ETA-HTP09

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Measurement and Evaluation of Magnetic Fields (EMF) and Electromagnetic Radiation (EMI) Generated by Hybrid Electric Vehicles

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TABLE OF CONTENTS

Appendices

1. Purpose

The purpose of this procedure is to identify qualitative methods to determine the low frequency (power frequency) magnetic field (EMF) and high frequency electromagnetic radiation (EMI) from vehicles participating in HEV America.

This activity is meant to quantify results obtained while the vehicle is being tested 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 HEV America Vehicle Specification.

2. Objective

The following are the objectives of this procedure:

2.1 Determination of maximum, minimum and average values of EMF at various locations inside the HEV during the SAE J1634 driving cycle.

2.2 Determination of frequency spectrum of EMF during the SAE1634 driving cycle.

2.3 Determination of EMF at driver's seat during the full acceleration mode.

2.4 Determination of EMF at front passenger seats during the full acceleration mode.

2.5 Determination of EMF at rear passenger seats during the full acceleration mode.

2.6 Determination of EMF at driver's seat at a constant speed of 10 mph.

2.7 Determination of EMF at front passenger seats at a constant speed of 10 mph.

2.8 Determination of EMF at rear passenger seats at a constant speed of 10 mph.

2.9 Determination of EMF at driver's seat at a constant speed of 25 mph.

2.10 Determination of EMF at front passenger seats at a constant speed of 25 mph.

2.11 Determination of EMF at rear passenger seats at a constant speed of 25 mph.

2.12 Determination of EMF at driver's seat at a constant speed of 40 mph.

2.13 Determination of EMF at front passenger seats at a constant speed of 45 mph.

2.14 Determination of EMF at rear passenger seats at a constant speed of 40 mph.

2.15 Determination of EMF at driver's seat during the deceleration mode.

2.16 Determination of EMF at front passenger seats during the deceleration mode.

2.17 Determination of EMF at rear passenger seats during the deceleration mode.

2.18 Determination of maximum and average values for each location.

2.19 Determination of Total Harmonic Distortion (THD) of EMF for each location and each mode of operation.

2.20 Determination of electromagnetic radiation from the HEV in the frequency range of 9 kHz to 30 MHz.

2.21 Determination of EMI on both sides of vehicle 1 meter away from the vehicle during the constant speed of 10 mph.

2.22 Determination of location of maximum EMI generated from the vehicle.

2.23 Determination of EMI during the constant speed of 10, 25 and 40 mph at that location.

2.24 Determination of interference of AM and FM radio stations during the normal driving of the HEV.

2.25 Determination of EMI interference on the operation of cellular phones.

2.26 Determination of EMI interference on operation of mobile radio scanning devices.

2.27 Determination of EMI interference on operation of citizen band radios.

2.28 Determination of EMI interference on operation of portable disc players.

2.29 Determination of EMI interference on operation of notebook computers.

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. Limitations and Precautions/ Initial Conditions and Prerequisites

Prior to conduct of any testing, the following initial conditions and prerequisites shall be met. Satisfactory completion of these items shall be verified as complete and recorded on the HEV Appropriate Test Data Sheets.

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 All documentation required to complete the testing shall be completed, approved and issued prior to commencing the testing it addresses.

4.3 The following data shall be collected during conduct of the various tests specified by this procedure.

4.3.1 X component of magnetic field versus time;
4.3.2 Y component of magnetic field versus time;
4.3.3 Z component of magnetic field versus time; and

4.3.4 Battery charge/discharge current.

4.4 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. This shall be verifiable to the requirements of ETA-HQA01, "Quality Audits."

4.5 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

4.5.1 Manufacturer
4.5.2 Model Number
4.5.3 Serial Number
4.5.4 Last Calibration date
4.5.5 Next Calibration date

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

4.6.1 Range of ambient temperature during the test;
4.6.2 Air humidity.

4.7 For each test or portion thereof, record the date and starting and ending times.

4.8 Any deviation from the test procedure and the reason for the deviation shall be approved in advance by the Program Manager or Test Manager as provided for in procedure ETA-HAC02, "Control of Test Conduct."

4.9 Necessary measurement and monitoring equipment shall be installed in a manner that does not hinder operation or alter the operating characteristics of the vehicle.

4.10 During testing, all surfaces, other than those normally in contact with water, shall be dry.

5. Materials and Tools

A variety of instrumentation, materials and tools will be used in this test.

5.1 All instrumentation used in the test shall be listed on Appendix H, attached to the test data sheets/results, and shall include the following information:

5.1.1 Manufacturer

5.1.2 Model Number

5.1.3 Serial Number

5.1.4 Last Calibration date

5.1.5 Next Calibration date

5.2 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), in accordance with ETA-HAC02, "Control of Test Conduct."

5.3 Approximate list of instrumentation to be used for this test is as follows:

- 5.3.1 Data acquisition system based on the LabView environment.
- 5.3.2 Data acquisition PCMCIA card from National Instruments installed on a portable computer.
- 5.3.3 Analog to Digital (A/D) converter.
- 5.3.4 Voltage divider.
- 5.3.5 Shunt resistor for current measurement.
- 5.3.6 Clamp-on current transformer.
- 5.3.7 Three-axis Magnetic field sensor with frequency range 0 – 9 kHz.
- 5.3.8 Receiving antenna – 1.0 m nominal length.
- 5.3.9 Scanning receiver with frequency range 9 kHz – 1000 MHz.
- 5.3.10 Temperature sensors.
- 5.3.11 Humidity sensors.
- 5.3.12 Portable computer.

6. Magnetic Field and Electromagnetic Radiation

6.1. Magnetic Field Measurement Procedure

Figure 1 represents the measurement circuit, which is implemented to monitor the magnetic field generated by an electric vehicle in a running mode.

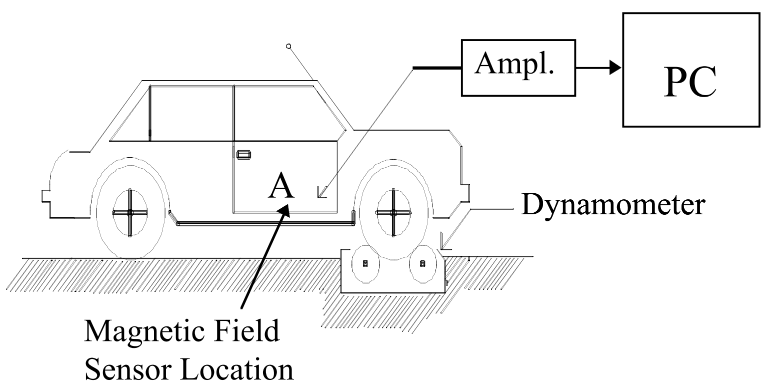

Figure 1. Measurement circuit for monitoring the magnetic field

The following instrumentation is required:

- DC/AC current transformer - FLUKE Y8100 or equivalent
- Three axis magnetic field sensor with a frequency range of DC to 50 kHz
- LabVIEW data acquisition system and equipment

The DC/AC current probe shall have two ranges of operation - 20A and 200A. It shall also have an amplifier with an analog output of ± 2 V for each measurement range. This analog output is fed to the computer.

The magnetic field sensor shall contain three orthogonal mounted sensors. Each sensor measures a corresponding component of the magnetic field and has a built-in amplifier. Each of the amplifiers provides a ± 2V analog output signal, which is also fed to the computer. The sensor has three measurement ranges. Each axis is normally set at the 200 mG range.

Data acquisition program shall be written in LabVIEW (a virtual instrument), to take the signals from four sources (the current probe and the three components of the magnetic field) and perform the necessary computations. These data shall be taken in continuous snapshots, with the only delay between the snapshots being the time required to perform necessary calculations. Time data are sampled at a rate of 21.6 kHz (this is a time interval between samples of 0.0463 ms.) This sampling rate enables monitoring of the frequency harmonics of any parameter up to 10.8 kHz.

6.2. Magnetic Field Evaluation Procedure

The magnetic fields shall be measured in every seat-belted position in the vehicle in the following operational modes:

- Acceleration
- Constant Speed (Cruising)
- Deceleration
- Charging Mode

However, in the charging mode, the fields shall be measured only in the close vicinity of the charger.

Four channels shall acquire analog signals from four sources. Each signal shall then be corrected for the particular current probe ratio and magnetometer amplification. The signal shall then be digitized. The rms value of current shall be calculated based on the equation:

$$I = \sqrt{\frac{1}{N}\sum i^2} \qquad \textit{Eq. 1}$$

The calculated rms value is then stored in the computer file.

The analog signal from each magnetic field sensor is directly proportional to the magnetic field. The DC component of the magnetic field shall be calculated for each axis as follows:

$$bx_{dc} = mean(bx)$$

$$by_{dc} = mean(by) \qquad Eq.\ 2$$

$$bz_{dc} = mean(bz)$$

The AC components of the field shall be extracted as follows:

$$bx_{ac} = bx - bx_{dc}$$

$$by_{ac} = by - by_{dc} \qquad Eq.\ 3$$

$$bz_{ac} = bz - bz_{dc}$$

The following equations shall be used to calculate the rms value of each component of the AC magnetic field:

$$BX_{ac} = \sqrt{\frac{1}{N}\sum bx_{ac}{}^{2}}$$

$$BY_{ac} = \sqrt{\frac{1}{N}\sum by_{ac}{}^{2}} \qquad Eq.\ 4$$

$$BZ_{ac} = \sqrt{\frac{1}{N}\sum bz_{ac}{}^{2}}$$

The total AC and DC magnetic fields shall then be calculated as follows:

$$B_{dc} = \sqrt{bx_{dc}^2 + by_{dc}^2 + bz_{dc}^2} \qquad Eq.\ 5$$

$$B_{ac} = \sqrt{BX_{ac}^2 + BY_{ac}^2 + BZ_{ac}^2} \qquad Eq.\ 6$$

Both field components shall be continuously stored in the same file with the current.

The frequency spectrum of each magnetic field component shall be performed as follows:

$$FFT(bx_{ac})$$

$$FFT(by_{ac}) \qquad \textit{Eq. 7}$$

$$FFT(bz_{ac})$$

The frequency spectrum of the total magnetic field shall then be calculated as follows:

$$FFT(b) = \sqrt{(FFT(bx_{ac}))^2 + (FFT(by_{ac}))^2 + (FFT(bz_{ac}))^2} \qquad \textit{Eq. 8}$$

Using the first harmonic in the spectrum and the rms value of the total magnetic field, the Total Harmonic Distortion (THD) of the magnetic field is calculated:

$$THD = \sqrt{\frac{B_{ac}^2 + B1^2}{B1^2}} \qquad \textit{Eq. 9}$$

6.3. Magnetic Field Measurement During Conduct of SAEJ1634 Drive Cycle

This test is designed to determine the magnetic field generated by the vehicle at the different modes of operations. Measurements will be made in at least one location inside the vehicle. Data will be taken at distances of 1 ft above the seat.

6.3.1 The results of the magnetic field test include:

6.3.1.1 Identification of the vehicle's magnetic field vs. time curves for each of measurement locations. These curves will identify the relationship between the maximum magnetic fields and mode of vehicle operation.

6.3.1.2 Determination of the Total Harmonic Distortion of the magnetic field in each measurement location at various modes of operations.

6.3.1.3 Capture of three axis magnetic field waveforms at various modes of operations.

6.3.1.4 Determination of average, max., min, and median values of magnetic field during the test duration.

6.3.1.5 Determination of frequency spectrum of magnetic field generated from the vehicle.

6.3.1.6 Determination of the max. Frequency components of magnetic field.

6.3.2 This testing shall be completed subject to the initial conditions and prerequisites stated in Section 4 of this procedure.

6.3.3 Instrument the vehicle to obtain, at a minimum, the data identified in Section 4.3.

6.3.4 Place the vehicle on the dynamometer.

6.3.5 Turn the vehicle off.

6.3.6 Start the computer data acquisition system. Data shall be stored in appropriately named file in the computer – C:\HEV1\EMF Test\main file.

6.3.7 Acquire sample waveforms of three-axis magnetic field and store them in an appropriately named file in the computer – C:\HEV1\EMF Test\Waveforms\. This would be a background magnetic field.

6.3.8 Record the magnetic field generated in the vehicle when the vehicle is turned off for 2 minutes.

6.3.9 While the magnetic field data are being recorded turn on the dynamometer and run the vehicle through the an SAEJ1634 drive cycle (2 UDS and 2 HWFET) in accordance with ETA-HTP03, Implementation of SAE J1634 May93 - “Electric Vehicle Energy Consumption and Range Test Procedure”

6.3.10 During the test collect magnetic field waveforms periodically.

6.3.11 At the end of SAEJ1634 driving cycle turn the vehicle off.

6.3.12 Continue collecting data for another 2 minutes.

6.3.13 Stop data collection. Record the end time test.

6.3.14 Calculate the average, maximum, minimum, median and standard deviation of magnetic field and record them in Appendix B.

6.4. Magnetic Field Measurement during the Three Speed Test

This test is designed to determine the magnetic field generated by the vehicle at the various modes of operations in every seat inside the vehicle. Data will be taken at distances of 1 ft above the seat.

6.4.1 The purpose of the magnetic field test is to:

6.4.1.1 Identify the magnetic field vs. time curves for each of measurement locations generated from the vehicle. These curves will identify the relationship between the maximum magnetic fields and mode of vehicle operation.

6.4.1.2 Determine location inside the vehicle that is exposed to max magnetic file generated from the vehicle.

6.4.1.3 Determine the variation between vehicles speed and magnetic field generated.

6.4.1.4 Determine the Total Harmonic Distortion of the magnetic field in each measurement location at various modes of operations.

6.4.1.5 Capture three axis magnetic field waveforms at various modes of operations.

6.4.1.6 Determine average, max, min, and median values of magnetic field during the test duration.

6.4.1.7 Determine frequency spectrum of magnetic field generated from the vehicle.

6.4.1.8 Determine the max. Frequency components of magnetic field.

6.4.2 This testing shall be completed subject to the initial conditions and prerequisites stated in Section 4 of this procedure.

6.4.3 Instrument the vehicle to obtain, at a minimum, the data identified in Section 4.3.

6.4.4 Place the vehicle on the dynamometer.

6.4.5 Place the three-axis magnetic field sensor on the passenger front seat.

6.4.6 Turn the injection key on and let the vehicle running for two minutes.

6.4.7 Start the computer data acquisition system. Data shall be stored in appropriately named file in the computer – C:\HEV1\EMF Test\Front passenger seat\main file.

6.4.8 Acquire sample waveforms of three-axis magnetic field and store them in a appropriately named file in the computer – C:\HEV1\EMF Test\ Front passenger seat \Waveforms\. This is a background magnetic field. Collect the data for approximately 60 seconds.

6.4.9 After 60 seconds data collection accelerate the vehicle to the speed of 10 mph. Establish steady state condition of 10 mph (16 km/h).

6.4.10 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.11 Continue to collect data for approximately 60 seconds.

6.4.12 After 60 seconds of data collection, accelerate the vehicle to the speed of 25 mph. Establish steady state condition of 25 mph (40 km/h).

6.4.13 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.14 Continue to collect data for approximately 60 seconds.

6.4.15 After 60 seconds of data collection accelerate the vehicle to the speed of 40 mph. Establish steady state condition of 40 mph (64 km/h)..

6.4.16 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.17 Continue to collect data for approximately 60 seconds.

6.4.18 After 60 seconds at constant speed of 40 mph, decelerate rapidly and bring the speed at 0 mph.

6.4.19 Continue to collect data for approximately 60 seconds.

6.4.20 Turn off the vehicle and stop the data collection.

6.4.21 Place the three-axis magnetic field sensor in drivers seat.

6.4.22 Turn the injection key on and let the vehicle running for two minutes.

6.4.23 Start the computer data acquisition system. Data shall be stored in appropriately named file in the computer – C:\HEV1\EMF Test\Drivers seat\main file.

6.4.24 Acquire sample waveforms of three-axis magnetic field and store them in a appropriately named file in the computer – C:\HEV1\EMF Test\ Drivers seat \Waveforms\. This is a background magnetic field. Collect the data for approximately 60 seconds.

6.4.25 After 60 seconds data collection accelerate the vehicle to the speed of 10 mph. Establish steady state condition of 10 mph (16 km/h).

6.4.26 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.27 Continue to collect data for approximately 60 seconds.

6.4.28 After 60 seconds data collection, accelerate the vehicle to the speed of 25 mph. Establish steady state condition of 25 mph (40 km/h).

6.4.29 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.30 Continue to collect data for approximately 60 seconds.

6.4.31 After 60 seconds data collection accelerate the vehicle to the speed of 40 mph. Establish steady state condition of 40 mph (64 km/h).

6.4.32 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.33 Continue to collect data for approximately 60 seconds.

6.4.34 After 60 seconds at constant speed of 40 mph, decelerate rapidly and bring the speed at 0 mph.

6.4.35 Continue to collect data for approximately 60 seconds.

6.4.36 Turn off the vehicle and stop the data collection.

6.4.37 Place the three-axis magnetic field sensor in rear right seat.

6.4.38 Turn the ignition key on and let the vehicle run for two minutes.

6.4.39 Start the computer data acquisition system. Data shall be stored in appropriately named file in the computer – C:\HEV1\EMF Test\Rear Right seat\main file.

6.4.40 Acquire sample waveforms of three-axis magnetic field and store them in a appropriately named file in the computer – C:\HEV1\EMF Test\Rear Right seat \Waveforms\. This is a background magnetic field. Collect the data for approximately 60 seconds.

6.4.41 After 60 seconds data collection accelerate the vehicle to the speed of 10 mph. Establish steady state condition of 10 mph (16 km/h).

6.4.42 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.43 Continue to collect data for approximately 60 seconds.

6.4.44 After 60 seconds data collection, accelerate the vehicle to the speed of 25 mph. Establish steady state condition of 25 mph (40 km/h).

6.4.45 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.46 Continue to collect data for approximately 60 seconds.

6.4.47 After 60 seconds data collection accelerate the vehicle to the speed of 40 mph. Establish steady state condition of 40 mph (64 km/h).

6.4.48 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.49 Continue to collect data for approximately 60 seconds.

6.4.50 After 60 seconds at constant speed of 40 mph, decelerate rapidly and bring the speed to 0 mph.

6.4.51 Continue to collect data for approximately 60 seconds.

6.4.52 Turn off the vehicle and stop the data collection.

6.4.53 Place the three-axis magnetic field sensor in rear left seat.

6.4.54 Turn the ignition key on and let the vehicle run for two minutes.

6.4.55 Start the computer data acquisition system. Data shall be stored in appropriately named file in the computer – C:\HEV1\EMF Test\Rear Left seat\main file.

6.4.56 Acquire sample waveforms of three-axis magnetic field and store them in a appropriately named file in the computer – C:\HEV1\EMF Test\Rear Left seat \Waveforms\. This is a background magnetic field. Collect the data for approximately 60 seconds.

6.4.57 After 60 seconds data collection accelerate the vehicle to the speed of 10 mph. Establish steady state condition of 10 mph (16 km/h).

6.4.58 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.59 Continue to collect data for approximately 60 seconds.

6.4.60 After 60 seconds data collection, accelerate the vehicle to the speed of 25 mph. Establish steady state condition of 25 mph (40 km/h).

6.4.61 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.62 Continue to collect data for approximately 60 seconds.

6.4.63 After 60 seconds data collection accelerate the vehicle to the speed of 40 mph. Establish steady state condition of 40 mph (64 km/h).

6.4.64 Acquire sample waveforms of three-axis magnetic field at this speed.

6.4.65 Continue to collect data for approximately 60 seconds.

6.4.66 After 60 seconds at constant speed of 40 mph, decelerate rapidly and bring the speed to 0 mph.

6.4.67 Continue to collect data for approximately 60 seconds.

6.4.68 Turn off the vehicle and stop the data collection. Record the end time test.

6.4.69 Record the calculated data on Appendix C.

6.5. Measurement of Electromagnetic Radiation (EMI)

This test is designed to determine the radiated magnetic and electric filed strengths over the frequency range 9 kHz to 30 MHz. Data will be taken outside the vehicle at three constant speeds consistent with SAE 551.

6.5.1 The purpose of the magnetic field test is to:

6.5.1.1 Determine the EMI on four sides of the vehicle during the constant speed of 25 mph.

6.5.1.2 Determine in which side of the vehicle occurs maximum EMI radiation.

6.5.1.3 On the side of the vehicle with higher EMI values, determine the EMI at 10 mph.

6.5.1.4 On the side of the vehicle with higher EMI values, determine the EMI at 40 mph

6.5.1.5 Determine the relationship between the maximum EMI and speed of vehicle.

6.5.1.6 Determine the Radiated field strengths as a function of frequency.

6.5.2 This testing shall be completed subject to the initial conditions and prerequisites stated in Section 4 of this procedure.

6.5.3 Instrument the vehicle to obtain, at a minimum, the data identified in Section 4.3.

6.5.4 Measurement of EMI Radiation in front of the vehicle.

6.5.4.1 Place the antenna of 1.0 m nominal length mounted above the ground plane 1.0 ±0.5 m above the ground level and 1.0 m ± 0.05 m away from the nearest part of the front of the vehicle.

6.5.4.2 Establish steady state condition of 25 mph (40 km/h) in high gear.

6.5.4.3 Scan the radiated emission levels in the frequency range from 9 to 30 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.4 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.5 Scan the radiated emission levels in the frequency range from 30 to 60 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.6 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.7 Scan the radiated emission levels in the frequency range from 60 to 120 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.8 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.9 Scan the radiated emission levels in the frequency range from 120 to 250 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.10 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.11 Scan the radiated emission levels in the frequency range from 250 to 500 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.12 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.13 Scan the radiated emission levels in the frequency range from 500 to 1.1 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.14 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.15 Scan the radiated emission levels in the frequency range from 1.1 to 2.4 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.16 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.17 Scan the radiated emission levels in the frequency range from 2.4 MHz to 5.0 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.18 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.19 Scan the radiated emission levels in the frequency range from 5.0 to 10 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.20 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.21 Scan the radiated emission levels in the frequency range from 10 to 20 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.22 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.23 Scan the radiated emission levels in the frequency range from 20 to 30 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.4.24 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.4.25 Record each reading in Appendix D.

6.5.5 Measurement of EMI Radiation on the back of the vehicle

6.5.5.1 Place the antenna of 1.0 m nominal length mounted above the ground plane 1.0 ±0.5 m above the ground level and 1.0 m ± 0.05 m away from the nearest part of the end of the vehicle.

6.5.5.2 Establish steady state condition of 25 mph (40 km/h) in high gear.

6.5.5.3 Scan the radiated emission levels in the frequency range from 9 to 30 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.4 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.5 Scan the radiated emission levels in the frequency range from 30 to 60 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.6 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.7 Scan the radiated emission levels in the frequency range from 60 to 120 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.8 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.9 Scan the radiated emission levels in the frequency range from 120 to 250 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.10 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.11 Scan the radiated emission levels in the frequency range from 250 to 500 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.12 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.13 Scan the radiated emission levels in the frequency range from 500 to 1.1 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.14 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.15 Scan the radiated emission levels in the frequency range from 1.1 to 2.4 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.16 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.17 Scan the radiated emission levels in the frequency range from 2.4 MHz to 5.0 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.18 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.19 Scan the radiated emission levels in the frequency range from 5.0 to 10 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.20 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.21 Scan the radiated emission levels in the frequency range from 10 to 20 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.22 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.23 Scan the radiated emission levels in the frequency range from 20 to 30 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.5.24 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.5.25 Record each reading in Appendix D.

6.5.6 Measurement of EMI Radiation on the left side of the vehicle.

6.5.6.1 Place the antenna of 1.0 m nominal length mounted above the ground plane 1.0 ±0.5 m above the ground level and 1.0 m ± 0.05 m away from the nearest part of the left side of the vehicle.

6.5.6.2 Establish steady state condition of 25 mph (40 km/h) in high gear.

6.5.6.3 Scan the radiated emission levels in the frequency range from 9 to 30 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.4 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.5 Scan the radiated emission levels in the frequency range from 30 to 60 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.6 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.7 Scan the radiated emission levels in the frequency range from 60 to 120 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.8 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.9 Scan the radiated emission levels in the frequency range from 120 to 250 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.10 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.11 Scan the radiated emission levels in the frequency range from 250 to 500 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.12 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.13 Scan the radiated emission levels in the frequency range from 500 to 1.1 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.14 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.15 Scan the radiated emission levels in the frequency range from 1.1 to 2.4 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.16 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.17 Scan the radiated emission levels in the frequency range from 2.4 MHz to 5.0 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.18 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.19 Scan the radiated emission levels in the frequency range from 5.0 to 10 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.20 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.21 Scan the radiated emission levels in the frequency range from 10 to 20 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.22 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.23 Scan the radiated emission levels in the frequency range from 20 to 30 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.6.24 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.6.25 Record each reading in Appendix D.

6.5.7 Measurement of EMI Radiation on the right side of the vehicle

6.5.7.1 Place the antenna of 1.0 m nominal length mounted above the ground plane 1.0 ±0.5 m above the ground level and 1.0 m ± 0.05 m away from the nearest part of the right side of the vehicle.

6.5.7.2 Establish steady state condition of 25 mph (40 km/h) in high gear.

6.5.7.3 Scan the radiated emission levels in the frequency range from 9 to 30 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.4 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.5 Scan the radiated emission levels in the frequency range from 30 to 60 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.6 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.7 Scan the radiated emission levels in the frequency range from 60 to 120 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.8 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.9 Scan the radiated emission levels in the frequency range from 120 to 250 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.10 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.11 Scan the radiated emission levels in the frequency range from 250 to 500 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.12 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.13 Scan the radiated emission levels in the frequency range from 500 to 1.1 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.14 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.15 Scan the radiated emission levels in the frequency range from 1.1 to 2.4 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.16 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.17 Scan the radiated emission levels in the frequency range from 2.4 MHz to 5.0 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.18 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.19 Scan the radiated emission levels in the frequency range from 5.0 to 10 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.20 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.21 Scan the radiated emission levels in the frequency range from 10 to 20 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.22 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.23 Scan the radiated emission levels in the frequency range from 20 to 30 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.7.24 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.7.25 Record each reading in Appendix D.

6.5.8 From the data collected in sections 5.4, 5.5, 5.6, and 5.7 determine the side of the vehicle with the maximum EMI radiation.

6.5.9 Place the antenna on the side of the vehicle with maximum EMI radiation.

6.5.10 Measurement of EMI radiation on the side with maximum radiation during the steady state condition of 10 mph.

6.5.10.1 Place the antenna of 1.0 m nominal length mounted above the ground plane 1.0 ±0.5 m above the ground level and 1.0 m ± 0.05 m away from the nearest part of the side of the vehicle with maximum radiation.

6.5.10.2 Establish steady state condition of 10 mph (16 km/h) in high gear.

6.5.10.3 Scan the radiated emission levels in the frequency range from 9 to 30 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.4 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.5 Scan the radiated emission levels in the frequency range from 30 to 60 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.6 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.7 Scan the radiated emission levels in the frequency range from 60 to 120 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.8 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.9 Scan the radiated emission levels in the frequency range from 120 to 250 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.10 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.11 Scan the radiated emission levels in the frequency range from 250 to 500 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.12 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.13 Scan the radiated emission levels in the frequency range from 500 to 1.1 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.14 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.15 Scan the radiated emission levels in the frequency range from 1.1 to 2.4 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.16 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.17 Scan the radiated emission levels in the frequency range from 2.4 MHz to 5.0 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.18 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.19 Scan the radiated emission levels in the frequency range from 5.0 to 10 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.20 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.21 Scan the radiated emission levels in the frequency range from 10 to 20 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.22 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.23 Scan the radiated emission levels in the frequency range from 20 to 30 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.10.24 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.10.25 Record each reading in Appendix D.

6.5.11 Measurement of EMI radiation on the side with maximum radiation during the steady state condition of 40 mph.

6.5.11.1 Place the antenna of 1.0 m nominal length mounted above the ground plane 1.0 ±0.5 m above the ground level and 1.0 m ± 0.05 m away from the nearest part of the side of the vehicle with maximum radiation.

6.5.11.2 Establish steady state condition of 40 mph (64 km/h) in high gear.

6.5.11.3 Scan the radiated emission levels in the frequency range from 9 to 30 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.4 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.11.5 Scan the radiated emission levels in the frequency range from 30 to 60 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.6 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.11.7 Scan the radiated emission levels in the frequency range from 60 to 120 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.8 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.11.9 Scan the radiated emission levels in the frequency range from 120 to 250 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.10 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.11.11 Scan the radiated emission levels in the frequency range from 250 to 500 kHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.12 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.11.13 Scan the radiated emission levels in the frequency range from 500 to 1.1 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.14 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.11.15 Scan the radiated emission levels in the frequency range from 1.1 to 2.4 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.16 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.11.17 Scan the radiated emission levels in the frequency range from 2.4 MHz to 5.0 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.18 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.11.19 Scan the radiated emission levels in the frequency range from 5.0 to 10 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.20 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.11.21 Scan the radiated emission levels in the frequency range from 10 to 20 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.22 Determine the peak field intensity within this range and record it in the units of dBμV or dBμV/kHz.

6.5.11.23 Scan the radiated emission levels in the frequency range from 20 to 30 MHz. Determine the radiated field strength as a function of frequency by plotting or graphing the data.

6.5.11.24 Determine the peak field intensity within this range and record it in units of dBμV or dBμV/kHz.

6.5.11.25 Record each reading in Appendix D.

6.6. Determination of Radio Frequency Interference

6.6.1. As vehicles are operated through their test program drivers should conduct random checks of the AM and FM radio bands, to determine if radio stations which can normally be received in non hybrid electric vehicles can also be received in the test electric vehicles. Those comments will be noted on driver comment sheets, as appropriate, for transcription at a later date.

6.6.2. While operating on the dynamometer in accordance with ETA-HTP003, the following devices shall be operated to determine if any interference is being generated from the vehicle:

6.6.2.1 Cellular telephone (analog)

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

6.6.2.3 Citizen band radio

6.6.2.4 Portable compact disc player

6.6.2.5 Notebook computer

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.]

6.6.3 Device operation and any interference noted shall be recorded on Appendix B.

6.6.4 The following devices shall be operated with the vehicle on the dynamometer to determine if the any impact on the vehicle charge system can be detected:

6.6.4.1 A Citizen's Band Radio operating at the legal limit of 5 watts output

6.6.4.2 Mobile radio antennae (70 cm and 2M band frequencies) operating at 7 watts output.

6.6.4.3 A cellular telephone (analog)

6.6.4.4 Record any impact on Appendix E.

7. Glossary

7.1. Audible Noise - Noise that is considered to be within the range of normal human hearing, nominally 20 Hz to 20,000 Hz.

7.2. Frequency Harmonic - A multiple of the fundamental or base frequency. May also be a sub-harmonic.

7.3. Frequency Spectrum - The entire range of frequencies being considered.

7.4. Orthogonally - Consisting of the -*x*, -*y* and -*z* axes (three dimensional)

7.5. 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.]

7.6. RMS - Root Mean Squared. For sinusoidal waveforms, a value that is equal to the measured value multiplied by 1.414 (the square root of 2). Can also be determined by multiplying the peak value by 0.707.

7.7. Shall - Items which require adherence without deviation. Shall statements identify binding requirements. A go, no-go criterion.

7.8. Should - Items which require adherence if at all possible. Should statements identify preferred conditions.

7.9. Snapshot - A term given to the time frame that normally accompanies a single event or a number of concurrent events. Usually indicates a repetitive series of events is occurring or is meant to occur.

7.10. Test Director - The individual within Electric Transportation Applications responsible for all testing activities associated with HEV America.

7.11. 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.

7.12. 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.]

7.13. 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.]

7.14. Time Stamp - The arbitrary time zero (t_o) denoting the beginning of an event.

8. References

8.1 HEV America Vehicle Specification

8.2 IEEE-450 1987, “Recommended Practices for Stationary Lead Acid Storage Batteries”

8.3 ETA-HAC01 “Control, Close-out and Storage of Documentation”

8.4 ETA-HAC02 - “Control of Test Conduct”

8.5 ETA-HAC04 - “Review of Test Results”

8.6 ETA-HAC05 - “Training and Certification Requirements for Personnel Utilizing ETA Procedures”

8.7 ETA-HAC06 - “Receipt Inspection”

8.8 ETA-HTP03 - "Implementation of SAE J1634 May93 - Electric Vehicle Energy Consumption and Range Test Procedure”

8.9 ETA-HTP11 - “Vehicle Verification”

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

Vehicle VIN: ___________________________

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)

APPENDIX-B
Electro Magnetic Field Test
During the SAEJ1634 Cycle
Data Sheet (Page 1 of 1)

Sequence No:	File No.:	
Time (initial):	Time (final):	
Vehicle Temp (initial): (°F or °C)	Vehicle Temp (final): (°F or °C)	
Odometer Reading (initial): (Miles)	Odometer Reading (final): (Miles)	

Sensor at Passenger Seat	Maximum Value	Minimum Value	Average Value	Median Value	Standard Deviation
	mG	mG	mG	mG	mG
Background – Vehicle off					
Background – Vehicle on					
SAEJ1634					
Background – Vehicle on					
Background – Vehicle off					
Vehicle on Charge					

Comments (initials/date):

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

APPENDIX-C
Electro Magnetic Field Test
During the Three Speed Test
Data Sheet (Page 1 of 1)

Sequence No:	File No.:	
Time (initial):	Time (final):	
Vehicle Temp (initial): (°F or °C)	Vehicle Temp (final): (°F or °C)	
Odometer Reading (initial): (Miles)	Odometer Reading (final): (Miles)	

Mode of Operation	Drivers Seat		Passenger Seat		Rear Left Seat		Rear Right Seat	
	EMF	THD	EMF	THD	EMF	THD	EMF	THD
	mG	%	mG	%	mG	%	mG	%
Background – Vehicle off								
Background – Vehicle on								
Acceleration								
10								
25								
40								
Deceleration								
Background – Vehicle on								
Background – Vehicle off								
Vehicle on Charge								

Comments (initials/date): The reported values of magnetic field and total harmonic distortion are average values during the duration of the test

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

APPENDIX-D
Electromagnetic Radiation Test Data Sheet (Page 1 of 6)

Sequence No:	File No.:	
Time (initial):	Time (final):	
Micro Turbine Temp (initial): (°F or °C)	Micro Turbine Temp (final): (°F or °C)	
Run Time (initial): (Hours)	Run Time (final): (Hours)	

Electromagnetic Radiated Levels

Sensor Location:	1 m away from the **FRONT** of the vehicle
Mode of operation of the vehicle:	Constant Speed of **25 mph**

Frequency Range	Radiated level	Frequency Range	Radiated level	Frequency Range	Radiated level
kHz	dBµV/kHz	kHz	dBµV/kHz	MHz	dBµV/kHz
9 – 30		0.25 – 0.5		5.0 – 10.0	
30 – 60		0.5 – 1.1		10 – 20	
60 – 120		1.1 – 2.4		20 - 30	
120 – 250		2.4 – 5.0			

Comments (initials/date): The values of radiated field are peak values within a frequency range

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

APPENDIX-D
Electromagnetic Radiation Test
Data Sheet
(Page 2 of 6)

Sequence No:	File No.:	
Time (initial):	Time (final):	
Micro Turbine Temp (initial): (°F or °C)	Micro Turbine Temp (final): (°F or °C)	
Run Time (initial): (Hours)	Run Time (final): (Hours)	

Electromagnetic Radiated Levels	
Sensor Location:	1 m away from the **BACK** of the vehicle
Mode of operation of the vehicle:	Constant Speed of **25 mph**

Frequency Range	Radiated level	Frequency Range	Radiated level	Frequency Range	Radiated level
kHz	dBμV/kHz	kHz	dBμV/kHz	MHz	dBμV/kHz
9 – 30		0.25 – 0.5		5.0 – 10.0	
30 – 60		0.5 – 1.1		10 – 20	
60 – 120		1.1 – 2.4		20 – 30	
120 – 250		2.4 – 5.0			

Comments (initials/date): The values of radiated field are peak values within a frequency range

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

APPENDIX-D
Electromagnetic Radiation Test
Data Sheet
(Page 3 of 6)

Sequence No:	File No.:	
Time (initial):	Time (final):	
Micro Turbine Temp (initial): (°F or °C)	Micro Turbine Temp (final): (°F or °C)	
Run Time (initial): (Hours)	Run Time (final): (Hours)	

Electromagnetic Radiated Levels	
Sensor Location:	1 m away from the **LEFT SIDE** of the vehicle
Mode of operation of the vehicle:	Constant Speed of **25 mph**

Frequency Range	Radiated level	Frequency Range	Radiated level	Frequency Range	Radiated level
kHz	dBμV/kHz	kHz	dBμV/kHz	MHz	dBμV/kHz
9 – 30		0.25 – 0.5		5.0 – 10.0	
30 – 60		0.5 – 1.1		10 – 20	
60 – 120		1.1 – 2.4		20 - 30	
120 – 250		2.4 – 5.0			

Comments (initials/date): The values of radiated field are peak values within a frequency range

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

APPENDIX-D
Electromagnetic Radiation Test
Data Sheet
(Page 4 of 6)

Sequence No:	File No.:	
Time (initial):	Time (final):	
Micro Turbine Temp (initial): (°F or °C)	Micro Turbine Temp (final): (°F or °C)	
Run Time (initial): (Hours)	Run Time (final): (Hours)	

Electromagnetic Radiated Levels	
Sensor Location:	1 m away from the **RIGHT SIDE** of the vehicle
Mode of operation of the vehicle:	Constant Speed of **25 mph**

Frequency Range kHz	Radiated level dBµV/kHz	Frequency Range kHz	Radiated level dBµV/kHz	Frequency Range MHz	Radiated level dBµV/kHz
9 – 30		0.25 – 0.5		5.0 – 10.0	
30 – 60		0.5 – 1.1		10 – 20	
60 – 120		1.1 – 2.4		20 - 30	
120 – 250		2.4 – 5.0			

Comments (initials/date): The values of radiated field are peak values within a frequency range

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

APPENDIX-D
Electromagnetic Radiation Test Data Sheet
(Page 5 of 6)

Sequence No:	File No.:	
Time (initial):	Time (final):	
Micro Turbine Temp (initial): (°F or °C)	Micro Turbine Temp (final): (°F or °C)	
Run Time (initial): (Hours)	Run Time (final): (Hours)	

Electromagnetic Radiated Levels

Sensor Location:	1 m away from the **LOCATION WITH MAXIMUM EMI** of the vehicle
Mode of operation of the vehicle:	Constant Speed of **10 mph**

Frequency Range	Radiated level	Frequency Range	Radiated level	Frequency Range	Radiated level
kHz	dBµV/kHz	kHz	dBµV/kHz	MHz	dBµV/kHz
9 – 30		0.25 – 0.5		5.0 – 10.0	
30 – 60		0.5 – 1.1		10 – 20	
60 – 120		1.1 – 2.4		20 - 30	
120 – 250		2.4 – 5.0			

Comments (initials/date): The values of radiated field are peak values within a frequency range

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

APPENDIX-D
Electromagnetic Radiation Test
Data Sheet
(Page 6 of 6)

Sequence No:	File No.:	

Time (initial):	Time (final):
Micro Turbine Temp (initial): (°F or °C)	Micro Turbine Temp (final): (°F or °C)
Run Time (initial): (Hours)	Run Time (final): (Hours)

Electromagnetic Radiated Levels	
Sensor Location:	1 m away from the **LOCATION WITH MAXIMUM EMI** of the vehicle
Mode of operation of the vehicle:	Constant Speed of **40 mph**

Frequency Range	Radiated level	Frequency Range	Radiated level	Frequency Range	Radiated level
kHz	dBμV/kHz	kHz	dBμV/kHz	MHz	dBμV/kHz
9 – 30		0.25 – 0.5		5.0 – 10.0	
30 – 60		0.5 – 1.1		10 – 20	
60 – 120		1.1 – 2.4		20 - 30	
120 – 250		2.4 – 5.0			

Comments (initials/date): The values of radiated field are peak values within a frequency range

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

APPENDIX-E
Driver Interface Record
Test Data Sheet
(Page 1 of 1)

VIN Number: ____________________________

Radio Frequency Interference			
Procedure		**Interference?**	
Step:	**Instrument/Device:**	**Yes:**	**No:**
6.2.1	Cellular Phone		
6.2.2	Mobil Radio Scanning Over the 70 cm Band		
6.2.2	Mobil Radio Scanning Over the 2M Band		
6.2.3	Citizens Band Radio		
6.2.4	Portable Compact Disk Player		
6.2.5	Notebook Computer		
Comments (initials/date):			

Electromagnetic Susceptibility			
7.1.1	A Citizen's Band Radio Operating at 5 Watts Output		
7.1.2	Mobil Radio Antennae Operating at 7 Watts Output on the 70 cm Band		
	Mobil Radio Antennae Operating at 7 Watts Output on the 2M Band		
7.1.3	A Cellular Telephone		
Comments (initials/date):			

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