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Idaho National Engineering and Environmental Laboratory

# Doe Field Operations Program EV and HEV Testing

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# DOE Field Operations Program – EV and HEV Testing PP017

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## Abstract

The United States Department of Energy's (DOE) Field Operations Program tests advanced technology vehicles (ATVs) and disseminates the testing results to provide fleet managers and other potential ATV users with accurate and unbiased information on vehicle performance. The ATVs (including electric, hybrid, and other alternative fuel vehicles) are tested using one or more methods - Baseline Performance Testing (EVAmerica and Pomona Loop), Accelerated Reliability Testing, and Fleet Testing. The Program (http://ev.inel.gov/sop) and its nine industry testing partners have tested over 30 full-size electric vehicle (EV) models and they have accumulated over 4 million miles of EV testing experience since 1994. In conjunction with several original equipment manufacturers, the Program has developed testing procedures for the new classes of hybrid, urban, and neighborhood EVs. The testing of these vehicles started during 2001.

The EVS 18 presentation will include (1) EV and hybrid electric vehicle (HEV) test results, (2) operating experience with and performance trends of various EV and HEV models, and (3) experience with operating hydrogen-fueled vehicles. Data presented for EVs will include vehicle efficiency (km/kWh), average distance driven per charge, and range testing results. The HEV data will include operating considerations, fuel use rates, and range testing results.

**Keywords**: EV (electric vehicle), HEV (hybrid electric vehicle), vehicle performance, fleet, range.

## 1 Introduction

The Field Operations Program provides fleet managers and other potential advanced technology vehicle (ATV) users with accurate and unbiased information on vehicle performance. This allows the purchaser to make informed decisions about acquiring and operating ATVs. Vehicle information is obtained by testing ATVs in conjunction with industry partners and disseminating the testing results. The ATVs are tested using three methods - Baseline Performance Testing, Accelerated Reliability Testing, and Fleet Testing. The testing results are disseminated on the Program's Website (http://ev.inel.gov/sop) in the form of vehicle fact sheets, summary reports, and survey results. Additional information on the Website includes testing procedures as well as general information about ATVs, such as how they work and their histories.

The Field Operations Program conducts its testing in conjunction with industry partners. The Program signed a 5-year testing agreement in 1999 with the following group of Qualified Vehicle Testers (QVTs):

- Electric Transportation Applications (lead partner)
- Arizona Public Service
- Southern California Edison
- Potomac Electric Power Company
- Salt River Project
- Virginia Power
- Bank One of Arizona
- Southwest Airlines
- American Red Cross.

DOE's Office of Transportation Technologies (under the Office of Energy Efficiency and Renewable Energy) manages the Field Operations Program, which is conducted jointly by the Idaho National Engineering and Environmental Laboratory (INEEL) in Idaho Falls, Idaho, and the National Renewable Energy Laboratory in Golden, Colorado. The program works with commercial and government fleets, and industry groups to support the testing and deployment of ATVs in today's evolving transportation market. Test procedures are developed jointly with industry stakeholders to measure real-world performance. The Field Operations Program's activities comprise four areas:

- Light-Duty Electric Vehicles
- Light-Duty Hybrid and Fuel Cell Vehicles
- Light-Duty Alternative Fuel Vehicles
- Medium- and Heavy- Duty Advanced Technology Vehicles.

The INEEL manages the first two program areas. These testing activities and the results are discussed in this paper, grouped by testing activity.

- Light-Duty Electric Vehicles – Sections 2, 3, and 4
- Light-Duty Hybrid Vehicles – Section 5
- Hydrogen Vehicles – Section 6
- Postal Service Light-Duty Electric Vehicles – Section 7
- Conclusion – Section 8

# 2 Light-Duty Electric Vehicle Testing

The Field Operations Program, in conjunction with its Qualified Vehicle Testing (QVT) partners, uses several testing methods to validate full-size EV performance. The testing results are discussed by testing method.

## 2.1 EV Baseline Performance Testing Methods

The Field Operations Program has traditionally used two Baseline Performance testing methods, EVAmerica and Pomona Loop testing.

### 2.1.1 EVAmerica Testing Results

The EVAmerica testing is conducted on closed tracks and dynamometers, and the results are highly repeatable. The test parameters include acceleration, three types of range tests, gradeability, handling, charging, maximum speed, braking, and minimum safety standards that the vehicles must meet.

The Field Operations Program and its QVT partners have conducted EVAmerica Baseline Performance testing on 21 vehicle models since 1994. Test vehicles include the Chevrolet S-10, Chrysler EPIC, Ford Ranger, General Motors EV1, and Toyota RAV4. These vehicles were equipped with nickel-metal-hydride (NiMH) battery packs. The test results provide a good characterization of vehicle performance. The testing has documented range increases of up to 150% when comparing the 1998 test vehicles to the 1994 test vehicles (Figure 1). The 1998 results include a drive-cycle range of 225 kilometers (km) for the General Motors EV1 (Figure 2).

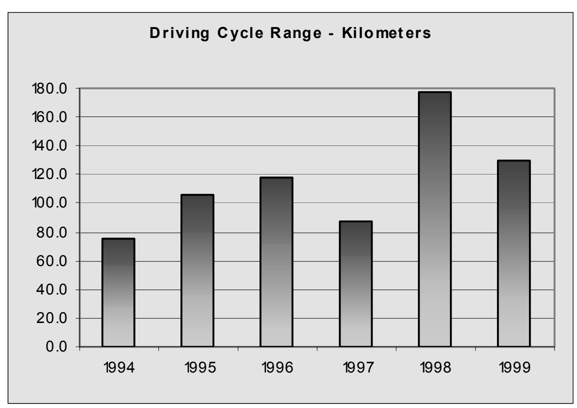



**Figure 1**: EVAmerica drive cycle (SAE J1634) average annual testing results.

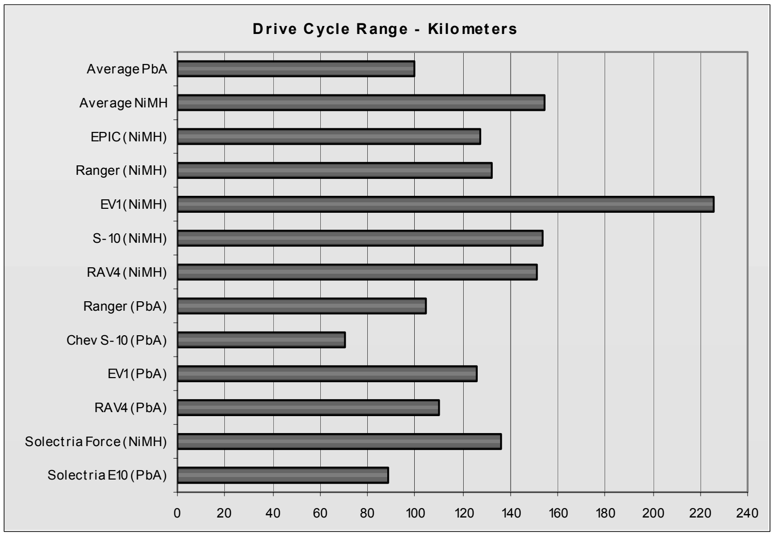



**Figure 2:** EVAmerica individual testing results for SAE J1634 drive cycle tests. (Not all vehicles shown).

All three of the range tests (Driving Cycle, Constant Speeds at 72 and 97 km/h) exhibit similar trends – continuing improvements in electric vehicle performance. The 1997 decreases in range can be at least partially attributed to the type of vehicles tested that year. Both of the 1997 test vehicles were pickups, with lead acid batteries, intended for use in utility types of fleet applications.

The 1998 results were driven by the NiMH equipped EV1. The EV1 had the highest test results to date; it went 356 km in the 72-km/h constant speed test and 259 km in the 97-km/h constant speed test. The two pickups tested during 1999 were also equipped with NiMH batteries and they averaged 143 km for the drive-cycle test, 198 km in the 72 km/h constant speed test, and 130 km in the 97-km/h constant speed test. The 1999 results did not increase compared to the 1994 – 1997 years; vehicles other than the EV1 with NiMH batteries simply could not replicate the 1998 results.

The average annual acceleration tests (performed at 50% state-of-charge) show an overall increase in vehicle performance (Figure 3). The average annual time to accelerate from 0 to 80 km/h has decreased from the 24-second average recorded during 1994 to 12 seconds for the 1999 test vehicles. The 1996 vehicles averaged 10 seconds in the acceleration testing. The lead-acid EV1, tested during 1996, had a 0 to 80-km/h-acceleration time of 6.7 seconds at a 50% state-of-charge. At 100% state-of-charge, the EV1 accelerated from 0 to 80 km/h in 6.3 seconds.

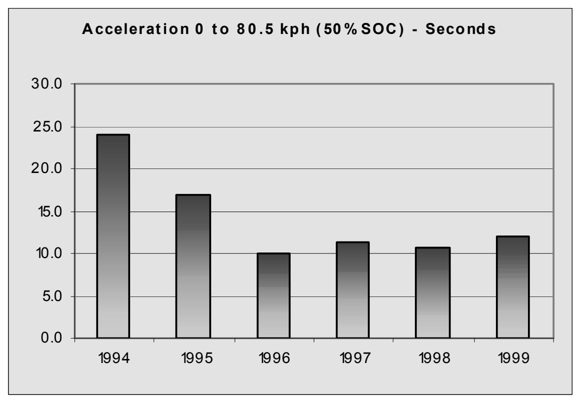



**Figure 3**: EVAmerica acceleration results.

The single most important factor for increasing vehicle range is the amount of kWh stored onboard in a vehicle's battery. Increasing kWh can be accomplished by increasing the number of batteries onboard or using a higher-capacity battery technology. NiMH batteries were used on seven vehicles to increase range. The higher specific energy of NiMH batteries is evident when looking at Figure 4. During 1995, two out of the three test vehicles were equipped with NiMH batteries, as were all five vehicles tested during 1998 and 1999. During 1994, 1996, and 1997, lead-acid batteries were used in 12 of the

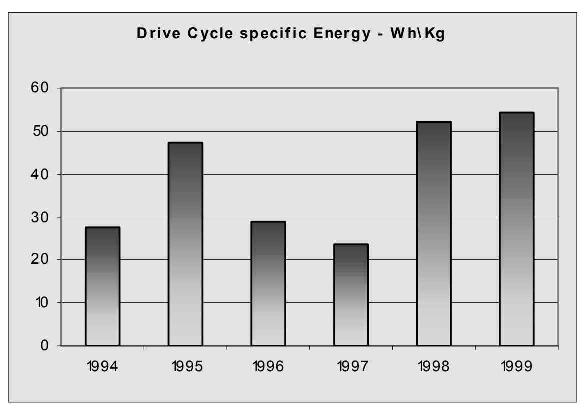



**Figure 4:** Average specific energy (watt-hours per kilogram) of the EVAmerica test vehicles.

13 vehicles tested (one 1994 vehicle used Nickel Iron batteries). The watt-hours per kilogram of the two NiMH battery packs used in the 1999 test vehicles is 130% greater than the lead acid battery packs in the two 1997 test vehicles.

### 2.1.2 Pomona Loop Testing Results

The Field Operations Program also supports the Urban and Highway Pomona Loop testing performed in Southern California. In addition to confirming EVAmerica test results, the Pomona Loop testing sometimes provides access to vehicles that are only available in California. In contrast to the "closed track" nature of the EVAmerica Baseline Performance tests, the Pomona Loop tests are performed on Southern California urban streets and area freeways. The Urban Loop test is 31.1 km long and its elevation varies from 274 to 457 meters above sea level. The Freeway Loop is 59.9 km long and its elevation varies from 213 to 351 meters above sea level. The loops are fair representations of "typical" Southern California driving patterns. The tested vehicles are driven on each loop four times. Each trip is driven with either the minimum or maximum payloads, and either with or without auxiliary power loads (such as air conditioning).

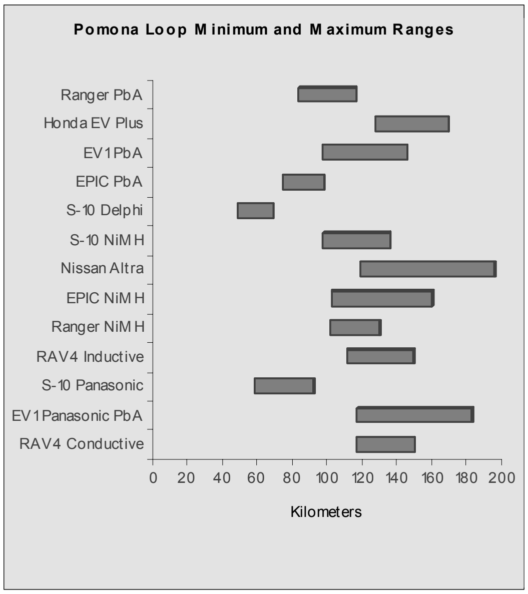



**Figure 5**: Range testing results for the 13 vehicles Pomona Loop tested. The results include all eight driving tests conducted on the Urban and Freeway Loops.

The Pomona Loop testing results (Figure 5) include the minimum and maximum mileage results for all eight Urban and Freeway tests. The graph ranges include the four testing scenarios for each Loop. (Additional testing and vehicle information is available at http://ev.inel.gov/fop/sce/default.htm).

Generally, the Pomona Loop testing results are lower than the Baseline Performance testing results. The Urban Pomona Loop test includes over 50 stop signs and traffic lights, while the Constant Speed tests do not include stops and reacceleration. The Freeway Pomona Loop can include many stops, depending on traffic conditions. The lowest range results for the Baseline Performance test vehicles occurs during the EVAmerica 97-km/h Constant Speed testing. The highest range results for the Baseline Performance test vehicles occurs during the EVAmerica 72-km/h Constant Speed testing.

## 2.2 EV Accelerated Reliability Testing

The Accelerated Reliability testing is similar to the Fleet Operations testing with the important difference that the vehicles are operated in an accelerated mileage mode. That is, the QVTs operate each vehicle up to 40,000 km per year (48,000 km for vehicles equipped with advanced batteries). The goal is to obtain several years of traditional fleet-use operations data within a single year. The information collected includes energy use, maintenance requirements, and the effects of accumulated driving on vehicle performance and range. Energy use is collected with kWh meters mounted onboard the vehicles conductively charged or mounted on dedicated chargers for vehicles that are inductively charged. Several other parameters are calculated, including km per kWh and charging profiles, not only for entire fleets, but also for single model types and individual vehicles. Toyota RAV4s and Chevrolet S-10s were Accelerated Reliability tested. As an example of the Accelerated Reliability testing activities, some of the RAV4s testing results are discussed below.

Three RAV4s were range tested when they were delivered to SCE and subsequently during Accelerated Reliability testing. Testing was conducted on the Urban Pomona Loop with minimum payload (driver only) and no auxiliary loads. Most of the tests were conducted with all three vehicles following each other to minimize the effects of varying ambient conditions, traffic, and driving style. The ranges listed in Table 1 are the mileage readings when reaching the “stop condition” (flashing charge light). As seen in the Table, the range for all three vehicles varied from 141 km to 173 km. The reasons for the variation in range are not completely clear. However, the most obvious possibilities are declining battery capacity, the effect of ambient temperature on battery capacity, and the so-called “memory effect.” Although the range varied directly with ambient temperature (Figure 6), the data was not clear enough to make a definite conclusion; several causes probably contributed.

**Table 1**: Periodic range testing results for the three RAV4s.

| Odometer (kilometers) | Average Temperature (C) | Range (Kilometers) |
|---|---|---|
| Vehicle 1 | | |
| 13 | 29 | 155 |
| 9,226 | 30 | 164 |
| 13,592 | 17 | 142 |
| 25,338 | 26 | 159 |
| 32,277 | 24 | 147 |
| | Average Range | 153 |
| Vehicle 2 | | |
| 16 | 29 | 173 |
| 14,500 | 14 | 141 |
| 28,217 | 26 | 163 |
| 39,525 | 24 | 150 |
| | Average Range | 157 |
| Vehicle 3 | | |
| 27 | 29 | 168 |
| 15,578 | 15 | 142 |
| 18,440 | 26 | 147 |
| 30,977 | 26 | 159 |
| 41,268 | 24 | 155 |
| | Average Range | 154 |
| | Overall Average Range | 155 |

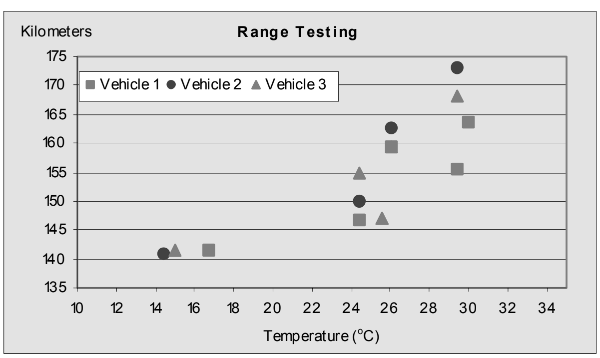



**Figure 6:** Range testing results of Toyota RAV4s at various temperatures.

## 2.3 EV Fleet Testing

In this testing process, the QVTs collect data on electric vehicles used in normal fleet operations within their respective commercial fleets. The data collected includes energy use, mileage, and maintenance requirements. While vehicles placed in Fleet testing do not normally accumulate vehicle data as quickly as during accelerated reliability testing, the Fleet testing is as “real world” as possible. In addition to providing non-controlled testing data, it also acts as a reality check against Baseline Performance and Accelerated Reliability testing results. Fleet testing is dichotomous to laboratory testing, in that the test vehicles are exposed to variables that are often unanticipated. However, this is the reality of how drivers use the vehicles and the best measure of how well a vehicle performs.

Figure 7 highlights how fleet-testing results can differ from dynamometer and track testing. All three bars for each of the four vehicles measure km driven per kWh charged. (The charging efficiency was not measured for the Nissan Altra). As measured in km driven per kWh, the least efficient energy use occurred during fleet testing with the four vehicles averaging 2.7 km/kWh (Table 2). The average energy use for the four vehicles during the drive-cycle dynamometer testing (SAE J1634) was 5.4 km/kWh. The average EVAmerica charging efficiency results for the three vehicles was 3.5 km/kWh. The average fleet energy use results were 50% lower than the average drive cycle efficiency results and 23% lower than the EVAmerica charging efficiency results. Generally, hotel loads while on charge in fleet use contributes to lower energy efficiencies. These hotel loads can include heating and cooling vehicle battery packs and passenger cabins. Extended time left on charge, such as over weekends, will also lower energy efficiencies.

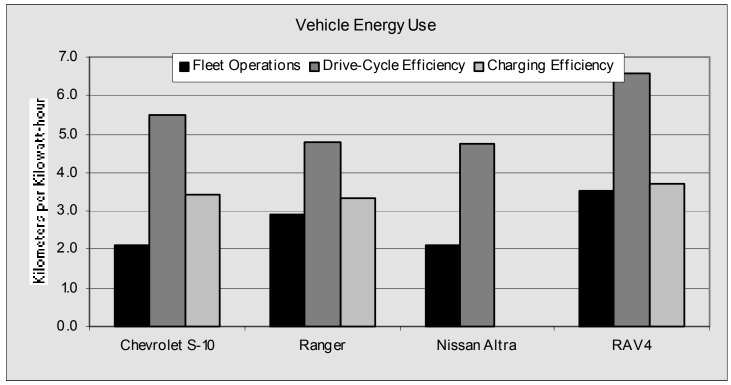



**Figure 7**: Energy efficiency based on kilometers traveled per kilowatt-hour of energy.

**Table 2**: Energy use (kilometers per kilowatt-hour) measured during Fleet, EVAmerica Drive Cycle (SAE J1634) and EVAmerica Charging Efficiency tests. The Nissan Altra drive cycle data is the average efficiency for the eight Pomona Loop tests. N/A - Not available.

| Vehicle | Fleet Operations | Drive Cycle | Charging Efficiency |
|---|---|---|---|
| Chevrolet S-10 | 2.1 | 5.5 | 3.4 |
| Ford Ranger | 2.9 | 4.8 | 3.3 |
| Nissan Altra | 2.1 | 4.7 | N/A |
| Toyota RAV4 | 3.5 | 6.6 | 3.7 |
| Average | 2.7 | 5.4 | 3.5 |

Fleet testing can also generate energy use information that cannot be collected during controlled testing. For instance, Figure 8 shows the average charge load profile for 18 Toyota RAV4s. The data is plotted for 24 hours, as 1-hour energy use periods, running left to right, from 1 a.m. to midnight. The highest average energy use occurs at 5 p.m. and the lowest at 7 a.m. The maximum energy used in any 15 minute period was 1.41 kWh and the total quarterly energy used for the 18 RAV4s was 7,343 kWh.

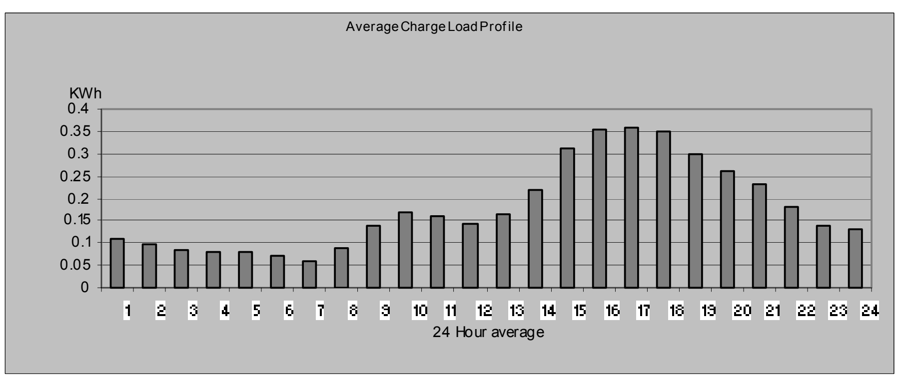



**Figure 8**: Average Charge Load Profile for 18 Toyota RAV4s.

# 3 Neighborhood Electric Vehicle Testing

A neighborhood electric vehicle (NEV) is 4-wheeled, generally larger than a golf car in size, but smaller than most light-duty passenger vehicles. NEVs are usually configured to carry two or four passengers (Figures 9–11), or two passengers with a pickup bed or maintenance equipment.

NEVs are defined by the United States National Highway Traffic Safety Administration as subject to Federal Motor Vehicle Safety Standard (FMVSS) No. 500 (49 CFR 571.500). Per FMVSS 500, NEVs have top speeds between 32 and 45 km/h and are defined specifically as "Low Speed Vehicles" (LSV). While "Low Speed Vehicle" is technically the correct term, "NEV" has become the term used by industry and fleets to refer to passenger vehicles subject to FMVSS 500.

**Figure 9:** NEV from Ford/Th!nk.

FMVSS 500 requires that NEVs be equipped with headlamps, stop lamps, turn signal lamps, tail lamps, reflex reflectors, parking brakes, rear view mirrors, windshields, seat belts, and vehicle identification numbers. About 30 states have passed legislation or regulations allowing NEVs to be licensed and driven on roads that generally are posted at 56 kph.

**Figure 10**: NEV from Global Electric Motor (GEM).

While NEVs were initially used in gated communities, they have been increasingly used by the general public for neighborhood types of applications such as transporting kids to school, shopping, and general neighborhood trips. NEVs are very cost efficient, in terms of initial capital costs, fuel costs, and overall operating expenses.

As part of its 2003 zero emissions mandates for full-size light-duty and sport utility vehicles, the California Air Resources Board (CARB) approved 4 credits for NEVs used in California during the years 2001 and 2002, with decreasing credits after 2002. Many expect that NEVs will be used by original equipment automotive manufacturers to meet at least part of their zero emission mandates by 2003.

**Figure 11**: NEV from Frazier Nash.

In addition to the above uses, many federal, private, and public fleets are increasingly using NEVs at military bases, national parks, and commercial airports, and for local government activities. NEVs are reducing petroleum use and simplifying fueling requirements by decreasing or eliminating the need for gasoline infrastructure. For federal fleets, NEVs can significantly decrease petroleum use, helping the federal fleets comply with Executive Order 13149 (Greening The Government Through Federal Fleet and Transportation Efficiency) which requires a 20% decrease in annual petroleum use by fiscal year 2005.

To better understand how fleets are using NEVs, and if and how the Field Operations Program should be testing NEVs, fifteen fleets were surveyed concerning their use of NEVs. The fifteen fleets operate a total of 348 NEVs in a variety of missions. The fleets include military, commercial, municipal, rental, and transportation organizations. The average size of the fifteen NEV fleets is 23 NEVs and the median size is 10 NEVs. The NEV fleets range in size from 2 to 82 NEVs. Thirty percent of the 348 NEVs were purchased as replacement vehicles. Fifty-six percent of the NEVs are used only on private roads, 32% are used only on public roads, and 12% are used on both public and private roads. The fleets reported that 91% of the 348 NEVs did not have any problems; 4% of the NEVs have had their battery packs replaced. The fleets are charging 99% of their NEVs at 110 volts.

The NEVs' contribution to petroleum avoidance and cleaner air can be estimated based on the miles driven information provided by the fleets, and by assuming gasoline use and air emissions values. Gasoline and emissions data for a Honda Civic are used as the Civic has the best fuel efficiency for a gasoline-powered vehicle and very clean emissions. The 348 NEVs are being driven a total of about 1.9 million kilometers per year. This equates to an average of 5,200 km per NEV annually or 14 km per day. It is estimated that 110,515 liters of petroleum use is avoided annually by the 348 NEVs. This equates to 320 liters of petroleum use avoided per NEV, per year. Using the 348 NEVs avoids the generation of at least 352 kilograms of smog-forming emissions annually.

Given the increasing use of NEVs, the CARB mandates providing for NEV credits, that all of the large companies manufacturing vehicles in the United States have made investments to build NEVs, and the contribution NEVs make to decreasing petroleum use and air emissions, the Program has initiated NEV testing.

The first step was to develop Baseline Performance test procedures based on the EVAmerica test procedures. These are being adapted with active input from NEV manufacturers. The EVAmerica Baseline Performance test procedures require vehicle performance capabilities that the NEVs are not capable of, nor are they designed for. For instance, coast-down testing from 101 km/h is required for calibration of the drive cycle dynamometer testing.  The NEV EVAmerica procedures in final form will likely include one or more drive range tests on closed tracks, but certainly not the 72- and 97-km/h constant speed testing used with the original EVAmerica tests. In addition, the performance goals will be significantly lower than the EVAmerica goals.

Given the early development stage of the NEV industry, the testing activities will document if the NEVs comply with the FMVSS No. 500 standards. The Field Operations Program will be NEV EVAmerica Baseline Performance testing up to fifteen NEV models during the fall of 2001. In addition, the Program will also initiate NEV Fleet testing during October 2001; four fleets with 185 NEVs will participate.

# 4 Urban Electric Vehicle Testing

Urban electric vehicles (UEVs) have been developed (Figures 12 and 13) for use in urban applications, with top speeds of approximately 85 km/h. Similar to the NEVs, the UEVs are not capable of being tested with all of the EVAmerica procedures. The UEVs cannot attain 101 km/h for the coast-down tests, nor operate at the required 97 km/h for one of the constant speed tests.


**Figure 12:** City UEVfrom Ford/Th!nk.

Some of the new Urban EVAmerica performance goals include acceleration times of 0 to 48 km/h within 8.5 seconds, a minimum top speed of 72 km/h within 1.6 km, and a minimum range of 48 km when tested to the Urban Drive Cycle. The Urban EVAmerica technical specifications and test procedures are available on the Field Operations Program Website.

**Figure 13:** Toyota e-com UEV.

The Program will start Urban EVAmerica baseline performance testing during September 2001. Five models of UEVs are currently candidate test vehicles. In addition, fleet testing on 4 UEV models will start during January 2002, in as many as four different fleets.

# 5 Hybrid Electric Vehicle Testing

Hybrid electric vehicles require completely new test procedures given their potential operating scenarios. For instance, should HEVs be tested in pure electric modes, combined modes, or only in drive cycles when internal combustion engines provide energy and power? The Program is developing testing procedures that incorporate these and other operating scenarios while it performs initial Pomona Loop testing on HEVs such as the Honda Insight (Figure 14) and Toyota Prius (Figure 15). These initial tests will be used to refine the Hybrid EVAmerica testing procedures to incorporate the lessons learned. The existing Accelerated Reliability and Fleet test procedures are also being modified to accommodate these new-technology HEVs.

Testing changes include testing the HEV when it is operated in the "rechargeable energy storage system" (RESS) mode if it is capable of being driven in RESS mode only, so an HEV's "pure electric" range can be captured. HEVs will also be tested in the manufacturer-specified normal operating mode with testing to commence at a full (100%) state-of-charge. When applicable, both km-per-liter of fuel and the km-per-kWh will be captured as well as the HEV's range when operated in pure electric mode.

**Figure 14.** Honda Insight HEV.

When this paper was submitted, only the Honda Insight HEV had completed the initial Pomona Loop testing. (The Toyota Prius is scheduled for Pomona Loop testing during the summer of 2001). Both vehicles, as well as two additional HEV models, will be Hybrid EVAmerica Baseline Performance tested starting the fall of 2001. One Insight and one Prius will also be Accelerated Reliability tested for 1 year. In addition, a combination of up to 10 Insights and Priuses will be fleet tested in four fleets.

**Figure 15:** Toyota Prius HEV.

The initial Pomona Loop testing of the Insight demonstrated that how the vehicle is tested can significantly impact the energy consumption results. When the vehicle is tested in urban driving with a full payload and the air conditioning turned on maximum, the fuel economy dropped to 13.0 km per liter. With the air conditioning off and a minimum payload, the fuel economy was 22.2 km per liter. The highest average fuel economy was obtained during the freeway testing, when the Insight averaged 32.2 km per liter. The highest individual test was with the air conditioning off; the Insight used 5.5 liters of fuel to travel 186 km, averaging 33.8 km per liter. Note that these tests are being rerun to ensure the accuracy of the fuel use.

The Insight also underwent several performance tests. In six tests, it accelerated from 0 to 48 km/h in 4.2 seconds and from 0 to 97 km/h in 12.7 seconds. Over three tests, within a distance of 0.4 km, the Insight accelerated to an average top speed of 116 km/h in an average of 19.1 seconds.

# 6 Hydrogen Vehicle Testing

The Field Operations Program will be conducting operations and fueling evaluations on three hydrogen-powered vehicles. One vehicle will be a 100% hydrogen-fueled Mercedes van, and the other two vehicles will be blended compressed natural gas (CNG) Ford F150 pickups using 30% and 15% hydrogen fuel, respectively. The vehicles will be driven in a combination of fleet operations and with dedicated drivers to gain experience with the vehicles and the hydrogen/CNG refueling structure that supports them. These activities will commence by the end of 2001. Testing these hydrogen vehicles also provides hydrogen-fueling experience in preparation for future fuel cell vehicle testing activities.

# 7 USPS Electric Vehicle Testing

The Field Operations Program is supporting the U.S. Postal Services' (USPS) purchase of 500 light-duty electric delivery vehicles by providing testing and technical support to demonstrate the capabilities of the 500 light-duty electric delivery vehicles (Figure 16). The drive train, batteries, and electric components are all based on Ford Motor Company's electric Ford Ranger. The testing and demonstration activities include baseline performance testing, accelerated reliability testing, onboard data collection, field testing at three USPS locations in California and New York, and a final analysis of the entire 500 vehicle deployment.

Southern California Edison has performed the baseline performance tests, which includes gradeability, maximum speed, several range tests, energy consumption, water hazards, and overcharging rates. The highest dynamometer range results have been achieved during city drive cycles; the highway portion of the dynamometer testing lowers the range results. The city-drive cycle portion of the dynamometer testing and the Pomona Urban Loop testing may more closely resemble how the USPS vehicles will be used. The vehicles exceed the requirement to ascend a 25% grade at maximum payload. However, at maximum payload the dynamometer results decrease from 85 to 50 km.

**Figure 16.** U.S. Postal Service light-duty electric delivery vehicle being charged at Southern California Edison.

Southern California Edison has also been performing accelerated reliability testing on two additional vehicles; each one is driven 32,000 km within 1 year. To date, each vehicle has accumulated over 14,500 km. Range, energy use, and ambient temperatures are collected whenever the vehicles are driven. The two vehicles have been averaging 2.4 km per AC kWh. The vehicle ranges are periodically tested on the Pomona Urban Loop and the results have ranged from 62 to 78 km per charge, with an average of 70 km per charge. There have been some vehicle maintenance issues, as would be expected with a new production vehicle; the availability rate averages 97.5%.

# 8 Conclusion

The Field Operations Program supports the deployment of advanced technology vehicles by demonstrating vehicle performance and fleet suitability. The Program has evolved in step with industry to ensure the latest generations of vehicles are tested and the results disseminated in a timely manner. In continuing this history, the Program has initiated the testing of neighborhood electric, hybrid electric, and urban electric vehicles.

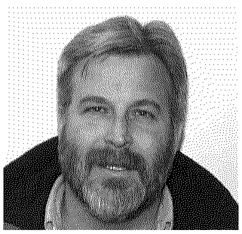
The initial EVAmerica testing of full-size pure-electric vehicles demonstrated the capabilities, and sometimes the lack of capabilities, of these early products. The resizing of pure electric vehicles to fit niche markets should result in greater market penetration. The NEVs are lower priced than the earlier full-size EVs, providing greater economic utilization while meeting the mission requirements of many fleets. That is, most of the NEVs should provide vehicle range capabilities (30+ km) that exceed many mission requirements. The manufacturing barriers to enter the NEV market are less than the full-size EV market, with the result that there is a greater need to ensure that the products are safe and perform as advertised. The Field Operations Program is developing a testing program to ensure the NEV purchaser that the NEVs perform as advertised.

While UEVs, with their higher advertised range capabilities (50+ km) and tops speeds, should be able to successfully function in station car and other urban missions, there is no historical record of their performance characteristics and life-cycle costs. As with the NEVs, the Field Operations Program is developing testing procedures and initiating the testing of several UEV models.

With the advent of commercially available HEVs, the Program has designed test procedures specifically for them. Testing will answer questions concerning their true fuel-use rates and the life of their propulsion batteries. While groups such as the Partnership for New Generation of Vehicles (PNGV) may have battery-life goals of 15 years, the Program will document the life of HEV battery packs with their advanced materials. The Program will also document HEV operational issues and life-cycle costs.

The Field Operations Program and its testing partners will continue to ensure that fleet managers and others have unbiased information to support their transportation technology decisions.

# 9 Authors



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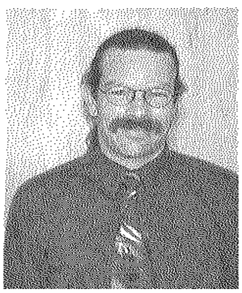

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