

ETA-HTP12

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Evaluation of Hybrid Vehicle Energy Management System(s) [EMS]

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1. Objective

This procedure provides a consistent method for the evaluation of the performance of the RESS Energy Management System (EMS) of vehicles participating in HEV America.

2. Purpose

The purpose of this procedure is to provide a quantifiable methodology for the collection and evaluation of EMS data. This activity is meant to quantify results obtained from the operation of the EMS during conduct of HEV America testing. Although it is necessary to test and monitor vehicle performance to ensure the successful operation of the EMS, vehicles tests are addressed by other test procedures. This testing and data acquisition meets the requirements specified in the HEV America Vehicle Specifications 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 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. Prerequisites

- 4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure as evidenced by Certification by the Program Manager or Test Manager, any applicable SAE Test Instructions, and the Administrative Control Procedures, prior to commencing any testing activities.
- 4.2 Overall error in recording or indicating instruments shall not exceed $\pm 2\%$ of the maximum value of the variable being measured, unless otherwise excepted. Periodic calibration shall be performed and documented to ensure compliance with this requirement. [This error value does not apply to instrumentation permanently installed by the Supplier that is required by the RFP.]

- 4.3 A list of all instrumentation used in the test shall be identified on 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 Last Calibration date
 - 4.3.5 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 ETA-HAC02, "Control of Test Conduct," 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.

5. Measurement of Energy Monitoring System (EMS) Performance

This procedure is designed as a non-intrusive, qualitative evaluation tool to assist the Test Manager to determine if the EMS is operating correctly. Based upon the Supplier's submittal, the vehicle will be assumed to contain a EMS unless otherwise noted. The EMS (if installed) shall be evaluated to ensure it is capable of properly maintaining the RESS.

"The vehicle should be equipped with an RESS Energy Management System (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 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 an 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. Voltages which change rapidly on discharge are 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 telltale 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.

6.0 Glossary

- 6.1 EMS - RESS Energy Management System.
- 6.2 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.
- 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 Program Manager - As used in this procedure, the individual within Electric Transportation Applications responsible for oversight of the HEV America Performance Test Program. [Subcontract organizations may have similarly titled individuals, but they are not addressed by this procedure.]
- 6.5 Shall - Items which require adherence without deviation. Shall statements identify binding requirements. A go, no-go criterion.
- 6.6 Should - Items which require adherence if at all possible. Should statements identify preferred conditions.
- 6.7 Test Director - The individual within Electric Transportation Applications responsible for all testing activities associated with HEV America.
- 6.8 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.
- 6.9 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.]
- 6.10 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.]

7. References

- 7.1 HEV America Vehicle Specification
- 7.2 ETA-HAC01 - "Control, Close-out and Storage of Documentation"
- 7.3 ETA-HAC02 - "Control of Test Conduct"
- 7.4 ETA-HAC04 - "Review of Test Results"
- 7.5 ETA-HAC05 - "Training and Certification Requirements for Personnel Utilizing ETA Procedures"
- 7.6 ETA-HAC06 - "Receipt Inspection"
- 7.7 ETA-HTP11 - "Vehicle Verification"

