Ford Ranger Fleet Evaluation Report

January - December 1999

ELECTRIC TRANSPORTATION DIVISION
with
TRANSPORTATION SERVICES DEPARTMENT

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PURPOSE

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

The following facts support this purpose:

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

Southern California Edison (SCE) operates one of the largest electric vehicle fleets in the nation. The fleet is composed of EVs from all major auto manufacturers. Currently the fleet has a total of 315 EVs and has accumulated over 3.2 million miles. By far the Toyota RAV4 makes up the majority of the vehicles in the fleet, at 245 vehicles. Although the RAV4 satisfies a great deal of missions, there are still some missions that are more properly met with a pick up truck. To satisfy this need, SCE, in cooperation with the Department of Energy, acquired a total of seven Nickel/Metal-Hydride powered Ford Rangers.

When the vehicles were originally acquired, there were three main missions they were intended to meet. Vehicle 23642 was used for SCE’s Fleet Trials Program, which makes various models of EVs available for periods of one to two months to SCE customers who are also fleet operators. Vehicle 23643 was used for SCE’s communications program, which involves taking various EVs to internal and external public relations programs. The remaining five EVs were intended for meter reading applications. See Table 1-1 below for additional details.

Table 1.1 Vehicle History

<table>
<thead>
<tr>
<th>Vehicle #</th>
<th>In Service Date</th>
<th>Initial Range</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>23639</td>
<td>12/98</td>
<td>78 (1/99)</td>
<td>Fleet Testing</td>
</tr>
<tr>
<td>23640</td>
<td>12/98</td>
<td>68 (1/99)</td>
<td>Fleet Testing</td>
</tr>
<tr>
<td>23641</td>
<td>12/98</td>
<td>77 (1/99)</td>
<td>Fleet Testing</td>
</tr>
<tr>
<td>23642</td>
<td>12/98</td>
<td>85 (1/99)</td>
<td>Fleet Testing</td>
</tr>
<tr>
<td>23643</td>
<td>12/98</td>
<td>83 (1/99)</td>
<td>Fleet Testing</td>
</tr>
<tr>
<td>24470</td>
<td>12/98</td>
<td>84 (1/99)</td>
<td>Fleet Testing</td>
</tr>
<tr>
<td>24471</td>
<td>12/98</td>
<td>78 (1/99)</td>
<td>Fleet Testing</td>
</tr>
</tbody>
</table>
II. FLEET OPERATION

The following tables and figures summarize the performance of the seven NiMH equipped Ford Rangers in 1999.

**Table 2.1 Fleet Operation Overview**

<table>
<thead>
<tr>
<th></th>
<th>1st Qtr. '99</th>
<th>2nd Qtr. '99</th>
<th>3rd Qtr. '99</th>
<th>4th Qtr. '99</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active EVs</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Miles Driven</td>
<td>6260</td>
<td>7041</td>
<td>7576</td>
<td>8225</td>
</tr>
<tr>
<td>Miles/EV</td>
<td>894</td>
<td>1006</td>
<td>1082</td>
<td>1175</td>
</tr>
<tr>
<td>Miles/EV/Week</td>
<td>69</td>
<td>77</td>
<td>83</td>
<td>90</td>
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</tbody>
</table>

**Figure 2.1** Cumulative mileage of the Ranger fleet during the evaluation period
### Table 2-2 Monthly Mileage Report

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>23639</td>
<td>Ranger</td>
<td>176</td>
<td>441</td>
<td>488</td>
<td>473</td>
<td>95</td>
<td>465</td>
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<tr>
<td>23640</td>
<td>Ranger</td>
<td>190</td>
<td>202</td>
<td>604</td>
<td>975</td>
<td>206</td>
<td>79</td>
</tr>
<tr>
<td>23641</td>
<td>Ranger</td>
<td>303</td>
<td>586</td>
<td>649</td>
<td>151</td>
<td>177</td>
<td>0</td>
</tr>
<tr>
<td>23642</td>
<td>Ranger</td>
<td>201</td>
<td>126</td>
<td>293</td>
<td>576</td>
<td>291</td>
<td>385</td>
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<tr>
<td>23643</td>
<td>Ranger</td>
<td>208</td>
<td>63</td>
<td>135</td>
<td>399</td>
<td>301</td>
<td>277</td>
</tr>
<tr>
<td>24470</td>
<td>Ranger</td>
<td>206</td>
<td>539</td>
<td>140</td>
<td>419</td>
<td>576</td>
<td>302</td>
</tr>
<tr>
<td>24471</td>
<td>Ranger</td>
<td>140</td>
<td>155</td>
<td>415</td>
<td>246</td>
<td>524</td>
<td>124</td>
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<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>23639</td>
<td>Ranger</td>
<td>31</td>
<td>592</td>
<td>33</td>
<td>0</td>
<td>1,579</td>
<td>2,127</td>
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<tr>
<td>23640</td>
<td>Ranger</td>
<td>108</td>
<td>154</td>
<td>120</td>
<td>197</td>
<td>188</td>
<td>70</td>
</tr>
<tr>
<td>23641</td>
<td>Ranger</td>
<td>427</td>
<td>92</td>
<td>1,624</td>
<td>337</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>23642</td>
<td>Ranger</td>
<td>106</td>
<td>173</td>
<td>179</td>
<td>206</td>
<td>253</td>
<td>373</td>
</tr>
<tr>
<td>23643</td>
<td>Ranger</td>
<td>703</td>
<td>468</td>
<td>552</td>
<td>51</td>
<td>126</td>
<td>99</td>
</tr>
<tr>
<td>24470</td>
<td>Ranger</td>
<td>1,306</td>
<td>285</td>
<td>216</td>
<td>237</td>
<td>0</td>
<td>458</td>
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<tr>
<td>24471</td>
<td>Ranger</td>
<td>220</td>
<td>7</td>
<td>180</td>
<td>202</td>
<td>637</td>
<td>1,071</td>
</tr>
</tbody>
</table>

**Figure 2.2** Total mileage by vehicle number
**Figure 2-3** Monthly mileage summary

**Figure 2.4** Average miles per charge by vehicle number
### III. VEHICLE MAINTENANCE AND RELIABILITY

#### First Quarter 1999

<table>
<thead>
<tr>
<th>Veh. No.</th>
<th>Vehicle Model</th>
<th>Component Name</th>
<th>Odometer Reading</th>
<th>Reported Problem</th>
<th>Date Reported</th>
<th>Date Repaired</th>
<th>Downtime (Days)*</th>
<th>Man Hours</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>23639</td>
<td>RANGER</td>
<td>POWER STEERING CONTROLLER</td>
<td>296</td>
<td>AIR IN POWER STEERING SYSTEM</td>
<td>02/02/99</td>
<td>02/08/99</td>
<td>4</td>
<td>1.5</td>
<td>CYCLE STEERING LOCK TO LOCK 15 TIMES</td>
</tr>
<tr>
<td>23639</td>
<td>RANGER</td>
<td>TRACTION BATTERY</td>
<td>175</td>
<td>VEHICLE DOES NOT CHARGE, CHARGER STOPS WHEN PLUGGED IN AND PACK DISCHARGES.</td>
<td>01/26/99</td>
<td>02/04/99</td>
<td>7</td>
<td>15.5</td>
<td>R&amp;R BATTERY PACK</td>
</tr>
<tr>
<td>23640</td>
<td>RANGER</td>
<td>BATTERY MODULE</td>
<td>192</td>
<td>LOW RANGE ~ 25 MILES</td>
<td>02/02/99</td>
<td>02/11/99</td>
<td>7</td>
<td>8</td>
<td>R&amp;R BATTERY MODULE #1</td>
</tr>
<tr>
<td>23640</td>
<td>RANGER</td>
<td>AUXILIARY BATTERY</td>
<td>63</td>
<td>VEHICLE WILL NOT START - AUXILIARY BATTERY LOW</td>
<td>01/18/99</td>
<td>01/18/99</td>
<td>0</td>
<td>1</td>
<td>CHARGED AUXILIARY BATT. &amp; PLACED VEH. ON CHARGE</td>
</tr>
<tr>
<td>23640</td>
<td>RANGER</td>
<td>BATTERY MODULE</td>
<td>392</td>
<td>VEHICLE SOC DROPPED TO 25% FROM 50%</td>
<td>02/22/99</td>
<td>03/10/99</td>
<td>12</td>
<td>24.5</td>
<td>R&amp;R TWO BATTERY MODULES</td>
</tr>
<tr>
<td>23641</td>
<td>RANGER</td>
<td>AUXILIARY BATTERY</td>
<td>145</td>
<td>VEHICLE WILL NOT START - AUXILIARY BATTERY LOW</td>
<td>01/18/99</td>
<td>01/18/99</td>
<td>0</td>
<td>1</td>
<td>CHANGED AUXILIARY BATT. &amp; PLACED VEH. ON CHARGE</td>
</tr>
<tr>
<td>23642</td>
<td>RANGER</td>
<td>AUXILIARY BATTERY</td>
<td>62</td>
<td>VEHICLE WILL NOT START - AUXILIARY BATTERY LOW</td>
<td>01/19/99</td>
<td>01/19/99</td>
<td>0</td>
<td>1</td>
<td>CHANGED AUXILIARY BATT. &amp; PLACED VEH. ON CHARGE</td>
</tr>
<tr>
<td>23643</td>
<td>RANGER</td>
<td>AUXILIARY BATTERY</td>
<td>59</td>
<td>VEHICLE WILL NOT START - AUXILIARY BATTERY LOW</td>
<td>01/19/99</td>
<td>01/19/99</td>
<td>0</td>
<td>1</td>
<td>CHANGED AUXILIARY BATT. &amp; PLACED VEH. ON CHARGE</td>
</tr>
<tr>
<td>24470</td>
<td>RANGER</td>
<td>AUXILIARY BATTERY</td>
<td>63</td>
<td>VEHICLE WILL NOT START - AUXILIARY BATTERY LOW</td>
<td>01/18/99</td>
<td>01/18/99</td>
<td>0</td>
<td>1</td>
<td>CHANGED AUXILIARY BATT. &amp; PLACED VEH. ON CHARGE</td>
</tr>
</tbody>
</table>

#### Second Quarter 1999

<table>
<thead>
<tr>
<th>Veh. No.</th>
<th>Vehicle Model</th>
<th>Component Name</th>
<th>Odometer Reading</th>
<th>Reported Problem</th>
<th>Date Reported</th>
<th>Date Repaired</th>
<th>Downtime (Days)*</th>
<th>Man Hours</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>23639</td>
<td>RANGER</td>
<td>BATTERY MANAGEMENT SYSTEM</td>
<td>1,335</td>
<td>VEH. WILL NOT CHARGE, SOC VERY LOW, WRENCH LIGHT ON</td>
<td>05/14/99</td>
<td>05/19/99</td>
<td>4</td>
<td>10</td>
<td>R&amp;R BATTERY CONTROL MODULE</td>
</tr>
<tr>
<td>23641</td>
<td>RANGER</td>
<td>BATTERY SYSTEMS</td>
<td>1,866</td>
<td>VEHICLE DIED IN YARD, WRENCH LIGHT ON</td>
<td>05/27/99</td>
<td>06/18/99</td>
<td>16</td>
<td>19</td>
<td>R&amp;R CONTACTOR BOX</td>
</tr>
<tr>
<td>24470</td>
<td>RANGER</td>
<td>AUXILIARY BATTERY</td>
<td>1,768</td>
<td>REMOVE AUX. BATT. NEGATIVE TO CLEAR POWER LOSS LIGHT</td>
<td>05/27/99</td>
<td>05/27/99</td>
<td>1</td>
<td>1</td>
<td>REMOVED NEGATIVE POWER CABLE FROM AUX. BATT.</td>
</tr>
</tbody>
</table>

#### Third Quarter 1999

<table>
<thead>
<tr>
<th>Veh. No.</th>
<th>Vehicle Model</th>
<th>Component Name</th>
<th>Odometer Reading</th>
<th>Reported Problem</th>
<th>Date Reported</th>
<th>Date Repaired</th>
<th>Downtime (Days)*</th>
<th>Man Hours</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>23641</td>
<td>RANGER</td>
<td>AUXILIARY BATTERY</td>
<td>2,293</td>
<td>AUXILIARY BATTERY DEAD</td>
<td>08/09/99</td>
<td>08/09/99</td>
<td>1</td>
<td>1</td>
<td>RECHARGED AUXILIARY BATTERY</td>
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<tr>
<td>23641</td>
<td>RANGER</td>
<td>NON EV RELATED</td>
<td>2,371</td>
<td>CHARGE DOOR BROKEN</td>
<td>08/20/99</td>
<td>08/23/99</td>
<td>2</td>
<td>2</td>
<td>R&amp;R CHARGE DOOR</td>
</tr>
<tr>
<td>24471</td>
<td>RANGER</td>
<td>ONBOARD CHARGING</td>
<td>1,613</td>
<td>VEHICLE WILL NOT CHARGE</td>
<td>07/09/99</td>
<td>07/15/99</td>
<td>5</td>
<td>8</td>
<td>R&amp;R ONBOARD CHARGER</td>
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</tbody>
</table>

#### Fourth Quarter 1999

<table>
<thead>
<tr>
<th>Veh. No.</th>
<th>Vehicle Model</th>
<th>Component Name</th>
<th>Odometer Reading</th>
<th>Reported Problem</th>
<th>Date Reported</th>
<th>Date Repaired</th>
<th>Downtime (Days)**</th>
<th>Man Hours</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>23639</td>
<td>RANGER</td>
<td>TIRE</td>
<td>5,703</td>
<td>LEFT REAR TIRE FLAT</td>
<td>12/23/99</td>
<td>12/23/99</td>
<td>1</td>
<td>1.5</td>
<td>REPAIRED TIRE</td>
</tr>
<tr>
<td>23642</td>
<td>RANGER</td>
<td>CHARGE PORT</td>
<td>2,648</td>
<td>CHARGE PORT NOT CLOSING CORRECTLY</td>
<td>10/20/99</td>
<td>10/28/99</td>
<td>7</td>
<td>2.5</td>
<td>R&amp;R CHARGE PORT</td>
</tr>
<tr>
<td>23643</td>
<td>RANGER</td>
<td>BACKUP ALARM</td>
<td>3,104</td>
<td>INSTALL BACKUP ALARM</td>
<td>12/13/99</td>
<td>12/13/99</td>
<td>1</td>
<td>2.5</td>
<td>INSTALLED BACKUP ALARM</td>
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<tr>
<td>24471</td>
<td>RANGER</td>
<td>ABB METER</td>
<td>2,212</td>
<td>INSTALL ABB METER</td>
<td>10/29/99</td>
<td>10/29/99</td>
<td>1</td>
<td>1.5</td>
<td>INSTALLED ABB METER FROM 24078</td>
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</table>
Figure 3.1 Servicing Man-hours

Figure 3.2 Service downtime by vehicle number
Figure 3.3 Vehicle system or component reliability

Figure 3.4 Total “Out of Service” fleet summary
# IV. BATTERY REPORT

<table>
<thead>
<tr>
<th>SCE Batt. Nbr.</th>
<th>Manufacturer</th>
<th>Model</th>
<th>Chemistry</th>
<th>Battery Type</th>
<th>In Service Date</th>
<th>Battery Rated Capacity</th>
<th>Last lab Certified Capacity</th>
<th>Total Miles</th>
<th>Total Module Replacements in 1999</th>
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</thead>
<tbody>
<tr>
<td>23639</td>
<td>Panasonic</td>
<td>MHB-100</td>
<td>NiMH</td>
<td>Sealed VR</td>
<td>Dec-98</td>
<td>100Ah C/3</td>
<td>na</td>
<td>6,500</td>
<td>0</td>
</tr>
<tr>
<td>23640</td>
<td>Panasonic</td>
<td>MHB-100</td>
<td>NiMH</td>
<td>Sealed VR</td>
<td>Dec-98</td>
<td>100Ah C/3</td>
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<td>23641</td>
<td>Panasonic</td>
<td>MHB-100</td>
<td>NiMH</td>
<td>Sealed VR</td>
<td>Dec-98</td>
<td>100Ah C/3</td>
<td>na</td>
<td>4,360</td>
<td>0</td>
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<tr>
<td>23642</td>
<td>Panasonic</td>
<td>MHB-100</td>
<td>NiMH</td>
<td>Sealed VR</td>
<td>Dec-98</td>
<td>100Ah C/3</td>
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<td>23643</td>
<td>Panasonic</td>
<td>MHB-100</td>
<td>NiMH</td>
<td>Sealed VR</td>
<td>Dec-98</td>
<td>100Ah C/3</td>
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<td>3,382</td>
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<td>24470</td>
<td>Panasonic</td>
<td>MHB-100</td>
<td>NiMH</td>
<td>Sealed VR</td>
<td>Dec-98</td>
<td>100Ah C/3</td>
<td>na</td>
<td>4,684</td>
<td>0</td>
</tr>
<tr>
<td>24471</td>
<td>Panasonic</td>
<td>MHB-100</td>
<td>NiMH</td>
<td>Sealed VR</td>
<td>Dec-98</td>
<td>100Ah C/3</td>
<td>na</td>
<td>3,921</td>
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</table>

VRLA = Valve Regulated Lead Acid
VRLA (AE) = VRLA Absorbed Electrolyte
VRLA (Gel) = VRLA Gelled Electrolyte
kWh = kilowatt hours
Ah = amp hours
C/rate = Ah capacity at an established current over time in hours discharge.
An alphabet notation following a battery number indicates the number of battery pack changeouts. i.e. 1742b is the 2nd pack installed since it was new.
Cycles = the number of times the vehicle has been taken off charge, driven and put back on charge.
V. DISCUSSION AND CONCLUSION

Vehicle 23642, which was used for fleet loans, was able to meet the requirements of the mission that it was assigned to. A total of three loans were made to local entities. A sample report for a trial with a local city is included in Appendix A, page 13. Vehicle 23643 worked well for the communications group. The mission requirements in this application were not very demanding. The remaining five vehicles were intended for SCE fleet applications. Full deployment of the NiMH Ford Ranger into the SCE Fleet has not been achieved to date. These vehicles were evaluated in Pomona before being sent out to regular fleet users.

Experience to date has shown that a vehicle in the SCE fleet needs a minimum range of 65 miles on the Pomona Loop at full payload and A/C on maximum in order to be accepted favorably by the users. The vehicle must also be highly reliable. Unfortunately the Ranger did not perform well in at least three different field locations. For example, in the first quarter the Rangers were in service for a combined thirty days (see Table 3-4, page 10). Problems included charging anomalies, quit-on-road incidents, and lower than expected range (40 miles approx. in some cases). Once this information was relayed to other field locations, placing the Rangers became a nearly impossible task. Therefore, for most of 1999, these five Rangers were based out of Pomona and were used for relatively undemanding tasks. As a result there were months when the vehicles were driven very few miles (see Table 2-2, page 6).

Vehicle acceptance can be very subjective and although the Ranger didn’t meet SCE’s range and reliability requirements, 50% of surveyed drivers preferred the electric Ford Ranger to a gasoline-fueled truck for their work. As seen in the enclosed driver questionnaires, Appendix B, page 14, features that fared well with drivers were the ease of operation, quick acceleration and refueling at home or work rather than at a service station. But drivers also noted a need for longer range between charging.

Ford has made great efforts in remedying the problems with the Rangers. Software and hardware upgrades have been made on the vehicles and as of the time this report was being
written the changes made seem extremely promising - SCE is willing to give the Ranger “a second chance” and deploy it in its fleet in 2000 and beyond.
Appendix A

Vehicle Trial Report
Dear Program Participant:

Thank you for participating in Southern California Edison’s *EV Trials* program. We hope that the program was a positive experience for your organization. In addition to exposing you to new vehicles and opportunities to be in the forefront of future transportation technologies, this program is very important to SCE. The data collected from your trial will help us evaluate load management scenarios, customer power quality, and the effects of EV charging on the overall power supply system. Information collected about your EV use and the opinions of your drivers will also be instrumental to our plans for meeting future charging infrastructure needs.

The information presented in this report was compiled from on-site metering and surveys of your drivers. In this report you will find summaries of energy use and cost, graphs illustrating your site’s load profile, and results from the driver survey.

We believe electric transportation can benefit your organization financially as well as through positive public relations. We encourage you to contact us any time in the future if you have questions about this particular program or electric transportation in general—including questions about vehicles, costs, infrastructure needs, and project financing opportunities. In particular, we can show you how to take advantage of “Subvention” funds which are available to some cities. Further, we offer special time-of-use (TOU) Electric Vehicle Rates so that you can take maximum advantage of off-peak charging.

Again, thank you for helping us promote a cleaner future through electric transportation.

Sincerely,

Cecilia Mushinskie
Technical Specialist
Southern California Edison
Electric Transportation
626.302.3934
Summary

The following illustration highlights your organization’s experience with an EV. The information summarizes key facets of EV use and charging, as well as user benefits. This information, collected during the EV Trials program, provides insights into how the EV was actually used by your drivers and how EVs may eventually fit in as an integral part of your fleet.

Key Findings

**USE:**
Vehicle range (mfg. specification): 65 miles  
Average daily miles: 17 miles  
Total miles driven: 353 miles  
Trial duration: 71 days (Vehicle used 27 days)

**DRIVING CHARACTERISTICS:**
45% of driving with charge above 50%  
55% of driving with charge below 50%

**CHARGING:**
36% occurred off-peak  
64% occurred on-peak

**ENERGY USE:**
Total kWh consumed during Trials: 271 kWh  
Average kWh per mile: 0.77

**ENERGY COST:**
Electric: $12.21 if 100% of charging was off-peak  
Gasoline equivalent: $53.19  
Driving 10000 miles you would save $636.78

**EMISSIONS BENEFITS:**
While driving your EV 353 miles, you reduced air pollution by over 84 lbs.  
If you drove 10000 miles a year, you would reduce pollution by 2,381 lbs.

* Energy Costs—reflect current SCE TOU EV rates.
Trial Results and Analysis

This section provides detailed information about your use of the EV during the Trials Program.

Trial Duration

The trial period was July 21, 1999 to September 30, 1999 (71 days), during which the EV was operated 27 days.

Vehicle Use Characteristics

During the Trials, your organization drove the EV a total of 353 miles. The average driving distance was 17 miles a day, with an average trip of 16 miles. 45% of the driving occurred when the vehicle was over 50% state-of-charge. This is not unusual during a trial period because of operator concerns over range. Once drivers are more familiar with the vehicle, they are more comfortable driving further, increasing average daily mileage, and the depth of charge between charges.

Vehicle Charging

A critical advantage of EVs is their low “fuel” costs due to their ability to be charged during off-peak hours (9:00 PM to 12 PM) when electricity rates are lowest. EV owners receive a further advantage through SCE’s special EV time-of-use (TOU) rate, which costs even less than standard off-peak rates during these off-peak hours.

During the Trials period, 36% of your EV charging occurred during off-peak hours, the best time to charge. The remaining 64% occurred on-peak at a higher electricity rate. Your driver indicated that the charging process was acceptable and that the EV was adequately charged in the morning and ready for use. When operating an EV for 17 miles per day it is not necessary to “top-off” the vehicle charge. Ultimately, the most cost-effective approach to EV charging is to—whenever possible—charge your EV during off-peak hours when the lowest TOU rate is in effect.

Energy Use

SCE installed separate electricity meters at your facility to monitor EV charging during the Trials period. This enabled us to determine how much electricity was used and what time of the day charging occurred. The figure on the following page graphically depicts electricity consumption for EV charging by hour intervals during the Trials period. This information can be used to analyze individual charging patterns and optimize charging for off-peak periods.
**Energy Costs**

Based on your driving patterns, and applying SCE’s TOU-EV3 rate, your energy cost for operating the EV was $12.21 for the entire trial. This assumes that all charging occurred off-peak. If you were operating a gasoline vehicle that got 15 mpg at $2.26 per gallon, your energy cost would be $53.19 for the same number of miles driven. Therefore, your net savings came to $40.98. Over 10,000 miles, total fuel savings would be $637.

**Emissions Benefits**

A major benefit of EV use is a reduction in harmful emissions. Even when power plant emissions in the Los Angeles basin are taken into consideration, your use of an EV during the trial program reduced emissions by 84 lbs. If you operated this vehicle for one year, assuming 10,000 miles per year, the emissions reduction would be 2,381 lbs. The composition of the emissions reductions are shown in Table 1:

<table>
<thead>
<tr>
<th>Emission</th>
<th>Trials Reduction (lbs.)</th>
<th>Annual Reduction (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>68.6</td>
<td>1943.1</td>
</tr>
<tr>
<td>Reactive Organic Gases (ROG)</td>
<td>8.6</td>
<td>244.5</td>
</tr>
<tr>
<td>Nitrogen Oxides (NOx)</td>
<td>5.5</td>
<td>155.0</td>
</tr>
<tr>
<td>Sulfur Oxides (SOx)</td>
<td>1.0</td>
<td>27.6</td>
</tr>
<tr>
<td>Particulates (PM10)</td>
<td>0.4</td>
<td>10.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>84</strong></td>
<td><strong>2381</strong></td>
</tr>
</tbody>
</table>

**User Response**

A critical issue tied to future EV use is what drivers think about operating the EV. The figure on the following page graphically depicts your drivers’ opinions on 21 attributes related to their experience with the vehicle. Drivers were most pleased with the drivability. In general, drivers were favorably impressed with the performance and amenities provided by the vehicle.

In addition to the tabulated data, written comments were submitted by drivers. While opinions vary, rapid acceleration is what your drivers liked best and the limited range is what they liked least.
Driver Questionnaire Responses

- The vehicle feels stable and safe: 5
- The vehicle steering is responsive on the road: 5
- The vehicle acceleration is adequate: 5
- The vehicle braking is responsive and safe: 5
- The temperature controls are easy to operate: 5
- The "state-of-charge" gauge was helpful: 5
- The "range remaining" gauge was helpful: 5
- The charging controls are easy to operate: 5
- The charging connector is easy to use: 5
- The charging cord is easy to manage: 5
- The vehicle charges adequately: 4
- The charger is quiet: 4
- The heater provides adequate heat: 4
- The air conditioner provides adequate cooling: 4
- The vehicle is quiet: 4
- The vehicle has adequate payload: 4
- The vehicle has adequate range: 2
- The vehicle is easy to operate: 5
- The vehicle is suited for your job application: 3
- The vehicle meets your expectation: 3

Average response: 1 = strongly disagree, 5 = strongly agree
Appendix B
Driver Questionnaires
**Electric Vehicle Driver Questionnaire**

**Participant:**

**Driver Name:**[REDACTED]
**Location:**
**Vehicle Number:**
**Vehicle Application:**
**Vehicle Make & Model:** Ford Ranger
**Date:** 03/03/99

### Driveability

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<tbody>
<tr>
<td>1. The vehicle feels stable and safe</td>
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<tr>
<td>2. The vehicle steering is responsive</td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>3. The vehicle acceleration is adequate</td>
<td>✔</td>
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<tr>
<td>4. The vehicle braking is responsive and safe</td>
<td>✔</td>
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### Driving Controls and Gauges

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<tbody>
<tr>
<td>1. The cabin temperature controls are easy to operate</td>
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<tr>
<td>2. The &quot;state-of-charge&quot; gauge is helpful and easy to read</td>
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<td>3. The &quot;range remaining&quot; gauge is helpful and easy to read</td>
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### Charging Controls and Gauges

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<tr>
<td>1. The charging controls are easy to operate</td>
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<tr>
<td>2. The charging connector (plug) is easy to use</td>
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<td>3. The charging cord is easy to manage</td>
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<td>4. The vehicle charges adequately (full in the morning)</td>
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<td>5. The charger is reasonably quiet</td>
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<td>6. Do you know the differences between Inductive and Conductive charging?</td>
<td>Yes</td>
<td>✔</td>
<td>No</td>
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<tr>
<td>If yes, which do you prefer?</td>
<td>Inductive</td>
<td>✔</td>
<td>Conductive</td>
<td>No preference</td>
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<tr>
<td>7. Did you have any problems charging?</td>
<td>Yes</td>
<td>✔</td>
<td>No</td>
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<tr>
<td>If yes, please describe*</td>
<td>WE ARE ON CALL 24 HRS A DAY IT IS NOT feasible to have a vehicle on charge</td>
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### Interior

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<td>1. The heater provides adequate heat</td>
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<td>2. The air conditioner provides adequate cooling</td>
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<td>3. The vehicle is quiet</td>
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<tr>
<td>4. Did you use electronic equipment (cell phone, radio, etc.) inside the EV?</td>
<td>Yes</td>
<td>✔</td>
<td>No</td>
<td></td>
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<tr>
<td>If yes, please list equipment(s) and describe any problems encountered*</td>
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### General

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<tbody>
<tr>
<td>1. The vehicle has adequate payload</td>
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<td>2. The vehicle has adequate range</td>
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<tr>
<td>3. The vehicle is easy to operate</td>
<td>✔</td>
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<td>4. The vehicle is suited for your job application</td>
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<td>5. The vehicle meets your expectations</td>
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<tr>
<td>6. If you had to choose between this vehicle or a similar gasoline vehicle for use in your work, which one would you select? (Circle One)</td>
<td>Electric Vehicle</td>
<td>✔</td>
<td>Gasoline Vehicle</td>
<td>Either</td>
<td></td>
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### Comments*

- What did you like best? **ACCELERATES RAPIDLY**
- What did you like least? **THE RANGE DIMINISHED AFTER TIME AND THE CHARGE WENT DOWN RAPIDLY WHILE CARRYING A PASSENGER OR A LOAD**

* SA: Strongly Agree; A: Agree; NS: Not Sure; D: Disagree; SD: Strongly Disagree; NA: Not Applicable

* Please use the back of this form if you need additional space.
Electric Vehicle Driver Questionnaire
Participant: [Name]

DRIVER NAME: Suzan Boyer
LOCATION: Rosemead

VEHICLE NUMBER: 23643
VEHICLE MAKE & MODEL: Ford Ranger

VEHICLE APPLICATION: Fleet Testing
DATE: 5/21/99

DRIVEABILITY
1. The vehicle feels stable and safe ✓
2. The vehicle steering is responsive ✓
3. The vehicle acceleration is adequate ✓
4. The vehicle braking is responsive and safe ✓

DRIVING CONTROLS AND GAUGES
1. The cabin temperature controls are easy to operate ✓
2. The "state-of-charge" gauge is helpful and easy to read ✓
3. The "range remaining" gauge is helpful and easy to read ✓

CHARGING CONTROLS AND GAUGES
1. The charging controls are easy to operate ✓
2. The charging connector (plug) is easy to use ✓
3. The charging cord is easy to manage ✓
4. The vehicle charges adequately (full in the morning) ✓
5. The charger is reasonably quiet ✓
6. Do you know the differences between Inductive and Conductive charging? Yes ✓ No
   If yes, which do you prefer? Inductive ✓ Conductive No preference
7. Did you have any problems charging? Yes ✓ No
   If yes, please describe*

INTERIOR
1. The heater provides adequate heat ✓
2. The air conditioner provides adequate cooling ✓
3. The vehicle is quiet ✓
4. Did you use electronic equipment (cell phone, radio, etc.) inside the EV? Yes ✓ No
   If yes, please list equipment(s) and describe any problems encountered*

GENERAL
1. The vehicle has adequate payload ✓
2. The vehicle has adequate range ✓
3. The vehicle is easy to operate ✓
4. The vehicle is suited for your job application ✓
5. The vehicle meets your expectations ✓
6. If you had to choose between this vehicle or a similar gasoline vehicle for use in your work, which one would you select? (Circle One) Electric Vehicle ✓ Gasoline Vehicle No preference
   Either

COMMENTS*
What did you like best? No Gas Station Visits
What did you like least? ________________

SA: Strongly Agree; A: Agree; NS: Not Sure; D: Disagree; SD: Strongly Disagree; NA: Not Applicable

* Please use the back of this form if you need additional space.

Revised: 03/03/99 © Copyright 1999 SCE
**Electric Vehicle Driver Questionnaire**

**Participant**: SCE

**Driver Name**: Cecilia Mushinskie  
**Location**: Rosemead  
**Vehicle Number**: 23642  
**Vehicle Make & Model**: Ford Ranger  
**Vehicle Application**: Fleet Testing  
**Date**: 5/21/99

### Driveability
1. The vehicle feels stable and safe  
2. The vehicle steering is responsive  
3. The vehicle acceleration is adequate  
4. The vehicle braking is responsive and safe  

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### Driving Controls and Gauges
1. The cabin temperature controls are easy to operate  
2. The "state-of-charge" gauge is helpful and easy to read  
3. The "range remaining" gauge is helpful and easy to read  

<table>
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</table>

### Charging Controls and Gauges
1. The charging controls are easy to operate  
2. The charging connector (plug) is easy to use  
3. The charging cord is easy to manage  
4. The vehicle charges adequately (full in the morning)  
5. The charger is reasonably quiet  
6. Do you know the differences between Inductive and Conductive charging?  
   - Yes  
   - No  
   If yes, which do you prefer?  
   - Inductive  
   - Conductive  
   - No preference  
7. Did you have any problems charging?  
   - Yes  
   - No  
   If yes, please describe:

### Interior
1. The heater provides adequate heat  
2. The air conditioner provides adequate cooling  
3. The vehicle is quiet  
4. Did you use electronic equipment (cell phone, radio, etc.) inside the EV?  
   - Yes  
   - No  
   If yes, please list equipment(s) and describe any problems encountered:

### General
1. The vehicle has adequate payload  
2. The vehicle has adequate range  
3. The vehicle is easy to operate  
4. The vehicle is suited for your job application  
5. The vehicle meets your expectations  
6. If you had to choose between this vehicle or a similar gasoline vehicle **for use in your work**, which one would you select?  
   - (Circle One)  
     - Electric Vehicle  
     - Gasoline Vehicle  
     - Either

### Comments:
- What did you like best?  
- What did you like least?  

**SA**: Strongly Agree; A: Agree; NS: Not Sure; D: Disagree; SD: Strongly Disagree; NA: Not Applicable

*Please use the back of this form if you need additional space.*

Revised: 03/03/99  
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SCE Electric Vehicle Driver Questionnaire

DRIVER NAME: Roger Thornton
LOCATION: General Office 1
VEHICLE #: 24471
VEHICLE MAKE & MODEL: FORD RANGER
VEHICLE APPLICATION: Reability Testing
DATE: Dec 29, 99

DRIVEABILITY
1. The vehicle feels stable and safe
2. The vehicle steering is responsive
3. The vehicle acceleration is adequate
4. The vehicle braking is responsive and safe

DRIVING CONTROLS AND GAUGES
1. The cabin temperature controls are easy to operate
2. The “state-of-charge” gauge is helpful and easy to read
3. The “range remaining” gauge is helpful and easy to read

CHARGING CONTROLS AND GAUGES
1. The charging controls are easy to operate
2. The charging connector (plug) is easy to use
3. The charging cord is easy to manage
4. The vehicle charges adequately (full in the morning)
5. The charger is reasonably quiet
6. Do you know the differences between Inductive and Conductive charging? Yes No
   If yes, which do you prefer? Inductive Conductive No preference
7. Did you have any problems charging? Yes No
   If yes, please describe

INTERIOR
1. The heater provides adequate heat
2. The air conditioner provides adequate cooling
3. The vehicle is quiet
4. Did you use electronic equipment (cell phone, radio, etc.) inside the EV? Yes No
   If yes, please list equipment(s) and describe any problems encountered

GENERAL
1. The vehicle has adequate payload
2. The vehicle has adequate range
3. The vehicle is easy to operate
4. The vehicle is suited for your job application
5. The vehicle meets your expectations
6. If you had to choose between this vehicle or a similar gasoline vehicle for use in your work, which one would you select? Electric Vehicle Gasoline Vehicle Either

COMMENTS
What did you like best? I enjoy the ease of charging at home and work.
What did you like least? Range, I would like to travel further between charges.

SA: Strongly Agree; A: Agree; NS: Not Sure; D: Disagree; SD: Strongly Disagree; NA: Not Applicable

* Please use the back of this form if you need additional space.
Revised: 03/03/99
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**Electric Vehicle Driver Questionnaire**

**Participant:** City of Avalon

**Driver Name:** Pastor Lover Jr.

**Vehicle Number:** 23642

**Vehicle Make & Model:** Ford Ranger

**Date:** 27 Sept 1999

### Driveability
1. The vehicle feels stable and safe
2. The vehicle steering is responsive
3. The vehicle acceleration is adequate
4. The vehicle braking is responsive and safe

### Driving Controls and Gauges
1. The cabin temperature controls are easy to operate
2. The "state-of-charge" gauge is helpful and easy to read
3. The "range remaining" gauge is helpful and easy to read

### Charging Controls and Gauges
1. The charging controls are easy to operate
2. The charging connector (plug) is easy to use
3. The charging cord is easy to manage
4. The vehicle charges adequately (full in the morning)
5. The charger is reasonably quiet

6. Do you know the differences between Inductive and Conductive charging? **Yes** / **No**
   - If yes, which do you prefer? **Inductive** / **Conductive** / **No preference**
7. Did you have any problems charging? **Yes** / **No**
   - If yes, please describe: "We are on call 24 hrs a day. It is not feasible to have a vehicle on charge".

### Interior
1. The heater provides adequate heat
2. The air conditioner provides adequate cooling
3. The vehicle is quiet
4. Did you use electronic equipment (cell phone, radio, etc.) inside the EV? **Yes** / **No**
   - If yes, please list equipment(s) and describe any problems encountered:

### General
1. The vehicle has adequate payload
2. The vehicle has adequate range
3. The vehicle is easy to operate
4. The vehicle is suited for your job application
5. The vehicle meets your expectations

6. If you had to choose between this vehicle or a similar gasoline vehicle for use in your work, which one would you select? **Electric Vehicle** / **Gasoline Vehicle** / **Either**

### Comments:
- What did you like best? **ACCELERATES RAPIDLY**
- What did you like least? **THE RANGE DIMINISHED AFTER TIME. A PASSANGER OR A LOAD GO DOWN RAPIDLY**

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<tr>
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*Please use the back of this form if you need additional space.*
SCE Electric Vehicle Driver Questionnaire

**DRIVEABILITY**
1. The vehicle feels stable and safe
2. The vehicle steering is responsive
3. The vehicle acceleration is adequate
4. The vehicle braking is responsive and safe

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**DRIVING CONTROLS AND GAUGES**
1. The cabin temperature controls are easy to operate
2. The "state-of-charge" gauge is helpful and easy to read
3. The "range remaining" gauge is helpful and easy to read

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<tr>
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**CHARGING CONTROLS AND GAUGES**
1. The charging controls are easy to operate
2. The charging connector (plug) is easy to use
3. The charging cord is easy to manage
4. The vehicle charges adequately (full in the morning)
5. The charger is reasonably quiet
6. Do you know the differences between Inductive and Conductive charging? _Yes _No
   If yes, which do you prefer? _Inductive _Conductive _No preference
7. Did you have any problems charging? _Yes _No
   If yes, please describe*

**INTERIOR**
1. The heater provides adequate heat
2. The air conditioner provides adequate cooling
3. The vehicle is quiet
4. Did you use electronic equipment (cell phone, radio, etc.) inside the EV? _Yes _No
   If yes, please list equipment(s) and describe any problems encountered*

**GENERAL**
1. The vehicle has adequate payload
2. The vehicle has adequate range
3. The vehicle is easy to operate
4. The vehicle is suited for your job application
5. The vehicle meets your expectations
6. If you had to choose between this vehicle or a similar gasoline vehicle for use in your work, which one would you select? (Circle One) Electric Vehicle Gasoline Vehicle _Either_

**COMMENTS***
What did you like best?

What did you like least?

---

* SA: Strongly Agree; A: Agree; NS: Not Sure; D: Disagree; SD: Strongly Disagree; NA: Not Applicable

* Please use the back of this form if you need additional space.

Revised: 03/03/99

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Electric Vehicle Driver Questionnaire
Participant: SCE

DRIVER NAME: V. J. Sreedharan
LOCATION: Pomona

VEHICLE NUMBER: 23639
VEHICLE MAKE & MODEL: Ranger

VEHICLE APPLICATION: 

DATE: 

**DRIVEABILITY**

1. The vehicle feels stable and safe

2. The vehicle steering is responsive

3. The vehicle acceleration is adequate

4. The vehicle braking is responsive and safe

**DRIVING CONTROLS AND GAUGES**

1. The cabin temperature controls are easy to operate

2. The “state-of-charge” gauge is helpful and easy to read

3. The “range remaining” gauge is helpful and easy to read

**CHARGING CONTROLS AND GAUGES**

1. The charging controls are easy to operate

2. The charging connector (plug) is easy to use

3. The charging cord is easy to manage

4. The vehicle charges adequately (full in the morning)

5. The charger is reasonably quiet

6. Do you know the differences between Inductive and Conductive charging?
   - Yes: X, No: __

   If yes, which do you prefer?
   - Inductive: ____, Conductive: ____, No preference: __

7. Did you have any problems charging?
   - Yes: X, No: __

   If yes, please describe: __

**INTERIOR**

1. The heater provides adequate heat

2. The air conditioner provides adequate cooling

3. The vehicle is quiet

4. Did you use electronic equipment (cell phone, radio, etc.) inside the EV?
   - Yes: X, No: __

   If yes, please list equipment(s) and describe any problems encountered: __

**GENERAL**

1. The vehicle has adequate payload

2. The vehicle has adequate range

3. The vehicle is easy to operate

4. The vehicle is suited for your job application

5. The vehicle meets your expectations

6. If you had to choose between this vehicle or a similar gasoline vehicle for use in your work, which one
   - You would select: (Circle One) Electric Vehicle, Gasoline Vehicle, Either

**COMMENTS**

What did you like best? **EASE OF OPERATION**

What did you like least? **LIMITED VONAGE**

SA: Strongly Agree; A: Agree; NS: Not Sure; D: Disagree; SD: Strongly Disagree; NA: Not Applicable

* Please use the back of this form if you need additional space.