PERFORMANCE CHARACTERIZATION

1999 TOYOTA RAV4 EV – CONDUCTIVE

Panasonic NiMH Battery

SOUTHERN CALIFORNIA EDISON

An *EDISON INTERNATIONAL* Company

ELECTRIC TRANSPORTATION DIVISION

Report prepared by:

Alvaro Mendoza

Juan Argueta

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PURPOSE

The purpose of SCE’s evaluation of electric vehicles (EVs), EV chargers, batteries, and related items is to support their safe and efficient use and to minimize potential utility system impacts.

The following facts support this purpose:

- As a fleet operator and an electric utility, SCE uses EVs to conduct its business.
- SCE must evaluate EVs, batteries, and charging equipment in order to make informed purchase decisions.
- SCE must determine if there is any safety issues with EV equipment and their usage.
- SCE has a responsibility to educate and advise its customers about the efficient and safe operation of EVs.

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I. INTRODUCTION

The tests documented in this report characterize the performance of a 1999 Toyota RAV4 electric vehicle (SCE vehicle # 24551) equipped with Panasonic Nickel-Metal Hydride (NiMH) batteries and conductive charging. The tests performed were: weight certification, range, state of charge meter evaluation, sound level, acceleration, maximum speed, braking, power quality evaluation, and charger performance.

This report will also compare the Toyota RAV4 EV 1998 and 1999 models with conductive charging. The comparison is based on results of the April 1998 testing of the 1998 model (SCE vehicle # 23821), and the results of the August 1999 testing of the 1999 model. A second 1998 model vehicle (SCE vehicle # 24191) tested in December 1999, was used to compare results of acceleration, braking and maximum speed testing (page 8). Although this report includes a comparison between the two model years, more emphasis will be given to the 1999 model throughout the report.

Testing of both the 1998 and 1999 conductive RAV4 EVs was performed at the Electric Vehicle Technical Center (EV Tech Center), on the Urban and Freeway Pomona Loops, and the Pomona Raceway in Pomona, California. For detailed procedures used for the testing, please refer to the SCE Electric Vehicle Test Procedure in Appendix I, page 73.

II. MANUFACTURER'S SPECIFICATIONS

Vehicle Make:	Toyota
Model:	1999 RAV4 EV (Conductive)
Range:	130 miles city, 106 highway, 118 combined city and highway
Maximum Speed:	79 mph (governed)
Motor Type:	Permanent Magnet
Maximum Power:	50 kW (67 hp) (3100-4600 rpm)
Maximum Torque:	190 N-m (0-1500 rpm)
Transaxle:	Single speed, front wheel drive
Traction Battery	
Type:	Nickel-Metal Hydride (NiMH)
Manufacturer:	Panasonic
Model:	MHB-100
Capacity:	95 Ah (5-hour rate)
Number of Modules:	24
Nominal Pack Voltage:	288 V
Battery Pack Weight:	910 lb
Curb Weight:	3500 lb
GVWR:	4266 lb
Payload:	825 lb
Dimensions	
Length:	156.7 in.
Width:	66.7 in.
Height:	65.9 in.
Wheelbase:	94.9 in.

III. DEVIATIONS FROM THE SCE ELECTRIC VEHICLE TEST PROCEDURE

1. The battery capacity test was not performed.
2. The charger sound level test was not performed.

IV. RESULTS

A. Nameplate Data Collection

Please Refer to Appendix C on page 31, for the vehicle test Equipment List and Nameplate Data sheet, which records all applicable nameplate data, serial numbers, and ratings of the tested vehicles.

B. Weight Certification

Table 4-1. Weight Certification

	Front Axle		**Rear Axle**		**Total Weight**	
	1998	**1999**	**1998**	**1999**	**1998**	**1999**
GVWR (lb)	2258	2258	2297	2297	4266	4266
Curb Weight (lb)	1960 [1]	1940 [1]	1560 [1]	1560 [1]	3520	3500
Available Payload (lb)	298	318	737	737	**746** [2]	**766** [2]

[1] Front and rear weights are not certified.
[2] Specified payload on vehicle door sticker: 825 lb.

C. Range Tests

C1. Urban Range Tests

Table 4-2. Urban Range Test Results*

Tests	UR1		UR2		UR3		UR4	
	1998	1999	1998	1999	1998	1999	1998	1999
Range at Stop Condition (mi.)	91.7	93.0	77.9	84.0	79.6	85.0	73.7	72.3
Total Miles Driven	93.0	93.5	78.4	84.9	80.0	85.6	74.4	75.9
Driving Conditions								
Payload (lb)	190	180	190	180	746	766	746	766
Avg. Amb. Temp. °F	54.0	82.0	59.0	80.5	57.0	72.0	58.0	83.3
Average Speed (mph)	23.0	23.3	24.0	24.1	27.0	24.5	27.0	25.6
Recharge								
AC kWh Recharge	31.56	33.21	30.73	31.35	32.31	30.28	33.38	33.10
AC kWh/mi.	0.339	0.355	0.392	0.369	0.404	0.354	0.449	0.436

*Average of two tests.

UR1: Pomona loop range test with minimum payload
UR2: Pomona loop range test with minimum payload and auxiliary loads
UR3: Pomona loop range test with maximum payload
UR4: Pomona loop range test with maximum payload and auxiliary loads

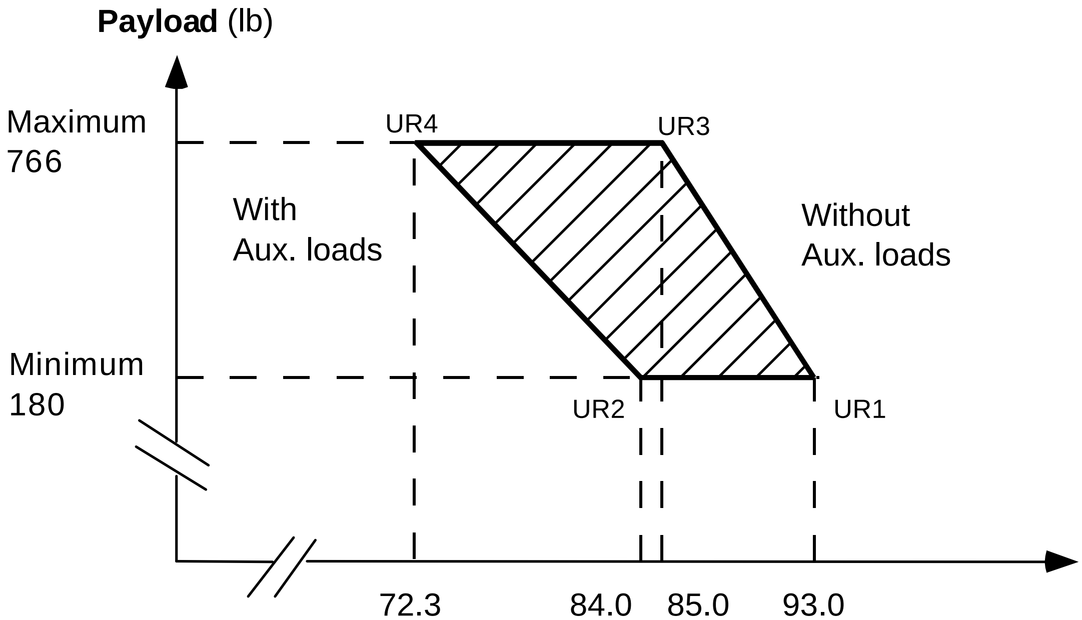


Figure 4-1. 1999 RAV4 EV Urban Range Envelope

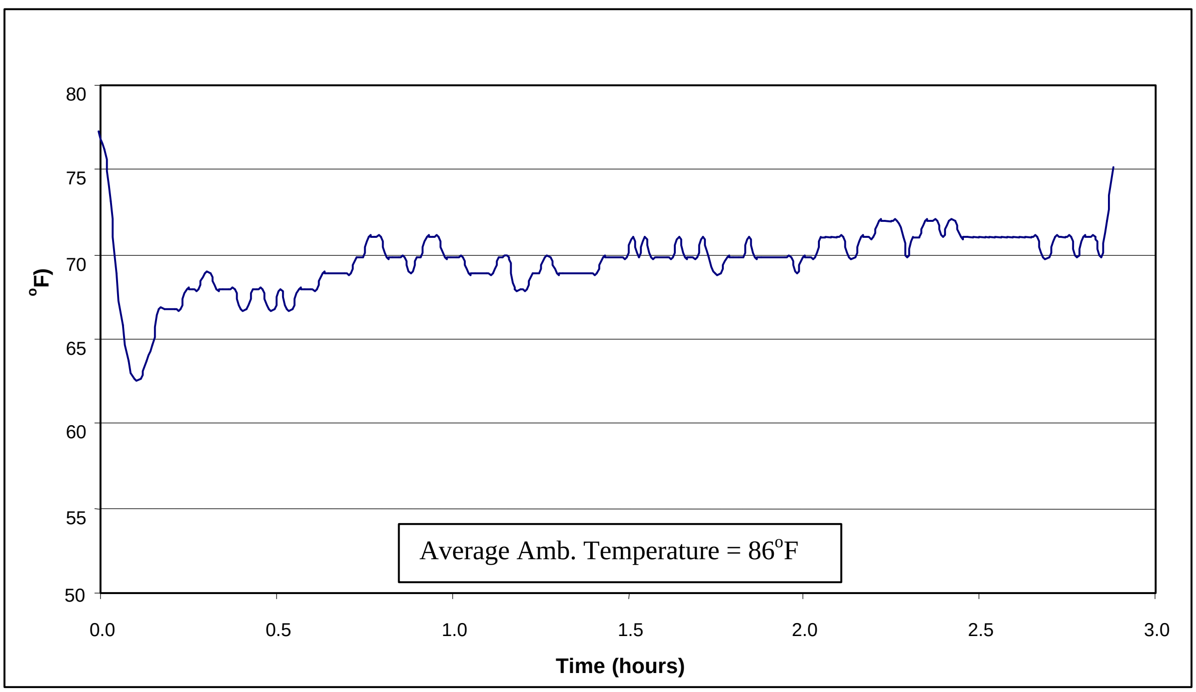


Figure 4-2. 1999 RAV4 EV cabin temperature recorded with A/C on during the second UR4 range test.

C2. Freeway Range Tests

Table 4-3. Freeway Range Test Results*

Tests	FW1		FW2		FW3		FW4	
	1998	1999	1998	1999	1998	1999	1998	1999
Range at Stop Condition (mi.)	88	82.3	85.2	78.4	81.5	80	81.8	74.6
Total Miles Driven	89.2	82.8	86	79.2	82.1	80.3	82.1	75.6
Driving Conditions								
Payload (lb)	190	180	190	180	746	766	746	766
Avg. Amb. Temp. ^{o} F	59	84	64	79	62	81	63	83.5
Average Speed (mph)	59	44.7	49	48.7	52	47.2	33	46.1
Recharge								
AC kWh Recharge	31.44	30.98	31.8	32.36	33.2	32.86	34.49	30.96
AC kWh/mi.	0.352	0.374	0.365	0.409	0.404	0.409	0.420	0.410

*Average of two tests.

FW1: Freeway loop range test with minimum payload
FW2: Freeway loop range test with minimum payload and auxiliary loads
FW3: Freeway loop range test with maximum payload
FW4: Freeway loop range test with maximum payload and auxiliary loads

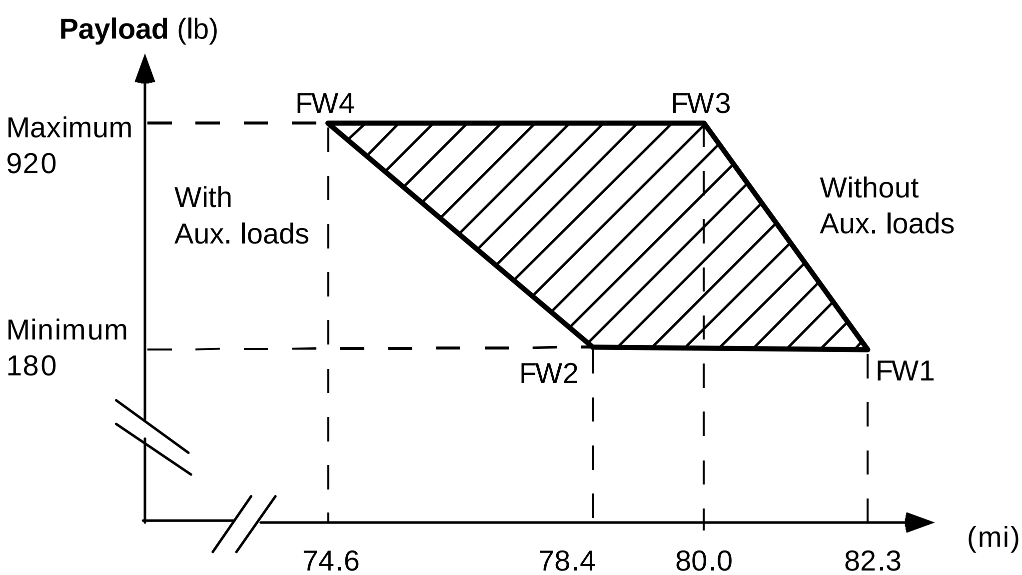


Figure 4-3. 1999 RAV4 EV Freeway Range Envelope

D. State of Charge (SOC) Meter Evaluation

D1. Driving State of Charge (SOC) Meter Evaluation

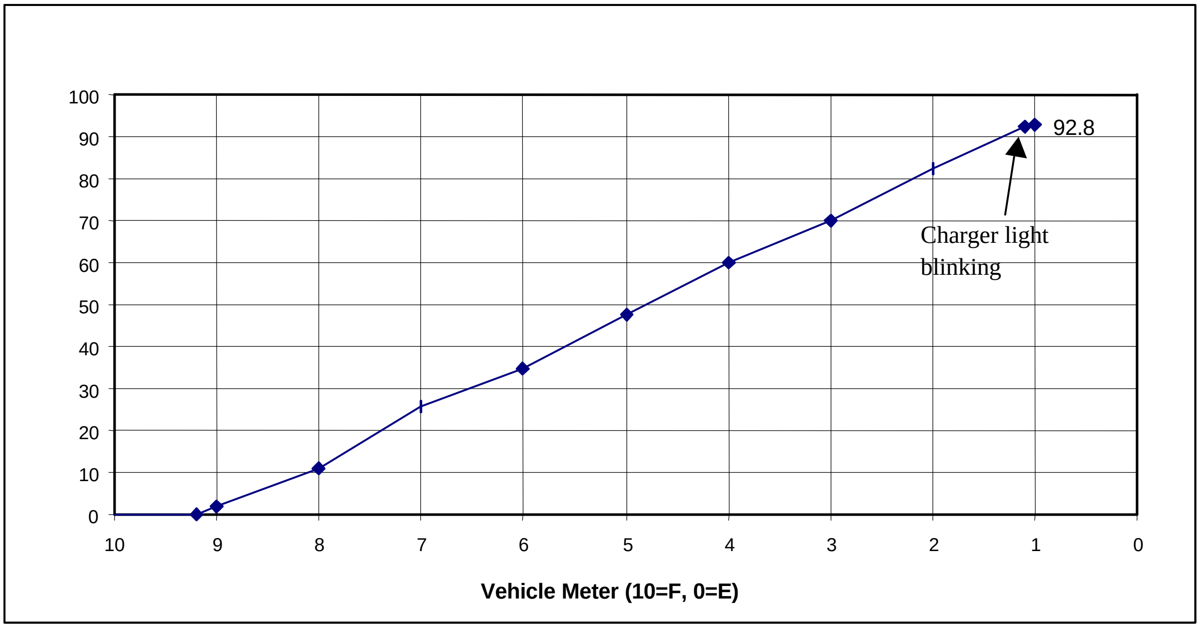


Figure 4-4. 1999 RAV4 EV State of Charge meter readings as a function of miles driven. Meter numbers are shown in Figure 4-5.

Figure 4-5. 1999 RAV4 EV SOC and traction battery voltage gages.

Note: The numbers on the SOC scale were added to this figure.

D2. Charging State of Charge Meter Evaluation

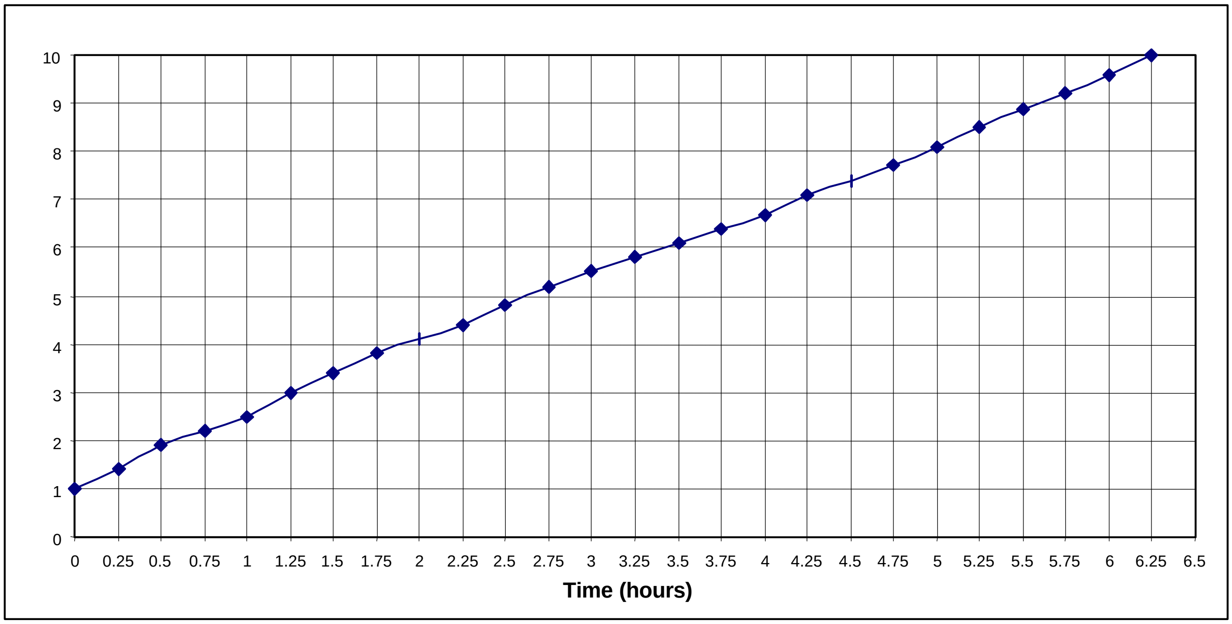


Figure 4-6. 1999 RAV4 EV SOC meter evaluation while charging vehicle (starting ambient temperature: 82^0 F).

E. Acceleration, Braking and Maximum Speed Tests

Table 4-4. 1998 RAV4 EV Summary of Results[1]

	100% SOC	80% SOC	60% SOC	40% SOC	20% SOC
0 to 30 mph (sec.)	5.00	5.02	5.00	5.15	5.01
30 to 55 mph (sec.)	9.34	9.58	9.53	9.70	9.19
0 to 60 mph (sec.)	16.28	16.16	15.83	17.27	15.76
Max Speed (mph)	74.75	*	*	*	76.25
Braking (25-0 mph) (ft.)	*	*	24.80	*	*

[1] Average values (ambient temperature: 45-68^0 F). (150 lb. Payload)
* Not tested
Note: These results are for a 1998 RAV4 EV tested in December 1999.

Table 4-5. 1999 RAV4 EV Summary of Results[1]

	100% SOC	80% SOC	60% SOC	40% SOC	20% SOC
0 to 30 mph (sec.)	4.88	5.06	5.05	5.11	5.04
30 to 55 mph (sec.)	9.40	9.53	9.39	9.44	9.50
0 to 60 mph (sec.)	15.30	16.10	16.19	16.70	15.95
Max Speed (mph)	77.00	*	*	*	77.50
Braking (25-0 mph) (ft.)	*	*	29.00	*	*

[1]Average values (average ambient temperature: 83^{0} F). (150 lb. Payload)
* Not tested

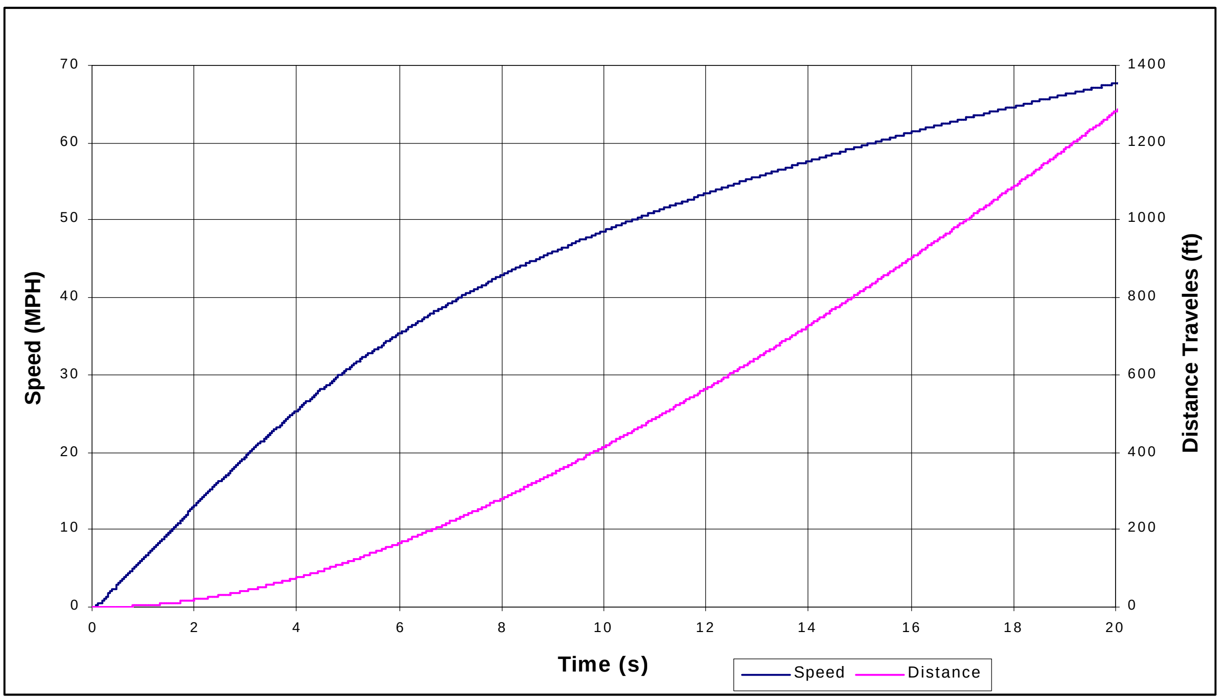


Figure 4-7. 1999 RAV4 EV acceleration and distance performance testing.

Note: Performance testing results were obtained using a Vericom VC2000PC performance computer.

F. Charger Performance / Profile Test

F1. Charger Performance / Profile Test at EV Tech Center

Table 4-6. Charger Profile Data

Measured Value[1]	1998 RAV4 EV	1999 RAV4 EV
Voltage	209.4 Vrms	232.8 Vrms
Current	24.31 Arms	21.20 Arms
Real Power	5.043 kW	4.899 kW[2]
Reactive Power	695.7 VAR	573.8 VAR
Apparent Power	5.092 kVA	4.935 kVA
Total Power Factor	0.99 PF	0.99 PF
Displacement Power	0.99 dPF	0.99 dPF
Voltage THD	0.5%	2.1%
Current THD	N/A	2.6%
Current TDD	2.0%	2.1%
Total Charging Time	6 hours, 30 minutes	6 hours, 17 minutes[3]
Total Energy Consumption	32.31 AC kWh	30.97 AC kWh
Time Observed on Stand-by	24 hours	24 hours
Energy Consumption	0.195 kWh	0.313 kWh
Average Power	8.0 W	13.07 W

Note: Refer to Appendix G, page 58, for BMI Power Profiler graphical data (1999 model). Data was recorded after the 2nd FW4 test.

[1] Values recorded with charger near maximum power on the AC (input) side of the charger.
[2] Maximum recorded instantaneous real power was 5.078 W.
[3] Average ambient temperature: 78°F.

1. Equalization and Thermal Management Charging Profile

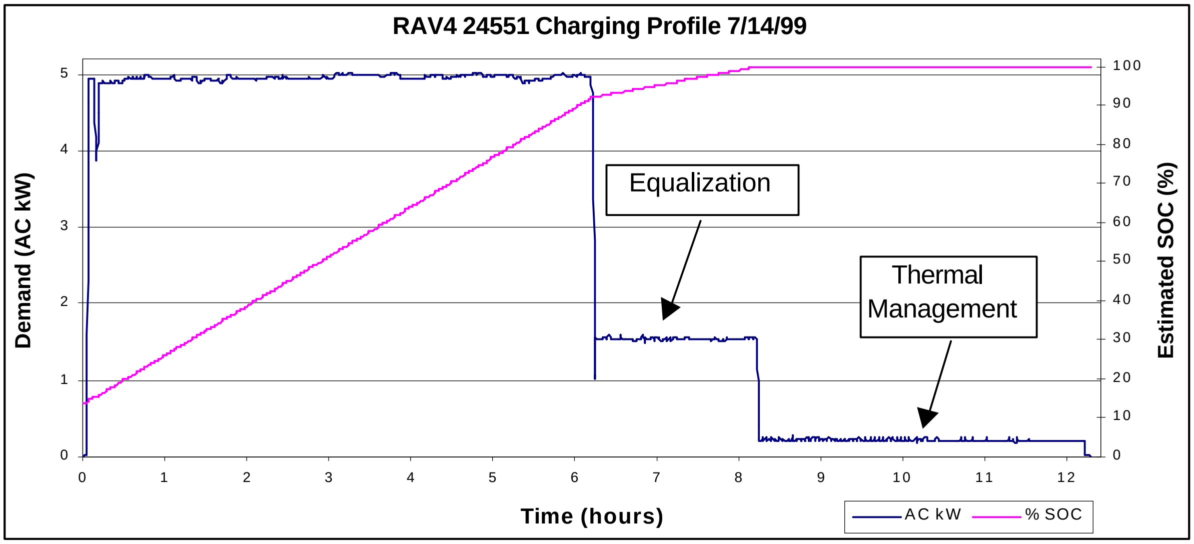


Figure 4-8. 1999 RAV4 EV AC charging profile form ABB meter (first UR1 test).

Note: Charging equalization occurs about every ten cycles. The thermal management step is independent of frequency of charging and occurs whenever the battery temperature is high. Ambient temperature at start of charge: 88^0 F (see discussion section).

2. One-Step Charging Profile

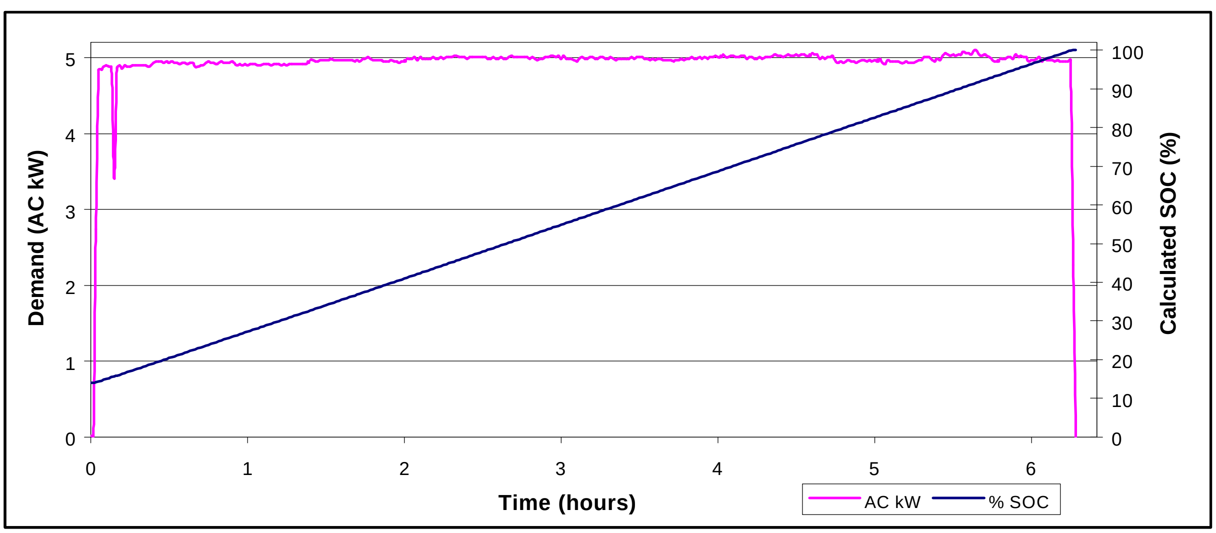


Figure 4-9. 1999 RAV4 EV AC charging profile from ABB meter (second FW4 test).

Note: Charging was applied 14 hours after the end of drive test using the charge timer on vehicle. Ambient temperature at start of charge: 78^0 F (see discussion section).

F2. Charger Performance at Residence

Table 4-7. Charger Profile Data (1999 RAV4 EV only).

Measured Value[1]	1999 RAV4 EV
Voltage	250.3 Vrms
Current	19.27 Arms
Real Power[2]	4.799 kW
Reactive Power	462.2 VAR
Apparent Power	4.823 kVA
Total Power Factor	1.0 PF
Displacement Power	1.0 dPF
Voltage THD	1.0%
Current TDD	1.4%

Total Charging Time	6 hours, 15 minutes
Total Energy Consumption	31.09 AC kWh

Note: Refer to Appendix H, page 66, for BMI Power Profiler graphical data.

[1] Values recorded with charger near maximum power on the AC (input) side of the charger (240 V).
[2] Maximum recorded instantaneous real power was 4.923 W.

G. Sound Level Tests*

G1. Urban Sound Level Test

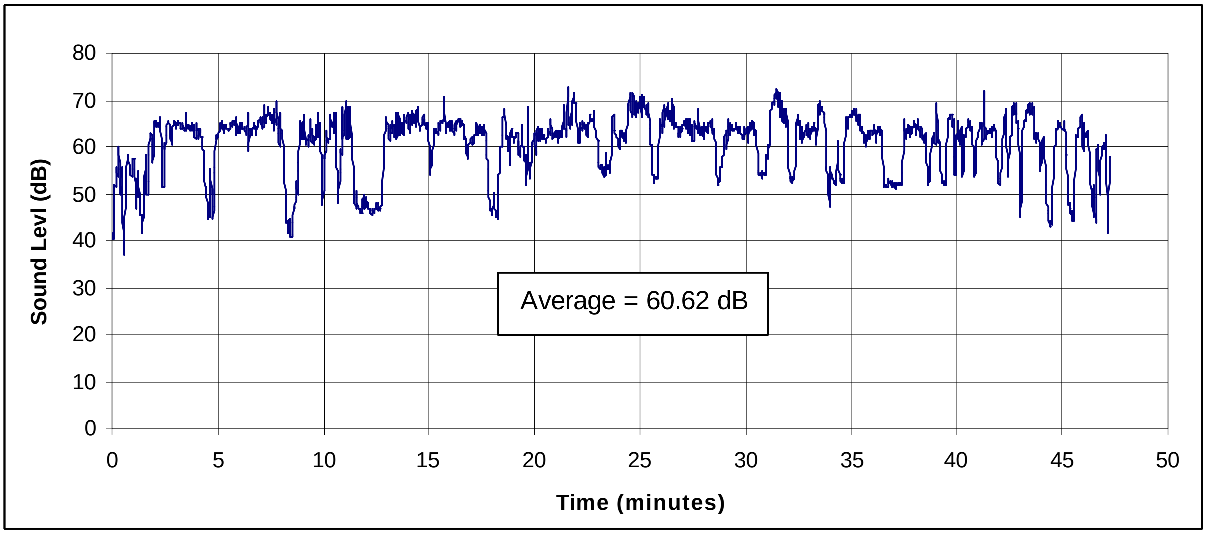


Figure 4-10. Sound intensity in dB recorded during a driving test on the Urban Pomona Loop.

G2. Freeway Sound Level Test

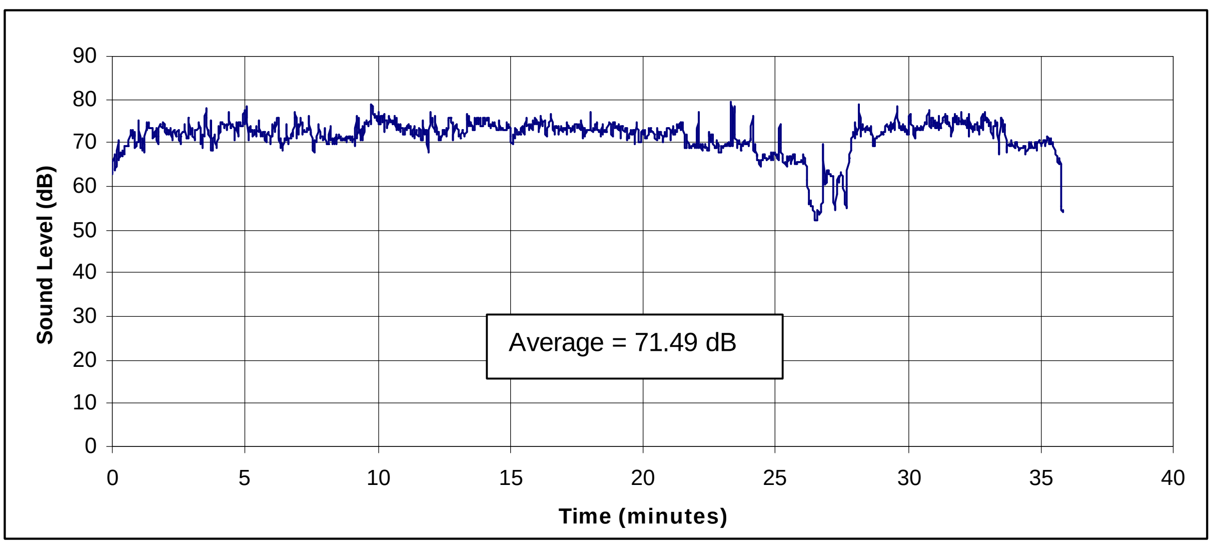


Figure 4-11. Sound intensity in dB recorded during a driving test on the Freeway Loop.

* Sound level testing was not performed on the 1998 RAV4 EV model.

V. DISCUSSION

A. Weight Certification

Both 1998 and 1999 conductive RAV4 EVs were taken to a certified scale to measure the front axle, rear axle, and total weight. The 1998 model weighed twenty pounds more than the 1999 model. The manufacturer's gross vehicle weight rating (GVWR) label on both models is 4266 pounds, and the specified payload is 825 pounds. The GVWR minus the total curb weight yielded a payload of 746 pounds for the 1998 model and 766 pounds for the 1999 model. Both vehicles were loaded to their resulting payload for the maximum payload tests. The load was evenly distributed on the vehicles when they were loaded to their maximum legal weight (766 lb payload). The figures below show the weight added to the front and rear passenger compartment, and the cargo area of the 1999 model.

Figure 5-1. Rear passenger compartment loaded With 350 lbs.

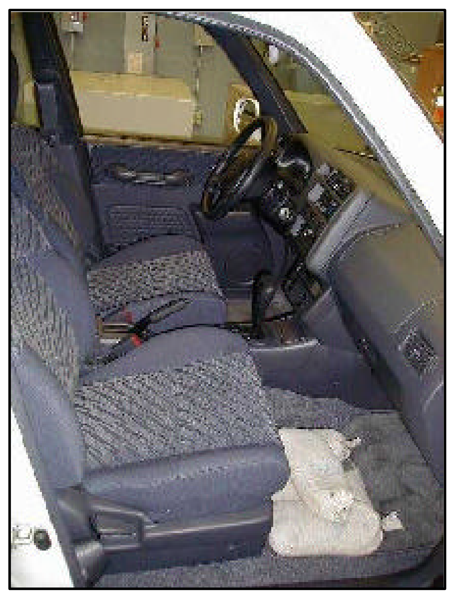


Figure 5-2. Front passenger compartment loaded with 280 lbs. including driver weight.

Figure 5-3. Cargo area loaded with 150 lbs.

B. Range Tests

The traction motor of both 1998 and 1999 RAV4 EVs can be used as a generator to convert kinetic energy into electric energy during braking and thereby extend the vehicle range. Regenerative braking occurs during deceleration when the selector lever is in the "D" mode with the "EB" (engine braking effect) button on. For more braking effect (driving downhill), "B" can be selected via the selector lever.

Figure 5-4. RAV4 EV selector lever.

The RAV4 EV also has a “creep” feature that slowly moves the vehicle forward when in gear with the brakes released. Testing on the Pomona Loop (city driving) was conducted with “EB” on and the selector in “D”. On the freeway, testing was done with “EB” off and the selector in “D” in order to avoid excessive speed reduction as a result of engine braking effect when the accelerator pedal was released.

To perform range tests, the driving was done in a manner that was safe and compatible with the flow of traffic at or below the posted speed limits. As the Electric Vehicle Test Procedure indicates, the range tests were repeated until the range result was within 5.0% of the previous result. To accomplish this, it was only necessary to perform each of the eight different range tests twice, except the FW1 and FW3 tests of the 1999 model which had to be done three times.

The instrument panel of the RAV4 EV is equipped with a charger light that is located below the traction battery SOC meter (see figure 4-5, page 7). This light illuminates when the SOC meter indicator reaches the yellow zone, and starts flashing when it reaches the top of the red zone. To be consistent with all range tests, the vehicles were driven until the charger light flashed. Acceleration and braking of these vehicles seemed responsive at all times, and they never had trouble keeping up with the flow of traffic during the range tests. However, acceleration was slower when the range tests were conducted at maximum payload, as would be expected.

B1. Urban Range Tests

To test the RAV4 EVs in a city driving environment, both vehicles were driven on the Urban Pomona Loop to their maximum range as defined above. The maximum speed of the RAV4 EVs varied between 30 and 50 mph according to posted speed limits. The vehicles were driven and charged only once per day, and at least four loops were completed for each of the four urban drive scenarios, except in the case of the UR4 tests. During the UR4 range tests, the available energy was not enough to complete four loops. Therefore, three complete loops were accomplished during this range test, and driving continued until the SOC dropped to the desired level.

The highest range achieved on both models during city driving (93.0 miles) occurred when the vehicles were driven at minimum payload and without auxiliary loads (UR1 tests). This range also represents the highest achieved for all of the eight range test scenarios.

As seen from the range envelope (Figure 4-1, page 5), variations in payload and auxiliary loads (air conditioning and headlights) clearly affected the range of the 1999 RAV4 EV. Auxiliary loads usage with the vehicle unloaded (driver only) reduced the range by 9.7%. Maximum payload reduced the range by 8.6%. When the vehicle was driven with both auxiliary loads and maximum payload, the range decreased by 22.3%.

Energy consumption on both models was similar for most of the recharging cycles since the driving was stopped until the SOC (as marked by the vehicle's SOC meter) was 10%. The average energy supplied during charging after urban range testing was 31.75 and 31.99 AC kWh on the 1998 and 1999 models respectively.

It was observed that during hot days, as in the case of the second UR4 test (1999 model), the air conditioning works harder and makes more noise. During the same test, a thermocouple temperature logger was used to continuously record the temperature of the cabin temperature. The thermocouple was placed at the front passenger's seat, at chest level. The average recorded cabin temperature with the thermocouple temperature logger set to take readings every minute was 69.6 ^{o}F. As seen from Figure 4-2, page 5, the cabin temperature was relatively constant throughout the drive.

Air conditioning temperatures were also measured from the A/C outlet air from the center cabin vent. The UR2 range tests of the 1999 model averaged a minimum of 47.3 ^{o}F, while the average minimum during the UR4 tests was 45.2 ^{o}F.

B2. Freeway Range Test

Traffic conditions were good on the freeway for all the driving range tests, and the speed was kept as close to 65 mph as traffic would allow. The recorded range included urban driving of approximately 4 miles to access the freeway and ½ mile each loop to transition between freeways. Although there were differences in range on the freeway between all of the eight range test scenarios, the range obtained on freeway testing reflects more consistency as compared to the set of ranges obtained from the urban range tests.

The highest range obtained from freeway driving (82.3 miles) was from the 1999 model range tests at minimum payload and without auxiliary loads (average of FW1 tests). As in the case of urban range tests, variations in payload and auxiliary loads reduced the range of both RAV4 EV models.

Results for the 1999 model indicate that auxiliary loads usage with the vehicle unloaded (driver only) reduced the range by 4.7%. Maximum payload reduced the range by 2.8%. When the vehicle was driven with both auxiliary loads and maximum payload, the range decreased by 9.4%.

Energy consumption after freeway range testing was also similar on both vehicles for most of the tests. The average energy supplied was 31.79, and 32.73 AC kWh on the 1998 and 1999 models respectively.

C. State of Charge Meter Evaluation

The SOC (state of charge) meter in both vehicles is identical. As shown in Figure 4-5 on page 7, the SOC meter is located on the right side of the instrument panel. This meter gives an estimate of the traction battery's state of charge whenever the vehicle is on, or during charging. A traction battery voltmeter is also included on the right side of the SOC meter, as shown in Figure 4-5. It gives an approximation of the actual voltage of the traction battery.

The SOC meter consists of ten segments, eight green, one yellow and one red. According to the manufacturer, the yellow zone is the area where application of charge is recommended, and the red zone is the area where immediate application of charge is necessary. For convenience, the SOC scale on Figure 4-5 (page 7) was marked with numbers starting from 0 at E (Empty), and ending with 10 at F (Full). A warning light supplements the gauge when the SOC indicator enters the yellow zone ("2" in Figure 4-5) which corresponds to about 20% SOC. The light flashes when the indicator enters the red zone, which corresponds to about 10% SOC.

For both models, the SOC meter was found to be accurate and easy to use. A linear relationship could be made with regards to the state of charge readings and miles driven. As seen in Figure 4-4 on page 7, the relationship between the SOC and miles driven was also linear for 1999 model.

It should be noted that the SOC indicator on the 1999 model went to the top of the SOC meter after a complete charge, but went down to just above the ninth line within a few hours (see Figure 4-5, page 7 for a picture of the SOC meter). This behavior was not observed on the 1998 model. According to the manufacturer, the 1999 model had some improvement on the SOC calculation software. They also claim that self-discharge calculation occurs immediately after the vehicle is fully charged, and the SOC meter adjusts itself accordingly.

C1. Driving

The SOC meter indicator rotates in a clockwise direction during driving. The driving distance was recorded using the odometer at intervals corresponding to the RAV4 EV's SOC meter levels. The SOC meter evaluation shown on Figure 4-4, page 7, can be useful in estimating the distance the vehicle can travel at particular SOC meter levels with a consistent driving style.

C2. Charging

As shown in Figure 4-6 on page 8, the SOC meter also displayed a near-linear pattern while charging. This plot can be very useful in estimating, at any particular SOC, the time required to achieve a full charge. The linear behavior of the SOC meter throughout this particular charge suggests that the charger provided the vehicle with a relatively constant peak power charge. A charging profile of this type would look similar to the plot shown in Figure 4-9, page 11. The total charging time was 6 hours and 25 minutes, starting at 10% SOC (as indicated by the vehicle SOC meter). The charging SOC meter evaluation was conducted on the 1999 model the day after a full range test.

D. Acceleration, Braking, and Maximum Speed Tests

Performance testing of both RAV4 EV models took place at the Pomona Race Track. A recently acquired performance-testing computer was used to determine the braking distance from 25 to 0 mph, and the acceleration from 0 to 30 mph and from 0 to 60 mph. The VC2000PC by Vericom Computers, Inc. uses an accelerometer to determine acceleration, speed, and distance 100 times per second. The computer is also able to calculate the power developed at the wheels. The average of two runs was used for each of the acceleration tests performed. The average of the two runs takes slope and head wind into account when each test is done in opposite directions. A total of four runs were completed for the braking test, two in each direction.

It is important to note that the results of the 1998 RAV4 EV illustrated in the April, 1998 report were obtained using a stop watch and a measuring wheel. In order to make a good comparison between the 1998 and 1999 RAV4 EVs, a different 1998 RAV4 EV was tested in December 1999 using the VC2000PC computer, and the results are shown on page 8.

Both vehicles responded very reliably and consistently, with no noticeable drop in power as the state of charge decreased. It was observed that during take off a strong torque steer was present because of the vehicle's front-wheel drive setup.

The average acceleration from 0 to 30 mph took 5.03 seconds on the 1999 model, and 5.04 seconds on the 1998 model. From 0 to 60 mph, acceleration took 16.26 seconds on the 1998 model, and 15.30 seconds on the 1999 model. The 30 to 55 mph average was 9.47 seconds on the 1998 model, and 9.35 seconds on the newer model. These results show that it takes about double the time to accelerate from 30 to 55 mph than what it takes to accelerate form 0 to 30 mph.

Both models were tested for maximum speed at 100% and 20% SOC. At 100% SOC, the average speed calculated from two runs was 74.8 mph on the 1998 model, and 77.0 on the 1999 model. At 20% SOC, the average speed obtained from two runs was 76.3 mph on the 1998 model and 77.5 mph on the 1999 model. It is important to note that the maximum speed recorded was limited by the available length of the test track, which was 0.6 miles.

The average braking distance of the 1998 model from 25 to 0 mph at 100% SOC was 24.8 feet, while on the 1999 model this distance was 29.0 feet at 60% SOC. No skidding was noticed on either vehicle. The 1999 version was tested for turning radius, and the average of two measurements was 17 feet and 10 inches.

E. Charger Performance / Profile Test

Charging of the RAV4 EV is achieved with the on-board Toyota charger connected to a conductive EVSE (Electric Vehicle Supply Equipment), see Figure 5-5 below. The ICS-200 unit uses a generated voice to interact with the user and stores time and energy data for charging cycles.

Figure 5-5. Charger testing with ICS-200 unit.

According to the manufacturer, the vehicle's thermal control system monitors the temperature of the traction battery in order to provide cooling whenever a predetermined threshold is reached. For example, if the traction battery temperature is high at the end of charging, the charger provides the vehicle with a relatively low power (around 0.2 kW) in order to run the battery's cooling fan. This cooling process takes energy only from the AC source, not from the battery. Figure 4-8, page 11, shows a charging profile with a cooling step at the end of full charge on the 1999 RAV4 EV model. This figure also shows a charging equalization process that occurs about every ten charging cycles. Figure 4-9, page 11, shows a one-step charging profile. This charge was applied with the use of the vehicle's charge timer. When the charge timer was used to charge at a later time (under more economical rates, and cooler ambient temperatures), charging normally took a little more than 6 hours to complete. The starting state of charge on both charging profiles was calculated using the manufacturer's specified SOC of 15% at the point where the SOC meter indicator points to the top of the red area, and the charger light in the control panel starts blinking.

E1. Charger Performance at the EV Tech Center

As shown in Table 4-6, page 10, no major differences were observed between the two models. The instantaneous peak power recorded with a snapshot using the BMI Power Profiler on the 1998 model was 5.043 kW, with a current of 24.31 A rms, and a voltage of 209.4 V rms.

Figure 5-4. BMI Power Profiler.

The 1999 model showed an instantaneous peak power of 4.899 kW, with a current of 21.20 A rms, and a voltage of 232.8 V rms.

Charging of the 1998 model during this particular test took six hours and thirty minutes for approximately 15% to 100% SOC and consumed 32.31 AC kWh. The power factor was 1.0 and the displacement power factor was also 1.0. The voltage total harmonic distortion (THD) was 0.5%, and the current total demand distortion (TDD) was 2.0%. Starting at about the same SOC, the 1999 model charged for six hours and seventeen minutes, and the energy delivered to the vehicle was 30.97 AC kWh. Both the power and displacement power factors were 0.99. The voltage THD was 2.1%, the current THD was 2.6% and the current TDD was 2.1%. All values obtained are well within the limits set by the National EV Infrastructure Working Council (IWC), and the Institute of Electrical and Electronics Engineering (IEEE) 519, 1992 guidelines.

E2. Charger Performance Test at Residence

The same ICS-200 unit was used to perform the residential charging test on the 1999 model. The vehicle was discharged to the same level as done for the range tests in order to collect full charge data using the BMI power profiler. The results obtained from this test are very similar to those obtained from the charger performance test at the EV Tech Center. As shown in Table 4-7 on page 12, the peak power was 4.799 kW, 0.1 kW below the EV Tech Center readings. The current at this power level was 19.27 A rms, and the voltage was 250.3 V rms. The power factor was 1.0, and the displacement power factor was also 1.0. The voltage THD was 1.0%, and the current TDD was 1.4%. The total energy consumption was 0.12 kWh higher than at the EV Tech Center (31.09 kWh), and the time required to completely charge was 6 hours and 15 minutes. These values are also well within the ICW and IEEE guidelines.

F. Sound Level Tests

Sound level testing was done only on the 1999 model. These tests were conducted using a sound level meter set at a frequency range of 20Hz to 8 kHz. The measuring level was adjusted to measure sound intensity from 30 dB to 130 dB, and the sampling rate was two seconds. The sound level meter was mounted on a tripod, as seen in Figure 5-6, and placed on the vehicle's front passenger seat at ear level. As indicated by Figures 4-10 and 4-11 on page 13, the sound level during the urban test varied over a broader range than the freeway test. The average sound level recorded during the urban sound level test was 60.62 dBs, while the average sound level recorded during freeway testing was 71.49 dBs.

Figure 5-6. Sound level meter test setup.

The sound level recorded during the range tests does not necessarily represent the noise emitted solely form the vehicle. Although the vehicle's windows were closed throughout the tests, ambient noise was also recorded. Sound levels were higher during freeway tests since at higher speeds the vehicle's wind noise level is higher. For this reason, the plot of the freeway driving test (Figure 4-11) shows a more consistent, but higher on average, noise level as compared to the urban test.

APPENDIX A

VEHICLE MANUFACTURER'S FACT SHEET

TOYOTA

RAV4 EV

The popular RAV4 will soon be available to fleet users as an electric vehicle. The front-drive, four-door Toyotas will be among the first mass-produced vehicles to use advanced nickel-metal hydride batteries with twice the power of lead-acid batteries. With a combined per-charge range of 118 miles and an electronically controlled top speed of 79 mph, the RAV4-EV is a serious player in the race for zero emissions.

STANDARD FEATURES

Front-wheel drive, 5-passenger, 4-door vehicle
Dual air bag Supplemental Restraint System (SRS)*
Fully reclining front and rear seats
Low-energy heat pump-type CFC-free air conditioning
Power windows, door locks and mirrors
Deluxe AM/FM stereo with cassette
Heated seats (driver and front-passenger)
Heated and tinted windshield
Rear window defogger and wiper
Control panel with pre-heat and pre-cool cabin function
Concealed spare tire
195/80R16 low rolling resistance steel-belted radial tires
50/50 split fold-down (and up) rear seats
Cold Weather Package available

*To help avoid serious injury, always wear your seatbelt. Driver and front-passenger air bags are a supplemental restraint only.

EXTERIOR	Overall length	156.5 in.	INTERIOR, FRONT/REAR	Head room	40.3 in./39.0 in.	CURB WEIGHT	3,439 lbs.
	Overall width	66.7 in.		Shoulder room	53.1 in./53.1 in.	GROUND CLEARANCE	8.0 in.
	Overall height	65.7 in.		Hip room	55.9 in./56.0 in.	PAYLOAD CAPACITY	827 lbs.
	Wheelbase	94.9 in.		Leg room	39.5 in./33.9 in.	CARGO VOLUME	31.4 cu. ft. (behind rear seats)

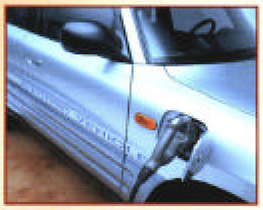
Note: 1998 model shown, the vehicle used for performance characterization was a 1999 conductive RAV4 EV.

Note: 1998 model shown, the vehicle used for performance characterization was a 1999 conductive RAV4 EV.

In the RAV4-EV, a lightweight and responsive permanent-magnet motor powers the front wheels through a single-speed transaxle. This maintenance-free air-cooled motor is "fueled" by 24 12-volt (288 volts) nickel-metal hydride batteries located under the vehicle's floor.

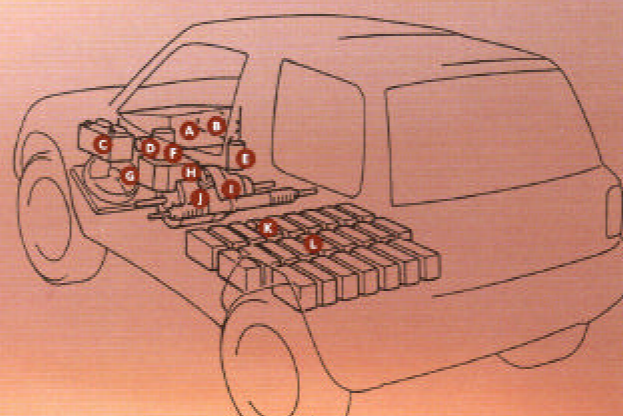
The on-board charger lets you recharge the batteries using 220-volt household current. With the built-in timer, you can charge conveniently during off-peak hours when electricity is cheapest. ECUs (electronic control units) monitor the charging rate, as well as control the motor output in response to acceleration and braking.

The low rolling resistance tires exclusively developed for EVs, along with the regenerative brake system, convert the kinetic energy of braking into electrical energy, thus increasing the vehicle's single-charge driving range.



POWERTRAIN	Motor	50-kW, 67 hp @ 2,600-2,800 rpm permanent-magnet
	Transaxle	Single-speed, front-wheel drive
BATTERIES	Type	Sealed nickel-metal hydride, 24 12-volt units; one 12-volt lead-acid auxiliary battery
	Charger	On-board, 220-volt/40-amp conductive with timer
	Recharge time	6-8 hours
PERFORMANCE	City/highway/ combined range	130/106/118 miles per charge**
	Acceleration, 0-60 mph	17 seconds
	Top speed	79 mph (electronically limited)
SUSPENSION	Independent MacPherson strut front/ double-wishbone coil-spring rear	
STEERING	Vehicle speed-sensing electro-hydraulic power steering	
BRAKES	Power-assisted front disc/rear drum ABS brakes with regenerative function	

**Actual range may vary based on driving habits.



- A control unit box
- B compressor (for A/C)
- C auxiliary battery
- D hydraulic brake accumulator
- E accumulator (for A/C)
- F vane pump (for power steering)
- G heat exchanger (for A/C)
- H inverter
- I transaxle
- J motor
- K safety plug
- L main batteries

PT7-366 (3/97)
Litho in U.S.A. (SM)

APPENDIX B

BATTERY MANUFACTURER'S FACT SHEET

主要諸元 Principal specifications

形式 Type	MHB-100
公称電圧 Nominal Voltage	12V
公称容量 Nominal Capacity	100Ah
外形寸法 Dimensions	W116×L388×H175
重量 Weight	17.2kg
エネルギー密度 Specific Energy	70Wh/kg

EV用ニッケル·水素蓄電池周辺機器
Peripherals for Ni/Metal-Hydride Battery for EVs

当社は、高性能ニッケル·水素蓄電池の特性をフルに発揮する電池マネジメントシステム及び充電器をセットにして、ユーザーに提供します。

Matsushita Battery provides users with the cha er and the battery management system wh maximize the performance of the Ni/MH batter

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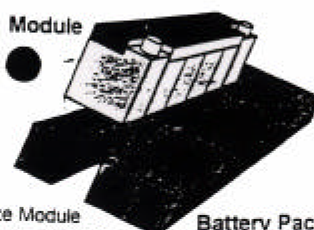
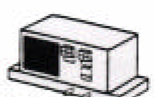
ニッケル·水素蓄電池と周辺機器のコンセプト
Configuration of Ni/MH Battery and its Peripherals

Module



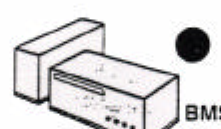
Battery Pack

- Standard Size Module
- 100Ah, 200W/kg, 1000Cycle
- Excellent Thermal Management
- Uniformity in Performance
- Higy Reliability



On Board Charger

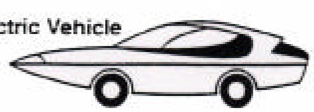
- High Power Factor
- Non-Insulate, Water Cooling
- With Vehicle Interface



BMS

- User-Friendly BMS
- Battery-Friendly BMS

Electric Vehicle



EV用ニッケル・水素蓄電池
Ni/Metal-Hydride Battery for Electric Vehicles

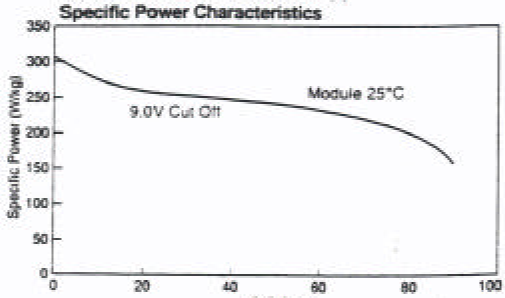
「あらゆる生命の源、母なる地球のためにいま私たちができること」松下電池工業はそんな視点から、地球環境を大切に考えた色々な活動を推進しています。
排気ガスはもちろん騒音も殆どなく、多様なエネルギー源による電気を動力源とする電気自動車(EV)が次世代の乗り物として注目を集めています。より豊かで快適な未来の創造に向けて松下電池工業は総合技術力を結集し、本格的EV用の蓄電池として、人と環境に優しい、EV用ニッケル・水素蓄電池を開発し、'98年に向けて量産化技術の開発を進めています。

"Doing what we can to protect Mother Earth, the source of all life." Based on this concept, we at Matsushita Battery Industrial Company are developing technologies and products that help protect the global environment.
An Electric Vehicle, or EV, has become the focus of attention as a next-generation vehicle, one which is powered by electricity whose energy supply is virtually unlimited, and one which generates virtually no exhaust or noise.
To help achieve a more prosperous, comfortable society, Matsushita Battery has applied its comprehensive technologies toward the mass production of Ni/MH batteries which will serve as a power source for EVs by 1998.

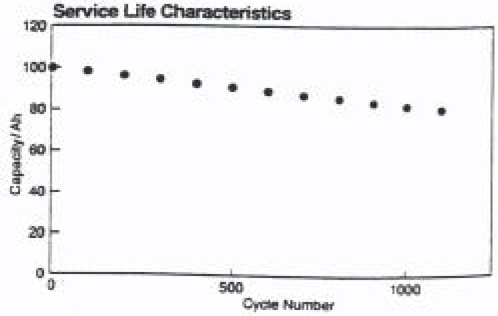
EV用ニッケル・水素蓄電池の特長
Characteristics of Ni/Metal-Hydride Battery for EVs

高エネルギー密度 High Specific Energy/Energy Density	従来の電池では、一充電走行距離が100km未満と短く実用上課題がありました。この電池の使用により実走行で200km程度の走行が可能になりました。	With conventional storage batteries, there are practical problems such as a car can only run up to 100 km before its battery must be recharged. With this battery, however, up to 200 km per charge is now possible.
高出力 High Specific Power	EVの加速、登坂性能は電池の出力特性に左右されます。この電池を使用すれば最後まで走行中安定した出力が得られます。	An electric vehicle's acceleration and performance on uphill grades depend on the power output characteristics of the battery. With this battery, stable power output is maintained throughout the life of the charge.
長寿命 Long Life	従来の電池では、何回か電池交換が必要です。この電池は1000回以上の使用が可能で、殆ど交換の必要がありません。	Existing storage batteries have to be replaced frequently. This battery can be used more than 1,000 times, however, so it rarely needs replacing.
メンテナンスフリー 高安全性 Maintenance-Free and Safety	この電池は密閉形でメンテナンスは不要です。また、安全性について、さまざまな使用条件を予想した確認と改良を行っています。	This battery is sealed to provide maintenance-free use. Furthermore, we at Panasonic have designed the battery to operate safely under a variety of conditions.
環境に優しく リサイクルが可能 Environmentally-Friendly and Recyclable	使用材料はリサイクルが可能で貴重な地球資源を有効に活用できます。	All materials are recyclable to maximize the use of precious resources.

Ni/MH蓄電池の出力特性の一例
Specific Power Characteristics



寿命特性の一例
Service Life Characteristics



APPENDIX C

EQUIPMENT LIST AND NAMEPLATE DATA

VEHICLE TEST EQUIPMENT AND NAMEPLATE DATA SHEET

Project: E V Field Operations Program
Test: Performance Characterization
Date(s): 7/12/99 - 8/25/99
File Name(s): PM 99-RAV4 Conductive
Vehicle #: 24551
Technician: Alvaro Mendoza

~~VEHICLE~~

Manufacturer: Toyota
VIN: T3GS10V0X0001643
Model: RAV4 Electric
Model Year: 1999
Date of Manufacture: Jan-99
GVWR: 4266 lbs.
Front AWR: 2258 lbs.
Rear AWR: 2297 lbs.
Motor Manufacturer: Toyota
Type: Permanent - Magnet
Motor Rating/Speed: 50 kW DC Brushless / 3100 - 4600 rpm
Version/Serial No.: XTYXT00.0222
EPA Label Fuel Economy: 29 kW-hr/100 miles (city), 37 kW-hr/100 miles (freeway)
Controller Version/Serial No.: N/A
Battery Pack Type/Version/Serial No.: NiMH / Panasonic
Tire Manufacturer: Firestone
Model: ECOPIA EP02
Tire Size: 195/80 R16
Maximum Pressure: 44 PSI
Maximum Tire Load: 1609 lbs.
Treadwear Rating: 360

~~CHARGER~~

On-board
Manufacturer: N/A
Model: N/A
Serial Number: N/A
Charger Type/Version: Conductive - On-board
EVSE Manufacturer: Electric Vehicle Infrastructure Inc.
EVSE Model/Version: ICS-200
Serial Number: TR0898107
EVSE Software Version: N/A
Charge Port Manufacturer/Model/Version/SN: N/A

~~TEST EQUIPMENT~~

BMI Power Profiler 3030A EVTC Number: BMI-002
ABB kWh Meter Serial Number: 01 223 620
Thermometer EVTC Number: THR - 006
Optical Meter Probe EVTC Number: OPB - 001
Laptop Computer EVTC Number: CMP - 002
Desktop Computer EVTC Number: CMP - 016
Stopwatch EVTC Number: STW - 002
Digital multimeter EVTC Number: N/A
ABC-150 EVTC Number: N/A
Smart Guard Interface Serial Number: N/A
Smart Guard Numbers: N/A
Sound Level Meter EVTC Number: SMR - 001
Measuring Wheel EVTC Number: N/A
Other Equipment: Vericom Performance Computer DYM-001

~~WEIGHT CERTIFICATION~~

Scale Location and Proprietor: Mission Recycling Center, Pomona, CA
Examiner: William Boyd
Date: 07/29/1999
Notes:

VEHICLE TEST EQUIPMENT AND NAMEPLATE DATA SHEET

Project: E V Field Operations Program
Test: Performance Characterization
Date(s): 2/20/98 - 2/28/98
File Name(s): N/A
Vehicle #: 23821
Technician: Rogelio Mok

~~VEHICLE~~

Manufacturer: Toyota
VIN: JT3GS10V3W0001148
Model: RAV4 Electric
Model Year: 1998
Date of Manufacture: N/A
GVWR: 4266 lbs.
Front AWR: 2258 lbs.
Rear AWR: 2297 lbs.
Motor Manufacturer: Toyota
Type: Permanent - Magnet
Motor Rating/Speed: 50 kW DC Brushless / 3100 - 4600 rpm
Version/Serial No.: XTYXT00.0222
EPA Label Fuel Economy: 29 kW-hr/100 miles (city), 37 kW-hr/100 miles (freeway)
Controller Version/Serial No.: N/A
Battery Pack Type/Version/Serial No.: NiMH / Panasonic
Tire Manufacturer: Firestone
Model: ECOPIA EP02
Tire Size: 195/80 R16
Maximum Pressure: 44 PSI
Maximum Tire Load: 1609 lbs.
Treadwear Rating: 360

~~CHARGER~~

On-board
Manufacturer: N/A
Model: N/A
Serial Number: N/A
Charger Type/Version: Conductive - On-board
EVSE Manufacturer: Electric Vehicle Infrastructure Inc.
EVSE Model/Version: ICS-200
Serial Number: F1197030
EVSE Software Version: N/A
Charge Port Manufacturer/Model/Version/SN: N/A

~~TEST EQUIPMENT~~

BMI Power Profiler 3030A EVTC Number: N/A
ABB kWh Meter Serial Number: N/A
Thermometer EVTC Number: N/A
Optical Meter Probe EVTC Number: N/A
Laptop Computer EVTC Number: N/A
Desktop Computer EVTC Number: N/A
Stopwatch EVTC Number: N/A
Digital multimeter EVTC Number: N/A
ABC-150 EVTC Number: N/A
Smart Guard Interface Serial Number: N/A
Smart Guard Numbers: N/A
Sound Level Meter EVTC Number: N/A
Measuring Wheel EVTC Number: N/A
Other Equipment: N/A

~~WEIGHT CERTIFICATION~~

Scale Location and Proprietor: Mission Recycling Center, Pomona, CA
Examiner: N/A
Date: N/A
Notes:

VEHICLE TEST EQUIPMENT AND NAMEPLATE DATA SHEET

Project: E V Field Operations Program Test: Performance Characterization
Date(s): Dec-99 File Name(s): N/A
Vehicle #: 24191 Technician: Ricardo Solares

~~VEHICLE~~

Manufacturer: Toyota VIN: JT3GS10V9W0001333
Model: RAV4 Electric
Model Year: 1998 Date of Manufacture: May-98
GVWR: 4266 lbs. Front AWR: 2258 lbs. Rear AWR: 2297 lbs.
Motor Manufacturer: Toyota Type: Permanent - Magnet
Motor Rating/Speed: 50 kW DC Brushless / 3100 - 4600 rpm
Version/Serial No.: XTYXT00.0222
EPA Label Fuel Economy: 29 kW-hr/100 miles (city), 37 kW-hr/100 miles (freeway)
Controller Version/Serial No.: N/A
Battery Pack Type/Version/Serial No.: NiMH / Panasonic
Tire Manufacturer: Firestone Model: ECOPIA EP02
Tire Size: 195/80 R16 Maximum Pressure: 44 PSI
Maximum Tire Load: 1609 lbs. Treadwear Rating: 360

~~CHARGER~~

On-board Manufacturer: N/A
Model: N/A Serial Number: N/A
Charger Type/Version: Conductive - On-board
EVSE Manufacturer: Electric Vehicle Infrastructure Inc.
EVSE Model/Version: ICS-200 Serial Number: F1197030
EVSE Software Version: N/A
Charge Port Manufacturer/Model/Version/SN: N/A

~~TEST EQUIPMENT~~

BMI Power Profiler 3030A EVTC Number: N/A
ABB kWh Meter Serial Number: N/A
Thermometer EVTC Number: THR-006
Optical Meter Probe EVTC Number: N/A
Laptop Computer EVTC Number: CMP-002
Desktop Computer EVTC Number: CMP-016
Stopwatch EVTC Number: STW-002
Digital multimeter EVTC Number: N/A
ABC-150 EVTC Number: N/A
Smart Guard Interface Serial Number: N/A
Smart Guard Numbers: N/A
Sound Level Meter EVTC Number: N/A
Measuring Wheel EVTC Number: N/A
Other Equipment: Vericom Performance Computer DYM-001

~~WEIGHT CERTIFICATION~~

Scale Location and Proprietor: Mission Recycling Center, Pomona, CA
Examiner: N/A Date: N/A
Notes: This 1998 model was used only for the acceleration, braking and maximum speed tests. Please refer to pages 8 and 20 for results and comments.

APPENDIX D

RANGE TEST DATA SHEETS

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/12/1999	24551	1643	FW1	A. Mendoza	Performance Charact.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44 psi	180 lbs				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:00	574	86			80 F		
Stop	9:52	657	10			93 F		Min. A/C
Net	1:52	82.2	76					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	10.0		
0	9.0		
0	8.6		Start of drive
4.5	8.0		
19	7.0		
31	6.0		
40	5.0		
52	4.0		
63	3.0		Mile 74.8; Charger light on
72	2.0		Mile 81.5; Charger light started flashing
82.2	1.0		Mile 82.2; End of drive
	0.0		

Accessories used: Radio

Drive / Regen setting: Drive / EB off

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 289 387		N/A			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/12/1999	9:54	966				93.0 F	
Stop	07/13/1999	7:20	996				78.0 F	
Net			30.07					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/13/1999	24551	1643	FW1	A. Mendoza	Performance Charact.	**Start**	
Road Cond	**Tire Press**	**Payload**				**Stop**	
Dry	44	180				**Net**	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	7:45	657	92			83.0 F		
Stop	9:20	732	12			87.0 F		**Min. A/C**
Net	1:35	75.8	80					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10.0		
0	9.2		Start of drive
11.5	8.0		
23.5	7.0		
33	6.0		
40	5.0		
51	4.0		
60.5	3.0		Mile 68.7; Charger light on
69	2.0		Mile 75.5; Charger light started flashing
75.8	1.0		Mile 75.8; End of drive
	0.0		

Accessories used: Radio
Drive / Regen setting: Drive / EB off
Handling/Braking: Good handling / fair braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620		BMI-01			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	07/13/1999	9:57	5284	0			87.0 F	
Stop	07/14/1999	7:11	5314	29.59			82.0 F	
Net			29.78	29.59				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/14/1999	24551	1643	UR1	A. Mendoza	Performance Charact.	**Start**	
Road Cond	**Tire Press**	**Payload**				**Stop**	
Dry	44	180				**Net**	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	7:27	732	92			75.0 F		
Stop	11:08	825	11			91.0 F		**Min. A/C**
Net	3:41	92.4	81					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10		
0	9.2		Start of drive
2	9		
11	8		
25.5	7		
35	6		
47.5	5		
60	4		
70	3		Mile 83.4; Charger light on
82.5	2		Mile 92.3; Charging light started flashing
92.4	1.1		Mile 92.8; End of drive
92.8	1		

Accessories used: Radio

Drive / Regen setting: Drive / EB on

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620		BMI-01			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	07/14/1999	11:16	5314	29.59			88.0 F	
Stop	07/15/1999	7:18	5348	63.96			81.0 F	
Net			34.5	34.37				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/16/1999	24551	1643	UR1	A. Mendoza	Performance Charact.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	180				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:55	732	92			75.0 F		
Stop	12:38	825	11			91.0 F		Min. A/C
Net	3:43	94.2	81					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	10.0		
0	9.1		Start of drive
0.8	9.0		
11	8.0		
26.5	7.0		
39	6.0		
49	5.0		
63	4.0		
72	3.0		Mile 83.4; Charger light on
85.2	2.0		Mile 92.3; Charging light started flashing
94.2	1.0		Mile 92.8; End of drive
	0.0		

Accessories used: Radio
Drive / Regen setting: Drive / EB on
Handling/Braking: Good handling / fair braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/16/1999	13:37	5349				86.0 F	
Stop	07/16/1999	23:56	5381				75.0 F	
Net			31.92					

Comments: No BMI used for this charging test

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/19/1999	24551	1643	FW1	A. Mendoza	Performance Charact.	**Start**	
Road Cond	**Tire Press**	**Payload**				**Stop**	
Dry	44	180				**Net**	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:13	920	90			79.0 F		
Stop	11:03	1003	10			84.0 F		**Min. A/C**
Net	1:50	83.3	80					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10.0		
0	9.0		Start of drive
9	8.0		
21	7.0		
32.5	6.0		
42	5.0		
55	4.0		
66.5	3.0		Mile 77; Charger light on
76	2.0		Mile 83.1; Charger light started flashing
83.3	1.0		Mile 83.3; End of drive
	0.0		

Accessories used: Radio

Drive / Regen setting: Drive / EB off

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620					
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	07/19/1999	11:05	5381				85.0 F	
Stop	07/20/1999	9:00	5413				77.0 F	
Net			31.88					

Comments: No BMI used for this charging test

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/20/1999	24551	1643	FW2	A. Mendoza	Performance Charact.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	180				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:08	1003	92			78.0 F	79.3 F	54.0 F
Stop	10:47	1082	10			85.0 F	57.4 F	Min. A/C
Net	1:39	79.3	82					45.7 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	10.0		
0	9.2		Start of drive
2	9.0		
11.5	8.0		
23	7.0		
33	6.0		
41.5	5.0		
52.5	4.0		Mile 72.8; Charger light on
63.5	3.0		Mile 78.5; Charger light started flashing
72	2.0		Mile 79.3; End of drive
79.3	1.0		
	0.0		

Accessories used: Radio, lights, A/C set on high

Drive / Regen setting: Drive / EB off

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/20/1999	11:18	5413				85.0 F	
Stop	07/21/1999	7:48	5446				74.0 F	
Net			32.31					

Comments: No BMI used for this charging test

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/26/1999	24551	1643	FW2	A. Mendoza	Performance Charact.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	180				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:05	1159	90			73.0 F	76.0 F	56.0 F
Stop	10:41	1238	10			80.0 F	62.1 F	Min. A/C
Net	1:36	79	80					44.6 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	10.0		
0	9.0		Start of drive
9	8.0		
21	7.0		
32	6.0		
40	5.0		
53	4.0		
63	3.0		Mile 72.7; Charger light on
72.5	2.0		Mile 78.3; Charger light started flashing
79	1.0		Mile 79; End of drive
	0.0		

Accessories used: Radio, lights, A/C set on high

Drive / Regen setting: Drive / EB off

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/26/1999	11:00	5481				78.0 F	
Stop	07/27/1999	21:23	5513					
Net			32.4					

Comments: No BMI used for this charging test

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/27/1999	24551	1643	UR2	B. Sanchez	Performance Charact.	**Start**	
Road Cond	**Tire Press**	**Payload**				**Stop**	
Dry	44	160				**Net**	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:30	1238	92			88.9 F	78.8 F	51.8 F
Stop	17:10	1321	10			81.1 F	58.5 F	**Min. A/C**
Net	3:40	82.9	82					47.8 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10.0		
0	9.2		Start of drive
2.1	9.0		
10.8	8.0		
24.8	7.0		
32.9	6.0		
45.9	5.0		
53.1	4.0		
66	3.0		
72.6	2.0		Mile 76.2; Charger light on
81.9	1.0		Mile 82.1; Charger light started flashing
82.9	1.0		Mile 82.9; End of drive

Accessories used: Radio, lights, A/C set on high

Drive / Regen setting: Drive / EB on

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620					
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	07/27/1999	16:59	0				78.0 F	
Stop	07/28/1999	4:35	32					
Net			32.1					

Comments: No BMI used for this charging test

Timer charge @ 10:00 pm

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/28/1999	24551	1643	UR2	A. Mendoza	Performance Charact.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	180				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	7:35	1321	94			70.0 F	77.5 F	56.3 F
Stop	10:58	1407	10			82.0 F	60.5 F	Min. A/C
Net	3:23	86.8	84					46.8 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	10.0		
0	9.4		Start of drive
4.5	9.0		
13	8.0		
26.5	7.0		
35	6.0		
47.5	5.0		
60	4.0		
68.5	3.0		Turned back at Central Ave.
81.5	2.0		Mile 81.7; Charger light on
85.8	1.0		Mile 85.8; Charger light started flashing
86.8	1.0		Mile 86.8; End of drive

Accessories used: Radio, lights, A/C set on high

Drive / Regen setting: Drive / EB on

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/28/1999	10:00	32					
Stop	07/29/1999	4:11	63					
Net			30.6					

Comments: No BMI used for this charging test

Timer charge @ 10:00 pm

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/29/1999	24551	1643	FW3	A. Mendoza	Performance Charact.	**Start**	
Road Cond	**Tire Press**	**Payload**				**Stop**	
Dry	44	766				**Net**	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:13	1408	94			80.0 F		
Stop	11:00	1494	10			86.0 F		**Min. A/C**
Net	1:47	85.8	84					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10.0		
0	9.4		Start of drive
3.7	9.0		
16.5	8.0		
27	7.0		
38	6.0		
49	5.0		
60	4.0		
69.5	3.0		Mile 80.0; Charger light on
79	2.0		Mile 85.0; Charger light started flashing
85.8	1.0		Mile 85.8; End of drive

Accessories used: Radio

Drive / Regen setting: Drive / EB off

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620					
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	07/29/1999	10:00	63				86.0 F	
Stop	07/30/1999	4:20	94				79.0 F	
Net			31.11					

Comments: No BMI used for this charging test

Timer charge @ 10:00 pm

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/30/1999	24551	1643	FW3	A. Mendoza	Performance Charact.	**Start**	
Road Cond	**Tire Press**	**Payload**				**Stop**	
Dry	44	766				**Net**	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:58	1494	94			79.6 F		
Stop	10:40	1575	10			86.0 F		**Min. A/C**
Net	1:42	81.2	84					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10.0		
0	9.4		Start of drive
2.5	9.0		
13	8.0		
25	7.0		
34.5	6.0		
42.5	5.0		Mile 73.4; Exit Fwy. @ Towne Ave (10 Fwy.) 20% SOC
55	4.0		Mile 77; U-turn @ Monte Vista Ave 16% SOC
64	3.0		Mile 74.9; Charger light on
73.6	2.0		Mile 80.9; Charger light started flashing
81.2	1.0		Mile 81.2; End of drive

Accessories used: Radio

Drive / Regen setting: Drive / EB off

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620					
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	07/30/1999	10:00	94				86.0 F	
Stop	07/31/1999	10:17	129					
Net			34.42					

Comments: No BMI used for this charging test

Timer charge @ 10:00 pm

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/02/1999	24551	001643	FW3	A. Mendoza	Performance Charact.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	766				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	7:48	1575	90			75.0 F		
Stop	9:30	1655	10			84.0 F		Min. A/C
Net	1:42	79.4	80					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	10.0		
0	9.0		Start of drive
10	8.0		
21.5	7.0		
33.8	6.0		
41	5.0		
52.3	4.0		
63	3.0		
71.5	2.0		Mile 72.6; Charger light on
79.1	1.0		Mile 79.1; Charger light started flashing
79.4	1.0		Mile 79.4; End of drive

Accessories used: Radio

Drive / Regen setting: Drive / EB off

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/02/1999	10:00	129					
Stop	08/03/1999	4:19	161				72.0 F	
Net			31.3					

Comments: No BMI used for this charging test

Timer charge @ 10:00 pm

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/04/1999	24551	001643	UR3	A. Mendoza	Performance Charact.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	766				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	7:15	1655	90			74.0 F		
Stop	10:50	1741	10			83.0 F		Min. A/C
Net	3:35	86.6	80					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	10.0		
0	9.0		Start of drive
8.5	8.0		
20.2	7.0		
29.5	6.0		
44.7	5.0		
52.3	4.0		
66.3	3.0		Mile 79.9: U-turn @ Monte Vista
75.5	2.0		Mile 78.7; Charger light on
86	1.0		Mile 86; Charger light started flashing
86.6	1.0		Mile 86.6; End of drive

Accessories used: Radio
Drive / Regen setting: Drive / EB on
Handling/Braking: Good handling / fair braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/04/1999	22:00	187					
Stop	08/05/1999	4:15	218					
Net			30.82					

Comments: No BMI used for this charging test
Timer charge @ 10:00 pm

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/10/1999	24551	001643	UR3	A. Mendoza	Performance Charact.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	766				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	7:20	1834	90			64.0 F		
Stop	10:45	1919	10			67.0 F		Min. A/C
Net	3:25	84.5	80					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	10.0		
0	9.0		Start of drive
9	8.0		
20.4	7.0		
30	6.0		
43	5.0		
50	4.0		
64.5	3.0		Mile 79.8; U-turn @ Monte Vista
71.3	2.0		Mile 76.4; Charger light on
83.9	1.0		Mile 83.9; Charger light started flashing
84.5	1.0		Mile 84.5; End of drive

Accessories used: Radio
Drive / Regen setting: Drive / EB on
Handling/Braking: Good handling / fair braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620		BMI-002			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/11/1999	8:52	228				69.6 F	
Stop	08/12/1999	14:54	258				73.2 F	
Net			29.73					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/12/1999	24551	001643	FW4	A. Mendoza	Performance Charact.	**Start**	
Road Cond	**Tire Press**	**Payload**				**Stop**	
Dry	44	766				**Net**	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:45	1919	91			76.3 F	75.8 F	59.0 F
Stop	10:14	1995	10			80.0 F	63.0 F	**Min. A/C**
Net	1:29	76	81					48.0 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10.0		
0	9.1		Start of drive
9.4	8.0		
21.7	7.0		
31.7	6.0		
39	5.0		
48.7	4.0		
60	3.0		Mile 73.8; Exit Fwy. 10 East at Holt Ave.
69.2	2.0		Mile 70.5; Charger light on
75.7	1.0		Mile 75.7; Charger light started flashing
76	1.0		Mile 76; End of drive

Accessories used: Radio, A/C, lights
Drive / Regen setting: Drive / EB off
Handling/Braking: Good handling / fair braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620		BMI-002			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	08/12/1999	22:00	258				69.6 F	
Stop	08/13/1999	4:18	289				73.2 F	
Net			30:95					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/13/1999	24551	001643	FW4	A. Mendoza	Performance Charact.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	766				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:00	1997	91			87.0 F	76.7 F	51.4 F
Stop	11:50	2072	9			90.5 F	55.0 F	Min. A/C
Net	1:50	75.2	82					50.4 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	10.0		
0	9.1		Start of drive
7.7	8.0		
19.2	7.0		
29.5	6.0		
37	5.0		
48.3	4.0		
58.3	3.0		Mile 73.8; Exit Fwy. 10 East at Holt Ave.
67.3	2.0		Mile 68.5; Charger light on
73.5	1.0		Mile 73.5; Charger light started flashing
75.2	0.9		Mile 75.2; End of drive

Accessories used: Radio, A/C, lights

Drive / Regen setting: Drive / EB off

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620		BMI-002			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/14/1999	2:00	289				78.0 F	
Stop	08/14/1999	8:16	321				77.0 F	
Net			30.97					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/16/1999	24551	001643	UR4	A. Mendoza	Performance Charact.	**Start**	
Road Cond	**Tire Press**	**Payload**				**Stop**	
Dry	44	766				**Net**	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:05	2072	90			75.0 F	77.3 F	60.6 F
Stop	11:07	2150	6			87.0 F	56.1 F	**Min. A/C**
Net	3:02	78.4	84					44.4 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10.0		
0	9.0		Start of drive
8.3	8.0		
20	7.0		
29.2	6.0		
40	5.0		
478.5	4.0		
59.5	3.0		
67.5	2.0		Mile 68.2; Charger light on
71.8	1.0		Mile 71.8; Charger light started flashing
78.4	0.6		Mile 78.4; End of drive

Accessories used: Radio, A/C, lights
Drive / Regen setting: Drive / EB off
Handling/Braking: Good handling / fair braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620		BMI-002			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	08/16/1999	22:00	321					
Stop	08/17/1999	4:36	354					
Net			32.69					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File / Project		Volts
08/20/1999	24551	001643	UR4	A. Mendoza	Performance Charact.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	766				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:54	2152	90			82.0 F	76.1 F	56.8 F
Stop	12:48	2226	9			89.0 F	53.8 F	Min. A/C
Net	2:54	73.6	81					46.0 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	10.0		
0	9.0		Start of drive
8.6	8.0		
21.1	7.0		
29.1	6.0		
42.1	5.0		
48.4	4.0		
59.1	3.0		Mile 61.7; U-turn @ Vineyard Ave.
68.1	2.0		Mile 69.1; Charger light on
72.8	1.0		Mile 72.8; Charger light started flashing
73.6	0.9		Mile 73.5; End of drive

Accessories used: Radio, A/C, lights

Drive / Regen setting: Drive / EB off

Handling/Braking: Good handling / fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
P049	TR 0898107		01 223 620		BMI-002			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/20/1999	13:00	358				89.0 F	
Stop	08/21/1999	1:05	391					
Net			33.95					

Comments:

APPENDIX E

ACCELERATION, BRAKING AND MAXIMUM SPEED TEST DATA

ACCELERATION, MAXIMUM SPEED, AND BRAKING TESTS

Vehicle No.: 24551
Location: Pomona Raceway
Date: 07/21/99
Technician: Ben Sanchez

	Start	Stop
Time	12:15 PM	5:10 PM
Temp.	83 F	
Odometer	1083	1147

Acceleration (100% SOC)

	0-30 mph	0-60 mph	Direction	Max. Speed	30-55 mph
1	4.71	14.39	S	80	8.2
2	5.04	16.21	N	74	10.6
3					
4					
Average	4.88	15.30		77.00	9.40

Acceleration (80% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1	4.88	15.47	S	8.9
2	5.23	16.73	N	10.15
3				
4				
Average	5.06	16.10		9.53

Acceleration (60% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1	4.85	15.4	S	8.65
2	5.24	16.98	N	10.12
3				
4				
Average	5.05	16.19		9.39

Braking 25-0 mph, 60% SOC

	Feet	Inches	Total Ft.	Direction
1	28		28.0	S
2	28		28.0	N
3	33		33.0	S
4	27		27.0	N
5				
6				
7				
8				
9				
10				

29.0 Average ft.

Acceleration (40% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1	4.9	15.56	S	8.37
2	5.32	17.83	N	10.5
3				
4				
Average	5.11	16.70		9.44

Acceleration (20% SOC)

	0-30 mph	0-60 mph	Direction	Max. Speed	30-55 mph
1	4.96	15.59	S	80	8.59
2	5.12	16.31	N	75	10.4
3					
4					
Average	5.04	15.95		77.50	9.50

Comments: Started tests with vehicle at 92% SOC.
Calculated vehicle turning radius = 17'10".

APPENDIX F

CHARGER TESTING / ANALYSIS DATA SHEET

CHARGER TESTING / ANALYSIS DATA SHEET

Name of test conductor: Alvaro Mendoza   Date: 08/13/99

Location of test: EVTC Pomona   Phone: (909) 469-0245

~~Charger Information~~

Manufacturer: Toyota

Model No.: N/A

Supply Side Voltage Rating: 220 V, 60 Hz

~~After Completion of Recharging Cycle~~

Time of Day: N/A

Final Pack Voltage: N/A

AC kWh Used: 30.97   DC kWh Delivered: N/A

Charger Energy Efficiency: N/A (DC kWh/AC kWh)

Amp-hours to battery: N/A   kWh to battery: N/A

Overcharge Factor: N/A (Ah removed/Ah returned)

DC Output Ripple Voltage: N/A   Ripple Frequency: N/A

~~Charger Operation Information/Evaluation~~

Exterior Dimensions: N/A   Weight: N/A

Charging Profile Type: Vehicle Dependant

End Point Determination Method: Vehicle Dependant

Battery Monitoring Method: Monitored by vehicle

Programmable Charging Profiles: none

Connector Type(s): Conductive

Safety Features / Protection Devices: N/A

Agency/Industry Approvals: N/A

Installation Techniques/Requirements: N/A

Appropriate for Interior and/or Exterior Use: Yes

User Interface:

Ease of Use: Simple

Current & Future Cost:

Warranty: N/A

Reliability History/Manuf. Reputation: Reliable

Maintenance Schedule: None

Accompanying Supplies: EVSE (Electric Vehicle Supply Equipment) ICS-200

Manufacturer Support: Yes

Other Notes:

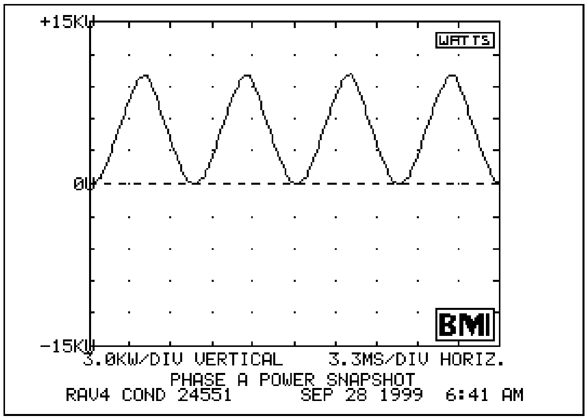
APPENDIX G

CHARGER PROFILE TEST GRAPHICAL DATA - EVTC

Snapshots at Full Power

PHASE A POWER SNAPSHOT 6:41:06 AM

INSTANTANEOUS POWER: 4.899 kW



PHASE A POWER SPECTRUM 6:41:39 AM

Power: 4.899 kW

Fundamental freq: 60.0 Hz

HARM	POWER	HARM	POWER
FUND	+4.898 kW	2nd	
3rd	+0.03 W	4th	
5th	+1.74 W	6th	
7th	+0.22 W	8th	
9th		10th	
11th	+0.02 W	12th	
13th		14th	
15th		16th	
17th		18th	
19th		20th	
21st		22nd	
23rd		24th	
25th		26th	
27th		28th	
29th		30th	
31st		32nd	
33rd		34th	
35th		36th	
37th		38th	
39th		40th	
41st		42nd	
43rd		44th	
45th		46th	
47th		48th	
49th		50th	
ODD	1.98 W	EVEN	0.01 W
THP:	1.99 W		

POWER FACTOR SNAPSHOT 6:41:08 AM

Phase A-N: 4.899 kW

Phase A-N: 4.935 kVA

Phase A-N: 573.8 VAR

Phase A-N: 0.99 PF

Phase A-N: 0.99 dPF

HARMONICS SNAPSHOT 6:41:09 AM

Fundamental freq: 60.0 Hz

Phase A-N Volts: 2.1% THD

Phase A Current: 2.6% THD

VOLTAGE & CURRENT SNAPSHOT 6:41:48 AM

Phase A-N: 232.8 Vrms, 0 (ref)
Neut-Gnd: 117.3 Vrms, -69

Phase A: 21.20 A rms, -7

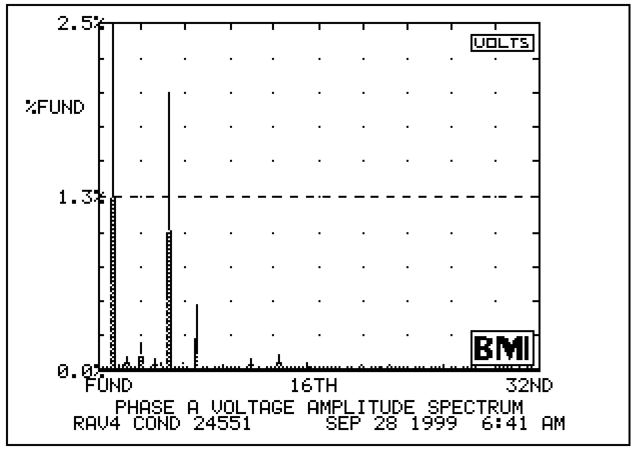
PHASE A VOLTAGE SPECTRUM 6:41:13 AM

Fundamental volts: 232.7 Vrms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	0	2nd		
3rd	0.2%	-169	4th		
5th	2.0%	1	6th		
7th	0.5%	107	8th		
9th			10th		
11th			12th		
13th	0.1%	166	14th		
15th			16th		
17th			18th		
19th			20th		
21st			22nd		
23rd			24th		
25th			26th		
27th			28th		
29th			30th		
31st			32nd		
33rd			34th		
35th			36th		
37th			38th		
39th			40th		
41st			42nd		
43rd			44th		
45th			46th		
47th			48th		
49th			50th		
ODD	2.1%		EVEN	0.1%	

THD: 2.1%



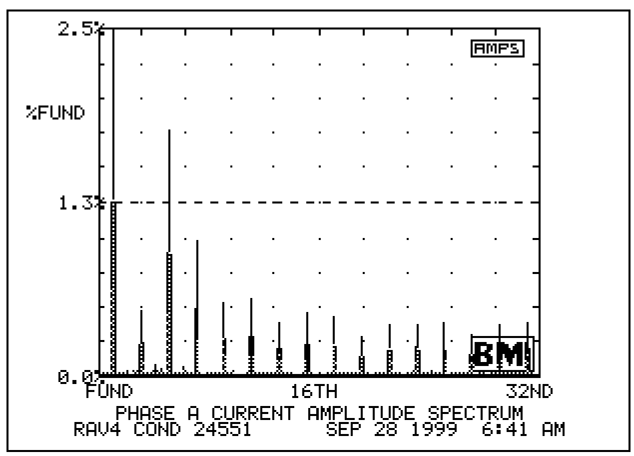
PHASE A CURRENT SPECTRUM 6:41:22 AM

Fundamental amps: 21.19 A rms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	-7	2nd		
3rd	0.5%	136	4th		
5th	1.8%	11	6th		
7th	1.0%	124	8th		
9th	0.5%	83	10th		
11th	0.6%	115	12th		
13th	0.4%	69	14th		
15th	0.5%	95	16th		
17th	0.4%	50	18th		
19th	0.3%	72	20th		
21st	0.4%	35	22nd		
23rd	0.4%	57	24th		
25th	0.4%	37	26th		
27th	0.3%	39	28th		
29th	0.4%	23	30th		
31st	0.4%	17	32nd		
33rd	0.5%	-7	34th		
35th	0.4%	-23	36th		
37th	0.4%	-30	38th		
39th	0.3%	-37	40th		
41st	0.2%	-47	42nd		
43rd	0.2%	-53	44th		
45th	0.2%	-83	46th		
47th	0.2%	-59	48th		
49th	0.2%	-74	50th		
ODD	2.7%		EVEN	0.1%	

THD: 2.6%



PHASE A SNAPSHOT 6:41:52 AM

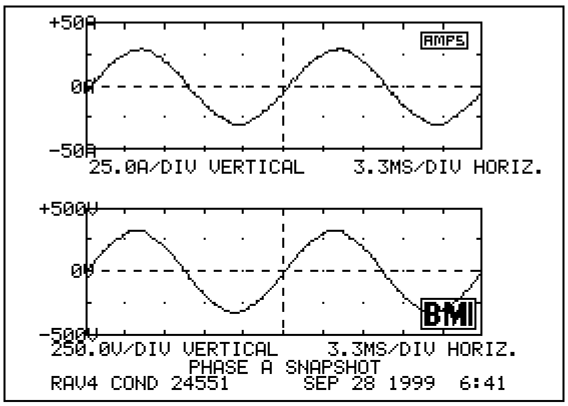
Phase A-N VOLTAGE: 232.8 Vrms
1.4 Crest Factor
1.1 Form Factor

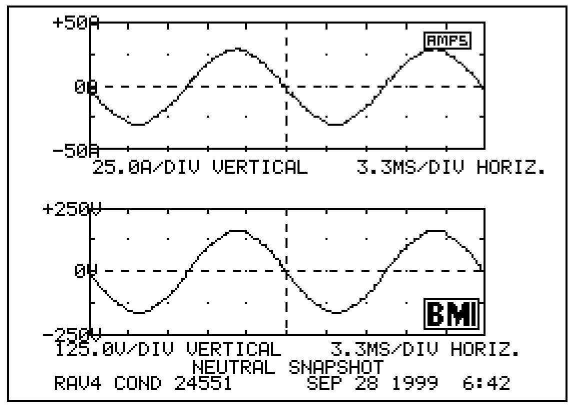
Phase A CURRENT: 21.20 A rms
1.5 Crest Factor
1.1 Form Factor

CURRENT LAGS VOLTAGE BY 7 (0.99 dPF)

NEUTRAL SNAPSHOT 6:42:03 AM

Neut-Gnd VOLTAGE: 117.3 Vrms
1.4 Crest Factor
1.1 Form Factor



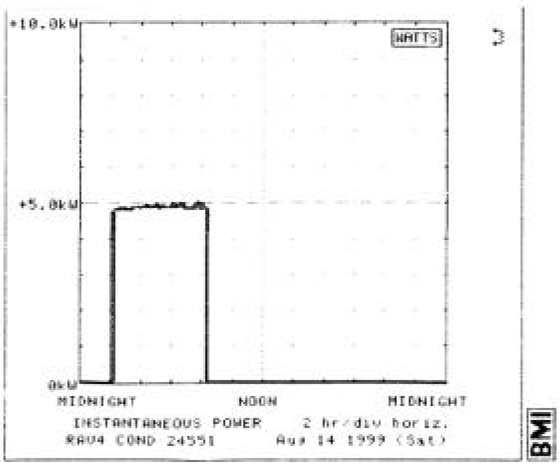


CUMMULATIVE PROFILES – 24 HOURS

INSTANTANEOUS POWER 12:00:02 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

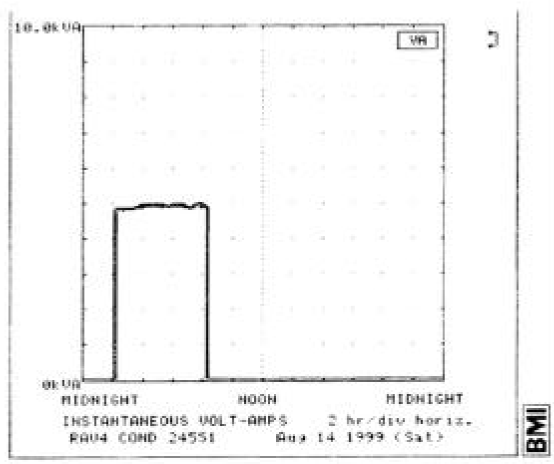
Phase A-N:
MAX: 5.1 kW, 7:37 AM
MIN: 0.0 kW, 10:41 AM



INSTANTANEOUS VOLT-AMPS 12:00:05 AM

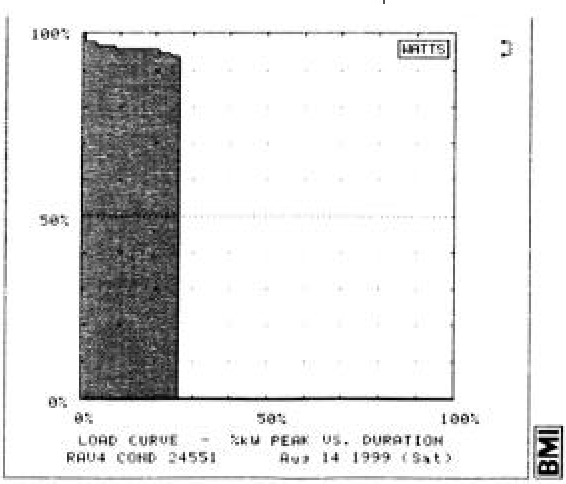
FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

Phase A-N:
MAX: 5.1 kVA, 7:37 AM
MIN: 0.0 kVA, 9:09 AM



LOAD DURATION CURVE 12:00:21 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)



TOTAL POWER CONSUMPTION 12:00:40 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

FLAT RATE: Cost: $ 0.060/kWh
Cost: $ 0.000/kWpk

BILLING DEMAND:

4.962 kW	Pk Today
4.962 kW	Pk Accumulated
$ 0.000	Today
$ 0.000	Accumulated

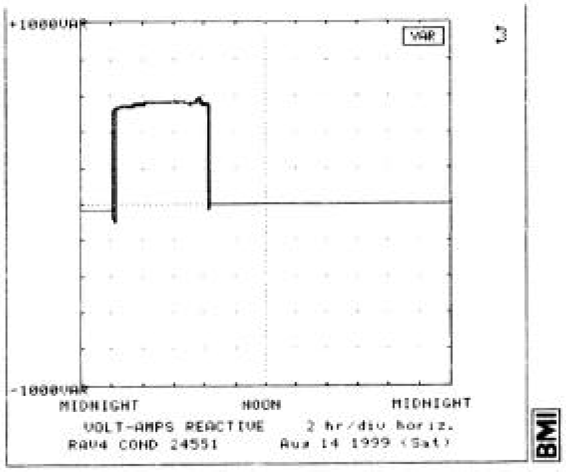
CONSUMPTION:

30.79 kWh	Today
30.91 kWh	Accumulated
$ 1.847	Today
$ 1.853	Accumulated
18.28 kQh	Today
3.390 kVARh	Today

VOLT-AMPS REACTIVE 12:00:40 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

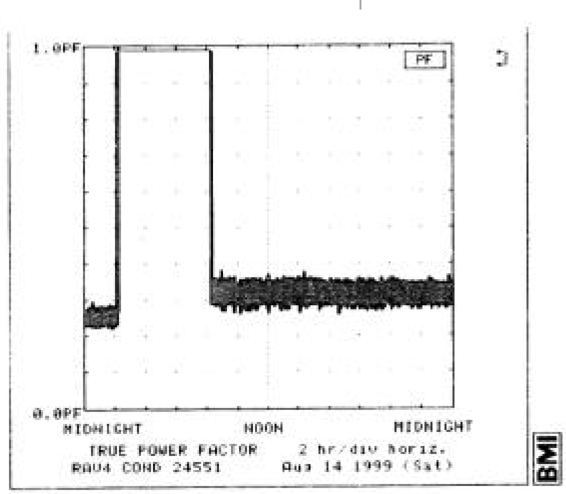
Phase A-N:
MAX: 598.2 VAR, 7:32 AM
MIN: -90.1 VAR, 2:07 AM



TRUE POWER FACTOR 12:00:59 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

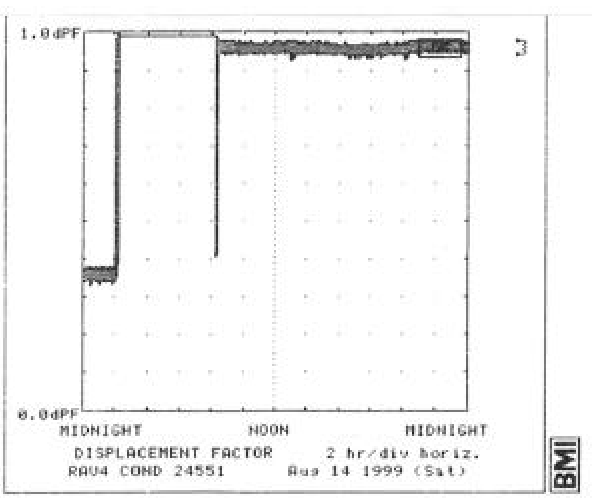
Phase A-N:
MAX: 1.00 PF, 2:07 AM
MIN: 0.22 PF, 1:43 AM



DISPLACEMENT FACTOR 12:01:05 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

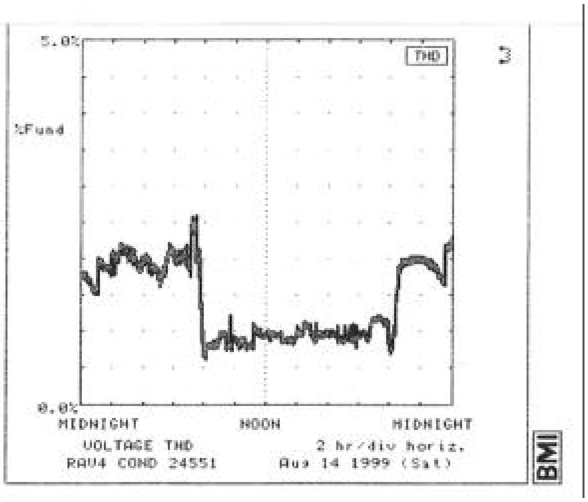
Phase A-N:
MAX: 1.00 dPF, 2:07 AM
MIN: 0.33 dPF, 12:24 AM



VOLTAGE THD 12:01:23 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

Phase A-N:
MAX: 2.6% THD, 7:21 AM
MIN: 0.6% THD, 8:00 AM

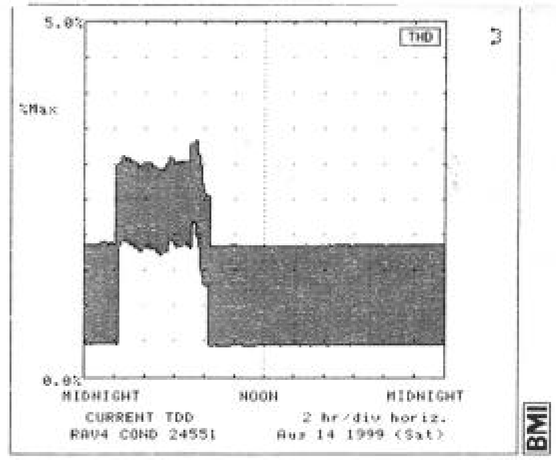


CURRENT TDD 12:01:34 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

Max load current: 28300 mA rms

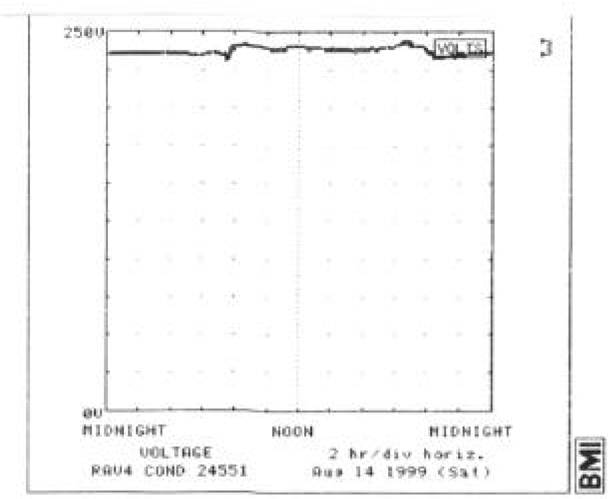
Phase A:
MAX: 2.4% TDD, 7:21 AM
MIN: 0.4% TDD, 5:46 PM



VOLTAGE 12:02:08 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

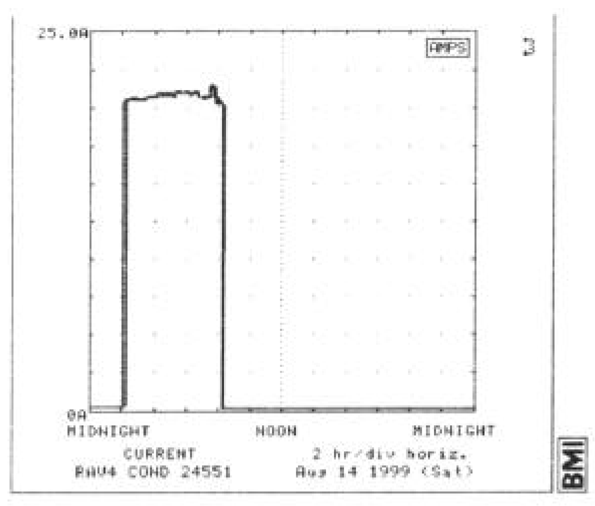
Phase A-N:
MAX: 245.1 V, 6:52 PM
MIN: 231.5 V, 7:23 AM



CURRENT 12:02:10 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

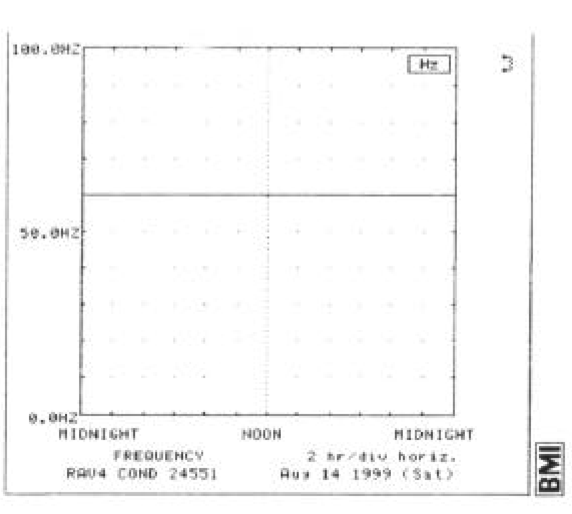
Phase A:
MAX: 21.7 A, 7:32 AM
MIN: 0.1 A, 9:09 AM



FREQUENCY 12:02:37 AM

FROM: MIDNIGHT Aug 13 1999 (Fri)
To: MIDNIGHT Aug 14 1999 (Sat)

MAX: 60.1 Hz, 12:07 AM
MIN: 59.9 Hz, 4:58 AM



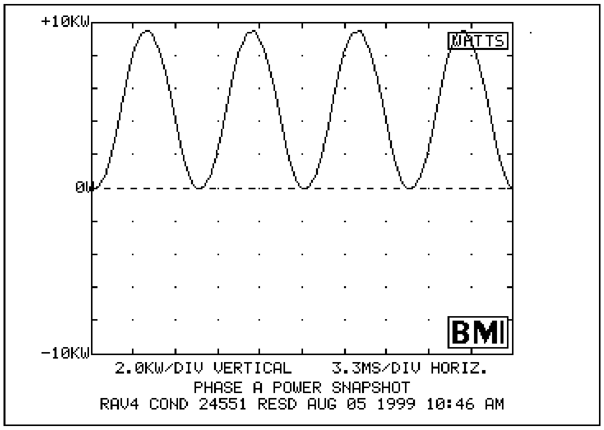
APPENDIX H

CHARGER PROFILE TEST GRAPHICAL DATA – RESIDENTIAL

SNAPSHOTS AT FULL POWER

PHASE A POWER SNAPSHOT 10:46:31 AM

INSTANTANEOUS POWER: 4.799 kW



PHASE A POWER SPECTRUM 10:47:04 AM

Power: 4.799 kW

Fundamental freq: 60.0 Hz

HARM	POWER	HARM	POWER
FUND	+4.799 kW	2nd	
3rd	+0.14 W	4th	
5th	+0.48 W	6th	
7th	-0.08 W	8th	
9th	-0.02 W	10th	
11th		12th	
13th		14th	
15th		16th	
17th		18th	
19th		20th	
21st		22nd	
23rd		24th	
25th		26th	
27th		28th	
29th		30th	
31st		32nd	
33rd		34th	
35th		36th	
37th		38th	
39th		40th	
41st		42nd	
43rd		44th	
45th		46th	
47th		48th	
49th		50th	
ODD	0.52 W	EVEN	0.00 W
THP:	0.52 W		

POWER FACTOR SNAPSHOT 10:46:34 AM

Phase A-N: 4.799 kW

Phase A-N: 4.823 kVA

Phase A-N: 462.2 VAR

Phase A-N: 1.00 PF

Phase A-N: 1.00 dPF

HARMONICS SNAPSHOT 10:46:36 AM

Fundamental freq: 60.0 Hz

Phase A-N Volts: 1.0% THD

Phase A Current: 1.4% TDD

VOLTAGE & CURRENT SNAPSHOT 10:47:14 AM

Phase A-N: 250.3 Vrms, 0 (ref)
Neut-Gnd: 125.3 Vrms, -131

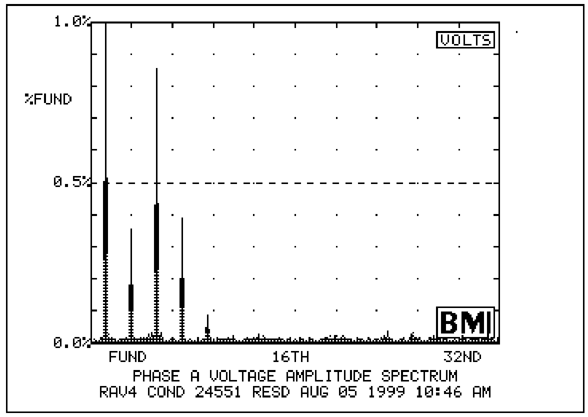
Phase A: 19.27 A rms, -6

PHASE A VOLTAGE SPECTRUM   10:46:40 AM

Fundamental volts: 250.3 Vrms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	0	2nd		
3rd	0.4%	175	4th		
5th	0.9%	142	6th		
7th	0.4%	-25	8th		
9th			10th		
11th			12th		
13th			14th		
15th			16th		
17th			18th		
19th			20th		
21st			22nd		
23rd			24th		
25th			26th		
27th			28th		
29th			30th		
31st			32nd		
33rd			34th		
35th			36th		
37th			38th		
39th			40th		
41st			42nd		
43rd			44th		
45th			46th		
47th			48th		
49th			50th		
ODD	1.0%		EVEN	0.1%	
THD:	1.0%				

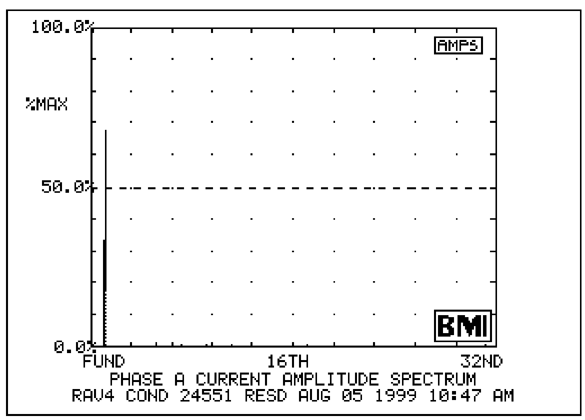


PHASE A CURRENT SPECTRUM   10:46:50 AM

Max load current: 28300 mA rms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	68.1%	-6	2nd		
3rd	0.6%	148	4th		
5th	0.8%	147	6th		
7th	0.3%	135	8th		
9th	0.4%	91	10th		
11th	0.3%	144	12th		
13th	0.2%	95	14th		
15th	0.2%	114	16th		
17th	0.3%	74	18th		
19th	0.2%	61	20th		
21st	0.2%	63	22nd		
23rd	0.2%	34	24th		
25th	0.2%	73	26th		
27th	0.2%	22	28th		
29th	0.2%	25	30th		
31st	0.3%	1	32nd		
33rd	0.2%	-17	34th		
35th	0.2%	-30	36th		
37th	0.2%	-46	38th		
39th	0.1%	-53	40th		
41st	0.1%	-63	42nd		
43rd			44th		
45th			46th		
47th			48th		
49th			50th		
ODD	1.4%		EVEN	0.1%	
TDD:	1.4%				

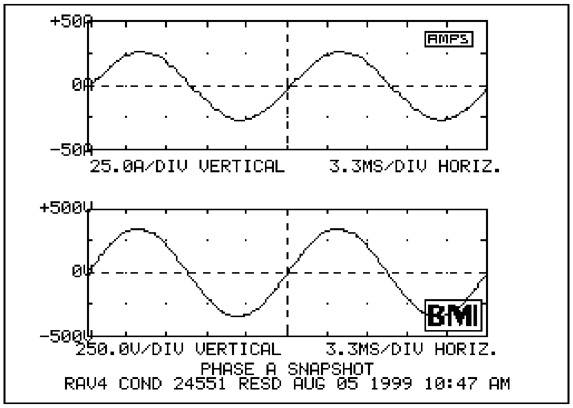


PHASE A SNAPSHOT 10:47:17 AM

Phase A-N VOLTAGE: 250.3 Vrms
1.4 Crest Factor
1.1 Form Factor

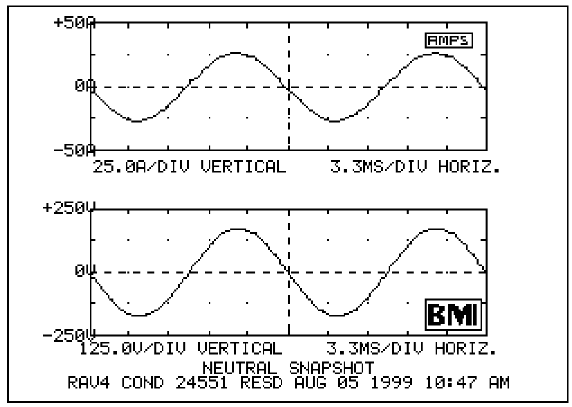
Phase A CURRENT: 19.27 A rms
1.4 Crest Factor
1.1 Form Factor

CURRENT LAGS VOLTAGE BY 6 (1.00 dPF)



NEUTRAL SNAPSHOT 10:47:27 AM

Neut-Gnd VOLTAGE: 125.3 Vrms
1.4 Crest Factor
1.1 Form Factor

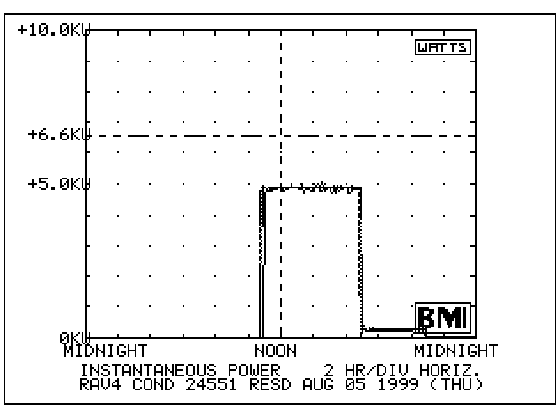


CUMMULATIVE PROFILES – 24 HOURS

INSTANTANEOUS POWER 12:00:01 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

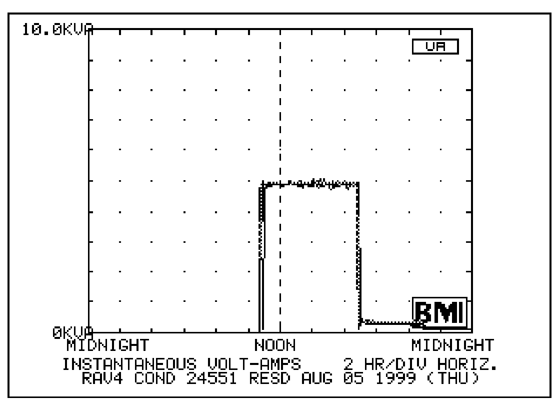
Phase A-N:
MAX: 5.0 kW, 2:27 PM
MIN: 0.0 kW, 10:42 AM



INSTANTANEOUS VOLT-AMPS 12:00:04 AM

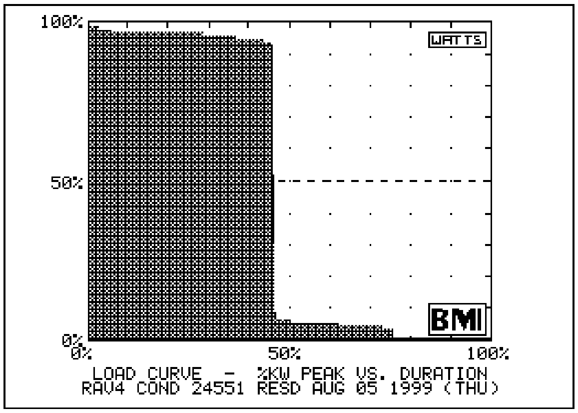
FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

Phase A-N:
MAX: 5.1 kVA, 2:27 PM
MIN: 0.0 kVA, 10:39 AM



LOAD DURATION CURVE 12:00:22 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)



TOTAL POWER CONSUMPTION 12:00:40 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

FLAT RATE: Cost: $ 0.060/kWh
Cost: $ 0.000/kWpk

BILLING DEMAND:

4.923 kW	Pk Today
4.923 kW	Pk Accumulated
$ 0.000	Today
$ 0.000	Accumulated

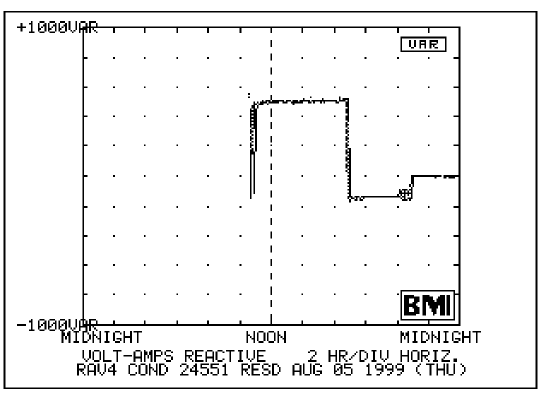
CONSUMPTION:

31.09 kWh	Today
31.09 kWh	Accumulated
$ 1.865	Today
$ 1.865	Accumulated
17.81 kQh	Today
2.617 kVARh	Today

VOLT-AMPS REACTIVE 12:00:49 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

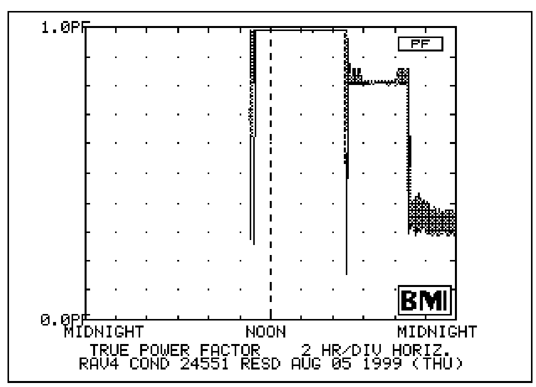
Phase A-N:
MAX: 535.6 VAR, 2:27 PM
MIN: -168.0 VAR, 4:58 PM



TRUE POWER FACTOR 12:01:00 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

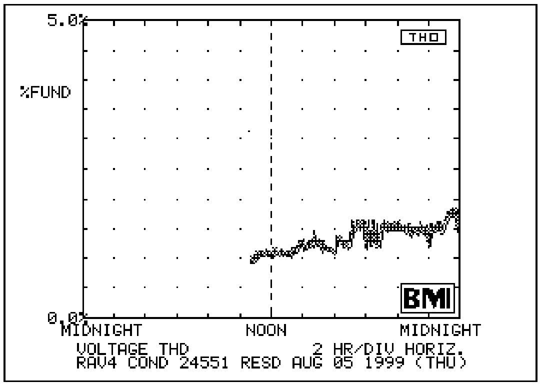
Phase A-N:
MAX: 1.00 PF, 10:52 AM
MIN: 0.16 PF, 4:56 PM



VOLTAGE THD 12:01:22 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

Phase A-N:
MAX: 1.9% THD, 11:30 PM
MIN: 0.9% THD, 10:51 AM

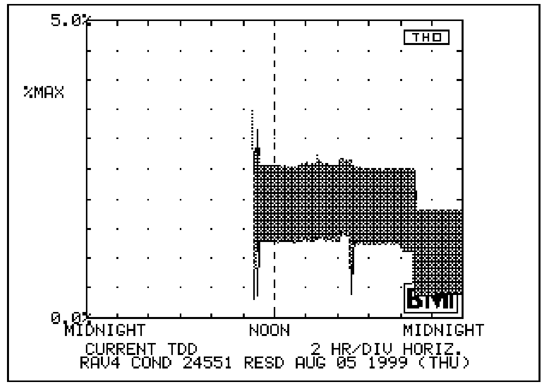


CURRENT TDD 12:01:33 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

Max load current: 28300 mA rms

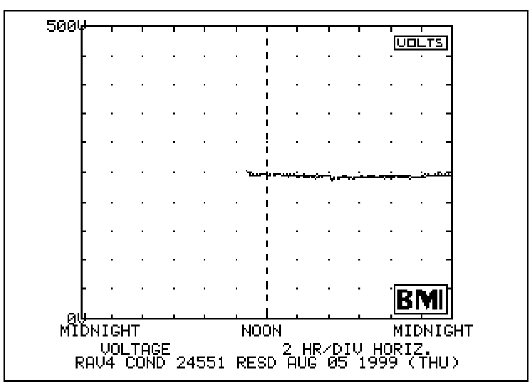
Phase A:
MAX: 2.1% TDD, 10:52 AM
MIN: 0.3% TDD, 10:39 AM



VOLTAGE 12:02:08 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

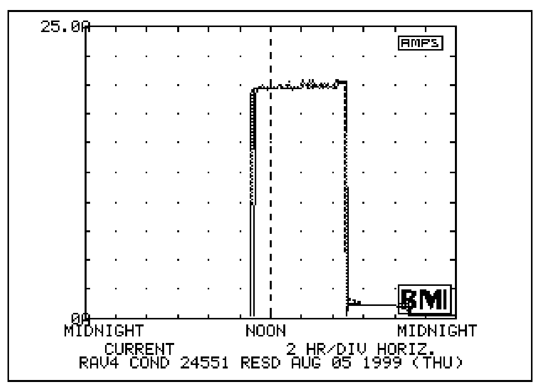
Phase A-N:
MAX: 251.6 V, 10:44 AM
MIN: 237.1 V, 4:14 PM



CURRENT 12:02:18 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

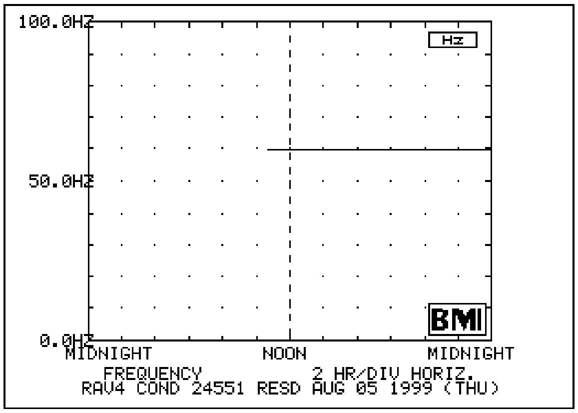
Phase A:
MAX: 20.5 A, 2:27 PM
MIN: 0.1 A, 10:43 AM



FREQUENCY 12:02:36 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

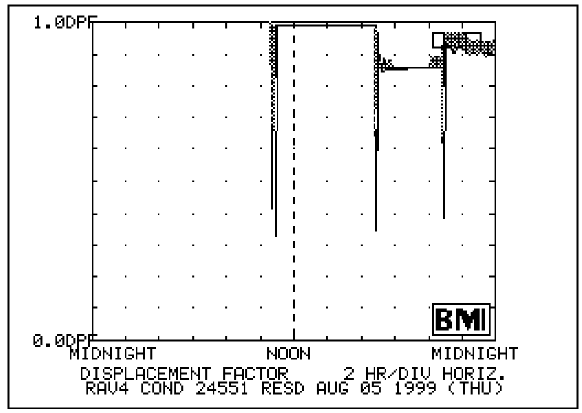
MAX: 60.1 Hz; 10:55 AM
MIN: 59.9 Hz; 11:19 AM



DISPLACEMENT FACTOR 12:01:08 AM

FROM: MIDNIGHT Aug 04 1999 (Wed)
To: MIDNIGHT Aug 05 1999 (Thu)

Phase A-N:
MAX: 1.00 dPF; 10:52 AM
MIN: 0.33 dPF; 10:52 AM



APPENDIX I

SCE ELECTRIC VEHICLE TEST PROCEDURE

ELECTRIC VEHICLE TEST PROCEDURE

SOUTHERN CALIFORNIA
EDISON

An *EDISON INTERNATIONAL* Company

ELECTRIC TRANSPORTATION DIVISION

JUAN C. ARGUETA
NAUM PINSKY
JORDAN W. SMITH
MICHEL WEHREY

August 1999

TABLE OF CONTENTS

I. INTRODUCTION

Since this test procedure was originally written in 1995, the type of electric vehicle (EV) tested at the Electric Vehicle Technical Center (EV Tech Center) in Pomona, California has changed dramatically. Instead of prototypes and small-scale production models, most vehicles tested are now production vehicles from major manufacturers, and most are very refined, with acceleration and braking characteristics close to that of gasoline-powered vehicles.

At first, weight certification was mainly a safety issue, as converted vehicles sometimes exceeded their original gross vehicle weight rating (GVWR). With current production vehicles the total vehicle weight is usually well within the specified gross vehicle weight rating, and the issue is a more practical one – related to passenger and cargo capacity.

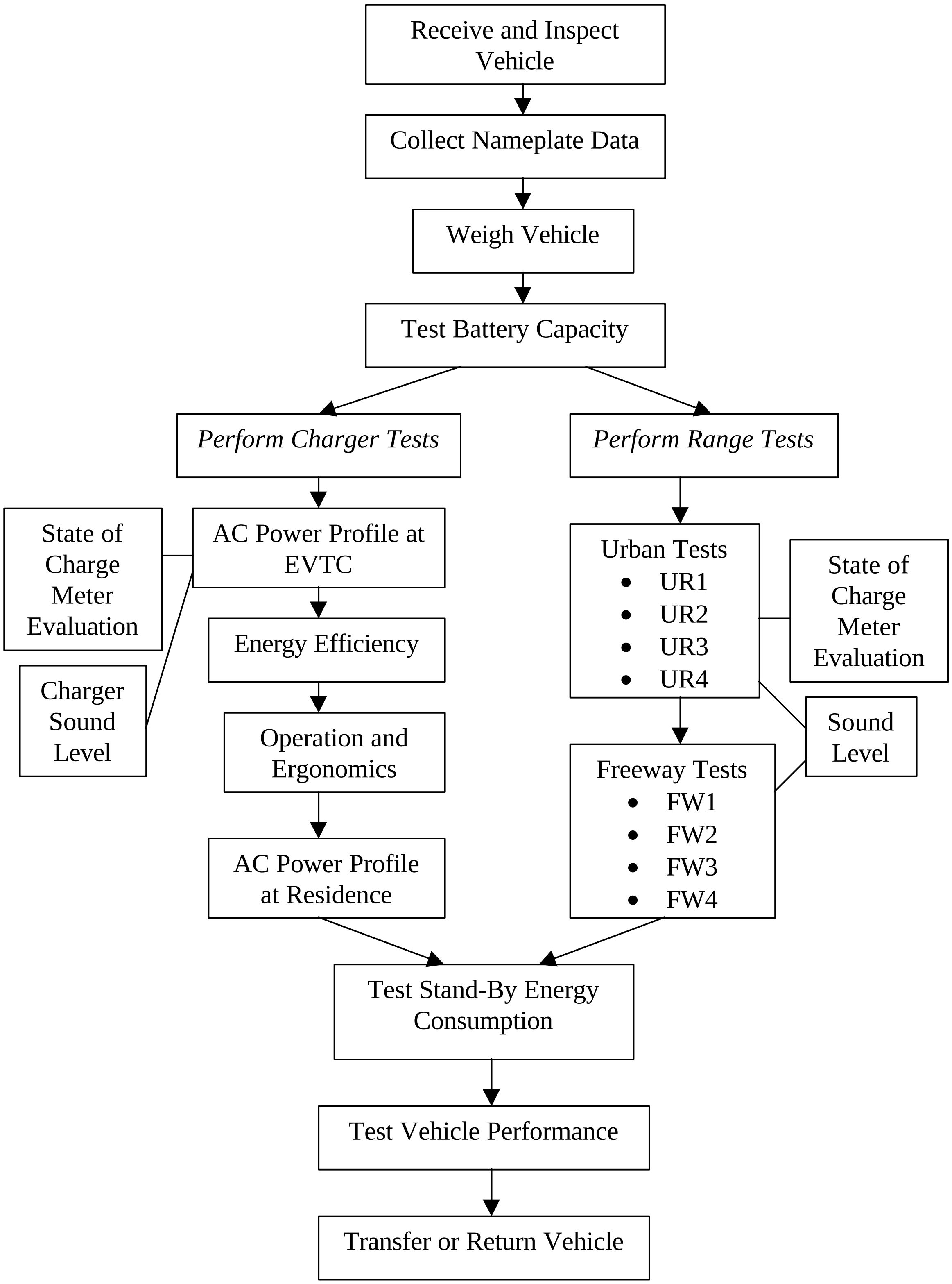
Range tests under different vehicle conditions no longer always have predictable results. Automatic climate controls limit air conditioner power on cool days, thus conserving battery energy and increasing range. The battery pack and the output side of the charger may no longer be readily accessible; some manufacturers may not allow access. Therefore, not all of the following charger and battery test procedures or efficiency measurements can be performed on all vehicles.

Since chargers are associated with each electric vehicle, the EV evaluation must include testing of the charger. As the use of EVs and their associated chargers increase, the potential for local demand and power quality problems increases. The combined impact of many chargers on the whole of the electric utility system could be detrimental. In order to plan properly, and to encourage manufacturers to build satisfactory chargers, the individual contribution of each type of charger must be determined through testing.

This publication describes testing methods and evaluation criteria used by the Electric Transportation Division of Southern California Edison to evaluate electric vehicles and chargers. These procedures are followed for each EV test unless otherwise noted in the test report. The document is divided into four main parts: Test Plan, Test Instrumentation, Test Procedure, and Appendices. The Test Plan gives an outline of tests performed and the reasons or justification for the procedures. The Test Instrumentation section is a listing of the required equipment for each procedure. The Test Procedure section gives detailed instructions on how to perform the tests. The Appendices include maps, data sheets, and diagrams.

The EV Tech Center maintains a network database (called "Project Manager") for test reports, results, and standard forms. The intent is to allow EV Tech Center personnel access to all current and past projects and test data in the interest of sharing information. As data is gathered during a test, it is entered in the database on the standard forms mentioned in the test procedure.

SCE EV TEST PROCEDURE FLOW DIAGRAM



II. TEST PLAN

A. NAMEPLATE DATA COLLECTION

Record all applicable nameplate data, serial numbers, and ratings for all tested components. This data is important to record in order to keep track of the version of the software and hardware of the vehicle, since this technology can change rapidly.

B. WEIGHT DOCUMENTATION

At a certified scale, measure the weight of the vehicle. The curb weight is subtracted from the GVWR to determine the available payload.

C. BATTERY CAPACITY TEST

The battery capacity test should be performed before the range tests to determine the pack's health. Follow the USABC (United States Advanced Battery Consortium) procedure for constant current discharge tests. Use the ABC-150 battery tester to discharge the EV's battery pack at a constant current until a manufacturer recommended cutoff voltage is reached. At a starting battery temperature of $23^o \pm 2^o$ C, perform groups of three constant current discharge cycles at each of $C_3/3$, $C_2/2$, $C_1/1$, and $C_3/3$ Amperes. Repeat until the $C_3/3$ capacity is stable with three consecutive discharges within 2%. Construct a Peukert Curve, which shows the effect of discharge rate on capacity and can be used to determine the battery capacity at a specific rate.

D. RANGE TESTS

Repeat the tests until the range result is within 5.0% of the previous result. Report the average of the final two tests.

1. **UR1 -** Urban Range Test at Minimum Payload (driver and test equipment only).
   Drive the EV on the "Urban Pomona Loop" without using auxiliary loads. Record data to determine distance per charge, AC kWh/mile, and DC kWh/mile. The "Urban Pomona Loop" is a local street route of about 20 miles with approximately 50 stop signs and traffic lights. Refer to the Appendix, p.21, for a map and elevation profile.

2. **UR2** - Urban Range Test at Minimum Payload with Auxiliary Loads.
   Repeat the above test with the vehicle's auxiliary loads on (air conditioning, lights, and radio). Record air conditioning vent temperature and cabin temperature continuously.

3. **UR3** - Urban Range Test at Maximum Payload (GVWR)
Urban Pomona Loop range test with auxiliary loads off and with the vehicle loaded to its maximum legal weight limit.

4. **UR4** - Urban Range Test at Maximum Payload (GVWR) With Auxiliary Loads Repeat the above test with auxiliary loads on. Record air conditioning vent temperature and cabin temperature continuously.

5. **FW1** - Freeway Range Tests at Minimum Payload
Drive the EV on the "Freeway Pomona Loop" without using auxiliary loads. Record data to determine distance per charge, AC kWh/mile, and DC kWh/mile. The Freeway Pomona Loop is a loop on four local freeways of approximately 37 miles (one transition requires one-half mile on access roads). Refer to the Appendix, p.21, for a map and elevation profile.

6. **FW2** - Freeway Range Test at Minimum Payload with Auxiliary Loads
Repeat the above test with the vehicle's auxiliary loads on. Record air conditioning vent temperature and cabin temperature continuously.

7. **FW3** - Freeway Range Test at Maximum Payload (GVWR)
Pomona Freeway Loop range test with auxiliary loads off and with the vehicle loaded to its maximum legal weight limit.

8. **FW4** - Freeway Range Test at Maximum Payload (GVWR) With Auxiliary Loads
Repeat the above test with the vehicle's auxiliary loads on. Record air conditioning vent temperature and cabin temperature continuously.

E. SOUND LEVEL TEST

The interior cabin sound level will be measured for one urban and one freeway loop. A recorded plot from the meter and an average sound level will be reported.

F. STATE OF CHARGE METER EVALUATION

1. **Driving**
While performing the Urban Range Tests, record data to produce a distance traveled vs. state-of-charge graph.

2. **Charging**
While charging, record data to produce a state of charge vs. time graph. Plot with the charging profile to associate indicated state of charge with energy delivered.

G. PERFORMANCE TESTS

The acceleration tests are designed to measure peak power capability of the vehicle and battery pack on the test track. Use the accelerometer performance computer to measure the time, speed, and acceleration. The tests will be performed in the sequence and number described in the test procedure in order to minimize heating effects on the traction battery. The vehicle will be driven gently between tests to discharge.

1. Acceleration

Accelerate the EV from a stop to over 60 mph at maximum power. Repeat this procedure two times in opposite directions (to average the effects of wind and grade) at the following traction battery states-of-charge: 100%, 80%, 60%, 40%, and 20%, as measured by the EV's state of charge gage. Read the data from the computer to obtain the time for 0-30 mph and 0-60 mph.

2. Maximum Speed

Continue to accelerate the EV from the 60 mph test until the maximum speed is reached. Conduct twice in opposite directions at both 100% and 20% SOC.

3. Acceleration - 30 to 55 mph

Accelerate the EV from a steady 30 mph to 55 mph at maximum power. Perform this procedure twice in opposite directions at the following approximate traction battery states-of-charge: 100%, 80%, 60%, 40%, and 20% (after the above tests).

4. Braking

Brake the vehicle from a steady 25 mph without skidding the tires. Repeat this procedure four times in opposite directions. Use the performance computer to determine braking distance. This test will be performed between 50% and 60% SOC.

H. CHARGER PERFORMANCE/CHARGING PROFILE TEST

1. AC Input Data

Use the BMI Power Profiler to record the following on the AC (input) side of the charger for the duration of the charge at the EV Tech Center:

- Real, reactive, and apparent power
- Energy consumption
- True and displacement power factors
- Voltage and current total harmonic distortion
- Current total demand distortion
- Voltage, current, and frequency
- Ambient temperature and humidity

2. **Charging Profile**

   Use the ABB Recording kWh Meter recording at one-minute intervals to collect AC demand and energy data.

3. **Charging at a Residential Setting**

   While standard power quality measurements are made at SCE's EV Tech Center, it is useful to know what the effects of the charger are in a "real world" setting, as the type of service can affect results. In order to observe the power quality of the charger through a typical residential service; charge the vehicle at a designated residence. Use the BMI Power Profiler to record energy and power quality characteristics. Use the portable ABB Recording kWh Meter to collect AC demand and energy data.

4. **Charger Energy Efficiency**

   If the output side of the charger is accessible, use the SmartGuard Control Center to record Voltage, current, power, and energy data. Use the results to determine the charger energy efficiency.

5. **Audible Noise Levels**

   Use a sound level meter to measure charger noise intensity at maximum power from a distance of one meter.

6. **Operation and Ergonomics**

   Observe these aspects of the charger's operation:

   - Charging algorithm
   - Battery monitoring
   - End point determination
   - Protective features

   Examine the user's interface with the charger:

   - Switches, indicators, displays
   - Dimensions, weight
   - Connector types
   - Ease of use

I. STAND-BY ENERGY CONSUMPTION TESTS ("HOTEL" LOADS)

1. **Vehicle on Charger**

   After recharging the battery pack to 100% SOC, record the amount of AC kWh drawn by the charger and the DC kWh being delivered to the batteries for a 24 hour period.

2. Vehicle off Charger

After completing the preceding test, disconnect AC Power supply from the charger and record the amount of DC kWh consumed by the vehicle for a 24-hour period.

J. TRANSFER THE VEHICLE

Once the vehicle has undergone a full performance test, it must be transferred to the Transportation Services Department in order to place it in its intended service. If the vehicle is on loan it must be returned to the owning organization.

III. TEST INSTRUMENTATION

A. WEIGHT DOCUMENTATION

1. Certified Weight Scale

B. RANGE TESTS

1. EV odometer
2. Thermometer
3. Temperature loggers (2)
4. SmartGuard Control Center
4. Laptop computer
5. BMI Power Profiler

C. BATTERY CAPACITY TEST

1. Aerovironment ABC-150 Battery Cycler
2. SmartGuard Control Center
3. Digital multimeter
4. Thermometer

D. SOUND LEVEL TEST

1. Sound level meter
2. Laptop computer (optional)

E. STATE OF CHARGE METER EVALUATION

1. EV odometer
2. EV state-of-charge meter
3. Stopwatch

F. PERFORMANCE TESTS

1. Acceleration Tests
    a. EV speedometer
    b. Stopwatch
    c. EV state-of-charge meter
    d. Vericom VC2000PC Performance Computer

2. Maximum Speed
    a. EV speedometer

3. Braking
    a. EV speedometer
    b. Vericom VC2000PC Performance Computer

G. CHARGER PERFORMANCE/CHARGING PROFILE TEST

1. BMI Power Profiler 3030A
2. ABB Recording kWh Meter
3. Laptop computer
4. SmartGuard Control Center
5. EV state-of-charge meter
6. Stopwatch
7. Decibel Meter

H. STAND-BY ENERGY CONSUMPTION TESTS (HOTEL LOADS)

1. Vehicle on charger:
    a. BMI Power Profiler
    b. SmartGuard Control Center
2. Vehicle off charger:
    SmartGuard Control Center

IV. TEST PROCEDURE

A. NAMEPLATE DATA COLLECTION

Record all applicable nameplate data, serial numbers, and ratings for all tested components and test equipment on the Equipment and Nameplate Data Sheet (EVTC–040) (see page 34). On the vehicle, readily available data should be recorded for the controller, motor, charger, traction battery, tires, payload, etc.

B. WEIGHT DOCUMENTATION

Take the EV to a certified scale and measure the curb weight of the vehicle, as well as the weight on each axle. Enter the data on the Weight Certification form available on "Project Manager".

C. BATTERY CAPACITY TEST

Before attempting the battery capacity test, obtain documents containing specifications and recommended values and procedures from the battery manufacturer. The specifications should include a range for which the specified capacity is acceptable so that the health of the battery can be determined.

Data Acquisition Equipment
If possible, and permissible with the manufacturer, configure the vehicle with the SmartGuard Control Center (SGCS) system to record current and voltage information from the battery pack. Using piercing voltage probes and a current transformer probe on the high voltage cables on the output side of the battery pack, connect to the SGCS. If access to the battery pack is possible, configure each module with a Smart Guard unit. Connect the SGCS to the ABC-150.

Fully charge the battery pack with the vehicle's charging system (or use the battery manufacturer's charge algorithm). Take the pack off charge at least 30 minutes before beginning the discharge test. Connect the ABC-150 battery tester to the main battery pack. Record on the Vehicle Battery Capacity Test form (EVTC-060) (see page 36) the initial open circuit pack voltage, pack average temperature and ambient temperature with the SGCS. The pack average temperature can be obtained with the vehicle's diagnostic tool or with thermocouples placed on modules at various pack locations.

Use the ABC-150 battery tester to discharge the EV's battery pack at a constant current until a manufacturer recommended cutoff voltage is reached. Record the following data at 10 second intervals: pack current, pack voltage, Ah, kWh, module Voltage, module temperature.

At a starting battery temperature of 23° ± 2° C, perform groups of three constant current discharge cycles at each of $C_3/3$, $C_2/2$, $C_1/1$, and $C_3/3$ Amperes. At the end of each test, record the following data: open circuit pack voltage (at least 30 minutes after the end of discharge), ambient temperature, average pack temperature, the Voltage difference at the stop condition, the lowest module at the stop condition, DC Ah out, and DC kWh out. Repeat until the $C_3/3$ capacity is stable with three consecutive discharges within 2%.

Charge the vehicle with the vehicle's charger, and record the AC kWh input to the charger and the DC kWh used to return the pack to a fully charged state. Divide the DC kWh returned by the DC kWh out to determine the percent overcharge.

Construct a Peukert Curve – a plot of the logarithm of the discharge rate versus the logarithm of the discharge time to a specified end-of-discharge voltage (Figure 3-1). The curve shows the effect of discharge rate on capacity and can be used to determine the battery capacity at a specific rate.

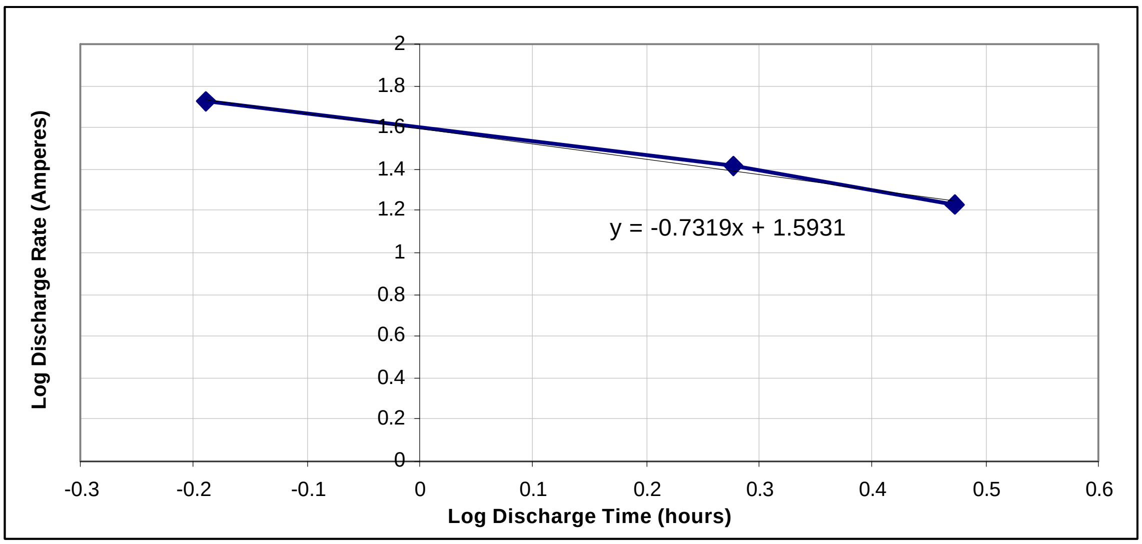


Figure 3-1. Sample Peukert Curve.

D. RANGE TESTS

Vehicle Preparation/Inspection

All new vehicles should first be inspected using the New Vehicle Turnkey Inspection form available from Transportation Services Department (TSD), Pomona. The New Vehicle Turnkey inspection is typically conducted by TSD. All other tested vehicles should be subjected to the functional testing on that form. Inflate tires to the maximum pressure indicated on the tire sidewall. Check the pressure at least once per week. Check the vehicle fluid levels once per week.

Data Acquisition Equipment

If possible, and permissible with the manufacturer, configure the vehicle with the SmartGuard Control Center (SGCS) system to record current and voltage information from the battery pack. Using piercing voltage probes and a current transformer probe on the high voltage cables on the output side of the battery pack, connect to the SGCS. Connect the SGCS to a laptop computer to record data at 30 second intervals during driving.

Stop Conditions

The maximum useable range of the EV is determined by vehicle gage indications specified by the manufacturer, or if no instructions are specified, by diminished vehicle performance such that the EV is no longer capable of operating with the flow of traffic. Typically, a vehicle will have two warning lights near the end of the vehicle's range. The first is usually a cautionary light at roughly 20% SOC. This light is usually a reminder to the driver that he should notice that the state of charge is low. The second warning usually comes on at about 10% to 15% SOC, and is an indication to charge immediately. The EV Tech Center usually uses this second warning signal, as recommended by the manufacturer, to stop the range test, so that there is no chance to harm the traction battery by overdischarge. At this point, the driver should be within a mile or two of the EV Tech Center, and he will drive it in slowly and conservatively. If the vehicle is five miles or more from the EV Tech Center, the driver will have it towed in.

1. **Urban Range Tests:**

   Record the pack voltage, odometer reading and ambient temperature on the Pomona Driving Test Data sheet (EVTC-010) (see page 31). Drive the EV on the Urban Pomona Loop in a manner that is compatible with the safe flow of traffic. Record the following data on the EVTC-010 form at five-mile intervals (or at intervals determined by the vehicle's state of charge meter, if it has sufficient graduations to correspond to about five miles driving between marks): state of charge meter reading, pack voltage, DC kWh, and odometer mileage.

   Near the end of the drive, if needed to manage the range, it is permissible to reverse direction after completing a partial loop, or to shorten the loop by using a parallel street; record this deviation (and all other deviations from the Pomona Loop) on the EVTC-010. Record the distance traveled (to the tenth of a mile) at the stop condition and at the end of the drive.

   Upon returning to the EV Tech Center, record the end of test data (odometer, state of charge, ambient temperature, DC kWh, and pack voltage after 30 minutes).
   Connect the BMI Power Profiler to the AC supply side, and collect data necessary for the *Charger Performance Test* (see p. 16) after the first and second UR-1 tests. For the remaining tests, after completion of charging,

record the AC kWh data from the BMI Power Profiler, and the DC data, if applicable, from the SmartGuard system.

Conduct this procedure in the following four vehicle test configurations:

UR-1 Minimum payload (driver only) with no auxiliary loads.

UR-2 Minimum payload (driver only) with the following auxiliary loads on: air conditioning set on high, fan high, low beam headlights, and radio. Use thermocouple temperature loggers to continuously record the temperature of the air-conditioned outlet air from the center cabin vent and the cabin ambient temperature at mid-cabin chest level.

UR-3 Repeat the UR-1 test at the vehicle's maximum legal weight limit (without exceeding the gross axle weight ratings).

UR-4 Repeat the UR-2 test at the vehicle's maximum legal weight limit (without exceeding the gross axle weight ratings).

Repeat the tests until the range result is within 5.0% of the previous result. Report the average of the final two tests.

2. **Freeway Range Tests:**
   Record the pack voltage, odometer reading, and ambient temperature. Drive the EV (with windows closed) on the Freeway Pomona Loop in a manner that is compatible with the safe flow of traffic. Maintain speed on the freeway as close to 65 mph as possible; drive conservatively on the transitions. Record the following data on the EVTC-010 form at five-mile intervals (or at intervals determined by the vehicle's state of charge meter, if it has sufficient graduations to correspond to about five miles driving between marks): state of charge meter reading, pack voltage, DC kWh, and odometer mileage. Note the current being delivered by the battery pack at a constant 65 mph on the 10 Freeway between Haven Street and Milliken Avenue.

   Near the end of the drive, if needed to manage the range, it is permissible to reverse direction after completing a partial loop; record this deviation (and all other deviations from the Freeway Loop) on the EVTC-010. Leave the freeway loop only at Towne Avenue or Indian Hill Boulevard, if on the 10 Freeway, or Reservoir Street if on the 60 Freeway to minimize city driving. Record the distance traveled (to the tenth of a mile) at the stop condition and at the end of the drive.

   Upon returning to the EV Tech Center, record the end of test data (odometer, state of charge, ambient temperature, DC kWh, and pack voltage after 30 minutes).
   Connect the BMI Power Profiler to the AC supply side to record energy data. After completion of charging, read the AC kWh data from the BMI

Power Profiler, and the DC data from the SmartGuard Control Center system.

Conduct this procedure in the following four vehicle test configurations:

FW-1 Minimum payload (driver only) with no auxiliary loads.
FW-2 Minimum payload (driver only) with the following auxiliary loads on: air conditioning set on high, fan high, low beam headlights, and radio. Use thermocouple temperature loggers to continuously record the temperature of the air-conditioned outlet air from the center cabin vent and the cabin ambient temperature at mid-cabin chest level.
FW-3 Repeat the FW-1 test at the vehicle's maximum legal weight limit (without exceeding the gross axle weight ratings).
FW-4 Repeat the FW-2 test at the vehicle's maximum legal weight limit (without exceeding the gross axle weight ratings).

Repeat the tests until the range result is within 5.0% of the previous result. Report the average of the final two tests.

AC kWh per mile efficiency
To determine the AC kWh per mile efficiency, recharge the pack fully and use the BMI Power Profiler to record the energy consumption in AC kWh; this number divided by the number of total miles driven, will yield an approximate figure for AC kWh per mile efficiency.

Range Envelope
Once all the data for the range tests have been gathered, a "Range Envelope" can be created for the vehicle for both urban and freeway driving (Figure 3-2). To construct the envelope, use the range in miles recorded at the stop condition; this is a more consistent value than the total miles driven (which may vary based on the distance the driver is from the EV Tech Center when the stop condition is reached) and can be more easily used by others to estimate range. Typically, the longest range will be achieved when the vehicle is tested at minimum payload with no auxiliary loads, and conversely, the shortest range will be achieved with a fully loaded vehicle with all auxiliary loads turned on. Plotting these data should yield a chart similar to the one shown in Figure 3-2.

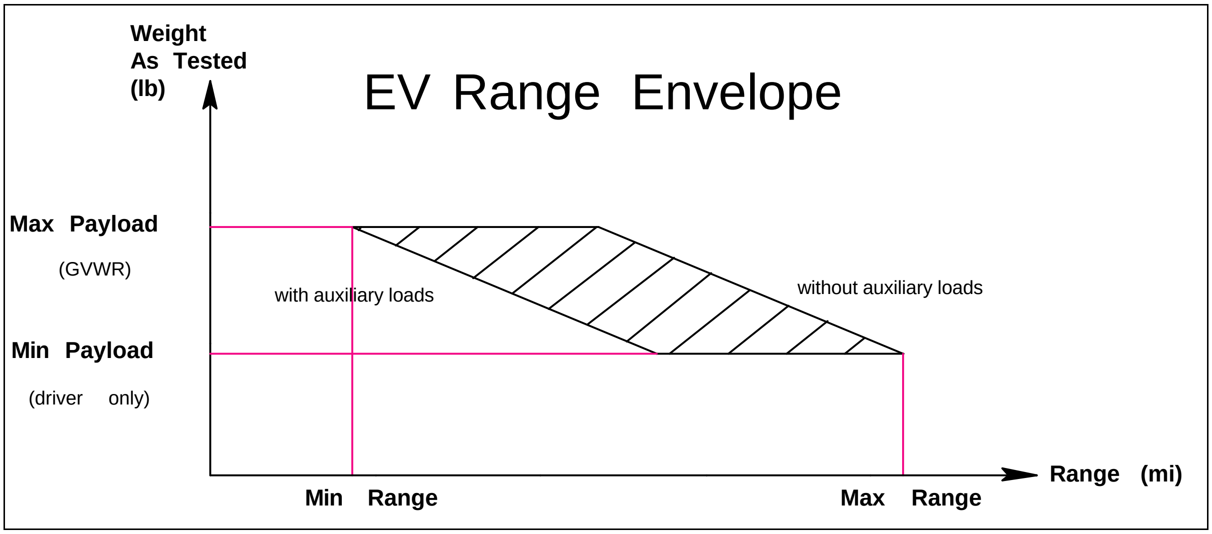


Figure 3-2. Range Envelope.

Air Conditioning Performance
Plot the two curves: air conditioning vent temperature versus time and cabin temperature versus time on the same graph.

E. SOUND LEVEL TEST

Position the sound level meter in the vehicle cabin at ear level on the passenger seat. Record the sound level for both one urban and one freeway loop. The windows will be rolled up and all interior accessories will be off. Any external noises from sources other than the test vehicle loud enough to register on the meter will be noted and reported on the Sound Level Test Data Sheet (EVTC-050) (see page 35). Report the average sound level and present the plot of the recorded data in the Performance Characterization report.

F. STATE OF CHARGE METER EVALUATION

1. Driving

While running the Urban Range Tests, record on the EVTC-010 the distance traveled using the EV's odometer at intervals corresponding to the EV's state-of-charge meter (such as 3/4, 1/2, 1/4 and "empty"). If the vehicle has only an energy meter, record data at five-mile intervals. At the end of the trip, record the total number of miles driven. In an ideal case, the maximum range would be reached at the time that the state of charge meter indicates "empty". An ideal state-of-charge meter would yield the following chart for an 80-mile maximum range vehicle:

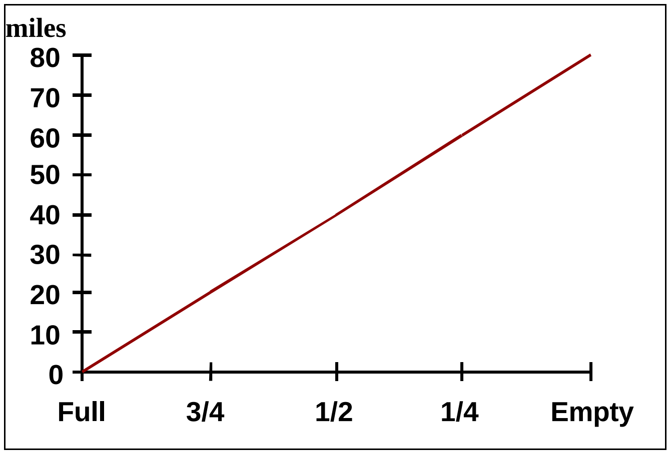


Figure 3-3. State of Charge Meter Evaluation.

2. **Charging**

During charging record on the EVTC-010 the state of charge reading on the EV's state-of-charge meter at fifteen-minute intervals. Use this data to create an indicated state of charge versus time graph, and plot with the charging profile and calculated state of charge plot. This plot will assist the user in estimating the state of charge after a certain amount of time and the energy needed to reach that state.

3. **Driving Range per Charging Time**

Use the results from (1) and (2) to estimate the vehicle range per charging time under UR1 conditions. Use the UR1 average range and state of charge data, to create a set of data points that show miles driven versus indicated state of charge. Subtract the range at each point from the maximum range at the stop condition to obtain a set of points giving the range available at each state of charge point. Use the results giving state of charge versus charging time from (2) to create a plot giving driving range available per charging time (Figure 3-4).

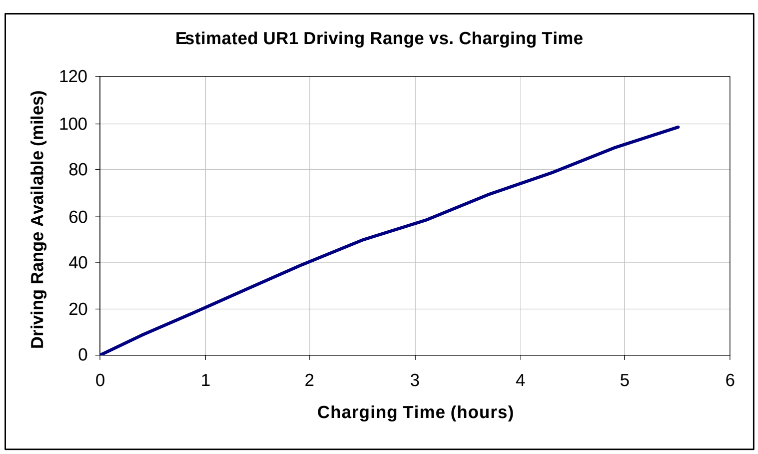


Figure 3-4. Sample plot of estimated range versus charging time.

G. PERFORMANCE TESTS

These tests will be performed with minimum payload at the Los Angeles County Fairplex drag strip in Pomona. Tires should be at maximum pressure. Record the starting and ending data on the EVTC-030 form (see page 33): odometer, ambient temperature, relative humidity, date, time, pack voltage. Note the maximum current and maximum power observed during acceleration.

1. **Acceleration**
   Use the Vericom VC2000PC Performance Computer to measure the performance of the vehicle. Accelerate the EV from stop to over 60 mph at maximum power, and then stop. Record the time expired for 0 to 30 mph and from 0 to 60 mph on the EVTC-030 form. Repeat this procedure twice in opposite directions (to average the effects of wind and grade) at the following traction battery states-of-charge: 100%, 80%, 60%, 40%, and 20%, as measured by the EV's state of charge gage. Report the average of the readings at each state of charge level.

2. **Maximum Speed**
   Continue to accelerate the EV from the 60 mph test until the maximum speed is reached. Conduct this procedure twice in opposite directions at both 100% and 20% SOC. Report the average of these readings. If unable to reach the maximum speed before the end of the track, note the highest speed achieved.

3. **Acceleration - 30 to 55 mph**
   Accelerate the EV from a steady 30 mph to 55 mph at maximum power and use a stopwatch record the time expired. Repeat this procedure twice in opposite directions at the following approximate traction battery states-of-charge: 100%, 80%, 60%, 40%, and 20% (after the above tests), as measured by the EV's state-of-charge gage. Report the average of each pair of readings.

4. **Braking**
   Drive the EV to a speed of 25 mph, and apply the brakes hard enough to bring the vehicle to a quick stop without skidding the tires. Use the Vericom VC2000PC Performance Computer to measure the braking distance. Make four runs in opposite directions, and report the average of these readings.

H. CHARGER PERFORMANCE/CHARGING PROFILE TEST

Enter results on form EVTC-020 (see page 32).

1. **AC Input Data**
   After the first UR-1 range test, use the BMI Power Profiler to record the following on the AC (input) side of the charger for the duration of the charge at the EV Tech Center:
   - Real, reactive, and apparent power
   - Energy consumption

- True and displacement power factors
- Voltage and current total harmonic distortion
- Voltage, current, and frequency
- Ambient temperature and humidity

Monitor the vehicle's state of charge meter as specified for the State of Charge Meter Evaluation.

After completion of the charge note the maximum current reported by the BMI. After the second UR-1 test, set up the BMI Power Profiler to record current total demand distortion instead of harmonic distortion. Charge the vehicle and record a snapshot at maximum, intermediate and minimum power. Record data for the duration of the charge at the EV Tech Center.

2. Charging Profile

After the first UR-1 test use the ABB Recording kWh Meter recording at one-minute intervals to collect AC demand and energy data. Read the meter and determine the total charging time.

3. Charger Energy Efficiency

Use the SmartGuard Control Center as described in Range Tests to record voltage and current data on the output side of the charger. Use the results to determine the charger energy efficiency.

4. Data Analysis/Reports

Using the ABB Meter data and a spreadsheet program, plot the power versus time curve. Plot the instantaneous indicated state of charge on the same graph. Use the charger efficiency and energy data to plot calculated state of charge on the same graph (Figure 3-5).

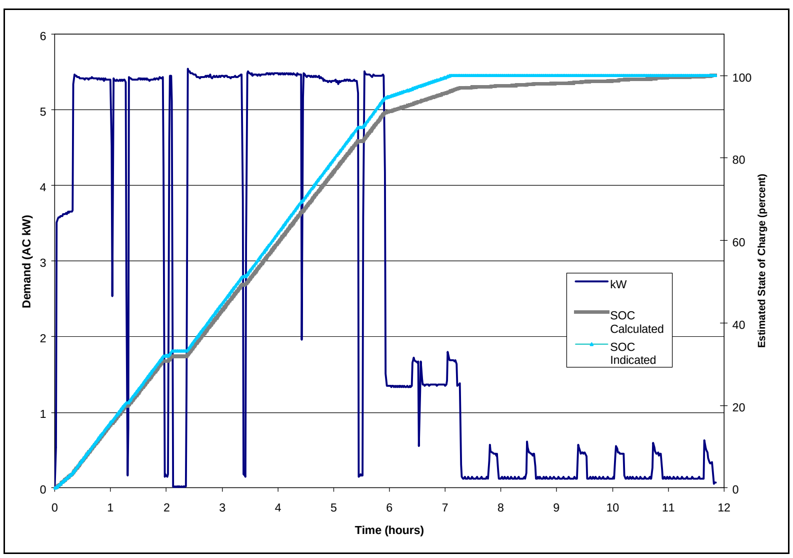


Figure 3-5. Sample AC charging profile plots.

From the BMI and SmartGuard data collected, calculate the energy efficiency for the battery/charger/vehicle system by dividing the total DC kWh delivered to the battery pack by the total AC kWh delivered to the charger. Divide the DC kW curve recorded with the SmartGuard by the AC kW curve recorded with the ABB meter to produce a power conversion efficiency curve.

Using instantaneous data captured with the SmartGuard, determine the ripple factor by dividing the AC RMS current flowing through the battery pack by the average current flowing through the pack.

Determine the overcharge factor by dividing the number of DC kWh (or Ah) returned to the battery pack during recharge by the number of DC kWh (or Ah) delivered from the battery pack during discharge.

By observing the DC current and voltage profiles obtained with the SmartGuard, determine the end of charge conditions.

Divide the current short circuit duty for the charging circuit (see page 29 for a line diagram) by the maximum load current. Use the result to apply IEEE 519-1992, *IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.* Apply the recommendations from the National Electric Vehicle Infrastructure Working Council (October 1997) shown in Table 3-1.

Table 3-1. EPRI IWC EV Charging Standards.

	Level 1 Charging	**Level 2 Charging**
Total Power Factor (minimum)	95%	95%
Power Conversion Efficiency (minimum)	85%	85%
Total Harmonic Current Distortion (max.)	20%	20%
Inrush Current (maximum)	28 A	56 A

5. Audible Noise Levels

Charge the vehicle in a quiet room or chamber. Use a sound level meter to record (on the EVTC-050 form) the charger noise intensity from a distance of one meter from the charger. Present the plot of the recorded data and the average sound level in the Performance Characterization report.

6. Operation and Ergonomics Evaluations

Observe the operation of the charger, and use the collected data, along with information from the manufacturer to determine:

- Charging algorithm (constant current/voltage steps, etc.) – determined by viewing the charging profile.

- Battery monitoring method – from the manufacturer.
- End point determination (time, gas emission, voltage change, etc.) – from the manufacturer.
- Protective features (battery protection, GFCI, etc.)

Examine and record (objectively and subjectively) on form EVTC-020 the user's interface with the charger and any electric vehicle supply equipment (EVSE):

- Switches, indicators, displays
- Dimensions, weight
- Connector types, compatibility
- Ease of use

7. Charging at a Residential Setting

Take the vehicle to a designated residence and charge from the stop condition state of charge (see page 12) to 100% SOC (see page 29 for a line diagram of the designated residence). Use the BMI Power Profiler to record energy and power quality characteristics. Use the portable ABB Recording kWh Meter recording at one-minute intervals to collect AC demand and energy data. Construct a charging profile, as described in task 2 (page 16).

I. STAND-BY ENERGY CONSUMPTION TESTS ("HOTEL" LOADS)

1. Vehicle on Charger

After completing the *Charger Performance Test*, leave the BMI Power Profiler and SmartGuard Control Center connected to the vehicle and install the most sensitive current probes (5A) available for the BMI. For a 24-hour period, record the amount of AC kWh drawn by the charger and the amount of DC kWh delivered by the charger to the battery pack.

2. Vehicle off Charger

After completing the preceding test, disconnect the AC power supply from the charger and continue to record data on the DC side. This data will show how much energy is consumed by the vehicle's stand-by systems, such as thermal management system on high temperature batteries.

J. TRANSFER THE VEHICLE

Return control of the vehicle to Transportation Services Department if an SCE vehicle, or to its owning organization if on loan.

APPENDICES

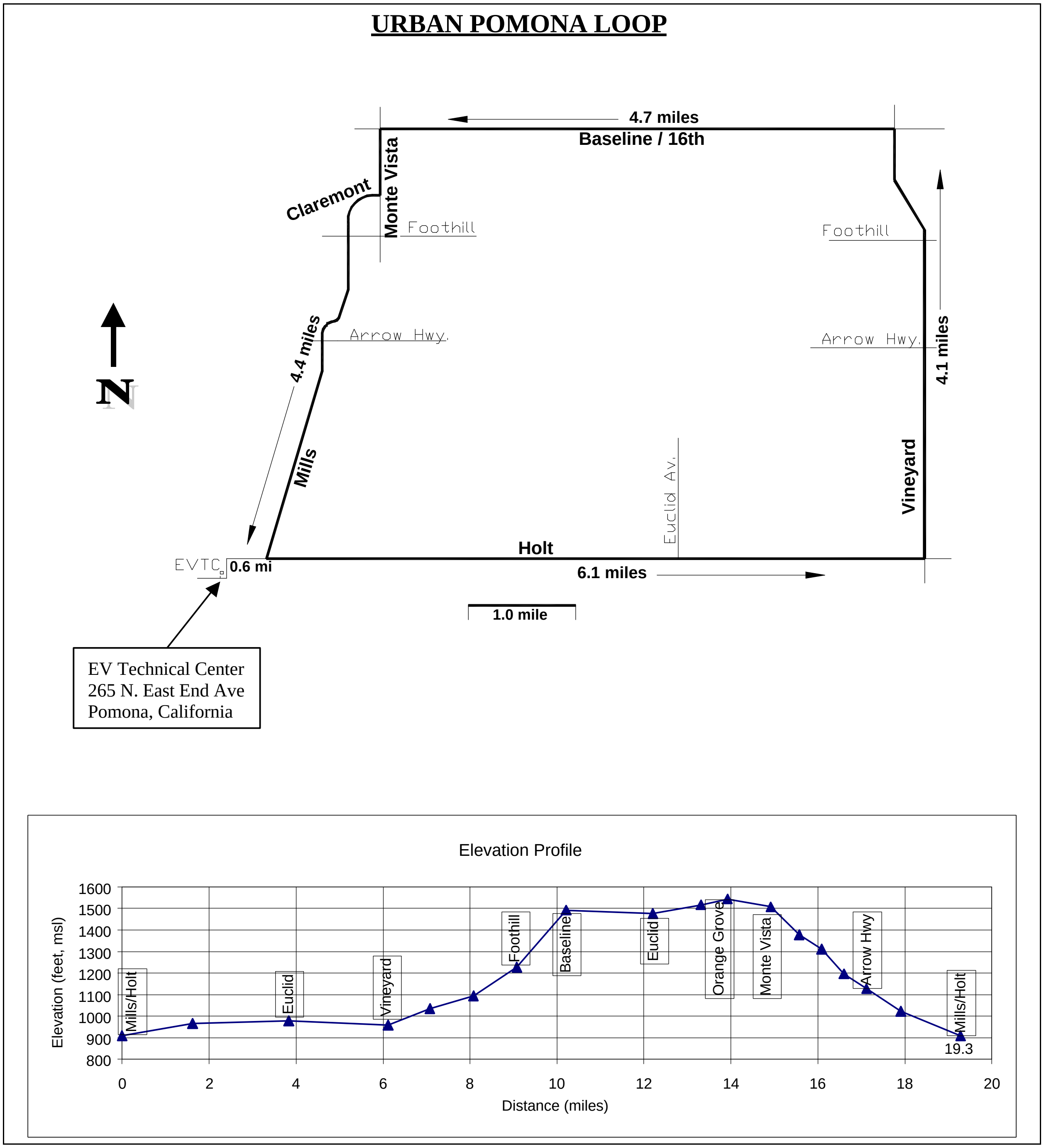
EV Performance Characterization Testing Schedule

		Duration (days)
1.	Nomenclature Data Collection	½
2.	Weight Documentation - Curb (Front, Rear, Total) - GVWR (Front, Rear, Total)	½
3.	Battery Capacity Test	4
4.	Urban Range Tests - Distance per charge - AC kWh/mile - DC kWh/mile	8
5.	Freeway Range Tests - Distance per charge - AC kWh/mile - DC kWh/mile	8
6.	Sound Level Tests	3*
7.	State-of-Charge Meter Evaluation (Dynamic/Static)	2*
8.	Acceleration / Maximum Speed / Braking Tests	1
9.	Stand-by Energy Consumption Tests ("Hotel" Loads)	2
10.	Charger Performance/Charging Profile Test	3

Minimum total days needed for full testing: 27

* The data gathered for these tests are recorded at the same time that other tests are in progress.

Pomona Loop Map



Urban Pomona Loop - Tabulated Data

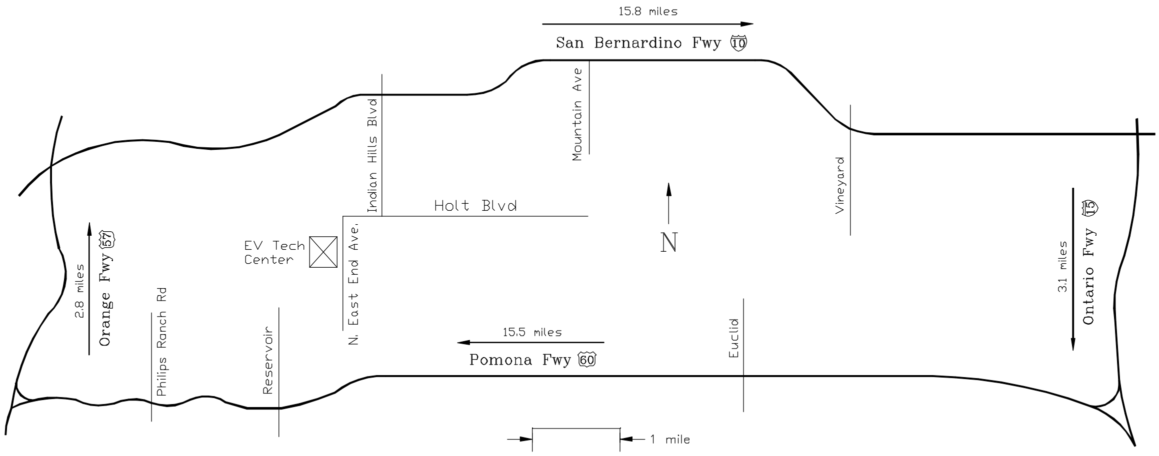
Stop No.	Distance from Start (miles)	Type	Distance from Previous stop	Comments
0	0.00	light	0.00	East End & Holt
1	0.10	light	0.10	
2	0.15	light	0.05	Mills & Holt
3	0.80	light	0.65	
4	1.30	light	0.50	
5	1.80	light	0.50	
6	2.30	light	0.50	
7	2.90	light	0.60	
8	3.50	light	0.60	
9	3.70	light	0.20	
10	4.00	light	0.30	
11	4.01	light	0.01	
12	4.30	light	0.29	
13	4.60	light	0.30	
14	4.80	light	0.20	
15	4.82	light	0.02	
16	5.30	light	0.48	
17	6.30	light	1.00	Vineyard & Holt
18	6.66	light	0.36	
19	6.70	light	0.04	
20	6.80	light	0.10	
21	6.90	light	0.10	
22	7.30	light	0.40	
23	7.80	light	0.50	
24	8.30	light	0.50	
25	8.60	light	0.30	
26	8.80	light	0.20	
27	9.30	light	0.50	
28	9.50	light	0.20	
29	9.60	light	0.10	
30	9.70	light	0.10	
31	10.40	light	0.70	Vineyard & Baseline
32	10.70	light	0.30	
33	10.90	light	0.20	
34	11.60	light	0.70	
35	11.90	light	0.30	
36	12.30	light	0.40	
37	12.50	light	0.20	
38	12.70	light	0.20	
39	13.00	light	0.30	
40	13.60	light	0.60	
41	14.10	light	0.50	
42	15.20	light	1.10	Baseline & Padua
43	16.30	light	1.10	
44	16.80	light	0.50	
45	17.10	sign	0.30	
46	17.40	light	0.30	

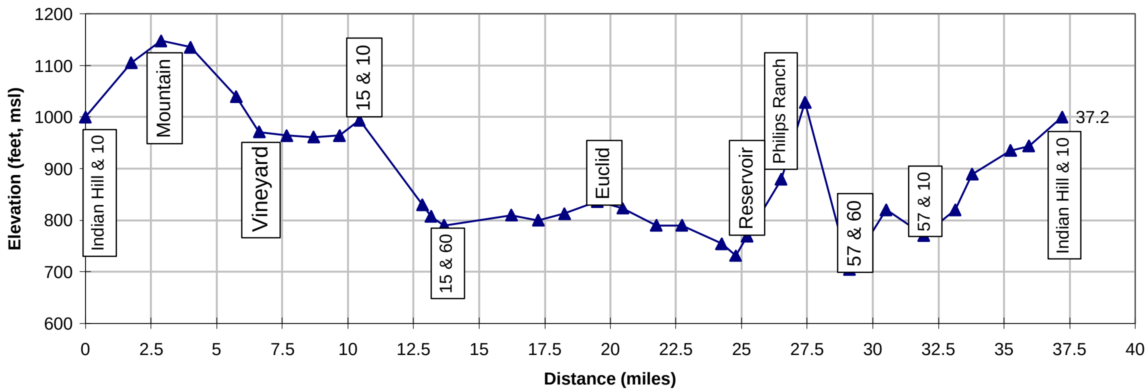
47	17.60	sign	0.20	
48	18.60	light	1.00	
49	18.70	sign	0.10	
50	19.00	sign	0.30	
51	19.30	light	0.30	
52	19.50	light	0.20	Holt & Mills
53	19.60	light	0.10	
54	19.80	light	0.20	Holt & East End

MCW: ttt
9/23/92

Freeway Loop Map

FREEWAY POMONA LOOP





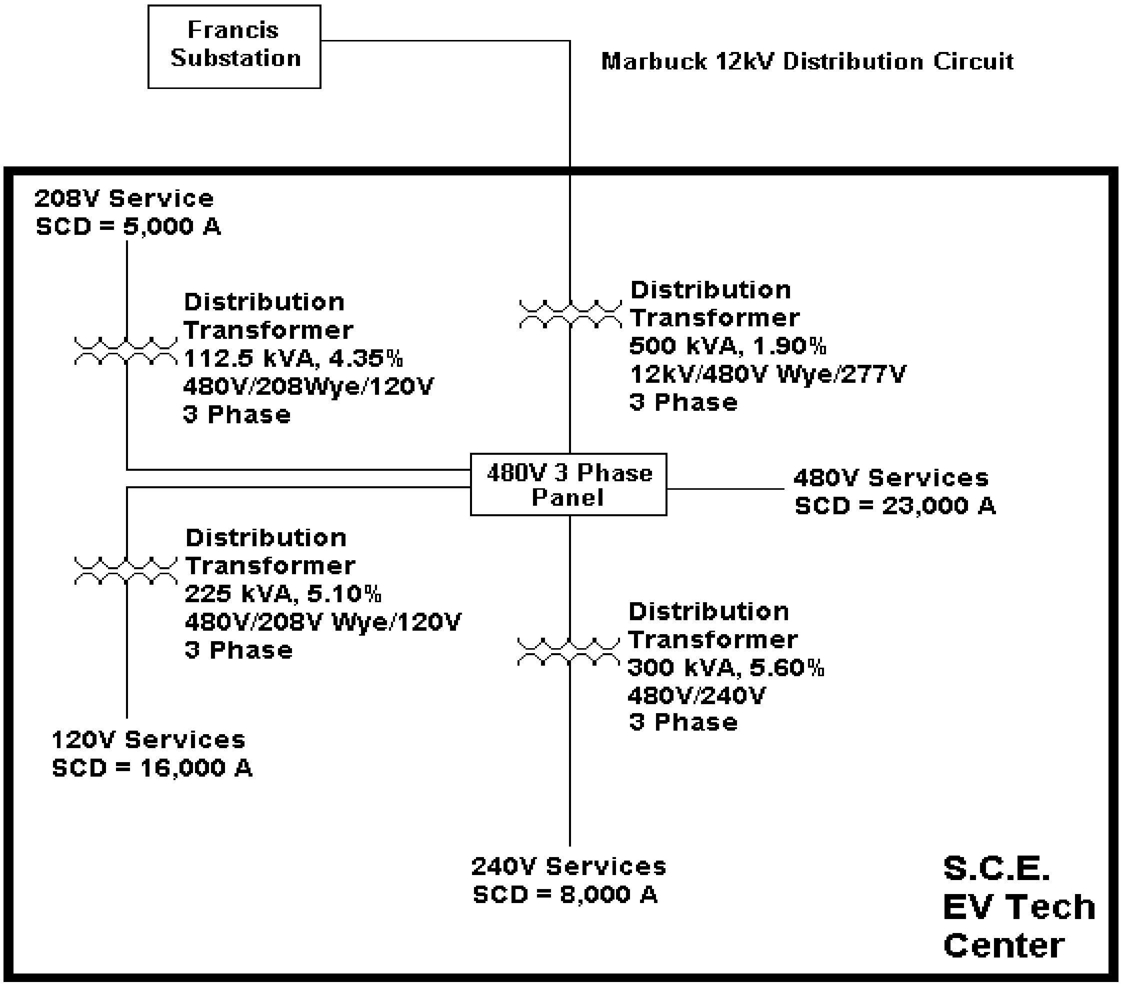
EVTC Equipment

EVTC Number	Manufacturer	Model	Description	Quantity
ABB-001	ABB	A1T-L	PORTABLE KWH METER	4
ACD-001	Various	PC140HS	DC/AC INVERTER	5
AMC-001	FLUKE	33	TRUE RMS CLAMP AMMETER	3
AVI-001	AEROVIRONMENT	ABC-150	ADVANCED BATTERY CYCLER	2
BCH-001	PHILLIPS	PM8906/003	NICD 4C 6V CHARGER	1
BMI-001	BMI	3030A	POWER PROFILER	2
CHG-001	Various	Various	PORTABLE BATTERY CHARGER	3
CHG-002	LA MARCHE	A70B-45-108LBD1	NICD BATTERY CHARGER	1
CMA-001	Various	Various	CAMERA DIGITAL/35 mm	4
CMP-001	Various	Various	DESKTOP COMPUTER	18
CPB-001	BMI	A-115	CURRENT PROBE 60A	3
CPB-004	BMI	A-116	CURRENT PROBE 600A	6
CPB-010	BMI	A-120	CURRENT PROBE 3000A	3
CPB-013	BMI	A-705	CURRENT PROBE 5A	1
CPB-014	FLUKE	80I-1000S	600A AC DMM PROBE	3
CPB-017	FLUKE	80I-500S	500A AC SCOPE PROBE	3
DAP-001	FLUKE	Y8100	DC/AC CURRENT PROBE	3
DAP-004	FLUKE	801-1010	DC/AC CURRENT PROBE	1
DAP-005	TEKTRONIX	AM503B	AC/DC CURRENT PROBE SYSTEM	1
DAP-006	TEKTRONIX	A6303	AC/DC HIGH CURRENT PROBE	1
DAP-007	FLUKE	80I-110S	100A AC/DC PROBE	2
DAQ-001	HEWLETT PACKARD	3497A	DATA ACQUISITION UNIT	1
DAQ-002	HEWLETT PACKARD	3421A	DATA AQUISITION CONTROL UNIT	6
DAQ-008	FLUKE	DAC	DATA AQUISITION CONTROL UNIT	2
DAQ-010	HEWLETT PACKARD	3498A	DATA AQUISITION UNIT	1
DAT-001	OMEGA	HH-F10	AIR SPEED INDICATOR	1
DAT-002	CHRYSLER CORP	SCAN TOOL	EPIC DIAGNOSTIC TOOL	2
DAT-004	HEWLETT PACKARD	Z1090A	GM TECH 2	1
DCG-001	PROPEL	ABT85-220	BATTERY DISCHARGER	1
DCG-002	PROPEL	ABT100-350	BATTERY DISCHARGER	1
DPM-001	YOKOGAWA	2533E43	DIGITAL POWER METER	1
DPS-001	ICC	ICC-21000005-12	DC POWER SUPPLY 13V	2
DPS-002	STANCOR	W120DUJ50-1	DC POWER SUPPLY 12V	1
DPS-004	HEWLETT PACKARD	6479C	DC POWER SUPPLY	1
DPS-005	HEWLETT PACKARD	6448B	DC POWER SUPPLY	1
DVM-001	HEWLETT PACKARD	3456A	DIGITIAL VOLTMETER	1
DYN-001	VERICOM	VC2000PC	PERFORMANCE COMPUTER	1
EDE-001	BERNOULLI	ED	EXTERNAL DRIVE	1
EMT-001	CRUISING EQUIPMENT	RS-2323	E-METER	3
ENV-001	ASSOCIATED ENV.SYS.	ZFK-5116	ENVIRONMENTAL ENCLOSURE UNIT	3
EVC-001	MAGNECHARGE	FM 100	INDUCTIVE CHARGER	3
EVC-004	MAGNECHARGE	WM 200	INDUCTIVE CHARGER	3
EVC-020	MAGNECHARGE	FM 200	INDUCTIVE CHARGER	13
EVC-042	MAGNECHARGE	P200	1.2 KW INDUCTIVE CHARGER	2
EVC-007	EVI	ICS-200	CONDUCTIVE EVSE	10
EVC-014	EVI	MCS 100-3	CONDUCTIVE EVSE (EVI-100) AVCON	2
EVC-017	SCI	GEN1	CONDUCTIVE EVSE/ODU	2
EVC-019	SCI	GEN 2	CONDUCTIVE EVSE/AVCON	7
FGE-001	SHIMPO	MF	FORCE GAUGE	1
GPB-001	HEWLETT PACKARD	GPIB-422CT	GPIB CONTROLLER	1
IST-001	BK PRECISION	1604A	ISOLATION TRANSFORMER	1
ITR-001	NEWPORT	OS520	INFRARED THERMOMETER	1
ITR-002	BMI	A-003	TEMPERATURE SENSOR	1
LPC-001	Various	Various	COMPUTER LAPTOP	9
LPP-001	TOSHIBA	PA2711U	DOCKING PORT	2

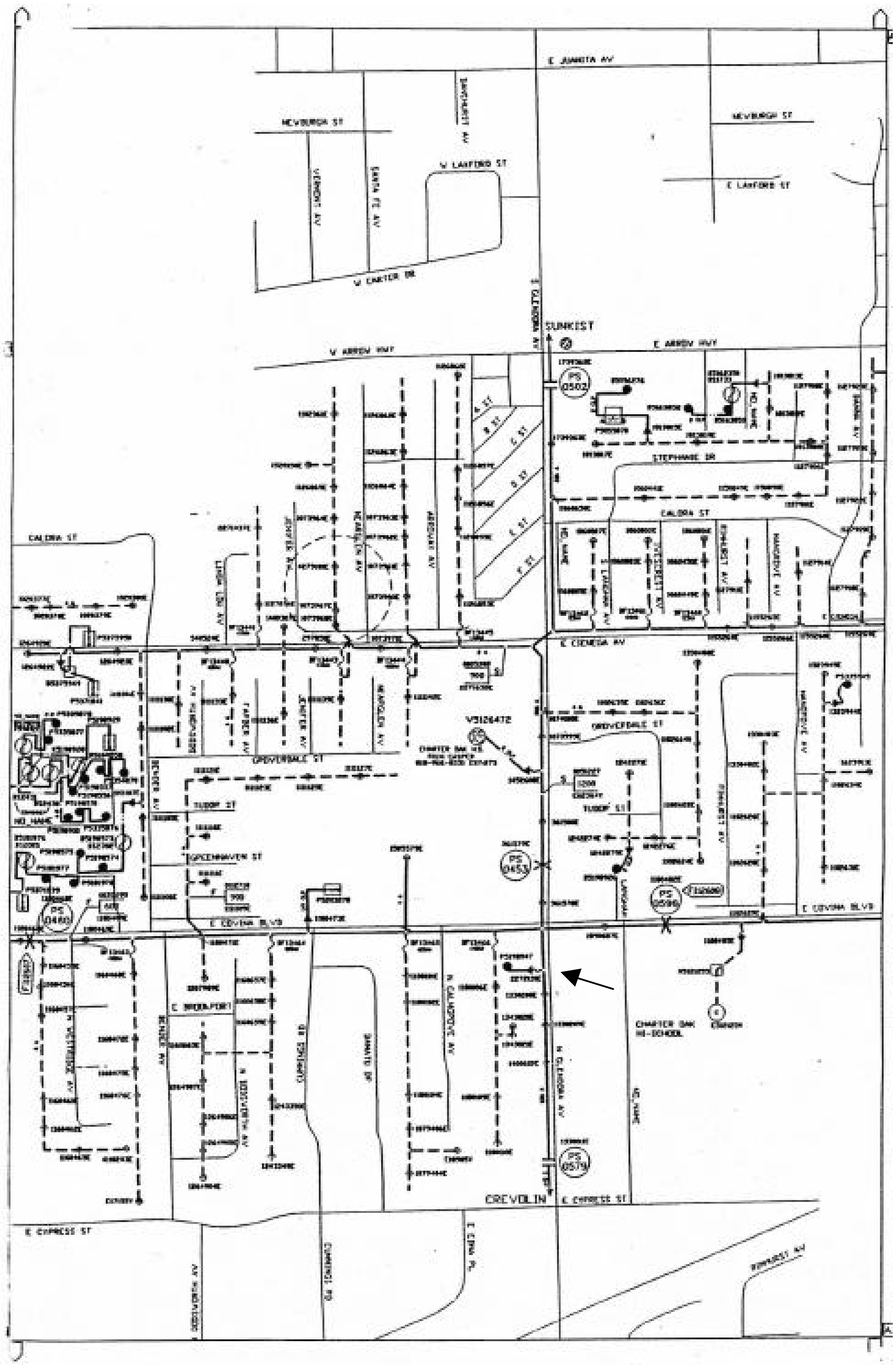
EVTC Number	Manufacturer	Model	Description	Quantity
MCR-001	OLYMPUS	MICRO-32	MICRO CASSETTE RECORDER	1
MMR-001	Various	Various	DIGITAL MULTIMETER	14
MMR-012	HEWLETT PACKARD	34401 A	MULTIMETER	1
MMW-001	ROLATAPE	MEASUMASTERMM30	MEASURING WHEEL	1
MPG-001	HEWLETT PACKARD	6942A	MULTIPROGRAMMER	1
NVK-001	NORVIK TRACTION INC.	BC-500-4	MINIT CHARGER	1
OHM-001	MEGGER	210200	OHM METER	1
OPB-001	U.S. MICROTEL	PM-500	OPTICAL PROBE	2
OSC-001	HEWLETT PACKARD	54600B	OSCILLOSCOPE	1
OSC-002	YOKOGAWA	701810-1D	DL708 DIGITAL SCOPE	1
OSC-003	YOKOGAWA	OR3412/PM-M	OSC. RECORDER H.A.	1
OVP-001	3M	9700 9000AJJ	OVERHEAD PROJECTOR	1
PHA-001	FLUKE	41	POWER HARMONICS ANALYZER	1
PHA-003,4	FLUKE	43	POWER HARMONICS ANALYZER	2
PHA-002	BMI	155	HARMONICS METER	1
PRI-001	EXTECH	480300	PHASE ROTATION TESTER	1
PRT-001	HEWLETT PACKARD	C3167A	LASERJET 5SI/MX PRINTER	1
PRT-002	HEWLETT PACKARD	C2001A	LASERJET 4M PRINTER	1
PRT-003	HEWLETT PACKARD	C4530A	2000C COLOR PRINTER	1
PSY-001	WAYNE-KERR	LS30-10	POWER SUPPLY	1
SCL-001	METTLER	FEHD-R	DIGITAL SCALE	1
SCR-001	FLUKE	97	SCOPEMETER	1
SGM-001	KEM	DA-110	DENSITY/SPECIFIC GRAVITY METER	1
SGN-001	WAVETEK	191	SIGNAL GENERATOR	1
SMR-001	EXTECH INSTRUMENTS	407762	SOUND LEVEL METER	1
STW-001	Various	Various	STOPWATCH	2
THR-001	OMEGA	PTH-1X	TEMP/HUMIDITY METER	2
THR-002	Various	Various	THERMOCOUPLE THERMOMETER	3
THR-004	SEALED UNIT PARTS	PT-100	DIGITAL THERMOMETER	1
THR-006	RADIO SHACK	63-867A	DIGITAL TEMP/HUMIDITY METER	2
WHR-001	CRUISING EQUIPMENT	KWH METER	KILOWATT-HOUR METER	2
YOK-001	YOKOGAWA	AR1100A	ANALYZING RECORDER	1
ZIP-001	IOMEGA	Z100PS	ZIP HARDWARE	3

JWS 4/15/99

EV Tech Center Line Diagram



Residence Line Diagram



EVTC-010 Driving Test Data Sheet

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
						Start	
Road Cond	Tire Press	Payload				Stop	
						Net	

Driving	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start								
Stop								Min. A/C
Net								

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	

Accessories used: __________
Drive / Regen setting: __________
Handling/Braking: __________
Other comments: __________

Charger	Serial No.		AC meter#		BMI #

Charging	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start								
Stop								
Net								

Comments: __________

EVTC-010

EVTC-020 Charger Testing / Analysis Data Sheet

Technician: ____________________________ Date:______________
Location:______________________________ Phone:_____________

Charger Information

Manufacturer: ______________________________________
Model No.: ____
Supply Side Voltage Rating: __________________________

After Completion of Recharging Cycle

Time of Day: _________________________
Final Pack Voltage: ___________________
AC kWh Used: _________________________ DC kWh Delivered: _____________
System Energy Efficiency: ___________________ (DC kWh/AC kWh)
Amp-hours to battery: _________________________kWh to battery: __________________
Overcharge Factor: ___________________ (Ah removed/Ah returned)
DC Output Ripple Voltage: ______________ Ripple Frequency: _____________

Charger Operation Information/Evaluation

Exterior Dimensions: ____________________ Weight: __________________
Charging Profile Type: ____
End Point Determination Method: ____
Battery Monitoring Method: ____
Programmable Charging Profiles: ____
Connector Type(s): ____
Safety Features / Protection Devices: ____
Agency/Industry Approvals: ____
Installation Techniques/Requirements: ____
Appropriate for Interior and/or Exterior Use: ____
User Interface (Switches, Indicators, Display):____
Ease of Use: ____
Current & Future Cost: ____
Warranty: ____
Reliability History / Manufacturer Reputation: ____
Maintenance Schedule: ____
Accompanying Supplies: ____
Manufacturer Support: ____
Other Notes:____
____
____
____
____

EVTC-030 Performance Testing Data Sheet

ACCELERATION, MAXIMUM SPEED, AND BRAKING TESTS

		Start	Stop
Vehicle No.:	Time:		
Location:	Temp.:		
Date:	Odometer:		

Acceleration (100% SOC)

	0-30 mph	0-60 mph	Direction	Max. Speed	30-55 mph
1					
2					
3					
4					
Average					

Acceleration (80% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1				
2				
3				
4				
Average				

Acceleration (60% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1				
2				
3				
4				
Average				

Braking 25-0 mph, 50% SOC

Feet	inches	Total feet	Direction	
				1
				2
				3
				4
				5
				6
				7
				8
				9
				10

______ Average ft

Acceleration (40% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1				
2				
3				
4				
Average				

Acceleration (20% SOC)

	0-30 mph	0-60 mph	Direction	Max. Speed	30-55 mph
1					
2					
3					
4					
Average					

Comments

EVTC-040 Vehicle Test Equipment and Nameplate Data Sheet

Project:______________________________ Test:______________________________
Date(s):______________________ File Name(s):______________________________
Vehicle Number:______________ Technician:______________________________

VEHICLE

Manufacturer: ______________________VIN:_______________________________
Model: ______________________Model Year:______ Date of Manufacture: __________
GVWR:________________Front AWR:__________ Rear AWR:___________________
Motor Manufacturer:_________________ Motor Type:______________________
Motor Rating/Speed:____
Version/Serial No.:____
EPA Label Fuel Economy: ____
Controller Version/Serial No.: ____
Battery Pack Type/Version/Serial No.: ___________________________________
Tire Manufacturer: _______________________Model:______________________
Tire Size:____________________ Maximum Pressure:______________________
Maximum Tire Load: ___________ Treadwear Rating:______________________

CHARGER

On-board / Off-board Manufacturer:_________________________________
Model: ______________________Serial Number:_____________________________
Charger Type/Version:____
EVSE Manufacturer: _________________________________
EVSE Model/Version:_____________________Serial Number:_________________
EVSE Software Version:______________________________
Charge Port Manufacturer/Model/Version/SN:___________________________

TEST EQUIPMENT

BMI Power Profiler 3030A EVTC Number:_______________________________
ABB kWh Meter Serial Number:_____________________________________
Thermometer EVTC Number:____
Optical Meter Probe EVTC Number:___________________________________
Laptop Computer EVTC Number:_____________________________________
Desktop Computer EVTC Number:____________________________________
Stopwatch EVTC Number:____
Digital multimeter EVTC Number:____________________________________
ABC-150 EVTC Number:____
Smart Guard Interface Serial Number:__________________________________
Smart Guard Numbers:____
Sound Level Meter EVTC Number:____________________________________
Measuring Wheel EVTC Number:_______________________________
Other Equipment:____

WEIGHT CERTIFICATION

Scale Location and Proprietor:__________________________________
Examiner:_______________________________ Date:__________________
Notes:____

EVTC-050 Sound Level Meter Data Sheet

Sound Level Test Data

Urban Driving Sound Level Test

Date:	
Project:	
Technician:	
Veh. No.:	
Location:	
Start odo:	
End odo:	
Trip:	

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: ______

Freeway Driving Sound Level Test

Date:	
Project:	
Technician:	
Veh. No.:	
Location:	
Start odo:	
End odo:	
Trip:	

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: ______

Charger Sound Level Test

Date:	
Project:	
Technician:	
Veh. No.:	
Location:	
Start odo:	
End odo:	
Trip:	

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: ______

EVTC-060 Vehicle Battery Constant Current Discharge Capacity Test Data Sheet

Project:________________________ Test File:________________________
Date(s):________________________ Technician:________________________
Vehicle Number:____________________ Battery Nos.:________________________

BATTERY SPECIFICATIONS

Manufacturer: ______________________ Model: ________________________
Date of Manufacture: ________________ Nominal Voltage:________________________
Ah Rating @ C/3:____________________ Voltage Range:________________________
Weight/Module:______________________ Temp. Range:________________________

BATTERY PACK

Number of Modules:_________________ Nominal Voltage:________________________
Configuration: ____
Location for Test:____

TEST EQUIPMENT

Discharge Unit: ___________________________ Serial No.________________________
Charging Unit: ___________________________ Serial No.________________________
Data Acquisition Equipment:____
____
Other Equipment:____

RESULTS

	TEST 1	TEST 2	TEST 3
DATE			
DISCHARGE (A)			
STOP CONDITION			
START TIME			
STOP TIME			
TOTAL TIME			
START TEMP.			
STOP TEMP.			
START O.C. VOLTS			
STOP O.C. VOLTS			
ΔV at STOP			
Ah OUT			
kWh OUT			
LOWEST MODULE			
DATA FILE			

RECHARGE TYPE			
Ah RETURNED			
kWh RETURNED			
DATA FILE			

NOTES:____
____