PERFORMANCE CHARACTERIZATION

1999 TOYOTA RAV4 EV–INDUCTIVE

Panasonic NiMH Battery

SOUTHERN CALIFORNIA EDISON

An *EDISON INTERNATIONAL* Company

ELECTRIC TRANSPORTATION DIVISION

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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 are 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.

Table of Contents

List of Appendices

I. INTRODUCTION

This report characterizes the performance of a 1999 Toyota RAV 4 inductively charged electric vehicle equipped with Panasonic Nickel Metal Hydride (NiMH) batteries. The tests performed were weight certification, range, vehicle performance, sound level tests, power quality evaluation, state of charge meter evaluation, and charger performance. Testing was performed at the Electric Vehicle Technical Center (EV Tech Center), at the Pomona Raceway, and on the Urban and Freeway Pomona Loops. For detailed procedures used for the testing, please refer to the *SCE Electric Vehicle Test Procedure* in Appendix K, page 70. Also refer to Appendix C, page 30, for maps of the Urban and Freeway Pomona Loops.

II. MANUFACTURER'S SPECIFICATIONS

Note: Refer to Appendix A, page24, for the manufacturer's vehicle specification sheet

Vehicle Make:	Toyota
Model:	RAV 4 EV - Inductive
Range:	130 miles city, 106 highway, 118 combined city and highway
Maximum Speed:	79 mph (governed)
Motor Type:	Permanent magnet
System Power:	20kW Rated - continuous
	50 kW (67 hp) @ 3100-4600 rpm - peak
Torque:	190 Nm @ 0-1500 rpm
Transmission:	Single Speed, front wheel drive
Battery Type:	Nickel Metal-Hydride (NiMH)
Manufacturer:	Panasonic
Model:	MHB-100
Pack Capacity:	95 Ampere-hour (5-hour rate)
Battery Pack Weight:	910 lbs.
Number of Modules:	24
Nominal Pack Voltage:	288 V

Curb *Weight:*	3500 lbs.
GVWR:	4266 lbs.
Payload:	825 lbs.
Dimensions	
Wheelbase:	94.9 in.
Length:	156.5 in.
Width:	66.7 in.
Height:	64.4 in.

III. DEVIATIONS FROM THE SCE ELECTRIC VEHICLE TEST PROCEDURE

1. The battery capacity test was not performed.
2. The DC stand-by energy consumption tests were not performed.

IV. RESULTS

A. Nameplate Data Collection

Please Refer to Appendix D, page 32, for the Vehicle Test Equipment and Nameplate Data Sheet, which records all applicable nameplate data, serial numbers, and ratings for all tested components.

B. Weight Certification

Table 1. Weight Results

	Front Axle	Rear Axle	Total Weight
GVWR (lbs.)	2258	2297	4266
Curb Weight (lbs.)	1950	1550	3500[1]
Available Payload (lbs.)	308	747	766[2]

[1] Certified within 10%.
[2] Specified payload on vehicle door sticker: 825 lb.

C. Range Tests

Note: A/C was found to be operating irregularly, results may vary from other RAV4s

C1. Urban Range Tests

Table 2. Urban Range Test Results

Tests	UR1	UR2	UR3	UR4
Range at Stop Condition (mi.)	92.8	84.8	89.5	68.9
Total Miles Driven	96.8	86.2	90.9	74.3
Driving Conditions				
Payload (lb.)	160	160	766	766
Avg. Amb. Temp. ^{o}F	68.5	75.3	80.0	87.0
Average Speed (mph)	24	25	25	24
Recharge				
AC kWh recharge	31.80	33.96	32.72	32.22
AC kWh/mi.	0.329	0.394	0.360	0.434

Note: Results are the average of two drives.

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

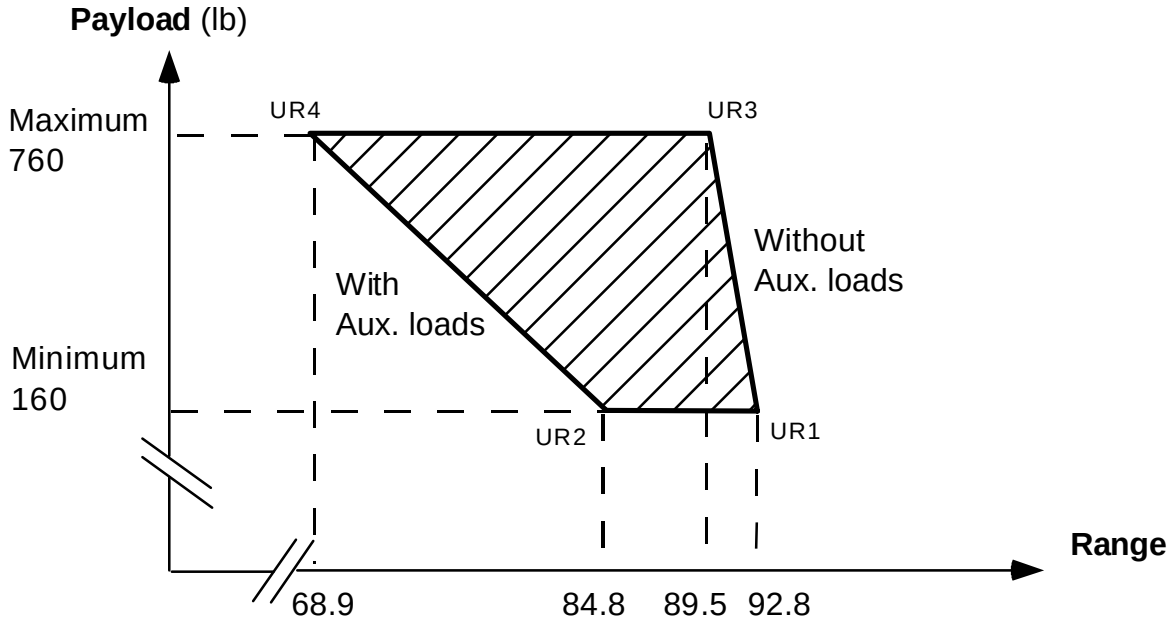


Figure 4-1. Urban Range Envelope

C2. Freeway Range Tests

Table 3. Freeway Range Test Results

Tests	FW1	FW2	FW3 *	FW4
Range at Stop Condition (mi.)	79.9	76.6	76.2	75.3
Total Miles Driven	80.6	77.3	77.9	76.2
Driving Conditions				
Payload (lb.)	160	160	766	766
Avg. Amb. Temp. ^{o}F	89.5	88.0	79.0	81.0
Average Speed (mph)	41.0	40.0	47.0	51.1
Recharge				
AC kWh recharge	32.54	31.33	31.79	31.88
AC kWh/mi.	0.404	0.406	0.428	0.418

Note: Results are the average of two drives. * Average of 4 drives.

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

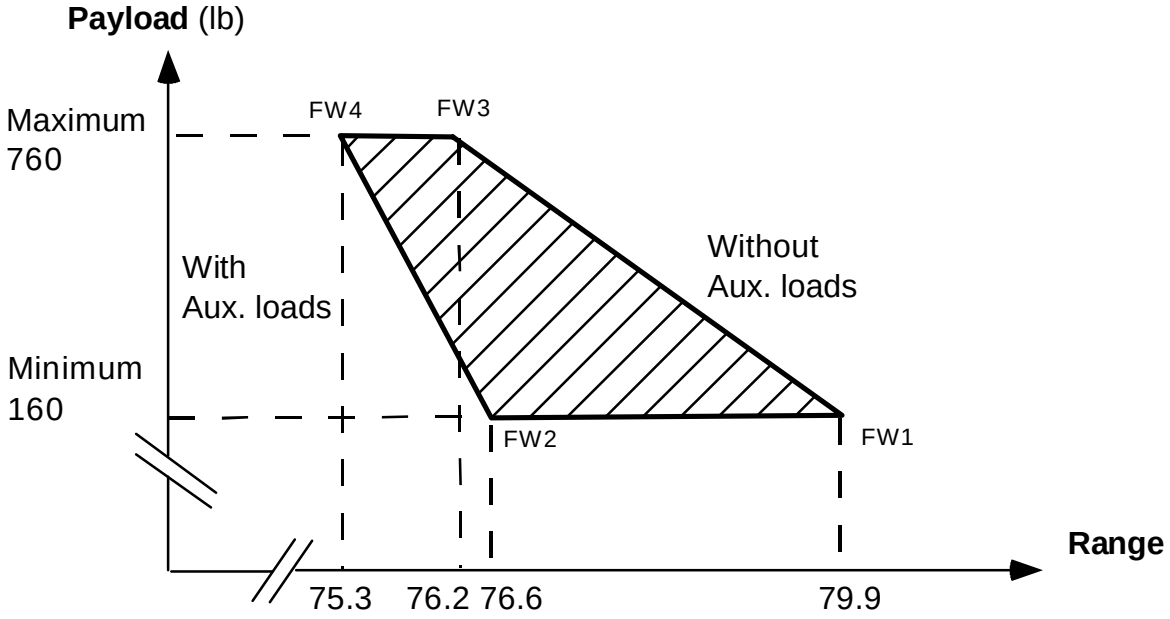


Figure 4-2. Freeway Range Envelope (Freeway envelope not to scale with urban envelope)

D. Sound Level Testing

D1. Driving Sound Level Tests

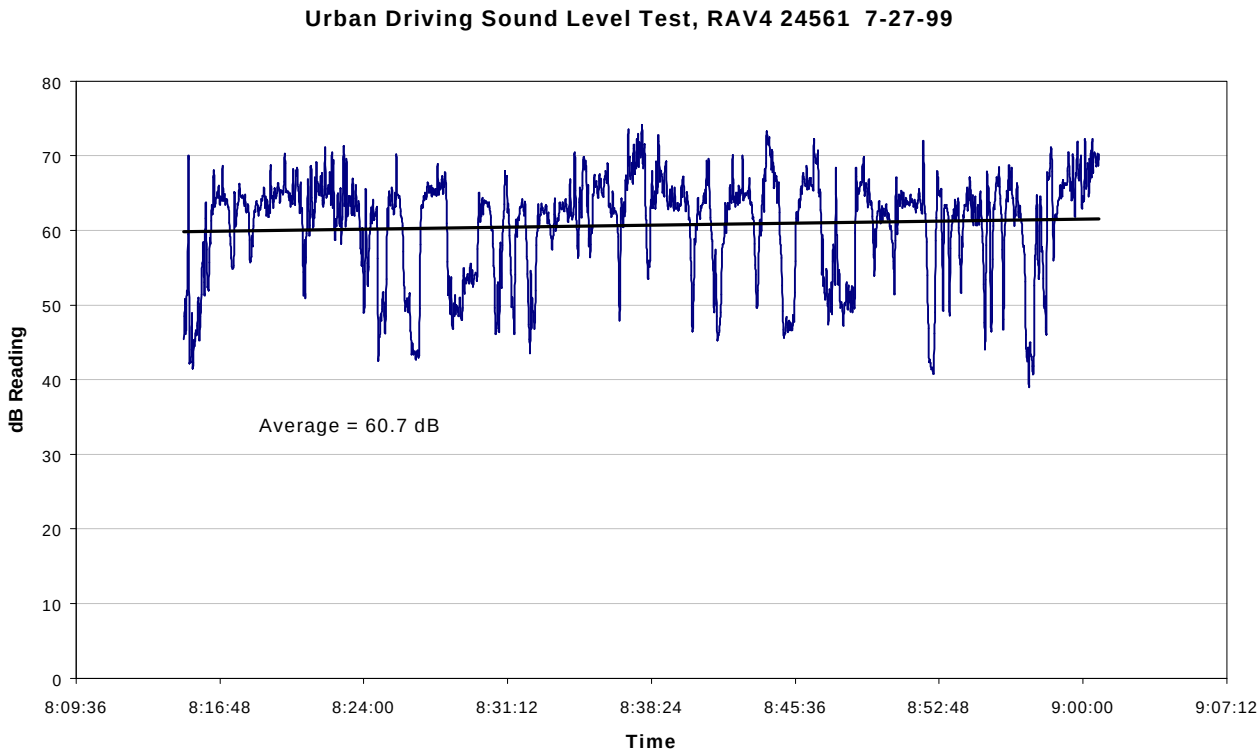


Figure 4-3 Urban Sound Level Test

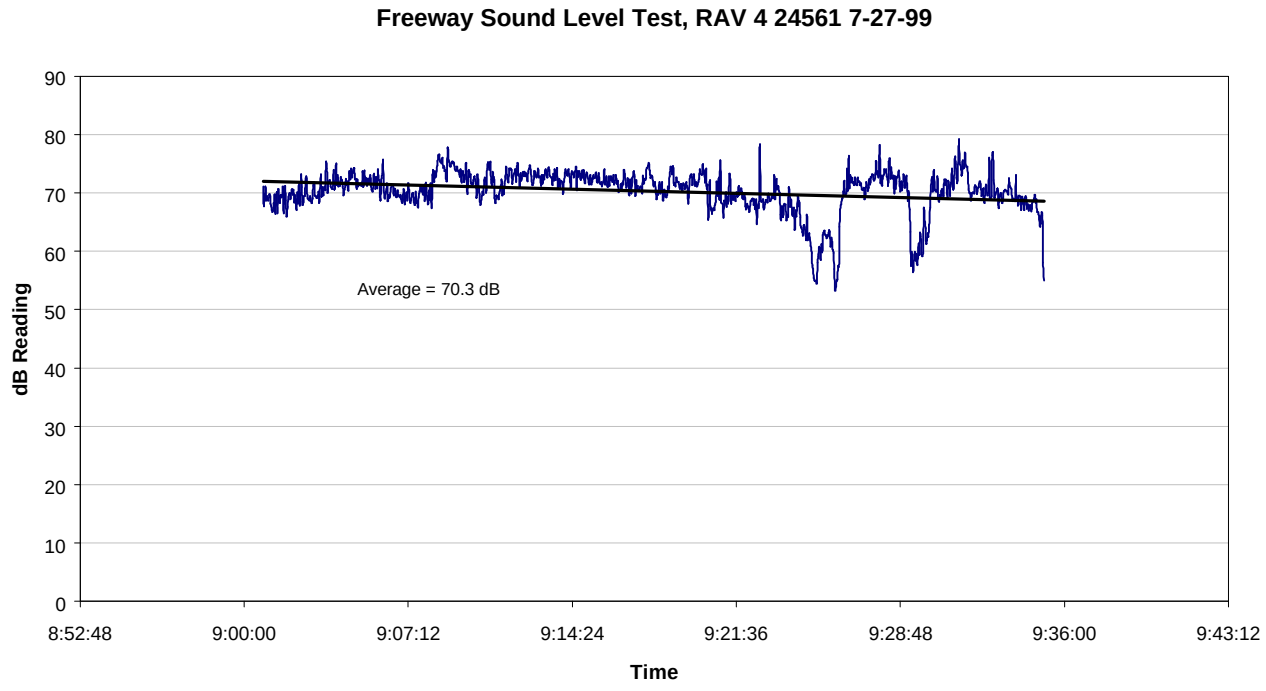


Figure 4-4 Freeway Sound Level Test

D2. Charging Sound Level Test

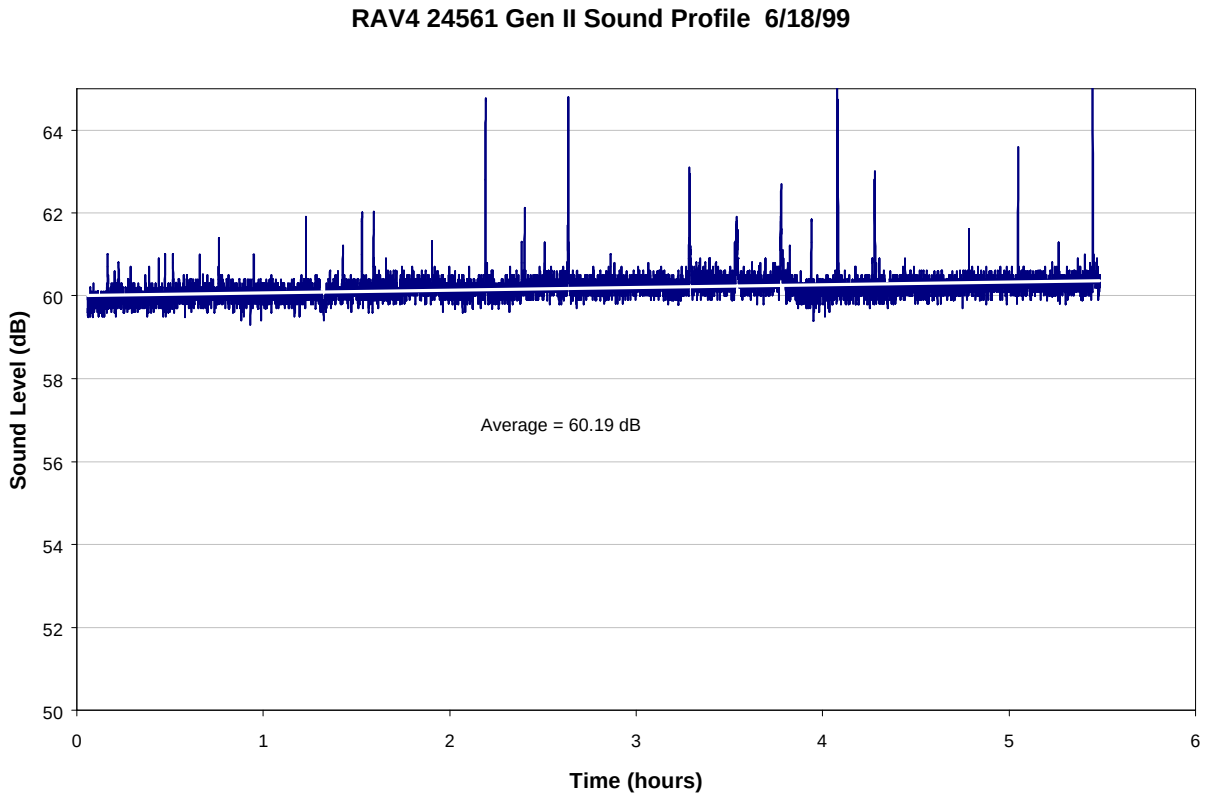


Figure 4-5 Gen II Sound Profile Test

E. State of Charge Meter Evaluation

E1. Driving State of Charge (SOC) Meter Evaluation

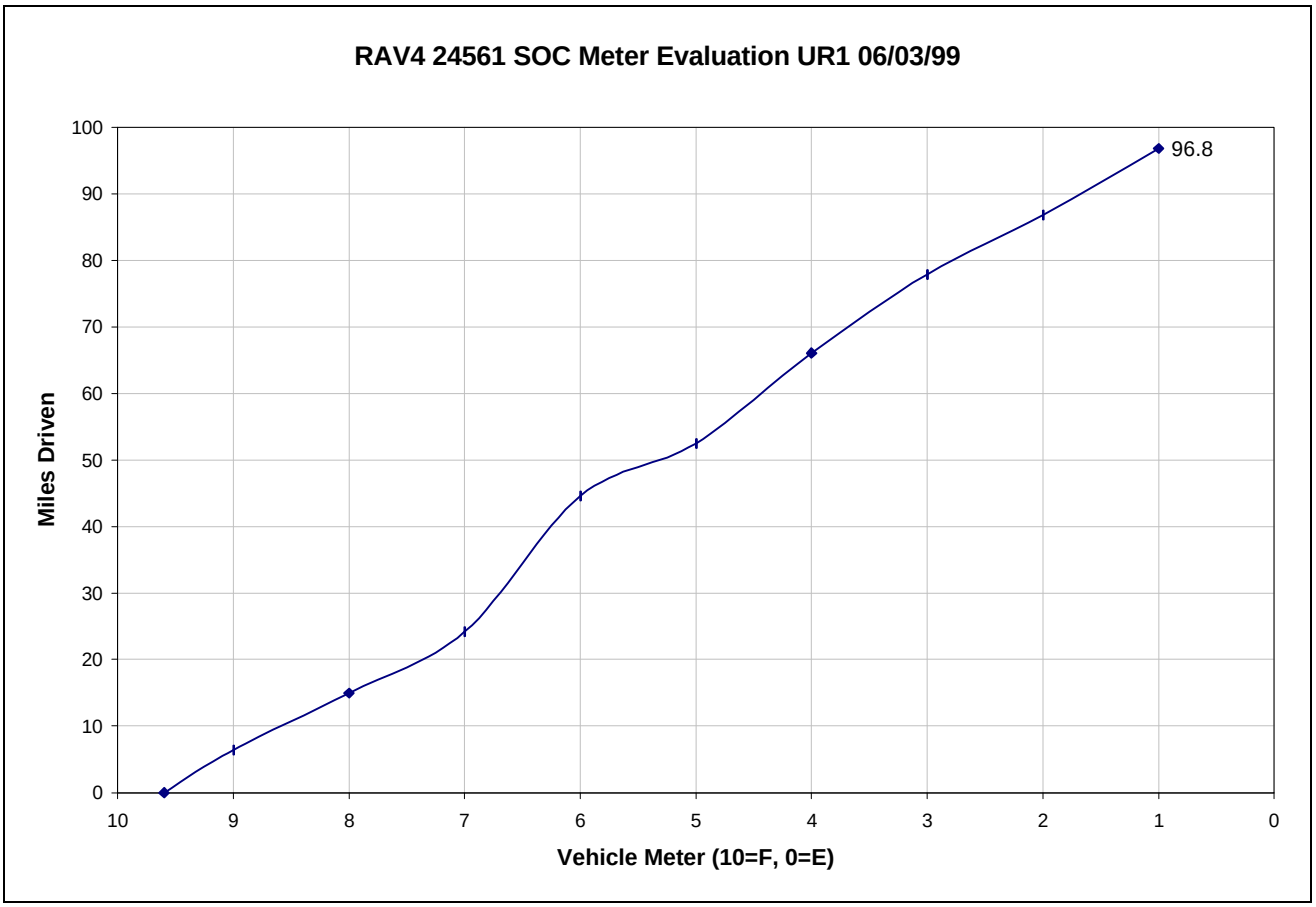
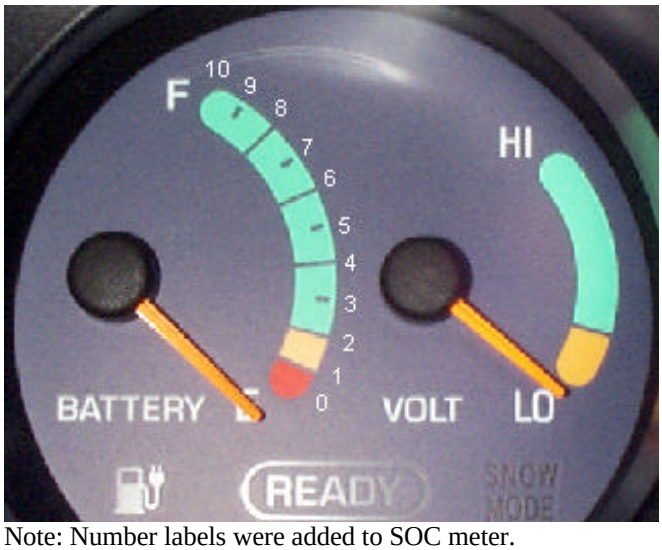


Figure 4-6. State of Charge meter reading as a function of miles driven.



Note: Number labels were added to SOC meter.

Figure 4-7. SOC meter with 10 divisions and Voltage meter.

E2. Charging State of Charge Meter Evaluation

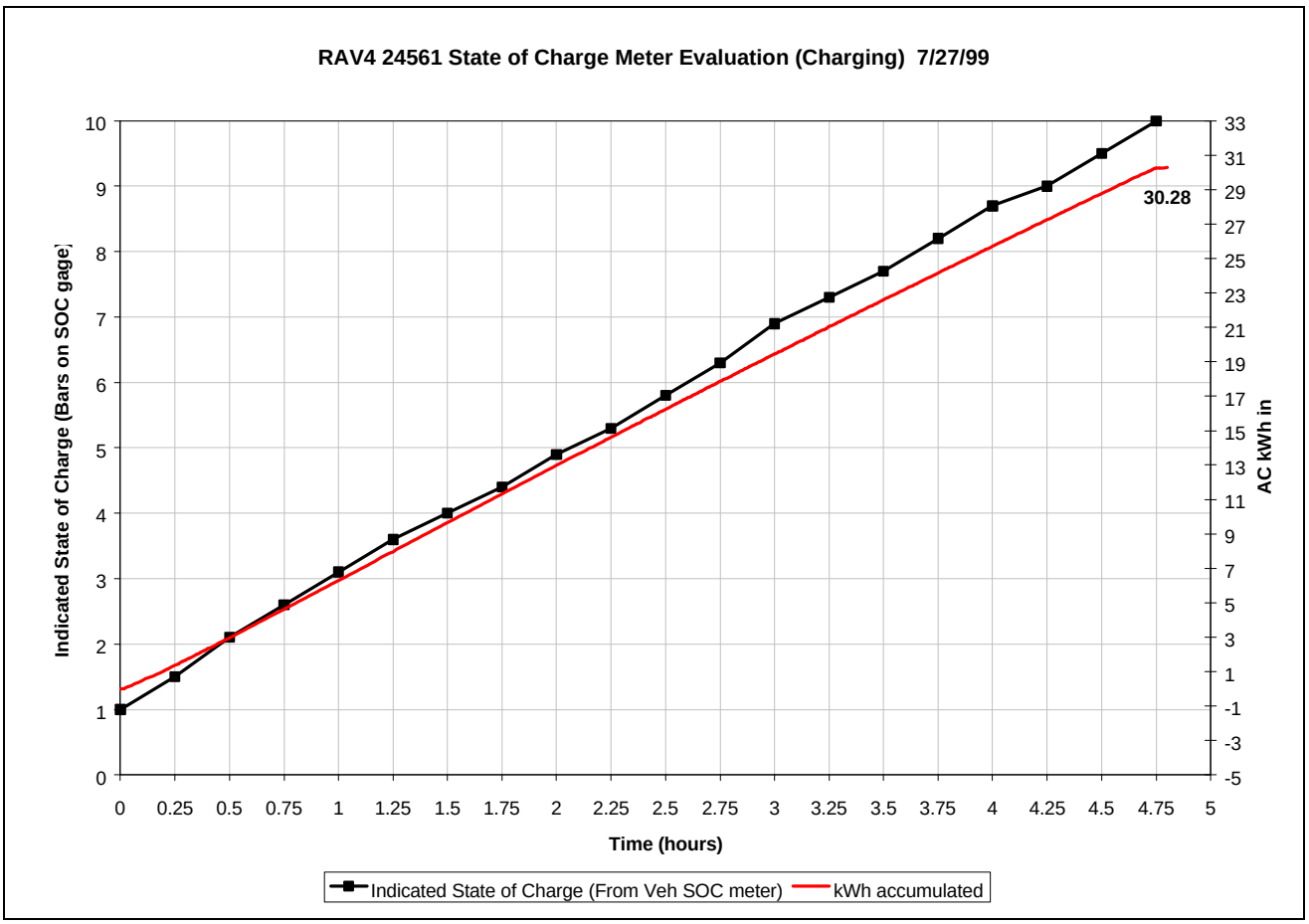


Figure 4-8. SOC meter evaluation while charging vehicle. (Amb Temp. = 80^{o} F)

F. Acceleration, Braking and Maximum Speed Tests[1]

Table 4. Performance Testing Data

	100% SOC	80% SOC	60% SOC	40% SOC	20% SOC
0-30 mph (s)	4.91	4.78	4.95	4.90	5.00
30-55 mph (s)	9.42	9.23	9.69	9.48	9.67
0-60 mph (s)	16.35	14.27	14.38	15.01	16.21
Maximum Speed (mph)	76	*	*	*	76
Braking (25-0 mph) (ft.)	*	*	27.7	*	*

[1] Average values (average ambient temperature: 84°F). (150 lb. Payload)
* Not tested

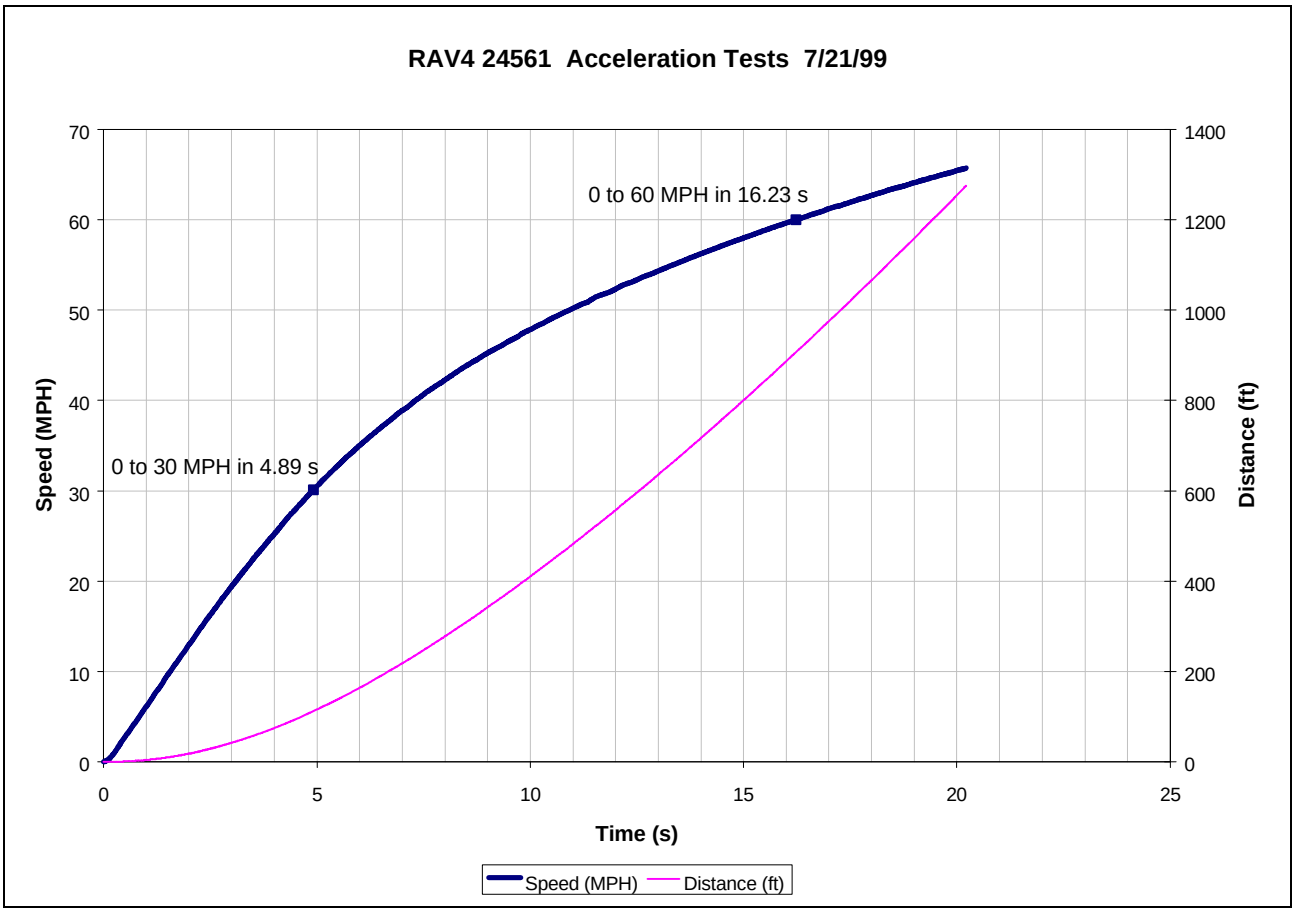


Figure 4-9. Acceleration Tests (Refer to Appendix F, page 36, for an acceleration and estimated HP chart)

G. Charger Performance / Profile Test

G1. Charger Performance / Profile Test at EVTC

Table 5. Charger Profile Data

Measured Value[1]	
Voltage	238.1 V rms
Current	29.39 A rms
Real Power[2]	6.972 kW
Reactive Power	540.5 VAR
Apparent Power	6.997 kVA
Total Power Factor	1.00 PF
Displacement Power Factor	1.00 dPF
Voltage THD	1.3%
Current THD	3.1%
Current TDD	2.84%

Total Charging Time[3]	4 hours 41 min
Total Energy Consumption	32 AC kWh

Time observed on Stand-by (7-24-99)	24 hours
Total Energy Consumption	0.299 kWh

Note: Refer to Appendix G, page 38 for BMI Power Profiler graphical data. Data was recorded after the UR1 on June 8, 1999.

[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 6.987 kW
[3] Ambient Temperature: Average =70.7°F

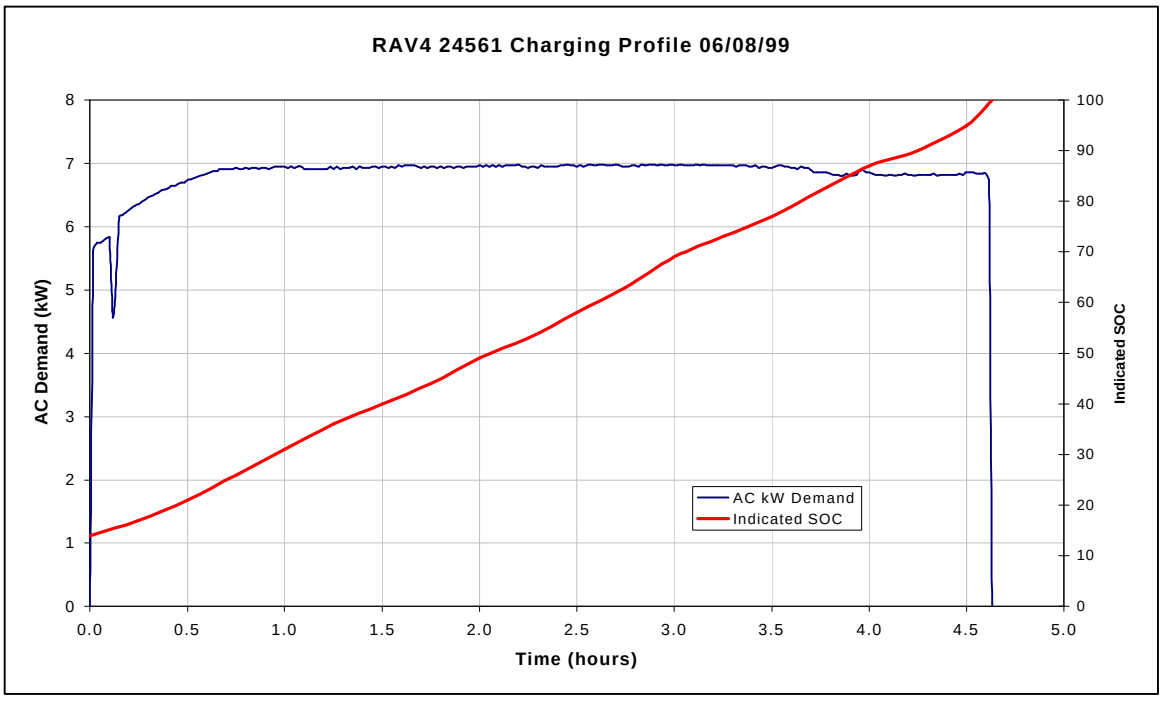


Figure 4-10. AC input charging profile from ABB meter (recorded after the UR1)

G2. Charger Performance at Residence

Table 6. Charger Profile Data

Measured Value[1]	
Voltage	242.3 V rms
Current	25.04 A rms
Real Power[2]	6.066 kW
Reactive Power	546.1 VAR
Apparent Power	6.095 kVA
Total Power Factor	1.00 PF
Displacement Power Factor	1.00 dPF
Voltage THD	1.2%
Current THD	3.50%
Current TDD	3.3%

Total Charging Time [3]	3 hours 38 min
Total Energy Consumption	21.5 AC kWh

Time observed on Stand-by	24 hours
Total Energy Consumption	0.505 kWh

Note: Refer to Appendix H, page 44 for BMI Power Profiler graphical data.
Data was recorded after a UR1 followed by a short freeway drive to residence on August 4, 1999.

[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 6.111 kW
[3] Vehicle did not charge completely (approximately 67% charge in).

V. DISCUSSION AND CONCLUSIONS

A. Nameplate Data Collection

All applicable nameplate data, serial numbers, and ratings for all tested components are recorded. This data is important to record in order to keep track of the version of the software and hardware of the vehicles, since this technology changes rapidly.

B. Weight Certification

The vehicle was taken to a certified scale to measure the total weight, as well as the front and rear axle weight. The measured total curb weight was 3500 pounds. The manufacturer's gross vehicle weight rating (GVWR) label on the vehicle was 4266 pounds, and the specified payload was 825 pounds. The GVWR minus the total curb weight yielded a payload of 766 pounds, which was the weight used for the maximum payload tests. Table 1, page 5, shows an available front axle payload of 308 pounds, and an available rear axle payload of 747 pounds. The weight was evenly distributed when the vehicle was loaded to its maximum legal weight (766-lbs. payload). Weight was added to the front passenger compartment, as well as the rear passenger compartment (see Figures below). The load added to the rear passenger compartment was 466 pounds, and the load added to the front passenger compartment, including the driver, was 300 pounds.

Figure 5-1 The rear passenger compartment was loaded with 350 lbs. plus 116 lbs. in rear cargo

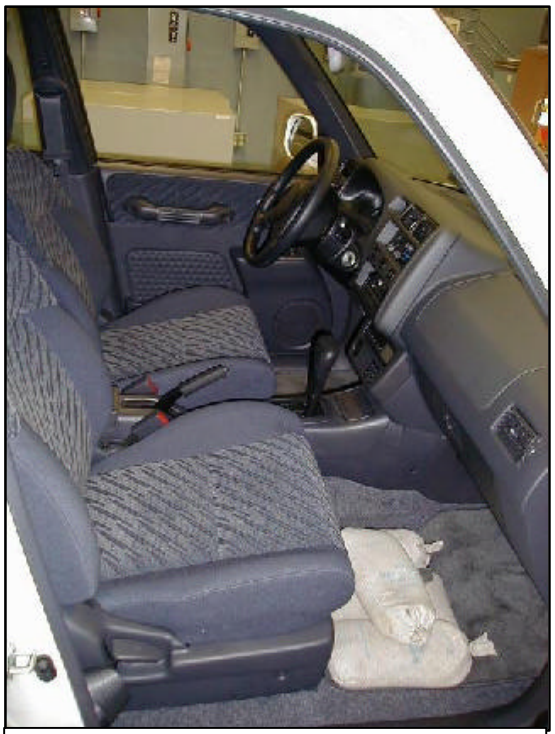


Figure 5-2 The front passenger compartment was loaded with 300 lbs. including driver weight

C. Range Tests

The vehicle was driven in a manner that was safe and compatible with the flow of traffic at or below the posted speed limits on the Pomona Urban and Freeway Loops (see Appendix C, page30). To be consistent with all range drives, the vehicle was driven until the battery light flashed (approximately 15% state-of-charge (SOC) according to Toyota). The average of two drives that were within 5% of each other was used for each test. Drive test sheets are shown in Appendix I, page 49.

Acceleration and braking of this vehicle was responsive while driving on both freeway and urban environments. Additionally, the vehicle never had trouble keeping up with the flow of traffic during each range test. However, acceleration seemed slower when the vehicle was driven with maximum payload. Braking time and stopping distance also seemed to increase slightly at maximum payload as would be expected. The road conditions were dry for all the drive tests completed.

Air conditioning temperatures as measured from the A/C outlet air from the center cabin vent were taken for the auxiliary load tests done on the freeway and urban loops. Recent data taken on this vehicle shows that the A/C temperature as measured from the center cabin vent fluctuates violently between 45°F and 65°F every 5 to 10 minutes when sitting idle and less severely when driving as seen in Appendix J, page 68. According to SCE service personnel, the A/C system required service. Therefore, the impact of A/C use was not as significant as would be normally expected.

C1. Urban Range Tests

For the drives on the Pomona loop, the speed of the vehicle varied between 30 mph and 50 mph. The Urban Pomona Loop, is a 20-mile urban loop that exposes the EV to a real world urban driving environment. At least three loops were completed for each drive with the RAV4. The vehicle was driven in the “drive” mode with the “EB” electronic brake switch on. The “EB” mode takes advantage of regenerative braking, which increases a vehicle’s range when driving in downhill or stop-and-go conditions. Variations in payload and auxiliary loads (air conditioning and headlights) clearly affected the range of the vehicle, as seen in Figure 4-1, page 6.

The lowest range, 68.9 miles, was found when driving the RAV4 with maximum payload and all auxiliary loads on. The highest range, 92.8 miles, was found when driving the vehicle with minimum payload and with no auxiliary loads on, as would be expected. It was noticed that auxiliary loads had the most effect on range when testing at maximum payload on the urban loop where the range was found to decline from 89.5 miles without auxiliary loads to 68.9 miles with auxiliary loads (23%). At minimum payload, the effects on range from auxiliary loads were less noticeable, only decreasing from 92.8 miles without auxiliary loads to 84.8 miles with auxiliary loads.

Energy consumption was similar for most of the recharging cycles because the vehicle was always driven to the same level of discharge (15% SOC). The average energy used by the vehicle after urban drive testing was 32.7 AC kWh. The largest deviation from this value was 3.7% during a UR2 test.

C2. Freeway Range Tests

During freeway testing the vehicle's speed was kept as close as possible to the posted speed limits. The vehicle was driven in the "drive" mode with the "EB" electronic brake switch off. The "EB" mode is recommended for downhill or stop-and-go traffic and may reduce the range when driving near constant speeds for long periods of time. The reasoning under this assumption is that the vehicle's momentum is more critical for obtaining a greater range when minor slow downs occur on the freeway. Power demands on the freeway are generally smaller than the high demands that are needed for stop-and-go urban driving. As seen in Table 3, page 7, a maximum range of 79.9 miles was obtained for the least demanding FW1 test (minimum payload, no auxiliary loads). It can also be seen that the freeway range tests were very comparable, all within 6% of each other, whereas the urban tests showed a deviation of more that 25%. Because of the high power demands encountered during urban driving, payload and auxiliary loads play more of an effect on the available range. During freeway driving, aerodynamics play more of an effect on range, whereas payload will have less of an effect due to the constant driving speed. Also, battery capacity depends on the discharge rate. This would mean that a high constant discharge rate while driving on the freeway would yield a lower range. For these reasons, less overall range was obtained on the freeway tests, while higher range

results with significant deviations were found during urban tests. Comparable results were found when testing the 1998 Toyota RAV4 EV conductive under similar conditions (see report dated April 1998). The average energy used by the vehicle after freeway drive testing was 31.9 AC kWh. The largest deviation from this value was 2% during a FW1 test.

A. Sound Level Test

D1. Driving Sound Level Test

Sound level tests were performed for both the urban Pomona loop and freeway Pomona loop. These sound tests are very sensitive, so all vehicle accessories must be off and windows must be rolled up. The driver must also observe complete silence for each of the tested loops. The "EXTECH Instruments" sound level meter was placed at passenger ear level with the use of a tripod. Data was taken from the start of each loop at two-second intervals until the loop was completed. Results show that the RAV4 had an average sound intensity of 60.7 decibels on the urban Pomona loop and an average sound intensity of 70.3 decibels on the freeway Pomona loop. Wind and road noise play a major part in the increased test readings for the freeway tests. Sound level profiles for urban and freeway driving can be seen in Figures 4-3 and 4-4 on page 8.

D2. Charging Sound Level Test

Charger sound level testing was performed after hours within a closed vehicle bay to minimize superfluous sounds. Even with all the necessary precautions taken, unavoidable peaks were found during the sound profile test. Loud vehicles and passing trains were possible causes of most of these sound peaks. The number of peaks found were small and did not adversely affect the average sound level for the test. The average sound level, measured one meter (3.28 ft.) away from the Gen II charger, was found to be 60.2 decibels. The value for the charger sound level test was found to be 2% lower than that of the Gen I, Magne Charge charger, tested under similar conditions.

B. State of Charge Meter Evaluation

State of charge meter evaluation is valuable for determining the available range of a vehicle and the time required for charging. As seen in Figure 4-7, page 10, the RAV 4 SOC meter is broken down into 10 segments, where 10 corresponds to "Full" and 0 corresponds to "Empty". The SOC read on this meter does not refer to the actual SOC of the battery, but rather to the SOC level within the range set by the vehicle or battery manufacturer as the vehicle's operating range. The SOC gage was quite linear for both the driving and charging SOC meter evaluations. When the miles per division of the SOC gage are known, the estimated range of the vehicle from any starting SOC can be determined. Also, the time required to charge the vehicle can easily be determined. Overall the SOC meter was very helpful and was also easy to read. The voltmeter on the other hand seemed unnecessary for the casual driver, since the available range specified by the SOC meter is of more interest. In most cases, the driver tends to forget that the voltmeter is there. Users could pay more attention to the Voltmeter if they knew how to use it to their advantage. By trying to keep the voltmeter needle as far away from the red section while accelerating, one could increase their range due to efficient driving techniques. The voltmeter could stand out more if the divisions and voltage readings were present on the gage.

E1. Driving

Figure 4-6, page 10, shows that the RAV 4 had a range of 96.8 miles during after a UR1 test. The plot shows vehicle SOC meter reading versus miles driven. Data points were taken while driving on the Pomona Loop at each of the ten SOC meter divisions, except for '0', since the vehicle was only driven to 15% SOC. The available miles at a particular SOC can easily be estimated with the use of this graph. Also, one can estimate the number of miles available per division of the gage.

E2. Charging

The charging state-of-charge meter evaluation is performed to create a chart that assists the user in estimating the state-of-charge at a particular elapsed time and the energy

needed to reach that state. The AC kilowatt-hours accumulated is plotted along with the indicated SOC with respect to the charging time. As seen in Figure 4-8, on page 11, both the SOC and the AC kWhrs-in are very linear, which shows that the charging system uses a constant peak power charge.

C. Acceleration, Braking and Maximum Speed Tests

Performance testing of the vehicle took place at the Pomona Raceway. The test site was dry, and the ambient temperature averaged approximately 82 °F from the start to end of testing.

A Vericom Computers, Inc. VC2000PC performance computer was used to calculate acceleration, speed, and distance for the tests. The average of two runs was reported in Table 4, page 12, for each of the acceleration tests performed. A total of four runs were completed for the braking test, each going in the opposite direction.

The vehicle performed reliably, with no noticeable drop in power as the state of charge declined. As shown in Table 4, page 12, the average acceleration time at 100% SOC was 4.91 seconds for 0 to 30 mph, 9.42 seconds for 30 to 55 mph, and 16.35 seconds for 0 to 60 mph. Figure 4-9, page 12, shows the average speed and distance profiles taken at 100% SOC.

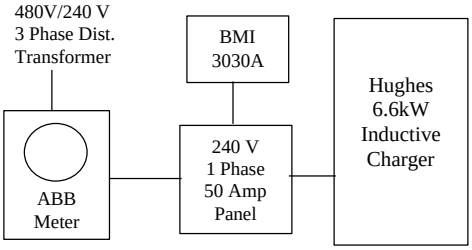
The average maximum speed obtained for 4 runs, two at 100% SOC and two at 20% SOC, was 76 mph. The maximum speed did not decrease when comparing tests done at 100% SOC to tests done at 20% SOC. The vehicle was very stable under maximum acceleration. It should be noted that the maximum speed obtained in this test is not the true maximum obtainable speed. The track length is only sufficient for determining the vehicle's performance while accelerating from 0 to 70 mph for most EVs. On all maximum speed tests the RAV 4 was still accelerating when the maximum value was recorded. The goal in doing the maximum speed and acceleration tests is to find out whether or not a vehicle is safe to operate on the freeway, whether or not a vehicle can merge into traffic on on-ramps and then successfully keep up with traffic. Please refer to Appendix F, page 36, for an acceleration in g's versus time graph, which also includes the estimated power at the wheel.

The average braking distance for 25-0 mph at 50% SOC was 27.7 feet. The ABS system worked very well, with very little skidding noticed. The average stopping time recorded by the VC2000PC accelerometer computer was 1.54 seconds.
The vehicle was observed to have a turning radius of 17 feet and 10 inches.

G. Charger Performance / Profile Test

The RAV 4 was charged with an off-board inductively coupled Gen II charger, as seen in Figure 5-3, below. The Hughes Gen II inductive charger is rated at 6.6 kW and can use either 208 or 240 Volt services. When connected, the charger starts automatically, unless the timer in the vehicle is set to charge at a later time (under possibly more economical rates). The timer can also be used to control cabin pre-heating or cooling. The average charging time, from approximately 14% to 100% SOC was found to be 4 hours and 40 minutes.
The vehicle's SOC after a complete charge cycle the following day was inconsistent throughout testing, showing between 90% to 100% SOC. The RAV4 was noticed to have a high self-discharge rate of about 7% overnight, but was not always consistent. It was

Figure 5-3. RAV4 with Gen II Inductive Charger.



Figs 5-4 & 5-5 Hughes block diagram *above*, BMI Power Profiler *below*

also noticed that if the vehicle was charged immediately after a drive, especially on a hot day, the charge time would go beyond the normal time needed. The longer charge times were probably due to high battery temperatures or equalization charging. The charge timer was used, so as to give the batteries time to cool down before charging. Refer to Appendix E, page 34, for the Charger Testing and Analysis Data sheet.
Power quality data was acquired using a BMI Power Profiler, seen in Figure 5-5, page 21. The power quality of the Hughes Gen II charger was monitored at the service panel supplying the Hughes charger as shown in Figure 5-4, page 21, and recorded during charge with snapshots taken near the charger's maximum AC demand.

G1. Charger Performance / Profile Test at EVTC

As shown in Table 5, page 13, the peak instantaneous power demand was 6.972 kW, with the current at 29.39 A and voltage at 238.1 V for the Gen II charger. The power factor was found to be 1.00, the displacement power factor was also 1.00, the voltage total harmonic distortion (THD) was 1.3%, and the current total demand distortion (TDD) was 2.84%. The current total harmonic distortion (THD) for the charger was found to be 3.1%. In terms of power quality, the performance of the Gen II charger was excellent. All values obtained were well below the limits recommended by the Infrastructure Working Council (IWC) and the Institute of Electrical and Electronics Engineer's (IEEE) 519-1992 standard (Refer to the EV Test Procedures for these values). The plot seen in Figure 4-10, page 13, shows a typical charging profile along with the estimated percent SOC with respect to time. Refer to Appendix G, page 38, for BMI graphical data for charging at the EV Tech Center.

G2. Charger Performance Test at Residence

The residential charging test was performed with a Hughes inductively coupled Gen I Magne Charge charger rated at 6.6 kW. The charging system charged the vehicle to about 76% SOC, putting back 21.5 AC kWh into the battery pack. The charge time was 3 hours and 38 minutes. It was noticed that the charger did not charge at its normal peak

power of about 7 kW. Never the less, power quality data was taken at the highest peak charging power.

As shown in Table 6, page 14, the peak instantaneous power demand was 6.066 kW with the current at 28.3 A and the voltage at 242.3 V. The power factor was found to be 1.00, the displacement power factor was also 1.00, the voltage total harmonic distortion (THD) was 1.2%, and the current total demand distortion (TDD) was 3.3%. The current total harmonic distortion (THD) for the charger was found to be 3.5%. In terms of power quality, the performance of the charger was excellent. All values obtained were well below the limits recommended by the Infrastructure Working Council (IWC) and the Institute of Electrical and Electronics Engineer's (IEEE) 519-1992 standard (Refer to the EV Test Procedures for these standard values). Refer to Appendix H, page 44, for BMI graphical data for residential charging.

H. Conclusion

The 1999 inductive version of the Toyota RAV4 EV is the first generation vehicle of this product line to offer an inductive charging system. Conductive versions of the RAV4 EV were previously available for the 1998 model year and are also available for the 1999 model year.

The RAV4 EV, which is powered by Panasonic "NiMH" batteries performed very well in terms of on-road performance. The vehicle accelerated well on freeway on-ramps and had very good braking characteristics. Data obtained from performance testing shows that this vehicle is very well suited for many everyday applications that do not exceed a round trip mileage of approximately 80 miles.

In terms of power quality characteristics such as Power Factors, and harmonic distortions generated, the performance of all the charging systems tested with the RAV4 EV were excellent. The power factors for the inductive chargers remained well above 0.95 (TPF and dPF) throughout the normal operating range. The chargers were also well within the acceptable range for current and voltage harmonic distortions generated, as established by the National Electric Vehicle Infrastructure Working Council (IWC) and the Institute of Electrical and Electronics Engineers (IEEE 519 standards).

APPENDIX A

Vehicle Specification 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
ϟ Heated seats (driver and front-passenger)
ϟ Heated and tinted windshield
Rear window defogger and wiper
ϟ 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)

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.

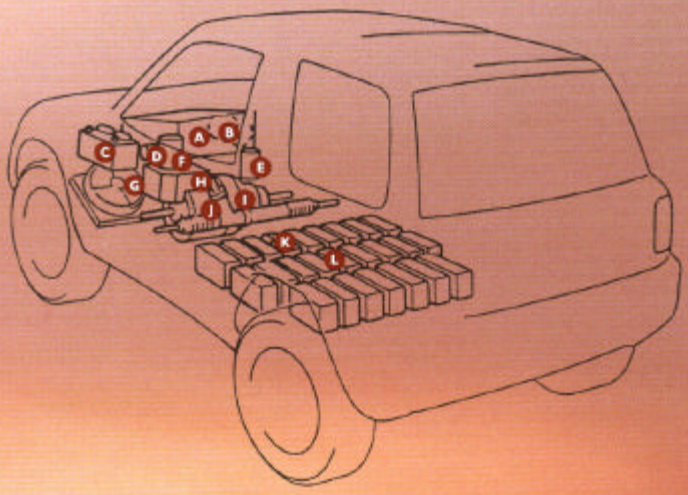
The on-board charger lets you recharge the batteries using 220-volt household current. With the built-in timer, you can charge conveniently during off-peak hours when electricity is cheapest. ECUs (electronic control units) monitor the charging rate, as well as control the motor output in response to 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)
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10% post-consumer waste

Call 1-800-GO-TOYOTA or check out our Web site at www.toyota.com. Vehicle information is based upon availability at the time of printing and is subject to change without notice.

TOYOTA

* 1998 Conductive model shown, all specifications are identical to the 1999 inductive version, except for the inductively coupled charging system, the motor rating and charge time.

APPENDIX B

Battery Specification Sheet

Battery For Electric Vehicle

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 x L388 x H175
重量 Weight	17.2kg
エネルギー密度 Specific Energy	70Wh/kg

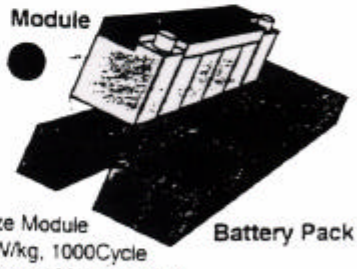
EV用ニッケル・水素蓄電池周辺機器

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

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



- 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

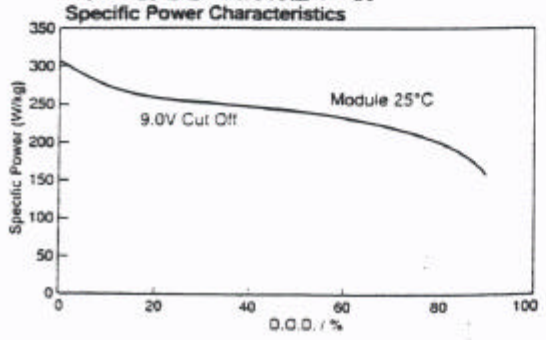
「あらゆる生命の源、母なる地球のためにいま私たちができること」松下電池工業はそんな視点から、地球環境を大切に考えた色々な活動を推進しています。
排気ガスはもちろん騒音も殆どなく、多様なエネルギー源による電気を動力源とする電気自動車(EV)が次世代の乗り物として注目を集めています。より豊かで快適な未来の創造に向けて松下電池工業は総合技術力を結集し、本格的EV用の蓄電池として、人と環境に優しい、EV用ニッケル・水素蓄電池を開発し、'98年に向けて量産化技術の開発を進めています。

"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.

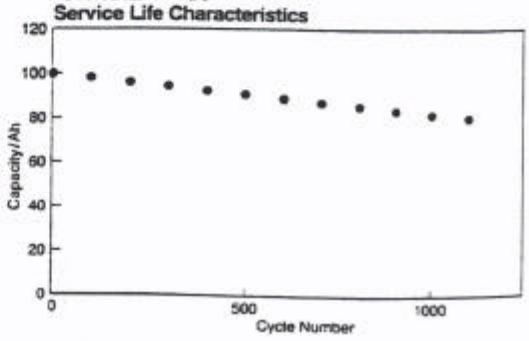
EV用ニッケル・水素蓄電池の特長
Characteristics of Ni/Metal-Hydride Battery for EVs

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



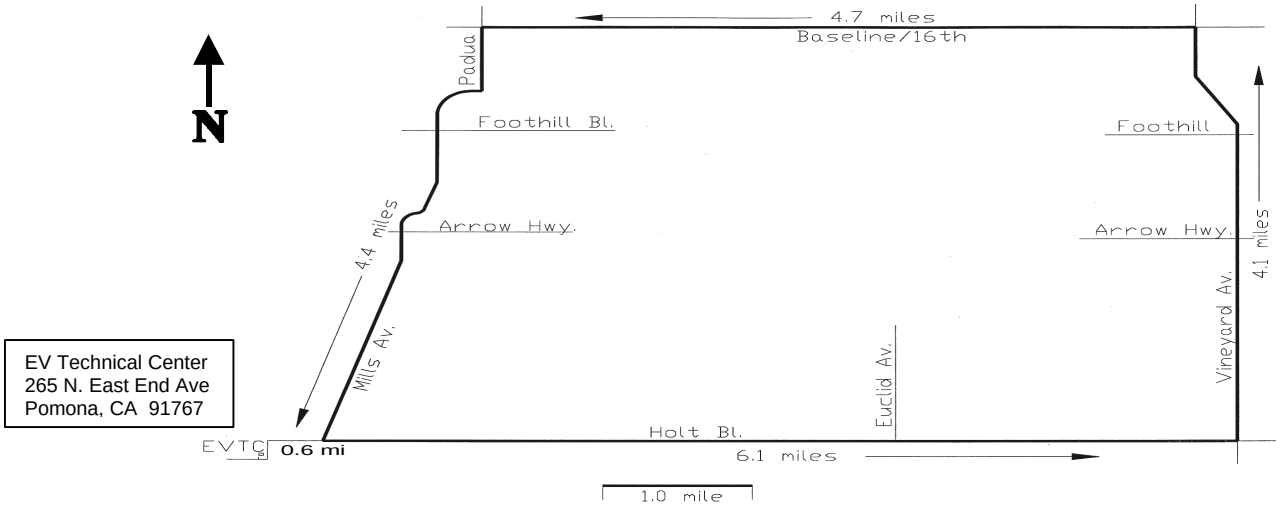
寿命特性の一例
Service Life Characteristics



APPENDIX C

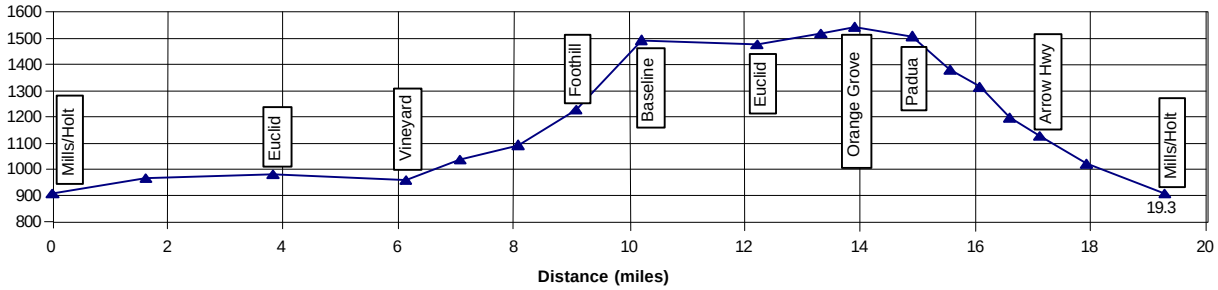
Pomona Urban and Freeway Loop Maps

Urban Pomona Loop

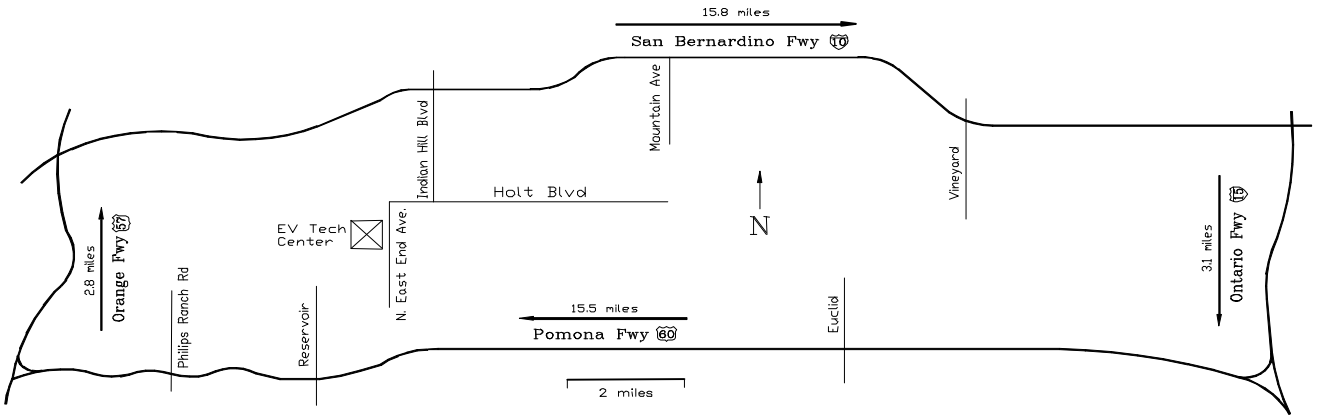


EV Technical Center
265 N. East End Ave
Pomona, CA 91767

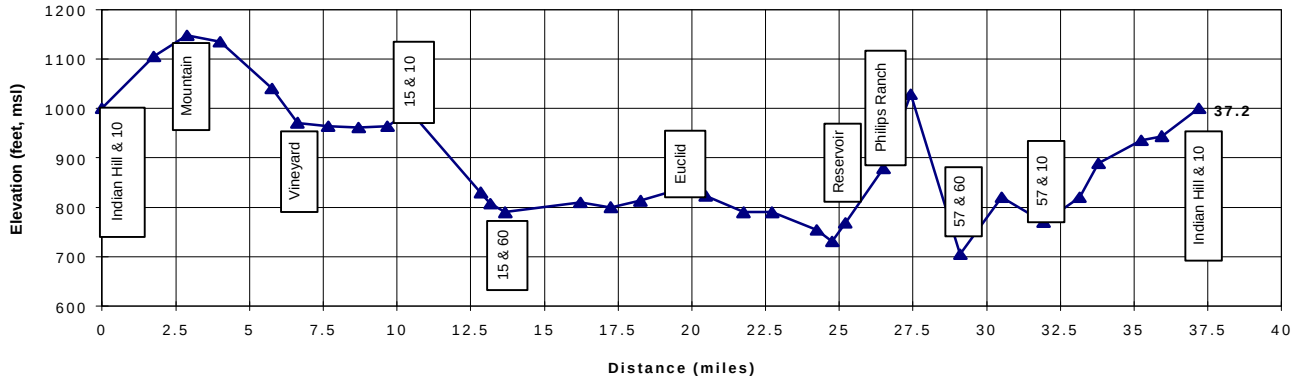
Elevation Profile



Freeway Pomona Loop



Elevation Profile



APPENDIX D

Vehicle Test Equipment and Nameplate Data Sheet

VEHICLE TEST EQUIPMENT AND NAMEPLATE DATA SHEET

Project: DOE Field Operations Program Test: Performance Characterization
Date(s): 6-10-99 to 8-2-99 File Name(s): PM 98 - RAV 4 Inductive
Vehicle #: 24561 Technician: R. Solares, B. Sanchez

~~VEHICLE~~

Manufacturer: Toyota VIN: JT3GS10VXX0001648
Model: RAV4 Inductive
Model Year: 1999 Date of Manufacture: 01/99
GVWR: 4266 Front AWR: 2258 Rear AWR: 2297
Motor Manufacturer: NA Type: Permanent-magnet
Motor Rating/Speed: 20 kW Rated, 50kW Max @ 3100-4600 rpm
Version/Serial No.: JT3GS10VXX0001648
EPA Label Fuel Economy: 29 kWh/100 miles (City) 37kWh/100 miles (Highway)
Controller Version/Serial No.: G9100-42100HL18W 1521
Battery Pack Type/Version/Serial No.: VR NiMH 12V, 95Ah (5hr), 24 modules, 288V nominal pack
Tire Manufacturer: ECOPIA Model: EPO2
Tire Size: 195/80R16 Maximum Pressure: 44 psi
Maximum Tire Load: 1609 lbs. Treadwear Rating: 2

~~CHARGER~~

Off-board Manufacturer: Hughes Magne Charge (GM ATV)
Model: Gen II, 6.6kW Serial Number: SM4770P9829005B-
Charger Type/Version: 6.6kW max power, Inductive off-board charger
EVSE Manufacturer: NA
EVSE Model/Version: NA Serial Number: NA
EVSE Software Version: NA
Charge Port Manufacturer/Model/Version/SN: NA

~~TEST EQUIPMENT~~

BMI Power Profiler 3030A EVTC Number: BMI-001
ABB kWh Meter Serial Number: 01-223-620
Thermometer EVTC Number: THR-003
Optical Meter Probe EVTC Number: OPB-001
Laptop Computer EVTC Number: CMP-002
Desktop Computer EVTC Number: CMP-008;CMP-013
Stopwatch EVTC Number: NA
Digital multimeter EVTC Number: NA
ABC-150 EVTC Number: NA
Smart Guard Interface Serial Number: NA
Smart Guard Numbers: NA
Sound Level Meter EVTC Number: SMR-001
Measuring Wheel EVTC Number: NA
Other Equipment: VC200PC Accelerometer computer

~~WEIGHT CERTIFICATION~~

Scale Location and Proprietor: Mission Recycling Center Pomona, CA
Examiner: Yolanda Olvia Date: 06/18/1999
Notes:

APPENDIX E

Charger Testing / Analysis Data Sheet

CHARGER TESTING / ANALYSIS DATA SHEET

Name of test conductor: R. Solares Date: 06/28/99

Location of test: EVTC Pomona Phone: (909)469-0289

~~Charger Information~~

Manufacturer: Hughes

Model No.: Magne Charge Gen II

Supply Side Voltage Rating: 208-240 V ac, 60 Hz

~~After Completion of Recharging Cycle~~

Time of Day: NA

Final Pack Voltage: NA

AC kWh Used: 30.28 DC kWh Delivered: NA

Charger Energy Efficiency: NA (DC kWh/AC kWh)

Amp-hours to battery: NA kWh to battery: NA

Overcharge Factor: NA (Ah removed/Ah returned)

DC Output Ripple Voltage: NA Ripple Frequency: NA

~~Charger Operation Information/Evaluation~~

Exterior Dimensions: 26"H 16"W 12"D Weight: 55 lbs.

Charging Profile Type: Vehicle determined

End Point Determination Method: Vehicle determined

Battery Monitoring Method: Monitored by vehicle

Programmable Charging Profiles: none

Connector Type(s): Inductive Paddle

Safety Features / Protection Devices: Charging Circuit Interrupting Device (CCID)

Agency/Industry Approvals: UL Listed EV charger

Installation Techniques/Requirements: Min. circuit capacity 40A, over current protection 40A

Appropriate for Interior and/or Exterior Use: Yes

User Interface: Display

Ease of Use: Simple

Current & Future Cost: $1,900.00 (current)

Warranty: 3 yrs. After date of first installation

Reliability History/Manuf. Reputation: Reliable

Maintenance Schedule: Only cleaning (turn off charger at circuit breaker)

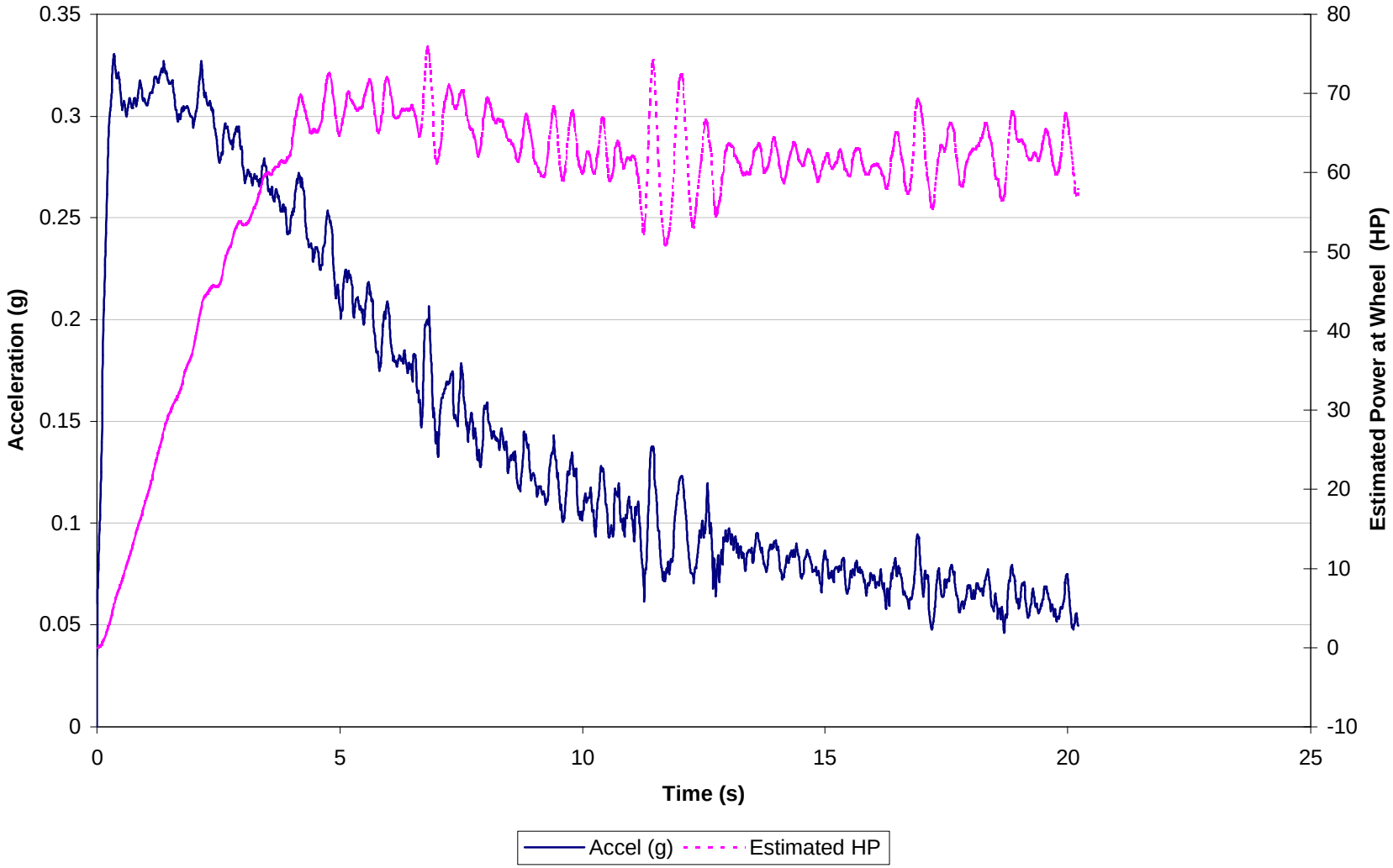
Accompanying Supplies: Top and Bottom installation brackets

Manufacturer Support: Yes

Other Notes: Vehicle was discharged to 15% SOC on the Urban Pomona Loop.

APPENDIX F

Acceleration and Estimated Horsepower Chart

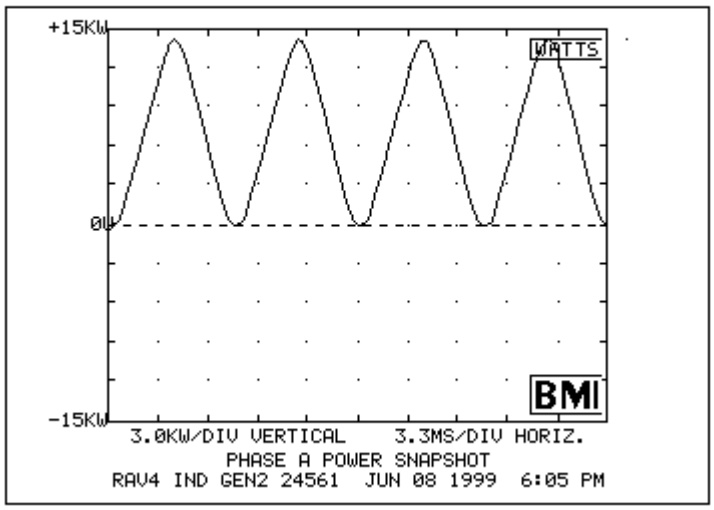

RAV4 24561 Acceleration vs. Time
Acceleration (g)
Estimated Power at Wheel (HP)
Time (s)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
80
70
60
50
40
30
20
10
0
-10
0
5
10
15
20
25
Accel (g)
Estimated HP

APPENDIX G

BMI Graphical Data - EVTC

Hughes Gen II Inductive -- Snapshots near Maximum Power

RAV4 IND GEN2 24561 Jun 08 1999 (Tue)
PHASE A POWER SNAPSHOT 6:05:47 PM
INSTANTANEOUS POWER: 6.972 kW



PHASE A POWER SPECTRUM 6:06:21 PM
Power: 6.972 kW
Fundamental freq: 60.0 Hz

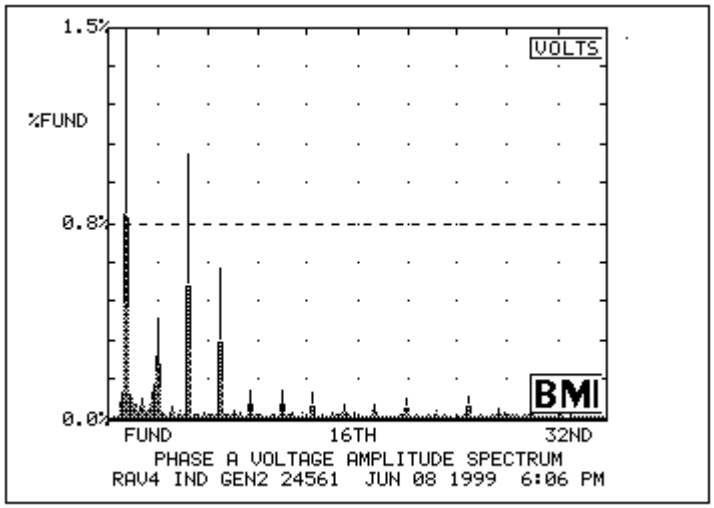
HARM	POWER	HARM	POWER
FUND	+6.966 kW	2nd	+0.01 W
3rd	-0.21 W	4th	
5th	+0.91 W	6th	
7th	+0.13 W	8th	
9th		10th	
11th	-0.04 W	12th	
13th	+0.01 W	14th	
15th	-0.01 W	16th	
17th	+0.01 W	18th	
19th	+0.01 W	20th	
21st		22nd	
23rd	+0.01 W	24th	
25th		26th	
27th		28th	
29th		30th	
31st		32nd	
33rd		34th	
35th		36th	
37th		38th	
39th		40th	
41st		42nd	
43rd		44th	
45th		46th	
47th		48th	
49th		50th	
ODD	0.81 W	EVEN	0.02 W
THP:	0.82 W		

POWER FACTOR SNAPSHOT 6:05:49 PM
Phase A-N: 6.972 kW
Phase A-N: 6.997 kVA
Phase A-N: 540.5 VAR
Phase A-N: 1.00 PF
Phase A-N: 1.00 dPF

HARMONICS SNAPSHOT 6:05:51 PM
Fundamental freq: 60.0 Hz
Phase A-N Volts: 1.3% THD
Phase A Current: 3.1% THD

PHASE A VOLTAGE SPECTRUM 6:05:54 PM
Fundamental volts: 238.0 Vrms
Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	0	2nd		
3rd	0.4%	-173	4th		
5th	1.0%	-22	6th		
7th	0.6%	171	8th		
9th	0.1%	167	10th		
11th	0.1%	86	12th		
13th	0.1%	160	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	1.3%		EVEN	0.1%	
THD:	1.3%				



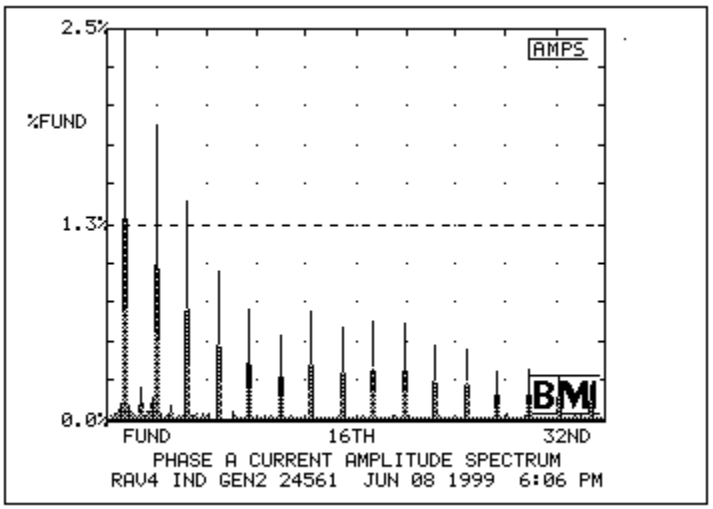
PHASE A CURRENT SPECTRUM 6:06:05 PM

Fundamental amps: 29.36 A rms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	-4	2nd	0.2%	89
3rd	1.9%	73	4th		
5th	1.4%	-2	6th		
7th	1.0%	-119	8th		
9th	0.7%	-104	10th		
11th	0.5%	-112	12th		
13th	0.7%	-123	14th		
15th	0.6%	-134	16th		
17th	0.6%	-140	18th		
19th	0.6%	-156	20th		
21st	0.5%	-157	22nd		
23rd	0.5%	177	24th		
25th	0.3%	165	26th		
27th	0.3%	144	28th		
29th	0.3%	134	30th		
31st	0.2%	113	32nd		
33rd			34th		
35th			36th		
37th	0.1%	23	38th		
39th			40th		
41st			42nd		
43rd			44th		
45th			46th		
47th			48th		
49th	0.1%	-59	50th		
ODD	3.1%		EVEN	0.2%	

THD: 3.1%



VOLTAGE & CURRENT SNAPSHOT 6:06:30 PM

Phase A-N: 238.1 Vrms, 0 (ref)
Neut-Gnd: 119.9 Vrms, -138

Phase A: 29.39 A rms, -4

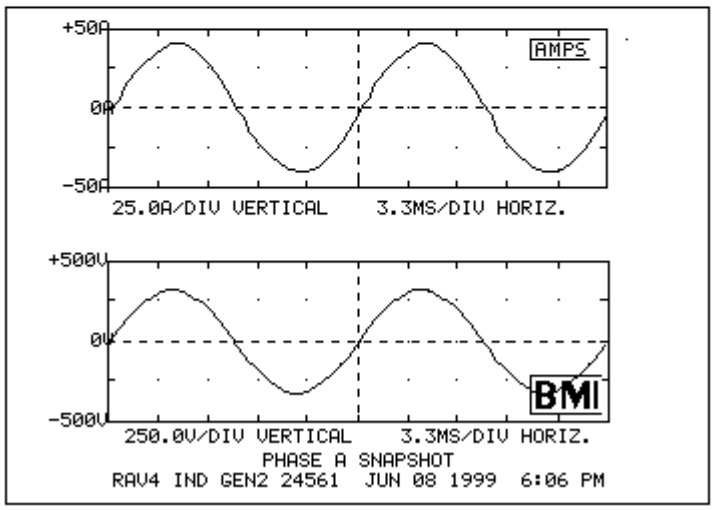
RAV4 IND GEN2 24561 Jun 08 1999 (Tue)

PHASE A SNAPSHOT 6:06:33 PM

Phase A-N VOLTAGE: 238.1 Vrms
1.4 Crest Factor
1.1 Form Factor

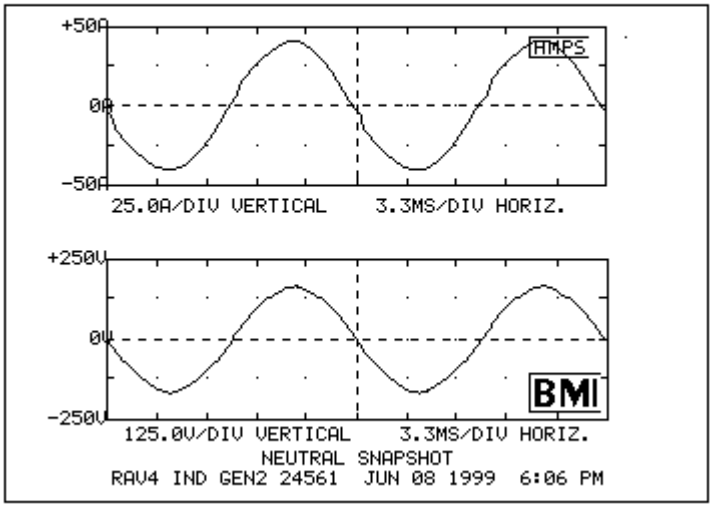
Phase A CURRENT: 29.39 A rms
1.4 Crest Factor
1.1 Form Factor

CURRENT LAGS VOLTAGE BY 4 (1.00 dPF)



NEUTRAL SNAPSHOT 6:06:42 PM

Neut-Gnd VOLTAGE: 119.9 Vrms
1.4 Crest Factor
1.1 Form Factor



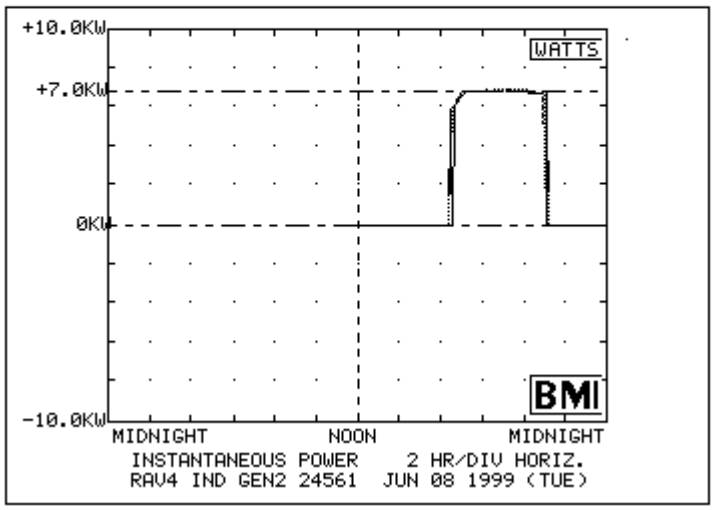
Cumulative Profiles – 24 Hours

RAV4 IND GEN2 24561 Jun 09 1999 (Wed)

INSTANTANEOUS POWER MIDNIGHT

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

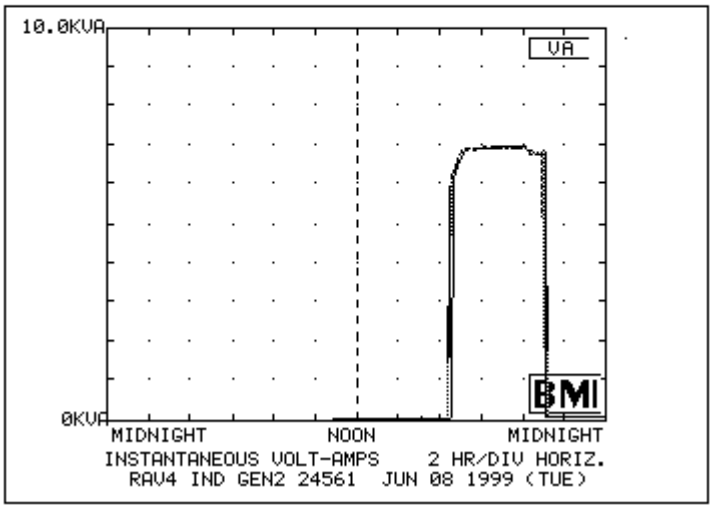
Phase A-N:
MAX: 7.0 kW, 6:38 PM
MIN: -0.0 kW, 4:34 PM



INSTANTANEOUS VOLT-AMPS 12:00:04 AM

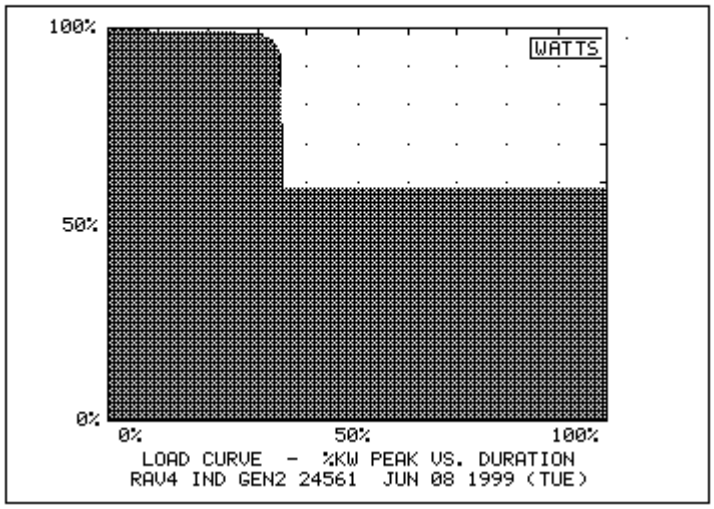
FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

Phase A-N:
MAX: 7.0 kVA, 6:38 PM
MIN: 0.0 kVA, 9:04 PM



LOAD DURATION CURVE 12:00:22 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)



TOTAL POWER CONSUMPTION 12:00:41 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

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

BILLING DEMAND:

6.964 kW	Pk Today
6.964 kW	Pk Accumulated
$ 0.502	Today
$ -32.23	Accumulated

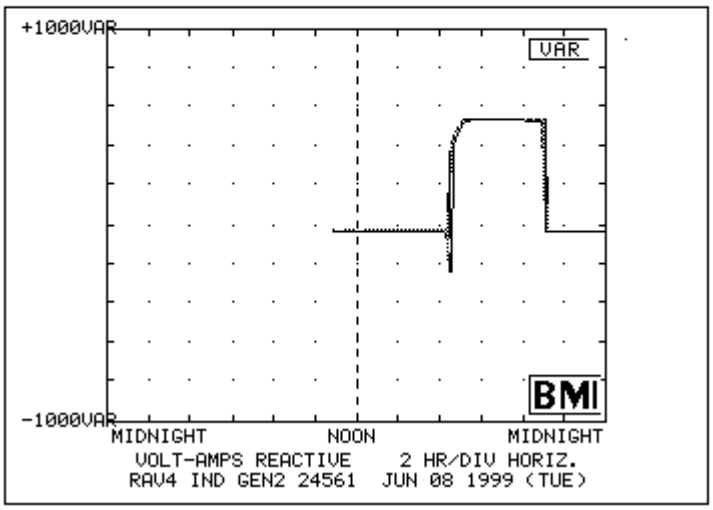
CONSUMPTION:

31.60 kWh	Today
31.60 kWh	Accumulated
$ 1.896	Today
$ 1.896	Accumulated
17.70 kQh	Today
2.198 kVARh	Today

VOLT-AMPS REACTIVE 12:00:50 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

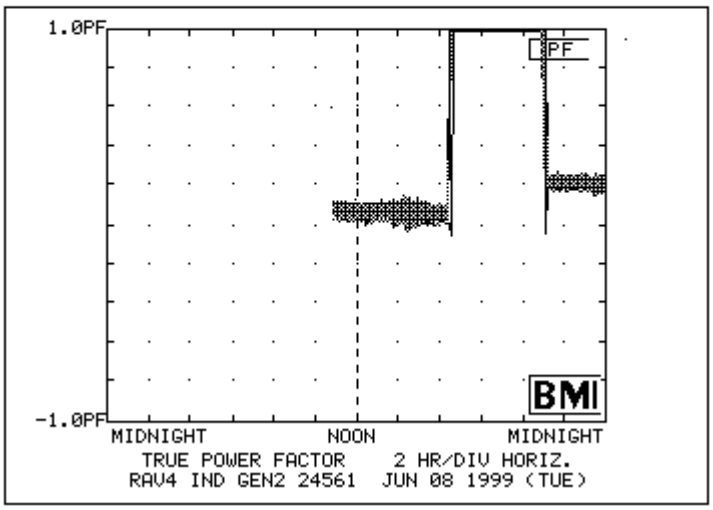
Phase A-N:
MAX: 542.4 VAR; 6:30 PM
MIN: -244.8 VAR; 4:34 PM



TRUE POWER FACTOR 12:00:59 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

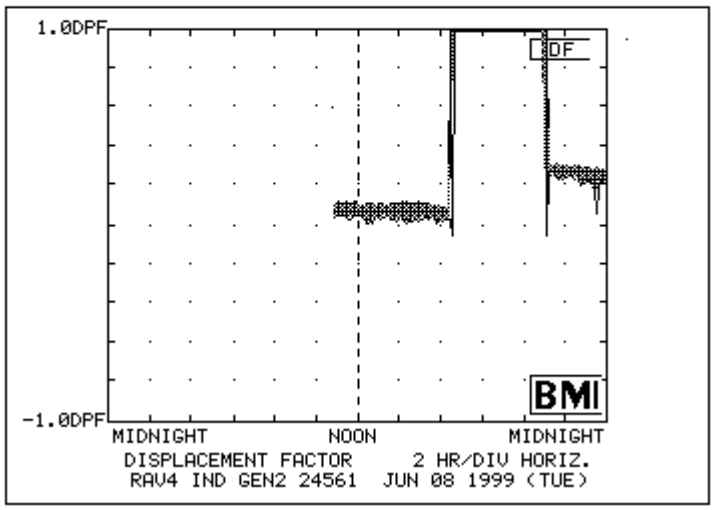
Phase A-N:
MAX: 1.00 PF; 4:34 PM
MIN: -0.06 PF; 4:34 PM



DISPLACEMENT FACTOR 12:01:07 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

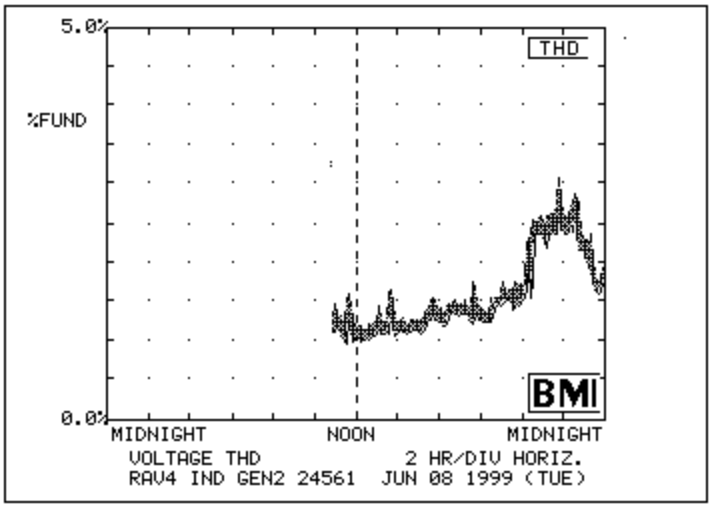
Phase A-N:
MAX: 1.00 dPF; 4:34 PM
MIN: -0.06 dPF; 9:04 PM



VOLTAGE THD 12:01:21 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

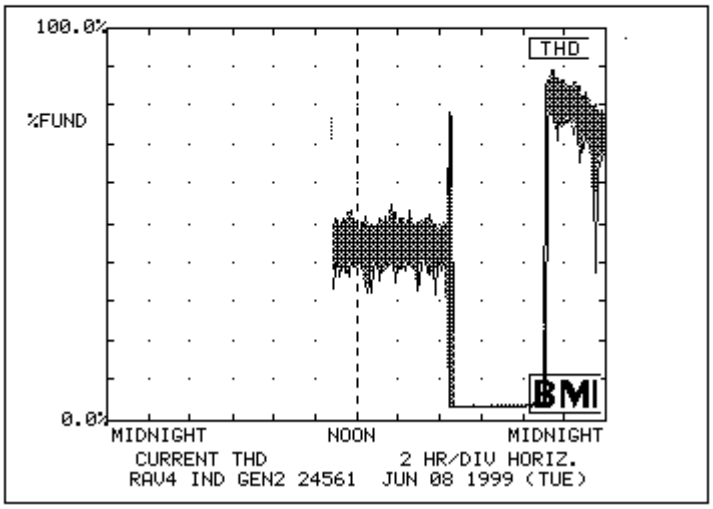
Phase A-N:
MAX: 3.1% THD; 9:46 PM
MIN: 0.9% THD; 11:26 AM



CURRENT THD 12:01:32 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

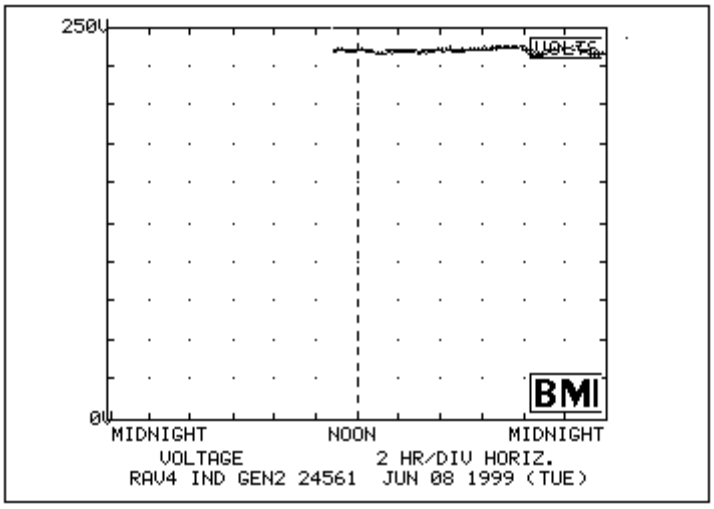
Phase A:
MAX: 89.7% THD, 9:25 PM
MIN: 3.1% THD, 6:19 PM



VOLTAGE 12:02:06 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

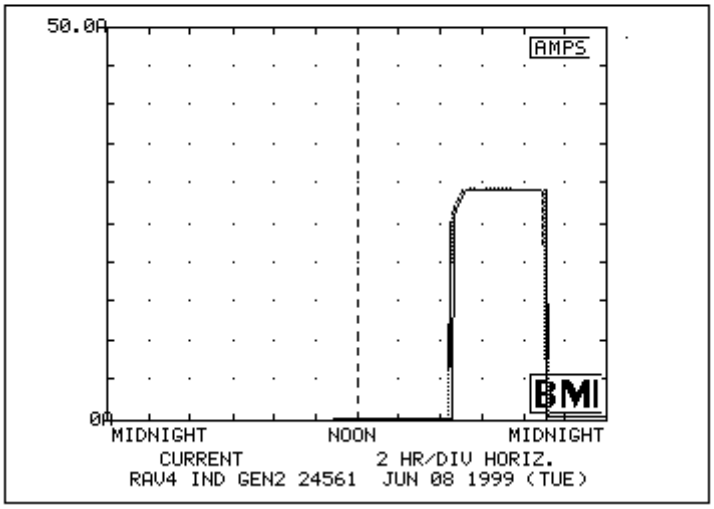
Phase A-N:
MAX: 238.9 V, 7:04 PM
MIN: 231.5 V, 11:30 PM



CURRENT 12:02:17 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

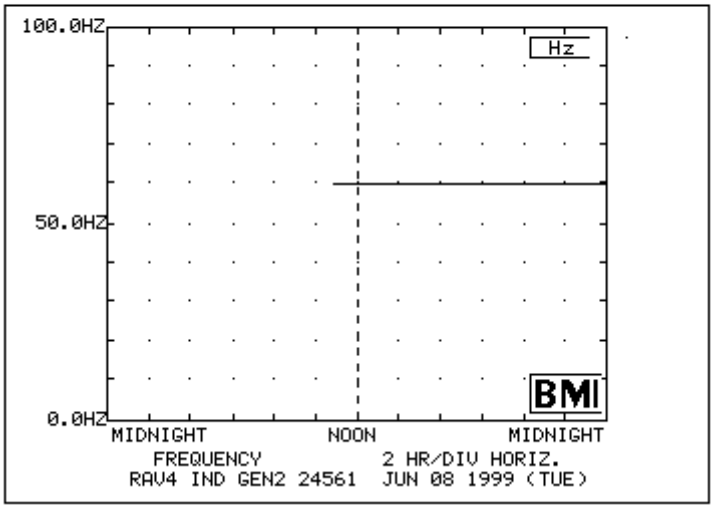
Phase A:
MAX: 29.5 A, 5:08 PM
MIN: 0.1 A, 9:04 PM



FREQUENCY 12:02:37 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

MAX: 60.1 Hz, 10:54 AM
MIN: 59.9 Hz, 6:10 PM



AMBIENT A Temperature 12:02:51 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

MAX: 24.5 C, 4:46 PM
MIN: 19.0 C, 10:50 AM

AMBIENT A Humidity 12:03:04 AM

FROM: MIDNIGHT Jun 07 1999 (Mon)
To: MIDNIGHT Jun 08 1999 (Tue)

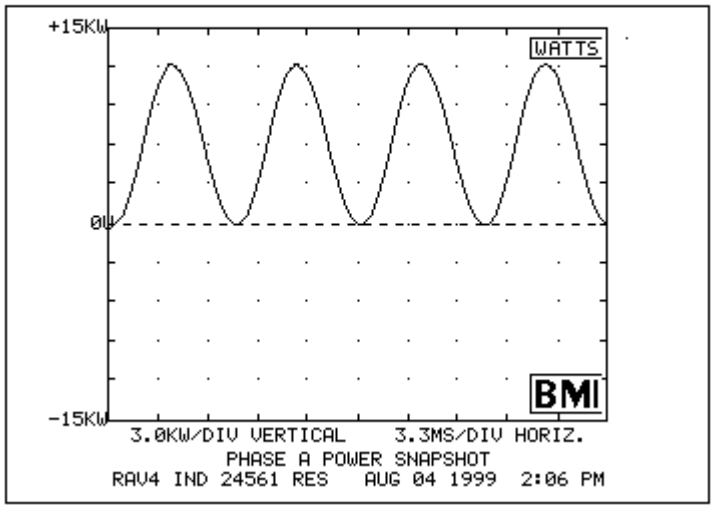
MAX: 55.7 %RH, 10:51 AM
MIN: 38.2 %RH, 5:37 PM

APPENDIX H

BMI Graphical Data – Residential Charging

Snapshots at Full Power

RAV4 IND 24561 RES Aug 04 1999 (Wed)
PHASE A POWER SNAPSHOT 2:06:54 PM
INSTANTANEOUS POWER: 6.066 kW



PHASE A VOLTAGE SPECTRUM 2:07:01 PM
Fundamental volts: 242.3 Vrms
Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	0	2nd		
3rd	0.2%	164	4th		
5th	1.0%	169	6th		
7th	0.6%	-2	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	1.2%		EVEN	0.0%	

THD: 1.2%

POWER FACTOR SNAPSHOT 2:06:57 PM
Phase A-N: 6.066 kW
Phase A-N: 6.095 kVA
Phase A-N: 546.1 VAR
Phase A-N: 1.00 PF
Phase A-N: 1.00 dPF

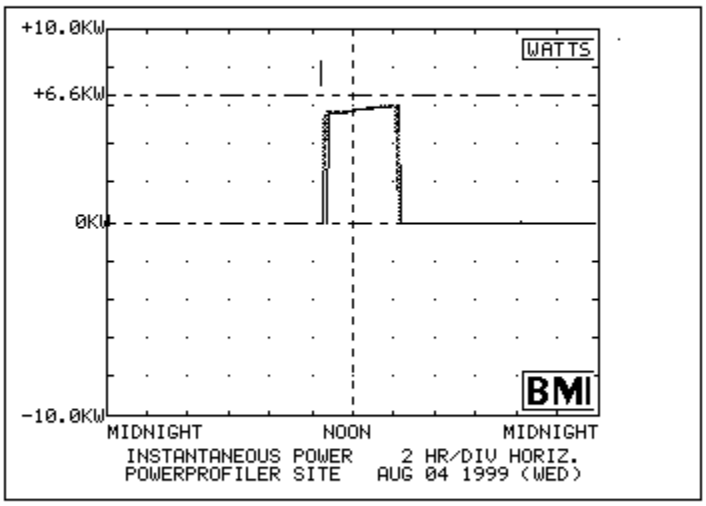
HARMONICS SNAPSHOT 2:06:59 PM
Fundamental freq: 60.0 Hz
Phase A-N Volts: 1.2% THD
Phase A Current: 3.3% TDD

Cumulative Profiles – 24 hour

INSTANTANEOUS POWER 11:41:57 PM

FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)

Phase A-N:
MAX: 6.1 kW, 2:04 PM
MIN: -0.0 kW, 10:32 AM

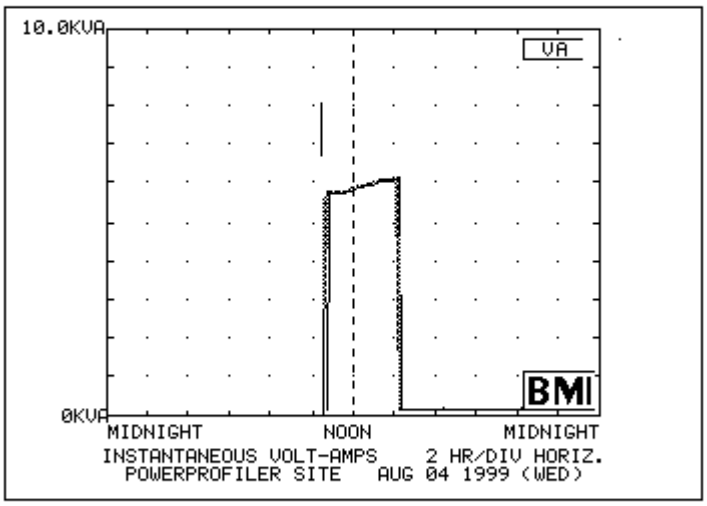


INSTANTANEOUS POWER (ACCUMULATED):
MAX: 6110.5 W
2:04 PM Aug 04 1999 (Wed)
MIN: -2.2 W
10:32 AM Aug 04 1999 (Wed)

INSTANTANEOUS VOLT-AMPS 11:42:01 PM

FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)

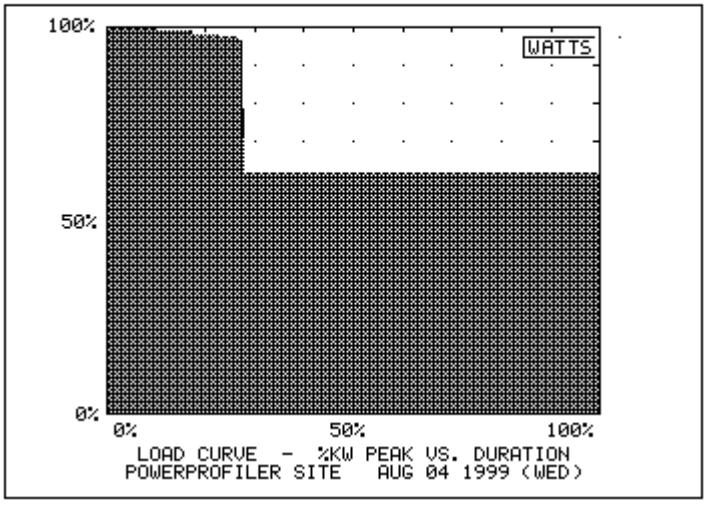
Phase A-N:
MAX: 6.1 kVA, 2:02 PM
MIN: 0.0 kVA, 10:32 AM



INSTANTANEOUS VOLT-AMPS (ACCUMULATED):
MAX: 6139.9 VA
2:02 PM Aug 04 1999 (Wed)
MIN: 5.2 VA
10:32 AM Aug 04 1999 (Wed)

LOAD DURATION CURVE 11:42:20 PM

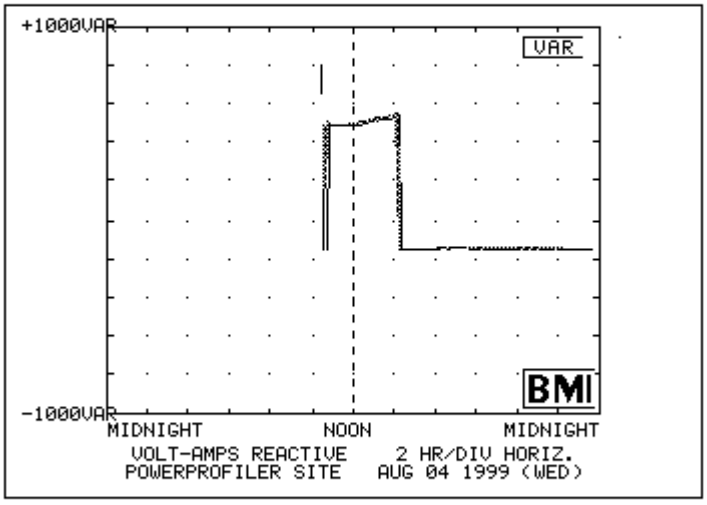
FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)



VOLT-AMPS REACTIVE 11:42:47 PM

FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)

Phase A-N:
MAX: 557.9 VAR, 2:08 PM
MIN: -154.0 VAR, 4:05 PM

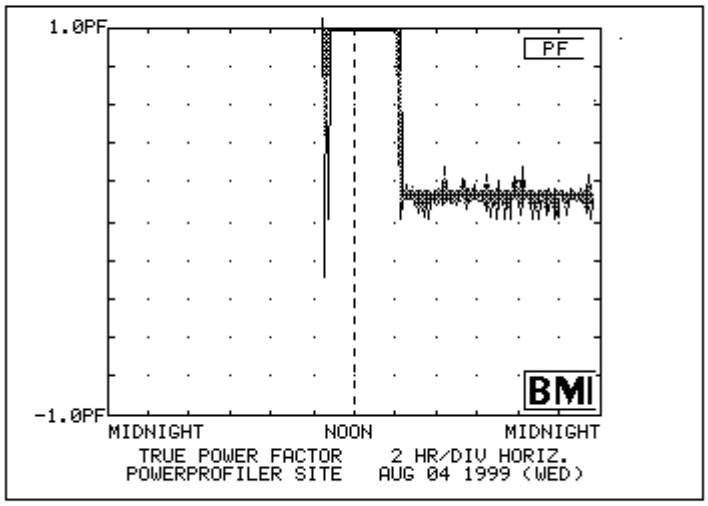


VOLT-AMPS REACTIVE (ACCUMULATED):
MAX: 557.9 VAR
2:08 PM Aug 04 1999 (Wed)
MIN: -154.0 VAR
4:05 PM Aug 04 1999 (Wed)

TRUE POWER FACTOR 11:42:56 PM

FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)

Phase A-N:
MAX: 1.00 PF; 10:42 AM
MIN: -0.29 PF; 10:32 AM

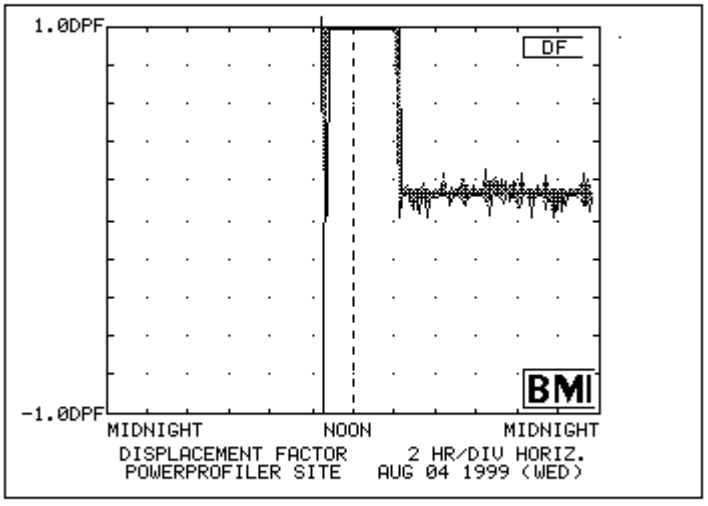


TRUE POWER FACTOR (ACCUMULATED):
MAX: 1.00 PF
10:42 AM Aug 04 1999 (Wed)
MIN: -0.29 PF
10:32 AM Aug 04 1999 (Wed)

DISPLACEMENT FACTOR 11:43:04 PM

FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)

Phase A-N:
MAX: 1.00 dPF; 10:42 AM
MIN: -1.00 dPF; 10:32 AM

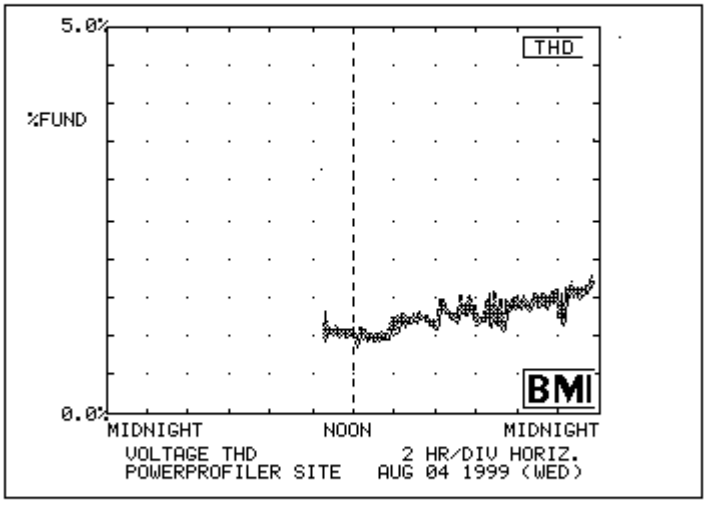


DISPLACEMENT FACTOR (ACCUMULATED):
MAX: 1.00 dPF
10:42 AM Aug 04 1999 (Wed)
MIN: -1.00 dPF
10:32 AM Aug 04 1999 (Wed)

VOLTAGE THD 11:43:18 PM

FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)

Phase A-N:
MAX: 1.8% THD; 11:37 PM
MIN: 0.9% THD; 12:09 PM



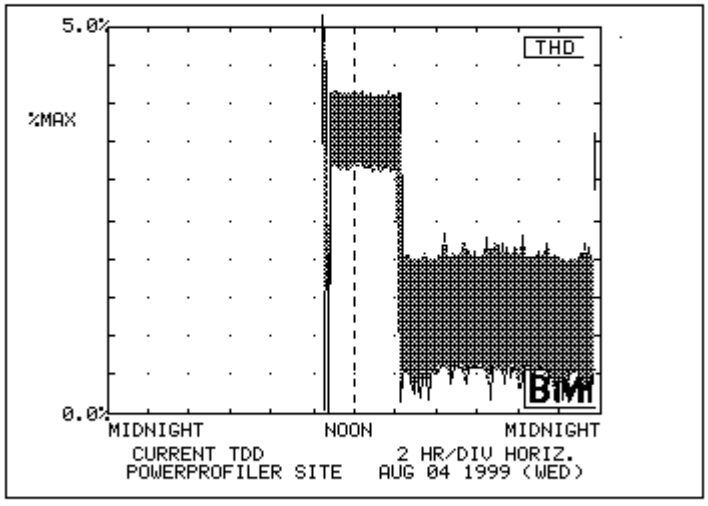
VOLTAGE THD (ACCUMULATED):
MAX: 1.8% THD
11:37 PM Aug 04 1999 (Wed)
MIN: 0.9% THD
12:09 PM Aug 04 1999 (Wed)

CURRENT TDD 11:43:29 PM

FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)

Max load current: 28300 mA rms

Phase A:
MAX: 5.0% TDD; 10:42 AM
MIN: 0.0% TDD; 10:32 AM

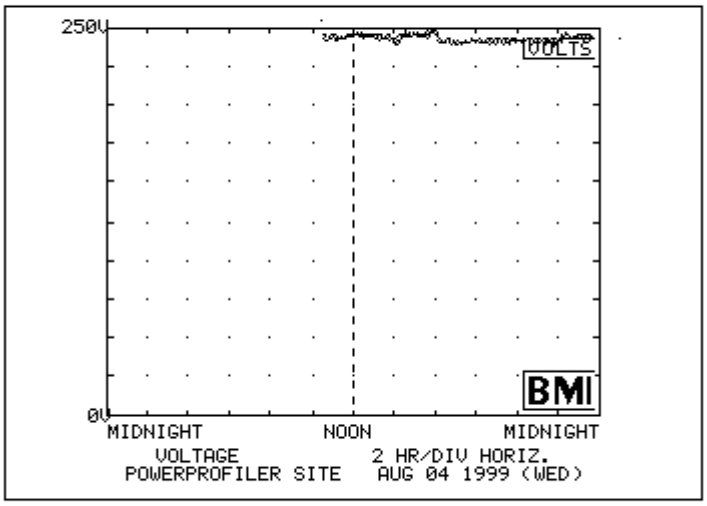


CURRENT TDD (ACCUMULATED):
MAX: 5.0% TDD
10:42 AM Aug 04 1999 (Wed)
MIN: 0.0% TDD
10:32 AM Aug 04 1999 (Wed)

VOLTAGE 11:44:04 PM

FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)

Phase A-N:
MAX: 249.6 V; 4:05 PM
MIN: 238.7 V; 9:43 PM

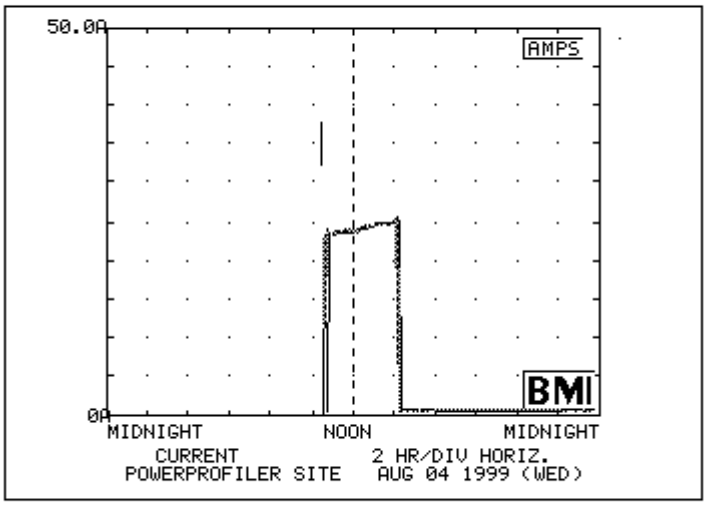


VOLTAGE (ACCUMULATED):
MAX: 249.6 V
4:05 PM Aug 04 1999 (Wed)
MIN: 238.7 V
9:43 PM Aug 04 1999 (Wed)

CURRENT 11:44:15 PM

FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)

Phase A:
MAX: 25.6 A; 2:08 PM
MIN: 0.0 A; 10:32 AM

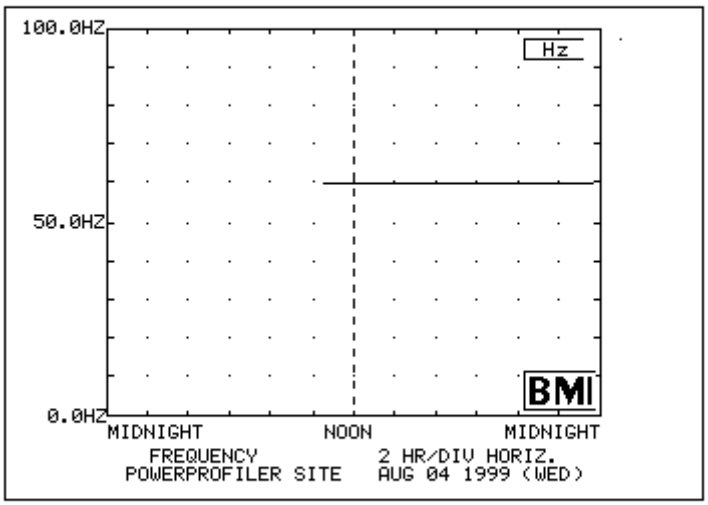


CURRENT (ACCUMULATED):
MAX: 25640.8 mA
2:08 PM Aug 04 1999 (Wed)
MIN: 21.2 mA
10:32 AM Aug 04 1999 (Wed)

FREQUENCY 11:44:34 PM

FROM: MIDNIGHT Aug 03 1999 (Tue)
To: MIDNIGHT Aug 04 1999 (Wed)

MAX: 60.1 Hz; 11:47 AM
MIN: 59.9 Hz; 12:07 PM



FREQUENCY (ACCUMULATED):
MAX: 60.1 Hz
11:47 AM Aug 04 1999 (Wed)
MIN: 59.9 Hz
12:07 PM Aug 04 1999 (Wed)

APPENDIX I

Test Drive Data

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
06/03/1999	24561	001648	UR1	Sanchez	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	45 psi	160				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:45	2125	92%	NA	NA	63	NA	
Stop	1:45	2222	14%	NA	NA	66	NA	**Min. A/C**
Net	4:00	97	78%			3		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.2		
3.9	9.0		
12.9	8.0		
28.9	7.0		
43.4	6.0		
52	5.0		
67.5	4.0		
77	3.0		
86.8	2.0		Light on at 86.8 miles.
95.5	1.0		Light flashing at 91.3 miles
96.8	0.8		

Accessories used: Radio

Drive / Regen setting:

Handling/Braking:

Other comments:

Charger	Serial No.	AC meter#	BMI #
Gen 2	SM 4770p98290058	01 223 620	BMI 002

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp
Start	06/03/1999	2:45	4644	0	NA	NA	
Stop				32	NA	NA	
Net							

Comments: Charger went into standby mode after a few minutes, then restarted.

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
06/08/1999	24561	001648	UR1	Sanchez	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	45 psi	160				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	12:05	2423	96%	NA	NA	70	NA	
Stop	4:24	2520	14%	NA	NA	75	NA	**Min. A/C**
Net	4:19	97	82%			5		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.6		
6.4	9.0		
15	8.0		
24.2	7.0		
44.6	6.0		
52.5	5.0		
66.1	4.0		
77.9	3.0		
86.8	2.0		Light on at 86.8 miles.
96.8	1.0		Light flashing at 94.2 miles

Accessories used: Radio

Drive / Regen setting:

Handling/Braking:

Other comments:

Charger	Serial No.	AC meter#	BMI #
Gen 2	SM 4770p98290058	01 223 620	BMI 002

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp
Start	06/03/1999	NA	NA	NA	NA	NA	NA
Stop							
Net			31.59				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
06/21/1999	24561	001648	UR2	Sanchez	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	45 psi	150 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	1:12	2888	90%	NA	NA	85	68.7	62.5
Stop	4:55	2975	14%	NA	NA	81	68.8	**Min. A/C**
Net	3:43	87						47.5

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.0		
10.6	8.0		
24.1	7.0		
33.1	6.0		
47.9	5.0		
59.6	4.0		
68.6	3.0		
80	2.0		Low charge light on at 80.3 miles.
87.7	1.0		Light flashing at 86.5 miles.

Accessories used: Radio, Air Conditioner, Headlamps.

Drive / Regen setting: EB Mode on.

Handling/Braking: Good handling. Good brakes.

Other comments:

Charger	Serial No.		AC meter#		BMI #		
Gen 2	SM 4770p98290058		01 223 620		1		
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	06/21/1999	16:55	4897	0	NA	NA	
Stop			4934		NA	NA	
Net							

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
06/22/1999	24561	001648	UR2	Sanchez	Perf. Characterization	Gen 2

Road Cond	Tire Press	Payload
Dry	45 psi	150 lbs.

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	1:30	2975	96%	NA	NA	83	68	61.5
Stop	4:50	3060	10%	NA	NA	82	67.5	Min. A/C
Net	3:20	85						51.2

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	9.6		
7.3	9.0		
14.5	8.0		
27.8	7.0		
38.7	6.0		
483	5.0		
38.1	4.0		
67.6	3.0		
77	2.0		Low charge light on at 77.0 miles.
84.6	1.0		Low charge light flashing at 83.1 miles. End drive.

Accessories used: Radio, Air Conditioner, Headlamps.

Drive / Regen setting: EB Mode on.

Handling/Braking: Good handling. Good brakes.

Other comments:

Charger	Serial No.	AC meter#	BMI #
Gen 2	SM 4770p98290058	01 223 620	1

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp
Start	06/22/1999	5:20	4934	NA	NA	NA	87
Stop			4965		NA	NA	
Net							

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
07/08/1999	24561	001648	UR3	Sanchez	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	44 psi	160 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:10	3589	95%	NA	NA	79	NA	
Stop	12:45	3679	14%	NA	NA	78.8	NA	**Min. A/C**
Net	3:35	90	81%					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.5		
4.3	9.0		
12.6	8.0		
27.4	7.0		
40.4	6.0		
48.5	5.0		
60.6	4.0		
69.5	3.0		
80.1	2.0		Low charger light on at 80.1 miles
89.4	1.0		Light foashing at 87.1 miles / End Drive

Accessories used: Radio

Drive / Regen setting:

Handling/Braking: Stiff, poor handling.

Other comments:

Charger	Serial No.		AC meter#		BMI #		
Gen 2			01 457 415				
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	07/08/1999	12:45	10197		NA	NA	
Stop					NA	NA	
Net			29.72				

Comments: Charger stopped restarted at 4:20

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
07/26/1999	24561	001648	UR3	Sanchez	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	44 psi	760				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:45	4132	98%	NA	NA	79	NA	
Stop	14:30	4225	16%	NA	NA		NA	**Min. A/C**
Net	3:45	93	82%					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.8		
6.6	9.0		
14.1	8.0		
28.7	7.0		
41.1	6.0		
49.2	5.0		
63.8	4.0		Euclid to Baseline, to finish final loop.
70.2	3.0		
83.6	2.0		Low charger light on at 83.6 miles
92.4	1.2		Light foashing at 91.8 miles / End Drive

Accessories used: Radio

Drive / Regen setting: EB on

Handling/Braking: poor handling, good brakes - longer stopping.

Other comments: 24.64 MPH average

Charger	Serial No.		AC meter#		BMI #		
Gen 2			01 457 415				
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	07/26/1999	12:45	142	NA	NA	NA	NA
Stop					NA	NA	
Net			35.71				

Comments: Charge timer

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
06/30/1999	24561	001648	UR4	Sanchez	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	45 psi	760 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	12:40	3442	92%	NA	NA	91	76.1	60.1
Stop	15:30	3513	14%	NA	NA	92	64.9	**Min. A/C**
Net	2:50	71						51.6

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.2		
3.1	9.0		
10.3	8.0		
19.7	7.0		
28.7	6.0		
35.1	5.0		
47.4	4.0		
56.7	3.0		Took Mountain to Baseline to finish the loop.
63.7	2.0		Low charge light on at 63.3 miles.
70.9	1.0		Low charge light flashing at 68.2 miles.

Accessories used: Radio, Air Conditioner, Headlamps.

Drive / Regen setting: EB Mode on.

Handling/Braking: Good handling. Good brakes.

Other comments:

Charger	Serial No.		AC meter#		BMI #		
Gen 2	SM 4770p98290058		01 223 620				
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	06/30/1999			0	NA	NA	
Stop					NA	NA	
Net			33.12				

Comments: Fans on at start of drive.

Charge stopped within 45min of start 4.06 kWh in

charge re-started on 7-6-99 29.06 kWh in

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
07/28/1999	24561	001648	UR4	Ruiz	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	44 psi	760 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:05	4304	98%	NA	NA	82.5	79	58.5
Stop	16:20	4382	13%	NA	NA	NA	47.5	**Min. A/C**
Net	3:!5	78	85%					47.5

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.8		
3.4	9.0		
10.4	8.0		
22.4	7.0		
30.7	6.0		
40.6	5.0		Train at 15:01, 46.8 miles.
48.2	4.0		
50	3.0		low charge light on at 66.5 miles.
66.5	2.0		Low charge light started flashing at 69.7 miles.
71.3	1.0		
77.6	0.7		

Accessories used: Radio, lights, and A/C on.
Drive / Regen setting: EB on, also used B for added regen.
Handling/Braking: Good handling, and good braking.
Other comments: Stopped test at 71.0 miles and continued back to EVTC slowly.

Charger	Serial No.	AC meter#	BMI #				
Gen 2	SM4770P98290058	01 457 415					
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	07/28/1999	16:25	NA		NA	NA	
Stop					NA	NA	
Net			31.31				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
06/23/1999	24561	001648	FW1	Sanchez	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	45 psi	150 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:35	3060	92%	NA	NA	85	NA	NA
Stop	15:15	3141	10%	NA	NA	91	NA	**Min. A/C**
Net	3:20	81						NA

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.2		
2.4	9.0		
13.1	8.0		
24	7.0		
33.4	6.0		
45.1	5.0		
55	4.0		
63.5	3.0		Turned back at Diamond Bar Blvd.
73.8	2.0		Low charge light on at 73.8 miles.
81	1.0		Low charge light flashing at 79.7 miles. End drive.

Accessories used: Radio.

Drive / Regen setting: EB Mode on.

Handling/Braking: Good handling. Good brakes.

Other comments:

Charger	Serial No.	AC meter#	BMI #			
Gen 2	SM 4770p98290058	01 223 620	1			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	06/23/1999	5:20	4965	NA	NA	NA	87
Stop			4997		NA	NA	
Net			31.6				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
06/24/1999	24561	001648	FW1	Sanchez	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	45 psi	150 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:25	3141	92%	NA	NA	89	NA	NA
Stop	15:50	3221	14%	NA	NA	93	NA	**Min. A/C**
Net	2:25	80						NA

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.2		
1.5	9.0		
11.5	8.0		
24.5	7.0		
34	6.0		
44.6	5.0		
56	4.0		
64.6	3.0		Turned back at Garey Ave.
72.7	2.0		Low charge light on at 73.2 miles.
80.1	1.0		Low charge light flashing at 80.0 miles. End drive.

Accessories used: Radio.
Drive / Regen setting: EB Mode on.
Handling/Braking: Good handling. Good brakes.
Other comments:

Charger	Serial No.	AC meter#	BMI #			
Gen 2	SM 4770p98290058	01 223 620	1			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	06/24/1999	13:47	4997	NA	NA	NA	87
Stop					NA	NA	
Net			33.48				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
06/25/1999	24561	001648	FW2	Sanchez	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	45 psi	150 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	2:45	3221	95%	NA	NA	86	75.7	62.4
Stop	4:45	3297	14%	NA	NA	92	61.5	**Min. A/C**
Net	2:00	76						51.4

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.5		
5.2	9.0		
16.6	8.0		
25.5	7.0		
35.3	6.0		
44.2	5.0		
53.9	4.0		
62.6	3.0		
69.2	2.0		Low charge light on at 69.2 miles.
75.4	1.0		Low charge light flashing at 74.3 miles. End drive.

Accessories used: Radio, Air Conditioner, Headlamps.

Drive / Regen setting: EB Mode on.

Handling/Braking: Good handling. Good brakes.

Other comments:

Charger	Serial No.		AC meter#		BMI #		
Gen 2	SM 4770p98290058		01 223 620				
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	06/25/1999	13:47	NA	NA	NA	NA	
Stop					NA	NA	
Net			31.48				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
06/28/1999	24561	001648	FW2	Sanchez	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	45 psi	150 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	14:15	3297	90%	NA	NA	88	76	62.6
Stop	16:10	3376	14%	NA	NA	87	69	**Min. A/C**
Net	1:55	79						51.8

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.0		
11	8.0		
22.3	7.0		
32.4	6.0		
43.8	5.0		
54.8	4.0		
66.4	3.0		
73.5	2.0		Low charge light on at 73.5 miles.
79.1	1.2		Low charge light flashing at 78.8 miles. End drive.

Accessories used: Radio, Air Conditioner, Headlamps.
Drive / Regen setting: EB Mode on.
Handling/Braking: Good handling. Good brakes.
Other comments:

Charger	Serial No.		AC meter#		BMI #		
Gen 2	SM 4770p98290058		01 223 620				
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	06/28/1999	21:00	5063	0	NA	NA	
Stop					NA	NA	
Net			31.17				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
07/16/1999	24561	001648	FW3	Ruiz	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	44 psi	760 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:55	3844	95%	NA	NA	75.2		
Stop	10:30	3919	15%	NA	NA	81.7		**Min. A/C**
Net	1:35	75	80%					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.5		
2.9	9.0		
11.5	8.0		
22.7	7.0		
34	6.0		
40.5	5.0		
51.6	4.0		
61.7	3.0		Exit on Towne (fwy)
69.5	2.0		Warning light turned on @ 69.5
75.6	1.0		Light started flashing @ 74.4

Accessories used: Radio.
Drive / Regen setting: EB off,
Handling/Braking: Car dips when braking, long braking distance.
Other comments:

Charger	Serial No.		AC meter#		BMI #		
Gen 2	SM770P9829005B		01 457 415				
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start			10271		NA	NA	
Stop					NA	NA	
Net			31.03				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
07/20/1999	24561	001648	FW3	Ruiz	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	44 psi	760 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:15	3919	90%	NA	NA	75.4		
Stop	10:50	3995	14%	NA	NA	83.1		**Min. A/C**
Net	1:35	76	76%					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.0		
10.1	8.0		
23	7.0		
31.2	6.0		
41	5.0		
48.8	4.0		
57.7	3.0		
65.2	2.0		Warning light turned on @ 69.2
72.8	1.0		Light started flashing @ 71.8

Accessories used: Radio.
Drive / Regen setting: EB off.
Handling/Braking:
Other comments: Car does not beep on reverse, warning light come on sooner than other cars.

Charger	Serial No.		AC meter#		BMI #		
Gen 2	SM770P9829005B		01 457 415				
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	07/20/1999	11:00			NA	NA	83.1
Stop					NA	NA	
Net			32.54				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
08/02/1999	24561	001648	FW3	Ruiz	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	44 psi	760 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:00	4386	100%	NA	NA	75.2	NA	
Stop	10:50	4474	14%	NA	NA	83.7	NA	**Min. A/C**
Net	1:50	88	86%					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10.0		
7.1	9.0		
20	8.0		
30.9	7.0		
39	6.0		
44.9	5.0		
62	4.0		
69.9	3.0		low charge light on at 76.9 miles.
76.9	2.0		Low charge light started flashing at 83.9 miles.
86.6	1.0		
87.6	0.8		

Accessories used: Radio
Drive / Regen setting: EB off on freeway
Handling/Braking: okay
Other comments: car goes back on an uphill, when you stop

Charger	Serial No.		AC meter#		BMI #		
Gen 2	SM4770P98290058		01 457 415				
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	08/02/1999	10pm(timer)	253		NA	NA	83.7
Stop					NA	NA	
Net			31.31				

Comments: reset 8-3-99 at around 8am
Charger stopped at about 20% SOC
observed on maintenance at 12:06 (8-3-99) high ambient temperatures ~ 90 degree F

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
08/04/1999	24561	001648	FW3	Ruiz	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	44 psi	760 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:35	4474	93%	NA	NA	74.3	NA	
Stop	10:20	4549	14%	NA	NA	79.6	NA	**Min. A/C**
Net	3:!5	75	79%					

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	9.3		
1.9	9.0		
11.9	8.0		
22	7.0		
32	6.0		
38.9	5.0		
49.8	4.0		
61.5	3.0		low charge light on at 69.1 miles.
69.1	2.0		Low charge light started flashing at 74.5 miles.
75.4	1.0		
75.5	0.9		

Accessories used: Radio

Drive / Regen setting: EB off on freeway

Handling/Braking: okay

Other comments:

Charger	Serial No.	AC meter#	BMI #				
Gen 2	SM4770P98290058	01 457 415					
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	08/03/1999	10pm(timer)	286		NA	NA	
Stop					NA	NA	
Net			31.31				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
07/07/1999	24561	001648	FW4	Mendoza	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	45 psi	760 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:30	3515	100%	NA	NA	72	79	69
Stop	9:33	3589	12%	NA	NA	80.5	68.4	**Min. A/C**
Net	1:33	76	88%					63.1

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10.0		
5	9.0		
12.5	8.0		
12.3	7.0		
34	6.0		
39.5	5.0		
52.5	4.0		
63	3.0		Charger light @ 63 miles.
71.2	2.0		Mile 69, exit fwy at Holt Ave. (10 fwy)
76.9	1.0		Charger light started flashing @ 76.2 miles

Accessories used: Radio, Air Conditioner, Headlamps.
Drive / Regen setting: EB Mode off, drive.
Handling/Braking: Good handling, good braking.
Other comments:

Charger	Serial No.		AC meter#		BMI #		
Gen 2			02 143 045				
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	07/07/1999	9:37	946	NA	NA	NA	79.3
Stop					NA	NA	
Net			32.57				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project	
07/23/1999	24561	001648	FW4	Mendoza	Perf. Characterization	Gen 2
Road Cond	**Tire Press**	**Payload**				
Dry	45 psi	760 lbs.				

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:50	4057	100%	NA	NA	84	79	66
Stop	11:16	4132	11%	NA	NA	88	71.5	**Min. A/C**
Net	1:26	75	89%					53.2

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0	10.0		
3	9.0		
13.5	8.0		
24	7.0		
33	6.0		
40.5	5.0		Mile 69.3; charger light on.
52	4.0		Mile 73.3; exit fwy @ Towne Ave.
62	3.0		Mile 74.3: charger light flashing (13% soc)
69.3	2.0		Mile 75.5; end of driving.
75.5	1.0		

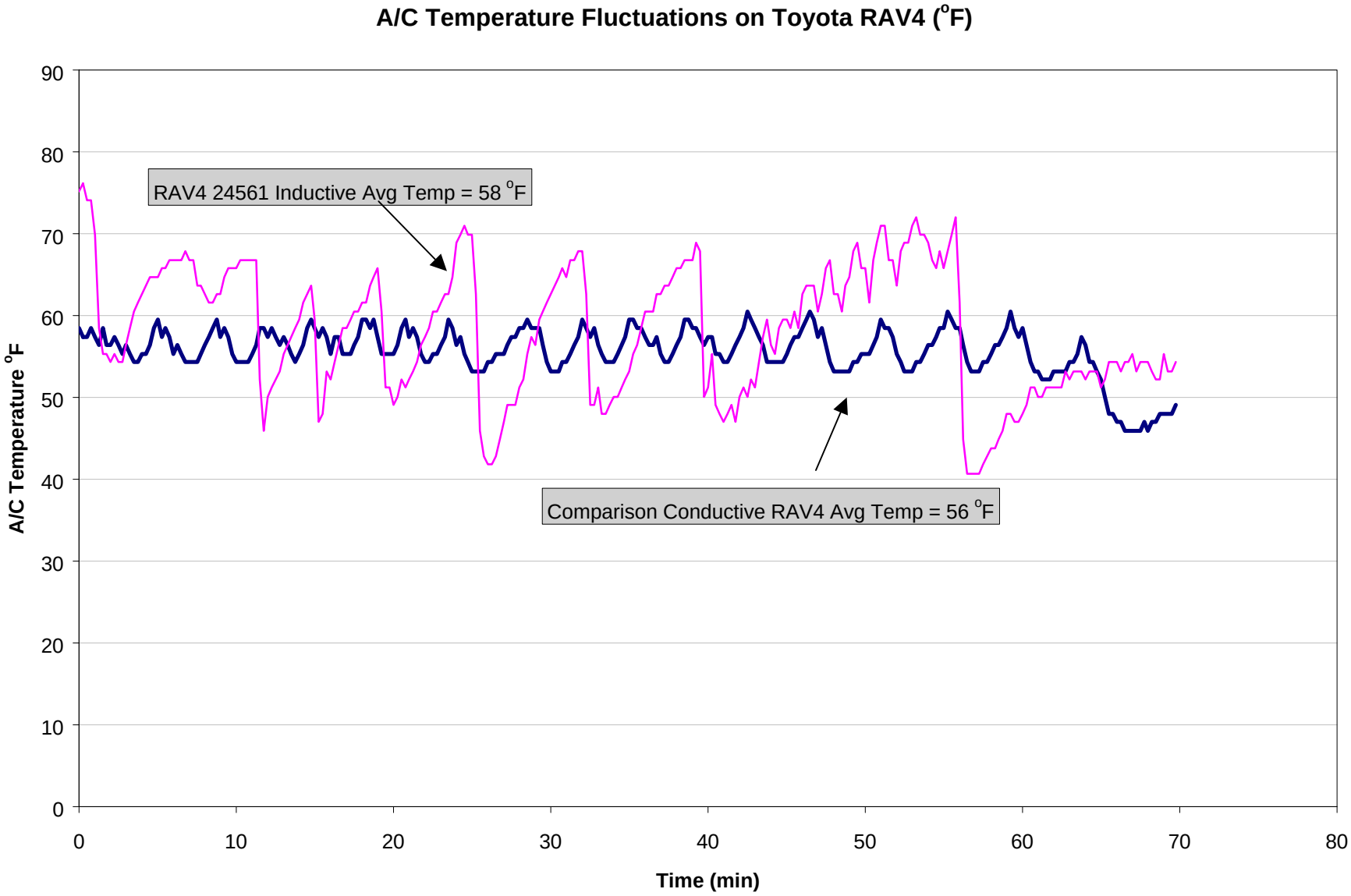
Accessories used: Radio, lights, and A/C on.
Drive / Regen setting: EB off, Drive.
Handling/Braking: Good handling, and good braking.
Other comments:

Charger	Serial No.		AC meter#		BMI #		
Gen 2	SM4770P98290058		01 457 415				
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**
Start	07/23/1999	9:02	107		NA	NA	
Stop					NA	NA	
Net			31.19				

Comments:

APPENDIX J

A/C Temperature Fluctuations


A/C Temperature Fluctuations on Toyota RAV4 (°F)
RAV4 24561 Inductive Avg Temp = 58 °F
Comparison Conductive RAV4 Avg Temp = 56 °F
A/C Temperature °F
Time (min)
0
10
20
30
40
50
60
70
80
90

APPENDIX K

SCE Electric Vehicle Test Procedures

ELECTRIC VEHICLE TEST PROCEDURE

SOUTHERN CALIFORNIA EDISON

An *EDISON INTERNATIONAL* Company

ELECTRIC TRANSPORTATION DIVISION

JUAN C. ARGUETA
NAUM PINSKY
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MICHEL WEHREY

August 1999

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.

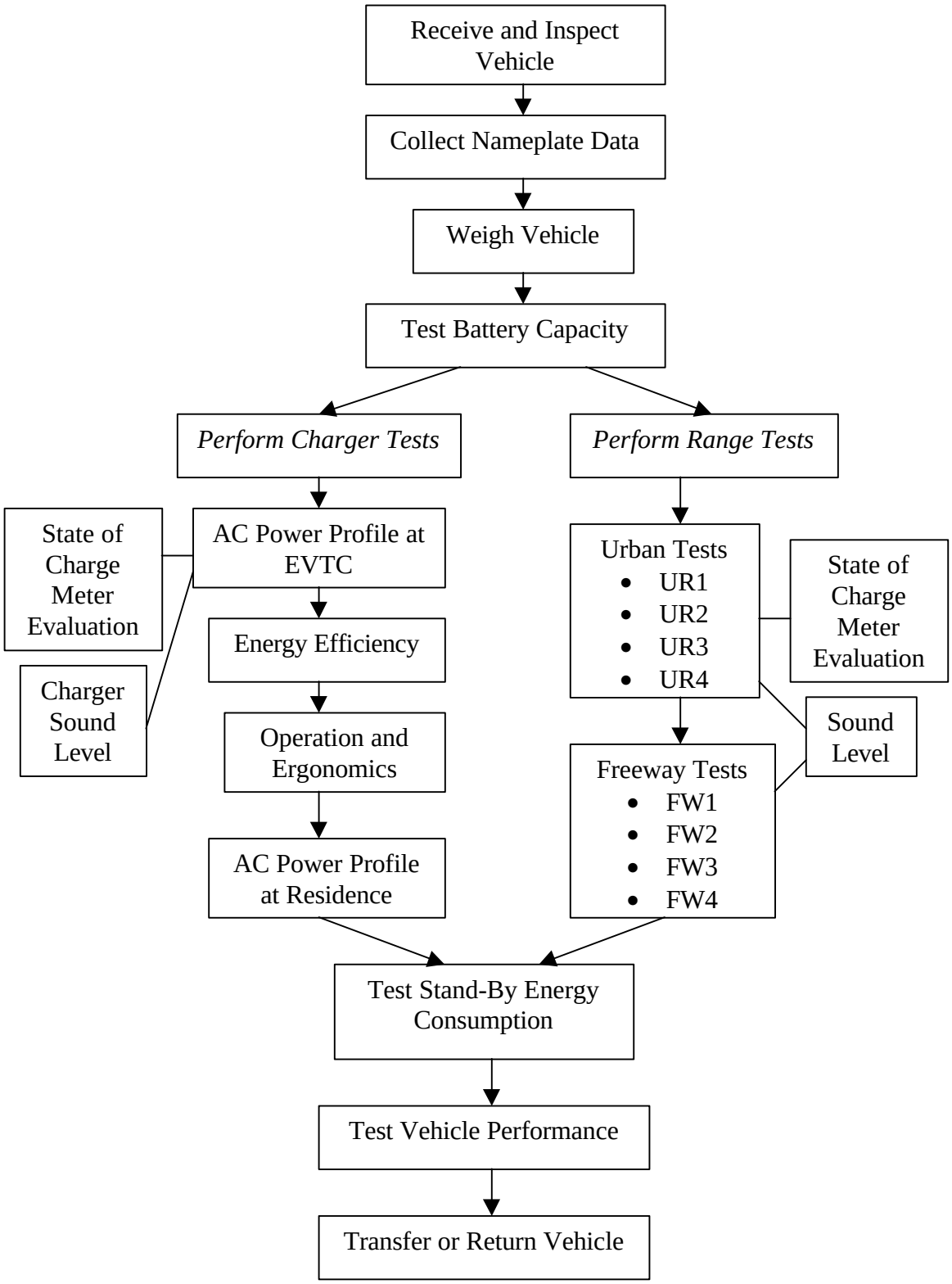
Range tests under different vehicle conditions no longer always have predictable results. Automatic climate controls limit air conditioner power on cool days, thus conserving battery energy and increasing range. The battery pack and the output side of the charger may no longer be readily accessible; 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.20, 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.16, 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 33). 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 35) 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 $23^{o} \pm 2^{o}$ 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. 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.

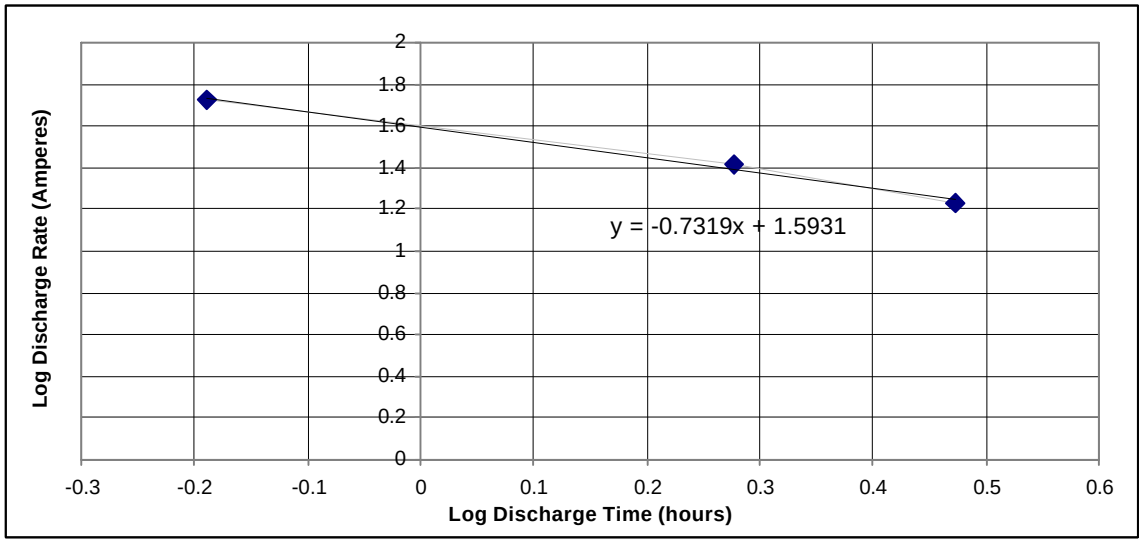


Figure 3-1. Sample Peukert Curve.

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 30). 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.

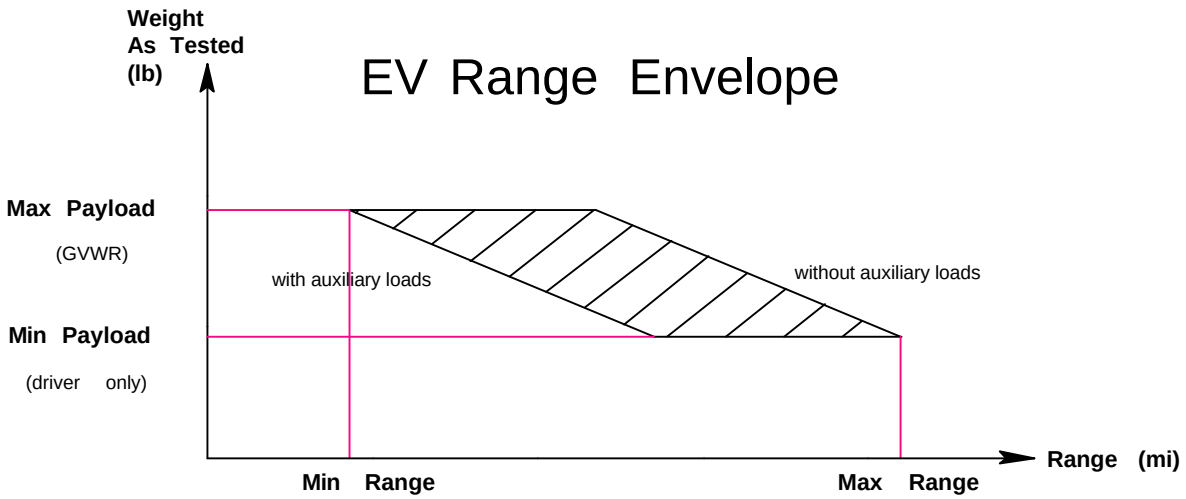


Figure 3-2. Range Envelope.

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 34). 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:

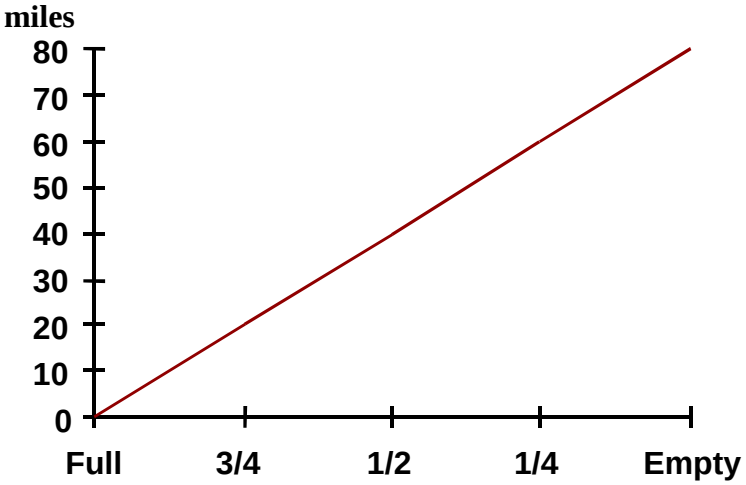


Figure 3-3. State of Charge Meter Evaluation.

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).

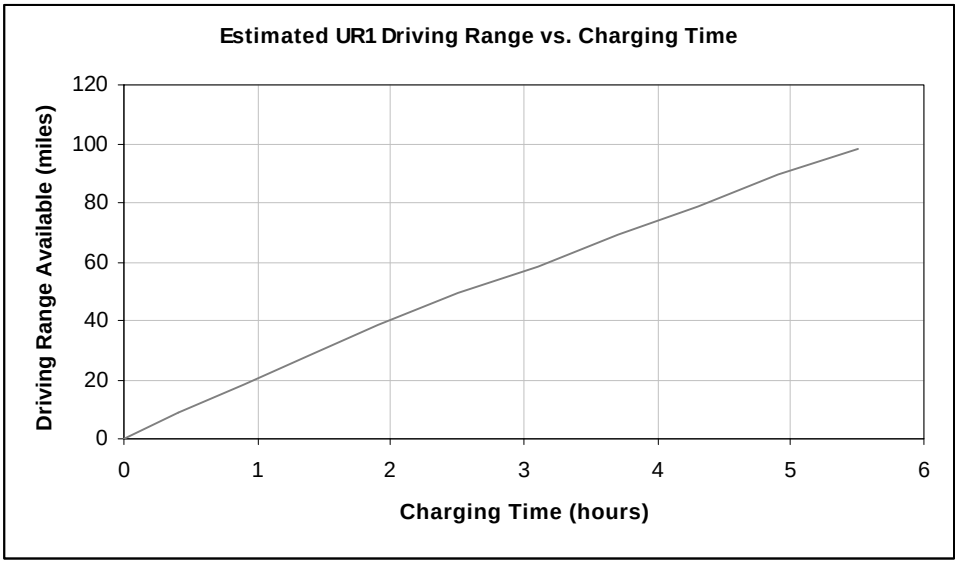


Figure 3-4. Sample plot of estimated range versus charging time.

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 32): 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 31).

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).

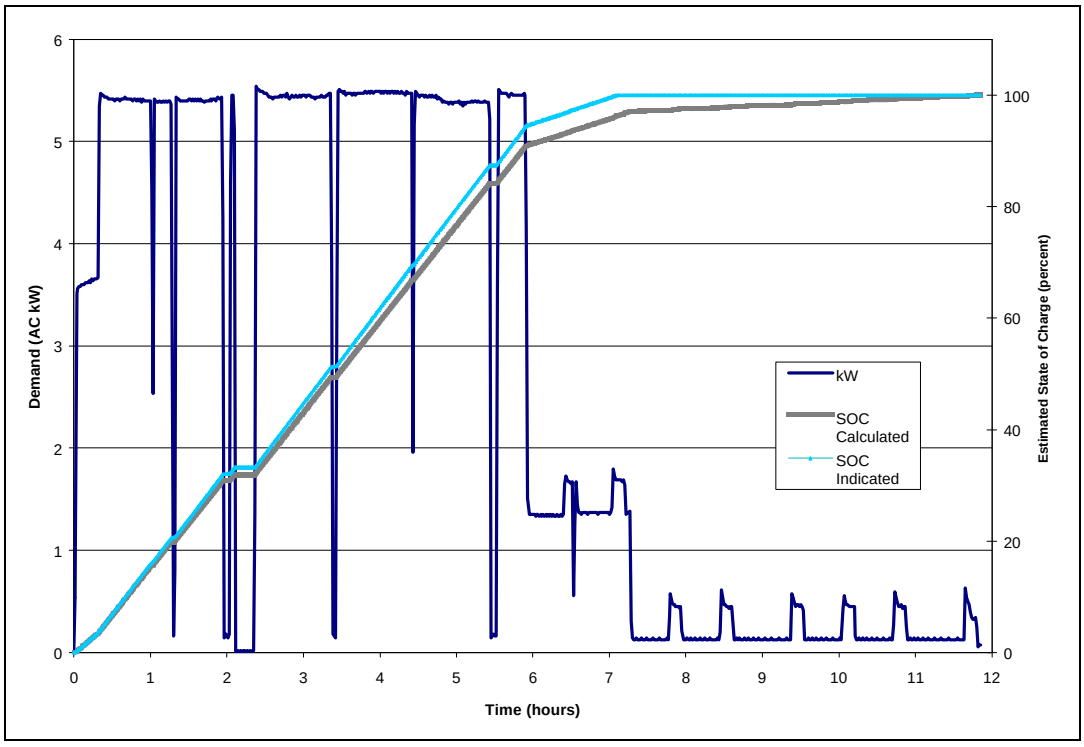


Figure 3-5. Sample AC charging profile plots.

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 27 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 10) to 100% SOC (see page 28 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 15).

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

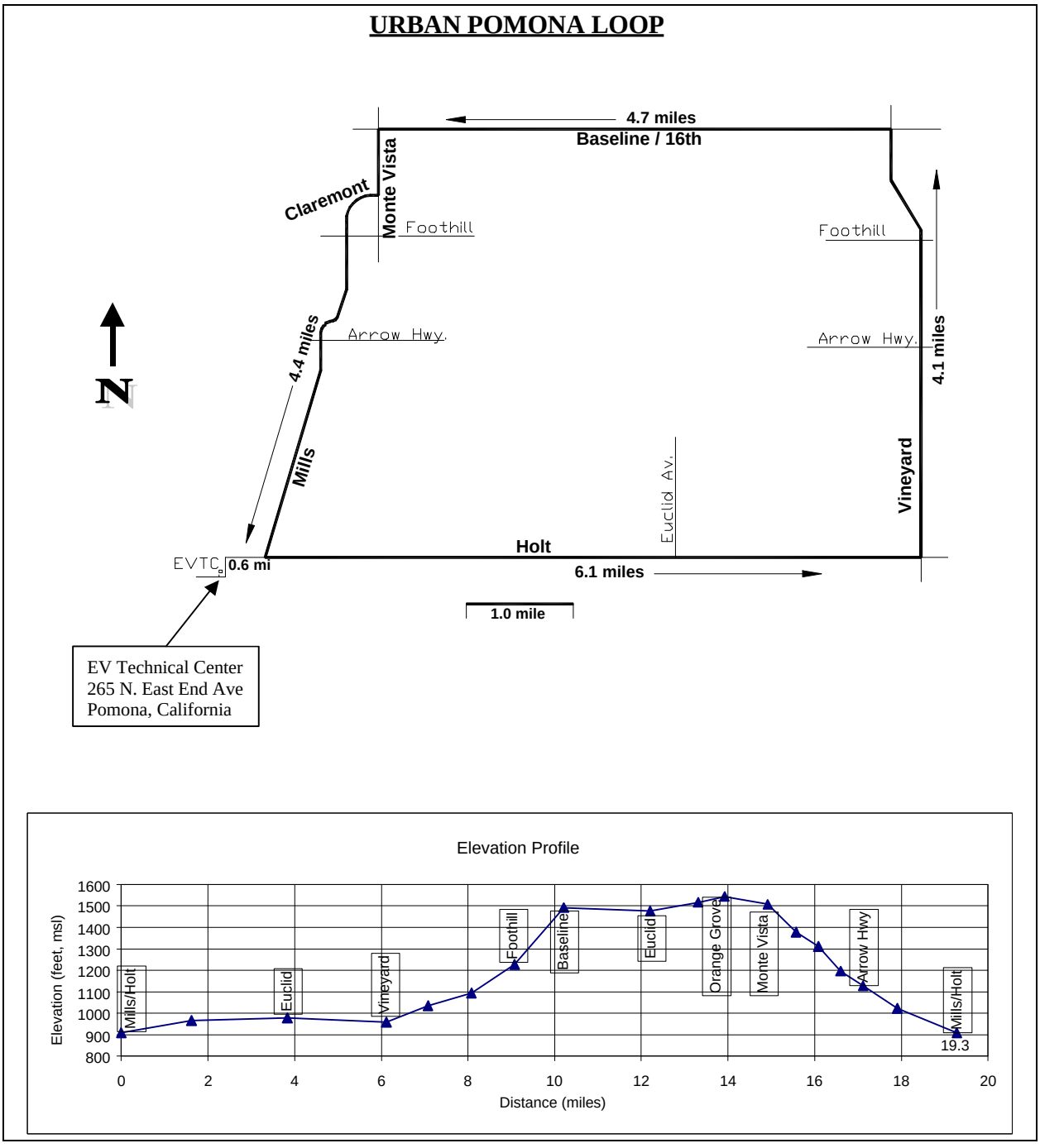
EV Performance Characterization Testing Schedule

		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

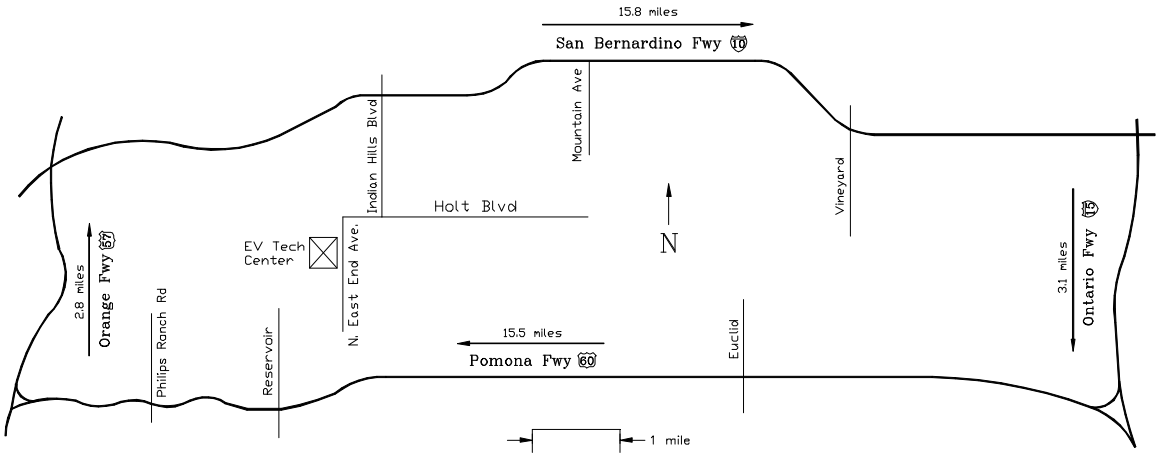
Stop No.	Distance from Start (miles)	Type	Distance from Previous stop	Comments
0	0.00	light	0.00	East End & Holt
1	0.10	light	0.10	
2	0.15	light	0.05	Mills & Holt
3	0.80	light	0.65	
4	1.30	light	0.50	
5	1.80	light	0.50	
6	2.30	light	0.50	
7	2.90	light	0.60	
8	3.50	light	0.60	
9	3.70	light	0.20	
10	4.00	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	

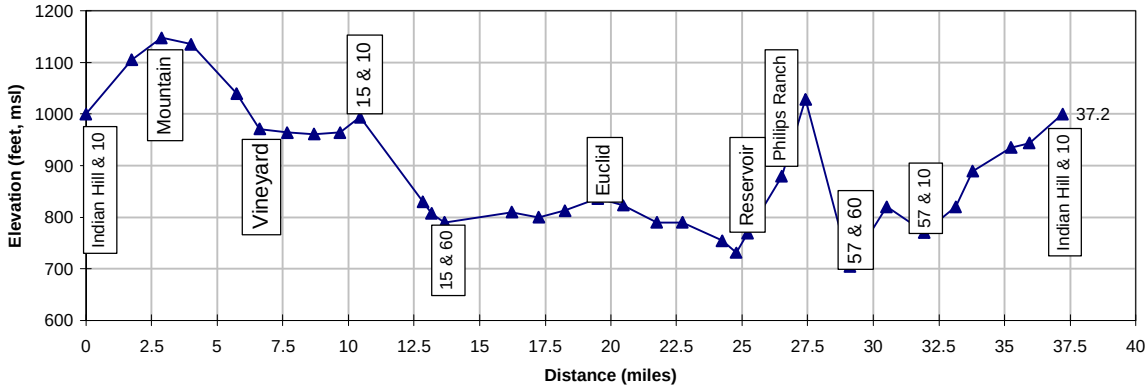
47	17.60	sign	0.20	
48	18.60	light	1.00	
49	18.70	sign	0.10	
50	19.00	sign	0.30	
51	19.30	light	0.30	
52	19.50	light	0.20	Holt & Mills
53	19.60	light	0.10	
54	19.80	light	0.20	Holt & East End

MCW: ttt
9/23/92

Freeway Loop Map

FREEWAY POMONA LOOP





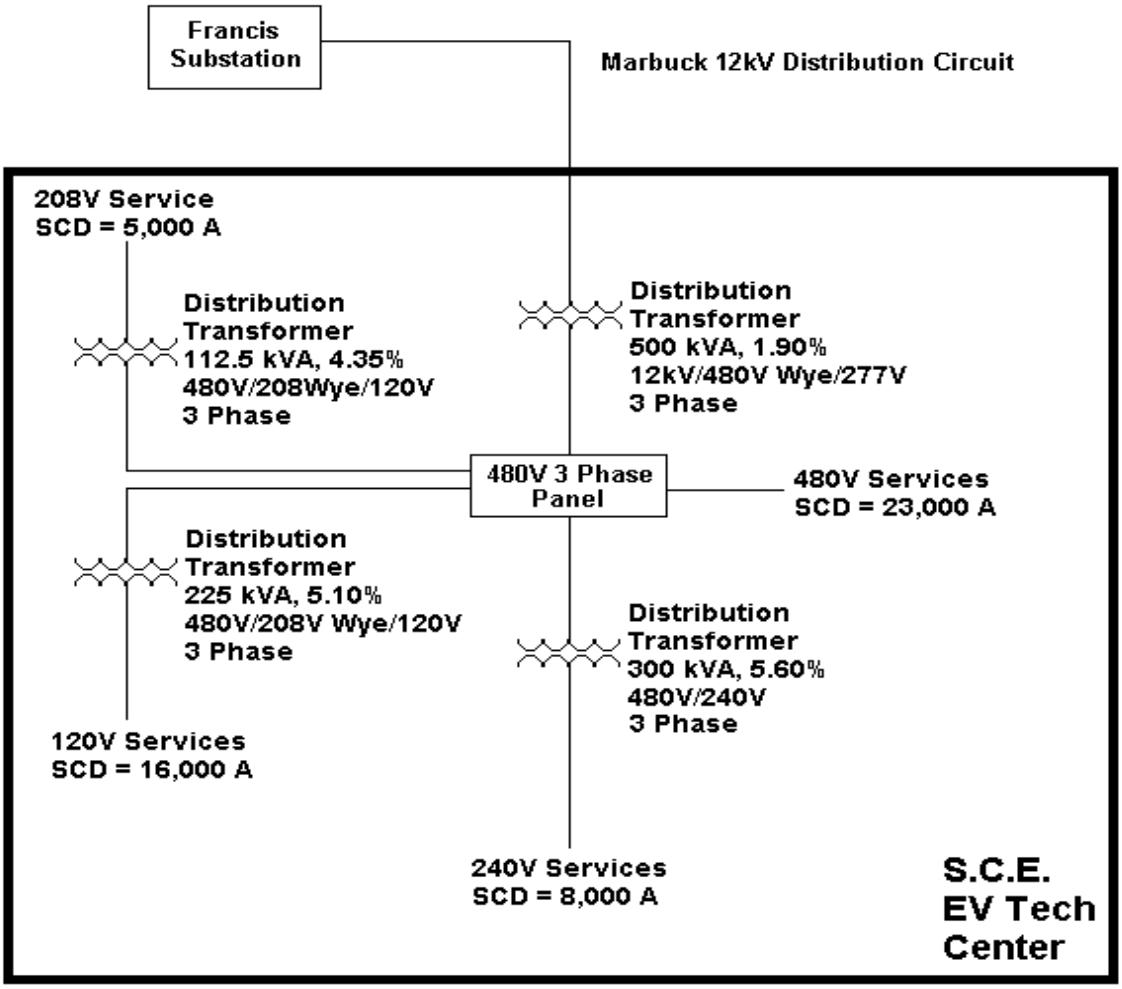
EVTC Equipment

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

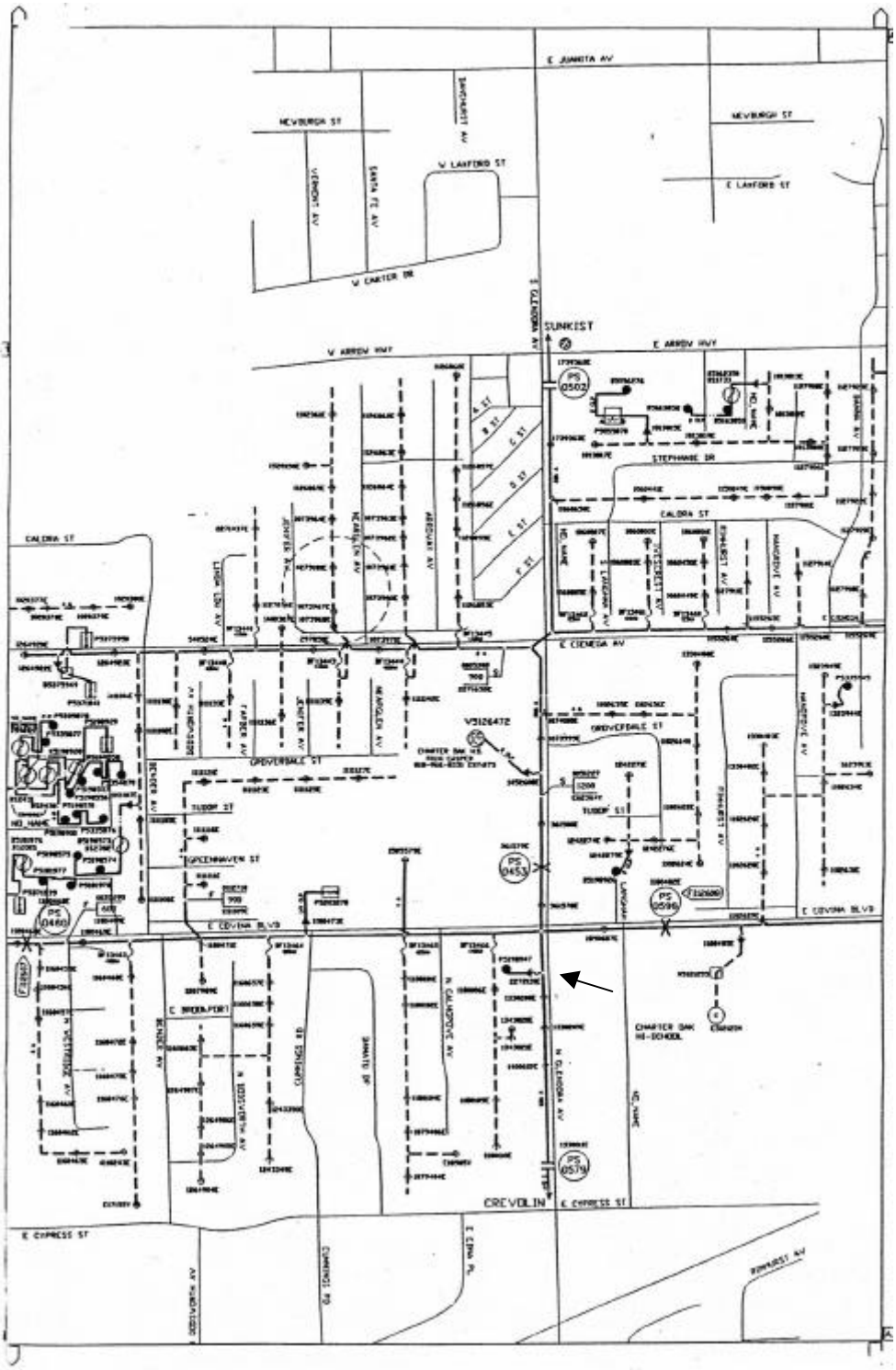
EVTC Number	Manufacturer	Model	Description	Quantity
MCR-001	OLYMPUS	MICRO-32	MICRO CASSETTE RECORDER	1
MMR-001	Various	Various	DIGITAL MULTIMETER	14
MMR-012	HEWLETT PACKARD	34401 A	MULTIMETER	1
MMW-001	ROLATAPE	MEASUMASTERMM30	MEASURING WHEEL	1
MPG-001	HEWLETT PACKARD	6942A	MULTIPROGRAMMER	1
NVK-001	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

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

Braking 25-0 mph, 50% SOC

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

Average ft

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:_____

_____