Kansas State University

Electric Vehicle Site Operator Program

Year 1

First Quarter Report

July 2, 1991 thru September 30, 1991

MASTER

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INTRODUCTION

Kansas State University

Kansas State University was founded in February 1863 as a land-grant institution under the Morrill Act. It has evolved into an internationally recognized comprehensive university that offers excellent academic programs, a lively intellectual and cultural atmosphere, and a friendly campus to its community of approximately 17,500 undergraduate and 3,500 graduate students.

The 668-acre main campus is in the northeastern Kansas community of Manhattan. Manhattan is approximately fifty miles to the west of the state's capitol of Topeka and eighty five miles west of Kansas City (a non-attainment area). For reference purposes, a state map is provided as Figure 1. The university offers more than 200 undergraduate degree programs and options, 60 master's degree programs, and 42 doctoral programs within its eight colleges; agriculture, arts and sciences, architecture and design, business administration, education, engineering, human ecology, and veterinary medicine.

FIGURE 1

K-State accomplishments have had far-reaching effects: astronaut space gloves and the water-purifying system used on the NASA space shuttles were developed here; two Kansas Centers of Excellence, one in manufacturing and one in value added research are located on campus; the University has national hazardous substance and atomic physics research programs; the Konza Prairie Research Natural Area is used for a

National Science Foundation ecological research study on erosion and prairie mammals; and a major national center for basic cancer research is located at K-State.

Paul Harvey, in a special commentary, labeled Kansas State University the "student scholar capital of the world." This statement was made based on the number of Rhodes, Trumans, Fulbrights, Mellons, Goldwaters, Phi Beta Kappas, Rotary Internationals, Javits, Tilden-Snow, and Marshalls scholarships that have been awarded to K-State students over the past sixteen years.

College of Engineering

The College of Engineering at Kansas State University has excellent programs in every aspect of engineering. The college has an enrollment of 2,600 undergraduate students and 300 graduate students and offers degrees or options in almost every major field of engineering, including aerospace, agricultural, architectural, biomedical, chemical, civil, computer, construction science, electrical, engineering technology, industrial, manufacturing, mechanical, and nuclear.

Kansas State's College of Engineering is recognized nationally for the quality of both its students and faculty. Approximately half of all K-State's National Merit Scholarship finalists enroll in the college.

For six consecutive years, one or more K-State students have been selected for the Washington, D.C., Internships for Students in Engineering program. Each year WISE selects a group of only 14 to 16 engineering students from more than 200 engineering colleges across the nation to work on the engineering and technology public policy issues.

Ray Dempsey, a senior in industrial engineering, was selected as the 1989-90 outstanding black engineer by the National Society of Black Engineers.

The K-State College of Engineering is one of only 10 colleges in the country to be cited twice by the National Society of Professional Engineers for its outstanding professional programs. The chapters of the departmental professional sectors have received national recognition. Most recently, agricultural engineering, civil engineering, and construction science have been designated as the outstanding student chapters in the nation.

Kansas Electric Utilities Research Program (KEURP)

Formed on July 15, 1981, the goal of this program is to undertake applied research and development projects which may enhance reliability and minimize the cost of electric service in Kansas. The Kansas Electric Utilities Research Program (KEURP) is a contractual joint venture between six major electric utilities that serve the residents of the State of Kansas:

Kansas Gas and Electric Company, Wichita, Kansas
KPL Gas Service, Topeka, Kansas
Kansas City Power & Light Company, Kansas City, Missouri
Centel Electric - Kansas, Great Bend, Kansas
The Empire District Electric Company, Joplin, Missouri
Midwest Energy, Inc., Hays, Kansas

The establishment of **KEURP** was made possible by the Kansas Corporation Commission that allowed Kansas electric utilities to include their research and development (R&D) costs in their operating expenses, including dues to the Electric Power Research Institute (EPRI).

Kansas' universities play a unique role in **KEURP** with representation on the executive, technical and advisory committees of the program. The universities receive significant direct and indirect support from **KEURP** through direct funded projects as well as **KEURP**/EPRI co-funded projects. **KEURP** is working with EPRI researchers on projects to develop or expand Kansas' knowledge and expertise in the fields of high technology and economic development. **KEURP** is a major source of funding in the EHV demonstration program.

ICE Corporation

ICE Corporation is an original equipment electronics manufacturer. Seventeen employees produce solid state and microprocessor based control systems for the aircraft, agriculture, and oil industries. Complete design and manufacturing facilities are located in Manhattan, Kansas.

Recently, ICE Corporation was one of seven Kansas companies that was awarded a SBIR grant. The grant, from the U.S. Army Small Business Innovation Research Program, was for \$436,000, earmarked to complete Phase II of ICE's research of high technology power switches.

Pat Connelly, president of ICE, said interest in the project is high. Connelly said that the new switches would be more compact and have a quicker switching time than those currently available. The switches may be used in anything from a computer to an automobile. As a member of KSU's team for the EHV demonstration program, ICE can demonstrate these new integrated circuit technology switches. ICE has provided KSU with a written commitment of \$2,000.00 per year in support of KSU's EHV demonstration program. Further, ICE Corporation is working on several motor controllers that may prove applicable in electric vehicles.

Hancock Electric Motor, Inc.

Hancock Electric Motor (HEM) is one of the largest electric motor repair facilities in the state of Kansas. The shop facilities in Lyons, Kansas, contain a welding shop (metalizing, welding, and chroming facilities), machine shop (500 ton horizontal press, 250 ton vertical press, horizontal boring machine, and a 60 inch engine lathe), dynamic balancing, vacuum pressure impregnation system, and capabilities to rewind electric motors with 13,200 volt 10,000 horsepower ratings. AC motors, DC motors, synchronous motors and generators, pumps, traction motors, locomotive main generators, alternators, generators, semihermetic motors, and haul truck wheel motors are all within the realm of HEM's repair capability. Further impedance testing can be done with the 750KVA core loss tester. Labor rates run \$40/hour with design and consulting costs at \$75/hour plus expenses. HEM is committed to helping KSU in EHV demonstration, research, testing, and evaluation and has provided a letter of commitment for \$2,000.00 per year for the life of DOE's contract.

PROGRAM PLAN

Statement of Objectives

Short Term Goals

1. Participate in the Department of Energy's Site Operator Program.
2. Evaluate Electric/Hybrid Vehicle technology through purchase of vehicles.
3. Collect EHV user data.
4. Provide reports to DOE and KEURP on EHV data collected.

Long Term Goals

1. Assist the nation in reversing environmental trends concerning air quality.
2. Assist Kansas City, a non-attainment area, in reducing air pollution.
3. Apply and develop technological enhancements to EHV's.
4. Assist Kansas-based companies in developing EHV sub-system components for commercial use.

Kansas State University, with funding support from federal, state, public, and private companies, is participating in the Department of Energy's Electric Vehicle Site Operator Program. Through participation in this program, Kansas State is demonstrating, testing, and evaluating electric or hybrid vehicle (EHV) technology. This participation will provide participating organizations the opportunity to examine the latest EHV prototypes under actual operating conditions. KSU proposes to purchase four (4) electric or hybrid vans and one (1) electric car during the first two years of this five year program. KSU has purchased one G-Van built by Conceptor Industries, Toronto, Canada and is actively involved in seeking to purchase one or two more vehicles this calendar year.

The G-Van, see front cover, has been signed in order for the general population to be aware that this is an electric drive vehicle. All financial participant's names have been stenciled on the back door of the van. Presently this vehicle is being loaned out to interested utilities and companies. When other vehicles are procured, the G-Van will be maintained on K-State's campus.

SIGNIFICANT EVENTS/MEETINGS/PUBLICITY

Slide Presentations

First Quarter

»» June 11 Kansas City Manager's Office
Kansas City, MO

Provided information to the Kansas City, Missouri city manager's office on electric and hybrid vehicles and the application of these vehicles in the city's fleet.

»» June 18 Electric Rural Cooperatives
Salina, KS

Presented a one-hour slide show on electric and hybrid vehicles. The DOE's Site Operator Program was discussed. Electric Rural Cooperatives are interested in participating but financially constrained from being major participants.

»» June 25 Manhattan Kiwanis Club
Manhattan, KS

Presented a one-hour slide show on electric and hybrid vehicles. The DOE's Site Operator Program was discussed.

»» September 27 Energy Research Group
Topeka, KS

Presented a one-hour slide show on electric/hybrid vehicles and DOE's Site Operator Program.

Second Quarter

»» October 4 Utility Fleet Managers
Kansas City, MO

»» October 22 Kansas State Engineering Technology Organization
Manhattan, KS

»» October 21 Senator Bob Dole and CEO's of Kansas Utilities
Manhattan, KS

»» October 25 Kansas Corporation Commission
Topeka, KS

»» October 28 Kansas State Engineering Honors Class
Manhattan, KS

»» January 16 Empire Electric
Joplin, MO

G-Van Media Events

First Quarter

G-Van was unavailable for media events during first quarter.

Second Quarter

»» October 3 WIBW TV Coverage of Site Operator Meeting
Manhattan, KS

»» October 9-13 Earth Awareness Exposition
Kansas City, MO

Conferences and Meetings

First Quarter

»» July 25 - 26 McKee Engineering and Soleq Corporation
Chicago, IL

Jim Hague visited Mr. Bob McKee and Mr. S. Ohba to discuss fabrication and production of electric vehicles, electric vehicle subsystems, and electric vehicle design.

»» August 14 - 16 South Central Electric Vehicle Consortium
Amarillo, TX

Two day meeting of the South Central Electric Vehicle Consortium, Electric Vehicle Development Corporation's G-Van User's Group and the Southwestern Public Service Companies Electric Van Demonstration Project.

Second Quarter

»» October 3 DOE Site Operator Program Kick-Off Meeting
Manhattan, KS

»» December 11 Electric Vehicle Users Group
Tampa, FL

NEW VEHICLES AND COMPONENTS

G-Van

As of September 30, 1991 Kansas State University's Site Operator Program had ordered and received the electric G-Van produced by Conceptor Industries, Newmarket, Ontario, Canada. The Rally-STX passenger version of the G-Van was ordered on July 30, 1991 with the following options:

- Sliding Side Door
- Deep Tinted Glass
- Auxiliary lighting
- Stainless Steel Dual Mirrors
- AM/FM ETR Stereo
- Custom Cloth High Back Bucket Seats
- Air Conditioning

The KSU G-Van, vehicle identification number (VIN) 29CGG35X1MN103048, was delivered to Elkins' Motors on August 15, 1991. Elkins is a GM truck dealership located in Manhattan, Kansas. Kansas State University received the G-Van from Elkins August 19, 1991. The vehicle read 23.3 miles on the odometer when KSU took delivery of the van. Based on K-State's experience with Conceptor Industries, Elkins' GMC dealership, and Chloride, significant improvements will need to be made in delivering electric vehicles to customers. This opinion was highlighted in K-State's Acceptance Report, dated September 17, 1991, to the Department of Energy.

G-Van Support Equipment

The vehicle charger was not delivered before the G-Van's arrival, as is the standard procedure with Conceptor Industries. The charger was delivered by freight carrier on August 26, 1991. Due to problems encountered during the switching of the charger from the 240 volt rating to the university's 208 volt rating the G-Van did not receive a complete charge until September 6, 1991. The circumstances surrounding this problem were highlighted in K-State's Acceptance Report, dated September 17, 1991, to the Department of Energy.

The water trolley, used to water batteries, was delivered to KSU by freight carrier on August 29, 1991. Two delay problems with the water trolley occurred. First, the water trolley was shipped with no form of protective packing. Failure to protect the water trolley in shipment resulted in a broken connection for the pumps main feed line. The repairs were a simple replacement of the broken part supplied by Conceptor. But, even with Conceptor's responsive service support, it still put the water trolley out of operation for one to two days. Second, the factory wiring of the water trolley caused problems with the unit. The water trolley was shipped with a standard American 110 volt (three prong) plug. The unit was connected to 110 volt service and didn't work. The unit was opened and a jumper showed the unit was set for 240 volt internally. The

jumper was reset for 110 volt operation and restarted. Fuses were blown inside the unit. Professor Hague and Mr. Royce Steinert spent approximately half a day finding replacement fuses, trouble shooting the water trolley, and rewiring the pump motor. Note: analysis revealed that a wire on the pump motor had to be reset to 110 volts. With these changes completed, the unit operated as expected. As a side note, it is interesting that Conceptor Industries faxed K-State a technical note on properly wiring the water trolley to correct the factory's improper internal setting of the system's voltage. But, this fax did not arrive until a week after the problem had already been discovered and corrected and more than a month after the trolley had been received. Conceptor Industries was never consulted during the water trolley wiring problem as the work was completed on a Sunday.

The wiring delays encountered on both the water trolley and the charger are problems which Conceptor and Chloride need to eliminate. Both devices, in the original delivery conditions, would be unacceptable to the general public and would have required service technicians to correct the problem.

Unique Mobility Van

The Site Operator contract stated in Task 1 that K-State would purchase a hybrid electric van with an ICE driven auxiliary range extender, as manufactured by Unique Mobility. The funds in the contract allocated for the purchase of Unique Mobility's van was \$110,000.00. A quote from Unique Mobility established the price based on a sale of at least ten vehicles. Unique Mobility received purchase orders for only two units. Thus, Unique now quotes the price of a hybrid vehicle as \$200,000.00. All attempts to reduce that price have failed and Kansas State has requested authority from DOE and KEURP to negotiate with other EHV manufacturers to procure an electric or hybrid vehicle, within contract funding limits.

K-State expects, upon contract approval, to negotiate with McKee Engineering or Soleq Corporation, the purchase of additional electric vehicles. One other option is being explored through the Department of Energy. DOE is communicating with the Big Three automakers requesting they provide electric vehicles for the site operator program. The site operator program would provide test and evaluation of the automaker's vehicles. Test results and operating experiences would be provided to all concerned in the way of reports. It is hoped that DOE's efforts on behalf of the site operator program are successful.

OPERATIONS

The G-Van is being operated daily on the K-State campus or within the surrounding vicinity of Manhattan. The G-Van has been used to demonstrate the latest electric vehicle technology to state executives, utility executives, and students at the university. Several rides have been given to these different groups to allow them to see first hand what an electric vehicle has to offer.

As of September 30, 1991 the G-Van has accumulated 430 miles. No unscheduled maintenance has been required. With the problems worked out on the accessories, the G-Van is performing comparable to the performance claims made by Conceptor Industries. Table 1 summarizes the pertinent data during the first quarter.

TABLE 1

Average miles/day driven (since delivery)	10.2
Average kilowatt/mile	1.4

Cost Comparison: Electric Cost versus Comparative Gasoline Fuel Cost
(Based on 16 mpg fuel efficiency for standard GMC Vandura vehicle)

At \$.06 per kilowatt-hour the fuel equivalent for gasoline would be \$1.38 per gallon.

SUMMARY/CONCLUSIONS

During the past fifteen years Kansas State's faculty has been involved in research of alternative fuel vehicles. From formulation of fuels and automotive fuel storage to development of electronic controls, K-State's faculty research has been ongoing. With the increased awareness of what is occurring to the world's environment, the catalyst -- to ensure applied results from faculty research will occur -- has been activated.

The Department of Energy's Electric Vehicle Site Operator Program is the platform being used to demonstrate international efforts to bring a more acceptable daily mode of transportation to our highways. The first new electrical vehicle procured at K-State in the last ten years, a G-Van, is a technological dinosaur. It does not incorporate leading edge control or drive systems nor does it provide the type of vehicle frame and body to meet a majority of the daily commuter needs required by the American market. Yet, this vehicle represents initial efforts to bring a federally crash certified vehicle to the commercial automotive market. As such, it is an evolutionary step in the mass production of electric vehicle products. Let us recognize the contribution the G-Van is making to the electric vehicle market but, let us apply previous research results and bring a cost effective, next generation electric vehicle to market.

K-State's Site Operator Program has begun operation. Two students, Tammy Nissen-Pfrang and Royce A. Steinert have been hired. Tammy is an electrical engineering technology student and Royce is a mechanical engineering technology student. Tammy and Royce have eighteen months left until they receive their degrees. Further, as future engineers, they are very interested in the electric vehicle. An office including fax machine, laser printer, digitizer tablets, and two 486-33 machines with 16 inch cad color monitors have been provided by K-State's College of Engineering. A 35mm slide development system is on order. Next year a large cad plotter will be provided by the College. All equipment is being used to provide public information, slide presentations, and track daily data on the G-Van's use. The College has also provided a garage bay where the G-Van is housed. As more vehicles are procured for use in the site operator program, a larger shop bay will be required. Several options are being explored. The university's vehicle facility is large enough to handle any increase in electric vehicles; still, it is the desire of the site operator director that a dedicated facility be found for electric vehicles until full commercialization of these products are realized.

Efforts are being made to procure the second electric vehicle or hybrid vehicle for the site operator program. The test and demonstration efforts will continue with the G-Van. Results of these efforts will be highlighted in the next report.

Kansas State University

Electric Vehicle Site Operator Program

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