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U.S. DEPARTMENT OF ENERGY
ELECTRIC & HYBRID VEHICLE
SITE OPERATOR PROGRAM
AT
PLATTE RIVER POWER AUTHORITY

FINAL REPORT
BY
ROBERT A. EMMERT

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INTRODUCTION

The Platte River Power Authority ("Platte River") is a political subdivision of the state of Colorado, owned by the four municipalities of Fort Collins, Loveland, Longmont and Estes Park, Colorado. Platte River is a non-profit, publicly owned, joint-action agency formed to construct, operate and maintain generating plants, transmission systems and related facilities for the purpose of delivering to the four municipalities electric energy for distribution and resale.

Platte River, as a participant in the U.S. Department of Energy (DOE) Site Operator Program, worked to accomplish the Site Operator Program goals and objectives to field test and evaluate electric and electric-hybrid vehicles and electric vehicle systems in a real world application/environment. This report presents results of Platte River's program (Program) during the five-years Platte River participated in the DOE Site Operator Program. Platte River participated in DOE Site Operator Program from July 3, 1991 through August 31, 1996. During its Program, Platte River conducted vehicle tests and evaluations, and electric vehicle demonstrations in the Front Range region of Northern Colorado. Platte River also investigated electric vehicle infrastructure issues and tested infrastructure components. Platte River's Program objectives were as follows:

- Evaluate the year round performance, operational costs, reliability, and life cycle costs of electric vehicles in the Front Range region of Northern Colorado.
- Evaluate an electric vehicle's usability and acceptability as a pool vehicle.
- Test any design improvements or technological improvements on a component level that may be made available to PRPA and which can be retrofit into our vehicles.
- Develop, test and evaluate, and demonstrate components to be used in charging electric vehicles.

VEHICLE OPERATION

Vehicles in Operation

A listing of the electric vehicles (EV) operated at Platte River during the Program with their associated battery and charger information is provided in Table 1 below. During the Program all vehicles were used primarily as a pool vehicles and secondarily as courier and demonstration vehicles. During the later part of the Program the vehicles were also used as commuter vehicles by Platte River employees.

The first vehicle operated by Platte River was a 1984 Bedford Griffon van loaned to Platte River by the DOE. The Griffon van was received by Platte River on April 10, 1992. The DOE owned van was previously with Detroit Edison as a site operator vehicle and had 28,654 miles of previous operation when Platte River received it.

During the Program, Platte River purchased and operated two Soleq EVcorts, a Ford EVcort station wagon conversion made by the Soleq Corporation of Chicago, Illinois. The Specification and Cost Computation sheets for the two EVcorts are located in Appendix A. Platte River received the first of its two Soleq EVcorts on March 5, 1993. The first EVcort was a converted 1992 Ford Escort station wagon and was given the DOE vehicle number 355. Platte River received its second Soleq EVcorts on January 5, 1994. The converted 1993 Ford Escort station wagon and was given the DOE vehicle number 356.

TABLE 1

PRPA ELECTRIC VEHICLE FLEET							
DOE VEHICLE NO.	PRPA VEHICLE NO.	VEHICLE TYPE	BATTERY TYPE	NO. OF BATTERY MODULES	SYSTEM VOLTAGE	CHARGER TYPE	CHARGER VOLTAGE
354	54	1984 Bedford Griffon Van	Chloride Lead Acid	36 6 Volt	216	Chloride Spegel (Offboard)	220
355	55	1992 Soleq EVcort	Sonnenschein Lead Acid Gelled-Electolyte	18 6 Volt	108	Soleq (Onboard)	110
356	56	1993 Soleq EVcort	Sonnenschein Lead Acid Gelled-Electolyte	18 6 Volt	108	Soleq (Onboard)	110

Operational Data

The Griffon van's battery pack charging energy was metered at the two charging stations used to charge the van. Vehicle log sheets were used to record charge times and vehicle miles driven.

Both of the EVcorts were equipped with an onboard load profile meter that continually integrated the AC energy used for charging over each 15 minute time period of the charge cycle and stores the load data with its corresponding time interval. The meter automatically captures all vehicle charge data without any action required by the vehicle user. The data from the meter was downloaded once a month by the city of Ft. Collins when they read other Platte River facility demand meters. Typical 15-minute meter data is shown in Appendix C.

Originally, each EVcort also utilized a log sheet to obtain operator recorded data for each trip made by the vehicle. A sample Vehicle Log Sheet is located in Appendix B. With this system, no vehicle charge data was lost. Even if a log sheet entry were to be omitted, the trip data should be able to be reconstruct based on the meter data and available log sheet data. The meter data are compiled and used to produce Tables 2, 3, and 5 of this report.

Presented in Appendix B are summaries of the onboard meter and operator log sheet data. The beginning of a trip is defined as when the vehicle is unplugged after a charge (either full or partial charge). The end of a trip is defined as when the vehicle was plugged back in, initiating a charge. Charging of Platte River's vehicles is typically done at a location and for a long enough duration of time for the initiation of a vehicle charge to be considered the end of a trip, even if the vehicle does not receive a full charge. So, normally, each row of data in the Log Sheet & Meter Data Summaries (in Appendix B) represents a single vehicle trip. Platte River's vehicles do experience a limited amount of short-term opportunity charging and short interruptions of charging (less than 15 minutes) for short trips. This makes it difficult to proportion the onboard meter's 15-minute charge energy data into the actual vehicle trips. Therefore, in a few cases, the end of a trip, as represented in the Log Sheet & Meter Data Summaries (in Appendix B) is defined as when the vehicle has received a full charge.

Platte River, with the concurrence of the Site Operator Program - Program Manager, discontinued the use of vehicle log sheets at the end of 1994. The requirement of completing the vehicle log sheet was considered to be a burden by some people and was impacting the number of people who were willing to use the EVcorts. From that point forward Platte River recorded monthly odometer data for each vehicle. The meter and the monthly odometer data were used to compile and produce Tables 2, 3, and 5 of this report for the remainder of the Program.

Operation & Maintenance Costs

Table 2 (on the following page) summarizes the variable operation and maintenance (O&M) costs for operating Platte River's EVs by quarter. The variable O&M costs associated with the operation of Platte River's EVs are preventative and routine maintenance, repairs, tire replacement, individual battery module replacement and electric energy to the charger. The City of Ft. Collins small commercial electric rate (energy component only) of \$0.027 per kilowatt-hour is used as the cost of electricity to charge the EVs. The major maintenance requirements for all vehicles operated in the Program is presented in Table 4 in Appendix F. The Maintenance Repair & Problem Codes definitions are also located in Appendix F.

TABLE 2

EV PERFORMANCE AND O&M SUMMARY											
Vehicle	Quarter of Year	Miles Traveled	AC Charge Energy (kWh)	Efficiency (Total Energy) (Miles/kWh)	Energy Cost at (\$0.0269/kWh)	Maintenance Labor (Man-hours)	Maintenance Labor Cost (\$28/Man-hours)	Maintenance Parts & Service Cost	Variable Cost (\$/Mile)	Energy Cost Increment (%)	Maintenance Cost Increment (%)
Griffon No. 354	3rd-92	434	254	1.71	\$12.69	1	\$28.00	\$0.00	\$0.094	31%	69%
	4th-92	3,171	2,265	1.40	\$113.25	1	\$28.00	\$0.00	\$0.045	80%	20%
	YTD	3,605	2,519	1.43	\$125.94	2	\$56.00	\$0.00	\$0.050	69%	31%
Griffon No. 354	1st-93	1,253	935	1.34	\$46.75	1	\$28.00	\$0.00	\$0.060	63%	37%
	2nd-93	0	0	0.00	\$0.00	0	\$0.00	\$0.00	---	---	---
	YTD	1,253	935	1.34	\$46.75	1	\$28.00	\$0.00	\$0.060	63%	37%
Griffon No. 354	Program Totals	4,858	3,454	1.41	\$172.69	3	\$84.00	\$0.00	\$0.110	67%	33%
EVcort No. 355	1st-93	327	161	2.03	\$8.05	1	\$28.00	\$18.77	\$0.168	15%	85%
	2nd-93	1,310	653	2.01	\$32.65	1	\$28.00	\$18.77	\$0.061	41%	59%
	3rd-93	941	446	2.11	\$22.28	0	\$0.00	\$0.00	\$0.024	100%	0%
	4th-93	881	466	1.89	\$23.28	0	\$0.00	\$0.00	\$0.026	100%	0%
	YTD	3,459	1,726	2.00	\$86.26	2	\$56.00	\$37.54	\$0.052	48%	52%
EVcort No. 355	1st-94	366	263	1.39	\$7.07	0	\$0.00	\$0.00	\$0.019	100%	0%
	2nd-94	645	337	1.91	\$9.06	0	\$0.00	\$0.00	\$0.014	100%	0%
	3rd-94	1,183	537	2.20	\$14.45	2	\$56.00	\$0.00	\$0.060	21%	79%
	4th-94	297	232	1.28	\$6.23	0	\$0.00	\$0.00	\$0.021	100%	0%
	YTD	2,491	1,369	1.82	\$36.81	2	\$56.00	\$0.00	\$0.037	40%	60%
EVcort No. 355	1st-95	702	387	1.81	\$10.40	0	\$0.00	\$0.00	\$0.015	100%	0%
	2nd-95	1,416	615	2.30	\$16.55	0	\$0.00	\$0.00	\$0.012	100%	0%
	3rd-95	858	417	2.06	\$11.21	4	\$112.00	\$0.00	\$0.144	9%	91%
	4th-95	634	422	1.50	\$11.36	0	\$0.00	\$0.00	\$0.018	100%	0%
	YTD	3,610	1,841	1.96	\$49.52	4	\$112.00	\$0.00	\$0.045	31%	69%
EVcort No. 355	Program Totals	9,560	4,936	1.94	\$172.59	8	\$224.00	\$37.54	\$0.134	40%	60%
EVcort No. 356	1st-94	434	299	1.45	\$8.03	0	\$0.00	\$0.00	\$0.019	100%	0%
	2nd-94	457	229	2.00	\$6.17	0	\$0.00	\$0.00	\$0.014	100%	0%
	3rd-94	338	209	1.62	\$5.63	4	\$112.00	\$0.00	\$0.348	5%	95%
	4th-94	842	522	1.61	\$14.03	0	\$0.00	\$0.00	\$0.017	100%	0%
	YTD	2,071	1,259	1.64	\$33.86	4	\$112.00	\$0.00	\$0.070	23%	77%
EVcort No. 356	1st-95	621	344	1.81	\$9.25	4	\$112.00	\$0.00	\$0.195	8%	92%
	2nd-95	1,693	793	2.13	\$21.34	2	\$56.00	\$0.00	\$0.046	28%	72%
	3rd-95	670	N/A	N/A	N/A	0	\$0.00	\$0.00	N/A	N/A	N/A
	4th-95	7	N/A	N/A	N/A	4	\$112.00	\$1,208.21	N/A	N/A	N/A
	YTD	2,991	N/A	N/A	N/A	10	\$280.00	\$1,208.21	N/A	N/A	N/A
EVcort No. 356	Program Totals	4,385	2,396	1.83	\$64.45	10	\$280.00	\$0.00	\$0.311	19%	81%
Note: No meter data for last 677 miles traveled by No. 356											

The life cycle cost of operating these vehicles was not determined since the end of the economic life of the vehicles was not reached during the five year Program.

Vehicle Usability and Acceptability

Griffon Van

The Griffon van was primarily used for van pooling Platte River maintenance personnel to and from the Rawhide Energy Station from Platte River's corporate headquarters. The round trip mileage is 58 miles, most of which is interstate highway driving. The Griffon was charged at both ends of the trip and the 29 mile one way trip between charges was very close to the vehicles usable range during the coldest days of the winter season. The vehicle's payload ranged from one to five people, averaging about three people per trip. The Griffon is very well suited for this type of mission. All of the van pool participants rated their experience with the Griffon as highly favorable with the only complaint being the vehicle's limited top speed of 55 miles per hour on an interstate highway with a posted speed limit of 65 mile per hour (at that time).

After traveling a total of 5,548 miles, the Griffon van's drive motor failed. The Griffon van was on loan to Platte River from DOE and its National Highway Traffic Safety Administration's permit to operate on public roads was nearing its expiration date. With the high expense of rebuilding the motor and the limited remaining time the van could be on public roads, the van was shipped back to the INEL. The van was repaired and used by the United States Navy, another participant in the DOE Site Operator Program, where its entire use was on a navel base, off public roads.

EVcorts

The EVcort was initially used as a pool vehicle and as a demonstration EV. Ride and drive demonstrations were given to people through out Colorado and the Rocky Mountain region. The people the Program initially targeted for ride and drive demonstrations were officials of the cities of Ft. Collins, Longmont, Loveland, Estes Park and Boulder, regional utility personnel, regional fleet operators, and U.S. legislators. Later demonstrations were with the general public. The EVcort is a high quality conversion EV and shows well. The vast majority of comments on the performance of the EVcort were positive. Most people felt the EVcort was capable of meeting number of fleet vehicle applications and was suitable for personal use.

As a pool vehicle operating under non-winter conditions, the EVcorts achieved full charge to 80 percent discharge ranges from 30 to 45 miles, with a range of 35 miles typical of most trips and drivers. As with many new technologies, a number of people checking out pool vehicles enjoyed and requested an EVcort, while others felt uncomfortable with the EVcorts. Even after detailed training, many of those who originally felt uncomfortable with the EVcorts chose not to use them. A few instances of minor equipment failures or poor planning by a user that left a user stranded served to exacerbate that situation. Also, a large percentage of the trips Platte River's pool vehicles are used for requires traveling a distance of greater than 40 miles without the opportunity for charging. This also limited the use of the EVcorts. The vehicles performed satisfactorily in missions and conditions that were within the vehicle's capabilities.

Later in the Program both EVcorts were used as pool vehicles and as commuter vehicles by Platte River employees. With the typical commuting distance of the majority of Platte River employees working at Platte River's Fort Collins office facility being approximately ten miles or less, the vehicle was able to charge quickly enough to be utilized as both as a pool and a commuter vehicle. Employees were allowed to use a vehicle for commuting and as a second vehicle for their family for one month. Employees using the vehicles as a commuter vehicle quickly become comfortable with the vehicles and enjoy using them. They also found the vehicles to be quite adequate in meeting their family needs as a second vehicle. Typically, employees were

enthusiastic about using the EVcorts for commuting and as a second vehicle for their family. If given the opportunity most employees would gladly drive the vehicle for more than one month.

The EVcorts were charged in a non-heated garage area. During the colder days of the months of December, January, and February, when the vehicles experiencing the coldest ambient temperatures and with the additional load of the interior electric heater for driver/passenger comfort, the range of the EVcorts decreased to approximately 20 miles. Without a thermal management system for the EVcort's Sonnenschein lead-acid batteries, the winter range of the EVcort was not sufficient to perform some of the fleet applications it could be used for during the warmer months of the year. The cold weather range of the EVcorts was not tested with the vehicles being charged in a heated environment.

Driver comfort also became a significant issue during cold weather since the electric heating system's performance is marginal in the colder winter months. Using the preheat option (which uses house power) to preheat the interior of the vehicle before starting a trip does slightly increase the vehicle's range and does increase driver/passenger comfort. But use of this option takes some planning, and not all vehicle users were willing to go through the extra effort to use the EVcorts during cold periods. Over the term of the Program the use of the EVcorts continually decreased during the winter months.

Fuel Cost Comparison

The fuel cost for operating the EVcort was compared to the fuel cost for operating a 1991 Ford Escort wagon. Table 3 below is based on the annual average fuel cost and vehicle total energy efficiency of the EVcort versus a 1991 Ford Escort Wagon. The fuel cost for the gasoline vehicle is approximately \$0.041 per mile and the EVcort's fuel cost is approximately \$0.014 per mile at the City of Ft. Collins small commercial electric rate (energy only) of \$0.027 per kilowatt-hour.

TABLE 3

FUEL COST COMPARISON								
ELECTRIC VEHICLE VERSUS GASOLINE FUELED ICE								
VEHICLE	GASOLINE COST (\$/GAL)	AC DEMAND COST (\$/kW)	AC ENERGY COST (\$/kWh)	VEHICLE EFFICIENCY (MILES/GAL)	VEHICLE MAX. DEMAND (kW)	VEHICLE EFFICIENCY (MILES/kWh)	FUEL COST with DEMAND CHARGE (\$/MILE)	FUEL COST ENERGY ONLY (\$/MILE)
Ford Escort Wagon	\$1.15			28			\$0.041	\$0.041
Soleq EVcort Wagon		\$8.01	\$0.027		3.079	1.94	\$0.221	\$0.014
Notes: (1) Figures are program average for EV-355 (gasoline cost is estimated). (2) Fuel cost for energy only assumes vehicle charging during off-peak periods. (3) Fuel cost with demand charge assumes vehicle charging over peak demand period.								

Emissions Comparison

In doing a comparison of the emissions from an EV to the emissions from an internal combustion engine (ICE) driven vehicle, the emissions that are attributed to an EV are the emissions of the generation resource producing the energy to charge the EV. Platte River's resource mix for our own load, not including sales to other utilities, is approximately 36 percent hydro generation and 64 percent coal fired thermal generation. Table 5 and Figure 1 in Appendix G is a comparison of the rate of emission for the EVcort being charged from energy produced from Platte River's current resource mix to the rate of emission for the ICE Ford Escort before it was converted to electric drive, under similar driving conditions.

Currently, carbon monoxide is the only pollutant that has the potential to exceed EPA standards in the Ft. Collins area. Carbon monoxide is also one of the air pollutants of concern along the entire Front Range region of Colorado. The EVcort reduces the emission rate of carbon monoxide by over 99 percent. When all emissions are added together on a grams per mile basis, the EVcort's total emission rate represents a reduction of approximately 91 percent as compared to an ICE vehicle, based on Platte River's resource mix. Since the majority of Platte River's coal fired thermal generation is located in a very sparsely populated region of Northern Colorado, those emissions do not impact any of the urban areas of the Colorado Front Range region where air pollution problems exist. Consequently, although there are emissions associated with the charging of EVs, the impact of those emissions on the urban environment of Northern Colorado is negligible and EVs can truly be considered a zero emission vehicle for the Front Range region of Colorado.

EV Infrastructure

Under an agreement with Colorado State University, the university developed an intelligent charger controller for the charging of EVs. The charger controller acts as an interface between the EV operator, the electric utility's rate structure and the vehicle being charged. The charger controller gives the operator the ability to input charge requirements such as charge cycle completion time and the desired vehicle state of charge at end of charge. The charger controller will determine the charge initiation time and the charge rate based on user input, the vehicle's state of charge, and the utility's rate structure. The primary benefits will be to minimize the impact on the utility's peak demand, minimize the operators cost for charging the vehicle while maintaining a high degree of convenience for the operator in charging the vehicle. The Intelligent Charging Control System For Electric Vehicles - Final Report is included in Appendix I.

A meter was installed in vehicle No. 356 to record the energy used per trip, which allows the charger controller to determine the energy required to fully charge the vehicle. The charger controller was installed in the vehicle-charging bay for vehicle No. 356.

The charger controller worked very well in calculating the required charge start time and completion time to full battery pack state of charge. The charger controller would work best in applications where an EV goes out on its mission at the beginning of the day and returns at the end of the day, to be charged over night. As a Platte River pool vehicle, the EVcort No. 356 was going out for short trips and brought back a number of times a day. This mode of operation was not the ideal application for the charger controller and it was not as useful in this type of application. Also, plugging in the charger controller was one additional task for the vehicle operator to perform and the charger controller was often not plugged in to the car. Used in the appropriate application and possibly with a few simplifying options to the charger controller's input options, the charger controller could be a very useful tool for fleet operators and personal vehicle

operators in limiting the cost to charge their EV. It would also be a very useful tool for helping utility decrease the impact large numbers of EVs could have on the utility's peak demand.

Demonstration Activities

Numerous demonstration and educational activities were done throughout the Rocky Mountain region. The following list are examples of some of those activities:

- Participated in the City of Ft. Collins Earth Day educational program for all seventh graders in the city. Approximately 2,000 students and teachers attended.
- Participated in the "Alternative Fuels Forum" sponsored by the Boulder County Clean Air Consortium and the Regional Air Quality Council. As part of the event, Platte River participated in a EV rally through the streets of Longmont, Colorado.
- Showed the EVcort to the City of Boulder, Colorado City Manager, Director of Environmental Affairs, and Fleet Manager for their consideration in studying the use of alternative fueled vehicles in their vehicle fleet.
- A presentation followed by a ride and drive was done for the Colorado Air Quality Control Commission.
- Gave a presentation and a ride & Drive at the American Public Power Association's summer Engineering and Operations meeting.
- Gave a presentation to the City of Longmont, Colorado City Council that was televised on local cable television.
- Participated in the Ft. Collins annual Environmental Fair with an EV display including the EVcort.
- The EVcort was displayed at the Rocky Mountain Home Show in Denver, Colorado.
- A presentation was made and the EVcort was displayed at the Rocky Mountain Technology Expo in Denver, Colorado.
- A presentation followed by a ride and drive was done for the Fort Collins Department of Natural Resources.
- Gave an presentation and ride & drive for the City of Loveland, Colorado certified teacher training coarse.
- A delegation of electric utility dignitaries from China participated in a presentation and a ride and drive.
- An EVcort was displayed at various Platte River Integrated Resource Plan public input forums.
- EV displays and ride and drives were done for various Earth Day activities along the front range of Northern Colorado.
- One EVcort was loaned to San Isabel Electric Association for demonstration during their 4th of July activities.
- An EVcort was loaned to numerous other rural electric cooperatives for demonstration during annual events.
- A demonstration was held at the Fort Collins Environmental Fair.
- Held a ride & drive during Platte River's annual company picnic.

Clean Cities Program

Platte River was instrumental in the formation of the Weld County, Larimer County and Rocky Mt. National Park (Weld/Larimer/RMNP) Alternative Fuels Partnership, which received the U.S. DOE "Clean Cities" designation. The U.S. DOE established the Clean Cities Program to coordinate the creation of "city-based" alternative fuel programs. The Mission of the Weld/Larimer/RMNP Clean Cities Program is to establish a self-sustaining, cost effective, alternative fuels vehicle program, which will complete the Colorado Front Range AFV infrastructure and achieve targeted public policy goals. The "infrastructure" includes significant use and availability of alternative fuel vehicles, refueling sites, associated services and information. As a member of the Program Team, Platte River's five year alternative fueled vehicle plan includes the following.

- Develop an incentive electric rate for use by customers charging electric vehicles
- Continue to make electric vehicles available to public interested in pursuing electric vehicles
- Continue to provide technical assistance to those interested in pursuing electric vehicles
- Continue adding alternative fueled vehicles to Platte River's vehicle fleet
- Continue with education and information dissemination in the region including data from ours and others' use of electric vehicles
- Continue to evaluate electric generation emissions associated with charging electric vehicles and make that data available to the public
- Continue to participate in events promoting alternative fueled vehicles
- Continue to make an electric vehicle available to others who want to promote or demonstrate electric vehicles in community and technology events
- Provide a representative to the Program Team Steering Committee

Conclusions

All conclusions are based on Platte River's experience with the EVs operated in its fleet and on Platte River's participation in the Site Operator Program.

- Although reliability of the EVs was very good, their reliability has to increase to equal or exceed that of an ICE vehicle to obtain wider acceptance.
- Using the price of gasoline and electricity in the city of Ft. Collins, the fuel cost to operate an EV was approximately one-third the fuel cost to operate an ICE vehicle (assuming the charging is done during off-peak hours).
- Lead-acid battery pack thermal management systems are highly recommended for colder climates.
- Maintenance free batteries are very important for wide acceptance of EVs.
- The range of the Soleq EVcorts with Sonnenschein gelled-electrolyte lead-acid batteries was too short to be practical for enough applications to be a viable commercial product.
- Fuel fired heaters for heating the internal space of an EV is highly recommended for colder climates.
- Emission reductions of a EVs are substantial, making continued funding of all aspects of EV research, engineering, field-testing and demonstration of EVs essential.
- EV infrastructure such as charger controllers can increase the convenience of charging EVs while decreasing the impact on the electric utility system using existing technology.
- Demonstrations revealed the acceptance of EVs and enthusiasm for EVs to be significantly higher for the sector of the population in the pre-driving age and those just recently coming of driving age. This is an indicator that over time the market acceptance of EVs may increase as these young people become part of the overall vehicle market.
- The indirect subsidization of the price of gasoline is a major impediment to the advancement of all alternative vehicles.
- The restrained cooperation of the automotive industry severely hindered the progress of the Site Operator Program in its effort to facilitate the process of delivering a commercially viable EV to the market.

For further information contact

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Platte River Power Authority
2000 East Horsetooth Road
Fort Collins, Colorado 80525-2942
(970) 229-5284, Fax: (970) 207-4251

APPENDIX A

5969 NORTH ELSTON AVENUE
CHICAGO, ILLINOIS 60646
U. S. A.

SOLEQ CORPORATION
SOLID STATE INVERTERS CONVERTERS REGULATORS
CONTROLLERS POWER INTEGRATORS BATTERY METERS

CENTRAL FILES
AREA CODE 312
792-3811

RECEIVED
PLATTE RIVER POWER

JAN 09 1992

FILE _____

January 3, 1991

Mr. Robert A. Emmert
Platte River Power Authority
2000 E. Horse Tooth Road
Fort Collins, CO 80525
Phone: (303) 229-5284
Fax: (303) 229-5244

Dear Mr. Emmert:

Re: E.V. Specification and cost computation

Please find attached specification and cost computation sheet. Regarding further modifications. Please contact S. Ohba at 312-792-3811.

Please furnish following 3 items of info:

- 1) Sales tax exemption number for Platte River Power Authority is #98-02103 (State of Colorado)
- 2) Exact title name the vehicle to be purchased under is:
Platte River Power Authority
2000 E. Horse Tooth Road
Fort Collins, CO 80525
- 3) IC components removed from vehicle (worth \$500) is used to purchase manual steering and other dealer components. If you like to keep them please inform S. Ohba.

Sincerely,

S. Ohba

Jan. 3, 1992

Specification and Cost Computation

Conversion For: Platte River Power Authority
Vehicle: 1st of 2 Vehicles
Basic Vehicle: 1992 LX Station Wagon
Color: Silver Metallic Glo-Coat (Tentative)

Cost Computation

Basic Controller and related components	\$7,500
Two Stage Regeneration System	\$3,000
Electrical Components	\$1,500
Drive Motor	\$3,100
Other Motors	\$500
Control Head with State of Charge meter, performance and Function Trimming Capability	\$2,000

Sub Total \$17,600

Vehicle body fully equipped	\$10,155
Omit Air Conditioner	-0-

Sub Total \$10,155

Vehicle Modification	\$13,000
Battery Box, Motor Mount	\$2,800
Suspension & Others	\$2,000

Sub Total \$17,800

Traction Batteries (Sealed No Maintenance)	\$3,060
12V No Maintenance Battery System	\$100

Sub Total \$3,160

Oversize (3KW) Heaters per Vehicle	\$750
------------------------------------	-------

On-board Charger	\$1,800
------------------	---------

F.O.B. Chicago	<u>Total</u> \$51,265.00
----------------	--------------------------

(Estimated Shipping Charge \$1,000.00/Vehicle)

Half or preferably 60% of the total amount will
be required to initiate the conversion program.

Jan. 3, 1992

Specification and Cost Computation

Conversion For: Platte River Power Authority
Vehicle: 2nd of 2 Vehicles
Basic Vehicle: 1992 LX Station Wagon
Color: Silver Metallic Glo-Coat (Tentative)

Cost Computation

Basic Controller and related components	\$7,500
Two Stage Regeneration System	\$3,000
Electrical Components	\$1,500
Drive Motor and related components	\$3,100
Other Motors	\$500
Control Head with State of Charge meter, performance and Function Trimming Capability	\$2,000

Sub Total \$17,600

Vehicle body fully equipped	\$10,155
Inverter Driven Air Conditioner (24000 BTU)	\$4,400

Sub Total \$14,555

Vehicle Modification	\$13,000
Battery Box, Motor Mount	\$2,800
Suspension & Others	\$2,000

Sub Total \$17,800

Traction Batteries (Sealed No Maintenance)	\$3,060
12V No Maintenance Battery System	\$100

Sub Total \$3,160

Oversize (3KW)) Heater per vehicle	\$750
------------------------------------	-------

On-board Charger	\$1,800
------------------	---------

F.O.B. Chicago	<u>Total</u> \$55,665.00
----------------	--------------------------

(Estimated Shipping Charge \$1,000.00/Vehicle)

Half or preferably 60% of the total amount will
be required to initiate the conversion program.

Jan. 1992 S. Ohba

Condition of Sales For Soleq Converted E.V.S.

Basic Designs and Concept

Soleq converted vehicles are, proof of concept devices, to show performance of electronic packages and components of today.

Safety and Reliability

Users of these demonstration vehicles have been selected to be self-insured organizations. Soleq is not providing vehicle conversion service as a profit oriented enterprise. Rather to demonstrate capability of currently available electric vehicle components. By the nature of original design criteria, the vehicles are durable and reliable.

Free User Services Training

For more than ten years Soleq has been providing Engineer/Technician training. We offer a 4 to 5 day training at Soleq's Chicago Facility that will cover the following:

- 1) Proper driving condition and determining proper component function including: charger, on-off circuit, batteries, converter, accelerator, controller in drive mode, cruising mode, braking mode, end of discharge sensing, and recharging batteries.
- 2) Battery set, determining state of charge, charging, cross-over voltage vs temperature, modes of charge for gel cell batteries and antimony batteries, aligning charger for proper end of charge voltage, and charging current.
- 3) Testing electronic and related components, participating in all aspects of sub-assembly testing and up to system operation test.
- 4) Early detection and preventive maintenance to avoid major component damage.
- 5) Some suggestions to maintain trouble-free E.V. fleet operation

Payments

Conversion service has been proven as nearly non-profit and in the past, sometimes even a financial loss. Our bank remembers the 1980-1982 episode of E.V. business failures. Soleq is not willing to risk financial losses by promoting this very marginal business. As a result, we have been requesting the following.

- A) 50% to 60% payment with order, or we make progress payment request(s). Vehicle title will be transferred when vehicle testing starts. There will be 5 to 10 day driving time available when the vehicle title is applied.
- B) Balance to be cleared at the point of vehicle transfer. Normally Soleq will request vehicle inspection prior to shipment.

Free Repair Service

Soleq provides free component warranty service for 12 to 18 months. In combination with the free training service program, site operators mastered the method of E.V. fleet service procedures.

Infrastructure Service

To this point users of Soleq converted electric vehicles have been limited to: automobile manufacturers, electric power companies, research laboratories and other organizations. Past users of the E.V. were limited to where skilled or highly knowledgeable engineers were available. However where such service is not available, Soleq may be able to arrange outside infrastructure service (such as KMS Corporation).

Component Service After Warranty Period

Being the original equipment manufacturer, Soleq is capable of giving reasonable and efficient repair service for long after components become no longer up-to-date. Unlike consumer electronics products Soleq components are designed for 20 to 30 years of service. There are some indications of transferring the traction system form an old chassis to a new chassis, when the IC vehicle body becomes rested and unattractive.

Jan. 4, 1992 S. Ohba

Some New Features on Soleq EV Conversion 1992

1) Mark IV Escort Motor Controller

Basic controller design has been the same for the last 12 years. New standard features and optional features are available to enhance driving comfort and performance.

Standard

Redundant and soft failure design. Since the original application for D.O.E.'s demonstration program the vehicle design includes important features to avoid sudden failures. Today's vehicle still employs an extensive redundant circuit and fail safe design. The life of the electronics and traction motor is expected to be 3 times longer than the cold rolled steel automobile body. There are some discussions to transplant the traction system from 1980 chassis to 1990 chassis.

New Interface

The 1991 addition was a logic circuit to interface accelerator and brake pedal signals with acceleration and deceleration commands. This interface provides soft take off and soft braking with increased feel of response. At the same time the circuit eliminates instability caused by minute foot movement due to rough pavement or going over railroad tracks.

Optional

4 Chopper Controllers

For the total recovery of kinetic energy during vehicle deceleration optional 2 stage regenerative controllers were developed.

The controller for the peak 40K system is made of 4 choppers. Two choppers are for armature choppers for running. One step up chopper is a regenerative voltage booster when motor EMF is lower than battery EMF and to complete stop. The last small chopper is for field control for series mode acceleration, field weakening and field regeneration control.

The two running chopper design was standard with peak 80KW system. Now the same circuit is adapted to peak system for smoother operation and elimination of ripple current voltage which used to appear in battery circuit during acceleration and chopper regeneration.

Control Head

Original design for a large vehicle is adapted for the small car for convenience

- A) Voltage Depression integrator style battery charge state meter.
 - B) Adjustable regeneration function; 2 stage, field regeneration deactivated
 - C) 5 Potentiometers to set operating parameters. 1 Accelerator span, maximum regeneration voltage, maximum regeneration current, coasting regeneration (Engine Braking) current and battery discharge limit voltage. These were only adjustable at controller where accessibility was very limited.
 - D) Digital voltmeter and ammeter for running power and charge power, were made to respond slow enough to give steady readings rather than flickering several times a second.
- 2) Inverter driven Air Conditioner of 1200 BTU has been standard with EV cort. In recent years, the 2400 BTU unit appeared to be more suitable, especially for southern state users. The larger system was made available as optional equipment.

APPENDIX B

(Original size = $8\frac{1}{2}" \times 14"$)

VEHICLE LOG

DOE Electric Vehicle Test and Evaluation Project
Vehicle Number _____

[illegible]

Payload Codes:

1. 0-200 lbs.
2. 201-400 lbs.
3. over 400 lbs.

Problems Encountered Codes:

1. Air Conditioning	9. Controller/Inverter	17. Motor
2. Auxiliary Battery	10. Defroster/Heater	18. Plug/Receptacle
3. Battery Pack	11. Doors	19. Shock/Suspension
4. Body	12. Horn	20. Steering
5. Brakes	13. Instrumentation	21. Tires/Wheels
6. Charge meter	14. Interior	22. Windows
7. Charger	15. Lights	23. Wipers
8. Clutch/Transmission	16. Mirrors	24. Other

Please fill out "Vehicle Defect Report" describing any problems encountered with vehicle. Forms are available from the receptionist and should be returned to the receptionist.

- Trip starts when vehicle is unplugged and ends when vehicle is plugged in.

/st 07/30/93

Return completed log sheet to Bob Emmert.

TABLE 1

DOE Griffon Van
 DOE Vehicle No. 354
 PRPA Vehicle No. 54

Date	Odometer Reading	-kWh Meter On Chg	Reading- Off Chg	Status Code	Payload Code	Miles Driven	kWh Used	Miles per kWh
5-19-92	28654	**	**		1	--	--	--
5-20-92	28682	**	**		1	28	--	--
5-21-92	28704	**	**		1	22	--	--
5-22-92	28739	**	**		1	35	--	--
5-26-92	28764	**	**		1	25	--	--
5-27-92	28778	**	**		1	14	--	--
5-28-92	28798	0	73		1	20	--	--
5-29-92	28820	73	90		1	22	17	1.29
6-1-92	28854	90	117		1	34	27	1.26
6-2-92	28891	117	141		1	37	24	1.54
6-3-92	28934	141	169		1	43	28	1.54
6-4-92	28990	169	210		1	56	41	1.37
6-5-92	29008	210	210		1	18	--	--
6-9-92	29039	210	250		1	31	40	1.23
6-17-92	29088	250	297		1	49	47	1.04
TOTAL	434				AVERAGE	36	32	1.32

** kWh meter not installed

TABLE 1

DOE Griffon Van
DOE Vehicle No. 354
PRPA Vehicle No. 54

3rd Quarter 1992

Date	Odometer Reading	--kWh Meter Reading-- Off Chg-HQ Off Chg-RH	Status Passengers Code	Miles Driven	kWh Used	Miles per kWh
Vehicle	Out Off	Service For	Repairs	1		
9-17-92	N/A	N/A		--	23	--
9-17-92	N/A		N/A	--	--	--
9-18-92	N/A	N/A		--	30	--
9-18-92	29316		1888	3	--	--
9-21-92	29344	465		2	28	15
9-21-92	29372		1913	2	28	25
9-22-92	29400	479		3	28	14
9-22-92	29431		1937	3	31	24
9-23-92	29461	505		4	31	26
9-23-92	29489		1958	4	28	21
9-24-92	29518	511		3	29	6
9-24-92	29546		1978	2	28	20
9-25-92	29573	528		3	27	17
9-25-92	29601		2002	4	28	24
9-29-92	29630	558		3	29	30
9-29-92	29662		2026	6	32	24
9-30-92	29691	573		5	29	15
9-30-92	29720		2034 <-----	3	29	8
10-1-92	29750	604		3	30	31
TOTAL	434					
			*AVERAGE	29	23	1.26
			**AVERAGE	29	18	1.60
			***AVERAGE	29	15	1.86

* Average values calculated using Rawhide meter data only.

** Average values calculated using HQ TOU meter data only.

*** Average values calculated using HQ TOU meter data when battery reaches full charge and charger goes into full charge maintenance mode.

<----- Partial charge.

TABLE 1

DOE Griffon Van
DOE Vehicle No. 354
PRPA Vehicle No. 54

4th Quarter 1992

Date	Odometer--kWh Meter Reading---	Status	Passengers	Miles	kWh	Miles
	Reading Off Chg-HQ Off Chg-RH Code			Driven	Used	per kWh
10-1-92	29750	604		3	30	23
10-1-92	29778			2	28	9
10-1-92	29803	613	2044	2	25	9
10-5-92	29816	642		2	13	29
10-5-92	29845		2066	2	29	22
10-6-92	29873	650		4	28	8
10-6-92	29901		2085	4	28	19
10-7-92	29931	670		4	30	20
10-7-92	29960		2110	4	29	25
10-8-92	29988	689		4	28	19
10-8-92	30016		2133	3	28	23
10-9-92	30045	711		4	29	22
10-9-92	30075		2154	4	30	21
10-10-92	30103	726		3	28	15
10-10-92	30131		2175	3	28	21
10-11-92	30159	744		4	28	18
10-11-92	30189		2197	4	30	22
10-12-92	30217	761		4	28	17
10-12-92	30247		2221	4	30	24
10-13-92	30272	777		4	25	16
10-13-92	30302	814		4	30	37
10-16-92	30336	827		2	34	13
10-16-92	30366		2244	2	30	23
10-19-92	30422		2284	5	56	40
10-20-92	30480	841		5	58	14
10-21-92	30508	860		5	28	19
10-21-92	30537		2328	5	29	44
10-22-92	30565	875		5	28	15
10-22-92	30595		2351	5	30	23
10-23-92	30623	890		5	28	15
10-23-92	30653		2374	5	30	23
10-24-92	30681	919		4	28	29
10-24-92	30709		2394	4	28	20
10-26-92	30738	927		5	29	8
10-26-92	30767		2417	5	29	23
10-27-92	30795	944		5	28	17
10-27-92	30824		2438	5	29	21
10-29-92	30909	981		1	85	37
10-29-92	30937		2478	1	28	40
10-30-92	30993	1014		1	56	33
10-30-92	31021		2497	1	28	19
10-30-92	31050	1031		2	29	17
10-31-92	31079		2517	2	29	20
11-2-92	31107	1050		2	28	19
11-2-92	31135		2541	2	28	24
11-3-92	31164	1068		4	29	18
11-3-92	31193		2565	4	29	24
11-4-92	31221	1085		5	29	18
11-4-92	31247		2591	5	26	25
11-5-92	31272	1103		4	26	18
11-5-92	31308		2615	4	36	24

TABLE 1

DOE Griffon Van
DOE Vehicle No. 354
PRPA Vehicle No. 54

1st Quarter 1993

Date	Odometer--kWh Meter Reading---	Status Passengers	Miles	kWh	Miles	
	Reading Off Chg-HQ Off Chg-RH Code		Driven	Used	per kWh	
1-5-93	32949 1687	3	28	24	1.17	
1-5-93	32975 3267	3	26	22	1.18	
1-6-93	33002 1718	3	27	31	0.87	
1-6-93	33032 3294	3	30	27	1.11	
1-7-93	33060 1727	3	28	9	3.11	
1-7-93	33090 3315	3	30	21	1.43	
1-8-93	33118 1745	3	28	18	1.56	
1-8-93	33147 3339	1	29	45	0.64	
1-11-93	33175 1766	2	28	21	1.33	
1-11-93	33205 3364	1	30	25	1.20	
1-12-93	33233 1787	2	28	21	1.33	
1-12-93	33261 3386	1	28	22	1.27	
1-13-93	33289 1805	2	28	18	1.56	
1-13-93	33319 3413	2	30	27	1.11	
1-19-93	33347 1831	2	28	26	1.08	
1-20-93	33377 3441	2	30	28	1.07	
1-21-93	33405 1850	3	28	19	1.47	
1-21-93	33435 3464	3	30	23	1.30	
1-22-93	33462 1863	3	27	13	2.08	
1-22-93	33492 3484	3	30	20	1.50	
1-25-93	33520 1883	2	28	20	1.40	
1-25-93	33548 3511	2	28	27	1.04	
1-26-93	33576 1903	3	28	20	1.40	
1-26-93	33606 3534	3	30	23	1.30	
1-27-93	33634 1921	3	28	18	1.56	
1-27-93	33664 3554	3	30	20	1.50	
2-2-93	33695 1935	3	31	14	2.21	
2-2-93	33732 3577	3	37	23	1.61	
2-3-93	33760 1984	3	28	49	0.57	
2-3-93	33790 3603	3	30	26	1.15	
2-4-93	33818 1991	3	28	7	4.00	
2-18-93	33853 3652	3	35	49	0.71	
2-19-93	33881 2012	3	28	21	1.33	
2-19-93	33910 3675	3	29	23	1.26	
2-22-93	33941 2035	2	31	23	1.35	
2-22-93	33969 3698	2	28	23	1.22	
2-23-93	33997 2051	3	28	16	1.75	
2-23-93	34028 3723	3	31	25	1.24	
2-24-93	34056 2070	3	28	19	1.47	
2-24-93	34086 3744	3	30	21	1.43	
2-25-93	34114 2090	3	28	20	1.40	
2-25-93	34143 3767	3	29	23	1.26	
3-2-93	34171 2117	3	28	27	1.04	
3-2-93	34202 3794	3	31	27	1.15	
TOTAL	1253	AVERAGE	2.6	29.1	21.8	1.34

TABLE 1

DOE Griffon Van
DOE Vehicle No. 354
PRPA Vehicle No. 54

11-6-92	31336	1121		3	28	18	1.56
11-6-92	31366		2635	3	30	20	1.50
11-7-92	31392	1140		1	26	19	1.37
11-7-92	31421		2655	1	29	20	1.45
11-9-92	31449	1160		1	28	20	1.40
11-9-92	31477		2677	1	28	22	1.27
11-10-92	31508	1180		5	31	20	1.55
11-10-92	31537		2699	5	29	22	1.32
11-11-92	31565	1197		5	28	17	1.65
11-11-92	31595		2724	5	30	25	1.20
11-12-92	31623	1213		4	28	16	1.75
11-12-92	31654		2746	4	31	22	1.41
11-13-92	31682	1228		4	28	15	1.87
11-13-92	31712		2768	4	30	22	1.36
11-16-92	31740	1259		2	28	31	0.90
11-16-92	31768		2791	2	28	23	1.22
11-17-92	31796	1273		4	28	14	2.00
11-17-92	31826		2813	4	30	22	1.36
11-18-92	31854	1281		4	28	8	3.50
11-18-92	31883		2834	4	29	21	1.38
11-19-92	31911	1300		3	28	19	1.47
11-19-92	31941		2854	4	30	20	1.50
11-20-92	31969	1327		2	28	27	1.04
11-20-92	31998		2875	2	29	21	1.38
11-30-92	32028	1356		2	30	29	1.03
11-30-92	32058		2901	2	30	26	1.15
12-1-92	32086	1378		2	28	22	1.27
12-1-92	32115		2923	2	29	22	1.32
12-2-92	32143	1408		2	28	30	0.93
12-2-92	32174		2944	3	31	21	1.48
12-3-92	32203	1428		3	29	20	1.45
12-3-92	32232		2965	3	29	21	1.38
12-8-92	32260	1449		2	28	21	1.33
12-8-92	32289		2992	2	29	27	1.07
12-9-92	32317	1456		3	28	7	4.00
12-9-92	32347		3014	3	30	22	1.36
12-10-92	32376	1473		2	29	17	1.71
12-10-92	32404		3035	2	28	21	1.33
12-11-92	32432	1490		3	28	17	1.65
12-11-92	32491		3071	3	59	36	1.65
12-15-92	32547	1529		2	57	39	1.45
12-15-92	32577		3106	3	30	36	0.85
12-16-92	32605	1557		3	28	28	1.00
12-16-92	32636		3132	2	31	26	1.19
12-17-92	32664	1564		2	28	7	4.00
12-17-92	32694		3155	2	30	23	1.30
12-22-92	32722	1590		3	28	26	1.08
12-22-92	32750		3178	3	28	23	1.22
12-29-92	32778	1619		2	28	29	0.97
12-29-92	32808		3203	2	30	25	1.20
12-30-92	32836	1642		2	28	23	1.22
12-30-92	32864		3224	2	28	21	1.33
12-31-92	32892	1663		2	28	21	1.33
12-31-92	32921		3245	2	29	21	1.38
TOTAL	3171		AVERAGE	3	31	22	1.40

TABLE 4

VEHICLE LOG SHEET DATA SUMMARY

Soleq EVcort
DOE Vehicle No. 355
PRPA Vehicle No. 55

"M" Denotes Missing Data

2nd Quarter 1993

Date	Odometer Reading Start	Odometer Reading End	Miles Driven	Battery Voltage Start	Battery Voltage End	Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
4-9-93	769	803	34	M	M		18.400	1.85	0.54	2	
4-10-93	803	815	12	M	M		7.118	1.69	0.59	1	
4-11-93	815	821	6	M	M		4.326	1.39	0.72	1	
4-12-93	821	838	17	M	M		10.517	1.62	0.62	1	
4-12-93	838	854	16	M	M		9.898	1.62	0.62	1	
4-13-93	854	868	14	M	M		10.922	1.28	0.78	1	
4-13-93	868	882	14	M	M		10.922	1.28	0.78	1	
4-14-93	882	898	16	M	M		11.150	1.44	0.70	1	
4-15-93	898	914	16	M	M		10.447	1.53	0.65	1	
4-16-93	914	923	9	M	M		5.319	1.69	0.59	1	
4-17-93	923	933	10	M	M		5.609	1.78	0.56	1	
4-19-93	933	943	10	M	M		4.986	2.01	0.50	1	
4-19-93	943	948	5	M	M		2.493	2.01	0.50	1	
4-20-93	948	956	8	M	M		3.734	2.14	0.47	1	
4-20-93	956	965	9	M	M		3.452	2.61	0.38	1	
4-20-93	965	979	14	M	M		5.370	2.61	0.38	2	
4-20-93	979	991	12	M	M		7.892	1.52	0.66	2	
4-21-93	991	1003	12	M	M		4.304	2.79	0.36	2	
4-21-93	1003	1010	7	M	M		3.236	2.16	0.46	1	
4-21-93	1010	1020	10	M	M		3.877	2.58	0.39	1	
4-21-93	1020	1038	18	119.7	112.3		8.288	2.17	0.46	2	
4-22-93	1038	1043	5	119.5	116.3		2.329	2.15	0.47	1	
4-22-93	1043	1048	5	118.5	115.0		2.329	2.15	0.47	1	
4-22-93	1048	1051	3	M	116.9		1.140	2.63	0.38	2	
4-22-93	1051	1066	15	118.4	112.7		5.698	2.63	0.38	2	
4-22-93	1066	1076	10	115.2	110.9		3.799	2.63	0.38	2	
4-23-93	1076	1086	10	121.5	115.4		3.799	2.63	0.38	2	
4-23-93	1086	1091	5	M	M		1.899	2.63	0.38	1	
4-23-93	1091	1105	14	M	112.9		7.661	1.83	0.55	2	
4-23-93	1105	1111	6	120.0	115.1		3.283	1.83	0.55	2	
4-24-93	1111	1117	6	119.6	116.9		3.656	1.64	0.61	1	
4-25-93	1117	1133	16	118.5	112.7		7.151	2.24	0.45	1	
4-25-93	1133	1147	14	118.0	111.5		6.257	2.24	0.45	1	
4-26-93	1147	1152	5	M	M		2.235	2.24	0.45	1	
4-26-93	1152	1165	13	118.0	114.0		6.125	2.12	0.47	1	
4-27-93	1165	1170	5	118.0	111.0		2.356	2.12	0.47	1	
4-27-93	1170	1191	21	M	M		9.317	2.25	0.44	1	
4-28-93	1191	1196	5	M	M		2.218	2.25	0.44	1	
4-28-93	1196	1227	31	119.0	108.0		15.976	1.94	0.52	2	
4-29-93	1227	1232	5	M	M		1.139	4.39	0.23	1	
4-30-93	1232	1237	5	M	M		2.915	1.72	0.58	1	
5-1-93	1237	1246	9	M	M		4.312	2.09	0.48	1	
5-1-93	1246	1265	19	118.5	111.5		9.136	2.08	0.48	1	
5-2-93	1265	1299	34	118.0	105.2		17.276	1.97	0.51	1	
5-3-93	1299	1303	4	M	M		1.466	2.73	0.37	1	
5-3-93	1303	1306	3	119.0	116.1		1.099	2.73	0.37	1	
5-6-93	1303	1330	27	119.0	111.1		15.885	1.70	0.59	3	

TABLE 4

VEHICLE LOG SHEET DATA SUMMARY

Soleq EVcart
DOE Vehicle No. 355
PRPA Vehicle No. 55

"M" Denotes Missing Data

2nd Quarter 1993

Date	Odometer Reading Start	Odometer Reading End	Miles Driven	Battery Voltage Start	Battery Voltage End	Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
5-13-93	1330	1334	4	119.0	115.8		2.189	1.83	0.55	1	
5-13-93	1334	1346	12	120.2	114.8		7.927	1.51	0.66	1	
5-14-93	1346	1354	8	118.9	115.5		2.513	3.18	0.31	1	
5-14-93	1354	1364	10	118.9	M		3.142	3.18	0.31	1	
5-16-93	1364	1404	40	118.5	102.4		15.880	2.52	0.40	1	
5-17-93	1404	1416	12	119.4	115.6		4.037	2.97	0.34	1	
5-17-93	1416	1423	7	M	M		3.286	2.13	0.47	1	
5-17-93	1423	1436	13	119.4	114.0		6.230	2.09	0.48	1	
5-18-93	1436	1439	3	117.0	115.9		1.578	1.90	0.53	1	
5-18-93	1439	1447	8	120.0	116.1		3.167	2.53	0.40	1	
5-18-93	1447	1458	11	120.0	116.6		7.019	1.57	0.64	1	
5-19-93	1458	1461	3	119.0	115.8		1.554	1.93	0.52	1	
5-19-93	1461	1473	12	119.7	114.8		6.215	1.93	0.52	1	
5-19-93	1473	1481.5	8.5	120.0	114.2		5.962	1.43	0.70	2	
5-20-93	1481.5	1482	0.5	M	M		0.286	1.75	0.57	1	
5-22-93	1482	1495	13	118.0	113.6		11.438	1.14	0.88	2	
5-28-93	1495	1500	5	119.7	M		2.875	1.74	0.57	4	
5-28-93	1500	1510	10	119.0	113.6		4.753	2.10	0.48	3	
5-29-93	1510	1539	29	119.0	111.0		9.542	3.04	0.33	2	
5-29-93	1539	1558	19	120.0	115.0		6.251	3.04	0.33	2	
5-30-93	1558	1571	13	120.0	111.0		9.595	1.35	0.74	2	
5-30-93	1571	1579	8	120.0	118.0		5.905	1.35	0.74	2	
6-3-93	1579	1585	6	118.2	114.7		3.589	1.67	0.60	1	
6-3-93	1585	1609	24	119.4	115.0		12.263	1.96	0.51	1	
6-7-93	1609	1626	17	118.7	115.2		7.172	2.37	0.42	1	
6-8-93	1626	1638	12	115.2	109.4		5.062	2.37	0.42	1	
6-8-93	1638	1649	11	122.1	114.6		5.590	1.97	0.51	1	
6-8-93	1649	1658	9	117.1	112.2		4.573	1.97	0.51	1	
6-8-93	1658	1660	2	113.5	112.0		1.016	1.97	0.51	1	
6-8-93	1660	1676	16	120.1	110.6		8.130	1.97	0.51	1	
6-9-93	1676	1687	11	113.4	104.5		12.501	0.88	1.14	1	
6-9-93	1687	1693	6	121.3	116.1		6.819	0.88	1.14	3	
6-9-93	1693	1705	12	121.3	114.3		6.757	1.78	0.56	1	
6-10-93	1705	1710	5	116.4	111.8		2.815	1.78	0.56	1	
6-10-93	1710	1728	18	121.2	114.0		7.992	2.25	0.44	1	
6-10-93	1728	1740	12	121.7	114.7		5.328	2.25	0.44	1	
6-11-93	1740	1751	11	116.0	111.0		4.884	2.25	0.44	1	
6-11-93	1751	1771	20	114.0	101.6		8.880	2.25	0.44	1	
6-14-93	1771	1776	5	118.2	115.9		1.922	2.60	0.38	1	
6-14-93	1776	1793	17	120.5	114.1		6.127	2.77	0.36	1	
6-15-93	1793	1798	5	120.3	117.5		1.450	3.45	0.29	1	
6-15-93	1798	1839	41	120.0	109.3		13.912	2.95	0.34	1	
6-16-93	1839	1859	20	120.4	113.5		9.836	2.03	0.49	2	
6-18-93	1859	1885	26	119.7	112.5		10.685	2.43	0.41	2	
6-21-93	1885	1893	8	119.0	116.0		3.054	2.62	0.38	1	
6-21-93	1893	1900	7	120.0	116.1		2.425	2.89	0.35	1	
6-21-93	1900	1916	16	119.9	114.0		5.824	2.75	0.36	1	

TABLE 4

VEHICLE LOG SHEET DATA SUMMARY

Soleq EVcort
DOE Vehicle No. 355
PRPA Vehicle No. 55

"M" Denotes Missing Data

2nd Quarter 1993

Date	Odometer Start	Reading End	Miles Driven	Battery Start	Voltage End	Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
6-22-93	1916	1923	7	119.6	113.0	A/C	3.876	1.81	0.55	2	00
6-23-93	1923	1927	4	120.8	115.8		2.215	1.81	0.55	2	
6-23-93	1927	1945	18	M	M		9.968	1.81	0.55	2	
6-24-93	1945	1966	21	120.0	110.7		10.414	2.02	0.50	2	
6-25-93	1966	2004	38	119.9	103.4		16.522	2.30	0.43	33	
6-28-93	2004	2011	7	120.9	M		3.554	1.97	0.51	2	
6-28-93	2011	2036	25	M	112.9		12.694	1.97	0.51	3	
6-29-93	2036	2053	17	M	114.2		8.632	1.97	0.51	3	
6-30-93	2053	2079	26	M	106.0		12.477	2.08	0.48	2	
TOTALS:			1310	---	---	---	653.020	---	---	---	---
AVERAGES:			12.7	119.0	113.0	---	6.340	2.01	0.50	1.7	---

TABLE 4

Log Sheet Data Summary

Soleq EVcart
DOE Vehicle No. 355
PRPA Vehicle No. 55

3rd Quarter 1993

"M" Denotes Missing Data

"N/A" Denotes Data Not Available At Time Of Report

Date	Odometer Reading Start	Odometer Reading End	Miles Driven	Battery Voltage Start	Battery Voltage End	Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
7-1-93	2079	2092	13	M	98.0		6.238	2.08	0.48	2	
7-1-93	2092	2093	1	M	M		0.480	2.08	0.48	2	
7-1-93	2093	2102	9	118.2	117.0		4.319	2.08	0.48	2	
7-2-93	2102	2122	20	117.3	112.0		9.597	2.08	0.48	2	
7-2-93	2122	2123	1	112.0	M		0.480	2.08	0.48	2	
7-4-93	2123	2144	21	M	M		10.060	2.09	0.48	3	
7-4-93	2144	2155	11	120.5	115.5		5.269	2.09	0.48	3	
7-5-93	2155	2161	6	119.4	116.8		2.983	2.01	0.50	1	
7-6-93	2161	2176	15	119.3	116.9		7.354	2.04	0.49	1	
7-6-93	2176	2184	8	119.2	115.9		3.922	2.04	0.49	1	
7-7-93	2184	2186	2	119.4	117.6		0.449	4.46	0.22	1	
7-7-93	2186	2214	28	120.2	115.9		11.727	2.39	0.42	2	
7-7-93	2214	2227	13	118.7	109.8		5.445	2.39	0.42	1	
7-8-93	2227	2231	4	119.6	M		3.023	1.32	0.76	3	
7-20-93	2231	2244	13	119.5	113.7		7.2214	1.80	0.56	1	
7-20-93	2244	2248	4	M	113.7		2.2220	1.80	0.56	2	
7-24-93	2248	2260	12	M	M		6.2484	1.92	0.52	4	
7-26-93	2260	2264	4	118.4	116.3		1.7585	2.27	0.44	2	
7-26-93	2264	2273	9	121.0	114.6		3.9565	2.27	0.44	1	
7-27-93	2273	2281	8	119.2	116.2		4.6122	1.73	0.58	1	
7-30-93	2281	2318	37	119.0	M		11.317	3.27	0.31	1	
8-3-93	2318	2328	10	116.3	113.2		2.9208	3.42	0.29	2	
8-3-93	2328	2333	5	119.8	114.2		4.2756	1.17	0.86	1	
8-4-93	2333	2340	7	119.0	117.5		3.2188	2.17	0.46	2	
8-4-93	2340	2346	6	117.5	114.2		2.7590	2.17	0.46	2	
8-5-93	2346	2373	27	119.0	111.0		12.9492	2.09	0.48	3	
8-6-93	2373	2377	4	120.7	116.9		2.4274	1.65	0.61	1	
8-6-93	2377	2380	3	118.2	M		1.8206	1.65	0.61	1	
8-9-93	2380	2418	38	120.3	108.6		13.8936	2.74	0.37	1	
8-10-93	2418	2428	10	118.5	115.7		4.6212	2.16	0.46	1	
8-11-93	2428	2437	9	118.9	115.3		1.1004	8.18	0.12	1	
8-11-93	2437	2439	2	121.7	M		1.0954	1.83	0.55	1	
8-11-93	2439	2464	25	110.2	108.9		13.6922	1.83	0.55	1	
8-12-93	2464	2481	17	120.2	115.2		7.5042	2.27	0.44	1	
8-13-93	2481	2495	14	119.0	114.5		4.7724	2.93	0.34	1	
8-13-93	2495	2509	14	119.3	113.3		7.815	1.79	0.56	1	
8-15-93	2509	2527	18	118.2	113.2		7.479	2.41	0.42	2	
8-17-93	2527	2540	13	118.0	114.8		6.0420	2.15	0.46	1	
8-18-93	2540	2548	8	119.0	115.6		3.7182	2.15	0.46	1	
8-18-93	2548	2552	4	119.9	117.1		1.8342	2.18	0.46	1	
8-18-93	2552	2555	3	119.9	117.5		0.9110	3.29	0.30	1	
8-19-93	2555	2581	26	117.7	106.3		7.8952	3.29	0.30	1	
8-19-93	2581	2590	9	111.1	100.3		2.7330	3.29	0.30	1	
8-19-93	2590	2618	28	119.2	109.5		18.6492	1.50	0.67	1	

TABLE 4

Log Sheet Data Summary

Soleq EVcort
DOE Vehicle No. 355
PRPA Vehicle No. 55

3rd Quarter 1993

"M" Denotes Missing Data

"N/A" Denotes Data Not Available At Time Of Report

Date	Odometer Reading Start	Odometer Reading End	Miles Driven	Battery Voltage Start	Battery Voltage End	Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
8-23-93	2618	2625	7	119.0	114.0		2.6473	2.64	0.38	1	
8-23-93	2625	2627	2	114.0	115.5		0.7564	2.64	0.38	2	
8-24-93	2627	2634	7	118.7	114.8		2.6473	2.64	0.38	1	
8-24-93	2634	2640	6	119.2	115.7		2.2888	2.62	0.38	1	
8-24-93	2640	2650	10	115.7	114.0		3.8147	2.62	0.38	1	
8-25-93	2650	2657	7	114.6	113.0		2.6703	2.62	0.38	1	
8-25-93	2657	2666	9	119.3	116.3		4.4874	2.01	0.50	1	
8-26-93	2666	2672	6	117.0	114.5		2.9916	2.01	0.50	1	
8-27-93	2672	2674	2	116.0	113.7		0.9972	2.01	0.50	2	
8-30-93	2674	2688	14	118.1	113.9		5.3652	2.61	0.38	2	
8-30-93	2688	2704	16	118.8	112.9		6.7656	2.36	0.42	1	
8-31-93	2704	2711	7	120.0	116.2		3.0402	2.30	0.43	1	
8-31-93	2711	2730	19	119.7	113.2		18.207	1.04	0.96	1	
9-14-93	2730	2737	7	115.0	113.0		3.0216	2.32	0.43	1	
9-15-93	2737	2778	41	116.0	105.0		19.9366	2.06	0.49	1	
9-17-93	2778	2781	3	119.0	115.0		1.4588	2.06	0.49	1	
9-17-93	2781	2782	1	122.3	120.1		5.1012	0.20	5.10	1	
9-17-93	2782	2790	8	122.9	116.8		6.3234	1.27	0.79	2	
9-18-93	2790	2799	9	118.9	115.6	H	3.732	2.41	0.41	2	
9-20-93	2799	2816	17	M	110.9	H	7.6631	2.22	0.45	2	
9-21-93	2816	2834	18	116.4	107.4		8.1138	2.22	0.45	2	
9-23-93	2834	2838	4	M	96.8		1.8031	2.22	0.45	2	
9-24-93	2838	2852	14	120.0	112.0		8.5932	1.63	0.61	2	
9-24-93	2852	2873	21	120.1	109.2	H	12.8102	1.64	0.61	2	
9-24-93	2873	2877	4	115.4	111.0		2.4400	1.64	0.61	3	
9-25-93	2877	2878	1	118.4	116.5		1.1148	0.90	1.11	2	
9-26-93	2878	2895	17	120.2	111.2		8.3033	2.05	0.49	2	
9-27-93	2895	2897	2	119.0	118.0		0.9769	2.05	0.49	2	
9-28-93	2897	2898	1	116.0	M		1.482	0.67	1.48	2	
9-28-93	2898	2903	5	119.1	114.4		1.4226	3.51	0.28	2	
9-28-93	2903	2928	25	118.1	109.8		13.3317	1.88	0.53	3	
9-29-93	2928	2930	2	118.7	115.9	H	1.0665	1.88	0.53	2	
9-29-93	2930	2939	9	116.2	114.2		5.6640	1.59	0.63	2	
9-29-93	2939	2978	39	120.0	104.5		12.2910	3.17	0.32	1	
9-30-93	2978	2982	4	121.6	117.7		3.8718	1.03	0.97	1	
9-30-93	2982	3020	38	122.3	108.4		15.6438	2.43	0.41	1	
TOTALS:			941	---	---	---	445.654	---	---	---	---
AVERAGES:			11.8	118.5	113.2	---	5.571	2.11	0.47	1.6	---

TABLE 2
Platte River Power Authority
LOG SHEET & METER DATA SUMMARY

Soleq EVcort
DOE Vehicle No. 355
PRPA Vehicle No. 55

"M" Denotes Missing Data

4th Quarter 1993

Date	Odometer Reading Start	Odometer Reading End	Miles Driven	Battery Voltage Start	Battery Voltage End	Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
10-1-93	3020	3065	45	121.3	106.7		18.3954	2.45	0.41		1
10-4-93	3065	3090	25	120.1	113.7		6.636	3.77	0.27		2
10-4-93	3090	3107	17	120.7	111.4		8.6112	1.97	0.51		2
10-5-93	3107	3108	1	120.4	119.2		1.5324	0.65	1.53		2
10-5-93	3108	3128	20	119.5	114.7		7.6152	2.63	0.38		1
10-6-93	3128	3132	4	119.4	116.2		2.106	1.90	0.53		1
10-7-93	3132	3148	16	M	M		5.235	3.06	0.33		1
10-7-93	3148	3177	29	M	M		13.173	2.20	0.45	M	
10-8-93	3177	3189	12	120.7	M		4.6422	2.58	0.39	M	
10-8-93	3189	3203	14	119.9	113.3		11.5014	1.22	0.82		3
10-12-93	3203	3223	20	119.9	M		8.727	2.29	0.44		2
10-13-93	3223	3246	23	119.9	110.3	H	10.8558	2.12	0.47		1
10-14-93	3246	3262	16	120.7	113.8	H	10.2966	1.55	0.64		1
10-18-93	3262	3278	16	119.7	112.6	H	7.6188	2.10	0.48		1
10-19-93	3278	3285	7	120.5	117.0		2.1378	3.27	0.31		2
10-19-93	3285	3319	34	120.7	108.3		14.7144	2.31	0.43		1
10-20-93	3319	3353	34	122.8	110.8		11.943	2.85	0.35		1
10-21-93	3353	3406	53	120.5	101.8		20.4756	2.59	0.39		1
10-23-93	3406	3415	9	122.1	118.2		5.7792	1.56	0.64		1
10-24-93	3415	3422	7	122.0	117.5		3.8052	1.84	0.54		3
10-25-93	3422	3425	3	119.5	116.1		3.5382	0.85	1.18		1
10-26-93	3425	3430	5	120.1	114.8	H	2.703	1.85	0.54	M	
10-27-93	3430	3444	14	119.8	113.9		6.4728	2.16	0.46	M	
10-28-93	3444	3448	4	119.7	114.4	H	3.2898	1.22	0.82	M	
10-29-93	3448	3458	10	119.6	113.4		5.4882	1.82	0.55	M	
10-30-93	3458	3465	7	120.7	114.8		4.2402	1.65	0.61	M	
11-1-93	3465	3467	2	118.6	115.8	H	3.2678	0.61	1.63		1
11-1-93	3467	3469	2	120.5	116.8		3.2678	0.61	1.63		1
11-3-93	3469	3471	2	119.1	114.9		3.2678	0.61	1.63		1
11-8-93	3471	3480	9	119.7	114.1		8.814	1.02	0.98		1
11-9-93	3480	3488	8	119.3	113.5	H	4.407	1.82	0.55		1
11-9-93	3488	3509	21	119.7	109.7	H	10.6668	1.97	0.51		1
11-10-93	3509	3516	7	120.8	113.2		3.5556	1.97	0.51		1
11-10-93	3516	3522	6	121.8	117.2		2.5318	2.37	0.42		1
11-10-93	3522	3527	5	120.6	116.9		2.1098	2.37	0.42		1
11-11-93	3527	3541	14	119.1	115.4		7.7642	1.80	0.55		1
11-11-93	3541	3544	3	119.2	114.0		1.6638	1.80	0.55		2
11-11-93	3544	3559	15	119.4	110.9	H	8.3188	1.80	0.55		2
11-15-93	3559	3560	1	118.0	115.9	H	0.5546	1.80	0.55		1
11-15-93	3560	3561	1	118.1	M	H	0.5546	1.80	0.55		1
11-15-93	3561	3562	1	116.9	112.3	H	0.5546	1.80	0.55		1
11-15-93	3562	3563	1	113.8	112.4	H	0.5546	1.80	0.55		1
11-15-93	3563	3568	5	121.1	116.0	H	2.7729	1.80	0.55		1
11-16-93	3568	3579	11	118.9	113.9	H	6.4058	1.72	0.58		1
11-16-93	3579	3591	12	117.8	108.3		6.9881	1.72	0.58		1
11-16-93	3591	3596	5	120.4	110.8	H	2.9117	1.72	0.58		1
11-17-93	3596	3601	5	120.9	115.3	H	2.2854	2.19	0.46		1

TABLE 2
Platte River Power Authority
LOG SHEET & METER DATA SUMMARY

Soleq EVcart
DOE Vehicle No. 355
PRPA Vehicle No. 55

"M" Denotes Missing Data

4th Quarter 1993

Date	Odometer Reading Start End	Miles Driven	Battery Voltage Start End	Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
11-17-93	3601 3608	7	118.9 115.8		3.1995	2.19	0.46	2	
11-17-93	3608 3617	9	122.7 114.3	H	4.1136	2.19	0.46	1	
11-20-93	3617 3618	1	118.1 114.6		0.4571	2.19	0.46	1	
11-20-93	3618 3624	6	118.4 112.9		2.7424	2.19	0.46	2	
11-21-93	3624 3630	6	116.7 112.6		2.7424	2.19	0.46	2	
11-22-93	3630 3639	9	118.8 113.1	H	4.1136	2.19	0.46	2	
11-23-93	3639 3644	5	125.0 115.1	H	2.2854	2.19	0.46	2	
11-24-93	3644 3646	2	117.5 115.0	H	0.9141	2.19	0.46	1	
11-24-93	3646 3652	6	123.6 110.7	H	2.7424	2.19	0.46	2	
11-24-93	3652 3660	8	180.0 110.6	H	7.9650	1.00	1.00	1	
11-25-93	3660 3661	1	119.5 118.6		2.7648	0.36	2.76	1	
11-28-93	3661 3673	12	120.2 113.2		6.7710	1.77	0.56	1	
11-29-93	3673 3681	8	119.8 116.1		11.1462	0.72	1.39	1	
12-14-93	3681 3698	17	118.3 112.3	H	10.7004	1.59	0.63	1	
12-15-93	3698 3722	24	122.8 108.1	H	11.9502	2.01	0.50	1	
12-16-93	3722 3730	8	124.3 115.7	H	4.491	1.78	0.56	1	
12-16-93	3730 3741	11	121.9 113.9	H	6.3066	1.74	0.57	1	
12-17-93	3741 3755	14	120.0 M	H	8.5848	1.63	0.61	1	
12-18-93	3755 3766	11	121.5 113.9		3.6252	3.03	0.33	1	
12-18-93	3766 3782	16	121.8 109.9	H	9.6628	1.66	0.60	2	
12-19-93	3782 3799	17	121.6 112.0	H	10.2668	1.66	0.60	1	
12-20-93	3799 3807	8	120.6 114.3	H	5.1348	1.56	0.64	1	
12-20-93	3807 3817	10	122.6 113.2	H	6.5202	1.53	0.65	1	
12-21-93	3817 3826	9	125.1 112.7	H	6.5802	1.37	0.73	1	
12-22-93	3826 3848	22	121.4 107.0	H	12.6048	1.75	0.57	2	
12-23-93	3848 3869	21	119.4 109.4	H	11.3016	1.86	0.54	2	
12-24-93	3869 3877	8	120.2 115.1	H	5.7186	1.40	0.71	2	
12-26-93	3877 3893	16	121.4 113.5		6.8682	2.33	0.43	3	
12-27-93	3893 3901	8	120.4 114.4	H	8.5476	0.94	1.07	1	
TOTALS:		881	---	---	---	465.572	---	---	---
AVERAGES:		11.6	121.0	113.4	---	6.126	1.89	0.53	1.3

Table 2.A

Soleq EVcort
DOE Vehicle No. 355
PRPA Vehicle No. 55

Platte River Power Authority

LOG SHEET & METER DATA SUMMARY

"M" Denotes Missing Data

1st Quarter 1994

Date	Odometer Reading		Miles Driven	Battery Voltage		Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
Start	End		Start	End							
1-5-94	3901	3919	18	123.4	110.0	H	9.7122	1.85	0.54	1	
1-6-94	3919	3944	25	117.0	110.0	H	16.6764	1.50	0.67	2	
1-7-94	3944	3950	6	125.0	113.0	H	4.587	1.31	0.76	1	
1-8-94	3950	3963	13	122.0	114.0	H	4.7568	2.73	0.37	2	
1-9-94	3963	3981	18	116.0	112.0		11.5752	1.56	0.64	2	
1-10-94	3981	3987	6	117.0	115.3	H	3.4308	1.75	0.57	1	
1-10-94	3987	4001	14	122.0	113.2	H	6.7668	2.07	0.48	1	
1-10-94	4001	4016	15	120.0	116.0	H	9.3138	1.61	0.62	1	
1-11-94	4016	4026	10	123.5	113.5	H	5.514	1.81	0.55	1	
1-12-94	4026	4034	8	121.2	114.3	H	4.6026	1.74	0.58	1	
1-12-94	4034	4046	12	125.5	113.2		6.8214	1.76	0.57	1	
1-13-94	4046	4053	7	116.2	112.9		5.0964	1.37	0.73	1	
1-13-94	4053	4072	19	117.4	111.6	H	13.0008	1.46	0.68	1	
1-15-94	4072	4081	9	120.4	115.1		4.7172	1.91	0.52	1	
1-16-94	4081	4097	16	119.6	111.0	H	8.9472	1.79	0.56	1	
1-17-94	4097	4105	8	121.3	114.7	H	8.0886	0.99	1.01	1	
1-21-94	4105	4110	5	122.9	115.9	H	9.5334	0.52	1.91	2	
1-28-94	4110	4127	17	126.5	110.4	H	17.7918	0.96	1.05	1	
2-7-94	4127	4128	1	121.6	116.1	H	0.9888	1.01	0.99	1	
2-8-94	4128	4133	5	121.6	114.5	H	6.984	0.72	1.40	3	
2-11-94	4133	4138	5	121.6	114.8	H	5.9616	0.84	1.19	3	
2-14-94	4138	4143	5	121.5	114.6	H	10.7712	0.46	2.15	1	
2-24-94	4143	4153	10	117.3	113.6		9.306	1.07	0.93	3	
2-28-94	4153	4165	12	122.6	109.5	H	8.643	1.39	0.72	1	
3-2-94	4165	4170	5	116.8	113.6	H	5.2938	0.94	1.06	2	
3-4-94	4170	4200	30	119.4	110.7		16.3056	1.84	0.54	1	
3-7-94	4200	4212	12	118.5	109.1		9.1236	1.32	0.76	2	
3-8-94	4212	4215	3	M	M	H	5.0214	0.60	1.67	3	
3-10-94	4215	4228	13	122.4	113.5		10.0608	1.29	0.77	1	
3-10-94	4228	4245	17	119.6	112.5		7.9392	2.14	0.47	1	
3-16-94	4245	4257	12	118.1	112.9		6.0744	1.98	0.51	1	
3-17-94	4257	4267	10	M	M		9.4044	1.06	0.94	1	
TOTALS:			366	---	---	---	262.810	---	---	---	---
AVERAGES:			11.4	120.6	113.1	---	8.213	1.39	0.72	1.4	---

Table 2.A

Soleq EVcort
DOE Vehicle No. 355
PRPA Vehicle No. 55

Platte River Power Authority

LOG SHEET & METER DATA SUMMARY

"M" Denotes Missing Data

2nd Quarter 1994

Date	Odometer Reading		Miles Driven	Battery Voltage		Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
	Start	End		Start	End						
4-4-94	4267	4275	8	123.5	M		4.399	1.82	0.55	1	
4-5-94	4275	4297	22	M	110.6		10.133	2.17	0.46	1	
4-6-94	4297	4305	8	120.7	115.6		4.075	1.96	0.51	2	
4-7-94	4305	4311	6	119.6	115.4		3.601	1.67	0.60	1	
4-8-94	4311	4318	7	122.1	115.2		5.257	1.33	0.75	1	
4-10-94	4318	4349	31	119.9	101.0		14.074	1.96	0.45	2	
4-11-94	4349	4354	5	125.7	117.4		2.200	2.27	0.44	1	
4-11-94	4354	4359	5	125.0	115.7	H	4.336	1.15	0.87	1	
4-13-94	4359	4375	16	119.0	113.2		8.561	1.87	0.54	1	
4-15-94	4375	4388	13	118.5	113.9		M	---	---	M	
4-18-94	4388	4397	9	119.3	111.3		10.502	0.86	1.17	1	
4-19-94	4397	4410	13	124.4	115.8		5.426	2.40	0.42	1	
4-20-94	4410	4443	33	120.4	96.1		13.880	2.38	0.42	1	
4-20-94	4443	4471	28	122.9	114.2		9.347	3.00	0.33	1	
4-22-94	4471	4494	23	122.1	110.1		11.483	2.00	0.50	1	
4-22-94	4494	M	8	M	M	M	4.747	1.61	0.62	M	
4-23-94	M	M	2	M	M	M	1.466	1.61	0.62	M	
4-23-94	M	M	13	M	M	M	8.369	1.61	0.62	M	
4-26-94	M	4540	23	M	M	M	13.976	1.61	0.62	M	
5-3-94	4540	4541	1	M	116.5		0.882	1.13	0.88	1	
5-4-94	4541	4545	4	118.6	116.1		3.850	1.04	0.96	3	
5-6-94	4545	4562	17	118.5	113.3		9.189	1.85	0.54	1	
5-9-94	4562	4577	15	117.3	112.1		8.181	1.83	0.55	1	
5-10-94	4577	4604	27	118.2	110.7		12.712	2.12	0.47	1	
5-11-94	4604	4613	9	M	M		4.232	2.12	0.47	M	
5-12-94	4613	4623	10	M	M		4.713	2.12	0.47	M	
5-13-94	4623	4632	9	114.1	112.7		8.314	1.08	0.92	2	

Table 2.A

5-16-94	4632	4647	15	117.7	112.7		7.107	2.11	0.47	1	
5-17-94	4647	4675	28	118.7	101.2		13.124	2.13	0.47	2	
5-17-94	4675	4677	2	M	M	M	0.937	2.13	0.47	M	
5-18-94	4677	4705	28	118.3	111.8		10.875	2.57	0.39	1	
5-22-94	4705	4722	17	117.6	112.9		9.818	1.73	0.58	3	
5-24-94	4722	4730	8	117.4	114.0		4.124	1.94	0.52	2	
5-24-94	4730	4739	9	117.6	115.2		5.456	1.65	0.61	2	
5-24-94	4739	4753	14	119.8	111.8		9.106	1.54	0.65	2	
5-25-94	4753	4754	1	118.1	116.2		0.887	1.13	0.89	1	
5-26-94	4754	4758	4	116.5	116.1	H	6.169	0.65	1.54	2	
5-31-94	4758	4759	1	117.4	115.1	A	0.857	1.17	0.86	1	
5-31-94	4759	4766	7	123.6	114.9	A	4.579	1.53	0.65	1	
6-1-94	4766	4775	9	119.3	113.5		5.887	1.53	0.65	1	
6-1-94	4775	4780	5	118.5	117.0		3.270	1.53	0.65	1	
6-1-94	4780	4782	2	121.4	116.0	A	1.308	1.53	0.65	1	
6-6-94	4782	4793	11	117.3	113.0		6.032	1.82	0.55	2	
6-7-94	4793	4807	14	117.3	111.0	A	13.949	1.00	1.00	1	
6-14-94	4807	4817	10	117.3	112.2	A	7.732	1.29	0.77	1	
6-16-94	4817	4848	31	121.7	M		10.558	2.94	0.34	1	
6-20-94	4848	4854	6	117.0	113.6		2.149	2.79	0.36	1	
6-22-94	4854	4890	36	117.0	111.6		12.895	2.79	0.36	2	
6-27-94	4890	4895	5	117.8	115.7		4.207	1.19	0.84	3	
6-29-94	4895	4899	4	117.5	M		1.607	2.49	0.40	2	
6-30-94	4899	4912	13	118.2	M		6.296	2.06	0.48	2	
TOTALS:			645	---	---	---	336.837	---	---	---	---
AVERAGES:			12.6	119.4	112.8	---	6.737	1.91	0.52	1.4	---

Table 2.B

Soleq EVcort
DOE Vehicle No. 356
PRPA Vehicle No. 56

Platte River Power Authority
LOG SHEET & METER DATA SUMMARY

"M" Denotes Missing Data

1st Quarter 1994

Date	Odometer Reading		Miles Driven	Battery Voltage		Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
	Start	End		Start	End						
1-5-94	92	100	8	117.0	111.9	H	5.6466	1.42	0.71	1	
1-6-94	100	109	9	119.6	112.7	H	4.8564	1.85	0.54	1	
1-6-94	109	119	10	119.0	102.0	H	5.8302	1.72	0.58	1	
1-7-94	119	124	5	122.3	114.0	H	3.6	1.39	0.72	3	
1-10-94	124	142	18	116.0	110.0		11.169	1.61	0.62	1	
1-10-94	142	150	8	123.0	113.5		4.2582	1.88	0.53	1	
1-11-94	150	158	8	119.7	112.3	H	6.4194	1.25	0.80	1	
1-12-94	158	166	8	123.8	112.6	H	4.2618	1.88	0.53	1	
1-13-94	166	177	11	119.8	112.3	H	5.7624	1.91	0.52	1	
1-13-94	177	181	4	121.9	115.8	H	2.3136	1.73	0.58	1	
1-13-94	181	191	10	120.7	113.4		4.9848	2.01	0.50	1	
1-14-94	191	209	18	118.8	112.6	H	10.1052	1.78	0.56	2	
1-15-94	209	218	9	121.0	114.2		5.8176	1.55	0.65	2	
1-16-94	218	231	13	119.4	114.8		7.1838	1.81	0.55	2	
1-17-94	231	235	4	119.4	114.0		5.7414	0.70	1.44	1	
1-19-94	235	246	11	124.3	113.0	H	6.2442	1.76	0.57	1	
1-20-94	246	267	21	122.1	104.7	H	11.9994	1.75	0.57	1	
1-21-94	267	272	5	120.5	115.3	H	23.1906	0.22	4.64	3	
1-21-94	272	280	8	124.5	112.7	H	4.5970	1.74	0.57	3	
2-7-94	280	289	9	121.6	111.0	H	5.1716	1.74	0.57	1	
2-8-94	289	297	8	125.8	112.9	H	5.4594	1.47	0.68	1	
2-8-94	297	301	4	124.3	114.8	H	3.2766	1.22	0.82	2	
2-8-94	301	310	9	124.3	111.7	H	6.5448	1.38	0.73	1	
2-9-94	310	318	8	120.2	113.0	H	5.2428	1.53	0.66	1	
2-9-94	318	326	8	124.2	113.1	H	5.7552	1.39	0.72	1	
2-10-94	326	335	9	119.9	113.7	H	4.7982	1.88	0.53	1	
2-10-94	335	343	8	123.3	113.9	H	4.6548	1.72	0.58	1	
2-11-94	343	351	8	119.8	113.6	H	20.6454	0.39	2.58	1	
2-24-94	351	356	5	124.8	115.1		9.4272	0.53	1.89	2	
3-1-94	356	367	11	124.2	112.8	H	5.8596	1.88	0.53	1	
3-2-94	367	376	9	120.2	114.6	H	3.8376	2.35	0.43	1	
3-4-94	376	386	10	124.0	114.9		5.379	1.86	0.54	1	
3-4-94	386	398	12	121.0	113.4		6.4548	1.86	0.54	1	
3-7-94	398	407	9	119.2	M		5.6232	1.60	0.62	1	
3-17-94	407	408	1	124.1	120.1		3.9654	0.25	3.97	1	
3-21-94	408	413	5	124.2	116.9		2.6694	1.87	0.53	1	
3-21-94	413	432	19	123.0	112.0		8.1258	2.34	0.43	1	
3-22-94	432	440	8	122.7	116.0		3.4992	2.29	0.44	1	
3-22-94	440	475	35	119.8	105.7		16.4958	2.12	0.47	1	
3-24-94	475	479	4	119.4	116.1		2.3424	1.71	0.59	2	
3-25-94	479	483	4	119.7	116.7		5.8644	0.68	1.47	1	
3-29-94	483	510	27	123.9	103.8	H	14.7303	1.83	0.55	1	
3-30-94	510	513	3	109.5	107.7	H	1.6367	1.83	0.55	2	
3-30-94	513	526	13	116.8	101.0		7.0924	1.83	0.55	1	
TOTALS:			434	---	---	---	298.534	---	---	---	---
AVERAGES:			9.9	121.2	112.5	---	6.785	1.45	0.69	1.3	---

Table 2.B

Soleq EVcort
DOE Vehicle No. 356
PRPA Vehicle No. 56

Platte River Power Authority

LOG SHEET & METER DATA SUMMARY

"M" Denotes Missing Data

2nd Quarter 1994

Date	Odometer Reading		Miles Driven	Battery Voltage		Heat or A/C Used	Energy Used-kWh	Miles per kWh	kWh Used per Mile	Payload Code	Problem Code
	Start	End		Start	End						
4-4-94	526	530	4	M	M		3.7206	1.08	0.93	3	
4-11-94	530	534	4	123.0	114.2		3.7206	1.08	0.93	1	
4-12-94	534	546	12	124.4	112.8		5.6130	2.14	0.47	3	
4-12-94	546	580	34	124	112		18.8151	1.81	0.55	1	
4-13-94	580	585	5	112	108		2.7669	1.81	0.55	1	
4-15-94	585	589	4	118	116		1.4493	2.76	0.36	1	
4-18-94	589	602	13	117	114		4.7103	2.76	0.36	1	
4-19-94	602	607	5	118	116		2.7300	1.83	0.55	1	
4-20-94	607	616	9	114.1	113.4		5.7426	1.57	0.64	1	
4-21-94	616	628	12	115	M		3.1902	3.76	0.27	1	
4-22-94	628	663	35	M	112.5		9.2940	3.77	0.27	1	
4-24-94	663	702	39	119.4	106.9		14.7864	2.64	0.38	1	
4-25-94	702	710	8	121.6	116.6		4.6146	1.73	0.58	1	
4-27-94	710	717	7	114.7	112.5	H	5.0804	1.52	0.66	1	
5-3-94	717	718	1	119	M		4.0566	0.20	5.08	1	
5-9-94	718	728	10	117.5	111.9		6.6396	1.51	0.66	2	
5-11-94	728	733	5	118.3	116.2		2.4504	2.04	0.49	3	
5-12-94	733	742	9	118.2	114.3		9.1218	0.99	1.01	1	
5-18-94	742	760	18	118.9	111.9		9.7596	1.84	0.54	1	
5-20-94	760	785	25	M	M		13.6758	1.83	0.55	1	
5-23-94	785	821	36	118.8	102.2		12.6390	2.85	0.35	1	
5-23-94	821	830	9	120.9	116.2		5.5206	1.63	0.61	1	
5-24-94	830	838	8	118.9	115.7		3.0342	2.64	0.38	1	
5-24-94	838	840	2	118.7	115.0		2.0808	0.96	1.04	2	
5-25-94	840	855	15	121.0	113.9		6.9996	2.14	0.47	1	

Table 2.B

5-27-94	855	861	6	118.3	M		6.1272	0.98	1.02	1	
5-31-94	861	872	11	117.5	111.5	A	6.1740	1.78	0.56	2	
6-1-94	872	908	36	118.0	109.3		12.3120	2.92	0.34	2	
6-2-94	908	919	11	121.7	115.7		5.0334	2.19	0.46	1	
6-3-94	919	927	8	118.7	115.5		5.5776	1.43	0.70	1	
6-6-94	927	944	17	121.5	112.8		8.7305	1.95	0.51	1	
6-7-94	944	953	9	120.5	112.8		4.6221	1.95	0.51	2	
6-13-94	953	970	17	119.9	115.5		9.9426	1.71	0.58	1	
6-27-94	970	975	5	113.9	113.7		4.3098	1.16	0.86	3	
6-29-94	975	983	8	117.7	114.4		4.1532	1.93	0.52	1	
TOTALS:			457	---	---	---	229.194	---	---	---	---
AVERAGES:			13.1	118.7	113.1	---	6.548	1.99	0.50	1.4	---

APPENDIX C

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Customer_Name PRPA CAR 56
Address_Line_1 N SIDE GAR IN MAIN B

DATE	TIME	KW
11/01/94	00:00	0.029
11/01/94	00:15	0.031
11/01/94	00:30	0.029
11/01/94	00:45	0.031
11/01/94	01:00	0.029
11/01/94	01:15	0.029
11/01/94	01:30	0.031
11/01/94	01:45	0.029
11/01/94	02:00	0.029
11/01/94	02:15	0.031
11/01/94	02:30	0.029
11/01/94	02:45	0.031
11/01/94	03:00	0.029
11/01/94	03:15	0.031
11/01/94	03:30	0.029
11/01/94	03:45	0.031
11/01/94	04:00	0.031
11/01/94	04:15	0.029
11/01/94	04:30	0.031
11/01/94	04:45	0.029
11/01/94	05:00	0.029
11/01/94	05:15	0.031
11/01/94	05:30	0.031
11/01/94	05:45	0.029
11/01/94	06:00	0.029
11/01/94	06:15	0.031
11/01/94	06:30	0.264
11/01/94	06:45	1.212
11/01/94	07:00	1.231
11/01/94	07:15	1.243
11/01/94	07:30	1.229
11/01/94	07:45	0.708
11/01/94	08:00	0.271
11/01/94	08:15	0.149
11/01/94	08:30	0.106
11/01/94	08:45	0.089
11/01/94	09:00	0.074
11/01/94	09:15	0.070

11/01/94	09:30	0.065
11/01/94	09:45	0.065
11/01/94	10:00	0.060
11/01/94	10:15	0.060
11/01/94	10:30	0.060
11/01/94	10:45	0.062
11/01/94	11:00	0.036
11/01/94	11:15	0.026
11/01/94	11:30	0.026
11/01/94	11:45	0.024
11/01/94	12:00	0.022
11/01/94	12:15	0.019
11/01/94	12:30	0.024
11/01/94	12:45	0.026
11/01/94	13:00	0.024
11/01/94	13:15	0.019
11/01/94	13:30	0.019
11/01/94	13:45	0.026
11/01/94	14:00	0.024
11/01/94	14:15	0.022
11/01/94	14:30	0.019
11/01/94	14:45	0.022
11/01/94	15:00	0.026
11/01/94	15:15	0.002
11/01/94	15:30	0.000
11/01/94	15:45	0.586
11/01/94	16:00	1.222
11/01/94	16:15	1.231
11/01/94	16:30	1.236
11/01/94	16:45	1.243
11/01/94	17:00	1.246
11/01/94	17:15	1.250
11/01/94	17:30	1.250
11/01/94	17:45	1.253
11/01/94	18:00	1.253
11/01/94	18:15	1.255
11/01/94	18:30	1.255
11/01/94	18:45	1.255
11/01/94	19:00	1.262
11/01/94	19:15	1.262
11/01/94	19:30	0.931
11/01/94	19:45	0.485
11/01/94	20:00	0.221
11/01/94	20:15	0.125
11/01/94	20:30	0.098
11/01/94	20:45	0.089
11/01/94	21:00	0.084

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11/01/94	21:15	0.084
11/01/94	21:30	0.079
11/01/94	21:45	0.079
11/01/94	22:00	0.082
11/01/94	22:15	0.077
11/01/94	22:30	0.077
11/01/94	22:45	0.079
11/01/94	23:00	0.043
11/01/94	23:15	0.031
11/01/94	23:30	0.029
11/01/94	23:45	0.029
11/02/94	00:00	0.029
11/02/94	00:15	0.029
11/02/94	00:30	0.029
11/02/94	00:45	0.031
11/02/94	01:00	0.029
11/02/94	01:15	0.029
11/02/94	01:30	0.029
11/02/94	01:45	0.029
11/02/94	02:00	0.029
11/02/94	02:15	0.029
11/02/94	02:30	0.029
11/02/94	02:45	0.029
11/02/94	03:00	0.029
11/02/94	03:15	0.029
11/02/94	03:30	0.031
11/02/94	03:45	0.029
11/02/94	04:00	0.029
11/02/94	04:15	0.029
11/02/94	04:30	0.029
11/02/94	04:45	0.029
11/02/94	05:00	0.029
11/02/94	05:15	0.029
11/02/94	05:30	0.029
11/02/94	05:45	0.029
11/02/94	06:00	0.029
11/02/94	06:15	0.031
11/02/94	06:30	0.182
11/02/94	06:45	1.210
11/02/94	07:00	1.231
11/02/94	07:15	1.246
11/02/94	07:30	0.955
11/02/94	07:45	0.360
11/02/94	08:00	0.163
11/02/94	08:15	0.110
11/02/94	08:30	0.089
11/02/94	08:45	0.082

11/02/94	09:00	0.074
11/02/94	09:15	0.072
11/02/94	09:30	0.072
11/02/94	09:45	0.072
11/02/94	10:00	0.070
11/02/94	10:15	0.070
11/02/94	10:30	0.070
11/02/94	10:45	0.062
11/02/94	11:00	0.022
11/02/94	11:15	0.022
11/02/94	11:30	0.024
11/02/94	11:45	0.026
11/02/94	12:00	0.026
11/02/94	12:15	0.026
11/02/94	12:30	0.024
11/02/94	12:45	0.022
11/02/94	13:00	0.024
11/02/94	13:15	0.024
11/02/94	13:30	0.026
11/02/94	13:45	0.024
11/02/94	14:00	0.026
11/02/94	14:15	0.024
11/02/94	14:30	0.022
11/02/94	14:45	0.024
11/02/94	15:00	0.024
11/02/94	15:15	0.026
11/02/94	15:30	0.026
11/02/94	15:45	0.024
11/02/94	16:00	0.312
11/02/94	16:15	1.246
11/02/94	16:30	1.265
11/02/94	16:45	0.648
11/02/94	17:00	0.000
11/02/94	17:15	0.000
11/02/94	17:30	0.000
11/02/94	17:45	0.000
11/02/94	18:00	0.000
11/02/94	18:15	0.000
11/02/94	18:30	0.002
11/02/94	18:45	0.250
11/02/94	19:00	1.238
11/02/94	19:15	1.250
11/02/94	19:30	1.260
11/02/94	19:45	1.267
11/02/94	20:00	1.272
11/02/94	20:15	1.277
11/02/94	20:30	1.279

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11/02/94	20:45	1.282
11/02/94	21:00	1.284
11/02/94	21:15	1.294
11/02/94	21:30	1.010
11/02/94	21:45	0.547
11/02/94	22:00	0.271
11/02/94	22:15	0.154
11/02/94	22:30	0.115
11/02/94	22:45	0.094
11/02/94	23:00	0.089
11/02/94	23:15	0.082
11/02/94	23:30	0.079
11/02/94	23:45	0.077
11/03/94	00:00	0.074
11/03/94	00:15	0.077
11/03/94	00:30	0.074
11/03/94	00:45	0.074
11/03/94	01:00	0.053
11/03/94	01:15	0.029
11/03/94	01:30	0.029
11/03/94	01:45	0.029
11/03/94	02:00	0.026
11/03/94	02:15	0.029
11/03/94	02:30	0.029
11/03/94	02:45	0.029
11/03/94	03:00	0.029
11/03/94	03:15	0.029
11/03/94	03:30	0.029
11/03/94	03:45	0.029
11/03/94	04:00	0.029
11/03/94	04:15	0.029
11/03/94	04:30	0.029
11/03/94	04:45	0.026
11/03/94	05:00	0.029
11/03/94	05:15	0.026
11/03/94	05:30	0.029
11/03/94	05:45	0.026
11/03/94	06:00	0.029
11/03/94	06:15	0.024
11/03/94	06:30	0.686
11/03/94	06:45	1.229
11/03/94	07:00	1.246
11/03/94	07:15	1.270
11/03/94	07:30	0.919
11/03/94	07:45	0.365
11/03/94	08:00	0.166
11/03/94	08:15	0.108

11/03/94	08:30	0.089
11/03/94	08:45	0.079
11/03/94	09:00	0.074
11/03/94	09:15	0.074
11/03/94	09:30	0.067
11/03/94	09:45	0.070
11/03/94	10:00	0.067
11/03/94	10:15	0.067
11/03/94	10:30	0.065
11/03/94	10:45	0.060
11/03/94	11:00	0.024
11/03/94	11:15	0.026
11/03/94	11:30	0.026
11/03/94	11:45	0.026
11/03/94	12:00	0.026
11/03/94	12:15	0.026
11/03/94	12:30	0.026
11/03/94	12:45	0.024
11/03/94	13:00	0.024
11/03/94	13:15	0.024
11/03/94	13:30	0.026
11/03/94	13:45	0.026
11/03/94	14:00	0.026
11/03/94	14:15	0.026
11/03/94	14:30	0.026
11/03/94	14:45	0.026
11/03/94	15:00	0.024
11/03/94	15:15	0.024
11/03/94	15:30	0.017
11/03/94	15:45	1.174
11/03/94	16:00	1.267
11/03/94	16:15	1.282
11/03/94	16:30	1.296
11/03/94	16:45	1.250
11/03/94	17:00	0.869
11/03/94	17:15	0.398
11/03/94	17:30	0.178
11/03/94	17:45	0.113
11/03/94	18:00	0.091
11/03/94	18:15	0.082
11/03/94	18:30	0.077
11/03/94	18:45	0.074
11/03/94	19:00	0.072
11/03/94	19:15	0.072
11/03/94	19:30	0.067
11/03/94	19:45	0.072
11/03/94	20:00	0.065

11/03/94	20:15	0.065
11/03/94	20:30	0.029
11/03/94	20:45	0.026
11/03/94	21:00	0.029
11/03/94	21:15	0.029
11/03/94	21:30	0.029
11/03/94	21:45	0.026
11/03/94	22:00	0.029
11/03/94	22:15	0.029
11/03/94	22:30	0.029
11/03/94	22:45	0.029
11/03/94	23:00	0.029
11/03/94	23:15	0.029
11/03/94	23:30	0.029
11/03/94	23:45	0.029
11/04/94	00:00	0.029
11/04/94	00:15	0.029
11/04/94	00:30	0.029
11/04/94	00:45	0.029
11/04/94	01:00	0.029
11/04/94	01:15	0.029
11/04/94	01:30	0.029
11/04/94	01:45	0.029
11/04/94	02:00	0.029
11/04/94	02:15	0.029
11/04/94	02:30	0.029
11/04/94	02:45	0.029
11/04/94	03:00	0.029
11/04/94	03:15	0.029
11/04/94	03:30	0.031
11/04/94	03:45	0.029
11/04/94	04:00	0.029
11/04/94	04:15	0.029
11/04/94	04:30	0.029
11/04/94	04:45	0.029
11/04/94	05:00	0.029
11/04/94	05:15	0.029
11/04/94	05:30	0.029
11/04/94	05:45	0.029
11/04/94	06:00	0.029
11/04/94	06:15	0.029
11/04/94	06:30	0.559
11/04/94	06:45	1.236
11/04/94	07:00	1.260
11/04/94	07:15	1.267
11/04/94	07:30	0.878
11/04/94	07:45	0.420

11/04/94	08:00	0.209
11/04/94	08:15	0.137
11/04/94	08:30	0.106
11/04/94	08:45	0.089
11/04/94	09:00	0.079
11/04/94	09:15	0.072
11/04/94	09:30	0.072
11/04/94	09:45	0.065
11/04/94	10:00	0.065
11/04/94	10:15	0.067
11/04/94	10:30	0.065
11/04/94	10:45	0.062
11/04/94	11:00	0.026
11/04/94	11:15	0.026
11/04/94	11:30	0.024
11/04/94	11:45	0.024
11/04/94	12:00	0.022
11/04/94	12:15	0.022
11/04/94	12:30	0.026
11/04/94	12:45	0.026
11/04/94	13:00	0.026
11/04/94	13:15	0.024
11/04/94	13:30	0.019
11/04/94	13:45	0.007
11/04/94	14:00	0.000
11/04/94	14:15	0.000
11/04/94	14:30	0.000
11/04/94	14:45	0.000
11/04/94	15:00	0.000
11/04/94	15:15	0.000
11/04/94	15:30	0.000
11/04/94	15:45	0.000
11/04/94	16:00	0.490
11/04/94	16:15	0.000
11/04/94	16:30	0.000
11/04/94	16:45	0.000
11/04/94	17:00	0.000
11/04/94	17:15	0.900
11/04/94	17:30	1.226
11/04/94	17:45	1.236
11/04/94	18:00	1.243
11/04/94	18:15	1.246
11/04/94	18:30	1.253
11/04/94	18:45	1.255
11/04/94	19:00	1.253
11/04/94	19:15	1.255
11/04/94	19:30	1.255

11/04/94	19:45	1.255
11/04/94	20:00	1.253
11/04/94	20:15	1.258
11/04/94	20:30	1.255
11/04/94	20:45	1.258
11/04/94	21:00	1.258
11/04/94	21:15	1.260
11/04/94	21:30	1.262
11/04/94	21:45	1.262
11/04/94	22:00	1.267
11/04/94	22:15	1.270
11/04/94	22:30	1.274
11/04/94	22:45	1.277
11/04/94	23:00	1.284
11/04/94	23:15	1.289
11/04/94	23:30	1.301
11/04/94	23:45	1.241
11/05/94	00:00	1.013
11/05/94	00:15	0.794
11/05/94	00:30	0.614
11/05/94	00:45	0.461
11/05/94	01:00	0.336
11/05/94	01:15	0.254
11/05/94	01:30	0.206
11/05/94	01:45	0.175
11/05/94	02:00	0.161
11/05/94	02:15	0.144
11/05/94	02:30	0.137
11/05/94	02:45	0.127
11/05/94	03:00	0.120
11/05/94	03:15	0.118
11/05/94	03:30	0.110
11/05/94	03:45	0.108
11/05/94	04:00	0.106
11/05/94	04:15	0.043
11/05/94	04:30	0.029
11/05/94	04:45	0.029
11/05/94	05:00	0.031
11/05/94	05:15	0.029
11/05/94	05:30	0.029
11/05/94	05:45	0.029
11/05/94	06:00	0.029
11/05/94	06:15	0.029
11/05/94	06:30	0.031
11/05/94	06:45	0.029
11/05/94	07:00	0.029
11/05/94	07:15	0.029

11/05/94	07:30	0.019
11/05/94	07:45	0.000
11/05/94	08:00	0.000
11/05/94	08:15	0.000
11/05/94	08:30	0.000
11/05/94	08:45	0.000
11/05/94	09:00	0.288
11/05/94	09:15	1.238
11/05/94	09:30	1.255
11/05/94	09:45	1.260
11/05/94	10:00	1.267
11/05/94	10:15	1.274
11/05/94	10:30	1.279
11/05/94	10:45	1.286
11/05/94	11:00	1.301
11/05/94	11:15	0.571
11/05/94	11:30	0.000
11/05/94	11:45	0.000
11/05/94	12:00	0.000
11/05/94	12:15	0.000
11/05/94	12:30	0.000
11/05/94	12:45	0.000
11/05/94	13:00	0.000
11/05/94	13:15	0.000
11/05/94	13:30	0.000
11/05/94	13:45	0.000
11/05/94	14:00	0.000
11/05/94	14:15	0.000
11/05/94	14:30	0.002
11/05/94	14:45	0.000
11/05/94	15:00	0.000
11/05/94	15:15	0.000
11/05/94	15:30	0.000
11/05/94	15:45	0.398
11/05/94	16:00	0.000
11/05/94	16:15	0.000
11/05/94	16:30	0.869
11/05/94	16:45	0.684
11/05/94	17:00	1.217
11/05/94	17:15	1.229
11/05/94	17:30	1.236
11/05/94	17:45	1.238
11/05/94	18:00	1.246
11/05/94	18:15	1.248
11/05/94	18:30	1.248
11/05/94	18:45	1.250
11/05/94	19:00	1.253

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11/05/94	19:15	1.253
11/05/94	19:30	1.253
11/05/94	19:45	1.255
11/05/94	20:00	1.258
11/05/94	20:15	1.260
11/05/94	20:30	1.265
11/05/94	20:45	1.277
11/05/94	21:00	1.171
11/05/94	21:15	0.787
11/05/94	21:30	0.473
11/05/94	21:45	0.290
11/05/94	22:00	0.194
11/05/94	22:15	0.149
11/05/94	22:30	0.125
11/05/94	22:45	0.113
11/05/94	23:00	0.101
11/05/94	23:15	0.098
11/05/94	23:30	0.094
11/05/94	23:45	0.089
11/06/94	00:00	0.086
11/06/94	00:15	0.086
11/06/94	00:30	0.082
11/06/94	00:45	0.065
11/06/94	01:00	0.031
11/06/94	01:15	0.029
11/06/94	01:30	0.029
11/06/94	01:45	0.029
11/06/94	02:00	0.031
11/06/94	02:15	0.029
11/06/94	02:30	0.031
11/06/94	02:45	0.029
11/06/94	03:00	0.031
11/06/94	03:15	0.029
11/06/94	03:30	0.031
11/06/94	03:45	0.029
11/06/94	04:00	0.029
11/06/94	04:15	0.031
11/06/94	04:30	0.031
11/06/94	04:45	0.029
11/06/94	05:00	0.031
11/06/94	05:15	0.029
11/06/94	05:30	0.031
11/06/94	05:45	0.029
11/06/94	06:00	0.029
11/06/94	06:15	0.031
11/06/94	06:30	0.029
11/06/94	06:45	0.029

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11/06/94	07:00	0.031
11/06/94	07:15	0.029
11/06/94	07:30	0.029
11/06/94	07:45	0.029
11/06/94	08:00	0.029
11/06/94	08:15	0.031
11/06/94	08:30	0.029
11/06/94	08:45	0.029
11/06/94	09:00	0.029
11/06/94	09:15	0.031
11/06/94	09:30	0.029
11/06/94	09:45	0.029
11/06/94	10:00	0.029
11/06/94	10:15	0.029
11/06/94	10:30	0.031
11/06/94	10:45	0.029
11/06/94	11:00	0.029
11/06/94	11:15	0.026
11/06/94	11:30	0.000
11/06/94	11:45	0.000
11/06/94	12:00	0.000
11/06/94	12:15	0.000
11/06/94	12:30	0.000
11/06/94	12:45	0.000
11/06/94	13:00	0.000
11/06/94	13:15	0.000
11/06/94	13:30	0.000
11/06/94	13:45	0.000
11/06/94	14:00	0.000
11/06/94	14:15	0.000
11/06/94	14:30	0.002
11/06/94	14:45	0.000
11/06/94	15:00	0.000
11/06/94	15:15	0.000
11/06/94	15:30	0.000
11/06/94	15:45	0.000
11/06/94	16:00	0.283
11/06/94	16:15	1.226
11/06/94	16:30	1.238
11/06/94	16:45	1.248
11/06/94	17:00	1.255
11/06/94	17:15	1.262
11/06/94	17:30	1.265
11/06/94	17:45	1.272
11/06/94	18:00	1.274
11/06/94	18:15	1.265
11/06/94	18:30	0.907

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11/06/94	18:45	0.487
11/06/94	19:00	0.252
11/06/94	19:15	0.156
11/06/94	19:30	0.118
11/06/94	19:45	0.098
11/06/94	20:00	0.091
11/06/94	20:15	0.086
11/06/94	20:30	0.084
11/06/94	20:45	0.082
11/06/94	21:00	0.079
11/06/94	21:15	0.079
11/06/94	21:30	0.079
11/06/94	21:45	0.079
11/06/94	22:00	0.046
11/06/94	22:15	0.031
11/06/94	22:30	0.029
11/06/94	22:45	0.031
11/06/94	23:00	0.029
11/06/94	23:15	0.031
11/06/94	23:30	0.029
11/06/94	23:45	0.031
11/07/94	00:00	0.029
11/07/94	00:15	0.031
11/07/94	00:30	0.029
11/07/94	00:45	0.031
11/07/94	01:00	0.029
11/07/94	01:15	0.031
11/07/94	01:30	0.029
11/07/94	01:45	0.031
11/07/94	02:00	0.029
11/07/94	02:15	0.031
11/07/94	02:30	0.029
11/07/94	02:45	0.029
11/07/94	03:00	0.029
11/07/94	03:15	0.029
11/07/94	03:30	0.031
11/07/94	03:45	0.029
11/07/94	04:00	0.029
11/07/94	04:15	0.029
11/07/94	04:30	0.029
11/07/94	04:45	0.029
11/07/94	05:00	0.029
11/07/94	05:15	0.029
11/07/94	05:30	0.029
11/07/94	05:45	0.026
11/07/94	06:00	0.029
11/07/94	06:15	0.029

11/07/94	06:30	0.223
11/07/94	06:45	1.210
11/07/94	07:00	1.231
11/07/94	07:15	1.246
11/07/94	07:30	1.258
11/07/94	07:45	0.814
11/07/94	08:00	0.307
11/07/94	08:15	0.158
11/07/94	08:30	0.110
11/07/94	08:45	0.089
11/07/94	09:00	0.079
11/07/94	09:15	0.074
11/07/94	09:30	0.070
11/07/94	09:45	0.072
11/07/94	10:00	0.067
11/07/94	10:15	0.070
11/07/94	10:30	0.067
11/07/94	10:45	0.067
11/07/94	11:00	0.050
11/07/94	11:15	0.026
11/07/94	11:30	0.024
11/07/94	11:45	0.019
11/07/94	12:00	0.022
11/07/94	12:15	0.024
11/07/94	12:30	0.026
11/07/94	12:45	0.024
11/07/94	13:00	0.022
11/07/94	13:15	0.019
11/07/94	13:30	0.024
11/07/94	13:45	0.026
11/07/94	14:00	0.024
11/07/94	14:15	0.022
11/07/94	14:30	0.022
11/07/94	14:45	0.024
11/07/94	15:00	0.026
11/07/94	15:15	0.019
11/07/94	15:30	0.979
11/07/94	15:45	1.260
11/07/94	16:00	1.274
11/07/94	16:15	1.234
11/07/94	16:30	0.734
11/07/94	16:45	0.281
11/07/94	17:00	0.130
11/07/94	17:15	0.094
11/07/94	17:30	0.082
11/07/94	17:45	0.079
11/07/94	18:00	0.077

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11/07/94	18:15	0.079
11/07/94	18:30	0.074
11/07/94	18:45	0.077
11/07/94	19:00	0.074
11/07/94	19:15	0.074
11/07/94	19:30	0.077
11/07/94	19:45	0.058
11/07/94	20:00	0.029
11/07/94	20:15	0.026
11/07/94	20:30	0.029
11/07/94	20:45	0.026
11/07/94	21:00	0.029
11/07/94	21:15	0.026
11/07/94	21:30	0.029
11/07/94	21:45	0.026
11/07/94	22:00	0.026
11/07/94	22:15	0.029
11/07/94	22:30	0.026
11/07/94	22:45	0.026
11/07/94	23:00	0.029
11/07/94	23:15	0.029
11/07/94	23:30	0.026
11/07/94	23:45	0.029
11/08/94	00:00	0.029
11/08/94	00:15	0.029
11/08/94	00:30	0.029
11/08/94	00:45	0.029
11/08/94	01:00	0.029
11/08/94	01:15	0.029
11/08/94	01:30	0.029
11/08/94	01:45	0.029
11/08/94	02:00	0.029
11/08/94	02:15	0.029
11/08/94	02:30	0.029
11/08/94	02:45	0.029
11/08/94	03:00	0.029
11/08/94	03:15	0.029
11/08/94	03:30	0.029
11/08/94	03:45	0.026
11/08/94	04:00	0.029
11/08/94	04:15	0.029
11/08/94	04:30	0.029
11/08/94	04:45	0.029
11/08/94	05:00	0.029
11/08/94	05:15	0.026
11/08/94	05:30	0.029
11/08/94	05:45	0.175

11/08/94	06:00	1.205
11/08/94	06:15	1.226
11/08/94	06:30	1.243
11/08/94	06:45	1.260
11/08/94	07:00	0.929
11/08/94	07:15	0.384
11/08/94	07:30	0.182
11/08/94	07:45	0.125
11/08/94	08:00	0.103
11/08/94	08:15	0.089
11/08/94	08:30	0.082
11/08/94	08:45	0.079
11/08/94	09:00	0.077
11/08/94	09:15	0.077
11/08/94	09:30	0.074
11/08/94	09:45	0.074
11/08/94	10:00	0.074
11/08/94	10:15	0.070
11/08/94	10:30	0.026
11/08/94	10:45	0.024
11/08/94	11:00	0.026
11/08/94	11:15	0.026
11/08/94	11:30	0.026
11/08/94	11:45	0.026
11/08/94	12:00	0.026
11/08/94	12:15	0.026
11/08/94	12:30	0.026
11/08/94	12:45	0.026
11/08/94	13:00	0.026
11/08/94	13:15	0.026
11/08/94	13:30	0.024
11/08/94	13:45	0.026
11/08/94	14:00	0.024
11/08/94	14:15	0.026
11/08/94	14:30	0.029
11/08/94	14:45	0.026
11/08/94	15:00	0.026
11/08/94	15:15	0.029
11/08/94	15:30	0.026
11/08/94	15:45	0.026
11/08/94	16:00	0.026
11/08/94	16:15	0.017
11/08/94	16:30	1.018
11/08/94	16:45	1.272
11/08/94	17:00	1.289
11/08/94	17:15	1.310
11/08/94	17:30	0.996

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11/08/94	17:45	0.526
11/08/94	18:00	0.235
11/08/94	18:15	0.142
11/08/94	18:30	0.113
11/08/94	18:45	0.094
11/08/94	19:00	0.086
11/08/94	19:15	0.082
11/08/94	19:30	0.079
11/08/94	19:45	0.074
11/08/94	20:00	0.077
11/08/94	20:15	0.072
11/08/94	20:30	0.074
11/08/94	20:45	0.074
11/08/94	21:00	0.041
11/08/94	21:15	0.029
11/08/94	21:30	0.029
11/08/94	21:45	0.029
11/08/94	22:00	0.031
11/08/94	22:15	0.029
11/08/94	22:30	0.029
11/08/94	22:45	0.031
11/08/94	23:00	0.029
11/08/94	23:15	0.031
11/08/94	23:30	0.029
11/08/94	23:45	0.031
11/09/94	00:00	0.031
11/09/94	00:15	0.029
11/09/94	00:30	0.031
11/09/94	00:45	0.031
11/09/94	01:00	0.029
11/09/94	01:15	0.031
11/09/94	01:30	0.031
11/09/94	01:45	0.029
11/09/94	02:00	0.031
11/09/94	02:15	0.029
11/09/94	02:30	0.029
11/09/94	02:45	0.031
11/09/94	03:00	0.029
11/09/94	03:15	0.029
11/09/94	03:30	0.031
11/09/94	03:45	0.029
11/09/94	04:00	0.029
11/09/94	04:15	0.031
11/09/94	04:30	0.029
11/09/94	04:45	0.029
11/09/94	05:00	0.029
11/09/94	05:15	0.029

11/09/94	05:30	0.031
11/09/94	05:45	0.046
11/09/94	06:00	1.200
11/09/94	06:15	1.234
11/09/94	06:30	1.253
11/09/94	06:45	1.274
11/09/94	07:00	1.171
11/09/94	07:15	0.746
11/09/94	07:30	0.374
11/09/94	07:45	0.197
11/09/94	08:00	0.134
11/09/94	08:15	0.106
11/09/94	08:30	0.094
11/09/94	08:45	0.084
11/09/94	09:00	0.077
11/09/94	09:15	0.074
11/09/94	09:30	0.072
11/09/94	09:45	0.070
11/09/94	10:00	0.070
11/09/94	10:15	0.067
11/09/94	10:30	0.065
11/09/94	10:45	0.024
11/09/94	11:00	0.026
11/09/94	11:15	0.026
11/09/94	11:30	0.026
11/09/94	11:45	0.026
11/09/94	12:00	0.029
11/09/94	12:15	0.024
11/09/94	12:30	0.026
11/09/94	12:45	0.026
11/09/94	13:00	0.024
11/09/94	13:15	0.024
11/09/94	13:30	0.026
11/09/94	13:45	0.026
11/09/94	14:00	0.029
11/09/94	14:15	0.026
11/09/94	14:30	0.026
11/09/94	14:45	0.029
11/09/94	15:00	0.026
11/09/94	15:15	0.358
11/09/94	15:30	1.258
11/09/94	15:45	1.286
11/09/94	16:00	1.306
11/09/94	16:15	1.133
11/09/94	16:30	0.694
11/09/94	16:45	0.343
11/09/94	17:00	0.168

11/09/94	17:15	0.120
11/09/94	17:30	0.101
11/09/94	17:45	0.089
11/09/94	18:00	0.084
11/09/94	18:15	0.079
11/09/94	18:30	0.077
11/09/94	18:45	0.074
11/09/94	19:00	0.072
11/09/94	19:15	0.074
11/09/94	19:30	0.072
11/09/94	19:45	0.058
11/09/94	20:00	0.029
11/09/94	20:15	0.029
11/09/94	20:30	0.031
11/09/94	20:45	0.029
11/09/94	21:00	0.029
11/09/94	21:15	0.029
11/09/94	21:30	0.029
11/09/94	21:45	0.029
11/09/94	22:00	0.029
11/09/94	22:15	0.029
11/09/94	22:30	0.029
11/09/94	22:45	0.029
11/09/94	23:00	0.029
11/09/94	23:15	0.029
11/09/94	23:30	0.029
11/09/94	23:45	0.029
11/10/94	00:00	0.029
11/10/94	00:15	0.031
11/10/94	00:30	0.029
11/10/94	00:45	0.029
11/10/94	01:00	0.031
11/10/94	01:15	0.029
11/10/94	01:30	0.029
11/10/94	01:45	0.029
11/10/94	02:00	0.029
11/10/94	02:15	0.031
11/10/94	02:30	0.029
11/10/94	02:45	0.029
11/10/94	03:00	0.029
11/10/94	03:15	0.029
11/10/94	03:30	0.029
11/10/94	03:45	0.031
11/10/94	04:00	0.029
11/10/94	04:15	0.029
11/10/94	04:30	0.029
11/10/94	04:45	0.029

11/10/94	05:00	0.029
11/10/94	05:15	0.029
11/10/94	05:30	0.029
11/10/94	05:45	0.571
11/10/94	06:00	1.226
11/10/94	06:15	1.255
11/10/94	06:30	1.277
11/10/94	06:45	1.013
11/10/94	07:00	0.588
11/10/94	07:15	0.288
11/10/94	07:30	0.170
11/10/94	07:45	0.122
11/10/94	08:00	0.106
11/10/94	08:15	0.089
11/10/94	08:30	0.082
11/10/94	08:45	0.077
11/10/94	09:00	0.074
11/10/94	09:15	0.072
11/10/94	09:30	0.072
11/10/94	09:45	0.070
11/10/94	10:00	0.070
11/10/94	10:15	0.048
11/10/94	10:30	0.026
11/10/94	10:45	0.024
11/10/94	11:00	0.026
11/10/94	11:15	0.026
11/10/94	11:30	0.029
11/10/94	11:45	0.026
11/10/94	12:00	0.026
11/10/94	12:15	0.026
11/10/94	12:30	0.024
11/10/94	12:45	0.024
11/10/94	13:00	0.024
11/10/94	13:15	0.024
11/10/94	13:30	0.026
11/10/94	13:45	0.026
11/10/94	14:00	0.026
11/10/94	14:15	0.026
11/10/94	14:30	0.024
11/10/94	14:45	0.022
11/10/94	15:00	0.024
11/10/94	15:15	0.026
11/10/94	15:30	0.026
11/10/94	15:45	0.017
11/10/94	16:00	1.046
11/10/94	16:15	1.272
11/10/94	16:30	1.296

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11/10/94	16:45	1.289
11/10/94	17:00	0.960
11/10/94	17:15	0.564
11/10/94	17:30	0.276
11/10/94	17:45	0.156
11/10/94	18:00	0.113
11/10/94	18:15	0.000
11/10/94	18:30	0.000
11/10/94	18:45	0.000
11/10/94	19:00	0.000
11/10/94	19:15	0.571
11/10/94	19:30	1.222
11/10/94	19:45	1.236
11/10/94	20:00	1.243
11/10/94	20:15	1.248
11/10/94	20:30	1.255
11/10/94	20:45	1.260
11/10/94	21:00	1.265
11/10/94	21:15	1.265
11/10/94	21:30	1.267
11/10/94	21:45	1.267
11/10/94	22:00	1.265
11/10/94	22:15	1.270
11/10/94	22:30	1.270
11/10/94	22:45	1.274
11/10/94	23:00	1.279
11/10/94	23:15	1.294
11/10/94	23:30	1.126
11/10/94	23:45	0.706
11/11/94	00:00	0.396
11/11/94	00:15	0.228
11/11/94	00:30	0.156
11/11/94	00:45	0.127
11/11/94	01:00	0.113
11/11/94	01:15	0.103
11/11/94	01:30	0.098
11/11/94	01:45	0.096
11/11/94	02:00	0.091
11/11/94	02:15	0.089
11/11/94	02:30	0.086
11/11/94	02:45	0.086
11/11/94	03:00	0.086
11/11/94	03:15	0.036
11/11/94	03:30	0.031
11/11/94	03:45	0.029
11/11/94	04:00	0.031
11/11/94	04:15	0.031

11/11/94	04:30	0.031
11/11/94	04:45	0.029
11/11/94	05:00	0.029
11/11/94	05:15	0.031
11/11/94	05:30	0.031
11/11/94	05:45	0.029
11/11/94	06:00	0.029
11/11/94	06:15	0.024
11/11/94	06:30	0.802
11/11/94	06:45	1.224
11/11/94	07:00	1.241
11/11/94	07:15	1.258
11/11/94	07:30	1.118
11/11/94	07:45	0.494
11/11/94	08:00	0.194
11/11/94	08:15	0.118
11/11/94	08:30	0.096
11/11/94	08:45	0.086
11/11/94	09:00	0.082
11/11/94	09:15	0.079
11/11/94	09:30	0.077
11/11/94	09:45	0.077
11/11/94	10:00	0.074
11/11/94	10:15	0.074
11/11/94	10:30	0.074
11/11/94	10:45	0.072
11/11/94	11:00	0.026
11/11/94	11:15	0.026
11/11/94	11:30	0.026
11/11/94	11:45	0.026
11/11/94	12:00	0.029
11/11/94	12:15	0.026
11/11/94	12:30	0.026
11/11/94	12:45	0.029
11/11/94	13:00	0.026
11/11/94	13:15	0.026
11/11/94	13:30	0.024
11/11/94	13:45	0.026
11/11/94	14:00	0.024
11/11/94	14:15	0.026
11/11/94	14:30	0.026
11/11/94	14:45	0.026
11/11/94	15:00	0.029
11/11/94	15:15	0.713
11/11/94	15:30	1.258
11/11/94	15:45	1.274
11/11/94	16:00	1.286

11/11/94	16:15	0.878
11/11/94	16:30	0.360
11/11/94	16:45	0.156
11/11/94	17:00	0.106
11/11/94	17:15	0.094
11/11/94	17:30	0.084
11/11/94	17:45	0.082
11/11/94	18:00	0.079
11/11/94	18:15	0.079
11/11/94	18:30	0.079
11/11/94	18:45	0.077
11/11/94	19:00	0.079
11/11/94	19:15	0.079
11/11/94	19:30	0.062
11/11/94	19:45	0.029
11/11/94	20:00	0.029
11/11/94	20:15	0.031
11/11/94	20:30	0.029
11/11/94	20:45	0.029
11/11/94	21:00	0.026
11/11/94	21:15	0.029
11/11/94	21:30	0.029
11/11/94	21:45	0.029
11/11/94	22:00	0.029
11/11/94	22:15	0.029
11/11/94	22:30	0.029
11/11/94	22:45	0.029
11/11/94	23:00	0.029
11/11/94	23:15	0.029
11/11/94	23:30	0.029
11/11/94	23:45	0.029
11/12/94	00:00	0.029
11/12/94	00:15	0.029
11/12/94	00:30	0.029
11/12/94	00:45	0.029
11/12/94	01:00	0.029
11/12/94	01:15	0.031
11/12/94	01:30	0.029
11/12/94	01:45	0.029
11/12/94	02:00	0.029
11/12/94	02:15	0.029
11/12/94	02:30	0.029
11/12/94	02:45	0.029
11/12/94	03:00	0.031
11/12/94	03:15	0.029
11/12/94	03:30	0.029
11/12/94	03:45	0.029

11/12/94	04:00	0.029
11/12/94	04:15	0.029
11/12/94	04:30	0.029
11/12/94	04:45	0.029
11/12/94	05:00	0.029
11/12/94	05:15	0.029
11/12/94	05:30	0.029
11/12/94	05:45	0.029
11/12/94	06:00	0.029
11/12/94	06:15	0.026
11/12/94	06:30	0.029
11/12/94	06:45	0.029
11/12/94	07:00	0.029
11/12/94	07:15	0.029
11/12/94	07:30	0.029
11/12/94	07:45	0.029
11/12/94	08:00	0.029
11/12/94	08:15	0.026
11/12/94	08:30	0.029
11/12/94	08:45	0.012
11/12/94	09:00	0.000
11/12/94	09:15	0.000
11/12/94	09:30	0.000
11/12/94	09:45	0.715
11/12/94	10:00	1.226
11/12/94	10:15	1.236
11/12/94	10:30	1.243
11/12/94	10:45	1.248
11/12/94	11:00	1.253
11/12/94	11:15	1.255
11/12/94	11:30	1.258
11/12/94	11:45	1.258
11/12/94	12:00	1.258
11/12/94	12:15	1.255
11/12/94	12:30	1.255
11/12/94	12:45	1.253
11/12/94	13:00	1.258
11/12/94	13:15	1.258
11/12/94	13:30	1.260
11/12/94	13:45	1.267
11/12/94	14:00	1.277
11/12/94	14:15	1.178
11/12/94	14:30	0.778
11/12/94	14:45	0.468
11/12/94	15:00	0.283
11/12/94	15:15	0.192
11/12/94	15:30	0.146

11/12/94	15:45	0.127
11/12/94	16:00	0.113
11/12/94	16:15	0.106
11/12/94	16:30	0.101
11/12/94	16:45	0.098
11/12/94	17:00	0.096
11/12/94	17:15	0.094
11/12/94	17:30	0.091
11/12/94	17:45	0.091
11/12/94	18:00	0.072
11/12/94	18:15	0.029
11/12/94	18:30	0.029
11/12/94	18:45	0.029
11/12/94	19:00	0.029
11/12/94	19:15	0.029
11/12/94	19:30	0.026
11/12/94	19:45	0.029
11/12/94	20:00	0.029
11/12/94	20:15	0.029
11/12/94	20:30	0.029
11/12/94	20:45	0.029
11/12/94	21:00	0.029
11/12/94	21:15	0.029
11/12/94	21:30	0.029
11/12/94	21:45	0.029
11/12/94	22:00	0.029
11/12/94	22:15	0.029
11/12/94	22:30	0.031
11/12/94	22:45	0.029
11/12/94	23:00	0.029
11/12/94	23:15	0.029
11/12/94	23:30	0.029
11/12/94	23:45	0.029
11/13/94	00:00	0.029
11/13/94	00:15	0.029
11/13/94	00:30	0.029
11/13/94	00:45	0.029
11/13/94	01:00	0.029
11/13/94	01:15	0.031
11/13/94	01:30	0.029
11/13/94	01:45	0.029
11/13/94	02:00	0.029
11/13/94	02:15	0.031
11/13/94	02:30	0.029
11/13/94	02:45	0.029
11/13/94	03:00	0.029
11/13/94	03:15	0.031

11/13/94	03:30	0.029
11/13/94	03:45	0.029
11/13/94	04:00	0.029
11/13/94	04:15	0.031
11/13/94	04:30	0.029
11/13/94	04:45	0.029
11/13/94	05:00	0.031
11/13/94	05:15	0.029
11/13/94	05:30	0.029
11/13/94	05:45	0.029
11/13/94	06:00	0.029
11/13/94	06:15	0.029
11/13/94	06:30	0.029
11/13/94	06:45	0.029
11/13/94	07:00	0.029
11/13/94	07:15	0.029
11/13/94	07:30	0.029
11/13/94	07:45	0.029
11/13/94	08:00	0.029
11/13/94	08:15	0.029
11/13/94	08:30	0.026
11/13/94	08:45	0.029
11/13/94	09:00	0.029
11/13/94	09:15	0.029
11/13/94	09:30	0.029
11/13/94	09:45	0.024
11/13/94	10:00	0.000
11/13/94	10:15	0.000
11/13/94	10:30	0.000
11/13/94	10:45	0.000
11/13/94	11:00	0.000
11/13/94	11:15	0.000
11/13/94	11:30	0.000
11/13/94	11:45	0.000
11/13/94	12:00	0.000
11/13/94	12:15	0.000
11/13/94	12:30	0.002
11/13/94	12:45	0.000
11/13/94	13:00	0.000
11/13/94	13:15	0.000
11/13/94	13:30	0.000
11/13/94	13:45	0.000
11/13/94	14:00	0.190
11/13/94	14:15	0.000
11/13/94	14:30	0.048
11/13/94	14:45	1.205
11/13/94	15:00	1.229

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11/13/94	15:15	1.236
11/13/94	15:30	1.241
11/13/94	15:45	1.248
11/13/94	16:00	1.253
11/13/94	16:15	1.253
11/13/94	16:30	1.253
11/13/94	16:45	1.250
11/13/94	17:00	1.250
11/13/94	17:15	1.250
11/13/94	17:30	1.250
11/13/94	17:45	1.250
11/13/94	18:00	1.253
11/13/94	18:15	1.253
11/13/94	18:30	1.255
11/13/94	18:45	1.260
11/13/94	19:00	1.260
11/13/94	19:15	1.267
11/13/94	19:30	1.274
11/13/94	19:45	1.255
11/13/94	20:00	0.967
11/13/94	20:15	0.662
11/13/94	20:30	0.439
11/13/94	20:45	0.300
11/13/94	21:00	0.221
11/13/94	21:15	0.175
11/13/94	21:30	0.149
11/13/94	21:45	0.137
11/13/94	22:00	0.122
11/13/94	22:15	0.120
11/13/94	22:30	0.113
11/13/94	22:45	0.108
11/13/94	23:00	0.106
11/13/94	23:15	0.103
11/13/94	23:30	0.101
11/13/94	23:45	0.086
11/14/94	00:00	0.031
11/14/94	00:15	0.029
11/14/94	00:30	0.029
11/14/94	00:45	0.031
11/14/94	01:00	0.029
11/14/94	01:15	0.029
11/14/94	01:30	0.029
11/14/94	01:45	0.029
11/14/94	02:00	0.029
11/14/94	02:15	0.031
11/14/94	02:30	0.029
11/14/94	02:45	0.029

11/14/94	03:00	0.029
11/14/94	03:15	0.029
11/14/94	03:30	0.029
11/14/94	03:45	0.031
11/14/94	04:00	0.029
11/14/94	04:15	0.029
11/14/94	04:30	0.029
11/14/94	04:45	0.029
11/14/94	05:00	0.029
11/14/94	05:15	0.029
11/14/94	05:30	0.029
11/14/94	05:45	0.451
11/14/94	06:00	1.224
11/14/94	06:15	1.246
11/14/94	06:30	1.217
11/14/94	06:45	0.622
11/14/94	07:00	0.247
11/14/94	07:15	0.149
11/14/94	07:30	0.115
11/14/94	07:45	0.098
11/14/94	08:00	0.089
11/14/94	08:15	0.086
11/14/94	08:30	0.079
11/14/94	08:45	0.079
11/14/94	09:00	0.079
11/14/94	09:15	0.077
11/14/94	09:30	0.074
11/14/94	09:45	0.077
11/14/94	10:00	0.041
11/14/94	10:15	0.026
11/14/94	10:30	0.026
11/14/94	10:45	0.029
11/14/94	11:00	0.026
11/14/94	11:15	0.026
11/14/94	11:30	0.026
11/14/94	11:45	0.026
11/14/94	12:00	0.026
11/14/94	12:15	0.026
11/14/94	12:30	0.024
11/14/94	12:45	0.026
11/14/94	13:00	0.026
11/14/94	13:15	0.026
11/14/94	13:30	0.029
11/14/94	13:45	0.026
11/14/94	14:00	0.029
11/14/94	14:15	0.026
11/14/94	14:30	0.026

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11/14/94	14:45	0.026
11/14/94	15:00	0.024
11/14/94	15:15	0.024
11/14/94	15:30	0.175
11/14/94	15:45	1.246
11/14/94	16:00	1.272
11/14/94	16:15	1.289
11/14/94	16:30	1.282
11/14/94	16:45	0.811
11/14/94	17:00	0.372
11/14/94	17:15	0.185
11/14/94	17:30	0.122
11/14/94	17:45	0.098
11/14/94	18:00	0.089
11/14/94	18:15	0.084
11/14/94	18:30	0.079
11/14/94	18:45	0.077
11/14/94	19:00	0.077
11/14/94	19:15	0.074
11/14/94	19:30	0.077
11/14/94	19:45	0.074
11/14/94	20:00	0.067
11/14/94	20:15	0.029
11/14/94	20:30	0.031
11/14/94	20:45	0.029
11/14/94	21:00	0.031
11/14/94	21:15	0.029
11/14/94	21:30	0.031
11/14/94	21:45	0.029
11/14/94	22:00	0.029
11/14/94	22:15	0.031
11/14/94	22:30	0.029
11/14/94	22:45	0.029
11/14/94	23:00	0.029
11/14/94	23:15	0.029
11/14/94	23:30	0.031
11/14/94	23:45	0.029
11/15/94	00:00	0.029
11/15/94	00:15	0.029
11/15/94	00:30	0.029
11/15/94	00:45	0.031
11/15/94	01:00	0.029
11/15/94	01:15	0.029
11/15/94	01:30	0.029
11/15/94	01:45	0.029
11/15/94	02:00	0.029
11/15/94	02:15	0.031

11/15/94	02:30	0.029
11/15/94	02:45	0.029
11/15/94	03:00	0.029
11/15/94	03:15	0.029
11/15/94	03:30	0.031
11/15/94	03:45	0.029
11/15/94	04:00	0.029
11/15/94	04:15	0.029
11/15/94	04:30	0.029
11/15/94	04:45	0.026
11/15/94	05:00	0.000
11/15/94	05:15	0.000
11/15/94	05:30	0.000
11/15/94	05:45	0.000
11/15/94	06:00	0.000
11/15/94	06:15	0.002
11/15/94	06:30	0.000
11/15/94	06:45	1.174
11/15/94	07:00	1.207
11/15/94	07:15	1.224
11/15/94	07:30	1.234
11/15/94	07:45	1.243
11/15/94	08:00	1.253
11/15/94	08:15	1.258
11/15/94	08:30	1.258
11/15/94	08:45	1.255
11/15/94	09:00	1.253
11/15/94	09:15	1.250
11/15/94	09:30	1.253
11/15/94	09:45	1.255
11/15/94	10:00	1.255
11/15/94	10:15	1.258
11/15/94	10:30	1.262
11/15/94	10:45	1.265
11/15/94	11:00	1.270
11/15/94	11:15	1.274
11/15/94	11:30	1.282
11/15/94	11:45	1.291
11/15/94	12:00	1.178
11/15/94	12:15	0.970
11/15/94	12:30	0.778
11/15/94	12:45	0.619
11/15/94	13:00	0.473
11/15/94	13:15	0.360
11/15/94	13:30	0.281
11/15/94	13:45	0.233
11/15/94	14:00	0.194

APPENDIX D

GRIFFON VAN BATTERY CHARGER

SEPTEMBER 16, 1992

TOTAL KWH 22.968

GRIFFON VAN BATTERY CHARGER

SEPTEMBER 17, 1992

TOTAL KWII 29.666

GRIFFON VAN BATTERY CHARGER

SEPTEMBER 18, 1992

TOTAL KWH 14.654

GRIFFON VAN BATTERY CHARGER

SEPTEMBER 21, 1992

TOTAL KWH 13.074

GRIFFON VAN BATTERY CHARGER

SEPTEMBER 22, 1992

TOTAL KWH 16.060

GRIFFON VAN BATTERY CHARGER

SEPTEMBER 23, 1992

TOTAL KWII 15.684

GRIFFON VAN BATTERY CHARGER

SEPTEMBER 24, 1992

TOTAL KWH 15.313

GRIFFON VAN BATTERY CHARGER

SEPTEMBER 25, 1992

TOTAL KWH 17.079

GRIFFON VAN BATTERY CHARGER

SEPTEMBER 29, 1992

TOTAL KWH 15.700

GRIFFON VAN BATTERY CHARGER

SEPTEMBER 30, 1992

TOTAL KWH 30.753

SOLEQ EVCORT BATTERY CHARGER

March 17 - 18, 1993

Figure 2

EVcort Battery Charger Load Profile June 16, 1993

Total Energy ~ 13.91 kWh
Distance Driven ~ 41 miles

FIGURE 4

FIGURE 4

EVcoort Battery Charger Load Profile
Charge Rate Set At 16 Amps
July 30, 1993

Total Energy = 10.82 kWh
Distance Driven = 37 miles

FIGURE 3

EVcort Battery Charger Load Profile
 Charge Rate Set At 30 Amps
 August 9, 1993

Total Energy = 13.48 kWh
 Distance Driven = 38 miles

FIGURE 3

EVcort Battery Charger Load Profile
Charge Rate Set At 16 Amps
December 22, 1993

FIGURE 1

Total Energy = 12.20 kWh
Distance Driven = 22 miles (with electric heater on)

FIGURE 2

EVcort Battery Charger Load Profile
 Charge Rate Set At 30 Amps
 December 15, 1993

Total Energy = 10.70 kWh
 Distance Driven = 17 miles (with electric heater on)

Figure 1
EVCort No. 355 Battery Charger Load Profile
First Quarter 1994

Figure 2
EVcort No. 356 Battery Charger Load Profile
First Quarter 1994

APPENDIX E

Plot 1

prpa electric car 55

Current 55-2

CAR 55

Current 55-3

Current 55-3

CAR 55

55-5 Current

Customer_Name prpa electric car 55

55-6 Current

Customer_Name prpa electric car 55

55-8&9 Current

Customer_Name prpa electric car 55

Current, 55-3

Customer_Name prpa electric car 55

Current, 55-4

car 55

Current 55, 7-96 Chart 1

Plot 2

PRPA ELECTRIC CAR #56

Plot 5

Current 56-2

CAR 56

Current 56-1

Current 56-2

PRPA CAR 56

56-4 Current

56-5 Current

56-8 Current

Customer_Name PRPA CAR 56

Current, 56-2

Customer_Name PRPA CAR 56

Current, 56-4

Customer_Name PRPA CAR 56

Current, 56-5

Current, 56-6 Chart 1

APPENDIX F

Table 4

ELECTRIC VEHICLE MAINTENANCE REPORT											
DOE VEHICLE NO.	VEHICLE	DATE OUT OF SERVICE	DATE BACK IN SERVICE	SERVICE CODE	FAILURE CODE	LABOR MAN- HOURS	COMMENTS	ODOMETER	PARTS COST	MAINTENANCE TYPE	
354	Griffon van		9-16-'92				Following limited operation of the Griffon van, an inspection of the van revealed a number of problems that needed repair. Repairs were performed on the following systems: emergency brake cable, brake shoe relining, wheel bearing seal replacement, auxillary battery replaced, diesel heating system, and one of two battery chargers was repaired.	29,316	\$1,724	Repair	
354	Griffon van	3-2-'93	-	49	Failure		Drive motor failure, Van shipped to INEL due to pending expiration of NHTSA operating permit. NHTSA operating permit.	34,202	\$4,229	Repair	
355	Soleq EVcort	3-11-'93	3-13-'93	45	49	1	Replaced blown 350 amp rear battery pack isolation fuse with 400 amp fuse	620	\$5.00	Repair	
355	Soleq EVcort	4-17-'93	4-18-'93	45	49	1	Replaced blown 350 amp front battery pack isolation fuse with 400 amp fuse	933	\$5.00	Repair	
356	Soleq EVcort	8-18-'94	9-14-'94	36	53	4	The DC/DC converter failed and was repaired by the manufacturer under warranty. The 12 volt auxiliary battery was also replaced.	1,208	\$ -	Repair	
355	Soleq EVcort	9-22-'94	9-29-'94	43	12	2	Both of the two return springs in the accelerator & regenerative brake controller module were replace under warranty. The return spring for the accelerator was broken and the return spring for the regenerative braking was cracked.	6,076	\$ -	Repair	
356	Soleq EVcort	1-30-'95	3-1-'95	36	53	4	The DC/DC converter failed and was repaired by the manufacturer under warranty.	2,460	\$ -	Repair	
356	Soleq EVcort	6-12-'95	-	43	52	2	One battery cable terminal connection failed. Abnormally high resistance in the cable to terminal connector produced excessive heat causing the lead terminal connector to become deformed which caused the integrity of the connection to fail.	4,477	\$ -	Repair	
356	Soleq EVcort	6-12-'95	-	46	-	-	Controller regenerative braking circuit was modified by manufacturer to produce smoother battery over-voltage control.	4,477	\$ -	Modification	
355	Soleq EVcort	7-26-'95	7-27-'95	46	-	-	Controller regeneration gain was lowered to increase stability of braking when traction batteries are nearly at full charge and controller current limit gain was lowered to increase stability at high acceleration. Modifications were performed by manufacturer on site.	8,811	\$ -	Modification	
356	Soleq EVcort	6-12-'95	7-26-'95	46	-	-	Controller regeneration gain was lowered to increase stability of braking when traction batteries are nearly at full charge and controller current limit gain was lowered to increase stability at high acceleration. Modifications were performed by manufacturer in Chicago.	4,477	\$ -	Modification	
356	Soleq EVcort	11-3-'95	-	46	53	-	Motor controller and capacitor/contactor module were shipped to Soleq for inspection, testing and repair. The base drive rectifier was bad and replaced by Soleq.	5,154	\$ 1,208	Repair	

MAINTENANCE LOG
SERVICE - REPAIR CODES

MAJOR GROUP 00	AIR CONDITIONING, BODY AND INSTRUMENTATION
00	Air conditioning
02	Body, glass, interiors
03	Instruments, gauges, radio
05	Heater
06	Battery tray, cabinet
07	Cleanup (paint, wash)
MAJOR GROUP 10	CHASSIS
11	Axle - nondriven front
12	Axle - nondriven rear
13	Brakes
14	Frame
15	Steering
16	Suspension
17	Tires, tubes, liners and valves
18	Wheels, rims, hubs and bearings
MAJOR GROUP 20	DRIVE TRAIN
21	Axle - driven front
22	Axle - driven rear
23	Clutch
24	Drive shaft
26	Transmission - manual
27	Transmission - automatic

MAINTENANCE LOG
SERVICE - REPAIR CODES

MAJOR GROUP 30	ELECTRICAL - AUXILIARY
31	Charging system 12VDC
33	Activation system (potentiometer, contactor)
34	Lighting system
35	Battery - auxiliary
36	DC - DC converter
37	Wiring - low voltage
38	Blower systems (motor, battery cabinet)
39	Fuses
MAJOR GROUP 40	ELECTRICAL - TRACTION
41	Charging system, traction
42	Cords, recepticals, GFI
43	Module interconnection system (cables, clamps)
45	Battery pack
46	Motor controller
47	Contactor - main
48	Regenerative braking
49	Motor
MAJOR GROUP 90	OTHER
91	State of charge meter
92	Watering system
93	Data acquisition equipment (VDAS, OBM)

MAINTENANCE LOG
PROBLEM CODES

CODE	PROBLEMS/PART FAILURE
10	Bent
11	Binds, sticks
49	Blown fuse
12	Broken
13	Chipped
14	Cracked
15	Foreign matter
16	Glazed
47	High pressure
17	Insufficient lube
18	Leaking
19	Loose
46	Lost or missing
48	Low pressure
20	Oil-soaked
21	Misadjusted
22	Misaligned
23	Not connected
24	Not drilled
25	Out of balance
26	Out of round
27	Overheated
28	Improper installation

MAINTENANCE LOG PROBLEM CODES

CODE	PROBLEMS/PART FAILURE
29	Part omitted
30	Poor fit
31	Poor metal finish
32	Porosity
33	Registers incorrect
34	Rough
35	Rusted/corroded
36	Scored/scratch
37	Seized
38	Shorted
39	Soiled/stained
40	Stripped
41	Torn/punctured
42	Warped
43	Weak
44	Worn
45	Wrong part
49	Dirty connections
50	Dirty contacts
51	Burnt
52	Melted
53	Open circuit
54	Low range
55	Low level

APPENDIX G

TABLE 5

EV Emissions Comparison to Internal Combustion Engine Emissions
Based on PRPA's Resource Mix

SOLEQ EVCORT ELECTRIC POWERED STATION WAGON
ELECTRIC USEAGE = 1.95 MI/KWH

SO2 grams/MI	NOx grams/MI	PM10 grams/MI	CO grams/MI	CO2 grams/MI	VOC's grams/MI
0.145	0.522	0.0205	0.0120	244	0.00628

SO2+NOx grams/MI	All (excluding PM10 & CO2)
0.666	0.685

FORD GASOLINE-POWERED ESCORT STATION WAGON (based on EPRI data)
FUEL USEAGE = 28 MI/GAL

SO2 grams/MI	NOx grams/MI	PM10 grams/MI	CO grams/MI	CO2 grams/MI	VOC's grams/MI
0.114	1.03	?	5.71	394	0.571

SO2+NOx grams/MI	All (excluding PM10 & CO2)
1.14	7.43

EV EMISSION % REDUCTION FROM INTERNAL COMBUSTION ENGINE

SO2	NOx	PM10	CO	CO2	VOC's
-26.6%	49.3%	?	99.8%	38.0%	98.9%

SO2 + NOx	All (excluding PM10 & CO2)
41.7%	90.8%

EV EMISSIONS AS A % OF INTERNAL CUMBUSTION ENGINE EMISSIONS

SO2	NOx	PM10	CO	CO2	VOC's
127%	50.7%	?	0.211%	62.0%	1.10%

SO2 + NOx	All (excluding PM10 & CO2)
58.3%	9.22%

FIGURE 1

EMISSIONS COMPARISON

Charging With Platte River's Current Resource Mix

APPENDIX H

Table 9

BATTERY MODULE VOLTAGE TEST LOG

Vehicle Number: 356
 Vehicle Type: EVcort
 Vehicle Mileage: 475
 Date: 3-23-94
 Time: 2:47 pm
 Ambient Temperature: 71 F

Battery Voltage
 At Time Of Test: 107.1

Module Number	Final Module Test Voltage	% Difference From Highest Battery	Comments
1	4.90	-2.6%	
2	4.89	-2.8%	
3	4.85	-3.6%	
4	4.86	-3.4%	
5	4.89	-2.8%	
6	4.89	-2.8%	
7	4.97	-1.2%	
8	4.94	-1.8%	
9	4.99	-0.8%	
10	4.83	-4.0%	
11	4.99	-0.8%	
12	5.03	0.0%	
13	4.98	-1.0%	
14	5.00	-0.6%	
15	5.01	-0.4%	
16	5.00	-0.6%	
17	4.97	-1.2%	
18	5.01	-0.4%	
Auxiliary 12V Battery	10.2		

BATTERY MODULE VOLTAGE TEST LOG

	Vehicle Number:	356	
	Vehicle Type:	EVcort	
	Date:	1-13-1995	
	Time:	1:30 PM	
	Ambient Temperature:	64 Deg. F	
	Battery Voltage		
	At Time Of Test:	106.8	1.75V/CELL = TOTAL SAFE DISCHARGE OR 5.25V/MODULE
Module Number	Final Module Test Voltage	% Difference From Highest Battery	Comments
1	5.03	-0.2%	
2	4.92	-2.4%	
3	4.86	-3.6%	
4	5.04	0.0%	
5	4.97	-1.4%	
6	5.03	-0.2%	
7	4.78	-5.2%	
8	4.74	-6.0%	
9	4.88	-3.2%	
10	4.89	-3.0%	
11	4.92	-2.4%	
12	4.98	-1.2%	
13	4.96	-1.6%	
14	4.96	-1.6%	
15	4.90	-2.8%	
16	4.82	-4.4%	
17	4.60	-8.7%	
18	4.93	-2.2%	
Auxiliary			
12V Battery			

BATTERY MODULE VOLTAGE TEST LOG

	Vehicle Number:	356	
	Vehicle Type:	93 EVcort	
	Date:	5/2/96	
	Time:	8:31	
	Ambient Temperature:	67.9 Deg. F	
	Battery Voltage		
	At Time Of Test:	111.9	1.75V/CELL = TOTAL SAFE DISCHARGE OR 5.25V/MODULE
Module Number	Final Module Test Voltage	% Difference From Highest Battery	Comments
1	5.2	0.0%	
2	5.2	0.0%	
3	5.1	-2.0%	
4	5.2	0.0%	
5	5.2	0.0%	
6	5.2	0.0%	
7	4.9	-6.1%	
8	5.0	-4.0%	
9	5.1	-2.0%	
10	3.3	-57.6%	
11	5.1	-2.0%	
12	5.2	0.0%	
13	5.1	-2.0%	
14	5.2	0.0%	
15	5.1	-2.0%	
16	5.0	-4.0%	
17	4.2	-23.8%	
18	5.1	-2.0%	
Auxiliary			
12V Battery	6.1		

TABLE 8

BATTERY MODULE VOLTAGE TEST LOG

Vehicle Number: 355

Vehicle Type: EVcort

Date: 10-22-93

Time: 1:30 pm

Ambient Temperature: 68 F

Battery Voltage
At Time Of Test: 109.1

Module Number	Final Module Test Voltage	% Difference From Highest Battery	Comments
1	3.84	-8.6%	
2	3.98	-5.2%	
3	4.11	-2.1%	
4	3.82	-9.0%	
5	3.86	-8.1%	
6	3.97	-5.5%	
7	3.98	-5.2%	
8	3.89	-7.4%	
9	4.09	-2.6%	
10	4.16	-1.0%	
11	4.09	-2.6%	
12	4.18	-0.5%	
13	4.18	-0.5%	
14	4.03	-4.0%	
15	4.19	-0.2%	
16	4.20	0.0%	
17	3.81	-9.3%	3.66 on 2nd test, voltage did not stabilize after approximately 4 seconds
18	3.92	-6.7%	
Auxiliary 12V Battery	7.5		

Table 8

BATTERY MODULE VOLTAGE TEST LOG

Vehicle Number: 355

Vehicle Type: EVcort

Date: 3-4-94

Time: 1:45 pm

Ambient Temperature: 65.7 F

 Battery Voltage
 At Time Of Test: 111.3 (110.7 V at end of test)

Module Number	Final Module Test Voltage	% Difference From Highest Battery	Comments
1	4.85	-6.4%	
2	5.06	-2.3%	
3	5.09	-1.7%	
4	4.15	-19.9%	4.15 V after 30 seconds, 3.65 V after 45 seconds and still dropping
5	4.91	-5.2%	
6	5.02	-3.1%	
7	5.02	-3.1%	
8	4.88	-5.8%	
9	5.07	-2.1%	
10	5.16	-0.4%	
11	5.08	-1.9%	
12	5.18	0.0%	
13	5.14	-0.8%	
14	5.03	-2.9%	
15	5.15	-0.6%	
16	5.17	-0.2%	
17	4.84	-6.6%	After 30 Seconds
18	4.85	-6.4%	
Auxiliary 12V Battery	6.5		

BATTERY MODULE VOLTAGE TEST LOG

	Vehicle Number:	355	
	Vehicle Type:	EVcort	
	Date:	1-16-1995	
	Time:	2:15 PM	
	Ambient Temperature:	70 Deg. F	
	Battery Voltage		
	At Time Of Test:	110.6	1.75V/CELL = TOTAL SAFE DISCHARGE OR 5.25V/MODULE
Module Number	Final Module Test Voltage	% Difference From Highest Battery	Comments
1	4.68	-10.3%	
2	5.02	-3.8%	
3	4.80	-8.0%	
4	5.22	0.0%	Module was replaced 4-94
5	4.73	-9.4%	
6	4.63	-11.3%	
7	4.48	-14.2%	
8	4.58	-12.3%	
9	4.78	-8.4%	
10	4.99	-4.4%	
11	3.98	-23.8%	
12	5.01	-4.0%	
13	4.88	-6.5%	
14		-	Voltage would not stabilize
15	5.00	-4.2%	
16	5.09	-2.5%	
17		-	Voltage would not stabilize
18	4.58	-12.3%	
Auxiliary 12V Battery			

BATTERY MODULE VOLTAGE TEST LOG			
	Vehicle Number:	355	
	Vehicle Type:	EVcort	
	Date:	31-Aug-95	
	Time:	11:00 AM	
	Ambient Temperature:	75 Deg F	
	Battery Voltage		
	At Time Of Test:	110.4	1.75V/CELL = TOTAL SAFE DISCHARGE OR 5.25V/MODULE
Module Number	Final Module Test Voltage	% Difference From Highest Battery	Comments
1	4.9	-5.8%	
2	5.1	-1.9%	
3	5.1	-1.9%	
4	5.2	0.0%	Module was replaced 4-94
5	4.9	-5.8%	
6	5.0	-3.8%	
7	4.8	-7.7%	
8	4.9	-5.8%	
9	5.0	-3.8%	
10	5.1	-1.9%	
11	4.7	-9.6%	
12	5.1	-1.9%	
13	5.0	-3.8%	
14	4.9	-5.8%	
15	5.2	0.0%	
16	5.1	-1.9%	
17	4.8	-7.7%	
18	5.0	-3.8%	
Auxiliary			
12V Battery	9.5		

BATTERY MODULE VOLTAGE TEST LOG

	Vehicle Number:	355	
	Vehicle Type:	EVcort	
	Date:	4/11/96	
	Time:	8:15	
	Ambient Temperature:	68 deg. F	
	Battery Voltage		
	At Time Of Test:	113.8	1.75V/CELL = TOTAL SAFE DISCHARGE OR 5.25V/MODULE
Module Number	Final Module Test Voltage	% Difference From Highest Battery	Comments
1	4.3	-20%	voltage continuing to drop at end of approximately 5 seconds
2	5.2	-4%	
3	5.2	-4%	
4	4.0	-26%	voltage continuing to drop at end of approximately 5 seconds
5	4.9	-9%	
6	4.9	-9%	
7	3.5	-35%	Replace Module
8	3.1	-43%	Replace Module
9	4.1	-24%	voltage continuing to drop at end of approximately 5 seconds
10	5.3	-2%	
11	3.5	-35%	Replace Module
12	5.3	-2%	
13	5.0	-7%	
14	4.3	-20%	voltage continuing to drop at end of approximately 5 seconds
15	5.3	-2%	
16	5.4	0%	
17	3.3	-39%	Replace Module
18	4.3	-20%	voltage continuing to drop at end of approximately 5 seconds
Auxiliary			
12V Battery	7.8		

APPENDIX I

**INTELLIGENT CHARGING CONTROL SYSTEM
FOR ELECTRIC VEHICLES
FINAL REPORT**

Presented to

**Platte River Power Authority
Fort Collins, Colorado**

by

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AN ADAPTIVE BATTERY CHARGER CONTROLLER FOR ELECTRIC VEHICLES

ABSTRACT

The purpose of this report is to describe a control system which can assist an electric vehicle owner to avoid peak electrical demand charges and thereby significantly reduce his electrical operating costs. The controller is designed to meet both the electric vehicle owners and the electric utilities requirements for managing the vehicle's electric demand during battery charging. Operation of the user's battery charger is restricted only through the choices that the user makes. The controller can be thought of as an "indirect" demand side management system for electric vehicles in that users select time to charge options based on cost. Most electric vehicle chargers today begin charging as soon as the vehicle is plugged in and remain on until the vehicle is unplugged. Rather than begin the charging process as soon as the charger is "plugged in", the control system presented delays the charging process through the use of a heuristic, adaptive control algorithm where the user specifies his required departure time.

INTRODUCTION

Most battery charging systems are concerned only with the termination of the charging process which is typically based on either a maximum voltage or a minimum current. When these conditions are met, then the charging process is either terminated or the charger switches to a "float" operating mode where the charger typically cycles on and off. The control system developed considers all charger and connected batteries as a "grey box", where only a few variables are given. The controller can be thought of as an intelligent switch which controls the on/off state of the electric vehicle's battery charger.

The adaptive, battery charger controller, ABC, has the capability of providing the following:

- Provide the user with time to charge, cost to charge, and percent of charge estimates based on the user provided departure time before the charging process begins.

- Be programmed to shut the charging system off during peak electrical demand intervals.

- Use an adaptive programming algorithm that allows the controller to be used for different combinations of traction battery and battery charger types.

- Automatically adapt to changing environments which may affect the time to complete the charge process.

- Monitor battery energy, voltage, current and power levels and detect low battery voltage conditions.

- Remember if the batteries were either fully charged or partially charged since the last charge cycle and automatically adjust the time to charge estimates.

Provide a human interface for setup and daily use of the controller.

HARDWARE

The controller utilizes a 80386 25 MHZ microprocessor as its main central processing unit. One Megabyte of RAM is used for the storage of temporary files and a 512K EPROM is used to store and execute the main control program. A compiled basic Language was used to implement the control algorithms running under a DOS operating system. The controller utilizes two 9600 baud RS232 serial communications ports. Communications port 2 is used to gather information from a kilowatt meter installed on-board the electric vehicle and communications port 1 is used to download data from the controller to a terminal or personal computer during the charging process. The user interfaces with the controller via a 4x4 matrix keypad and a 2 line by 20 character vacuum florescent display. Two digital outputs are used to drive a tri-color LED which displays the status of the controller. A single digital input is connected to a dip switch which enables or disables serial data to be output to communications port 2. All of the electronics are housed in a fiberglass enclosure which can be hung on a wall.

The front door of the enclosure is illustrated on page 6 and in drawing 4-1 of Appendix B. The vacuum florescent display and LED, part #'s 8 and 39 are located above the user keypad #9. The door swings on a hinge and can be opened by removing 2 screws located on the right side of the door. The component placement within the box is illustrated in drawing 4-3. Power enters the box via an electrical cord # 37 and is fused. The high and low voltage components are separated by an insulated divider #42. A duplex outlet #20 provides 120 VAC power to the computer power supply #7 and to a 12 volt battery charger #19 which is used to charge the kWh meter battery. The computer, digital I/O and power supply, part #'s 3, 2 and 7, are stacked on top of each other and are located in the low voltage compartment of the enclosure. A duplex outlet, containing RJ45 and RJ11 female connectors, #18 and #10, are located on the right side of the enclosure. The RJ45 connector is used to receive serial data from the kWh meter and the RJ11 connector is used to send serial data to a user provided data acquisition system. Power is delivered to the user's electric vehicle via an electrical switch #4, and a 120 VAC receptacle #22. The machining and assembly processes are described in sections 2.8 and 2.9 of the Design Specification given in Appendix A.

The LED located to the right of the vacuum florescent display is used to display the charging status to the user. When the LED is green, the system is in "Standby", which indicates that the controller has been programmed but the charger is presently off. A red colored LED indicates that the controller has closed its relay and the charger is presently on. A yellow LED indicates that the charger reached the user programmed stopping condition and the controller is allowing the charger to "float charge". When the LED is off, the charger is not receiving any power from the controller and is waiting to be programmed by the user.

The high voltage schematic drawing is given in drawing 3-2. The electric vehicle and ABC controller are indicated by dotted lines in the drawing. 120 VAC power enters the controller via a power cord #37 and the hot lead is fused #39. The hot lead is switched on and off via a 12 volt coil actuated relay which has a continuous current rating of 30 amperes. The switch power terminates at a 120 VAC receptacle #22 which is mounted on the right side of the controller. Power is provided to the electrical vehicle's battery charging system via a user supplied power cord #36. The 12 volt coil receives its power from the computer controller I/O board #2. The prototype was designed to allow a standard 120 VAC cord to be plugged into the receptacle #22. A single 8 wire cord #35 is used to provide serial communications between the energy meter #23 and the controller's computer. Cord #35 also supplies DC power to charge the 12 volt gel cell battery #24 which is required to power the energy meter #23. The 12 volt charger #19 is housed inside of the controller and receives its power from a duplex, 120 VAC, receptacle #20. The computer power supply #7 requires 120 VAC power which is also supplied via the duplex receptacle #20. The entire

controller with electric cord weighs approximately 12 pounds. Outside dimensions of the ABC's enclosure are approximately 11" wide, 12" high and 6.5" thick. Photographs of the controller's front, sides, and inside are given on the following page.

HUMAN INTERFACE

SETUP - Drawing 4-1 in Appendix B illustrates the keypad and display layout. As explained in the user manual, see Appendix C, the user has to program a number of set points for initial setup of the controller. The set points include: time, date, stopping condition (above a voltage or below a current), an equalizing charge time, how to charge following a power failure, battery capacity, maximum allowable time to charge, low level battery voltage, battery charger efficiency, peak electrical demand time intervals, demand rate, energy rate and float charging. The controller was designed to require that the setup procedure be run only once. It is expected that the user would follow the setup procedure when the controller is initially placed into service. The user can invoke the setup mode by simultaneously holding down the "#" key on the keypad and by plugging in the controller. Setup can also be used to force a hard reset of the system which will erase all of the data which are used by the adaptive control algorithms used in the controller. If the user erases all of the data, then he must charge his vehicle at least five times before the adaptive algorithms take affect. During the training charges, see the user's manual, the controller will use the maximum allowable time to charge to control the battery charger. The following displays are available to the user through the use of a scrolling display. At each display the user can change the setup parameters to meet his vehicle's charging requirements.

THE TIME IS 11:24:53	THE DATE IS 01-18-1994	THE STOPPING POINT ABOVE 108 VOLTS
WITH EQUALIZING TIME = 2 HOURS	ON POWER FAILURE CHARGE OFF PEAK	BATTERY CAPACITY 10 kwh
MAXIMUM TIME TO CHARGE OF 10 HOURS	LOW BATTERY VOLTAGE 95 VOLTS	CHARGER EFFICIENCY 98 %
USER PEAK CHANGES ARE ENABLED	kW RATE \$3.88	kWh RATE \$.017
SUNDAY PEAK HRS 9 - 17	FLOAT CHARGING IS DISABLED	PRESS START TO EXIT PRESS # TO RE-TRAIN
RE-TRAIN SYSTEM? ARE YOU SURE? NO	ERASE CHARGE HISTRY CONFIRM (Y/N)? NO

OPERATION - After the user follows the setup procedure, the controller can be programmed by the operator to complete the charging process according to his desired departure time. The user simply enters the time when he plans to use the electric vehicle and then selects if he wishes the charger to operate during peak electrical demand intervals. If he does not want the charger to operate during peak demand intervals, he either selects either "OFF PEAK" or "AUTO". If the user wishes to allow the controller to charge through a peak demand interval then he can select "ON PEAK". When the user selects any of the three keys above, he is given estimates of the cost to charge and the percent state of charge that batteries will be in at the user's specified departure time. The percent state of charge, % SOC, is a function of the available time to charge, and the estimated amount of time it will take for the batteries to reach a full charge. After the user selects the type of charge, he can then either press the "START" key or he may change his departure time by using the "UP" and "DOWN" arrows. The "MENU" key is used to scroll through the controller's display and the "CANCEL" key is used to cancel a programmed charge. A detailed description of the controller's operation is given in the operations manual and the program flowcharts can be found in Figures 6-1 through 6-4.

Figure 6-5. First In First Out Data Buffer

OFF PEAK - If the user selects "OFF PEAK", then the controller displays the estimated cost to charge and the estimated amount of charge that the batteries will receive. The controller calculates the amount of time that is available to charge the batteries based on the user's departure, and any peak demand time intervals that may exist between the present time and the user's departure time. The controller estimates the amount of time it will take to charge the vehicle and then estimates the cost to charge and the percent of charge which will be received by the end of the charge period and presents this information to the user. If the % SOC is too low then the user can specify a new departure time which is later than the departure time previously set.

AUTO - The auto key can be used to determine the minimum cost and the minimum time it will take to charge the vehicle to 100% state of charge. When the user selects the "AUTO" key, the controller automatically determines the earliest possible departure time without charging during the peak demand intervals.

ON PEAK - On peak is similar to "OFF PEAK" except that the controller will allow the charger to operate during the peak demand intervals. Charging through a peak electric demand interval will be more expensive than charging through an on peak demand interval if the user has not charged through a peak interval during the present month. The cost estimating algorithms implemented in the prototype controller assume that if the user has already charged his batteries during a peak demand interval in a given month, then the user has already been assessed his peak electrical demand.

START - After the user has entered a departure time which satisfies his % SOC and charging cost requirements, then the user must press the "START" key. When the start key is pressed, the controller closes the main relay and then reads the amount of charging current. If the current is below 1 ampere then the controller assumes that the power cord is not plugged in and alerts the user. If the current is above 1 ampere, then the controller will change its state to either standby or normal charging operation.

MENU - The following displays are available to the user through the use of a scrolling display. The display is scrolled up 2 lines each time the user presses the menu key. Example data are given to illustrate the displays:

SET DEPARTURE TIME 6:15 AM MONDAY	DEMAND RATE IS \$ 3.8899 /kW	ENERGY RATE IS \$.017 /kWh
APPROX. COST FOR THIS MONTH \$000.00	APPROX. COST FOR LAST MONTH \$000.00	PRESENT TIME IS 23:29:01 MONDAY
MEASURED VOLTAGE IS POWER IS 180.5 VOLTS	MEASURED CURRENT IS 14 AMPERES	MEASURED 2.71 kW
METER ENERGY VALUE -5.02 kWh	ENERGY USED LAST TRIP 3 kWh	METER TIME IS 20448 SECONDS
CHARGING BEGAN AT 11:28 PM SUNDAY		

CONTROL ALGORITHMS

The controller utilizes six control algorithms which include: time to charge, demand peak skip, energy to charge, power to charge, cost to charge, partial charge, and battery monitoring algorithms. When the user selects either the "OFF PEAK", "ON PEAK" or "AUTO" keys at the keypad all six algorithms are called in succession. First the time to complete 100% charge is calculated and then the peak skipping algorithm is called which determines how much time is available to charge. The energy and power to charge are calculated based on the available time to charge and the energy dissipated by the batteries. The cost to complete the charge is then estimated based on the power and energy estimated to complete the charge cycle. If the user aborts a charge prematurely and takes the vehicle for a drive, then the partial charge algorithm remembers how much charge was given to the batteries to insure a full charge for future charge cycles. If the battery voltage is below a user defined value prior to charge, the controller alerts the user through the use of the battery monitoring algorithm. The controller flowcharts are given in Appendix D and the source code is given in Appendix E.

TIME TO CHARGE ALGORITHM - The algorithm assumes that the time to charge the batteries is a function of the energy discharged by the batteries. After the batteries have been discharged, the user must plug two cords into the vehicle. One cord connects the electrical power to the charger and the other cord connects a communication line between the on-board battery energy meter and the adaptive battery charger controller, ABC. When the user selects either "OFF PEAK", "ON PEAK", or "AUTO" then the time to

charge estimate is calculated based on:

$$TIM5 = K0 + K1 * KWHR2 + K2 * KWHR2^2$$

where

TIM5	=	Time required to reach 100% State of Charge (seconds)
K0, K1, K2	=	Polynomial Coefficients
KWHR2	=	Amount of Energy Discharged During Last Drive Cycle (kWh)

The time to charge algorithm estimates the amount of time it will take to charge the vehicle to 100% state of charge. The coefficients, K0, K1 and K2 are calculated using a second order regression algorithm based on previous battery discharge data and the amount of time that each corresponding discharge took to reach 100% SOC. If the user selects the end of charge to be based on voltage, then 100% SOC occurs when the batteries have float charged for some predetermined amount of time after reaching a high voltage limit. If the user selects the end of charge to be based on current, then 100% SOC occurs when the batteries have float charged for some predetermined amount of time after reaching a low current limit. Both the float charging time and either the high voltage limit or low current limit must be specified by the user during the initial setup of the controller.

The data which are used in the polynomial curve fit is limited to 15 x,y pairs where the independent variable is the energy dissipated by the vehicle and the dependant variable is time required for the charger to reach 100% SOC. The time to charge algorithm utilizes a 15 point, x,y buffer which contains five, three point, first in first out sub-buffers and is illustrated in the Figure 6-5. After the charge cycle is completed, KwHR2 and the polynomial curve fit are used to calculate the estimated time to charge. The actual time for the charge to reach 100% SOC, STOP2, is then compared to this estimated time. If the deviation between STOP2 and the estimated time is greater than three times the standard deviation from the curve, then the new point is considered not acceptable and will not be used for future time to charge estimates. If the deviation is considered acceptable, then the new point is placed into a sub-buffer based on the point's magnitude. If the three point sub-buffer is full, then a first in first out, FIFO, algorithm is used to throw out a point in the sub-buffer so that the new point can be added to the sub-buffer. The ABC then places the value of the energy meter reading measured in kWh in the appropriate sub-buffer. If the number of points in the 15 point buffer is greater than five points, then the buffer along with their corresponding times to complete charge will be used to calculate a new curve fit when the next discharge cycle occurs. If the buffer contains less than five data points, then the time to charge estimate is set to a fixed value called the maximum time to charge. The maximum time to charge value must be specified by the user during the setup procedure.

DEMAND PEAK SKIP ALGORITHM - The demand peak skip algorithm is called directly after the estimated time to charge algorithm. The algorithm calculates the percent of charge that the user can receive given his departure time and when the peak demand time intervals occur. The algorithm controls the charger to remain off during the peak intervals if either "AUTO" or "OFF PEAK" are selected. If "ON PEAK" is selected then the algorithm allows charging through the peak demand time intervals.

ENERGY TO CHARGE ALGORITHM - The energy to charge algorithm uses much of the same programming as is used in the time to charge algorithm. A linear relationship is assumed to exist between the energy required to charge and the energy dissipated by the batteries during the discharge cycle. When the batteries are charged, the DC energy to charge the batteries is monitored by the controller. At the end of each charge cycle the energy dissipated and the energy required to charge is added to a buffer with a capacity of 15 points. A first order polynomial curve fit algorithm uses the buffer data to calculate the

coefficients of the equation:

$$KWHR3 = E0 + E1 * KWHR2$$

where

KWHR3	=	Energy Required to Charge
KWHR2	=	Energy dissipated by the batteries

The buffer contains the same values for the energy dissipated as those used for the buffer of the time to charge algorithm. The coefficients are re-calculated whenever the time to charge algorithm's buffer is changed.

POWER TO CHARGE ALGORITHM - The power to charge algorithm is exactly the same code as is used in the energy to charge algorithm. A linear relationship is assumed to exist between the power required to charge and the energy dissipated by the batteries during the discharge cycle. When the batteries are charged, the maximum DC power to charge the batteries is monitored by the controller. At the end of each charge cycle, the power dissipated and the energy required to charge data are added to a buffer with a capacity of 15 points. A first order regression algorithm uses buffer data to calculate the coefficients of the equation:

$$NEWKW = P0 + P1 * KWHR2$$

where

NEWKW	=	Power Required to Charge
KWHR2	=	Energy dissipated by the batteries

The buffer contains the same energy dissipated values as those used for the buffer of the time to charge algorithm. The coefficients, P0 and P1 are re-calculated whenever the time to charge algorithm's buffer is changed.

COST TO CHARGE ALGORITHM - The cost to charge algorithm utilizes the time available to charge, the maximum power required to charge estimate and the energy required to charge estimate from the three previous algorithms and estimates the cost required to charge utilizing the following equation:

$$DOLL = KWRATE * NEWKW * FLAG * PEAK2 + KWHR3 * KWHRATE * CHRGEST / 100 * EFF$$

where

DOLL	=	Estimated cost to charge (Dollars)
KWRATE	=	Energy Demand Rate (\$/kW)
KWHRATE	=	Energy Use Rate (\$/kWh)
FLAG	=	Multiplier (1 if charging through a peak interval) (0 if not charging through a peak interval)
PEAK2	=	Multiplier (1 if charge has not occurred during a peak interval this month) (0 if charge has occurred during a peak interval this month)
CHRGEST	=	The estimate Percentage of time available for charging (%)
EFF	=	Charger Efficiency(0-1)

PARTIAL CHARGE ALGORITHM - There are three possible times, that a vehicle could receive a partial charge and they include:

1. The user selects a departure time that will not allow complete charging of the vehicle
2. The user interrupts a charge in progress
3. The power to the charger is interrupted because of a power failure and a full charge is not completed.

If for any reason, a full charge is not completed, the partial charge algorithm remembers the amount of energy that was given to the batteries and will base further charge cycles on any deficit charge cycles that may of occurred previously.

BATTERY MONITOR ALGORITHM - The battery voltage is checked and compared with a low level set point whenever the user selects the type of charge, "OFF PEAK", "ON PEAK" or "AUTO". If the sensed battery voltage is below the user defined low level set point (specified during setup), then the user is alerted by the message "Low Battery Voltage" ... "Check Batteries". If during a full charge sequence the charger never reaches the user specified end of charge set point then a message "Check Batteries" is given to the user alerting him that the end of charge set point was not reached.

TEST RESULTS

Test data was collected during the charging process for a 1982 City Car outfitted with 8 Trojan, T145, 6 volt, deep cycle batteries arranged in series to form a 48 volt battery pack. A kWh energy meter, # 23, a gel cell battery, # 24 and a female RJ45 receptacle was installed in the vehicle. The vehicle uses a Vanguard Automatic Charging System. The Charger input capacity is 110 VAC 60 CPS @ 15 Amperes. The output capacity of the charger is approximately 25 amperes. The charger is set to cycle off when the battery voltage reaches 57.5 volts. After this voltage is reached then the vanguard charger cycles on and off to maintain the batteries. The controller received its power from a 120 VAC source with a 20 Ampere ground fault interrupter protected breaker. The prototype controller was used to charge the vehicle for approximately 1 month. The vehicle's batteries were discharged by driving the vehicle in normal city traffic, which included hilly terrain during the months of December 1993 and January 1994 in Fort Collins Colorado. All charging tests were conducted inside a non-heated residential garage.

The data collected during the charging process was collected via the RS232 port of the controller. The data was taken directly from the readings taken by the kWh meter. The data collected is highly discrete due to the resolution of the energy meter. Battery voltage data presented are to the nearest .5 volts and battery current data presented are to the nearest 1 ampere. Energy data are displayed to the nearest .01 kWh. A typical continuous charge is illustrated in Figure 6-6 and a typical charge with a peak demand interval skip is given in Figure 6-7. Figures 6-8 through 6-10 illustrate the ABC's ability to predict the end of charge time, the DC energy required to charge the batteries, and the peak DC power during the charging process. The test data presented are for both interrupted and non-interrupted charge cycles. Figure 6-8 illustrates that the algorithm predicted the time to reach 57.5 volts plus a 2 hour equalizing charge within 13 minutes. The algorithms which are used to predict the energy and peak power, (see Figures 6-9 and 6-10) had a maximum deviation of +.14 kwh and +.055 kW respectively.

CONCLUSIONS

An adaptive battery charger control system has been demonstrated which can be used to reduce the electric demand imposed on the utility and thereby reduce the costs to both the utility and to the user. The control system uses an indirect approach to demand side management. The controller gives the time required to charge, % SOC, and cost estimates to charge to the user before the charging process begins. The electrical charging demand is indirectly managed through the user's selections which typically will be based on minimizing his costs to charge his electric vehicle. The control system employs adaptive, heuristic control algorithms to estimate the amount of time to charge, the power and energy required and the costs associated with a user specified departure time. Results to date indicate, that through the use of an adaptive programming technique, a single control system can be utilized to estimate the amount of time it will take to charge an electrical vehicle's battery system, when the amount of energy dissipated by the traction battery system is known. Tests conducted on an electric vehicle outfitted with a 48 Volt lead acid battery system and a Vanguard battery charger indicate that by simply knowing the amount of energy dissipated by the traction batteries, the time required to charge can be estimated within 39 minutes. The required energy and power required to charge the traction batteries can be estimated within +.4 kWh and +.065 kW respectively. Further testing is required to demonstrate the control system's adaptability to other charger and battery systems. Additional testing is also required to evaluate the control system's performance under changing environmental conditions and through the life cycle of a traction battery.

Figure 6-1. ABC Program Overview

Figure 6-2. ABC Curvefit Flowchart

Figure 6-3. ABC Cost Estimate Flowchart

Figure 6-4A. ABC Program Flowchart

Figure 6-6. Typical Continuous Battery Charge Cycle

Figure 6-7. Typical Charge Cycle with Peak Demand Interval Skip

Figure 6-8. Time to Charge Performance

Figure 6-9. Energy to Charge Performance

Figure 6-10. Power to Charge Performance

APPENDIX A
DESIGN SPECIFICATION FOR
AN ADAPTIVE BATTERY CHARGING CONTROLLER
FOR ELECTRIC VEHICLES

INTELLIGENT CONTROLLER FOR ELECTRIC VEHICLE CHARGING DESIGN SPECIFICATION

1.0 Design Objective

The objective of this project was to develop a control system which can assist an electric vehicle owner to avoid peak electrical demand charges and thereby significantly reduce his electrical operating costs. The controller was designed with the electric vehicle owner in mind. Operation of the user's battery charger is restricted only through the choices that the user makes. The controller can be thought of as an "indirect" demand side management system for electric vehicles in that users select time to charge options based on cost. The control system was also designed with the electric utility in mind. Most electric vehicle chargers today begin charging as soon as the vehicle is plugged in. Since electric vehicles are expected to be used for commuting purposes, electric vehicle owners would typically plug in their vehicles after work between 5 and 6 pm. The controller begins the charge sequence based on how much energy the user used in his last drive cycle, and back calculates the time to begin charging based on the user's required departure time. As a result, the time that the charger turns on will be based on the amount of energy the user uses from his batteries, the user's required departure time, the type of charger, and batteries that is installed in the user's vehicle. If most of the utility's customers, who owned electric vehicles, used the controller, the overall electrical demand requirements by the utility would be less. In order to insure a more diversified load, the electric utilities could offer rebates to those electric vehicle owners who utilize the controller.

2.0 Performance Requirements

2.1 General Description

The controller must, at a minimum provide, the following :

- Automatic on/off control of charger
- Optimal departure time selection
(minimum cost, minimum time)
- Manual departure time selection
- Human Interface consisting of a keypad and display

In general the control process is as follows (See System Overview Flowchart, Appendix D):

1. Read Operations Manual and Run Setup.
2. Plug the controller into a suitable wall receptacle.
3. Plug in the kWh meter communications cord.
4. Plug your charger cord into the controller.
5. Press Menu Key for "SET DEPARTURE TIME".
6. Select your next "Departure Time".
7. Press either the "Off Peak" or "On-Peak" key.
8. If Cost or Charge estimate is not acceptable...
Repeat (Steps 5 and 6) or (Press the "AUTO" key).
9. To Begin Charging Press the "Start Key".
10. When the LED is "OFF" or "YELLOW" the charging process is done.
11. Unplug the charger cord.
12. Unplug the communications cord.
13. Get in your vehicle and depress the kWh meter reset switch for 10 seconds.
14. Drive your Vehicle.
15. Return vehicle to Controller Station.
16. Repeat Steps 3 through 16.

A one time setup is required for the user to select if the controller should stop charging the batteries based on current or voltage, the magnitude of the current or voltage for the stopping condition, and the amount of time to equalize the battery charge after the condition is met. (See User's Manual, Appendix C, for more details) The utility has the capability to download a single peak interval for each day of the week as well as the \$/kW peak costs and \$/kWh costs. This is accomplished using a specialized RS232 cable and a palm top or lap top computer using a MicroSoft® DOS utility program or during the setup procedure.

2.2 Inputs

2.2.1 kWh Meter

A Cruising Equipment Kilowatt-Hour Meter model +KWH shall be used. The meter shall have an LCD display and a reset switch. The meter shall be field wired to operate from its own 12 Volt battery. A separate battery is required to power the meter because the meter must make its measurements with reference to the primary battery pack. The kWh meter shall be mounted inside the passenger compartment of the vehicle. Through the use of the meter, the driver can monitor the battery pack voltage, current and kWh since the last reset. The meter shall have an RS232 port capable of 1200 baud communications. The user's manual for the meter is given in Appendix C.

2.2.1 Keypad

A military grade, NEMA 2 rated 4 x 4 matrix keypad shall be used. The keypad shall be EMI shielded. Minimum Life Expectancy shall be 3 million operations. Only 9 of the 16 Keys shall be used. The function of each of the

nine keys shall be as follows:

- Menu
- Up
- Down
- Cancel
- On Peak
- Off Peak
- Auto
- Start
- # (Used for Setup)

The location of each key is shown in drawing 4-1 of Appendix B .

2.2.2 Power Input

120 VAC cord 8 feet long.

2.3 Outputs

2.3.1 Relay Controlled Power Output

2.3.2 Display

The controller shall use an Industrial Electronic Engineers Inc, model S03601-95-040 vacuum florescent display . The display shall have a 20 character by 2 line vacuum florescent display. The display shall use an 8 bit parallel interface.

2.3.2 Display Outputs

- Departure Time
- Demand rate (\$xx.xx/kW)
- Energy rate (\$x.xxxx/kWh)
- Current Month Cost Estimate for Charging
- Previous Month Cost Estimate for Charging
- Present Time
- Present Day
- Battery Voltage (volts)
- Battery Current (amperes)
- Battery power (kW)
- Battery energy (kWh)
- Battery energy used Last Trip (kWh)
- Time since last reset of kWh meter
- Time that controller will start the charger
- Approximate Charging Cost and % Battery Charged for the departure time entered by the user.

2.3.3 Algorithm Status LED

A three color, green, red and yellow, LED with a common ground shall be used. The LED shall be operated to indicate the status of the controller. State of the LED shall be as follows:

Green....Standby
Red.....Normal Charge
Yellow...Float Charge
Off.....System Off

2.3.4 Central Processing Unit

The controller shall use an Octagon Systems 5025-1MB 25 MHZ Controller, model #3442. The CPU shall be an Intel© 80386. The Keypad and Display shall interface to the controller via a parallel port. Communications with the kWh meter shall be accomplished through the use of a standard RS232 communications port.

2.4.5 Digital I/O

A total of 4 digital outputs are required and are listed as follows:

Green LED (Standby)
Red LED (Charging)
Charger Control Relay
kWh Meter Reset

Only 1 digital input is required. The input shall be used to enable or disable data output to the second RS232 port. Note that the system has 7 spare digital inputs for future controller revisions.

Digital I/O shall be accomplished through the use of an Octagon systems 5971 prototype card with the necessary circuitry. See Drawing 3-3.

2.4 Control Operation

2.4.1 Operations Manual

A users manual for the prototype controller is included in Appendix C of the report. The user interfaces with the prototype controller via the keypad. There are 14 different possible displays presented to the user based on his interaction with the keyboard. There are 3 additional displays which are activated if the charger senses that the charger is unplugged, an illegal connection to the RS232 port is made or if the utility is downloading new constants to the controller. The user displays are given as an appendix to the users manual.

2.4.1 Control Algorithm Description

The control algorithms utilized shall use control strategies which can give electric vehicle users reliable "Time to Charge" and "Cost to Charge" estimates based on the amount of energy the vehicle has used during prior battery discharges. The algorithm shall be structured such that when the user selects a departure time and presses one of 3 keys, Off Peak, On Peak, or Auto, the algorithm determines a cost estimate according to the following:

1. Read from the kWh meter the amount of energy discharged from the batteries.
2. Calculate the required amount of time to charge based on previous charge histories:

$$\text{Time} = f(\text{kWh discharged})$$

3. If the selection is "ON PEAK" the available time to charge will be the full time between the present and departure time. If the selection is "OFF PEAK" the available time will only be off peak time between the present and departure time. If the selection is "AUTO" then the departure time will be automatically set to a time which allows a full charge which occurs during off peak time. The kWh and kW required to charge the batteries is calculated based on previous charge histories:

$$\text{kWh to charge} = \text{Function}(\text{kWh discharged})$$

$$\text{kW to charge} = \text{Function}(\text{kWh discharged})$$

4. Calculate The cost estimate to charge is based on the following relationship:

If the user selects Off Peak charging then the cost shall be:

$$\text{Cost} = \text{kWh} * \text{kWhrate} * \% \text{Charge} * \text{Eff}$$

If the user selects On Peak charging then the cost shall be:

$$\text{Cost} = \text{kW} * \text{kWrate} + \text{kWh} * \text{kWhrate} * \% \text{Charge} * \text{Eff}$$

where:

kW	= Estimate of the required kW to charge.
kWrate	= Utility demand rate (Dollars/kW).
kWh	= Estimate of the required kWh to charge.
kWhrate	= Utility energy rate (Dollars/kWh).
% Charge	= Estimated charge achieved (available time/required time)
Eff	= Charger Efficiency

The kWh rate for both on and off peak shall be the same.

5. Display the Cost Estimate to the User.
6. Display the Percent of Charge to the User.
7. The user then must decide to either press the "Start" key to begin the algorithm process or he must select a new departure time.

2.4.2 Program Flowcharts

The software flowcharts for the controller's software are given in Appendix D. The algorithm determines a relationship between time to complete charge and the amount of energy utilized during a driving cycle. The unique feature of the algorithm is that the controller was designed to be applied to almost all electric vehicle applications since the algorithm adapts to the type of charger, battery and vehicle after only a few charging cycles. The controller predicts: estimated time to charge, energy and demand costs, previous and current monthly cost totals. Battery voltage, current, power, and energy used last trip are all displayed by the controller. After the vehicle batteries have been discharged, the user simply enters his required departure time, and the computer gives the user an estimate of the cost, % charge, and when the charger will begin charging. The flow charts for the cost estimation and curve fitting algorithms are given in Appendix D.

2.5 Environmental Requirements

Design Goal: -40 to 70 degrees C
5% to 95% RH

Critical Component	Known Operating Environ. Characteristics
SPST Control Relay (4)	Not Known
CPU (3)	-40 to 70 degrees C operating 5% to 95% RH
Digital I/O (2)	-40 to 70 degrees C operating 5% to 95% RH
Display (8)	0 to 50 degrees C operating
Keypad (9)	-40 to 70 degrees C operating 5% to 100% RH

(x) Signifies part#, see parts list in section 2.

2.6 Mechanical

2.6.1 Ratings

At this time no shock or vibration specifications have been established for the assembly.

2.6.2 Drawings

Process and assembly drawings can be found in Appendix B of this report.

2.7 Electrical

2.7.1 Ratings

DESCRIPTION	RATING
SPST Control Relay (4)	30amps @ 120VAC 30amps @ 240VAC
CPU (3)	5 VDC @ 400 mA
Digital I/O (2)	5 VDC @ 70 mA
Display (8)	5 VDC @ 820 mA Max
Keypad (9)	not known

2.7.2 Drawings

A layout of the hardware used for the prototype controller is given in Appendix B. The diagram depicts the interconnections of the electric vehicle's charger and kWh meter to the controller and computer. The prototype shall be designed to be mounted on the wall. All wiring shall conform to the NEC standard and shall be wired according to the wiring schematics found in Appendix B.

2.8 Machining Process Description

The machining to be done on the NEMA box, part #21, will be done per the mechanical process drawings (see drawings 4-1 through 4-9 of Appendix B). The cover will need to have 11 holes drilled and 2 cutouts made to accommodate the display (8), keypad (9), and LED (39) as in drawing 4-2. The NEMA panel will need to have 4 holes drilled for mounting the power supply (7) as in drawing 4-9. There will be a cutout made for the communications receptacle (26), and 2 holes drilled and 1 punched for the single receptacle (22), as in drawing 4-6. Two holes will need to be punched as in drawing 4-7. A box divider will be fabricated from paper filled phenolic and secured to the panel using two part epoxy. Six additional holes will be drilled in the panel to mount the high voltage switch (4), DP-IFB (6), and the receptacle box (43), as in drawing 4-9.

2.9 Assembly Process Description

Once the NEMA box (21) has been completely machined the components may be installed. Process the NEMA panel as in drawing 4-9. Wire the single receptacle (22), duplex receptacle (20) and control relay (4) per national electric code with the control relay switching the power to the single receptacle. The power will come in through the left side of the nema box on 10/3 AC wire (37) secured by a cord grip strain relief (38). Wire allowing extra wire for installation and secure items to the

NEMA panel. Wire cable 17 to RJ45 receptacle. Mount using provided hardware. Mount computer (1, 2, 3) to power supply (7) and mount power supply and DP-IFB (6) to NEMA panel as in drawings 4-4. Plug power supply into the dual receptacle (20). Mount the panel in the box and secure the single receptacle (22) to the NEMA box. Connect all cables between interface board, computer, proto card, RJ11 and RJ45 plugs as per drawing 3-1. Plug 12V charger (19) into dual receptacle (20) and wire +12 and ground to RJ45 receptacle. Mount LED (39), display (8), and keypad (9) to cover of NEMA box as shown in drawing 4-1. Plug display and keypad cables into DP-IFB and DP-IFB into LPT port of computer. Run cable from port J3 of interface board, around voltage divider, and secure it to control relay. Close and latch door of NEMA box. Plug in main power supply. **WARNING!** The box will have charged wires inside, do not open while plugged in. Run RS232 from remote PC to communications receptacle. Burn in program as described in the Octagon Systems 5025 control card users manual.

3.0 Field Installation Requirements

3.1 Size

The overall dimensions of the controller shall not exceed 10" x 12" x 6" See Appendix B for detailed dimensions.

3.2 Mounting and Orientation

Mounting feet are provided to attach enclosure on indoor wall or suitable stand. (typically inside a garage or service bay area). The controller should be oriented either on its back or with the door facing the user.

3.3 Field Wiring

The controller should receive its power from a user supplied UL listed outlet with GFI protection. The only field wiring required is installation of a kWh meter, shunt, kWh meter battery, and communications cable. The meter should be installed by qualified service personnel with an understanding in high voltage DC systems. Complete electrical schematics can be found in Appendix B.

3.4 Service/Controller Checkout

None

4.0 Graphics/Styling Requirements

4.1 Keypad

9 keypad keys must clearly be labeled and should be black print with a white background and should be typed in a Font similar to Drawing # 4-1 (See Appendix B).

4.2 Light Emitting Diode

Lettering shall be placed below the LED indicating the status of the controller and should be typed in a Font similar to Drawing # 4-1 (See Appendix B).

Green....Standby
Red.....Normal Charge
Yellow...Float Charge
Off.....System Off

4.3 The words "Adaptive Battery Charging Controller" Shall appear in a prominent location on the front door of the enclosure.

4.4 The text: "No User Serviceable Parts Inside! "

Shall appear near the latch mechanism to the enclosure door.

4.6 The text: "Warning! Electric Shock Hazard"
Shall appear in the high voltage section of the enclosure.

4.7 The following text shall be attached to the right side of the enclosure:

To Operate:

1. Read Operations Manual and Run Setup.
2. Plug the controller into a suitable wall receptacle.
3. Plug in the kWh meter communications cord.
4. Plug your charger cord into the controller.
5. Press Menu Key for "SET DEPARTURE TIME".
6. Select your next "Departure Time".
7. Press either the "Off Peak" or "On Peak" key.
8. If Cost or Charge estimate is not acceptable...
Repeat (Steps 5 and 6) or (Press the "AUTO" key).
9. To Begin Charging Press the "Start Key".
10. When the LED is "OFF" or "YELLOW" the
charging process is done.
11. Unplug the charger cord.
12. Unplug the communications cord.
13. Get in your vehicle and depress the kWh meter
reset switch for 10 seconds.
14. Drive your Vehicle.
15. Return vehicle to Controller Station.
16. Repeat Steps 3 through 16.

(Not intended for Outdoor Use)

5.0 Approval Body

Typically, UL or CSA approval would be required and would meet most of the customer's requirements. At this time only prototypes will be built for evaluation purposes. Currently there are no plans to obtain any approvals

APPENDIX B
ABC COMPONENT PARTS LIST AND DRAWINGS

KEY NO.	PART NAME	MODEL NUMBER	MANF.	QT
1	2 SLOT CARD CAGE	#5971	OCTAGON	1
2	5720 DIG. I/O CARD	#3258	OCTAGON	1
3	5025-1MB 25MHz PC CONTROL CARD	#3442	OCTAGON	1
4	SPST CONTROL RELAY	#700-HG47Z12	ALLEN BRADLEY	1
5	INTERFACE BOARD	#XJW1	N/A	1
6	KEYBOARD/DISPLAY INTERFACE	#3216	OCTAGON	1
7	5100 SWITCHING POWER SUPPLY	#2740-5100	OCTAGON	1
8	DP-2x20 V.F. DISPLAY	#1201	OCTAGON	1
9	KP-3 KEYPAD	#1737	OCTAGON	1
10	RJ45 FEMALE	17M-51-6E-01	MOD/TAP	1
11	RS232 JUMPER	XJW5	N/A	1
12	CMA-20-12 IDC CABLE	#2909	OCTAGON	1
13	POWER SUPPLY HARNESS	#XJW2	N/A	1
14	LED CABLE	#XJW3	N/A	1
15	V.F. DISPLAY CABLE	#1201	OCTAGON	1
16	KEYPAD CABLE (IDC 10)	#1737(CABLE)	OCTAGON	1
17	RS232 CABLE	#XJW4	N/A	1
18	RJ11 RECEPTACLE	17M-51-6E-01	MOD/TAP	1
19	12 VOLT CHARGER	#PSC-12550A	POWER SONIC	1
20	15 AMP/125V AC DUPLEX RECEPTACLE	#5262/G-6A666	HUBBEL	1
21	NEMA TYPE 4X ELECTRICAL ENCLOSURE	#A12106CHSCFG	HOFFMAN	1
22	15 AMP/125V AC SINGLE RECEPTACLE	#5261	HUBBEL	1
23	KILOWATT HOUR METER	KWHR+	CRUSING EQUIP.	1

24	7AH 12V GEL BATTERY	1270	POWER SONIC	1
25	50mV 500Amp SHUNT	SHUNT	CRUISING EQUIP.	1
26	MULTIPURPOSE RECEPTACLE	17-51-68-08-0492	MOD-TAP	1
27	8-32x 1" SCREW	N/A	N/A	2
28	8-32 NUT	N/A	N/A	2
29	#8 LOCK WASHER	N/A	N/A	2
30	1-32 x 1/2" SCREW	N/A	N/A	4
31	PANEL MOUNT FUSE	R10009	BUSS HPF	1
32	RS232 COMMUNICATIONS CABLE	#2906	OCTAGON	1
33	12V CHARGER CABLE	XJW6	N/A	1
34	CONTROL RELAY CABLE	XJW7	N/A	1
35	EXTERNAL COMMUNICATIONS CABLE	XJW8	N/A	1
36	120V AC (USER SUPPLIED) EXTENSION CORD	XJW9	N/A	1
37	8' CORD MALE CONNECTIONS	XJW10	N/A	1
38	CORD GRIP STRAIN RELIEF	TBD	TBD	1
39	DISPLAY BEZEL	DMH-23441G-08	IEE	1
40	PANEL MOUNT LED HOLDER		TANDY	1
41	TRI-COLOR LED		MOUNTAIN STATES	1
42	HIGH/LOW VOLTAGE DIVIDER	CUSTOM PART	REGAL PLASTICS	1
43	DUPLEX RECEPTACLE COVER			1

IO-XJWI PARTS LIST

QTY	DESCRIPTION	PART NUMBER
1	Buffered Proto Board	Octagon-5971

3	270 Ohm 5% .25 Watt Resistor	JDR-R270
2	1.68 kOhm 5% .25 watt Resistor	JDR-R1600
2	14 Pin Tooled Wire Wrap Socket	JDR-AUGAT14WW
1	16 Pin Tooled Wire Wrap Socket	JDR-AUGAT16WW
1	40 Pin Tooled Wire Wrap Socket	JDR-AUGAT40WW
2	IDC header Socket 2x5 wrap	JDR-IDH10WR
2	SIP Socket 1x40	JDR-SIP Socket WW
1	4 Pin Male Header Wire Wrap	Mountain States Elec
1	2 Pin Male Header Wire Wrap	Mountain States Elec
1	82C55	JDR-82C55-5
1	NTE 7406	JDR-7406
1	8 Position Dip Switch	NEWARK-46F2957
1	Opto Relay	NEWARK-89F090
1	ID WRAP	JDR-IDWRAP40
1	Reed Relay	JDR-RELAY-DIP

XJW4 RS232 Cable

1	10 Pin Female IDC 2x5	JDR Microdevices®
8 "	10 conductor Ribbon Cable	JDR Microdevices

Cable XJW6 Battery Charger Cable

1 ft	18 Gauge Stranded Wire	JDR Microdevices
2	Crimp Connectors	JDR Microdevices

Cable XJW7 Control Relay Cable

1 ft	18 Gauge Stranded Wire	JDR Microdevices
2	Crimp Connectors	JDR Microdevices
1	2 Pin Female Plug Crimp	Mountain States Electronics

Cable XJW2 Power Supply Harness

2 ft	18 Gauge Stranded Wire	JDR Microdevices
1	Molex Female Connector	Mountain States Elec

DRAWN BY: CAMERON SWEN 10/27/93

FILENAME: BOXCOVR DWG: 4-1

NEMA BOX COVER MODIFICATIONS

ASSEMBLY DRAWING

DRAWN BY: CAMERON SWEN 10/27/93
FILENAME: BOXCOVER2 DWG: 4-2

FRONT VIEW

TOLERANCE
XXX = $\pm .015$ (IN INCHES)

FRONT VIEW

NEMA BOX COMPONENT PLACEMENT	DRAWN BY: CAMERON SWEN 10/29/93
ASSEMBLY DRAWING	FILENAME: BOX1 DWG: 4-4

Technical drawing of a mechanical part with dimensions:

- Overall width: 4.625
- Overall height: 12.000
- Top rectangular feature: width 1.625, height 0.938
- Bottom rectangular feature: width 1.750, height 1.250
- Central circular feature: diameter $\phi 1.375$
- Bottom circular feature: diameter $\phi 1.38$ (2X)
- Vertical dimension from bottom to center of bottom circular feature: 2.750
- Vertical dimension from center of bottom circular feature to center of top rectangular feature: 1.250
- Vertical dimension from center of bottom circular feature to center of bottom circular feature: 1.250
- Horizontal dimension from left edge to center of bottom circular feature: 2.500

.XXX = $\pm .015$ (IN INCHES)

FILENAME: BOX2-2 DWG: 4-6

TOLERANCE

.XXX = $\pm$.015(IN INCHES)

NEMA BOX RIGHT SIDE VIEW	DRAWN BY: CAMERON SWEN
PROCESS DRAWING	FILENAME: BOX2-2 DWG: 4-7

TOP VIEW, TOP TRANSPARENT

ASSEMBLY DRAWING

DRAWN BY: CAMERON SWEN 10/29/93

FILENAME: BOXTOP DWG: 4-8

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NEMA PANEL

NEMA BOX COMPONENT PLACEMENT

DRAWN BY: CAMERON SWEN 10/29/93

PROCESS DRAWING

FILENAME: BOX1-2 DWG:4-9

APPENDIX C
ABC OPERATIONS MANUAL

**ADAPTIVE BATTERY CHARGER CONTROLLER
FOR ELECTRIC VEHICLES
OPERATIONS MANUAL**

**Colorado State University
Mechanical Engineering Department**

Platte River Power Authority

GETTING STARTED

Energy Meter

In order for your Adaptive Battery Charger Controller to operate properly, a Crusing Equipment, Kilowatt-Hours + energy meter must be installed in your vehicle. Installation should be done by either the vehicle manufacturer or by qualified personnel with high DC voltage experience. Meter installation instructions are shipped with the meter. Crusing Equipment is located in Seattle Washington. The controller has the capability to automatically charge the auxiliary battery required by the energy meter. The pinout to connect the kilowatt hour meter to the RJ45 connector on the controller is given below:

RJ45 Connector at Controller	9 Pin RS232 Connector at Energy Meter	Function
1	2	Receive
2	3	Transmit
3	5	Ground
4	n/c	
5	n/c	
6	n/c	+12 V from Charger
7	n/c	
8	n/c	Ground from Charger

A high voltage schematic is given on the following page and should be used for reference purposes only.

Setup Procedure

To get your controller going you will first need to run the controller setup. To do this, hold down the # key and plug the system in. Follow the directions outlined in the User Setup Mode section. Set all values to the best of your abilities as these values will determine the reliability of operation. When you get all of the values set you will need to set the system up for re-training. This is the last menu item in setup.

To Re-Train System;

To re-train the system the controller will need to be taught how your particular battery and charger combination works. To do this first be sure all of the values in set up are set to the appropriate setting. Once this is done go to the last menu item in setup and press # to begin the re-training. You will need to confirm the choice. Do this by pressing the UP arrow for YES and the DOWN arrow for NO. Once you do this, the old information in the system will be erased and you will start to train the controller. To train the controller follow this procedure;

1. The car will need to be driven for five drives. One of each of the following discharges are required but they may be performed in any order. Drive the vehicle as you normally would.

Battery Capacity = MXkWh

- a. Take car for a MXkWh discharge.
- b. .8 * MXkWh discharge.
- c. .6 * MXkWh discharge.
- d. .4 * MXkWh discharge.
- e. .2 * MXkWh discharge.

NOTES: 1. FOR INSTALLATION OF KWH METER
SEE KILOWATT-HOUR+ METER
WIRING DIAGRAM

2. The car will need full uninterrupted charges between each discharge. To do this select an ON PEAK charge which provides 100% charge. If the user does not wish to actually charge on peak then it is necessary to set the departure time to a time the following morning which allows the charger enough time to run over night, during low peak time, but still select ON PEAK. Once the charger starts allow it to run until it shuts off on its own. If the stopping conditions are set properly the charger should finish before the departure time during the re-training. NOTE! If upon returning to the controller, after a charge, the display reads STOPPING CONDITION NOT REACHED then either a stopping condition which the charger could not reach was selected, or the user did not allow enough time for the charger to charge, by setting the MAXIMUM TIME TO CHARGE in set up too small. If this occurs during training of the controller the user will need to go into set up and adjust the values and then restart the training by performing a train mode reset.

Operation of intelligent controller:

1. Scroll the display using the MENU key to ENTER DEPARTURE TIME. NOTE! The MENU key can be pressed at any time to scroll through the display and see operation information.
2. Use the UP and DOWN arrow keys to adjust the departure time. Remember! The time available between now and the departure time will affect the cost and percent charge.
3. When an acceptable departure time is reached press either ON PEAK, OFF PEAK or AUTO. The display will change to show the approximate cost and percent charge for the given departure time and charge condition.
4. If the cost or percent charge is not acceptable then return to step 2 or 3.
5. Press START to place the controller in standby mode. The controller can now be left to charge the vehicle. Remember! If you change the departure time you need to repeat step 3 before you can begin the charge.
6. To stop the controller, or remove the controller from stand by mode, press CANCEL. This is used if you decide to change the departure time, or if you return before the controller has finished charging the batteries and you wish to take the vehicle. NOTE! As an added safety precaution always press the cancel key before unplugging the vehicle from the controller.
7. Return to step 1.

WARNING!

Most production electric vehicles have a safety feature which will not allow the vehicle to be moved if the charging cord is still plugged into the vehicle. Vehicles such as the City-Car sense the presence of 120 VAC and then disable the vehicle from moving. Since the controller turns off the AC power delivered to the electric vehicle, Electric vehicles such as the City Car will allow you to drive away while the cord is still plugged in to the vehicle. Damage to the vehicle can result if the charging cord is not removed before driving away.

Colorado State University assumes no responsibility for any damage to any person or property that may occur as a result of the use of the Adaptive Battery Charging Controller. The controller is a prototype and should be used with caution.

KEY	FUNCTION
MENU-	When the MENU key is pressed the display will cycle through the various indicators to tell the user utility rate information, charge information and controller status.
UP arrow-	If the display is at the <u>ENTER DEPARTURE TIME</u> state then the departure time will increase by 15 minutes. The departure time can be set for one week in advance.
DOWN arrow-	If the display is in the <u>ENTER DEPARTURE TIME</u> state then the departure time will decrease by 15 minutes. The departure time can only go as low as 15 minutes from the current time.
OFF PEAK- ON PEAK-	The function of the these keys is to give the user an opportunity to see what the charge will cost, how much charge the vehicle will get and if it will be during peak. When either of these keys are pressed the time to charge is estimated from the kilowatt-hours used on the previous trip. This time is compared with the departure time to see if a full charge can be obtained. If a full charge can be obtained it then checks if the charge can be completed during the low demand time between the present and the departure time. If the user presses ON PEAK and there is enough off peak time to charge, then it is the same as pressing OFF PEAK. If the charge can be completed during the off peak period then the demand charge will be low and the controller will determine the cost accordingly. If it can not charge completely during the off peak period and the ON PEAK key was pressed then the demand charge will be higher and the cost will be determined for this condition. If there is not enough time to charge completely then the % Charge will be less than 100%.
AUTO-	The auto key is an alternative to using the ON PEAK and OFF PEAK keys. It does the same function but differs from these keys in that the auto key selects the departure time for the user based on the time required to achieve 100% charge and the peak demand schedule. The departure time is set to a time which allows for a 100% charge which will occur off peak.
START-	START can only be pressed after a time has been accepted. When this key is pressed the controller will go into stand by mode or start to charge the vehicle. In stand by mode the controller waits until the right time, determined by the departure time, to begin charging. If the user opted for a high demand charge then the controller will begin the charger at the estimated charge time before the departure time. If the user did not want a peak charge then the charger will start charging at some time before the departure time determined by the demand period.
CANCEL-	This key takes the charger out of stand by mode and returns it to idle mode. The time can now be adjusted and the charger restarted.

USER SETUP MODE

To enter setup mode the user holds down the pound key and then plugs in the control unit. The setup mode determines the function of the controller by allowing the user to;

1. Adjust the time and date.
2. Set the stopping conditions associated with the charge profile of the vehicle.
3. Decide whether to charge over a peak after a power failure.
4. Input the battery capacity, low voltage, and charger efficiency.
5. Input the utility rates.
6. Input the peak demand schedule.
7. Enable or disable float charging.
8. Reset the system.

Time/Date

It is important that the user sets the time and date, as the rate charged is dependant on the time of day, day of week and date associated with the peak demand schedule. If the time and date are not correct then the estimated cost for a charge will be invalid and the user may be charged more, or less, than he expects. The time and date are changed by pressing display until the article the user wishes to change appears on the display. The # key is pressed to activate the change setting mode. The up and down keys are then used to change the setting to the correct value. When the display reads the correct setting then the # key is pressed again to store the new setting.

End of charge profile

Stopping point: The stopping point for a charge is not the point at which the charger turns off but rather the point at which it determines when it can turn off. This can be either a voltage which is exceeded as the batteries near the end of a charge or a declining current that the charger puts out as the batteries become fully charged.

Equalizing charge time: The equalizing charge time is the time that the charger needs to run after it reaches the stopping point to ensure a full charge. Most charge cycles require this time as the exact end of charge is not easily determined.

Both the stopping point and the equalizing charge time vary widely based on charger, application and battery type used.

Changing end of charge setting

The process for changing the end of charge profile is similar to changing the time and date. The display is scrolled to the stopping point main screen. The # key is pressed activating the change setting mode. The up and down keys can then be used to toggle between amps and volts. When the correct setting is displayed the user presses #. The up and down keys now change the value of amps/volts for the stopping condition. When the correct value is reached then the user again presses the # key. The user is now prompted to enter the equalizing charge time. When the correct number of hours is entered the user presses # thus removing it from the change setting mode and returning it to the stopping point display.

Charging After Power Failure

After a power failure the controller may not be able to complete the charging cycle requested by the user. As in the case of the power being out for several hours and the controller not having enough time to charge the vehicle fully under the given settings. In this case it may be desirable to allow the vehicle to charge during a demand peak to ensure the batteries are charged enough for the user to make the required trip at the departure time. This condition may significantly increase the cost of the monthly charging by charging over the peak but the user would not be left with only a partial charge.

Battery Capacity

In order for you to determine your vehicle's traction battery capacity you will need to contact either your vehicle's manufacturer or contact the battery manufacturer. It is favorable to slightly under estimate, rather than over estimate, the battery capacity. This will ensure that the estimated kWh remaining in the batteries is actually available for use. The battery capacity value is used by the controller to limit the amount of data that is used to estimate the time to charge and is also used to estimate the amount of energy in the battery following a charge cycle.

Maximum time to Charge

After setting the battery capacity it is necessary to set the maximum time to charge. To estimate this use the longest time it has ever taken the charger to fully charge the batteries and then add three hours. It will not hurt if this number is large because this will be the time allowed for the car to charge during the initial learning cycles and it will not likely take this long to charge. Placing too small of a number in for the maximum will cut the charge short and will result in a warning message, requiring the training cycle to be repeated.

Low Battery Voltage

This value is typically calculated by multiplying 1.75 by the number of cells in a lead acid battery pack. Note! A typical 6V deep cycle traction battery has three cells. Contact your vehicle or battery manufacturer to determine the safest low voltage operating point.

Utility Rate Values

To change the utility demand and energy rate, and peak/off peak hour values you must first enable the user utility changes. If your local utility company has already set the values then changing the values will make the controller operate incorrectly and the cost estimates will be invalid. To enable utility changes, scroll through the menu to USER UTILITY CHANGES and change it in the usual manner. Once this is done you can go to kW rate and kWh rate in the menu and change them to the local utility rate values. You can scroll to the daily peak settings and then scroll through the days using the up and down arrows. To change the daily peak settings, go to the day you wish to change, then press the # key. The first change will be to the beginning of the peak. The time is in military time and in increments of 15 minutes. Use the up and down arrows to change the time then press the # key as usual to move to the next change.

Float Charging

Float charging is when the charger remains on following a charge at some low current level. Some chargers are designed to operate in this state but in many cases it is not favorable. In the case of many chargers extended battery life can be achieved by shutting down the charger as soon as full charge is achieved. This limits the boiling of the batteries and reduces the need for battery maintenance. In well designed chargers, a float charge can extend the life of the batteries. The vehicle manufacturer can recommend the appropriate method of charging.

Re-train System

You will want to retrain the system if you replace the batteries or charger. This will remove from the systems memory all of the former battery cycle data. This will require the user to perform the initial drive cycles, (see Getting Started), for the controller to familiarize itself with the batteries and charger.

To Exit

To exit the setup mode press the START button. This will save the new values for use. If the controller is unplugged while in setup without first pressing start the new values will be lost.

Downloading Utility Rates

Using a specialized RS232 cable and a palm top or lap top computer, the utility rates and peak demand periods can be updated by the utility without using the setup procedure. The program "utility.exe" must exist on a disk or on the hard drive of the computer. To execute the program simply type: "utility" at the DOS prompt and follow the prompts.

DO YOU WISH TO MAKE A NEW FILE (Y/N)

If you answer "Y" then a new utility rate file will be created. If you answer "N" then the program terminates.

ENTER NEW KW RATE

for example enter 12.11 for \$12.11/kW

ENTER KWH RATE

for example enter ".056" for 5.6 cents/kWh

HIGH DEMAND START FOR SUN(0-24)

for example enter "13.25" for 1:15 PM

HIGH DEMAND END FOR SUN (0-24)

for example enter "17" for 5:00 PM

repeat this process for each day of the week.

At the end of the program the demand and use rates that you entered are displayed with the peak demand intervals for each day of the week.

DO YOU WISH TO MAKE A NEW FILE

enter "Y" to create a new utility file and a "N" to end the program

Once the file has been created any standard terminal program can be used to send the file the controller. Simply plug in the RS232 cable between the palm top and the RJ45 connector on the controller and download the file "BILL" using the terminal program's "text" download mode. The communication settings must be set to 9600 baud, 1 stop bit, 8 characters and no parity to work properly.

Warning Messages

LOW BATTERY VOLTAGE:

If, upon returning from a drive the battery voltage is below the low limit set in the system set-up, this message will occur. The low voltage can be an indicator of an excessive discharge on the batteries or a bad battery cell. Battery inspection and maintenance is recommended.

STOPPING CONDITION NOT REACHED:

If this is displayed after a charge then this indicates that a full charge was selected but was not achieved. This can occur if the stopping conditions are set to a point that is not reached by the charger during every full charge cycle. This may also occur if there is a battery or charger failure. If this occurs during the system training it is necessary to start the training over.

If all else fails, re-train the system.

APPENDIX D
ABC SOFTWARE FLOWCHARTS

Figure 6-4B. ABC Program Flowchart

Figure 6-4C. ABC Program Flowchart

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Figure 6-4D. ABC Program Flowchart

Figure 6-4E. ABC Program Flowchart

Figure 6-4F. ABC Program Flowchart

Figure 6-4G. ABC Program Flowchart

Figure 6-4H. ABC Program Flowchart

Figure 6-4J. ABC Program Flowchart

Figure 6-4K. ABC Program Flowchart

Figure 6-4L. ABC Program Flowchart

Figure 6-4M. ABC Program Flowchart

Figure 6-4N. ABC Program Flowchart

Figure 6-4P. ABC Program Flowchart

Figure 6-4R. ABC Program Flowchart

Figure 6-1S

Figure 6-1T

Figure 6-4S & 6-4T. ABC Program Flowchart

Figure 6-4U

Figure 6-4V

Figure 6-4W

Figure 6-4AA. ABC Program Flowchart

Figure 6-4BB. ABC Program Flowchart

Figure 6-4CC. ABC Program Flowchart

Figure 6-4FF. ABC Program Flowchart

Figure 6-4GG. ABC Program Flowchart

Figure 6-4HH. ABC Program Flowchart

APPENDIX E
ABC SOFTWARE SOURCE CODE LISTING

' INTELLIGENT CHARGING SYSTEM
 ' BASIC PROGRAM FILE: PRPA56
 ' CAMERON SWEN
 ' WILLIAM KRAMER
 ' CREATED JUNE 15, 1993
 ' LAST REVISION JANUARY 12, 1994

```

"
"
"  VARIABLE LIST:
"
"  FUNCTIONS:
"    DAYWK- RETURNS 0 FOR SUNDAY & AND 6 FOR SATURDAY
"    TIME- 3600*HOUR+60*MIN+SEC
"    JULIAN- RETURNS JULIAN TIME
"    GETKEYP- RETURNS THE VALUE FOR THE KEY PRESSED. 1-16
"    KEYBCNT- RETURNS # OF KEYS IN THE KEYPAD BUFFER.
"
"  VARIABLES:
"    AV- 0 OR 1, TELLS WHETHER THE STOPPING CONDITION IS IN
"        AMPS OR VOLTS, FROM SETUP.
"    AVLIM- LIMIT OF AMPS OR VOLTS FOR STOPPING CONDITION, FROM
"        SETUP.
"    BADPT- 0/1 INDICATOR OF A BAD DATA POINT.
"    CHRG- 1/0 1 WHEN IN CHARGE STANDBY MODE.
"    CHRG2- 1/0 1 WHEN RELAY IS CLOSED.
"    COS- STRING NAME FOR COEFFICIENTS FILE.
"    DA- DAY OF WEEK FOR DEPARTURE OR START TIME.0-6
"    DIS- POINTER TO WHICH MENU ITEM TO DISPLAY.
"    DK- INCREMENTS EACH TIME YOU PRESS THE DOWN KEY.
"    FLAG- 0/1 INDICATES IF YOU WILL BE CHARGING THROUGH A PEAK,
"        FROM ICONTROL.
"    FUNCT- INDICATES WHICH FUNCTION YOU ARE CHANGING, IN SETUP.
"
"    KWHR- CURRENT KWH READING FROM KWH2 METER.
"    KWHR2- STORED READING FROM KWH2 METER INDICATING THE AMOUNT
"        OF KWH USED ON TRIP.
"    KWHR3- SUM OF ACTUAL KWH USED TO CHARGE THE VEHICLE.
"    KWHR5- TOTAL OF KWH USED ON MULTIPLE TRIPS. SUM OF MORE
"        THAN ONE KWHR2.
"    KWHR6- INTERMEDIATE KWH VALUE.
"    KWLEFT-KWH IN THE BATTERIES AFTER A PARTIAL CHARGE OR
DISCHARGE.
"    LMAX- MAX KW USED IN A CHARGE LAST MONTH.
"    LTOT- TOTAL KWH USED IN CHARGING LAST MONTH.
"    MXKW- MAX PREDICTED KW FOR A CHARGE.
"    OLDMAX- MAX KW FOR A CHARGE THIS MONTH.
"    OLDRTIM-OLD DEPARTURE TIME BEFORE PROGRAM CHANGES TIM.
"    PEAK2- 1 IF MXKW>OLDMAX.
"    RACH- 0/1 ENABLES OR DISABLES USER UTILITY CHANGES. IN SETUP.
"    RESUM- DELAYS THE STOPPING CONDITION BEING REACHED WHEN LOW
  
```

" CURRENT IS SELECTED.
 " RETIM- IF =7 THEN IT HASNT CHARGED FOR A WEEK SO IT SCHEDULES
 " A CHARGE.
 " STOP1- 1/0 1 IF STOPPING CONDITION HAS BEEN REACHED.
 " STOP2- TIM3+EQTIME WHEN STOPPING CONDITION IS REACHED. TIME
 " WHICH IS ADDED TO CURVE FIT.
 " STTIM- TIME CHARGER IS SCHEDULED TO START. IN SECONDS FROM
 " MIDNIGHT TODAY.
 " STX- 1/0 IF 1 THEN FINDING DAY FOR BEGIN CHARGE.
 " TIM- DEPARTURE TIME IN SECONDS FROM MIDNIGHT TODAY.
 " TIM3- TIME THAT THE CHARGER HAS BEEN ON. CHARGING.
 " TIM5- ESTIMATED TIME IN SECONDS FOR THE CHARGE TO COMPLETE.
 " BASED ON KWHR2.
 " TIM6- CALCULATED VALUE OF TIME REQUIRED TO CHARGE. SENT TO
 " ICONTROL.
 " TINOW- TIME IN SECONDS SINCE MIDNIGHT.
 " TIMW2- USED IN CALCULATING START TIME.
 " TOT- TOTAL KWH USED IN CHARGING THIS MONTH.
 " TOUT- ARRAY FROM ICONTROL TELLING WHEN TO CHARGE.
 " TPK- LENGTH OF NEAREST PEAK FROM ICONTROL.
 " TYTTEM- LONGEST POSSIBLE TIME IT WILL TAKE TO CHARGE.
 " SET IN SETUP.
 " UK- INCREMENTS WHEN YOU PRESS THE UP KEY.

```
'$INCLUDE: 'QB.BI'
DECLARE SUB CLRKEYPB ()
DECLARE FUNCTION GETKEYP ()
DECLARE SUB KEYPBNC (ticks)
DECLARE SUB KEYPRPT (ron)
DECLARE SUB BITOUT (PORTA%, BITL%, S%)
DECLARE FUNCTION BITIN% (A%, L%)
DECLARE SUB GDATA (N!, M!, X!(), XBAR!(), STD!(), D!(), SUMSQ!())
DECLARE SUB ORDER (R!(), NDEP!, K!, ISAVE!(), RX!(), RY!())
DECLARE SUB MINV (A!(), N!, DET!, L!(), M!())
DECLARE SUB MULTR (N!, K!, XBAR!(), STD!(), D!(), RX!(), RY!(), ISAVE!(), B!(), SB!(),
TNWE!(), ANS!())
DECLARE SUB POLRG (POINTS$, COEF$)
DECLARE FUNCTION JULIAN# ()
DECLARE FUNCTION DAYWK! ()
DECLARE FUNCTION INKEY2$ ()
DECLARE FUNCTION KEYHITS ()
DECLARE FUNCTION KEYPBCNT ()
DECLARE FUNCTION CKEYPRSD ()
DECLARE FUNCTION TIME! ()
DECLARE SUB ICONTROL (TOUT(), TPK!, D!, J!(), K!(), Esttime!, Peakflag!, Chgtime!, ES, Chg!,
PKK!)
DECLARE SUB DATASUB (STOP2!, KWHR2!, COEF$, POINT$, BADPT)
DIM SHARED BSET(8) AS INTEGER
DIM J1(10), K1(10), TOUT(700), T(700), KW1(700)
DIM SHARED COEF(10) AS DOUBLE
DIM INPT$(100)
```

```

CLEAR , , 30000
'
'   INITIALIZE DIGITAL BOARD
'
OUT &H100 + &HB, &H90 ' DETERMINES WHICH PORTS ARE OUTPUTS/INPUTS
OUT &H100 + &H9, 15 ' INITIALIZES PORT STATES
FOR N = 0 TO 7
  BSET(N) = 1
  IF N > 3 THEN BSET(N) = 0
NEXT
'DIM INPT$(100), Timer$(80), Kwhr$(80), Amps$(5), Volts$(5), Tout(700)
'DIM Security$(20), Check1$(1), Check2$(1), Filenam$(34), Kwl(700)
'DIM Da$(9), Dal$(9)
'
'   INITIALIZE PORT/BIT VALUES
'
DIPPORT% = &H100 + &H8 ' PORT WHERE DIP IS READ ON I/O CARD
DIPBIT% = 0 ' BIT WHERE DIP IS READ ON I/O CARD
PORTA% = &H100 + &H9 ' PORT WHERE RELAY IS SWITCHED ON I/O CARD
BITL% = 2 ' BIT WHERE RELAY IS SWITCHED ON I/O CARD
STBPORT% = &H100 + &H9 ' PORT FOR STANDBY LED
STBBIT% = 0 ' BIT FOR STANDBY LED
CHGPORT% = &H100 + &H9 ' PORT FOR CHARGING LED
CHGBIT% = 1 ' BIT FOR CHARGING LED
CR$ = CHR$(13)
CL$ = CHR$(&H15)
'
'   SET INITIAL KEYPAD SETTINGS
'
CALL KEYPRPT(1)
'
'   OPEN COM2 FOR INPUT FROM METER
'
ON ERROR GOTO ERRHANDLER
100 OPEN "COM2:9600,N,8,1,DS0,CD0,CS0,OP0,RS" FOR INPUT AS #4 LEN = 1024
ON ERROR GOTO 0

' TURN LED'S OFF
CALL BITOUT(STBPORT%, STBBIT%, 1)
CALL BITOUT(CHGPORT%, CHGBIT%, 1)

' OPEN RELAY
CALL BITOUT(PORTA%, BITL%, 1)
'
'   CHECK DIP FOR SETUP MODE
'

IF (KEYPBCNT > 0) THEN
  KEYY = GETKEYP

```

```

        IF KEYY = 16 THEN
            GOSUB SETUP
395      LPRINT CL$ + "PLEASE REMOVE POWER" + CRS;
            LPRINT "AND RESTART SYSTEM";
400      'GOTO 400
            STOP
        END IF
    END IF
    CLRKEYPB
    CALL KEYPRPT(0)
    CALL KEYPBNC(2)

```

INPUT CONSTANTS FROM FILES

```

        CLOSE #1
        OPEN "F:\SETTING" FOR INPUT AS #1
        INPUT #1, AV, AVLIM, EQTIME, PKK, MAXI, RACH, FLOT, TYPTIM, LOVOLT,
CHGEFF
        CLOSE #2
        OPEN "F:\UTIL" FOR INPUT AS #2

```

CHECK DATA COLLECTION DIP

```

        DIP2 = BITIN(DIPPORT%, 1)
        IF DIP2 = 0 THEN
            CLOSE #1
            OPEN "COM1:9600,N,8,1,DS0,RS" FOR OUTPUT AS #1 LEN = 512
        END IF

```

CHECK STATUS OF CHARGER AT SHUTDOWN

```

        ON ERROR GOTO ERLN3
        CLOSE #3
        OPEN "F:\STATUS" FOR INPUT AS #3
        INPUT #3, TIM, OLDRTIM, TIM5, TIM3#, CHRG, KWHR2, KWHR5, BADPT, Dt45,
Oldmax, Tot, Lmax, Ltot, OLDKWHR, ADDTIME, FULLCH, Oldate
        ON ERROR GOTO 0

```

READ UTILITY CONSTANTS FILE

```

405    INPTIS = INPUT$(90, #2)
        GOSUB Utility

```

'!ADDED 8/24/93
'!ADDED 8/24/93

REACT TO AN INTERRUPTED CHARGE

```

        IF ABS(FULLCH - TIM3#) < 900 THEN
            CHRG = 0
            GOTO 710
        END IF

```

```

IF CHRГ = 1 THEN
IF DIP2 = 0 THEN WRITE #1, "POWER LOSS DURING CHARGE, RECOVERING"
TURN ON STANDBY LED
PK2 = PKK
CHRG = 0
ON ERROR GOTO ERRHANDLER
FOR I = 1 TO 3
DO WHILE LOC(4) < 23
INPTTS = INPUT$(LOC(4), #4)
LOOP
SLEEP 2
NEXT
ON ERROR GOTO 0
Timer$ = LEFT$(INPTTS, 5)
TIMER2 = VAL(Timer$)
KWHR = VAL(MID$(INPTTS, 7, 6))
AMPS = VAL(MID$(INPTTS, 14, 4))
VOLTS = VAL(MID$(INPTTS, 19, 5))
GOSUB COST0A
GOSUB 4730
END IF

```

```

710 '
' INITIALIZE VARIABLES
'

```

```

STOP1 = 0
STOP2 = 0
TIM2# = 0
Start1 = 0
BADPT = 0
CLZ# = JULIAN#

```

```

890 DIS = 1
900 '
1020 ON ERROR GOTO 0

```

```

'
' PRINT DISPLAY
'

```

```

1070 ' CALCULATE AND DETERMINE IF TO CLEAR DISPLAY
IF DIS = 14 THEN GOTO 1725
DIS2 = 1
CLDI# = CLDI# + (JULIAN# - CLZ#)
CLZ# = JULIAN#
IF CLDI# > 300 THEN LPRINT CL$; : GOTO 1750
'
IF INPTTS = "00000,+00.00,+000,+00.0" THEN GOTO 1750
IF DIS = 1 THEN
TIMW = TIM
IF TIMW >= 86400 THEN TIMW = TIMW - INT(TIM / 86400) * 86400
HRRS = INT(TIMW / 3600)

```

```

PMS = "AM "
IF HRRS >= 12 THEN PMS = "PM "
MINS = INT((TIMW - 3600 * HRRS) / 60)
IF HRRS > 12 THEN HRRS = HRRS - 12
IF HRRS = 0 THEN HRRS = 12
LPRINT CHR$(&H16) + "SET DEPARTURE TIME" + CR$;
MINSS$ = LTRIM$(STR$(MINS))
HRRS$ = STR$(HRRS)
IF HRRS > 9 THEN HRRS$ = LTRIM$(STR$(HRRS))
IF LEN(MINSS$) < 2 THEN MINSS$ = "0" + MINSS$
LPRINT HRRS$ + ":"; MINSS$; " " + PMS + CHR$(&H1B) + CHR$(&H40 + 9) + Da$;
GOTO 1750
END IF
IF DIS = 2 THEN
LPRINT CHR$(&H16) + " DEMAND RATE IS" + CR$;
LPRINT " $"; Kwrate; "/kW";
GOTO 1750
END IF
IF DIS = 3 THEN
LPRINT CHR$(&H16) + " ENERGY RATE IS" + CR$;
LPRINT " $"; Kwirate; "/kWh";
GOTO 1750
END IF
IF DIS = 4 THEN
Costt = INT((Oldmax * Kwrate + Tot * Kwirate) / CHGEFF * 100 * 100) / 100
LPRINT CHR$(&H16) + " APPROX. COST FOR" + CR$;
LPRINT " THIS MONTH $"; Costt;
GOTO 1750
END IF
IF DIS = 5 THEN
Costt = INT((Lmax * Kwrate + Ltot * Kwirate) / CHGEFF * 100 * 100) / 100
LPRINT CHR$(&H16) + " APPROX. COST FOR" + CR$;
LPRINT " LAST MONTH $"; Costt;
GOTO 1750
END IF
IF DIS = 6 THEN
LPRINT CHR$(&H16) + " PRESENT TIME IS" + CR$;
LPRINT " "; TIMES; " "; Da1$;
GOTO 1750
END IF
IF DIS = 7 THEN
LPRINT CHR$(&H16) + "MEASURED VOLTAGE IS" + CR$;
LPRINT " "; VOLTS; " " + CHR$(&H1B) + CHR$(&H40 + 8) + " VOLTS ";
GOTO 1750
END IF
IF DIS = 8 THEN
LPRINT CHR$(&H16) + "MEASURED CURRENT IS" + CR$;
LPRINT " "; AMPS; " " + CHR$(&H1B) + CHR$(&H40 + 9) + "AMPERES ";
GOTO 1750
END IF
IF DIS = 9 THEN
LPRINT CHR$(&H16) + " MEASURED POWER IS" + CR$;

```

```

LPRINT " "; Kw, " " + CHR$(&H1B) + CHR$(&H40 + 9) + " kW";
GOTO 1750
END IF
IF DIS = 10 THEN
LPRINT CHR$(&H16) + " METER ENERGY VALUE" + CR$;
LPRINT " "; KWHR; " " + CHR$(&H1B) + CHR$(&H40 + 10) + " kWh";
GOTO 1750
END IF
IF DIS = 11 THEN
LPRINT CHR$(&H16) + "ENERGY USED ON TRIP" + CR$;
LPRINT " "; KWHR2; " " + CHR$(&H1B) + CHR$(&H40 + 10) + " kWh";
GOTO 1750
END IF
IF DIS = 12 THEN
LPRINT CHR$(&H16) + " METER TIME IS" + CR$;
LPRINT " "; TIMER2; " SECONDS";
GOTO 1750
END IF
IF DIS = 13 THEN
Stx = 1
GOSUB 5900
Stx = 0
IF CHR2 = 1 AND TIME < STTIM THEN TIMW2 = TIME: STTIM = TIME: GOTO
1698
IF STTIM < 86400 * INT(ABS(OLDRTIM - TIM) / 86400) + TIME THEN
1698 LPRINT CHR$(&H16) + " CHARGING BEGAN AT " + CR$;
GOTO 1700
END IF
1699 LPRINT CHR$(&H16) + " CHARGING BEGINS AT" + CR$;
1700 IF Accept = 0 THEN
LPRINT "***ESTABLISH CHARGE***";
GOTO 1750
END IF
HRRS = INT(TIMW2 / 3600)
PMS = "AM"
IF HRRS >= 12 THEN PMS = "PM"
MINS = INT((TIMW2 - 3600 * HRRS) / 60)
IF HRRS > 12 THEN HRRS = HRRS - 12
IF HRRS = 0 THEN HRRS = 12
MINSS = LTRIM$(STR$(MINS))
IF LEN(MINSS) < 2 THEN MINSS = "0" + MINSS
LPRINT RTRIM$(STR$(HRRS)); ":", MINSS; " " + PMS + " " + Da$;
END IF
1725 IF DIS = 14 THEN
LPRINT CHR$(&H16) + "STOPPING CONDITION" + CR$;
LPRINT " NOT REACHED";
1750 END IF

CHECK THE KEY BUFFER

IF (KEYPBCNT > 0) THEN
KEYY = GETKEYP

```

```

SELECT CASE KEY
CASE 1: 'SCROLL THROUGH THE DISPLAY
  IF CLDI# > 300 THEN DIS = DIS - 1
  CLDI# = 0
  UK = 0: DK = 0
  KEYPRPT (1)
  CLRKEYPB
  GOTO DISPLY
CASE 2: 'UP KEY
  CLDI# = 0
  UK = UK + 1
  DK = 0
  IF DIS = 1 AND CHRG = 0 THEN
    KEYPRPT (1)
    CLRKEYPB
    GOTO 4290
  END IF
CASE 3: 'DOWN KEY
  CLDI# = 0
  DK = DK + 1
  UK = 0
  IF DIS = 1 AND CHRG = 0 THEN
    KEYPRPT (1)
    CLRKEYPB
    GOTO 4380
  END IF
CASE 4: 'CANCEL KEY
  CLDI# = 0
  UK = 0: DK = 0
  KEYPRPT (0)
  CLRKEYPB
  CHRG2 = 0
  'OPEN RELAY
  CALL BITOUT(STBPORT%, STBBIT%, 1)
  CALL BITOUT(CHGPORT%, CHGBIT%, 1)
  CALL BITOUT(PORTA%, BITL%, 1)
  GOSUB 5190
CASE 5: 'OFF PEAK CHARGE
  CLDI# = 0
  UK = 0: DK = 0
  KEYPRPT (0)
  CLRKEYPB
  GOSUB COST1
CASE 6: 'ON PEAK CHARGE
  CLDI# = 0
  UK = 0: DK = 0
  KEYPRPT (0)
  CLRKEYPB
  GOSUB COST
CASE 7: 'AUTO SELECT TIME
  CLDI# = 0
  UK = 0: DK = 0

```

1752


```

KEYPRPT (0)
CLRKEYPB
GOSUB COST0
CASE 8: 'START CYCLE
CLDI# = 0
UK = 0: DK = 0
KEYPRPT (0)
CLRKEYPB
IF CHR$ = 0 THEN
CALL BITOUT(STBPORT%, STBBIT%, 1)
CALL BITOUT(CHGPORT%, CHGBIT%, 1)
GOSUB 4730
END IF
CASE 16:
'STOP
END SELECT
END IF

```

```

' RECEIVE METER READING AND CONVERT TO VARIABLES

```

```

1790 ON ERROR GOTO ERRHANDLER 'SLEEP 1
1791 IF LOC(4) >= 23 THEN
1792 INPTT$ = INPUT$(LOC(4), #4)
ON ERROR GOTO 0
1793 END IF
" INPTT$ = "12345,+01.46,+000,+52.5"
1795 Check1$ = MID$(INPTT$, 6, 1)
Check2$ = MID$(INPTT$, 13, 1)
IF (Check1$ = "," AND Check2$ = ",") THEN GOTO 1870
1840 'LPRINT CHR$(&H16) + " ";
INPTT$ = OLDINPUTS
SLEEP 1
GOTO 1790
1870 Security$ = LEFT$(INPTT$, 20)
'PRINT "CHECKING SECURITY"
IF Security$ = "PRPA ,523049,2831254" THEN
'PRINT "PASSED SECURITY"
GOSUB Utility
END IF
IF Uflag = 1 THEN "ADDED 8/23/93
Uflag = 0
GOTO 1790
END IF
IF (MID$(INPTT$, 10, 1) <> "." AND MID$(INPTT$, 22, 1) <> ".") THEN GOTO 1840
OLDINPUT$ = INPTT$
' IF NO METER COMMUNICATIONS
IF INPTT$ = "00000,+00.00,+000,+00.0" THEN
GOSUB RS232ERR
END IF

```

```

OLDTIMER = TIMER2
Timer$ = LEFT$(INPTT$, 5)
TIMER2 = VAL(Timer$)
KWHRS$ = MID$(INPTT$, 7, 6)
KWHR = VAL(KWHRS)
AMPSS$ = MID$(INPTT$, 14, 4)
AMPS = VAL(AMPSS)
VOLTSS$ = MID$(INPTT$, 19, 5)
VOLTS = VAL(VOLTSS)
Kw = INT(VOLTS * AMPS / 1000 * 100) / 100
' FOR METER TIMEOUT
IF TIMER2 = OLDTIMER THEN
RSCHK = RSCHK + 1
IF RSCHK > 100 THEN RSCHK = 100
ELSE
IF RSCHK > 10 THEN CLDI# = 0: DIS = 1
RSCHK = 0
END IF
IF RSCHK = 10 THEN INPTT$ = "00000,+00.00,+000,+00.0": TIMER2 = 0: GOTO 1752
'      ^ # OF LOOPS UNTIL TIMEOUT

=====
"
" CHECK VOLTAGE OR CURRENT TO SEE IF CHARGE IS COMPLETE
"
'

=====
IF AV = 1 AND VOLTS >= AVLIM AND STOP1 = 0 AND CHR2 = 1 THEN GOTO
2610
IF TIMB# > (RESUM + 900) AND AV = 0 AND AMPS <= AVLIM AND CHR2 = 1 AND
STOP1 = 0 THEN
2610 ' STOP2 = LENGTH OF CHARGE TO BE WRITTEN TO DATA POINT
      STOP2 = TIMB# + EQTIME
      STOP1 = 1
      IF DIP2 = 0 THEN WRITE #1, TIMER2, VOLTS, AMPS, KWHR, TIMES, "STOPPING
CONDITION REACHED", STOP2, TIMB#
      ' CHARGE FOR THE REMAINING EQUALIZING TIME
      END IF

=====
'
' CHECK TO SEE IF IT IS A 15 MIN INTERVAL
' THEN TURN CHARGER ON OR OFF RELATIVE TO THE CHARGING MATRIX
'

=====
' IF USER JUST PRESSED START DO THIS PART ONCE
IF NEWSTRT = 1 THEN
  NEWSTRT = 0
  IF CHR2 = 0 AND TOUT(1) = 1 AND CHR = 1 AND CHRTYP$ <> "OFF PEAK"
THEN
    'CLOSE RELAY
    LPRINT CL$ + " BEGINNING CHARGE" + CR$;

```

```

LPRINT "  STANDBY MODE";
SLEEP 10
CALL BITOUT(PORTA%, BITL%, 0)
CHRG2 = 1
RESUM = TIM3#
TIM2# = JULIAN#
Started = 1
TURN ON CHARGING LED
CALL BITOUT(STBPORT%, STBBIT%, 1)
CALL BITOUT(CHGPORT%, CHGBIT%, 0)
END IF
END IF

IF CHRG = 1 AND Dt45 = 1 THEN KW1(L2) = VOLTS * AMPS / 1000
T45 = VAL(MID$(TIMES$, 4, 2))
IF (T45 MOD 15) < 0 THEN Dt45 = 0

' THIS CONDITION EXISTS ONLY ONCE EVERY 15 MIN
IF (T45 MOD 15) = 0 AND Dt45 = 0 THEN
  Dt45 = 1
  IF CHRG = 0 AND Accept = 1 THEN Accept = 0
  IF CHRG = 1 THEN
    L2 = L2 + 1
  END IF

  ' CLOSE RELAY
  IF CHRG2 = 0 AND TOUT(L2) = 1 AND CHRG = 1 THEN
    CALL BITOUT(PORTA%, BITL%, 0)
    CHRG2 = 1
    Started = 1
    RESUM = TIM3#
  END IF

  ' DEPARTURE TIME HAS BEEN REACHED STOP CYCLE
  IF TOUT(L2) = 9 THEN
    IF CHRGEST > 99 AND STOP1 = 0 THEN
      DIS2 = 14
    ELSE
      DIS2 = 1
      GOSUB 5190
    END IF
  END IF

  ' OPEN RELAY
  IF CHRG2 = 1 AND TOUT(L2) = 0 AND CHRG = 1 THEN
    CALL BITOUT(PORTA%, BITL%, 1)
    CHRG2 = 0
  END IF

  ' CHANGE THE LED
  IF CHRG = 1 THEN
    IF CHRG2 = 0 THEN

```

```

      ' TURN ON STANDBY LED
      CALL BITOUT(STBPORT%, STBBIT%, 0)
      CALL BITOUT(CHGPORT%, CHGBIT%, 1)
      END IF
      IF CHRG2 = 1 THEN
        ' OR TURN ON CHARGING LED
        CALL BITOUT(STBPORT%, STBBIT%, 1)
        CALL BITOUT(CHGPORT%, CHGBIT%, 0)
      END IF
    ELSE
      ' OTHERWISE TURN OFF BOTH LED'S
      ' CALL BITOUT(STBPORT%, STBBIT%, 1)
      ' CALL BITOUT(CHGPORT%, CHGBIT%, 1)
    END IF
    IF CHRG = 1 THEN
      IF DIP2 = 0 THEN WRITE #1, TIMER2, VOLTS, AMPS, KWHR, TIMES, "^TIM3",
        "^CHRG", "^CHRG2", "^TOUT", "^L2", "^STOP1", "^STOP2"
      IF DIP2 = 0 THEN WRITE #1, TIMER2, VOLTS, AMPS, KWHR, TIMES, TIM3#,
        CHRG, CHRG2, TOUT(L2), L2, STOP1, STOP2
    END IF
  END IF

  ' INCREMENT TIM3# EVERY 5 SECONDS
  T05 = VAL(MID$(TIMES, 7, 2))
  TT0 = ((T05 / 5) - INT(T05 / 5)) * 10
  IF TT0 > 1 AND TT0 < 3 AND OLTIM2 <> T05 THEN
    ' 5 SEC. THEN DO THIS ONCE
    IF CHRG2 = 1 THEN
      ' CHARGING IS ON THEN DO THIS
      TIM3# = TIM3# + (JULIAN# - TIM2#)
    END IF
    TIM2# = JULIAN#
    OLTIM2 = T05
  END IF

  '
  ' SEE IF CHARGE IS FINISHED BY TIME
  '
  IF TIM3# > STOP2 AND STOP1 = 1 THEN GOSUB 5190

  '
  ' WRITE CHARGER STATUS FILE
  '

  CLOSE #3
  OPEN "F:\STATUS" FOR OUTPUT AS #3
  WRITE #3, TIM, OLDRTIM, TIM5, TIM3#, CHRG, KWHR2, KWHR5, BADPT, Dt45,
    Oldmax, Tot, Lmax, Ltot, OLDKWHR, ADDTIME, FULLCH, Oldate
  CLOSE #3

```

WRITE DATA COLLECTION OUTPUT TO FILE

2615

```
IF OLTIM <> TIMER2 THEN
IF (MID$(INPTTS, 5, 1) <> "0" OR CHR2 = 0) THEN GOTO 2750
IF DIP2 = 0 THEN WRITE #1, TIMER2, VOLTS, AMPS, KWHR, TIMES
OLTIM = TIMER2
END IF
```

2750 GOTO 5900 ' GO DO DAY AND MONTH FUNCTIONS

```
"
" CALCULATE THE TIME TO CHARGE AND COST ESTIMATES
" THEN DISPLAY THEM TO THE USER
"
```

```
COST0: ' OPTIMIZED CHARGE CALCULATION
      CHRTYP$ = "OPTIMIZED"
      ' MINIMUM TIME AND MINIMUM COST
      PK2 = 0 ' THIS IS USED IN SUBROUTINE ICONTROL
```

```
COST0A: ' FOR POWER FAILURE RECOVERY
      Opt = 1
      WHILE TIM > Tinow + 1800
      TIM = TIM - 900
      WEND
      GOTO 2930
```

```
COST1: ' FOR OFF PEAK ONLY CHARGING
      CHRTYP$ = "OFF PEAK"
      PK2 = 0
      GOTO 2930
```

```
COST: ' FOR ON PEAK CHARGING
      CHRTYP$ = "ON PEAK"
      PK2 = 1 ' THE CODE FOR ICONTROL EXECUTES AS ORIGINAL
```

```
2930 IF VOLTS < LOVOLT THEN
      LPRINT CL$ + "LOW BATTERY VOLTAGE" + CRS;
      LPRINT " !CHECK BATTERIES!";
      SLEEP 4
      END IF
      IF CHR2 = 0 THEN
      Accept = 1
      ' TIM5 = POLINOMIAL WITH KWH AS THE DETERMINING FACTOR
      ' ESTIMATE TIME TO CHARGE USING POLINOMIAL
      IF Rechrg = 1 THEN GOTO 3250
```

```

' THIS IS EXECUTED IF YOU JUST TOOK A DRIVE
  IF ABS(OLDKWHR - KWHR) > .01 THEN
    ADDTIME = FULLCH - TIM3# - EQTIME
    IF DIP2 = 0 THEN WRITE #1, "", "^ADDTIM", "^FULLCH", "^TIM3", "^KWHR2",
^KWHR5"
    IF DIP2 = 0 THEN WRITE #1, "NEW DRV", ADDTIME, FULLCH, TIM3#, KWHR2,
KWHR5
    IF ADDTIME <= 0 THEN ADDTIME = 0
    IF ADDTIME > 900 THEN
      IF TIM3# < 900 THEN KWHR5 = KWHR5 + ABS(KWHR)
      IF TIM3# >= 900 THEN KWHR5 = KWHR5 - (TIM3# / FULLCH) * KWHR5 +
ABS(KWHR)
    ELSE
      KWHR5 = ABS(KWHR)
    END IF
    KWHR2 = ABS(KWHR)
    TIM3# = 0
    OLDKWHR = KWHR
    IF DIP2 = 0 THEN WRITE #1, "NEW DRV2", ADDTIME, FULLCH, TIM3#, KWHR2,
KWHR5
  END IF

```

3250 READ IN COEFFICIENTS AND CALCULATE THE DEPENDANT VARIABLE

```

FOR N = 1 TO 3
  IF N = 1 THEN Co$ = "F:\COEFT"
  IF N = 2 THEN Co$ = "F:\COEFT2"
  IF N = 3 THEN Co$ = "F:\COEFT3"
  IF N = 1 THEN Kwhr6 = KWHR2
  IF N = 2 THEN Kwhr6 = KWHR5
  IF N = 3 THEN Kwhr6 = KWHR5
  CLOSE #2
  OPEN Co$ FOR INPUT AS #2
  Varbl = 0
  INPUT #2, ORDR(1)
  IF ORDR(1) = 69 THEN
    TIM5 = TYPTIM
    ADDTIME = 0
    GOTO 3300
  END IF
  FOR I = 1 TO (ORDR(1) + 1)
    INPUT #2, COEF(I)
    Varbl = Varbl + COEF(I) * ABS(Kwhr6) ^ (I - 1)
  NEXT I
  IF N = 1 THEN TIM5 = Varbl
  IF N = 2 THEN KWHR3 = Varbl
  IF N = 3 THEN MAXKW = Varbl

```

```

3300 NEXT N

      READ STATUS FILE TO GET OLD MAXKW

CLOSE #3
OPEN "F:\STATUS" FOR INPUT AS #3
INPUT #3, Txx, Oxxx, Txxx, Txx, Cxx, Kxx, Kxxx, Bxxx, Dxxx, Oldmax, Tot, Lmax, Ltot,
Olxx, Adxxx, Fulxx, Oxx
IF MAXKW > Oldmax THEN
    Peak2 = 1
    Newkw = MAXKW - Oldmax
ELSE
    Peak2 = 0
END IF
'WHEN OPT IS 1 THEN SET DEPARTURE TIME IS NOW+CHARGE TIME
IF Opt = 1 AND (TIM5 - TIM3# + ADDTIME) < 901 THEN
    TIM = TIM + EQTIME
    GOTO 3590
END IF
IF Opt = 1 THEN TIM = TIM + INT((TIM5 - TIM3# + ADDTIME) / 900) * 900 - 900

3590 OLDRTIM = TIM ' Oldrtim is used for weekly charging
    ' TO CLEAR THE COM2 BUFFER WHILE WORKING
    IF NOT EOF(4) THEN
        INPTTS = INPUT$(LOC(4), #4)
    END IF
    'TIMM IS THE AMOUNT OF TIME BETWEEN NOW AND DEPARTURE TIME
    TIMM = TIM - TIME
    TIM6 = TIM5 - TIM3# + ADDTIME
    IF Rechr = 1 THEN TIM6 = TIM5

    ' CORRECT TIM6 FOR BATTERIES WHICH ARE ALREADY FULLY CHARGED

    IF TIM6 < 901 THEN THIS PROTECTS ICONTROL FROM DIVIDE BY ZERO
    TIM6 = TIM5
    BADPT = 1
    END IF
    LPRINT CL$ + "      WORKING" + CR$;

    CALL ROUTINE TO DETERMINE CHARGE TIMES

CALL ICONTROL(TOUT), TPK, TIMM, J1(), K1(), TIM6, Flag, CHGTIM, A$, CHRGET,
PK2)
FULLCH = (TIM5 + ADDTIME)
IF KWHR5 = 0 THEN FULLCH = TIM5: ADDTIME = 0
IF KWHR > 0 AND TIM3# > 0 THEN FULLCH = TIM3#
IF TIM3# > 0 THEN CHRGET = INT((TIM3# / FULLCH + ((FULLCH - TIM3#) *

```

CHRGEST / 100) / FULLCH) * 100) + 1

' IF CHRGEST < 100 WHEN SELECTING AUTO DO THIS

IF Opt = 1 AND CHRGEST < 100 THEN

IF YOU GOT HERE THEN DO THIS ONLY ONCE SINCE PRESSING ACCEPT

IF Dunn = 0 THEN

Dunn = 1

TIM = TIM + 900 * TPK - 900

END IF

TIM = TIM + 900

GOTO 3590

END IF

Dunn = 0

IF CHRGEST > 100 THEN CHRGEST = 100

L2 = 0

IF DIP2 = 0 THEN WRITE #1, "CALCS", "^ADDTIME", "^FULLCH", "^TIM3", "^TIM5",
"^CHRGEST", "^KWHR"

IF DIP2 = 0 THEN WRITE #1, "", ADDTIME, FULLCH, TIM3#, TIM5, CHRGEST, KWHR

,

,' CALCULATE COST

Doll = Kwrate * Newkw * Flag * Peak2 + KWHR3 * Kwrate * CHRGEST / 100

IF CHRGEST = 0 THEN Doll = 0

Dollars = (INT(Doll / CHGEFF * 100 * 1000) / 1000)

' OUTPUT RESULT

LPRINT CL\$ + "APPROX CHARGING COST";

LPRINT "\$"; Dollars; INT(CHRGEST); "% CHRG";

SLEEP 5

IF Peak2 = 1 AND Flag = 1 THEN

LPRINT CL\$ + "CONSIDER NEW TIME OR";

LPRINT "PAY PEAK ELECT. RATE";

SLEEP 2

END IF

DIS = 1

LPRINT CL\$;

END IF

Opt = 0

,

,' CALCULATE TIME TO BEGIN CHARGING

STTIM = OLDRTIM - ((TIMM - CHGTIM + 1) * 900)

WHILE STTIM < TIME

STTIM = STTIM + 900

WEND

TIMW2 = STTIM


```

        WHILE TIMW2 >= 86400
            TIMW2 = TIMW2 - 86400
        WEND
    RETURN

```

ADJUST DEPARTURE TIME

```

4290 'UP KEY
        IF NOT EOF(4) THEN
            INPTTS = INPUT$(LOC(4), #4)
        END IF
        IF UK >= 8 THEN
            TIM = TIM + 3600
        ELSE
            TIM = TIM + 900
        END IF
        IF TIM > 604800 THEN TIM = 604800
        Accept = 0
        GOTO 5920

```

```

4380 'DOWN KEY
        IF NOT EOF(4) THEN
            INPTTS = INPUT$(LOC(4), #4)
        END IF
        IF DK >= 8 THEN
            TIM = TIM - 3600
        ELSE
            TIM = TIM - 900
        END IF
        Accept = 0
        GOTO 5920

```

DISPLY: ' SCROLL THROUGH CHANGE DISPLAY

```

        LPRINT CLS;
        DIS = DIS + 1
        IF DIS > 13 THEN DIS = 1
        IF NOT EOF(4) THEN
            INPTTS = INPUT$(LOC(4), #4)
        END IF
        GOTO 1070

```

```

RS232ERR: ' METER COMMUNICATIONS TIMEOUT
        IF CLDI# < 300 THEN
            LPRINT CLS + " PLEASE PLUG IN" + CR$;
            LPRINT " METER";
            SLEEP 3
        END IF
        INPTTS = "00000,+00.00,+000,+00.0"
        Accept = 0

```

```
AS = ""  
RETURN
```

```
4730      SMART CHARGING ROUTINE
```

```
Begchrg:      BEGIN CHARGING
```

```
IF CHRGE = 0 AND Accept = 0 THEN  
  LPRINT CL$ + "ESTABLISH CHARGE" + CR$;  
  LPRINT "CYCLE AND TIME";  
  SLEEP 1.5  
  LPRINT CL$;  
END IF  
IF CHRGE = 0 AND Accept = 1 THEN  
  CHRGE = 1  
  'TURN ON STANDBY LED  
  CALL BITOUT(STBPORT%, STBBIT%, 0)  
  IF CHRGEST < 98 THEN BADPT = 1  
  IF CHRGEST > 98 THEN BADPT = 0  
  IF KWHR > 0 THEN BADPT = 1  
  LPRINT CL$ + " BEGINNING CHARGE" + CR$;  
  LPRINT " STANDBY MODE";  
  'CLOSE RELAY TO TEST IF THE CHARGER IS PLUGGED IN  
  CALL BITOUT(PORTA%, BITL%, 0)  
  SLEEP 1  
  IF NOT EOF(4) THEN  
    INPTTS = INPUT$(LOC(4), #4)  
  END IF  
  I = 0  
4960 DO  
  I = I + 1  
  SLEEP 1  
  IF NOT EOF(4) THEN  
    INPTTS = INPUT$(LOC(4), #4)  
  END IF  
  IF (MID$(INPTTS, 10, 1) <> "." AND MID$(INPTTS, 22, 1) <> ".") THEN  
    INPTTS = "00001,+00.00,+000,+00.0"  
  END IF  
  AMPSS = MID$(INPTTS, 14, 4)  
  AMPS = VAL(AMPSS)  
  KWHR = VAL(MID$(INPTTS, 7, 6))  
  IF AMPS = 0 THEN  
    LPRINT CL$ + " PLEASE PLUG IN" + CR$;  
    LPRINT " CHARGER";  
  END IF  
  LOOP UNTIL (AMPS > 1 OR I = 5)
```

```

        OLDKWHR = KWHR
        REOPEN THE RELAY
        CALL BITOUT(PORTA%, BITL%, 1)
        IF I = 5 AND AMPS < 2 THEN GOTO 5191
        NEWSTRT = 1
    END IF
    DIS = 13
    LPRINT CLS;
    IF DIP2 = 0 THEN WRITE #1, DATE$, TIME$, TIM, TIM5, TIM3#, CHRG, KWHR2,
KWHR5, BADPT, CHRTYPS
    RETURN

'
' AFTER CHARGING EVALUATE POINT AND STATUS BEFORE SENDING OUT
POINT

5190  Accept = 0
      TIM = OLDRTIM
      Retim = 0
5191  IF CHRG = 1 AND STOP1 = 1 THEN
      FULLCH = TIM3#
      ADDTIME = 0
      Perct = INT(TIM3# / (STOP2 - TIM3#) * 100)
      STOP1 = 0
      IF BADPT = 0 THEN
          '
          ' CALL DATA FILE MANIPULATION ROUTINE
          '
          CALL DATASUB(INT(STOP2), KWHR5, "F:\COEFT", "F:\POINTT", BADPT)
          ON ERROR GOTO 0
          IF BADPT = 1 THEN GOTO 5192
          KWHR3 = 0
          MXKW = 0
          FOR I = 0 TO L2
              KWHR3 = KWHR3 + KW1(I) * .25
              IF MXKW < KW1(I) THEN MXKW = KW1(I)
          NEXT I
          CALL DATASUB(KWHR3, KWHR5, "F:\COEFT2", "F:\POINTT2", BADPT)
          CALL DATASUB(MXKW, KWHR5, "F:\COEFT3", "F:\POINTT3", BADPT)
          ON ERROR GOTO 0
          END IF
5192      BADPT = 0
      END IF
      IF CHRG = 1 THEN
          Kwhr4 = 0
          MXKW2 = 0
          FOR I = 0 TO L2
              Kwhr4 = Kwhr4 + KW1(I) * .25
              IF MXKW2 < KW1(I) THEN MXKW2 = KW1(I)
          NEXT I
          IF MXKW2 > Oldmax AND Flag = 1 THEN Oldmax = MXKW2
      
```

```
Tot = Tot + Kwhr4  
END IF
```

```
IS CHARGER ON, THEN STOP THE CHARGER
```

```
IF CHRG = 1 THEN
```

```
STOP CHARGING AND RESET ROUTINE
```

```
TURN OFF LED'S  
CALL BITOUT(STBPORT%, STBBIT%, 1)
```

```
IF CHRG2 = 1 THEN  
OPEN RELAY  
IF FLOT = 0 THEN  
CALL BITOUT(PORTA%, BITL%, 1)  
CALL BITOUT(CHGPORT%, CHGBIT%, 1)  
ELSE  
CALL BITOUT(PORTA%, BITL%, 0)  
CALL BITOUT(STBPORT%, STBBIT%, 0)  
END IF  
END IF
```

```
RESET PROGRAM VARIABLES
```

```
OLDKWHR = KWHR  
CHRG2 = 0  
CHRG = 0  
A$ = ""  
DIS = DIS2  
L2 = 0
```

```
WRITE DATA FILE TRAILER  
IF DIP2 = 0 THEN WRITE #1, "DATE", "TIME", "TIM", "TIM5", "TIM3", "CHRG",  
"KWHR2", "KWHRS", "BADPT", "CHRTYP"  
IF DIP2 = 0 THEN WRITE #1, DATES, TIMES, TIM, TIM5, TIM3#, CHRG, KWHR2,  
KWHRS, BADPT, CHRTYP$
```

```
CALCULATE AND DISPLAY PERCENT CHARGE ACHIEVED
```

```
IF STOP1 = 0 THEN Percnt = INT(TIM3# / FULLCH * 100)  
IF Percnt > 100 THEN Percnt = 100  
LPRINT CL$ + " A "; Percnt; "% CHARGE" + CR$;  
LPRINT " WAS ACHIEVED";  
SLEEP 2.5  
LPRINT CL$;
```

```

' CALCULATE AND DISPLAY KWH IN BATTERIES BASED ON
' BATTERY CAPACITY AND KWH USED ON TRIP(S)

```

RETURN 5900

5900 ' DETERMINE THE DAY FOR DEPARTURE

102

·
· CHECK TO SEE IF IT IS A CHANGE OF DAY
·

IF Oldate <> Danow THEN
 Oldate = Danow
 IF CHRG = 0 THEN TIM = OLDRTIM
 IF CHRG = 1 THEN TIM = TIM - 86400
 Retim = Retim + 1

·
· CHECK TO SEE IF IT HAS BEEN A WEEK SINCE CHARGING
·

IF (Retim + INT(OLDRTIM / 86400)) = 7 AND CHRG = 0 THEN
 Rechrg = 1
 GOSUB COST1
 GOSUB Begchrg
 'ON ERROR GOTO 1790
 Rechrg = 0
END IF

·
· CHECK IF IT IS A CHANGE OF MONTH
·

IF VAL(MID\$(DATE\$, 4, 2)) = 1 THEN
 Lmax = Oldmax
 Oldmax = 0
 Ltot = Tot
 Tot = 0
END IF
END IF
IF Stx = 1 THEN RETURN

GOTO 1070

Utility: ·

· PRPA DOWNLOAD OF UTILITY CHARGES AND RATES
·

CLOSE #2
OPEN "F:\UTIL" FOR OUTPUT AS #2
PRINT #2, INPTTS
Kwhrate = VAL(MID\$(INPTTS, 22, 5))
Kwrate = VAL(MID\$(INPTTS, 28, 7))
FOR I = 0 TO 6
 Xx = 28 + (I + 1) * 8
 J1(I) = VAL(MID\$(INPTTS, Xx, 3))
 K1(I) = VAL(MID\$(INPTTS, Xx + 4, 3))
NEXT I
LPRINT CL\$;

```

LPRINT CL$ + "DOWNLOADING NEW" + CR$;
LPRINT "UTILITY CONSTANTS";
SLEEP 2
LPRINT CL$ + "KWHRATE= "; Kwhrate; CR$;
LPRINT "KWRATE= "; Kwrate;
SLEEP 2
LPRINT CL$ + "DOWNLOAD COMPLETE" + CR$;
Uflag = 1
INPTTS = "00000,+00.00,+000,+00.0"
RETURN

```

```

SETUP: "WELCOME TO SUBROUTINE SETUP
      DIM STRT(15) AS SINGLE, SRAT(15) AS INTEGER, ENND(15) AS SINGLE, ENND0(15)
AS INTEGER
      ON ERROR GOTO ERLN1
      LPRINT CL$ + " BEGINNING SETUP" + CR$;
      LPRINT "PRESS START TO EXIT";
      SLEEP 5
SET:   CLOSE #4
      OPEN "F:\SETTING" FOR INPUT AS #4
      INPUT #4, AV, AVLIM, EQTIME, PK, MAXI, RACH, FLOT, TYPTIM, LOVOLT,
CHGEFF
      ON ERROR GOTO ERLN2
3     CLOSE #3
      OPEN "F:\UTIL" FOR INPUT AS #3
      INPTTS = INPUT$(90, #3)
      KWRA = VAL(MID$(INPTTS, 28, 7))
      KHRA = VAL(MID$(INPTTS, 22, 5))
      FOR I = 0 TO 6
      Xx = 28 + (I + 1) * 8
      SRAT(I) = VAL(MID$(INPTTS, Xx, 3))
      ENND0(I) = VAL(MID$(INPTTS, Xx + 4, 3))
      STRT(I) = (SRAT(I) - (96 * I)) / 96 * 24
      ENND(I) = (ENND0(I) - (96 * I)) / 96 * 24
      NEXT I
4     ON ERROR GOTO 0
      FUNCT = 1
      '
      ' CHECK THE KEY BUFFER
      '
280   IF (KEYPBCNT > 0) THEN
      KEYY = GETKEYP
      SELECT CASE KEYY
      CASE 1: 'SCROLL THROUGH THE DISPLAY
          DK = 0: UK = 0
          GOTO 1430
      CASE 2: 'UP KEY
          IF FUNCT = 1 OR FUNCT = 2 THEN UK = UK + 1: DK = 0
          IF CHNG = 1 AND FUNCT = 1 THEN GOTO 1270
          IF CHNG = 1 AND FUNCT = 2 THEN GOTO 1370
          IF CHNG = 1 AND FUNCT = 4 THEN GOTO 1980

```

```

IF CHNG = 1 AND FUNCT = 5 AND FUN5 = 1 THEN GOTO TYPUP
IF CHNG = 1 AND FUNCT = 5 THEN GOTO 2110
IF CHNG = 1 AND FUNCT = 5.5 THEN GOTO 2140
IF CHNG = 1 AND FUNCT = 6 THEN CHGEFF = CHGEFF + 1: GOTO 280
IF CHNG = 1 AND FUNCT = 6.5 THEN GOTO 2210
IF CHNG = 1 AND FUNCT = 7 AND RACH = 1 THEN GOTO 2320
IF CHNG = 1 AND FUNCT = 8 AND RACH = 1 THEN GOTO 2410
IF CHNG = 1 AND FUNCT = 9 AND FUN9 = 0 AND RACH = 1 THEN GOTO

UPPEAK
IF CHNG = 1 AND FUNCT = 9 AND FUN9 = 1 AND RACH = 1 THEN GOTO

UPPEAK2
IF CHNG = 0 AND FUNCT = 9 THEN GOTO DAY1
IF CHNG = 1 AND FUNCT = 10 THEN GOTO 2650
CASE 3: ' DOWN KEY
IF FUNCT = 1 OR FUNCT = 2 THEN DK = DK + 1: UK = 0
IF CHNG = 1 AND FUNCT = 1 THEN GOTO 1300
IF CHNG = 1 AND FUNCT = 2 THEN GOTO 1400
IF CHNG = 1 AND FUNCT = 4 THEN GOTO 1980
IF CHNG = 1 AND FUNCT = 5 AND FUN5 = 1 THEN GOTO TYPDN
IF CHNG = 1 AND FUNCT = 5 THEN GOTO 2130
IF CHNG = 1 AND FUNCT = 5.5 THEN GOTO 2150
IF CHNG = 1 AND FUNCT = 6 THEN CHGEFF = CHGEFF - 1: GOTO 280
IF CHNG = 1 AND FUNCT = 6.5 THEN GOTO 2210
IF CHNG = 1 AND FUNCT = 7 AND RACH = 1 THEN GOTO 2340
IF CHNG = 1 AND FUNCT = 8 AND RACH = 1 THEN GOTO 2430
IF CHNG = 1 AND FUNCT = 9 AND FUN9 = 0 AND RACH = 1 THEN GOTO

DOWPEAK
IF CHNG = 1 AND FUNCT = 9 AND FUN9 = 1 AND RACH = 1 THEN GOTO

DOWPEAK2
IF CHNG = 0 AND FUNCT = 9 THEN GOTO DAY2
IF CHNG = 1 AND FUNCT = 10 THEN GOTO 2650
CASE 8: ' CANCEL KEY
DK = 0: UK = 0
GOSUB WRITPEAKS
'CASE 5: 'OFF PEAK CHARGE
' GOSUB COST1
'CASE 6: 'ON PEAK CHARGE
' GOSUB COST
'CASE 7: 'AUTO SELECT TIME
' GOSUB COST0
'CASE 8: 'START CYCLE
' GOSUB 4730
CASE 16: 'CHANGE
DK = 0: UK = 0
IF CHNG = 1 AND FUNCT = 5 AND FUN5 = 0 THEN
FUN5 = 1
CLRKEYPB
GOTO 281
END IF
IF CHNG = 1 AND FUNCT = 9 AND FUN9 = 0 THEN
FUN9 = 1
GOTO 281

```



```

        END IF
        IF CHNG = 1 AND FUNCT = 5 AND FUN5 = 1 THEN FUN5 = 0
        IF CHNG = 1 AND FUNCT = 9 AND FUN9 = 1 THEN FUN9 = 0
        GOTO 1090
281  END SELECT
      END IF
    IF FUNCT = 1 THEN
      IF CHNG = 0 THEN LPRINT CHR$(&H16) + "THE TIME IS" + CR$;
      IF CHNG = 1 THEN LPRINT CHR$(&H16) + "NEW TIME IS" + CR$;
      LPRINT TIMES;
      GOTO 280
    END IF
    IF FUNCT = 2 THEN
      IF CHNG = 0 THEN LPRINT CHR$(&H16) + "THE DATE IS" + CR$;
      IF CHNG = 1 THEN LPRINT CHR$(&H16) + "NEW DATE IS" + CR$;
      LPRINT DATES;
      GOTO 280
    END IF
    IF FUNCT = 3 THEN
      IF AV = 0 THEN AV$ = "AMPS"
      IF AV = 0 THEN Ab$ = "BELOW"
      IF AV = 1 THEN AV$ = "VOLTS"
      IF AV = 1 THEN Ab$ = "ABOVE"
      LPRINT CHR$(&H16) + "THE STOPPING POINT" + CR$;
      LPRINT Ab$; AVLIM; AV$;
      GOTO 280
    END IF
    IF FUNCT = 4 THEN
      LPRINT CHR$(&H16) + "ON POWER FAILURE" + CR$;
      IF PK = 0 THEN LPRINT "CHARGE OFF PEAK ";
      IF PK = 1 THEN LPRINT "CHARGE OVER PEAK ";
      GOTO 280
    END IF
    IF FUNCT = 5 AND FUN5 = 0 THEN
      MAXI2 = INT(MAXI * 100) / 100
      IF CHNG = 0 THEN LPRINT CHR$(&H16) + "BATTERY CAPACITY" + CR$;
      IF CHNG = 1 THEN LPRINT CHR$(&H16) + "NEW BATTERY CAP." + CR$;
      LPRINT MAXI2; "kWh ";
      GOTO 280
    END IF
    IF FUNCT = 5 AND FUN5 = 1 THEN
      TYPTIM2 = INT((TYPTIM / 3600) * 100) / 100
      LPRINT CHR$(&H16) + "W/ MAXIMUM TIME TO" + CR$;
      LPRINT "CHARGE OF"; TYPTIM2; " " + CHR$(&H1B) + CHR$(&H40 + 15) + "HRS";
      GOTO 280
    END IF
    IF FUNCT = 5.5 THEN
      IF CHNG = 0 THEN LPRINT CHR$(&H16) + "LOW BATTERY VOLTAGE" + CR$;
      IF CHNG = 1 THEN LPRINT CHR$(&H16) + "NEW LOW VOLTAGE " + CR$;
      LPRINT " "; LOVOLT; " " + CHR$(&H1B) + CHR$(&H40 + 8) + " VOLTS ";
      GOTO 280
    END IF

```

```

IF FUNCT = 6 THEN
IF CHNG = 0 THEN LPRINT CHR$(&H16) + "CHARGER EFFICIENCY" + CR$;
IF CHNG = 1 THEN LPRINT CHR$(&H16) + "SET EFFICIENCY " + CR$;
LPRINT " "; CHGEFF; " " + CHR$(&H1B) + CHR$(&H40 + 8) + " % ";
IF CHGEFF > 100 THEN CHGEFF = 100
IF CHGEFF < 50 THEN CHGEFF = 50
GOTO 280
END IF
IF FUNCT = 6.5 THEN
IF RACH = 0 THEN RACH$ = "DISABLED "
IF RACH = 1 THEN RACH$ = "ENABLED "
IF CHNG = 0 THEN LPRINT CHR$(&H16) + "USER PEAK CHANGES" + CR$;
IF CHNG = 1 THEN LPRINT CHR$(&H16) + "ENTER PEAK OPTION" + CR$;
IF CHNG = 0 THEN LPRINT "ARE "; RACH$;
IF CHNG = 1 THEN LPRINT RACH$;
GOTO 280
END IF
IF FUNCT = 7 THEN
KWRA2 = INT(KWRA * 100) / 100
IF CHNG = 0 THEN LPRINT CHR$(&H16) + "kW RATE=" + CR$;
IF CHNG = 1 THEN LPRINT CHR$(&H16) + "ENTER NEW kW RATE" + CR$;
LPRINT " $"; KWRA2;
GOTO 280
END IF
IF FUNCT = 8 THEN
KHRA2 = INT(KHRA * 1000) / 1000
IF CHNG = 0 THEN LPRINT CHR$(&H16) + "kWh RATE=" + CR$;
IF CHNG = 1 THEN LPRINT CHR$(&H16) + "ENTER NEW kWh RATE" + CR$;
LPRINT " $"; KHRA2;
GOTO 280
END IF
IF FUNCT = 9 THEN
IF DAYOF = 0 THEN LPRINT CHR$(&H16) + "SUNDAY PEAK HRS" + CR$;
IF DAYOF = 1 THEN LPRINT CHR$(&H16) + "MONDAY PEAK HRS" + CR$;
IF DAYOF = 2 THEN LPRINT CHR$(&H16) + "TUESDAY PEAK HRS" + CR$;
IF DAYOF = 3 THEN LPRINT CHR$(&H16) + "WEDNESDAY PEAK HRS" + CR$;
IF DAYOF = 4 THEN LPRINT CHR$(&H16) + "THURSDAY PEAK HRS" + CR$;
IF DAYOF = 5 THEN LPRINT CHR$(&H16) + "FRIDAY PEAK HRS" + CR$;
IF DAYOF = 6 THEN LPRINT CHR$(&H16) + "SATURDAY PEAK HRS" + CR$;
IF CHNG = 0 THEN LPRINT STRT(DAYOF); " - "; ENND(DAYOF); " ";
IF CHNG = 1 AND FUN9 = 0 THEN LPRINT STRT(DAYOF); " - ";
IF CHNG = 1 AND FUN9 = 1 THEN LPRINT " - "; ENND(DAYOF); " ";
GOTO 280
END IF
IF FUNCT = 10 THEN
IF FLOT = 0 THEN FLOTS = "DISABLED "
IF FLOT = 1 THEN FLOTS = "ENABLED "
LPRINT CHR$(&H16) + "FLOAT CHARGING" + CR$;
IF CHNG = 0 THEN LPRINT "IS " + FLOTS;
IF CHNG = 1 THEN LPRINT FLOTS;
GOTO 280
END IF

```

```

    IF FUNCT = 11 THEN
    LPRINT CHR$( &H16) + "PRESS START TO EXIT" + CR$;
    LPRINT "PRESS # TO RE-TRAIN";
    GOTO 280
    END IF

    GOTO 280
TYPUP:  TO INCREASE THE TYPICAL TIME TO CHARGE
        TYPTIM = TYPTIM + 900
        GOTO 280
TYPDN:  TO DECREASE THE TYPICAL TIME TO CHARGE
        TYPTIM = ABS(TYPTIM - 900)
        GOTO 280

DAY1:   TO SCROLL UP THROUGH THE DAYS
        DAYOF = DAYOF + 1
        IF DAYOF >= 7 THEN DAYOF = 0
        LPRINT CL$;
        GOTO 280
DAY2:   TO SCROLL DOWN THROUGH THE DAYS
        DAYOF = DAYOF - 1
        IF DAYOF < 0 THEN DAYOF = 6
        LPRINT CL$;
        GOTO 280
1090    IF CHNG = 0 THEN
        CHNG = 1
        IF FUNCT = 1 OR FUNCT = 2 OR FUNCT = 7 OR FUNCT = 8 OR FUNCT = 9 OR
FUNCT = 5 OR FUNCT = 5.5 OR FUNCT = 6 THEN KEYPRPT (1)
        IF FUNCT = 3 THEN GOTO 1520
        IF FUNCT = 11 THEN GOTO HRESET
        GOTO 280
        END IF
        IF FUNCT = 1 OR FUNCT = 2 OR FUNCT = 7 OR FUNCT = 8 OR FUNCT = 9 OR
FUNCT = 5 OR FUNCT = 5.5 OR FUNCT = 6 THEN KEYPRPT (0)
        CLRKEYPB
        CHNG = 0
        HR = 0
        LPRINT CL$;
        GOTO 280
1270    MIN = VAL(MID$(TIMES$, 4, 2))
        HOUR = VAL(LEFT$(TIMES$, 2))
        MIN = MIN + 1
        IF MIN >= 60 THEN
        MIN = 0
        HOUR = HOUR + 1
        IF HOUR >= 24 THEN HOUR = 0
        END IF
        GOTO 1325
1300    MIN = VAL(MID$(TIMES$, 4, 2))
        HOUR = VAL(LEFT$(TIMES$, 2))
        MIN = MIN - 1
        IF MIN < 0 THEN

```

```

    MIN = 59
    HOUR = HOUR - 1
    IF HOUR < 0 THEN HOUR = 23
    END IF
1325 T2$ = "  "
    HOUS = STR$(HOUR)
    MINS = STR$(MIN)
    ZA = 4
    IF VAL(MINS) < 10 THEN MID$(T2$, 4) = "0": ZA = 5
    IF VAL(HOUS) >= 10 THEN MID$(T2$, 1) = MID$(HOUS, 2, 2)
    IF VAL(HOUS) < 10 THEN MID$(T2$, 1) = "0": MID$(T2$, 2) = MID$(HOUS, 2, 1)
    MID$(T2$, 3) = "."
    MID$(T2$, ZA) = MID$(MINS, 2, 2)
    TIMES = T2$
    GOTO 280
1370 DAY = VAL(MID$(DATES$, 4, 2))
    MONTH = VAL(LEFT$(DATES$, 2))
    YER = VAL(RIGHT$(DATES$, 4))
    AS$ = "+1"
    IF UK >= 45 THEN MONTH = MONTH + 1
    DAY = DAY + 1
    IF DAY > 31 THEN
        DAY = 1
        MONTH = MONTH + 1
    END IF
    IF MONTH > 12 THEN
        YER = YER + 1
        MONTH = 1
    END IF
    GOTO 1425
1400 DAY = VAL(MID$(DATES$, 4, 2))
    MONTH = VAL(LEFT$(DATES$, 2))
    YER = VAL(RIGHT$(DATES$, 4))
    IF DK >= 45 THEN MONTH = MONTH - 1
    DAY = DAY - 1
    AS$ = "-1"
    IF DAY < 1 THEN
        DAY = 31
        MONTH = MONTH - 1
    END IF
    IF MONTH < 1 THEN
        YER = YER - 1
        MONTH = 12
    END IF
1425 IF MONTH = 4 OR MONTH = 6 OR MONTH = 9 OR MONTH = 11 THEN
    IF DAY = 31 THEN DAY = DAY + VAL(AS$)
    IF DAY > 31 THEN DAY = 1: MONTH = MONTH + 1
    END IF
    IF MONTH = 2 THEN
    IF DAY = 29 OR DAY = 30 OR DAY = 31 THEN
    WHILE DAY > 28
    DAY = DAY + VAL(AS$)

```

```

IF DAY > 31 THEN DAY = 1: MONTH = MONTH + 1
WEND
END IF
END IF
ds$ = "      "
DAY$ = STR$(DAY)
MONTH$ = STR$(MONTH)
YER$ = STR$(YER)
ZA = 1: ZB = 4
IF VAL(MONTH$) < 10 THEN MID$(ds$, 1) = "0": ZA = 2
IF VAL(DAY$) < 10 THEN MID$(ds$, 4) = "0": ZB = 5
MID$(ds$, ZA) = MID$(MONTH$, 2, 2)
MID$(ds$, ZB) = MID$(DAY$, 2, 2)
MID$(ds$, 7) = MID$(YER$, 2, 4)
MID$(ds$, 3) = "-"
MID$(ds$, 6) = "-"
DATE$ = ds$
GOTO 280
1430 'SCROLL THROUGH DISPLAY
KEYPRPT (0)
CLRKEYPB
CHNG = 0
IF FUNCT = 5 OR FUNCT = 5.5 OR FUNCT = 6 OR FUNCT = 6.5 THEN FUNCT =
FUNCT - .5
FUNCT = FUNCT + 1
IF FUNCT > 11 THEN FUNCT = 1
LPRINT CLS;
GOTO 280
1520 FUN3 = 0
GOTO 1600
1580 AV = AV + 1
IF AV > 1 THEN AV = 0
1600 IF AV = 0 THEN AV$ = "AMPS  "
IF AV = 0 THEN Ab$ = "BELOW"
IF AV = 1 THEN AV$ = "VOLTS  "
IF AV = 1 THEN Ab$ = "ABOVE"
1640 LPRINT CHR$(&H16) + "NEW STOPPING POINT" + CR$;
LPRINT Ab$; AVLIM; AV$;
IF (KEYBCNT > 0) THEN
KEYY = GETKEYP
SELECT CASE KEYY
CASE 2:
IF FUN3 = 0 THEN GOTO 1580
IF FUN3 = 1 THEN GOTO 1720
CASE 3:
IF FUN3 = 0 THEN GOTO 1580
IF FUN3 = 1 THEN GOTO 1740
CASE 16:
KEYPRPT (0)
CLRKEYPB
IF FUN3 = 0 THEN GOTO 1680
IF FUN3 = 1 THEN LPRINT CLS: GOTO 1800

```

```

        END SELECT
        END IF
        GOTO 1640
1680 FUN3 = 1
        KEYPRPT (1)
        CLRKEYPB
        GOTO 1640
1720 AVLIM = AVLIM + .5
        GOTO 1640
1740 AVLIM = ABS(AVLIM - .5)
        GOTO 1640
1800 LPRINT CHR$(&H16) + "WITH EQUALIZING" + CR$;
        LPRINT "TIME ="; Eqtime2; "HOURS  ";
        Eqtime2 = EQTIME / 900 / 4
        KEYPRPT (1)
        IF (KEYPBCNT > 0) THEN
            KEYY = GETKEYP
            SELECT CASE KEYY
                CASE 2:
                    GOTO 1841
                CASE 3:
                    GOTO 1860
                CASE 16:
                    KEYPRPT (0)
                    GOTO 1901
            END SELECT
        END IF
        GOTO 1800
1841 EQTIME = EQTIME + 900
        IF EQTIME > 43200 THEN EQTIME = 43200
        GOTO 1800
1860 EQTIME = EQTIME - 900
        IF EQTIME < 1800 THEN EQTIME = 1800
        GOTO 1800
1901 CHNG = 0: FUN3 = 0
        LPRINT CL$;
        GOTO 280
1980 PK = PK + 1
        IF PK > 1 THEN PK = 0
        GOTO 280
Maxkw:   TO INPUT THE MAXIMUM KWH FOR BATTERIES
2110 MAXI = MAXI + .01
        GOTO 280
2130 MAXI = MAXI - .01
        IF MAXI < 0 THEN MAXI = 0
        GOTO 280
lovoltage: TO INPUT THE LOW BATTERY VOLTAGE
2140 LOVOLT = LOVOLT + .5
        GOTO 280
2150 LOVOLT = LOVOLT - .5
        IF LOVOLT < 0 THEN LOVOLT = 0
        GOTO 280

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Chrapeak:  ' TO ALLOW USER TO INPUT HIS OWN PEAK TIMES AND RATES
2210 RACH = RACH + 1
      IF RACH > 1 THEN RACH = 0
      GOTO 280
Kwrt:  ' TO CHANGE THE KW RATE
2320 KWRA = KWRA + .01
      GOTO 280
2340 KWRA = KWRA - .01
      IF KWRA < 0 THEN KWRA = 0
      GOTO 280
Kwhrt:  ' TO CHANGE THE KWH RATE
2410 KHRA = KHRA + .001
      GOTO 280
2430 KHRA = KHRA - .001
      IF KHRA < 0 THEN KHRA = 0
      GOTO 280
Pkchg:  ' TO CHANGE THE PEAKS FOR A DAY
UPPEAK:  ' TO MOVE THE START PEAK UP
      STRT(DAYOF) = STRT(DAYOF) + .25
      IF STRT(DAYOF) > 24 THEN STRT(DAYOF) = 24
      IF STRT(DAYOF) > ENND(DAYOF) THEN ENND(DAYOF) = STRT(DAYOF)
      GOTO 280
DOWPEAK:  ' TO MOVE THE START OF PEAK DOWN
      STRT(DAYOF) = STRT(DAYOF) - .25
      IF STRT(DAYOF) < 0 THEN STRT(DAYOF) = 0
2620 GOTO 280
Enpeek:  ' TO CHANGE THE END PEAK FOR THE DAY
UPPEAK2:  ' TO MOVE THE START PEAK UP
      ENND(DAYOF) = ENND(DAYOF) + .25
      IF ENND(DAYOF) > 24 THEN ENND(DAYOF) = 24
      GOTO 280
DOWPEAK2:  ' TO MOVE THE START OF PEAK DOWN
      ENND(DAYOF) = ENND(DAYOF) - .25
      IF ENND(DAYOF) < 0 THEN ENND(DAYOF) = 0
      IF ENND(DAYOF) < STRT(DAYOF) THEN STRT(DAYOF) = ENND(DAYOF)
      GOTO 280
      ' TO ALLOW FOR FLOAT CHARGING
2650 FLOT = FLOT + 1
      IF FLOT > 1 THEN FLOT = 0
      GOTO 280

2800 GOTO 280

HRESET:  ' THIS IS THE SYSTEM HARD RESET
      HR = 0
      FOR I = 1 TO 2
      LPRINT CL$ + "!!!! WARNING !!!!" + CR$;
      LPRINT "!!!! WARNING !!!!";
      SLEEP 1
      LPRINT CL$ + CR$;
      SLEEP 1
      NEXT

```

```

LPRINT CL$ + "RE-TRAIN SYSTEM!" + CR$;
LPRINT "SEE USERS MANUAL";
SLEEP 3
LPRINT CL$ + CR$;
2805 YN$ = "NO ": GOTO 2808
2806 YN$ = "YES"
2808 IF HR = 0 THEN
LPRINT CHR$(&H16) + "RE-TRAIN SYSTEM?" + CR$;
LPRINT "ARE YOU SURE ? " + YN$;
GOTO 2810
END IF
2809 LPRINT CHR$(&H16) + "ERASE CHARGE HISTRY" + CR$;
LPRINT "CONFIRM (Y/N)? " + YN$;
2810 IF (KEYPBCNT > 0) THEN
KEYY = GETKEYP
SELECT CASE KEYY
CASE 2:
GOTO 2806
CASE 3:
GOTO 2805
CASE 16:
IF HR = 0 THEN GOTO 2815
IF HR = 1 THEN LPRINT CL$ + " WORKING" + CR$; : GOTO 2817
END SELECT
END IF
GOTO 2808
2815 IF YN$ = "NO " THEN GOTO 1090
YN$ = "NO "
HR = 1: LPRINT CL$ + " " + CR$; : GOTO 2808
2817 IF YN$ = "NO " THEN GOTO 1090
SHELL "DEL F:\COEF*.*"
SHELL "DEL F:\POINT*.*"
FU2 = FREEFILE
CLOSE #FU2
OPEN "F:\POINTT" FOR OUTPUT AS #FU2
NNUM = 0
OORD = 2
WRITE #FU2, NNUM, OORD
CLOSE #FU2
OPEN "F:\POINTT2" FOR OUTPUT AS #FU2
OORD = 1
WRITE #FU2, NNUM, OORD
CLOSE #FU2
OPEN "F:\POINTT3" FOR OUTPUT AS #FU2
WRITE #FU2, NNUM, OORD
CLOSE #FU2
OORD = 69
OPEN "F:\COEFT" FOR OUTPUT AS #FU2
WRITE #FU2, OORD
CLOSE #FU2
OPEN "F:\COEFT2" FOR OUTPUT AS #FU2
WRITE #FU2, OORD

```



```

CLOSE #FU2
OPEN "F:\COEFT3" FOR OUTPUT AS #FU2
WRITE #FU2, OORD
CLOSE #FU2

WRITEPEAKS:      ' TO WRITE THE PEAKS BACK TO THE FILE
2      CLOSE
      INPTT$ = "PRPA ,523049,2831254
      "
      OPEN "F:\UTIL" FOR OUTPUT AS #3
      MID$(INPTT$, 22) = STR$(KHRA)
      MID$(INPTT$, 28) = STR$(KWRA)
      FOR I = 0 TO 6
      Xx = 28 + (I + 1) * 8
      MID$(INPTT$, Xx, 3) = MID$(STR$(STRT(I) / 24 * 96 + 96 * I), 2, 3)
      MID$(INPTT$, Xx + 4, 3) = MID$(STR$(ENND(I) / 24 * 96 + 96 * I), 2, 3)
      NEXT I
      PRINT #3, INPTT$
2820 CLOSE #4
      OPEN "F:\SETTING" FOR OUTPUT AS #4
      WRITE #4, AV, AVLIM, EQTIME, PK, MAXI, RACH, FLOT, TYPTIM, LOVOLT,
CHGEFF
      CLOSE
      RETURN 395

ERLN1:      ' TO CREATE A NEW SETTING FILE
      SHELL "DEL SETTING"
      CLOSE #4
      OPEN "F:\SETTING" FOR OUTPUT AS #4
      AV = 1: AVLIM = 50: EQTIME = 3600: PK = 0: MAXI = 5: RACH = 1
      FLOT = 0: TYPTIM = 28800: LOVOLT = 50: CHGEFF = 100
      WRITE #4, AV, AVLIM, EQTIME, PK, MAXI, RACH, FLOT, TYPTIM, LOVOLT,
CHGEFF
      RESUME SET

ERLN2:      ' TO CREATE A NEW UTIL FILE
      SHELL "DEL UTIL"
      CLOSE #1
      OPEN "F:\UTIL" FOR OUTPUT AS #1
      CLOSE #1
      RESUME 4

ERLN3:      ' TO CREATE A NEW STATUS FILE
      SHELL "DEL STATUS"
      CLOSE #3
      OPEN "F:\STATUS" FOR OUTPUT AS #3
      CLOSE #3
      RESUME 405

ERRHANDLER:
      IF ERR = 24 THEN
      BEEP

```

```

        GOSUB RS232ERR
        RESUME
    END IF
    IF ERR = 57 THEN
        RESUME
    END IF
!EREW: CLOSE
"! SHELL "COPY " + POINTS2$ + " " + POINTS$
"! SHELL "COPY " + COEF2$ + " " + COEF$
    RESUME

    END

DEFINT A-Z
FUNCTION BITIN (A, L)

' Inputs a bit (l) from port a
' Value returned is either 0 or 1
DB = 255 - INP(A)
IF ((DB AND 2 ^ (L AND &H7)) <> 0) THEN BITIN = 1 ELSE BITIN = 0

END FUNCTION

SUB BITOUT (A, L, S)
' This routine sets the bit l at port a to value s
BSET(L) = S
D = 0
FOR N = 0 TO 7
D = D + BSET(N) * 2 ^ N
NEXT N
OUT A, D
END SUB

DEFSNG A-Z
FUNCTION CKEYPRSD
' Go get the current keypad key pressed.
' Returns 0 if no keypad key is being pressed.
' else returns 1-n depending on 16 or 32 character keypad.
' NOTE: Does not remove the key from the keypad buffer. (if it went into it)

DIM inregs AS RegType, outregs AS RegType

inregs.ax = &H302 ' check key pressed.
CALL INTERRUPT(&H17, inregs, outregs) ' do interrupt
CKEYPRSD = (outregs.ax AND &HFF00) / &H100 ' return key pressed.

END FUNCTION

SUB CLRKEYPB

```

' clears the keypad buffer.

DIM inregs AS RegType, outregs AS RegType

inregs.ax = &H303 ' clear keypad buffer.
CALL INTERRUPT(&H17, inregs, outregs) ' do interrupt

END SUB

SUB DATASUB (STOP2, KWHR2, COEF\$, POINT\$, BADPT)
DIM TIM2(30), TIM(30), KWH(30), KWH2(30), XXSQR(30)
COEF2\$ = COEF\$ + ".BAK"
Point2\$ = POINT\$ + ".BAK"
KWHR2 = INT(KWHR2 * 100) / 100

' READ DATA FILE OF POINTS AND CONVERT TO NUMBERS

'! ON ERROR GOTO EREW
CLOSE #5
OPEN POINT\$ FOR INPUT AS #5
INPUT #5, NUM, ORD
FOR I = 1 TO NUM
INPUT #5, KWH(I), TIM(I)
NEXT I
IF NUM < 6 THEN GOTO 222
IF POINT\$ <> "F:\POINTT" THEN GOTO 222

' READ COEFFICIENTS

CLOSE #5
OPEN COEF\$ FOR INPUT AS #5
INPUT #5, ORDR
FOR I = 1 TO (ORDR + 1)
INPUT #5, COEF(I)
NEXT I

' CHECK TO SEE IF THE POINT IS BAD

'CALCULATE STANDARD DEVIATION OF POINTS FROM CURVE

FOR I = 1 TO NUM
Tst = 0
FOR J = 1 TO (ORDR + 1)
Tst = Tst + COEF(J) * KWH(I) ^ (J - 1)
NEXT J
XXSQR(I) = (ABS(TIM(I) - Tst)) ^ 2
SUMXXSQR = SUMXXSQR + XXSQR(I)
NEXT I
STDEV = SQR(SUMXXSQR / (NUM - 1))
Tim1 = 0
FOR J = 1 TO (ORDR + 1)
Tim1 = Tim1 + COEF(J) * KWHR2 ^ (J - 1)

```

NEXT J
IF ABS(STOP2 - Tim1) > 3 * STDEV THEN BADPT = 1: EXIT SUB
'
' INITIALIZE VARIABLES FOR EXPANSION
222
CLOSE #5
OPEN "F:\SETTING" FOR INPUT AS #5
INPUT #5, AV, AVLIM, EQTIME, PK2, MAXI
Rang1 = (MAXI / 5)
K1 = 1
K2 = 4
K3 = 7
K4 = 10
K5 = 13
FOR I = 1 TO 15
TIM2(I) = 0!
KWH2(I) = 0!
NEXT I
'
' EXPAND THE POINTS FILE INTO LARGER ARRAY
'
FOR I = 1 TO NUM
IF KWH(I) < Rang1 THEN
KWH2(K1) = KWH(I)
TIM2(K1) = TIM(I)
K1 = K1 + 1
IF K1 > 3 THEN K1 = 3
END IF
IF KWH(I) >= Rang1 AND KWH(I) < (2 * Rang1) THEN
KWH2(K2) = KWH(I)
TIM2(K2) = TIM(I)
K2 = K2 + 1
IF K2 > 6 THEN K2 = 6
END IF
IF KWH(I) >= (2 * Rang1) AND KWH(I) < (3 * Rang1) THEN
KWH2(K3) = KWH(I)
TIM2(K3) = TIM(I)
K3 = K3 + 1
IF K3 > 9 THEN K3 = 9
END IF
IF KWH(I) >= (3 * Rang1) AND KWH(I) < (4 * Rang1) THEN
KWH2(K4) = KWH(I)
TIM2(K4) = TIM(I)
K4 = K4 + 1
IF K4 > 12 THEN K4 = 12
END IF
IF KWH(I) >= (4 * Rang1) THEN
KWH2(K5) = KWH(I)
TIM2(K5) = TIM(I)
K5 = K5 + 1
IF K5 > 15 THEN K5 = 15
END IF

```

```

NEXT I
'
' DETERMINE WHAT GROUP TO PLACE THE POINT IN
'
Rang = MAXI / 5
IF KWHR2 < Rang THEN Grp = 1
IF KWHR2 >= Rang AND KWHR2 < (2 * Rang) THEN Grp = 2
IF KWHR2 >= (2 * Rang) AND KWHR2 < (3 * Rang) THEN Grp = 3
IF KWHR2 >= (3 * Rang) AND KWHR2 < (4 * Rang) THEN Grp = 4
IF KWHR2 >= (4 * Rang) THEN Grp = 5
Tr = Grp * 3
Tu = (Grp * 3) - 1
One = (Grp * 3) - 2
TIM2(Tr) = TIM2(Tu)
KWH2(Tr) = KWH2(Tu)
TIM2(Tu) = TIM2(One)
KWH2(Tu) = KWH2(One)
TIM2(One) = STOP2
KWH2(One) = KWHR2
'
' DETERMINE THE ACTUAL NUMBER OF DATA POINTS
'
NUM = 0
FOR J = 1 TO 15
IF KWH2(J) < 0 THEN NUM = NUM + 1
NEXT J
'
' REFORMAT DATA TO BE SENT BACK TO POINTS FILE
'
SHELL "COPY " + POINTS + " " + Point2$
CLOSE #5
OPEN POINTS FOR OUTPUT AS #5
IF DIP2 = 0 THEN WRITE #1, "^NUM", "^ORD"
IF DIP2 = 0 THEN WRITE #1, NUM, ORD
WRITE #5, NUM, ORD
FOR J = 1 TO 15
IF KWH2(J) < 0 THEN
IF DIP2 = 0 THEN WRITE #1, KWH2(J), TIM2(J)
WRITE #5, KWH2(J), TIM2(J)
END IF
NEXT J
CLOSE #5
IF NUM < 6 THEN GOTO 600
SHELL "COPY " + COEF$ + " " + COEF2$
CALL POLRG(POINTS, COEF$)
600 END SUB

FUNCTION DAYWK
IHR = VAL(LEFT$(TIMES, 2))
IMIN = VAL(MID$(TIMES, 4, 2))
ISEC = VAL(MID$(TIMES, 7))

```

JULIAN2 = (JULIAN# - 3600 * IHR - 60 * IMIN - ISEC) / 86400
 DAYWK = (JULIAN2 MOD 7) + 1

END FUNCTION

SUB GDATA (N, M, X0, XBAR0, STD0, D0, SUMSQ0)
 ' *- TRANSFORT FORTRAN *-
 ' TRANSFORT v1.5 1-Mar-86

 SUBROUTINE GDATA

PURPOSE

GENERATE INDEPENDENT VARIABLES UP TO THE M-TH POWER (THE HIGHEST DEGREE POLYNOMIAL SPECIFIED) AND COMPUTE MEANS, STANDARD DEVIATIONS, AND CORRELATION COEFFICIENTS. THIS SUBROUTINE IS NORMALLY CALLED BEFORE SUBROUTINES ORDER, MINV AND MULTR IN THE PERFORMANCE OF A POLYNOMIAL REGRESSION.

USAGE

CALL GDATA (N,M,X,XBAR,STD,D,SUMSQ)

DESCRIPTION OF PARAMETERS

N - NUMBER OF OBSERVATIONS.
 M - THE HIGHEST DEGREE POLYNOMIAL TO BE FITTED.
 X - INPUT MATRIX (N BY M+1) . WHEN THE SUBROUTINE IS CALLED, DATA FOR THE INDEPENDENT VARIABLE ARE STORED IN THE FIRST COLUMN OF MATRIX X, AND DATA FOR THE DEPENDENT VARIABLE ARE STORED IN THE LAST COLUMN OF THE MATRIX. UPON RETURNING TO THE CALLING ROUTINE, GENERATED POWERS OF THE INDEPENDENT VARIABLE ARE STORED IN COLUMNS 2 THROUGH M.
 XBAR - OUTPUT VECTOR OF LENGTH M+1 CONTAINING MEANS OF INDEPENDENT AND DEPENDENT VARIABLES.
 STD - OUTPUT VECTOR OF LENGTH M+1 CONTAINING STANDARD DEVIATIONS OF INDEPENDENT AND DEPENDENT VARIABLES.
 D - OUTPUT MATRIX (ONLY UPPER TRIANGULAR PORTION OF THE SYMMETRIC MATRIX OF M+1 BY M+1) CONTAINING CORRELATION COEFFICIENTS. (STORAGE MODE OF 1)
 SUMSQ - OUTPUT VECTOR OF LENGTH M+1 CONTAINING SUMS OF PRODUCTS OF DEVIATIONS FROM MEANS OF INDEPENDENT AND DEPENDENT VARIABLES.

REMARKS

N MUST BE GREATER THAN M+1.
 IF M IS EQUAL TO 5 OR GREATER, SINGLE PRECISION MAY NOT BE SUFFICIENT TO GIVE SATISFACTORY COMPUTATIONAL RESULTS.

SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED

NONE

METHOD

REFER TO B. OSTLE, 'STATISTICS IN RESEARCH', THE IOWA STATE
COLLEGE PRESS, 1954, CHAPTER 6.

.....
DIM X(100), XBAR(100), STD(100), SUMSQ(100), D(100)
.....

IF A DOUBLE PRECISION VERSION OF THIS ROUTINE IS DESIRED, THE
C IN COLUMN 1 SHOULD BE REMOVED FROM THE DOUBLE PRECISION
STATEMENT WHICH FOLLOWS.

DOUBLE PRECISION X,XBAR,STD,D,SUMSQ,T1,T2

THE C MUST ALSO BE REMOVED FROM DOUBLE PRECISION STATEMENTS
APPEARING IN OTHER ROUTINES USED IN CONJUNCTION WITH THIS
ROUTINE.

THE DOUBLE PRECISION VERSION OF THIS SUBROUTINE MUST ALSO
CONTAIN DOUBLE PRECISION FORTRAN FUNCTIONS. SQRT AND ABS IN
STATEMENT 180 MUST BE CHANGED TO DSQRT AND DABS.

.....
GENERATE INDEPENDENT VARIABLES

IF (M - 1) <= 0 THEN 107
90 L1 = 0
FOR I = 2 TO M
L1 = L1 + N
FOR J = 1 TO N
L = L1 + J
K = L - N
104 X(L) = X(K) * X(J): NEXT J, I

CALCULATE MEANS

107 MM = M + 1
DF = N
L = 0
FOR I = 1 TO MM
XBAR(I) = 0!
FOR J = 1 TO N
L = L + 1
114 XBAR(I) = XBAR(I) + X(L): NEXT J
115 XBAR(I) = XBAR(I) / DF: NEXT I

FOR I = 1 TO MM

134 STD(I) = 0!: NEXT

CALCULATE SUMS OF CROSS-PRODUCTS OF DEVIATIONS

```
      L = ((MM + 1) * MM) / 2
      FOR I = 1 TO L
154  D(I) = 0: NEXT
      FOR K = 1 TO N
      L = 0
      FOR J = 1 TO MM
      LA2 = N * (J - 1) + K
      T2 = X(LA2) - XBAR(J)
      STD(J) = STD(J) + T2
      FOR I = 1 TO J
      L1 = N * (I - 1) + K
      T1 = X(L1) - XBAR(I)
      L = L + 1
170  D(L) = D(L) + T1 * T2: NEXT I, J, K
      L = 0
      FOR J = 1 TO MM
      FOR I = 1 TO J
      L = L + 1
175  D(L) = D(L) - STD(I) * STD(J) / DF: NEXT I, J
      L = 0
      FOR I = 1 TO MM
      L = L + I
      SUMSQ(I) = D(L)
180  STD(I) = SQR(ABS(D(L))): NEXT I
```

CALCULATE CORRELATION COEFFICIENTS

```
      L = 0
      FOR J = 1 TO MM
      FOR I = 1 TO J
      L = L + 1
      PRINT STD(I), STD(J), STD(I) * STD(J)
      D(L) = D(L) / (STD(I) * STD(J)): NEXT I, J
```

CALCULATE STANDARD DEVIATIONS

```
      DF = SQR(DF - 1!)
      FOR I = 1 TO MM
204  STD(I) = STD(I) / DF: NEXT
```

END SUB

FUNCTION GETKEYP

' Go get a key from the keypad buffer using the Display TSR keypad interrupt.
' Returns 0 if no keypad key is present
' else returns 1-n depending on 16 or 32 character keypad.

DIM inregs AS RegType, outregs AS RegType

inregs.ax = &H301 ' get keypad key from buffer.
CALL INTERRUPT(&H17, inregs, outregs) ' Get the first keypad key in buffer.
GETKEYP = (outregs.ax AND &HFF00) / &H100 ' return key from buffer. (0-n)

END FUNCTION

SUB ICONTROL (TOUTQ, TPK, D, J1Q, K1Q, Estime, Peakflag, Chgtime, ES, Chg, PKK)

DIM J(10) AS INTEGER, K(10) AS INTEGER, T(700) AS INTEGER

p = 1

* DEFINITIONS: *

* *

* T(*): NUMBER OF 15 MIN INTERVALS FOR 7 DAYS *

* D: DEPARTURE TIME POINTER *

* J(*): BEGINNING PEAK TIME INTERVAL POINTERS *

* K(*): ENDING PEAK TIME INTERVAL POINTERS *

* P: PRESENT TIME POINTER *

* ESTIME: NUMBER OF 15 MINUTE INTERVALS ESTIMATED *

* PEAKFLAG: FLAG TO DET IF CHARGING CAN OCCUR DURING PEAK *

* CHGTIME: THE 15 MINUTE INTERVAL TO BEGIN CHARGING *

* DEPTIME: THE TIME THE USER ENTERED FOR DEPARTURE *

* Pkk: 1 ALLOW CHARGE THRU A PEAK *

* 0 CHARGE ONLY OFF PEAK *

' CALCULATE THE NUMBER OF 15 MINUTE INTERVALS THAT HAVE

' ELAPSED SINCE SUNDAY AT MIDNIGHT *

'RT=XXXX

' ADJUST FIXED PEAK BEGINING AND ENDING TIMES TO A SLIDING *

' WINDOW WHERE INTERVAL 1 IS NOW AND INTERVAL 672 IS 7 DAYS *

' FROM NOW *

Rt = INT(((DAYWK) * 86400 + TIME) / 900)

Rt=INT((((TIMEDATE DIV 86400 MOD 7))*86400+TIME(TIMES(TIMEDATE)))/900)

Estime = INT(Estime / 900)

'PRINT Estime

D = INT(D / 900)

'PRINT D

FOR I = 0 TO 6

IF J1(I) > 0 AND K1(I) > 0 THEN

IF J1(I) < Rt THEN

J(I) = J1(I) + 672 - Rt - 1

ELSE

J(I) = J1(I) - Rt

END IF

IF K1(I) < Rt THEN

K(I) = K1(I) + 672 - Rt - 1

ELSE

K(I) = K1(I) - Rt

```

    END IF
  'END IF
  NEXT I
  'PRINT J(*);
  'PRINT
  'PRINT K(*);
  '*****

  FOR I = 1 TO 672 '672 IS THE NUMBER OF 15 MIN INTERVALS IN 7 DAYS
    T(I) = 1
    TOUT(I) = 0
  NEXT I
  '*****

  '*  NOW FILL THE ARRAY WITH ZEROS FOR THE PEAK INTERVALS  *
  '*****

  FOR I = 0 TO 6
    IF J1(I) <> K1(I) THEN
      IF J(I) < K(I) THEN
        FOR L = J(I) TO K(I) - 1
          T(L) = 0
        NEXT L
      ELSE
        FOR L = 0 TO K(I) - 1
          T(L) = 0
        NEXT L
      FOR L = J(I) TO 673
        T(L) = 0
      NEXT L
    END IF
  END IF
  NEXT I
  'PRINT T(*);
  'PAUSE
  '*****

  '*  COUNT THE LENGTH OF THE NEAREST PEAK
  '*****

  TPK = 0
  FOR I = 2 TO 96
    IF T(I) = 0 THEN TPK = TPK + 1
    IF T(I - 1) = 0 AND T(I) = 1 THEN GOTO 404
  NEXT I

404 '*****

  '*  COMPUTE THE NUMBER OF 15 MINUTE INTERVALS BETWEEN THE  *
  '*  PRESENT TIME AND THE DEPARTURE TIME AVAILABLE FOR CHARGING *
  '*  AND DETERMINE IF PEAK CHARGING IS REQUIRED.
  '*****

  Avaltime = 0
  FOR I = p TO D
    Avaltime = Avaltime + T(I)
  NEXT I
  'PRINT "AVALTIME=",Avaltime;"ESTTIME=";Esttime
  IF Avaltime >= Esttime OR PKK = 0 THEN
    Peakflag = 0

```

```

*****
'*  DETERMINE THE TIME TO BEGIN CHARGING IF OFF PEAK  *
*****
FOR I = D TO p STEP -1
    Sumtime = Sumtime + T(I)
    IF T(I) = 1 THEN Chgtime = I
    IF Sumtime >= Esttime OR I = p THEN
        FOR L = Chgtime TO D
            TOUT(L) = T(L)
            ' PRINT L
        NEXT L
        TOUT(L) = 9
        GOTO 761
    END IF
NEXT I
Chg = Sumtime / Esttime * 100
ELSE
    Peakflag = 1
    IF (D - p + 1) = Avaltime THEN Peakflag = 0
    *****
    '*  DETERMINE THE TIME TO BEGIN CHARGING IF ON PEAK  *
    *****
    Chgtime = D - Esttime
    E$ = ""
    IF Chgtime < p THEN
        Chg = (D - p) / Esttime * 100
        E$ = ""
        Chgtime = p
    ELSE
        Chg = 100
    END IF
    FOR L = Chgtime TO D
        TOUT(L) = 1
    NEXT L
    TOUT(L) = 9
END IF
761 FOR I = 1 TO 672
    SUM = SUM + TOUT(I)
NEXT
SUM = SUM - 9
Chg = SUM / Esttime * 100
IF Chg > 100 THEN Chg = 100
END SUB

FUNCTION INKEY2$
'
' Go get a key from the Bios keyboard buffer using the Bios keyboard
' interrupt.
' Returns "" if no key is present
' else returns ascii character pressed.
'
DIM inregs AS RegType, outregs AS RegType

```

```

IF (ASC(KEYHITS) <> 0) THEN
    inregs.ax = 0
    CALL INTERRUPT(&H16, inregs, outregs)      ' Bios key return int
    INKEY2$ = CHR$(outregs.ax AND &HFF)         ' return ascii character
ELSE
    INKEY2$ = ""
END IF

```

END FUNCTION

FUNCTION JULIAN#

```

    DIM JULIAN2 AS DOUBLE
    TS = TIMES
    DS = DATES
    IHR = VAL(LEFT$(TS, 2))
    IMIN = VAL(MID$(TS, 4, 2))
    ISEC = VAL(MID$(TS, 7))
    IYR = VAL(MID$(DS, 7))
    IMON = VAL(LEFT$(DS, 2))
    IDAY = VAL(MID$(DS, 4, 2))
    IF (IMON > 2) THEN
        IMON = IMON - 3
    ELSE
        IMON = IMON + 9
        IYR = IYR - 1
    END IF
    icentury = FIX(IYR / 100)
    iremainder = IYR MOD 100
    JULIAN2 = (FIX((146097 * icentury) / 4) + FIX((1461 * iremainder) / 4) + FIX((153 *
IMON + 2) / 5) + IDAY + 1721119)
    JULIAN# = JULIAN2 * 86400 + 3600 * IHR + 60 * IMIN + ISEC

```

END FUNCTION

FUNCTION KEYHITS

```

' Check if keyboard has been pressed using Bios interrupt.
' Returns 0 if no key has been pressed.
' or the ascii key pressed.
' NOTE: This does not remove the key from the buffer. Use GETKEY
'       for doing that.

```

```

DIM inregs AS RegType, outregs AS RegType
CONST zflag = &H40

```

```

    inregs.ax = &H100
    CALL INTERRUPT(&H16, inregs, outregs)      ' Bios key status int.

    IF ((outregs.flags AND zflag) <> 0) THEN    ' If zero flag set
        KEYHITS = CHR$(0)                     ' then no key present
    ELSE
        KEYHIT = CHR$(outregs.ax AND &HFF)    ' Key is present, return

```

```

END IF                                ' value but dont remove
                                      ' from keyboard buffer.
END FUNCTION

```

FUNCTION KEYPBCNT

```

' Get number of keys in the keypad buffer.

```

```

DIM inregs AS RegType, outregs AS RegType

```

```

inregs.ax = &H300                    ' get count of keys in keypad buffer
CALL INTERRUPT(&H17, inregs, outregs) ' do interrupt
KEYPBCNT = (outregs.ax AND &HFF00) / &H100

```

```

END FUNCTION

```

SUB KEYPBNC (ticks)

```

' Set keypad debounce value in number of ticks.

```

```

DIM inregs AS RegType, outregs AS RegType

```

```

inregs.ax = &H304                    ' Debounce value set.
inregs.bx = ticks                    ' Number of 18.2 times per sec. ticks
CALL INTERRUPT(&H17, inregs, outregs) ' do interrupt

```

```

END SUB

```

SUB KEYPRPT (ron)

```

' Set keypad repeat flag. (allows a key to be repeated if held down)

```

```

DIM inregs AS RegType, outregs AS RegType

```

```

inregs.ax = &H305                    ' Repeat flag set.
inregs.bx = ron                      ' ron = 0 repeat off, = 1 repeat on
CALL INTERRUPT(&H17, inregs, outregs) ' do interrupt

```

```

END SUB

```

```

SUB MINV (A0, N, DET, L0, M0)
' -- TRANSFORT FORTRAN --
' TRANSFORT v1.5 1-Mar-86

```

```

' .....

```

SUBROUTINE MINV

```

' PURPOSE
' INVERT A MATRIX

```

USAGE

CALL MINV(A,N,DET,L,M)

DESCRIPTION OF PARAMETERS

A - INPUT MATRIX, DESTROYED IN COMPUTATION AND REPLACED BY
RESULTANT INVERSE.

N - ORDER OF MATRIX A

D - RESULTANT DETERMINANT

L - WORK VECTOR OF LENGTH N

M - WORK VECTOR OF LENGTH N

REMARKS

MATRIX A MUST BE A GENERAL MATRIX

SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED

NONE

METHOD

THE STANDARD GAUSS-JORDAN METHOD IS USED. THE DETERMINANT
IS ALSO CALCULATED. A DETERMINANT OF ZERO INDICATES THAT
THE MATRIX IS SINGULAR.

.....
DIM A(100)

.....
IF A DOUBLE PRECISION VERSION OF THIS ROUTINE IS DESIRED, THE
C IN COLUMN 1 SHOULD BE REMOVED FROM THE DOUBLE PRECISION
STATEMENT WHICH FOLLOWS.

DOUBLE PRECISION A,D,BIGA,HOLD

THE C MUST ALSO BE REMOVED FROM DOUBLE PRECISION STATEMENTS
APPEARING IN OTHER ROUTINES USED IN CONJUNCTION WITH THIS
ROUTINE.

THE DOUBLE PRECISION VERSION OF THIS SUBROUTINE MUST ALSO
CONTAIN DOUBLE PRECISION FORTRAN FUNCTIONS. ABS IN STATEMENT
10 MUST BE CHANGED TO DABS.

.....
SEARCH FOR LARGEST ELEMENT

DIM L(100), M(100)

DET = 1!

NK = -N

FOR K = 1 TO N

NK = NK + N

L(K) = K

```

      M(K) = K
      KK = NK + K
      BIGA = A(KK)
      FOR J = K TO N
      IZ = N * (J - 1)
      FOR I = K TO N
      IJ = IZ + I
10    IF (ABS(BIGA) - ABS(A(IJ))) >= 0 THEN 20
15    BIGA = A(IJ)
      L(K) = I
      M(K) = J
20    NEXT I, J
      INTERCHANGE ROWS
      J = L(K)
      IF (J - K) <= 0 THEN 35
25    KI = K - N
      FOR I = 1 TO N
      KI = KI + N
      HOLD = -A(KI)
      JI = KI - K + J
      A(KI) = A(JI)
30    A(JI) = HOLD: NEXT
      INTERCHANGE COLUMNS
35    I = M(K)
      IF ((I - K) <= 0) THEN 45
38    JP = N * (I - 1)
      FOR J = 1 TO N
      JK = NK + J
      JI = JP + J
      HOLD = -A(JK)
      A(JK) = A(JI)
40    A(JI) = HOLD: NEXT
      DIVIDE COLUMN BY MINUS PIVOT (VALUE OF PIVOT ELEMENT IS
      CONTAINED IN BIGA)
45    IF ((ABS(BIGA) - (1 * 10 ^ (-20)))) > 0 THEN 48
46    DET = 0!
      RETURN
48    FOR I = 1 TO N
      IF (I - K) = 0 THEN 55
50    IK = NK + I
      A(IK) = A(IK) / (-BIGA)
55    NEXT
      REDUCE MATRIX
      FOR I = 1 TO N

```

```

        IK = NK + I
        HOLD = A(IK)
        IJ = I - N
        FOR J = 1 TO N
            IJ = IJ + N
            IF (I - K) = 0 THEN 65
60      IF (J - K) = 0 THEN 65
62      KJ = IJ - I + K
        A(IJ) = HOLD * A(KJ) + A(IJ)
65      NEXT J, I
    '
    ' DIVIDE ROW BY PIVOT
    '
        KJ = K - N
        FOR J = 1 TO N
            KJ = KJ + N
            IF (J - K) = 0 THEN 75
70      A(KJ) = A(KJ) / BIGA
75      NEXT
    '
    ' PRODUCT OF PIVOTS
    '
        DET = DET * BIGA
    '
    ' REPLACE PIVOT BY RECIPROCAL
    '
        A(KK) = 1 / BIGA
80      NEXT
    '
    ' FINAL ROW AND COLUMN INTERCHANGE
    '
        K = N
1001     K = (K - 1)
        IF (K) <= 0 THEN 156
105      I = L(K)
        IF (I - K) <= 0 THEN 120
108      JQ = N * (K - 1)
        JR = N * (I - 1)
        FOR J = 1 TO N
            JK = JQ + J
            HOLD = A(JK)
            JI = JR + J
            A(JK) = -A(JI)
110      A(JI) = HOLD: NEXT
120      J = M(K)
        IF (J - K) <= 0 THEN 1001
        KI = K - N
        FOR I = 1 TO N
            KI = KI + N
            HOLD = A(KI)
            JI = KI - K + J
            A(KI) = -A(JI)

```



```

132  A(JI) = HOLD: NEXT
      GOTO 1001
156  REM

```

```

END SUB

```

```

      SUB MULTR (N, K, XBARQ, STDQ, DQ, RXQ, RYQ, ISAVEQ, BQ, SBQ, TNWEQ, ANSQ)
' *- TRANSFORT FORTRAN *-
' TRANSFORT v1.5 1-Mar-86

```

SUBROUTINE MULTR

PURPOSE

PERFORM A MULTIPLE LINEAR REGRESSION ANALYSIS FOR A DEPENDENT VARIABLE AND A SET OF INDEPENDENT VARIABLES. THIS SUBROUTINE IS NORMALLY USED IN THE PERFORMANCE OF MULTIPLE AND POLYNOMIAL REGRESSION ANALYSES.

USAGE

CALL MULTR (N,K,XBAR,STD,D,RX,RY,ISAVE,B,SB,T,ANS)

DESCRIPTION OF PARAMETERS

N - NUMBER OF OBSERVATIONS.
K - NUMBER OF INDEPENDENT VARIABLES IN THIS REGRESSION.
XBAR - INPUT VECTOR OF LENGTH M CONTAINING MEANS OF ALL VARIABLES. M IS NUMBER OF VARIABLES IN OBSERVATIONS.
STD - INPUT VECTOR OF LENGTH M CONTAINING STANDARD DEVIATIONS OF ALL VARIABLES.
D - INPUT VECTOR OF LENGTH M CONTAINING THE DIAGONAL OF THE MATRIX OF SUMS OF CROSS-PRODUCTS OF DEVIATIONS FROM MEANS FOR ALL VARIABLES.
RX - INPUT MATRIX (K X K) CONTAINING THE INVERSE OF INTERCORRELATIONS AMONG INDEPENDENT VARIABLES.
RY - INPUT VECTOR OF LENGTH K CONTAINING INTERCORRELATIONS OF INDEPENDENT VARIABLES WITH DEPENDENT VARIABLE.
ISAVE - INPUT VECTOR OF LENGTH K+1 CONTAINING SUBSCRIPTS OF INDEPENDENT VARIABLES IN ASCENDING ORDER. THE SUBSCRIPT OF THE DEPENDENT VARIABLE IS STORED IN THE LAST, K+1, POSITION.
B - OUTPUT VECTOR OF LENGTH K CONTAINING REGRESSION COEFFICIENTS.
SB - OUTPUT VECTOR OF LENGTH K CONTAINING STANDARD DEVIATIONS OF REGRESSION COEFFICIENTS.
T - OUTPUT VECTOR OF LENGTH K CONTAINING T-VALUES.
ANS - OUTPUT VECTOR OF LENGTH 10 CONTAINING THE FOLLOWING INFORMATION.
ANS(1) INTERCEPT
ANS(2) MULTIPLE CORRELATION COEFFICIENT

ANS(3) STANDARD ERROR OF ESTIMATE
 ANS(4) SUM OF SQUARES ATTRIBUTABLE TO REGRES-
 SION (SSAR)
 ANS(5) DEGREES OF FREEDOM ASSOCIATED WITH SSAR
 ANS(6) MEAN SQUARE OF SSAR
 ANS(7) SUM OF SQUARES OF DEVIATIONS FROM REGRES-
 SION (SSDR)
 ANS(8) DEGREES OF FREEDOM ASSOCIATED WITH SSDR
 ANS(9) MEAN SQUARE OF SSDR
 ANS(10) F-VALUE

REMARKS

N MUST BE GREATER THAN K+1.

SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED

NONE

METHOD

THE GAUSS-JORDAN METHOD IS USED IN THE SOLUTION OF THE
 NORMAL EQUATIONS. REFER TO W. W. COOLEY AND P. R. LOHNES,
 'MULTIVARIATE PROCEDURES FOR THE BEHAVIORAL SCIENCES',
 JOHN WILEY AND SONS, 1962, CHAPTER 3, AND B. OSTLE,
 'STATISTICS IN RESEARCH', THE IOWA STATE COLLEGE PRESS,
 1954, CHAPTER 8.

.....
 DIM XBAR(100), STD(100), D(100), RX(100), RY(100), ISAVE(100), B(100), SB(100),
 TNWE(100), ANS(100)

.....
 IF A DOUBLE PRECISION VERSION OF THIS ROUTINE IS DESIRED, THE
 C IN COLUMN 1 SHOULD BE REMOVED FROM THE DOUBLE PRECISION
 STATEMENT WHICH FOLLOWS.

DOUBLE PRECISION XBAR,STD,D,RX,RY,B,SB,T,ANS,RM,BO,SSAR,SSDR,SY,
 1 FWN,FK,SSARM,SSDRM,F

THE C MUST ALSO BE REMOVED FROM DOUBLE PRECISION STATEMENTS
 APPEARING IN OTHER ROUTINES USED IN CONJUNCTION WITH THIS
 ROUTINE.

THE DOUBLE PRECISION VERSION OF THIS SUBROUTINE MUST ALSO
 CONTAIN DOUBLE PRECISION FORTRAN FUNCTIONS. SQRT AND ABS IN
 STATEMENTS 122, 125, AND 135 MUST BE CHANGED TO DSQRT AND DABS.

.....
 MM = K + 1

BETA WEIGHTS

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      FOR J = 1 TO K
102  B(J) = 0!: NEXT
      FOR J = 1 TO K
        L1 = K * (J - 1)
        FOR I = 1 TO K
          L = L1 + I
112  B(J) = B(J) + RY(I) * RX(L): NEXT I: NEXT J
          RM = 0!
          BO = 0!
          L1 = ISAVE(MM)

      COEFFICIENT OF DETERMINATION

      FOR I = 1 TO K
        RM = RM + B(I) * RY(I)

      REGRESSION COEFFICIENTS

      L = ISAVE(I)
      B(I) = B(I) * (STD(L1) / STD(L))

      INTERCEPT

121  BO = BO + B(I) * XBAR(L): NEXT
      BO = XBAR(L1) - BO

      SUM OF SQUARES ATTRIBUTABLE TO REGRESSION

      SSAR = RM * D(L1)

      MULTIPLE CORRELATION COEFFICIENT

126  RM = SQR(ABS(RM))

      SUM OF SQUARES OF DEVIATIONS FROM REGRESSION

      SSDR = D(L1) - SSAR

      VARIANCE OF ESTIMATE

      FWN = N - K - 1
      SY = SSDR / FWN

      STANDARD DEVIATIONS OF REGRESSION COEFFICIENTS

      FOR J = 1 TO K
        L1 = K * (J - 1) + J
        L = ISAVE(J)
1250 SB(J) = SQR(ABS(RX(L1) / D(L)) * SY))

      COMPUTED T-VALUES

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133 TNWE(J) = B(J) / SB(J): NEXT

STANDARD ERROR OF ESTIMATE

135 SY = SQR(ABS(SY))

F VALUE

FK = K

SSARM = SSAR / FK

SSDRM = SSDR / FWN

f = SSARM / SSDRM

ANS(1) = BO

ANS(2) = RM

ANS(3) = SY

ANS(4) = SSAR

ANS(5) = FK

ANS(6) = SSARM

ANS(7) = SSDR

ANS(8) = FWN

ANS(9) = SSDRM

ANS(10) = f

END SUB

SUB ORDER (R(), NDEP, K, ISAVE(), RX(), RY())

! *- TRANSFORT FORTRAN *-

! TRANSFORT v1.5 1-Mar-86

.....

SUBROUTINE ORDER

PURPOSE

CONSTRUCT FROM A LARGER MATRIX OF CORRELATION COEFFICIENTS
A SUBSET MATRIX OF INTERCORRELATIONS AMONG INDEPENDENT
VARIABLES AND A VECTOR OF INTERCORRELATIONS OF INDEPENDENT
VARIABLES WITH DEPENDENT VARIABLE. THIS SUBROUTINE IS
NORMALLY USED IN THE PERFORMANCE OF MULTIPLE AND POLYNOMIAL
REGRESSION ANALYSES.

USAGE

CALL ORDER (M,R,NDEP,K,ISAVE,RX,RY)

DESCRIPTION OF PARAMETERS

M - NUMBER OF VARIABLES AND ORDER OF MATRIX R.

R - INPUT MATRIX CONTAINING CORRELATION COEFFICIENTS.

THIS SUBROUTINE EXPECTS ONLY UPPER TRIANGULAR
PORTION OF THE SYMMETRIC MATRIX TO BE STORED (BY

COLUMN) IN R. (STORAGE MODE OF 1)

NDEP - THE SUBSCRIPT NUMBER OF THE DEPENDENT VARIABLE.

K - NUMBER OF INDEPENDENT VARIABLES TO BE INCLUDED
IN THE FORTHCOMING REGRESSION. K MUST BE GREATER
THAN OR EQUAL TO 1.

ISAVE - INPUT VECTOR OF LENGTH K+1 CONTAINING, IN ASCENDING
ORDER, THE SUBSCRIPT NUMBERS OF K INDEPENDENT
VARIABLES TO BE INCLUDED IN THE FORTHCOMING REGRES-
SION.

UPON RETURNING TO THE CALLING ROUTINE, THIS VECTOR
CONTAINS, IN ADDITION, THE SUBSCRIPT NUMBER OF
THE DEPENDENT VARIABLE IN K+1 POSITION.

RX - OUTPUT MATRIX (K X K) CONTAINING INTERCORRELATIONS
AMONG INDEPENDENT VARIABLES TO BE USED IN FORTH-
COMING REGRESSION.

RY - OUTPUT VECTOR OF LENGTH K CONTAINING INTERCORRELA-
TIONS OF INDEPENDENT VARIABLES WITH DEPENDENT
VARIABLES.

REMARKS

NONE

SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED

NONE

METHOD

FROM THE SUBSCRIPT NUMBERS OF THE VARIABLES TO BE INCLUDED
IN THE FORTHCOMING REGRESSION, THE SUBROUTINE CONSTRUCTS THE
MATRIX RX AND THE VECTOR RY.

.....
DIM R(100), ISAVE(100), RX(100), RY(100)

.....
IF A DOUBLE PRECISION VERSION OF THIS ROUTINE IS DESIRED, THE
C IN COLUMN 1 SHOULD BE REMOVED FROM THE DOUBLE PRECISION
STATEMENT WHICH FOLLOWS.

DOUBLE PRECISION R,RX,RY

THE C MUST ALSO BE REMOVED FROM DOUBLE PRECISION STATEMENTS
APPEARING IN OTHER ROUTINES USED IN CONJUNCTION WITH THIS
ROUTINE.

.....
COPY INTERCORRELATIONS OF INDEPENDENT VARIABLES
WITH DEPENDENT VARIABLE

MM = 0

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      FOR J = 1 TO K
      LA2 = ISAVE(J)
      IF (NDEP - LA2) >= 0 THEN 123
122  L = NDEP + (LA2 * LA2 - LA2) / 2
      GOTO 125
123  L = LA2 + (NDEP * NDEP - NDEP) / 2
125  RY(J) = R(L)
      '
      ' COPY A SUBSET MATRIX OF INTERCORRELATIONS AMONG
      ' INDEPENDENT VARIABLES
      '

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      FOR I = 1 TO K
      L1 = ISAVE(I)
      IF (L1 - LA2) >= 0 THEN 128
127  L = L1 + (LA2 * LA2 - LA2) / 2
      GOTO 129
128  L = LA2 + (L1 * L1 - L1) / 2
129  MM = MM + 1
131  RX(MM) = R(L): NEXT I, J
      '

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      ' PLACE THE SUBSCRIPT NUMBER OF THE DEPENDENT
      ' VARIABLE IN ISAVE(K+1)
      '

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      ISAVE(K + 1) = NDEP

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END SUB

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SUB POLRG (POINTS, COEFS)
DIM X(350), di(36), D(100), SB(6), TNWE(6), E(6), B(4)
DIM XBAR(7), STD(7), COE(7), SUMSQ(7), ISAVE(7), ANS(10), p(150)
CHARACTER DATFILE*12
' 1  FORMAT(I5,I2)
' 2  FORMAT(2F5.2)
' 3  FORMAT(/27H POLYNOMIAL REGRESSION.....A4,A2/)
' 4  FORMAT(/23H NUMBER OF OBSERVATION ,I6/)
' 5  FORMAT(/32H POLYNOMIAL REGRESSION OF DEGREE,I3)
' 6  FORMAT(/12H  INTERCEPT,F15.5)
' 7  FORMAT(/26H  REGRESSION COEFFICIENTS/(10F12.5))
' 8  FORMAT(/14X,24H ANALYSIS OF VARIANCE FOR,I4,18H DEGREE POLYNOMIAL)
' 9  FORMAT(/,2X,14H SOURCE OF VAR.,3X,9H DEGREE OF ,3X,6H SUM OF ,
' 18X,4H MEAN,9X,1HF,7X,14H IMPROVEMENT IN/20X,7H FREEDOM,4X,
' 27H SQUARES,6X,6H SQUARE,6X,5H VALUE,5X,14H SUM OF SQUARES)
' 10 FORMAT(/16H DUE TO REGRES.,2X,I4,F14.2,F13.2,F13.2,F15.2)
' 11 FORMAT(/19H DEV. ABOUT REGRES.,I4,F13.2,F13.2)
' 12 FORMAT(/1X,6HTOTAL:,12X,I4,F13.2)
' 13 FORMAT(/17H  NO IMPROVEMENT)
' 14 FORMAT(/27X,18HTABLE OF RESIDUALS/16H OBSERVATION NO.,5X,7HX VALUE,
' 17X,7HY VALUE,7X,10HY ESTIMATE,7X,8H RESIDUAL/)
' 15 FORMAT(/2X,I6,F18.5,F14.5,F17.5,F15.5)
' 16 FORMAT(2I2)
' 20 FORMAT (I2)
' 30 FORMAT (F18.5)

```

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' 17 PRINT *, 'ENTER FILE NAME TO READ'
' READ '(A)', DATFILE
' CLOSE #2
' CLOSE #7
' OPEN POINTS FOR INPUT AS #2
' OPEN COEF$ FOR OUTPUT AS #7
101 INPUT #2, N, M
' WRITE (6,3) PR,PR1
' WRITE (6,4) N

' L = N * M
' FOR I = 1 TO N
' J = L + I
111 INPUT #2, X(I), X(J): NEXT
CALL GDATA(N, M, X(), XBAR(), STD(), D(), SUMSQ())
MM = M + 1
SUM = 0!
NT = N - 1
FOR I = 1 TO M
ISAVE(I) = I

CALL ORDER(D(), MM, I, ISAVE(), di(), E())
CALL MINV(di(), I, DET, B(), TNWE())
CALL MULTR(N, I, XBAR(), STD(), SUMSQ(), di(), E(), ISAVE(), B(), SB(), TNWE(), ANS())

' WRITE(6,5) I
' IF (ANS(7)) < 0 THEN 140
130 SUMIP = ANS(4) - SUM
' IF (SUMIP) > 0 THEN 150
'140 WRITE(6,13)
140 GOTO 220
' WRITE(6,6)ANS(1)
' WRITE(6,7) (B(J),J=1,I)
' WRITE(6,8) I
' WRITE(6,9)
150 SUM = ANS(4)
' WRITE(6,10) L,ANS(4),ANS(6),ANS(10),SUMIP
' NI = ANS(8)
' WRITE(6,11) NI,ANS(7),ANS(9)
' WRITE(6,12) NT,SUMSQ(MM)

COE(1) = ANS(1)
FOR J = 1 TO I
160 COE(J + 1) = B(J): NEXT
LA = I
200 NEXT

220 NP3 = N + N
FOR I = 1 TO N
NP3 = NP3 + 1
p(NP3) = COE(1)
L = I

```

```

    FOR J = 1 TO LA
      p(NP3) = p(NP3) + X(L) * COE(J + 1)
230  L = L + N: NEXT J: NEXT I

      N2 = N
      L = N * M
      FOR I = 1 TO N
        p(I) = X(I)
        N2 = N2 + 1
        L = L + 1
240  p(N2) = X(L): NEXT

235  WRITE(6,3) PR,PR1
      WRITE(6,5) LA
      WRITE(6,14)
235  NP2 = N
      NP3 = N + N
      FOR I = 1 TO N
        NP2 = NP2 + 1
        NP3 = NP3 + 1
250  RESID = p(NP2) - p(NP3): NEXT
250  WRITE(6,15) I,p(I),p(NP2),p(NP3),RESID
255  CLOSE #2
      IF DIP2 = 0 THEN WRITE #1, COEF$
      IF DIP2 = 0 THEN WRITE #1, LA
      WRITE #7, LA
      FOR I = 1 TO LA + 1
        IF DIP2 = 0 THEN WRITE #1, COE(I)
        WRITE #7, COE(I)
257  NEXT
      CLOSE #7

END SUB

FUNCTION TIME
TIME = VAL(LEFT$(TIMES$, 2)) * 3600 + VAL(MID$(TIMES$, 4, 2)) * 60 + VAL(MID$(TIMES$, 7))
END FUNCTION

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