PERFORMANCE CHARACTERIZATION

1999 CHRYSLER EPIC
WITH SAFT NICKEL/METAL-HYDRIDE BATTERY

SOUTHERN CALIFORNIA EDISON

An *EDISON INTERNATIONAL* Company

ELECTRIC TRANSPORTATION DIVISION

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PURPOSE

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

The following facts support this purpose:

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

TABLE OF CONTENTS

I. INTRODUCTION

In June 1999 Southern California Edison received two EPIC (Electric Powered Interurban Commuter) minivans from Daimler Chrysler along with two 14 kW conductive chargers manufactured by Lockheed Martin. Preliminary testing was conducted with the chargers to determine if the vehicles would be charged by a single phase or three-phase grid connection setup. The single-phase charger had continuing problems and the three-phase setup was selected for the test. Three phase charging also provides the fastest recharge time and is likely to be the charging method of choice for the EPIC's target market, commercial fleets.

The 1999 EPIC models are equipped with liquid cooled Nickel Metal Hydride (NiMH) battery packs. They have the same drivetrain and body style as the 1999 models equipped with lead acid batteries.

II. MANUFACTURER'S SPECIFICATIONS

See Appendix B, page 20, for the manufacturer's fact sheet.

Wheelbase:	113.3"
Powertrain:	AC induction motor 100 hp peak / 75 hp continuous.
	Single speed front-wheel-drive transaxle.
Batteries:	Nickel-metal-hydride 336 volts (28 12-volt modules).
	Anticipated battery life 4-6 years.
Charging:	Compatible with off-vehicle charger – 208/240-volt, up to 60-amp circuit (approximately 6 to 8 hour charge time)
	Quick charge capability (440-volt public charging facility where available)
Chassis:	5800 Gross Vehicle Weight Rating
	925-pound payload.
	Heavy duty shocks springs and struts.
	Cast aluminum wheels.
	P205/75R/15 low rolling resistance tires.
Performance:	0 to 60 mph in 17 seconds and top speed of 80 mph.
	Range of 80 to 90 miles (SAEJ1634 combined city/highway in warm weather with no accessories.

Range is reduced in cold weather and varies with driving conditions and driving style.

Standard Equipment:
- Dual air bags
- Anti-lock brakes
- Regenerative braking
- Power steering
- Power Brakes
- Power door locks
- Four doors
- Air conditioning and heater
- Rear defrost
- Sunscreening glass
- AM/FM radio
- Rear wiper
- Off Vehicle Charger

Warranty: Vehicle and battery: 3-year/36,000 mile limited warranty.

III. DEVIATIONS FROM THE SCE ELECTRIC VEHICLE TEST PROCEDURE

Sound levels were not recorded during the charger performance test.

IV. RESULTS

A. Weight Certification

Table 4-1. Weight Results

	Front Axle*	**Rear Axle***	**Total Weight**
GVWR (lb)	2850	3100	5800
Curb Weight (lb)	2560	2310	4870
Available Payload (lb)	290	790	930

*Front and rear axle weights are not certified.

B. Range Tests

B1. Urban Range Tests

Table 4-2. Urban Range Test Results.

Tests	UR1	UR2	UR3	UR4
Range at Stop Condition (mi)	82.0	67.8	77.6	63.6
Total Miles Driven	82.5	68.2	77.9	64.0
Driving Conditions				
Payload (lb)	160	160	930	930
Avg. Amb. Temp. °F	75	80	79	85
Average Speed (mph)	24	24	24	24
Recharge				
AC kWh Recharge*	53.91	50.03	53.02	52.61
AC kWh/mi	0.663	0.734	0.675	0.823

* From ABB meter.

UR1: Pomona loop range test with minimum payload

UR2: Pomona loop range test with minimum payload and auxiliary loads

UR3: Pomona loop range test with maximum payload

UR4: Pomona loop range test with maximum payload and auxiliary loads

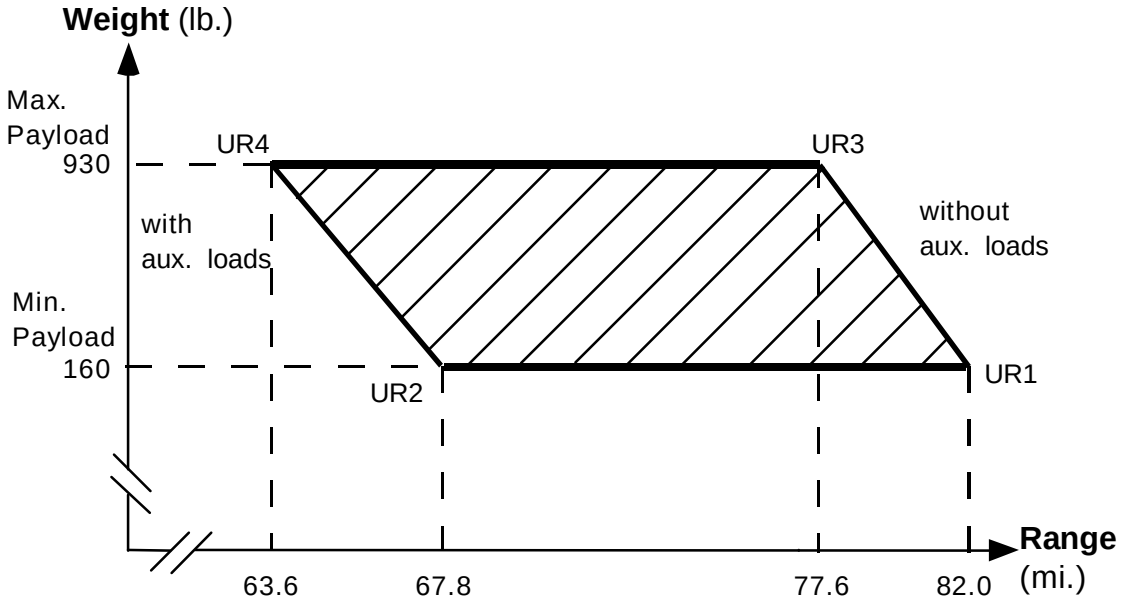

Figure 4-1. Urban Range Envelope.

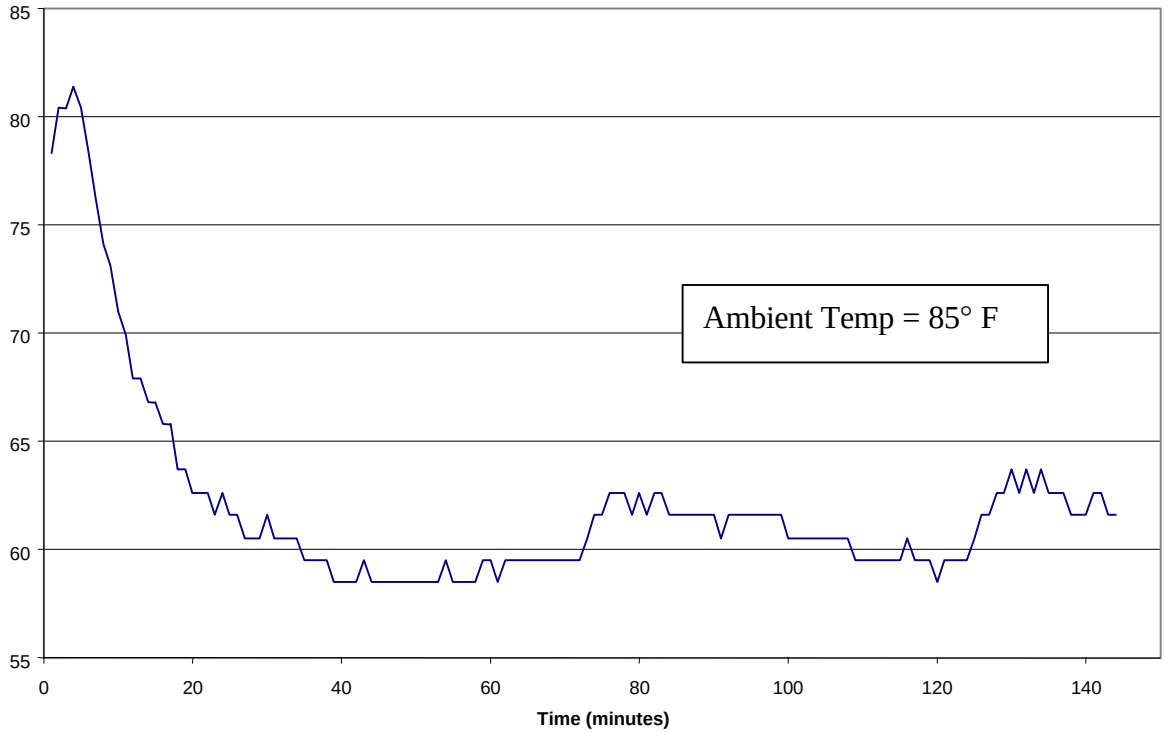

Figure 4-2. Interior cabin temperatures during UR4.

B2. Freeway Range Tests

Table 4-3. Freeway Range Test Results.

Tests	FW1	FW2	FW3	FW4
Range at Stop Condition (mi)	99.3	75.3	80.3	68.6
Total Miles Driven	99.7	78.2	82.2	69.5
Driving Conditions				
Payload (lb)	160	160	930	930
Avg. Amb. Temp. °F	86	88	83	101
Average Speed (mph)	51	51	52	52
Recharge				
AC kWh Recharge[1]	54.08	51.54	50.42	55.52
AC kWh/mi	0.542	0.674	0.598	0.799

[1] From ABB meter.

FW1: Freeway loop range test with minimum payload

FW2: Freeway loop range test with minimum payload and auxiliary loads

FW3: Freeway loop range test with maximum payload

FW4: Freeway loop range test with maximum payload and auxiliary loads

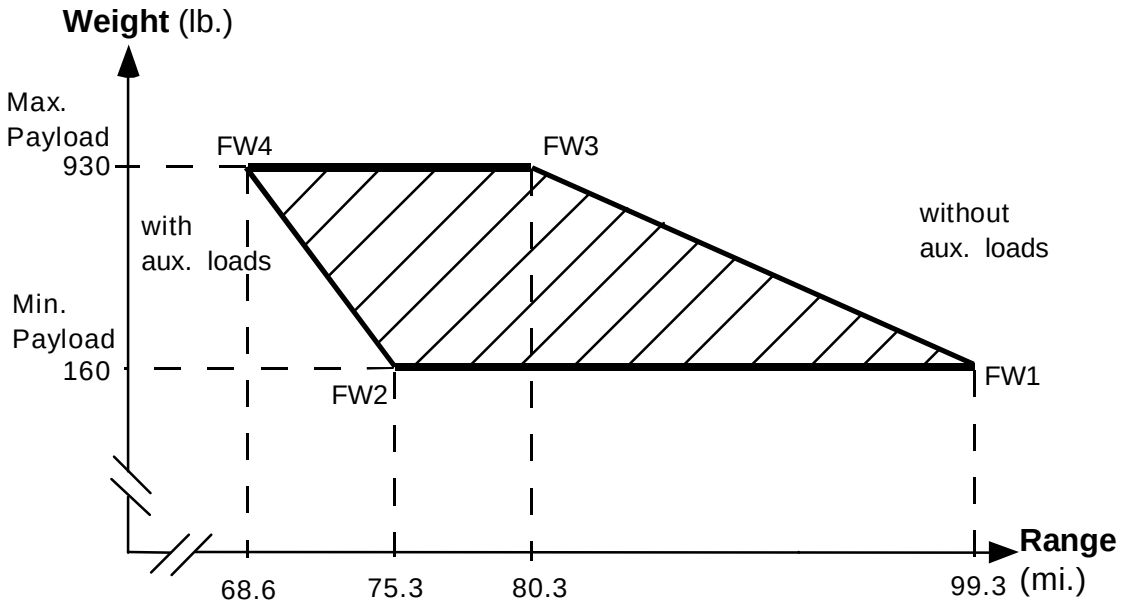

Figure 4-3. Freeway Range Envelope.

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D. State of Charge (SOC) Meter Evaluation

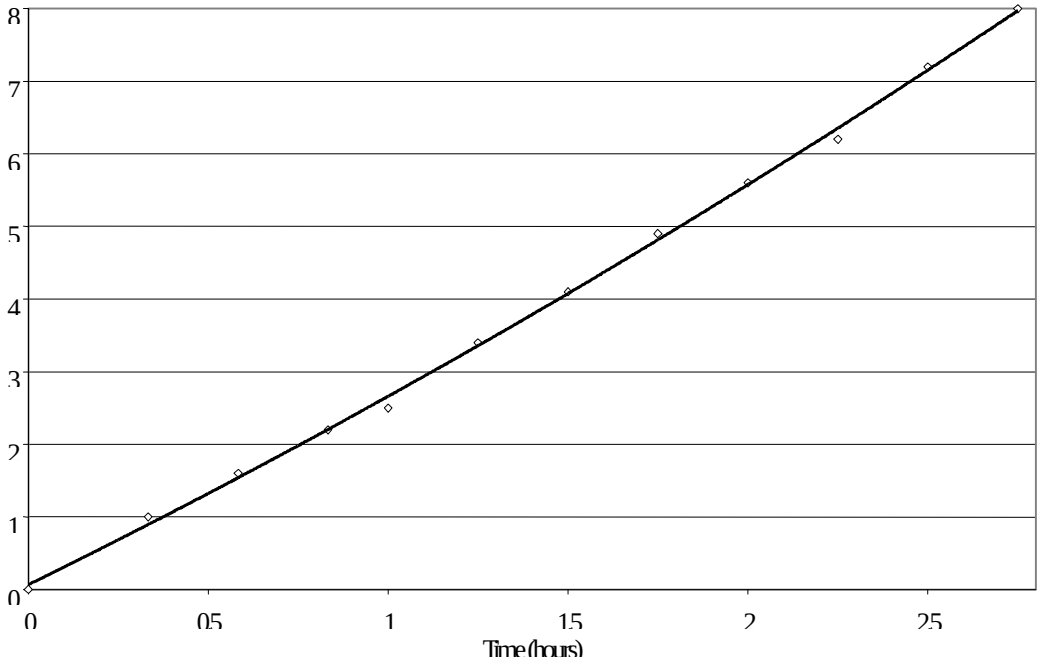


Figure 4-6. State-of-Charge meter readings vs. time on charge.
Note: The vehicle continued to charge after the user SOC had reached 100%.

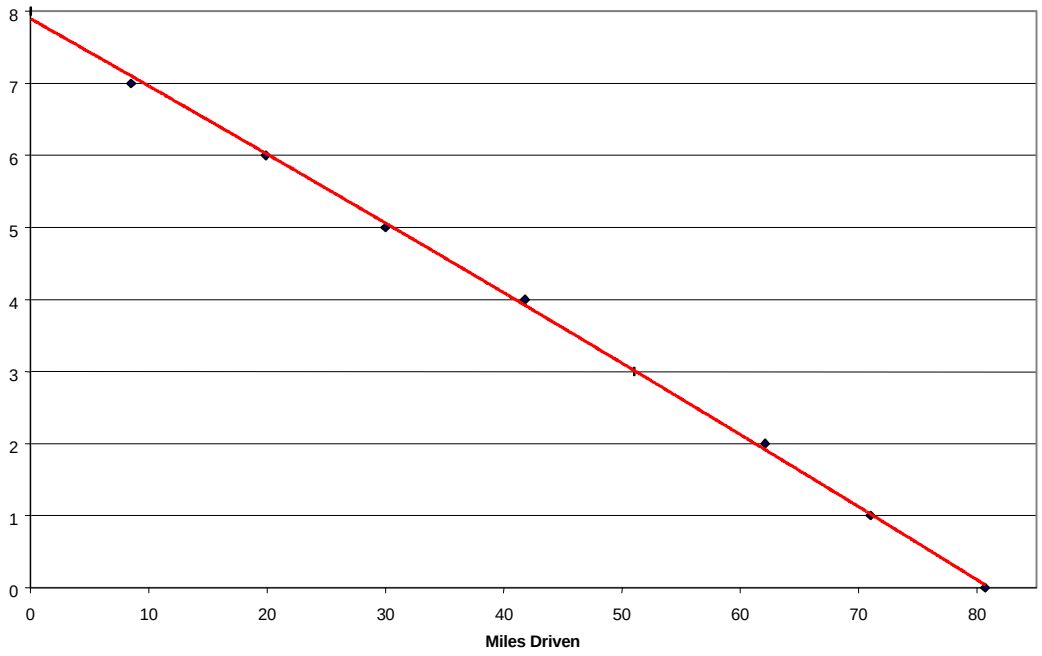


Figure 4-7. State-of-Charge meter evaluation during a drive.

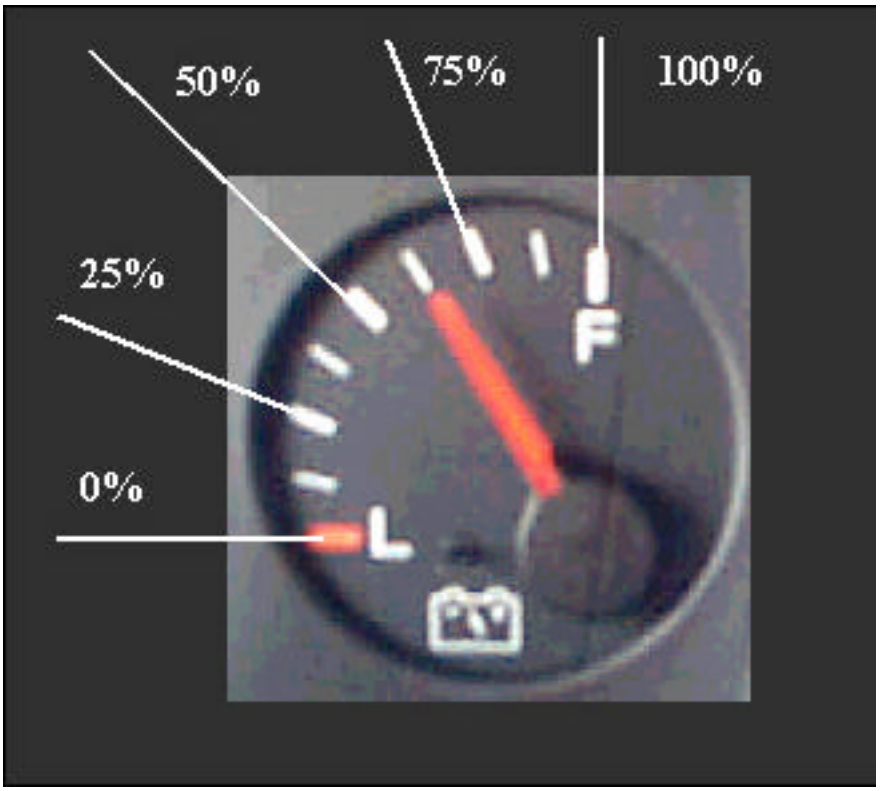


Figure 4-8. EPIC State-of-Charge gauge.

Note: The SOC percentages shown above refer to the "user SOC". At 0% user SOC, there is charge still available in the pack but draining that charge would damage the batteries. Damage is prevented by on-board control systems

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

Table 4-4. Performance Testing Data

Performance Testing Data	100% SOC	80% SOC	60% SOC	40% SOC	20% SOC
0 to 30 mph (sec.)	4.63	4.62	4.83	4.91	4.78
30 to 55 mph (sec.)	10.50	11.50	11.25	11.85	12.83
0 to 60 mph (sec.)	14.60	14.54	16.75	17.58	16.49
Max Speed (mph)	72.50	N/A	N/A	N/A	69.00
Braking (25-0 mph) (ft.)	N/A	N/A	31.57	N/A	N/A

[1] Average values (ambient temperature: 52-55^{o} F). (160 lb. payload)

F. Charger Performance / Profile Test

Table 4-5. Charger Profile Data.
Note: Refer to Appendix D, page 44, for BMI Power Profiler graphical data.

Measured Value[1]	Phase A	Phase B	Phase C	Total/Average
Voltage	204.7V	203.6V	206.5V	204.9V
Current	44.5 A	45.1 A	44.6 A	77.5 A
Real Power	5.079 kW	5.089 kW	5.053 kW	15.22 kW
Voltage THD	2.1%	2.3%	2.3%	2.2%
Current THD	28.3%	27.9%	28.4%	28.2%
Current TDD	27.2%	26.8%	27.3%	27.1%

Measured Value[1] (total)	
Real Power	15.22 kW
Reactive Power	771 VAR
Apparent Power	15.87 kVA
Total Power Factor	0.96 PF
Displacement Power Factor	1.00 dPF

Total Charging Time	4h 27min
Total Energy Consumption	51.95 kWh

Time Observed on Stand-by	24 hours
Average Power	26.7 kW
Energy Consumption	0.640 kWh

[1] Value recorded near peak power on the AC (input) side of the charger (208V service).

Starting ambient temperature: 66° F.

Data was recorded after the UR2 test.

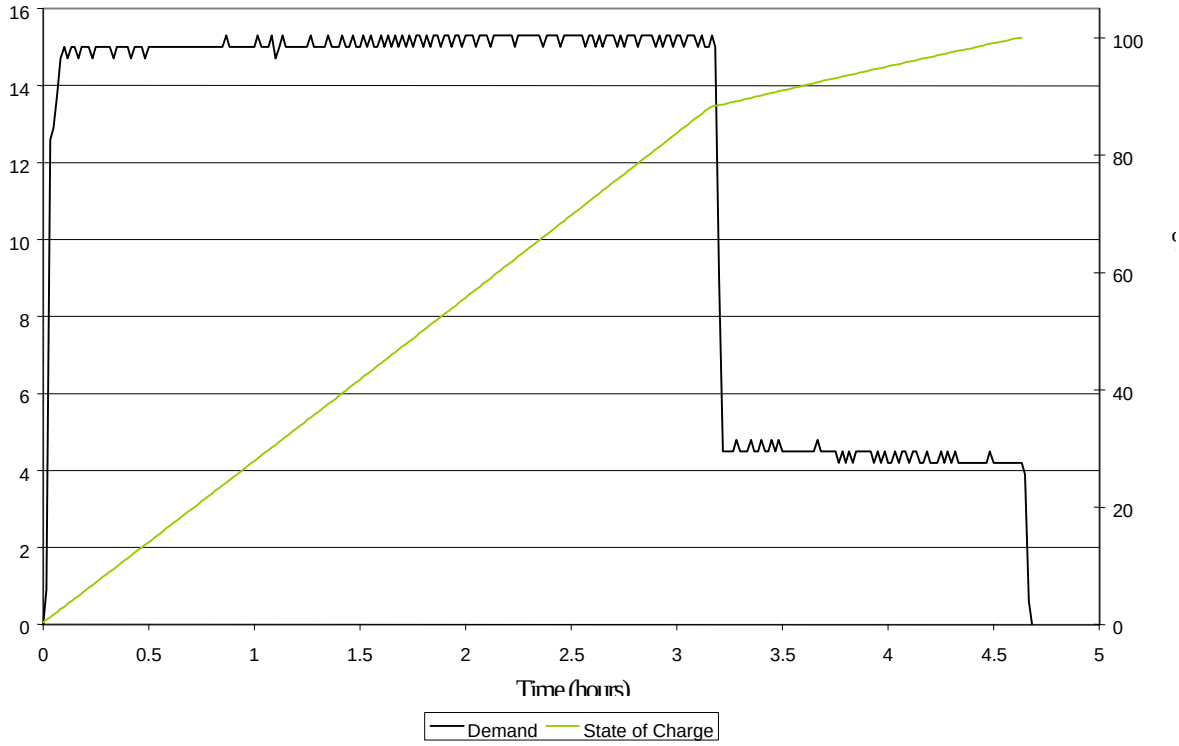


Figure 4-9. AC input charging profile from ABB meter.

V. DISCUSSION AND CONCLUSIONS

A. Weight Certification

A curb weight of 4870 lb was determined at a private scale. Using the manufacturer's gross vehicle weight rating of 5800 lb, the calculated available capacity is 930 lb. The manufacturer specifies a working payload of 925 lb. The front and rear axle weights listed in Table 4-1 are within 10% accuracy. Chrysler's first generation EPIC had a higher GVWR (5900 lb.). However, the heavier lead acid batteries that powered the minivan also lowered the available payload to about 800 lb.

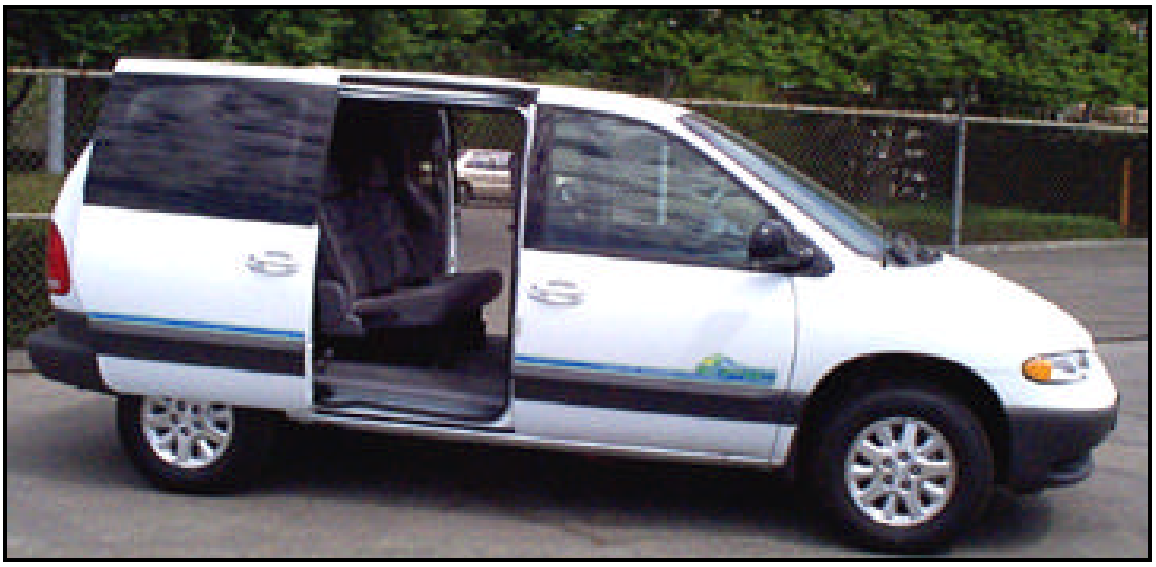


Figure 5-1. The 1999 EPIC's dual sliding rear doors.

B. Range Tests

Range tests on the Urban and Freeway Pomona Loops allow testing of vehicles in a real world setting.

Testing took place according to the instructions in SCE's electric vehicle test procedure. The EPIC was driven from a full charge to empty in a safe manner that did not interfere with the flow of traffic. The vehicle was equipped with a low charge warning system to prevent damage to the battery pack. The first signal of low charge was a light that illuminated at approximately 25%. When the vehicle was discharged to 0% state of charge, a "power limit" light turned on followed by a substantial reduction in vehicle performance. End of range testing was determined by the power limit light coming on.

The EPIC is equipped with regenerative braking that engages when braking is applied.

The EPIC feels underpowered when starting from a dead stop. The spring on the accelerator is too soft, making it difficult to maintain a constant speed. The problem is most noticeable on uneven roads; there is not enough resistance from the pedal to keep the driver's foot from bouncing back and forth.

The EPIC uses the same body as the Dodge Caravan. It has great interior cargo space along with seating accommodations for up to five passengers.

Urban Range Tests

City driving took place on the Urban Pomona Loop (for a map of the Urban Loop see Appendix E, page54). The EPIC was range tested at minimum and maximum payload, with and without accessories.

The EPIC travelled an average of 82.0 miles at minimum payload but decreased to 77.6 with the added 930 lbs (Table 4-2, page3).

The use of accessories (air conditioner, headlamps and radio) lessened the range. A 17% drop from 82.0 to 67.8 miles was noted. This was significantly more than the 5% decrease between minimum and maximum payload. Most of the demand was due to the air conditioner.

As seen in Figure 4-2 page 4 the temperature of the air coming from the center vents was extremely low (40.2° F). The interior cabin temperature during the urban test dropped to an average 64° F, while the ambient temperature was 85° F. Energy efficiency for the EPIC for all urban tests was 0.724 AC kWh/mi. The average ambient temperature in Pomona was 80° F.

Freeway Range Tests

While power demand varies during urban driving, it stays relatively constant during freeway driving. During the freeway tests the speed was kept as close to 65 mph as traffic would allow. The access route for the freeway entailed about two miles of urban driving each way. Also, transitioning from the Pomona to the Orange Freeway required exiting, driving about one-half mile and then re-entering.

Driver confidence in the EPIC dropped when entering the freeway. The EPIC was slow to reach 65 mph. This posed a hazard when attempting to merge with traffic. The problem became more evident as the grade of the on ramp increased.

When the voltage spread between the highest and lowest modules reached 0.6V, the power limit light came on regardless of state of charge (see ‘Battery Capacity

Test', page 14). This was observed while entering the freeway and while attempting to pass traffic on the freeway. Performance was not noticeably affected. According to Chrysler the power limit light will come on when one or more of the following occurs:

1. Low traction battery state of charge.
2. High traction battery temperature.
3. Low traction battery temperature.
4. High powertrain temperatures.

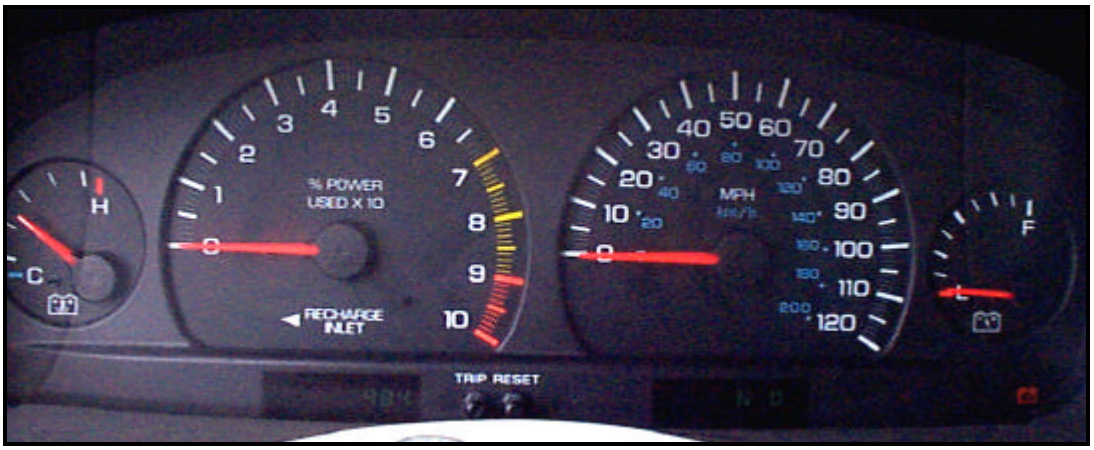


Figure 5-2. Battery pack temperature gauge, percent power used gauge speedometer and SOC gauge.

The EPIC's range increased greatly on the freeway. The largest increase was during the FW1 test. With minimum payload and no accessories the range increased by 17% to 99.3 miles in relation to the 82.0 miles for the UR1 test. With maximum payload and accessories on, the range decreased 31% to 68.6 miles. The ambient temperature ranged from an average of 86° F for the FW1 tests to 101° F for the FW4 tests. The large range reduction can be attributed to the added payload, and to the air conditioner, which cooled the air coming out of the vents to an average 42.5° F. The temperature in the cabin dropped to 80° F while the ambient temperature was 101° F.

C. Battery Capacity Test

The capacity test was performed using the ABC-150 battery cycler and a connector provided by Daimler-Chrysler. DC data was gathered using the

diagnostic tool engineered for the EPIC. The test yielded 90.1 Ah out, 97% of the packs rated capacity of 93 Ah.

As seen in Figure 4-5, page 6, the discharge was not at a constant current. During the capacity test it appears that the vehicle activated the battery cooling system. This extra demand increased the current coming out of the pack, but not the current being drawn by the ABC-150. The recorded capacity was 90.1 Ah. The estimated capacity of the pack at a constant current discharge was 92.9 Ah. The estimate was calculated by multiplying the C/3 rate and the total test time and adding the additional energy lost to the cooling system.

The capacity test also showed an increasing voltage spread between the modules towards the end of the test (See Appendix A, page 18). The voltage spread was a problem during the range tests because of a limit set by Daimler Chrysler. When the difference between the highest and lowest module (ΔV) reaches 0.6V, a power limit light goes on in the instrument cluster. The performance of the vehicle is not affected unless the depth of discharge (DOD) is low (about over 75% DOD) or the voltage spread spans more than a brief moment (approximately 60 s). According to Daimler-Chrysler, when the ΔV reaches 0.8V, the vehicle will shut down to maintain pack integrity. As of this report writing, software changes had been made to SCE's vehicles to address this problem.

D. State of Charge Meter Evaluation

The state of charge meter is located in front of the driver in the instrument cluster (Figure 5-2, page 13). The relationship between SOC displayed and miles driven, as seen in Figure 4-7, page 7, was fairly linear. The SOC meter helped to establish an estimate of charge remaining. The supplemental low charge light that comes on at 25% and the power limit light that came on at 0% aided the driver in establishing a more accurate stop condition.

The SOC meter is not active during charge unless the key is in the "on" position. This will temporarily interrupt charge until the key is returned to the "off" position. The SOC meter read full in two hours and forty-five minutes (see Figure 4-6, page

7). The charge profile (Figure 4-9, page 10) yields a total charge time of four hours and forty minutes. In this instance the SOC meter gave an incorrect reading. Although the SOC meter was reading full the operator should confirm charge status at the charger.

E. Acceleration, Braking, and Maximum Speed Tests

These tests were conducted at the Pomona Raceway. Acceleration times and braking distance information was gathered using the Vericon CC 2000 Performance Computer (Table 4-4, page 8). The ambient temperature ranged from 77° F in the morning to 88° F in the afternoon.

The EPIC's average acceleration time from 0-30 mph was 4.63 s at 100 % SOC. At 20% the time increased three percent to 4.78 s. When peak power demands were applied for a longer time, 0-60 mph, the difference in acceleration was greater. At 100% it took 14.60 s compared to the 16.49 s at 20%. The time it took to go from 30-55 mph also rose significantly as the available charge dropped. The times were over two seconds apart, 10.50 s at 100% and 12.83 s at 20%.

As mentioned previously, high power demands would cause the power limit light to come on. The light came on during four acceleration runs while traveling north with the slight uphill grade. The light coming on did not affect the performance of the EPIC. It is believed however, that once activated, the power limit will not allow demands greater than a pre-programmed setting.

F. Charger Performance Test

Initial testing was conducted to determine which grid connection setup (single or three phase) would be used for the test. The chargers were tested at single-phase 40A 240V, single-phase 60A 240V, and three-phase 60A 208V setups. The three-phase setup was chosen because it offered the shortest charge time. Fleets operating the EPIC may use the setup with the shortest charge time.


Figure 5-1. Lockheed Martin Charger (left) and EPIC charge port (right).

The prototype Lockheed Martin charger was mounted on a steel base with wheels. The charger starts and stops automatically. The conductive coupler is inserted into the charge port located in the rear quarter panel on the driver's side. Inserting the coupler required significant pressure. The coupler, along with the cable, was large and bulky to accommodate the high power and current. Once the coupler was inserted, the driver-side front turn indicator will flash for a few seconds and remain lit during charge.

On three-phase the charger used a total maximum power of 15.22 kW at an average 204.9V. The charger drew a total of 77.5 A with 44.5, 45.1, and 44.6 going to the individual phases.

As seen in Table 4-5, page 9, when evaluated according to the recommended practices of the Infrastructure Working Council, the charger's performance was fair. The recorded power factor of 96% was just above the 95% limit. Harmonic guidelines established in IEE 519-1992 limit THD_I and TDD to 20%. Under the chargers peak power conditions the recorded current THD average for

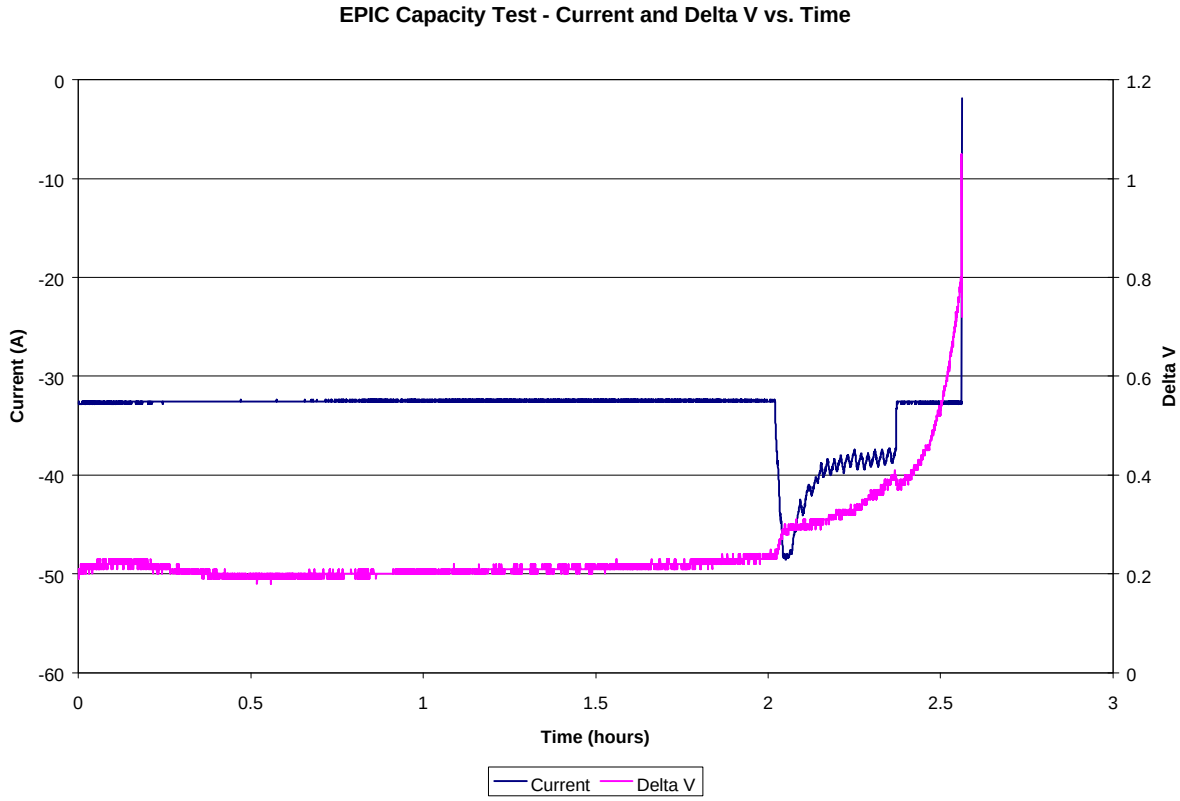
the three phases was 28.2%. The calculated TDD average for the three phases was 27.1%. The average voltage THD was 2.2%, well below the maximum limit of 5% (individual phase values can be seen in Table 4-5, page 9).

It took the EPIC 4 hours and 27 minutes to charge from empty to full (51.95 kWh).

When observed for twenty-four hours on stand-by, with the vehicle connected but not charging, the charger used 640 Wh at an average power of 26.7 W.

APPENDIX A

BATTERY CAPACITY TEST


EPIC Capacity Test - Current and Delta V vs. Time
Current (A)
Delta V
Time (hours)
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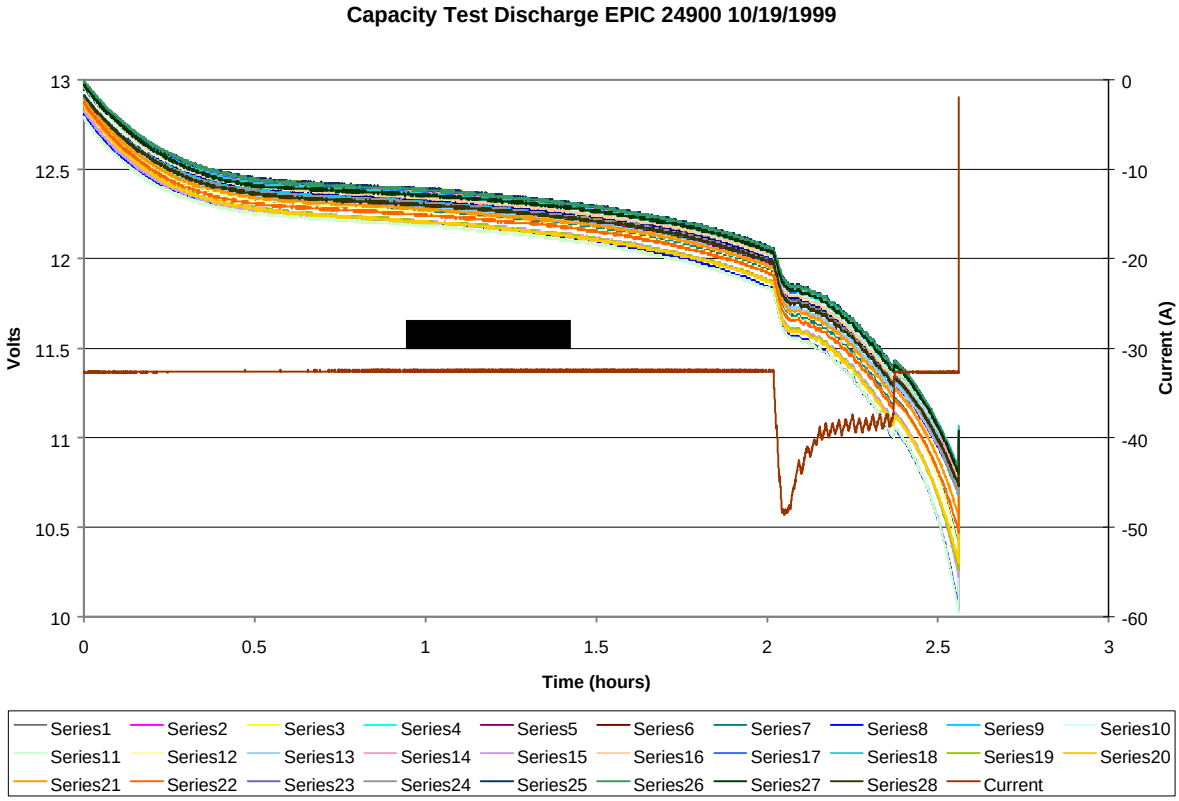
-10
-20
-30
-40
-50
-60
1.2
1
0.8
0.6
0.4
0.2
0
0.5
1
1.5
2
2.5
3
Current
Delta V


Capacity Test Discharge EPIC 24900 10/19/1999
Volts
Current (A)
Time (hours)
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12.5
12
11.5
11
10.5
10
0
-10
-20
-30
-40
-50
-60
0.5
1
1.5
2
2.5
3
Series1
Series2
Series3
Series4
Series5
Series6
Series7
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Series15
Series16
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Series18
Series19
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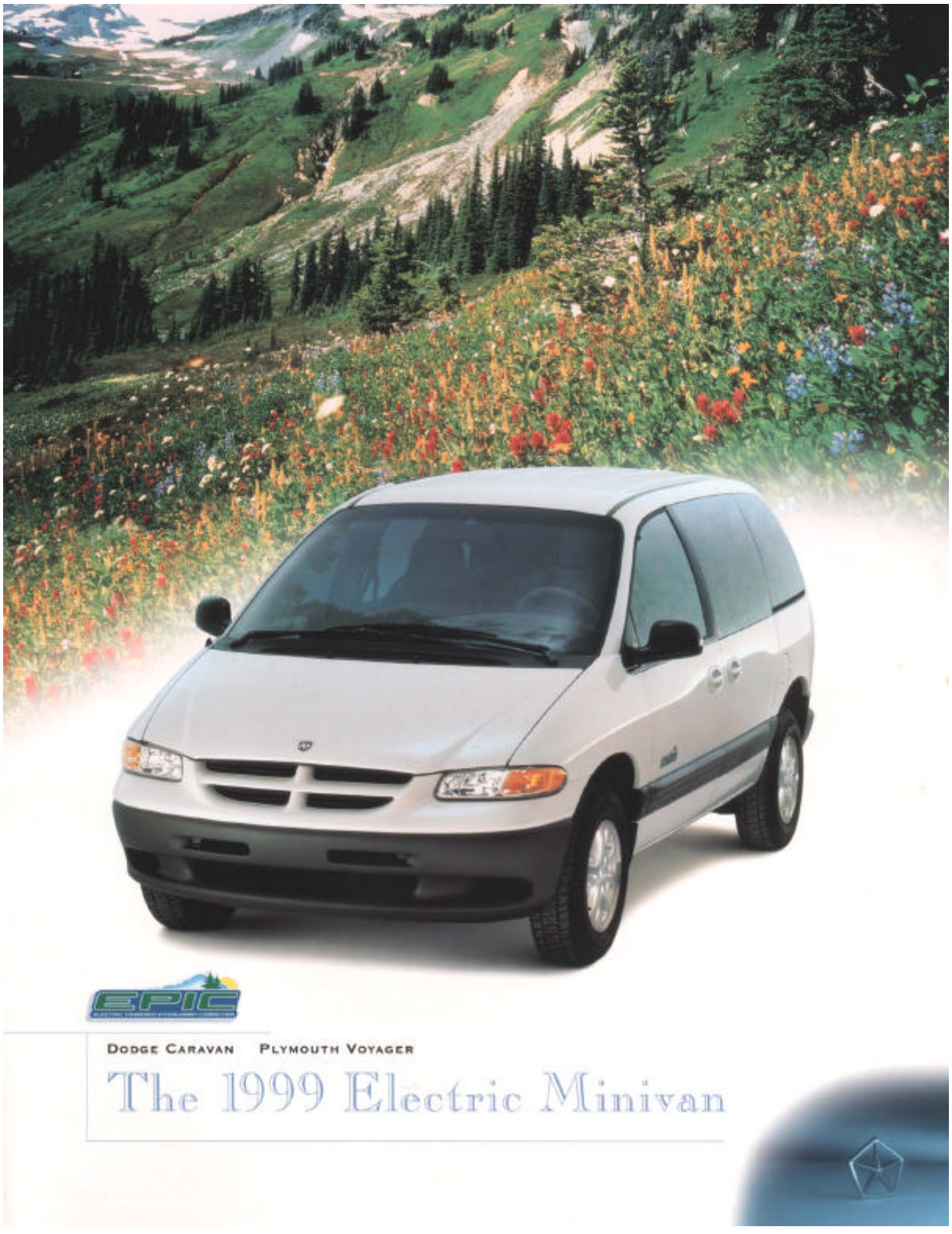
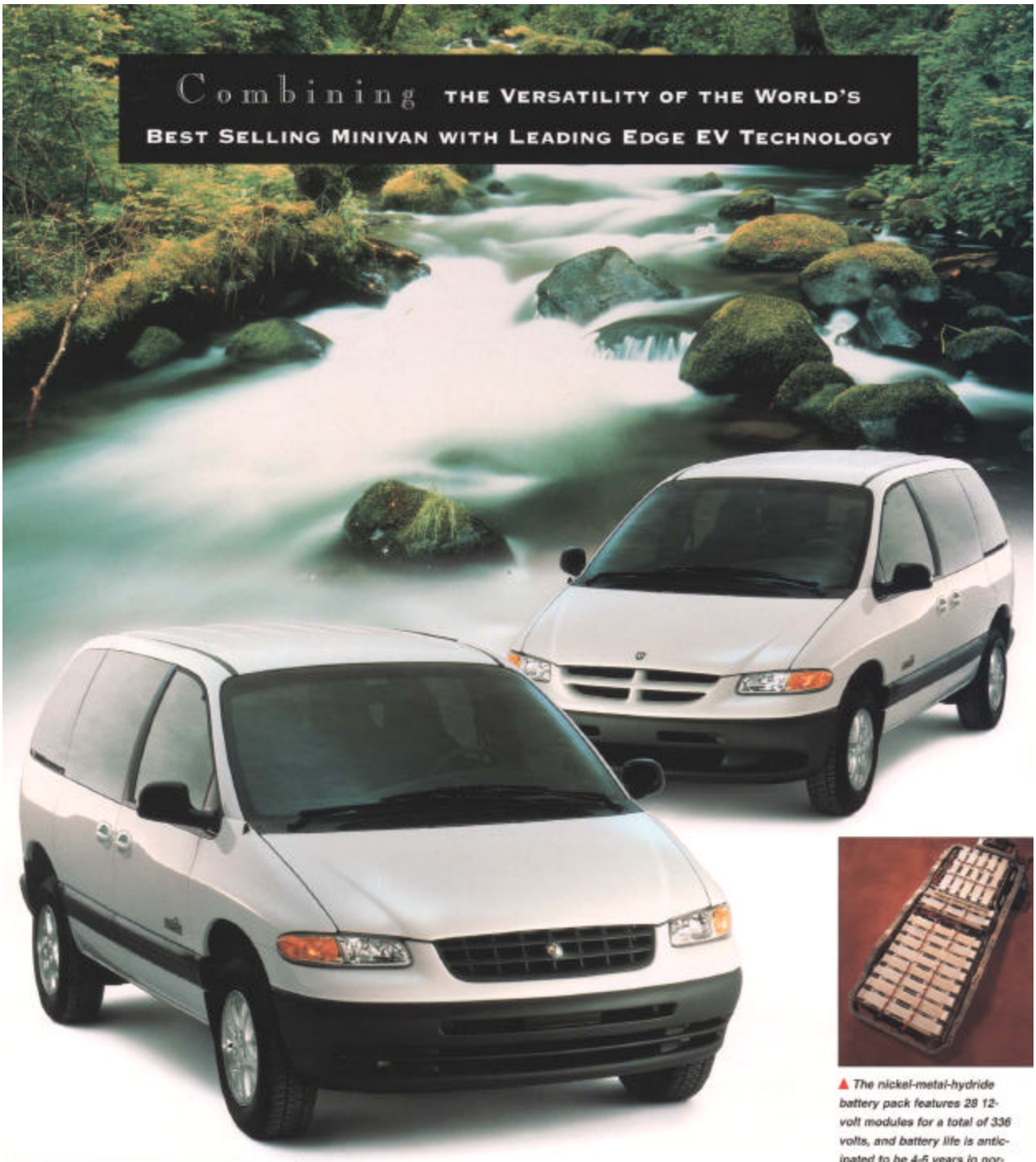
Series26
Series27
Series28
Current

APPENDIX B

VEHICLE MANUFACTURER'S FACT SHEET


EPIC
DODGE CARAVAN PLYMOUTH VOYAGER
The 1999 Electric Minivan

Combining the Versatility of the World's Best Selling Minivan with Leading Edge EV Technology



▲ The nickel-metal-hydride battery pack features 28 12-volt modules for a total of 336 volts, and battery life is anticipated to be 4-6 years in normal use.

◀ Distinctive decals identify the owner as an environmentally responsible citizen.

▶ The "brain" of the vehicle, the Motor Control Unit monitors and controls a variety of operation and motor functions.

▲ *The instrument cluster features a state-of-charge gauge which calculates the charge remaining in the battery system.*

Chrysler Corporation understands electric vehicles. In fact, while some automakers are still working to develop their first electric vehicle, the 1999 Dodge Caravan and Plymouth Voyager electric minivans represent Chrysler's second-generation electric vehicle and fourth generation battery technology. The real-world experience and valuable customer feedback gained from the design and sale of the previous generation electric minivans have given Chrysler engineers the knowledge to improve performance and reduce costs for the current family of zero emission vehicles.

Known as *EPIC*, an acronym for Electric Powered Interurban Commuter, this new generation electric is based on the five-passenger/113" wheelbase version of the world's most popular minivan...and takes zero emission technology to a new level.

Featuring Advanced Nickel-Metal-Hydride Technology

For 1999, all-new nickel-metal-hydride batteries replace the lead-acid battery pack used in previous *EPIC*s. "Fuel" for the *EPIC* comes from twenty-eight 12-volt modules, which combine to produce 336 volts of power. Thanks to lighter weight and increased energy density, the nickel-metal-hydride batteries provide the *EPIC* with a range of 80 to 90 miles, compared to 60 to 70 miles with the previous generation lead-acid batteries. And the new technology is less effected by cold weather than its lead-acid predecessor.

Power for the Dodge Caravan and Plymouth Voyager *EPIC* is supplied by a 100-peak horsepower AC induction motor and a single speed, front-wheel-drive transaxle for smooth and quiet operation.

For maximum vehicle range, the *EPIC* uses P205/75R/15 low rolling resistance tires to reduce road friction. In addition, an innovative regenerative braking system is activated when the brakes are applied and works to recharge the battery during vehicle deceleration.

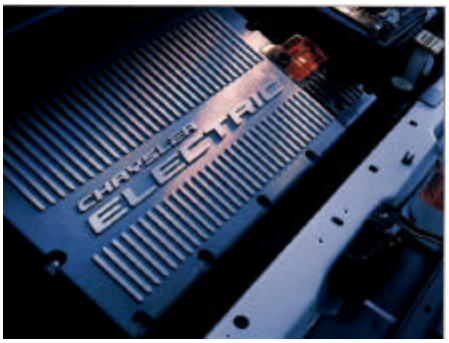
▲ *Right where it should be, the charging point is located in the same location as the fuel fill on a gasoline-powered minivan.*

An EPIC Combination

When you combine the world's best-selling minivan with advanced electric vehicle technology, you end up with an unbeatable combination of style and functionality.

With a 925-pound payload, the *EPIC* can carry five passengers and 175 pounds of cargo or any combination of the two. Heavy duty springs, shocks and struts guarantee a smooth and controlled ride. Four doors make entry and exit a snap.

▲ *Low rolling resistance tires reduce road friction.*



The 1999 Dodge Caravan and Plymouth Voyager *EPIC*. The current technology in electric vehicles from Chrysler Corporation, a leader in alternative fuel vehicles.

For more information on the *EPIC*, call Chrysler's Fleet Operations Hotline at 1-800-999-FLEET or visit our website at www.chrysler.com.

EPIC ELECTRIC MINIVAN HIGHLIGHTS

VEHICLES Plymouth Voyager EPIC
Dodge Caravan EPIC

WHEELBASE Short Wheelbase (113")

POWERTRAIN AC induction motor (100 peak/75 continuous horsepower) • Single speed front-wheel-drive transaxle (with drive, reverse, neutral and park positions)

BATTERIES Nickel-metal-hydride (with thermal management) 336 volts (28, 12-volt modules) • Controlled by battery engine management system • Anticipated battery life of 4 to 6 years in normal use

CHARGING Compatible with off-vehicle charger—208/240-volt, up to 60-amp circuit (approximately 6 to 8 hour charge time) Also features quick charge capability (440-volt public charging facility where available)

CHASSIS 5800 GVW • 925-pound payload • Heavy duty shocks, springs and struts • Cast aluminum wheels • P205/75R/15 low rolling resistance tires.

PERFORMANCE 0 to 60 in 17 seconds and top speed of 80 miles per hour • Range of 80 to 90 miles (SAE J1634 combined city/highway in warm weather with no accessories) • Range is reduced in cold weather and varies with driving conditions and driving style

STANDARD EQUIPMENT Dual air bags • Anti-lock brakes Regenerative braking • Power steering • Power brakes • Power door locks • Four doors • Air conditioning and heater (heat pump with auxiliary electric heating system) • Rear defrost • Sunscreening glass • AM/FM radio • Rear wiper • Off-vehicle charger

WARRANTY Vehicle and battery: 3-year/36,000 mile limited warranty

All product illustrations and specification are based upon current information at the time of publication approval (August of 1998). Although descriptions are believed correct, complete accuracy can't be guaranteed. Chrysler Motors Corporation reserves the right to make changes from time to time, without notice or obligation, in prices, specifications, colors and materials, and to change or discontinue models. See your Chrysler Motors Corporation dealer for the latest information.

CHRYSLER CORPORATION
FLEET OPERATIONS

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APPENDIX C

RANGE TEST DATA SHEETS

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/16/1999	9920	179920	UR1	Mendoza		Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	180 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:45	1292	100.00%	NA	NA	87 F	NA	NA
Stop	17:18	1369	0.00%	NA	NA	90 F	NA	Min. A/C
Net	3:33	77	100.00%			3 F		NA

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
8.8	7.0		
16	6.0		
29	5.0		
38	4.0		
48	3.0		
57.2	2.0		Mile 57.2 battery light on.
67	1.0		Mile 76.8 power limit light on.
76.9	0.0		Mile 76.9 end of drive.

Accessories used: Radio
Drive / Regen setting: Standard Regen
Handling/Braking: Fair handling, good brakes
Other comments:

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	89954-111E935768		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/16/99	17:30	NA	0	NA	NA	89 F	NA
Stop			NA	51.68	NA	NA		NA
Net				51.68				

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/19/1999	9920	179920	UR2	Sanchez	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	160 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	12:10	1369	100.00%	NA	NA	88 F	69 F	52 F
Stop	14:40	1427	0.00%	NA	NA	89 F	52 F	Min. A/C
Net	2:30	58	100.00%			2 F		43 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
6.4	7.0		
11	6.0		
20.2	5.0		
28.2	4.0		
37.4	3.0		
43.5	2.0		Mile 43.2 battery light on. (25%)
48.7	1.0		Mile 58.7 power limit light on.
57.8	0.0		
58.9	0.0		End drive

Accessories used: Radio, A/C, headlights
Drive / Regen setting: Standard Regen, Smooth Ride
Handling/Braking: Fair handling, good brakes
Other comments: Takes a lot of power going uphill.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 B0100		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/19/99	14:45	NA	0	NA	NA	89 F	NA
Stop			NA		NA	NA		NA
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/20/1999	9920	179920	UR2	Sanchez	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	160 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:35	1427	100.00%	NA	NA	77 F	67 F	43 F
Stop	11:00	1448	0.00%	NA	NA	86 F	49 F	Min. A/C
Net	1:25	21	100.00%			9 F		43 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
8.5	7.0		
15.2	6.0		
20.6	5.0		Flat tire at 16.8 miles. End drive.
	4.0		
	3.0		
	2.0		
	1.0		
	0.0		
	0.0		

Accessories used: Radio, A/C, headlights
Drive / Regen setting: Standard Regen, Smooth Ride
Handling/Braking: Fair handling, good brakes
Other comments:

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/20/99	11:00	NA	0	NA	NA	86 F	NA
Stop			NA		NA	NA		NA
Net								

Comments: Flat tire, drive no good.

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/23/1999	9920	179920	UR2	Sanchez	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	160 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:30	1486	100.00%	NA	NA	86 F	69 F	41 F
Stop	11:10	1553	0.00%	NA	NA	88 F	53 F	Min. A/C
Net	2:40	67	100.00%			2 F		39 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
6.2	7.0		
13.8	6.0		
24.9	5.0		
32.9	4.0		
45.1	3.0		A/C temp. stayed at 43 degrees until 25%SOC, then it rose to 55 degrees.
51.9	2.0		Battery light on at 50.7 miles.
60.2	1.0		Last loop took mission to Garey back to EVTC
65.1	0.0		Circling on Price at end of drive.
67.6	0.0		Power limit on at 67.0 miles.

Accessories used: Radio, A/C, headlights

Drive / Regen setting: Standard Regen, Smooth Ride

Handling/Braking: Fair handling, good brakes

Other comments:

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/23/99	11:10	NA	0	NA	NA	88 F	NA
Stop			NA		NA	NA		NA
Net								

Comments: Non EV tire on front right side.

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/28/1999	9920	179920	UR1	Ruiz	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	155 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:05	1575	100.00%	NA	NA	69 F	NA	NA
Stop	12:30	1656	0.00%	NA	NA	80 F	NA	Min. A/C
Net	3:25	81	100.00%			12 F		NA

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
8.5	7.0		
19.9	6.0		
30	5.0		
41.8	4.0		
51	3.0		10:05, Metrolink crossing 28.0 miles.\
62.1	2.0		Battery light on at 50.7 miles.
76	1.0		Last loop took mission to Garey back to EVTC
80.7	0.0		Power limit at 80.7 miles
81.3	0.0		End drive.

Accessories used: Radio

Drive / Regen setting: Standard Regen, Smooth Ride

Handling/Braking: Good handling and braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/28/99	12:30	NA	0	NA	NA	80 F	NA
Stop			NA		NA	NA		NA
Net								

Comments: Non EV tire on front right side.

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/29/1999	9920	179920	UR2	Sanchez	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	160 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	12:15	1656	100.00%	NA	NA	92 F	79 F	48 F
Stop	14:50	1718	0.00%	NA	NA	89 F	52 F	Min. A/C
Net	2:35	62	100.00%			4 F		42 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
x	7.0		
14.1	6.0		
25.3	5.0		
31.4	4.0		
39.7	3.0		
46.4	2.0		Battery light on at 46.1 miles.
53.1	1.0		
60.8	0.0		Power limit on at 61.4 miles.
61.9	0.0		End drive.

Accessories used: Radio, A/C, headlights.
Drive / Regen setting: Standard Regen, Smooth Ride
Handling/Braking: Fair handling, good brakes.
Other comments:

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/29/99	14:56	NA	0	NA	NA	89 F	NA
Stop			NA		NA	NA		NA
Net								

Comments: Non EV tire on front right side.
"5 hours, 12 minutes charge time"

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/30/1999	9920	179920	FW1	Sanchez	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	160 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:40	1718	100.00%	NA	NA	83 F	NA	NA
Stop	12:30	1816	0.00%	NA	NA	90 F	NA	Min. A/C
Net	1:50	98	100.00%			7 F		NA

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
14.6	7.0		
27.2	6.0		
37.8	5.0		
49.7	4.0		
63.7	3.0		Turned back at Archibald
74	2.0		Battery light on at 73.0 miles.
85.3	1.0		Exit on Town, circled on price twice.
95.9	0.0		Power limit on at 97.0 miles.
97.5	0.0		End drive.

Accessories used: Radio.
Drive / Regen setting: Standard Regen, Smooth Ride
Handling/Braking: Fair handling, good brakes.
Other comments: Acceleration is a slow for passing at highway speeds.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/30/99	12:38	NA	0	NA	NA	90 F	NA
Stop			NA		NA	NA		NA
Net								

Comments: Non EV tire on front right side.
"power applied for 4 hours 26 minutes"

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/02/1999	9920	179920	FW1	Sanchez	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	160 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:10	1816	100.00%	NA	NA	79 F	NA	NA
Stop	11:15	1920	0.00%	NA	NA	93 F	NA	Min. A/C
Net	2:05	104	100.00%			14 F		NA

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
13.3	7.0		
27.2	6.0		
38.2	5.0		
53.9	4.0		
69.4	3.0		
79.8	2.0		Battery light on at 79.0 miles.
94.1	1.0		Exit at Resevoir.
101.9	0.0		Power limit on at 101.5 miles.
104.4	0.0		End drive.

Accessories used: Radio.
Drive / Regen setting: Standard Regen, Smooth Ride
Handling/Braking: Fair handling, good brakes.
Other comments: Acceleration is a slow for passing at highway speeds.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/02/99	11:15	NA	0	NA	NA	93 F	NA
Stop			NA		NA	NA		NA
Net								

Comments: Non EV tire on front right side.

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/04/1999	9920	179920	FW2	Sanchez	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	160 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:35	1974	100.00%	NA	NA	85 F	83 F	64 F
Stop	12:10	2054	0.00%	NA	NA	92 F	50 F	Min. A/C
Net	1:35	80	100.00%			7 F		40 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
9.9	7.0		
21.6	6.0		
33.7	5.0		
41	4.0		
54.9	3.0		
64	2.0		Battery light on at 63.5 miles.
73	1.0		Turned back at Mountain, exited on Indian Hill.
79.6	0.0		Power limit on at 76.4 miles.

Accessories used: Radio, headlights, A/C

Drive / Regen setting: Standard Regen, Smooth Ride

Handling/Braking: Fair handling, good brakes.

Other comments: Acceleration is a slow for passing at highway speeds.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/04/99		NA	0	NA	NA	93 F	NA
Stop			NA		NA	NA		NA
Net								

Comments: Non EV tire on front right side.

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/05/1999	24900	179920	FW2	Sanchez	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	160 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:10	2054	100.00%	NA	NA	87 F	72 F	47 F
Stop	14:30	2131	0.00%	NA	NA	91 F	51 F	Min. A/C
Net	1:20	77	100.00%			4 F		44 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
10.3	7.0		
21.4	6.0		
30	5.0		
39.9	4.0		
50.9	3.0		
61.2	2.0		Battery light on at 60.3 miles.
69.4	1.0		Exit on Indian Hill.
76.8	0.0		Power limit on at 74.1 miles.

Accessories used: Radio, headlights, A/C

Drive / Regen setting: Standard Regen, Smooth Ride

Handling/Braking: Fair handling, good brakes.

Other comments: Acceleration is a slow for passing at highway speeds.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/05/99	15:04	NA	0	NA	NA	92 F	NA
Stop			NA		NA	NA		NA
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/06/1999	24900	179920	UR3	Sanchez	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	930 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	1:15	2131	100.00%	NA	NA	80 F	NA	NA
Stop	4:50	2208	0.00%	NA	NA	79 F	NA	Min. A/C
Net	3:35	77	100.00%			1 F		NA

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
9.4	7.0		
19	6.0		
29.4	5.0		
40.1	4.0		
49.5	3.0		
59.6	2.0		Battery light on at 69.3 miles.
66.3	1.0		Took Euclid to Baseline to finish the loop.
76.5	0.0		Power limit on at 76.7 miles.
77.1	0.0		End drive.

Accessories used: Radio.
Drive / Regen setting: Standard Regen, Smooth Ride
Handling/Braking: Fair handling, good brakes.
Other comments: Power feels good at full payload.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/06/99	16:55	NA	0	NA	NA	79 F	NA
Stop			NA		NA	NA		NA
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/11/1999	24900	179920	UR3	Sanchez	PM98-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	930 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:15	2208	100.00%	NA	NA	78 F	NA	NA
Stop	12:10	2287	0.00%	NA	NA	89 F	NA	Min. A/C
Net	2:55	79	100.00%			11 F		NA

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
9.5	7.0		
19.2	6.0		
28.4	5.0		
40	4.0		
49	3.0		
62.3	2.0		Battery light on at 61.4 miles.
69.9	1.0		Took Euclid to Baseline to finish the loop.
78.6	0.0		Power limit on at 78.4 miles.
			End drive.

Accessories used: Radio.
Drive / Regen setting: Standard Regen, Smooth Ride
Handling/Braking: Fair handling, good brakes.
Other comments: Power feels good at full payload.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/11/99	12:15	NA	0	NA	NA	89 F	NA
Stop			NA		NA	NA		NA
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/12/1999	24900	179920	UR4	Sanchez	PM99-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	930 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:30	2287	100.00%	NA	NA	77 F	67 F	41 F
Stop	12:21	2351	0.00%	NA	NA	90 F	44 F	Min. A/C
Net	2:51	64	100.00%			13 F		37 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
8.4	7.0		
14.1	6.0		
25.5	5.0		
32	4.0		
41.2	3.0		
48.8	2.0		Battery light on at 48.8 miles.
58.6	1.0		
64.2	0.0		Power limit on at 64.0 miles.
			End drive.

Accessories used: Radio, A/C, Headlights

Drive / Regen setting: Standard Regen, Smooth Ride

Handling/Braking: Fair handling, good brakes.

Other comments: Power feels good at full payload.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/12/99	12:30	NA	0	NA	NA	90 F	NA
Stop			NA		NA	NA		NA
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/13/1999	24900	179920	UR4	Sanchez	PM99-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	930 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:00	2351	100.00%	NA	NA	82 F	66 F	42 F
Stop	11:30	2415	0.00%	NA	NA	92 F	48 F	Min. A/C
Net	2:30	64	100.00%			10 F		38 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
8.3	7.0		
15.9	6.0		
25.9	5.0		
30.5	4.0		
40.5	3.0		
48.4	2.0		Battery light on at 48.1 miles.
57.7	1.0		
63.4	0.0		Power limit on at 63.1 miles.
63.7	0.0		End drive.

Accessories used: Radio, A/C, Headlights
Drive / Regen setting: Standard Regen, Smooth Ride
Handling/Braking: Fair handling, good brakes.
Other comments: Power feels good at full payload.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/13/99	11:30	NA	0	NA	NA	92 F	NA
Stop			NA		NA	NA		NA
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/20/1999	24900	179920	FW3	Sanchez	PM99-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	930 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:10	2463	100.00%	NA	NA	74 F	NA	NA
Stop	9:50	3547	0.00%	NA	NA	92 F	NA	Min. A/C
Net	1:40	1084	100.00%			18 F		NA

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
13.4	7.0		
26	6.0		
35.3	5.0		
47.3	4.0		
61	3.0		
70.4	2.0		Battery light on at 69.3 miles..
79.9	1.0		Turned back at Central, Exit on Towne.
84.3	0.5		Power limit on at 80.9 miles.
			End drive.

Accessories used: Radio
Drive / Regen setting: Standard Regen, Smooth Ride
Handling/Braking: Fair handling, good brakes.
Other comments:

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/20/99	9:55	1	NA	NA	NA	92 F	NA
Stop				NA	NA	NA		NA
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/23/1999	24900	179920	FW4	Sanchez	PM99-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	930 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	12:40	2547	100.00%	NA	NA	100 F	76 F	50 F
Stop	14:00	2617	0.00%	NA	NA	100 F	55 F	Min. A/C
Net	1:20	70	100.00%			F		40 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
5.1	7.0		
17.6	6.0		
26.8	5.0		
35.9	4.0		
47.1	3.0		
57.2	2.0		Battery light on at 55.2 miles.
645	1.0		Exit on Reservoir.
69.9	0.5		Power limit on at 68.6 miles.
			End drive.

Accessories used: Radio, A/C, Headlights.

Drive / Regen setting: Standard Regen, Smooth Ride

Handling/Braking: Fair handling, good brakes.

Other comments: Huge power demand when accelerating while entering the freeway. Power limit comes on early at a low SOC when the needle travels past the yellow zone.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/23/99	14:05	1	NA	NA	NA	100 F	NA
Stop				NA	NA	NA		NA
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/25/1999	24900	179920	FW4	Sanchez	PM99-EPIC NiMH Perf.	Start	NA
Road Cond	Tire Press	Payload				Stop	NA
dry	50 psi	930 lb				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:30	2618	100.00%	NA	NA	103 F	76 F	50 F
Stop	14:50	2687	0.00%	NA	NA	98 F	56 F	Min. A/C
Net	1:20	69	100.00%			5 F		46 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
4	7.0		
16.4	6.0		
26.3	5.0		
34	4.0		
42.5	3.0		Detour: Diamond Bar Closed. Took next exit and traveled back to the 57N.
53.7	2.0		Battery light on at 53.1 miles.
64	1.0		Exit on Reservoir.
68.5	0.0		Power limit on at 68.5 miles.
69	0.0		End drive.

Accessories used: Radio, A/C, Headlights.

Drive / Regen setting: Standard Regen, Smooth Ride

Handling/Braking: Fair handling, good brakes.

Other comments: Huge power demand when accelerating while entering the freeway. Power limit comes on early at a low SOC when the needle travels past the yellow zone.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/25/99	14:54	1	NA	NA	NA	98 F	NA
Stop					NA	NA		NA
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
08/30/1999	24900	179920	FW3	Sanchez	PM99-EPIC NiMH Perf.	Start	303.2
Road Cond	Tire Press	Payload				Stop	264.5
dry	50 psi	930 lb				Net	-38.7

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:00	2688	100.00%	NA	NA	80 F	NA	NA
Stop	13:30	2768	0.00%	NA	NA	86 F	NA	Min. A/C
Net	4:30	80	100.00%			6 F		NA

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	8.0		
5.4	7.0		
18.8	6.0		
30.3	5.0		
39.8	4.0		
54	3.0		
64.9	2.0		Battery light on at 64.4 miles.
74.5	1.0		Exit on Indian Hill.
80.1	0.2		Power limit on at 79.6 miles.
			End drive.

Accessories used: Radio.

Drive / Regen setting: Standard Regen, Smooth Ride

Handling/Braking: Fair handling, good brakes.

Other comments: Huge power demand when accelerating while entering the freeway. Power limit comes on early at a low SOC when the needle travels past the yellow zone.

Charger	Serial No.		AC meter#		BMI #			
LM 3phase	99 D0133		02 273 916		1			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	08/30/99	10:30	1	NA	NA	NA	86 F	264.5
Stop					NA	NA		NA
Net								

Comments:

APPENDIX D

CHARGER PROFILE GRAPHICAL DATA

Snapshots at Full Power

EPIC 9920 UR2 Jul 23 1999 (Fri)

POWER FACTOR SNAPSHOT 7:48:39 PM

Total: 15.22 kW

Total: 15.87 kVA

Total: 0.771 kVAR

Total: 0.96 PF

Total: 1.00 dPF

HARMONICS SNAPSHOT 7:48:39 PM

Fundamental freq: 60.0 Hz

VOLTAGE THD 2.2% THD avg

Phase A-Nm Volt: 2.1% THD
Phase B-Nm Volt: 2.3% THD
Phase C-Nm Volt: 2.3% THD

CURRENT THD 28.2% THD avg

Phase A Current: 28.3% THD
Phase B Current: 27.9% THD
Phase C Current: 28.4% THD

VOLTAGE & CURRENT SNAPSHOT 7:50:39 PM

VOLTAGE 204.9 Vrms

Phase A-B: 204.7 Vrms, 0°(ref)
Phase B-C: 203.6 Vrms, -121°
Phase C-A: 206.5 Vrms, 119°
Unbalance: 0.8%

CURRENT 77.5 A rms

Phase A: 44.5 A rms, -3°
Phase B: 45.1 A rms,-123°
Phase C: 44.6 A rms, 116°
Unbalance: 0.8%

EPIC 9920 UR2 Jul 23 1999 (Fri)

PHASE A POWER SPECTRUM 7:49:11 PM

Power: 5.079 kW

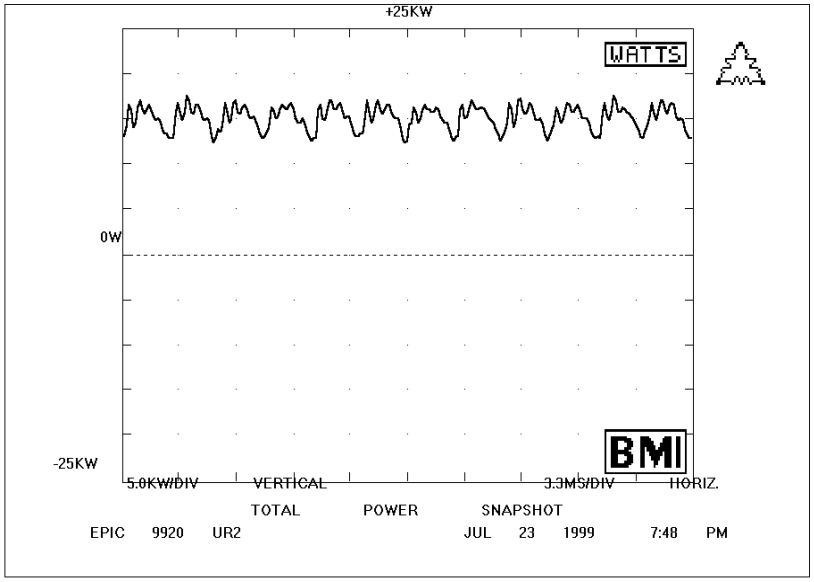
Fundamental freq: 60.0 Hz

HARM	POWER	HARM	POWER
FUND	+5.087 kW	2nd	
3rd		4th	
5th	-7.5 W	6th	
7th	+0.2 W	8th	
9th		10th	
11th	-0.7 W	12th	
13th	-0.8 W	14th	
15th		16th	
17th	-0.1 W	18th	
19th	-0.2 W	20th	
21st		22nd	
23rd	-0.1 W	24th	
25th		26th	
27th		28th	
29th		30th	
31st		32nd	
33rd		34th	
35th		36th	
37th	-0.1 W	38th	
39th		40th	
41st		42nd	
43rd		44th	
45th		46th	
47th		48th	
49th	-0.1 W	50th	
ODD	-9.2 W	EVEN	-0.0 W

THP: -9.2 W

TOTAL POWER SNAPSHOT 7:48:39 PM

INSTANTANEOUS POWER: 15.22 kW



PHASE B POWER SPECTRUM 7:49:50 PM

Power: 5.089 kW

Fundamental freq: 60.0 Hz

HARM	POWER	HARM	POWER
FUND	+5.093 kW	2nd	
3rd	+20 mW	4th	
5th	-11.44 W	6th	
7th	+810 mW	8th	
9th		10th	
11th	-800 mW	12th	
13th	-460 mW	14th	
15th	-10 mW	16th	
17th	-250 mW	18th	
19th	-170 mW	20th	
21st		22nd	
23rd	-330 mW	24th	
25th	-50 mW	26th	
27th		28th	
29th	-330 mW	30th	
31st		32nd	
33rd		34th	
35th	-100 mW	36th	
37th		38th	
39th		40th	
41st	-20 mW	42nd	
43rd	-10 mW	44th	
45th	-10 mW	46th	
47th	-10 mW	48th	
49th	-20 mW	50th	
ODD	-13.19 W	EVEN	-10 mW

THP: -13.20 W

PHASE C POWER SPECTRUM 7:50:30 PM

Power: 5.053 kW

Fundamental freq: 60.0 Hz

HARM	POWER	HARM	POWER
FUND	+5.059 kW	2nd	
3rd	+20 mW	4th	
5th	-9.41 W	6th	
7th	+1.07 W	8th	
9th	-10 mW	10th	
11th	-800 mW	12th	
13th	-750 mW	14th	
15th	-10 mW	16th	
17th	-430 mW	18th	
19th	-410 mW	20th	
21st		22nd	
23rd	-420 mW	24th	
25th	-290 mW	26th	
27th	-10 mW	28th	
29th	-450 mW	30th	
31st	-20 mW	32nd	
33rd		34th	
35th	-100 mW	36th	
37th	-90 mW	38th	
39th		40th	
41st	-40 mW	42nd	
43rd	-100 mW	44th	
45th		46th	
47th	-40 mW	48th	
49th	-100 mW	50th	
ODD	-12.37 W	EVEN	-10 mW

THP: -12.37 W

PHASE A VOLTAGE SPECTRUM 7:48:41 PM

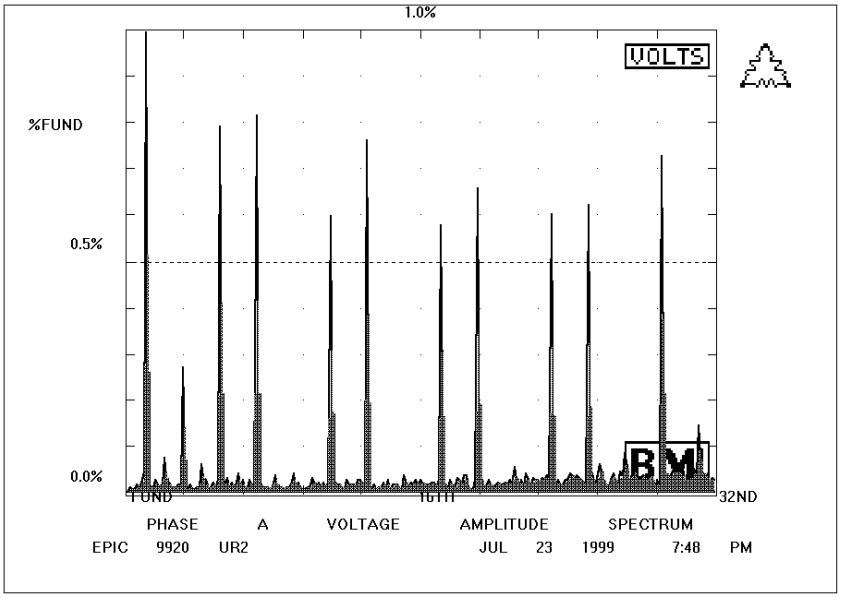
Fundamental volts: 118.9 Vrms

Fundamental freq: 60.0 Hz

SINE HARM	PCT	PHASE	SINE HARM	PCT	PHASE
FUND	100.0%	0°	2nd		
3rd	0.3%	32°	4th		
5th	0.8%	16°	6th		
7th	0.8%	61°	8th		
9th			10th		
11th	0.6%	-139°	12th		
13th	0.8%	-163°	14th		
15th			16th		
17th	0.6%	37°	18th		
19th	0.7%	-3°	20th		
21st			22nd		
23rd	0.6%	-171°	24th		
25th	0.6%	131°	26th		
27th			28th		
29th	0.7%	-50°	30th		
31st	0.1%	5°	32nd		
33rd			34th		
35th	0.4%	88°	36th		
37th	0.3%	134°	38th		
39th			40th		
41st	0.2%	-125°	42nd		
43rd	0.3%	-77°	44th		
45th			46th		
47th	0.3%	22°	48th		
49th	0.3%	59°	50th		

ODD 2.2% EVEN 0.2%

THD: 2.1%



PHASE A CURRENT SPECTRUM 7:48:54 PM

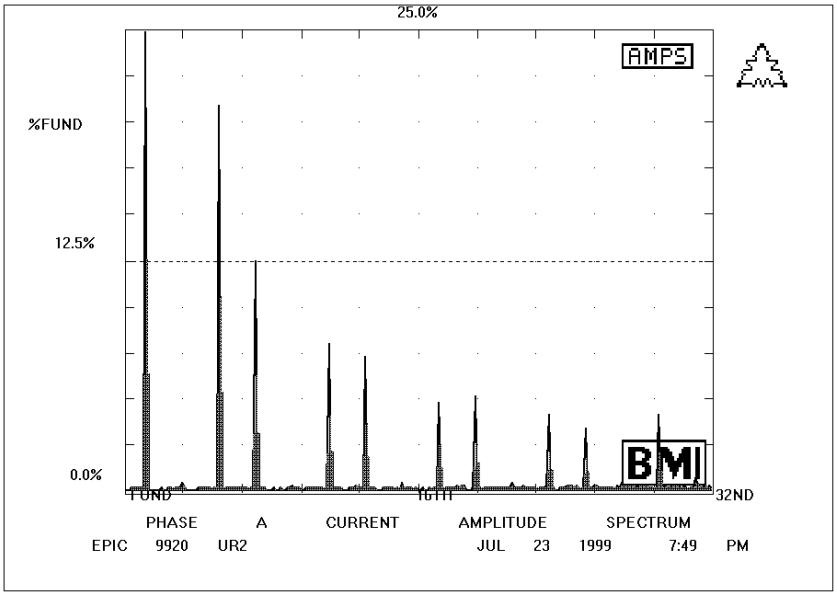
Fundamental amps: 42.8 A rms

Fundamental freq: 60.0 Hz

SINE HARM	PCT	PHASE	SINE HARM	PCT	PHASE
FUND	100.0%	-3°	2nd		
3rd	0.3%	-10°	4th		
5th	21.0%	167°	6th		
7th	12.6%	149°	8th		
9th	0.3%	155°	10th		
11th	8.0%	-33°	12th		
13th	7.2%	-58°	14th		
15th	0.4%	-31°	16th		
17th	4.8%	129°	18th	0.2%	-137°
19th	5.1%	93°	20th	0.2%	155°
21st	0.3%	97°	22nd	0.2%	57°
23rd	4.1%	-74°	24th	0.3%	-74°
25th	3.4%	-138°	26th		
27th	0.4%	-115°	28th	0.2%	92°
29th	4.1%	40°	30th	0.1%	148°
31st	0.6%	102°	32nd		
33rd	0.1%	9°	34th	0.2%	-108°
35th	1.6%	176°	36th		
37th	1.3%	-119°	38th		
39th	0.1%	62°	40th		
41st	1.0%	-41°	42nd		
43rd	1.2%	24°	44th		
45th			46th		
47th	0.7%	100°	48th	0.1%	-130°
49th	1.1%	170°	50th		

ODD 28.6% EVEN 0.6%

THD: 28.3%



PHASE B VOLTAGE SPECTRUM 7:49:20 PM

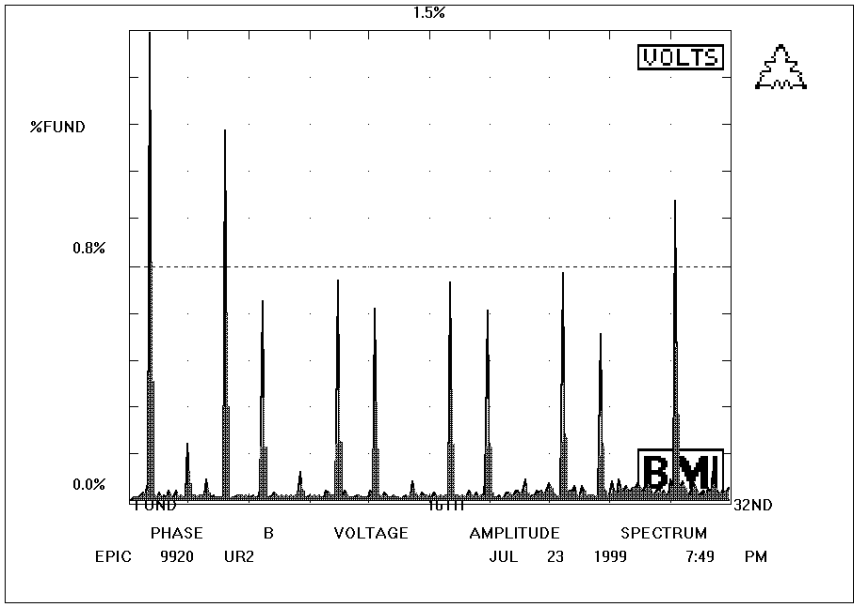
Fundamental volts: 117.6 Vrms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	-121°	2nd		
3rd	0.2%	151°	4th		
5th	1.2%	129°	6th		
7th	0.6%	-52°	8th		
9th			10th		
11th	0.7%	-22°	12th		
13th	0.6%	79°	14th		
15th			16th		
17th	0.7%	145°	18th		
19th	0.6%	-130°	20th		
21st			22nd		
23rd	0.7%	-64°	24th		
25th	0.5%	8°	26th		
27th			28th		
29th	1.0%	58°	30th		
31st			32nd		
33rd			34th		
35th	0.5%	-165°	36th		
37th	0.2%	9°	38th		
39th			40th		
41st	0.3%	-15°	42nd		
43rd	0.2%	168°	44th		
45th			46th		
47th	0.3%	126°	48th		
49th	0.2%	-49°	50th		

ODD 2.4% EVEN 0.2%

THD: 2.3%



PHASE B CURRENT SPECTRUM 7:49:34 PM

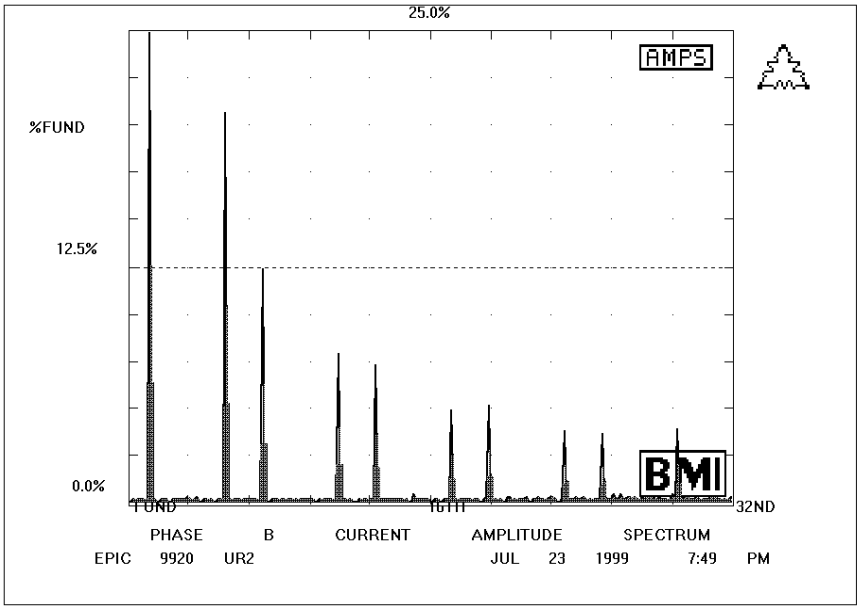
Fundamental amps: 43.4 A rms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	-123°	2nd		
3rd	0.2%	118°	4th		
5th	20.7%	-74°	6th	0.1%	57°
7th	12.4%	27°	8th	0.1%	-174°
9th			10th		
11th	7.9%	85°	12th		
13th	7.2%	-179°	14th		
15th	0.4%	-130°	16th		
17th	4.9%	-117°	18th	0.2%	46°
19th	5.2%	-34°	20th	0.2%	14°
21st	0.3%	-104°	22nd		
23rd	3.7%	40°	24th	0.3%	93°
25th	3.6%	101°	26th	0.3%	7°
27th			28th	0.2%	-60°
29th	3.9%	158°	30th	0.3%	-82°
31st	0.3%	-40°	32nd	0.2%	-135°
33rd	0.2%	-16°	34th		
35th	1.7%	-62°	36th		
37th	0.7%	103°	38th		
39th	0.1%	143°	40th	0.1%	-54°
41st	1.1%	81°	42nd	0.1%	-33°
43rd	0.7%	-94°	44th		
45th	0.3%	-71°	46th		
47th	0.8%	-139°	48th		
49th	0.5%	64°	50th		

ODD 28.2% EVEN 0.7%

THD: 27.9%



PHASE C VOLTAGE SPECTRUM 7:49:58 PM

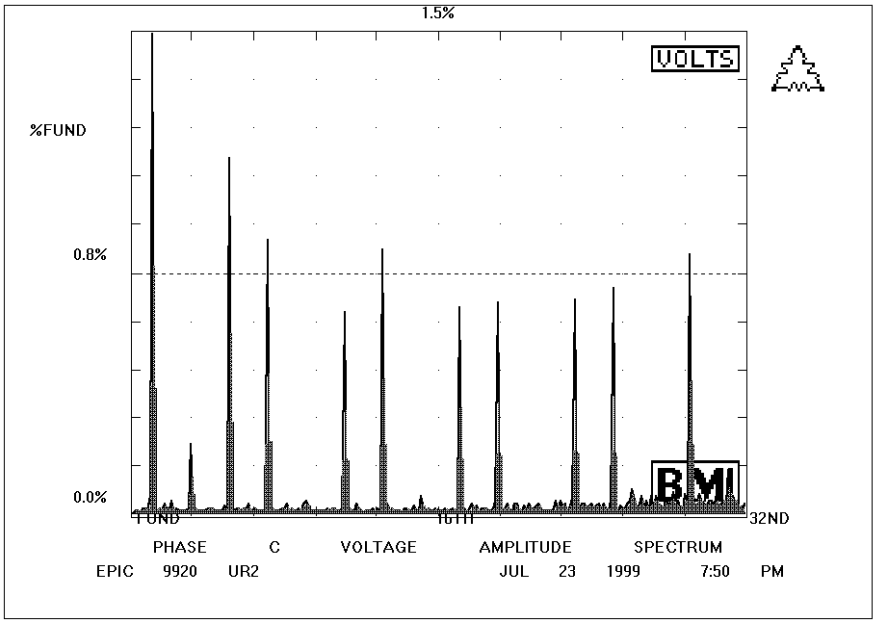
Fundamental volts: 118.3 Vrms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	119°	2nd		
3rd	0.2%	-116°	4th		
5th	1.1%	-96°	6th		
7th	0.9%	-170°	8th		
9th			10th		
11th	0.6%	98°	12th		
13th	0.8%	-44°	14th		
15th			16th		
17th	0.6%	-97°	18th		
19th	0.7%	102°	20th		
21st			22nd		
23rd	0.7%	53°	24th		
25th	0.7%	-126°	26th		
27th			28th		
29th	0.8%	172°	30th		
31st	0.1%	116°	32nd		
33rd			34th		
35th	0.4%	-51°	36th		
37th	0.3%	-126°	38th		
39th			40th		
41st	0.2%	92°	42nd		
43rd	0.3%	17°	44th		
45th			46th		
47th	0.2%	-135°	48th		
49th	0.4%	153°	50th		

ODD 2.5% EVEN 0.2%

THD: 2.3%



PHASE C CURRENT SPECTRUM 7:50:14 PM

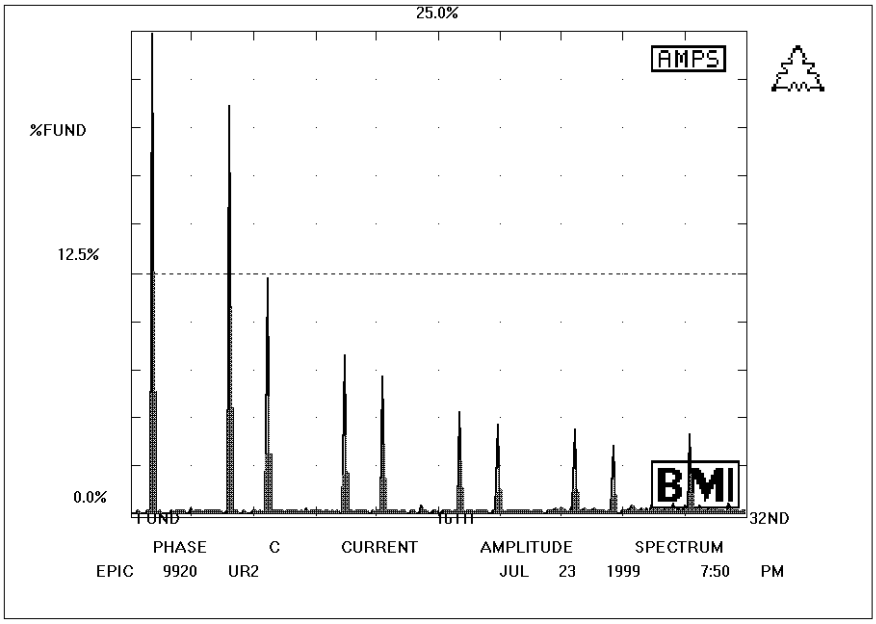
Fundamental amps: 42.8 A rms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	116°	2nd	0.2%	-97°
3rd	0.2%	-133°	4th	0.1%	175°
5th	21.2%	46°	6th		
7th	12.2%	-92°	8th	0.1%	46°
9th	0.3%	-11°	10th	0.1%	-133°
11th	8.2%	-155°	12th	0.1%	-29°
13th	7.2%	60°	14th		
15th	0.4%	96°	16th		
17th	5.3%	7°	18th		
19th	4.6%	-153°	20th	0.1%	-111°
21st			22nd	0.2%	-139°
23rd	4.3%	159°	24th	0.2%	-163°
25th	3.5%	-23°	26th	0.3%	177°
27th	0.4%	39°	28th	0.2%	-139°
29th	4.2%	-83°	30th	0.2%	65°
31st	0.5%	-120°	32nd	0.2%	49°
33rd	0.4%	174°	34th	0.2%	33°
35th	1.6%	58°	36th		
37th	0.9%	5°	38th		
39th	0.2%	-64°	40th		
41st	1.0%	-159°	42nd		
43rd	1.0%	145°	44th	0.1%	56°
45th	0.3%	79°	46th		
47th	0.7%	-11°	48th		
49th	0.8%	-71°	50th		

ODD 28.7% EVEN 0.7%

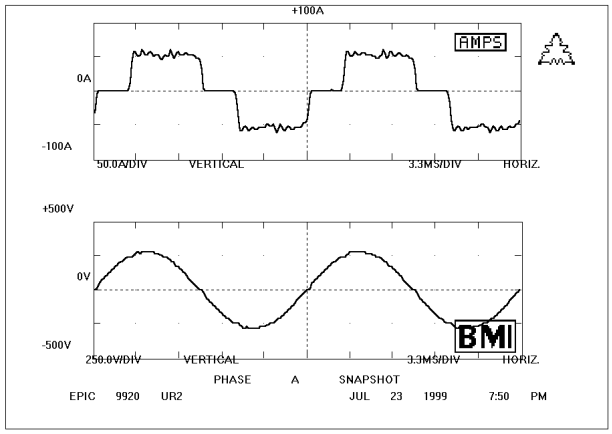
THD: 28.4%



PHASE A SNAPSHOT 7:50:55 PM

Phase A-B VOLTAGE: 204.7 Vrms
1.4 Crest Factor
1.1 Form Factor

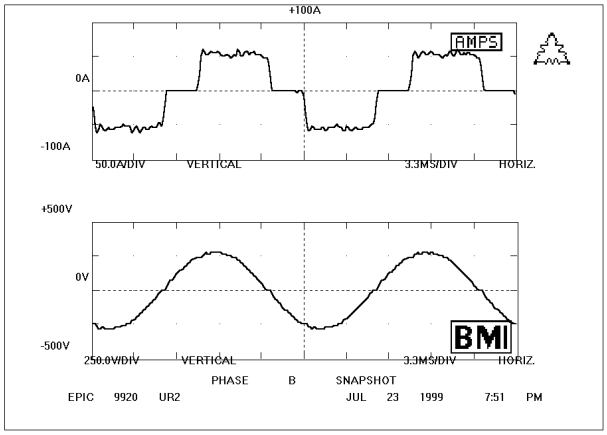
Phase A CURRENT: 44.5 A rms
1.4 Crest Factor
1.2 Form Factor



PHASE B SNAPSHOT 7:51:01 PM

Phase B-C VOLTAGE: 203.6 Vrms
1.4 Crest Factor
1.1 Form Factor

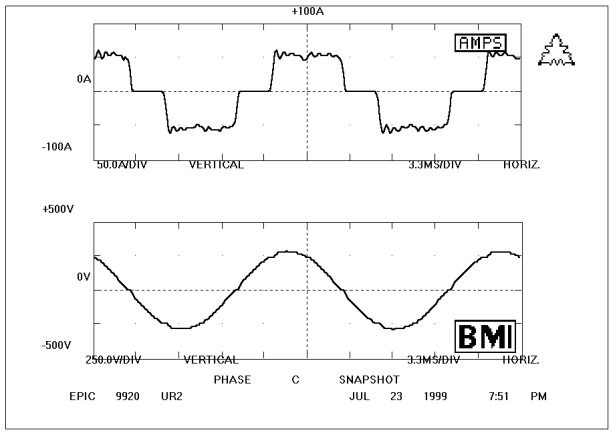
Phase B CURRENT: 45.1 A rms
1.4 Crest Factor
1.2 Form Factor



PHASE C SNAPSHOT 7:51:09 PM

Phase C-A VOLTAGE: 206.5 Vrms
1.4 Crest Factor
1.1 Form Factor

Phase C CURRENT: 44.6 A rms
1.4 Crest Factor
1.2 Form Factor



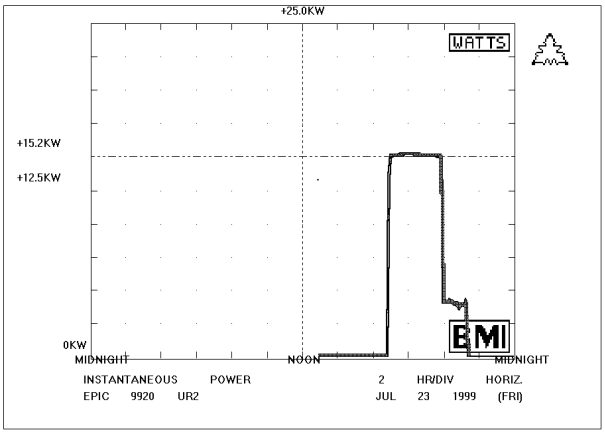
CUMULATIVE PROFILES – 24 HOURS

INSTANTANEOUS POWER MIDNIGHT

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)

Total:
MAX: 15.4 kW, 5:47 PM
MIN: 0.0 kW, 2:21 PM

Phase A-Nm:
MAX: 5.1 kW, 6:25 PM
MIN: -0.0 kW, 10:29 PM
Phase B-Nm:
MAX: 5.1 kW, 6:38 PM
MIN: -0.0 kW, 2:21 PM
Phase C-Nm:
MAX: 5.1 kW, 5:55 PM
MIN: -0.0 kW, 1:40 PM

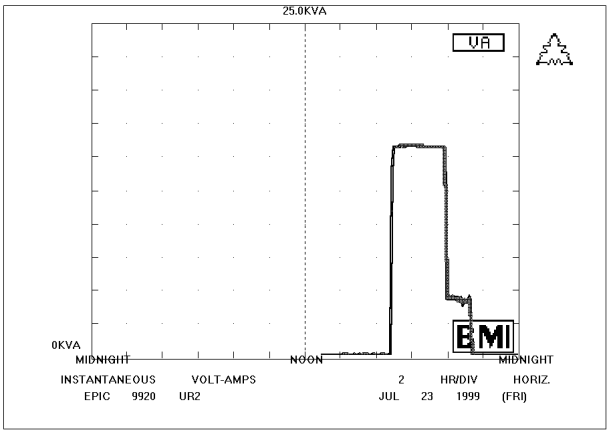


INSTANTANEOUS VOLT-AMPS 12:00:01 AM

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)

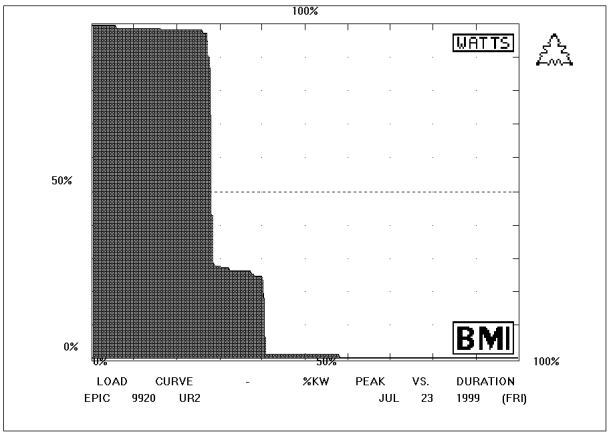
Total:
MAX: 16.0 kVA, 5:47 PM
MIN: 0.1 kVA, 12:55 PM

Phase A-Nm:
MAX: 5.4 kVA, 6:25 PM
MIN: 0.0 kVA, 1:14 PM
Phase B-Nm:
MAX: 5.4 kVA, 6:19 PM
MIN: 0.0 kVA, 12:55 PM
Phase C-Nm:
MAX: 5.3 kVA, 5:55 PM
MIN: 0.0 kVA, 1:29 PM



LOAD DURATION CURVE 12:00:24 AM

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)



TOTAL POWER CONSUMPTION 12:00:40 AM

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)

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

BILLING DEMAND:
15.27 kW Pk Today
15.27 kW Pk Accumulated
$ 0.000 Today
$ 0.000 Accumulated
CONSUMPTION:
51.95 kWh Today
105.4 kWh Accumulated
$ 3.117 Today
$ 6.322 Accumulated

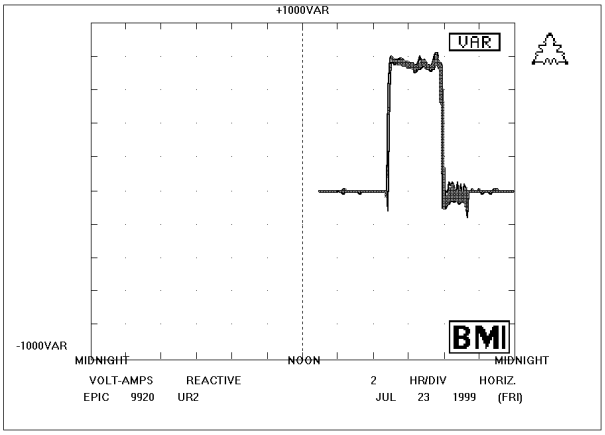
27.96 kQh Today
2.231 kVARh Today

VOLT-AMPS REACTIVE 12:00:49 AM

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)

Total:
MAX: 829.9 VAR, 7:30 PM
MIN: -156.4 VAR, 9:17 PM

Phase A-Nm:
MAX: 270.1 VAR, 7:30 PM
MIN: -52.2 VAR, 9:17 PM
Phase B-Nm:
MAX: 274.5 VAR, 7:28 PM
MIN: -61.1 VAR, 9:17 PM
Phase C-Nm:
MAX: 296.0 VAR, 7:30 PM
MIN: -48.8 VAR, 9:17 PM

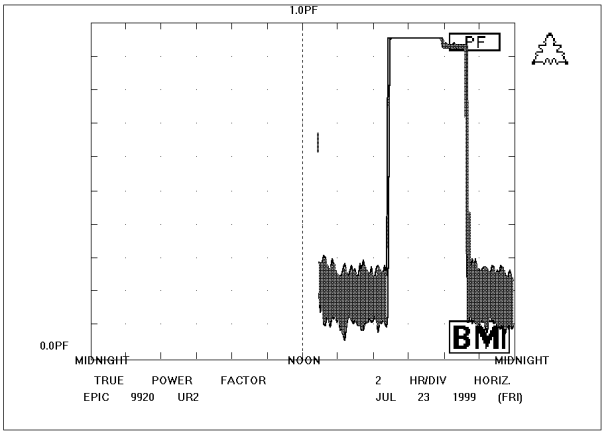


TRUE POWER FACTOR 12:01:01 AM

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)

Total:
MAX: 0.96 PF, 6:17 PM
MIN: 0.05 PF, 2:21 PM

Phase A-Nm:
MAX: 0.96 PF, 6:14 PM
MIN: -0.13 PF, 10:29 PM
Phase B-Nm:
MAX: 0.96 PF, 6:15 PM
MIN: -0.01 PF, 2:21 PM
Phase C-Nm:
MAX: 0.96 PF, 6:17 PM
MIN: -0.02 PF, 1:40 PM

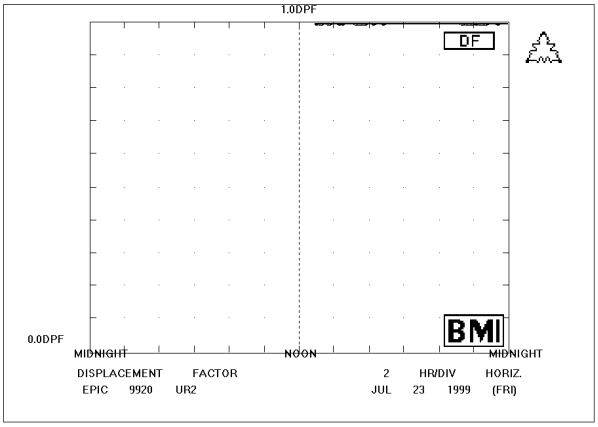


DISPLACEMENT FACTOR 12:01:12 AM

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)

Total:
MAX: 1.00 dPF, 1:33 PM
MIN: 0.99 dPF, 4:50 PM

Phase A-Nm:
MAX: 1.00 dPF, 12:56 PM
MIN: -1.00 dPF, 4:08 PM
Phase B-Nm:
MAX: 1.00 dPF, 8:21 PM
MIN: -0.91 dPF, 11:02 PM
Phase C-Nm:
MAX: 1.00 dPF, 1:56 PM
MIN: -0.89 dPF, 10:39 PM

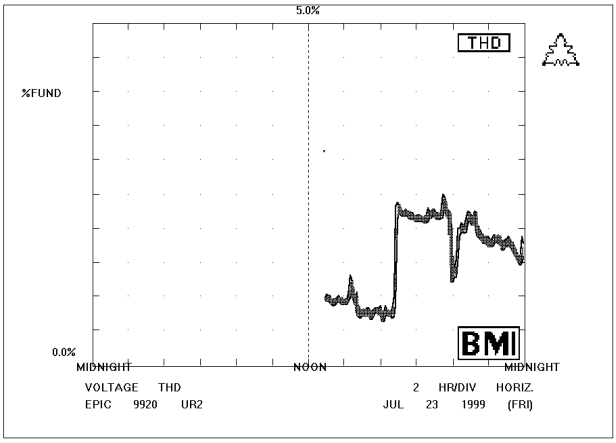


VOLTAGE THD 12:01:27 AM

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)

Average:
MAX: 2.5% THD, 7:29 PM
MIN: 0.6% THD, 4:08 PM

Phase A-Nm:
MAX: 2.4% THD, 7:27 PM
MIN: 0.7% THD, 3:31 PM
Phase B-Nm:
MAX: 2.6% THD, 7:27 PM
MIN: 0.6% THD, 4:08 PM
Phase C-Nm:
MAX: 2.6% THD, 7:26 PM
MIN: 0.5% THD, 4:08 PM

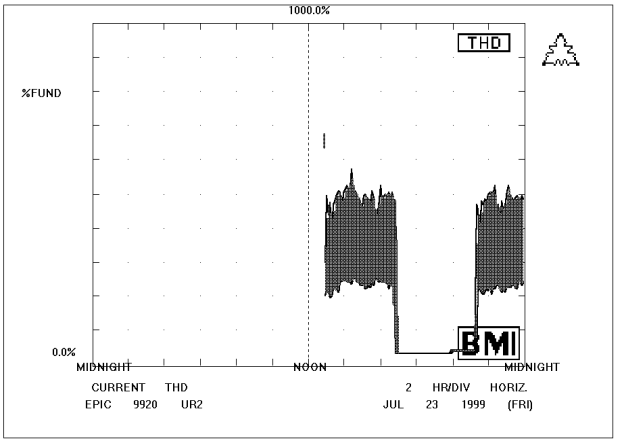


CURRENT THD 12:01:39 AM

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)

Average:
MAX: 576.2% THD, 2:20 PM
MIN: 28.0% THD, 5:09 PM

Phase A:
MAX: 999.9% THD, 12:56 PM
MIN: 28.0% THD, 5:10 PM
Phase B:
MAX: 763.9% THD, 2:20 PM
MIN: 27.6% THD, 6:10 PM
Phase C:
MAX: 999.9% THD, 1:40 PM
MIN: 28.2% THD, 7:43 PM

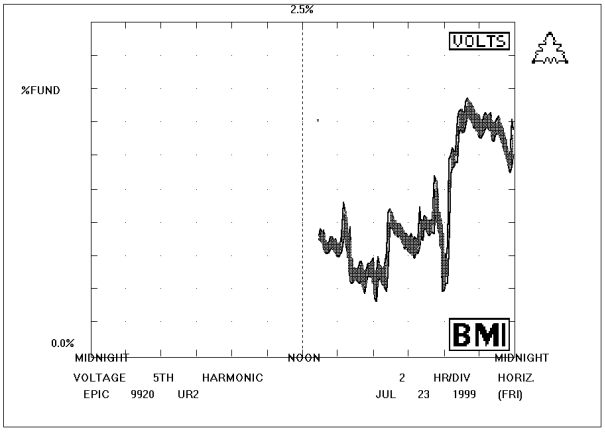


VOLTAGE 5th HARMONIC 12:01:49 AM

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)

Average:
MAX: 1.9%, 9:19 PM
MIN: 0.4%, 4:08 PM

Phase A-Nm:
MAX: 1.7%, 9:18 PM
MIN: 0.3%, 8:07 PM
Phase B-Nm:
MAX: 2.2%, 9:18 PM
MIN: 0.5%, 4:08 PM
Phase C-Nm:
MAX: 1.9%, 9:19 PM
MIN: 0.2%, 4:07 PM

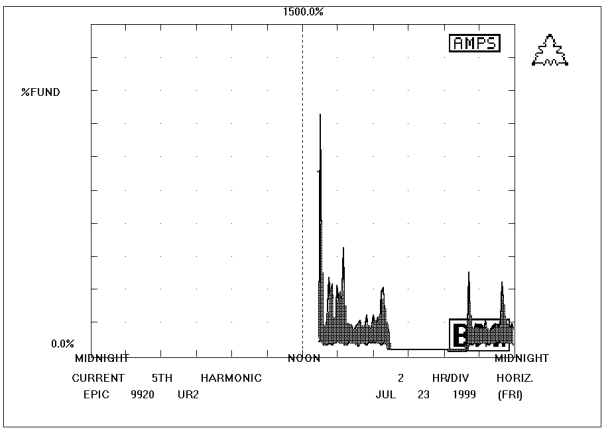


CURRENT 5th HARMONIC 12:02:03 AM

FROM: MIDNIGHT Jul 22 1999 (Thu)
To: MIDNIGHT Jul 23 1999 (Fri)

Average:
MAX: 1096.7%, 12:56 PM
MIN: 18.0%, 8:56 PM

Phase A:
MAX: 3144.7%, 12:56 PM
MIN: 0.8%, 4:19 PM
Phase B:
MAX: 183.8%, 2:20 PM
MIN: 16.8%, 8:56 PM
Phase C:
MAX: 467.0%, 1:40 PM
MIN: 18.5%, 8:44 PM



APPENDIX E

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.

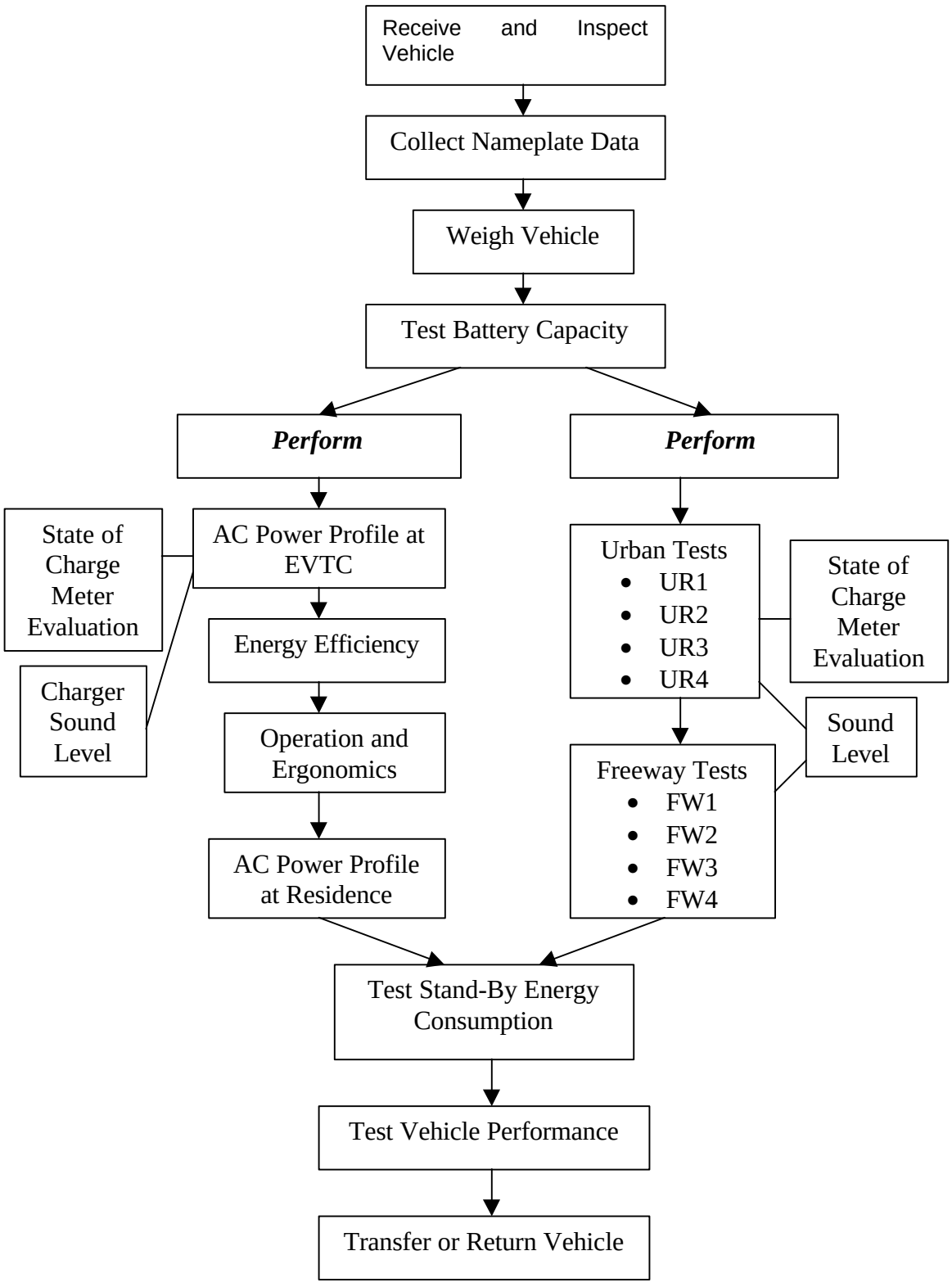
Range tests under different vehicle conditions no longer always have predictable results. Automatic climate controls limit air conditioner power on cool days, thus conserving battery energy and increasing range. The battery pack and the output side of the charger may no longer be readily accessible; 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.

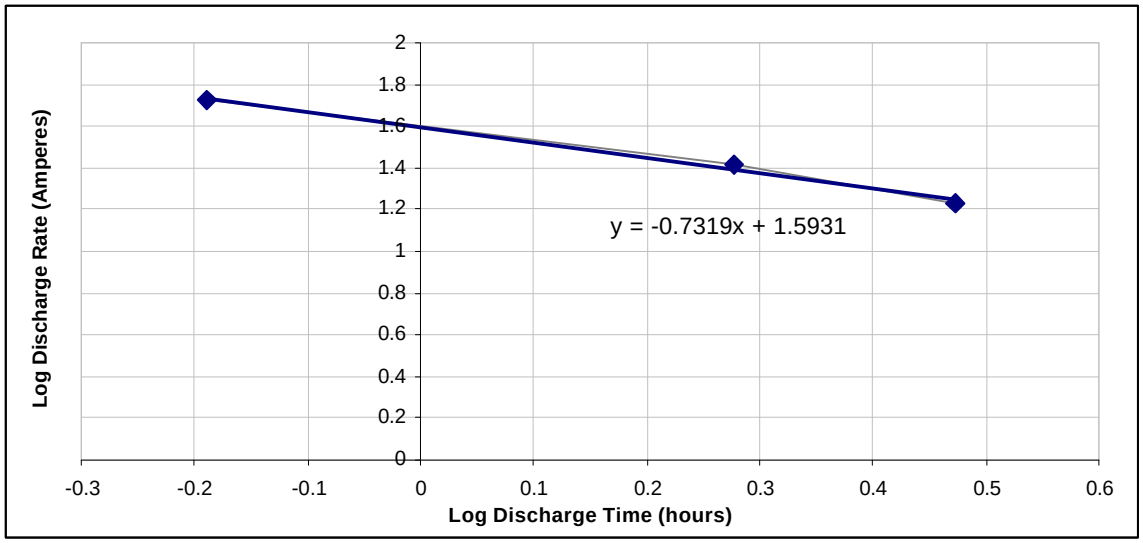


Figure 3-1. Sample Peukert Curve.

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.

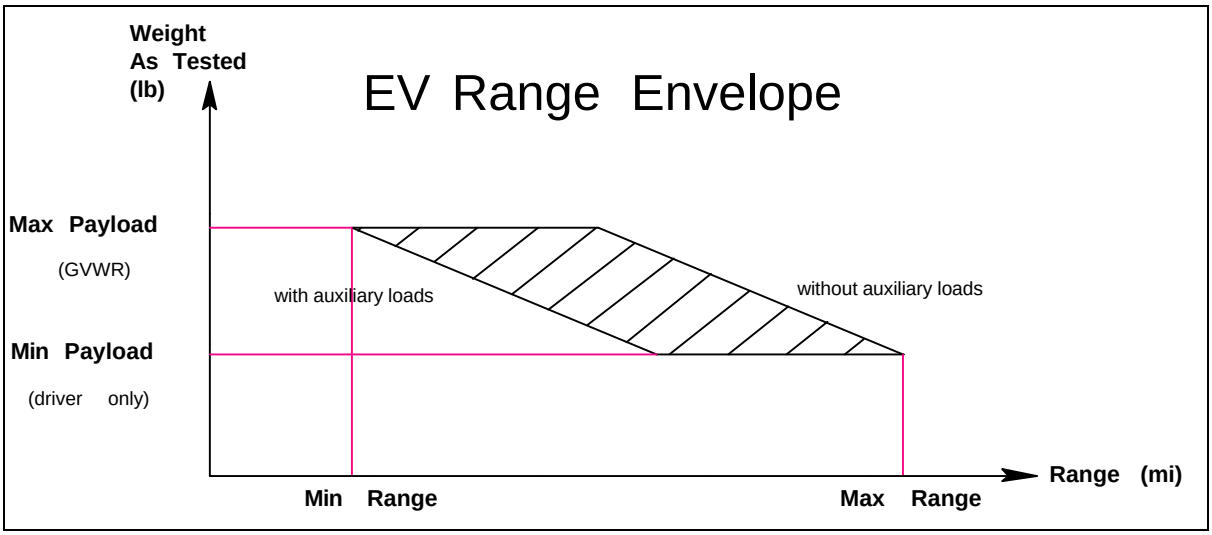


Figure 3-2. Range Envelope.

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:

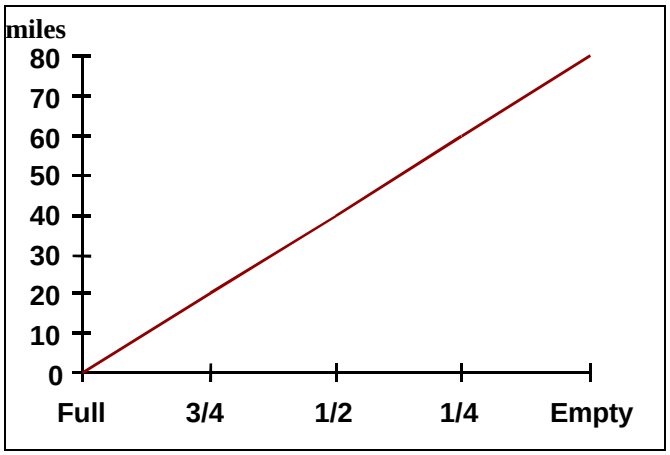


Figure 3-3. State of Charge Meter Evaluation.

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).

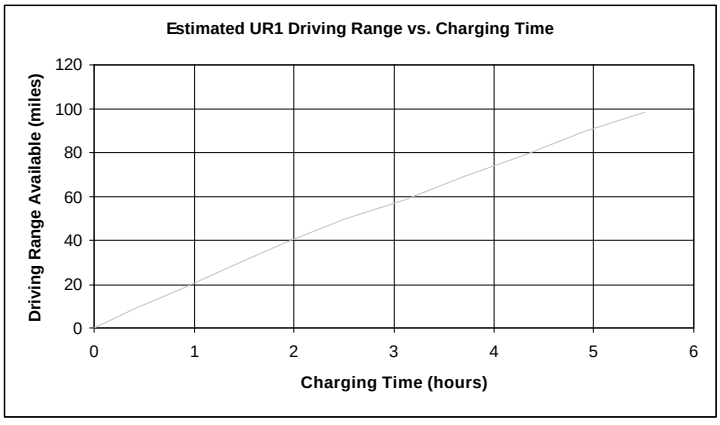


Figure 3-4. Sample plot of estimated range versus charging time.

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).

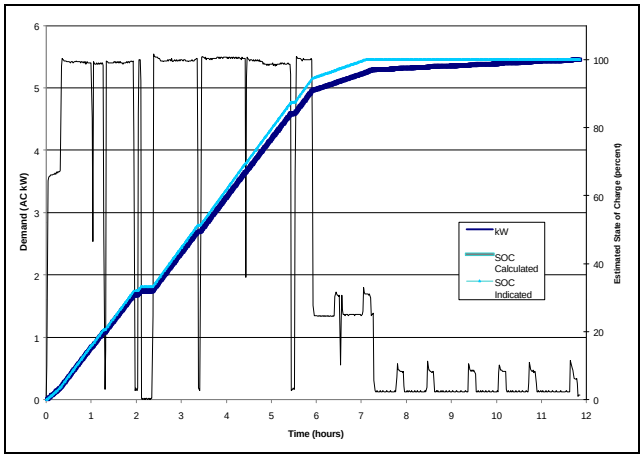


Figure 3-5. Sample AC charging profile plots.

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

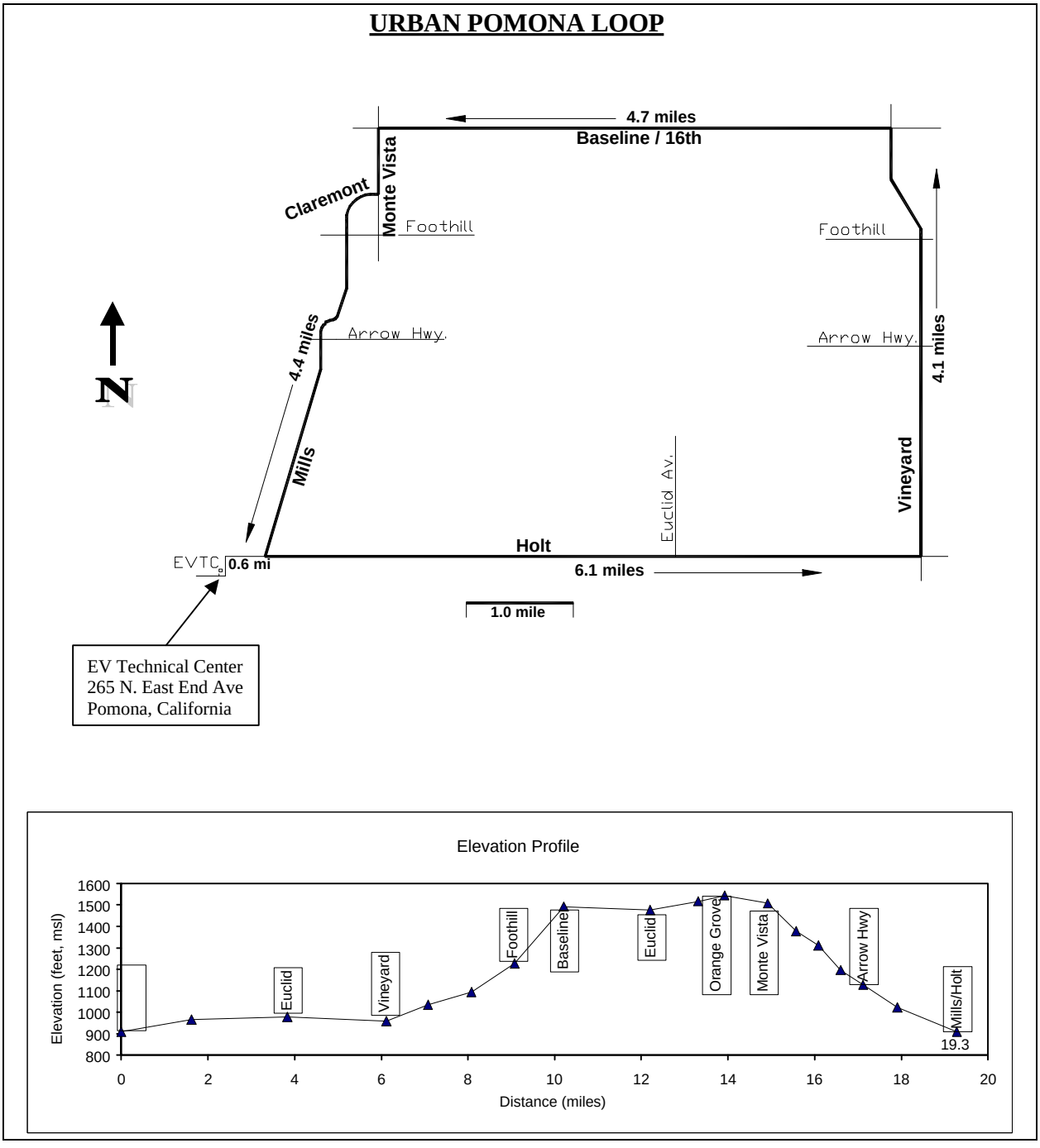
EV Performance Characterization Testing Schedule

		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

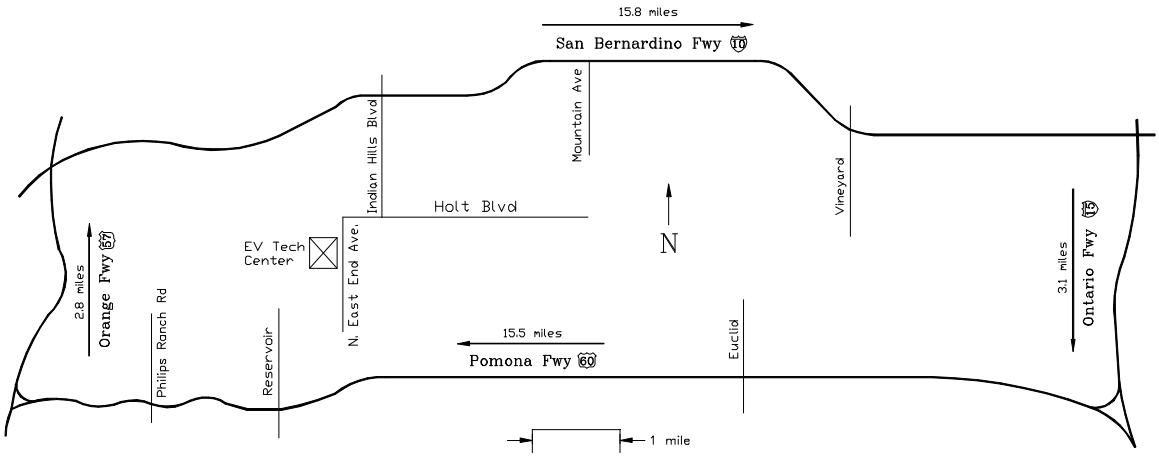
Stop No.	Distance from Start (miles)	Type	Distance from Previous stop	Comments
0	0.00	light	0.00	East End & Holt
1	0.10	light	0.10	
2	0.15	light	0.05	Mills & Holt
3	0.80	light	0.65	
4	1.30	light	0.50	
5	1.80	light	0.50	
6	2.30	light	0.50	
7	2.90	light	0.60	
8	3.50	light	0.60	
9	3.70	light	0.20	
10	4.00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

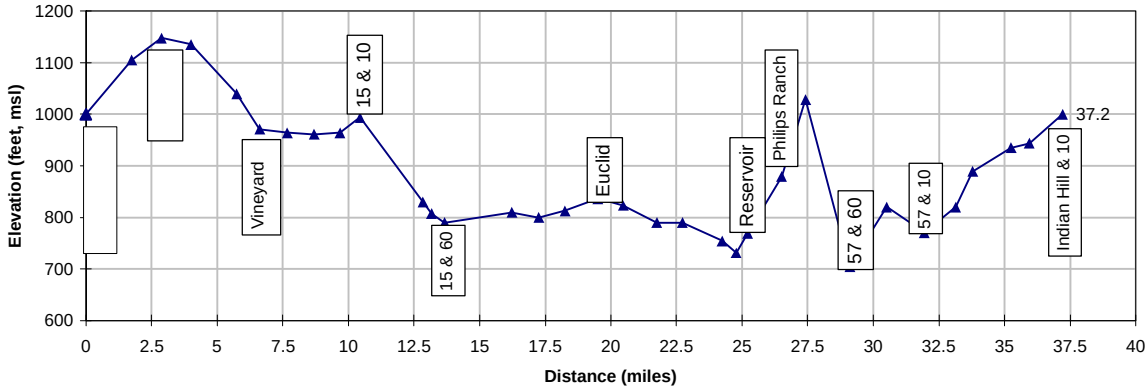
43	16.30	light	1.10	
44	16.80	light	0.50	
45	17.10	sign	0.30	
46	17.40	light	0.30	
47	17.60	sign	0.20	
48	18.60	light	1.00	
49	18.70	sign	0.10	
50	19.00	sign	0.30	
51	19.30	light	0.30	
52	19.50	light	0.20	Holt & Mills
53	19.60	light	0.10	
54	19.80	light	0.20	Holt & East End

MCW: ttt
9/23/92

Freeway Loop Map

FREEWAY POMONA LOOP





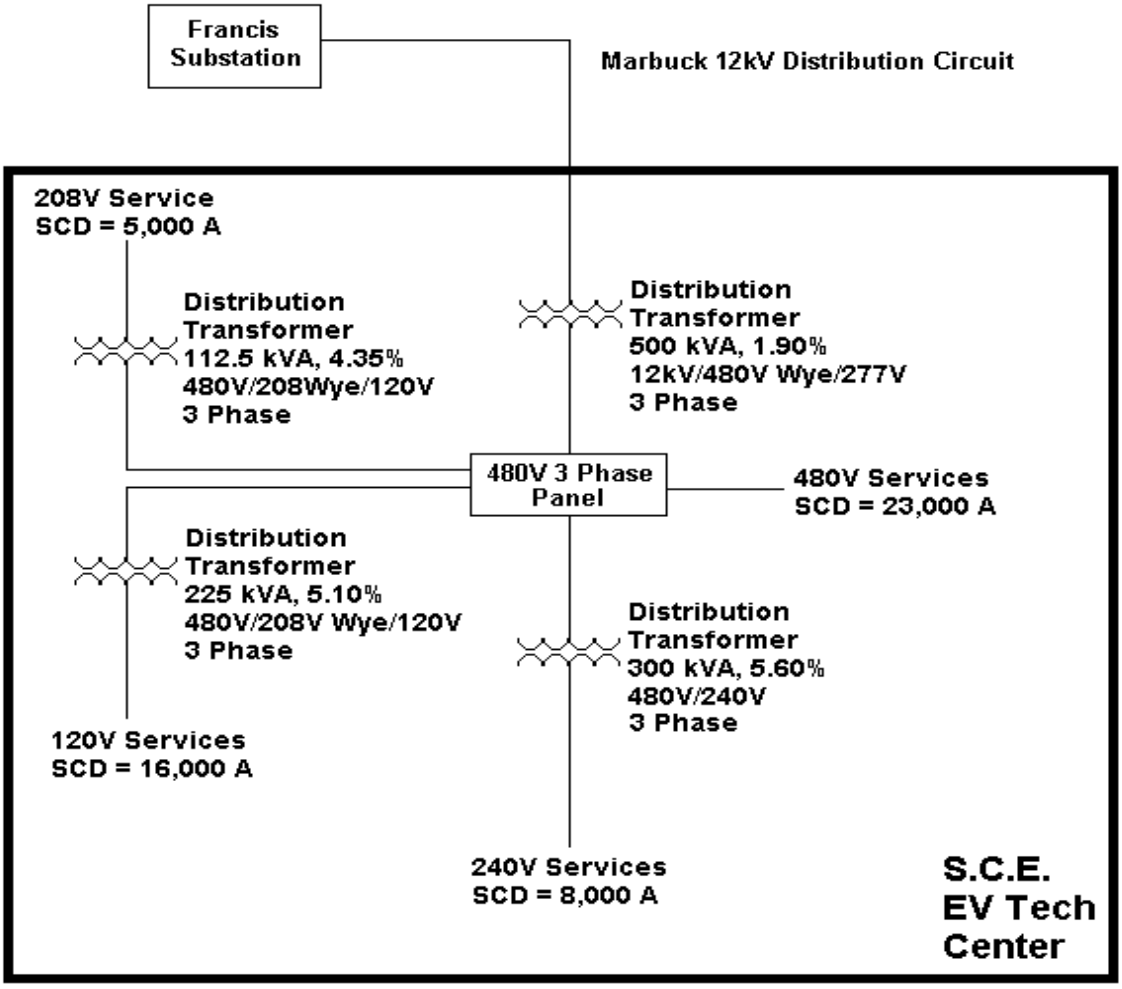
EVTC Equipment

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

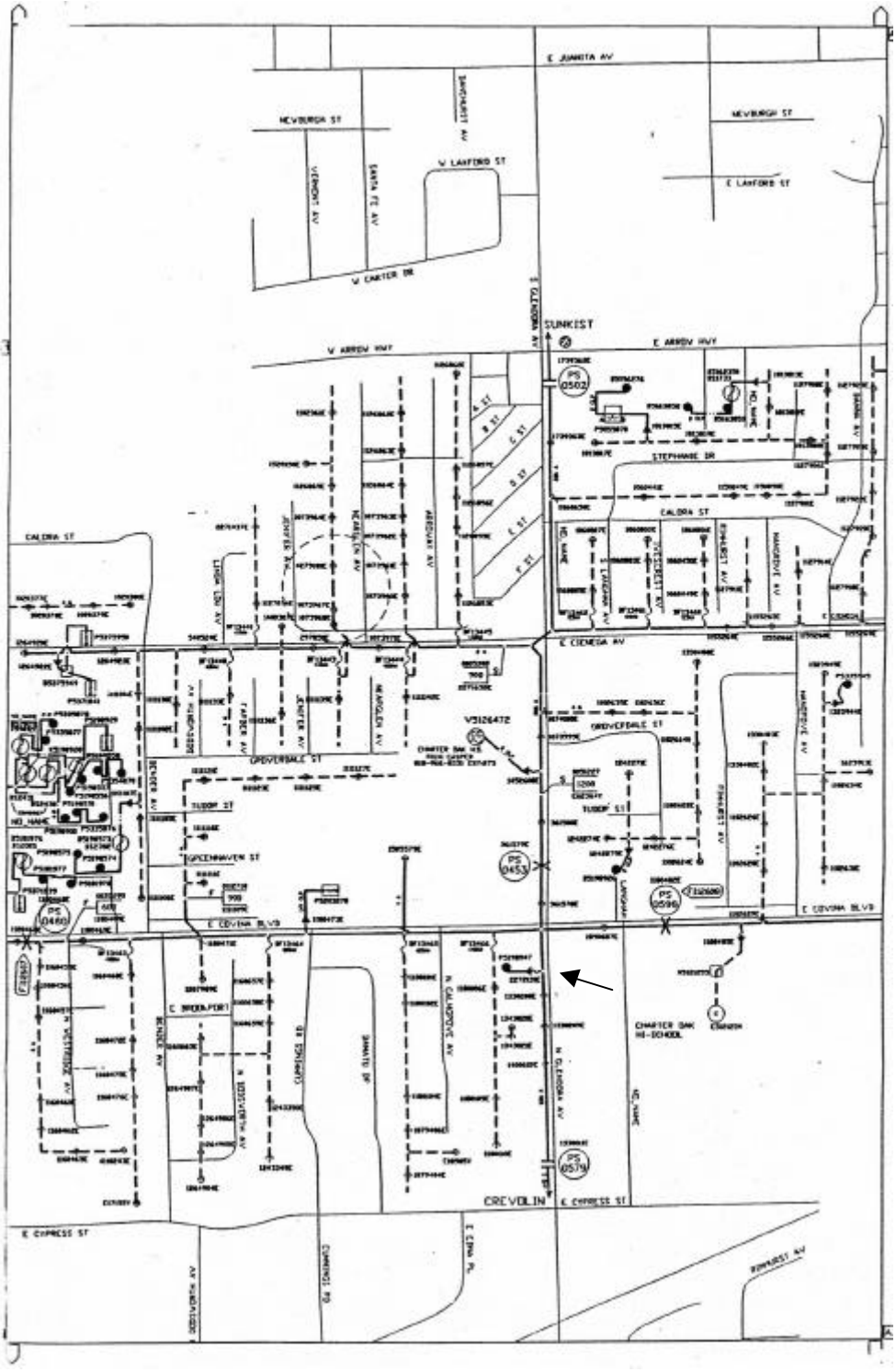
EVTC Number	Manufacturer	Model	Description	Quantity
MCR-001	OLYMPUS	MICRO-32	MICRO CASSETTE RECORDER	1
MMR-001	Various	Various	DIGITAL MULTIMETER	14
MMR-012	HEWLETT PACKARD	34401 A	MULTIMETER	1
MMW-001	ROLATAPE	MEASUMASTERMM30	MEASURING WHEEL	1
MPG-001	HEWLETT PACKARD	6942A	MULTIPROGRAMMER	1
NVK-001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

JWS 4/15/99

EV Tech Center Line Diagram



Residence Line Diagram



EVTC-010 Driving Test Data Sheet

POMONA DRIVING TEST DATA

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

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

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

Accessories used:

Drive / Regen setting:

Handling/Braking:

Other comments:

Charger	Serial No.	AC meter#	BMI #

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

Comments:

EVTC-010

EVTC-020 Charger Testing / Analysis Data Sheet

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

Charger Information

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

After Completion of Recharging Cycle

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

Charger Operation Information/Evaluation

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

EVTC-030 Performance Testing Data Sheet

ACCELERATION, MAXIMUM SPEED, AND BRAKING TESTS

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

Acceleration (100% SOC)

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

Average

Acceleration (80% SOC)

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

Average

Acceleration (60% SOC)

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

Average

Acceleration (40% SOC)

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

Average

Acceleration (20% SOC)

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

Average

Braking 25-0 mph, 50% SOC

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

Average ft

Comments

EVTC-040 Vehicle Test Equipment and Nameplate Data Sheet

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

VEHICLE

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

CHARGER

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

TEST EQUIPMENT

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

WEIGHT CERTIFICATION

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

EVTC-050 Sound Level Meter Data Sheet

Sound Level Test Data

Urban Driving Sound Level Test

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

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: _____

Freeway Driving Sound Level Test

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

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: _____

Charger Sound Level Test

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

Sound Level Range(dBs):	

	Start	Stop
Recording Time:		

Put a check mark on the settings selected

	A	C
Frequency Weighting:		

	Fast	Slow
Response:		

Comments: _____

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

Project:_____ Test File:_____

Date(s):_____ Technician:_____

Vehicle Number:_____ Battery Nos.:_____

BATTERY SPECIFICATIONS

Manufacturer: _____ Model: _____

Date of Manufacture: _____ Nominal Voltage:_____

Ah Rating @ C/3:_____ Voltage Range:_____

Weight/Module:_____ Temp. Range:_____

BATTERY PACK

Number of Modules:_____ Nominal Voltage:_____

Configuration: _____

Location for Test:_____

TEST EQUIPMENT

Discharge Unit: _____ Serial No._____

Charging Unit: _____ Serial No._____

Data Acquisition Equipment:_____

_____

Other Equipment:_____

RESULTS

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

RECHARGE TYPE			
Ah RETURNED			
kWh RETURNED			
DATA FILE			

NOTES:_____

_____