PERFORMANCE CHARACTERIZATION

1999 NISSAN ALTRA-EV
WITH LITHIUM-ION 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. ABSTRACT

This report characterizes the performance of the Nissan Altra Electric Vehicle equipped with Lithium-ion (Li-ion) batteries. The tests performed were: weight certification, range, battery capacity, state of charge meter evaluation, sound level, acceleration, maximum speed, braking, and charger performance.

Testing was performed at the Electric Vehicle Technical Center (EV Tech Center), on the Urban and Freeway Pomona Loops, and the Pomona Raceway in Pomona, California. For detailed procedures used for the testing, please refer to the *SCE Electric Vehicle Test Procedure* in Appendix E, page 52.

II. INTRODUCTION

Southern California Edison (SCE), in cooperation with the U. S. Department of Energy (DOE) and as part of the Field Operations Program evaluated the Altra-EV for performance. The Altra is equipped with a Sony Lithium-ion battery, jointly developed by Nissan and Sony. Performance Characterization measures the vehicle's performance in a "real world" setting. Tests in this type of setting will contribute more accurate results on how these vehicles will perform as a fleet and passenger car.

III. MANUFACTURER'S SPECIFICATIONS

Vehicle Make:	Nissan
Model:	Altra-EV
Range:	120 miles (LA4 mode Nissan test)
Maximum Speed:	75 mph
Motor Type:	Neodymium permanent magnet synchronous DC
System Power:	62 kW (83 hp)
Transmission:	Single Speed, front wheel drive
Battery Type:	Lithium-ion (Li-ion)
Manufacturer:	Sony
Weight:	67 lb.
Capacity:	95 Ampere-hour
Battery Pack Weight:	804 lb. (Battery pack tray not included)
Number of Modules:	12
Nominal Pack Voltage:	345 V
Cur*b Weight:*	3940 lb.
GVWR:	4579 lb.
Payload:	820 lb.
Dimensions	
Wheelbase:	110.2 in.
Length:	191.7 in.
Width:	69.5 in.
Height:	66.8 in.
Ground Clearance:	7.5 in.

IV. DEVIATIONS FROM THE SCE ELECTRIC VEHICLE TEST PROCEDURE

- Battery capacity test was not performed.
- The stand-by energy consumption test with the vehicle off charge was not performed.

V. RESULTS

A. Weight Certification

Table 5-1 Certified Weight Results

	Front Axle	Rear Axle	Total Weight
GVWR (lb)	2324	2299	4579
Curb Weight (lb)	2220	1720	3940 [1]
Available Payload (lb)	104	579	639 [2]

[1] Certified.
[2] Specified payload on vehicle door sticker: 820 lb.

Figure 5-1. The Altra-EV uses inductive charging.

B. Range Test

B1. Urban Range Tests

Table 5-2. Urban Range Test Results

Tests	UR1*	UR2*	UR3*	UR4*
Range at Stop Condition (mi.)	121.5	94.7	96.2	73.7
Total Driven (mi.)	121.9	95.3	96.6	74.4
Driving Conditions				
Payload (lb.)	180	180	639	639
Avg. Amb. Temp. ^{o}F	78.2	78.6	97.4	91.5
Average Speed (mph)	23.6	23.5	25.8	24.8
Recharge				
AC kWh recharge [1]	31.05	33.16	25.96	23.15
AC kWh/mi.	0.255	0.348	0.269	0.392

* Average of two tests
[1] From BMI Power Profiler

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

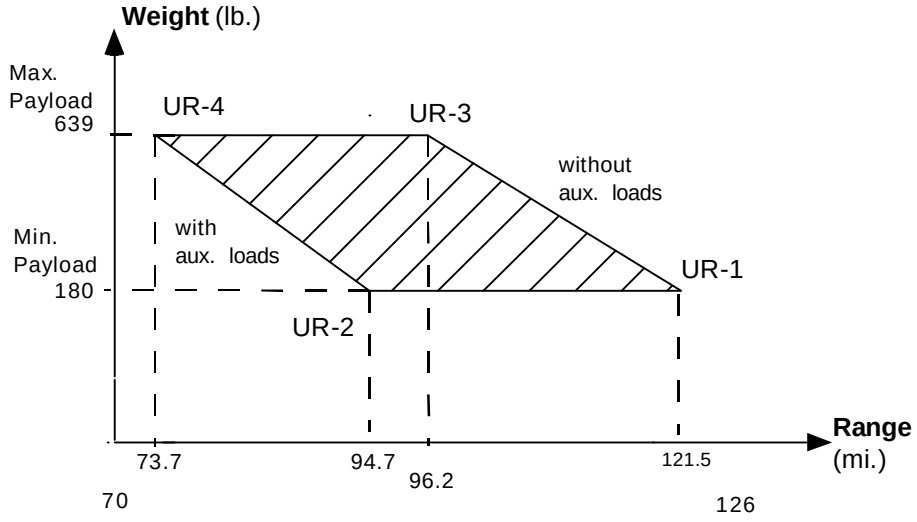


Figure 5-2. Urban Range Envelope.

B2. Freeway Range Tests

Table 5.4 Range Test.

Tests	FW1*	FW2*	FW3*	FW4*
Range at Stop Condition (mi.)	94.4	82.3	82.5	79.8
Total Driven (mi.)	96.55	79.45	83.33	79.95
Driving Conditions				
Payload (lb.)	180	180	639	639
Avg. Amb. Temp. °F	70.1	83.1	59.3	84.2
Average Speed (mph)	47.10	42.13	41.67	42.83
Recharge				
AC kWh recharge [1]	30.39	31.09	29.61	30.63**
AC kWh/mi.	0.315	0.391	0.355	0.383

*Average of two tests
**Result of one test
[1] From BMI Power Profiler

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

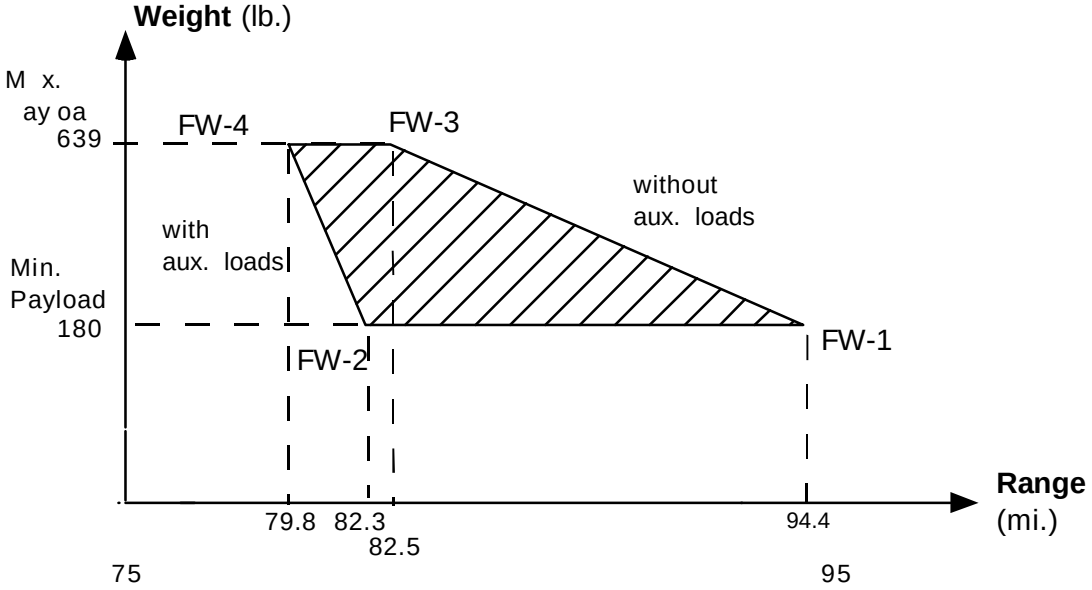


Figure 5-3. Freeway Range Envelope.

C. State of Charge (SOC) Meter Evaluation

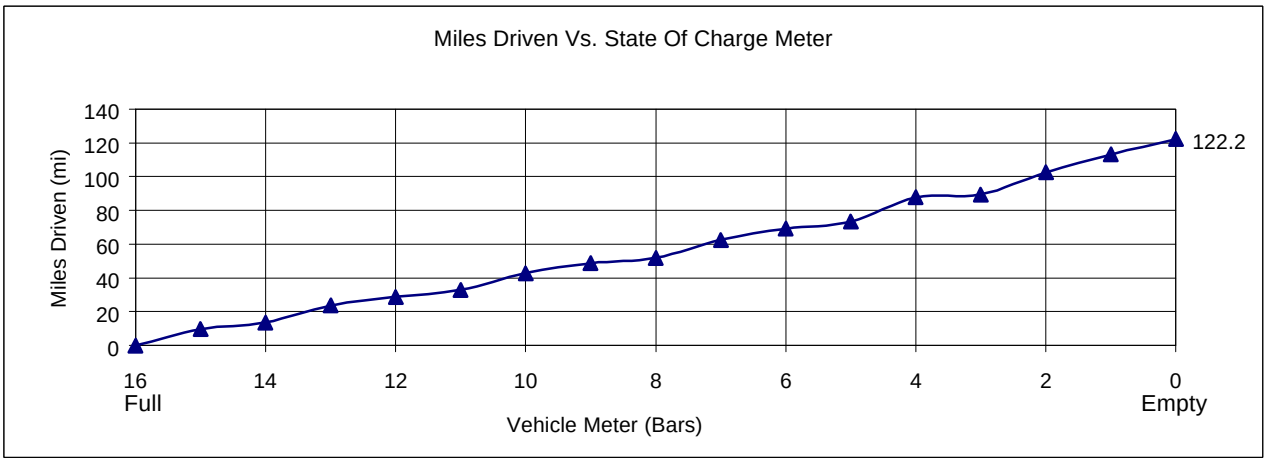


Figure 5-4. State of Charge Meter Evaluation- 6/29/99, UR1.

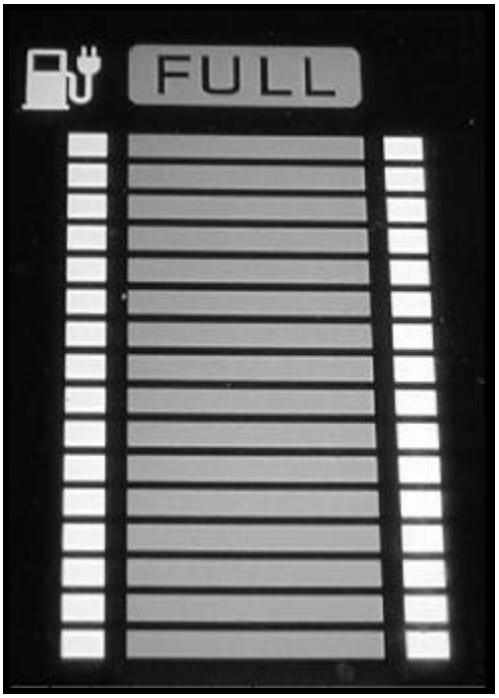


Figure 5-5. Altra-EV state-of-charge gage.

D. Acceleration, Maximum Speed, and Braking Tests.

Table 5-5. Summary of Acceleration, Maximum Speed, and Braking Tests[1]

Performance Testing Data[1]	100% SOC	80% SOC	60% SOC	40% SOC	20% SOC
0 to 30 mph (sec.)	4.91	4.56	4.56	4.52	4.58
30 to 55 mph (sec.)	7.80	8.42	9.01	8.04	8.10
0 to 60 mph (sec.)	15.56	14.28	15.18	14.32	14.74
Max Speed (mph)	75	N/A	N/A	N/A	75
Braking (25-0 mph) (ft.)	N/A	N/A	27.74*	N/A	N/A

[1]Average values out of two runs (ambient temperature 77-85° F). (180 lb. Payload)
* Test was done at 50% SOC

E. Charger Performance / Profile Test

Table 5-6. Charger Profile Data
Note: Refer to Appendix D, page 45 for BMI Power Profiler graphical data.

Measured Value[1]	
Voltage	247.3 V_{rms}
Current	25.69 A_{rms}
Real Power[2]	6.473 kW
Reactive Power	618.4 VAR
Apparent Power	6.582 kVA
Total Power Factor	0.99 PF
Displacement Power Factor	0.99 dPF
Voltage THD	1.1%
Current THD	3.2%
Current TDD	3.3%

Total Charging Time[3]	4 hours, 47 minutes
Total Energy Consumption	29.07 kWh AC

Data was recorded on the 7/29/99.

[1]Values recorded with charger near maximum power on the AC (input) side of the charger (240 V)
[2] Maximum recorded instantaneous real power for complete charge was 6.6kW
[3] Ambient Temperature: at start =85.0°F, at end=84.0°F, Ave.=84.5°F

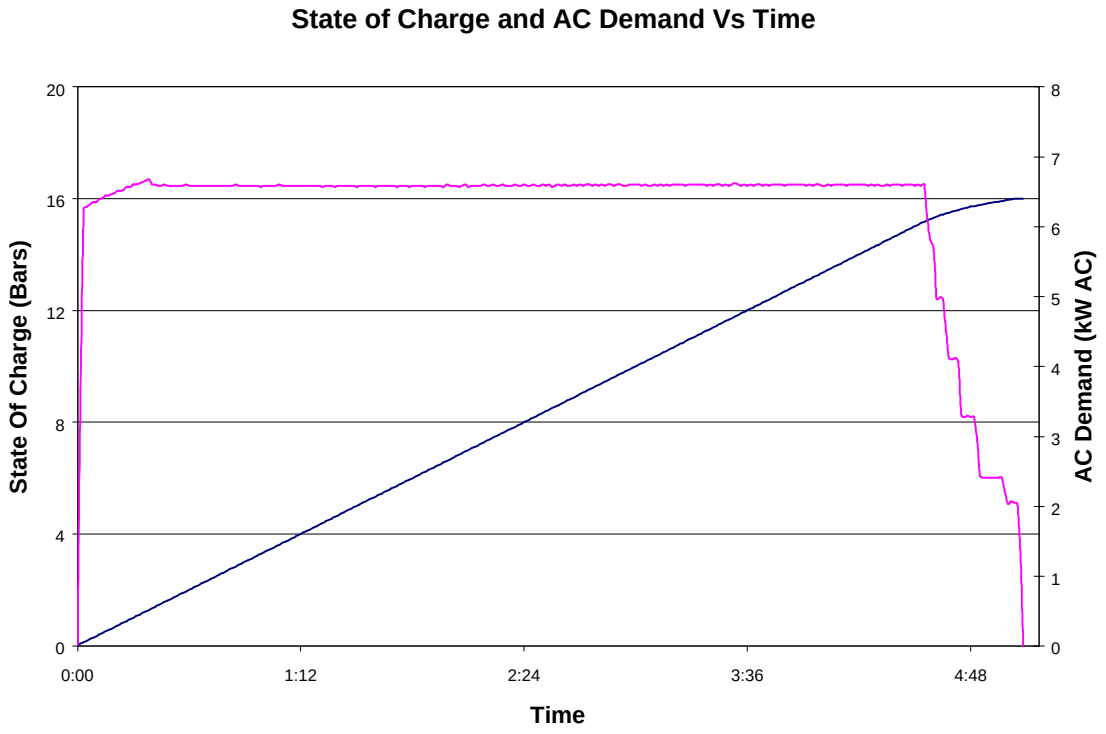


Figure 5-6. AC charging profile from ABB meter (recorded on 7/7/99 after FW-2).

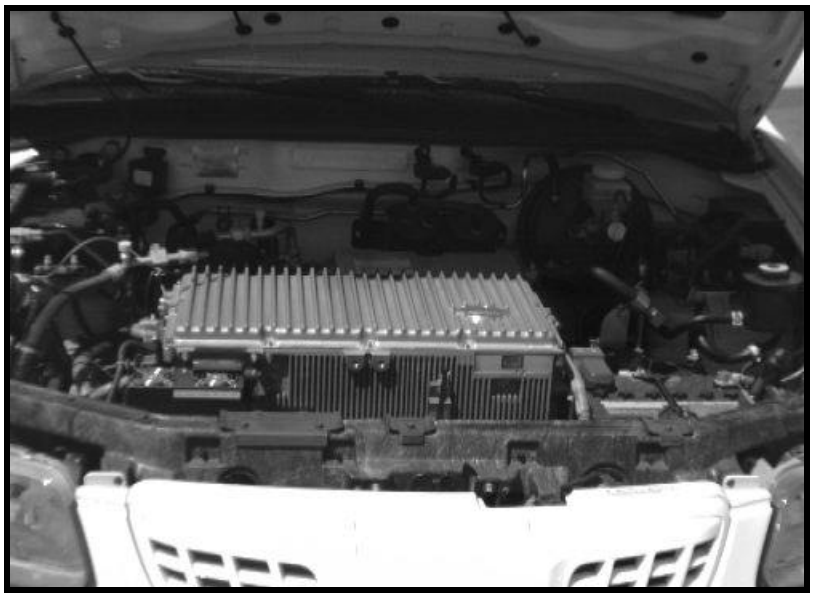


Figure 5-7. Motor controller and other critical electric controls are liquid cooled.

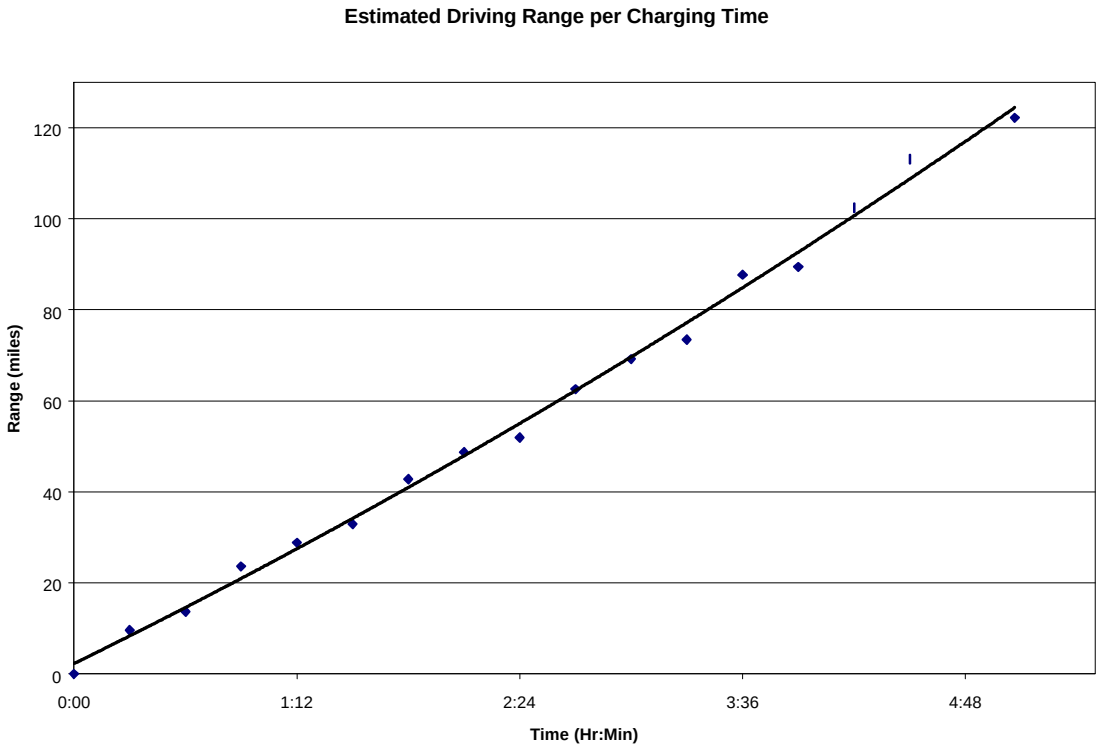


Figure 5-8. Driving Range Returned per Charging Time: 6/29/99, UR1.

F. Sound Level Tests

F1. Freeway Sound Level Test

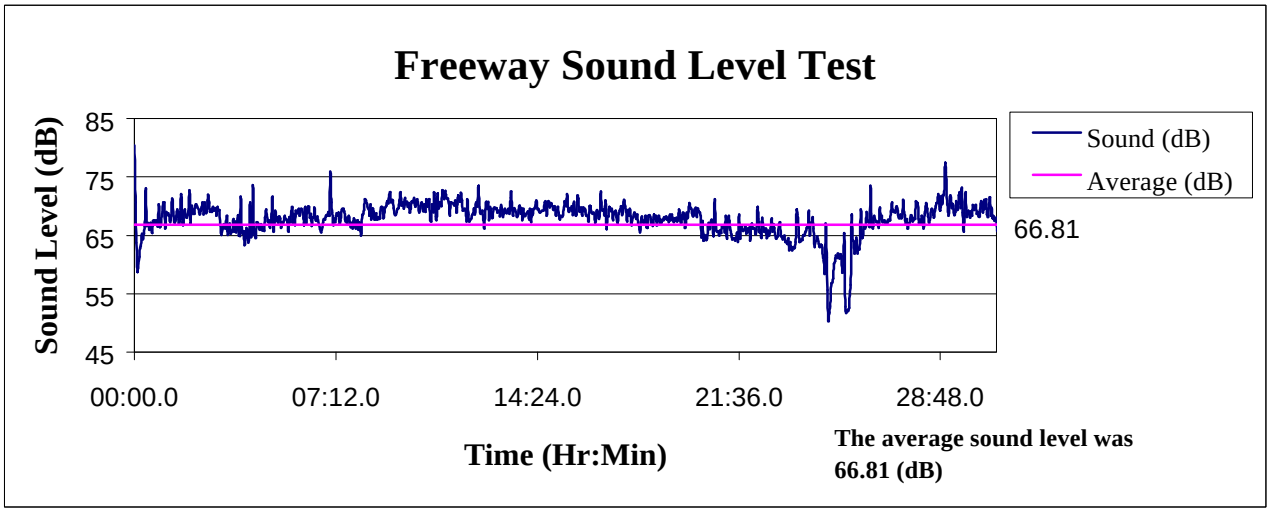


Figure 5-9. Sound intensity in dB recorded during a driving test on the Freeway Loop.

F2. Urban Sound Level Test

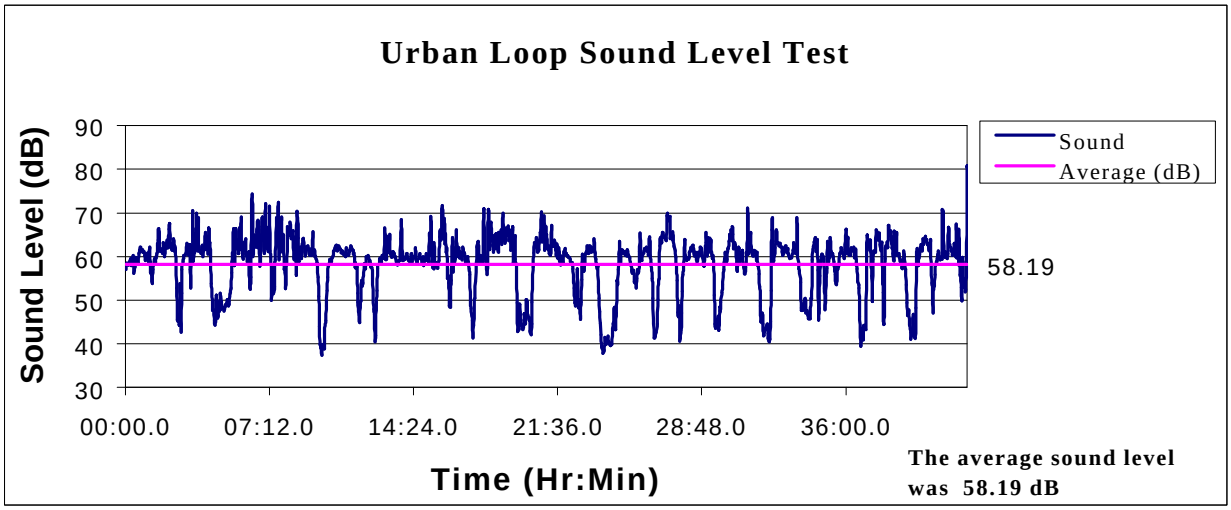


Figure 5-10. Sound intensity in dB recorded during a driving test on the Urban Pomona Loop.

Figure 5-11. Sound level meter positioned to measure sound intensity at ear level.

F3. Charger Sound Level Tests

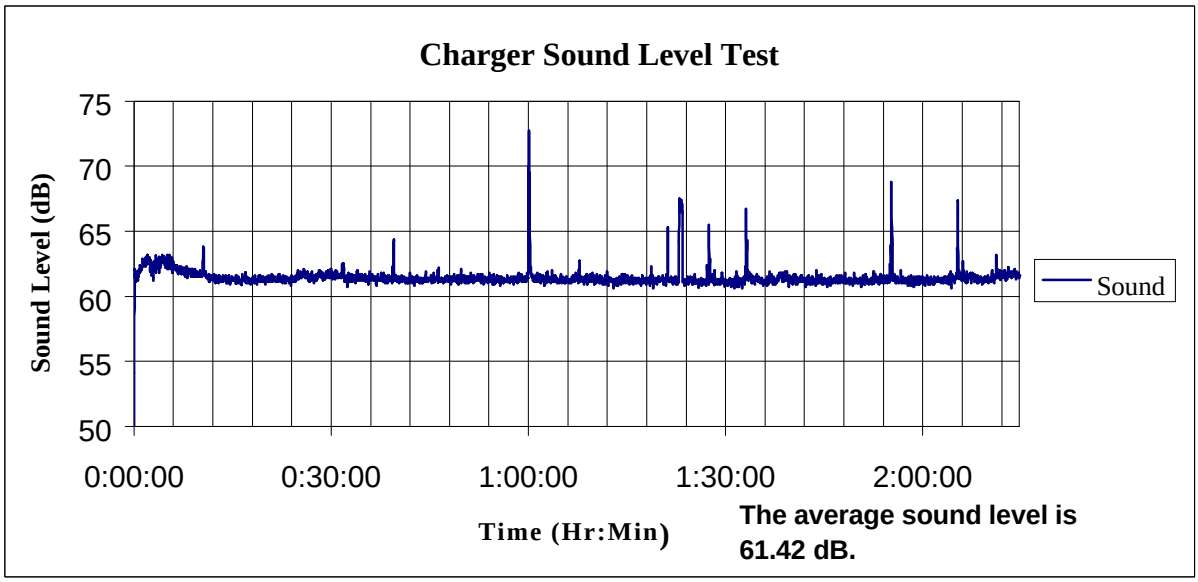


Figure 5-12. Sound intensity recorded during charging. The spikes are ambient noise events.

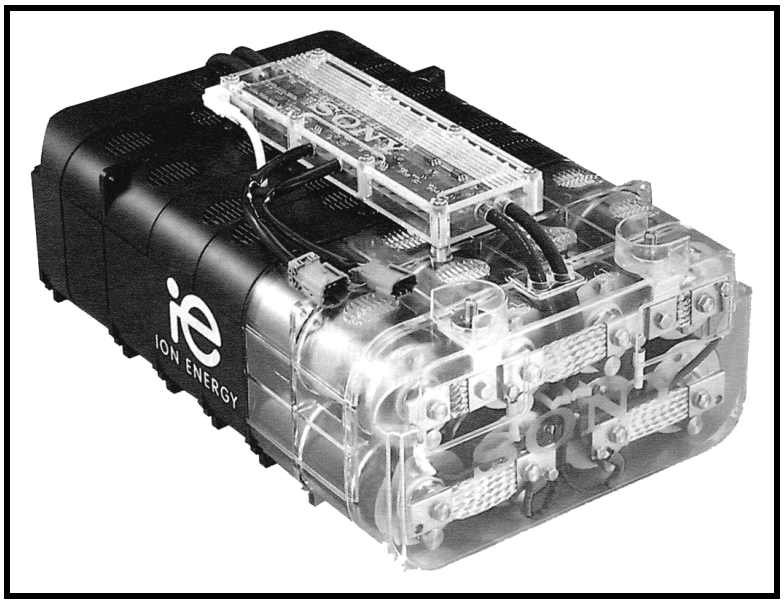


Figure 5-13. Nissan-Sony Lithium-ion battery module.

VI. Discussion

A. Weight Certification

The vehicle was taken to a certified scale to measure the total weight, and the front and rear axle weights (see Table 5-1). The measured total curb weight was 3940 pounds. The manufacturer's gross vehicle weight rating (GVWR) label on the vehicle is 4579 pounds, and the specified payload is 820 pounds. The GVWR minus the total curb weight yielded a payload of 639 pounds, which was the weight used for the maximum payload tests. Table 5-1, page 6, shows an available front axle payload of 104 pounds, and an available rear axle payload of 579 pounds. When the vehicle was loaded to its maximum legal weight (639 pounds), the load was evenly distributed using water dummies and weights (see Figure 6-1).

Figure 6-1. Water dummies used in load tests.

B. Range Tests

Range Testing was conducted in a manner that was safe and compatible with the flow of traffic. Speeds were never above the posted speed limits, but occasionally there was slower traffic. The state of charge meter on the Nissan Altra-EV has 16 divisions, with each division representing 6.25% of charge available. The vehicle was always driven until the last division turned off and the "EMPTY" light turned on. Once this occurred, the vehicle was usually about 1 to 2 miles from the EV Tech Center. The farthest the vehicle went, while the Empty indicator was on, was less than 5 miles.

During the tests (Freeway and Urban loops), the car handled very well. Acceleration was smooth, and the vehicle never had trouble reaching traffic speed and keeping up with the flow of traffic. Although with maximum payload, the range of the vehicle was reduced to about 80 miles, acceleration performance never decreased. As expected, the braking time and stopping distance seemed to increase slightly with maximum payload. The Altra-EV handled exceptionally well in rain although slight slipping did occur on steep inclines like freeway on-ramps. The vehicle also accelerated well during rainy conditions.

Figure 6-2. Nissan Altra-EV Instrument Panel.

B1. Urban Range Tests

The speed of the vehicle on the Pomona Loop, varied between 30 mph and 50 mph. At least two loops were completed for each drive. Variations in

payload and auxiliary loads (air conditioning and headlights) clearly affected the range of the vehicle, as seen in Table 5-2, page 7. Data from the UR1 and UR2 tests show that with minimum load, and when accessories (Radio, CD, and low beam headlights, A/C) were used, range was reduced by 22%. The data from the maximum load tests on the Pomona loop showed similar results. The Altra's range dropped 23% when the accessories were used with maximum payload. Range between minimum load and maximum load with no accessories (UR1, UR3) dropped by 21%. Comparing UR2 and UR4 yields almost a 22% decrease in range.

Energy consumption for the urban drives ranged from 31.05 kW for the UR1 drives down to 23.15 kW for the UR4 drives. The vehicle was driven down to (as indicated by the charger display) 5% SOC. Ambient temperatures from 78.4 ^{o}F to 94.4 ^{o}F were experienced throughout the test. The Altra-EV performed well and did not have any problems or unusual events during testing. Coast down braking is automatically controlled and cannot be normally adjusted.

Air conditioning (A/C) was tested during the UR2 and UR4 tests. A thermocouple was inserted in the air vent in the middle of the dashboard. Temperatures were taken at the beginning, ten minutes into the drive, and at the end of the drive. After ten minutes the average temperature indicated was 39^{o} F. This indicated that the air conditioning was functioning properly.

B2. Freeway Range Tests

On the freeway drives, there was little regenerative braking. Minimum payload tests with no auxiliary loads on the freeway produced a range of 94.4 miles. That is a 22% decrease (28 miles) on the freeway compared to driving on the street (UR1). Accessory loads didn't affect the results of the maximum load tests on the freeway. The FW3 achieved a range of 82.5 miles, while the FW4 only had a 3% loss of range with 79.8 miles. The

Nissan Altra-EV had no handling problems on the freeway. The suspension was very stable and the ride was comfortable and quiet. The Altra-EV has the longest wheelbase of all passenger vehicles tested by SCE.

C. State of Charge Meter Evaluation

The state of charge meter on the Nissan Altra-EV consists of 16 lighted bars. The bars in the middle column are green. This column will either turn on or off depending on whether the car is charging or discharging. The outer column displays white bars and these bars do not turn off. These bars help the driver compare how much energy the car has left. Each of the bars equals about 6.25% of the total user charge. The meter is located on the left-hand side of the instrument panel. When the vehicle is fully charged, a "FULL" indicator will illuminate on top of the scale. The "FULL" indicator will stay lit during the first 1.8 to 2 miles of driving. When 5 to 7% charge is left, the last bar will turn off and an "EMPTY" indicator illuminates. Overall the meter was very helpful, and when the meter does reach empty, the car still has enough charge to go about 5 miles with no loss of performance.

D. Power Meter

The power meter instrument panel (see Figure 6-3) shows the driver the amount of power used at any given time. When the vehicle is turned on, the light bar to the immediate left of the "ON" light will illuminate. When the car is off, the bar next to the "OFF" will turn on. When gradually braking or slowing down, the bar on the left will drop below the "ON" position towards the "OFF", indicating to the driver, that the regenerative braking is being used. The meter is very useful to help drivers conserve energy and achieve optimum range with this vehicle.

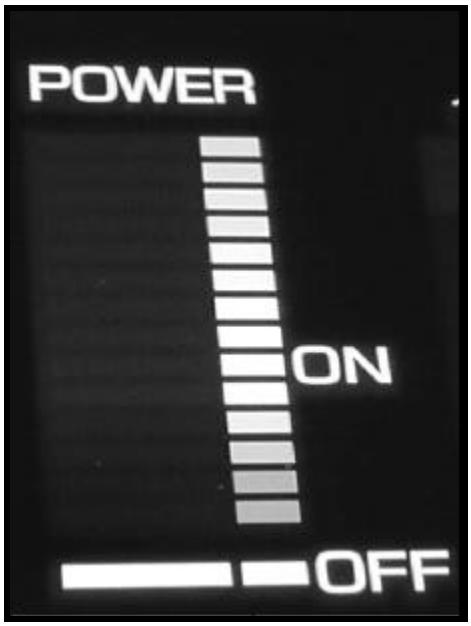


Figure 6-3. Power Meter for the Nissan Altra-EV.

E. Acceleration, Braking, and Maximum Speed Tests

The acceleration and maximum speed tests were conducted at the Pomona racetrack test site. Conditions at the track were warm with a temperature of 82^{O} F and 37.7% humidity. The temperature at the Technical center was about 95^{O} F with 45% humidity. Test data was recorded with a Vericom VC2000PC Performance Computer (see Figure 6.4) that measures acceleration, time, speed, and distance. Runs were made in both directions of the track, and measurements were averaged at 20% intervals of charge (100%, 80%, 60%, 40%, 20%). At 100% and 20%, the Altra-EV reached the top speed of 75 mph. From 0 to 30 mph, the average acceleration was 4.63 sec, with 4.52 sec at 40% charge being the quickest. The average time the Nissan took to get to 60 mph was 14.63 sec, with the fastest time recorded at 14.28 at 80% charge. With a stopwatch, we also tested the vehicle's ability to accelerate from a constant 30 mph to 55mph; the average time was 7.9 sec. The Nissan accelerated smoothly. The braking distance test revealed that it takes an average of 27.74 feet to come to a complete stop from 25mph. While applying the brake, the vehicle did not lean or "pull".

Figure 6-4. VC2000PC Performance Computer.

F. Charger Performance Test

Charging of the Nissan Altra-EV was done with a standard off-board 6.6 kW Magne Charge inductive charger (Figure 5-1). The average charging time from 5% to 100% SOC was about 5 hours. As shown in Table 4-5, the instantaneous peak power recorded was 6.6 kW, with a current of 25.69 A and a voltage of 247.3 V. The power factor was 0.99, the voltage THD was 1.10%, and the current total harmonic distortion was 3.2%. These results indicate that the performance of the charger was good when compared to the Infrastructure Working Council's recommended guidelines (see Appendix E, page 52). The AC Demand vs Time curve (Figure 5-6) shows a charge rate with a steep rise in energy in the beginning and a sharp decline of energy at the end of charging. The indicated State of Charge vs Time curve shows the charge acting in a linear matter. Using range data from a UR1 run and state of charge meter evaluation data, a graph that measures driving range per charging time (see Figure 5-8) was developed. With this graph, one can estimate how much time the car needs to charge in order to achieve a given distance.

Figure 6-5. BMI Power profiler.

G. Sound Level Tests

Sound level tests were performed using a sound level meter placed on the passenger seat at ear level (see Figure 5-11). The meter was set to record sound intensities from 30 dB to 130dB. The average sound level on the freeway was 66.81 dB, while the urban loop sound level averaged 58.19 dB. Constant wind noise during freeway driving produces much smoother sound levels than those produced in urban driving (see Figure 5-9 and Figure 5-10). Although freeway runs are smoother they also produce a higher intensity, which results in higher sound levels.

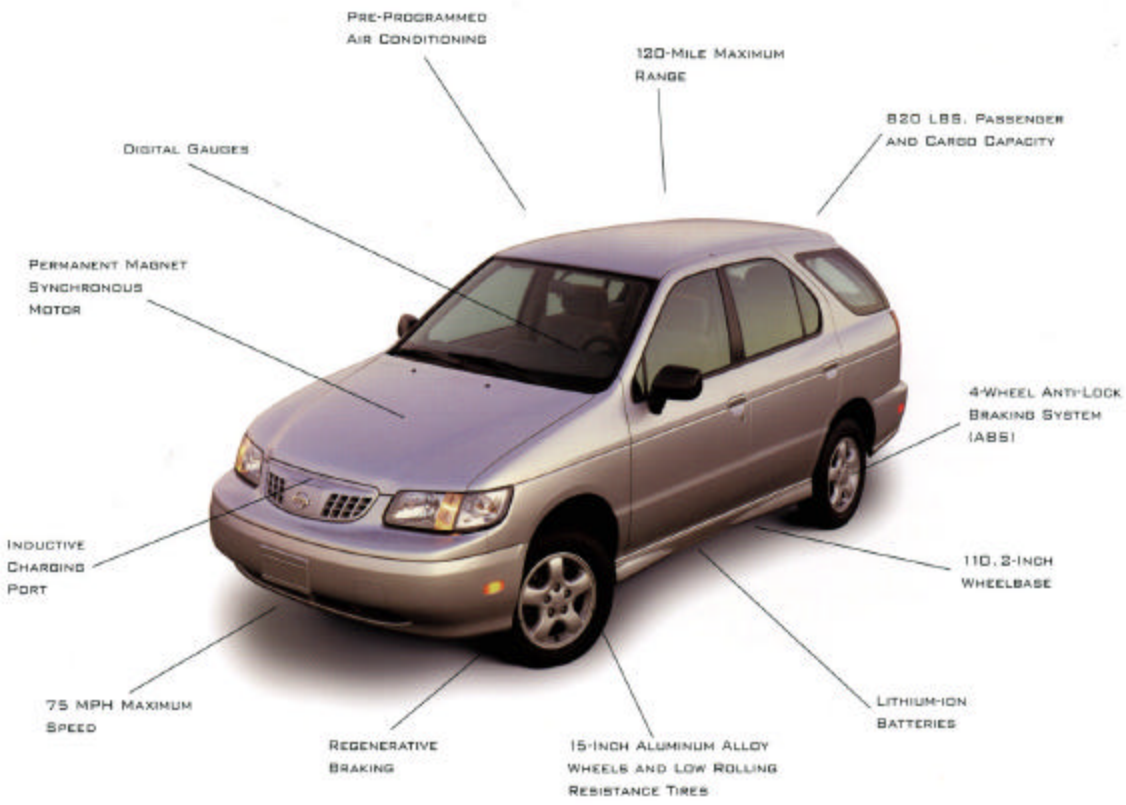
The sound level meter was also used on the charger. The tests revealed that the average sound level was 61.42 dB at 3 feet. On the graph, some spikes can be attributed to outside noise sources (see Figure 5-12).

Figure 6-6. Powerful rear lights makes the Altra very noticeable at night or during the day.

APPENDIX A

VEHICLE MANUFACTURER'S FACT SHEET

ALTRA EV™



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Nissan Altra EV

Features and Options

MECHANICAL	
83 horsepower synchronous DC permanent magnet electric motor	S
Electric power steering	S
Independent front strut suspension	S
Rear Multi-Link Beam™ suspension	S
Computer controlled vacuum assisted front brakes with ABS and regenerative braking	S
Computer controlled vacuum assisted rear brakes with ABS	S
12 Lithium-ion battery modules (96 cells)	S
6.6 kW inductive battery charger (220V)	S
Portable 1.1 kW inductive battery charger (110V)	S
Liquid-cooled DC/DC high voltage/low voltage power converter	S
EXTERIOR	
15-inch aluminum alloy wheels	S
5-mph impact front bumper	S
5-mph impact rear bumper	S
Tinted solar glass	S
High-efficiency halogen multi-parabola headlights	S
Rear side privacy glass	S
Dual power adjustable side view mirrors	S
Center high-mounted rear stop lamp	S
Aerodynamic undercarriage cover	S
External inductive charger paddle port	S
INTERIOR/SEATING AND TRIM	
Front seat captain's chairs	S
Rear seat captain's chairs	S
Adjustable front head rests	S
Fully carpeted floor covering	S
Passenger assist grips	S
Adjustable cargo area utility rails	S
NEAT automatic temperature climate control system	S
Pre-programmable air conditioning system	S
COMFORT, CONVENIENCE AND STORAGE	
Power windows	S
Power door locks	S
Cruise control	S
Variable intermittent windshield wipers	S
Rear window wiper	S
Rear window defrost	S
Center console dual cupholders	S
Rear seat cupholders	S
Locking glove box	S

Nissan Altra EV

Features and Options, continued

COMFORT AND CONVENIENCE, CONT.	
Interior cabin lighting	S
Driver and passenger vanity mirror	S
Front and rear door map pockets	S
Remote charge lid opener	S
Day/night rear view mirror	S
Keyless entry and information display system with air conditioning controller, state of charge display, charge time status and selective door lock/unlock functions	S
INSTRUMENTATION	
Digital speedometer	S
Digital state of charge meter	S
Digital tachometer	S
Digital odometer with dual trip meters	S
Digital quartz clock	S
Digital coolant temperature display	S
Adjustable illumination control	S
Safety warning lights	S
ABS activated display	S
Range display	S
Air bag system warning light	S
Electric power consumption meter	S
Transaxle shift position indicator	S
AUDIO SYSTEMS	
AM/FM/CD, 100-watts with 4 speakers and power and diversity antenna and integrated clock	S
SAFETY AND SECURITY	
Dual supplemental air bags	S
3-point lap and shoulder harness seat belts	S
Child safety door rear door locks	S
Pipe-style steel side-door guard beams	S

S - Standard

APPENDIX B

RANGE TEST DATA SHEETS

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
06/29/1999	24474	21	UR1	Kevin		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	180				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:03	3216.00	100.00%			68.10		
Stop	13:18	3339.00	6.00%			86.00		Min. A/C
Net	5:15	123.00	94.00%			17.90		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		Traffic at Alta Cuesta
9.6	15.0		
13.7	14.0		
23.6	13.0		
28.8	12.0		
32.9	11.0		
42.8	10.0		
48.7	9.0		
51.9	8.0		
62.6	7.0		
69.2	6.0		
73.4	5.0		
87.7	4.0		
89.4	3.0		
102.4	2.0		Made U-turn at Vineyard
113.1	1.0		Made circles around the block
122.2	0.0		
122.8			Stop Condition

Accessories used: radio

Drive / Regen setting: Drive

Handling/Braking:

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024	p029		1457422		2			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	06/29/1999	15:36	3088				90.2	
Stop	06/30/1999	8:20	3119.1				69.8	
Net			31.1					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
06/24/1999	24474	21	UR1	KEVIN	Nissan Altra Perf. Char.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	180				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:08	2887.00	100.00%			69.60		
Stop	13:24	3008.00	7.00%			87.00		Min. A/C
Net	5:16	121.00	93.00%			17.40		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		
7.3	15.0		
10.7	14.0		
20.3	13.0		
26.7	12.0		
30.8	11.0		
40.2	10.0		
46.3	9.0		
50.5	8.0		
62.4	7.0		
68.3	6.0		
80.4	5.0		
85.9	4.0		
88.9	3.0		Heavy Traffic (Const)
99.2	2.0		Made U-turn at Vineyard/Holt
111.5	1.0		Loops around the block
120.7	0.0		"EMPTY" light came on
121			Stop Condition

Accessories used: Radio
Drive / Regen setting: Drive
Handling/Braking: Good handling, Good Brakes
Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024	P029		1457422					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	06/24/1999	13:31	2993					
Stop	06/25/1999	10:33	3024					
Net			31					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
06/30/1999	24474	21	UR2	Kevin		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	180				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:50	3339.00	100.00%			72.70	75.20	41.50
Stop	13:00	3436.00	7.00%			86.00	38.80	Min. A/C
Net	4:10	97.00	93.00%			13.30	36.40	34.30

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		
8.4	15.0		
11	14.0		
19.9	13.0		
24.8	12.0		
29.3	11.0		
33	10.0		
41.3	9.0		
46.3	8.0		
51	7.0		
55.2	6.0		
67.6	5.0		
69.6	4.0		
72.2	3.0		
81.7	2.0		Made U-turn at San Antonio
85.7	1.0		
96.5	0.0		Made circles around the block "Empty Light came on
97			

Accessories used: radio, low beam, A/C high

Drive / Regen setting: Drive

Handling/Braking: Good handling/Braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024	P029		1457422					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	06/30/1999	3:04	3119	0				
Stop			3153.23					
Net			34.23					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
06/28/1999	24474	21	UR2	Kevin	Nissan Perf Char.	Start	
Road Cond	Tire Press	Payload				Stop	
DRY	51	180				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:30	3122	100%			70.7	64	35.8
Stop	13:30	3216	7%			84.9	40.1	Min. A/C
Net	4:00	94	93%	0	0	77.8	52.05	34

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		
6.9	15.0		
10.3	14.0		
14.3	13.0		
23.2	12.0		
27.9	11.0		
30.8	10.0		
38.1	9.0		
45.1	8.0		
49	7.0		
52.8	6.0		
62.9	5.0		
68.9	4.0		
70.5	3.0		
81.3	2.0		Made U-turn at Grove/Holt
84	1.0		Made loops around the block
92.9	0.0		Empty light
93.6			

Accessories used: radio, low beams, A/C high

Drive / Regen setting: Drive

Handling/Braking: Good Handling/Braking

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024	p029		1457422					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	06/28/1999	2:33	3056					
Stop	06/29/1999	7:57	3088					
Net	1	5:24	32					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/12/1999	24474	21	UR3	Chris M		Start	
Road Cond	Tire Press	Payload				Stop	
DRY	44	646				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	11:00	3877.00	100.00%			98.20		
Stop	14:40	3972.00	5.00%			107.80		Min. A/C
Net	3:40	95.00	95.00%			9.60		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		
9.6	15.0		
12.8	14.0		
20	13.0		Very hot outside (105 ^{0}F)
26.8	12.0		
30.9	11.0		
34.1	10.0		
42.1	9.0		
47.4	8.0		
50.9	7.0		
58.8	6.0		
65.6	5.0		
69.1	4.0		
72.9	3.0		
80.6	2.0		(85.7) Made U-turn at Vineyard
88.2	1.0		(90.8) (108 ^{0}F) Car Temp Is four down from the lowest red
95	0.0		
95.6			

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Good handling and brakes

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024	1457422		885m-117		2			
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/12/1999	17:00	72					
Stop	07/12/1999	21:00						
Net			28.53					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/22/1999	24474	21	UR4	Chris M	Altra Perf. Char.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	646				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	11:00	4513	100.00%			86.5	86.1	38
Stop	14:00	4587	5.00%			102.1	37.5	Min. A/C
Net	3:00	74	95.00%			15.6	48.6	37.2

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		(2.7 miles) "FULL" light turned off
7	15.0		
9.9	14.0		Great acceleration
13.4	13.0		
18.8	12.0		
24.2	11.0		
27.8	10.0		
30.8	9.0		
34.2	8.0		
42.8	7.0		
47.6	6.0		
50.2	5.0		
57.1	4.0		
61.9	3.0		
66	2.0		(66.2 miles) Left on Fourth to left on grove to right on holt to Tech Center
69.6	1.0		
73.1	0.0		
74.1			

Accessories used: Radio,CD, A/C, Low Beams

Drive / Regen setting: Drive

Handling/Braking: Both handled very well

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024			1457422					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start								
Stop								
Net		3:47	23.4					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/23/1999	24474	21	UR4	Chris M.	Altra Perf. Char	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	646				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:30	4587	100.00%			78.4	77.5	40.1
Stop	13:30	4662	7.00%			93	41.4	Min. A/C
Net	3:00	75	93.00%			14.6	36.1	38.5

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		"FULL" Light turned off at 2.1 miles
5.4	15.0		
9.5	14.0		
11.8	13.0		
18.5	12.0		
23.5	11.0		
28.6	10.0		
30.5	9.0		
34	8.0		
40.9	7.0		
47.6	6.0		
49.5	5.0		
53.9	4.0		
61.5	3.0		
65.7	2.0		(65.7 miles) Made Left on Indian Hill Blvd, went up 3 blocks then made
69.6	1.0		a U-turn. Then I made a right on holt and went back to the Tech Center and
74.3	0.0		drove around the block twice.
74.7			

Accessories used: Radio, A/C, Low Beams

Drive / Regen setting: Drive

Handling/Braking: Handled very well

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024	P029		1457422					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start								
Stop								
Net		3:43	22.9083					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/01/1999	24474	21	FW1	Chris M	Altra Perf. Char.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	180				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:25	3436	100.00%			67.6		
Stop	10:35	3532	5.00%			73.4		Min. A/C
Net	2:10	96	95.00%			5.8		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		
9.2	15.0		
15.1	14.0		
20.2	13.0		
25.1	12.0		
29.2	11.0		
35.1	10.0		
39	9.0		
44.5	8.0		
54.3	7.0		
59.1	6.0		
64.3	5.0		
71.5	4.0		
74.2	3.0		
81.2	2.0		Made U-turn at Euclid
86.2	1.0		Made U-turn at Towne
95.7	0.0		Exit Indian Hill (90.4 miles)
96.3			3 loops around the block

Accessories used: radio/CD
Drive / Regen setting: Drive
Handling/Braking:
Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024	P029		1457422					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/01/1999	10:40	3150					
Stop	07/02/1999	8:05	3181					
Net			31					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/02/1999	24474	21	FW1	Kevin C	Altra Perf. Char.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	180				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:27	3532.00	100.00%			66.50		
Stop	10:24	3629.00	5.00%			72.70		Min. A/C
Net	1:57	97.00	95.00%			69.60		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		
7.9	15.0		
13.5	14.0		
19.5	13.0		
25	12.0		
30.1	11.0		
36.1	10.0		
39.9	9.0		
46.1	8.0		
53.1	7.0		
58.3	6.0		
62.7	5.0		
71.6	4.0		
75.1	3.0		
80.4	2.0		(83.0 miles) U-turn at Vineyard while going east
87.4	1.0		(91.1 miles) U-turn at Towne While going west
93.1	0.0		Exit Monte Vist Ave "EMPTY" light came on
96.8			Stop Condition

Accessories used: Radio/cd

Drive / Regen setting: Drive

Handling/Braking:

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024	P029		1457422					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/02/1999	10:30	3181					
Stop	07/02/1999	16:33						
Net		6:03	29.793					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/07/1999	24474	21	FW2	Sanchez	Altra Perf. Char.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	50	160				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:00	3629	100.00%			87.3	72.3	40.5
Stop	14:50	3711	3.00%			89.2	41.7	Min. A/C
Net	1:50	82	97.00%			1.9	30.6	39.6

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		
5.2	15.0		
11.9	14.0		
16.3	13.0		
21.1	12.0		Heavy Traffic from the 57 to Monte Vista
25	11.0		
28.5	10.0		
32.2	9.0		
37.9	8.0		
43.4	7.0		
49.6	6.0		
55	5.0		Heavy traffic from " " " " "
61.5	4.0		
64.3	3.0		
68.1	2.0		
73.1	1.0		
77.9	0.0		
81.3			End Drive

Accessories used: Radio, Low beams, A/C

Drive / Regen setting: Standard Regen

Handling/Braking:

Other comments:

Charger	Serial No.	AC meter#	BMI #
EVC-024		1223620	2

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/07/1999	15:00	5221					
Stop	07/07/1999	19:00	5252.64					
Net		4:00	31.64					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/08/1999	24474	21	FW2	Sanchez		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	50	160				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	13:50	3711	100.00%			79	61.9	
Stop	16:15	3800	3.00%			77	44.6	Min. A/C
Net	2:25	89	97.00%			2	17.3	37.2

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		
6.1	15.0		
11.9	14.0		
17.1	13.0		Traffic slowed to 45mph & to Indian Hill Blvd
21.8	12.0		
26.3	11.0		
31.4	10.0		
35.9	9.0		
39.5	8.0		
46.4	7.0		
53.6	6.0		
57.7	5.0		Traffic slowed to 25mph 57 to Monte Vista
64.4	4.0		
65.9	3.0		
	2.0		
75.3	1.0		
86.8	0.0		Empty
89.7	0.0		

Accessories used: A/C, lights, radio

Drive / Regen setting:

Handling/Braking:

Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC-024	P029		1223620					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	07/08/1999	16:15	5253	0				
Stop	07/08/1999	19:15	5283.55					
Net			30.55					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/20/1999	24474	21	FW3	Chris M	Altra Perf. Char.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	44	646				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:00	4378.00	100.00%			94.40		
Stop	12:00	4462.00	7.00%			102.70		Min. A/C
Net	2:00	84.00	93.00%			98.55		

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		(2.1 miles) Full Indicator turned off
7.1	15.0		
13.3	14.0		
18.5	13.0		
23	12.0		
27.2	11.0		
32.1	10.0		
36.2	9.0		
39.2	8.0		
46.8	7.0		
53.6	6.0		
60	5.0		
65.8	4.0		
68.8	3.0		
75.1	2.0		
78.3	1.0		Got off mountain (79.1 miles) to 10 west to Indian Hill to Tech Center
82.1	0.0		
84.2			Stop condition

Accessories used: Radio

Drive / Regen setting: Drive

Handling/Braking: Both did very well

Other comments: I was very impressed with the way the vehicle performed today. I reached the empty light over 2 miles away from the Tech Center! The battery capacity on this vehicle is very well made.

Charger	Serial No.		AC meter#		BMI #			
EVC-024			1457422					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start		14:33						
Stop		19:29						
Net		4:56	30.1476					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/27/1999	24474	21	FW3	Chris M.	Altra Perf. Char.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	640				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:45	4662	100.00%			79.5	N/A	N/A
Stop	12:45	4745	4.00%			94.1	N/A	Min. A/C
Net	2:00	83	96.00%			86.8	N/A	N/A

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		(2.4 miles) "FULL" light turned off
5.8	15.0		
12.3	14.0		13.7 traffic on the 15 South
17.5	13.0		
19.6	12.0		
54.4	11.0		
29.8	10.0		
35.3	9.0		
36.7	8.0		
40.3	7.0		
49.4	6.0		
55.4	5.0		
60.1	4.0		
64.8	3.0		
69	2.0		(73.7 miles) Got off indian Hill and drove around the tech center for two
71.6	1.0		miles.
82	0.0		"EMPTY" light turned on
82.4	0.0		Stop condition

Accessories used: Radio, CD
Drive / Regen setting: Drive
Handling/Braking: Handled and braked really well
Other comments: Very comfortable and has great stereo system

Charger	Serial No.		AC meter#		BMI #			
EVC-024								
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start								
Stop								
Net		4:47	29.067					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/16/1999	24474	21	FW4	Chris M	Altra Perf. Char.	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	640				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:00	4151	100.00%			83.1 F	82.9 F	40.1 F
Stop	11:45	4231	7.00%			85.6 F	60.3 F	Min. A/C
Net	1:45	80	93.00%	0	0	2.5 F	22.6 F	38.7 F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		"FULL" light turned off (2.0 miles)
5.8	15.0		
11.2	14.0		15 south (12.2 miles)
17.3	13.0		60 west (15.3 miles)
22.3	12.0		
27.3	11.0		10 west (34.3 miles)
31.6	10.0		
35.1	9.0		
39.4	8.0		
44.3	7.0		
50.6	6.0		15 south (49.2 miles)
55.3	5.0		
60.6	4.0		
64.1	3.0		
68.7	2.0		57 south (68.5 miles)
73.5	1.0		10 east (70.2 miles)
80	0.0		
80.1			Last .5 miles was spent on holt and price.

Accessories used: Radio, Low beams,AC

Drive / Regen setting: Drive setting

Handling/Braking: Very well handling and 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	07/16/99	16:22						
Stop		21:17						
Net		4:55	30.6306	0	0	0	F	0

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
07/15/1999	24474	21	FW4	Chris M	Altra Perf Char	Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	640				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:30	4298	100.00%			81.3 F	80.1 F	39.7 F
Stop	12:30	4378	6.00%			86.9 F	38.8 F	Min. A/C
Net	2:00	80	94.00%	0	0	5.6 F	41.3 F	38. F

Distance	State of Charge		Notes / Deviations / Traffic / Weather / Performance
Miles	Veh meter	Range meter	
0	16.0		(1.8 miles) "Full" light turned off
5.5	15.0		
10.5	14.0		
16.4	13.0		
21.3	12.0		
26.2	11.0		
31.3	10.0		
36.1	9.0		
38.1	8.0		
44.6	7.0		
50.4	6.0		
56.9	5.0		
61.6	4.0		
66.5	3.0		
69.9	2.0		
74.3	1.0		(76.0 miles) Got off 10 to Indian Hill Blvd
79.5	0.0		
79.8			

Accessories used: Radio, A/C, Low beams

Drive / Regen setting: Drive

Handling/Braking: Both worked very well

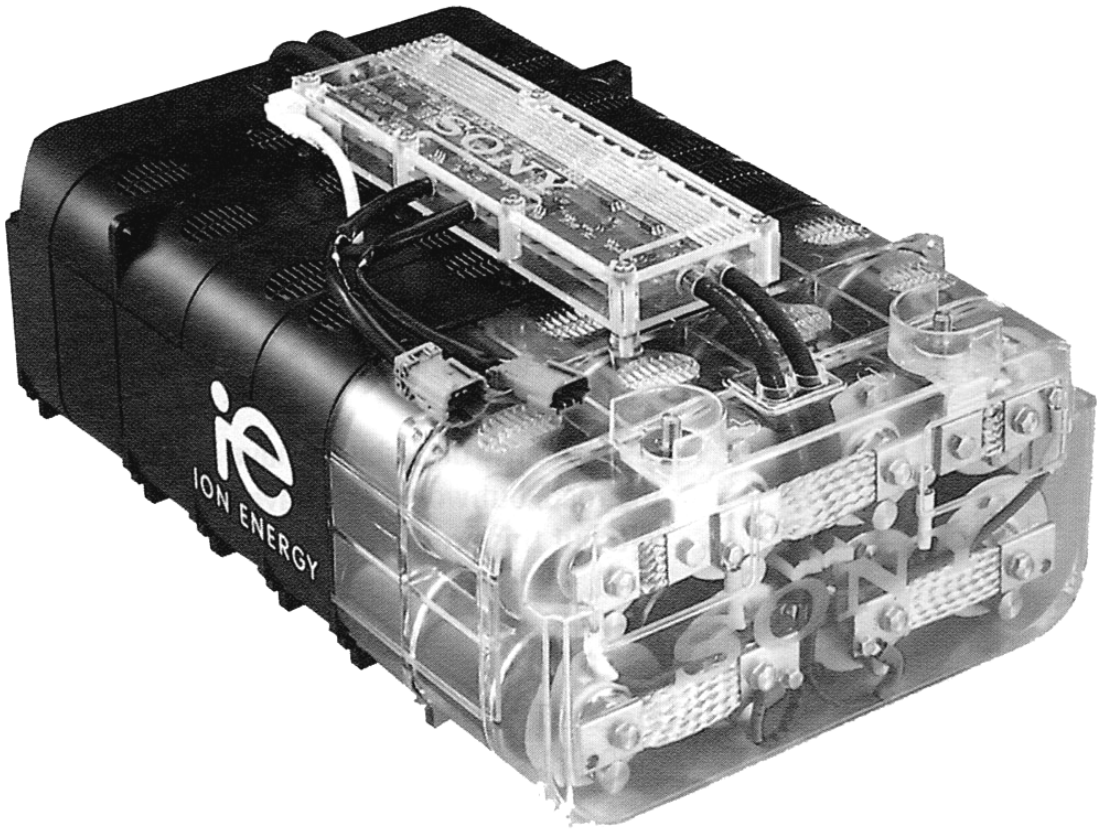
Other comments:

Charger	Serial No.		AC meter#		BMI #			
EVC 024	P029		1457422					
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start								
Stop								
Net		0:00	0	0	0	0	. F	0

Comments:

APPENDIX C

BATTERY MANUFACTURER'S FACT SHEETS



SONY LITHIUM-ION BATTERY MODULE

SPECIFICATIONS[1]

Dimensions (mm)	290 X 150 X 440
Weight	30 kg
Construction	Spiral Wound Plate
Capacity	94 Ah
Voltage	28.8 Volts
Energy Density	90 Wh/kg
Power Density	300 W/kg
Maximum Voltage	33.6 Volts
Minimum Voltage	20 Volts

[1] Source: *Development of the Nissan Altra-EV,* K. Suzuki et. al., 12/97.

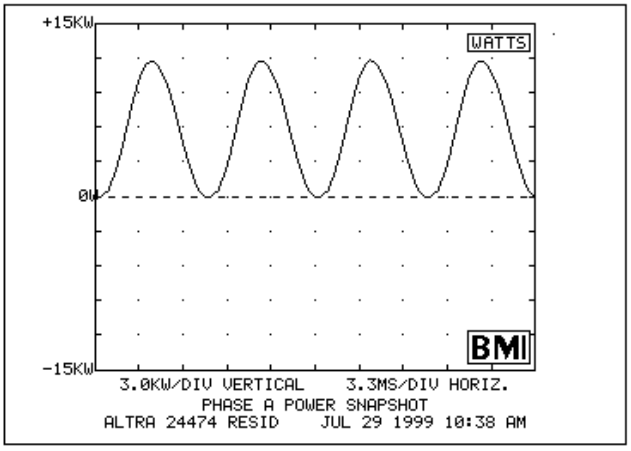
APPENDIX D

CHARGER PROFILE GRAPHICAL DATA

Snapshots at Full Power

```
POWER CONSUMPTION SNAPSHOT 10:38:42 AM
    Phase A-N:        5.808 kW

_____________________________________
ALTRA 24474 RESID    Jul 29 1999 (Thu)
PHASE A POWER SNAPSHOT      10:38:43 AM
  INSTANTANEOUS POWER:      5.808 kW
```




```
PHASE A POWER SPECTRUM      10:39:16 AM
 Power:                  5.808 kW
 Fundamental freq:       60.0 Hz
 HARM         POWER      HARM         POWER
 ---- ------------      ---- ------------
 FUND     +5.806 kW       2nd
  3rd       +0.34 W        4th
  5th       +0.72 W        6th
  7th       -0.12 W        8th
  9th       -0.01 W       10th
 11th                     12th
 13th                     14th
 15th                     16th
 17th                     18th
 19th                     20th
 21st                     22nd
 23rd                     24th
 25th                     26th
 27th                     28th
 29th                     30th
 31st                     32nd
 33rd                     34th
 35th                     36th
 37th                     38th
 39th                     40th
 41st                     42nd
 43rd                     44th
 45th                     46th
 47th                     48th
 49th                     50th
      ------------           ------------
 ODD         0.92 W      EVEN         0.00 W
 THP:        0.92 W
```

```
POWER FACTOR SNAPSHOT       10:38:46 AM
    Phase A-N:         5.808 kW
    Phase A-N:         5.836 kVA
    Phase A-N:       529.0 VAR
    Phase A-N:         1.00 PF
    Phase A-N:         1.00 dPF

=======================================

=======================================
ALTRA 24474 RESID    Jul 29 1999 (Thu)
HARMONICS SNAPSHOT          10:38:47 AM
 Fundamental freq:     60.0 Hz
    Phase A-N Volts:    1.1% THD
    Phase A Current:    3.3% TDD


VOLTAGE & CURRENT SNAPSHOT 10:39:24 AM
    Phase A-N: 247.3 Vrms,    0 (ref)
    Neut-Gnd:  124.1 Vrms,   50
    Phase A:    23.60 A rms,  -5
```

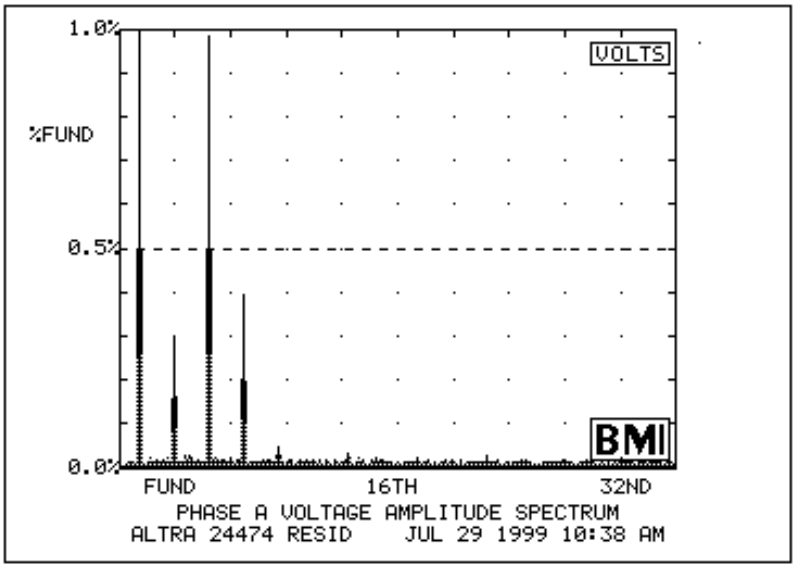
PHASE A VOLTAGE SPECTRUM 10:38:51 AM

Fundamental volts: 247.3 Vrms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	100.0%	0	2nd		
3rd	0.3%	167	4th		
5th	1.0%	148	6th		
7th	0.4%	-29	8th		
9th			10th		
11th			12th		
13th			14th		
15th			16th		
17th			18th		
19th			20th		
21st			22nd		
23rd			24th		
25th			26th		
27th			28th		
29th			30th		
31st			32nd		
33rd			34th		
35th			36th		
37th			38th		
39th			40th		
41st			42nd		
43rd			44th		
45th			46th		
47th			48th		
49th			50th		
ODD	1.1%		EVEN	0.1%	

THD: 1.1%



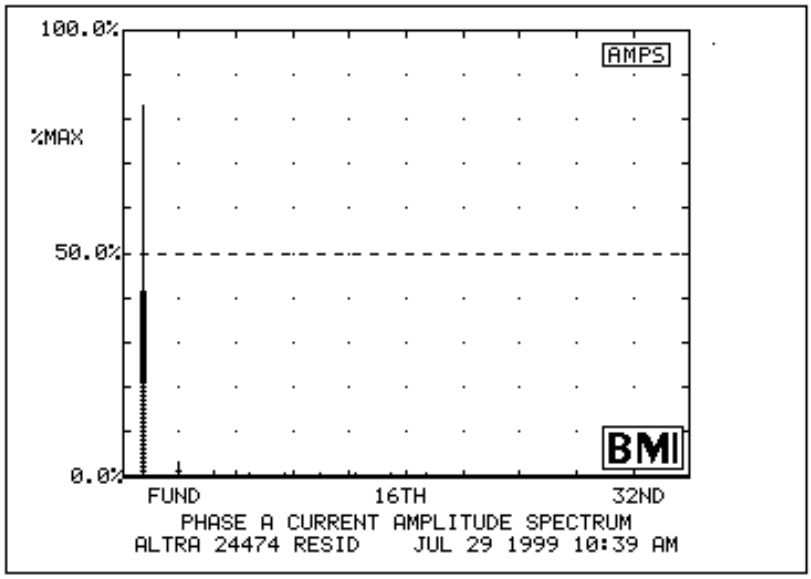
PHASE A CURRENT SPECTRUM 10:39:01 AM

Max load current: 28300 mA rms

Fundamental freq: 60.0 Hz

HARM	PCT	SINE PHASE	HARM	PCT	SINE PHASE
FUND	83.3%	-5	2nd		
3rd	2.9%	-137	4th		
5th	1.1%	171	6th		
7th	0.5%	-173	8th		
9th	0.5%	173	10th		
11th	0.3%	170	12th		
13th	0.3%	160	14th		
15th	0.3%	158	16th		
17th	0.3%	145	18th		
19th	0.2%	135	20th		
21st	0.2%	123	22nd		
23rd	0.2%	116	24th		
25th	0.2%	91	26th		
27th	0.2%	78	28th		
29th	0.2%	62	30th		
31st	0.2%	41	32nd		
33rd	0.2%	19	34th		
35th	0.2%	-5	36th		
37th	0.2%	-31	38th		
39th	0.2%	-54	40th		
41st	0.2%	-81	42nd		
43rd	0.1%	-99	44th		
45th	0.1%	-127	46th		
47th			48th		
49th			50th		
ODD	3.3%		EVEN	0.1%	

TDD: 3.3%

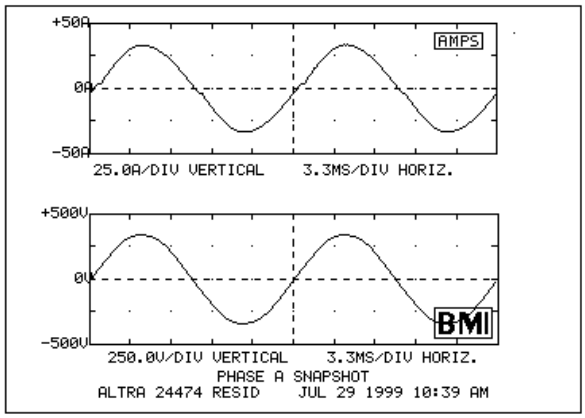


PHASE A SNAPSHOT 10:39:28 AM

Phase A-N VOLTAGE: 247.3 Vrms
1.4 Crest Factor
1.1 Form Factor

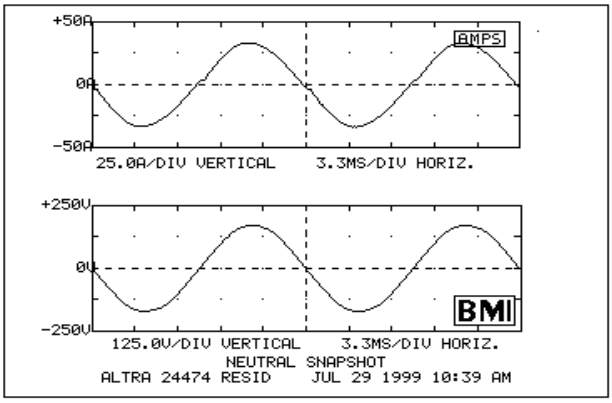
Phase A CURRENT: 23.60 A rms
1.5 Crest Factor
1.1 Form Factor

CURRENT LAGS VOLTAGE BY 5 (1.00 dPF)



NEUTRAL SNAPSHOT 10:39:39 AM

Neut-Gnd VOLTAGE: 124.1 Vrms
1.4 Crest Factor
1.1 Form Factor

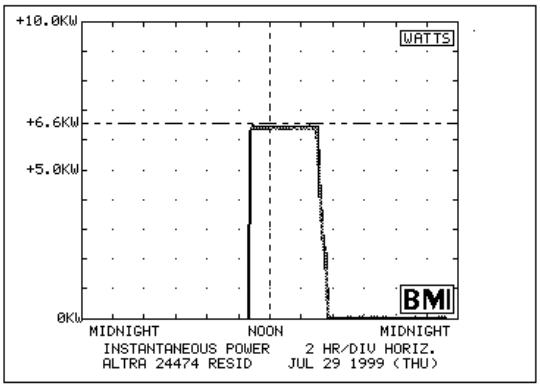


CUMULATIVE PROFILES – 24 HOURS

INSTANTANEOUS POWER 11:20:14 PM

FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)

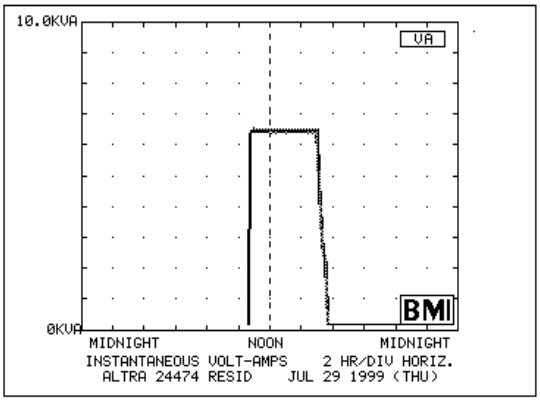
Phase A-N:
MAX: 6.5 kW, 10:53 AM
MIN: 0.0 kW, 7:47 PM



INSTANTANEOUS VOLT-AMPS 11:20:18 PM

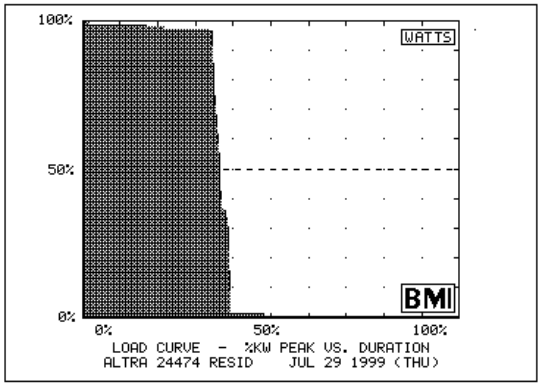
FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)

Phase A-N:
MAX: 6.6 kVA, 10:53 AM
MIN: 0.1 kVA, 7:47 PM



LOAD DURATION CURVE 11:20:36 PM

FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)



TOTAL POWER CONSUMPTION 11:20:54 PM

FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)

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

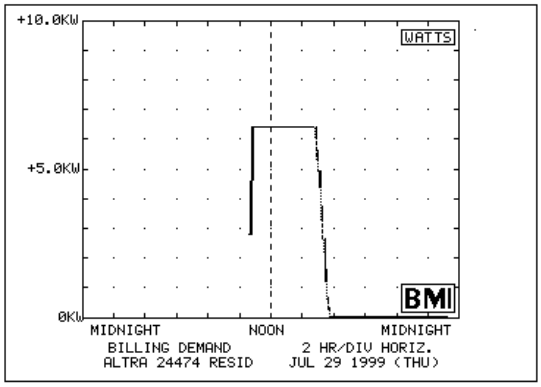
BILLING DEMAND:

6.473 kW	Pk Today
6.473 kW	Pk Accumulated
$ 0.000	Today
$ 0.000	Accumulated

CONSUMPTION:

30.39 kWh	Today
30.39 kWh	Accumulated
$ 1.824	Today
$ 1.824	Accumulated
16.53 kQh	Today
1.532 kVARh	Today

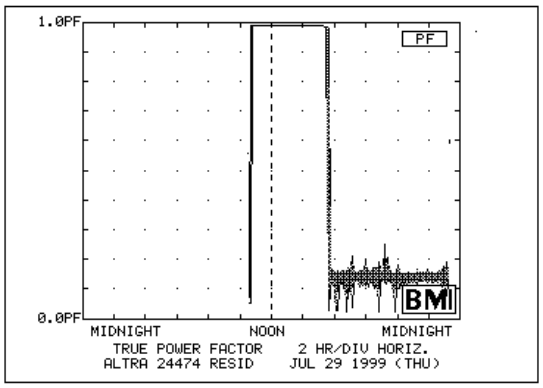
Phase A-N:
MAX: 6.5 kW, 10:59 AM
MIN: 0.0 kW, 8:14 PM



TRUE POWER FACTOR 11:21:14 PM

FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)

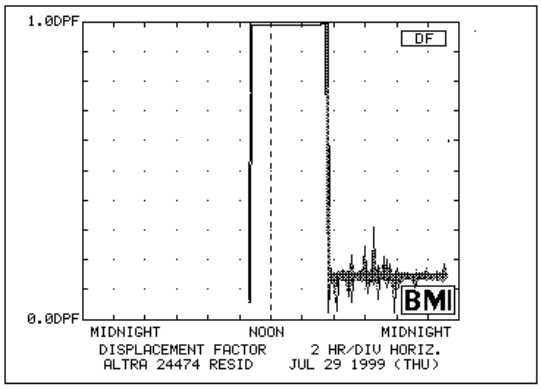
Phase A-N:
MAX: 1.00 PF, 3:08 PM
MIN: 0.02 PF, 6:46 PM



DISPLACEMENT FACTOR 11:21:22 PM

FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)

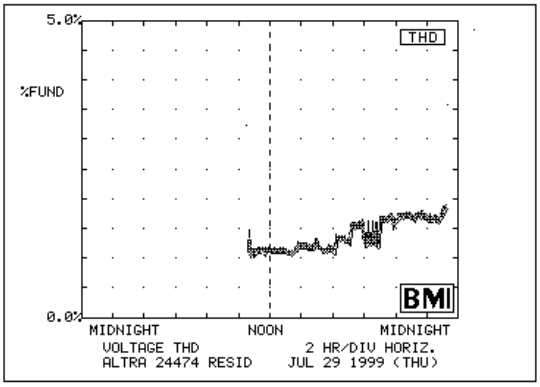
Phase A-N:
MAX: 1.00 dPF; 10:38 AM
MIN: 0.02 dPF; 7:47 PM



VOLTAGE THD 11:21:36 PM

FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)

Phase A-N:
MAX: 1.9% THD; 11:15 PM
MIN: 1.0% THD; 10:44 AM

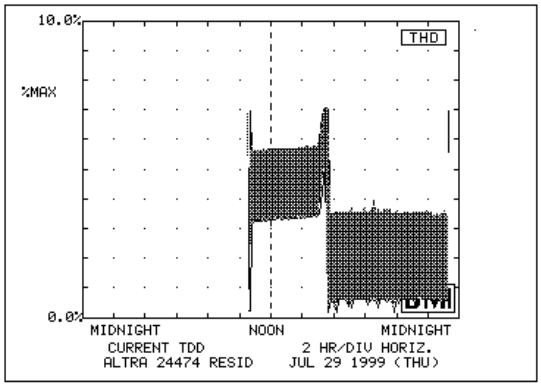


CURRENT TDD 11:21:47 PM

FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)

Max load current: 28300 mA rms

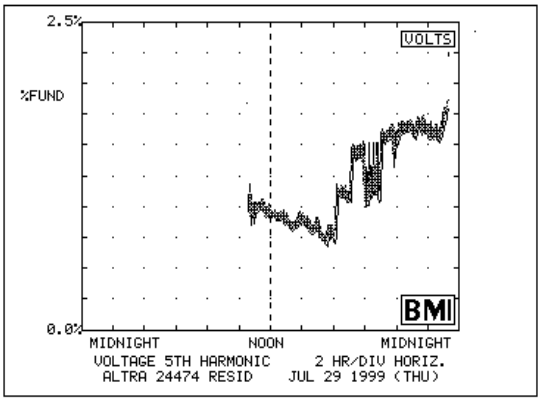
Phase A:
MAX: 5.2% TDD; 3:25 PM
MIN: 0.2% TDD; 3:54 PM



VOLTAGE 5th HARMONIC 11:21:57 PM

FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)

Phase A-N:
MAX: 1.9%; 11:15 PM
MIN: 0.7%; 3:34 PM



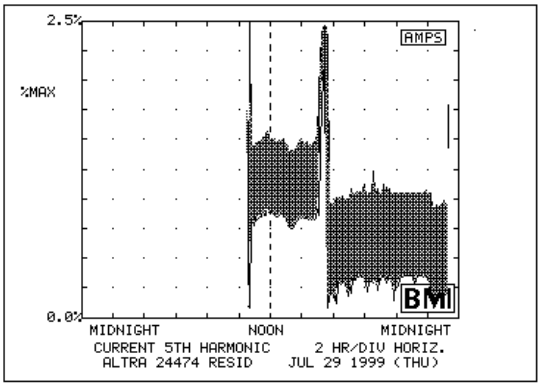
CURRENT 5th HARMONIC 11:22:08 PM

FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)

Max load current: 28300 mA rms

Phase A:

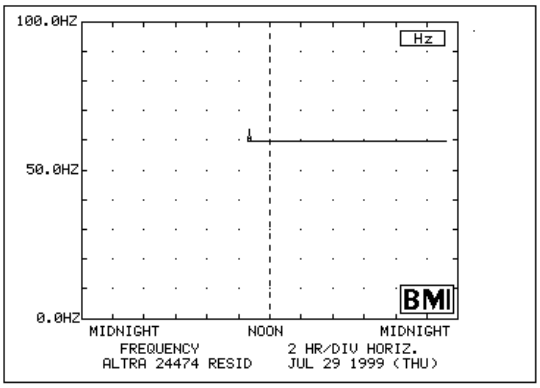
MAX: 2.2%; 10:38 AM
MIN: 0.1%; 10:37 AM



FREQUENCY 11:22:52 PM

FROM: MIDNIGHT Jul 28 1999 (Wed)
To: MIDNIGHT Jul 29 1999 (Thu)

MAX: 64.0 Hz; 10:37 AM
MIN: 59.9 Hz; 11:10 AM



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

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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.

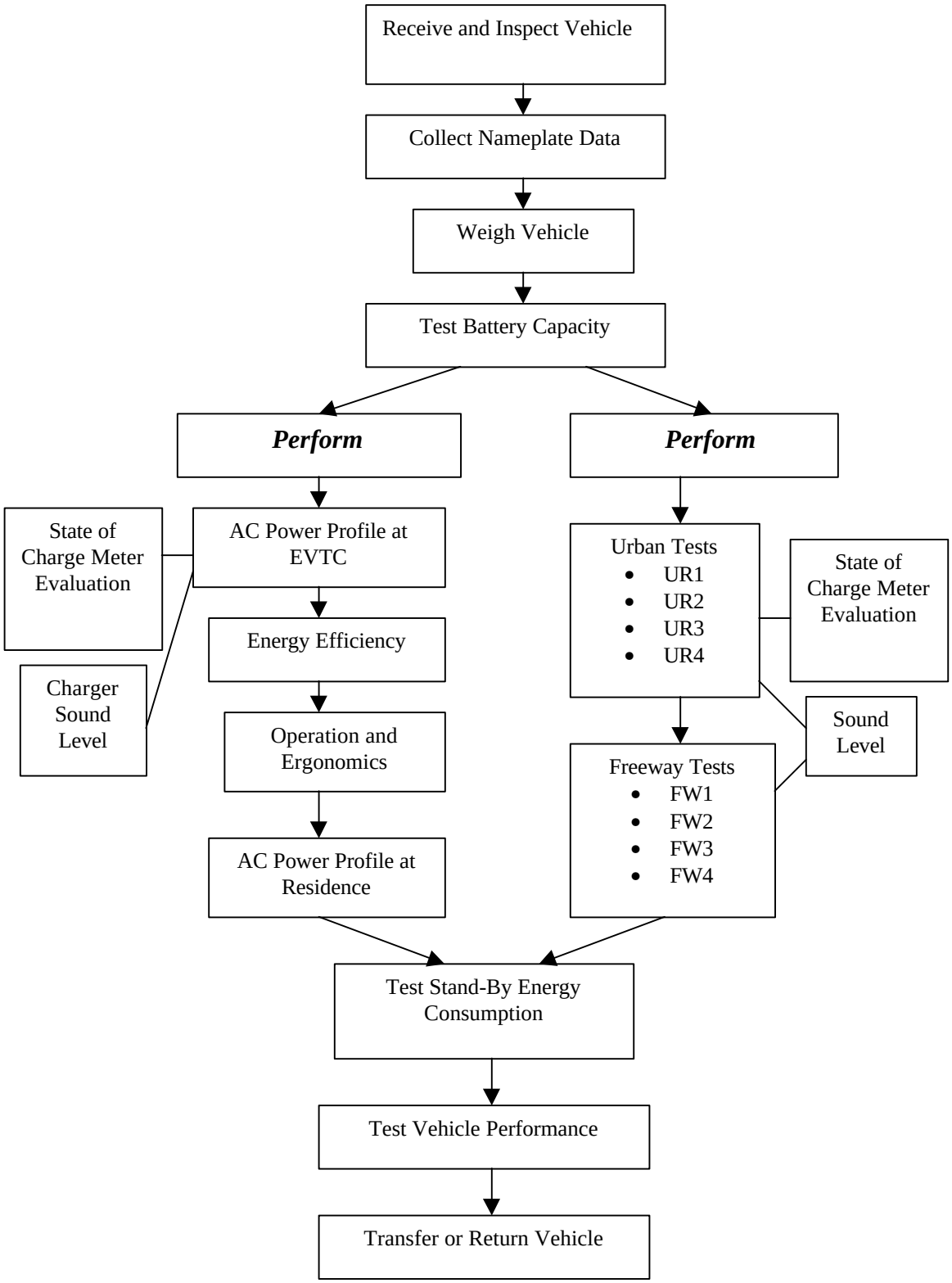
Range tests under different vehicle conditions no longer always have predictable results. Automatic climate controls limit air conditioner power on cool days, thus conserving battery energy and increasing range. The battery pack and the output side of the charger may no longer be readily accessible;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

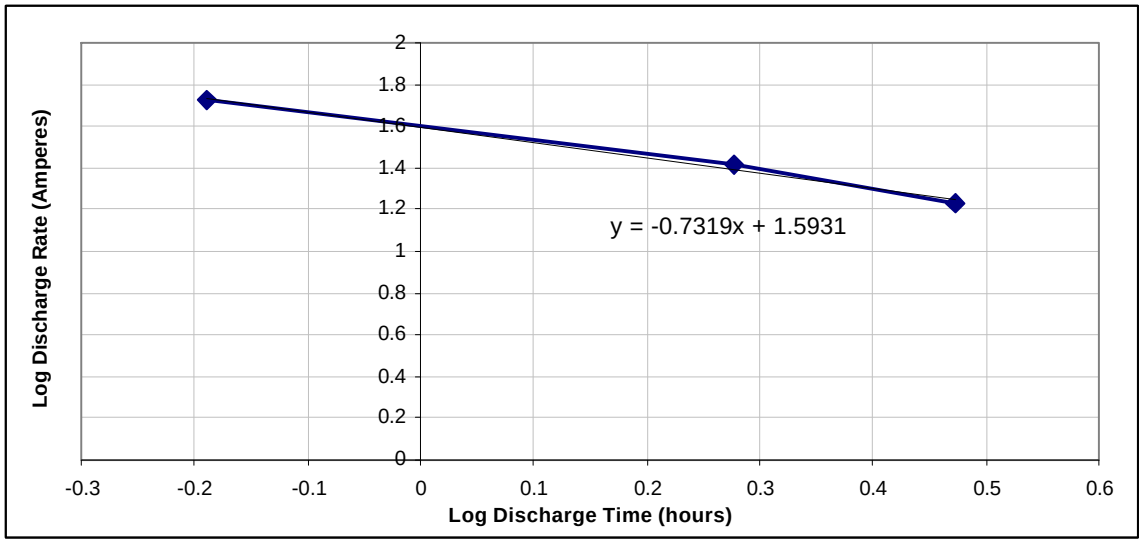


Figure 3-1. Sample Peukert Curve.

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.

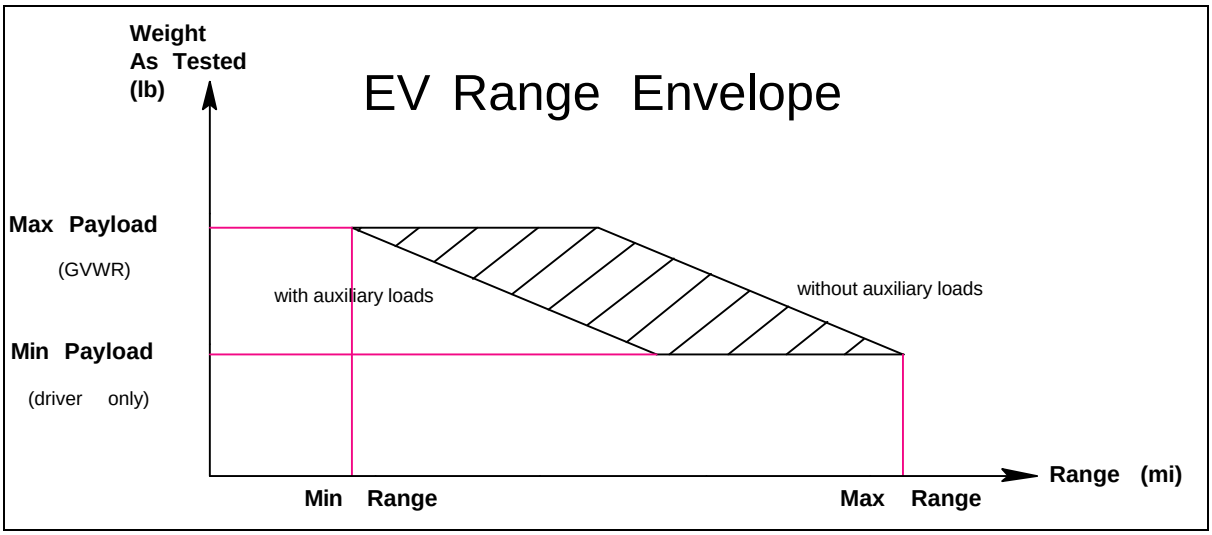


Figure 3-2. Range Envelope.

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:

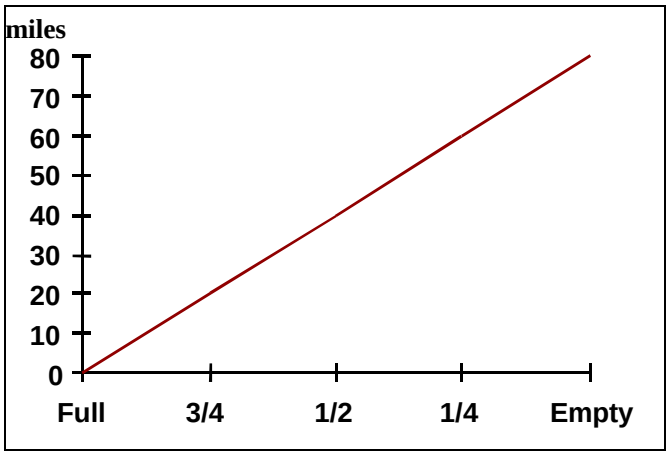


Figure 3-3. State of Charge Meter Evaluation.

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).

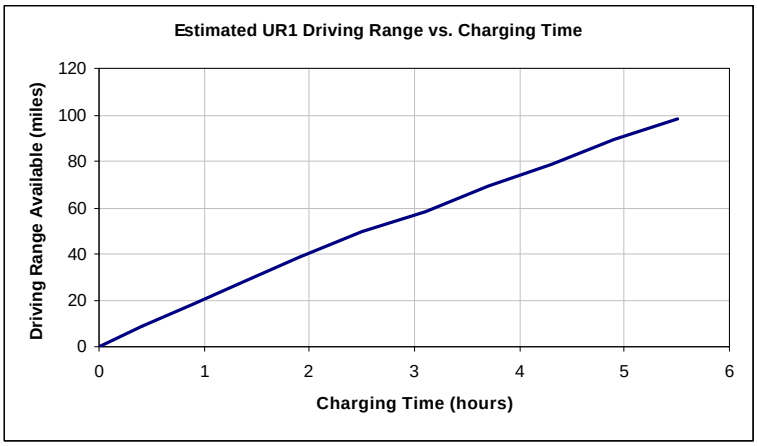


Figure 3-4. Sample plot of estimated range versus charging time.

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).

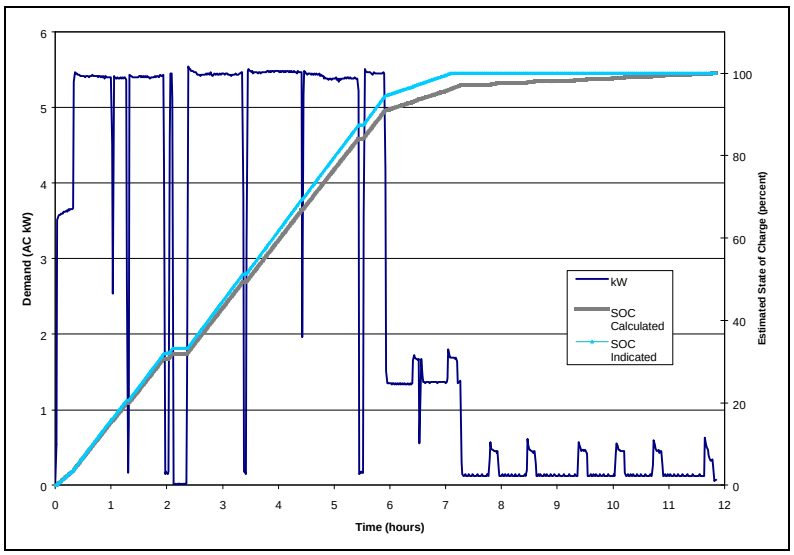


Figure 3-5. Sample AC charging profile plots.

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

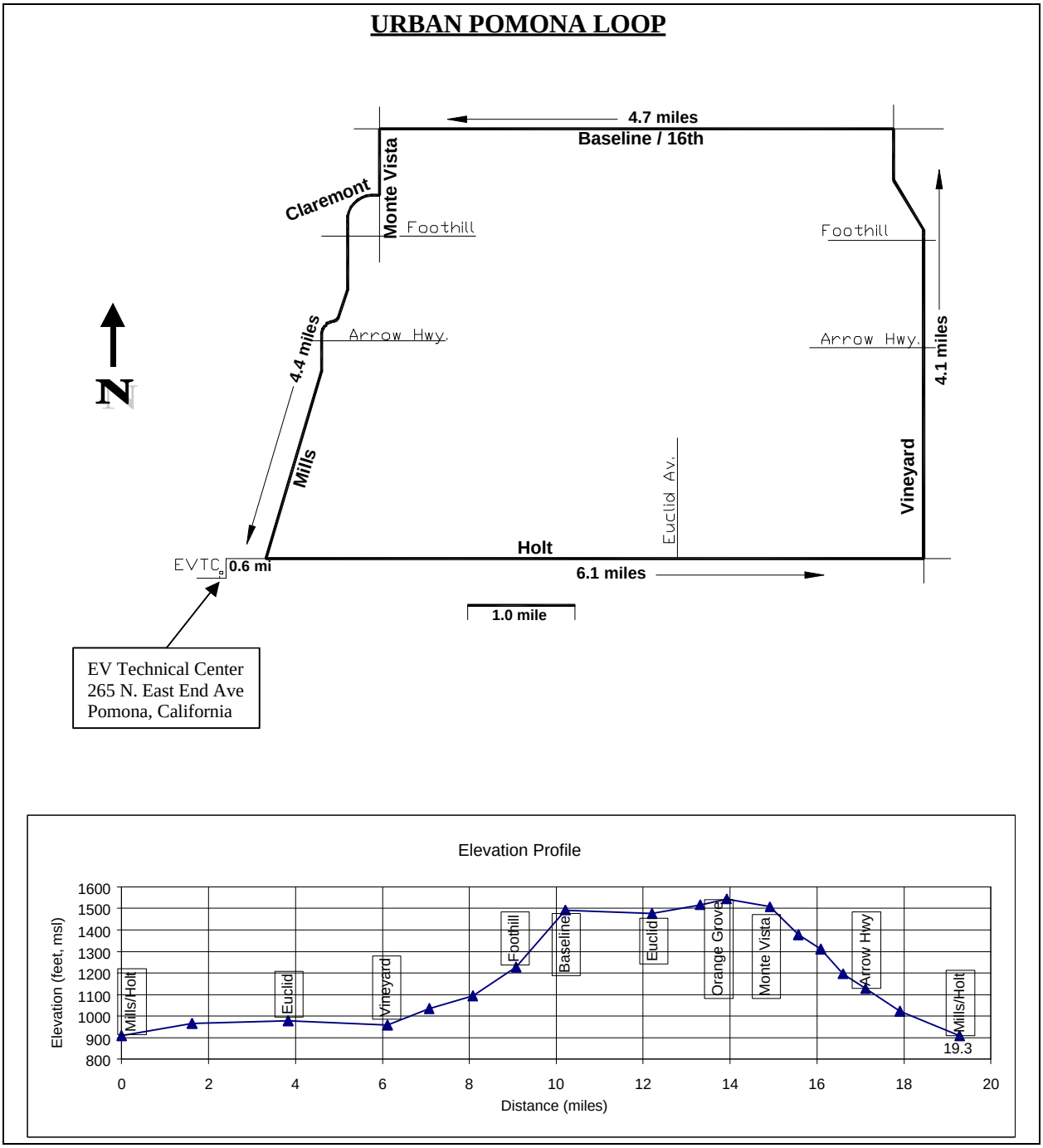
EV Performance Characterization Testing Schedule

		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

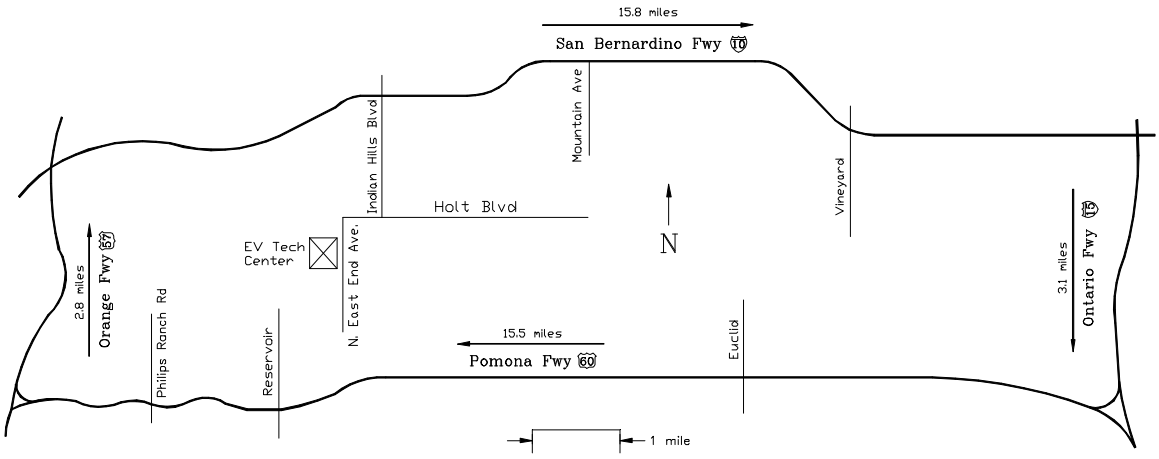
Stop No.	Distance from Start (miles)	Type	Distance from Previous stop	Comments
0	0.00	light	0.00	East End & Holt
1	0.10	light	0.10	
2	0.15	light	0.05	Mills & Holt
3	0.80	light	0.65	
4	1.30	light	0.50	
5	1.80	light	0.50	
6	2.30	light	0.50	
7	2.90	light	0.60	
8	3.50	light	0.60	
9	3.70	light	0.20	
10	4.00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

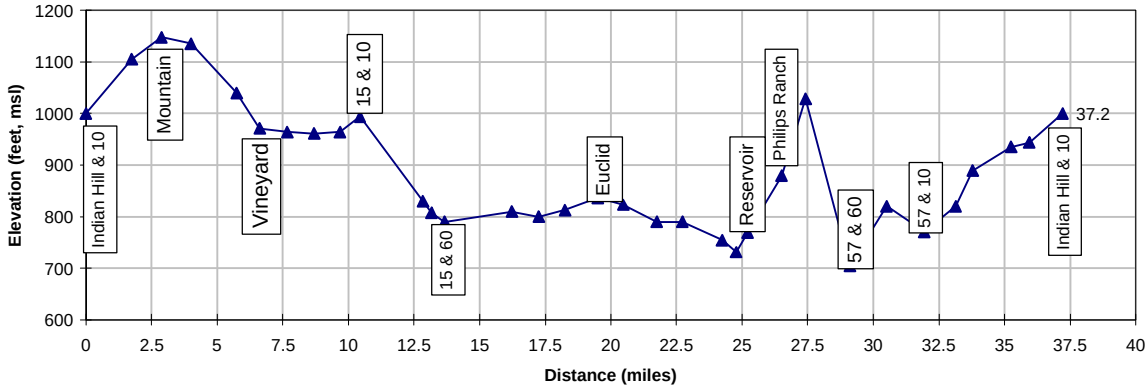
48	18.60	light	1.00	
49	18.70	sign	0.10	
50	19.00	sign	0.30	
51	19.30	light	0.30	
52	19.50	light	0.20	Holt & Mills
53	19.60	light	0.10	
54	19.80	light	0.20	Holt & East End

MCW: ttt
9/23/92

Freeway Loop Map

FREEWAY POMONA LOOP





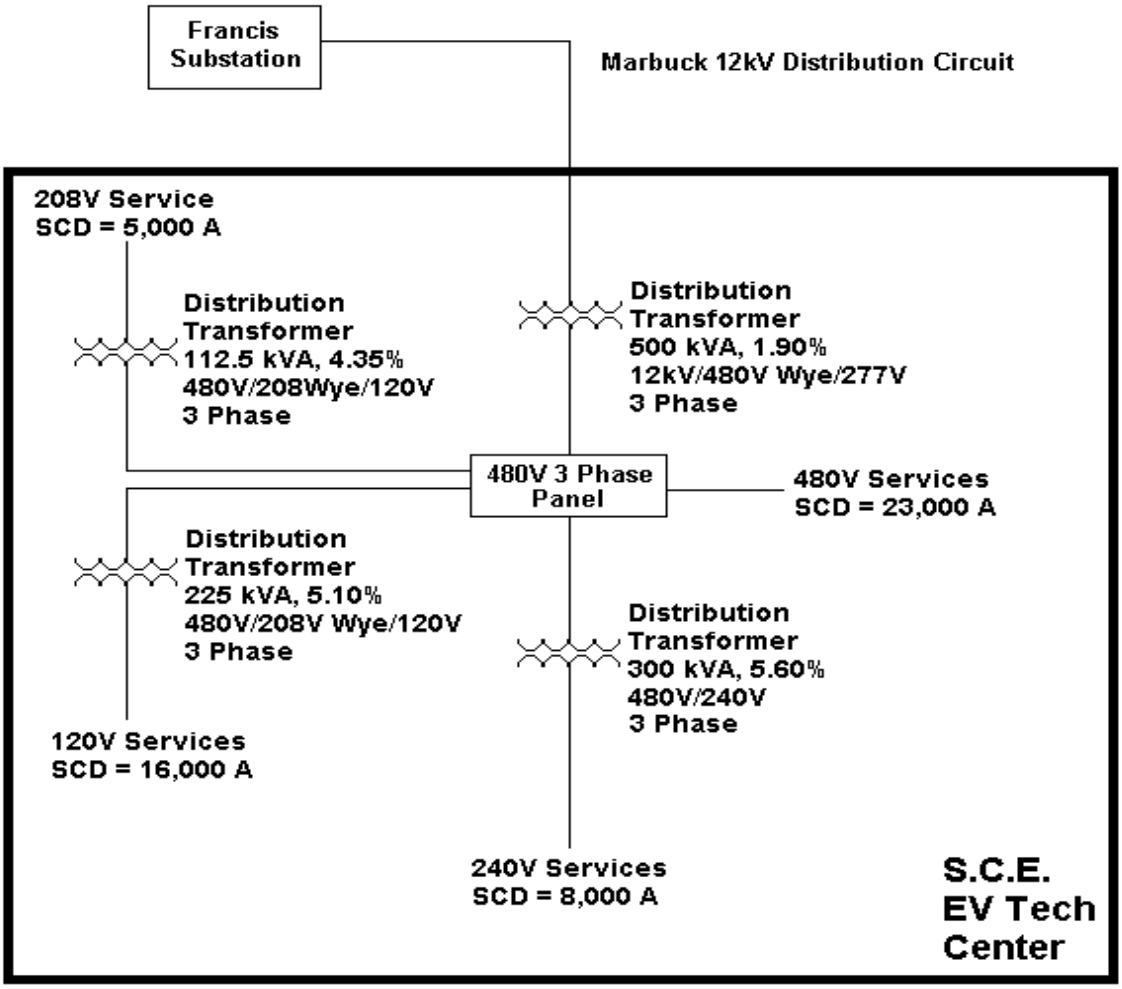
EVTC Equipment

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

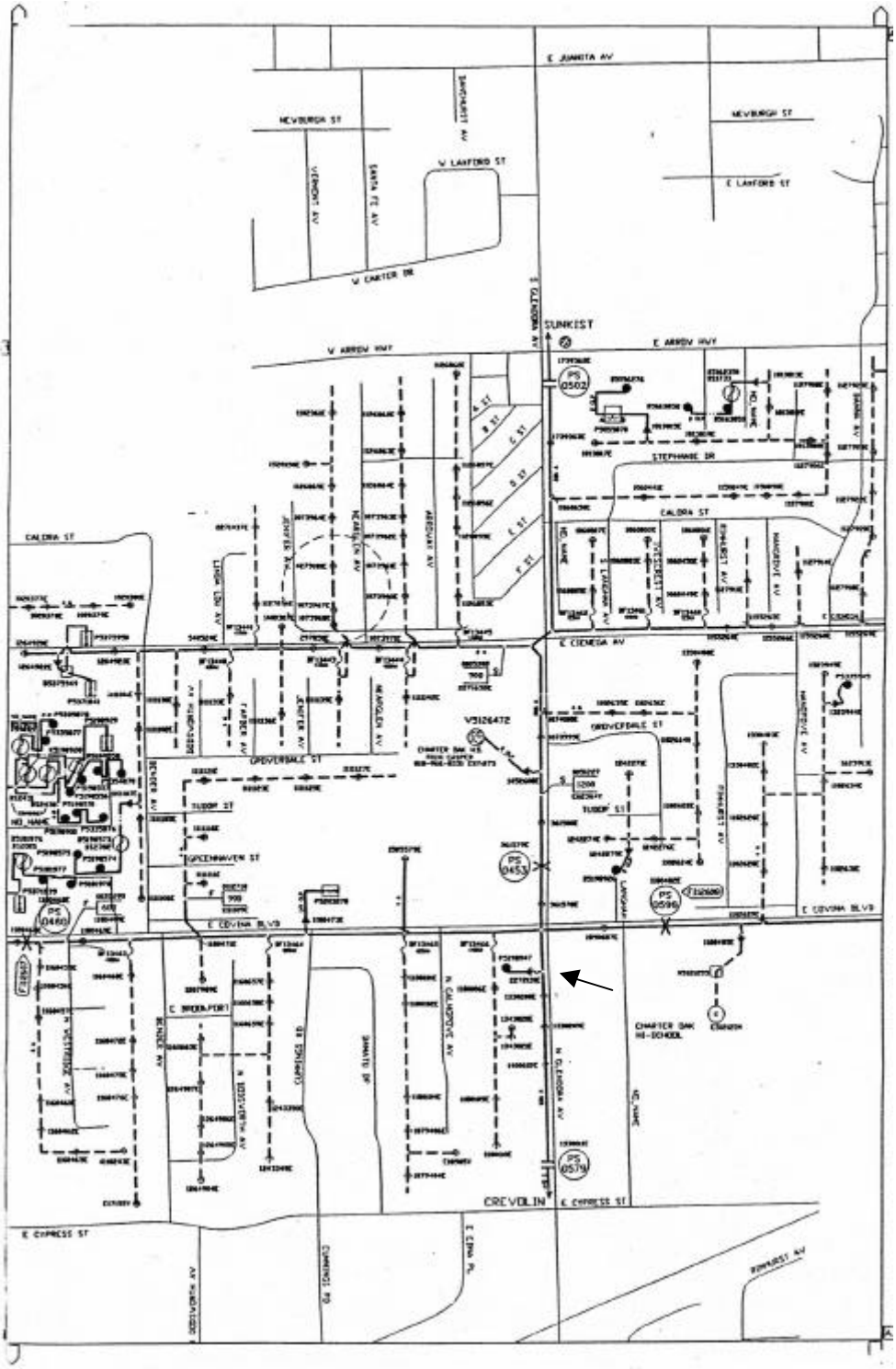
EVTC Number	Manufacturer	Model	Description	Quantity
MCR-001	OLYMPUS	MICRO-32	MICRO CASSETTE RECORDER	1
MMR-001	Various	Various	DIGITAL MULTIMETER	14
MMR-012	HEWLETT PACKARD	34401 A	MULTIMETER	1
MMW-001	ROLATAPE	MEASUMASTERMM30	MEASURING WHEEL	1
MPG-001	HEWLETT PACKARD	6942A	MULTIPROGRAMMER	1
NVK-001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