4. CARRIER SATISFACTION

Mail Carrier satisfaction is an important measure of vehicle performance. When vehicle users respond favorably to the vehicles they drive, they are more supportive of the initiatives to improve them and more tolerant when there is a need to make repairs or modifications. If a Postal Service vehicle presents frequent troublesome problems it can lead to a source of frustration to the carrier, especially if it limits their ability to carry out the work in an efficient and reliable manner. Reliable mail delivery is a paramount necessity, and the vehicles need to be capable of meeting this demanding objective.

In many cases, Carriers make judgments on the ECRV in comparison to other available vehicles. The most prevalent vehicle used for mail delivery and collection is the gasoline LLV, so this creates an obvious frame of reference for the Carriers.

As they are asked to use Alternative Fuel Vehicles, it is also important that the Carriers are given the training necessary to operate the vehicles safely and efficiently. In the case of electric vehicles, some of the issues that Carriers need to be aware of are the gauges, the correct actions to take when a potential problem presents itself, and the right procedure for refueling (charging) the vehicle.

Several formal and informal surveys were conducted to evaluate Carrier satisfaction prior to and following the first vehicle deployments. These include the Customer Acceptance Test, the Accelerated Reliability Testing, and other informal discussion held between Headquarters personnel and the Carriers. The main conclusions from the Customer Acceptance Test are summarized in Section 4.1 below. This early feedback made it clear that ergonomic issues were the main concerns expressed with the vehicles during the pilot testing.

To provide additional information for this report, an update survey was conducted in April 2003. By the time this present study was initiated, the ergonomic issues had been well-documented and addressed to the extent feasible. As such, the update survey targeted feedback on vehicle performance rather than ergonomics. The methodology used for this survey and the results from the survey are presented in Section 4.2.

4.1 CUSTOMER ACCEPTANCE AND ACCELERATED RELIABILITY TESTING

To obtain early information on the performance of the ECRVs, a Customer Acceptance Test was conducted at the Fountain Valley Post Office using two pilot ECRVs. This was conducted from July 11 through August 16, 2000. During this time, eighteen Carriers drove the ECRVs on their normal mail delivery routes for a period of two days each. Prior to driving the vehicles, the Carriers received training on the operation of the Electric Carrier Route Vehicles and participated in a short practice drive with an experienced electric vehicle operator. The Carriers then provided information pertaining to the vehicle’s performance during this period. The results of the Customer Acceptance Test were documented in a report, which identified 15 concerns pertaining to ECRV design and performance (RMA, 2000).

Postal Service Carriers interviewed during the Customer Acceptance Test, indicated their satisfaction with vehicle handling and performance was quite high. Some significant initial problems were experienced with the pilot test ECRVs that were corrected. A number of ergonomic problems were also identified during the Customer Acceptance Test. To date, some of these problems have been remedied.

In this series of tests, three complaints were expressed frequently by the Carriers:

1. The first complaint was that the ECRV body was too high off the ground. The stepwell of the ECRV is four inches higher than the LLV. Carriers expressed concern with injury from stepping down from the vehicle because of the added height. Some Carriers said that to get back into the vehicle, they had to pull themselves up using the steering wheel.
2. The second frequent complaint was in relation to the delivery of mail from the vehicle on a mounted route. In the ECRV, the driver is higher off the ground, and the lower edge of the window is also higher. Carriers said it was sometimes difficult to reach down to place mail into mailboxes, depending on the height of the mailbox.
3. The third frequent complaint relates to the height of the rear cargo door. It is higher than the LLV door, and reaching the door strap to close the door is sometimes difficult without climbing onto the rear bumper. Also, many of the shorter Carriers said that they could not physically climb into the cargo area from the rear. They would either access mail trays from the front door, or use some type of pole extension device to reach mail trays. Carriers were concerned with muscle strains from reaching for mail.

Other issues raised by the Carriers in these interviews were as follows:

- The rear bumper of the ECRV is higher than that for the LLV and it extends farther out from the vehicle, making it hard to reach mail in the vehicle.
- The ECRV parking brake is hard to set and release.
- The Postal Service procedure is to curb the wheel when parking, and the ECRV wheels are hard to uncurb.
- The seat belt-shoulder clasp is high and catches the driver in the neck rather than diagonally across the center of the shoulders.
- The brake pedal needs to be applied harder than the LLV (although the brakes perform well).

As a component of the Southern California Edison (SCE) Accelerated Reliability Testing, road handling of the ECRV was tested. Driver satisfaction with the road handling of the vehicle appeared to be quite high, with the driver indicating that the vehicle felt stable, acceleration was adequate, and the steering and braking were responsive. The drivers concluded the vehicle performance was comparable to a gasoline vehicle. The SCE employees who drove the ECRVs during the Accelerated Reliability Testing program were generally satisfied.

4.2 CARRIER SATISFACTION SURVEY – APRIL 2003

A survey on Carrier satisfaction was conducted during April and May 2003. A structured response type survey was sent to more than 100 Carriers and Managers, with the Carriers selected at random from all sites with ECRVs. The questions in this survey were designed to solicit information on vehicle performance, rather than ergonomics, safety and comfort.

An explanation of how the survey was conducted is included in Appendix E together with copies of the completed forms and the analysis that was conducted on the data. About 45% of the Carrier forms and 60% of the Manager forms were completed and returned within the requested timeframe.

The results from the survey are presented in the figures and tables at the end of this section. The responses are shown graphically in Figures 4-1 and 4-2 (for Carriers and Managers, respectively), and tabulated in Tables 4-1 and 4-2, along with the respective questionnaire statements that were used. Data in each cell of Tables 4-1 and 4-2 show the percentage of respondents that rated the corresponding statement in the respective category. For example, a response which strongly disagrees with a negative statement - such as “The ECRV is sometimes difficult to get started” - would be rated as a highly favorable response. Disagreeing with a positive statement – such as “The vehicle provides adequate heating capability at all times of the year” would be rated as a favorable response. Processing the data in this way provides an effective way to view the results of the survey in summary format.

In general, the ratings from the Carriers and the Managers are dominated by favorable or highly favorable responses (Figures 4-1 and 4-2). For the Carriers, the two statements that received less favorable responses were #7, concerning the loss of power on hills, and #17 which indicates some reluctance to use electrical equipment for fear of draining power from the traction battery. Specific statements were included to solicit feedback on the frequency of ECRV component failures compared with gasoline vehicles (#18 and #9). The responses to these questions were predominantly favorable, as they were for towing (#16), range (#8), and Carriers’ confidence in the State of Charge gauge for providing a reliable indication of range (#12). Specific comments provided by the Carriers are included in Appendix E.

In the responses from the Managers, the two statements that received the most critical feedback were on cargo capacity (#3) and the reliability of the charging system (#8). The statements with the most favorable responses were on adequate operational capability (#2) and adequate range (#5).

In the comment section of the questionnaire, the Post Office Managers reported that the Carriers’ main complaints with the ECRV were battery limitations (three out of twelve) and problems with the chargers (two out of twelve). These were the only two complaints specific to performance. One manager stated that the main complaint was that Carriers are upset that they may be losing their ECRVs, and another reported that Carriers were satisfied with the ECRVs and they had no complaints. Managers noted that the features which Carriers like best are that they do not have to go to the gasoline station (four out of twelve), and that they are quiet and clean (four out of twelve). Only three of the Managers had received feedback from Post Office customers. At two of the locations, the customers had expressed surprise that the Postal Service was using electric vehicles, and at the third, the customers liked the quietness and benefit to the environment.

There were no battery performance complaints expressed by the Managers at the colder climate East Coast sites (Lamond Riggs and White Plains Post Offices), though they did express a desire for increased heat output in winter.

Concerns about vehicle height and other ergonomic issues were again raised by several Managers and many Carriers.

4.3 SUMMARY

During the early deployment period, most of the carrier comments were directed at the ergonomics and safety aspects of the ECRV. The most recent survey --- focusing on vehicle performance --- provides a favorable response from the Carriers. In this last survey, responses were received from more than 40 of the 100 Carriers who were sent surveys and from 12 of the 22 Post Office Managers. Relatively few adverse comments were made about the batteries and the electrical drivetrain.

FIGURE 4-1 SUMMARY OF CARRIER QUESTIONNAIRE RESPONSES

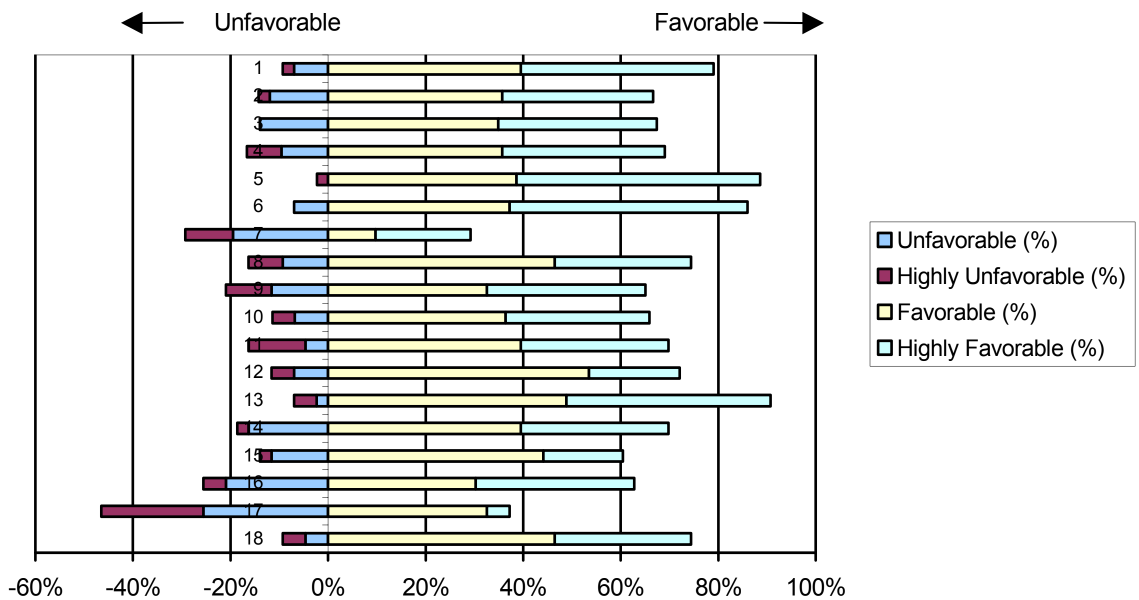


FIGURE 4-2 SUMMARY OF MANAGER QUESTIONNAIRE RESPONSES

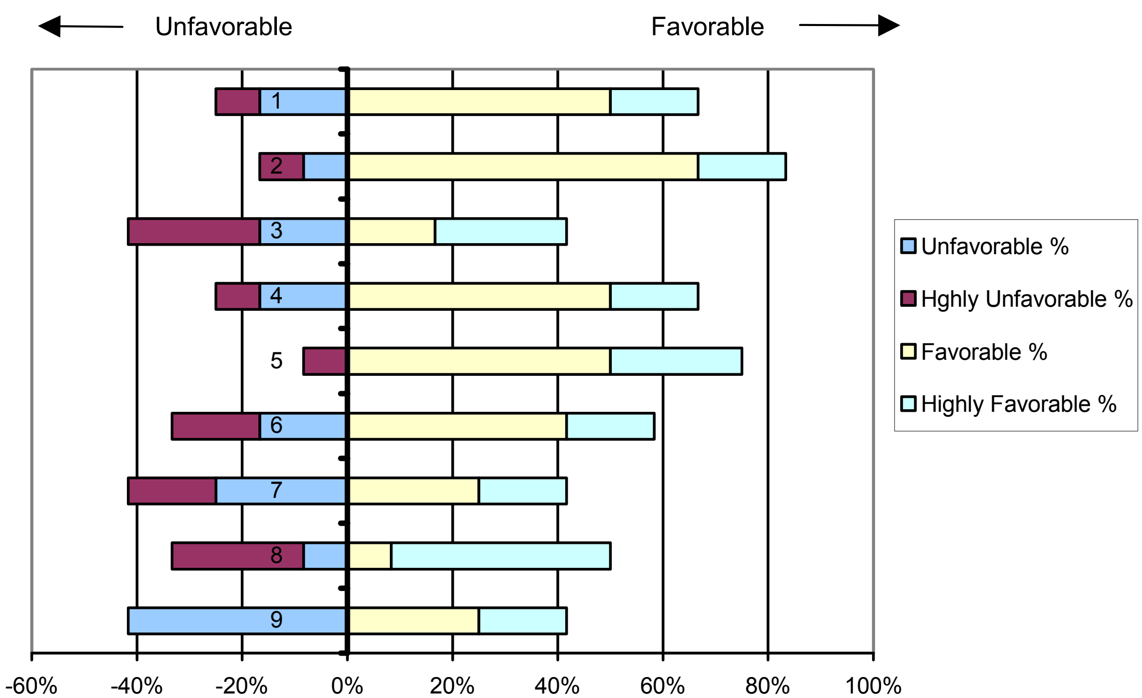


TABLE 4-1 SUMMARY OF CARRIER QUESTIONNAIRE RESPONSES

Carrier Questionnaire Statement	Highly Unfavorable (%)	Unfavorable (%)	Neutral (%)	Favorable (%)	Highly Favorable (%)
1. The ECRV has always had ample acceleration.	3%	9%	15%	33%	39%
2. The ECRV acceleration has deteriorated during the time I have been driving this vehicle.	3%	16%	25%	25%	31%
3. Acceleration deteriorates during the day as I proceed with my route.	0%	18%	24%	24%	33%
4. The top speed of the ECRV is less than adequate.	6%	9%	22%	31%	31%
5. The ECRV brakes perform just as well as those on a gasoline vehicle.	0%	0%	15%	42%	42%
6. The ECRV road handling (including steering and cornering) is good.	0%	3%	13%	41%	44%
7. The ECRV lacks power on steep hills.	6%	26%	48%	3%	16%
8. Under normal use, the ECRV provides adequate range.	9%	13%	9%	44%	25%
9. The ECRV I drive has been out of service for repairs more often than the gasoline vehicles at this Post Office.	13%	6%	13%	38%	31%
10. The charging system always works well and provides complete recharge of the battery each day.	3%	9%	22%	41%	25%
11. The vehicle provides adequate heating capability at all times of the year.	13%	3%	19%	31%	34%
12. I am confident that the State of Charge SOC indicator (fuel gauge) provides a reliable indication of remaining range.	6%	9%	16%	47%	22%
13. The ECRV has adequate cargo capacity for normal delivery operations.	6%	3%	3%	47%	41%
14. Sometimes the ECRV is difficult to get started.	0%	23%	13%	35%	29%
15. The ECRV performance deteriorates in cold weather.	3%	9%	31%	38%	19%
16. I have never needed to call for a tow while on route with an ECRV.	3%	22%	13%	25%	38%
17. I am reluctant to use electrical equipment (such as wipers, headlights, heater) because this could reduce vehicle range.	22%	31%	19%	22%	6%
18. The component parts on the ECRV are as reliable as for any other new vehicle.	6%	3%	22%	41%	28%

Refer to the text in Section 4.2 for an explanation of the data in this table.

TABLE 4-2 SUMMARY OF MANAGER QUESTIONNAIRE RESPONSES

Manager Questionnaire Statement	Highly Unfavorable (%)	Unfavorable (%)	Neutral (%)	Favorable (%)	Highly Favorable (%)
1. Carriers at this Post Office are satisfied with the ECRV's performance capabilities.	9%	18%	9%	45%	18%
2. The ECRVs at this Post Office provide adequate operational capability for their assigned routes.	9%	9%	0%	64%	18%
3. The ECRV cargo capacity sometimes limits our ability to deliver mail efficiently.	27%	9%	18%	18%	27%
4. The ECRVs always start each day without difficulty.	9%	18%	0%	55%	18%
5. Under normal use, the ECRVs provide adequate range.	9%	0%	18%	45%	27%
6. The ECRVs need to be towed in from a route more frequently than a comparable gasoline vehicle.	9%	18%	9%	45%	18%
7. The ECRVs are out of service for repairs more often than the other types of vehicle at this Post Office.	9%	27%	18%	27%	18%
8. The charging system at this Post Office works well, and provides adequate recharging of the vehicle batteries each day.	27%	9%	18%	0%	45%
9. Some Carriers are reluctant to use electrical equipment (such as wipers, headlights, and heater) because this could reduce vehicle range.	0%	45%	9%	27%	18%

Refer to the text in Section 4.2 for an explanation of the data in this table.

5. DATA COLLECTION

Twenty-five of the ECRVs are equipped with onboard Data Acquisition and Interface Systems (DAIS) to collect and store data on vehicle and battery performance. The DAIS units installed in the ECRVs include a data logger designed and assembled by Ford, together with proprietary software. Some of the many potential uses of the DAIS data include:

- Evaluating vehicle electricity usage and charging patterns.
- Conducting detailed analysis of individual vehicle performance.
- Diagnosing component failures.
- Analyzing parasitic loads and system component efficiencies.
- Establishing predictive maintenance programs based on component failure data.
- Analyzing and diagnosing components for future design changes.

Soon after deployment of the first ECRVs, the Postal Services contracted with Ryerson, Master and Associates, Inc. (RMA) to conduct an evaluation of the DAIS system, and a preliminary review of the data collected by the DAIS system (RMA, 2001b). This work included the preparation of a preliminary database format, data user interface, and report generator using Microsoft Access. RMA subsequently assisted Postal Service with the collection of DAIS data from the twenty five DAIS vehicles during the first year of operation.

This chapter provides a brief description of the Data Acquisition and Integration System. The system is described in Section 5.1, and a summary of the data collection effort is presented in Section 5.2. Section 5.3 includes a limited analysis of the DAIS data. These discussions are based on the information included in the previous report prepared by RMA (RMA, 2001b). Results are based on the data collected during the last one year period.

5.1 DATA ACQUISITION AND INTEGRATION SYSTEM

The Ford-designed DAIS collects and records data on the following parameters:

- Date and Time
- Wall Current (amps supplied to the vehicle by the off-board Power Control Station)
- Battery Pack Temperature (^{o}C)
- Battery Pack Voltage (volts)
- Battery Pack Current (amps flowing into or out of the battery pack)
- Vehicle Speed (mph)
- Ambient Temperature (^{o}C)

In addition to the above parameters, the DAIS derives and records data on the following parameters:

- Battery Pack Power (kW)
- Cumulative Battery Pack Current (Ahr)
- Cumulative Battery Pack Energy (kWhr into or out of the battery pack)
- Cumulative Wall Energy (kWhr supplied to the vehicle by the off-board Power Control Station)
- Miles Driven (miles)
- Estimate of Cumulative Charger Energy (kWhr)

Data values are recorded each second when the ECRV is being driven and each minute when the ECRV is connected to the off-board Power Control System (PCS). No data are collected when the ignition is off and the vehicle is not connected to the off-board PCS. The Personal Computer Memory Card International Association (PCMCIA) Data Cards (128 MB capacity) are installed in the onboard data logger units to record the DAIS data. The data are stored in files on the PCMCIA Data Cards. The data logger creates a “drive file” the first time the vehicle is started on each calendar day. As the vehicle is driven, data are appended to this drive file. A new drive file is created by the data logger when the vehicle is restarted on the next calendar day. This data storage protocol usually results in one drive file for each day the vehicle is driven.

The data logger creates a charge file the first time the vehicle is connected to the off-board PCS each calendar day. As the vehicle is charged, the data are appended to this charge file. If the vehicle is reconnected to the off-board PCS during the same calendar day, then the charge data are appended to the same charge file. The data logger only creates a new charge file when the vehicle is disconnected from the off-board PCS and then reconnected on the next calendar day. The charge file typically includes charge data past midnight, as a new charge file is not created by the Ford system until the connection to the off-board PCS is terminated and then reestablished. On a weekend, the charge file typically includes two or three days of data, as the ECRV is usually not disconnected from the PCS during this time.

On average, twelve data files are created by Ford’s system each week for each vehicle. Six of these files are for when the vehicle is being driven, and six files are for when the vehicle is connected to the PCS. A substantial amount of information is collected by the DAIS when it is working properly and the vehicles are used regularly. For each vehicle, as much as 30 megabytes of data per month may be collected. This equates to several gigabytes of data per year for the 25 DAIS vehicles.

The Ford data logger assigns a new filename each time a file is created. The convention for the file name is as follows:

Drive File	D DD MM YY
Charge File	C DD MM YY
Where: C stands for charge D for drive, DD for day of the month (two digits) on which the data file was created, MM for month (two digits), and YY for year (two digits).	

The drive file and the charge file both have the same column structure. It is important to note that the Ford DAIS records no vehicle identification number. This information is tracked by hand by writing the vehicle identification number on the outside of the Data Card. Table 5-1 shows an example DAIS Drive File, and Table 5-2 shows an example DAIS Charge File. Table 5-3 presents a DAIS “data dictionary” that explains how each value in the database is measured or calculated by the Ford data logger.

Further details of the DAIS system are included in the DAIS report prepared by RMA for the Postal Service (RMA, 2001b).

5.2 DAIS DATA COLLECTION

Microsoft Access was used to create a DAIS database and report generator (RMA, 2001). The database format allows new data to be uploaded from the PCMCIA Data Cards and appended to the database. Because of the large volume of data accumulated by the DAIS system, daily summary tables are included in the database. Creating daily summary tables enables the report generator to run more quickly, without the need to access and process the large amount of raw data contained within the database.

The Access database was initially developed and tested by RMA using data collected by the DAIS units installed on the two pilot vehicles used for the Customer Acceptance Tests at the Fountain Valley Post Office (USPS vehicle numbers 1240005 and 1240006). The data were collected during the period July-November, 2000. Subsequently, the database was populated using approximately one year of data (where available) for each of the 25 DAIS-equipped vehicles. The locations of these units and vehicle numbers are shown in Table 5-4.

To import data into the database, the raw data are transferred from the PCMCIA Data Cards into temporary folders on the host computer, and then prepared for importing to Access. The major steps for creating the database are as follows:

1. Transfer the records from the Data Cards into a temporary data file.
2. Add the vehicle identification number and the data type (charge or drive data).
3. Screen the data records for format errors.
4. Screen the data records for out-of-range errors.
5. Generate the Daily Summary Tables.

During the development of the database, several problems were encountered with the data generated by the DAIS units. First, the DAIS data files stored on the Data Cards do not include an identifier for the vehicle from which the data were collected. This information must be hand entered when the data files are transferred to the database. Second, while the type of data (Charge or Drive data) is specified in the file name (with a C or a D), a manual step was needed to include this with each record in the database. Data quality issues were also identified during the data import process.

TABLE 5-1 EXAMPLE OF DAIS DATA IN A CHARGE FILE

Time	Wall Current	Wall kWhrs	Pack Voltage	Pack Current	Pack kW	Pack Ahrs	Pack kWhrs	Pack Temp C	Vehicle Speed	Miles Driven	Ambient Temp C	Est. wall kWhrs
7/17/2000 15:51	0.54	0	327	-0.01	-0.003	0	0	27	0	0	26	0
7/17/2000 15:52	20.37	0.07	334	10.47	3.502	0.114	0.038	27	0	0	26	0.047
7/17/2000 15:53	20.05	0.139	337	10.4	3.507	0.288	0.097	27	0	0	26	0.114
7/17/2000 15:54	20.02	0.208	339	10.36	3.508	0.461	0.156	27	0	0	26	0.182
7/17/2000 15:55	19.97	0.277	339	10.31	3.499	0.633	0.215	27	0	0	26	0.249
7/17/2000 15:56	19.98	0.346	340	10.28	3.494	0.805	0.273	27	0	0	26	0.317
7/17/2000 15:57	19.91	0.415	340	10.25	3.488	0.976	0.332	27	0	0	26	0.384
7/17/2000 15:58	19.93	0.483	341	10.25	3.489	1.146	0.39	27	0	0	26	0.451
7/17/2000 15:59	19.85	0.552	341	10.23	3.486	1.314	0.448	27	0	0	26	0.517
7/17/2000 16:00	19.81	0.62	341	10.21	3.482	1.484	0.506	27	0	0	26	0.584
7/17/2000 16:01	19.77	0.688	341	10.2	3.48	1.655	0.565	27	0	0	26	0.651
7/17/2000 16:02	19.77	0.757	341	10.19	3.479	1.824	0.623	27	0	0	26	0.718
7/17/2000 16:03	19.77	0.825	341	10.18	3.476	1.994	0.681	27	0	0	26	0.785
7/17/2000 16:04	19.89	0.893	342	10.17	3.473	2.164	0.739	27	0	0	26	0.852
7/17/2000 16:05	19.77	0.962	342	10.16	3.472	2.333	0.797	27	0	0	26	0.918
7/17/2000 16:06	19.77	1.03	342	10.15	3.469	2.502	0.855	27	0	0	26	0.985
7/17/2000 16:07	19.77	1.098	342	10.13	3.464	2.671	0.913	27	0	0	26	1.052
7/17/2000 16:08	19.77	1.166	342	10.13	3.464	2.84	0.971	27	0	0	26	1.119
7/17/2000 16:09	19.77	1.235	342	10.12	3.461	3.009	1.029	27	0	0	26	1.185
7/17/2000 16:10	19.77	1.303	342	10.08	3.45	3.177	1.087	27	0	0	26	1.252
7/17/2000 16:11	19.77	1.371	342	10.08	3.452	3.345	1.145	27	0	0	26	1.319
7/17/2000 16:12	19.77	1.439	343	10.06	3.446	3.513	1.203	27	0	0	26	1.385
7/17/2000 16:13	19.77	1.507	343	10.05	3.444	3.68	1.261	27	0	0	26	1.452
7/17/2000 16:14	19.77	1.576	343	10.03	3.436	3.845	1.317	27	0	0	26	1.516
7/17/2000 16:15	19.77	1.644	343	10.02	3.435	4.012	1.376	28	0	0	26	1.584

TABLE 5-2 EXAMPLE OF DAIS DATA IN A DRIVE FILE

Time	Wall Current	Wall kWhrs	Pack Voltage	Pack Current	Pack kW	Pack Ahrs	Pack kWhrs	Pack Temp C	Vehicle Speed	Miles Driven	Ambient Temp C	Est. Wall kWhrs
7/17/2000 10:24	0	0	332	-3.7	-1.227	0	0	24	1	0	21	0
7/17/2000 10:24	0	0	332	-3.7	-1.227	0	0	24	1	0.0002	21	0
7/17/2000 10:24	0	0	332	-3.89	-1.294	0.001	0	24	1	0.0004	21	0
7/17/2000 10:24	0	0	332	-4.24	-1.406	0.003	0.001	24	2	0.0009	21	0
7/17/2000 10:24	0	0	331	-5.67	-1.878	0.005	0.002	24	2	0.0015	21	0
7/17/2000 10:24	0	0	331	-5.67	-1.874	0.008	0.003	24	2	0.0019	21	0
7/17/2000 10:24	0	0	330	-5.9	-1.95	0.009	0.003	24	2	0.0024	21	0
7/17/2000 10:24	0	0	331	-6.34	-2.097	0.011	0.004	24	2	0.0029	21	0
7/17/2000 10:24	0	0	330	-6.96	-2.293	0.014	0.005	24	1	0.0033	21	0
7/17/2000 10:24	0	0	329	-7.27	-2.396	0.017	0.006	24	1	0.0035	21	0
7/17/2000 10:24	0	0	330	-7.53	-2.482	0.019	0.006	24	1	0.0037	21	0
7/17/2000 10:24	0	0	329	-7.73	-2.547	0.021	0.007	24	0	0.0038	21	0
7/17/2000 10:24	0	0	329	-7.83	-2.575	0.023	0.008	24	1	0.004	21	0
7/17/2000 10:24	0	0	330	-7.92	-2.616	0.025	0.008	24	5	0.0053	21	0
7/17/2000 10:24	0	0	329	-8	-2.633	0.027	0.009	24	6	0.0069	21	0
7/17/2000 10:24	0	0	328	-8.31	-2.725	0.031	0.01	24	6	0.0088	21	0
7/17/2000 10:24	0	0	328	-9.1	-2.98	0.034	0.011	24	8	0.0109	21	0
7/17/2000 10:24	0	0	327	-9.9	-3.24	0.039	0.013	24	8	0.0132	21	0
7/17/2000 10:24	0	0	326	-10.54	-3.438	0.043	0.014	24	8	0.0156	21	0
7/17/2000 10:24	0	0	326	-10.49	-3.419	0.046	0.015	24	8	0.0179	21	0
7/17/2000 10:24	0	0	328	-10.81	-3.541	0.049	0.016	24	9	0.0203	21	0
7/17/2000 10:24	0	0	326	-11.46	-3.736	0.053	0.017	24	9	0.0229	21	0
7/17/2000 10:24	0	0	326	-12.54	-4.083	0.058	0.019	24	10	0.0255	21	0
7/17/2000 10:24	0	0	325	-13.67	-4.443	0.063	0.02	24	10	0.0285	21	0
7/17/2000 10:24	0	0	325	-14.48	-4.7	0.068	0.022	24	9	0.031	21	0
7/17/2000 10:24	0	0	324	-14.3	-4.638	0.071	0.023	24	9	0.0336	21	0
7/17/2000 10:24	0	0	326	-14.12	-4.604	0.074	0.024	24	9	0.0362	21	0
7/17/2000 10:24	0	0	326	-13.3	-4.331	0.076	0.025	24	9	0.0387	21	0

TABLE 5-3 DATA DICTIONARY FOR DAIS PARAMETERS [1]

Col #	Parameter (Label)	Units	Measured or Derived [2]	Instantaneous/ Cumulative [3]	Comments
1	Date and Time (Time)	Date time	Measured (data logger internal clock)	Instantaneous	Field is formatted as a daily time stamp. It includes the date and the time (24-hour clock).
2	Wall Current (Wall Current)	amps	Measured (current meter)	Instantaneous	Device is a current meter physically located in the vehicle. There may be some loss of power in the cable from the wall-mounted Power Control System (PCS) to the vehicle, but this is minimal (relatively short cable, no load). The current meter is the first device the current passes through in the vehicle.
3	Cumulative Wall Energy (Wall KWhrs)	kWhr	Derived: (Col2*207/(60*1000)) + kWhr in previous record	Cumulative	Voltage is not measured. The data logger assumes the voltage is a constant 207V (nominal 208V service). Since this is a cumulative parameter, the power used on the last time increment (1 minute) is added to the total in the previous record.
4	Battery Pack Voltage (Pack voltage)	volts	Measured (variable control module)	Instantaneous	Device is placed directly on pack terminals.
5	Battery Pack Current (Pack Current)	amps	Measured (current meter)	Instantaneous	Device is very close to battery. Measures net current going into or out of the pack - positive (in); negative (out).
6	Battery Pack Power (Pack KW)	kW	Derived: Col3*Col4/1000	Instantaneous	Instantaneous indication of pack power.
7	Cumulative Battery Pack Current (Pack Ahrs)	Ahr	Derived: Col5/60 + Ahr from previous record	Cumulative	Product of current (amps) and time increment (1 minute) with factor to adjust from minutes to hours, added to total in previous record.
8	Cumulative Battery Pack Energy (Pack KWhrs)	kWhr	Derived: Col4*Col7	Cumulative	Product of Pack Ahr and Pack voltage
9	Battery Pack Temperature (Pack Temp C)	^{o}C	Measured (thermocouple)	Instantaneous	Sensor is physically located inside the pack at a location considered to be the hottest place.

TABLE 5-3 DATA DICTIONARY FOR DAIS PARAMETERS [1]

Col #	Parameter (Label)	Units	Measured or Derived [2]	Instantaneous/ Cumulative [3]	Comments
10	Vehicle Speed (Vehicle Speed)	mph	Measured: device on transaxle	Instantaneous	Device is coupled to transaxle.
11	Miles Driven (Miles Driven)	miles	Derived: (Col10/3600)	Cumulative	DAIS value for miles driven is derived from speed indicator on transaxle. Formula here assumes time interval is 1 sec. This is not the same as the odometer reading in the car, which is a mechanical device that cannot be read by the data logger.
12	Ambient Temperature (Ambient Temp C)	degree Cent.	Measured	Instantaneous	Sensor on outside of vehicle.
13	Estimate of Cumulative Charger Energy (Est. wall kWhrs [4])	kWhr	Derived.	Cumulative	Ford has included this field to allow them to evaluate efficiency factors and parasitic losses.

Notes
[1] Data dictionary developed by Ryerson, Master and Associates, Inc., using input from Ford Motor Company.
[2] For measured data, this column includes the measuring device. For derived data, the column includes the formula.
[3] All cumulative data should begin at zero when a new daily data file is created.
[4] This value uses the pack kW-hrs to back-calculate the wall power assuming certain efficiencies and losses for the system. For example, if there is 10A at the pack, and the charging system has an 80% efficiency with no auxiliary load, the wall current would be about 12A. Efficiency factors are not constant. They depend on current. In making the comparisons, it is important to note that the pack voltage is different than the wall voltage, so power is a better parameter to use than current for this type of comparison.

TABLE 5-4 SUMMARY OF POST OFFICE SITES AND VEHICLES WITH DAIS UNITS

Fountain Valley	Linda Vista	La Mirada	Royal Oaks	Alameda
016	198	233	357	362
029	210	236	358	378
030	232	245	402	383
031	312	306	407	396
033	314	308	412	416

Only a limited amount of time was available to conduct quality control efforts on the initial data from the ECRVs. Additional quality control efforts are needed to establish a permanent database for the ECRVs. The screening steps for importing data discussed above and a data value verification step (to confirm each parameter is within expected range) are important steps in the needed quality control effort.

Preliminary "Out-of-Range" values were identified for each parameter using available data on the DAIS. These out-of-range values are listed in Table 5-5.

TABLE 5-5 PRELIMINARY OUT-OF-RANGE VALUES FOR DATA PARAMETERS

Parameter	Charge File Min. Value	Charge File Max. Value	Drive File Min. Value	Drive File Max. Value
Wall Current (amps)	0	50	0	0
Cumulative Wall Energy (kWhr)	0	60	0	0
Battery Pack Voltage (volts)	0	400	0	400
Battery Pack Current (amps)	-75	50	-600	200
Battery Pack Power (kW)	-25	20	200	100
Cumulative Battery Pack Current (Ahr)	-150	100	-1200	400
Cumulative Battery Pack Energy (kWhr)	-30	50	0	50
Battery Pack Temperature (deg. C)	0	100	0	100
Vehicle Speed (mph)	0	0	0	100
Miles Driven (miles)	0	0	0	100
Ambient Temperature (^{o}C)	-50	50	-50	50

Once the data were screened and incorporated into the initial database, an Access Query was written to produce daily summary tables. The parameters included in the daily summary tables are shown in Table 5-6. The daily summaries allow the report generator to run more quickly, without the need to access and process the raw data every time a report is prepared.

The report generator constructed by RMA provides the user with an option to generate three types of reports for each parameter. These is a **detailed report** that shows the daily data, a **monthly report** that shows monthly averages and/or totals, and a **summary** report that shows the total and/or average for the entire time period selected. The user has the option to select one or more vehicles for each report, and reports may be generated for any range of days for which data are available. The reports also have options for charting the data.

Whenever a report query is run, the report generator produces the report, together with an error report that summarizes the import errors and the screening errors applicable to the data used. The system is capable of generating the following reports:

- Vehicle daily usage level (e.g. operating hours per day)
- Vehicle monthly usage level (e.g. operating days per month)
- Vehicle miles driven (e.g. miles per day)
- Vehicle energy use over time (e.g. kW-hr per day or per month)

- Vehicle energy use over distance (e.g. kW-hr per mile)
- Vehicle charge time (e.g. hours to reach full charge)
- Battery pack energy flow (e.g. kW-hr into pack, kW-hr out of pack)
- Battery pack temperature

TABLE 5.6 PARAMETERS INCLUDED IN THE DATABASE DAILY SUMMARY TABLES

Miles Driven	Miles driven	**Vehicle Energy Use**	Wall kW hours
	Days driven		Miles driven
Drive Charge Time	Drive minutes	**Temperature Ranges Ambient**	-50 - 0 ºC
	Charge Minutes		0 - 15 ºC
	Not Used Minutes		15 - 30 ºC
Pack Energy	Drive kW positive		30 - 50 ºC
	Drive kW negative		Max. Ambient
	Drive kW net		Min. Ambient
	Pack Charge kW		Avg. Ambient
	Pack kWhrs		
Charge Profile	Low charge	**Temperature Ranges Pack**	0 - 25 ºC
	High charge		25 - 50 ºC
	Morning charge		50 - 100 ºC
	Day charge		Min. Pack
	Night charge		Max. Pack
Wall Energy	Wall kW hours		Avg. Pack

5.3 Analysis of the DAIS Data

The Report Generator was run to prepare a range of reports using the available DAIS data. The data span used for the DAIS reports is from vehicle deployment date to the end of 2002. In most cases this represents more than one year since the DAIS units were placed in operation. Reports were generated for a range of variables derived from the DAIS data. The reports are included in Appendix F.

A comparison of the DAIS data for the five sites is presented in Table 5-7. This table includes miles and days driven, electricity delivered to the pack (pack electricity), and the average daily hours driven and hours on charge for each of the five sites. The trends in miles per day and energy efficiency for all 25 DAIS vehicles are shown in Figures 5-1 and 5-2 respectively. There was considerable variability in the trend of energy efficiency for the five sites. This is not unexpected given that there were gaps in the data.

The energy efficiency data presented in Table 5-1 and in Figure 5-2 are derived using a measure of electricity flowing into the battery pack. This results in a higher value (1.55 miles per kWh) than previously estimated for the fleet using odometer readings and electricity totals for these five sites (0.92 miles/kWh) (Table 3.9). This is because the losses from the meter to the vehicle battery pack are not accounted for in the DAIS data. The large difference between these figures suggests there is a considerable efficiency penalty due to parasitic loads and system losses.

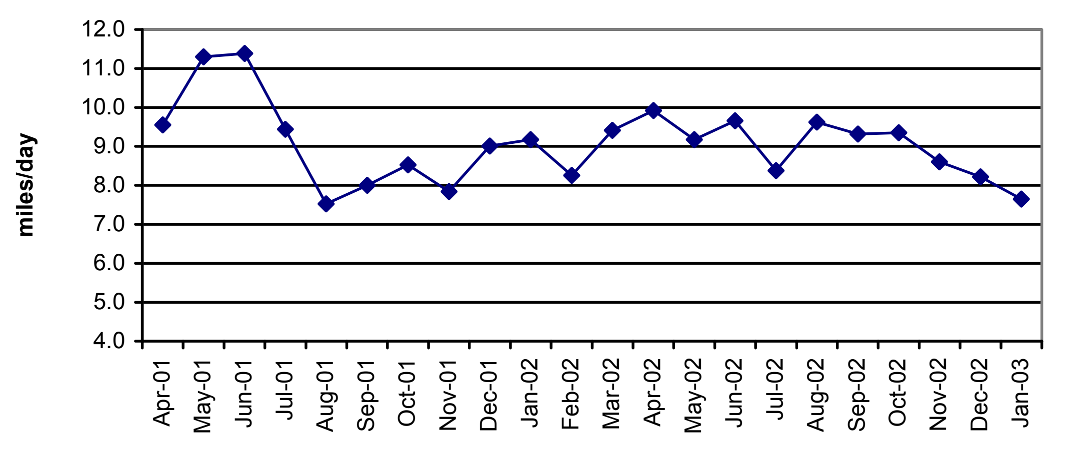
TABLE 5-7 SUMMARY OF DAIS DRIVE DATA

Post Office Location	Miles	Days Driven	Pack Electricity (kWh)	Average miles/day	Pack Energy Efficiency (miles/kWh)	Hours Driven per Day	Hours on Charge per Day	Average Speed (mph)
Alameda	8,867	827	5,831	10.7	1.52	1.17	14.9	9.2
Royal Oaks	8,882	831	5,183	10.7	1.71	0.58	15.8	18.4
Fountain Valley	6,555	702	4,528	9.3	1.45	0.47	15.1	19.9
Linda Vista	6,815	884	3,638	7.7	1.87	0.55	17.5	14.0
La Mirada	6,349	860	5,052	7.4	1.26	0.43	17.0	17.2
All	**37,468**	**4,104**	**24,231**	**9.1**	**1.55**	**0.64**	**16.14**	**14.3**

The range in the average route lengths for the DAIS vehicles was between 7.4 miles per day (average for La Mirada) and 10.7 miles per day (average for Alameda and Royal Oaks). The average energy efficiency for the five DAIS sites shows some correlation with the miles driven, but, again, there is considerable variability in the data.

The Ford Concern Report (CR) data included eleven CRs applicable to battery problems with the DAIS vehicles (Table 5-8). Of these eleven, six were pre-delivery and one was a “clear code”. For the four remaining, there was no data for two of the four (CRs 815, 941). For the two remaining CRs (892 and 0125), the vehicle DAIS data were reviewed for the week prior to the repair work, in order to determine whether any indicators of impending battery problems could be identified.

FIGURE 5-1 DAIS VEHICLES - MILES PER DAY



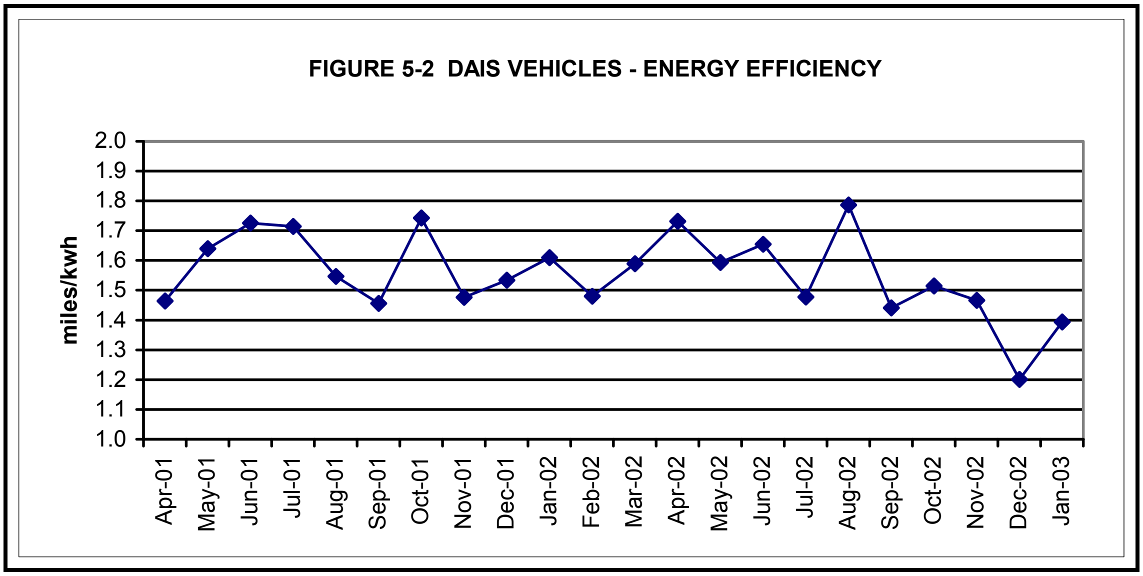


TABLE 5-8 SUMMARY OF FORD CONCERN REPORTS FOR THE DAIS VEHICLES

CR #	ECRV ID#	Date of Call	Odometer	Indicator	# Modules Defective	Replace Modules/Pack	Days Out	
627	016	21-Aug-02	1525	Wrench Light	N/A	N/A	1	Clear Codes
815	029	13-Dec-02	7,158	Low Range	2	Modules	1	
008	029	21-Mar-01	416	Low Range	1	Modules	1	Pre-delivery
892	233	19-Dec-02	4353	Wrench Light	3	Modules	1	
941	314	10-Jan-03	2644	Elec. Circuit Prob.	?	Pack	1	
9031	357	9-Jan-02	118	Wrench Light	1	Modules	33	Pre-delivery
9038	358	26-Mar-02	61	Low Range	1	Modules	32	Pre-delivery
9025	378	17-Dec-01	70	Wrench Light	?	Pack	0	Pre-delivery
9033	402	15-Jan-02	83	Wrench Light	1	Modules	42	Pre-delivery
9125	416	2-Dec-02	3,985	Low Pack Capacity	8	Modules	11	
9022	416	20-Dec-01	52	Low Range	?	Pack (Swap)	41	Pre-delivery

In this review, the only possible indicator of an issue was the pack current early in the program compared with the pack current immediately prior to the event for Vehicle #416 (Figure 5-1). From this figure, it can be seen there was a decline in the pack current from 12 amps soon after deployment (Dec. 21, 2001) down to 10 amps immediately prior to the battery work (Nov. 27, 2002). No other obvious indicators of battery problems were evident in the DAIS data for these two vehicles.

FIGURE 5-3 (a)
DAIS CHARGE DATA, VEHICLE 416
DECEMBER 21, 2001

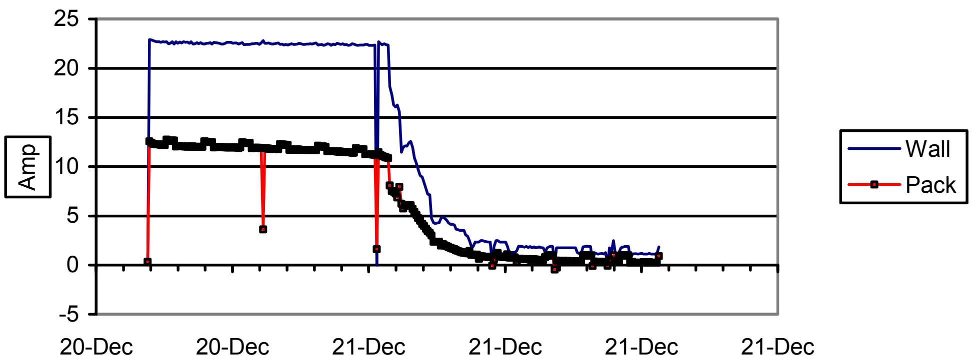
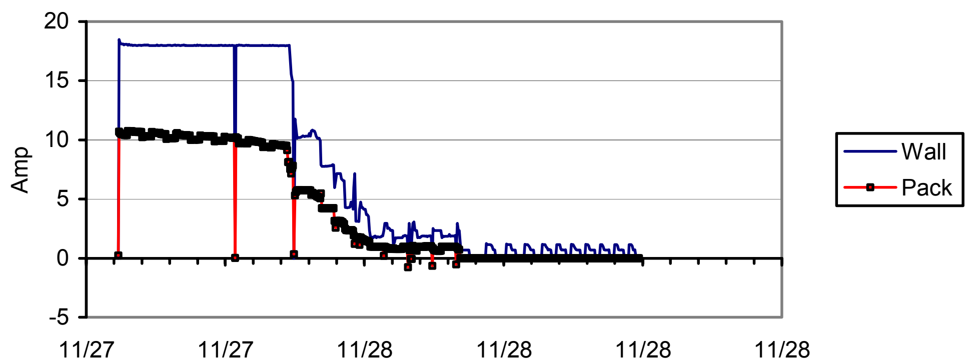


FIGURE 5-3 (b)
DAIS CHARGE DATA, VEHICLE 416
NOVEMBER 27, 2002



6. VEHICLE CHARGING INFRASTRUCTURE

This chapter includes a brief description of a typical ECRV charging demand profile (Section 6.1), the ECRV charging system and equipment (Section 6.2), and a summary of charging system performance and reliability (Section 6.3).

6.1 ECRV CHARGING DEMAND PROFILE

The ECRV charging system at each ECRV deployment site is designed to allow the ECRV traction batteries to be charged daily during the off-peak period designated by the utility. When the ECRV drivers return from their delivery routes in the late afternoon, they connect the ECRVs to the Power Control Station (PCS). Between the time the ECRV is placed “on-hook” and the time when the traction battery charge current is activated by the timer at night, the vehicle draws a low-level of current (called maintenance current) to provide energy for the parasitic loads associated with vehicle accessories and battery pack temperature control. The current supplied to the vehicle cycles on and off during this maintenance mode. Additional parasitic loads occur during the charging of the traction battery for the battery pack temperature control devices (cooling fan and heater). For vehicles with DAIS units, there is an additional parasitic load to operate the data processing and storage hardware.

A typical demand profile during maintenance mode, obtained from the DAIS data, is shown in Figure 6-1. Note that during the maintenance mode, there is no current flowing to the traction battery pack.

As soon as the timer activates power to charge the traction battery pack, the current to each vehicle increases to approximately 20 amps (equivalent to about 4.2 kW at the electricity meter). A typical demand profile during the charging period is shown in Figure 6-2. The demand shown in this figure, obtained from DAIS data, is based on a measurement of current as it flows to the vehicle (“wall current”) and a measurement of current as it reaches the battery pack (“pack current”). Figure 6-3 shows an example of the demand cycle at a single Post Office as the charging system comes on each night (except Sundays).

After the battery pack is charged, the current decreases as the charge cycle is completed. As soon as the charging is complete the battery control module turns off the charge current, and the charging system reverts to maintenance mode. The vehicles are kept on-hook whenever they are not being used. This is the procedure recommended by Ford in the Postal Service ECRV Operator Training Manual.

Based on a review of data obtained from the DAIS units installed on ECRVs at the Fountain Valley Post Office (between February and June, 2001), it appears that the full charge current (about 20 amps, 4.2 kW) is supplied for about two to four hours each evening, depending on the miles driven that day. Charging is completed after about one to two more hours as the power decreases to less than 1 kW. After the battery charging is complete, the system reverts to the maintenance mode. The maintenance mode continues to provide power as needed until the vehicle is taken off-hook.

FIGURE 6-1
DAIS VEHICLE DEMAND IN MAINTENANCE MODE
VEHICLE 30, JULY 2, 2001 (ON-HOOK)

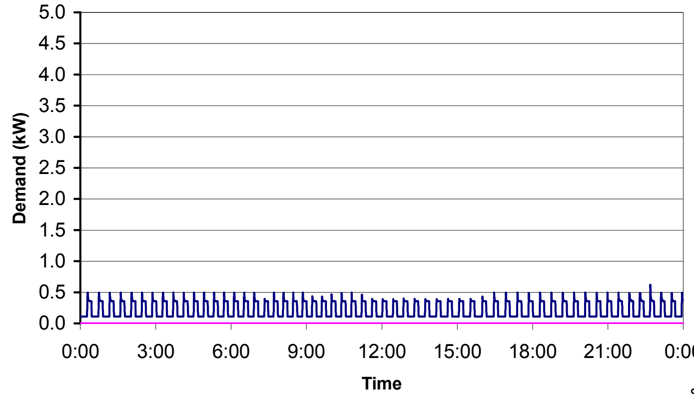


Chart 9 *Source: DAIS Data*

FIGURE 6-2
TYPICAL CHARGE PROFILE
VEHICLE 1240030, JUNE 30, JULY 1, 2001

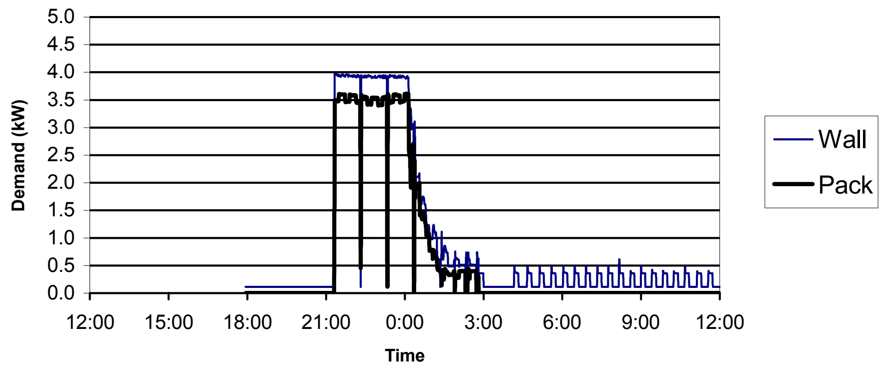


Chart 8 *Source: DAIS Data*

FIGURE 6-3
ECRV ELECTRICITY DEMAND
AT FOUNTAIN VALLEY P.O.
JUNE 2001

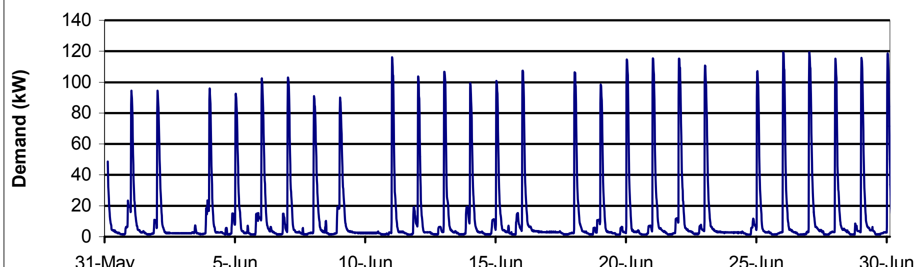


Chart 19 *Source:Edison Amicos*

6.2 POWER CONTROL SYSTEMS

The Ford ECRV uses an onboard conductive charger. The vehicle is connected to electric charging power via an offboard PCS. The PCS is a DCS-55 Dual Charging Station manufactured by Electrical Vehicle Infrastructure, Inc. (EVI). Each PCS has two charging cables for connection to two vehicles.

For the 500 vehicle ECRV fleet, Ford Motor Company (Ford) installed the PCS units and associated electrical equipment at each of the 22 Post Offices. The PCS units are used to supply electrical current to the ECRV's onboard battery charger when the ECRV is parked at the Post Office. The PCS units also supply power to the ECRV auxiliary systems, such as the battery pack temperature control system, when the vehicle is parked at the Post Office.

Single PCS units were also installed at each of the twelve Postal Service Vehicle Maintenance Facilities (VMFs) that service vehicles for the Post Offices. Table 6-1 presents a list of Post Offices and Vehicle Maintenance Facilities that have charging systems installed. At the time the systems were installed, each Station Manager and Vehicle Maintenance Manager at these facilities was provided an ECRV Program Overview, which provided a general description of the vehicle and the charging system.

The Model DCS-55 Dual Charging Station, manufactured by Electrical Vehicle Infrastructure, Inc. (EVI) of Auburn, California, was selected by Ford. As a cost saving measure requested by the Postal Service (Postal Service Charger Specification 3.2.1), EVI developed the DCS-55 to enable two vehicles to be charged from one charging station.

Each Power Control Station (PCS) supplies electrical current to two ECRVs. A maximum of 20 amps of current, at 208 volts single phase, is supplied to each vehicle by the PCS units. The PCS units are mounted on a pedestal or mounted to an existing wall.

In addition to the PCS units, the main electric infrastructure components installed at each Post Office include the following:

- A new electrical service entrance section housing an electric meter and main circuit breakers.
- A new electrical panel housing 50 amp circuit breakers for each PCS unit.
- A new step-down transformer, when needed to supply the 208-volt current to the PCS units.
- A new or upgraded main transformer, when needed to supply the required electrical current for the ECRVs.
- A timer unit that controls the time-of-day when the vehicles are charged.

The major electrical components installed at each Post Office and Vehicle Maintenance Facility are shown in Table 6-1 on the following page. Photographs showing the electrical infrastructure and charging systems are included in Figure 6-4.

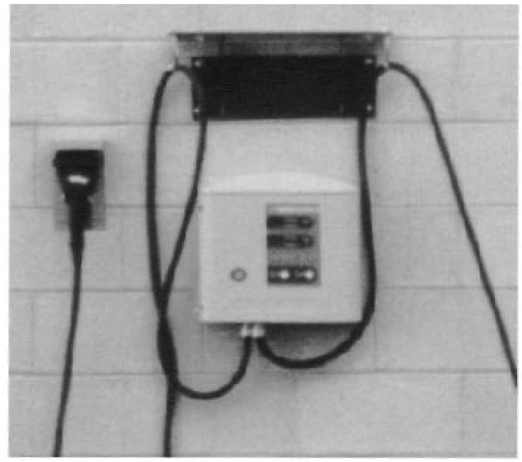
TABLE 6-1 MAJOR ELECTRICAL COMPONENTS INSTALLED AT EACH POST OFFICE AND VEHICLE MAINTENANCE FACILITY

Site Name	# of Vehicles	Infrastructure Components Installed				
		Service Entrance Section	Main Trans. Pad	Step-Down Trans.	EV Panel	# of PCS Units
Huntington Beach VMF	0	- -	- -	- -	- -	1
Fountain Valley P.O. (DAIS)	28	X	- -	X	X	14
Ida Jean Haxton Station P.O.	25	X	- -	- -	X	13
Irvine Harvest Station P.O.	24	X	- -	X	X	12
Costa Mesa Main P.O. (Leased)	20	X	X	- -	X	10
Los Angeles Central VMF	0	- -	- -	- -	- -	1
Dockweiler Station P.O. (Leased)	40	X	X	X	X	20
Alameda Station P.O.	24	X	- -	X	X	12
Los Angeles North VMF (Leased)	0	- -	- -	- -	- -	1
Los Feliz Station P.O.	32	X	X	X	X	16
Bicentennial Station P.O.	33	X	X	X	X	17
San Diego Midway VMF	0	- -	- -	- -	- -	1
Bostonia Station P.O. (Leased)	20	X	- -	- -	X	10
Linda Vista Station P.O. (DAIS)	22	X	- -	- -	X	11
La Puente VMF (Leased)	0	- -	- -	- -	- -	1
El Monte Main P.O.	30	X	- -	X	X	15
San Gabriel Main P.O.	20	X	- -	X	X	10
Glendora Main P.O.	20	X	- -	- -	X	10
Covina Main P.O. (Leased)	20	X	X	X	X	10
Long Beach VMF	0	- -	- -	X	- -	1
La Mirada P.O. (Leased) (DAIS)	15	X	- -	- -	X	8
Pico Rivera P.O. (Leased)	16	X	X	- -	X	8
Norwalk P.O.	26	X	X	- -	X	13
Torrance VMF (Leased)	0	- -	- -	- -	- -	1
Harbor City P.O.	5	- -	- -	- -	- -	3
San Jose VMF	0	- -	- -	- -	- -	1
Blossom Hill Station P.O.	20	X	X	- -	X	10
Oakland VMF (Leased)	0	- -	- -	- -	X	1
Alameda Main P.O. (Leased) (DAIS)	20	X	X	- -	X	10
Sacramento Main VMF	0	- -	- -	X	- -	1
Royal Oaks Station P.O. (DAIS)	20	X	X	X	X	10
West Chester VMF	0	- -	- -	- -	- -	1
White Plains P.O.	5	N/A	N/A	N/A	N/A	3
Brightwood VMF	0	- -	- -	- -	- -	1
Lamond Riggs Station P.O.	14	X			X	7
USPS Engineering Merrifield	1	- -	- -	- -	- -	0
Total	**500**	- -	- -	- -	- -	**264**

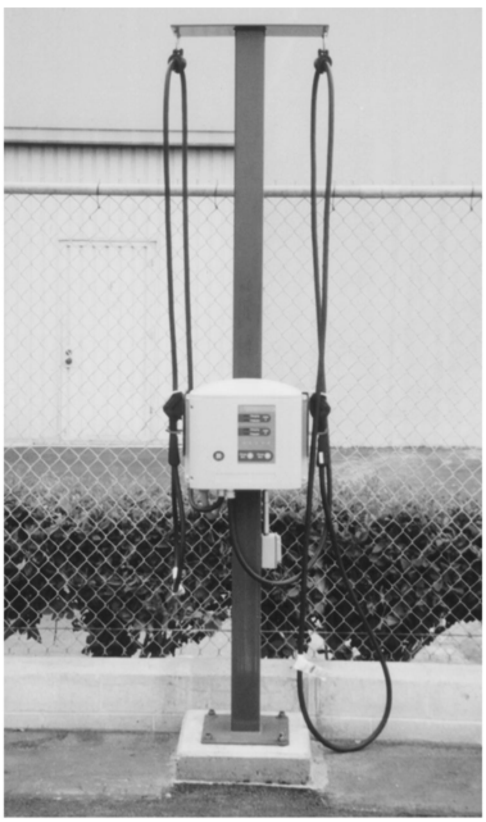
Notes
X = Installed with initial purchase
Initial Purchase of 500 vehicles

FIGURE 6-4 ELECTRICAL INFRASTRUCTURE AND CHARGING SYSTEMS

ECRV with Power Cord Attached



Wall-Mounted Power Control Station
Charges Two ECRVs



Pedestal-Mounted
Power Control Station (PCS)
Charges Two ECRVs

New Service Entrance Section with Meter

New Electrical Panel, Timer Control
and Step-Down Transformer

During the installation of the electric infrastructure, certain electrical components were sized to enable all the Carrier Route Vehicles at the Post Office to be replaced with ECRVs in the future. Specifically, the Postal Service Charger Specification 3.2.3.2 required new transformer pads, service entrance sections, buried conduit, and conduit placed in walls, to be sized to accommodate the total number of Carrier Route Vehicles located at each Post Office. This requirement was implemented to reduce future costs associated with deployment of additional ECRVs at these Post Offices. This requirement also reduced the potential that newly installed electrical components would need to be replaced to accommodate additional ECRVs at these Post Offices.

6.3 CHARGING SYSTEM PERFORMANCE AND RELIABILITY

In the ECRV Baseline Performance Testing conducted by Southern California Edison (SCE), the charging system performance specifications for total power factor (PF) and total harmonic distortion (THD) were easily satisfied by these units. Vehicles were successfully and fully charged in under 8 hours as required, with the “bulk” of the charge occurring in the first 5 hours.

Also in the Baseline Performance Assessment, SCE determined the power conversion efficiency of the on-board charger. For the two vehicles they evaluated, the efficiency factors were 85.1% and 86.9% at maximum power, and 81.6% to 82.0% over the full charge cycle (SCE, October 2000, page 16). These values do not account for any parasitic losses during the maintenance mode.

There have been some reports that the charging connector does not release easily from the ECRV. This concern was raised by Carriers at Fountain Valley and at Dockweiler. Ford has been replacing or repairing equipment, as necessary.

In the Satisfaction Survey conducted in April, 2003, there were a high number of unfavorable responses from the Post Offices Managers regarding the charging systems (refer to Chapter 4). Further inquiry is needed to understand the reasons for this, but some possible explanations could be the faulty release discussed above, or it may be a perception gained when the batteries fail to hold charge for an adequate length of time.

7. OTHER PROGRAM ACTIVITIES

During the time since the ECRV Program was conceived, the Postal Service has sponsored and commissioned many studies to help with the process of vehicle acquisition, site selection, vehicle acceptance testing, data collection and monitoring performance. Details of the site selection studies were discussed in Chapter 2 of this report; Customer Acceptance Testing was discussed in Chapter 4; and the Data Acquisition and Integration System (DAIS) was described in Chapter 5.

This chapter includes a brief summary of the work conducted by Southern California Edison (SCE) on Baseline Performance Testing and Accelerated Reliability Testing prior to the full-scale fleet deployment (Section 7.1). This information is based on a review of the formal reports issued by SCE covering these topics. Also included is a review of the ECRV Life Cycle Cost and Performance Evaluation study conducted by Ryerson, Master and Associates, Inc., in 2001 (Section 7.2).

7.1 ECRV BASELINE PERFORMANCE AND ACCELERATED RELIABILITY TESTING

Between July and December 2000, Southern California Edison (SCE) conducted Baseline Performance tests on two of the first ECRVs produced by Ford, and in December 2000, SCE began testing two other ECRVs for the Accelerated Reliability Test. The Accelerated Reliability Test will continue for a one year period, and SCE is expected to drive each vehicle over 20,000 miles in the one-year period. Results from the Baseline Performance Test and the Accelerated Reliability Test are discussed in Chapter 7.

The Baseline Performance Test was conducted on two ECRVs by SCE during the latter part of Year 2000. Results are documented in SCE's quarterly reports for October and December 2000 (SCE, 2000). SCE reported that, on the USPS Pomona delivery route that "duplicates the stop-and-go driving style of a house-to-house delivery route," the vehicles achieved a range of approximately 31 miles. During the tests, the vehicles were loaded to their maximum weight limit. (The maximum payload is 1,250 pounds.) On a more typical urban driving range, and also at maximum weight, the vehicles achieved 43 miles. The range of each vehicle was tested periodically as the vehicles accumulated miles. After reaching 10,000 miles, results revealed little loss of range. On the urban loop, range remained at about 40 miles.

The vehicles satisfied the minimum requirements set by the USPS for acceleration and braking. Acceleration did diminish somewhat as batteries lost power; however, the minimum performance requirements were still satisfied.

In the SCE road-handling test, the vehicles performed comparably to equivalent gas-powered vehicles. After each test run, the driver filled out a survey regarding the performance of the EV.

The results were as follows:

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

The driver reported that “both electric and gasoline vehicles performed equally with regard to handling and safety.”

7.2 ECRV LIFE CYCLE COST AND PERFORMANCE EVALUATION

Shortly after the ECRVs were deployed at the first three sites, the Postal Service commissioned a study by RMA to evaluate the Life Cycle Cost and Performance of the ECRVs based on information available at the time (RMA, 2001a). The main purpose of the study was to provide information to the Postal Service to help them make decisions concerning additional vehicle purchases under the existing contract with Ford. This involved data collection for the ECRVs and for other Carrier Route Vehicles used by the Postal Service for comparison purposes.

Although there had been only a short period of time for the Postal Service to gain operating experience with the ECRVs, the contract with Ford required the Postal Service to make a decision on the First Purchase Option for 1,000 additional ECRVs before 75% of the Initial Purchase ECRVs were delivered. This was necessary for Ford to avoid the need to temporarily discontinue the vehicle production process.

Intensive ECRV data collection and analysis was performed at the Fountain Valley Post Office, the Ida Jean Haxton Post Office, and the Dockweiler Station Post Office. At these three sites, there were a total of 93 ECRVs. Five of the ECRVs delivered to the Fountain Valley Post Office contained Data Acquisition and Interface Systems, which provided more performance data for these vehicles.

Comparison data were also collected on the costs and performance of the gasoline Long Life Vehicles (LLVs), the ethanol/gasoline Flex Fuel Vehicles (FFVs), and the Chrysler EPIC Electric Vehicles that were being operated at the Harbor City Post Office in Los Angeles.

Even though the available ECRV data spanned only a short period of time, quality data were obtained for a number of important cost and operating parameters. Valuable data were obtained on electricity use patterns, electricity costs, infrastructure costs, vehicle operator satisfaction, and early vehicle repair requirements.

Due to the short operating history of the ECRVs, insufficient data were available to reliably predict the life cycle repair and maintenance costs, battery replacement costs, and other long-term cost factors for the vehicle. To help address these important consideration, repair and maintenance data available for other electric vehicles were reviewed.

Using the available data, life cycle cost estimates were developed for each vehicle type, and the performance of the ECRVs to date was compared with that for the LLV. The final report included a number of recommendations for enhancing the ECRV program. One of the most significant conclusions was that there is considerable uncertainty in the battery cost and performance. A number of recommendations were included to help the Postal Service find ways to minimize the risk associated with this factor.

During 2003, the operating costs (for electricity) were updated using more extensive data for the same three Post Office locations (RMA, 2003). It was found that the energy efficiency of the ECRVs at the same three Post Offices over a longer time span (just under one year) was substantially the same as first reported. The update report also reviewed the extent to which the ECRV fleet and the associated infrastructure could be used as a “stepping stone” for other advancing vehicle technologies such as gasoline-battery hybrids and fuel cell vehicles.

8. CONCLUSIONS

This chapter summarizes some of the main conclusions on the experience gained by the Postal Service from implementing the ECRV Program. Section 8.1 presents some of the main ECRV Program accomplishments, Section 8.2 summarizes the Postal Service experience with the ECRV batteries and other vehicle limitations, and Section 8.3 includes a discussion on “lessons learned” during the implementation of this program. The final section presents an overall summary of the program including the current status.

8.1 ECRV PROGRAM ACCOMPLISHMENTS

Some of the more significant program accomplishments are presented below:

- The Postal Service has operated the 500 ECRVs for nearly two years. Over two million miles have been accumulated by the fleet, using about two million kWh of electricity. This represents a significant utilization of alternative fuel.

- The ECRV Program has yielded significant technology and data that are useful to the industry and program stakeholders. The vehicles have yielded tangible benefits to air quality during their deployment period.

- To enable the ECRV Program to proceed, the Postal Service – together with Ford and other stakeholders – succeeded in securing financial subsidies from a wide range of government agencies and electric utilities. With this funding, Ford was able to offer the Postal Service the new ECRVs at a purchase price competitive with gasoline vehicles, and the subsidies also helped to offset the costs of installing charging infrastructure.

- In collaboration with contractors, the Postal Service implemented a cost-saving measure that enables two vehicles to be charged from one charging station. The charging stations are easy to use and very convenient for the Carriers. The infrastructure also includes a separate electricity meter for the ECRVs at each Post Office, so that electricity use and costs can be tracked separately from other electrical usage at the Post Office.

- Mail Carrier satisfaction with the ECRVs has been favorable. Carriers have commented that they like not having to visit off-site refueling stations, and they like the clean, quiet characteristics of the ECRV.

- The Accelerated Reliability Testing conducted by Southern California Edison found the ECRV road-handling characteristics to be good, including adequate acceleration, good vehicle stability, and responsive braking and steering. A number of performance problems identified during pilot vehicle testing have been corrected. Many ergonomic concerns with the ECRV have also been resolved.

- The Data Acquisition and Interface Systems installed on 25 of the vehicles have accumulated detailed information on energy flow to and from the vehicle batteries, and other vehicle performance characteristics from deployment to the present.

- Vehicle availability to date for the ECRVs has been comparable with similar gasoline Long Life Vehicles used by the Postal Service for mail delivery.

8.2 ECRV LIMITATIONS

Some of the performance and cost issues associated with the ECRV batteries and other vehicle limitations are presented below:

- There remains significant uncertainty in the projected battery life and the cost associated with ECRV battery pack replacements. For a BEV, the frequency and cost of battery pack replacement have a significant impact on the life cycle cost. During the last three years, the costs for lead acid BEV batteries have not decreased as many anticipated. Data from Ford regarding the costs associated with recent ECRV pack replacements suggest that battery pack replacement costs have increased considerably.

- A considerable percentage of warranty repair work has been devoted to battery repairs. Battery modules have been repaired on 122 vehicles and battery packs have been replaced on 41. These data indicate that the ECRV battery pack life may be less than three years, as used for life cycle cost estimates.

- A high number of warranty repairs has been made by Ford on the ECRV fleet to date. In addition to the battery module repairs and replacements, other component categories with high numbers of repairs include 12-volt components (including water pumps) and wiring and harnesses.

- The relatively high production cost for the vehicle has been a key concern. This is not unusual for a new vehicle involving a new technology. Established production models have demonstrated that, if demand and production levels increase, the unit costs can be reduced to competitive levels over time (Sperling, 1995). However, increased demand for BEVs has not materialized, and there has been no reduction in BEV production cost.

8.3 LESSONS LEARNED FROM THE ECRV PROGRAM

Some lessons learned from the implementation of the ECRV Program are presented below:

- With the operation of any fleet that utilizes electrical charging systems, detailed planning is in order to avoid regular charging during the daytime and evening hours when electricity rates are the highest. This planning effort should include developing strategies for electrical load management, ensuring that charging system time clocks are adjusted properly, and using the best available electricity rate structures. Training for personnel and subsequent program audits are also important elements for maximizing efficiency.

- Precise guidelines have been lacking for deciding when a replacement pack is needed. This has led to uncertainty that makes it hard to make sound decisions about additional commitments to this technology. Defining the performance measures that trigger the need for battery pack replacements in vehicle acquisition contract documents could be a significant advantage.

- As new technologies utilizing alternative fuels are implemented, enhancements may be needed to the traditional databases used for tracking costs and performance metrics. New or revised management systems may be needed for capturing operating and maintenance data specific to the new technology during the early phases of a demonstration program.

- When Data Acquisition Systems are being installed on some (or all) vehicles within the fleet, there is a need to establish a database management system that defines how the data will be collected and processed, what quality control procedures will be used, and who will be responsible for maintaining the database system.

- Manufacturer warranty support has been critical for keeping the ECRV fleet operational to date. Such support is likely to be essential for any new technology vehicles that are brought into delivery fleet operations in large numbers.

- Emerging technologies that may replace or augment the vehicle being acquired should be considered to ensure that program investments on infrastructure, training, and maintenance practices are not lost as the newer technologies gain ground.

- Cost projections for new vehicles and new vehicle components can vary significantly during the years when a new technology is being demonstrated. At the time of ECRV deployment, there was an expectation that BEV production costs would decrease as California and other state Zero Emission Vehicle programs called for a higher level of BEV sales. Subsequently, this growth scenario has not materialized. Based on current information from Ford, the anticipated costs for maintaining the ECRV fleet through a normal vehicle life cycle far exceed the early estimates.

- The warranty agreements for new technology vehicles could benefit from a different emphasis than those for gasoline vehicles. With a conventional vehicle, the drive train has extremely high reliability, and the warranty provides the buyer with assurance that they will not have to change this major component under normal circumstances. With Alternative Fuel Vehicles, components are often unproven, and normal degradation may be expected (such as with the battery packs on the ECRVs).

8.4 PROGRAM SUMMARY AND CURRENT STATUS

With nearly two years of operating experience now available for the Postal Service 500-vehicle Electric Carrier Route Vehicle (ECRV) fleet, a substantial amount of data has been compiled on the performance of these BEVs. The program has provided valuable experience for the Postal Service, and this experience is likely to be helpful as other advanced technologies are tested and demonstrated in the future. The lessons learned may also be helpful to other organizations involved with the operation of a fleet of light duty vehicles in similar applications.

Many of the performance issues identified during the course of operating the ECRV fleet are similar to those that may be expected for any new type of vehicle or vehicle technology. Over time many of those issues could be adequately addressed with changes in the design, production or operation of the vehicles. As an example, problems with the ECRV power steering and water pump have been addressed by improving the quality in the supply chain. Costs for electricity have been similar if not less than for gasoline, and a number of opportunities were identified for improving the efficiency and cost-effectiveness of the program.

On the other hand, limitations with the traction batteries have been a pervasive problem. There has been considerable uncertainty associated with battery cost, performance and reliability. Considerable effort has been invested by the Postal Service, Ford, and other program stakeholders to gather more data on battery performance, and to identify ways to address the cost and performance challenges. These efforts have not been successful, however, and the decision has now been made to terminate the ECRV Program.

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