PERFORMANCE CHARACTERIZATION

2000 NISSAN ALTRA EV

Shin-Kobe Li-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.

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I. INTRODUCTION

This report characterizes the performance of a 2000 model year Nissan Altra EV equipped with Shin-Kobe (Hitachi Subsidiary) Lithium Ion (Li-Ion) batteries. The tests performed were weight certification, range testing, on-road vehicle performance testing, sound level testing, state of charge meter evaluation, and charger performance testing. Testing was performed at the Electric Vehicle Technical Center (EVTC), at the Pomona Raceway, and on the Urban and Freeway Pomona Loops. Data for a 1998 Altra, equipped with Sony Li-Ion batteries, is presented for comparison purposes. For detailed procedures used for the testing, please refer to the *SCE Electric Vehicle Test Procedure* in Appendix G, page 49. Also refer to Appendix C, page 28, for maps of the Urban and Freeway Pomona Loops.

II. MANUFACTURER'S SPECIFICATIONS

Vehicle Make:	Nissan
Model:	Altra EV
Range:	120 miles city
Maximum Speed:	75 mph
Motor Type:	Synchronous motor, water-cooled
System Power:	62 kW (83.1 hp) @ 3720-8500 rpm - peak
Torque:	159 Nm (117 ft.lbs) @ 0-3720 rpm
Transmission:	Single Speed, front wheel drive
Battery Type:	Lithium Ion (Li-Ion)
Manufacturer:	Shin-Kobe (Hitachi)
Model:	NA
Pack Capacity:	90 Ampere-hour [32.4 kWh]
Battery Pack Weight:	360 kg. (794 lbs.)
Number of Modules:	12
Nominal Pack Voltage:	365 V

Curb *Weight:* 1755 kg. (3870 lbs.)

GVWR: 2077 kg. (4579 lbs.)

Payload: 372 kg. (820 lbs.)

Dimensions

Wheelbase: 2800 mm (110.2 in)

Length: 4870 mm (191.7 in)

Width: 1765 mm (69.5 in)

Height: 1630 mm (64.2 in)

Ground Clearance: 1400 mm (55.1 in)

III. DEVIATIONS FROM THE SCE ELECTRIC VEHICLE TEST PROCEDURE

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

IV. RESULTS

A. Nameplate Data Collection

Please Refer to Appendix D, page 30, for the Vehicle Test Equipment and Nameplate Data Sheet which records all applicable nameplate data, serial numbers, and ratings for all tested components and test equipment.

B. Weight Certification

Table 4-1. Weight Results for 1998 and 2000 Altra EV Models

	Front Axle		Rear Axle		Total Weight	
	1998	**2000**	**1998**	**2000**	**1998**	**2000**
GVWR kg (lbs.)	1054 (2324)	1054 (2324)	1043 (2299)	1043 (2299)	2077 (4579)	2077 (4579)
Curb Weight kg (lbs.)	1007 (2220)	1002 (2210)	780 (1720)	753 (1660)	1787 (3940)[1]	1755 (3870)[1]
Available Payload kg (lbs.)	47 (104)	52 (114)	262 (579)	290 (639)	290 (639)[2]	322 (709)[2]

[1] Certified within 10%.

[2] Specified available payload on 1998 and 2000 vehicles: 820 lb. (371.9 kg)

C. Range Tests

C1. Urban Range Tests

Table 4-2. Urban Range Test Results for 1998 and 2000 Altra EV Models

Tests		UR1		UR2		UR3		UR4	
		1998	**2000**	**1998**	**2000**	**1998**	**2000**	**1998**	**2000**
Range at Stop Condition	km	195.5	165.8	152.4	147.7	154.8	153.2	118.6	140.0
	mi	121.5	103.0	94.7	91.8	96.2	95.2	73.7	87.0
Total Range	km	196.2	167.5	153.4	148.7	155.5	153.9	119.7	141.3
	mi	121.9	104.1	95.3	92.4	96.6	95.6	74.4	87.8
Driving Conditions									
Payload	kg	81.6	74.8	81.6	74.8	289.8	319.8	289.8	319.8
	lbs.	180	165	180	165	639	705	639	705
Average Ambient Temp	^{o}C	25.7	15.9	25.9	21.3	36.3	24.9	33.1	21.9
	^{o}F	78.2	60.6	78.6	70.4	97.4	76.9	91.5	71.5
Average Speed	km/h	38.0	39.4	37.8	41.0	41.5	39.3	39.9	38.8
	mph	23.6	24.5	23.5	25.5	25.8	24.4	24.8	24.1
Recharge									
AC kWh Recharge		31.1	32.5	33.2	32.0	26	33.0	23.2	33.7
Vehicle Efficiency	AC kWh/km	0.159	0.194	0.198	0.215	0.167	0.214	0.194	0.238
	AC kWh/mi	0.255	0.312	0.348	0.346	0.269	0.345	0.312	0.384

Note: Driving style will influence the range results, especially in urban settings where stop and go conditions exist. As is the case in this comparison where a very efficient driver performed the 1998 UR1 tests while an average trained driver performed the 2000 UR1 tests.

Note: 1998 results are average of two drives
2000 results are single tests, except for: UR1 (Avg. of 3 tests), UR2 (Avg. of 2 tests)

UR1: Urban Pomona Loop range test with minimum payload and no accessories.
UR2: Urban Pomona Loop range test with minimum payload and all accessories on.
UR3: Urban Pomona Loop range test with maximum payload and no accessories.
UR4: Urban Pomona Loop range test with maximum payload and all accessories on.

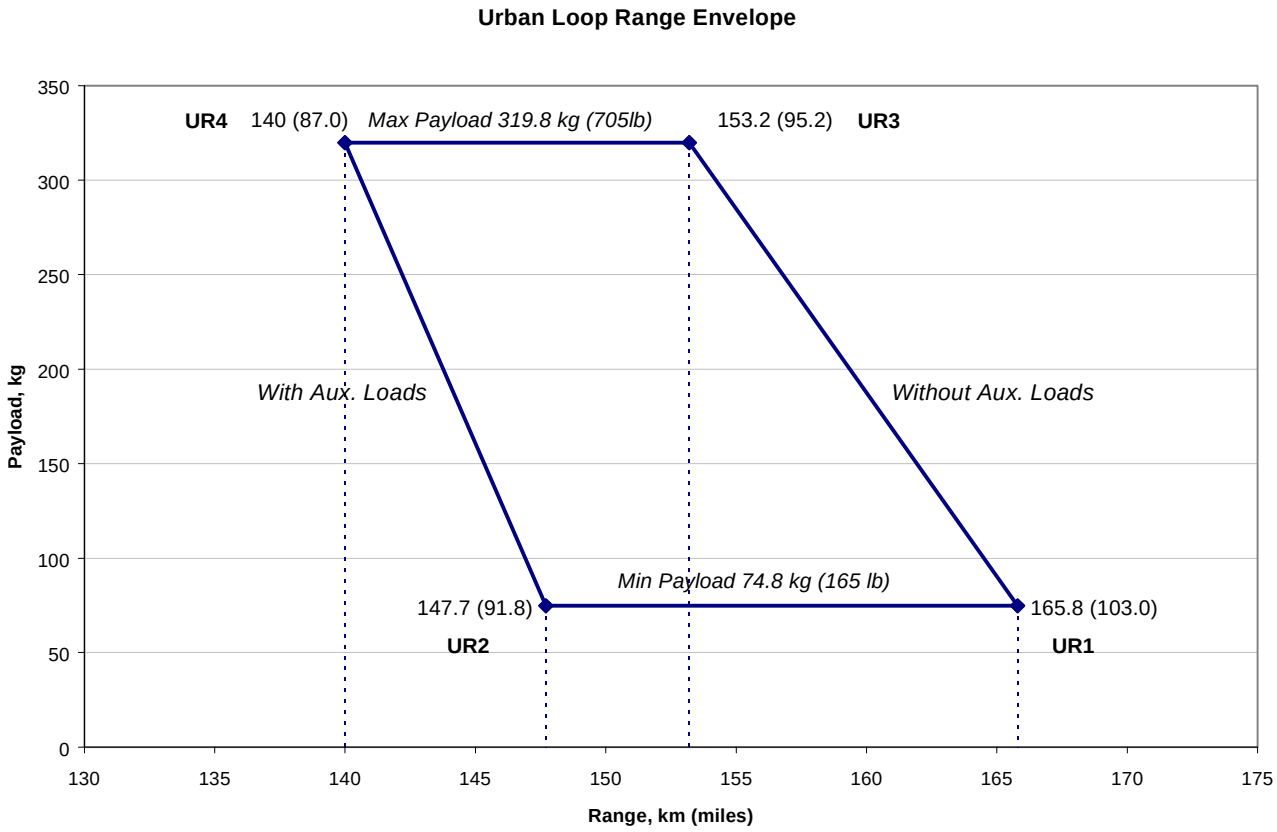


Figure 4-1 – Urban range envelope.

C2. Freeway Range Tests

Table 4-3. Freeway Range Test Results for 1998 and 2000 Altra EV Models

Tests		FW1		FW2		FW3		FW4	
		1998	**2000**	**1998**	**2000**	**1998**	**2000**	**1998**	**2000**
Range at Stop Condition	km	151.9	149.5	132.4	135.8	132.8	138.2	128.4	135.8
	mi	94.4	92.9	82.3	84.4	82.5	85.9	79.8	84.4
Total Range	km	155.5	153.7	127.9	139.9	134.1	142.6	128.7	139.2
	mi	96.6	95.5	79.5	86.9	83.3	88.6	80.0	86.5
Driving Conditions									
Payload	kg	81.6	74.8	81.6	74.8	289.8	319.8	289.8	319.8
	lbs.	180	165	180	165	639	705	639	705
Average Ambient Temp	^{o}C	21.2	17.9	28.4	19.6	15.2	19.1	29.0	19.6
	^{o}F	70.1	64.3	83.1	67.2	59.3	66.3	84.2	67.2
Average Speed	km/h	75.8	80.1	67.8	83.8	67.1	81.4	68.9	79.5
	mph	47.1	49.8	42.1	52.1	41.7	50.6	42.8	49.4
Recharge									
AC kWh Recharge		30.4	32.2	31.1	32.1	29.6	31.5	30.1	31.8
Vehicle Efficiency	AC kWh/km	0.195	0.209	0.243	0.229	0.221	0.221	0.234	0.228
	AC kWh/mi	0.315	0.337	0.391	0.369	0.355	0.356	0.376	0.368

Note: 1998 results are average of two drives
2000 results are single tests, except for: FW1 (Avg. of 3 tests)

FW1: Freeway Pomona Loop range test with minimum payload and no accessories.
FW2: Freeway Pomona Loop range test with minimum payload and all accessories on.
FW3: Freeway Pomona Loop range test with maximum payload and no accessories.
FW4: Freeway Pomona Loop range test with maximum payload and all accessories on.

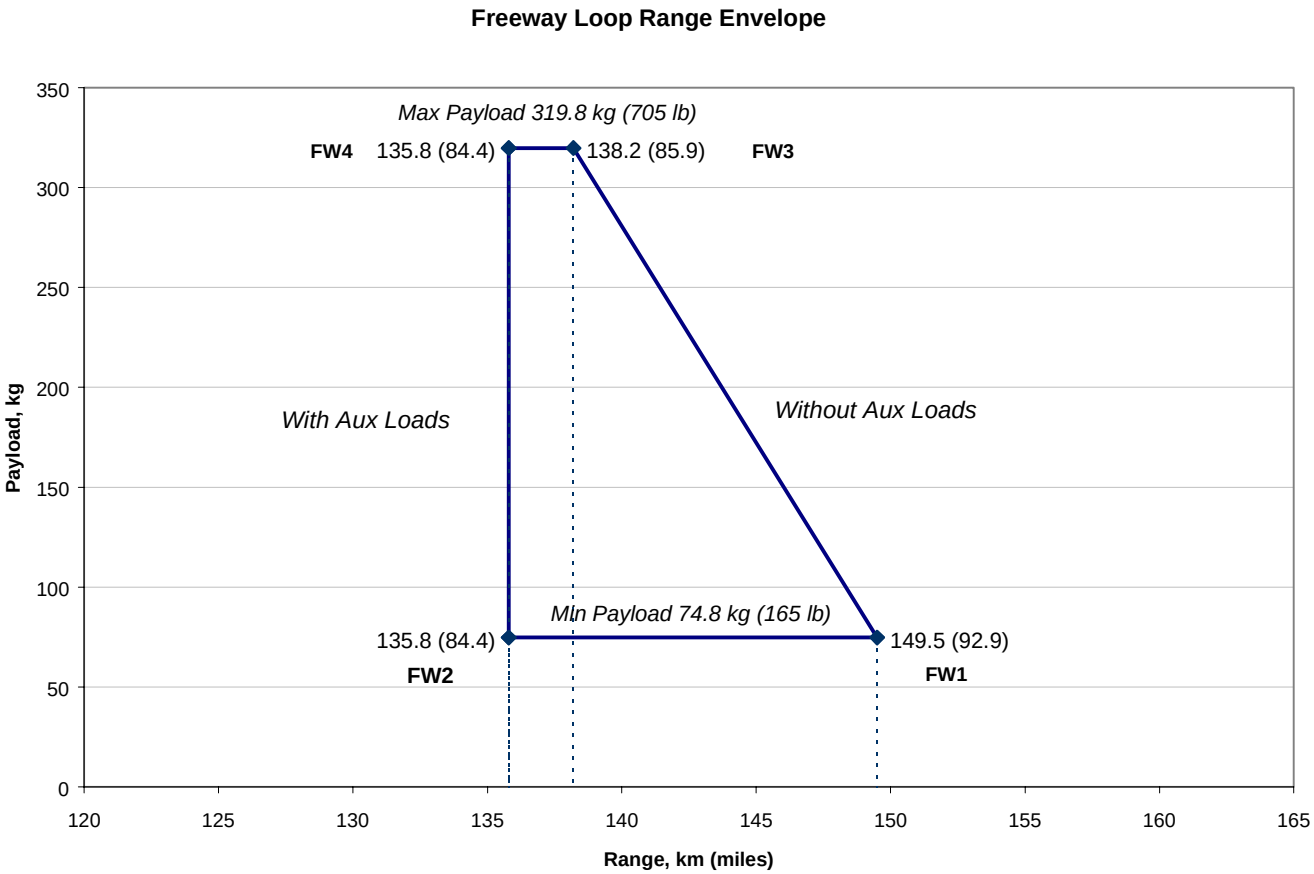


Figure 4-2 – Freeway range envelope.

D. Sound Level Testing

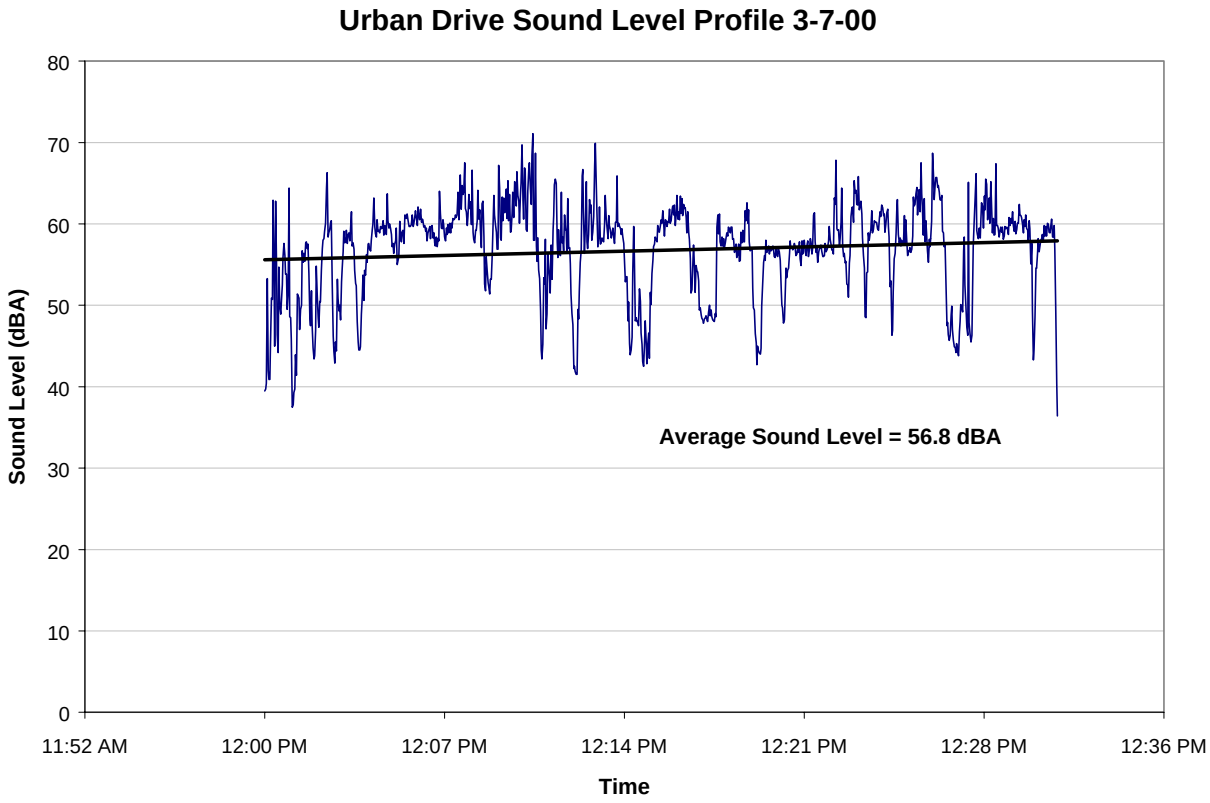


Figure 4-3 Urban Sound Level Test

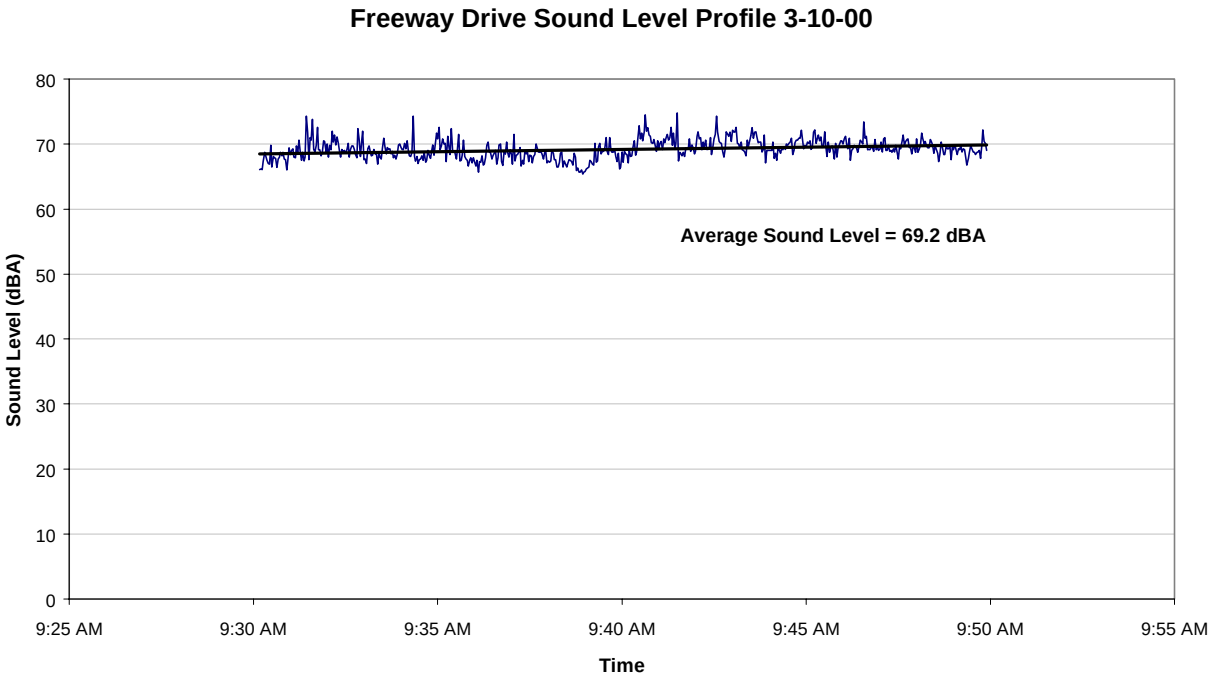


Figure 4-4 Freeway Sound Level Test

E. State of Charge Meter Evaluation

E1. State of Charge Meter Evaluation – Driving

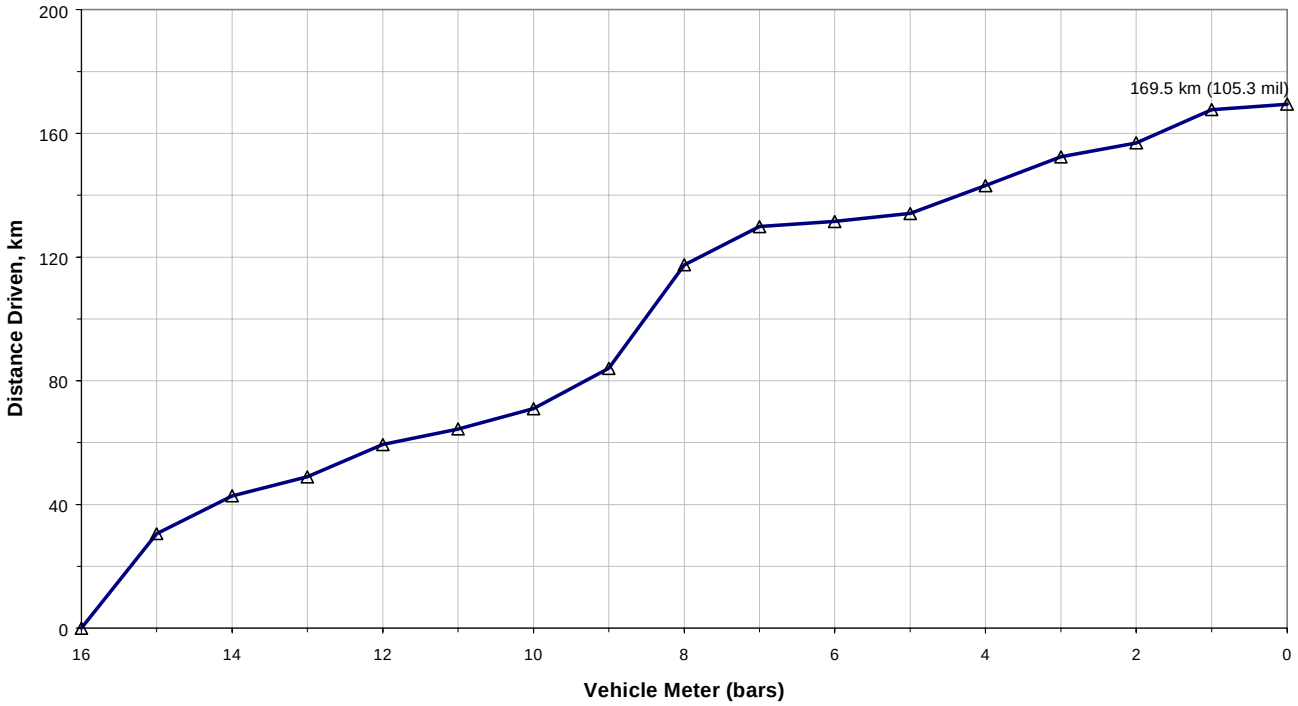


Figure 4-5. State of Charge meter reading as a function of miles driven.

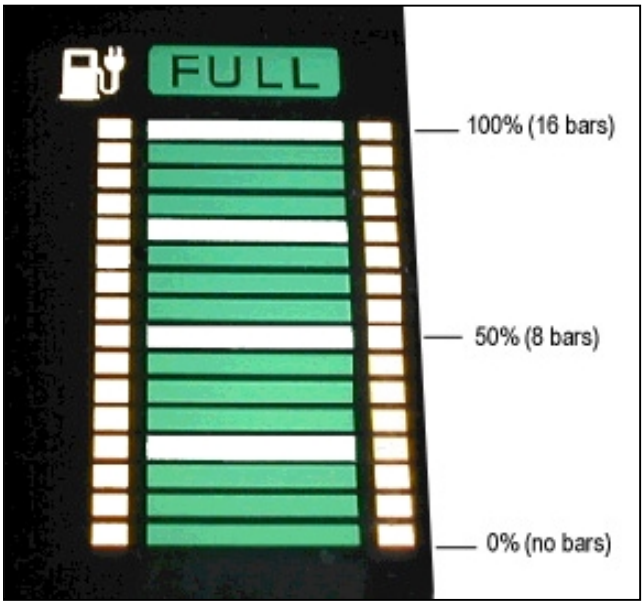


Figure 4-6. SOC meter (16 bars)

E2. State of Charge Meter Evaluation – Charging

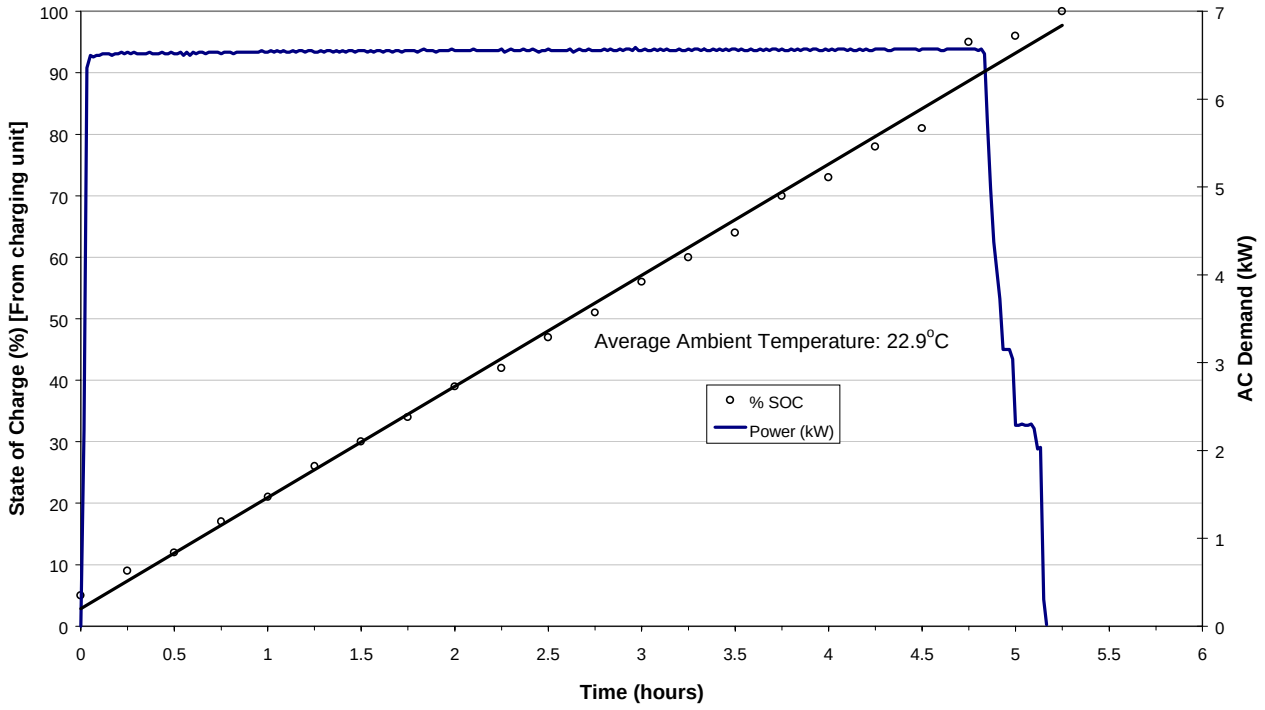


Figure 4-7. SOC meter evaluation while charging vehicle plotted with charging profile.

E3. Driving Range per Charging Time

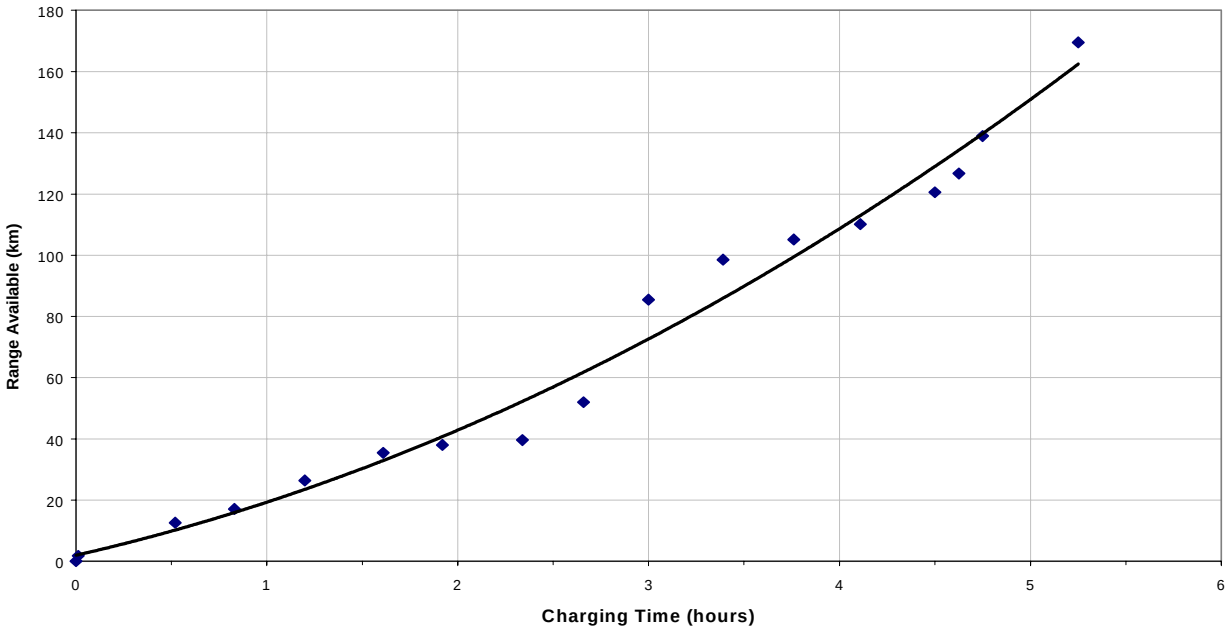


Figure 4-8. Estimated driving distance as a function of charging time for a UR1 test.

F. Acceleration, Braking and Maximum Speed Tests

Table 4-4. Performance Testing Results for 1998 and 2000 Altra EV Models [1]

	100% SOC		80% SOC		60% SOC		40% SOC		20% SOC	
	1998	**2000**	**1998**	**2000**	**1998**	**2000**	**1998**	**2000**	**1998**	**2000**
0-48.3 km/h [0-30 mph] (s)	4.91	4.70	4.56	4.65	4.56	4.65	4.52	4.65	4.58	4.60
48.3-88.5 km/h [30-55 mph] (s)	7.80	8.79	8.42	8.32	9.01	8.49	8.04	8.12	8.10	8.42
0-96.6 km/h [0-60 mph] (s)	15.56	15.97	14.28	15.00	15.18	14.83	14.32	15.03	14.74	14.38
Maximum Speed km/h (mph)	121 (75)	117 (73)	*	*	*	*	*	*	121 (75)	119 (74)
Braking 40.2-0 km/h [25-0 mph] m (ft.)	*	*	*	*	8.44 (27.7)	9.39 (30.8)	*	*	*	*

[1] Average values

* Not tested

Test Conditions: 1998 Altra EV: Average ambient temperature: 28.9°C (84.0°F). Payload: 81.6 kg (180 lb.)
2000 Altra EV: Average ambient temperature: 19.7°C (67.5°F). Payload: 68.0 kg (150 lb.)

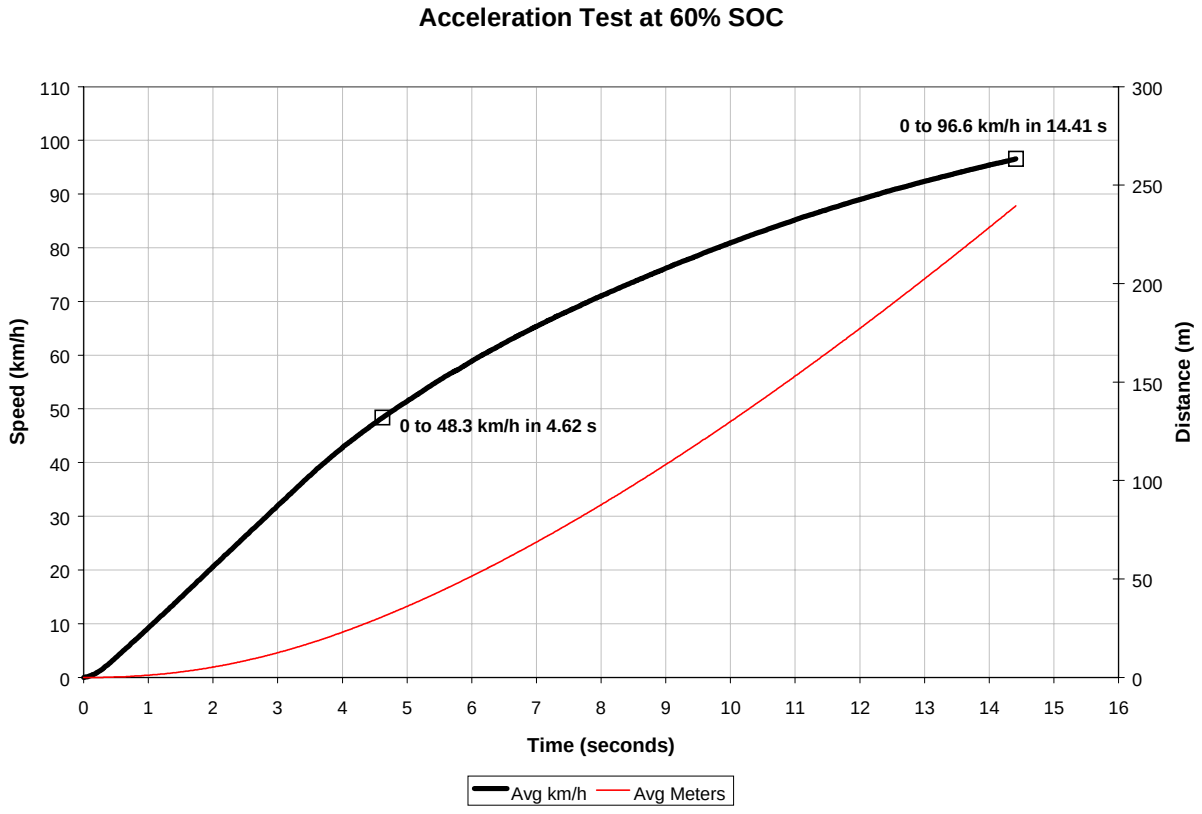


Figure 4-9. Acceleration Profile [Average of two acceleration tests performed in opposite directions.]

G. Charger Performance Test

Table 4-5. Charger Profile Data

Measured Value[1]	
Voltage	230.1 V
Current	28.6 A
Real Power	6.57 kW
Reactive Power	728.8 VAR
Apparent Power	6.622 kVA
Total Power Factor	0.99 PF
Displacement Power Factor	1.00 dPF
Voltage THD	2.4 %
Current THD	3.9 %
Current TDD	3.7 %

Total Charging Time[2]	5 hours, 10 minutes
Total Energy Consumption	32.5 AC kWh

Time observed on Stand-by	24 hours
Total Energy Consumption	0.518 kWh

Note: Data was recorded after the UR1 on March 3, 1998.

[1]Values recorded with charger near maximum power on the AC (input) side of the charger (240 V)
[2] Average ambient temperature: 15.8 °C (60.4°F)

V. DISCUSSION AND CONCLUSIONS

A. Nameplate Data Collection

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

B. Weight Certification

The vehicle was weighed at a certified public scale to measure the total weight, as well as the front and rear axle weight. The total curb weight of the 2000 Nissan Altra was 1755 kg (3870 lb.), approximately 31.8 kg (70 lb.) lighter than the curb weight of the 1998 Nissan Altra. Numerous changes have been made on the new Nissan Altra with regard to weight. According to Nissan Engineers, much more attention was given to the complexity and weight of the second generation Lithium Ion (Li-Ion) batteries that were integrated into the 2000 model. Lighter wheels, omission of a 110V charger, reduced insulation and a lighter wiring harness (due to the elimination of the data logger and the change from analog cell controller to digital cell controller), all helped to lower the vehicle's curb weight. The weight was offset, however, by the addition of a sheath (covering) heater, which improves the heater performance of the HVAC system. The weight results obtained from the certified scale are summarized in Table 4-1, on page 5.

The manufacturer's specified available payload for both 1998 and 2000 model Nissan Altras was 371.9 kg (820 lb.). Subtracting the total curb weight from the manufacturer's gross vehicle weight rating (GVWR) yielded an available payload of 321.6 kg (709 lb.), which was used for the testing. The maximum load on the vehicle was evenly distributed with water dummies and cylindrical weights so as not to exceed the front and rear axle weight limits.

C. Range Tests

Range testing was performed on urban roads and freeways to obtain real world results that will be more valuable to the end user than closed track constant-speed testing. Urban range tests were performed on the Pomona Urban Loop, a 20-mile (32.2 km) city-driving loop with a combination of approximately 55 stops and signals. Freeway testing was performed on a 37-mile (59.5 km) course that consists of four major freeways that connect to form a large rectangular test loop. Refer to Appendix C, page 28, for both Urban and Freeway Pomona loop maps.

Range testing was conducted under the four testing regimens listed below for both urban and freeway testing.

- Range test with minimum payload and no accessories. [UR1 or FW1]
- Range test with minimum payload and all accessories on. [UR2 or FW2]
- Range test with maximum payload and no accessories. [UR3 or FW3]
- Range test with maximum payload and all accessories on. [UR4 or FW4]

Testing under these conditions will give the user an idea of how payload and accessories such as air conditioning will affect the range of the vehicle. A range envelope as shown in figures 4-1 and 4-2, on pages 7 and 9, determines the maximum available range depending on the loading and accessories used. The accessory loads used during the testing were a combination of air conditioning at maximum level, low beam headlights and the radio. Single test drives were done for this study to get a generalization of the performance of the 2000 Nissan Altra. Full performance testing was completed with the 1998 Nissan Altra, where the average of three test drives was used for each test regimen. Since very few drives were performed on the vehicle, no significant variations were found in the A/C energy usage due to ambient temperature changes.

C1. Urban Range Tests

Driving speeds on the Urban Pomona Loop were kept at or below the posted speed limits and the driving style of the test driver was kept safe and as consistent as possible throughout testing. Driving style will influence the range results, especially in urban settings where stop and go conditions exist. It was difficult to maintain the UR1 test results consistent between the 1998 and 2000 Altra tests, because the 1998 Altra EV test drives were performed by a test driver with

very efficient driving manners. As a result, the average range results for the 1998 Nissan UR1 tests were found to be 15% better than those found for the 2000 Nissan UR1 tests.
Variations in payload and accessory loads clearly affected the range of the EV, as seen in the urban range envelope (Figure 4-1), on page 7. The range results for each test was obtained from a single test drive, except for the UR1 and UR2 tests (see note on Table 4-2, page 6). The largest decline in range, a 15.5% decrease, was observed when comparing UR1 to UR4. The UR4 range test was obviously the most extreme test, subjecting the vehicle to maximum payload and all accessories turned on. The smallest decline in range, a 5.2% decrease, was observed when comparing UR2 to UR4. The Nissan Altra was not very sensitive to payload effects when it was tested with all auxiliary loads turned on, as compared to testing it with the auxiliary loads turned off. It was also noticed that the EV was more sensitive to auxiliary loads when it was tested at minimum payload, as opposed to testing at maximum payload.

C2. Freeway Range Tests

Driving speeds on the Freeway Pomona Loop were kept at or below the posted speed limits and the driving style of the test driver was kept as consistent as possible throughout testing. The FW1 freeway test produced a range of 149.5 km (92.9 mil), which was about 10% lower than the 165.8 km (103 mil) results obtained when testing on the UR1 urban loop. Variations in payload and accessory loads clearly affected the range of the EV, as seen in the freeway range envelope (Figure 4-2), on page 9. The range results for each test was obtained from a single test drive, except for the FW1 tests (see note on Table 4-3, page 8). The largest decline in range, a 9.1% decrease, was observed when comparing FW1 to FW2 & FW4. The FW4 range test was obviously the most extreme test, subjecting the vehicle to maximum payload and all accessories turned on. Both FW2 and FW4 freeway tests resulted in the same range, which was 135.8 km (84.4 mil). This once again shows that the Altra is not very sensitive to payload effects when it is tested with all auxiliary loads turned on, as compared to testing with the auxiliary loads turned off. As with the urban testing, the EV was more sensitive to auxiliary loads when it was tested at minimum payload, as opposed to testing at maximum payload.

D. Sound Level Testing

Sound level testing was important for determining the amount of road noise and electronic noise that an EV produces during normal use. The purpose of these tests was to determine how driver comfort would be affected by the amount of noise present during the various drives. The results for the sound level tests were obtained using a sound level meter with a sampling interval of two seconds. The sound level meter was placed at front-passenger ear level with the use of a tripod. Sound level readings were taken for both urban and freeway driving environments. The sound level profiles for both urban and freeway testing are shown in Figures 4-3 and 4-4, on page 10. These graphs show that the average sound level of the urban driving environment was 56.8 dBA, about 18% lower than the average sound level of 69.2 dBA found for the freeway driving environment. Since the data for the freeway sound level test was taken at constant speed, it resulted in fewer variations in sound intensity as compared to the urban sound level test. Since the charger induces the highest sound intensity when charging a vehicle, the charger sound level tests were not performed because the same charger was used for the 1998 model Altra. The tests performed with the 1998 model Altra and a first generation inductive charger produced an average sound level intensity of 61.4 dBA at a one-meter distance.

E. State of Charge Meter Evaluation

The state-of-charge (SOC) meter evaluation performed on the 2000 Nissan Altra EV was valuable for determining the available range and the time required for charging with respect to the SOC. The estimated driving range as a function of charging time was also calculated in this evaluation.

The SOC meter is located on the left portion of the instrument cluster and consists of 16 lighted bars that diminish as the SOC decreases (see Figure 4-6, on page 11). The center column of bars are green when they are lit and have white bars to mark the ¼'s of the 100% reading. The outer bars, which help the user visually see the center columns disappear, are white and will turn off accordingly depending on temperature and battery age. The "Full" light above the bars will be activated, when the vehicle is completely charged. On the contrary, the "Empty" light will come on when the vehicle's last bar diminishes at the end of a drive. The "Empty" light was used as a stop condition indicator during range testing. No loss in performance was noticed when the vehicle was indicating empty or when it was just beyond empty. The "Turtle" light, which

comes on after the “Empty” light, is a true indication of an empty state, according to Nissan engineers.

E1. State of Charge Meter Evaluation – Driving

The SOC meter evaluation performed while driving showed that the miles per SOC meter bar logged during a drive were not very consistent. For instance, during a UR1 test the first bar that diminished produced 40.9 km (25.4 mil), while the next bar that diminished only produced 6.3 km (3.9 mil). After the first bar, the miles per bar for each subsequent bar was found to be relatively close to one another. This trend was also noticed during the freeway testing. See Figure 4-5, on page 11, for a graph showing miles driven versus SOC (SOC meter bars). This graph shows that the trend of the data points was not very linear. Refer to Appendix F, page 34, for the Pomona Driving Test Data sheets, which have detailed information on each of the drives.

E2. State of Charge Meter Evaluation – Charging

The SOC meter evaluation performed while charging was important for estimating the amount of time that it would take to reach a certain state of charge. To produce the graph seen in Figure 4-7, on page 12, the indicated SOC reading from the charger was taken at fifteen-minute intervals until the charge was complete. The test procedures call for obtaining the SOC reading from the vehicle SOC meter, but the Altra’s SOC meter does not operate while the vehicle is charging. The AC kilowatt power profile was also plotted along with the estimated SOC versus time plot to show the power that the vehicle draws for each segment of the charge. As seen in the plot, the maximum demand of approximately 6.5 kW was observed for 93% of the time on charge. From the plot it could be seen that the total charge time after a complete discharge test was 5.25 hours.

E3. Driving Range per Charging Time

By combining the data obtained from both previous SOC tests, it was possible to produce an estimated driving range versus charging time plot such as the one seen in Figure 4-8, on page 12. On this plot one can determine the estimated driving range obtainable per amount of time the vehicle has been on charge.

F. Acceleration, Braking, and Maximum Speed Tests

Performance testing of the 2000 model-year Nissan Altra EV took place at the Pomona Raceway, in Pomona CA. The test track was dry and the average ambient temperature for the time of testing was 19.7 ^{o}C. The performance tests consisted of acceleration, braking, and maximum speed tests. Acceleration testing was performed at five SOC intervals, which corresponded to 100%, 80%, 60%, 40%, and 20% SOC. Maximum speed tests were performed at 100% SOC and also at 20% SOC. The braking tests were performed when the vehicle was discharged to 50% SOC.

The acceleration tests were recorded with an acceleration computer, the Vericom VC2000PC, which recorded the time from 0-30 and 0-60 mph (0-48.3 and 0-96.6 km/h). The time required for the vehicle to go from 30-55 mph (48.3-88.5 km/h) was recorded manually with the use of a stopwatch and the vehicle speedometer. Braking tests were also recorded with the VC2000PC computer from 25-0 mph (40.2-0 km/h). The VC2000PC makes the appropriate changes to the performance results by taking into account such items such as vehicle weight, road slope, and actual speed of the vehicle when performing the braking tests.

The average of four runs, each run performed in the opposite direction of the previous, was calculated for each of the five SOC intervals. Tables 4-4 on page 13, summarize all the performance results obtained for the 1998 and 2000 model-year Altras. Although the new Altra is equipped with a new battery pack manufactured by Shin-Kobe (a subsidiary of Hitachi), the data shows that the difference between the acceleration results of the 1998 and the 2000 Nissan Altras were very small. Results for the 2000 model show that the vehicle averaged 4.65 seconds when accelerating from 0-30 mph (0-48.3 km/h) when accounting for all the tested SOCs. The 0-30 mph (0-48.3 km/h) tests showed that there was no correlation between the SOC of the vehicle and the acceleration performance. Results for both 1998 and 2000 model show that the 0-60 mph (0-96.6 km/h) test times for each of the tested SOCs were not as consistent with one another as they were with the 0-30 mph (0-48.3 km/h) tests, as seen in Figure 5-1, on the following page. Accuracy of test equipment at low rates of acceleration may have played a role in the inconsistency found for the 0-60 mph (0-96.6 km/h) tests. The average braking distance for 25-0 mph (40.2-0 km/h) at 50% SOC was 9.39 m (30.8 ft.). The ABS braking system on the Altra worked very well, with very little skidding noticed. The vehicle performed reliably during all tests, with no noticeable drop in power as the state of charge declined.

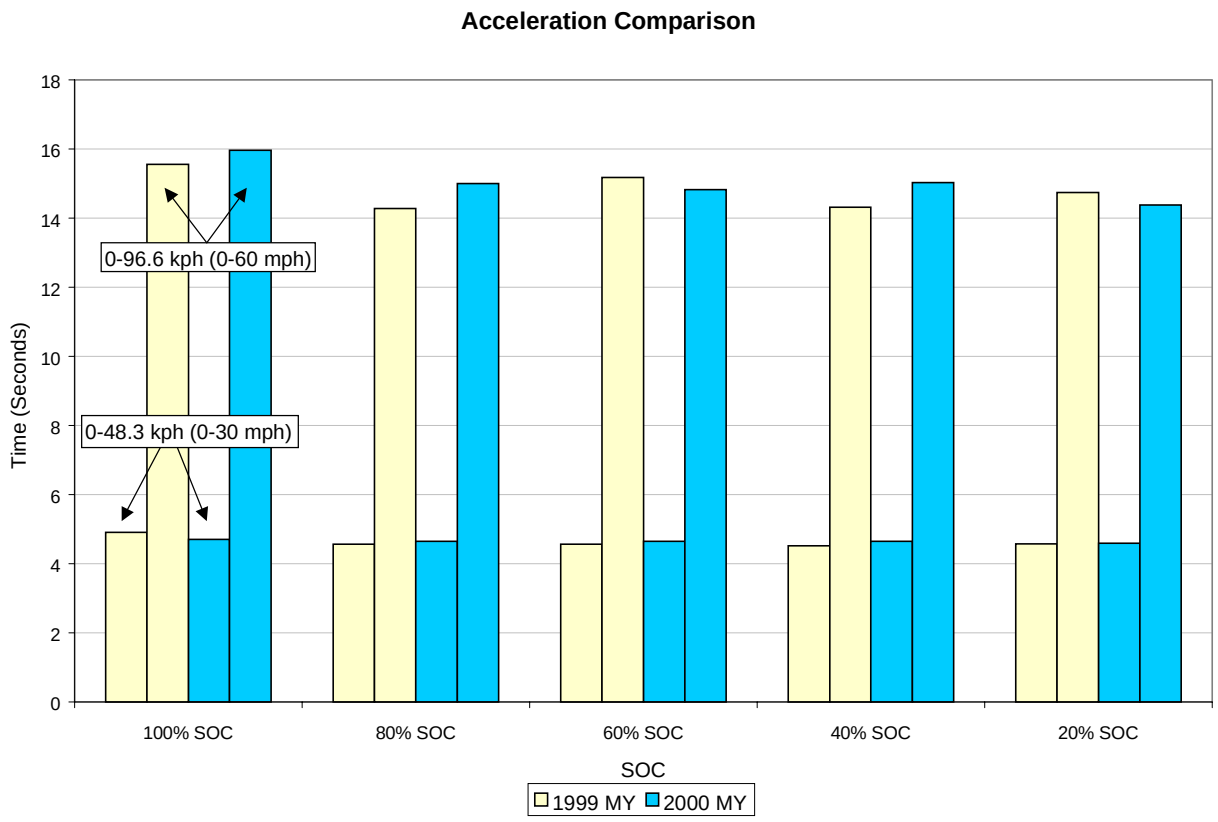


Figure 5-1. Acceleration Comparison for 1998 and 2000 Nissan Altras

The average maximum speed obtained for four runs, two at 100% SOC and two at 20% SOC, was 117.9 km/h (73.3 mph). It should be noted that the length of the racetrack was not sufficient to obtain an accurate top speed reading on the vehicle, since in most cases the vehicle was still accelerating at the end of the track. The primary goal in doing the maximum speed and acceleration tests is to find out if a vehicle is safe to operate on the freeway, can merge into traffic and successfully keep up with traffic.

Figure 4-9, on page 13, shows the acceleration profile, which gives the average speed and distance as a function of time. The acceleration profile was performed at 60% SOC and was created using the average of two acceleration tests performed in opposite directions.

G. Charger Performance Test

The Nissan Altra was charged using a first generation (GEN I) Level 2 inductive charger rated for a maximum power of 6.6 kW. The power quality data was acquired with a BMI Power Profiler, seen in Figure 5-2, below. The Power Profiler was set to monitor the charger's power quality characteristics such as power factors, current and voltage total harmonic distortions (THD), and to measure the power profile. The instrument was installed at the service panel supplying the charger, as shown in Figure 5-3, below. An ABB kilowatt-hour meter was set as shown in the diagram to collect energy usage throughout the testing. Table 4-5, on page 14, shows that the instantaneous peak power recorded was 6.57 kW, with a current of 28.6 A and a Voltage of 230.1 V. The power factor was 0.99, the voltage THD was 2.4%, and the current THD was 3.9%. These results show that the power quality characteristics of the GEN I charger with the Nissan Altra propulsion system was excellent when compared to the recommendations set by the National Electric Vehicle Infrastructure Working Council (IWC, see Appendix E, page 32).

Figure 5-2. BMI Power Profiler

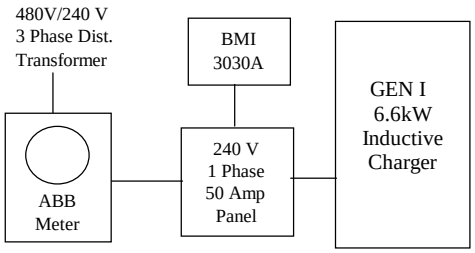


Figure 5-3. Test Setup Block Diagram

H. Conclusion

The Nissan Altra EV is the only fleet-available OEM electric vehicle that uses the Lithium Ion (Li-Ion) advanced battery. The Li-Ion technology has proven thus far to be reliable when tested in electric vehicles such as the 1998 Nissan Altra EV. Li-Ion batteries possess far greater energy density (amount of energy in relation to battery size) and power density (amount of power that can be delivered at a specific SOC) than Nickel-Metal Hydride (NiMH) or Lead-Acid (PbA) batteries.

The 2000 Nissan Altra EV is powered by Shin-Kobe (subsidiary of Hitachi) Li-Ion batteries, while the 1998 model used Li-Ion batteries manufactured by Sony. The battery performance of these battery packs is essentially the same. The new battery has a slightly lower amp-hour capacity, but has a higher nominal voltage, so the energy density is slightly greater. According to Nissan Engineers, the new batteries may loose capacity faster during early usage, but should have a longer useful life. Power density has been improved with the new batteries as well.

Power quality testing of the Nissan Altra in conjunction with a GEN I inductive charger has shown that the power quality characteristics of the charging system was excellent. All results found during testing were well within the recommendations set by IWC.

In terms of on-road performance, the vehicle felt exceptionally reliable and performed very well. The Altra accelerated very well on the freeway on-ramps and had very good braking characteristics. The urban range envelope shows that the Altra is suited for fleet applications that require a minimum of 140 km (87 miles) under the most extreme loading conditions. The freeway range envelope also shows that the Altra is suited for fleet applications that require a minimum capacity of 135.8 km (84.4 miles) under the most extreme loading conditions. With the proper driving techniques and minimum use of auxiliary systems and payload, the range of the Nissan Altra can be increased significantly.

APPENDIX A

Vehicle Fact Sheet

ALTRA EV™

NISSAN

Driven.™

In North America, Nissan's operations include automotive styling, engineering, consumer and corporate financing, sales and marketing, distribution and manufacturing. Nissan in North America, which includes employees and facilities in the United States, Canada and Mexico, generates more than 70,000 jobs, approximately 20,000 directly and 50,000 through more than 1,250 Nissan and Infiniti retailers across the continent. More information on Nissan in North America and the complete line of Nissan and Infiniti vehicles can be found online at www.nissandriven.com.

•Air bags can save lives and prevent injuries. That's why every Altra EV is equipped with "Second Generation" dual air bags. For added peace of mind, these particular air bags have been designed to deploy with less force. Please keep in mind, however, that air bags are a supplemental restraint system and must always be used in conjunction with seat belts. Also, a rear-facing child restraint must never be placed in the front-passenger's seat. In fact, children 12 and under should ride in the rear seat properly secured in child restraints, booster seats, or seat belts according to their size.

APPENDIX B

Battery Fact Sheet

Lithium Ion Battery
<High Power and High Power Density>

Nissan and Shin-Kobe have successfully developed the world's first mass-produced manganese-based Li-ion battery for both EV and HEV applications. The battery will be used on the Altra EV and Hypermini, and also for HEV applications such as the Tino Hybrid recently introduced in Japan.

Li-Ion Battery (EV)

Features:

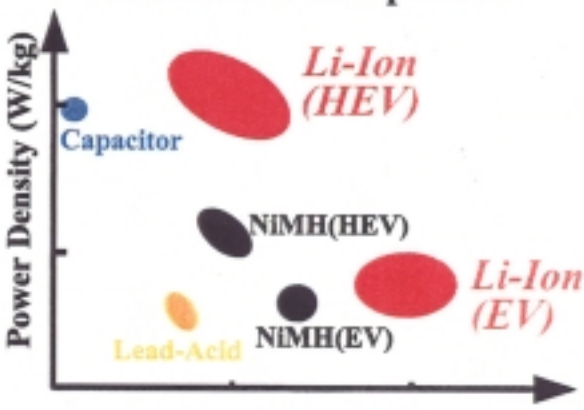
- High energy density (91 Wh/kg for EV, 31 Wh/kg for HEV)
- High power density (350 W/kg for EV, 800 W/kg for HEV)
- High charging/discharging efficiency contributes to improved fuel economy
- Gradual decrease in voltage allows easy control of state of charge

Li-Ion Battery (HEV)

Mn/Li-Ion Battery for EV & HEV

	EV	HEV
Dimensions (W x L x H mm)	288x438x186	260x540x160
Weight	30kg	20kg
Rated Voltage	30.4V	175V
Capacity	90Ah	3.6Ah
Energy Density	91Wh/kg	31Wh/kg
Power Density (@ 80%DOD)	350W/kg	800W/kg
Power/ Energy Ratio	3	26
Applications	Hypermini Altra EV	Tino Hybrid

Performance Comparison



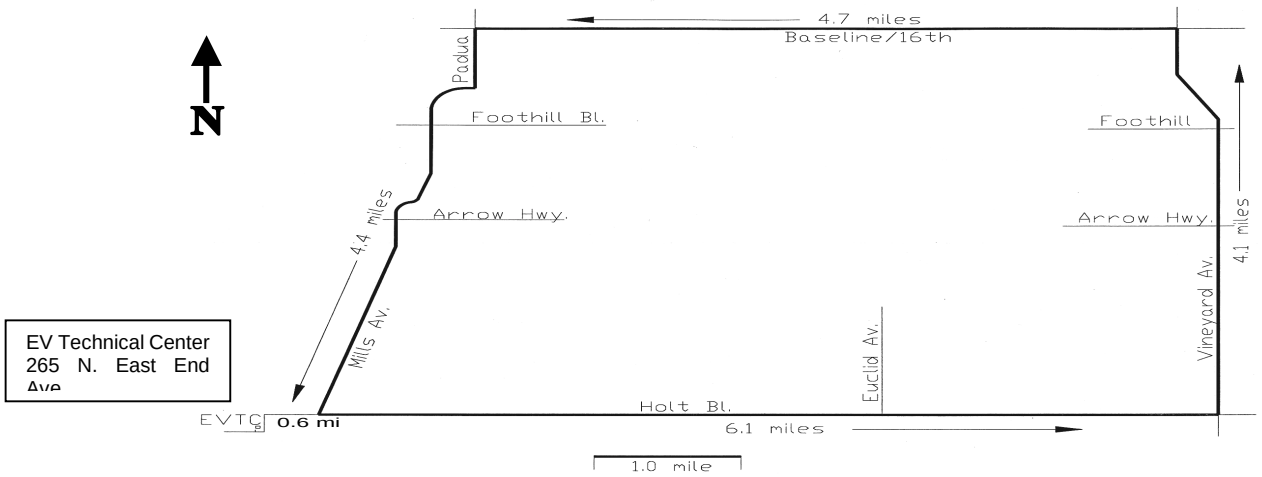
For more information

- **Technology Contact**
  Tatsuo Horiba
  General Manager, Shin-Kobe Denki
  e-mail: t.horiba@shinkobe-denki.co.jp
- **Sales Contact**
  Yukinobu Nukui
  Assistant General Manager, Shin-Kobe Denki
  e-mail: y.nukui@shinkobe-denki.co.jp

APPENDIX C

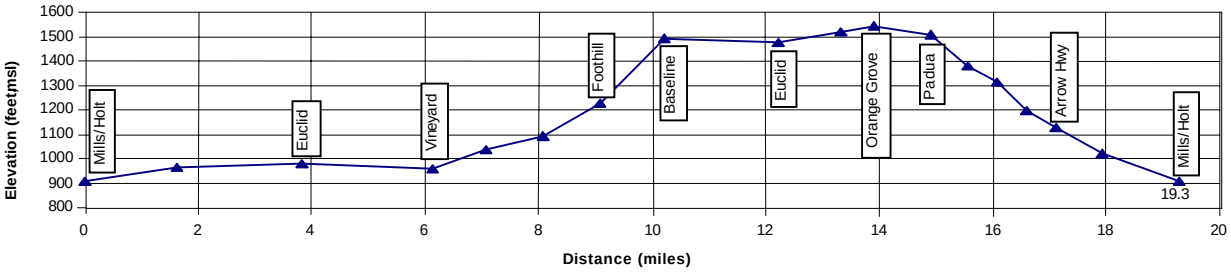
Pomona Urban and Freeway Loop Maps

Urban Pomona Loop



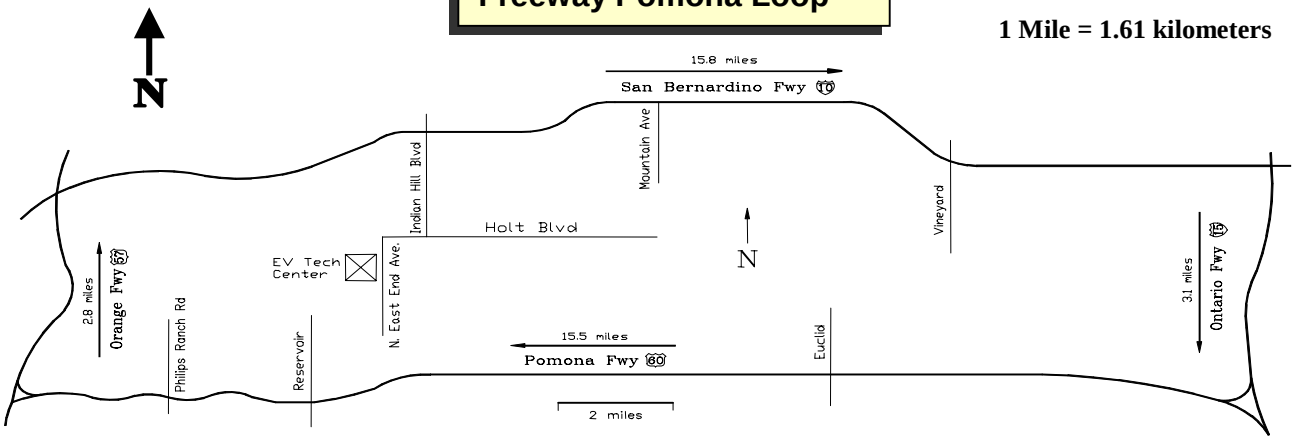
EV Technical Center
265 N. East End Ave

Elevation Profile

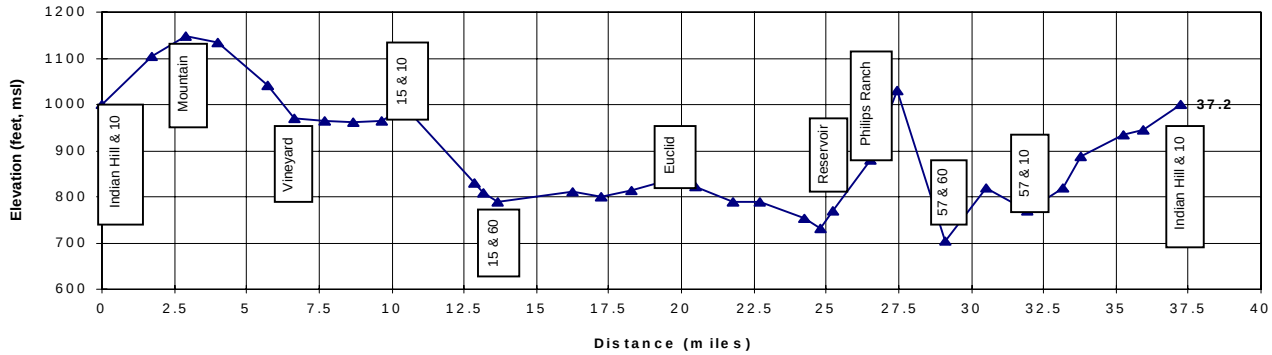


Freeway Pomona Loop

1 Mile = 1.61 kilometers



Elevation Profile



APPENDIX D

Vehicle Test Equipment and Nameplate Data Sheet

Vehicle Test Equipment and Nameplate Data Sheet

Project: Nissan Altra
Test: Performance Characterization
Date(s): 3-9-00
File Name(s):
Vehicle Number: 25267
Technician: R. Solares

VEHICLE

Manufacturer: Nissan
VIN: JN1AE05D9YM100011
Model: Altra EV
Model Year: 2000
Date of Manufacture: 8/99
GVWR: 4579 lb.
Front AWR: 2324 lb.
Rear AWR: 2299 lb.
Motor Manufacturer: NA
Type:
Motor Rating/Speed: 62 kW (83hp)
Version/Serial No.: EM 18
EPA Label Fuel Economy:
Controller Version/Serial No.: Hitachi EVC-XP38 / 291A09V003 96006
Battery Pack Type/Version/Serial No.: Li-Ion Shin-Kobe (Hitachi subsidiary)
Tire Manufacturer: Bridgestone
Model: Ecopia EP02
Tire Size: P205/65R15
Maximum Pressure: 51 PSI
Maximum Tire Load: 1400 lb
Treadwear Rating: 2

CHARGER

Off-board
Manufacturer: GM ATV
Model: Gen I Magne Charge
Serial Number: NA
Charger Type/Version: Inductive paddle
EVSE Manufacturer: NA
EVSE Model/Version: NA
Serial Number: NA
EVSE Software Version: NA
Charge Port Manufacturer/Model/Version/SN: Toyota Automatic Loom Works LTD. / TCPA08 July 99 / 990716

TEST EQUIPMENT

BMI Power Profiler 3030A EVTC Number: BMI-002
ABB kWh Meter Serial Number: 01 712 262
Thermometer EVTC Number: THR-008
Optical Meter Probe EVTC Number: OPB-002
Laptop Computer EVTC Number: LPC-016
Desktop Computer EVTC Number: D069905
Stopwatch EVTC Number: STW-002
Digital multimeter EVTC Number: NA
ABC-150 EVTC Number: NA
Smart Guard Interface Serial Number: NA
Smart Guard Numbers: NA
Sound Level Meter EVTC Number: SMR-001
Measuring Wheel EVTC Number: SMW-001
Other Equipment: DYM-001 (Acceleration computer)

WEIGHT CERTIFICATION

Scale Location and Proprietor: Mission Recycling Center
Examiner: Yolanda Olivi
Date: 3-3-00
Notes:

APPENDIX E

National Electric Vehicle Infrastructure Working Council Recommendations

IWC Load Management Committee

Electric Vehicle Charging Equipment Operational Recommendations

February 8, 1997

	Level 1 Charging	Level 2 Charging
POWER QUALITY PARAMETERS		
1. Total power Factor (minimum)	95%	95%
2. Power Conversion Efficiency (minimum)	85%	85%
3. Total harmonic Current Distortion	20% Maximum	20% Maximum
4. Current Distortion at Each Harmonic Frequency.	IEC 555-2 IEC 1000-3-2 3/95	IEC 1000-3-4 (draft)
5. Inrush Current	28 A	56 A
SUSCEPTIBILITY PARAMETERS		
1. Voltage Range	90% - 110% of nominal	90% - 110% of nominal
2. Voltage Swell	180% of nominal for 2 cycles	180% of nominal for 2 cycles
3. Voltage Surge	6 kV Minimum ANSI C62.41 & C62.45	6 kV Minimum ANSI C62.41 & C62.45
4. Voltage Sag	Down to 80% of nominal for 2 seconds	Down to 80% of nominal for 2 seconds
5. Momentary Outage	0 Volts for 12 cycles	0 Volts for 12 cycles
6. Frequency Variations	±2% of nominal	±2% of nominal
7. operation from Portable Generators	See text	See text
POWER CONTROL PARAMETERS		
1. Staggered restart after power loss	Delay restart 2 minutes + 10 minute random start or ramp up.	Delay restart 2 minutes + 10 minute random start or ramp up.

APPENDIX F

Test Drive Data

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
02/29/2000	Altra	25267	UR1	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	165				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	12:15	706	100	NA	NA	66	NA	
Stop	4:24	805	3			60.3		Min. A/C
Net		99						

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
40.9	25.4	15		
47.2	29.3	14		
52.0	32.3	13		
63.1	39.2	12		
71.6	44.5	11		
72.6	45.1	10		
81.3	50.5	9		
109.0	67.7	8		
110.7	68.8	7		
115.9	72	6		
120.5	74.9	5		
130.4	81	4		
140.0	87	3		Slowed Down
140.5	87.3	2		
155.6	96.7	1		Slowed Down < 25
159.6	99.2	0		Empty @ 99.2 miles; 159.6 km
160.0	99.4			

Accessories used: Radio.

Drive / Regen setting:

Handling/Braking:

Other comments:

Charger	Serial No.	AC meter#	BMI #
		01-712-262	

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	02/29/2000	4:30	192*6				60.3	
Stop								
Net			33.03					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/03/2000	Altra	25267	UR1	R. Diaz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	165				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	11:35	971	100	NA	NA	NA	NA	
Stop	3:55	1077	Empty					Min. A/C
Net								

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
30.6	19	15		
42.8	26.6	14		
48.9	30.4	13		
59.4	36.9	12		
64.4	40	11		
71.0	44.1	10		
84.0	52.2	9		
117.5	73	8		
129.9	80.7	7		
131.5	81.7	6		
134.1	83.3	5		
143.1	88.9	4		
152.4	94.7	3		
156.9	97.5	2		Light turned on @ 105.3; 169.5 km
167.7	104.2	1		
169.5	105.3	0		
171.1	106.3			

Accessories used: Radio

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			32.5					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/07/2000	Altra	25267	UR1	J.Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	165				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	12:00	1171	100	NA	NA	60.3	NA	
Stop	4:15	1277	empty			55.5		Min. A/C
Net		106						

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		"Full" turns off
22.0	13.7	15		
35.4	22	14		
44.3	27.5	13		
48.8	30.3	12		
56.2	34.9	11		Wipers
70.8	44	10		
76.9	47.8	9		
82.4	51.2	8		
114.3	71	7		
119.7	74.4	6		
129.2	80.3	5		
130.8	81.3	4		
159.3	99	3		
162.2	100.8	2		
162.9	101.2	1		
168.0	104.4	0		Empty @ 104.4; 168 km
170.9	106.6	End		

Accessories used: Radio./CD

Drive / Regen setting:

Handling/Braking: okay

Other comments:

Charger	Serial No.	AC meter#	BMI #
		01-712-262	BMI #002

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/07/2000	4:25	357*6				55.5	
Stop								
Net			32.05					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/13/2000	Altra	25267	UR2	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	165				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:20	1377	100	NA	NA	72.6	66.2	66.2
Stop	14:50	1471	0			76.1	46.5	Min. A/C
Net		94						39.2

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
27.4	17	15		
40.2	25	14		
46.3	28.8	13		
50.5	31.4	12		
62.8	39	11		
72.4	45	10		
78.1	48.5	9		
82.4	51..2	8	60.8	Stopped @ 11:30 59.7 mil
111.7	69.4	7		Continued @ 13:20
114.3	71	6		
117.6	73.1	5		
120.9	75.1	4		
132.0	82	3		
137.1	85.2	2		mile 85.2; U-turn @ Grove
147.7	91.8	1		
151.6	94.2	0		Empty Light

Accessories used: head lights, A/C max, radio

Drive / Regen setting:

Handling/Braking:

Other comments:

Charger	Serial No.	AC meter#	BMI #
Gen 1		01-712-262 (219)	BMI #002

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

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/27/2000	Altra	25267	UR2	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	165				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:05	2042	100			66.7	67.8	52.5
Stop	2:30	2132	Empty			66	55.4	Min. A/C
Net		90						

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
23.7	14.7	15		
32.8	20.4	14		
39.6	24.6	13		
45.9	28.5	12		
48.6	30.2	11		
58.7	36.5	10		
67.9	42.2	9		
77.6	48.2	8		
		7		
85.5	53.1	6		
107.8	67	5		
110.6	68.7	4		Stopped @ 74.7 at 1:12
122.3	76	3		
131.6	81.8	2		
140.8	87.5	1		
145.8	90.6	0		empty light at 89.4 miles; 143.9 km

Accessories used: _____

Drive / Regen setting: _____

Handling/Braking: _____

Other comments: _____

_____

Charger	Serial No.	AC meter#	BMI #
Gen 1		01 712 262	

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/27/2000	2:33	672					
Stop								
Net								

Comments: _____

_____

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/15/2000	Altra	25267	UR3	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	MAX				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	12:35	1472	100	NA	NA	75.6		
Stop	4:25	1567	5			78.1		Min. A/C
Net		95						

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
27.5	17.1	15		
40.2	25	14		
46.3	28.8	13		
50.5	31.4	12		
		11		
67.3	41.8	10		
75.2	46.7	9		
81.8	50.8	8		
110.7	68.8	7		
113.6	70.6	6		
115.6	71.8	5		
125.7	78.1	4		
137.8	85.6	3		
139.2	86.5	2		
		1		
153.2	95.2	0		Empty Light
153.9	95.6			

Accessories used: radio

Drive / Regen setting:

Handling/Braking: okay

Other comments:

Charger	Serial No.	AC meter#	BMI #
Gen 1		01-712-262 (219)	BMI #002

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/15/2000	4:30	456				78.1	
Stop								
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/16/2000	Altra	25267	UR4	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	MAX				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	12:20	1568	100	NA	NA	73.8	73.8	73.8
Stop	4:30	1655	5			72.5		Min. A/C
Net		87						39.4

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
27.7	17.2	15		
39.3	24.4	14		
45.1	28	13		
50.1	31.1	12		Stopped @ 35.8 mil 1:52
56.6	35.2	11		cont @ 2:10
65.8	40.9	10		
70.3	43.7	9		
79.0	49.1	8		
102.2	63.5	7		
111.0	69	6		
112.8	70.1	5		
118.4	73.6	4		cont @ 3:40
122.3	76	3		
125.2	77.8	2		
126.0	78.3	1		
140.0	87	0		Empty Light
141.3	87.8			

Accessories used: head lights, A/C max , radio

Drive / Regen setting:

Handling/Braking: okay

Other comments:

Charger	Serial No.	AC meter#	BMI #
Gen 1		01-712-262 (219)	BMI #002

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/16/2000	4:35	490				72.5	
Stop								
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/24/2000	Altra	25267	UR4	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	MAX				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:15	1957	100	NA	NA	68.7	67.8	56.2
Stop	12:45	2042	5			71.1		Min. A/C
Net		85						45.9

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
18.0	11.2	15		
25.3	15.7	14		
36.7	22.8	13		
43.1	26.8	12		
48.0	29.8	11		
51.2	31.8	10		
62.6	38.9	9		
70.3	43.7	8		
82.7	51.4	7		
99.6	61.9	6		
105.6	65.6	5		
107.8	67	4		
111.0	69	3		
122.1	75.9	2		
127.1	79	1		
134.7	83.7	0		Empty Light at 83.7 miles; 134.7 km
135.7	84.3			

Accessories used: head lights, A/C max , radio

Drive / Regen setting:

Handling/Braking: okay

Other comments:

Charger	Serial No.	AC meter#	BMI #
Gen 1		01-712-262 (219)	

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/24/2000	12:45	639 *6				71.1	
Stop								
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/01/2000	Altra	25267	FW1	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	165				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:15	805	100	NA	NA	65.2	NA	
Stop	11:10	901	empty			64.2		Min. A/C
Net		96						

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		"Full" light turns off
33.2	20.6	15		
42.0	26.1	14		
46.5	28.9	13		
54.9	34.1	12		
62.3	38.7	11		
69.5	43.2	10		
76.0	47.2	9		
84.2	52.3	8		
114.3	71	7		
117.5	73	6		
123.8	76.9	5		
127.9	79.5	4		
130.8	81.3	3		
139.0	86.4	2		
145.3	90.3	1		
149.5	92.9	0		Empty @92.9; 149.5 km
154.3	95.9	end		

Accessories used: Radio/ CD

Drive / Regen setting:

Handling/Braking: Okay

Other comments: Problems with cruise control.

Charger	Serial No.	AC meter#	BMI #
		01-712-262	

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/01/2000	11:20	225*6					
Stop								
Net			33					

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/06/2000	Altra	25267	FW1	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	165				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:40	1079	100	NA	NA	59.9	NA	
Stop	11:30	1171	0			69.5		Min. A/C
Net		92						

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
39.6	24.6	15		
45.9	28.5	14		
55.2	34.3	13		
62.1	38.6	12		
67.6	42	11		
76.9	47.8	10		
86.7	53.9	9		
111.0	69	8		
113.5	70.5	7		
116.4	72.3	6		
120.1	74.6	5		
123.3	76.6	4		
126.2	78.4	3		
130.2	80.9	2		
139.0	86.4	1		
140.0	87	0		Empty @ 87.0; 140 km
147.3	91.5	End		

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	03/06/2000	11:56	326*6					
Stop								
Net			31.21					

Comments: _____

_____

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/10/2000	Altra	25267	FW1	Solares		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	145				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	9:30	1277	100	NA	NA	58.1	NA	
Stop	11:30	1376	0			68.7		Min. A/C
Net		99						

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		Sound Level testing
35.9	22.3	15		
44.9	27.9	14		
52.0	32.3	13		
59.5	37	12		
64.7	40.2	11		
74.0	46	10		
85.0	52.8	9		
92.1	57.2	8	77	
105.4	65.5	7	78.1	
111.0	69	6	78.7	Jumped to 8, U turn on Euclid
130.5	81.1	5		
135.5	84.2	4		U turm fairplex 88.3 mi
142.4	88.5	3		
145.3	90.3	2		
148.1	92	1		U turm Indian Hill
159.6	99.2	0		

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

Charger	Serial No.	AC meter#	BMI #
Gen 1		01-712-262 (219)	BMI #002

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/10/2000	11:47	390	0			68.7	
Stop								
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/21/2000	Altra	25267	FW2	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	165				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	10:15	1695	100	NA	NA	66.7	67.3	
Stop	11:55	1782	empty			67.6		Min. A/C
Net		87						45.7

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
31.5	19.6	15		
40.2	25	14		
45.7	28.4	13		
53.9	33.5	12		
57.9	36	11		
71.8	44.6	10		
80.8	50.2	9		
85.0	52.8	8		
103.8	64.5	7		
107.3	66.7	6		
112.2	69.7	5		
115.9	72	4		
119.4	74.2	3		
123.9	77	2		
131.2	81.5	1		
135.8	84.4	0		
139.9	86.9	end		

Accessories used: head lights on, A/C max, radio

Drive / Regen setting: cruise control on

Handling/Braking: okay

Other comments:

Charger	Serial No.	AC meter#	BMI #
Gen 1		01-712-262 (219)	BMI #002

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/21/2000	12:00	542*6	0			67.6	
Stop								
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/22/2000	Altra	25267	FW3	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	MAX				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:35	1782	100	NA	NA	62.8		
Stop	10:20	1871	empty			69.8		Min. A/C
Net		89						

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
25.7	16	15		
32.2	20	14		
40.7	25.3	13		
46.8	29.1	12		
54.1	33.6	11		
61.3	38.1	10		
65.3	40.6	9		
73.5	45.7	8		
99.0	61.5	7		
103.6	64.4	6		
107.3	66.7	5		
112.2	69.7	4		
118.0	73.3	3		
128.7	80	2		
133.6	83	1		
138.2	85.9	0		empty
142.6	88.6	end		

Accessories used: radio

Drive / Regen setting: cruise control on

Handling/Braking: okay

Other comments:

Charger	Serial No.	AC meter#	BMI #
Gen 1		01-712-262 (219)	BMI #002

CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/22/2000	10:25	575*6	0			69.8	
Stop								
Net								

Comments:

POMONA DRIVING TEST DATA

Date	Vehicle	VIN last 6	Test	Driver	Data File/Project		Volts
03/23/2000	Altra	25267	FW4	J. Ruiz		Start	
Road Cond	Tire Press	Payload				Stop	
Dry	51	MAX				Net	

DRIVING	Time	Odom	% SOC	DC Ah	DC kWh	Amb temp	A/C temp	A/C>10 min
Start	8:55	1871	100	NA	NA	67.3	67.1	53.8
Stop	10:40	1957	empty			67.1		Min. A/C
Net		86						49.5

Distance		State of Charge		Notes / Deviations / Traffic / Weather / Performance
kilometers	miles	Veh meter	Range meter	
0.0	0	16		
18.3	11.4	15		
27.5	17.1	14		
33.6	20.9	13		
44.1	27.4	12		
50.7	31.5	11		
55.7	34.6	10		
62.1	38.6	9		
67.4	41.9	8		
110.1	68.4	7		
111.8	69.5	6		
114.9	71.4	5		
117.5	73	4		
121.2	75.3	3		
125.0	77.7	2		
132.0	82	1		
135.8	84.4	0		empty
139.2	86.5	end		

Accessories used: head lights, A/C max, head lights

Drive / Regen setting: cruise control on

Handling/Braking: okay

Other comments:

Charger	Serial No.	AC meter#	BMI #
Gen 1		01-712-262 (219)	BMI #002

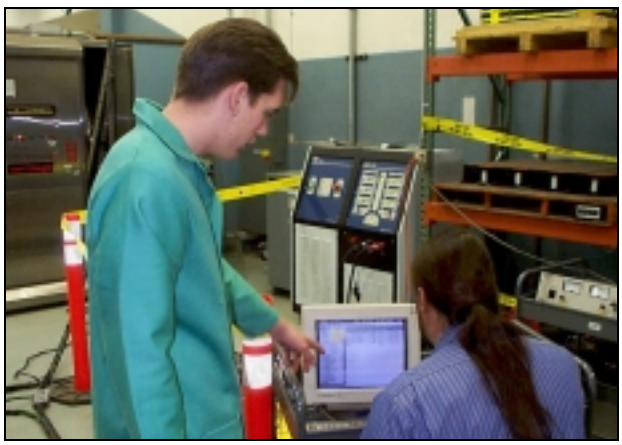
CHARGING	Date	Time	AC kWh in	BMI kWh in	DC kWh in	DC Ah in	Amb temp	Volts
Start	03/23/2000	10:45	607*6	0			67.1	
Stop								
Net								

Comments:

APPENDIX G

SCE Electric Vehicle Test Procedures

ELECTRIC VEHICLE TEST PROCEDURE



SOUTHERN CALIFORNIA EDISON

An *EDISON INTERNATIONAL* Company

ELECTRIC TRANSPORTATION DIVISION

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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.

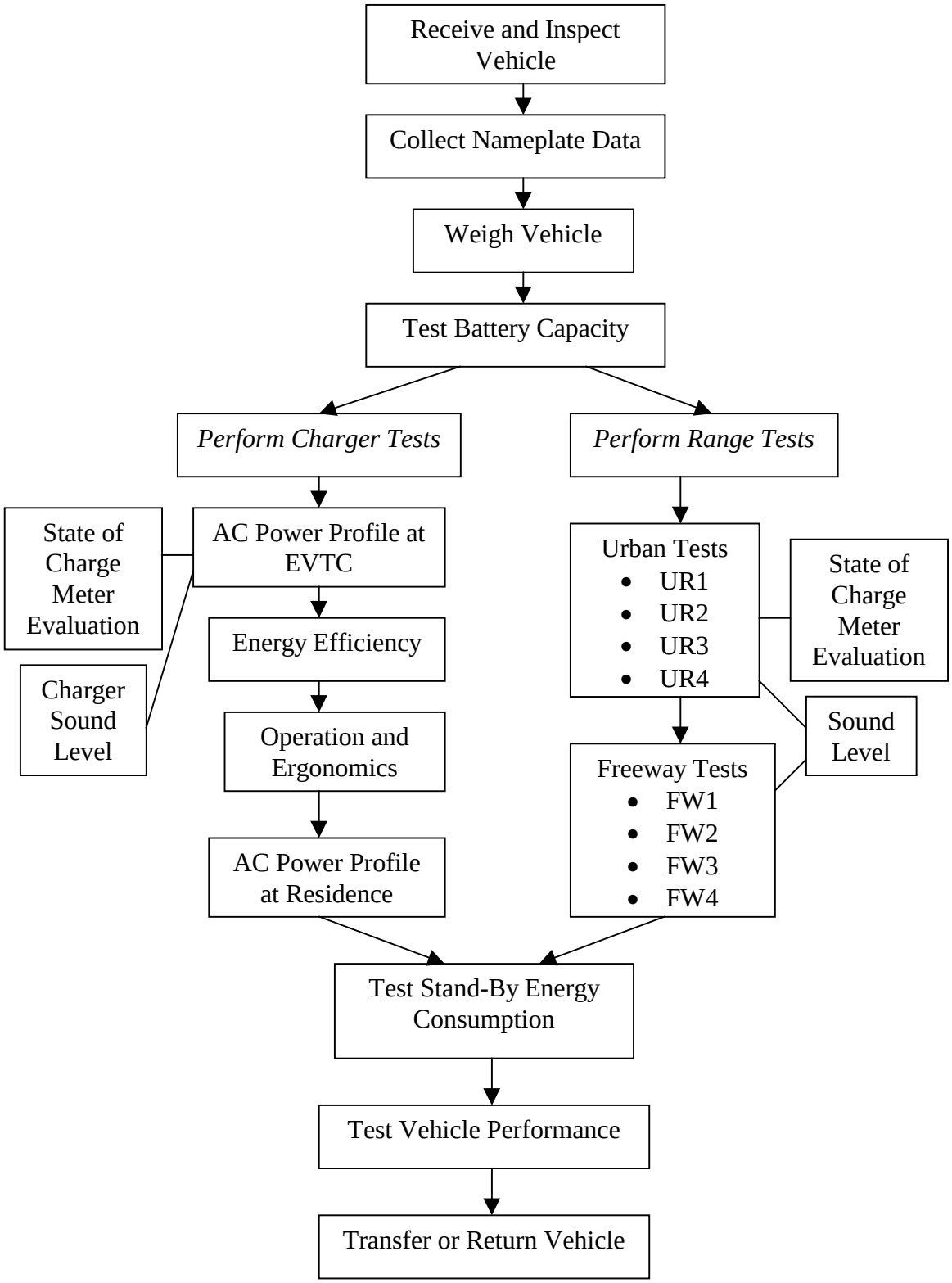
Range tests under different vehicle conditions no longer always have predictable results. Automatic climate controls limit air conditioner power on cool days, thus conserving battery energy and increasing range. The battery pack and the output side of the charger may no longer be readily accessible;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

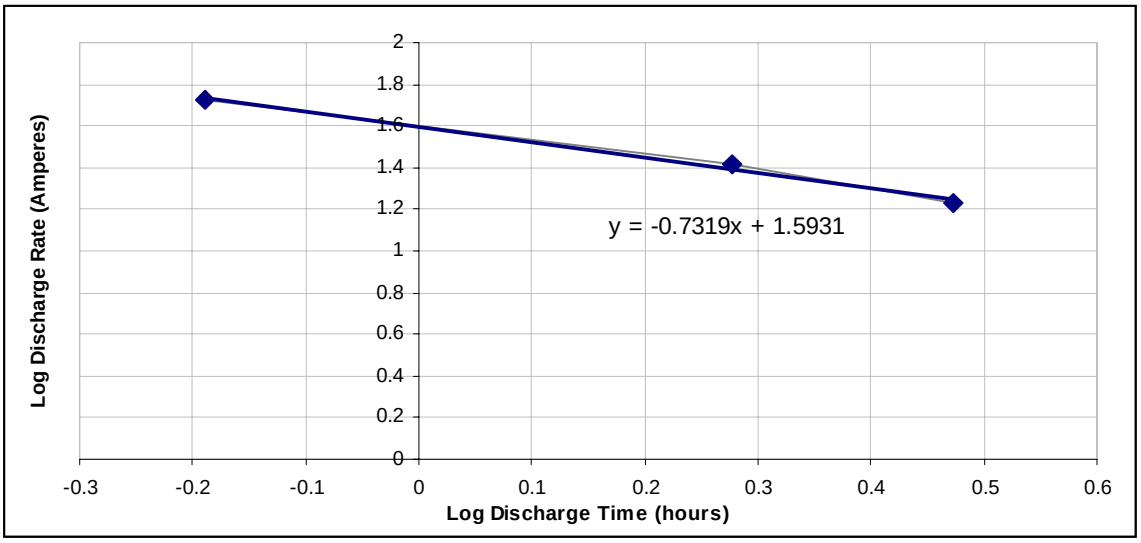


Figure 3-1. Sample Peukert Curve.

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.

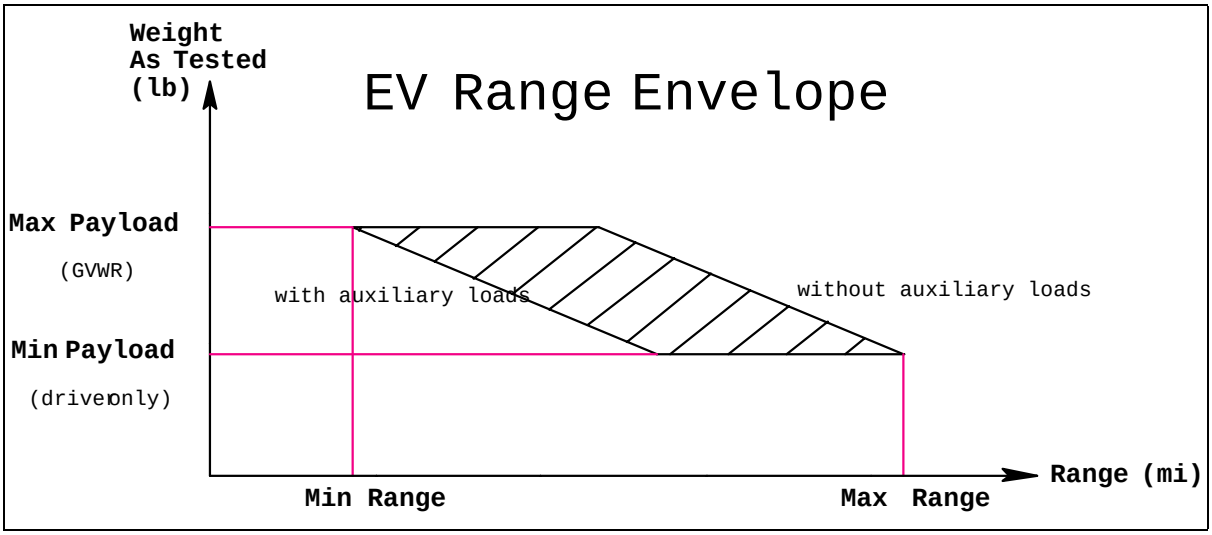


Figure 3-2. Range Envelope.

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:

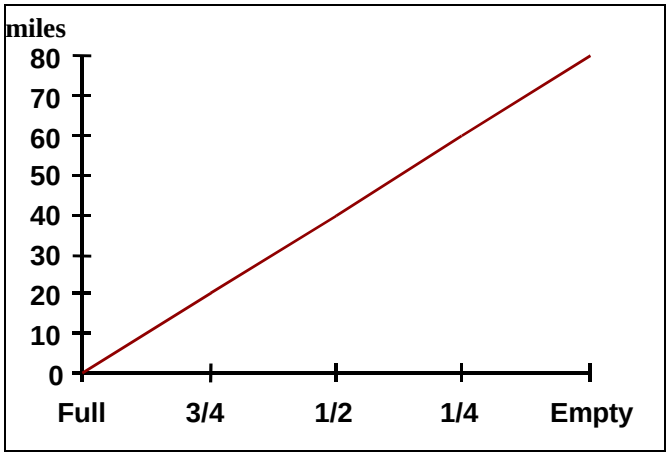


Figure 3-3. State of Charge Meter Evaluation.

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).

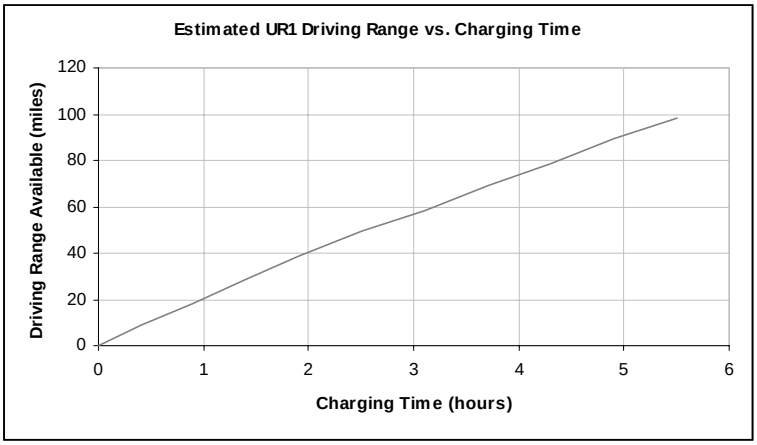


Figure 3-4. Sample plot of estimated range versus charging time.

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).

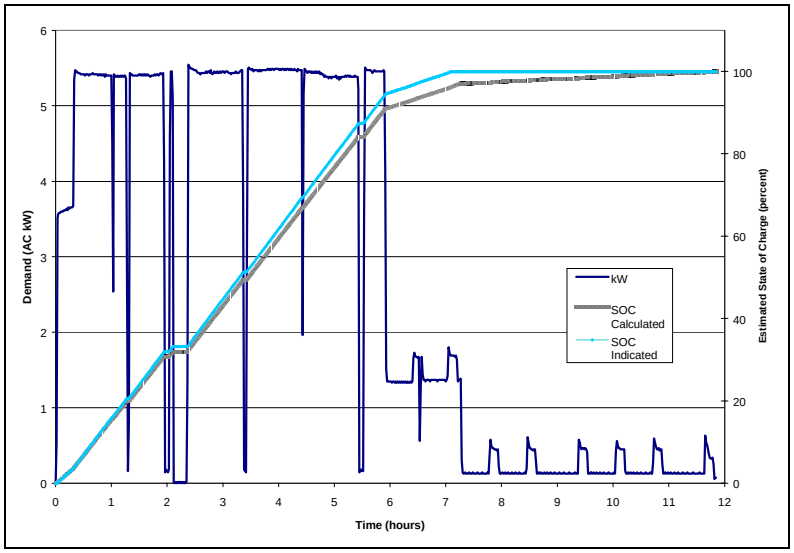


Figure 3-5. Sample AC charging profile plots.

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

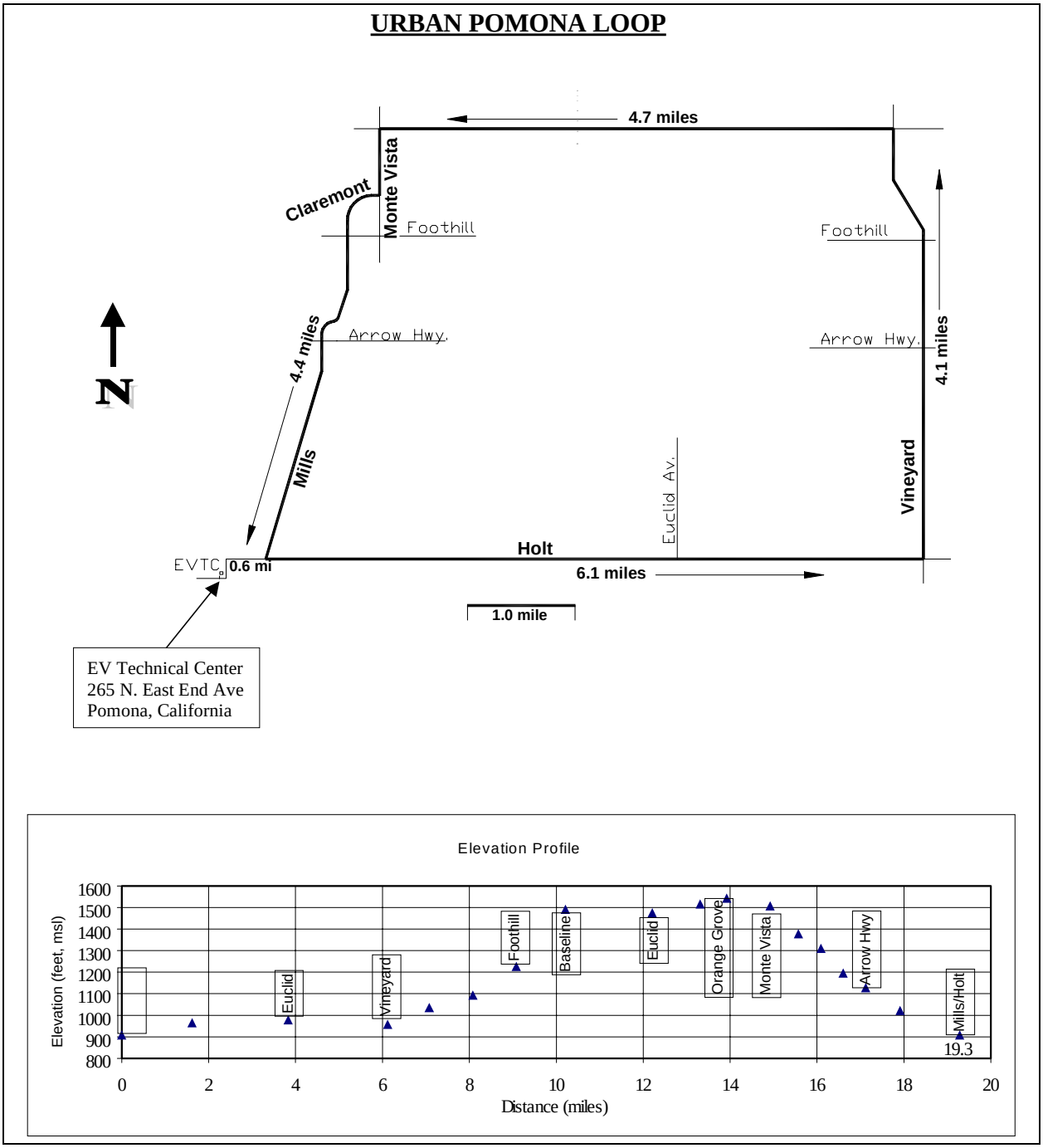
EV Performance Characterization Testing Schedule

		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

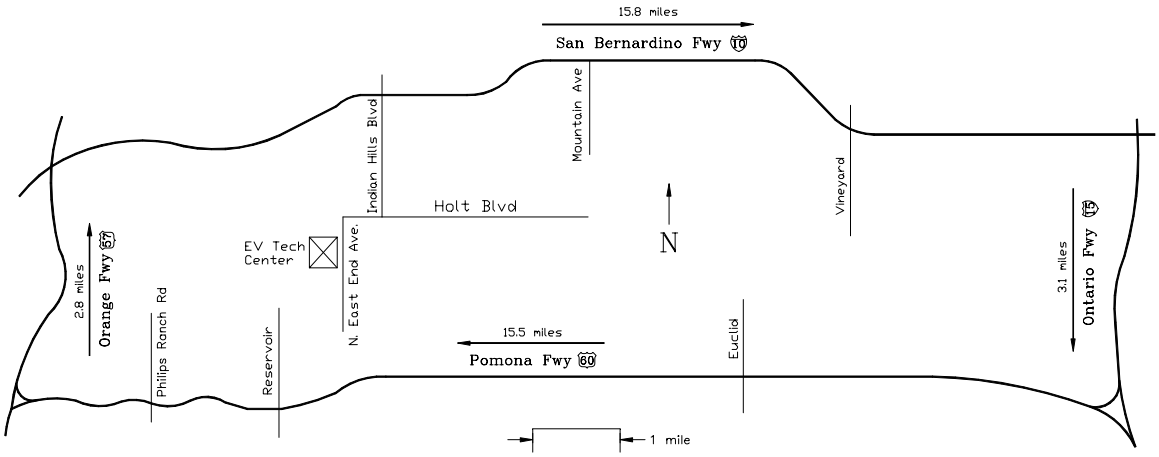
Stop No.	Distance from Start (miles)	Type	Distance from Previous stop	Comments
0	0.00	light	0.00	East End & Holt
1	0.10	light	0.10	
2	0.15	light	0.05	Mills & Holt
3	0.80	light	0.65	
4	1.30	light	0.50	
5	1.80	light	0.50	
6	2.30	light	0.50	
7	2.90	light	0.60	
8	3.50	light	0.60	
9	3.70	light	0.20	
10	4.00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

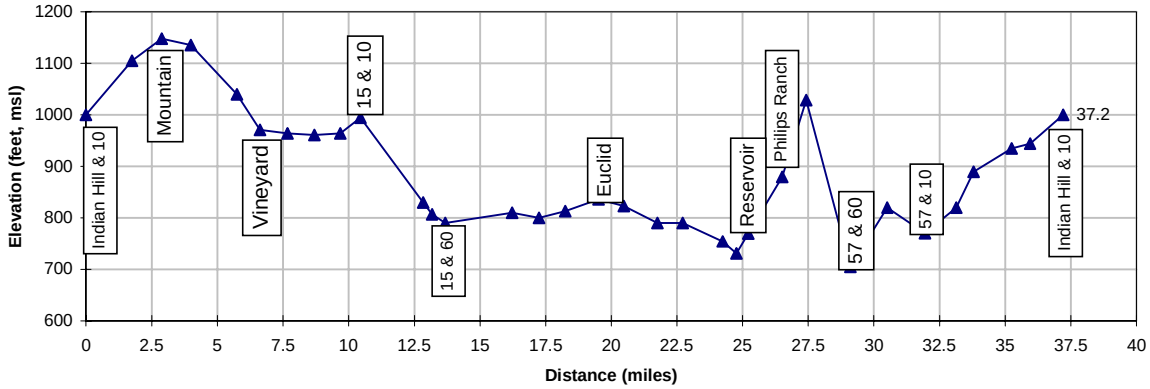
48	18.60	light	1.00	
49	18.70	sign	0.10	
50	19.00	sign	0.30	
51	19.30	light	0.30	
52	19.50	light	0.20	Holt & Mills
53	19.60	light	0.10	
54	19.80	light	0.20	Holt & East End

MCW: ttt
9/23/92

Freeway Loop Map

FREEWAY POMONA LOOP





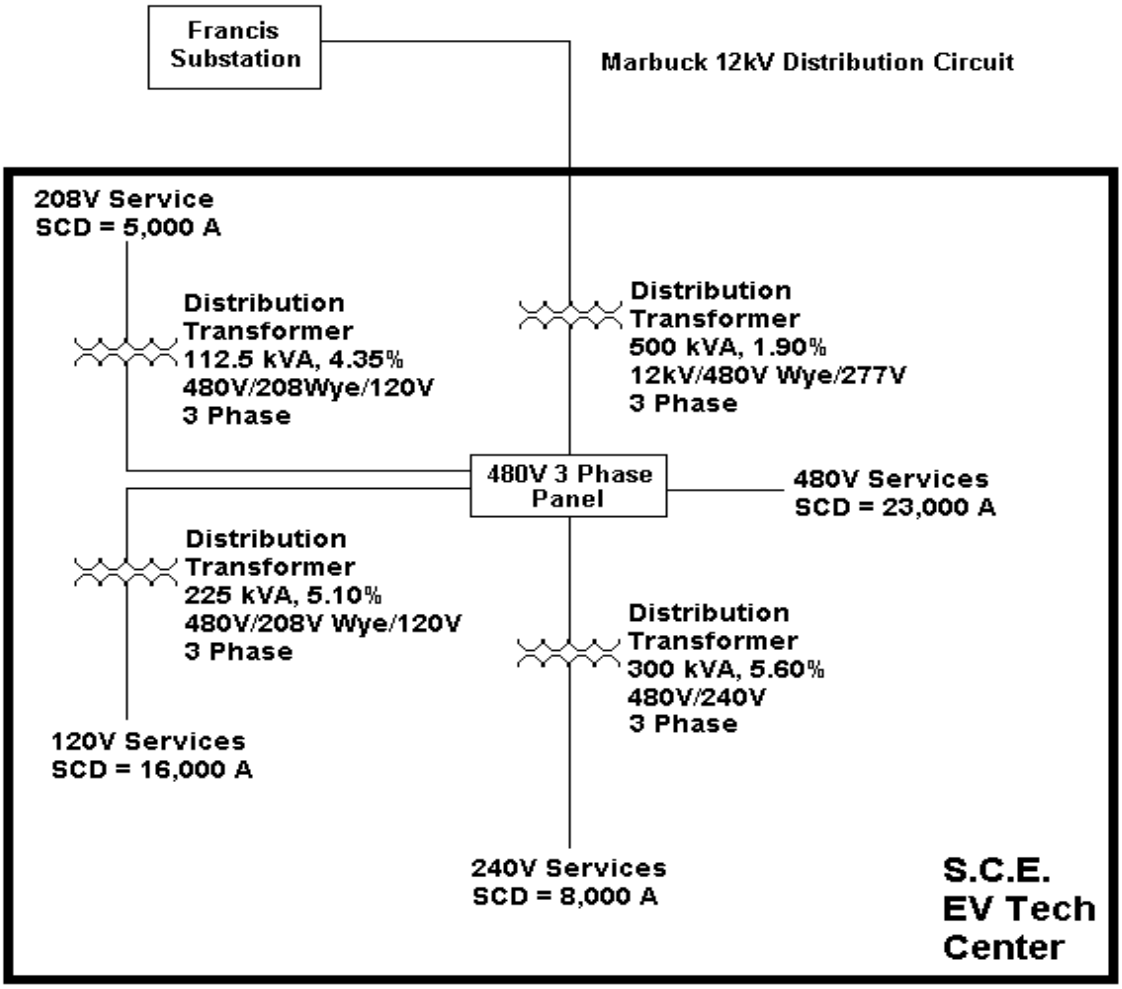
EVTC Equipment

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

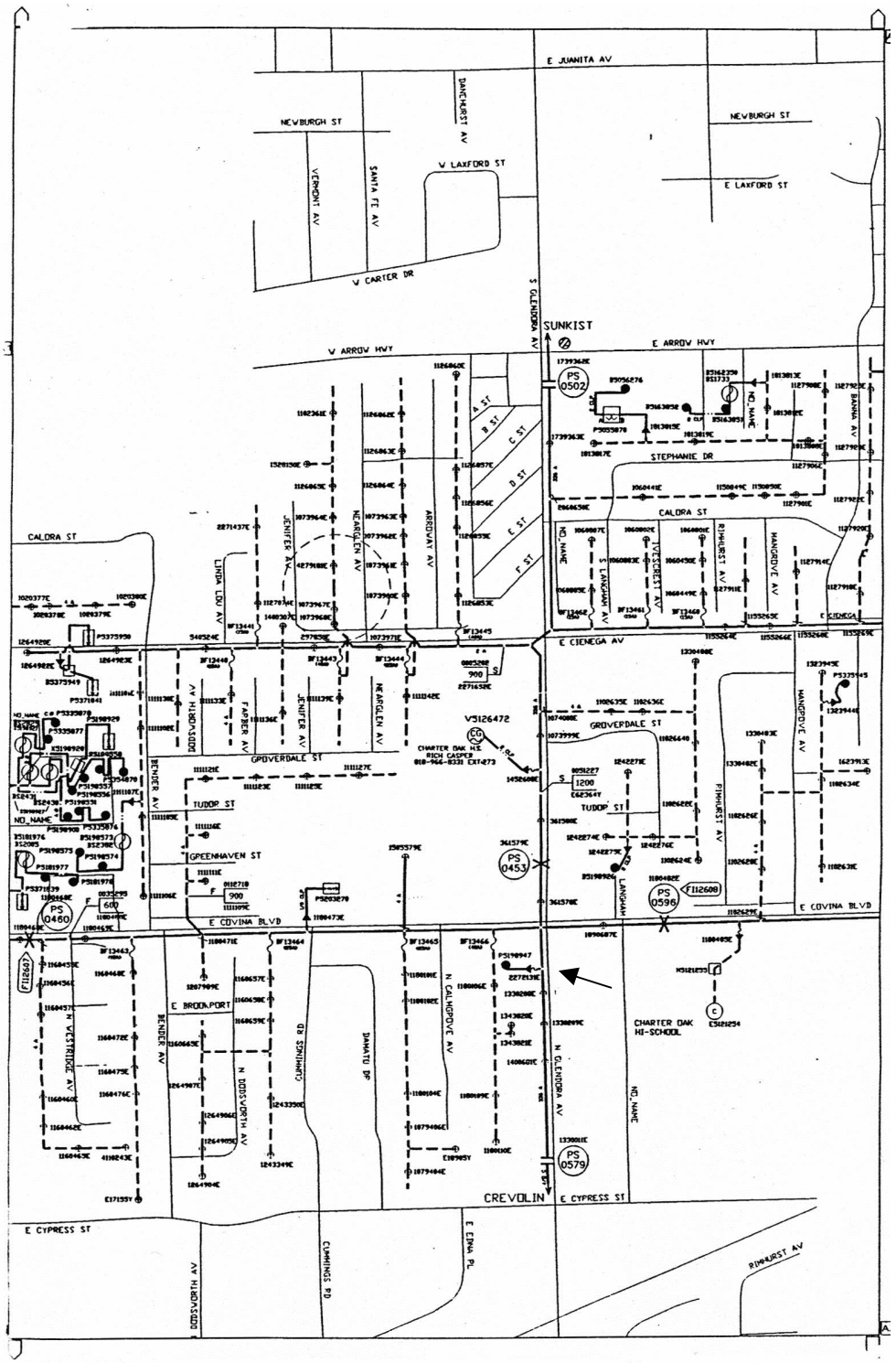
EVTC Number	Manufacturer	Model	Description	Quantity
MCR-001	OLYMPUS	MICRO-32	MICRO CASSETTE RECORDER	1
MMR-001	Various	Various	DIGITAL MULTIMETER	14
MMR-012	HEWLETT PACKARD	34401 A	MULTIMETER	1
MMW-001	ROLATAPE	MEASUMASTERMM30	MEASURING WHEEL	1
MPG-001	HEWLETT PACKARD	6942A	MULTIPROGRAMMER	1
NVK-001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