PERFORMANCE CHARACTERIZATION

CHEVROLET S-10 ELECTRIC

Panasonic Lead Acid Battery

SOUTHERN CALIFORNIA
EDISON

An *EDISON INTERNATIONAL* Company

ELECTRIC TRANSPORTATION DIVISION

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December 1999

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PURPOSE

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

The following facts support this purpose:

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

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I. INTRODUCTION

The tests documented in this report characterize the performance of a 1997 Chevrolet S-10 electric vehicle (SCE vehicle # 23631) equipped with Panasonic valve regulated lead-acid batteries and inductive charging system. The tests performed were: weight certification, battery capacity, range, state of charge meter evaluation, sound level, acceleration, maximum speed, braking, power quality evaluation, and charger performance.

The vehicle used for this performance characterization was originally equipped with a Delphi lead-acid battery pack. Testing was performed at the Electric Vehicle Technical Center (EV Tech Center), on the Urban and Freeway Pomona Loops, and the Pomona Raceway. For detailed procedures used for the testing, please refer to the SCE Electric Vehicle Test Procedure in Appendix K, page 74.

II. MANUFACTURERER'S SPECIFICATIONS

Vehicle Make:	Chevrolet
Model:	S-10 Electric / Lead Acid
Range:	City: 40 miles; Highway: 45 miles (w/original Delphi batt.)
Maximum Speed:	70 mph (governed)
Motor Type:	AC Induction, liquid cooled
System Power:	85 kW (114 hp)
Transaxle:	Single speed, front wheel drive
Traction Battery	
Type:	Lead Acid
Manufacturer:	Panasonic
Model:	EC-EV1260
Capacity:	60 Ah at C/3 rate
Number of Modules:	26
Nominal Pack Voltage:	312 V
Battery Pack Weight:	Approx. 1204 lb
Dimensions	
Length:	188.3 in.
Width:	67.9 in.
Height:	63.8 in.
Wheelbase:	108.3 in.
Curb Weight:	4300 lb
GVWR:	5150 lb
Payload:	850 lb

III. RESULTS

A. Nameplate Data Collection

Please Refer to Appendix C on page 29, for the vehicle test Equipment List and Nameplate Data sheet, which records all applicable nameplate data, serial numbers, and ratings for all tested components.

B. Weight Certification

Table 3-1. Weight Certification

	Front Axle	Rear Axle	Total Weight
GVWR (lb)	2700	2900	5150
Curb Weight (lb)	2090 [1]	2210 [1]	4300
Available Payload (lb)	610	690	**850** [2]

[1] Front and rear weights are not certified.
[2] This value also corresponds to the specified payload on vehicle door sticker.

C. Battery Capacity Test

Discharge

Discharge rate:	20.0 A (C/3)
Discharge time:	2 hours 59 minutes
kWh out:	16.86 kWh DC
Amp-hour out:	58.84 Ah
Manufacturer's rating:	60 Ah at C/3
Difference:	-1.93%

Recharge

Charging time:	5 hours 16 minutes
AC input:	27.22 kWh
Charger DC output:	19.87 kWh
	58.58 Ah
System efficiency:	73.0%

D. Range Tests

D1. Urban Range Tests

Table 3-2. Urban Range Test Results*

Tests	UR1	UR2	UR3	UR4
Range at Stop Condition (mi.)	49.9	40.8	41.6	36.4
Total Miles Driven	50.7	41.4	42.1	37.1
Driving Conditions				
Payload (lb)	180	180	850	850
Average Amb. Temp. ^{o} F	85	90	95	78
Average Speed (mph)	34.0	24.6	24.1	24.7
Recharge				
AC kWh Recharge	24.99	23.43	23.34	22.06
AC kWh/mi.	0.493	0.566	0.554	0.595

*Average of two tests.

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

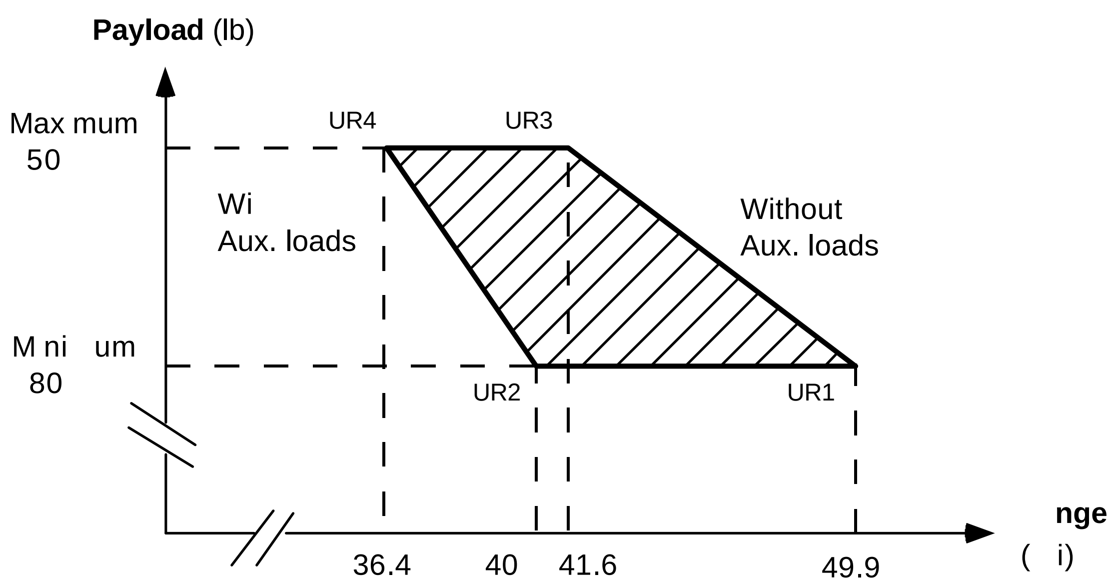


Figure 3-1. 1999 RAV4 EV Urban Range Envelope

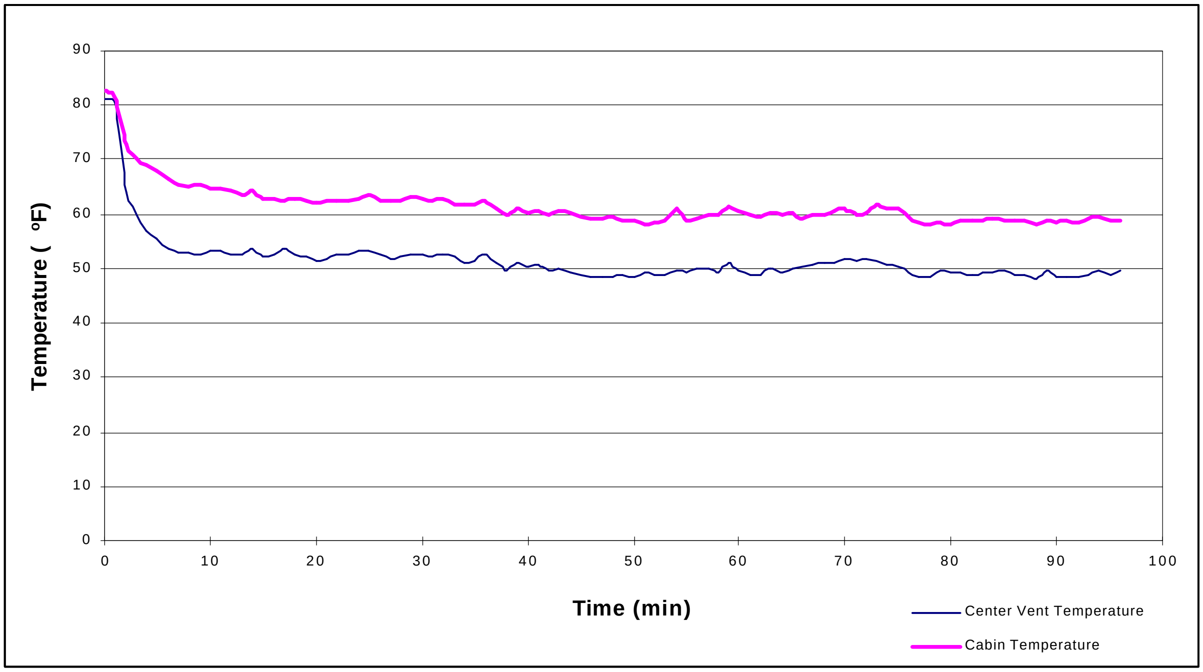


Figure 3-2. Cabin and center vent temperature recorded with A/C on during a UR4 test.

Note: Average ambient temperature during test was 79.2^o F.

D2. Freeway Range Tests

Table 3-3. Freeway Range Test Results*

Tests	FW1	FW2	FW3	FW4
Range at Stop Condition (mi.)	57.2	48.1	51.1	42.6
Total Miles Driven	57.6	48.8	51.4	43.2
Driving Conditions				
Payload (lb)	180	180	850	850
Average Amb. Temp. ^{o} F	83	102	98	87
Average Speed (mph)	36.8	45.0	42.0	38.7
Recharge				
AC kWh Recharge	23.51	24.82	23.51	22.73
AC kWh/mi.	0.408	0.509	0.457	0.526

*Average of two tests.

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

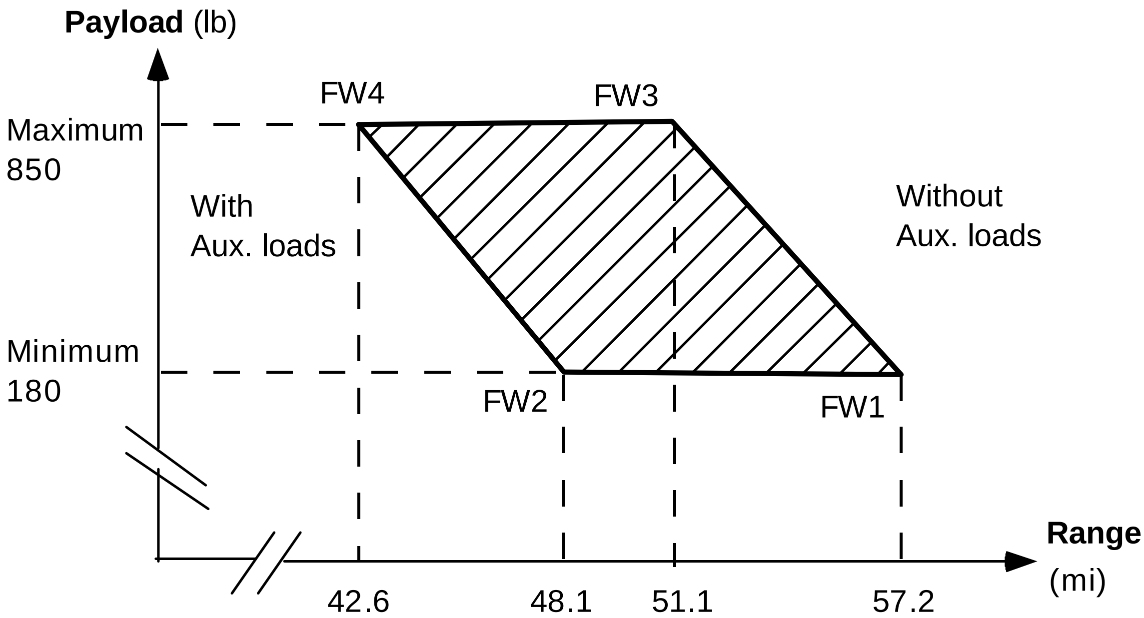


Figure 3-3. Freeway Range Envelope

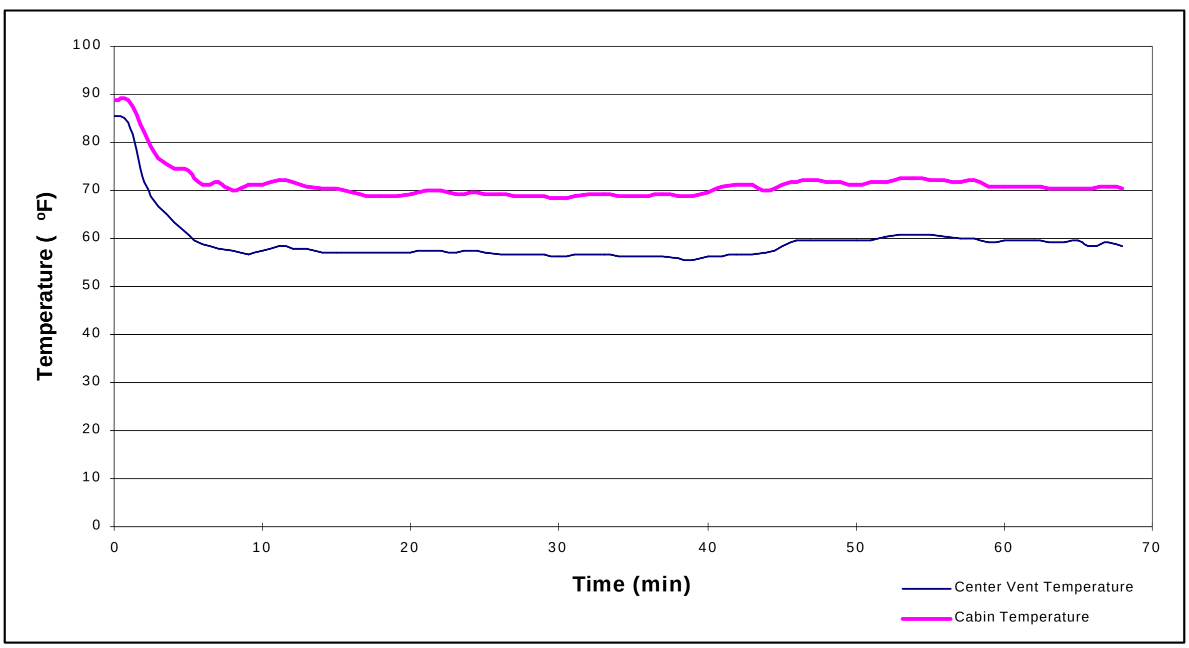


Figure 3-4. Cabin and center vent temperature recorded with A/C on during a FW4 test.

Note: Average ambient temperature during test was 79.2^{o} F.

E. State of Charge (SOC) Meter Evaluation

Note: The SOC referred to in the following results and discussions corresponds to the amount of charge available to the user. This user SOC ranges from 0% to 100% and correlates roughly to 9% to 100% of the pack's actual SOC.

E1. Driving State of Charge (SOC) Meter Evaluation

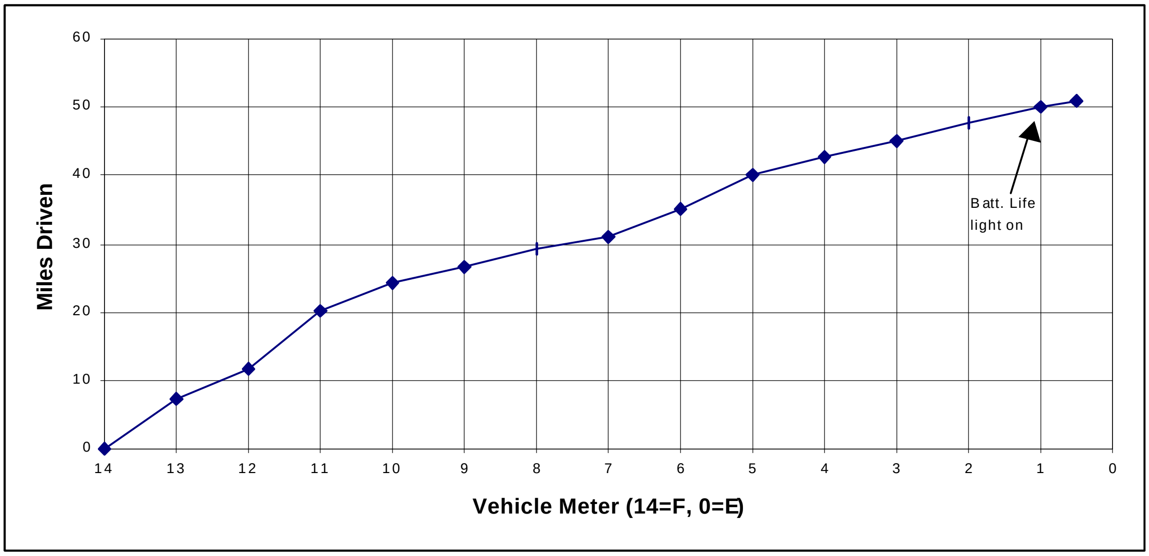


Figure 3-5. State of charge meter readings as a function of miles driven. Meter numbers are shown in Figure 3-6 below.

Figure 3-6. 1997 S-10 EV State-of-Charge gage

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

E2. Charging State of Charge Meter Evaluation

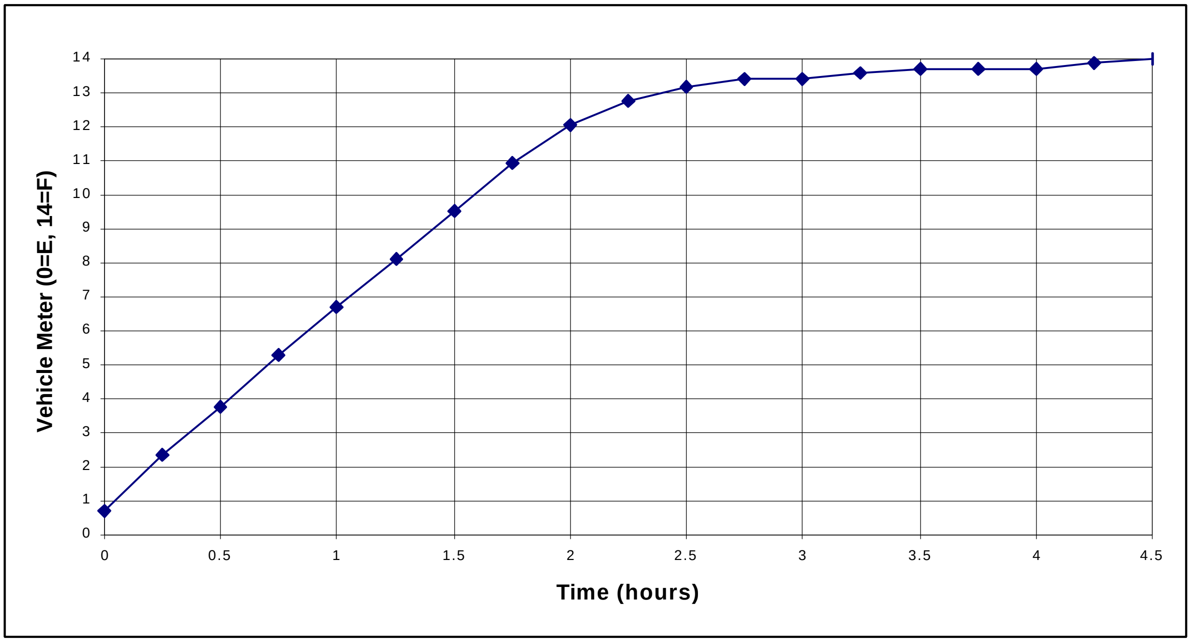


Figure 3-7. SOC meter readings at 15-minute intervals while the vehicle was recharging.

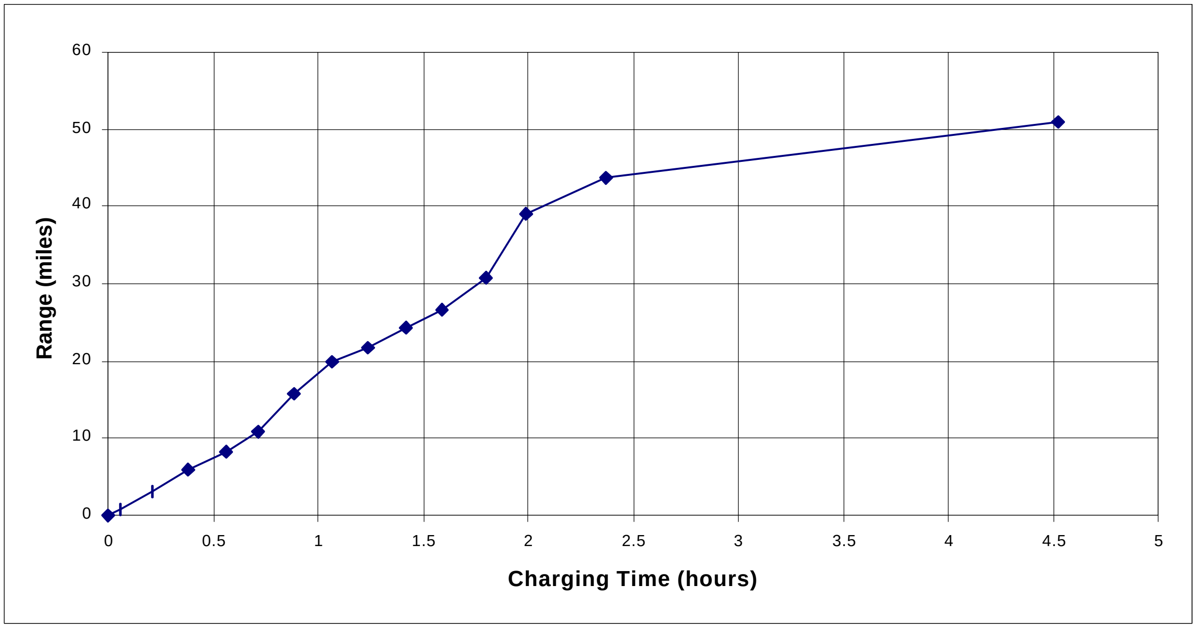


Figure 3-8. Driving range per charging time, UR1.

Note: This figure was calculated using results from the driving and charging SOC meter evaluation.

F. Acceleration, Braking and Maximum Speed Tests

Table 3-4. Acceleration, Braking, and Maximum Speed Summary of Results[1]

User State of Charge	100% SOC	80% SOC	60% SOC	40% SOC	20% SOC
0 to 30 mph (sec.)	4.35	4.35	4.42	4.54	4.56
30 to 55 mph (sec.)	7.92	8.14	8.39	8.94	10.04
0 to 60 mph (sec.)	12.84	12.66	13.21	14.36	14.80
Max Speed (mph)	70.5	*	*	*	71.0
Braking (25-0 mph) (ft.)	*	*	39.41	*	*

[1]Average values (average ambient temperature: 67^{0} F). (180 lb Payload)
* Not tested

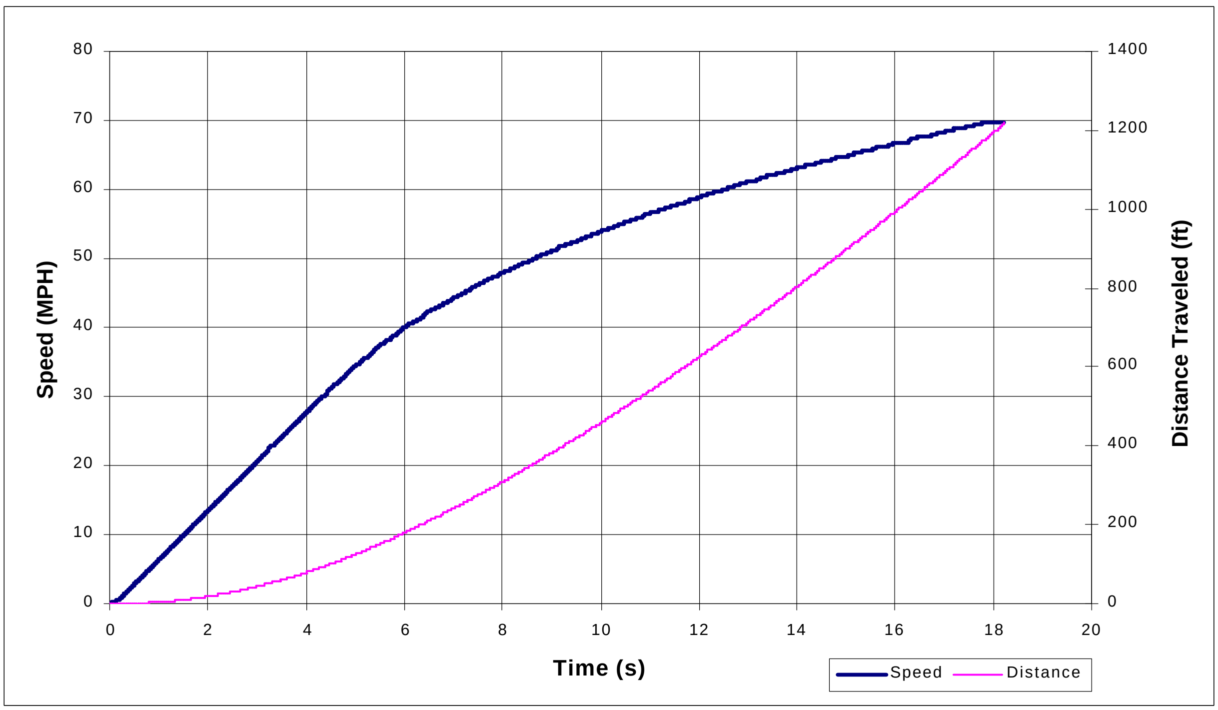


Figure 3-9. S-10 Electric performance testing plot at 100% SOC.

Note: Performance testing was performed with a Vericom VC2000PC computer, except acceleration tests from 30 to 55 mph, which were done with a stopwatch.

G. Charger Performance / Profile Test

G1. Charger Performance / Profile Test at EV Tech Center

Table 3-5. Charger Profile Data

Measured Value[1]	
Voltage	228.7 Vrms
Current	31.05 Arms
Real Power	7.048 kW
Reactive Power	788.1 VAR
Apparent Power	7.102 kVA
Total Power Factor	0.99 PF
Displacement Power Factor	0.99 dPF
Voltage THD	2.20%
Current THD	4.10%
Current TDD	4.10%

Total Charging Time	4 hours, 36 minutes
Total Energy Consumption	23.58 AC kWh

Time Observed on Stand-by	24 hours
Energy Consumption	0.532 kWh
Average Power	22.17 W

Note: Refer to Appendix H page 56, for BMI Power Profiler graphical data

Data was recorded after the first UR2 test at a starting ambient temperature of 84.5^{o} F.

[1] Values recorded with charger at maximum power on the AC (input) side of the charger (240 V). Maximum recorded instantaneous real power was 7.048 kW

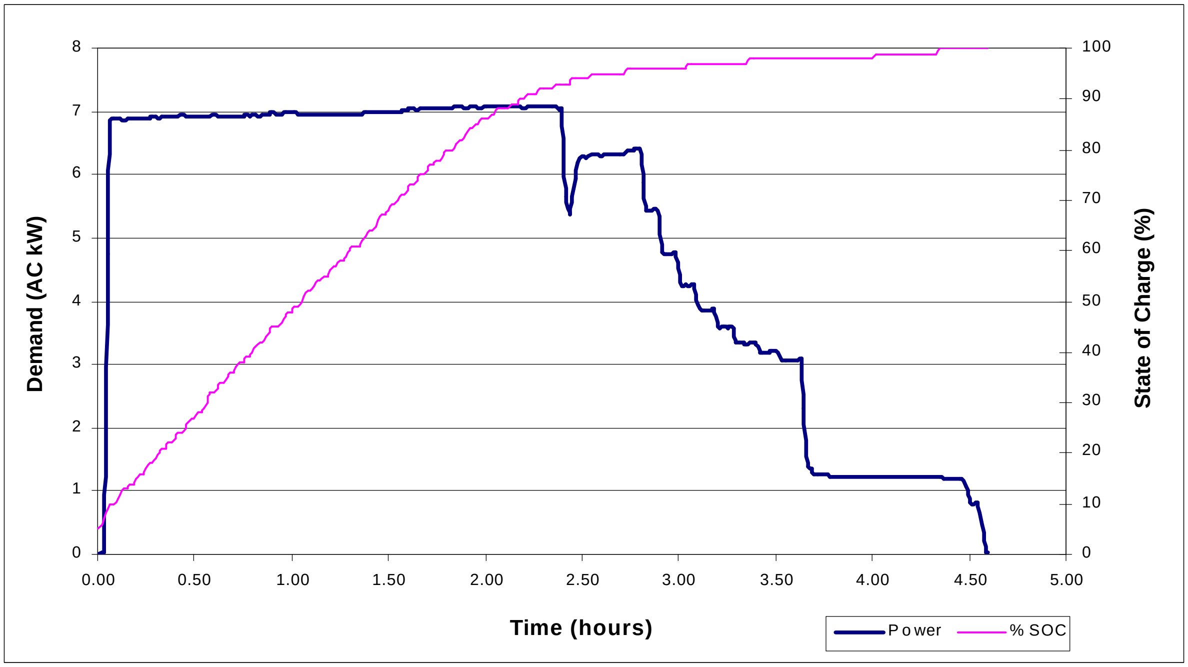


Figure 3-10. S-10 Electric AC charging profile from ABB meter (second UR3 test).

G2. Charger Performance at Residence

Table 3-6. Charger Profile Data – Residential.

Measured Value[1]	1999 RAV4 EV
Voltage	228.6 Vrms
Current	30.79 Arms
Real Power[2]	6.986 kW
Reactive Power	462.2 VAR
Apparent Power	760.8 kVA
Total Power Factor	0.99 PF
Displacement Power	0.99 dPF
Voltage THD	2.0%
Current TDD	4.1%

Total Charging Time	4 hours, 50 minutes
Total Energy Consumption	23.26 AC kWh

Note: Refer to Appendix I, page 64, for BMI Power Profiler graphical data.

[1] Values recorded with charger at maximum power on the AC (input) side of the charger (240 V).

H. Sound Level Tests

H1. Urban Sound Level Test

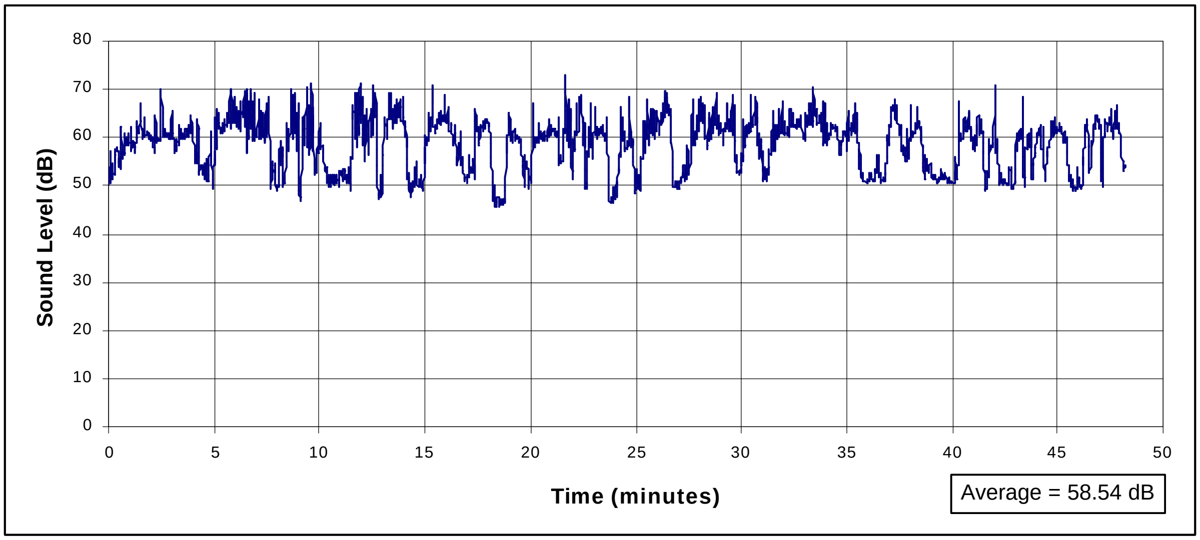


Figure 3-11. Sound intensity in dB recorded during a driving test on the Urban Pomona Loop.

H2. Freeway Sound Level Test

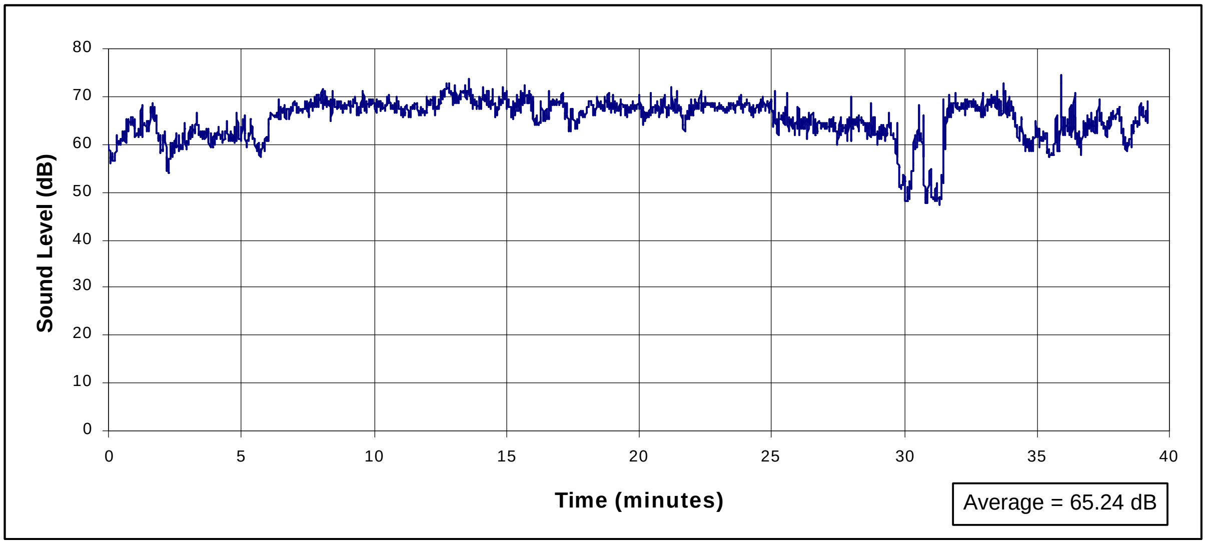


Figure 3-12. Sound intensity in dB recorded during a driving test on the Freeway Loop.

H3. Recharge Sound Level Test

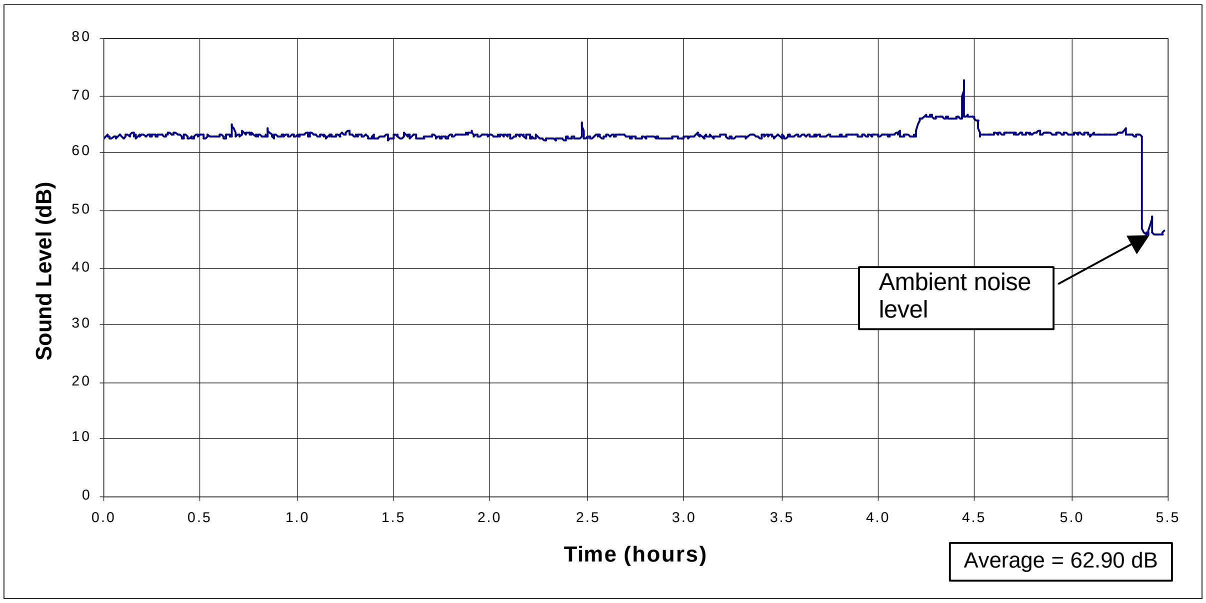


Figure 3-13. Sound intensity in dB recorded during a recharge test.

IV. DISCUSSION

A. Weight Certification

The S-10 Electric was taken to a certified scale to measure front axle, rear axle, and total weight. The measured total curb weight was 4300 pounds, while the total manufacturer's gross vehicle rating (GVWR) was 5150 pounds. The GVWR minus the total curb weight yielded a payload of 850 pounds, which was the same as that stated by the manufacturer. This was the weight used to perform range tests at maximum payload. As seen from Table 3-1, on page 3, the available front axle payload was 610 pounds, and an available rear axle payload of 690 pounds. To load the vehicle to its maximum legal payload (850 pounds), the load was distributed among the S-10's cabin and bed. This distribution of weight allowed the vehicle to have load on both the front and rear axles. The S-10 cabin was loaded with 300 pounds, including driver, meanwhile its bed was loaded with 550 pounds. Figures 4-1 and 4-2 below show the weight added to the vehicle's cabin and bed.

Figure 4-1. S-10 cabin loaded with 120 lb (not including driver.)

Figure 4-2. S-10 bed loaded with 550 lb.

B. Battery Capacity Test

The battery pack of the S-10 Electric consists of 26 Panasonic valve regulated lead-acid 12-V batteries. These batteries are rated at a normal capacity of 60 Ah, and a specific energy of 35 Wh/kg.

To meet SCE test procedure standards (see Appendix K, page 74), the capacity test was done at a C/3 discharge rate. Therefore, a 20 A discharge was applied to the battery pack. Ideally, at this discharge rate, and considering the manufacturer's rating of 60 Ah, a complete capacity test would take three hours. As seen from the results section on page 3, the capacity took 2 hours and 59 minutes to complete. The results obtained from this capacity test indicate that the pack was in good condition.

The discharge was stopped when the battery pack control module (BPCM) opened the pack disconnect. At the start of the test, the pack voltage was 346 V, and at the end of the test, it was 286 V, 11 V per module.

C. Range Tests

To perform range tests on the S-10 Electric, the driving was done in a manner that was safe and compatible with the flow of traffic at or below the posted speed limits. As the Electric Vehicle Test Procedure indicates, the range tests were repeated until the range result was within 5.0% of the previous result. To accomplish this, it was only necessary to perform twice each of the eight different range tests, except the UR2 and UR4 tests which had to be done three times. However, the average of only the closest two values was reported in Tables 3-2 and 3-3 on pages 4 and 5 respectively.

To be consistent with all range tests, the end of the range tests was determined when the vehicle's SOC meter reached the middle of the red area and the battery life light in the instrument panel illuminated. Upon returning to the EV Tech Center for battery recharging, the percent SOC displayed on the charger was 5% on average. Acceleration and braking of these vehicles seemed responsive at all times. The S-10 never had trouble keeping up with the flow of traffic during the range tests. However, acceleration was slower when the range tests were conducted at maximum payload, as would be expected.

C1. Urban Range Tests

To test the S-10 Electric in a city driving environment, it was driven on the Urban Pomona Loop to its maximum range as defined above (see Appendix J, page 72, for a map of the Urban Pomona Loop). The maximum speed of the S-10 Electric varied between 30 and 50 mph according to street posted speed limits. The vehicle was driven and charged only once per day, and at least two loops were completed for each of the four urban drive scenarios, except in the case of the UR4 tests. During the UR4 range tests, the energy of the vehicles was not enough to complete two loops. Therefore, one complete loop was accomplished during this range test, and driving continued until the SOC dropped to the desired level.

As seen from the range envelope (Figure 3-1, page 4), variations in payload and auxiliary loads (air conditioning and headlights) clearly affected the range of the S-10 Electric. The highest range obtained from urban driving (49.9 miles) is from the average of range tests conducted at minimum payload and no auxiliary loads. Auxiliary loads usage with the vehicle unloaded (driver only) reduced the range by 18.24%. Maximum payload reduced the range by 16.23%. The combined load reduced the range by 27.05%.

Energy consumption was similar for most of the recharging cycles since the end of test condition was always the same (middle of the red area). The average energy supplied during charging after urban range testing was 23.46 AC kWh.

Air conditioning temperatures were measured from the A/C outlet air from the center cabin vent. The biggest temperature decrease observed during most drives occurred within the first 15 minutes of driving. It was also observed that during hot days, as in the case of the third UR2 test, the air conditioning works harder and makes more noise. The UR2 range tests averaged a minimum of 51.2 ^{o}F, while the average minimum during the UR4 tests was 45.9 ^{o}F.

During the second UR4 test, a thermocouple temperature logger was used 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. As seen from Figure 3-2, page 5, the cabin and center cabin vent temperatures reached stability 10 minutes into the test, and continued dropping slightly until the end of the test. The thermocouple temperature logger was set to take readings every minute, and it recorded an average temperature of 51.6 °F at the center cabin vent, and 61.6 °F at mid-cabin chest level.

C2. Freeway Range Test

Traffic conditions were good for all range tests, and the speed was kept as close to 65 mph as traffic would allow. The recorded range included urban driving of approximately 4 miles to access the freeway and ½ mile each loop to transition between freeways (see Appendix J, page 72, for a map of the Freeway Pomona Loop).

As with the urban range tests, variations in payload and auxiliary loads played a major role in the range obtained. The highest range obtained from freeway driving (57.2 miles) was from the range tests at minimum payload and without auxiliary loads (average of FW1 tests). This range also represents the highest obtained from all of the eight range tests scenarios.

Results from indicate that auxiliary loads usage with the vehicle unloaded (driver only) reduced the range by 15.9%. Maximum payload reduced the range by 10.7%. When the vehicle was driven with both auxiliary loads and maximum payload, the range decreased by 25.5%.

Energy consumption after freeway range testing was also similar for most of the tests. The average energy supplied was 23.64 AC kWh. As seen from Tables 3-2 and 3-3, pages 4 and 5 respectively, the energy supplied to the vehicle during recharge shows that the S-10 consumes similar energy under different driving conditions.

Air conditioner temperature as measured with a thermometer averaged a minimum of 61.3 °F during the FW2 tests, while the average minimum during the FW4 tests was 52.2 °F. The plot of the temperatures recorded with the thermocouple temperature logger is shown on Figure 3-4, page 6. Unlike the urban range tests, the temperatures recorded during a FW4 test, show no constant decrease, instead, the temperatures staid relatively constant and increased slightly towards the end of the test. However, the smallest drop was observed during the first 10 minutes as in the case of the UR4 test. The average temperature recorded with the thermocouple temperature logger at the center cabin vent was 59.1 °F, and at mid-cabin chest level, the average was 71.2 °F.

D. State of Charge Meter Evaluation

The SOC meter (Figure 3-6, page 7) is located on the right hand side of the instrument panel. This meter gives an estimate of the traction battery's state of charge whenever the vehicle is on. A traction battery voltmeter is also included on the right hand side of the SOC meter, as shown in Figure 4-3 below. It gives an approximation of the actual voltage of the traction battery.

As in the 1998 S-10 Electric model, the SOC meter consists of seven major lines with half lines in between. The SOC meter contains a red zone at the left end occupying the area from "E" (Empty) to the first major line. For practical convenience, Figure 3-6 was marked with numbers starting from 0 at E, and ending with 14 at "F" (Full). A warning light supplements the gauge when the SOC indicator drops to the middle of the red area. This point represents 5% user SOC as indicated by the charger display.

D1. Driving

The SOC indicator rotates in a counterclockwise direction during driving. The driving distance was recorded using the odometer at intervals corresponding to the S-10 SOC meter levels. Figure 3-5, page 7, can be useful in estimating the distance the vehicle can travel at particular SOC meter levels with a consistent driving style.

Figure 4-3. 1997 S-10 EV instrument panel.

D2. Charging

As shown in Figure 3-7 on page 8, the SOC meter suggests that during the first two hours of charging, the charger provided the vehicle wit ha relatively constant peak power charge. The power was then gradually reduced over the next 2.5 hours. A charging profile of this type is typical of lead-acid batteries, see Figure 3-10, page 11.

E. Acceleration, Braking, and Maximum Speed Tests

Performance testing of the S-10 Electric took place at the Pomona Race Track. A recently acquired performance-testing computer was used for the vehicle acceleration and braking tests. The VC2000PC, by Vericom Computers, Inc., uses an accelerometer to determine acceleration, speed, and distance 100 times per second. The sophisticated computer is also able to calculate the power developed at the wheels. The average of two runs was used for each of the acceleration tests performed. The average of the two runs takes slope and head wind into account when each test is done in opposite directions.
The vehicle responded very reliably to acceleration tests, and no noticeable drop in power was observed as the state of charge decreased. However, acceleration times on Table 3-4, page 9, show a slight increment on each acceleration test at lower SOC. The only problem observed on the S-10 occurred at take off with full throttle as some torque steer was induced by the vehicle's front-wheel drive system.
The average acceleration time was only 4.44 seconds from 0 to 30 mph, and 13.57 seconds from 30 to 60 mph. From 30 to 55 mph, acceleration took 8.69 seconds. These results show that it takes about double the time to accelerate from 30 to 55 mph than what it takes to accelerate form 0 to 30 mph.
Maximum speed tests were conducted at 100% and 20% SOC. At 100% SOC, the vehicle accelerated to 70.5 mph, and at 20% SOC, it accelerated to 71.0 mph.
These results suggest that the performance of the vehicle is not significantly affected by a drop in SOC as long as the SOC is within the manufacturer's recommended operating range. It is important to note that the maximum speed recorded was limited by the available length of the test track, which was 0.6 miles.

Braking distance tests were also conducted with the VC2000PC performance-testing computer from 25 to 0 mph. Eight runs were done for the braking distance test, four in each direction. The average braking distance was 39.41 feet with no skidding noticed. Turning radius was also tested and the average of two measurements was 42.68 feet.

F. Charger Performance / Profile Test

Charging of the S-10 Electric was done with a standard off-board 6.6 kW Magne Charge Inductive charger, see Figure 4-4 below. Charging from 5% to 100% SOC took from 4.5 to 5 hours on most of the recharging cycles. However, charging would occasionally continue on low power for more than 2 hours as in the case of the 1^{st} FW1 and 1^{st} UR4 tests. On these two tests, charging time could be affected by the vehicle's thermal control system, which monitors the temperature of the batteries to provide cooling to the battery pack. The SOC of the vehicle during the charging profile test was obtained from the charger display at intervals of 5 minutes.

Figure 4-4. Charger testing with off-board 6.6 kW inductive charger.

F1. Charger Performance at the EV Tech Center

As shown in Table 3-5, page 10, the instantaneous peak power recorded using the BMI Power Profiler was 7.048 kW, with a current of 31.05 A rms, and a voltage of 228.7 V rms. Both the power and displacement power factors were 0.99. The voltage total harmonic distortion (THD) was 2.20%, the current total harmonic distortion (THD) was 4.10%, and the current total demand distortion (TDD) was 4.10%. Charging of the S-10 during this particular test took 4 hours and 36 minutes from 5% to 100% user SOC and consumed 23.58 AC kWh. The vehicle was monitored for a period of 24 hours after reaching full charge. During this 24-hour period, the vehicle consumed an average 22.17 W and 0.532 kWh.

Figure 4-5. BMI Power Profiler.

F2. Charger Performance Test at Residence

The same Magne Charge inductive charger unit was used to perform the residential charging test. The vehicle was discharged to the same level as done for the range tests in order to collect full charge data using the BMI power profiler. The results obtained from this test are very similar to those obtained at the EV Tech Center. As shown in Table 3-6 on page 11, the peak power was 6.986 kW, 0.26 kW below the EV Tech Center readings. The measurements also indicate that the current was 30.79 A rms, and the voltage was 228.6 V rms. The power factor was 0.99, and the displacement power factor was also 0.99. The voltage total harmonic distortion (THD) was 2.0%, and the current total demand distortion (TDD) was 4.1%. The total energy consumption was only 0.32 kWh lower than at the EV Tech Center (23.58 kWh), and the time required to completely charge was 4 hours and 50 minutes. All values obtained are well within the limits set by the Infrastructure Working Council (IWC), and the Institute of Electrical and Electronics Engineering (IEEE) 519-1992 standard (Refer to the EV test Procedures for these values).

G. Sound Level Tests

Sound level tests were conducted using a sound level meter set at a frequency range of 20Hz to 8 kHz. The measuring level was adjusted to measure sound intensity from 30 dB to 130 dB, and the sampling rate was two seconds. The sound level meter was mounted on a tripod, as seen in Figure 4-6, page 23, and placed on the vehicle's passenger seat near the center at chest level.

As indicated by Figures 3-11, 3-12, and 3-13, pages 12-13, sound level variation during the urban test was broader than that from the freeway test. The average sound level recorded during the urban sound level test was 58.54 dB, while the average sound level recorded during freeway testing was 65.24 dB.

Sound level was also recorded during a recharge full recharge. Figure 3-13, page 13, shows that the noise emitted from both the charger and the vehicle during recharge stays relatively constant until the end of charge. The sound level recorded during any of the three sound level tests does not necessarily represent the noise emitted solely form the vehicle. Although the vehicle's windows were closed throughout the range tests, and the vehicle was placed in a well-isolated room with good noise insulation during recharge, ambient noise was also picked up by the sound level meter.

Figure 4-6. Sound level meter test setup.

Sound levels were higher during freeway tests since at higher speeds the vehicle's wind noise level is higher. For this reason, the plot of the freeway-driving test (Figure 3-11) shows a more consistent, but higher on average, noise level as compared to the urban test.

APPENDIX A

VEHICLE MANUFACTURER'S FACT SHEET

Technical Specifications — S 10 Regular-Cab Short-Box Electric Pickup

Dimensions (in.)

Exterior:
Wheelbase — 108.3
Length — 188.7
Width, w/o mirrors — 67.9
Height, overall — 63.8
Overhang, front — 34.8
Overhang, rear — 45.9
Cab to axle — 37.4
Ground to top of load floor — 28.5
Ground clearance, min. — 7.5

Cargo Area:
Cargo-box length — 71.7
Cargo-box width, max. — 56.6
Cargo-box width at wheelhousings — 40.3
Cargo-box height — 17.1

Interior:
Head room, front — 39.5
Leg room, front — 42.4
Shoulder room, front — 57.2
Hip room, front — 52.0

Capacities (lbs.)
GAWR, front — 2,700
GAWR, rear — 2,900
GVWR — 5,150
Base curb weight — 4,300
Payload, max. — 850

Tires / Wheels
Tires — standard, front and rear — P205/75R15
Wheels — standard, front and rear — 15 x 7 steel
Spare tire — none

Motor Specifications
Description — 85 kW, (114 HP) three-phase, liquid-cooled AC induction motor
Acceleration (0-50 mph) — 13.5 seconds

Primary Charger Specifications
Location — off-board of vehicle
Type — Hughes Inductive 6.6kW
Input voltages — 156 to 260 VAC
Time to charge — (optimal) 2.5 hrs. at 70° F from 15% to 95% state of charge

Suspension / Steering
Type, front — independent, SLA w/torsion bar
Shock dia., front (mm) — 32
Type, rear — 2-stage leaf
Shock dia., rear (mm) — 32
Steering type — power, electro-hydraulic
Steering ratio — 17:1
Turning diameter, curb-to-curb (ft.) — 37.3

Battery Specifications
Manufacturer — Delphi Propulsion Systems
Type — lead acid
No. of modules — 26 propulsion, 1 auxiliary
Weight of propulsion battery pack — 1,400 lbs. (approx.)
Pack location — under body
Nominal module voltage — 12V
Nominal system voltage — 312V
Kilowatt hours for propulsion — 16.2kW
Driving range — 45.0 miles (highway)
Driving range — 40.0 miles (city)
Constant-speed range — 60 miles (@ 45 mph)

Interested?

Fleet operators who wish to place minimum 10-unit orders for the 1997 Chevrolet S 10 Electric Pickup, or who'd like to have additional information on this revolutionary new truck's capabilities, features and availability, can contact :

Chevrolet Customer Assistance Center
1-800-222-1020

MAGNE CHARGE charger distributors:

Edison EV, Inc.
515 S. Figueroa St. Suite 950
Los Angeles, CA 90071
Phone: (213) 452-4600
Fax: (213) 452-4699
State of CA

TravElectric Services, Corp.
800 Boylston Street
Boston, MA 02199
Phone: (617) 424-2493
States of: CT, MA, ME, NH, NJ, NY, PA, RI, VT

Virginia Power
Electric Transportation
P.O. Box 26666
Richmond, VA 23261
Phone: (800) 836-0131
Fax: (804) 771-3365
States of: DE, FL, GA, MD, NC, SC, TN, VA, WV, D.C.

MAGNE CHARGE™

Produced for
Chevrolet Motor Division 7/96

Note: The vehicle used for performance characterization is equipped with a lead-acid Panasonic battery pack..

APPENDIX B

BATTERY MANUFACTURER'S FACT SHEET

Panasonic

Valve Regulated Lead-Acid Battery for Electric Vehicles
EV用鉛電池

Valve Regulated Lead-Acid Batteries for Electric Vehicles provide the high power in the wide temperature range. The long cycle life and high power batteries offer approximately 1,000 charge/discharge cycles.

Matsushita Battery Industrial Co.,Ltd. has developed 3 types of vaive regulated lead-Acid batteries suitble for various applications such as small size electric cars, small size electric motor care, electric scooters and for cycle use.

**広い温度範囲で高出力を発揮、
また約1000回の充・放電が行える
長寿命高出力鉛電池**

松下電池工業は小型乗用車EV、小型電動車、電気スクータ用途ならびにサイクルユース用途に適した3タイプの鉛電池を開発しています。

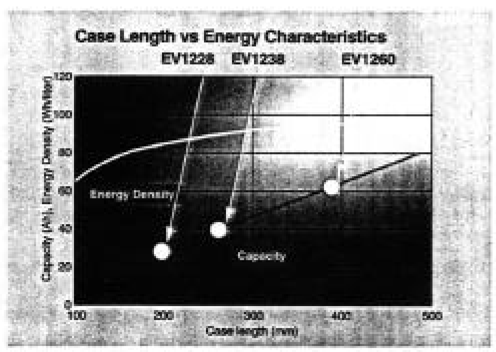
EC-EV1260 EC-EV1238 EC-EV1228

Principal specification 主要諸元

Type 形式	EC-EV1260	EC-EV1238	EC-EV1228
Nominal Voltage 公称電圧	12V	12V	12V
Nominal Capacity 公称容量	60Ah	38Ah	28Ah
Dimension(mm) 外形寸法	H175 × W116 × L388	H175 × W116 × L261	H175 × W116 × L200
Weight 重量	21kg	14kg	10kg
1/3C_3 Capacity 1/3C_3 容量	62Ah	40Ah	29Ah
1C_3 Capacity 1C_3 容量	57Ah	35Ah	26Ah
Specific Energy 重量エネルギー密度	35Wh/kg	34Wh/kg	34Wh/kg
Energy Density 体積エネルギー密度	94Wh/liter	91Wh/liter	86Wh/liter
Power 出力	4.4kW;DOD80%	2.9kW;DOD80%	2.1kW;DOD80%

The height and width of EV 1228 and EV 1238 are the same as thouse of EV 1260 (JEVA/SAE standard size) and the length of the batteries is varied to adjust the capacity of respective batteries.
All of the three models have achieved the high energy density because of their compact design.

EV1228とEV1238はEV1260(JEVA/SAE 標準サイズ)と高さ、幅を共通にし、長さを変えて容量を調整しています。
3タイプとも体積効率の良いコンパクト設計で高エネルギー密度を達成しました。



Note: The battery pack of the S-10 Electric is composed of 26 Panasonic lead-acid battery Modules (model # EC-EV1260)

Panasonic

Valve Regulated Lead-Acid Battery for Electric Vehicles
EV用鉛電池

Valve Regulated Lead-Acid Batteries for Electric Vehicles with high performance and high quality.

Matsushita Battery Industrial Co.,Ltd. has invented various energy utilization methods to address the energy conservation issue and environmental issues in the next generation, promoting our policy "Coexistence with the Global Environment".

EVs have attracted a public attention as one of the advanced transportation methods with low exhaust gases and low noise pollution, since their power sources come from an electricity of diverse energy sources. EVs are now entering the stage of commercialization.

Making best use of all of our battery technologies, we have developed high performancs Lead-Acid Batteries with excellent safaty and high reliability for EV applications. Now we offer out batteries to all the users around the world.

高性能・高品質のEV用鉛電池

松下電池工業は、次世代のエネルギー問題、環境問題に対応するさまざまなエネルギー活用方法を創識し、「地球環境との共存」を推進しています。多様なエネルギー源による電気を動力源とし、排気ガスや騒音の少ない次世代の交通手段として注目されてきた電気自動車（EV）はいよいよ実用化の時代を迎えようとしています。松下電池工業は総合技術を結集し、本格的EV用電池として、優れた安全性と信頼性を兼ね備えた高性能鉛電池を全世界のユーザーに提供します。

Characteristics 特徴

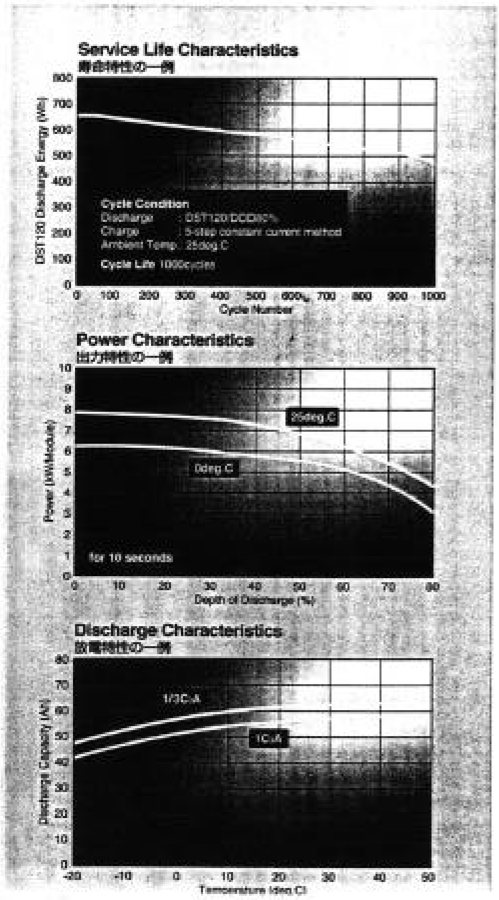
- **Approximately 1,000 charge/discharge cycles are possible:**
  Since battery replacement is rarely necessary, its cost performance is remarkable.
- 約1000回の充・放電が可能
  電池交換の必要性が殆ど不要で、コストパフォーマンスに優れます。

- **High power at the end of discharge:**
  Comfortable EV driving is ensured, since excellent performance of acceleration and hill climbing ability are maintained at the end of discharge.
- 放電末期まで高出力を発揮
  最後まで優れた加速性、登坂性を維持し、EVの快適走行を実現します。

- **High power in the wide temperature range:**
  The battery provides excellent discharge characteristics in the wide temperature range between low temperature and high temperature.
- 広い温度範囲で使用可能
  低温から高温まで優れた放電特性を発揮します。

- **Excellent safety and high reliability:**
  This is a maintenance-free battery. We have tested the battery under various working conditions and then improved it to ensure excellent safety.
- 安全性に優れた高信頼性
  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たメンテナンスフリータイプです。

- **Recyclable materials:**
  Since the battery materials are recyclable, we can make effective use of precious global resources.
- リサイクルが可能



APPENDIX C

EQUIPMENT LIST AND NAMEPLATE DATA

VEHICLE TEST EQUIPMENT AND NAMEPLATE DATA SHEET

Project: E V Field Operations Program
Test: Performance Characterization
Date(s): 9/27/99 - 11/24/99
File Name(s): PM 97-S10-LeadAcid
Vehicle #: 23631
Technician: Alvaro Mendoza

VEHICLE

Manufacturer: General Motors
VIN: 1GCDE14H6V8197578
Model: S-10 Electric
Model Year: 1997
Date of Manufacture: Jun-97
GVWR: 5150 lb
Front AWR: 2700 lb
Rear AWR: 2900 lb
Motor Manufacturer: GM
Type: 3-phase, AC induction, liq. cooled
Motor Rating/Speed: 85 kW (114 hp)
Version/Serial No.: H
EPA Label Fuel Economy: NA
Controller Version/Serial No.: Delco Electronics / System 110
Battery Pack Type/Version/Serial No.: Panasonic Valve regulated lead-acid / EC-EV1260
Tire Manufacturer: Uniroyal
Model: Tiger Paw
Tire Size: P205/75/R15
Maximum Pressure: 51 PSI
Maximum Tire Load: 1598 lb
Treadwear Rating: 480

CHARGER

Off-board
Manufacturer: Delco Electronics
Model: Magne Charge
Serial Number: EVC-10
Charger Type/Version: Inductive / WM200
EVSE Manufacturer: NA
EVSE Model/Version: NA
Serial Number: NA
EVSE Software Version: NA
Charge Port Manufacturer/Model/Version/SN: NA

TEST EQUIPMENT

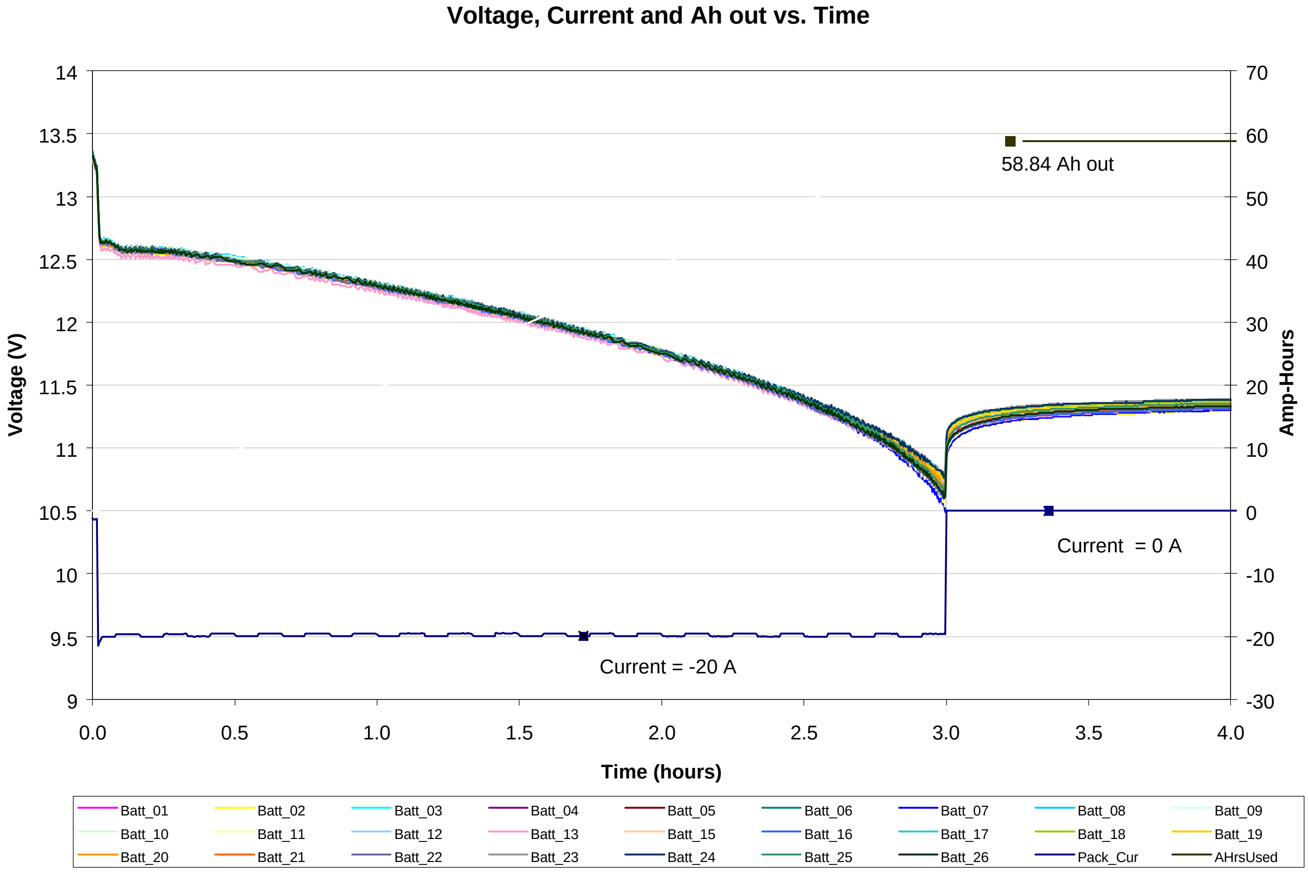
BMI Power Profiler 3030A EVTC Number: BMI-001
ABB kWh Meter Serial Number: 01 223 624
Thermometer EVTC Number: THR - 007
Optical Meter Probe EVTC Number: OPB - 001
Laptop Computer EVTC Number: CMP - 002
Desktop Computer EVTC Number: CMP - 016
Stopwatch EVTC Number: STW - 002
Digital multimeter EVTC Number: MMR-002
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: MMW-001
Other Equipment: Vericom Performance Computer DYM-001, Propel Discharger DCG-002

WEIGHT CERTIFICATION

Scale Location and Proprietor: Mission Recycling Center, Pomona, CA
Examiner: William Boyd
Date: 09/13/1999
Notes:

APPENDIX D

BATTERY CAPACITY TEST GRAPHICAL DATA


Voltage, Current and Ah out vs. Time
Voltage (V)
Amp-Hours
Time (hours)
58.84 Ah out
Current = 0 A
Current = -20 A
14
13.5
13
12.5
12
11.5
11
10.5
10
9.5
9
70
60
50
40
30
20
10
0
-10
-20
-30
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Batt_01
Batt_02
Batt_03
Batt_04
Batt_05
Batt_06
Batt_07
Batt_08
Batt_09
Batt_10
Batt_11
Batt_12
Batt_13
Batt_15
Batt_16
Batt_17
Batt_18
Batt_19
Batt_20
Batt_21
Batt_22
Batt_23
Batt_24
Batt_25
Batt_26
Pack_Cur
AHrsUsed

APPENDIX E

RANGE TEST DATA SHEETS

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
09/27/1999	23631	197578	FW1	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	180				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:38	6190.2	100%	NA	NA	85.0 F		
Stop	15:16	6248.5	6%	NA	NA	83.0 F		**Min. A/C**
Net	1:38	58.3	94%			-2.0 F		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
5.2	13		
13.5	12		
21.1	11		
26.4	10		
28.4	9		
34.3	8		
37.1	7		
40.6	6		Mile 42.0; Exit freeway 10 (East bound) at Mountain Ave.
43.8	5		Mile 42.2; Re-enter freeway 10 (West bound) at Mountain Ave.
47.5	4		Mile 45.2; Exit freeway 10 at Indian Hill Ave.
50.5	3		Mile 50.5; U-turn at Mountain Ave.
56.0	2		Mile 57.9; Battery life light illuminated
57.9	1		Mile 58.3; End of drive
	0		

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	09/27/1999	16:42	216	NA	NA	NA	79.0 F	NA
Stop	09/27/1999	21:25	239	NA	NA	NA		NA
Net		4:43	22.82					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
09/28/1999	23631	197578	FW1	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	180				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	11:15	6248.5	100%	NA	NA	80.0 F		
Stop	12:45	6305.3	6%	NA	NA	85.0 F		**Min. A/C**
Net	1:30	56.8	94%			5.0 F		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
4.1	13		
12.5	12		
19.7	11		
25.6	10		
29.5	9		
35.0	8		
38.0	7		
41.0	6		Mile 42.1; Exit freeway 10 (East bound) at Mountain Ave.
45.3	5		Mile 42.3; Re-enter freeway 10 (West bound) at Mountain Ave.
47.0	4		Mile 45.2; Exit freeway 10 at Indian Hill Ave.
51.2	3		Mile 50.5; U-turn at Mountain Ave.
54.4	2		Mile 56.5; Battery life light illuminated
56.5	1		Mile 56.8; End of drive
	0		

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	09/28/1999	12:50	239	NA	NA	NA	85.0 F	NA
Stop	09/28/1999	17:40	264	NA	NA	NA		NA
Net		4:50	24.2					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
09/29/1999	23631	197578	FW2	Mendoza	Performance Charact.	Start	340
Road Cond	Tire Press	Payload				Stop	290
Dry	51 psi	180				Net	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:55	6305.3	100%	NA	NA	98.0 F	87.4 F	61.5 F
Stop	15:00	6354.3	5%	NA	NA	99.0 F	65.7 F	Min. A/C
Net	1:05	49	95%			1.0 F	-21.7 F	61.2 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	14		
3.0	13		
7.3	12		
16.4	11		
21.2	10		
29.0	9		
31.0	8		
34.2	7		
36.3	6		
38.6	5		Mile 42.0; Exit freeway 10 (East bound) at Mountain Ave.
41.5	4		Mile 42.2; Re-enter freeway 10 (West bound) at Mountain Ave.
43.6	3		Mile 45.1; Exit freeway 10 at Indian Hill Ave.
47.4	2		Mile 48.5; Battery life light illuminated
48.4	1		Mile 49.0; End of drive
	0		

Accessories used: Radio, A/C on high, and headlights.

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	09/29/1999	15:05	264	NA	NA	NA	99.0 F	NA
Stop	09/29/1999	19:52	289	NA	NA	NA		NA
Net		4:47	24.44					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
09/30/1999	23631	197578	FW2	Mendoza	Performance Charact.	Start	340
Road Cond	Tire Press	Payload				Stop	290
Dry	51 psi	180				Net	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	13:05	6354.3	100%	NA	NA	110 F	87.6 F	63.0 F
Stop	14:10	6402.9	4%	NA	NA	101 F	65.7 F	Min. A/C
Net	1:05	48.6	96%			-9 F	-21.9 F	61.5 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	14		
3.0	13		
10.8	12		
17.0	11		
22.0	10		
25.8	9		
28.8	8		
32.3	7		
35.7	6		
38.2	5		Mile 42.1; Exit freeway 10 (East bound) at Mountain Ave.
39.8	4		Mile 42.3; Re-enter freeway 10 (West bound) at Mountain Ave.
42.2	3		Mile 45.1; Exit freeway 10 at Indian Hill Ave.
43.4	2		Mile 47.8; Battery life light illuminated
47.8	1		Mile 48.5; End of drive
	0		

Accessories used: Radio, A/C on high, and headlights.
Drive / Regen setting: Drive
Handling/Braking: Good handling and braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	09/30/1999	14:13	289	NA	NA	NA	98.0 F	NA
Stop	09/30/1999	19:08	315	NA	NA	NA		NA
Net		4:55	25.19					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/01/1999	23631	197578	UR1	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	180				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	13:48	6402.9	100%	NA	NA	92 F		
Stop	16:00	6453.8	5%	NA	NA	97 F		**Min. A/C**
Net	2:12	50.9	95%			5 F		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
7.3	13		
11.8	12		
20.2	11		
24.3	10		
26.5	9		
29.3	8		
31.0	7		
35.2	6		
40.0	5		
42.7	4		
45.0	3		
47.8	2		Mile 42.7; U-turn at Euclid Ave.
50.0	1		Mile 50.0; Battery life light illuminated
50.9	0		Mile 50.9; End of drive

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		BMI-001			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	10/01/1999	17:00	315	NA	NA	NA	88.5 F	NA
Stop	10/02/1999	23:42	342	NA	NA	NA		NA
Net		6:42	26.9					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/04/1999	23631	197578	UR1	Mendoza	Performance Charact.	Start	335
Road Cond	Tire Press	Payload				Stop	290
Dry	51 psi	180				Net	-45

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	8:37	6453.8	100%	NA	NA	71 F		
Stop	10:35	6504.3	5%	NA	NA	79 F		Min. A/C
Net	1:58	50.5	95%			8 F		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	14		
4.7	13		
10.0	12		
13.7	11		
21.5	10		
25.3	9		
28.7	8		
30.2	7		
34.7	6		
38.8	5		
41.7	4		
44.0	3		
48.0	2		Mile 43.7; U-turn at Euclid Ave.
49.8	1		Mile 49.8; Battery life light illuminated
	0		Mile 50.5; End of drive

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
EVC-10	1378520	01 223 624	BMI-001

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	10/04/1999	11:55	345	NA	NA	NA	79.7 F	NA
Stop	10/04/1999	16:47	369	NA	NA	NA		NA
Net		4:52	23.07					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/05/1999	23631	197578	UR2	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	180				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	13:34	6504.3	100%	NA	NA	88 F	82.3 F	53.2 F
Stop	15:14	6545.1	5%	NA	NA	89 F	54.3 F	**Min. A/C**
Net	1:40	40.8	95%			1 F	-28.0 F	51.3 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
4.9	13		
9.8	12		
13.0	11		
15.2	10		
21.3	9		
24.5	8		
26.9	7		
29.2	6		
30.8	5		
32.3	4		
34.3	3		
38.5	2		
40.5	1		Mile 40.5; Battery life light illuminated
40.8	0		Mile 40.8; End of drive

Accessories used: Radio, A/C on high, and headlights.
Drive / Regen setting: Drive
Handling/Braking: Good handling and braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		BMI-001			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	10/05/1999	15:37	369	NA	NA	NA	84.6 F	NA
Stop	10/05/1999	20:13	393	NA	NA	NA		NA
Net		4:36	23.37					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/06/1999	23631	197578	UR2	Mendoza	Performance Charact.	Start	340
Road Cond	Tire Press	Payload				Stop	290
Dry	51 psi	180				Net	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	13:19	6545.1	100%	NA	NA	74 F	74.7 F	79.0 F
Stop	15:07	6593.3	5%	NA	NA	75 F	66.7 F	Min. A/C
Net	1:48	48.2	95%			1 F	-8.0 F	51.4 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	14		
4.9	13		
10.4	12		
12.5	11		
21.6	10		
25.7	9		
28.3	8		
30.2	7		
33.2	6		
35.5	5		
40.8	4		
42.7	3		
45.0	2		Mile 42.6; U-turn at Mountain Ave.
47.5	1		Mile 47.5; Battery life light illuminated
	0		Mile 48.2; End of drive

Accessories used: Radio, A/C on high, and headlights.

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	10/06/1999	15:30	393	NA	NA	NA	84.6 F	NA
Stop	10/06/1999	21:00	416	NA	NA	NA		NA
Net		5:30	23.17					

Comments: A/C did not cool down as much. Air coming from the A/C vents was cold (around 54 ^{o}F) for about 25 minutes only.

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/07/1999	23631	197578	UR2	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	180				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	13:58	6593.3	100%	NA	NA	94 F	80.1 F	52.9 F
Stop	15:40	6635.2	5%	NA	NA	91 F	53.8 F	**Min. A/C**
Net	1:42	41.9	95%			-3 F	-26.3 F	51.1 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
4.8	13		
9.9	12		
13.5	11		
17.0	10		
21.5	9		
23.8	8		
25.5	7		
28.8	6		
30.5	5		
33.0	4		
35.7	3		
40.0	2		
41.1	1		Mile 41.1; Battery life light illuminated
	0		Mile 41.9; End of drive

Accessories used: Radio, A/C on high, and headlights.

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	10/07/1999	15:43	416	NA	NA	NA	90.0 F	NA
Stop	10/07/1999	20:30	420	NA	NA	NA		NA
Net		4:47	23.48					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/19/1999	23631	197578	FW3	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	850				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	13:06	6635.7	100%	NA	NA	101 F		
Stop	14:19	6686.7	6%	NA	NA	98 F		**Min. A/C**
Net	1:13	51	94%			-3 F		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
4.3	13		
11.0	12		
16.5	11		
21.7	10		
27.0	9		
31.8	8		
34.6	7		
37.4	6		
40.0	5		
41.7	4		Mile 42.0; Exit Freeway 10-East at Mountain Ave., and re-enter
46.3	3		Freeway 10-West
48.7	2		Mile 45.2; Exit Freeway 10-West at Indian Hill Ave.
50.7	1		Mile 50.7; Battery life light illuminated
	0		Mile 51.1; End of drive

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	10/19/1999	14:20	462	NA	NA	NA	93.0 F	NA
Stop	10/19/1999	19:02	486	NA	NA	NA		NA
Net		4:42	23.5					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/20/1999	23631	197578	FW3	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	850				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	13:16	6686.7	100%	NA	NA	95 F		
Stop	14:30	6738.5	6%	NA	NA	98 F		**Min. A/C**
Net	1:14	51.8	94%			3 F		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
3.5	13		
6.0	12		
12.5	11		
19.5	10		
24.8	9		
28.8	8		
34.5	7		
37.2	6		
39.5	5		
42.3	4		Mile 42.2; Exit Freeway 10-East at Mountain Ave., and re-enter
46.5	3		Freeway 10-West
49.2	2		Mile 45.2; Exit Freeway 10-West at Indian Hill Ave.
51.4	1		Mile 51.4; Battery life light illuminated
	0		Mile 51.8; End of drive

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	10/20/1999	14:35	486	NA	NA	NA	97.0 F	NA
Stop	10/20/1999	19:16	510	NA	NA	NA		NA
Net		4:41	23.52					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/21/1999	23631	197578	FW4	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	850				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	13:50	6738.5	100%	NA	NA	90 F	85.5 F	55.9 F
Stop	15:00	6783	5%	NA	NA	92 F	58.7 F	**Min. A/C**
Net	1:10	44.5	95%			2 F	-26.8 F	54.6 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
2.9	13		
11.3	12		
19.1	11		
22.2	10		
26.7	9		
29.5	8		
32.5	7		
35.0	6		
37.0	5		
38.5	4		
39.8	3		
42.0	2		Mile 41.0; Exit Freeway 10-East at Monte Vista Ave.
43.5	1		Mile 43.5; Battery life light illuminated
44.4	0		Mile 44.4; End of drive

Accessories used: Radio, A/C on high, and headlights.
Drive / Regen setting: Drive
Handling/Braking: Good handling and braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	10/21/1999	15:08	510	NA	NA	NA	91.0 F	NA
Stop	10/21/1999	19:47	534	NA	NA	NA		NA
Net		4:39	23.57					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/22/1999	23631	197578	UR3	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	850				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	14:05	6783	100%	NA	NA	102 F		
Stop	15:52	6826	6%	NA	NA	97 F		**Min. A/C**
Net	1:47	43	94%			-5 F		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
6.4	13		
9.5	12		
12.9	11		
16.8	10		
21.3	9		
26.0	8		
28.6	7		
30.5	6		
32.3	5		
34.2	4		
38.9	3		
41.5	2		
42.5	1		Mile 42.5; Battery life light illuminated
	0		Mile 43.0; End of drive

Accessories used: Radio
Drive / Regen setting: Drive
Handling/Braking: Good handling and braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	10/22/1999	16:18	534	NA	NA	NA	87.0 F	NA
Stop	10/22/1999	21:15	559	NA	NA	NA		NA
Net		4:57	23.97					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/25/1999	23631	197578	UR3	Mendoza	Performance Charact.	Start	340
Road Cond	Tire Press	Payload				Stop	290
Dry	51 psi	850				Net	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	14:40	6826	100%	NA	NA	90 F		
Stop	16:23	6867.2	5%	NA	NA	89 F		Min. A/C
Net	1:43	41.2	95%			-1 F		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	14		
4.6	13		
8.3	12		
10.8	11		
14.5	10		
21.0	9		
24.8	8		
27.5	7		
39.2	6		
31.0	5		
33.0	4		
34.9	3		
38.5	2		
40.7	1		Mile 40.7; Battery life light illuminated
	0		Mile 41.2; End of drive

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	10/25/1999	16:25	559	NA	NA	NA	89.0 F	NA
Stop	10/25/1999	21:02	583	NA	NA	NA		NA
Net		4:37	22.7					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/26/1999	23631	197578	UR4	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	850				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	14:45	6867.2	100%	NA	NA	88 F	80.0 F	
Stop	16:20	6902	5%	NA	NA	86 F	49.0 F	**Min. A/C**
Net	1:35	34.8	95%			-2 F	-31.0 F	

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
3.6	13		
9.4	12		
10.6	11		
12.0	10		
14.5	9		
20.3	8		
22.5	7		
25.0	6		
26.0	5		
28.1	4		
30.5	3		
32.8	2		Mile 27.9; U-turn at Vineyard Ave.
34.3	1		Mile 34.3; Battery life light illuminated
	0		Mile 34.8; End of drive

Accessories used: Radio, A/C on high, and headlights.
Drive / Regen setting: Drive
Handling/Braking: Good handling and braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-10	1378520		01 223 624		NA			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	10/26/1999	15:25	583	NA	NA	NA	73.0 F	NA
Stop	10/26/1999	22:19	609	NA	NA	NA		NA
Net		6:54	23.91					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/27/1999	23631	197578	UR4	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	850				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	14:05	6902	100%	NA	NA	79 F	76.1 F	46.0 F
Stop	15:35	6939.3	6%	NA	NA	79 F	46.8 F	**Min. A/C**
Net	1:30	37.3	94%			F	-29.3 F	45.7 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
4.5	13		
9.4	12		
11.5	11		
14.7	10		
20.5	9		
23.3	8		
25.8	7		
28.1	6		
30.0	5		
32.8	4		
34.2	3		
35.8	2		Mile 27.2; U-turn at Vineyard Ave.
36.5	1		Mile 36.5; Battery life light illuminated
	0		Mile 37.3; End of drive

Accessories used: Radio, A/C on high, and headlights.

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-24	1378520		01 223 624					
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	10/27/1999	16:05	609	NA	NA	NA	78.0 F	NA
Stop	10/27/1999	20:00	632	NA	NA	NA		NA
Net		3:55	21.87					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
10/28/1999	23631	197578	UR4	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	850				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	13:24	6939.3	100%	NA	NA	77 F	72.0 F	60.3 F
Stop	14:54	6976.1	4%	NA	NA	78 F	46.3 F	**Min. A/C**
Net	1:30	36.8	96%			1 F	-25.7 F	46.0 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
3.7	13		
8.1	12		
12.0	11		
15.1	10		
20.1	9		
23.1	8		
25.5	7		
27.8	6		
29.6	5		
32.3	4		
33.4	3		
35.0	2		
36.3	1		Mile 36.3; Battery life light illuminated
	0		Mile 36.9; End of drive

Accessories used: Radio, A/C on high, and headlights.
Drive / Regen setting: Drive
Handling/Braking: Good handling and braking
Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024	1378520		01 223 624		NA			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	10/28/1999	14:55	632	NA	NA	NA	78.0 F	NA
Stop	10/28/1999	18:45	654	NA	NA	NA		NA
Net		3:50	22.25					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
11/12/1999	23631	197578	FW4	Mendoza	Performance Charact.	**Start**	340
Road Cond	**Tire Press**	**Payload**				**Stop**	290
Dry	51 psi	850				**Net**	-50

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb Temp	A/C temp	A/C>10 min
Start	14:07	7122.9	100%	NA	NA	83 F	79.5 F	53.2 F
Stop	15:11	7164.8	4%	NA	NA	83 F	50.9 F	**Min. A/C**
Net	1:04	41.9	96%			F	-28.6 F	49.8 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	**Veh meter**	**Range meter**	
0.0	14		
2.2	13		
4.8	12		
13.1	11		
17.4	10		
21.0	9		
27.5	8		
29.9	7		
32.8	6		
35.5	5		
37.3	4		
39.4	3		
41.6	2		Mile 39.4; Exit Freeway 10-East at Indian Hill Ave.
41.9	1		Mile 41.6; Battery life light illuminated
	0		Mile 41.9; End of drive

Accessories used: Radio, A/C on high, and headlights.

Drive / Regen setting: Drive

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-24	1378520		01 378 520		NA			
CHARGING	**Date**	**Time**	**AC kWh in**	**BMI kWh in**	**DC kWh in**	**DC Ah in**	**Amb temp**	**Volts**
Start	11/12/1999	16:58	4077	NA	NA	NA	82.0 F	NA
Stop	11/12/1999	22:15	4099	NA	NA	NA		NA
Net		5:17	21.88					

Comments:

APPENDIX F

ACCELERATION, BRAKING AND MAXIMUM SPEED TEST DATA

ACCELERATION, MAXIMUM SPEED, AND BRAKING TESTS

Vehicle No.: S-10 23631
Location: Pomona Racetrack
Date: 10/05/99
Technician: Alvaro Mendoza

	Start	Stop
Time	9:55 AM	12:45 PM
Temp.	64	70
Odometer	7100	7121.8

Acceleration (100% SOC)

	0-30 mph	0-60 mph	Direction	Max. Speed	30-55 mph
1	4.246	11.359	N	73	8.32
2	4.448	14.318	S	68	7.51
3					
4					
Average	4.35	12.84		70.50	7.92

Acceleration (80% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1	4.466	13.07	N	8.68
2	4.234	12.257	S	7.59
3				
4				
Average	4.35	12.66		8.14

Acceleration (60% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1	4.534	13.919	N	8.9
2	4.31	12.491	S	7.87
3				
4				
Average	4.42	13.21		8.39

Acceleration (40% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1	4.712	15.33	N	9.53
2	4.364	13.38	S	8.34
3				
4				
Average	4.54	14.36		8.94

Acceleration (20% SOC)

	0-30 mph	0-60 mph	Direction	Max. Speed	30-55 mph
1	4.625	15.33	N	70	10.71
2	4.497	14.264	S	72	9.37
3					
4					
Average	4.56	14.80		71.00	10.04

Braking 25-0 mph, 60% SOC

	Feet	Inches	Total Ft.	Direction
1	43.26		43.3	S
2	44.26		44.3	S
3	37.77		37.8	S
4	34.33		34.3	S
5	38.55		38.6	N
6	39.87		39.9	N
7	39.9		39.9	N
8	37.35		37.4	N
9				
10				

39.4 Average ft.

Comments: Relative humidity was 55% at start of test, and 48% at the end.

APPENDIX G

CHARGER TESTING / ANALYSIS DATA SHEET

CHARGER TESTING / ANALYSIS DATA SHEET

Name of test conductor: Alvaro Mendoza   Date: 11/15/99

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

~~Charger Information~~

Manufacturer: Delco Electronics

Model No.: Magne Charge / WM200

Supply Side Voltage Rating: 240V, 60Hz

~~After Completion of Recharging Cycle~~

Time of Day: 8:15 PM

Final Pack Voltage: 382.6 V

AC kWh Used: 27.22 kWh   DC kWh Delivered: 19.87 kWh

Charger Energy Efficiency: 73% (DC kWh/AC kWh)

Amp-hours to battery: 58.58 Ah   kWh to battery: N/A

Overcharge Factor: 0.995 (Ah removed/Ah returned)

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

~~Charger Operation Information/Evaluation~~

Exterior Dimensions: 850 mm X 350 mm X 352 mn   Weight: 33 kg (73 lbs)

Charging Profile Type: Vehicle Dependant

End Point Determination Method: Vehicle Dependant

Battery Monitoring Method: Monitored by vehicle

Programmable Charging Profiles: none

Connector Type(s): Inductive

Safety Features / Protection Devices: N/A

Agency/Industry Approvals: Federal Communications Acommission (FCC)

Installation Techniques/Requirements: Wall mounting bracket installation

Appropriate for Interior and/or Exterior Use: Interior use only

User Interface: Digital display showing state of charge

Ease of Use: Simple

Current & Future Cost:

Warranty: N/A

Reliability History/Manuf. Reputation: Reliable

Maintenance Schedule: None

Accompanying Supplies: None

Manufacturer Support: Yes

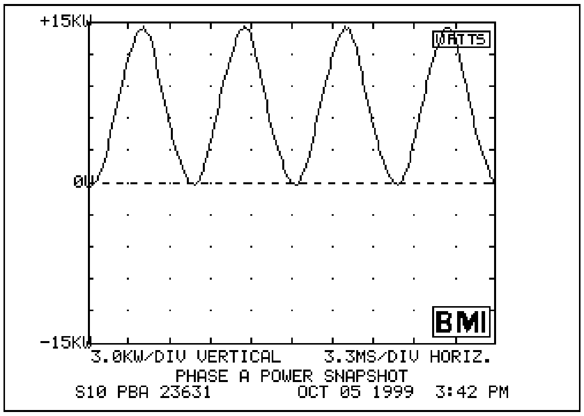
Other Notes:

APPENDIX H

CHARGER PROFILE TEST GRAPHICAL DATA - EVTC

Snapshots at Full Power

PHASE A POWER SNAPSHOT 3:42:53 PM
INSTANTANEOUS POWER: 7.048 kW



PHASE A POWER SPECTRUM 5:06:04 PM

Power: 6.941 kW

Fundamental freq: 60.0 Hz

HARM	POWER	HARM	POWER
FUND	+6.938 kW	2nd	
3rd	+0.07 W	4th	
5th	+2.54 W	6th	
7th	-0.01 W	8th	
9th	+0.01 W	10th	
11th		12th	
13th	+0.01 W	14th	
15th		16th	
17th	+0.01 W	18th	
19th	+0.01 W	20th	
21st	+0.02 W	22nd	
23rd	+0.02 W	24th	
25th	+0.02 W	26th	
27th	+0.03 W	28th	
29th	+0.04 W	30th	
31st	+0.03 W	32nd	
33rd	+0.03 W	34th	
35th	+0.02 W	36th	
37th	+0.01 W	38th	
39th	+0.01 W	40th	
41st		42nd	
43rd		44th	
45th		46th	
47th		48th	
49th		50th	
ODD	2.86 W	EVEN	0.01 W
THP:	2.87 W		

POWER FACTOR SNAPSHOT 3:42:54 PM

Phase A-N: 7.048 kW
Phase A-N: 7.102 kVA
Phase A-N: 788.1 VAR
Phase A-N: 0.99 PF
Phase A-N: 0.99 dPF

HARMONICS SNAPSHOT 3:42:54 PM

Fundamental freq: 60.0 Hz
Phase A-N Volts: 2.2% THD
Phase A Current: 4.1% TDD
Phase A Current: 4.1% THD

VOLTAGE & CURRENT SNAPSHOT 3:43:31 PM

Phase A-N: 228.7 Vrms, 0 (ref)
Neut-Gnd: 115.2 Vrms, 61

Phase A: 31.05 A rms, -6

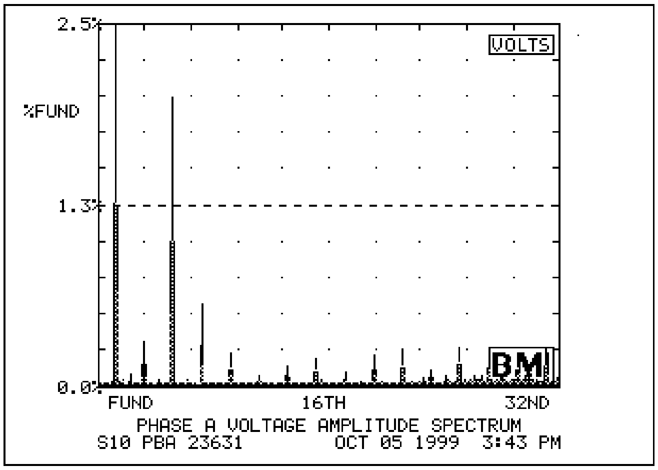
PHASE A VOLTAGE SPECTRUM 3:42:54 PM

Fundamental volts: 228.7 Vrms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	0	2nd		
3rd	0.3%	109	4th		
5th	2.0%	-12	6th		
7th	0.6%	95	8th		
9th	0.2%	-109	10th		
11th			12th		
13th	0.1%	170	14th		
15th	0.2%	-106	16th		
17th	0.1%	-112	18th		
19th	0.2%	-153	20th		
21st	0.3%	-134	22nd		
23rd	0.1%	-172	24th		
25th	0.3%	161	26th		
27th	0.2%	-172	28th		
29th	0.2%	104	30th		
31st	0.3%	111	32nd		
33rd			34th		
35th	0.1%	107	36th		
37th			38th		
39th			40th		
41st			42nd		
43rd			44th		
45th			46th		
47th			48th		
49th			50th		
ODD	2.2%		EVEN	0.3%	

THD: 2.2%



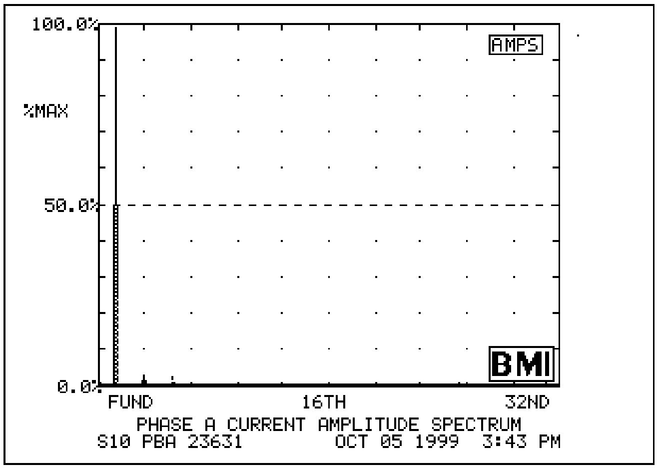
PHASE A CURRENT SPECTRUM 3:43:08 PM

Max load current: 31200 mA rms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	99.4%	-6	2nd		
3rd	3.1%	-100	4th		
5th	2.5%	-55	6th		
7th	0.2%	-8	8th		
9th	0.2%	-122	10th		
11th	0.1%	-69	12th		
13th	0.1%	-99	14th		
15th	0.1%	-84	16th		
17th	0.1%	-99	18th		
19th	0.2%	-100	20th		
21st	0.2%	-89	22nd		
23rd	0.2%	-136	24th		
25th	0.3%	-138	26th		
27th	0.2%	-126	28th		
29th	0.3%	168	30th		
31st	0.4%	166	32nd		
33rd	0.2%	132	34th	0.1%	-68
35th	0.3%	131	36th		
37th	0.2%	95	38th		
39th	0.2%	76	40th		
41st	0.1%	63	42nd		
43rd	0.1%	38	44th	0.1%	-176
45th	0.1%	-35	46th		
47th			48th		
49th			50th		
ODD	4.1%		EVEN	0.3%	

TDD: 4.1%

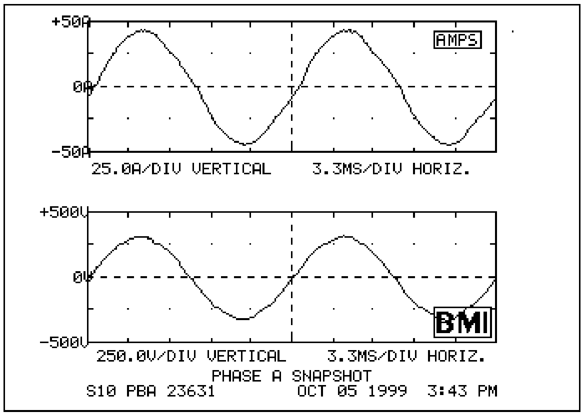


PHASE A SNAPSHOT 3:43:35 PM

Phase A-N VOLTAGE: 228.7 Vrms
1.5 Crest Factor
1.1 Form Factor

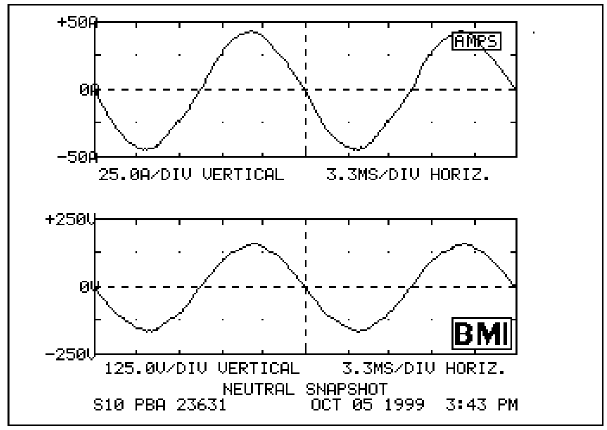
Phase A CURRENT: 31.05 A rms
1.4 Crest Factor
1.1 Form Factor

CURRENT LAGS VOLTAGE BY 6 (0.99 dPF)



NEUTRAL SNAPSHOT 3:43:47 PM

Neut-Gnd VOLTAGE: 115.2 Vrms
1.5 Crest Factor
1.1 Form Factor

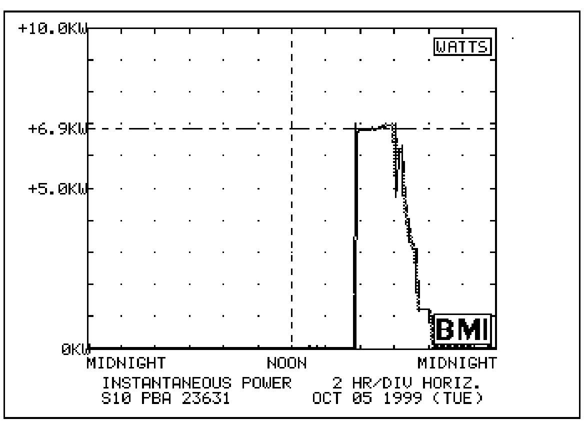


CUMMULATIVE PROFILES – 24 HOURS

INSTANTANEOUS POWER MIDNIGHT

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

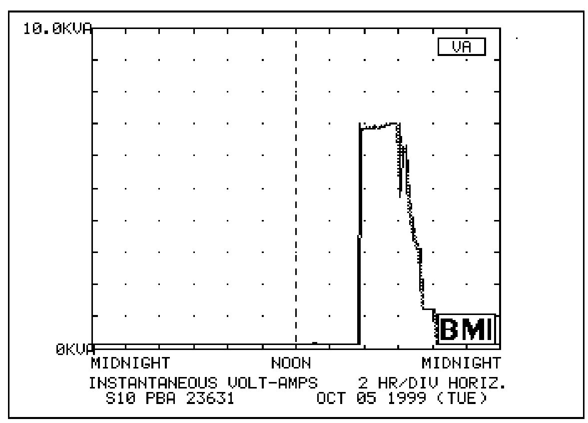
Phase A-N:
MAX: 7.0 kW; 3:42 PM
MIN: 0.0 kW; 3:07 PM



INSTANTANEOUS VOLT-AMPS 12:00:02 AM

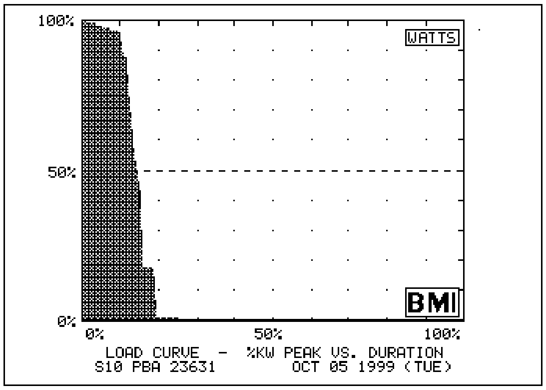
FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

Phase A-N:
MAX: 7.1 kVA; 3:42 PM
MIN: 0.1 kVA; 2:27 PM



LOAD DURATION CURVE 12:00:17 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)



TOTAL POWER CONSUMPTION 12:00:38 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

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

BILLING DEMAND:

7.017 kW	Pk Today
7.017 kW	Pk Accumulated
$ 0.000	Today
$ 0.000	Accumulated

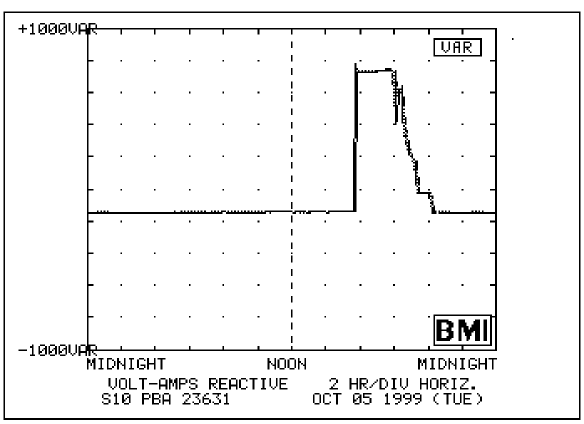
CONSUMPTION:

23.58 kWh	Today
77.10 kWh	Accumulated
$ 1.415	Today
$ 4.626	Accumulated
11.46 kQh	Today
-0.383 kVARh	Today

VOLT-AMPS REACTIVE 12:00:45 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

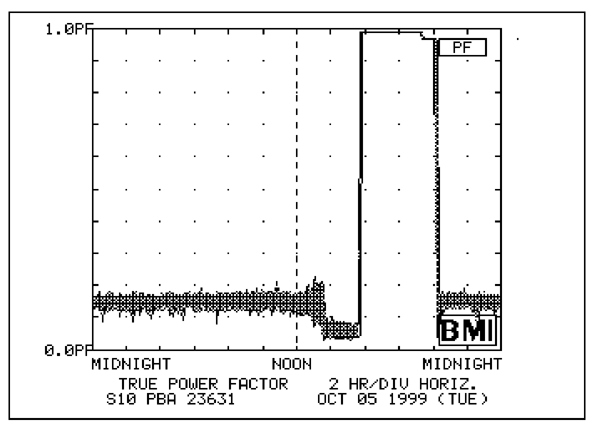
Phase A-N:
MAX: 788.1 VAR; 3:42 PM
MIN: -139.9 VAR; 12:03 AM



TRUE POWER FACTOR 12:00:56 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

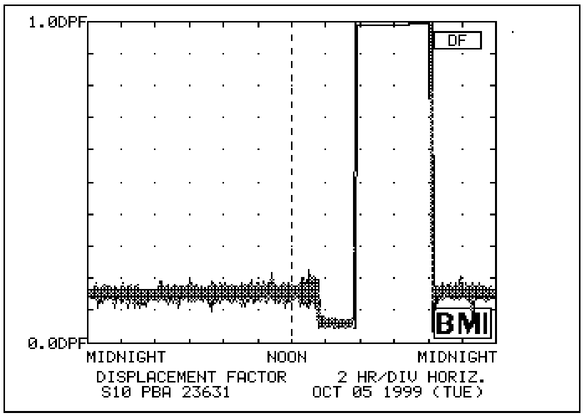
Phase A-N:
MAX: 1.00 PF; 6:49 PM
MIN: 0.03 PF; 3:07 PM



DISPLACEMENT FACTOR 12:01:02 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

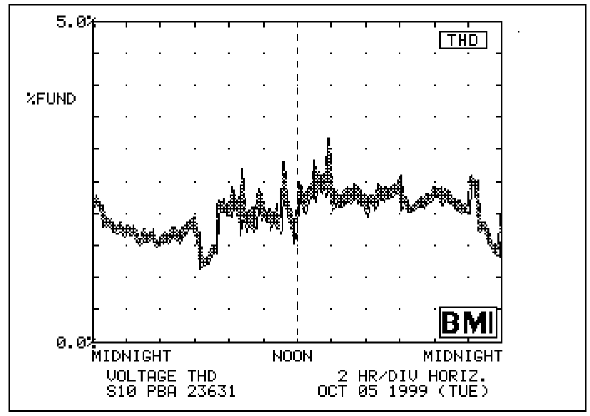
Phase A-N:
MAX: 1.00 dPF, 7:18 PM
MIN: 0.03 dPF, 8:13 PM



VOLTAGE THD 12:01:18 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

Phase A-N:
MAX: 3.2% THD, 1:42 PM
MIN: 1.2% THD, 6:14 AM

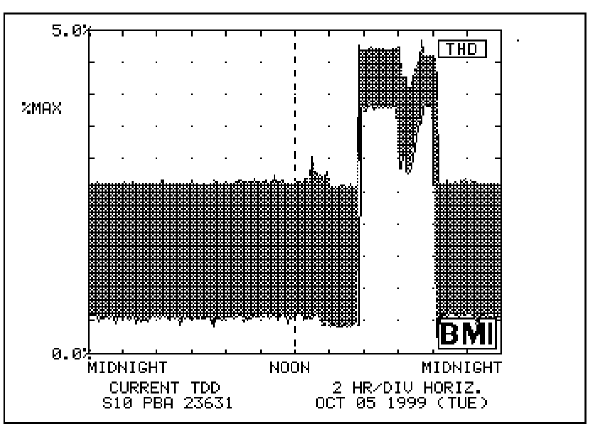


CURRENT TDD 12:01:28 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

Max load current: 31200 mA rms

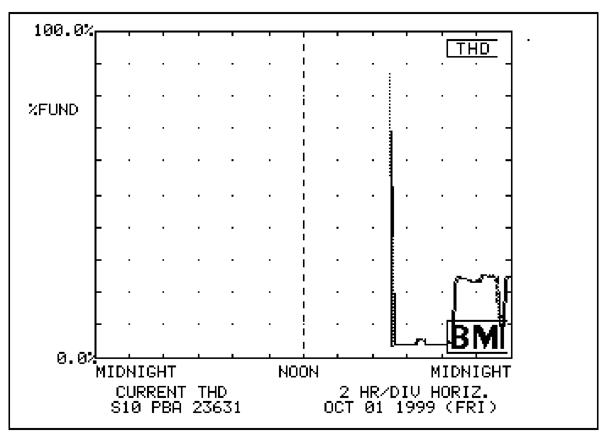
Phase A:
MAX: 4.2% TDD, 7:18 PM
MIN: 0.3% TDD, 8:13 PM



CURRENT THD 12:01:32 AM

FROM: MIDNIGHT Sep 30 1999 (Thu)
To: MIDNIGHT Oct 01 1999 (Fri)

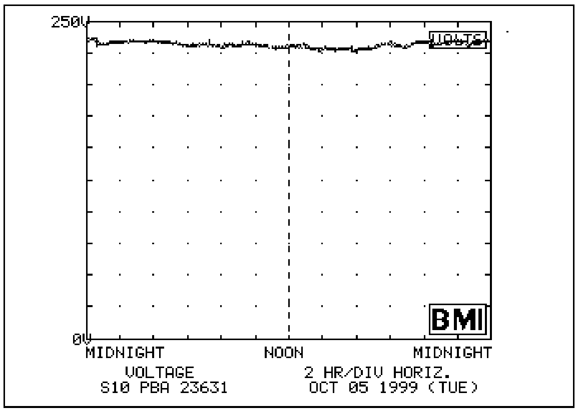
Phase A:
MAX: 69.4% THD, 4:59 PM
MIN: 3.7% THD, 5:00 PM



VOLTAGE 12:02:02 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

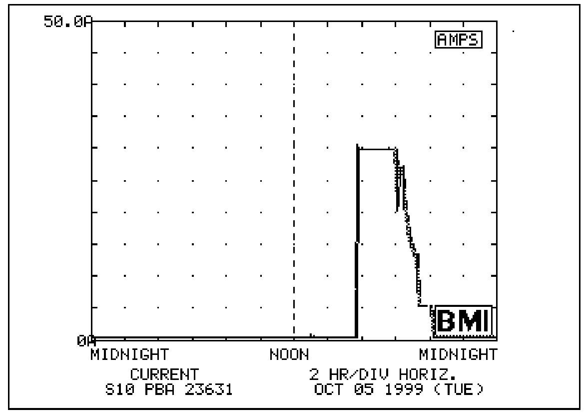
Phase A-N:
MAX: 238.5 V, 12:03 AM
MIN: 228.3 V, 3:47 PM



CURRENT 12:02:11 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

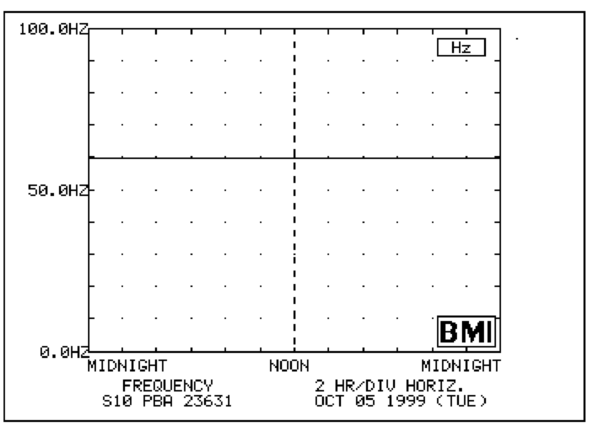
Phase A:
MAX: 31.0 A, 3:42 PM
MIN: 0.6 A, 2:27 PM



FREQUENCY 12:02:28 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

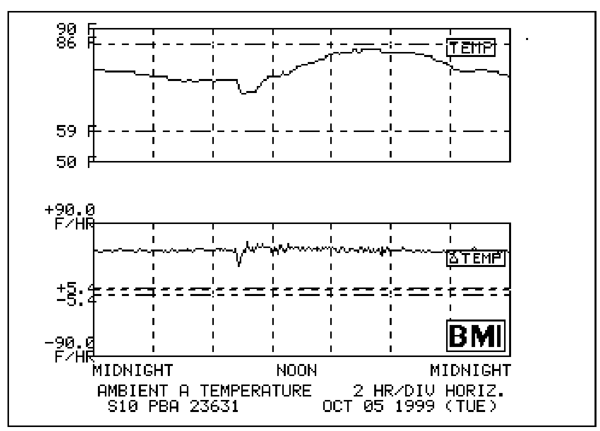
MAX: 60.1 Hz, 4:58 AM
MIN: 59.9 Hz, 5:51 PM



AMBIENT A Temperature 12:02:43 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

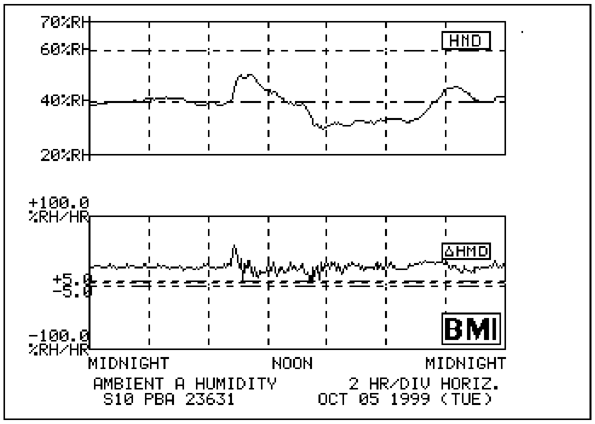
MAX: 84.8 F, 3:50 PM
MIN: 70.7 F, 8:41 AM



AMBIENT A Humidity 12:02:56 AM

FROM: MIDNIGHT Oct 04 1999 (Mon)
To: MIDNIGHT Oct 05 1999 (Tue)

MAX: 51.4 %RH; 9:16 AM
MIN: 29.4 %RH; 1:25 PM

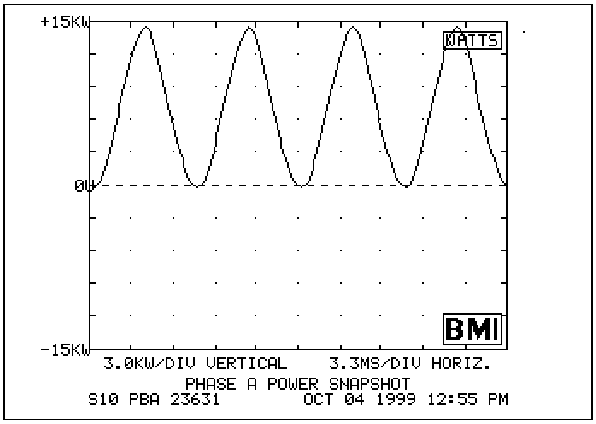


APPENDIX I

CHARGER PROFILE TEST GRAPHICAL DATA – RESIDENTIAL

SNAPSHOTS AT FULL POWER

PHASE A POWER SNAPSHOT 12:55:56 PM
INSTANTANEOUS POWER: 6.986 kW



PHASE A CURRENT SPECTRUM 12:56:14 PM
Max load current: 31200 mA rms
Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	98.2%	-6	2nd		
3rd	3.2%	-103	4th		
5th	2.4%	-51	6th		
7th			8th		
9th	0.1%	-102	10th		
11th	0.1%	-64	12th		
13th	0.1%	-89	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	4.0%		EVEN	0.1%	

TDD: 4.1%

POWER FACTOR SNAPSHOT 12:55:58 PM

Phase A-N: 6.986 kW
Phase A-N: 7.036 kVA
Phase A-N: 760.8 VAR
Phase A-N: 0.99 PF
Phase A-N: 0.99 dPF

HARMONICS SNAPSHOT 12:56:00 PM

Fundamental freq: 60.0 Hz
Phase A-N Volts: 2.0% THD
Phase A Current: 4.1% TDD

VOLTAGE & CURRENT SNAPSHOT 12:56:38 PM

Phase A-N: 228.6 Vrms, 0 (ref)
Neut-Gnd: 115.2 Vrms, -180
Phase A: 30.79 A rms, -6

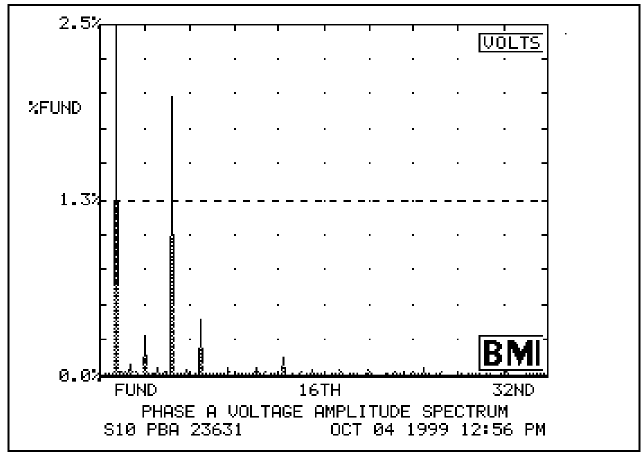
PHASE A VOLTAGE SPECTRUM 12:56:05 PM

Fundamental volts: 228.5 Vrms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	0	2nd		
3rd	0.3%	170	4th		
5th	2.0%	-7	6th		
7th	0.4%	125	8th		
9th			10th		
11th			12th		
13th	0.1%	164	14th		
15th			16th		
17th			18th		
19th			20th		
21st			22nd		
23rd			24th		
25th			26th		
27th			28th		
29th			30th		
31st			32nd		
33rd			34th		
35th			36th		
37th			38th		
39th			40th		
41st			42nd		
43rd			44th		
45th			46th		
47th			48th		
49th			50th		
ODD	2.1%		EVEN	0.1%	

THD: 2.0%



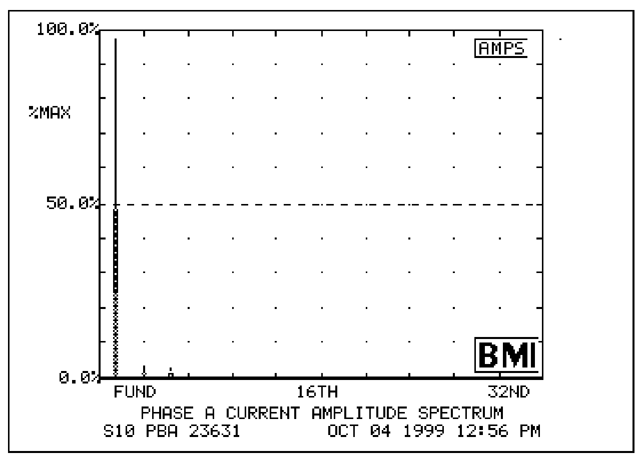
PHASE A CURRENT SPECTRUM 12:56:14 PM

Max load current: 31200 mA rms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	98.2%	-6	2nd		
3rd	3.2%	-103	4th		
5th	2.4%	-51	6th		
7th			8th		
9th	0.1%	-102	10th		
11th	0.1%	-64	12th		
13th	0.1%	-89	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	4.0%		EVEN	0.1%	

TDD: 4.1%

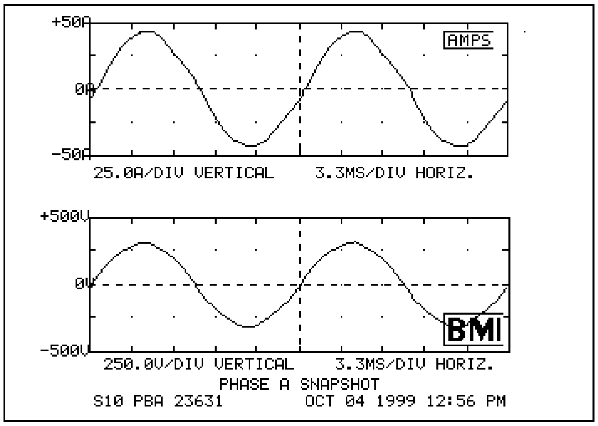


PHASE A SNAPSHOT 12:56:42 PM

Phase A-N VOLTAGE: 228.6 Vrms
1.5 Crest Factor
1.1 Form Factor

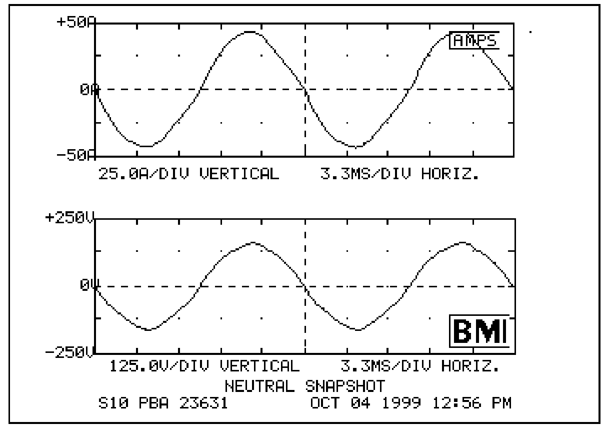
Phase A CURRENT: 30.79 A rms
1.4 Crest Factor
1.1 Form Factor

CURRENT LAGS VOLTAGE BY 6 (0.99 dPF)



NEUTRAL SNAPSHOT 12:56:51 PM

Neut-Gnd VOLTAGE: 115.2 Vrms
1.5 Crest Factor
1.1 Form Factor

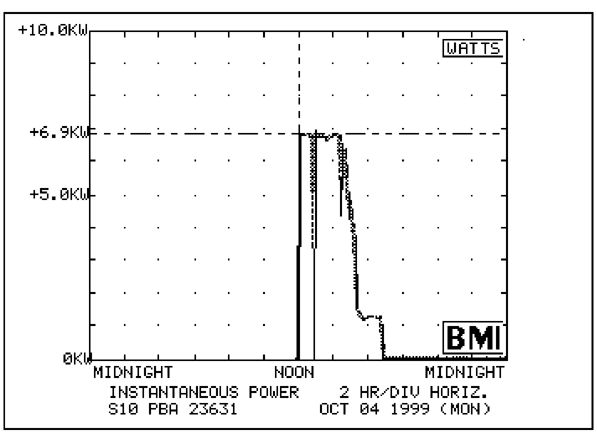


CUMMULATIVE PROFILES – 24 HOURS

INSTANTANEOUS POWER 12:00:01 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

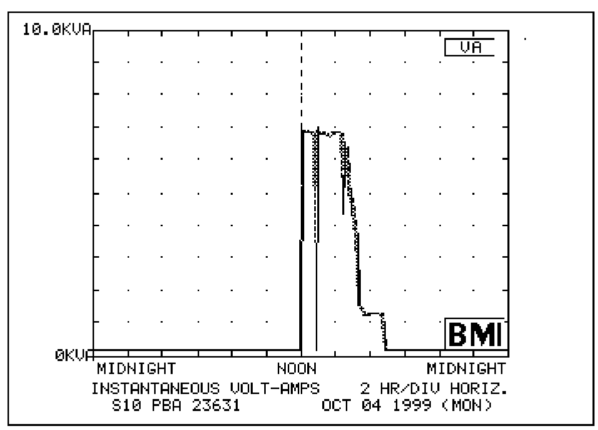
Phase A-N:
MAX: 7.0 kW, 12:55 PM
MIN: 0.0 kW, 12:54 PM



INSTANTANEOUS VOLT-AMPS 12:00:04 AM

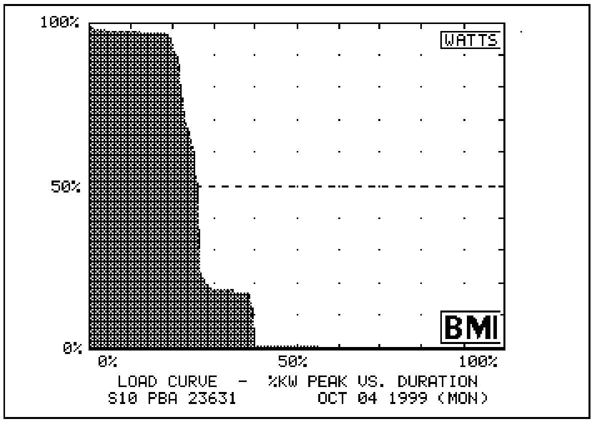
FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

Phase A-N:
MAX: 7.0 kVA, 12:55 PM
MIN: 0.1 kVA, 10:57 AM



LOAD DURATION CURVE 12:00:22 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)



TOTAL POWER CONSUMPTION 12:00:39 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

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

BILLING DEMAND:

6.890 kW	Pk Today
7.006 kW	Pk Accumulated
$ 0.000	Today
$ 0.000	Accumulated

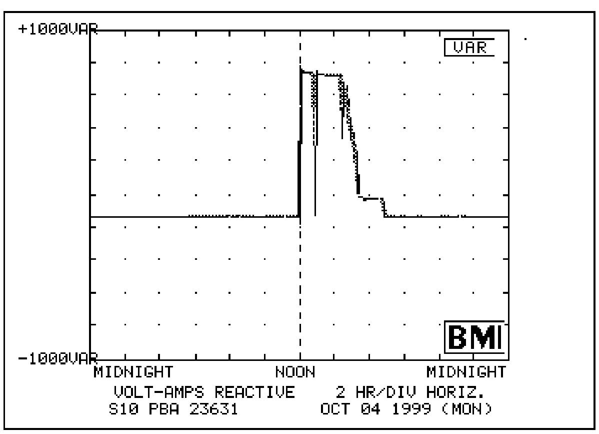
CONSUMPTION:

23.26 kWh	Today
53.44 kWh	Accumulated
$ 1.396	Today
$ 3.207	Accumulated
11.25 kQh	Today
-0.446 kVARh	Today

VOLT-AMPS REACTIVE 12:00:48 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

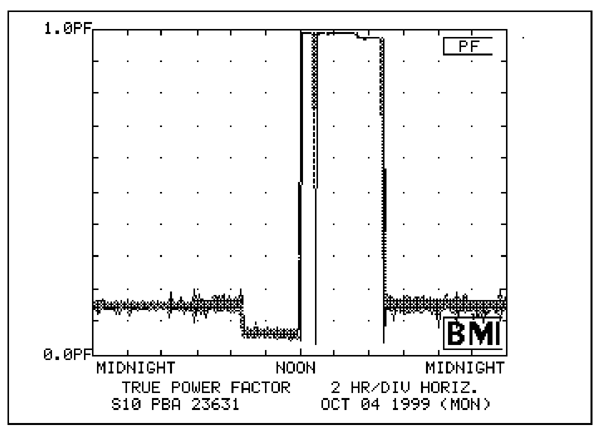
Phase A-N:
MAX: 793.4 VAR, 11:56 AM
MIN: -140.7 VAR, 3:16 AM



TRUE POWER FACTOR 12:00:59 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

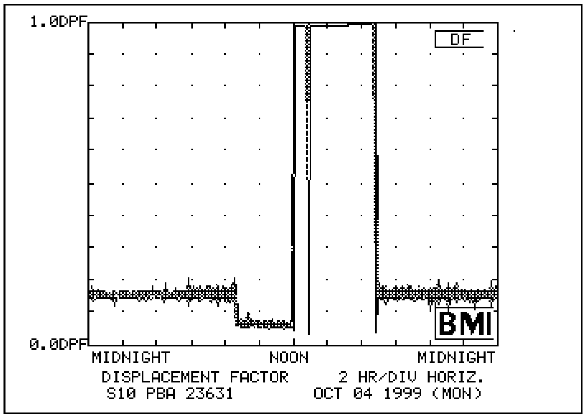
Phase A-N:
MAX: 1.00 PF, 3:06 PM
MIN: 0.03 PF, 12:54 PM



DISPLACEMENT FACTOR 12:01:06 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

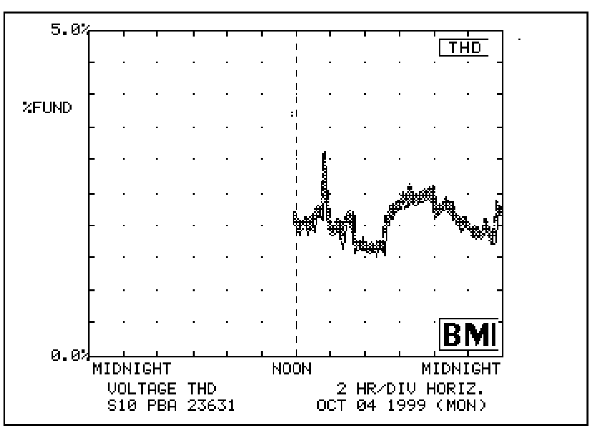
Phase A-N:
MAX: 1.00 dPF; 3:19 PM
MIN: 0.03 dPF; 12:54 PM



VOLTAGE THD 12:01:21 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

Phase A-N:
MAX: 3.1% THD; 1:37 PM
MIN: 1.5% THD; 4:37 PM

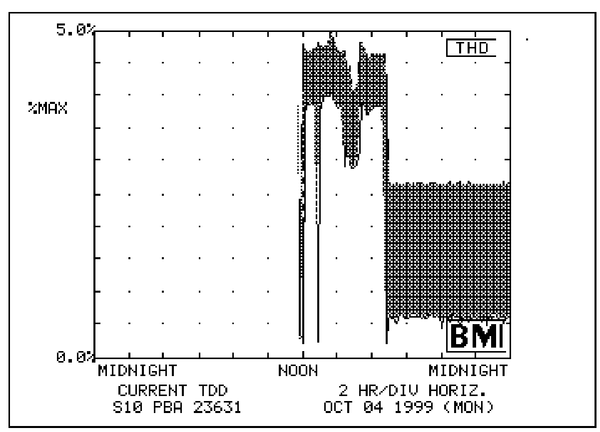


CURRENT TDD 12:01:32 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

Max load current: 31200 mA rms

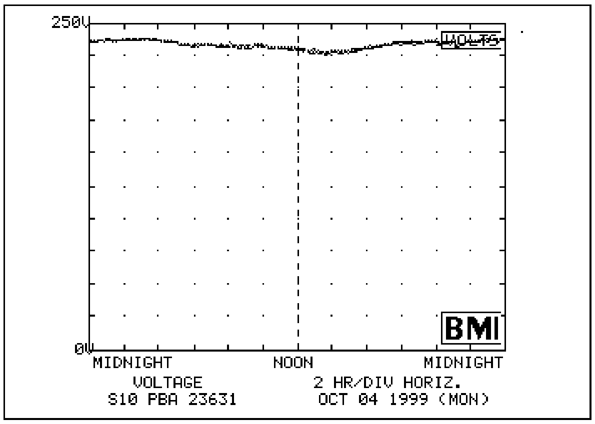
Phase A:
MAX: 4.5% TDD; 1:37 PM
MIN: 0.2% TDD; 4:48 PM



VOLTAGE 12:02:07 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

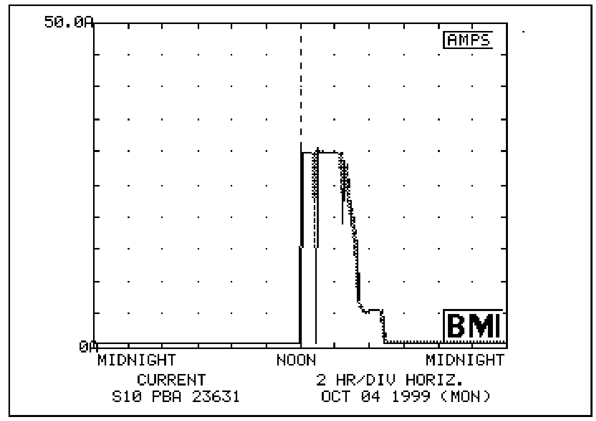
Phase A-N:
MAX: 238.9 V, 3:16 AM
MIN: 225.9 V, 1:36 PM



CURRENT 12:02:17 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

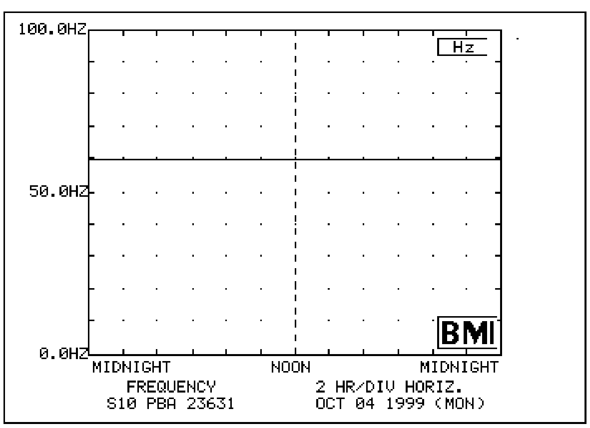
Phase A:
MAX: 30.8 A, 12:55 PM
MIN: 0.6 A, 10:57 AM



FREQUENCY 12:02:37 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

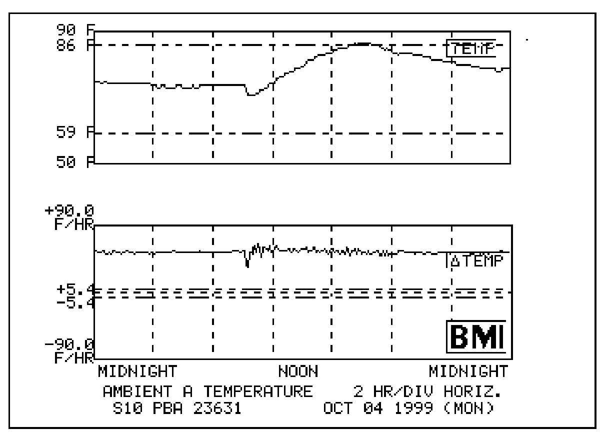
MAX: 60.1 Hz, 4:04 AM
MIN: 59.9 Hz, 5:32 AM



AMBIENT A Temperature 12:02:51 AM

FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

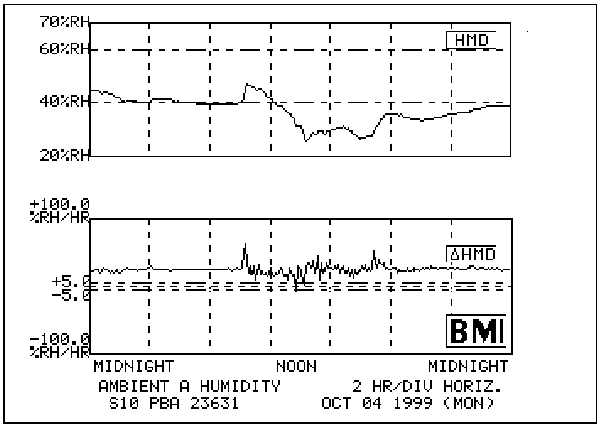
MAX: 86.8 F, 3:16 PM
MIN: 70.0 F, 9:05 AM



AMBIENT A Humidity 12:03:04 AM

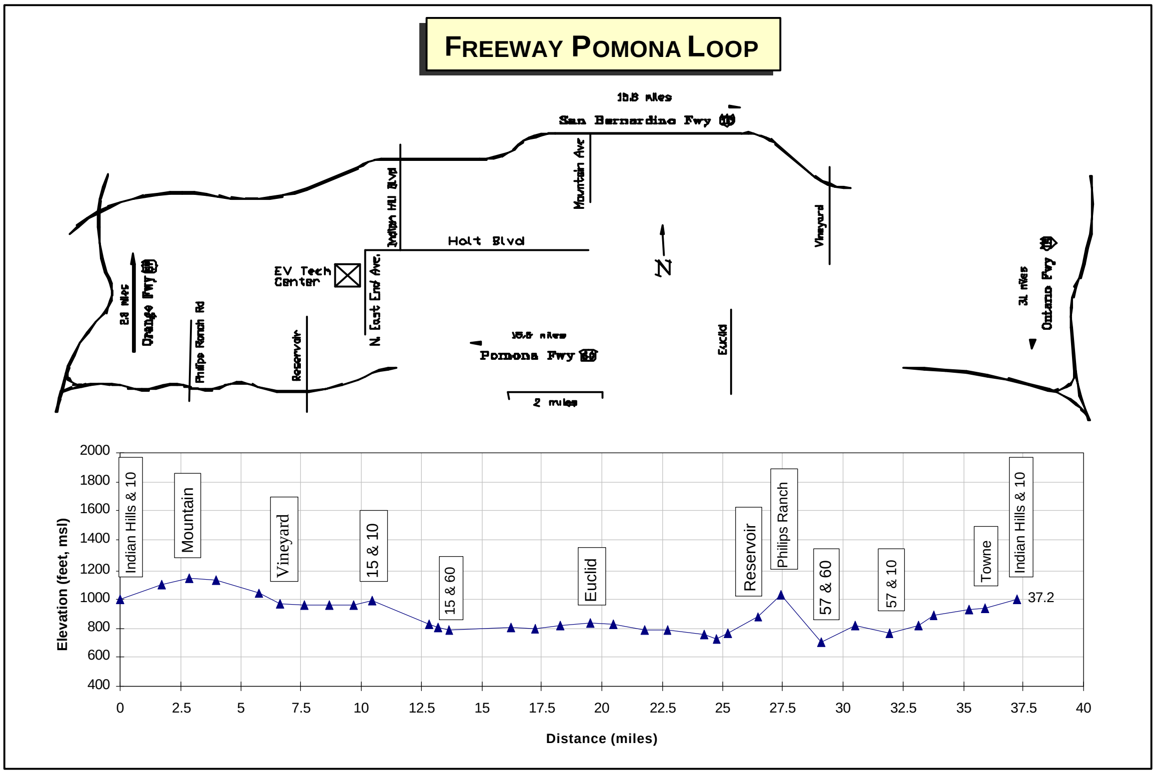
FROM: MIDNIGHT Oct 03 1999 (Sun)
To: MIDNIGHT Oct 04 1999 (Mon)

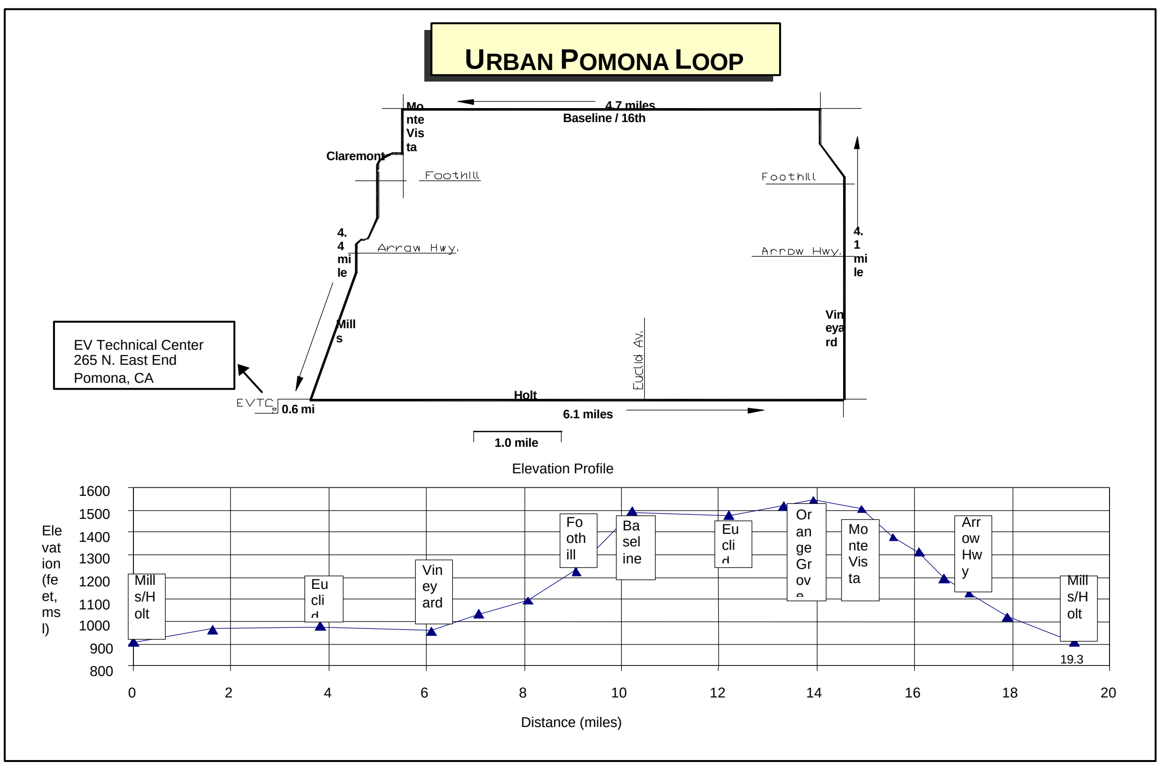
MAX: 47.4 %RH, 8:54 AM
MIN: 25.1 %RH, 12:16 PM



APPENDIX J

URBAN AND FREEWAY POMONA LOOPS


FREEWAY POMONA LOOP
San Bernardino Fwy
Holt Blvd
EV Tech Center
Pomona Fwy
Orange Fwy
Ontario Fwy
Indian Hill Blvd
N. East End Ave.
Mountain Ave
Vineyard
Euclid
Reservoir
Phillips Ranch Rd
2 miles
Indian Hills & 10
Mountain
Vineyard
15 & 10
15 & 60
Euclid
Reservoir
Philips Ranch
57 & 60
57 & 10
Towne
Indian Hills & 10
37.2
Elevation (feet, msl)
Distance (miles)


URBAN POMONA LOOP
4.7 miles
Baseline / 16th
Monte Vista
Claremont
Foothill
Foothill
Arrow Hwy.
Arrow Hwy.
4.4 mile
4.1 mile
Mills
Vineyard
Euclid Av.
Holt
EVTC
0.6 mi
6.1 miles
1.0 mile
EV Technical Center
265 N. East End
Pomona, CA
Elevation Profile
Elevation (feet, msl)
Mills/Holt
Euclid
Vineyard
Foothill
Baseline
Euclid
Orange Grove
Monte Vista
Arrow Hwy
Mills/Holt
19.3
Distance (miles)

APPENDIX K

SCE ELECTRIC VEHICLE TEST PROCEDURE

ELECTRIC VEHICLE TEST PROCEDURE

SOUTHERN CALIFORNIA EDISON

An *EDISON INTERNATIONAL* Company

ELECTRIC TRANSPORTATION DIVISION

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

August 1999

TABLE OF CONTENTS

I. INTRODUCTION

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

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

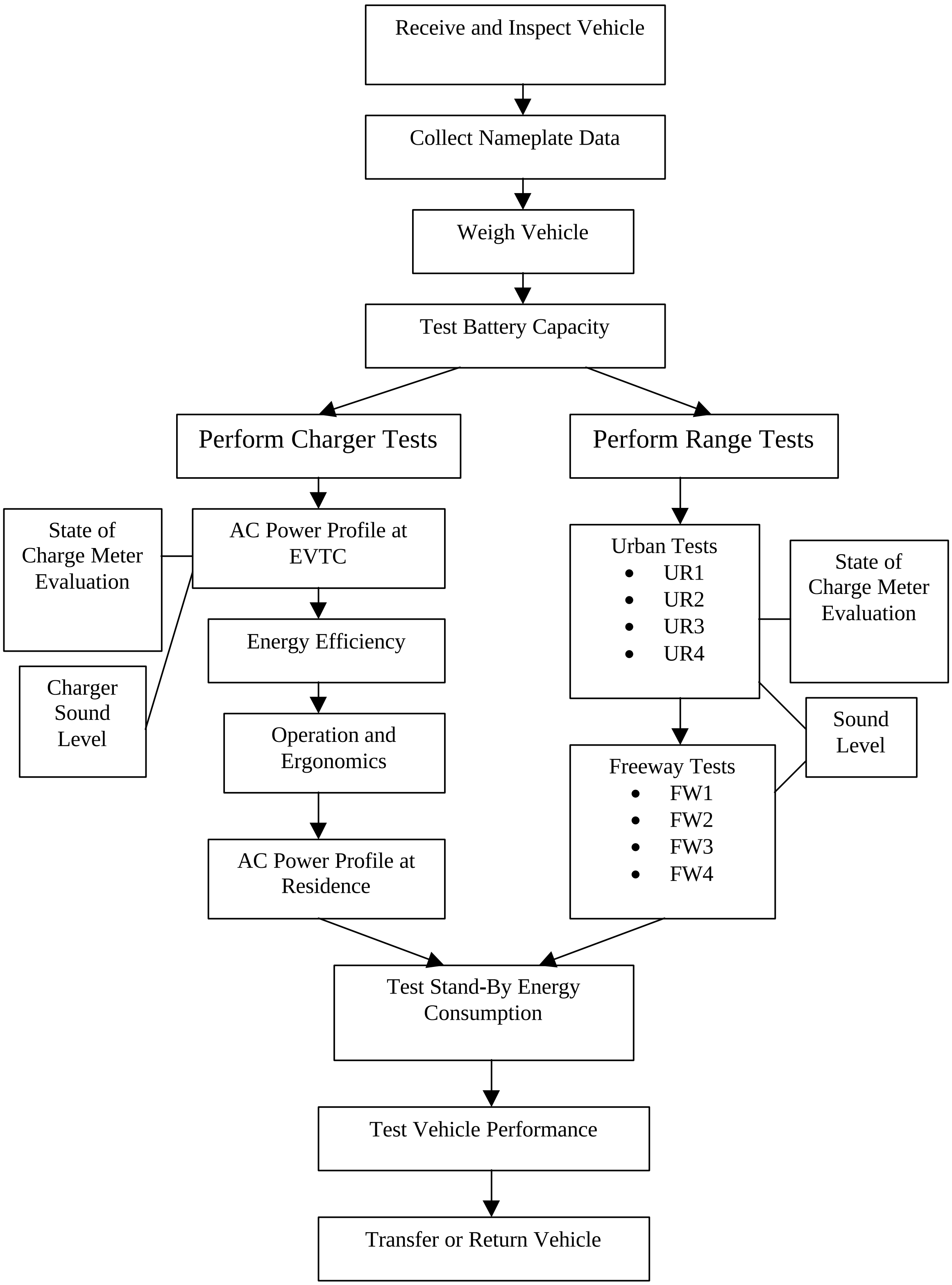
Range tests under different vehicle conditions no longer always have predictable results. Automatic climate controls limit air conditioner power on cool days, thus conserving battery energy and increasing range. The battery pack and the output side of the charger may no longer be readily accessible;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

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

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

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

SCE EV TEST PROCEDURE FLOW DIAGRAM



II. TEST PLAN

A. NAMEPLATE DATA COLLECTION

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

B. WEIGHT DOCUMENTATION

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

C. BATTERY CAPACITY TEST

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

D. RANGE TESTS

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

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

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

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

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

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

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

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

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

E. SOUND LEVEL TEST

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

F. STATE OF CHARGE METER EVALUATION

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

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

G. PERFORMANCE TESTS

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

1. Acceleration

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

2. Maximum Speed

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

3. Acceleration - 30 to 55 mph

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

4. Braking

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

H. CHARGER PERFORMANCE/CHARGING PROFILE TEST

1. AC Input Data

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

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

2. **Charging Profile**

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

3. **Charging at a Residential Setting**

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

4. **Charger Energy Efficiency**

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

5. **Audible Noise Levels**

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

6. **Operation and Ergonomics**

   Observe these aspects of the charger's operation:

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

   Examine the user's interface with the charger:

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

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

1. **Vehicle on Charger**

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

2. Vehicle off Charger

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

J. TRANSFER THE VEHICLE

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

III. TEST INSTRUMENTATION

A. WEIGHT DOCUMENTATION

1. Certified Weight Scale

B. RANGE TESTS

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

C. BATTERY CAPACITY TEST

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

D. SOUND LEVEL TEST

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

E. STATE OF CHARGE METER EVALUATION

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

F. PERFORMANCE TESTS

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

2. Maximum Speed
    a. EV speedometer

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

G. CHARGER PERFORMANCE/CHARGING PROFILE TEST

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

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

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

IV. TEST PROCEDURE

A. NAMEPLATE DATA COLLECTION

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

B. WEIGHT DOCUMENTATION

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

C. BATTERY CAPACITY TEST

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

Data Acquisition Equipment

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

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

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

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

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

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

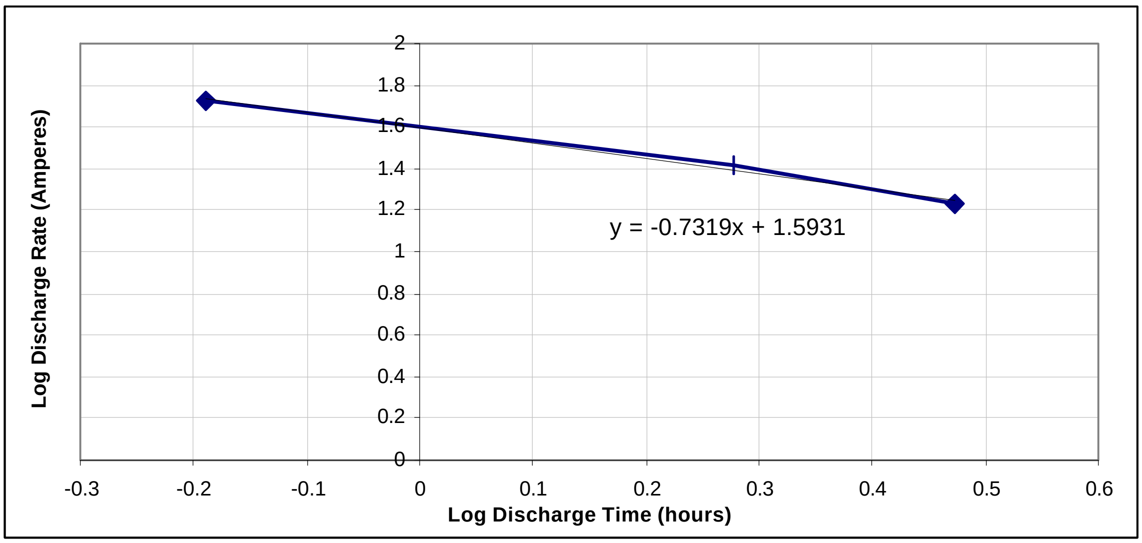


Figure 3-1. Sample Peukert Curve.

D. RANGE TESTS

Vehicle Preparation/Inspection

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

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

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

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

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

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

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

Conduct this procedure in the following four vehicle test configurations:

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

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

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

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

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

2. Freeway Range Tests:

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

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

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

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

Conduct this procedure in the following four vehicle test configurations:

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

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

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

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

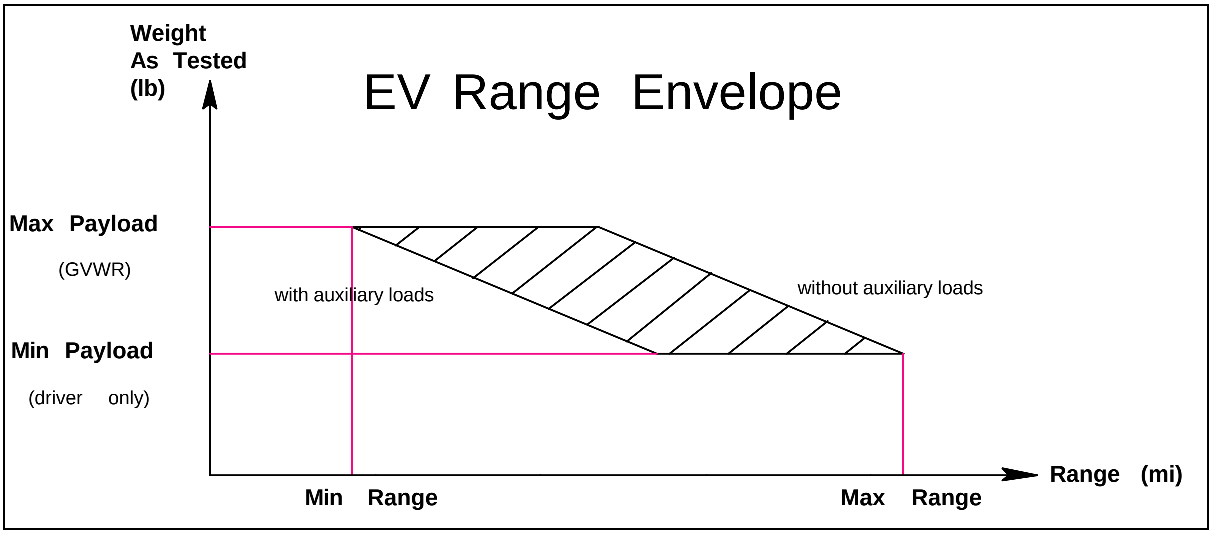


Figure 3-2. Range Envelope.

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

E. SOUND LEVEL TEST

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

F. STATE OF CHARGE METER EVALUATION

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

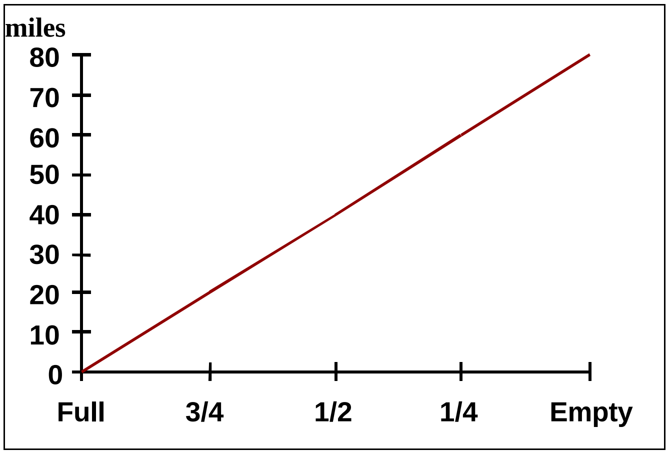


Figure 3-3. State of Charge Meter Evaluation.

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

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

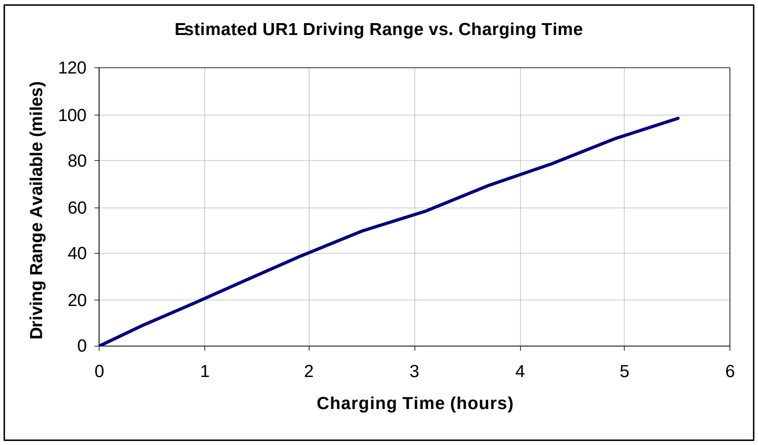


Figure 3-4. Sample plot of estimated range versus charging time.

G. PERFORMANCE TESTS

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

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

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

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

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

H. CHARGER PERFORMANCE/CHARGING PROFILE TEST

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

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

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

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

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

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

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

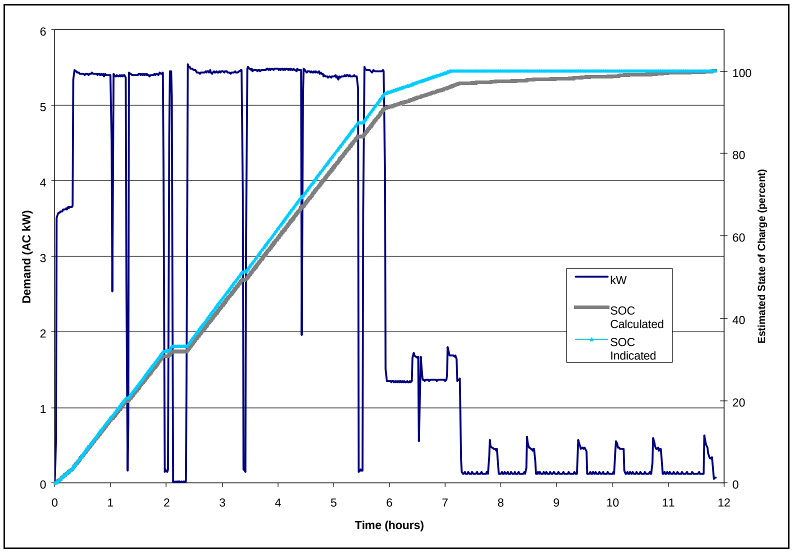


Figure 3-5. Sample AC charging profile plots.

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

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

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

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

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

Table 3-1. EPRI IWC EV Charging Standards.

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

5. Audible Noise Levels

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

6. Operation and Ergonomics Evaluations

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

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

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

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

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

7. Charging at a Residential Setting

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

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

1. Vehicle on Charger

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

2. Vehicle off Charger

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

J. TRANSFER THE VEHICLE

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

APPENDICES

EV Performance Characterization Testing Schedule

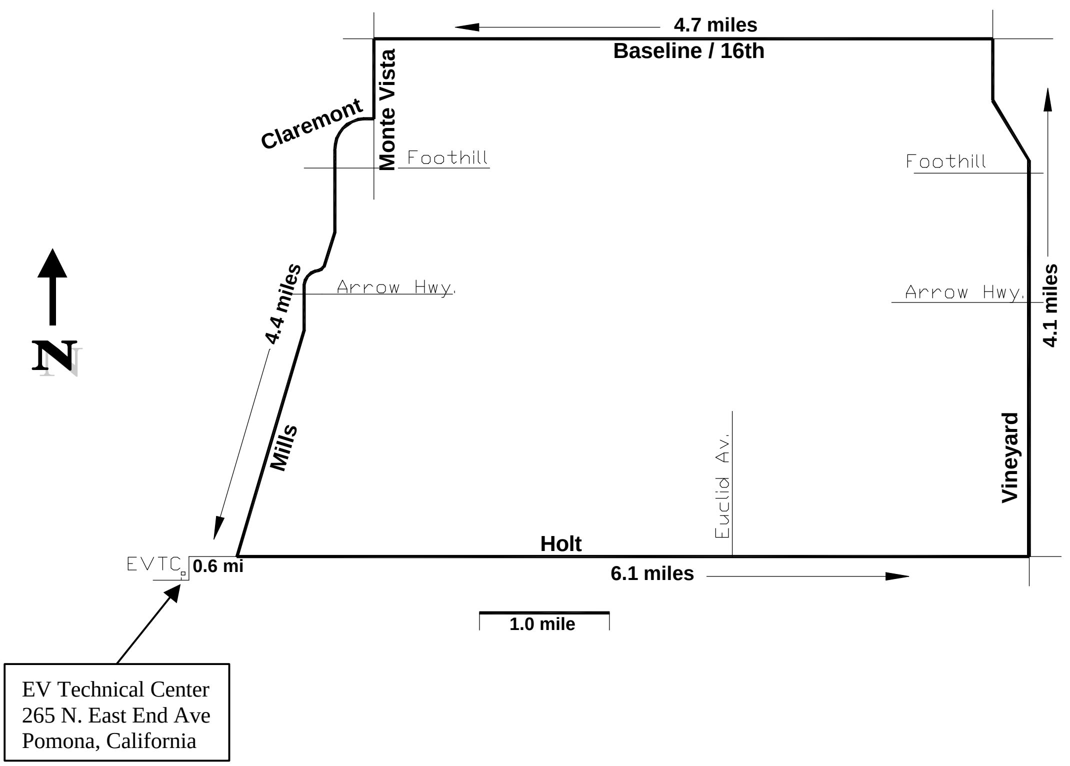
		Duration (days)
1.	Nomenclature Data Collection	½
2.	Weight Documentation - Curb (Front, Rear, Total) - GVWR (Front, Rear, Total)	½
3.	Battery Capacity Test	4
4.	Urban Range Tests - Distance per charge - AC kWh/mile - DC kWh/mile	8
5.	Freeway Range Tests - Distance per charge - AC kWh/mile - DC kWh/mile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

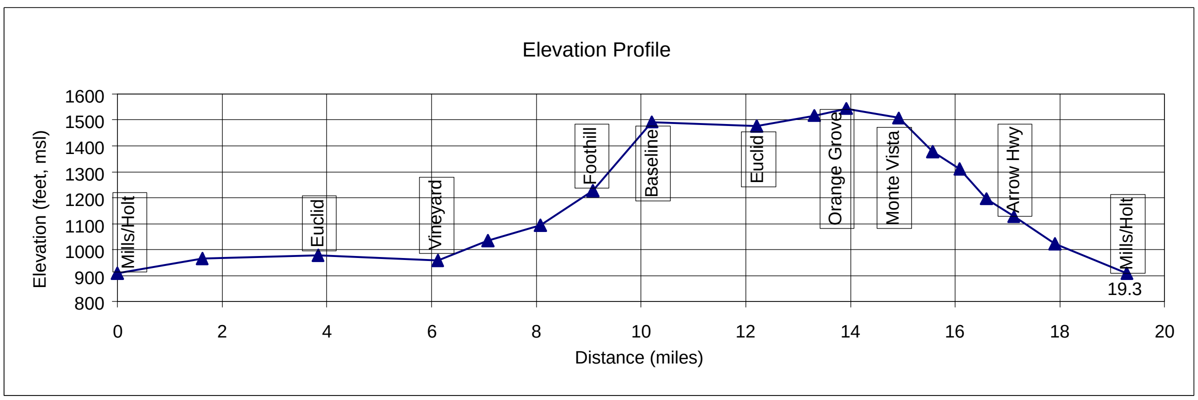
Minimum total days needed for full testing: 27

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

Pomona Loop Map

URBAN POMONA LOOP





Urban Pomona Loop - Tabulated Data

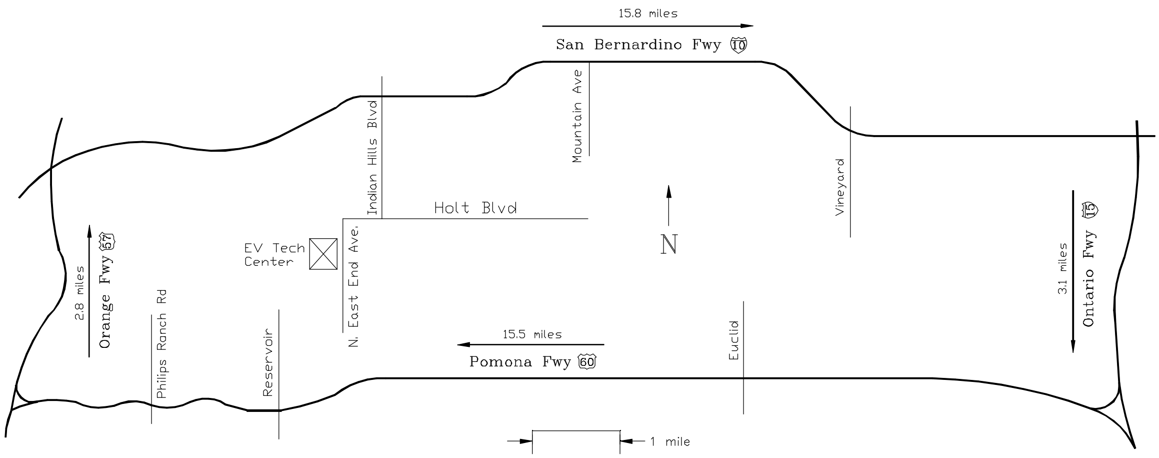
Stop No.	Distance from Start (miles)	Type	Distance from Previous stop	Comments
0	0.00	light	0.00	East End & Holt
1	0.10	light	0.10	
2	0.15	light	0.05	Mills & Holt
3	0.80	light	0.65	
4	1.30	light	0.50	
5	1.80	light	0.50	
6	2.30	light	0.50	
7	2.90	light	0.60	
8	3.50	light	0.60	
9	3.70	light	0.20	
10	4.00	light	0.30	
11	4.01	light	0.01	
12	4.30	light	0.29	
13	4.60	light	0.30	
14	4.80	light	0.20	
15	4.82	light	0.02	
16	5.30	light	0.48	
17	6.30	light	1.00	Vineyard & Holt
18	6.66	light	0.36	
19	6.70	light	0.04	
20	6.80	light	0.10	
21	6.90	light	0.10	
22	7.30	light	0.40	
23	7.80	light	0.50	
24	8.30	light	0.50	
25	8.60	light	0.30	
26	8.80	light	0.20	
27	9.30	light	0.50	
28	9.50	light	0.20	
29	9.60	light	0.10	
30	9.70	light	0.10	
31	10.40	light	0.70	Vineyard & Baseline
32	10.70	light	0.30	
33	10.90	light	0.20	
34	11.60	light	0.70	
35	11.90	light	0.30	
36	12.30	light	0.40	
37	12.50	light	0.20	
38	12.70	light	0.20	
39	13.00	light	0.30	
40	13.60	light	0.60	
41	14.10	light	0.50	
42	15.20	light	1.10	Baseline & Padua
43	16.30	light	1.10	
44	16.80	light	0.50	
45	17.10	sign	0.30	
46	17.40	light	0.30	
47	17.60	sign	0.20	

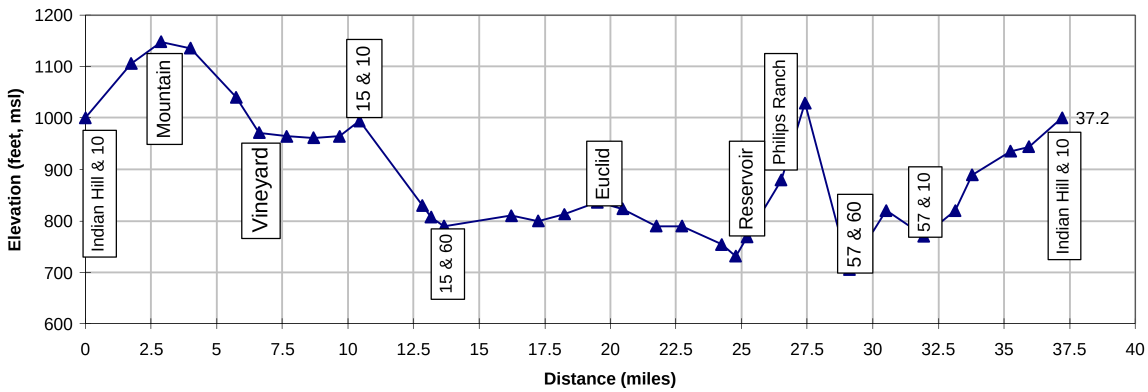
48	18.60	light	1.00	
49	18.70	sign	0.10	
50	19.00	sign	0.30	
51	19.30	light	0.30	
52	19.50	light	0.20	Holt & Mills
53	19.60	light	0.10	
54	19.80	light	0.20	Holt & East End

MCW: ttt
9/23/92

Freeway Loop Map

FREEWAY POMONA LOOP





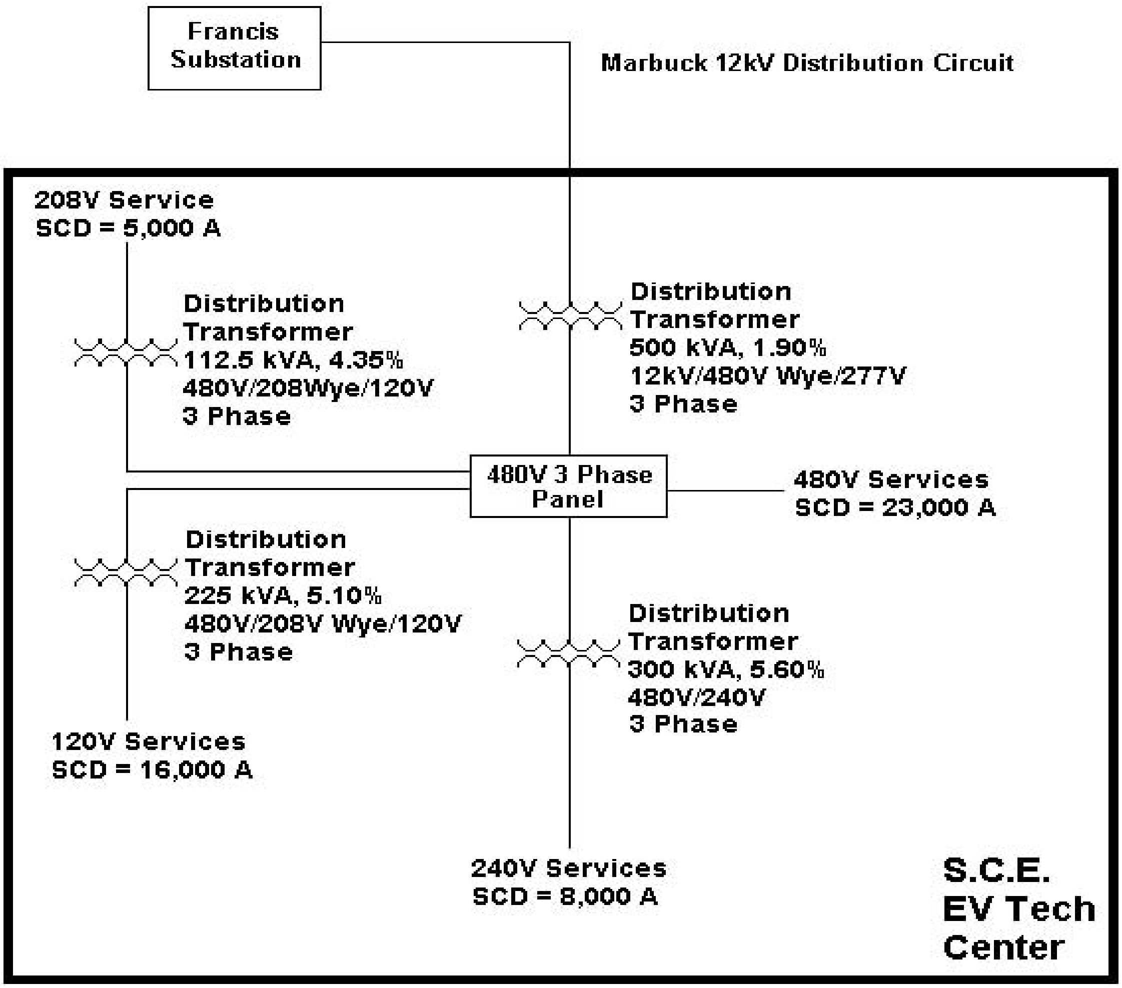
EVTC Equipment

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

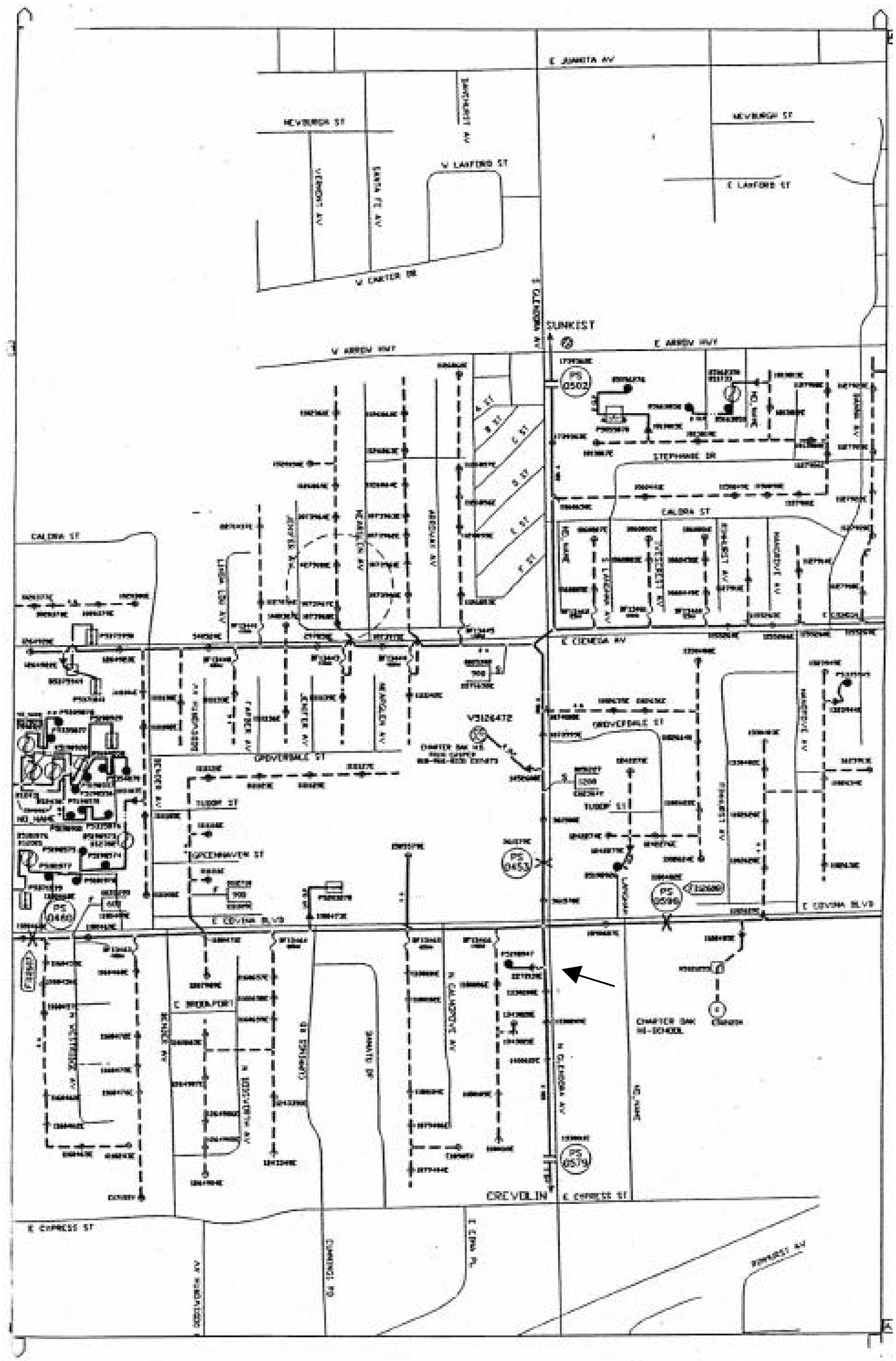
EVTC Number	Manufacturer	Model	Description	Quantity
MCR-001	OLYMPUS	MICRO-32	MICRO CASSETTE RECORDER	1
MMR-001	Various	Various	DIGITAL MULTIMETER	14
MMR-012	HEWLETT PACKARD	34401 A	MULTIMETER	1
MMW-001	ROLATAPE	MEASUMASTERMM30	MEASURING WHEEL	1
MPG-001	HEWLETT PACKARD	6942A	MULTIPROGRAMMER	1
NVK-001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

JWS 4/15/99

EV Tech Center Line Diagram



Residence Line Diagram



EVTC-010 Driving Test Data Sheet

POMONA DRIVING TEST DATA

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

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

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

Accessories used:

Drive / Regen setting:

Handling/Braking:

Other comments:

Charger	Serial No.		AC meter#		BMI #

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

Comments:

EVTC-010

EVTC-020 Charger Testing / Analysis Data Sheet

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

Charger Information

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

After Completion of Recharging Cycle

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

Charger Operation Information/Evaluation

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

EVTC-030 Performance Testing Data Sheet

ACCELERATION, MAXIMUM SPEED, AND BRAKING TESTS

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

Acceleration (100% SOC)

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

Acceleration (80% SOC)

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

Acceleration (60% SOC)

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

Braking 25-0 mph, 50% SOC

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

________ Average ft

Acceleration (40% SOC)

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

Acceleration (20% SOC)

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

Comments ________________________________

EVTC-040 Vehicle Test Equipment and Nameplate Data Sheet

Project:______________________________ Test:______________________________
Date(s):_______________________ File Name(s):______________________________
Vehicle Number:________________ Technician:_______________________________

VEHICLE

Manufacturer: _______________________VIN:______________________________________
Model: ________________________Model Year:_______ Date of Manufacture: ___________
GVWR:__________________Front AWR:____________ Rear AWR:______________________
Motor Manufacturer:___________________ Motor Type:__________________________
Motor Rating/Speed:____
Version/Serial No.:____
EPA Label Fuel Economy: ____
Controller Version/Serial No.: ____
Battery Pack Type/Version/Serial No.: ____
Tire Manufacturer: __________________________Model:________________________________
Tire Size:______________________ Maximum Pressure:___________________________
Maximum Tire Load: ____________ Treadwear Rating:____________________________

CHARGER

On-board / Off-board Manufacturer:____
Model: ________________________Serial Number:______________________________________
Charger Type/Version:____
EVSE Manufacturer: ____
EVSE Model/Version:_______________________Serial Number:___________________________
EVSE Software Version:____
Charge Port Manufacturer/Model/Version/SN:_____________________________________

TEST EQUIPMENT

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

WEIGHT CERTIFICATION

Scale Location and Proprietor:____
Examiner:___________________________________ Date:___________________________
Notes:____

EVTC-050 Sound Level Meter Data Sheet

Sound Level Test Data

Urban Driving Sound Level Test

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

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: ______________________________

Freeway Driving Sound Level Test

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

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: ______________________________

Charger Sound Level Test

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

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: ______________________________

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

Project:________________________ Test File:____________________________

Date(s):________________________ Technician:____________________________

Vehicle Number:____________________ Battery Nos.:____________________________

BATTERY SPECIFICATIONS

Manufacturer: ______________________ Model: __________________________________

Date of Manufacture: ________________ Nominal Voltage:____________________________

Ah Rating @ C/3:____________________ Voltage Range:______________________________

Weight/Module:______________________ Temp. Range:________________________________

BATTERY PACK

Number of Modules:__________________ Nominal Voltage:____________________________

Configuration: ____

Location for Test:____

TEST EQUIPMENT

Discharge Unit: ___________________________ Serial No.__________________________

Charging Unit: ____________________________ Serial No.__________________________

Data Acquisition Equipment:____

____

Other Equipment:____

RESULTS

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

RECHARGE TYPE			
Ah RETURNED			
kWh RETURNED			
DATA FILE			

NOTES:____

____