PERFORMANCE CHARACTERIZATION

GM EV1

Panasonic Lead Acid Battery

SOUTHERN CALIFORNIA EDISON

An *EDISON INTERNATIONAL* Company

ELECTRIC TRANSPORTATION DIVISION

Report prepared by:

Alvaro Mendoza

Juan Argueta

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PURPOSE

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

The following facts support this purpose:

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

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I. INTRODUCTION

The tests documented in this report characterize the performance of a 1997 GM EV1 (SCE vehicle # 23631) equipped with Panasonic valve regulated lead-acid batteries and inductive charging system. The original battery pack of the tested EV1 consisted of Delco lead-acid batteries and was upgraded to advanced Panasonic lead-acid batteries in January 2000. This EV1 has been part of Southern California Edison's fleet since 1997 and accumulated nearly seven thousand miles before the battery pack was upgraded.

The tests performed in this report were: weight certification, range, state of charge meter evaluation, acceleration, maximum speed, braking, power quality evaluation, and charger performance. Testing was performed at the Electric Vehicle Technical Center (EV Tech Center), on the Urban and Freeway Pomona Loops, and the Pomona Raceway. Please refer to Appendix I, page 58, for the procedure used.

II. MANUFACTURER'S SPECIFICATIONS

Vehicle Make:	General Motors
Model:	EV1 / Panasonic Lead Acid
Range:	55 to 95 miles/ recharge
Maximum Speed:	80 mph
Motor Type:	Three-phase, AC Induction, electric
System Power:	102 kW (137 hp) @ 7,000 rpm
Transaxle:	Single speed, front wheel drive
Traction Battery	
Type:	Lead Acid
Manufacturer:	Panasonic
Model:	EC-EV1260
Capacity:	60 DC Ah at C/3 rate, 18.7 DC kWh
Number of Modules:	26
Nominal Pack Voltage:	312 V
Battery Pack Weight:	1310 lb
Dimensions	
Length:	169.7 in.
Width:	69.7 in.
Height:	50.5 in.
Wheelbase:	98.9 in.
GVWR:	3507 lb

III. RESULTS

A. Weight Certification

Table 3-1. Weight Certification

	Front Axle	Rear Axle	Total Weight
GVWR (lb)	1779	1769	3507
Curb Weight (lb)	1610 *	1450 *	3060
Available Payload (lb)	169	319	**447**

*Front and rear weights are not certified.

B. Range Tests

B1. Urban Range Tests

Table 3-2. Urban Range Test Results*

Tests	UR1	UR2	UR3	UR4
Range at Stop Condition (mi.)	90.3	79.7	88.9	72.6
Total Miles Driven	91.0	80.5	89.1	73.0
Driving Conditions				
Payload (lb)	185	185	447	447
Average Amb. Temp. ^{o} F	65	72	70	71
Average Speed (mph)	27.0	25.4	26.1	23.1
Recharge				
AC kWh Recharge	26.91	26.61	27.69	22.8
AC kWh/mi.	0.296	0.331	0.311	0.312

*Average of two tests, except UR4.

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

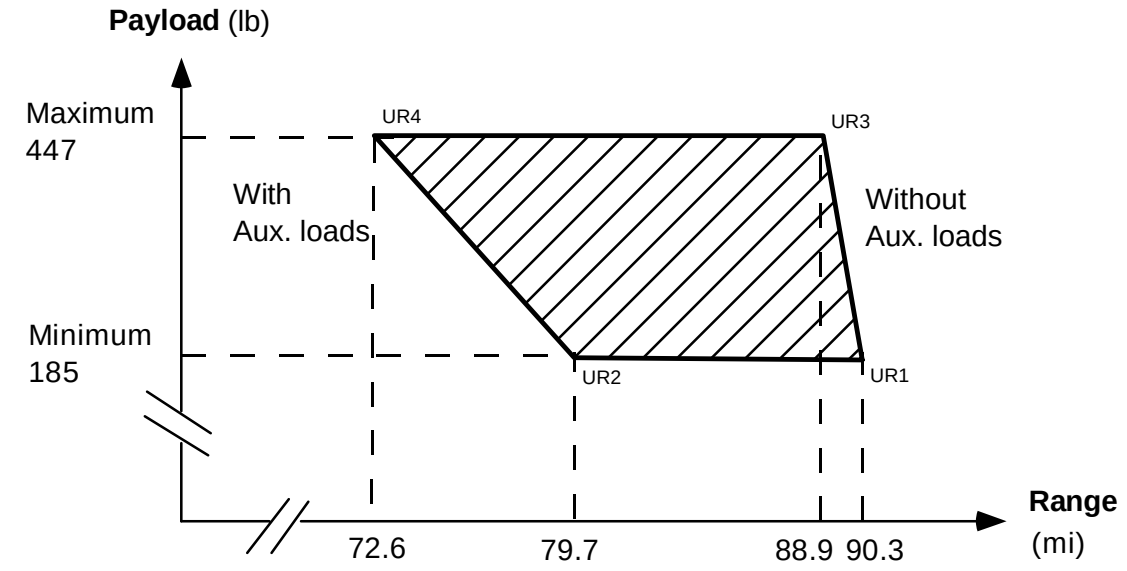


Figure 3-1. 1999 RAV4 EV Urban Range Envelope

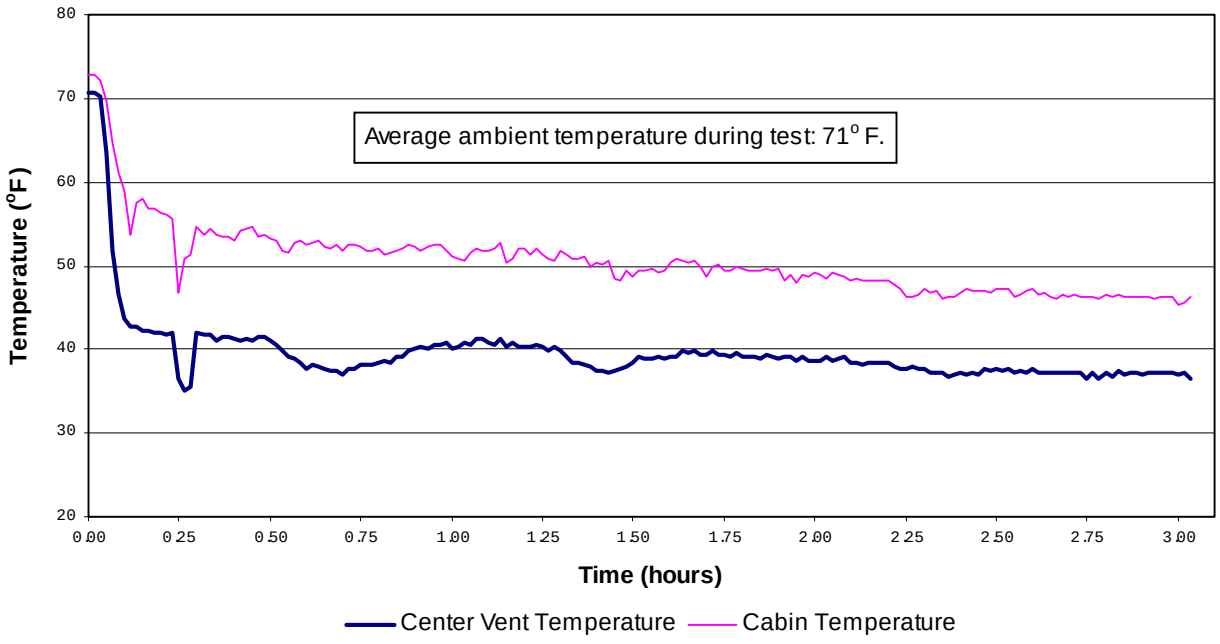


Figure 3-2. Air conditioning system (A/C) performance during the UR4 test.

B2. Freeway Range Tests

Table 3-3. Freeway Range Test Results*

Tests	FW1	FW2	FW3	FW4
Range at Stop Condition (mi.)	113.6	105.6	112.1	91.8
Total Miles Driven	114.6	105.7	115	92.1
Driving Conditions				
Payload (lb)	185	185	447	447
Average Amb. Temp. ^{o} F	64	78	67	72
Average Speed (mph)	53.9	54.0	55.0	52.6
Recharge				
AC kWh Recharge	25.53	27.35	27.45	24.23
AC kWh/mi.	0.223	0.259	0.239	0.263

*Average of two tests, except FW4.

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

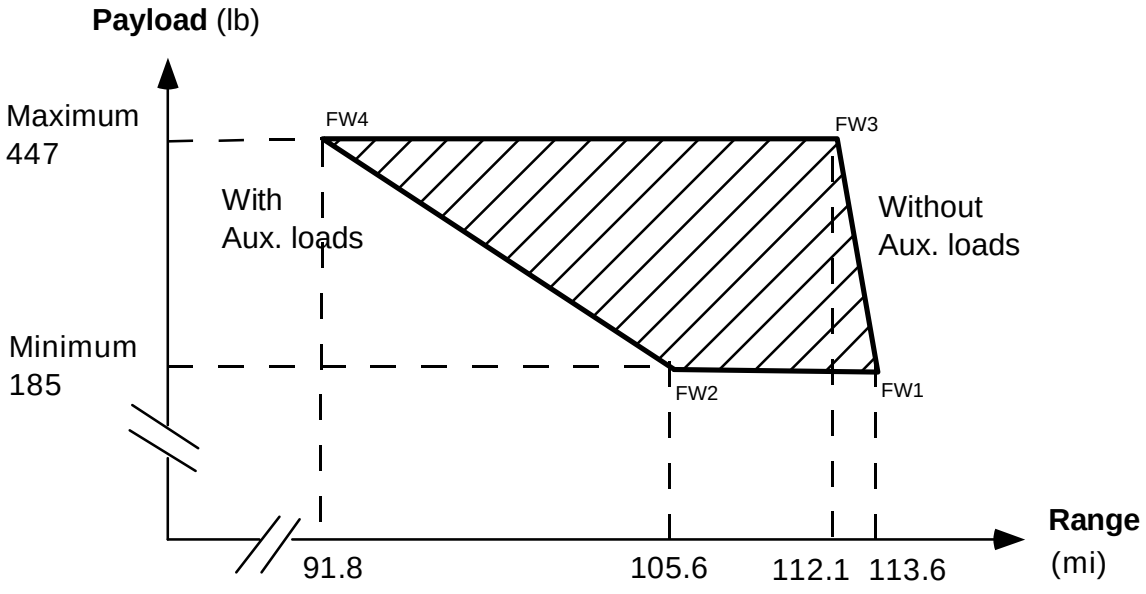


Figure 3-3. Freeway Range Envelope

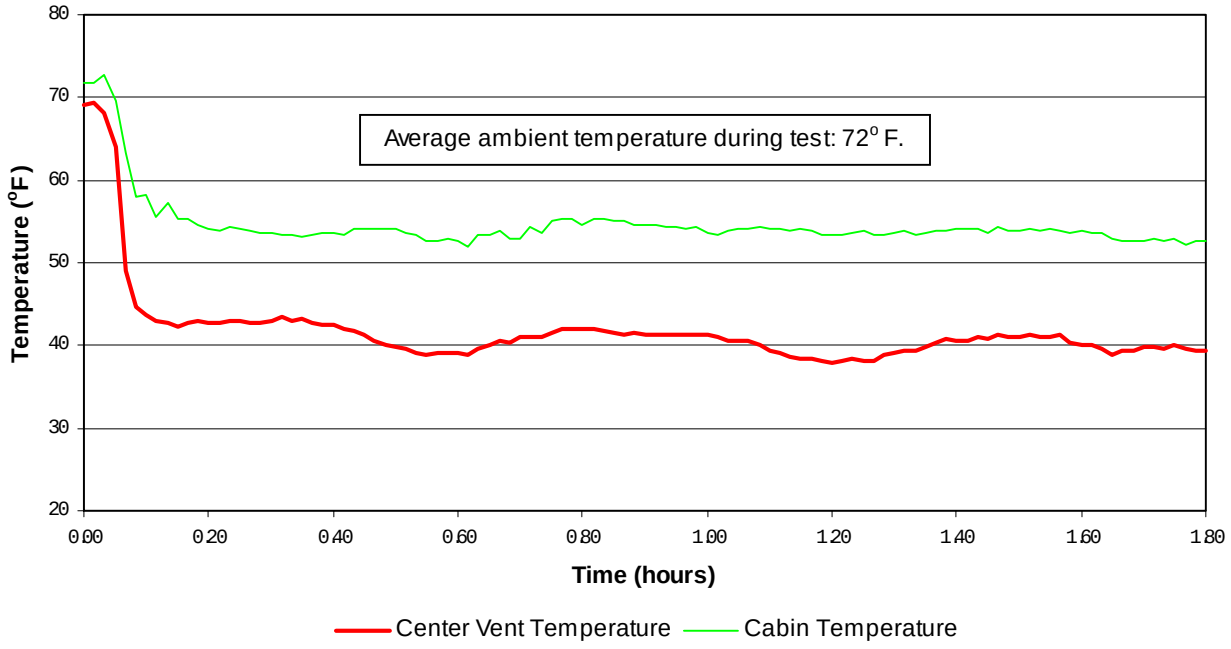


Figure 3-4. A/C performance during the FW4 test.

C. State of Charge (SOC) Meter Evaluation

C1. Driving SOC Meter Evaluation

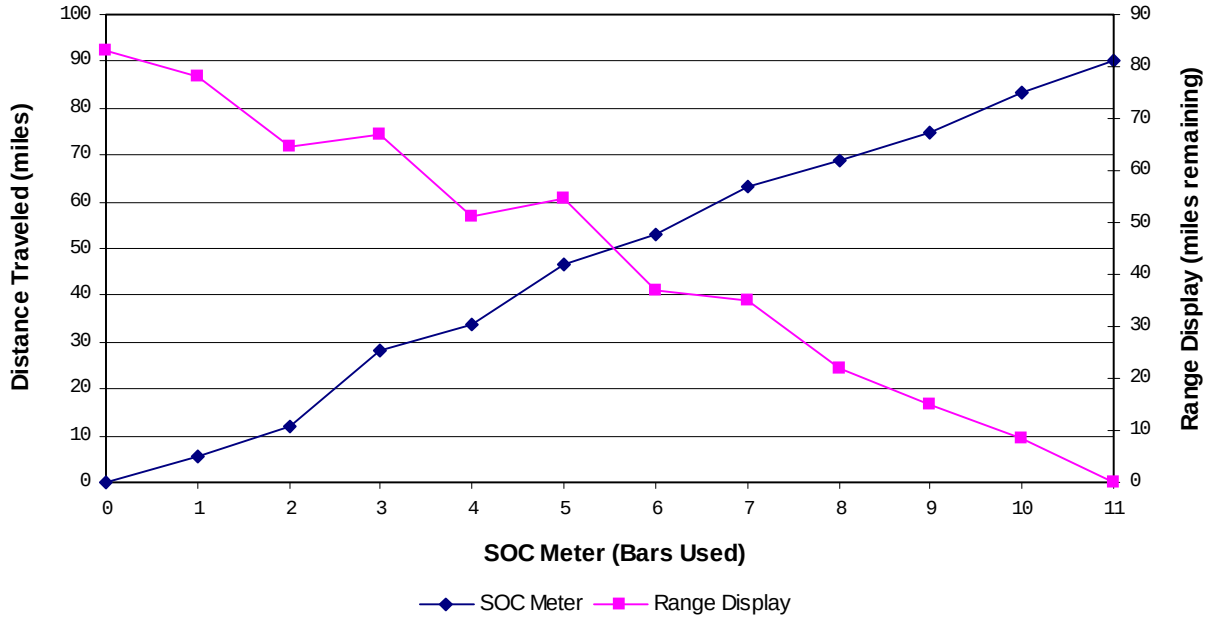


Figure 3-5. Evaluation of the battery SOC gage and available vehicle range display.

Figure 3-6. EV1 available vehicle range display and battery pack SOC meter.

C2. Charging State of Charge Meter Evaluation

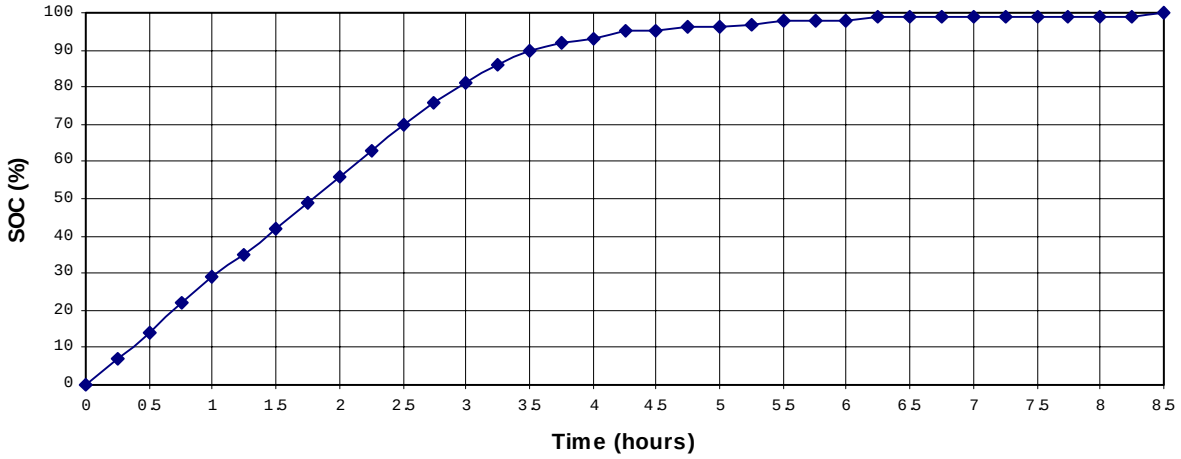


Figure 3-7. SOC meter readings at 15-minute intervals while the EV1 was recharging.

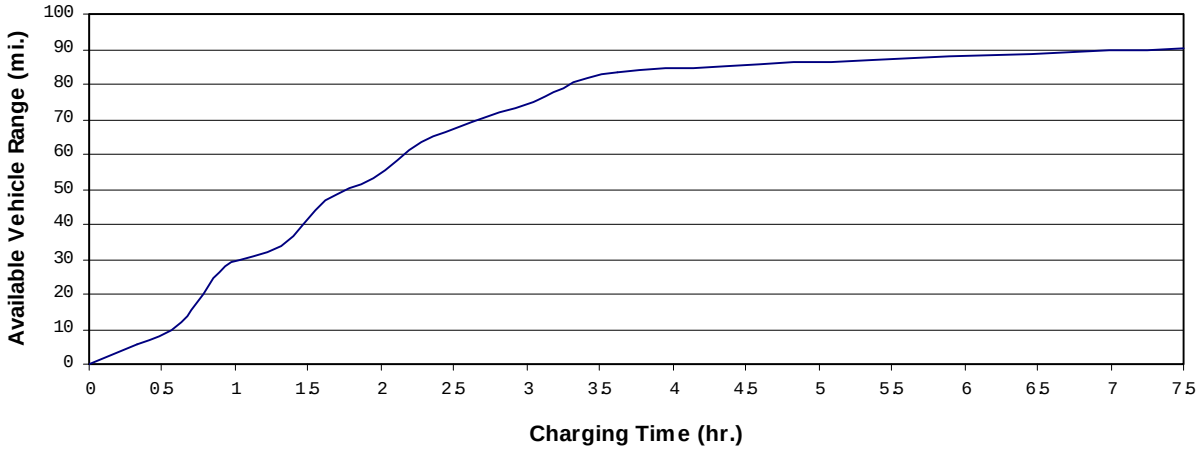


Figure 3-8. Available vehicle range vs. charging time, UR1.

Note: This curve was calculated using results of average charging time and average vehicle range from the two UR1 tests.

D. Acceleration, Braking and Maximum Speed Tests

Table 3-4. Summary of Test Results[1]

Battery SOC	100%	80%	60%	40%	20%
0 to 30 mph (sec.)	3.22	3.19	3.09	3.19	3.59
30 to 55 mph (sec.)	3.86	4.01	4.11	4.39	9.77
0 to 60 mph (sec.)	8.04	8.09	8.47	8.76	11.49
Max Speed (mph)	82	*	*	*	80.50
Braking (25-0 mph) (ft.)	*	*	34.71	*	*

[1]Average values (average ambient temperature: 67° F). (185 lb Payload)
* Not tested

Figure 3-9. Speed and distance vs. time at 100% battery SOC.

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

E. Charger Performance / Profile Test

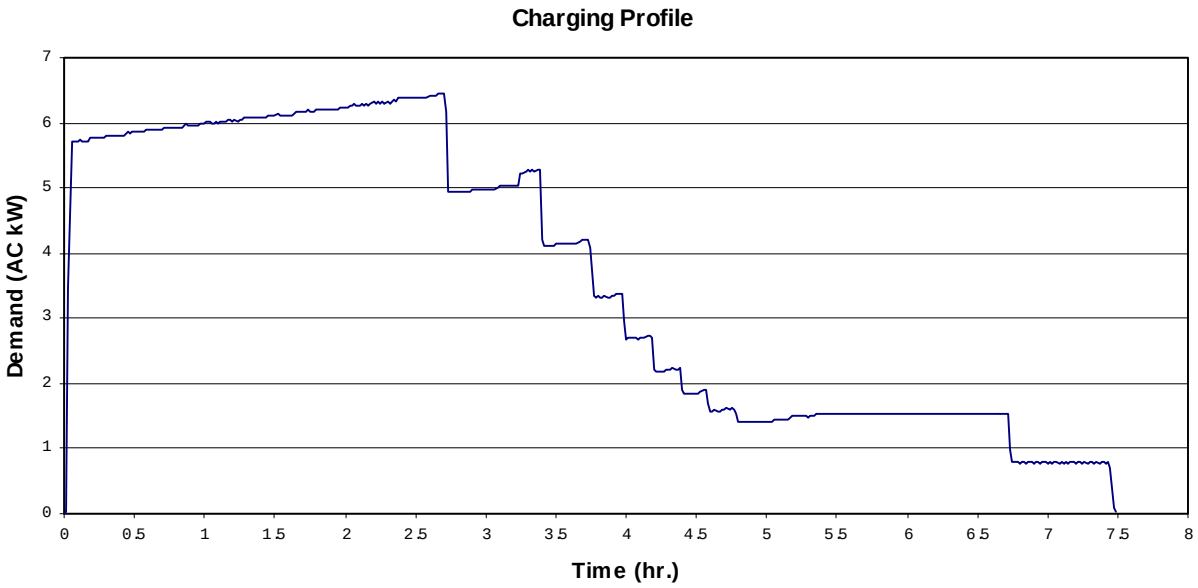


Figure 3-10. EV1 charging profile (second FW3 test).

Table 3-5. Charger Data at Peak Power Demand.

Measured Value*	Total
Voltage (V rms)	232.3**
Current (A rms)	27.4
Real Power (kW)	6.3
Apparent Power (kVA)	6.4
Reactive Power (kVAR)	0.6
Power Factor (PF)	0.996
Voltage THD	2.34%
Current THD	4.06%

Total Charging Time	7 hours, 28 minutes
Total Energy Consumption (kWh)	27.19

Time Observed on Stand-by	24 hours
Energy Consumption (kWh)	0.51
Average Power (W)	21.24

Note: Refer to Appendix G page 45, for Dranetz Power Platform 4300 graphical data.

*Values recorded with charger at maximum power at the AC (input) side of the charger (240 V) connected to a split single-phase supply system (see Figure 3-11, page 9). Test was conducted after the second FW3 test at a starting ambient temperature of 71^{o} F.

**Phase A-N and B-N voltage was 116.2V and 116.1V respectively.

Table 3-6. Power Quality Data

	Phase A			Phase B			Average
	Min.	Max.	Ave.	Min.	Max.	Ave.	phases A, B
Power Factor*	0.775	0.997	0.956	0.769	0.995	0.953	0.954
Voltage THD (%)	1.995	2.364	2.284	1.965	2.339	2.261	2.273
Current THD (%)	3.995	4.457	4.132	3.898	4.377	4.045	4.089
Voltage Harm. #3 (%)	0.324	0.475	0.373	0.248	0.401	0.313	0.343
Current Harm. #3 (%)	3.523	3.939	3.588	3.397	3.849	3.470	3.529

Note: All harmonic values are shown as a percentage of the fundamental component.

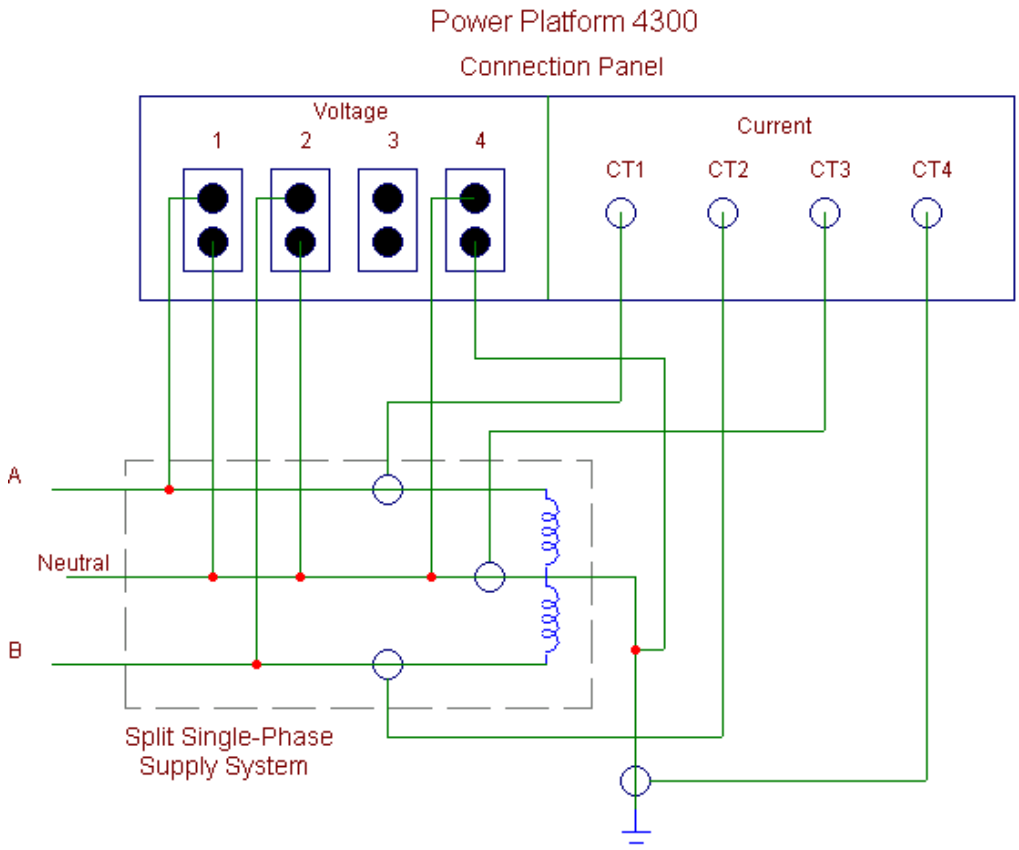


Figure 3-11. Dranetz Power Platform 4300 connection diagram.

IV. DISCUSSION OF TEST RESULTS

A. Weight Certification

The EV1 was taken to a certified scale to measure front axle, rear axle, and total weight. The measured total curb weight was 3060 pounds, 80 pounds heavier than the original 1997 EV1 with Delco lead-acid batteries. To compensate for the added weight from the new battery pack GM installed new shock absorbers. This increased the GVWR from 3410 to 3507 pounds and kept the available working payload of 460 pounds for the 1997 EV1 about the same. The GVWR minus the total curb weight yielded the maximum calculated payload of 447 pounds, which was used to perform the tests.

Figure 4-1. Passenger's seat loaded with 162 lb.

As seen from Table 3-1, on page 2, the available front axle payload was 169 pounds, and an available rear axle payload of 319 pounds. To load the vehicle to its maximum payload (447 pounds), a water dummy with a weight of 162 pounds was placed on the passenger's seat and 4 sacks of lead, 25 pounds each, were placed in the trunk. Figures 4-1 and 4-2 show the weight added to the vehicle's passenger seat and trunk.

Figure 4-2. Trunk loaded with 100 lb.

B. Range Tests

Range tests on the EV1 were performed by driving it 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 done twice or repeated until two results were within 5.0% of each other. For this reason, the FW3 test was done three times and the average of the two closest results was reported on Table 3-3 on page 4. In addition, the UR4 and FW4 tests were performed only once because the EV1 was recalled by GM due to a charger port fire hazard.

To provide consistency, all range tests were terminated when no bars were displayed in the SOC gage (see Figure 3-6, page 6) and the "battery life" warning light in the instrument panel came on. Upon returning to the EV Tech Center for battery recharging, the SOC displayed on the charger was 0%. The EV1 never had trouble keeping up with the flow of traffic during the range tests, and acceleration and braking were responsive throughout the drive.

B1. Urban Range Tests

To test the EV1 in a city-driving environment, it was driven on the Urban Pomona Loop to its maximum range as defined above (see Appendix H, page 56, for a map of the Urban Pomona Loop). Maximum speed varied between 30 and 50 mph according to posted speed limits. The vehicle was driven and charged only once per day, and at least three loops were completed for each of the four urban drive scenarios.

As seen from the range envelope (Figure 3-1, page 3), auxiliary loads (air conditioning and headlights) clearly affected the range of the EV1. On the other hand, driving at maximum payload with no auxiliary loads did not have a considerable effect on the range. The highest range obtained from urban driving (90.3 miles) is from the average of range tests conducted with the vehicle unloaded (driver only) and no auxiliary loads. Driving range was reduced 1.6% at maximum payload, 11.5% with auxiliary loads usage, and 19.6% with both auxiliary loads and maximum payload.

Energy consumption did not change considerably between driving modes since the end of test was determined by the energy available from the battery. The average energy supplied during charging after urban range testing was 26 AC kWh.

To evaluate the air conditioning (A/C) system, a thermocouple was placed at the center cabin vent to monitor the temperature at the start and end of the drive, and 10 minutes from start. The temperature decreased soon after the A/C was turned on. It was also observed that during warmer days, the A/C system is noisier. The system did not operate during a UR4 test at an ambient temperature of 63^{o}F. The 1997 EV1 seems to have a minimum temperature limit of 68^{o}F for A/C operation. The lowest recorded temperature at the vent was 36.8^{o}F during range tests at minimum payload (average of UR2s), and 35.1^{o}F during the test at maximum payload (UR4).

A thermocouple temperature logger was used on the UR4 and FW4 tests to continuously record the temperature from the center vent and the cabin ambient temperature at mid-cabin chest level. As seen from Figure 3-2, page 3, the difference in temperature between the cabin and center vent during the UR4 test averaged around 10^{o}F. The thermocouple temperature logger was set to take temperature readings every minute, recording an average of 38.7^{o}F at the center vent, and 49.6^{o}F at mid-cabin chest level during the UR4 test.

B2. Freeway Range Test

Traffic conditions were good for all range tests, and vehicle 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 H, page 56, for a map of the Freeway Pomona Loop).

Range from freeway driving was affected more by auxiliary load usage than by payload as in the case of the urban range tests. The highest range obtained from freeway driving (113.6 miles) occurred at minimum payload and without auxiliary loads (average of FW1 tests). Driving range was reduced 1.3% at maximum payload, 7.0% with auxiliary loads usage, and 19.2% with both auxiliary loads and maximum payload.

Energy consumption was also similar for most of the tests; the average recharge for freeway tests was 26.14 AC kWh, while after urban testing it was 26.0 AC kWh. These results indicate that energy consumption did not depend on the manner the vehicle was driven. Energy usage per mile on the freeway was smaller than it was on the urban loop by an average of 21.3%. This suggests that at higher speeds, the vehicle achieves its best performance due to its unique aerodynamic shape.

Test results show that driving range has been extended with the new Panasonic advanced lead-acid batteries. The increase in range has been achieved without considerably affecting vehicle efficiency (AC kWh/mile), and driving quality. The calculated rate of consumed energy per mile (urban and freeway combined) was 0.268 AC kWh/mile for the EV1 with Delco batteries and 0.279 AC kWh/mile with Panasonic batteries.

C. State of Charge Meter Evaluation

The SOC meter (Figure 3-6, page 6) indicates the level of charge in the traction battery whenever the vehicle is “on”. This meter consists of eleven bars that extinguish sequentially as energy is used; each bar represents about 9% of the usable battery energy. Readings of the distance traveled (trip meter) and available range display were taken every time a bar extinguished. The results are shown on Figure 3-5, page 5. The chart shows a mostly linear relationship between SOC meter bars and miles driven. It can be useful in estimating the remaining distance the

vehicle can travel with a consistent driving style. The small waves on the plot are likely caused by the grades on the Pomona Loop.

The available range display, located on the left side of the SOC meter, helps estimate the remaining driving distance under similar traffic conditions for the existing battery SOC. This display was fairly close to the actual distance the EV1 traveled. It was more accurate, after 20 miles or so, as the initial readings seemed to reflect the driving conditions prevailing before the vehicle had been recharged.

Vehicle range was determined by driving the vehicle until no bars were displayed on the SOC meter. At this point, the "battery life" warning light comes on indicating that there is a small charge reserve. This warning light was very consistent and always came on immediately after the last bar was distinguished. When these conditions were met, the usable SOC was 0% as indicated by the charger. Figure 3-8 on page 6 shows driving range per charging time calculated for minimum payload and no auxiliary usage (UR1 tests). The charging time was determined from the SOC meter evaluation data. The "waves" on the curve are caused by the grades on the Pomona Loop.

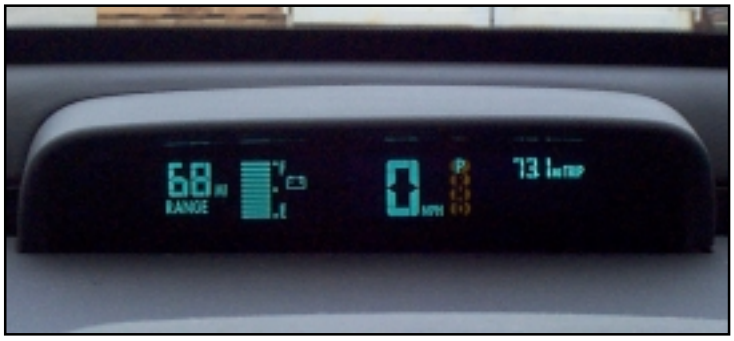


Figure 4-3. Instrument panel.

Figure 4-4. Battery life light.

Figure 4-5. Control Panel.

D. Acceleration, Braking, and Maximum Speed Tests

Performance testing of the EV1 took place at the Pomona Fairplex drag strip; the track was dry and the ambient temperature varied from 60 to 63°F. A VC2000PC performance-testing computer made by Vericom Computers, Inc. was used for the vehicle acceleration and braking tests. This computer uses an accelerometer to determine acceleration, speed, and distance at a sampling rate of 100 times per second. Two acceleration runs were conducted for each test at different SOC levels, and the average was documented on Table 3-4, page 7. Averaging of the values takes slope and head wind into account since each test is done in opposite directions. The vehicle responded very reliably to acceleration tests, and no noticeable drop in power was observed until the last tests at 20% SOC. With the exception of the tests at 20% SOC, the results were fairly consistent at all levels of energy; there was only a slight increment of acceleration time at lower charge levels. The most significant time increases occurred at 20% SOC: 11.5% from 0 to 30 mph, 42.9% from 0 to 60%, and 153.1% from 30 to 55 mph. to 20% SOC. These results indicate that the EV1's performance is affected more at higher speeds when the SOC drops.

Figure 4-6. Performance testing computer setup.

Maximum speed tests were conducted at 100% and 20% SOC. At 100% SOC, the average maximum speed was 70.5 mph, and at 20% SOC, it was 70.5 mph. Maximum speed was achieved easily in a short distance at 100% SOC, but at 20% SOC it took about double that distance.

Braking distance tests were conducted with the VC2000PC performance-testing computer from 25 to 0 mph at 60% SOC. Eight braking distance tests were conducted in opposite directions to compensate for the grades on the testing track and the average was 34.7 feet. The four-wheel ABS brakes of the EV1 worked very efficiently during the braking tests. Turning radius, as measured with a measuring wheel was 31 feet and 10 inches.

E. Charger Performance / Profile Test

Charging of the EV1 at the EV Tech Center was done with a standard off-board 6.6 kW Magne Charge Inductive charger (Figure 4-7). Full recharge time (0% to 100% SOC) was very inconsistent from charge to charge. The average time was 7 hours and 29 minutes. The shortest charging time was 4 hours and 54 minutes while the longest was 8 hours and 40 minutes.

Figure 4-7. Charger testing with off-board 6.6 kW inductive charger.

As shown in Table 3-5, page 8, the total peak power recorded with a 4300 Dranetz Power Platform (model 4300) was 6.3 kW, at a current of 27.4 A rms, a voltage of 232.3 V rms, and a power factor of 0.996. Data obtained with the Power Platform indicates that peak power was supplied to the vehicle for about 15 minutes only. The power quality of the charger was

acceptable throughout the charge. On average, the voltage total harmonic distortion (Vthd) was 2.27% and the current total harmonic distortion (Ithd) was 4.09%. Harmonic distortion at the third harmonic was also recorded; the average (percentage of fundamental) was 0.34% for voltage and 3.53% for current. These distortion levels do not have a significant effect on the load and the utility distribution system.

Charging of the EV1 during this particular test took 7 hours and 28 minutes (the charging time average) and consumed 27.19 AC kWh. The vehicle was monitored for a period of 24 hours after reaching full charge. During this 24-hour period, the charger drew a steady amount of low-level energy. The average power was 21.24 W, and the total "stand by" energy consumed was 0.51 AC kWh.

APPENDIX A

VEHICLE MANUFACTURER'S FACT SHEET

OKAY, THERE ARE A FEW THINGS INSIDE THAT ARE QUITE REMARKABLE.

PERFORMANCE

0-60 mph acceleration in less than 9 seconds

Top speed of 80 mph (electronically regulated)

EV1 prototype set land-speed record for electric cars at 183 mph

137-horsepower, alternating current induction motor revs to nearly 15,000 rpm

Smooth, shift-free, instantaneous throttle response

0.19 aerodynamic drag coefficient (25% lower than any other production car)

Estimated range using 85% of battery charge = EPA city: 70 miles, highway: 90 miles

Charge time with 15% battery capacity remaining:
- approximately 3 hours using 220-volt/6.6-kW charger
- approximately 15 hours using trunk-mounted 110-volt/1.2-kW charger

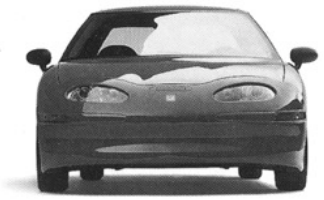
312 volts from 26 maintenance-free Valve-Regulated Lead-Acid (VRLA) batteries

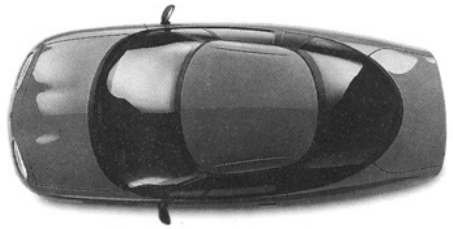
Regenerative braking system with "coast down" feature recovers kinetic energy to help recharge batteries

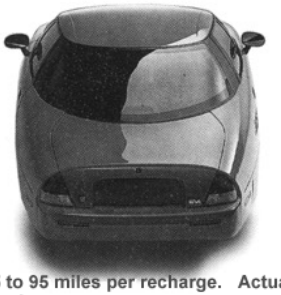
Short-long arm front/multi-link rear suspension uses aluminum and composite components to reduce weight

SPECIFICATIONS

Bodystyle	2-door/2-passenger coupe	
Powertrain configuration	Transverse mounted, front-wheel drive	
Length	169.7 in.	4,309 mm.
Width	69.5 in.	1,766 mm.
Height	50.5 in.	1,281 mm.
Wheelbase	98.9 in.	2,512 mm.
Frontal area	20.3 sq. ft.	1.89 sq.m.
Track (front)	57.9 in.	1,470 mm.
(rear)	49.0 in.	1,244 mm.
Passenger volume	50.4 cu. ft.	1.78 cu. m.
Trunk volume	9.7 cu. ft.	275 lt.
Curb weight	2,970 lbs.	1,350 kg.
Battery pack weight	1,175 lbs.	533 kg.







SPECIAL FEATURES

Dent/corrosion-resistant composite exterior body panels

Rigid, welded and bonded aluminum alloy spaceframe

"Heat pump" climate control system can be activated by timer to preheat or precool the passenger compartment while connected to charger

Inductively coupled charging system uses a separable isolation transformer to create a magnetic field that can charge the battery pack in any weather condition

Electro-hydraulic, variable-effort power steering system

Insulated Gate Bipolar Transistor (IGBT) power inverter manages enough electricity to power two 50,000-watt radio stations

Center-mounted fluorescent instrumentation places all information in driver's natural field of vision

STANDARD FEATURES

Driver and passenger front airbags

Anti-lock braking system (ABS)

Traction control

Self-sealing, puncture resistant 175/65R14 tires with check pressure system

"Squeeze cast" aluminum alloy wheels

AM/FM stereo with compact disc/cassette player and 4 speakers

Solar reflective/absorptive glass with Electriclear™ windshield defogger/deicer

Cruise control

Electronic keypad entry/vehicle-activation system

Power windows, door locks and outside mirrors

Reclining bucket seats with Scotchgard™ Fabric Protector

Daytime Running Lights (DRL)

EV1

Note: Range of the 1997 EV1 with Panasonic advanced lead-acid battery pack is 55 to 95 miles per recharge. Actual mileage and range will vary as a result of driving style, terrain, temperature and accessory usage, particularly, as affected by ambient temperature and the use of heating and air conditioning. The new curve weight is 3,060 lbs. (1,388 kg.), and the battery pack weight is 1,310 lbs. (594 kg.)

APPENDIX B

BATTERY MANUFACTURER'S FACT SHEET

Panasonic

EV Battery for Electric Vehicles

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

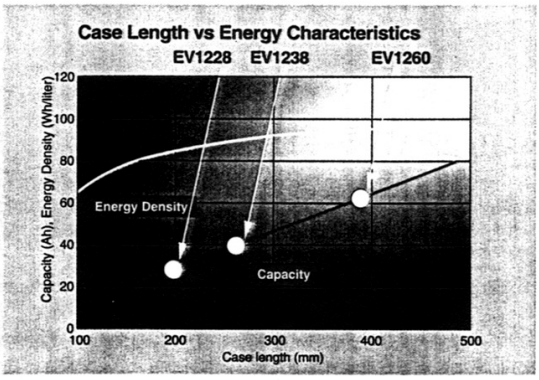
EC-EV1228

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 tested 1997 EV1 is composed of 26 Panasonic lead-acid battery Modules (model # EC-EV1260)

Panasonic

EV Battery for Electric Vehicles

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造し、「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.

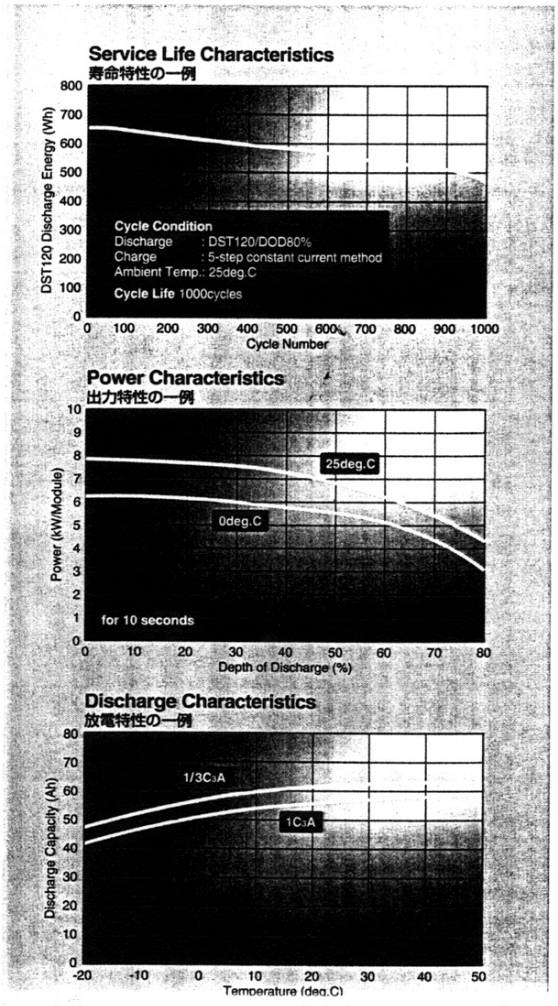
• 広い温度範囲で使用可能
低温から高温まで優れた放電特性を発揮します。

●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): 1/20/2000 - 3/2/2000
File Name(s): PM 97-EV1 Panasonci Lead-Acid
Vehicle #: 23615
Technician: Alvaro Mendoza

~~VEHICLE~~

Manufacturer: General Motors
VIN: 4G5PX225XV0200265
Model: EV1
Model Year: 1997
Date of Manufacture: Oct-96
GVWR: 3507 lb
Front AWR: 1779 lb
Rear AWR: 1769 lb
Motor Manufacturer: GM
Type: 3-phase, AC induction, electric.
Motor Rating/Speed: 102 kW (137 hp) @ 7,000 rpm.
Version/Serial No.: N/A
EPA Label Fuel Economy: 26 kWh/100 miles City and Highway.
Controller Version/Serial No.: System 110
Battery Pack Type/Version/Serial No.: Panasonic Valve regulated lead-acid / EC-EV1260
Tire Manufacturer: Michelin
Model: Proxima RR
Tire Size: 175/65R14
Maximum Pressure: 50 psi
Maximum Tire Load: 1102 lb (500 kg)
Treadwear Rating: 200

~~CHARGER~~

Off-board
Manufacturer: Delco Electronics
Model: Magne Charge
Serial Number: WM2009822038R
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: Dranetz-BMI 4300 Power Platform
ABB kWh Meter Serial Number: 01 223 620
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: NA
ABC-150 EVTC Number: NA
Smart Guard Interface Serial Number: NA
Smart Guard Numbers: NA
Sound Level Meter EVTC Number: SMR - 001
Measuring Wheel EVTC Number: MMW-001
Other Equipment: Vericom performance computer DYM-001, Omega temperature logger

~~WEIGHT CERTIFICATION~~

Scale Location and Proprietor: Mission Recycling Center, Pomona, CA
Examiner: Yolanda Oliva
Date: 01/20/2000
Notes:

APPENDIX D

RANGE TEST DATA SHEETS

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
01/21/2000	23615	200265	UR1	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	185				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:10	7036	100	N/A	N/A	65 F	N/A	N/A
Stop	16:50	7127	0	N/A	N/A	63 F	N/A	Min. A/C
Net	6:40	91.1	-100			-2 F		N/A

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	84	
5.7	10	82	
12.5	9	64	
26.8	8	75	
32.7	7	50	
46.4	6	59	
53.7	5	37	
64.8	4	36	
70.0	3	20	
77.2	2	16	
84.0	1	8	
90.4	0	0	Battery life light illuminated
91.1	0	0	End of drive.

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 620	2

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	01/21/2000	16:55	954	N/A	N/A	N/A	64 F	N/A
Stop	01/22/2000	0:17	982	N/A	N/A	N/A	N/A	N/A
Net		7:22	26.8					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
01/24/2000	23615	200265	UR1	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	185				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	7:35	7127	100	N/A	N/A	61 F	N/A	N/A
Stop	10:40	7218	0	N/A	N/A	69 F	N/A	Min. A/C
Net	3:05	90.8	-100			8 F		N/A

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	82	
5.2	10	74	
11.3	9	65	
29.4	8	59	
34.8	7	52	
46.8	6	50	
52.2	5	37	
62.0	4	34	
68.0	3	24	
72.1	2	14	
83.0	1	9	
90.2	0	0	Battery life light illuminated
90.8	0	0	End of drive.

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 620	2

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	01/24/2000	11:15	982	N/A	N/A	N/A	69 F	N/A
Stop	01/24/2000	19:46	1009	N/A	N/A	N/A	N/A	N/A
Net		8:31	27.02					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
01/25/2000	23615	200265	FW1	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	185				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:55	7218	100	N/A	N/A	59 F	N/A	N/A
Stop	12:00	7324	0	N/A	N/A	60 F	N/A	Min. A/C
Net	2:05	90.8	-100			1 F		N/A

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	82	
4.0	10	74	
24.0	9	65	
37.0	8	59	
47.3	7	52	
58.3	6	50	
69.7	5	37	
76.2	4	34	
81.6	3	24	
90.0	2	14	
97.3	1	9	Mile 103.5; Exit Freeway at Reservoir Ave.
104.8	0	0	Battery life light illuminated.
105.8	0	0	Reduced performance and service now lights illuminated.
106.40	0	0	End of drive.

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 620	2

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	01/25/2000	12:10	1009	N/A	N/A	N/A	60 F	N/A
Stop	01/25/2000	19:40	1036	N/A	N/A	N/A	N/A	N/A
Net		7:30	26.81					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
01/26/2000	23615	200265	FW1	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	185				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:58	7324	100	N/A	N/A	63 F	N/A	N/A
Stop	12:00	7429	0	N/A	N/A	63 F	N/A	Min. A/C
Net	2:02	114.5	-100					N/A

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	105	
3.7	10	82	
23.0	9	116	
37.0	8	86	
48.8	7	87	
61.6	6	85	
72.5	5	60	
80.7	4	44	
93.5	3	43	
102.3	2	24	
106.9	1	12	Mile 111.5; Exit Freeway at Towne Ave. (Freeway 10 East)
112.5	0	0	Mile 111.7; Battery life light illuminated.
114.0	0	0	Reduced performance and service now lights illuminated.
114.5	0.0	0	End of drive.

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
Inductive WM	WM2009822038R		01 223 620		N/A			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	01/26/2000	12:00	1036	0	N/A	N/A	64 F	N/A
Stop	01/26/2000	16:54	1061		N/A	N/A	N/A	N/A
Net		4:54	24.04					

Comments: 5 Hours 0 minutes to fill

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
01/27/2000	23615	200265	FW1	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	185				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:47	7439	100	N/A	N/A	63 F	N/A	N/A
Stop	13:00	7554	0	N/A	N/A	65 F	N/A	Min. A/C
Net	2:13	114.7	-100			2 F		N/A

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	113	
3.6	10	88	
20.0	9	118	
36.1	8	94	
47.5	7	90	
66.5	6	88	
73.8	5	59	
81.0	4	45	
93.0	3	44	
102.2	2	27	
110.5	1	9	Mile 112.3; Exit Freeway at Towne Ave. (Freeway 10 East)
114.6	0	0	Battery life light illuminated.
114.7	0	0	End of drive.

Accessories used: Radio
Drive / Regen setting: Drive
Handling/Braking: Decent handling, fair braking
Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 620	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	01/27/2000	13:01	1061	N/A	N/A	N/A	65 F	N/A
Stop	01/27/2000	20:51	1088	N/A	N/A	N/A	N/A	N/A
Net		7:50	27.02					

Comments: 5 Hours 0 minutes to fill

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
01/28/2000	23615	200265	UR2	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	185				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:37	7554	100	N/A	N/A	72 F	70.2 F	41. F
Stop	16:45	7635	0	N/A	N/A	68 F	36.9 F	Min. A/C
Net	3:08	81.3	-100			-4 F	-33.3 F	36.5 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	121	
6.6	10	99	
20.5	9	91	
30.0	8	61	
41.3	7	67	
47.0	6	54	
52.9	5	37	
62.3	4	37	
67.8	3	26	
71.3	2	14	
74.4	1	6	
81.0	0	0	Battery life light illuminated.
81.3	0	0	End of drive.

Accessories used: Radio, A/C set on hight and coldest temp., headlights

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 620	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	01/28/2000	16:50	1088	N/A	N/A	N/A	68 F	N/A
Stop	01/28/2000	23:32	1117	N/A	N/A	N/A	N/A	N/A
Net		6:42	25.47					

Comments: 5 Hours 5 minutes to fill

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
02/01/2000	23615	200265	UR2	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	185				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	14:08	7635	100	N/A	N/A	76 F	71.1 F	41. F
Stop	17:02	7715	0	N/A	N/A	72 F	39.5 F	Min. A/C
Net	2:54	79.6	-100			-4 F	-31.6 F	37. F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	98	
5.7	10	88	
14.4	9	64	
29.8	8	60	
34.4	7	55	
46.0	6	61	
51.3	5	36	
59.2	4	37	
66.0	3	24	
68.9	2	13	
72.0	1	5	
78.3	0	0	Battery life light illuminated.
79.6	0	0	End of drive.

Accessories used: Radio, A/C set on hight and coldest temp., headlights

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 620	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	02/01/2000	17:20	1117	N/A	N/A	N/A	69 F	N/A
Stop	02/02/2000	1:35	1145	N/A	N/A	N/A	N/A	N/A
Net		8:15	27.75					

Comments: 5 Hours 5 minutes to fill

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
02/02/2000	23615	200265	FW2	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	185				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	11:00	7715	100	N/A	N/A	77 F	70.8 F	41. F
Stop	13:00	7822	0	N/A	N/A	81 F	41.5 F	Min. A/C
Net	2:00	106.7	-100			4 F	-29.3	40.3 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	92	
3.9	10	70	
22.6	9	106	
36.6	8	91	
47.7	7	86	
61.5	6	88	
72.5	5	58	
78.7	4	38	
86.0	3	34	
95.7	2	24	
102.8	1	12	Mile 102.5; Exit Freeway 60 (West) at Reservoir Ave.
106.5	0	0	Battery life light illuminated.
106.7	0	0	End of drive.

Accessories used: Radio, A/C set on hight and coldest temp., headlights

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 620	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	02/02/2000	13:05	1145	N/A	N/A	N/A	78 F	N/A
Stop	02/02/2000	21:45	1173	N/A	N/A	N/A	N/A	N/A
Net		8:40	27.48					

Comments: 4 Hours 55 minutes to fill

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
02/03/2000	23615	200265	FW2	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	185				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:35	7822	100	N/A	N/A	78 F	72.1 F	41.5 F
Stop	15:30	7926	0	N/A	N/A	74 F	39.8 F	Min. A/C
Net	1:55	104.7	-100			-4 F	-32.3	39.4 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	104	
4.5	10	78	
22.8	9	109	
37.0	8	88	
50.0	7	91	
61.2	6	82	
71.3	5	57	
78.2	4	39	
88.5	3	37	
95.4	2	23	
101.4	1	11	Mile 102.5; Exit Freeway 60 (West) at Reservoir Ave.
104.6	0	0	Battery life light illuminated.
104.7	0	0	End of drive.

Accessories used: Radio, A/C set on hight and coldest temp., headlights

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 620	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	02/03/2000	15:33	1173	N/A	N/A	N/A	72 F	N/A
Stop	02/03/2000	23:51	1201	N/A	N/A	N/A	N/A	N/A
Net		8:18	27.22					

Comments: 4 Hours 55 minutes to fill

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
02/04/2000	23615	200265	UR3	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	447				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:30	7926	100	N/A	N/A	64 F	N/A	N/A
Stop	17:05	8015	0	N/A	N/A	60 F	N/A	Min. A/C
Net	3:35	88.7	-100			-4 F		N/A

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	108	
7.2	10	99	
25.8	9	99	
32.7	8	66	
45.0	7	75	
51.5	6	49	
60.8	5	48	
67.0	4	38	
71.0	3	24	
79.3	2	19	
83.6	1	9	
88.6	0	0	Battery life light illuminated.
88.7	0	0	End of drive.

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 620	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	02/04/2000	17:13	1201	N/A	N/A	N/A	60 F	N/A
Stop	02/05/2000	1:19	1230	N/A	N/A	N/A	N/A	N/A
Net		8:32	27.82					

Comments: 5 Hours 10 minutes to fill

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
02/07/2000	23615	200265	UR3	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	447				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:18	8015	100	N/A	N/A	73 F	N/A	N/A
Stop	12:32	8105	0	N/A	N/A	82 F	N/A	Min. A/C
Net	3:14	89.5	-100			9 F		N/A

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	98	
4.0	10	86	
11.2	9	67	
28.6	8	78	
38.2	7	73	
48.1	6	59	
54.0	5	40	
65.8	4	46	
70.4	3	22	
78.9	2	22	
84.4	1	9	
89.1	0	0	Battery life light illuminated.
89.5	0	0	End of drive.

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 620	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	02/07/2000	12:35	1230	N/A	N/A	N/A	80 F	N/A
Stop	02/07/2000	20:45	1258	N/A	N/A	N/A	N/A	N/A
Net		8:10	27.55					

Comments: 5 Hours 5 minutes to fill

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
02/08/2000	23615	200265	FW3	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	447				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:52	8105	100	N/A	N/A	64 F	N/A	N/A
Stop	10:58	8220	0	N/A	N/A	66 F	N/A	Min. A/C
Net	2:06	115.6	-100			2 F		N/A

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	101	
4.4	10	77	
28.5	9	122	
41.5	8	86	
56.5	7	102	
68.7	6	84	
77.0	5	54	
87.0	4	52	
96.7	3	43	
106.0	2	20	
111.1	1	6	
113.2	0	0	Battery life light illuminated.
115.6	0	0	End of drive.

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 624	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	02/08/2000	11:33	2200	N/A	N/A	N/A	66 F	N/A
Stop	02/08/2000	20:10	2228	N/A	N/A	N/A	N/A	N/A
Net		8:37	27.72					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
02/09/2000	23615	200265	FW3	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	447				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:40	8220	100	N/A	N/A	68 F	N/A	N/A
Stop	12:45	8335	0	N/A	N/A	71 F	N/A	Min. A/C
Net	2:05	114.5	-100			3 F		N/A

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	110	
4.5	10	82	
20.5	9	116	
36.2	8	92	
49.5	7	91	
62.7	6	81	
73.4	5	55	
79.5	4	45	
91.3	3	44	
101.5	2	26	
106.3	1	10	
111.0	0	0	Battery life light illuminated.
114.5	0	0	End of drive.

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 624	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	02/09/2000	13:42	2228	N/A	N/A	N/A	71 F	N/A
Stop	02/09/2000	21:10	2255	N/A	N/A	N/A	N/A	N/A
Net		7:28	27.19					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
02/18/2000	23615	200265	UR4	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	447				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	14:30	8403	100	N/A	N/A	73 F	70.4 F	42.1 F
Stop	17:40	8476	0	N/A	N/A	64 F	36.5 F	Min. A/C
Net	3:10	73	-100			-9 F	-33.9	35.1 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	71	
5.6	10	67	
15.3	9	60	
28.3	8	64	
33.3	7	49	
43.3	6	51	
48.3	5	38	
51.7	4	25	
66.0	3	22	
64.3	2	14	
68.5	1	7	
72.6	0	0	Battery life light illuminated.
73.0	0	0	End of drive.

Accessories used: Radio, A/C set on hight and coldest temp., headlights

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 624	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	02/18/2000	17:50	2320	N/A	N/A	N/A	64 F	N/A
Stop	02/18/2000	23:15	2353	N/A	N/A	N/A	N/A	N/A
Net		5:25	22.8					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/02/2000	23615	200265	FW4	A. Mendoza	Performance C.	Start	N/A
Road Cond	Tire Press	Payload				Stop	N/A
Dry	50 psi	447				Net	N/A

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:20	8477	100	N/A	N/A	72 F	68.4 F	42.5 F
Stop	15:05	8569	0	N/A	N/A	72 F	39.8 F	Min. A/C
Net	1:45	92.1	-100				-28.6 F	38. F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0.0	11	72	
2.5	10	56	
16.0	9	90	
28.5	8	82	
38.0	7	61	
47.3	6	65	
58.2	5	57	
65.7	4	45	
73.2	3	26	
79.6	2	16	
86.6	1	7	
91.8	0	0	Battery life light illuminated.
92.1	0	0	End of drive.

Accessories used: Radio, A/C set on hight and coldest temp., headlights

Drive / Regen setting: Drive

Handling/Braking: Decent handling, fair braking

Other comments:

Charger	Serial No.	AC meter#	BMI #
Inductive WM	WM2009822038R	01 223 624	N/A

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/02/2000	16:20	2355	N/A	N/A	N/A	65 F	N/A
Stop	03/02/2000	22:34	2379	N/A	N/A	N/A	N/A	N/A
Net		6:14	24.23					

Comments:

APPENDIX E

ACCELERATION, BRAKING AND MAXIMUM SPEED TEST DATA

ACCELERATION, MAXIMUM SPEED, AND BRAKING TESTS

Vehicle No.: 23615
Location: Pomona Racetrack
Date: 02/15/00
Technician: Alvaro Mendoza

	Start	Stop
Time	9:30 AM	5:30 PM
Temp.	63 F	60 F
Odometer	8346	8377

Acceleration (100% SOC)

	0-30 mph	0-60 mph	Direction	Max. Speed	30-55 mph
1	3.21	8.8	S	82	3.65
2	3.31	7.85	N	82	4.06
3	3	7.37	S		
4	3.34	8.13	N		
Average	3.22	8.04		82.00	3.86

Acceleration (80% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1	3.06	7.61	S	3.81
2	3.27	8.36	N	4.2
3	3.11	7.76	S	
4	3.32	8.61	N	
Average	3.19	8.09		4.01

Acceleration (60% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1	3.2	8.82	S	4.03
2	3.21	8.42	N	4.18
3	3.06	7.85	S	
4	3.3	8.77	N	
Average	3.19	8.47		4.11

Acceleration (40% SOC)

	0-30 mph	0-60 mph	Direction	30-55 mph
1	3.1	8.57	S	4.1
2	3.28	8.91	N	4.68
3	3.06	8.2	S	
4	3.33	9.35	N	
Average	3.19	8.76		4.39

Acceleration (20% SOC)

	0-30 mph	0-60 mph	Direction	Max. Speed	30-55 mph
1	3.29	9.85	S	81	8.99
2	3.48	10.84	N	80	10.55
3	3.57	11.24	S		
4	4.01	14.04	N		
Average	3.59	11.49		80.50	9.77

Braking 25-0 mph, 60% SOC

	Feet	Inches	Total Ft.	Direction
1	35	3.54	35.3	S
2	35	6.94	35.6	N
3	35	9.096	35.8	S
4	34	8.876	34.7	N
5	33	0.276	33.0	S
6	35	9.048	35.8	N
7	35	1.104	35.1	S
8	32	5.628	32.5	N
9				
10				

34.7 Average ft.

Comments: Vehicle turning radius was 31 feet and 10 inches.

APPENDIX F

CHARGER TESTING / ANALYSIS DATA SHEET

CHARGER TESTING / ANALYSIS DATA SHEET

Name of test conductor: Alvaro Mendoza Date: 02/09/00

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: 9:10 PM

Final Pack Voltage: N/A

AC kWh Used: 27.19 kWh DC kWh Delivered: N/A

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

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

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

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

~~Charger Operation Information/Evaluation~~

Exterior Dimensions: 850 mm X 350 mm X 352 mm 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 Commission (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

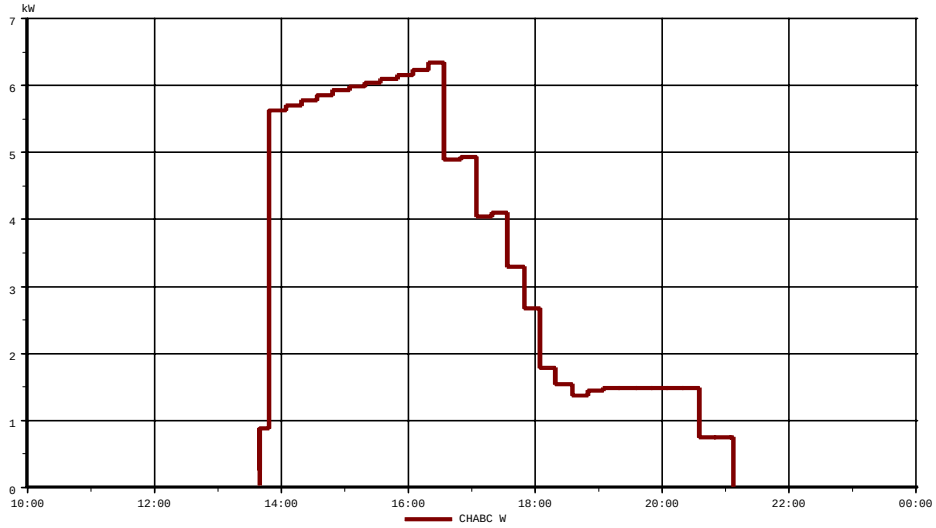
Manufacturer Support: Yes

Other Notes:

APPENDIX G

CHARGER PROFILE TEST GRAPHICAL DATA - EVTC

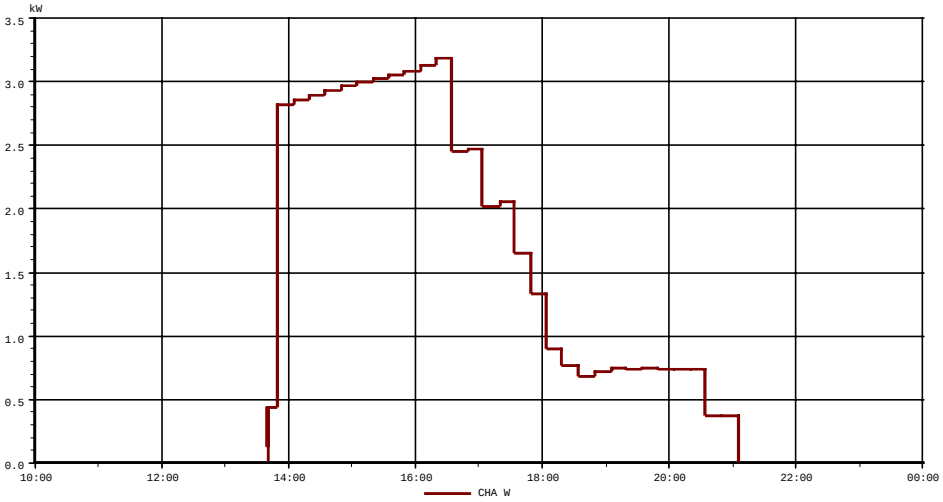
Total Power



	Min	Max
CHABC W	-0.01	6.35

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

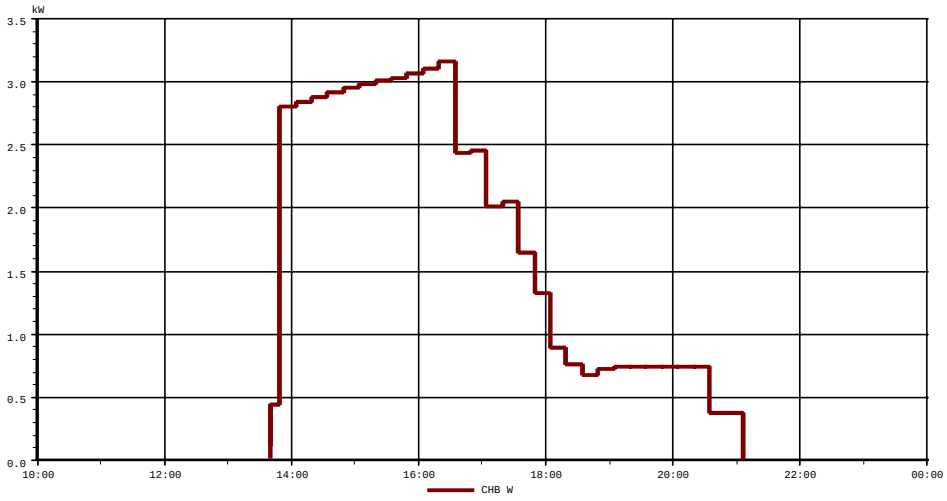
Phase A-N Power



	Min	Max
CHA W	-0.00	3.19

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

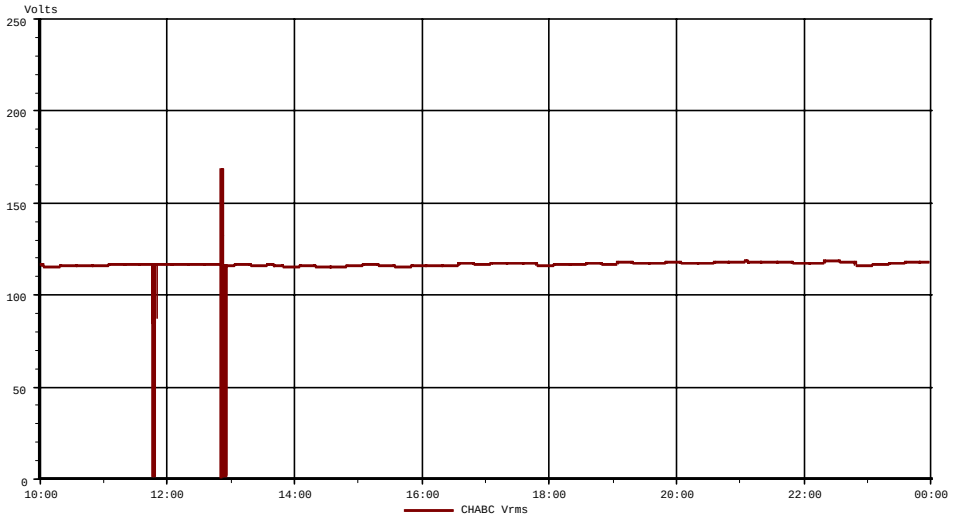
Phase B-N Power



	Min	Max
CHB W	-0.00	3.16

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

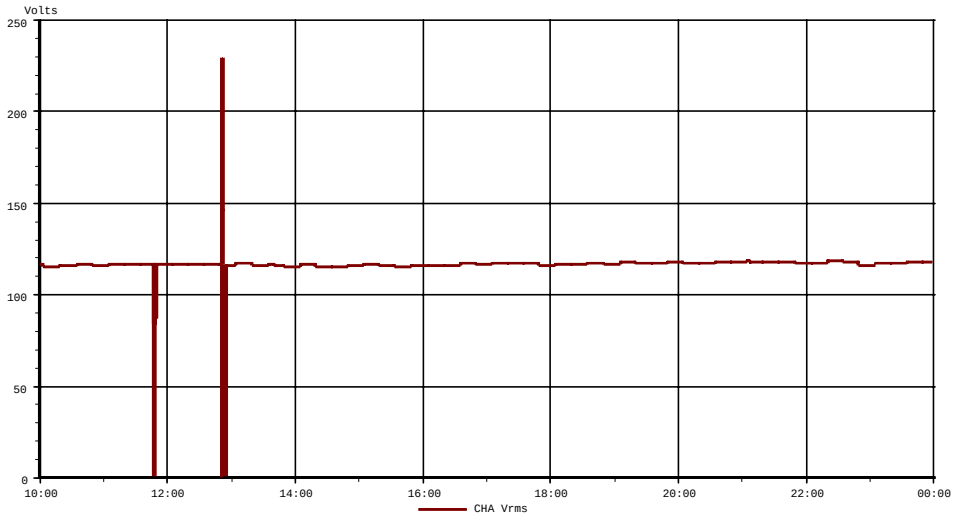
Total Voltage



	Min	Max
CHABC Vrms	0.77	168.90

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

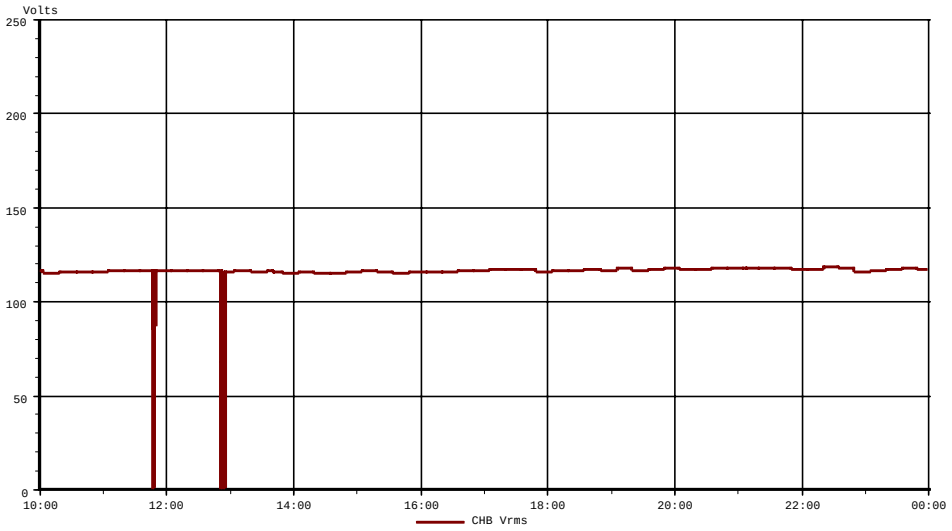
Phase A-N Voltage



	Min	Max
CHA Vrms	0.89	229.05

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

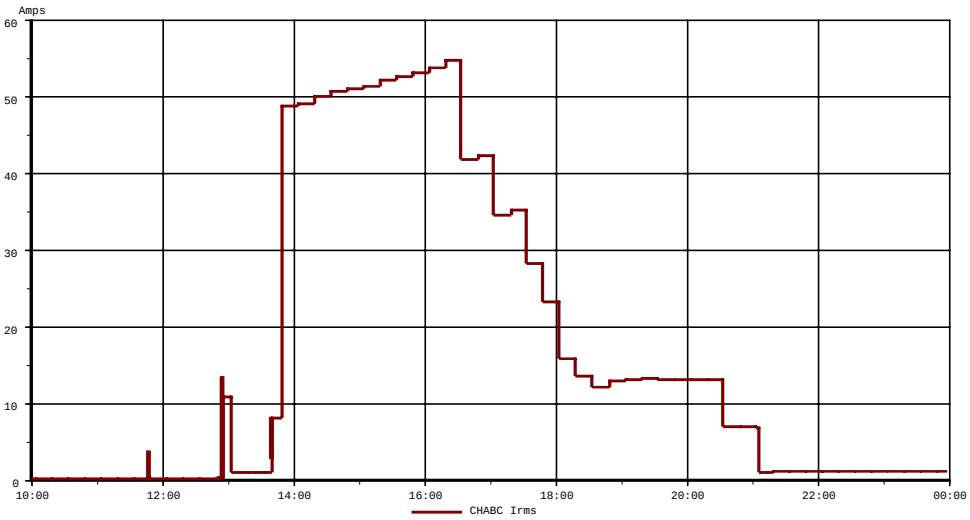
Phase B-N Voltage



	Min	Max
CHB Vrms	0.48	118.64

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

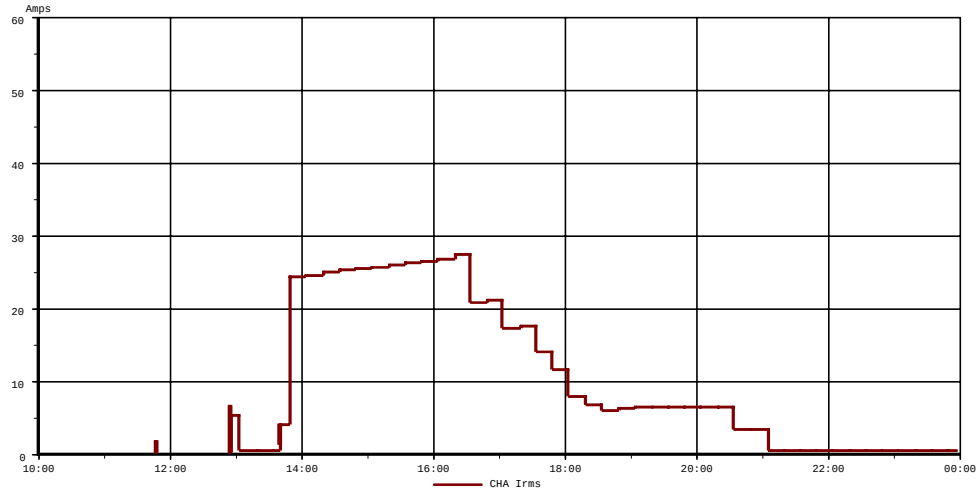
Total Current



	Min	Max
CHABC Irms	0.01	54.91

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

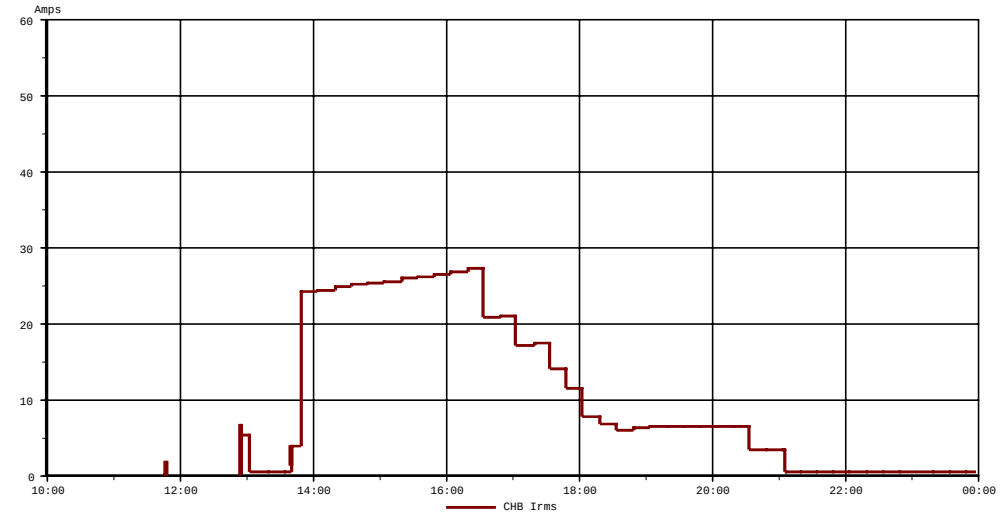
Phase A-N Current



	Min	Max
CHA Irms	0.01	27.50

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

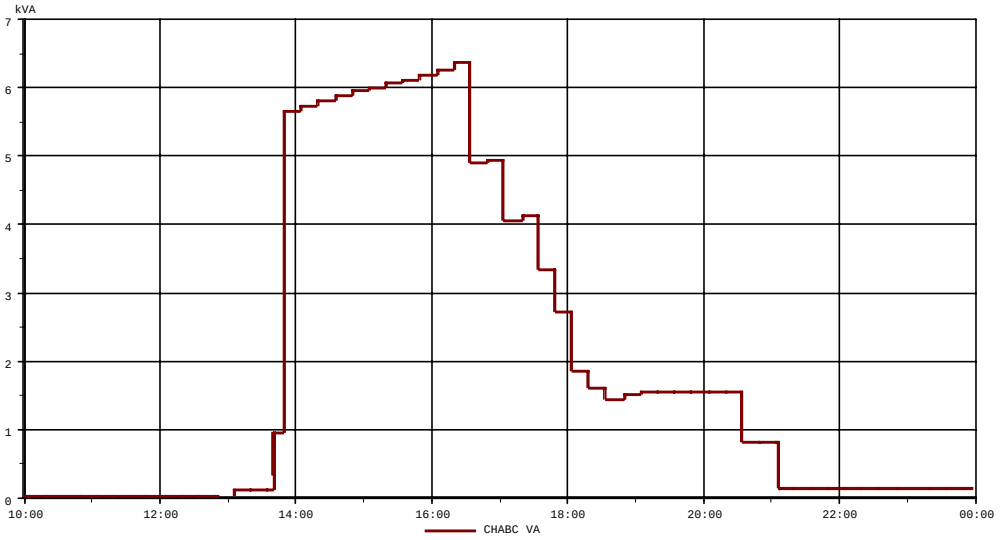
Phase B-N Current



	Min	Max
CHB Irms	0.01	27.41

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

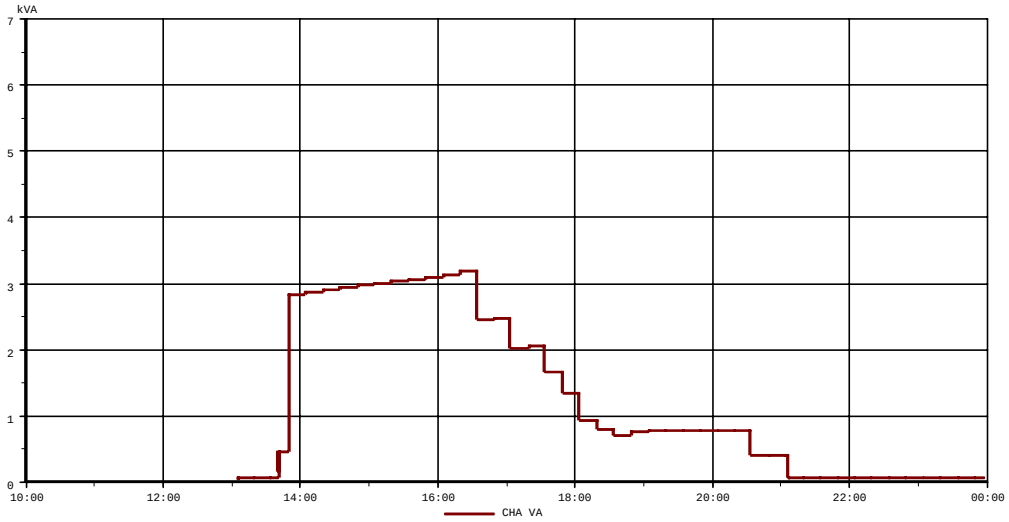
Total Apparent Power



	Min	Max
CHABC VA		6.38

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

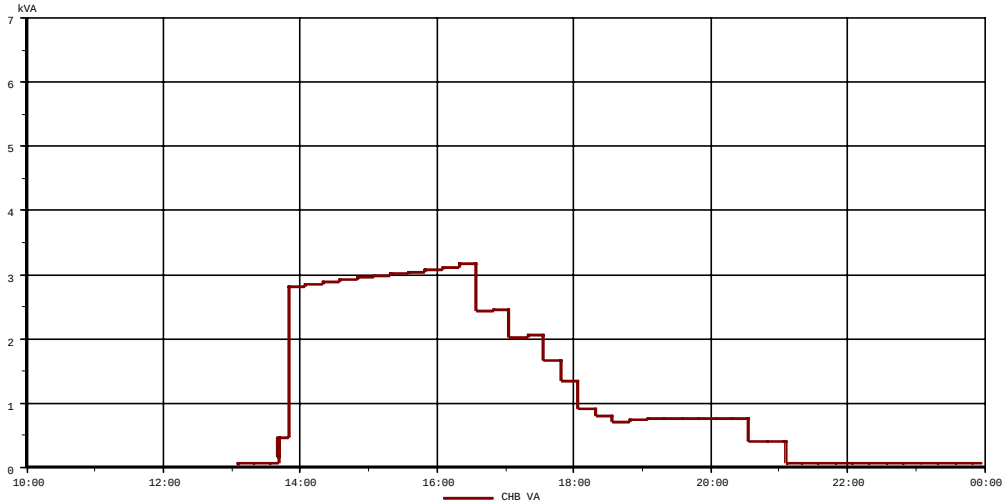
Phase A-N Apparent Power



	Min	Max
CHA VA		3.19

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

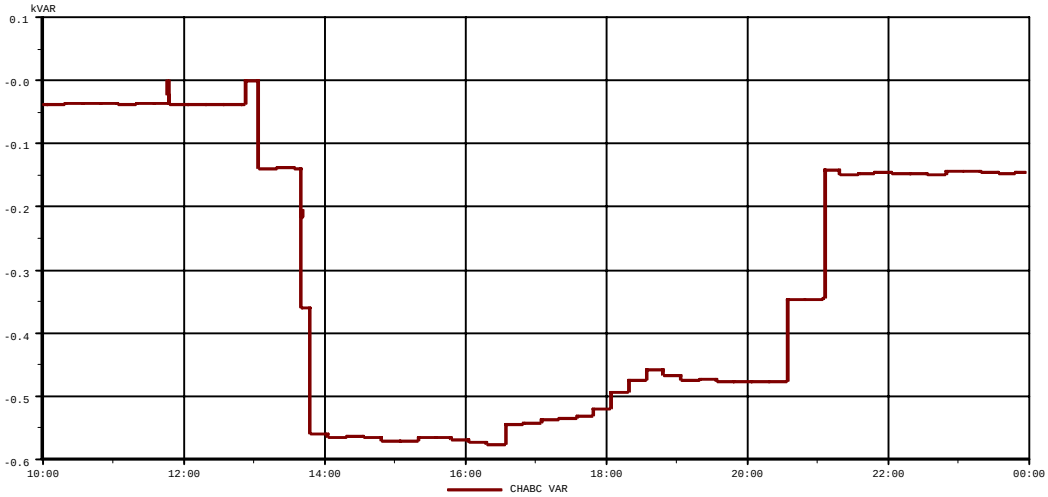
Phase B-N Apparent Power



	Min	Max
CHB VA		3.18

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

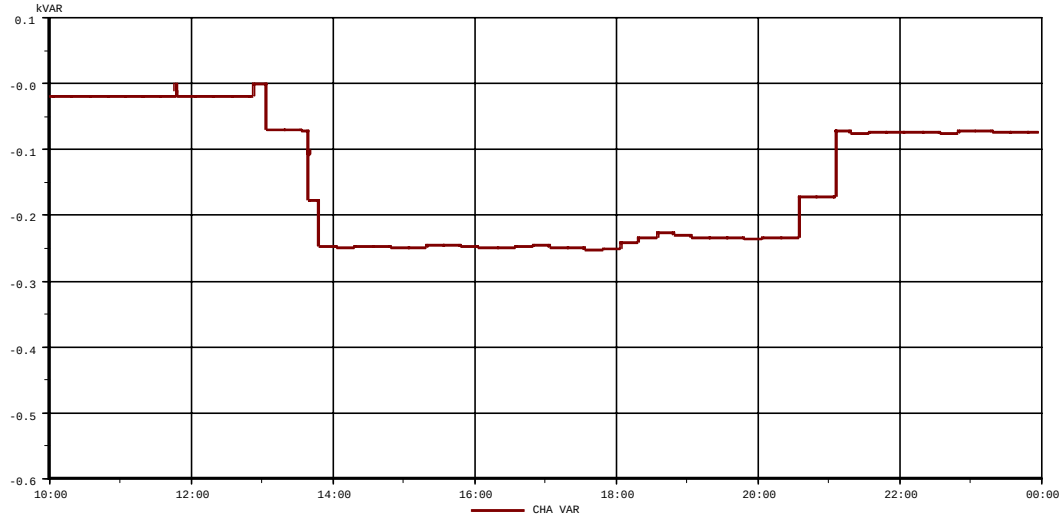
Total Reactive Power



	Min	Max
CHABC VAR	-0.57	0.00

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

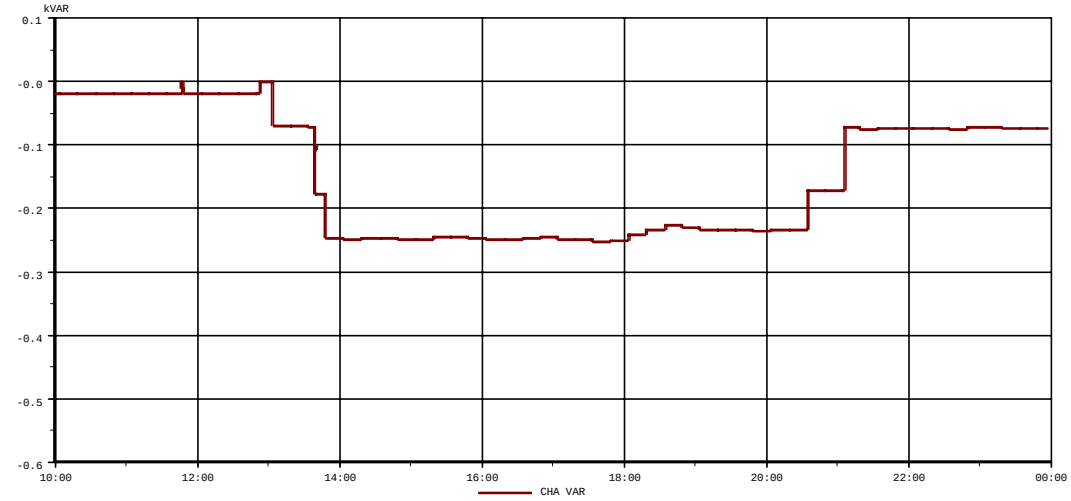
Phase A-N Reactive Power



	Min	Max
CHA VAR	-0.25	0.00

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

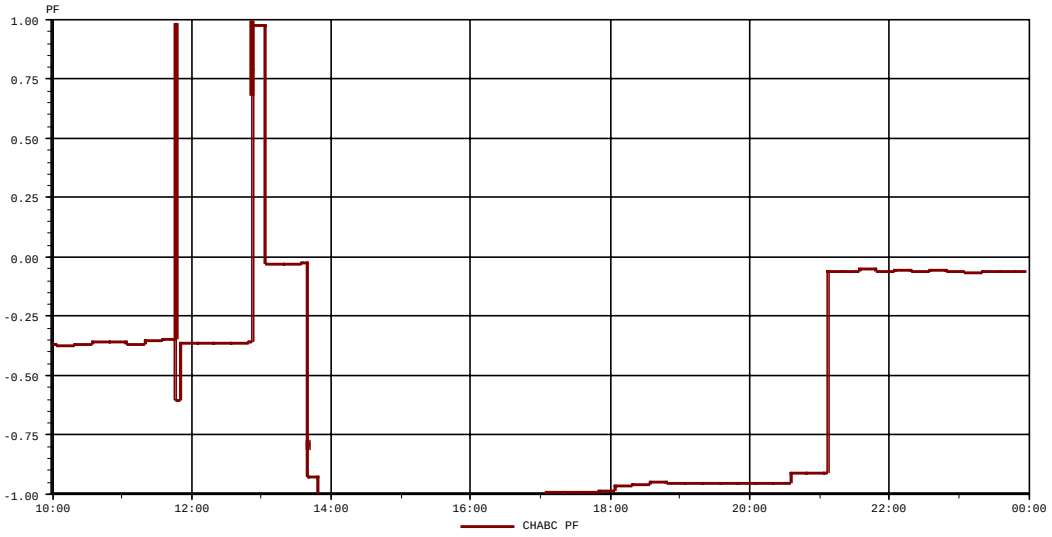
Phase B-N Reactive Power



	Min	Max
CHA VAR	-0.25	0.00

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

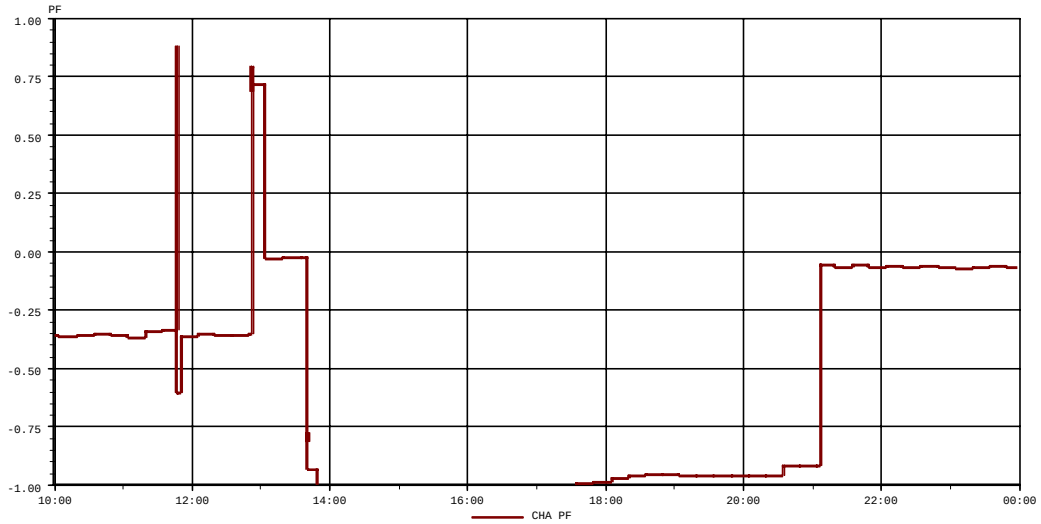
Total Power Factor



	Min	Max
CHABC PF	-1.00	0.99

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

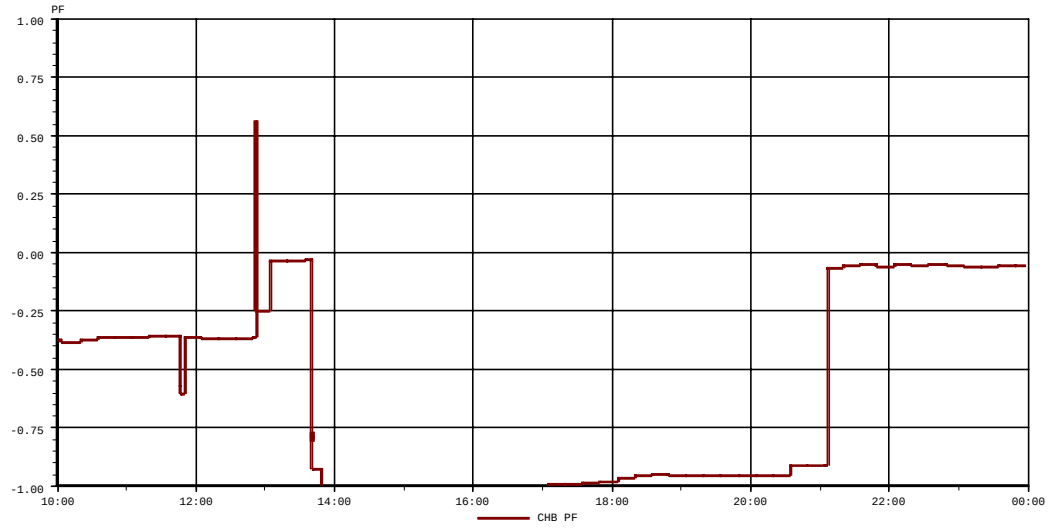
Phase A-N Power Factor



	Min	Max
CHA PF	-1.00	0.88

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

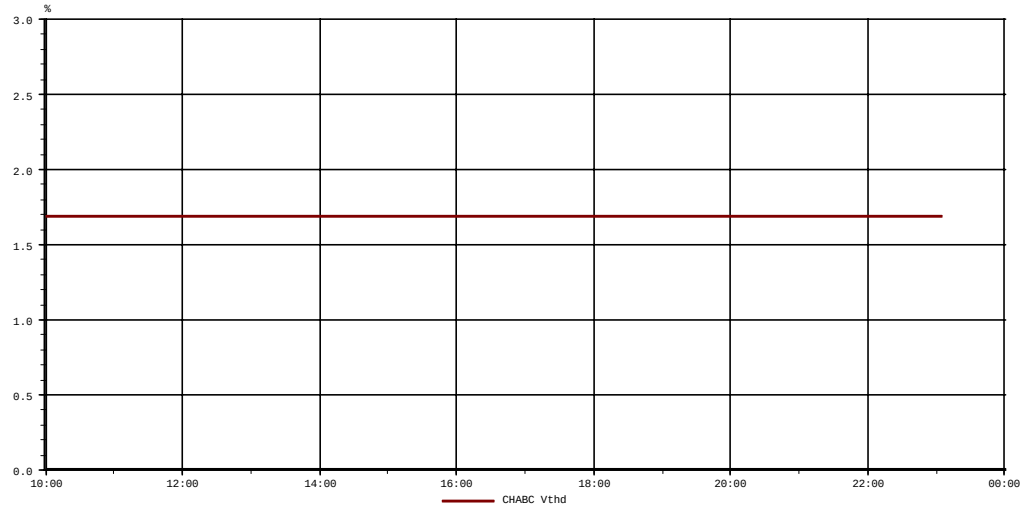
Phase B-N Power Factor



	Min	Max
CHB PF	-0.99	0.56

02/09/2000 10:00:00.00 - 02/10/2000 00:00:00.00

Total Voltage Hamonic Distortion



	Min	Max
CHABC Vthd		

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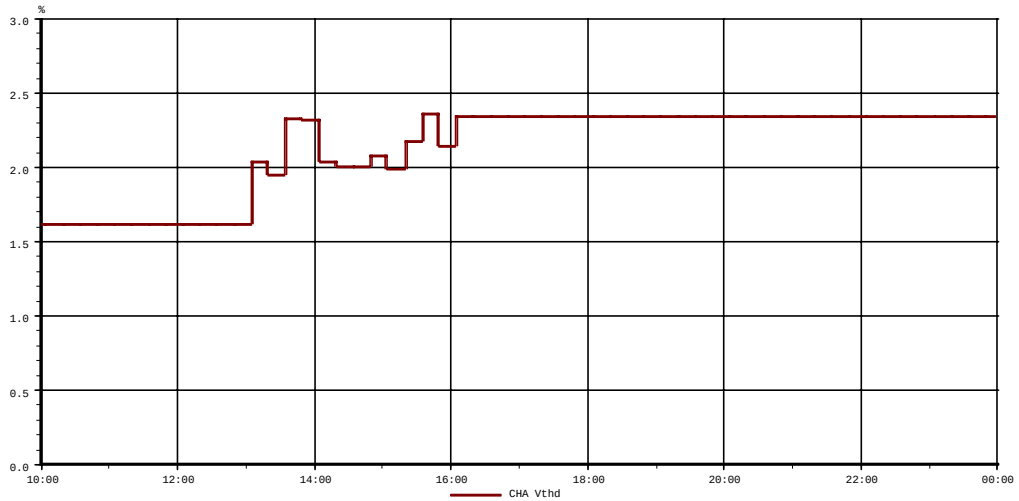
Phase A-N Voltage Hamonic Distortion



	Min	Max
CHA Vthd	1.62	2.36

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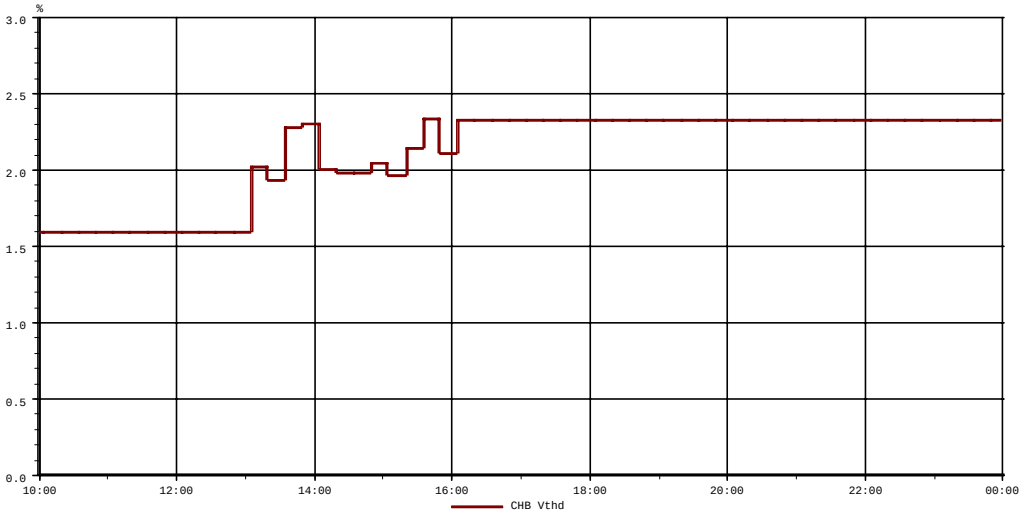
Phase B-N Voltage Hamonic Distortion



	Min	Max
CHB Vthd	1.60	2.34

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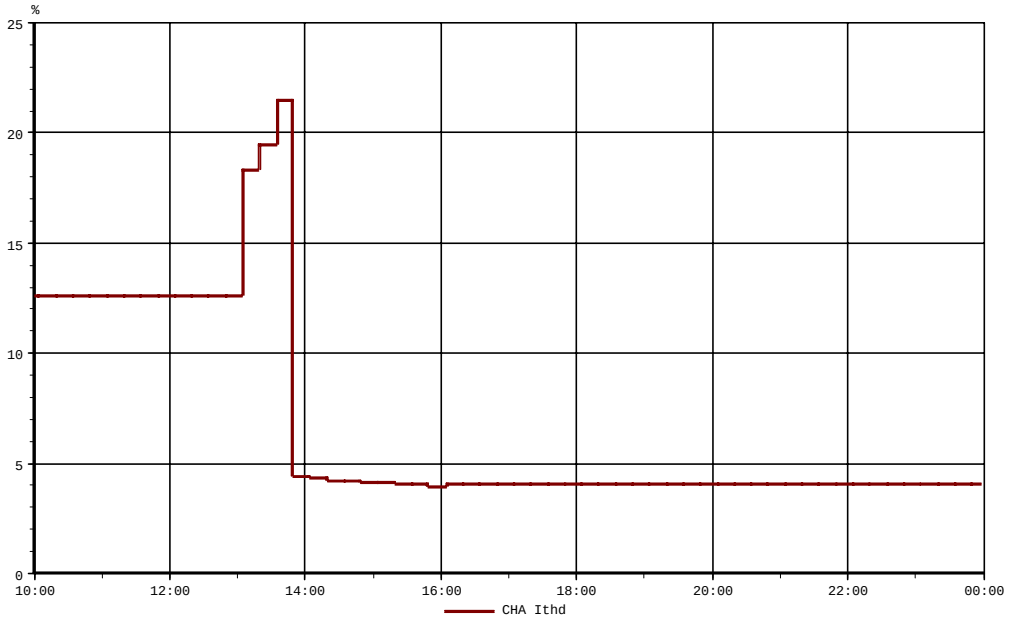
Phase A-N Current Harmonic Distortion



	Min	Max
CHA Ithd	3.99	21.52

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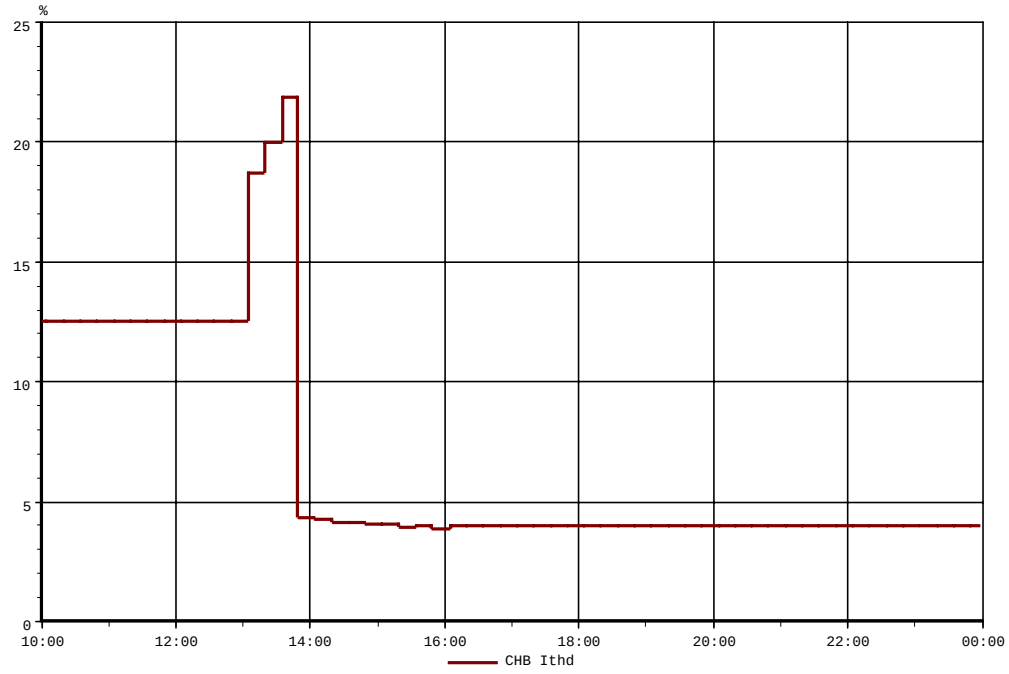
Phase B-N Current Harmonic Distortion



	Min	Max
CHB Ithd	3.90	21.89

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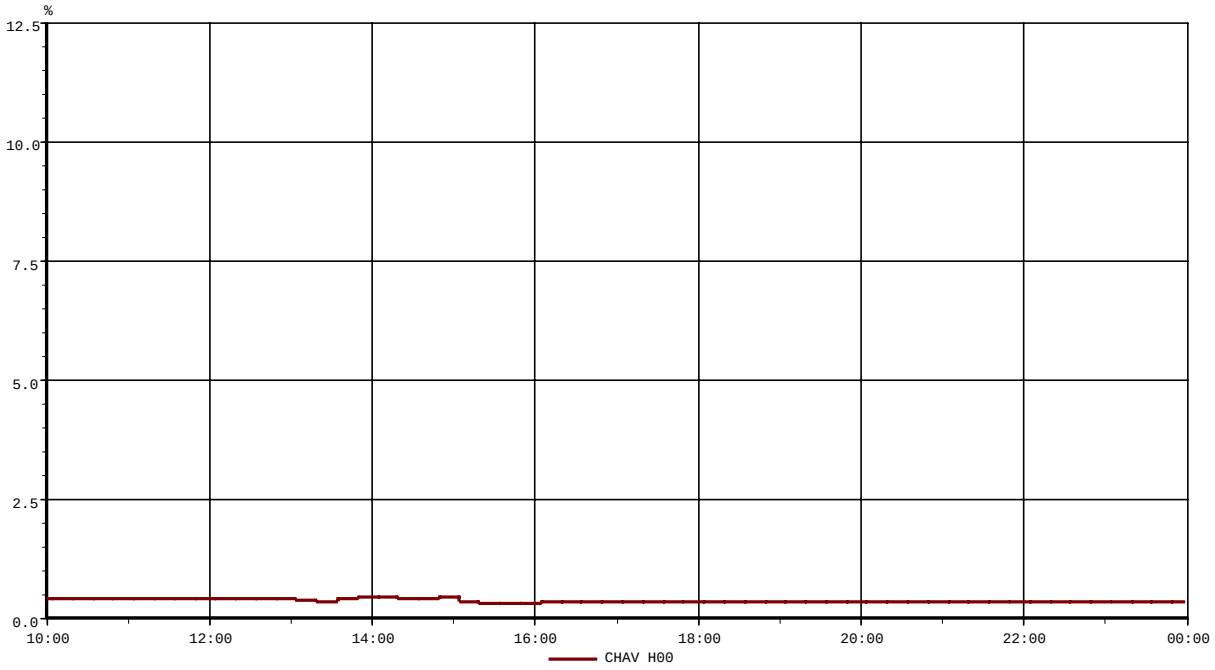
Phase A Voltage Harmonic # 3 (Percentage of Fundamental)



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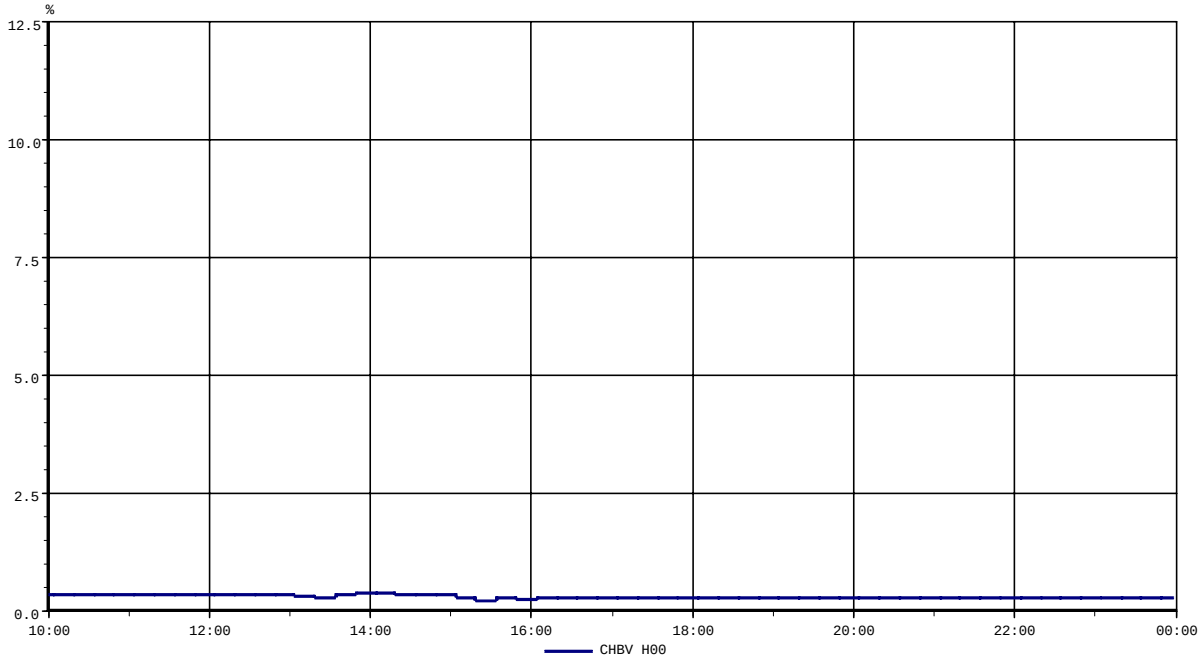
Phase B Voltage Harmonic # 3 (Percentage of Fundamental)



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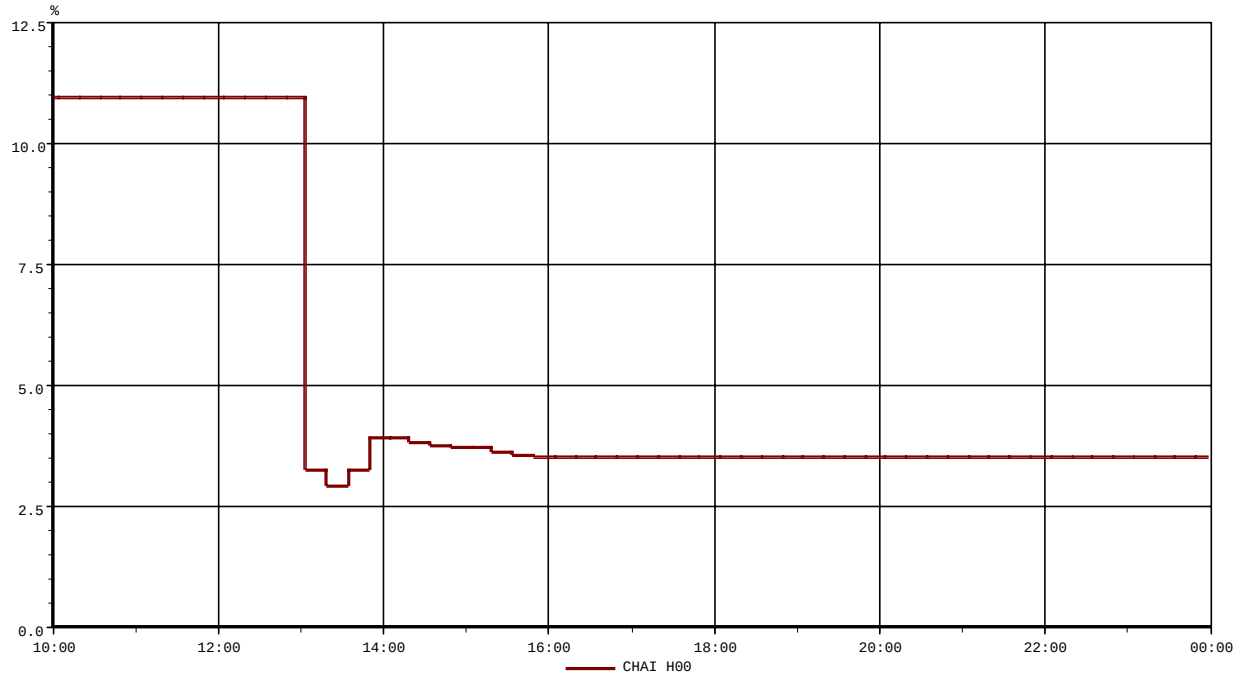
Phase A Current Harmonic # 3 (Percentage of Fundamental)



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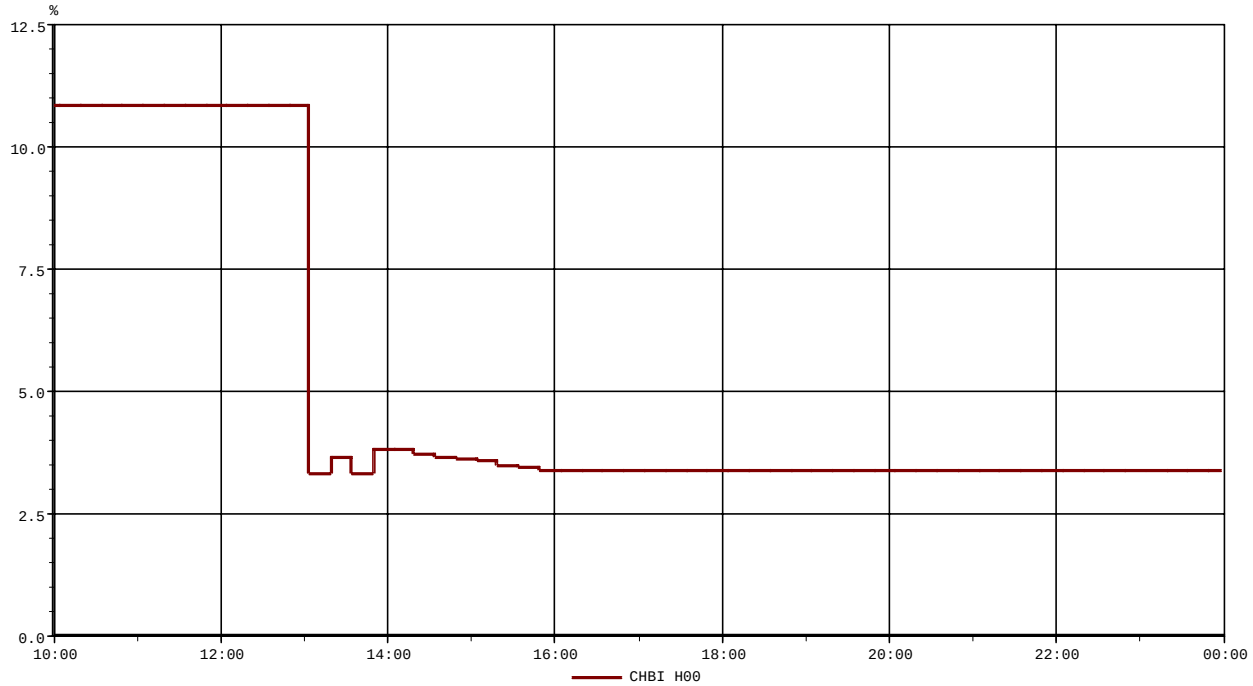
Phase B Current Harmonic # 3 (Percentage of Fundamental)



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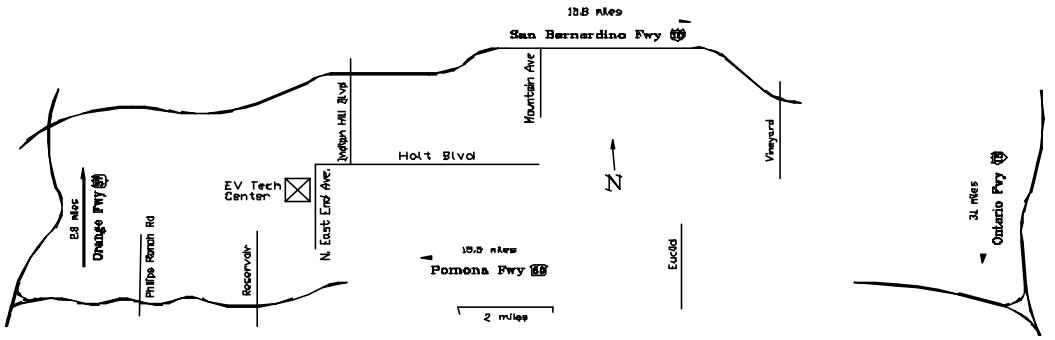
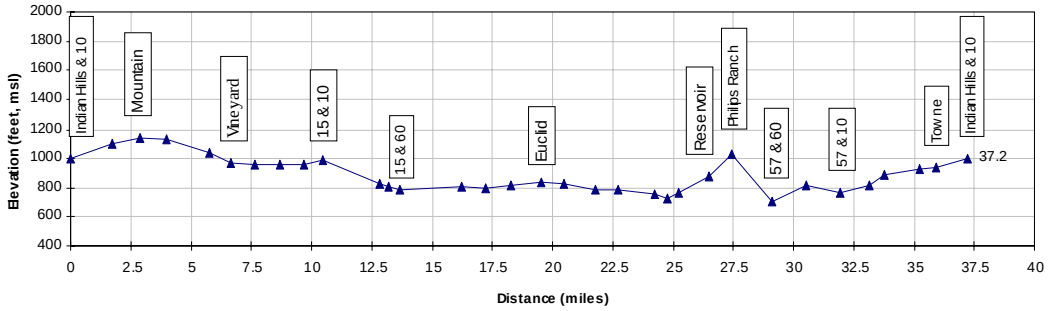
APPENDIX H

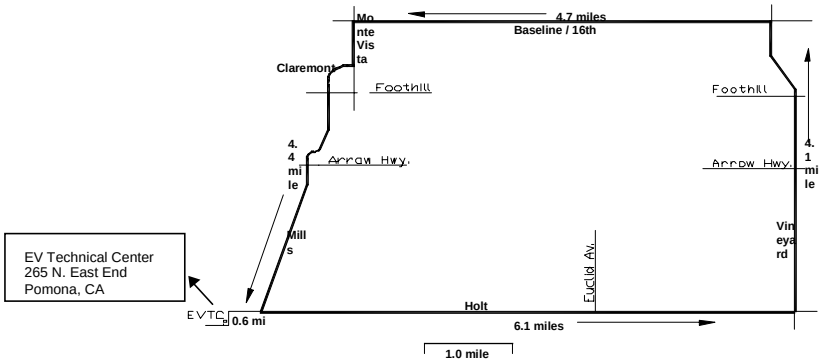
URBAN AND FREEWAY POMONA LOOPS

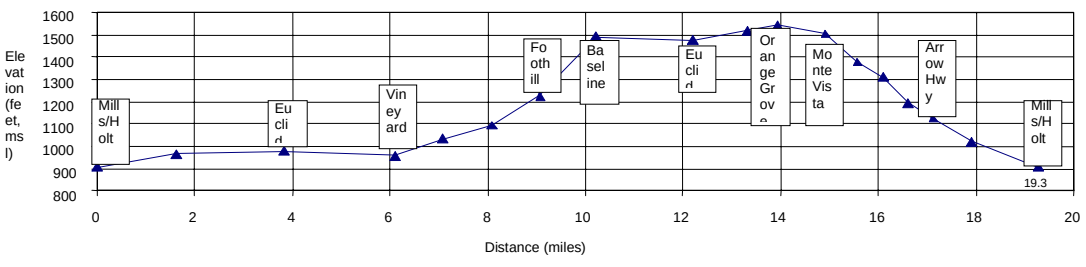
FREEWAY POMONA LOOP





URBAN POMONA LOOP





APPENDIX I

SCE ELECTRIC VEHICLE TEST PROCEDURE

ELECTRIC VEHICLE TEST PROCEDURE

SOUTHERN CALIFORNIA EDISON

An *EDISON INTERNATIONAL* Company

ELECTRIC TRANSPORTATION DIVISION

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

August 1999

TABLE OF CONTENTS

I. INTRODUCTION

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

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

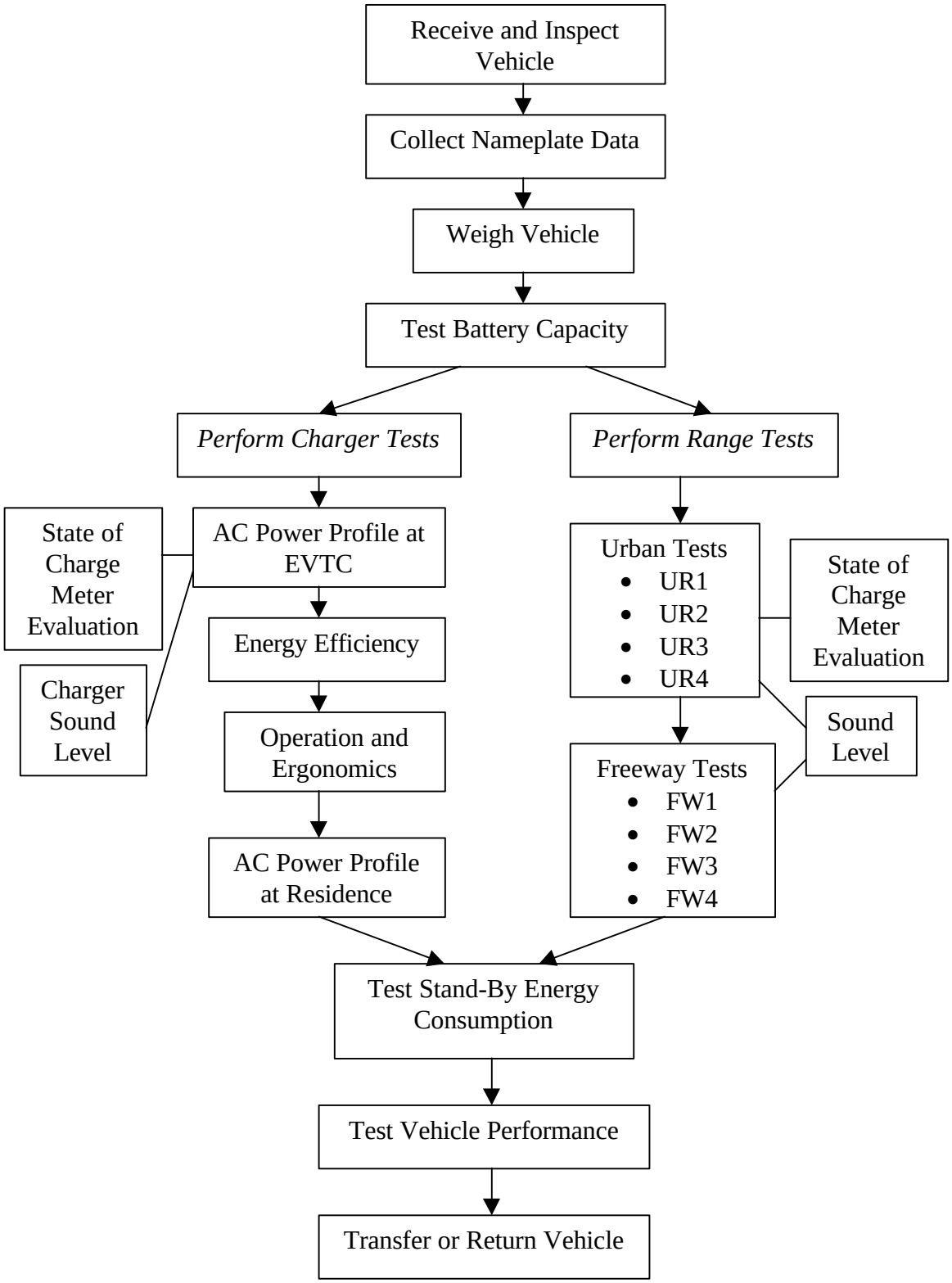
Range tests under different vehicle conditions no longer always have predictable results. Automatic climate controls limit air conditioner power on cool days, thus conserving battery energy and increasing range. The battery pack and the output side of the charger may no longer be readily accessible;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

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

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

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

SCE EV TEST PROCEDURE FLOW DIAGRAM



II. TEST PLAN

A. NAMEPLATE DATA COLLECTION

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

B. WEIGHT DOCUMENTATION

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

C. BATTERY CAPACITY TEST

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

D. RANGE TESTS

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

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

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

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

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

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

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

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

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

E. SOUND LEVEL TEST

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

F. STATE OF CHARGE METER EVALUATION

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

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

G. PERFORMANCE TESTS

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

1. Acceleration

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

2. Maximum Speed

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

3. Acceleration - 30 to 55 mph

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

4. Braking

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

H. CHARGER PERFORMANCE/CHARGING PROFILE TEST

1. AC Input Data

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

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

2. Charging Profile

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

3. Charging at a Residential Setting

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

4. Charger Energy Efficiency

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

5. Audible Noise Levels

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

6. Operation and Ergonomics

Observe these aspects of the charger's operation:

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

Examine the user's interface with the charger:

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

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

1. Vehicle on Charger

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

2. Vehicle off Charger

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

J. TRANSFER THE VEHICLE

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

III. TEST INSTRUMENTATION

A. WEIGHT DOCUMENTATION

1. Certified Weight Scale

B. RANGE TESTS

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

C. BATTERY CAPACITY TEST

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

D. SOUND LEVEL TEST

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

E. STATE OF CHARGE METER EVALUATION

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

F. PERFORMANCE TESTS

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

2. Maximum Speed
    a. EV speedometer

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

G. CHARGER PERFORMANCE/CHARGING PROFILE TEST

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

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

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

IV. TEST PROCEDURE

A. NAMEPLATE DATA COLLECTION

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

B. WEIGHT DOCUMENTATION

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

C. BATTERY CAPACITY TEST

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

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

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

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

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

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

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

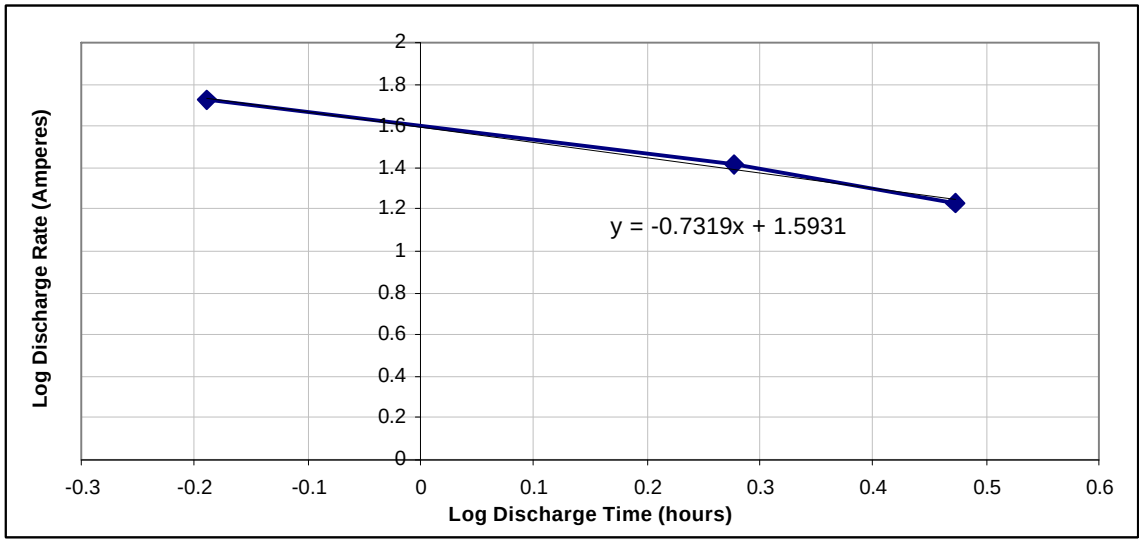


Figure 3-1. Sample Peukert Curve.

D. RANGE TESTS

Vehicle Preparation/Inspection

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

Data Acquisition Equipment

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

Stop Conditions

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

1. **Urban Range Tests:**

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

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

   Upon returning to the EV Tech Center, record the end of test data (odometer, state of charge, ambient temperature, DC kWh, and pack voltage after 30 minutes).

   Connect the BMI Power Profiler to the AC supply side, and collect data necessary for the *Charger Performance Test* (see p. 16) after the first and second UR-1 tests. For the remaining tests, after completion of charging,

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

Conduct this procedure in the following four vehicle test configurations:

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

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

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

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

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

2. Freeway Range Tests:

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

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

Upon returning to the EV Tech Center, record the end of test data (odometer, state of charge, ambient temperature, DC kWh, and pack voltage after 30 minutes).

Connect the BMI Power Profiler to the AC supply side to record energy data. After completion of charging, read the AC kWh data from the BMI

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

Conduct this procedure in the following four vehicle test configurations:

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

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

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

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

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

AC kWh per mile efficiency

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

Range Envelope

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

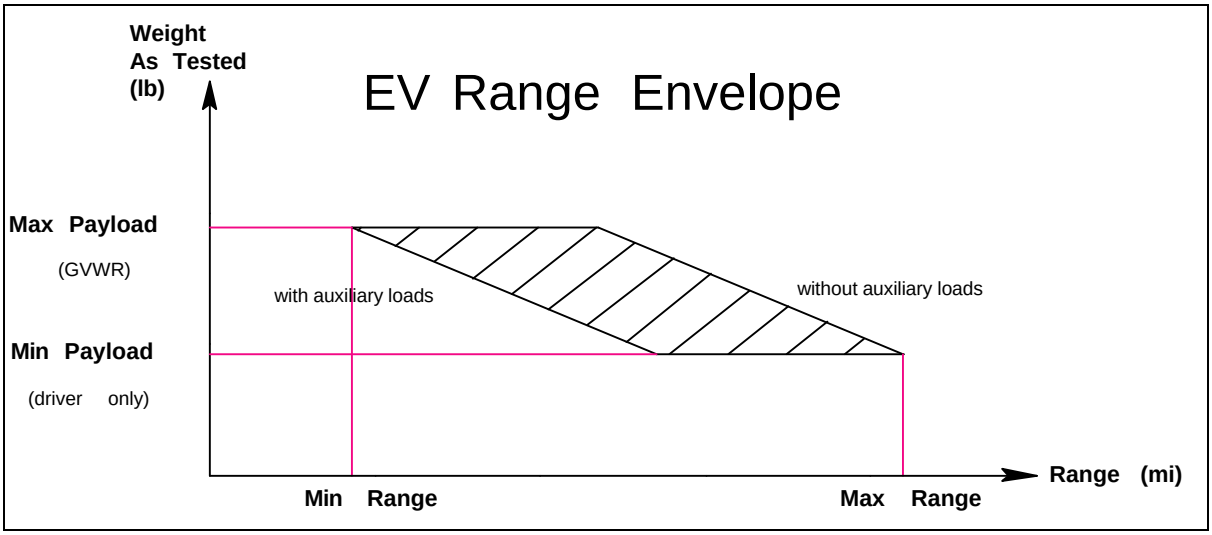


Figure 3-2. Range Envelope.

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

E. SOUND LEVEL TEST

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

F. STATE OF CHARGE METER EVALUATION

1. Driving

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

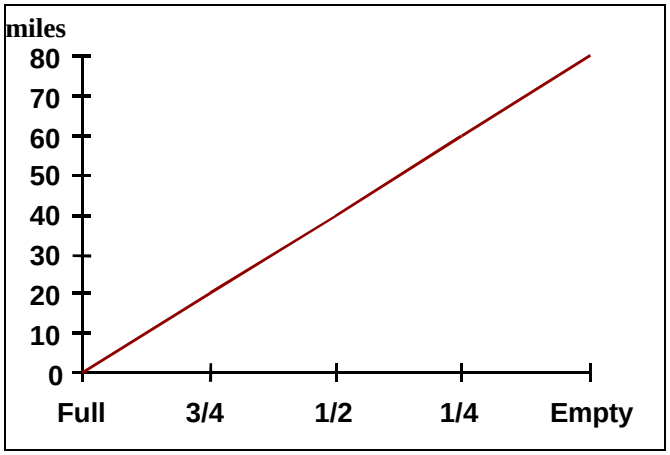


Figure 3-3. State of Charge Meter Evaluation.

2. Charging

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

3. Driving Range per Charging Time

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

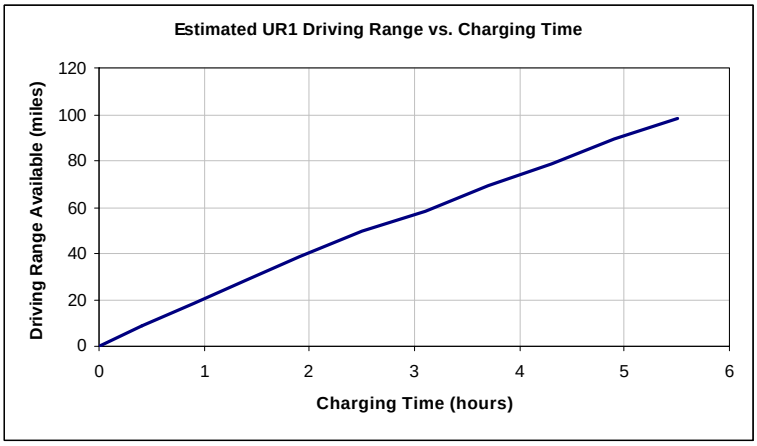


Figure 3-4. Sample plot of estimated range versus charging time.

G. PERFORMANCE TESTS

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

1. Acceleration

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

2. Maximum Speed

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

3. Acceleration - 30 to 55 mph

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

4. Braking

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

H. CHARGER PERFORMANCE/CHARGING PROFILE TEST

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

1. AC Input Data

After the first UR-1 range test, use the BMI Power Profiler to record the following on the AC (input) side of the charger for the duration of the charge at the EV Tech Center:

- Real, reactive, and apparent power
- Energy consumption

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

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

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

2. Charging Profile

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

3. Charger Energy Efficiency

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

4. Data Analysis/Reports

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

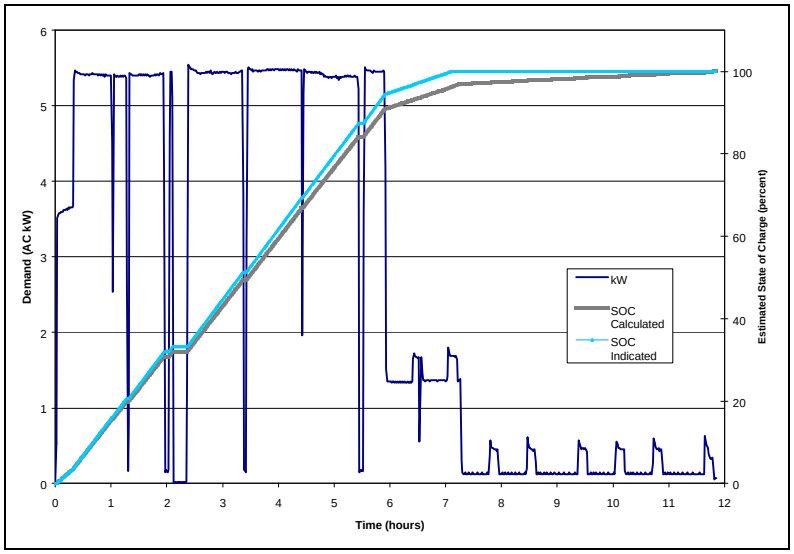


Figure 3-5. Sample AC charging profile plots.

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

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

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

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

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

Table 3-1. EPRI IWC EV Charging Standards.

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

5. Audible Noise Levels

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

6. Operation and Ergonomics Evaluations

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

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

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

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

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

7. Charging at a Residential Setting

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

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

1. Vehicle on Charger

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

2. Vehicle off Charger

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

J. TRANSFER THE VEHICLE

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

APPENDICES

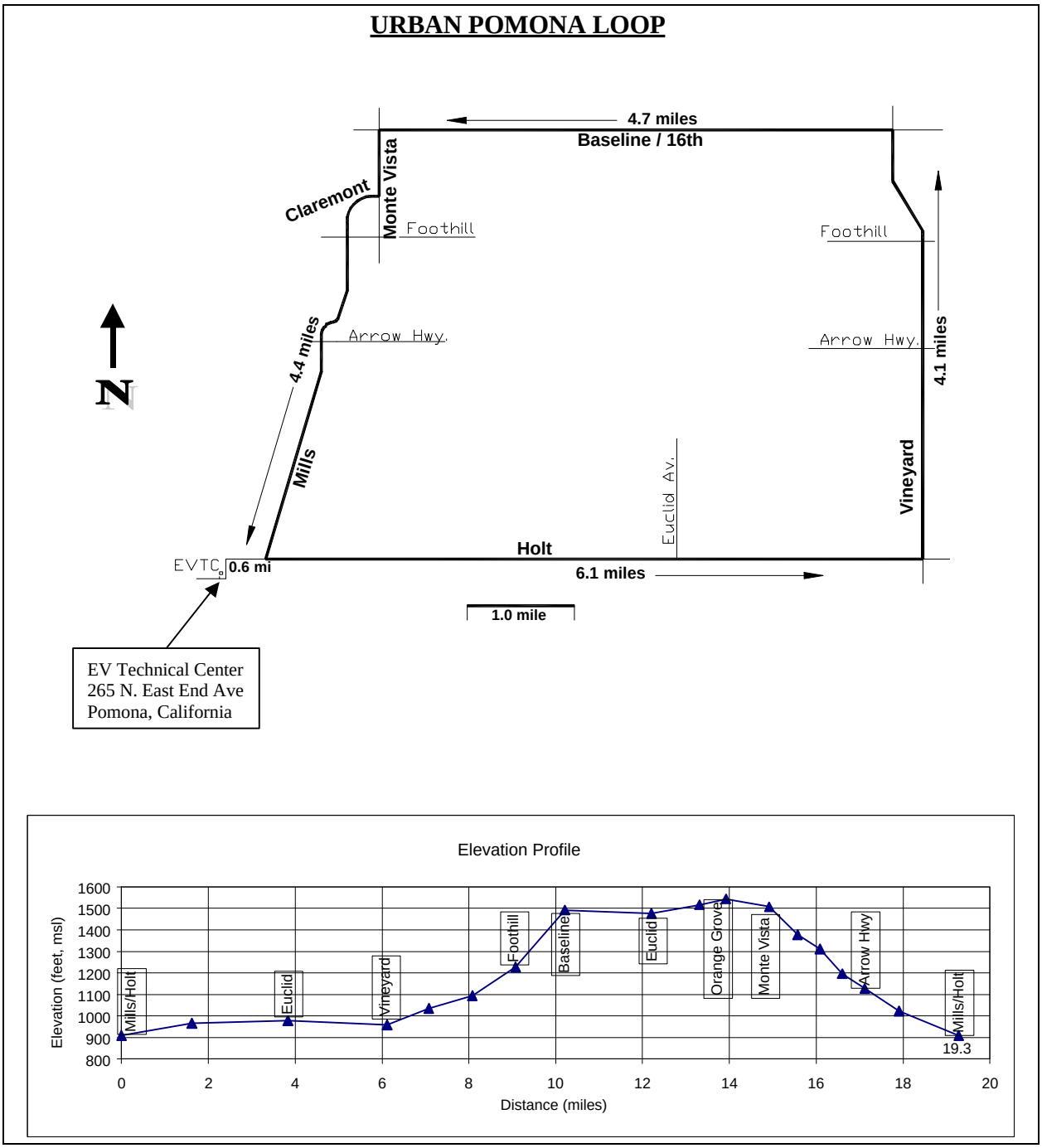
EV Performance Characterization Testing Schedule

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

Minimum total days needed for full testing: 27

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

Pomona Loop Map



Urban Pomona Loop - Tabulated Data

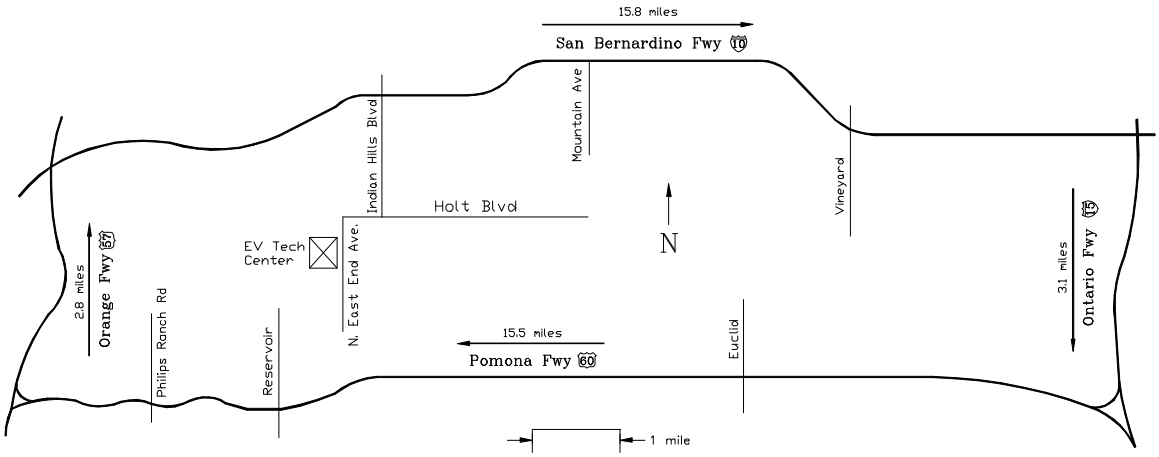
Stop No.	Distance from Start (miles)	Type	Distance from Previous stop	Comments
0	0.00	light	0.00	East End & Holt
1	0.10	light	0.10	
2	0.15	light	0.05	Mills & Holt
3	0.80	light	0.65	
4	1.30	light	0.50	
5	1.80	light	0.50	
6	2.30	light	0.50	
7	2.90	light	0.60	
8	3.50	light	0.60	
9	3.70	light	0.20	
10	4.00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

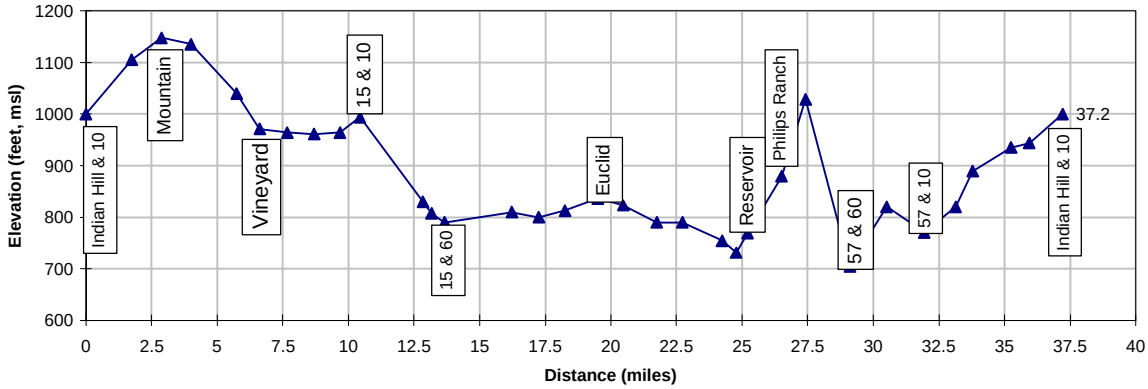
47	17.60	sign	0.20	
48	18.60	light	1.00	
49	18.70	sign	0.10	
50	19.00	sign	0.30	
51	19.30	light	0.30	
52	19.50	light	0.20	Holt & Mills
53	19.60	light	0.10	
54	19.80	light	0.20	Holt & East End

MCW: ttt
9/23/92

Freeway Loop Map

FREEWAY POMONA LOOP





EVTC Equipment

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

EVTC Number	Manufacturer	Model	Description	Quantity
MCR-001	OLYMPUS	MICRO-32	MICRO CASSETTE RECORDER	1
MMR-001	Various	Various	DIGITAL MULTIMETER	14
MMR-012	HEWLETT PACKARD	34401 A	MULTIMETER	1
MMW-001	ROLATAPE	MEASUMASTERMM30	MEASURING WHEEL	1
MPG-001	HEWLETT PACKARD	6942A	MULTIPROGRAMMER	1
NVK-001	NORVIK TRACTION INC.	BC-500-4	MINIT CHARGER	1
OHM-001	MEGGER	210200	OHM METER	1
OPB-001	U.S. MICROTEL	PM-500	OPTICAL PROBE	2
OSC-001	HEWLETT PACKARD	54600B	OSCILLOSCOPE	1
OSC-002	YOKOGAWA	701810-1D	DL708 DIGITAL SCOPE	1
OSC-003	YOKOGAWA	OR3412/PM-M	OSC. RECORDER H.A.	1
OVP-001	3M	9700 9000AJJ	OVERHEAD PROJECTOR	1
PHA-001	FLUKE	41	POWER HARMONICS ANALYZER	1
PHA-003.4	FLUKE	43	POWER HARMONICS ANALYZER	2
PHA-002	BMI	155	HARMONICS METER	1
PRI-001	EXTECH	480300	PHASE ROTATION TESTER	1
PRT-001	HEWLETT PACKARD	C3167A	LASERJET 5SI/MX PRINTER	1
PRT-002	HEWLETT PACKARD	C2001A	LASERJET 4M PRINTER	1
PRT-003	HEWLETT PACKARD	C4530A	2000C COLOR PRINTER	1
PSY-001	WAYNE-KERR	LS30-10	POWER SUPPLY	1
SCL-001	METTLER	FEHD-R	DIGITAL SCALE	1
SCR-001	FLUKE	97	SCOPEMETER	1
SGM-001	KEM	DA-110	DENSITY/SPECIFIC GRAVITY METER	1
SGN-001	WAVETEK	191	SIGNAL GENERATOR	1
SMR-001	EXTECH INSTRUMENTS	407762	SOUND LEVEL METER	1
STW-001	Various	Various	STOPWATCH	2
THR-001	OMEGA	PTH-1X	TEMP/HUMIDITY METER	2
THR-002	Various	Various	THERMOCOUPLE THERMOMETER	3
THR-004	SEALED UNIT PARTS	PT-100	DIGITAL THERMOMETER	1
THR-006	RADIO SHACK	63-867A	DIGITAL TEMP/HUMIDITY METER	2
WHR-001	CRUISING EQUIPMENT	KWH METER	KILOWATT-HOUR METER	2
YOK-001	YOKOGAWA	AR1100A	ANALYZING RECORDER	1
ZIP-001	IOMEGA	Z100PS	ZIP HARDWARE	3

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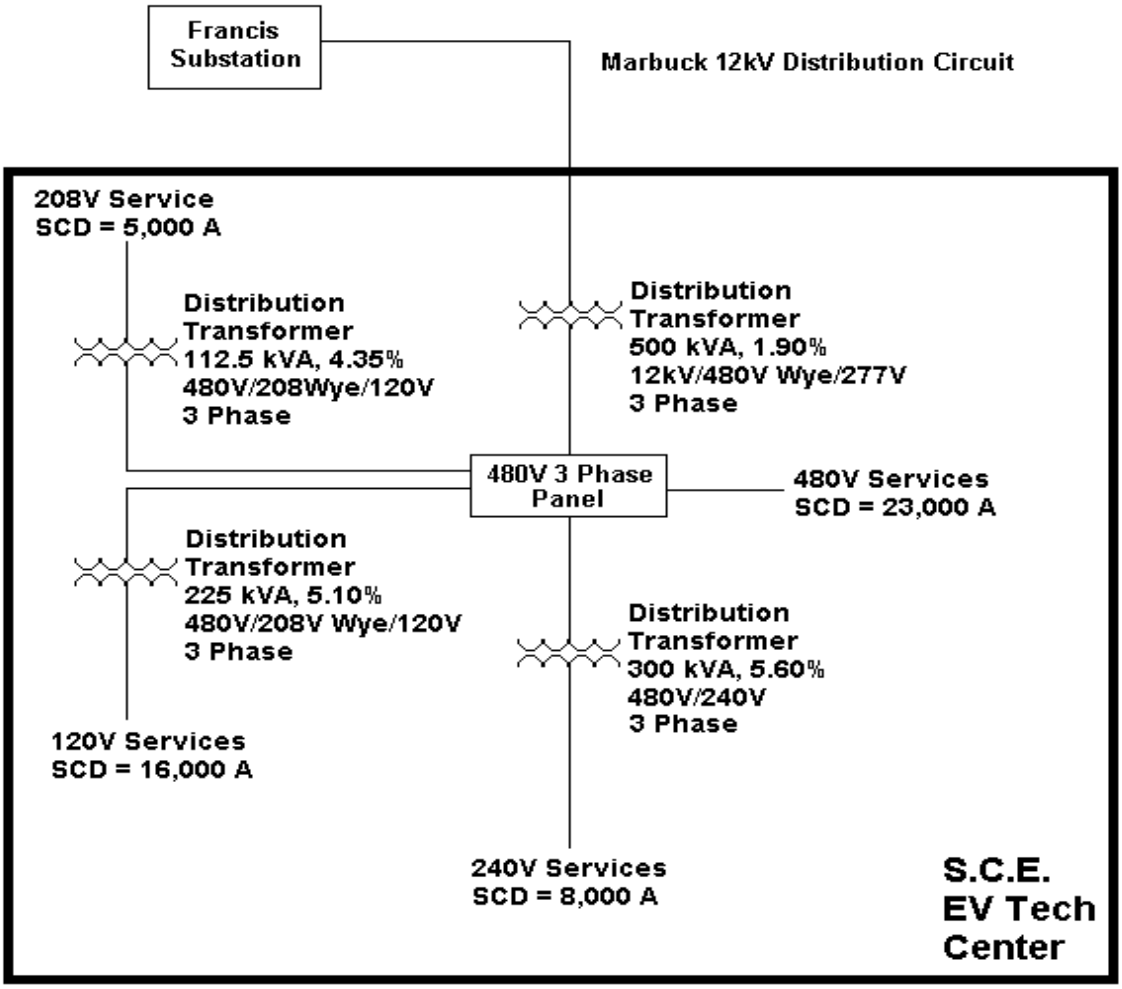
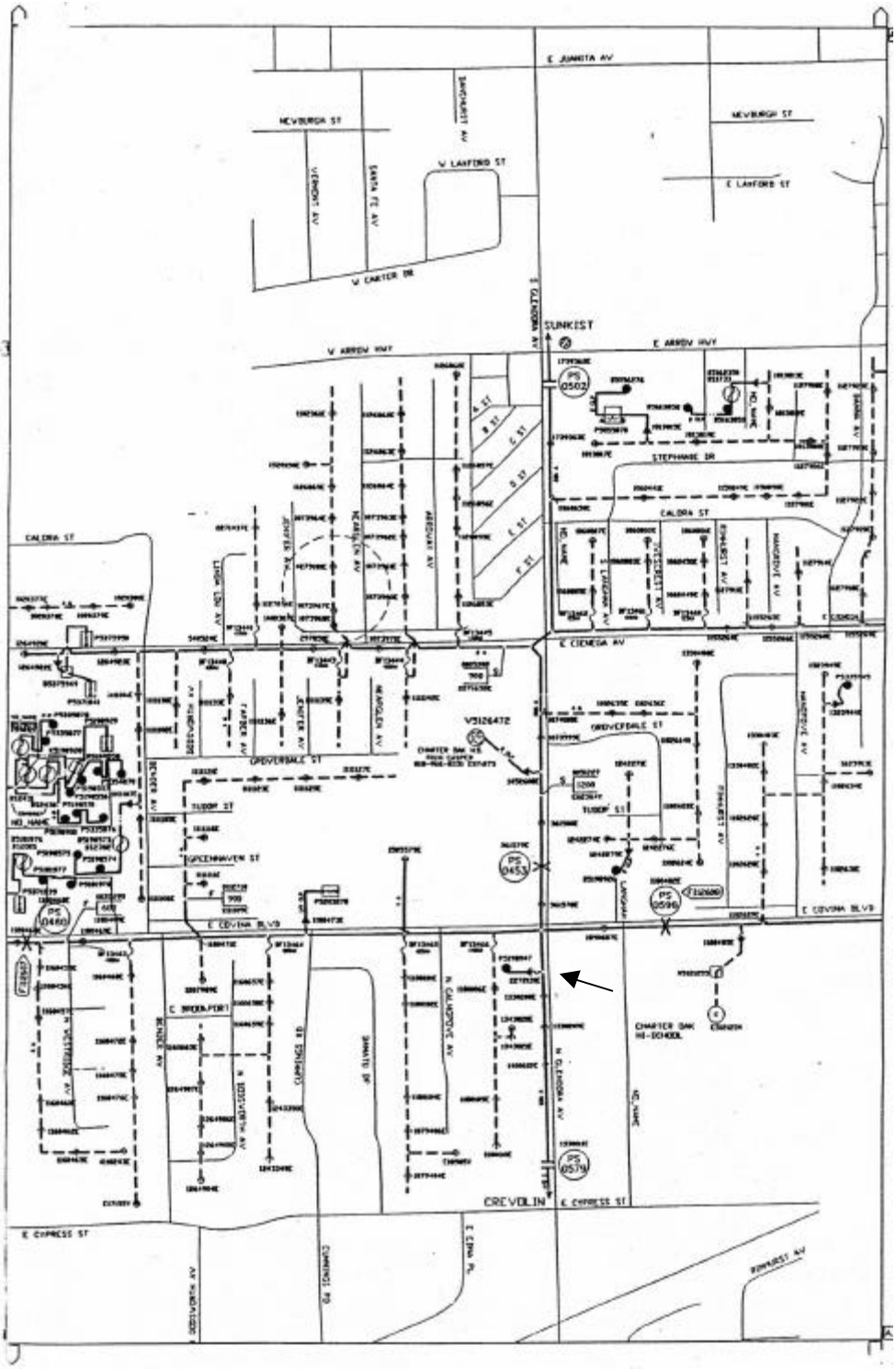
EV Tech Center Line Diagram



Residence Line Diagram



EVTC-010 Driving Test Data Sheet

POMONA DRIVING TEST DATA

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

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

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

Accessories used:

Drive / Regen setting:

Handling/Braking:

Other comments:

Charger	Serial No.	AC meter#	BMI #

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

Comments:

EVTC-010

EVTC-020 Charger Testing / Analysis Data Sheet

Technician: _____ Date: _____
Location: _____ Phone: _____

Charger Information

Manufacturer: _____
Model No.: _____
Supply Side Voltage Rating: _____

After Completion of Recharging Cycle

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

Charger Operation Information/Evaluation

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

EVTC-030 Performance Testing Data Sheet

ACCELERATION, MAXIMUM SPEED, AND BRAKING TESTS

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

Acceleration (100% SOC)

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

Average

Acceleration (80% SOC)

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

Average

Acceleration (60% SOC)

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

Average

Acceleration (40% SOC)

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

Average

Acceleration (20% SOC)

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

Average

Braking 25-0 mph, 50% SOC

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

Average ft

Comments

EVTC-040 Vehicle Test Equipment and Nameplate Data Sheet

Project:_____ Test:_____
Date(s):_____ File Name(s):_____
Vehicle Number:_____ Technician:_____

VEHICLE

Manufacturer: _____VIN:_____
Model: _____Model Year:_____ Date of Manufacture: _____
GVWR:_____Front AWR:_____ Rear AWR:_____
Motor Manufacturer:_____ Motor Type:_____
Motor Rating/Speed:_____
Version/Serial No.:_____
EPA Label Fuel Economy: _____
Controller Version/Serial No.: _____
Battery Pack Type/Version/Serial No.: _____
Tire Manufacturer: _____Model:_____
Tire Size:_____ Maximum Pressure:_____
Maximum Tire Load: _____ Treadwear Rating:_____

CHARGER

On-board / Off-board Manufacturer:_____
Model: _____Serial Number:_____
Charger Type/Version:_____
EVSE Manufacturer: _____
EVSE Model/Version:_____Serial Number:_____
EVSE Software Version:_____
Charge Port Manufacturer/Model/Version/SN:_____

TEST EQUIPMENT

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

WEIGHT CERTIFICATION

Scale Location and Proprietor:_____
Examiner:_____ Date:_____
Notes:_____

EVTC-050 Sound Level Meter Data Sheet

Sound Level Test Data

Urban Driving Sound Level Test

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

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: _____

Freeway Driving Sound Level Test

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

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: _____

Charger Sound Level Test

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

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: _____

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

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

BATTERY SPECIFICATIONS

Manufacturer: _____ Model: _____
Date of Manufacture: _____ Nominal Voltage:_____
Ah Rating @ C/3:_____ Voltage Range:_____
Weight/Module:_____ Temp. Range:_____

BATTERY PACK

Number of Modules:_____ Nominal Voltage:_____
Configuration: _____
Location for Test:_____

TEST EQUIPMENT

Discharge Unit: _____ Serial No._____
Charging Unit: _____ Serial No._____
Data Acquisition Equipment:_____
_____
Other Equipment:_____

RESULTS

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

RECHARGE TYPE			
Ah RETURNED			
kWh RETURNED			
DATA FILE			

NOTES:_____
_____