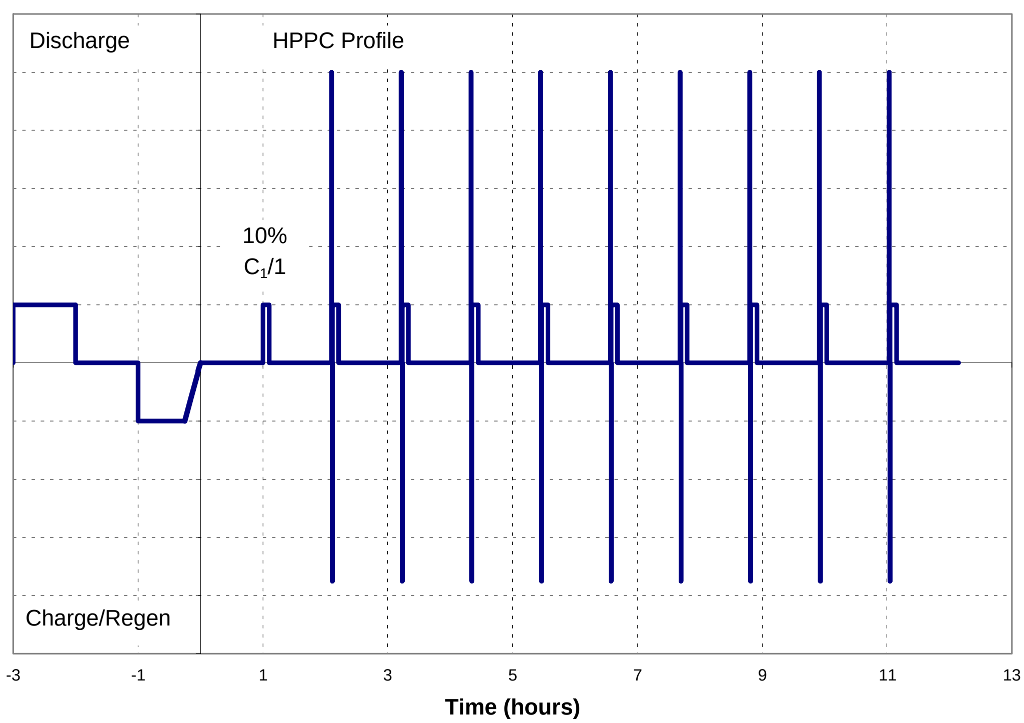


Figure 3 - HPPC test profile (complete HPPC procedure)

[Courtesy of US Department of Energy FreedomCAR Battery Test Manual]

5.4.2.1 Begin the HPPC test by discharging the battery at the C1 rate until it reaches 100% DOD or the minimum voltage is achieved.

5.4.2.2 Charge the battery with the charge profile (see Section 5.2).

5.4.2.3 Allow the battery to rest for one hour.

5.4.2.4 Discharge the battery at the C1 rate until it reaches 10% DOD.

5.4.2.5 Allow the battery to rest for one hour.

5.4.2.6 Discharge the battery at the maximum discharge rate for ten seconds.

5.4.2.7 Allow the battery to rest for forty seconds.

5.4.2.8 Charge the battery at the maximum charge rate for ten seconds.

5.4.2.9 Discharge the battery at the C1 rate until it reaches 20% DOD.

5.4.2.10 Allow the battery to rest for one hour.

5.4.2.11 Discharge the battery at the maximum discharge rate for ten seconds.

5.4.2.12 Allow the battery to rest for forty seconds.

5.4.2.13 Charge the battery at the maximum charge rate for ten seconds.

5.4.2.14 Discharge the battery at the C1 rate until it reaches 30% DOD.

5.4.2.15 Allow the battery to rest for one hour.

5.4.2.16 Discharge the battery at the maximum discharge rate for ten seconds.

5.4.2.17 Allow the battery to rest for forty seconds.

5.4.2.18 Charge the battery at the maximum charge rate for ten seconds.

5.4.2.19 Discharge the battery at the C1 rate until it reaches 40% DOD.

5.4.2.20 Allow the battery to rest for one hour.

5.4.2.21 Discharge the battery at the maximum discharge rate for ten seconds.

5.4.2.22 Allow the battery to rest for forty seconds.

5.4.2.23 Charge the battery at the maximum charge rate for ten seconds.

5.4.2.24 Discharge the battery at the C1 rate until it reaches 50% DOD.

5.4.2.25 Allow the battery to rest for one hour.

5.4.2.26 Discharge the battery at the maximum discharge rate for ten seconds.

5.4.2.27 Allow the battery to rest for forty seconds.

5.4.2.28 Charge the battery at the maximum charge rate for ten seconds.

5.4.2.29 Discharge the battery at the C1 rate until it reaches 60% DOD.

5.4.2.30 Allow the battery to rest for one hour.

5.4.2.31 Discharge the battery at the maximum discharge rate for ten seconds.

5.4.2.32 Allow the battery to rest for forty seconds.

5.4.2.33 Charge the battery at the maximum charge rate for ten seconds.

5.4.2.34 Discharge the battery at the C1 rate until it reaches 70% DOD.

5.4.2.35 Allow the battery to rest for one hour.

5.4.2.36 Discharge the battery at the maximum discharge rate for ten seconds.

5.4.2.37 Allow the battery to rest for forty seconds.

5.4.2.38 Charge the battery at the maximum charge rate for ten seconds.

5.4.2.39 Discharge the battery at the C1 rate until it reaches 80% DOD.

5.4.2.40 Allow the battery to rest for one hour.

5.4.2.41 Discharge the battery at the maximum discharge rate for ten seconds.

5.4.2.42 Allow the battery to rest for forty seconds.

5.4.2.43 Charge the battery at the maximum charge rate for ten seconds.

5.4.2.44 Discharge the battery at the C1 rate until it reaches 90% DOD.

5.4.2.45 Allow the battery to rest for one hour.

5.4.2.46 Discharge the battery at the maximum discharge rate for ten seconds.

5.4.2.47 Allow the battery to rest for forty seconds.

5.4.2.48 Charge the battery at the maximum charge rate for ten seconds.

5.4.2.49 Discharge the battery at the C1 rate until it reaches 100% DOD.

5.4.2.50 Allow the battery to rest for one hour.

5.4.2.51 Charge the battery with the charge profile (see Section 5.2).

5.4.2.52 In Appendix A record the following:

5.4.2.52.1 SOC at which the maximum charge voltage was reached, if applicable

5.4.2.52.2 SOC at which the minimum discharge voltage was reached, if applicable

5.4.2.52.3 SOC at which the test was terminated.

5.4.2.53 Save all data files.

5.5 Data Reduction

5.5.1 Data shall be reduced in accordance with the *FreedomCAR Battery Test Manual for Power-Assist Hybrid Electric Vehicles*.

5.5.2 A graph of available energy shall be prepared using the guidance of Appendix E of the *FreedomCAR Battery Test Manual for Power-Assist Hybrid Electric Vehicles*.

5.5.3 As the requirements of PHEV battery packs can differ markedly from vehicle model to vehicle model, the magnitude of the power pulses recorded in actual vehicle operation are calculated for comparison against the battery capability as determined by the HPPC test. The current data recorded during the dynamometer drive cycles of test procedure AVTA-PHTP03 shall be used to calculate maximum vehicle charge and discharge demand. Determine the vehicle charge and discharge demand by averaging the top 0.5% of charge data and discharge data respectively from the AC off dynamometer tests (ignoring all current data from -0.5 to + 0.5 Amps and ignoring any irregularly high data points). Repeat this step for the AC on dynamometer data sets. Use the greatest charge current among all dynamometer tests as the maximum charge demand and the greatest discharge current as maximum discharge demand.

5.6 End-Of-Life Testing

5.6.1 Repeat testing in accordance with Sections 5.3 and 5.4 at the end of vehicle accelerated testing in accordance with procedure AVTA-PHFTP01.

5.6.2 Results of end-of-life testing shall be compared to the beginning-of-life results and with the vehicle charge and discharge demand in accordance with Section 5.7.

5.7 Data Presentation

5.7.1 The results obtained from the HPPC testing shall be combined with vehicle charge and discharge demand data obtained from dynamometer testing in accordance with Section 5.5.3, and used to provide information on how battery degradation affects fuel economy over the life of the vehicle.

5.7.2 Test results shall be presented in a report, presenting beginning and end of life test results with vehicle charge and discharge demand in a format that clearly displays the margin between battery capability and vehicle demand .

Appendix A – Battery Evaluation Test Data Sheet

(Page 1 of 1)

VIN Number: _______________________

Project No.:	Test Date(s):
Data File Name:	
Test Engineer: (Initials) (Date)	

Determination of Battery C1 Capacity

Battery Cycle Log			
Battery Capacity Rating: (Amp-Hours)		Discharge Voltage Limit: (Volts)	
	Amp-Hours Replaced	Amp-Hours Removed	Comments
Cycle 1			
Cycle 2			
Cycle 3			
Cycle 4			
Cycle 5			
Cycle 6			
Cycle 7			
Cycle 8			
Average Amp-Hours Removed (of three consecutive cycles within 3% of lowest): (Amp-Hours)			

Determination of Plug-in Hybrid Pulse-Power Characterization

HPPC Settings			
I_{chmax}: (Amps)	I_{chmax} C Rate:	I_{dismax}: (Amps)	I_{dismax} C Rate:
Maximum Charge Voltage: (Volts)		Minimum Discharge Voltage: (Volts)	
HPPC Results			
SOC at maximum voltage limit: (% SOC)		SOC at minimum voltage limit: (% SOC)	
SOC at test termination: (% SOC)			

Appendix B – Vehicle Metrology Setup Sheets

(Page 1 of 1)

VIN Number: ________________________

Instrument/Device:	Calibration Due Date:	Initials / Date:
Battery Charger S/N:		
Temperature Measurement S/N:		
Fifth Wheel S/N:		
Fifth Wheel Calibrator S/N:		
DAS S/N:		
DAS Set-up Sheet S/N:		
kWh Meter S/N:		
Shunt S/N:		
Tire Pressure Gauge S/N:		
Fuel Scale S/N:		
Misc:		
Misc:		

Comments (initials/date):

Completed By:

(Printed Name) (Signature) (Date)

Reviewed By (QA):

(Printed Name) (Signature) (Date)

Approved By:

(Printed Name) (Signature) (Date)

Chapter V: Accelerated Test Procedures

Section I: AVTA-PHATP01 – Plug-in Hybrid Electric Vehicle Accelerated Test Procedure

TABLE OF CONTENTS

APPENDICES

1 Objectives

The objective of this procedure is to provide guidance for the conduct of accelerated onroad testing of plug-in hybrid electric vehicles (PHEV), the collection of operating data from these vehicles and the analysis of this data to provide evaluation of PHEV operation. This procedure also provides guidance for the preparation of Fleet Data Sheets summarizing vehicle performance for use by the U.S. Department of Energy Advanced Vehicle Test Activity (AVTA).

2 Purpose

The purpose of this procedure is to identify acceptable and repeatable methods for accelerated onroad testing of PHEVs.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation.

4 Test Conduct

PHEVs selected for evaluation by the AVTA shall be operated over established routes using drivers dedicated to test conduct. Test data shall be collected as specified in Section 5.

4.1 Test Objectives

Specific test objectives shall be established for each vehicle participating in accelerated testing. These objectives shall define, as a minimum, operating environment, charging infrastructure and supplemental data collection requirements.

4.2 Test Routes

An urban route and a highway route shall be selected which are each nominally ten miles in length. The urban route shall include the following characteristics:

- Maximum speed of 45 mph
- At least eight traffic control devices which require a full stop
- No uninterrupted drive distances greater than 1.5 mile.

The highway route shall include the following characteristics:

- Maximum speed of 75 mph
- Minimum speed of 45 mph

- No more than two traffic control devices which require a full stop.

These routes, in various combinations as defined in Section 4.3, shall be used for all accelerated testing. Vehicles shall be operated on these routes as consistently as road conditions allow, including such parameters as speed, acceleration rates and accessory use.

4.3 Test Sequence

Vehicles shall be operated over the routes defined in Section 4.2 using the test sequence presented in Appendix A. Testing shall be conducted sequentially (i.e. complete all 10 mile tests then complete all 20 mile tests, etc.).

4.4 Insurance Requirements

Before a vehicle begins testing, insurance shall be placed. The limits of liability shall be no less than $300,000 per occurrence with a $500,000 aggregate limit.

4.5 Driver Training

Drivers with the following qualifications shall be used for accelerated testing:

- Licensed to drive in the state where testing will be conducted
- No moving violations for the past two years
- Demonstrated reliability.

Drivers shall be trained prior to their participating in test conduct in accordance with procedure AVTA-PHAC05. Training shall include test objectives, proper operation of the test vehicle, charging requirements, and data collection requirements.

4.6 Vehicle Fueling Infrastructure

All vehicle fueling infrastructure shall be in place and operational prior to commencement of vehicle testing. Grid connections shall be assigned to a single vehicle and shall be metered. Whenever possible the same gasoline dispenser shall be used to fuel the test vehicle. Fueling infrastructure shall be located in sufficiently close proximity to the urban and highway test routes that no more than 10% of test miles on any test are accumulated driving to a fueling location.

5 Data Collection

Data shall be collected using a combination of electronic and manual means. Each PHEV test vehicle shall be equipped with an electronic means of auditing driver performance. All instrumentation shall be maintained in accordance with procedure AVTA-PHAC07.

5.1 Test Output Data

The following data shall be collected for each test listed in Appendix A:

- Date and time the test started and completed

- Electric energy used to recharge the vehicle
- Any anomalous conditions experienced during the test.

Fuel shall be added to the vehicle at intervals of approximately 200 miles. Fueling should be coordinated with the end of a test.

5.2 Test Summary Data

Test output data will be analyzed by the Idaho National Laboratory and posted to the AVTA website. The following data shall be presented:

- Vehicle fuel and electric energy consumption for each test cycle (e.g. 10 miles, 20 miles, etc.)
- Cumulative vehicle fuel and electric energy consumption
- Vehicle operating anomalies, if any
- Route and environmental condition description.

A sample data presentation is included in Appendix B.

Appendix A – PHEV Test Sequence

Cycle (mi)	Urban (10 mi)	Highway (10 mi)	Charge (hr)	Repititions (N)	Total (mi)	Repetitions (%)	Miles (%)	Cumulative (mi)
10	1	0	4	60	600	45%	14%	600
20	1	1	8	30	600	23%	14%	1200
40	4	0	12	5	200	4%	5%	1400
40	2	2	12	5	200	4%	5%	1600
40	0	4	12	5	200	4%	5%	1800
60	2	4	12	10	600	8%	14%	2400
80	2	6	12	8	640	6%	15%	3040
100	2	8	12	6	600	5%	14%	3640
200	2	18	12	3	600	2%	14%	4240
Total	1740	2500	984	132	4240			4240
Average	41%	59%	7.5	32.1				

Appendix B – Sample Data Presentation

FREEDOMCAR & VEHICLE TECHNOLOGIES PROGRAM

Plug-in Hybrid Electric Vehicle Fleet Testing
Advanced Vehicle Testing Activities

2006
EnergyCS Converted Toyota Prius Plug-in Hybrid Electric
Vehicle (PHEV)

VIN # xxxxxxxxxxxxxxxxxxxx

FreedomCAR & Fuel Partnership

A Strong Energy Portfolio for a Strong America
Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy

Fleet

Description:
This vehicle is operated by the City of San Van, California, by the Park and Recreation Department. It is generally operated six days a week, for various reasons.

Major Operations & Maintenance Events:
None

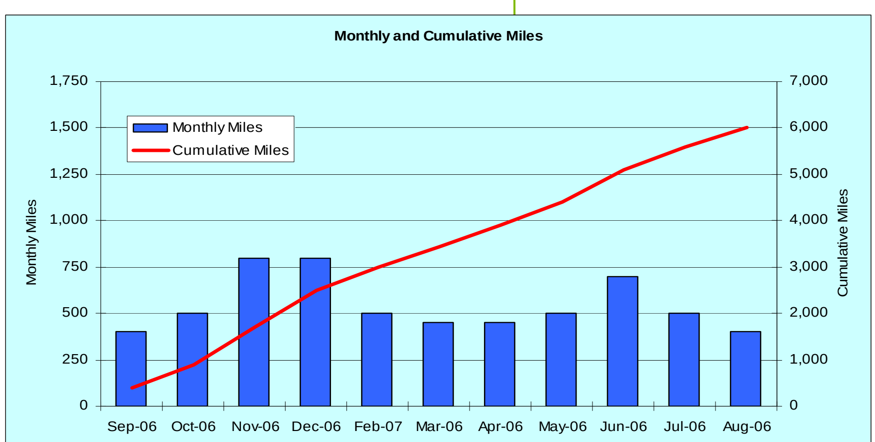
Operating Cost:
Purchase Cost: $65,000 (8/06)*
Kelly Used Vehicle Price: NA
Sale Price: In Operation
Maintenance Cost: $0.XX/mile
Operating Cost: $0.XX/mile
Total Ownership Cost: $0.XX/mile

Operating Performance:
Total miles driven: 000
Cumulative MPG: xxxxx.x
Cumulative kWh/mile: 0.xxx
Fuel cost per mile:* xxx.xxx

** Purchase includes dealer price with options*

Vehicle

Engine: 4-cylinder, 57 kW @ 5000 rpm
Electric Motor: 50 kW
Battery: **Valence** Lithium Ion 9 kWh
Seatbelt Positions: Five
Payload: 905 lbs
Features: Regenerative braking, CVT transmission



For more information contact:
EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov

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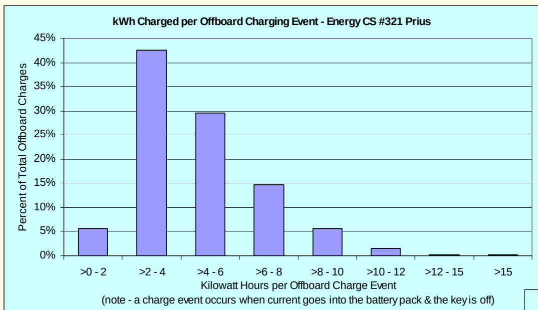
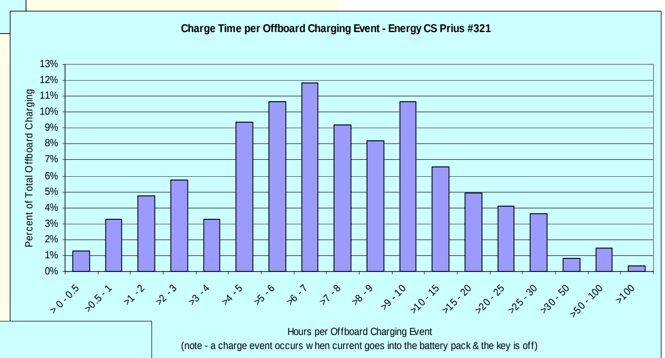
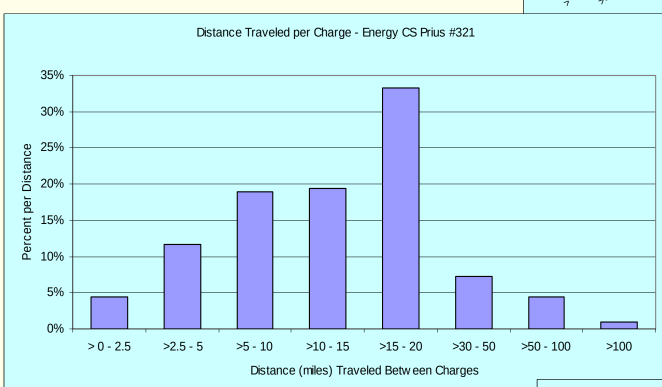
Appendix B – Sample Data Presentation (cont'd)

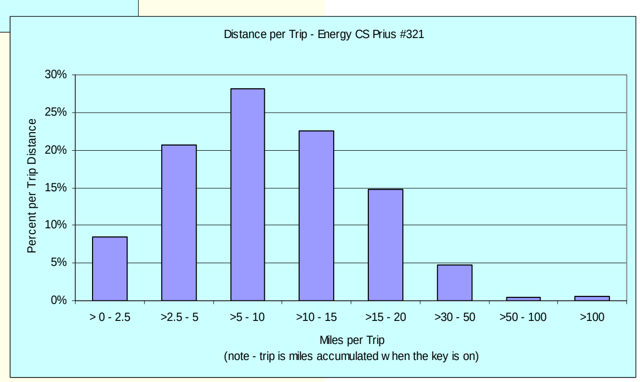
FREEDOMCAR & VEHICLE TECHNOLOGIES PROGRAM

Plug-in Hybrid Electric Vehicle Fleet Testing









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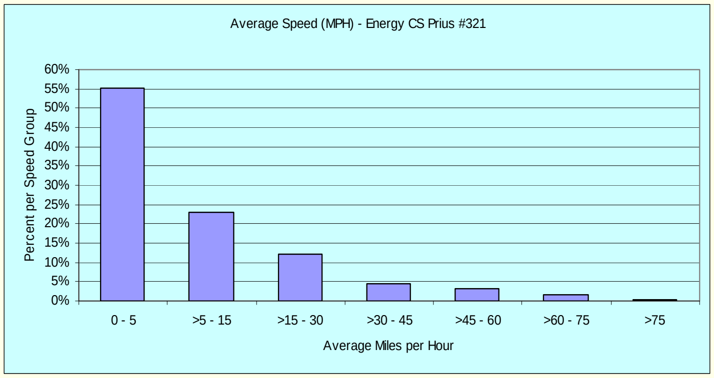
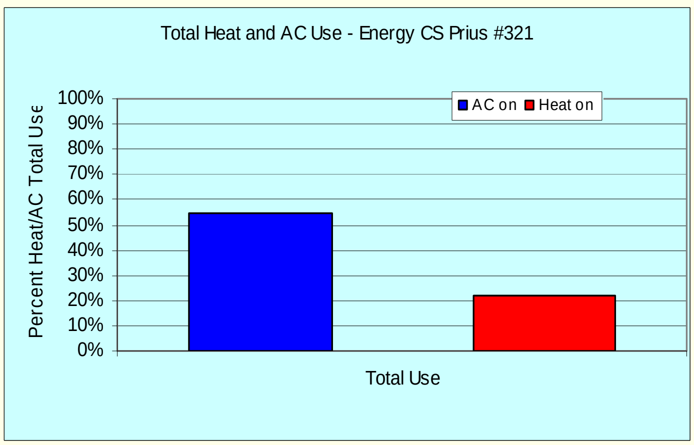
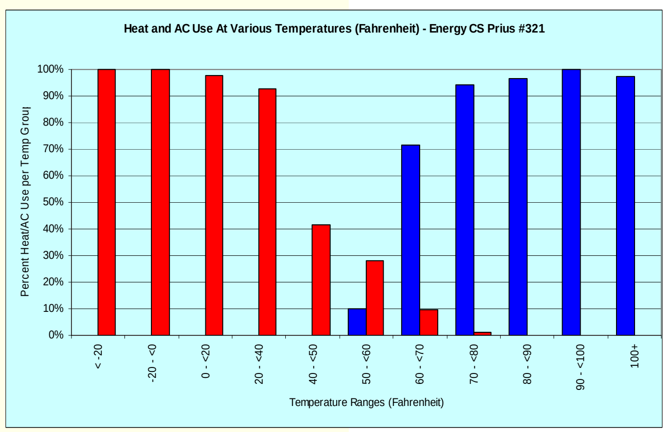
Appendix B – Sample Data Presentation (cont'd)

FREEDOMCAR & VEHICLE TECHNOLOGIES PROGRAM

Plug-in Hybrid Electric Vehicle Fleet Testing







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Chapter VI: Fleet Test Procedures

Section I: AVTA-PHFTP01 – Plug-in Hybrid Electric Vehicle Fleet Test Procedure

TABLE OF CONTENTS

1 Objectives

The objective of this procedure is to provide guidance for the establishment of plug-in hybrid electric vehicle (PHEV) evaluation fleets, the collection of operating data from these fleets and the analysis of this data. This procedure also provides guidance for the preparation of Fleet Data Sheets summarizing vehicle performance for use by the U.S. Department of Energy Advanced Vehicle Test Activity (AVTA).

2 Purpose

The purpose of this procedure is to identify acceptable and repeatable methods for the implementation of PHEV test fleets and the collection and analysis of such data.

3 Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation.

4 Fleet Selection

PHEVs selected for evaluation by the AVTA shall be operated in established fleets and their performance evaluated under fleet conditions. In order to optimize the opportunity to collect useful data, the following prerequisite conditions shall be evaluated for each vehicle and fleet prior to establishing each fleet test.

4.1 Test Diversity

To provide proper evaluation of the performance of a PHEV, care must be taken to provide diverse data for evaluation. The following diversity factors shall be considered in selecting the number of vehicles of a type to be tested and the number of fleets to be utilized to conduct such testing.

- The total miles to be accumulated in testing
- The possibility of losing a test vehicle to a traffic accident
- Operation of vehicles with various intensity (miles/month)
- Operation of vehicles in urban and highway environments
- Operation of vehicles in hot, cold and temperate climates
- Operation of vehicles over varying terrain
- Operation of vehicles in public, private and government fleets

These factors will have varying significance for each type of advanced vehicle and shall be considered for each vehicle type tested.

4.2 Vehicle Mission

Fleets shall be selected which will utilize test vehicles in missions complementing the performance capability of the vehicle. For example, testing of plug-in hybrid electric vehicles (PHEV) should be conducted in fleets having missions predominantly in urban areas and ending the day at a location equipped to support charging. The mission for each test vehicle shall be monitored on an ongoing basis to ensure that the vehicle continues to be operated within its performance capabilities. The Baseline Performance Testing data sheets, issued by the AVTA, provide such data for consideration.

4.3 Vehicle Maintenance

Vehicles shall be regularly serviced in accordance with the Supplier's maintenance schedule. Before vehicles enter test operation, arrangements shall be in place defining what service is be performed based on the Supplier's maintenance schedule, when service will be performed, what organization will provide the service, and who will pay for such service. Routine maintenance, such as oil changes and tire rotations, may be performed by the fleet's normal service provider. Specialized maintenance shall be performed by an authorized repair facility for the test vehicle. All maintenance activities shall be recorded in accordance with Section 5, regardless of whether the activity is covered by the warranty. Cost shall be recorded for all non-warranty vehicle maintenance.

4.4 Insurance Requirements

Before a vehicle begins test operation, proof of insurance of the vehicle shall be provided. Insurance may be provided by the operating fleet or by the test organization. In any case, the limits of liability shall be no less than $300,000 per occurrence with a $500,000 aggregate limit. The fleet manager shall ensure that all drivers of the test vehicle have a valid Driver's License issued from the state in which the vehicle will be operated.

4.5 Driver Training

Instructions shall be provided to the fleet manager for proper operation of the test vehicle. The fleet manager shall use their normal methods for disseminating such information to potential drivers of the test vehicle. Particular attention shall be given to the need to plug the vehicle charger into the charge infrastructure whenever possible.

4.6 Charging and Fueling Infrastructure

All vehicle charging and fueling infrastructure shall be in place and operational prior to commencement of vehicle operation. Special attention should be given to ensure that measurement of fuel and electricity used by the test vehicle is collected. The test vehicle mission shall be reviewed to verify that sufficient charging and fueling infrastructure is in place to properly support vehicle operation. Safety aspects of vehicle charging and fueling shall be established and reviewed with potential drivers of the test vehicle.

4.7 Test Objectives

Prior to test vehicle operation, the objectives of the test shall be presented to the Fleet Manager in writing. At a minimum, this shall include the following objectives:

- Test mileage per month required
- Overall test duration in miles and months
- Data requirements
- Vehicle mission requirements
- Vehicle service requirements
- Charging and fueling requirements (if any)
- Driver training requirements (if any).

5 Data Collection

Data shall be collected in accordance with the following diagram.

Driver[1] ⟶ **Fleet Manager**[2] ⟶ **Test Manager**[3] ⟶ **INL/AVTA**[4]

1 - Log sheets format or electronic data entry

2 - E-mail, or spreadsheet in electronic format

3- Spreadsheets containing the data for all fleet testing vehicles in column order VIN, license plate, monthly odometer, monthly mileage, fuel used (if applicable), number of fast charges (if applicable)

If no Fleet Manager exists for a particular test fleet, data shall be provided directly to the Test Manager.

5.1 Fleet Output Data

The following data shall be provided no less frequently than monthly by the Fleet Manager to the Test Manager:

- Odometer reading for every test vehicle
- Fuel consumption for the vehicle
- Electrical energy consumption for the vehicle
- Maintenance required and the date and cost of such maintenance
- Any unusual events vehicle operating events, particularly if the vehicle quit on the road.

The Test Manager shall endeavor to obtain complete data. However, this will often not be possible. Therefore, the Test Manager should utilize the following techniques to interpolate missing data.

- Interpolate same data linearly for missing periods.
- Infer missing data using alternate data and average proportionality (e.g. fuel used from miles driven and average fuel economy).

Care should be taken not to interpolate data over an excessive number of months or across periods when average factors may be changing (e.g. summer to winter).

5.2 Fleet Summary Data

The following data shall be provided monthly the INL/AVTA:

- Monthly mileage by vehicle
- Cumulative mileage by vehicle
- Monthly fuel economy by vehicle
- Cumulative fuel economy by vehicle
- Monthly electrical energy usage,
- Cumulative electrical energy usage,
- Monthly fleet mileage
- Cumulative fleet mileage
- Repair work by vehicle
- Maintenance cost by vehicle
- Incidents with any vehicle

6 Data Analysis

Test data should be evaluated on an ongoing basis to ensure the integrity of the fleet test. Upon completion of the fleet test, data from each test vehicle shall be summarized in the form of a data sheet.

6.1 Ongoing Data Analysis

On a monthly basis, data should be examined for reasonableness and completeness. Missing data should be investigated and a determination made if supplemental collection methods should be implemented or data should be interpolated (see Section 5.1). Supplemental collection methods, which should be considered if data is routinely missing, include the following:

- Transferring the test vehicle to a more conscientious fleet
- Follow up by the Test Manager with the Fleet Manager specific to the missing data to determine why it was missing and to develop corrective action to improve collection reliability
- Collection of data by the Test Manager or his/her representative.

It is the responsibility of the Test Manager to ensure that sufficient data is collected to accurately evaluate performance of the test vehicle.

6.2 Fleet Test Summary Data Sheet

At periodic milestones and upon completion of testing, a Fleet Test Summary Data Sheet shall be prepared for each test vehicle or group of identical vehicles operating in a single fleet. Information shall be presented in the data sheet in accordance with the following guidelines.

Description

This section of the data sheet provides a brief summary of the operating fleet characteristics. Fleet mission, location and typical trip characteristics should be presented.

Major Operations & Maintenance Events

This section of the data sheet provides a summary of major operating and maintenance events. Significant repairs and maintenance should be summarized along with their cost and vehicle mileage at the time of the repair or maintenance. If the repair or maintenance is covered by the base vehicle warranty, no cost should be shown. Rather the repair or maintenance should be noted as being covered by warranty. All onroad vehicle failures should be summarized along with the cause and mileage at which the failure occurred.

Operating Cost

This section of the data sheet provides the following cost data:

Purchase Cost - Purchase cost includes vehicle cost with options, delivery, dealer preparation costs, title fees, and taxes. It does not include annual registration and license costs or costs for extended warranties.

Maintenance Cost - Maintenance cost includes the actual cost for all non-warranty maintenance divided by the total mileage of the evaluation vehicle for the period covered by the data sheet. Work covered under extended warranties purchased to cover the evaluation vehicle shall be costed as part of maintenance cost.

Operating Cost - Operating cost includes the actual cost for all fuel, electricity, licenses and permits required to operate the vehicle divided by the total mileage of the evaluation vehicle for the period covered by the data sheet. Electricity costs shall be calculated using the kilowatt-hours consumed by the vehicle multiplied by an electric energy cost as obtained from "Electric Power Monthly" (DOE/IEA-0226) for the month is which the vehicle test concluded.

Operating Performance

This section of the data sheet summarizes the total miles driven for the period covered by the data sheet and the cumulative fuel economy (in gallons of gasoline and electricity used).

Vehicle Specifications

This section of the data sheet presents significant vehicle specifications including engine type and power, hybrid drive type and power, battery type, number of seating positions, vehicle payload, and significant vehicle features/options.

GLOSSARY

Accuracy - Closeness to the true or accepted (or nominal) value. See inaccuracy.

Assessment/Verification - The act of reviewing, inspecting, testing, checking, conducting surveillances, auditing or otherwise determining and documenting whether items, processes or services meet specified processes.

Bottom of Discharge (BOD) - The point of lowest voltage during a discharge cycle.

Calibration - comparison of a measurement standard or instrument with another standard or instrument to detect, correlate, report or eliminate by adjustment any inaccuracy of the compared.

Calibration Standards - The reference used to conduct a calibration. They are normally associated with a known Standard, such as NIST, ISO, etc.

Certification - The process of validating a person's qualifications to perform a certain activity or group of activities. A person should not be certified to perform a task without being qualified to do so.

Charge Sustaining Mode - An operating mode in which the RESS SOC is maintained within a prescribed range by operation of a Consumable Fuel Energy Converter (CFEC).

Charging Algorithm - The circuitry/mathematical controls used by a charger to automatically control the charging profile of current versus voltage versus time during the battery charge.

Charging Station Location - As used in this procedure, refers to the specific plug-in location assigned to each specific vehicle.

Comment Sheet - A form used to record the comments of test personnel during the conduct of performance tests.

Consumable Fuel Energy Converter (CFEC) - An engine which consumes fuel to produce work (either electrical or mechanical).

Correction - The act of changing a datum or data. The only approved method to change an entry or notation is to strike through the entry with a single horizontal line, and write the initials of the person making the correction, along with the date the correction was made. The correct information shall be placed immediately adjacent to the entry which was struck through.

Curb Weight - The total weight of the vehicle as delivered including batteries, lubricants, and other expendable supplies but excluding the driver, passengers, and other payloads.

Data Acquisition System (DAS) - A data recording system, nominally analog or digital, used to collect data for further processing. Usually a strip-chart recorder, a computer, tape recorded, etc.

Depth of Discharge (DOD) - The quantified percentage of discharge of a battery, in terms of ampere-hours or kilowatt-hours, expressed as a percentage of the total battery capacity in similar units.

Distribution - The presentation of any document to individuals or groups other than those directly involved in the document's generation and completion.

Document Administrator - The individual tasked with the maintenance and storage of records as stipulated by this procedure. This individual may be a member of a sub-contractors staff, or may be a member of Electric Transportation Applications assigned this function as a primary or collateral duty.

Effective Date - The date, after which the procedure has been reviewed and approved, that the procedure can be utilized in the field for official testing.

Effective Mass - The sum of the test mass and the effective inertia's of the driven and non-driven axles.

Fifth Wheel - A calibrated instrument used to measure a vehicle's speed and distance independent of the vehicles on-board systems.

Fleet Manager - The individual within a fleet organization responsible for providing fleet operating data and overseeing operation of test vehicles.

Gradeability - The maximum percent grade which the vehicle can traverse for a specified time at a specified speed.

Gradeability Limit – The grad upon which the vehicle can just move forward.

Gross Vehicle Weight Rating (GVWR) - The maximum design loaded weight of the vehicle specified by the Supplier.

Hybrid Pulse Power Characterization (HPPC) - HPPC test in accordance with the US Department of Energy *FreedomCAR Battery Test Manual for Power-Assist Hybrid Electric Vehicles*.

Highway Fuel Economy Driving Schedule (HWFEDS) - The Highway Fuel Economy Driving Schedule is defined in 40 CFR Part 600, Appendix 1. It has a duration of 12 min, 45 s. It is used to represent vehicle highway driving.

Ichmax - The maximum charge current attained during a test sequence.

Idiscmax - The maximum discharge current attained during a test sequence.

Inaccuracy - deviation from the true or accepted (or nominal) value. Inaccuracy may result from both imprecision and bias (or systematic error) in the measurement process

Initial Conditions - Conditions that shall exist prior to an event occurring.

Initial State of Charge (SOC) - RESS SOC at the beginning of a test.

Item - An all-inclusive term used in place of any of the following: appurtenance, facility, sample, assembly, component, equipment, material, module, part, structure, subassembly, subsystem, system, unit, documented concepts or data.

Measurement Assurance Program - A quality assurance program for a measurement process that quantifies the total uncertainty of the measurements (both random and systematic components of error) with respect to national or other designated standards.

Measurement Process - A sequence of operations whose purpose is to assign a number(s) that represent how much of a certainty property, a given substance or object has.

Measuring and Test Equipment (M&TE) - Devices or systems used to calibrate, measure, gauge, test, inspect or control in order to acquire research development, test, or operational data; to determine compliance with design, specifications or other technical requirements.

Non-Conforming M&TE - Equipment which no longer meets the calibration requirements imposed by the reference standard, and normally characterized as one of the following:

- Out of Tolerance M&TE
- M&TE overdue for calibration
- M&TE that has been identified as “Out of Service”
- M&TE with unacceptable documentation.

Normal Operation Mode (Normal Operation) - A vehicle operating mode in which the CFEC and RESS are automatically controlled to supply energy independently or in combination.

On-the-Job Training (OJT) - Training that is accomplished outside of a classroom or structured learning environment. Skills taught "in the field" to one crafts-person by another more experienced or senior crafts-person are examples of OJT (such as how to run a lathe or drill press).

Out of Service M&TE - Equipment which can no longer be used because of one of the following conditions:

- M&TE that is suspected to be out of tolerance or functioning improperly
- M&TE that is out of tolerance or functioning improperly.

Out of Tolerance Equipment - Equipment whose output is no longer reliable as characterized by one of the following:

- Equipment found with "As Found" data outside required tolerances
- Equipment in a condition such that "As Found" data cannot be taken
- Equipment that is lost, stolen or improperly maintained.

Permanent Storage - Any record that has been deemed to be complete and less than one (1) year has passed since either the end of its governing contract, or the affixing of its final completion signature.

Precision - The degree of mutual agreement of independent measurements of a single quantity yielded by repeated applications of a process under specific conditions. It is the quantitatively stated by a precision measure such as a standard deviation, for example.

Prerequisites - Requirements that must be met or resolved prior to an event occurring.

Process - A series of actions that achieves an end result.

Program Manager - As used in this procedure, the individual responsible for oversight of testing conducted by the U.S. Department of Energy Advanced Vehicle Testing Activity.

Qualification - The process an individual completes in establishing competence in a stated area of expertise. A person may be qualified to perform a task without being certified as such.

Quality - The degree to which an item meets or exceeds the user's requirements and expectations.

Quality Assessment - The procedures and activities utilized to verify that a quality control system is operating within acceptable limits, and to evaluate the quality of the product/measurement produced.

Quality Assurance - Actions that provide confidence that quality is achieved.

Quality Assurance Program - The overall program established by an organization to implement the requirements of this procedure. The Program assigns responsibilities and authorities, defines policies and requirements, and provides for the performance and assessment of work.

Quality Control - The procedures and activities developed and implemented to produce products/measurements of desired quality.

Random Errors - Errors that vary in a non-reproducible way (fortuitously) around the limiting mean. For a large set of measurements, the errors are distributed evenly above and below the average. Also, small errors occur more frequently than large ones. These errors can be treated statistically by use of the laws of probability.

Rechargeable Energy Storage System (RESS) - A component or system of components that stores energy and for which its supply of energy is rechargeable by an electric motor-generator system and an off-vehicle energy source. Examples of RESS's for PHEVs include batteries, capacitors and electromechanical flywheels.

RESS Capacity - The capacity of a RESS in kilowatt-hours or ampere-hours determined as a function of the total distance traveled by the vehicle during performance of the Constant Speed Range Test portion of procedure AVTA-PHTP04.

RESS Only Mode (RESS Only) - An operator selectable vehicle operating mode in which the CFEC is disabled and the vehicle operates solely on energy from the RESS.

Safe Stopping Distance - The distance required to bring a vehicle to a complete stop from a pre-determined speed, without losing control of the vehicle.

Service - The performance of work, such as design, fabrication, inspection, nondestructive examination, repair or installation.

Shall - Items that require adherence without deviation. Shall statements identify binding requirements; a go, no-go criterion.

Should - Items that require adherence if at all possible. Should statements identify preferred conditions.

State of Charge (SOC) - For this testing, the SOC of a battery is defined as the expected residual battery capacity, expressed in amperes-hours or watt-hours, as a percentage of the total available. The 100% SOC basis (available ampere-hours or kilowatt-hours) is determined by the actual discharge capability of the main propulsion battery when discharged to the requirements of the 45 mph RESS Only Mode Constant Speed Range Test portion of procedure AVTA-PHTP04.

Supplemental Federal Test Procedure US06 (US06) - The Supplemental Federal Test Procedure (SFTP) represents aggressive, high speed and/or high acceleration driving behavior, rapid speed fluctuations, and driving behavior following startup. The cycle represents an 8.01 mile (12.8 km) route with an average speed of 48.4 miles/h (77.9 km/h), maximum speed 80.3 miles/h (129.2 km/h), and a duration of 596 seconds

Team Leader - The individual responsible for approving the review of the test results.

Temporary Storage - Safekeeping or storage of records that are still active (not completed), either because they are still in process and not yet complete, or because the process they are associated with has been suspended for less than thirty days.

Test Mass/Weight - The mass/weight of the vehicle as tested; including driver, operator (if necessary) and all instrumentation.

Test Director - The individual within Electric Transportation Applications responsible for all U.S. Department of Energy Advanced Vehicle Testing Activity testing activities.

Test Director's Log - A daily diary kept by the Test Director, Program Manager, Test Manager or Test Engineer to document major activities and decisions that occur during the conduct of testing. This log is normally a running commentary, utilizing timed and dated entries to document the day's activities. This log is edited to develop the Daily Test Log published with the final report for each vehicle.

Test Engineer - The individual(s) assigned responsibility for the conduct of any given test. [Each contractor/subcontractor should have at least one individual filling this position. If so, they shall be responsible for adhering to the requirements of this procedure.]

Test Manager - The individual for the implementation of the test program for any given vehicle(s) being tested to U. S. Department of Energy Advanced Vehicle Testing Activity requirements.

Test Mass [Weight] - The mass [weight] of the vehicle as tested including driver, operator (if necessary), and all instrumentation.

Test Results Review Team - The team individuals assembled to review and approve the data collected during the test process(es).

Tolerance - The maximum allowable departure of a standard from its nominal value.

Top of Charge (TOC) - The point of highest voltage during a charge cycle.

Total Harmonic Distortion (THD) - THD is a measurement of the harmonic distortion present in the voltage and current of the AC power source for a grid-connected charger and is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental.

Traceability - The ability to relate an individual measurement result to national standards of measurement.

Tractive Force - The force available from the driving wheels at the driving wheel/ground interface.

Training - The endeavor an individual undertakes to achieve qualification and certification in a specific area of expertise.

Uncertainty - Allowance assigned to a measured value to include two major components of error: bias and random error.

Urban Dynamometer Driving Schedule (UDDS) - The Urban Dynamometer Driving Schedule is defined in 40 CFR Part 86, Appendix 1. It has a duration of 22 min, 52 s. It is used to represent vehicle city driving.

Vmin - The minimum voltage attained during a specific test sequence.

Vmax - The maximum voltage attained during a specific test sequence.

Whiteout - The use of a whiting or correction fluid, or correction tape, to change a previous notation, entry, signature, date, etc. These are not permitted. See the definition for Correction.

Work - The process of performing a defined task or activity. Research and development, operations, maintenance and repair, administration, software development and use, inspection, data collection and analysis are examples of work.

Yaw - the movement of a vehicle slightly to the side of its intended direction

REFERENCES

ANSI Standard C101.1, 1986

American Nuclear Society (ANS) 3.1, “Requirements for the Selection and Training of Personnel for Nuclear Power Plants”

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