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Nissan Hypermini Urban Electric Vehicle Testing

TECHNICAL REPORT

Roberta Brayer
James Francfort

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Idaho National Laboratory
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Roberta Brayer[1]
James Francfort[2]

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Idaho National Laboratory
Transportation Technology Department
Idaho Falls, Idaho 83415

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[1] Electric Transportation Applications
[2] Idaho National Laboratory

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ABSTRACT

The U.S. Department of Energy's (DOE's) Advanced Vehicle Testing Activity (AVTA), which is part of DOE's FreedomCAR and Vehicle Technologies Program, in partnership with the California cities of Vacaville and Palm Springs, collected mileage and maintenance and repairs data for a fleet of eleven Nissan Hypermini urban electric vehicles (UEVs). The eleven Hyperminis were deployed for various periods between January 2001 and June 2005. During the combined total of 439 months of use, the eleven Hyperminis were driven a total of 41,220 miles by staff from both cities. This equates to an average use of about 22 miles per week per vehicle.

There were some early problems with the vehicles, including a charging problem and a need to upgrade the electrical system. In addition, six vehicles required drive system repairs. However, the repairs were all made under warranty.

The Hyperminis were generally well-liked and provided drivers with the ability to travel any of the local roads. Full charging of the Hypermini's lithium-ion battery pack required up to 4 hours, with about 8–10 miles of range available for each hour of battery charging. With its right-side steering wheel, some accommodation of the drivers' customary driving methods was required to adapt for different blind spots and vehicle manipulation. For that reason, the drivers received orientation and training before using the vehicle. The Hypermini is instrumented in kilometers rather than in miles, which required an adjustment for the drivers to calculate speed and range. As the drivers gained familiarity with the vehicles, there was increased acceptance and a preference for using it over traditional city vehicles. In all cases, the Hyperminis attracted a great amount of attention and interest from the general public.

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INTRODUCTION

The Department of Energy's (DOE's) Advanced Vehicle Testing Activity (AVTA), which is part of DOE's FreedomCAR and Vehicle Technologies Program, conducts advanced technology vehicle testing and data collection of vehicles such as the Nissan Hypermini. Testing the Hypermini, which features a lithium-ion battery pack, supports the AVTA goal to provide benchmark data of emerging technologies for technology modeling, and research and development programs conducted by DOE and industry partners. The testing results are also leveraged as input to component, system, and vehicle models, as well as hardware-in-the-loop testing. The Idaho National Laboratory (INL) provides activity management, technical, data acquisition, data analysis, and reporting support to the AVTA.

This study collected mileage and maintenance data for eleven Nissan Hypermini urban electric vehicles (UEVs) operating in two low-mileage fleets. As sometimes occurs when attempting to collect maintenance and operations data for advanced technology vehicles that are in manufacturer-controlled deployment test fleets, detailed data were difficult to obtain. For instance, specifics as to the repairs for charging and drive system problems were not provided by the manufacturer, which was their prerogative. Normally, the AVTA collects and disseminates vehicle operations and repair details, including all fuel use, in order to understand in depth the operating characteristics of advanced technology vehicles and various subsystems. Though the normal level of detailed reporting was not possible for the Nissan Hypermini test fleets, the information that was obtainable is reported here.

INL and its testing partner, Electric Transportation Applications of Phoenix, Arizona, conducted the AVTA testing activities described in this report. This report summarizes the data collected and presents lessons learned from Nissan Hypermini UEV operations in two California demonstration fleets.

BACKGROUND

Urban electric vehicles are used internationally as a viable means of transportation because the UEVs provide energy-reduction benefits and are well suited for metropolitan use. The UEVs' small utilitarian size is designed for short commutes and drivers find they are easy to drive and park. These specialty vehicles were introduced into the United States for a limited time and were incorporated into various fleets as test vehicles.

Urban Electric Vehicles

Urban Electric Vehicles are classified by the United States National Highway Traffic Safety Administration as passenger vehicles and must meet Federal Motor Vehicle Safety Standards. The UEV class of vehicles typically attains top speeds of about 60 mph. On a full charge, the vehicles have a reported range of 35 to 60 miles, but there are claims of ranges up to 100 miles on a single charge. Vehicle range depends on load, road and weather conditions, vehicle accessory use, and battery age and driver modus operandi.

Nissan Hypermini Demonstration Program

The Nissan Hypermini (Urban Electric City-Car) Demonstration Program was an effort to determine whether the UEV concept was viable in the United States. The Hypermini HEVs were considered to have commercial potential because of emission cleanliness, reduced energy consumption, lower operating costs, and the convenience of home charging. Nissan North America leased 30 Hyperminis in California to state municipalities and utility companies. The vehicles and chargers were leased for a period of three years at a cost of $99 per month, which included installation of the required charging unit. Under the

program, Nissan hoped to obtain real-world data to assess the marketability of electric-drive vehicles in California.

The Hypermini

The Nissan Hypermini, shown in the figures below, is 8.3 feet in length, 5 feet tall, and accommodates two passengers, with minimal cargo space. Locating the battery pack beneath the floor creates a low center of gravity and high road stability. The Hypermini has a top speed of 60 mph and a marketed range 60 miles. The vehicles were equipped with air conditioning, lithium-ion batteries, anti-lock braking, and dual air bags. The vehicles recharge in four hours using an inductive charger.

The Nissan Hypermini.

PARTICIPATING FLEETS

Nissan leased three Hypermini UEVs to the City of Vacaville in January 2001. Vacaville is a 27 square mile city of about 100,000 residents, located about 30 miles southwest of Sacramento in Northern California. Vacaville was able to lease an additional three Hypermini HEVs in May 2004. The UEVs were assigned to various departments and services: one to the Police Department for parking

enforcement, one to their recycling program (Public Works) for travel to promotional and educational events, one to their Central Garage, and three to Traffic and Engineering. The vehicles were used for a variety of work-related functions. This fleet was well-established, and some operations data had been collected before the city joined the AVTA test. The Vacaville Hypermini fleet was driven a total of 16,763 miles (Table 1) during a total of 204 months of use. Each Vacaville Hypermini was driven an average of about 20 miles per week.

Table 1. City of Vacaville Nissan Hypermini fleet mileage.

Vehicle location	Time in the Fleet	Total Miles
Parking Enforcement	Jan 2001 - June 2005	5,808
Public Works \ Recycling	Jan 2001 - June 2005	3,489
Central Garage	Jan 2001 - June 2005	2,006
Public Works/Engineering	May 2004 - June 2005	2,244
Public Works/Engineering	May 2004 - June 2005	2,415
Public Works/Engineering	May 2004 - June 2005	801
Total		16,763

The City of Palm Springs, which has about 50,000 full-time residents in its 96 square miles, 100 miles east of Los Angeles, also leased a UEV fleet as part of the Nissan program. This fleet consisted of five Nissan Hypermini HEVs. These vehicles were also used for city-based services, which included Parks and Recreation, Airport Services, City Hall, Planning and Code Enforcement, and Information Services/Print Shop. The City of Palm Springs Hypermini fleet was driven a total of 24,457 miles (Table 2) during a total of 235 months of use. Each City of Palm Springs Hypermini was driven an average of about 25 miles per week.

Table 2. City of Palm Springs Nissan Hypermini fleet mileage.

Vehicle location	Time in the Fleet	Total Miles
Parks and Recreation	April 2001 – Jan 2005	2,958
Airport	April 2001 – Jan 2005	4,511
City Hall	April 2001 – Jan 2005	7,028
Print Shop/Information Services	April 2001 – Jan 2005	4,091
Planning and Code Enforcement	April 2001 – Jan 2005	5,869
Total		24,457

The two fleets drove the eleven Hyperminis a total of 41,220 miles during the combined 439 months of use. The eleven Hyperminis averaged a combined 22 miles of use per week.

MAINTENANCE

Early in the program, the vehicles were repaired to correct a warranty-covered charging problem. In early 2002, the vehicles were recalled to upgrade the electrical system. Of the eleven Hypermini HEVs, six required drive system repairs. One of the vehicles was involved in a collision, resulting in a significant out-of-service period. As the vehicles aged, it was reported that the auxiliary battery on the

Hypermini would drain if the vehicle had not been driven for several days. This was a concern, because the vehicle could not be charged if the auxiliary battery was low. Frequently, the battery could be recovered with a charge or jump; however, two vehicles required replacement of the auxiliary batteries, which Nissan provided at no charge. In some cases, maintenance requiring replacement parts or specialty services resulted in the vehicle being placed out of service for significant periods of time. The delays prompted the City of Vacaville's central garage staff to initiate a preventative maintenance program. With the assistance of the local Nissan dealer, they were able to set up and conduct an effective program that involved such routine tasks as checking fluid levels and rotating tires. When replacement parts such as tires or batteries were required, Nissan would provide them to the garage, and the work would be done in the city's central garage, resulting in a dramatic decrease in out-of-service time.

LESSONS LEARNED

Owing to their flexibility and adaptability, UEVs proved to be a better application for city-wide fleet use than did neighborhood electric vehicles (NEV). Neighborhood electric vehicles are a class of small vehicles that have top speeds of only 25 mph and are generally limited to roads with speed limits of 35 mph or lower. NEVs usually do not have side doors and are not required by regulation to undergo crash testing. The NEVs are very popular in desert communities such as the Palm Springs area, where many residents drive NEVs on errands and to and from the many local golf resorts. Unlike NEVs, the UEVs were not limited by their top speeds, which increased available route options and offered additional safety and comfort for passengers. As with all electric vehicles, trip distance was a consideration because of range and charging limitations. Charging the batteries required about 2.5 to 4 hours to obtain a full charge. From experience with the Hypermini, about 8–10 miles of range was available for each hour of battery charging. With judicious placement of the chargers, the fleets could be used effectively for extending range. The best general charging option is to have a charge station available at the parking location, so the vehicle could be charged at the end of each trip. Unfortunately, the chargers used by the Vacaville and Palm Springs fleets were not equipped with meters, so an analysis of the cost of electricity and the fuel cost per mile was not obtained.

Driver training and familiarity with the vehicle was critical to fleet use and success. Because the driver sits on the right side of the Hypermini, it took some accommodation of the drivers' customary driving methods to adapt for different blind spots and vehicle manipulation. For that reason, the drivers received orientation and training before using the vehicle. The Hyperminis are instrumented in kilometers rather than in miles, which required another adjustment for the drivers to calculate speed and range.

The City of Vacaville assigned specific cars to members of their staff. As the driver gained familiarity with the vehicle, there was increased acceptance and a preference for using it over traditional city vehicles. In all cases, the vehicles attracted a great amount of attention and interest from the general public.