

ETA-HTP13

Revision 0

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Onboard Generator Energy Efficiency Test

Prepared by

Electric Transportation Applications

Prepared by: _____

Ryan Harkins

Date: _____

Approved by: _____

Donald Karner

Date: _____

TABLE OF CONTENTS

1. Objectives	1
2. Purpose	1
3. Documentation Support	1
4. Initial Conditions and Prerequisites	2
5. Testing Activity Requirements	3
6. Glossary	5
7. References	6

Appendices

Appendix A - Fuel Consumption Data Sheet	7
Appendix B - Energy Efficiency Calculation Sheet	8
Appendix C - Metrology Usage Sheet	9

1. Objective

The objective of this procedure is to provide methods for the testing of fuel consumption and determining energy efficiency of an onboard generator as well as the vehicle's energy capacity as a generator. 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 test is: (1) to determine the energy efficiency of the generator; and (2) to determine the energy capacity of the vehicle working as a generator. No inferences concerning the fuel economy of any vehicle should be drawn from this test. This activity is meant to test the vehicle as a generator only.

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 ETA-HAC04, "Review of Test Results." Storage and retention of records during and following testing activities shall be completed as described in Procedure ETA-HAC01, "Control, Close-out and Storage of Documentation."

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 Test Data Sheet.

- 4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure, and when applicable, the appropriate SAE Test Instructions, Administrative Control Procedures, and be certified by the Program Manager or the Test Manager/Engineer prior to commencing any testing activities.
- 4.2 Ambient temperatures during testing shall be $77^{\circ}\text{F} \pm 9^{\circ}\text{F}$ ($25^{\circ}\text{C} \pm 5^{\circ}\text{C}$).
- 4.3 RESS and engine temperatures at the beginning of testing shall be less than 120°F , and should be less than 100°F .
- 4.4 Normal Supplier's recommended lubricants shall be employed.
- 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 $\pm 2\%$ 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.
 - 4.5.1 Electric energy supplied by the generator
 - 4.5.2 Fuel consumption
 - 4.5.2 Starting and ending ambient temperature
- 4.6 The range of ambient temperature during the testing shall be recorded.
- 4.7 The date, starting and ending times shall be recorded.
- 4.8 All instrumentation used in the test shall be listed on Appendix C and attached to the test data sheets/results and shall include the following information:
 - 4.8.1 Manufacturer
 - 4.8.2 Model Number
 - 4.8.3 Serial Number
 - 4.8.4 Last Calibration date
 - 4.8.5 Next Calibration date
- 4.9 Any deviation from the test procedure and the reason for the deviation shall be recorded in accordance with ETA-HAC02, "Control of Test Conduct."
- 4.10 No accessories, with the exception of the generator shall be used during testing activities.

- 4.11 All documentation required to complete the testing shall be completed, approved and issued prior to commencing the testing it addresses.
- 4.12 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 ETA-HAC02, "Control of Test Conduct."
- 4.13 Verify that procedures ETA-HAC06, "Receipt Inspection," and ETA-HTP11, "Vehicle Verification," have been, or are being, completed.
- 4.14 The volume of liquid fuels consumed when testing vehicles in "normal operating mode" shall be determined by a weight method. The test vehicle shall be supplied from an external fuel tank. The tank shall be weighed before and immediately after testing. The quantity of fuel consumed shall be calculated using the density of the fuel and the weight of the fuel consumed during testing. The scale used for this measurement shall have an accuracy of at least 2% of the weight of the fuel tank after testing.
- 4.15 Ensure that the exhaust of the vehicle is properly ventilated out of the test chamber during the test.

5. Onboard Generator Energy Efficiency Test

The purpose of this section is to determine the energy efficiency of an onboard generator on a HEV vehicle when subjected to half of the rated load of the generator over a period of time.

This procedure is performed at an ambient temperature of $77^{\circ}\text{F} \pm 9^{\circ}\text{F}$. Test room temperatures shall be controlled in accordance with existing facility instructions.

NOTE

All steps shall be completed in the order written. Deviations from any step or requirement shall have the prior written approval of the Test Manager or Test Engineer in accordance with Procedure ETA-HAC02, "Control of Test Conduct."

NOTE

During this testing, if the vehicle fails electrically or mechanically for any reason, the vehicle shall be removed from this test area (and the test schedule) until the Supplier can effect the necessary repairs. See ETA-HAC02, "Control of Test Conduct" for additional details.

- 5.1 Determine the weight of a one gallon sample of the fuel to be used. Record the results in Appendix A.
- 5.2 Start the vehicle and ensure that the onboard generator is turned on and working properly.
- 5.3 Connect a kWh meter to the generator output on the vehicle.

- 5.4 Record the following initial conditions in Appendix A.
- 5.4.1 Ambient Temperature
 - 5.4.2 Starting Fuel Weight
 - 5.4.3 Start Time
 - 5.4.4 Starting kWh meter reading
- 5.5 Connect a load to the kWh meter determined to be half of the rated wattage of the generator.
- 5.6 Allow the generator to run for at least eight hours or until the external fuel tank is approaching empty, whichever occurs first. During this time, ensure that the kWh meter is registering appropriate change.
- 5.7 After completing step 6.5, record the following information in Appendix A.
- 5.7.1 Ambient Temperature
 - 5.7.2 Ending Fuel Weight
 - 5.7.3 Ending Time
 - 5.7.4 Ending kWh meter reading
- 5.8 Using the weight of the fuel consumed and the measured fuel density calculate the fuel consumption in gallons. Record the results in Appendix A.

$$\text{Fuel Consumed (gallons)} = \frac{\text{Weight of Fuel Consumed (lbs)}}{\text{Measured Fuel Density (lbs/gallon)}}$$

- 5.9 Using the energy consumed and the test time calculate the average power of the load in kilo-watts. Record the results in Appendix B.

$$\text{Average Power (kW)} = \frac{\text{Energy Consumed (kWh)}}{\text{Test Time (hours)}}$$

- 5.10 Using the energy consumed and the fuel consumed calculate the energy efficiency of the generator in kWh/gallon. Record the results in Appendix B.

$$\text{Energy Efficiency} = \frac{\text{Energy Consumed (kWh)}}{\text{Fuel Consumed (gallons)}}$$

(kWh/gallon)

Fuel Consumed (gal)

- 5.11 Using the energy efficiency and the fuel tank size calculate the energy capacity of the vehicle in kilo-watt hours. Record the results in Appendix B.

$$\text{Energy Capacity (kWh)} = \text{Energy Efficiency (kWh/gal)} \times \text{Fuel Tank Size (gal)}$$

6. Glossary

- 6.1 Effective Date - The date, after which a procedure has been reviewed and approved, that the procedure can be utilized in the field for official testing.
- 6.2 Gross Vehicle Weight Rating (GVWR) - The maximum design loaded weight of the vehicle specified by the Supplier.
- 6.3 HEV America – Hybrid Electric Vehicle America Performance Test Program, the DOE sponsored test program for independently assessing the performance of vehicles submitted for testing.
- 6.4 Initial Conditions - Conditions that must exist prior to an event occurring.
- 6.5 Initial State of Charge (SOC) - RESS SOC at the beginning of a test.
- 6.6 Prerequisites - Requirements that must be met or resolved prior to an event occurring.
- 6.7 Program Manager - As used in this procedure, the individual within Electric Transportation Applications responsible for oversight of HEV America. [Subcontract organizations may have similarly titled individuals, but they are not addressed by this procedure.]
- 6.8 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, an off-vehicle energy source, or both. Examples of RESS's for HEVs include batteries, capacitors and electromechanical flywheels.
- 6.9 Shall - Items which require adherence without deviation. Shall statements identify binding requirements. A go, no-go criterion.
- 6.10 Should - Items which require adherence if at all possible. Should statements identify preferred conditions.
- 6.11 State of Charge (SOC) - For vehicles operable in "RESS only mode," the SOC of the RESS is defined as the present capacity, (amperes-hours or watt-hours or miles), expressed as a percentage of the total available. The 100% SOC basis (available ampere-hours, kilowatt hours or miles) is determined by the actual

discharge capability of the RESS when discharged to the requirements of the 45 mph Constant Speed Range Test portion of procedure ETA-HTP04.

- 6.12 Test Director - The individual within Electric Transportation Applications responsible for all testing activities associated with HEV America.
- 6.13 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 a Performance Test Evaluation Program. This log is normally a running commentary, utilizing timed and dated entries to document the days activities. This log is edited to develop the Daily Test Log published with the final report for each vehicle.
- 6.14 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.]
- 6.15 Test Manager - The individual within Electric Transportation Applications responsible for the implementation of the test program for any given vehicle(s) being evaluated to the requirements of HEV America. [Subcontract organizations may have similarly titled individuals, but they are not addressed by this procedure.]

8. References

- 8.1 HEV America Vehicle Specification
- 8.2 ETA-HAC01 - "Control, Close-out and Storage of Documentation"
- 8.3 ETA-HAC02 - "Control of Test Conduct"
- 8.4 ETA-HAC04 - "Review of Test Results"
- 8.5 ETA-HAC05 - "Training and Certification Requirements For Personnel Utilizing ETA Procedures"
- 8.6 ETA-HAC06 - "Receipt Inspection"
- 8.7 ETA-HTP04 - "Electric Vehicle Range at Steady Speed Test"
- 8.8 ETA-HTP08 - "RESS Charging"
- 8.9 ETA-HTP11 - "Vehicle Verification"

**APPENDIX-A
Fuel Consumption Data Sheet
(Page 1 of 1)**

VIN Number: _____

Test Data Sheet

File No.:	Test Date:
Time (initial):	Time (final): <small>(Minimum 8 hours)</small>
Ambient Temperature (initial): <small>(°F or °C)</small>	Ambient Temperature (final): <small>(°F or °C)</small>
kWh Meter Reading (initial): <small>(kWh)</small>	kWh Meter Reading (final): <small>(kWh)</small>
Fuel Weight (initial): <small>(lbs)</small>	Fuel Weight (final): <small>(lbs)</small>
Fuel Density: <small>(lbs/gal)</small>	Generator Power Rating: <small>(kW)</small>
<p>Calculations (initials/date):</p> <p>Fuel Consumed = $\frac{\text{Fuel Weight (final)} - \text{Fuel Weight (initial)}}{\text{Measured Fuel Density (lbs/gallon)}}$ (gallons)</p> <p>Fuel Consumed = _____ = (gallons)</p>	
<p>Completed By: _____ <small>(Printed Name) (Signature) (Date)</small></p>	
<p>Reviewed By: _____ <small>(Printed Name) (Signature) (Date)</small></p>	
<p>Approved By: _____ <small>(Printed Name) (Signature) (Date)</small></p>	

APPENDIX-B
Generator Energy Efficiency Calculation
Data Sheet
(Page 1 of 1)

VIN Number: _____

Calculations (initials/date):		
Average Power = (kW)	$\frac{\text{Energy Consumed (kWh)}}{\text{Test Time (hours)}}$	
Average Power = (kW)	_____	=
Energy Efficiency = (kWh/gallon)	$\frac{\text{Energy Consumed (kWh)}}{\text{Fuel Consumed (gallon)}}$	
Energy Efficiency = (kWh/gallon)	_____	=
Energy Capacity = (kWh)	Energy Efficiency (kWh/gallon) X Fuel Tank Size (gallon)	
Energy Capacity = (kWh)	_____ X _____	= _____
Completed By:		
(Printed Name)	(Signature)	(Date)
Reviewed By:		
(Printed Name)	(Signature)	(Date)
Approved By:		
(Printed Name)	(Signature)	(Date)

APPENDIX-A
Vehicle Metrology Setup Sheets
(Page 1 of 1)

Vin Number: _____

Instrument/Device:	Calibration Due Date:	Initials / Date:
DAS S/N:		
DAS Set-up Sheet S/N		
kWh Meter S/N:		
Temperature Chart Recorder S/N:		
Fuel Scale S/N:		
Misc:		
Misc:		
Misc:		
Comments (initials/date):		
Completed By:		
<small>(Printed Name)</small>	<small>(Signature)</small>	<small>(Date)</small>
Reviewed By (QA):		
<small>(Printed Name)</small>	<small>(Signature)</small>	<small>(Date)</small>
Approved By:		
<small>(Printed Name)</small>	<small>(Signature)</small>	<small>(Date)</small>