VERIFICATION TEST OF THE BATTRONIC MINI VAN

by
Edward J. Dowgiallo, Jr.
Ivan R. Snellings
and
William H. Blake

July 1980

Approved for public release; distribution unlimited.

U.S. ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT COMMAND
FORT BELVOIR, VIRGINIA
Destroy this report when it is no longer needed. Do not return it to the originator.

The citation in this report of trade names of commercially available products does not constitute official endorsement or approval of the use of such products.
The Batronic Mini Van Model M065MLB, an electric two-passenger multipurpose van, was tested at MERADCOM to verify conformity to the Department of Energy Performance Standards for Demonstrations, published in the Federal Register, 30 May 1978, Part V. The Batronic Mini Van is manufactured in Boyertown, Pennsylvania, by Batronic, Inc. It is powered by two 56-volt lead-acid batteries that are connected to the motor through an SCR control actuated by a foot pedal to control motor speed. The 42-horsepower motor drives the rear wheels through a direct drive to the differential. Regenerative braking is provided.
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>SUMMARY</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>III</td>
<td>OBJECTIVES</td>
<td>1</td>
</tr>
<tr>
<td>IV</td>
<td>TEST RESULTS</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>APPENDIX – VEHICLE SUMMARY DATA SHEET</td>
<td>12</td>
</tr>
</tbody>
</table>
## ILLUSTRATIONS

<table>
<thead>
<tr>
<th>Figure</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Front/side View of the Batronic Mini Van</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Rear/side View of the Batronic Mini Van</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Side of Vehicle Showing One of Two Battery Modules Made by the C&amp;D Division of the Eltra Company</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Access to the Batteries from Inside the Van</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Access to the Battery Compartment</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>Control Electronics, Consisting of a Pulsomatic MKX SCR Controller Made by Cableform</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Titan 6000MF 12-Volt Auxiliary Battery and Controller</td>
<td>9</td>
</tr>
</tbody>
</table>
VERIFICATION TEST OF THE BATTRONIC MINI VAN

I. SUMMARY

The Battronic Mini Van, manufactured by Battronic, Inc., Boyertown, Pennsylvania, was tested during the period from 17 January 1978 to 10 April 1978. Complete test results are contained in Section V. Part of the verification test results are summarized below:

Acceleration: 50 km/h (31.1 mi/h) in 14 s.

Range: 88 km (54.7 mi), 259 cycles of SAE J227a/type B driving cycle.

Forward Speed: 70 km/h (43.5 mi/h) for 35.3 min on the MERADCOM test track with a 5-percent grade.

Gradeability at Speed: At 25 km/h (15.5 mi/h) can traverse a 14.7-percent grade based on calculation from acceleration tests at 80-percent battery depth of discharge (DOD).

Gradeability limit: 26.5-percent grade for 20 s (calculated).

II. INTRODUCTION

The Battronic Mini Van electric vehicle was operated to determine conformity to the Department of Energy Performance Standards for Demonstrations, published in the Federal Register, 30 May 1978, Part V. The results of that testing, as performed by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), as well as other descriptive data concerning the vehicle, are presented in this report.

III. OBJECTIVES

The objectives of this test were to examine the Battronic Mini Van for suitability of those aspects of vehicle and component operating characteristics as outlined by the Department of Energy’s “Performance Standards for Demonstration.”
IV. DESCRIPTION OF TEST VEHICLE

The Battronic Mini Van is a commercial vehicle for use primarily as a delivery van (Figures 1 and 2). The vehicle has a wheelbase of 2.39 m (94 in.) The Mini Van has a curb weight of 2664 kg (5860 lb) and has the capacity for a 426-kg (940-lb) payload, plus driver. The batteries for the Mini Van are made by the C&D Batteries Division of the Eltra Company and are configured as two modules, one on either side of the vehicle (Figure 3). The batteries have a 292-Ah capacity. They can be accessed from outside the vehicle or from the inside (Figures 4 and 5). In the front of the vehicle are the control electronics, consisting of a Pulsomatic MKX SCR controller made by Cableform. Also, the Titan 6000MF 12-volt auxiliary battery is located in the front of the vehicle (Figures 6 and 7).

The propulsion motor is a General Electric DC motor, rated at 31.3 kW (42 hp). The Mini Van has a Clark tube-type front axle, with leaf springs in the rear, and drum brakes all around. The tires are Firestone transport 110, 6-ply, 6.70 - 15, with a C-road range, and inflated to 45 lbf/in². The Mini Van uses an off-board Hertner 208-volt charger equipped with a timer, type SFR 56-330-S.

The Mini Van comes equipped with standard equipment, such as windshield wipers, windshield washer, defroster, and odometer. The Battronic has a gasoline heater, ammeter, and battery discharge meter. The Mini Van has a Boyertown-type body, manufactured by Battronic Van. (See the Appendix for the Vehicle Summary Data Sheet.)

V. TEST RESULTS

The following are the results of the Verification Test performed at MERADCOM during the period of 17 January 1978 to 10 April 1978. Paragraphs are referenced to the DOE “Performance Standards for Demonstrations” criteria.

(a) Acceleration. 50 km/h in 14 s.

(b) Gradeability at speed. At 25-km/h can traverse a 14.7-percent grade based on calculation from acceleration tests at 80-percent depth of battery discharge (DOD).

(c) Gradeability limit. The vehicle should start and climb forward on a 26.5-percent grade for at least 20 s based on drawbar pull tests at 80-percent DOD.

(d) Forward speed capability. The vehicle maintained 70 km/h for 35.3 min on the MERADCOM test track with a 5-percent grade.
Figure 2. Rear/side view of the Battronic Mini Van.
Figure 3. Side of vehicle showing one of two battery modules made by the C&D Division of the Eltra Company.
Figure 7. Titan 6000MF 12-volt auxiliary battery and controller.
(e) Range. SAE J227a cycle “B” on level (± 1%) terrain, 88 km, and 259 cycles.

(f) Battery recharge time. After an 80-percent discharge, recharged vehicle with a Hert-Hertner Model SFR 56-330-S off-board charger for 10 h. After the recharge, the vehicle went 50 km to an SAE J227a cycle “B” regime.

(g) Recharge control. Timer, with a maximum setting of 16 h.

(h) Energy consumption. The only nonelectrical energy used is for the gasoline-fueled heater.

(i) Battery life. No longevity tests were run specifically for verification of this criterion because of vehicle test period limitations.

(j) State-of-charge meter. The vehicle was equipped with a state-of-charge meter.

(k) Odometer. Yes.

(l) Passenger comfort heater. The vehicle was equipped with a gasoline-fueled heater.

(m) Documentation. None.

(n) Emissions. Did not evaluate.

(o) Safety. The Department of Transportation is performing these evaluations; however, MERADCOM performed the following limited checks:

(1) Electrical isolation. The Battronic Mini Van is designed to have a floating traction battery system. The frame system holding the batteries is not insulated.

(2) Safety standards 208 and 301. The Department of Transportation will check compliance.

(3) Battery caps are standard industrial battery types. Flame-barrier characteristics were not tested.
(4) Ventilation of battery compartment. There is no forced ventilation of the batteries.

(5) Battery emergency disconnect. The emergency disconnect breaks the main battery-motor circuit and is opened from inside the cab.

(6) Parked temperature effect. An 8-h hot soak at 50°C and an 8-h cold soak at -25°C revealed no operational problems at either temperature.
APPENDIX

VEHICLE SUMMARY DATA SHEET

1. Vehicle Manufacturer:

   Battronic Truck Corp.
   Third and Walnut St.
   Boyertown, PA 19512
   (215) 367-2146

2. Vehicle Description

   Name: Battronic Van
   Availability: In stock
   Model: M065MLB
   Price: $16,500

3. Vehicle Weight

   Curb Weight: 2582 kg (5860 lb)
   Gross Weight: 3084 kg (6800 lb)
   Payload Weight: 426.4 kg (940 lb)

4. Vehicle Size

   Wheelbase: 2.39 m (94 in.)
   Length: 3.683 m (145 in.)
   Width: 1.88 m (74 in.)

5. Auxiliaries & Options

   No. Lights: 28
   Type and Function: 2 head; 2 park
   a. 2 turn; 4 side markers
   b. Instruments on dash and dome — 16
   c. 1 backup; 1 tag
   Windshield Wipers: Yes
   Windshield Washers: Yes
Defroster: Yes  
Heater: Yes  
Radio: No  
Energy Gage: Yes  
Ampmeter: Yes  
Tachometer: No  
Speedometer: Yes  
Odometer: Yes  
No. Mirrors: 3  
Power Steering: No  
Power Brakes: No  
Transmission Type: Two-speed transfer box

6. Propulsion Batteries

Type: C&D  
Manufacturer: Eltra Co., C&D Batteries Div.  
No. of Modules: 2  
S/N: 8C03355 HEP 294  
No. Cells: 56  
Battery Voltage: 112V  
AH Capacity: 294 A-Hr  
Battery Module Size: H0.495 m (19¼ in.) W0.533 m (21 in.) L0.857 m (33¾ in.)  
Battery Module Weight: 572.7 kg (1260 lb)  
Battery Age: C-23L GH-R  
Battery Rate: 3 Hr

7. Auxiliary Battery

Type: 6000MF (GBC Group 27)  
Manufacturer: Titan  
No. Cells: 6  
Battery Voltage: 12V  
AH Capacity: 95 A-Hr  
Battery Size: H0.229 m (9 in.) W0.172 m (6¼ in.) L0.298 m (11¾ in.)  
Battery Rate: 20 Hr  
Battery Weight: 12.3 kg (27 lb)
8. Controller

Type: Pulsomatic MKX (SCR)
Manufacturer: Cableform, Inc.
Voltage Rating: 84-140 V
Current Rating: 600 A
Size: H0.152 m (6 in.) W0.076 m (3 in.) L0.132 m (5-3/16)

9. Propulsion Motor

Type: GE-DC
Manufacturer: General Electric
Insulation Class: H
Voltage Rating: 94V
Current Rating: 390 A
HP Rating: 31.33 kW (42 hp)
Size: 0.533 m (21 in.) x 0.330 m (13 in.) DIA
Weight: 154.2 kg (340 lb)
Rated Speed: 2300 r/min
Max. Speed: 6000 r/min

10. Body

Type: Boyertown Steel
Manufacturer: Battronic Van
No. Doors: 3
Type: 2 side, 1 rear
No. Windows: 11
Type: 4 ea. side, 2 windshields, 1 rear
No. Seats: 2
Type: Driver + passenger
Cargo Volume: 4.53 m³ (160 ft³)

11. Chassis

Type Frame: Box
Manufacturer: Boyertown
Type Material: Steel
Modifications: None
Type Springs: 2 ea. 6-leaf
Type Shocks: Telescopic
Clark Axle Type Front: Tube
Axle Type Rear: Hypoid gears, flange axle shafts
Axle Manufacturer: Spicer (DANA)
Drive Line Ratio: Transmission 1.96:1, Differential 3.07:1
Type Brakes Front: Drum
Type Brakes Rear: Drum
Regenerative Brakes: Yes
Tire Type: Transport 110, 6-Ply
Manufacturer: Firestone
Size: 6.70-15
Pressure: 310 kPa (45 lbf/in²) Load range (C)

12. Battery Charger

Type: SFR 56-330-S
Manufacturer: Hertner
Off Board: Off
Input Voltage: 208/240
Peak Current: 68 A
Recharger Timer: Yes
Size: H0.660 m (26 in.) W0.495 m (19½ in.) L0.711 m (28 in.)
Weight: 113.4 kg (250 lb)
Automatic Turn Off: Yes
<table>
<thead>
<tr>
<th>No. Copies</th>
<th>Addressee</th>
<th>No. Copies</th>
<th>Addressee</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Department of Defense</td>
<td>1</td>
<td>Commander</td>
</tr>
<tr>
<td></td>
<td>Director, Technical Information Projects Agency</td>
<td></td>
<td>US Army Troop Support &amp; Aviation Materiel Readiness Command</td>
</tr>
<tr>
<td></td>
<td>ATTN: DRSTS-MES (1)</td>
<td></td>
<td>4300 Goodfellow Blvd</td>
</tr>
<tr>
<td></td>
<td>Arlington, VA 22209</td>
<td></td>
<td>St Louis, MO 63120</td>
</tr>
<tr>
<td>1</td>
<td>Director Defense Nuclear Agency</td>
<td>1</td>
<td>Director</td>
</tr>
<tr>
<td></td>
<td>ATTN: TITL</td>
<td></td>
<td>Petrol &amp; Fld Svc Dept</td>
</tr>
<tr>
<td></td>
<td>Washington, DC 20305</td>
<td></td>
<td>US Army Quartermaster School</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fort Lee, VA 23801</td>
</tr>
<tr>
<td>1</td>
<td>Defense Technical Information Ctr</td>
<td>1</td>
<td>Commander</td>
</tr>
<tr>
<td></td>
<td>Cameron Station</td>
<td></td>
<td>US Army Electronics Research &amp; Development Command</td>
</tr>
<tr>
<td></td>
<td>Alexandria, VA 22314</td>
<td></td>
<td>Technical Library Division</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ATTN: DELSD-L</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fort Monmouth, NJ 07703</td>
</tr>
<tr>
<td>1</td>
<td>Commander, HQ TRADOC</td>
<td>1</td>
<td>HQ, 193D Infantry Brigade (Pan)</td>
</tr>
<tr>
<td></td>
<td>ATTN: ATEN-ME</td>
<td></td>
<td>ATTN: AFZU-FE</td>
</tr>
<tr>
<td></td>
<td>Fort Monroe, VA 23651</td>
<td></td>
<td>APO Miami 34004</td>
</tr>
<tr>
<td>1</td>
<td>Technical Library Chemical Systems Laboratory</td>
<td>1</td>
<td>Special Forces Detachment, Europe</td>
</tr>
<tr>
<td></td>
<td>Aberdeen Proving Ground, MD 21010</td>
<td></td>
<td>ATTN: PBO</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>APO New York 09050</td>
</tr>
<tr>
<td>1</td>
<td>Commander US Army Aberdeen Proving Ground</td>
<td>1</td>
<td>Commander</td>
</tr>
<tr>
<td></td>
<td>ATTN: STEAP-MT-U (GE Branch)</td>
<td></td>
<td>Rock Island Arsenal</td>
</tr>
<tr>
<td></td>
<td>Aberdeen Proving Ground, MD 21005</td>
<td></td>
<td>ATTN: SARRI-LPL</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rock Island, IL 61201</td>
</tr>
<tr>
<td>1</td>
<td>Director US Army Materiel Systems Analysis Agency</td>
<td>1</td>
<td>HQDA</td>
</tr>
<tr>
<td></td>
<td>ATTN: DRXSX-CM</td>
<td></td>
<td>ODCSLOG</td>
</tr>
<tr>
<td></td>
<td>Aberdeen Proving Ground, MD 21005</td>
<td></td>
<td>DALO-TSE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Room 1E588</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pentagon, Washington, DC 20310</td>
</tr>
<tr>
<td>1</td>
<td>Director US Army Materiel Systems Analysis Agency</td>
<td>1</td>
<td>Commander</td>
</tr>
<tr>
<td></td>
<td>ATTN: DRXSX-MP</td>
<td></td>
<td>Headquarters, 39th Engineer Battalion (Cbt)</td>
</tr>
<tr>
<td></td>
<td>Aberdeen Proving Ground, MD 21005</td>
<td></td>
<td>Fort Devens, MA 01433</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Commander and Director USA FESA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ATTN: FESA-TS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fort Belvoir, VA 22060</td>
</tr>
<tr>
<td>No. Copies</td>
<td>Addressee</td>
<td>No. Copies</td>
<td>Addressee</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1</td>
<td>Director</td>
<td>3</td>
<td>Security Ofc (for liaison officers), DRDME-S</td>
</tr>
<tr>
<td></td>
<td>US Army TRADOC Systems Analysis Activity</td>
<td>2</td>
<td>Tech Library, DRDME-WC</td>
</tr>
<tr>
<td></td>
<td>ATTN: ATAA-SL (Tech Lib)</td>
<td>1</td>
<td>Programs &amp; Anal Dir, DRDME-U</td>
</tr>
<tr>
<td></td>
<td>White Sands Missile Range, NM 88002</td>
<td>1</td>
<td>Pub Affairs Ofc, DRDME-I</td>
</tr>
<tr>
<td>1</td>
<td>HQ, USAEUR &amp; Seventh Army Deputy Chief of Staff, Engineer</td>
<td>1</td>
<td>Ofc of Chief Counsel, DRDME-L</td>
</tr>
<tr>
<td></td>
<td>ATTN: AEAEN-MT-P</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>APO New York 09403</td>
<td></td>
<td>Department of the Navy</td>
</tr>
<tr>
<td>1</td>
<td>HQ, USAEUR &amp; Seventh Army Deputy Chief of Staff, Operations</td>
<td>2</td>
<td>Commander, Naval Facilities Engineering Command</td>
</tr>
<tr>
<td></td>
<td>ATTN: AEAGC-FMD</td>
<td></td>
<td>Department of the Navy</td>
</tr>
<tr>
<td></td>
<td>APO New York, 09403</td>
<td></td>
<td>ATTN: Code 032-B 062</td>
</tr>
<tr>
<td>2</td>
<td>District Engineer</td>
<td></td>
<td>200 Stovall St</td>
</tr>
<tr>
<td></td>
<td>ATTN: SWFED-MF</td>
<td></td>
<td>Alexandria, VA 22332</td>
</tr>
<tr>
<td></td>
<td>FWD Corps of Engineers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P.O. 17300</td>
<td></td>
<td>US Naval Oceanographic Office</td>
</tr>
<tr>
<td></td>
<td>Fort Worth, TX 76102</td>
<td></td>
<td>Navy Library/NSTL Station</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bay St Louis, MD 39522</td>
</tr>
<tr>
<td>1</td>
<td>MERADCOM</td>
<td>1</td>
<td>Library (Code L08A)</td>
</tr>
<tr>
<td></td>
<td>Commander, DRDME-Z Technical Director, DRDME-ZT</td>
<td></td>
<td>Civil Engineering Laboratory</td>
</tr>
<tr>
<td></td>
<td>Assoc Tech Dir/R&amp;D, DRDME-ZN</td>
<td></td>
<td>Naval Construction Battalion Center</td>
</tr>
<tr>
<td></td>
<td>Assoc Tech Dir/Engrg &amp; Acq, DRDME-ZE</td>
<td></td>
<td>Port Hueneme, CA 93043</td>
</tr>
<tr>
<td></td>
<td>Spec Asst/Matl Amt, DRDME-ZG</td>
<td>1</td>
<td>Naval Training Equipment Center</td>
</tr>
<tr>
<td></td>
<td>Spec Asst/Scs &amp; Tech, DRDME-ZK</td>
<td></td>
<td>ATTN: Technical Library</td>
</tr>
<tr>
<td></td>
<td>CIRCULATE</td>
<td></td>
<td>Orlando, FL 32813</td>
</tr>
<tr>
<td>1</td>
<td>Chief, Ctrmine Lab, DRDME-N</td>
<td>3</td>
<td>Naval Weapons Center (Code 2605)</td>
</tr>
<tr>
<td></td>
<td>Chief, Engy &amp; Wtr Res Lab, DRDME-G</td>
<td></td>
<td>China Lake, CA 93555</td>
</tr>
<tr>
<td></td>
<td>Chief, Elec Pwr Lab, DRDME-E</td>
<td></td>
<td>Department of the Air Force</td>
</tr>
<tr>
<td></td>
<td>Chief, Camo &amp; Topo Lab, DRDME-R</td>
<td>1</td>
<td>HQ USAF/RDPT</td>
</tr>
<tr>
<td></td>
<td>Chief, Mar &amp; Br Lab, DRDME-M</td>
<td></td>
<td>ATTN: Mr. Allan Eaffy</td>
</tr>
<tr>
<td></td>
<td>Chief, Mech &amp; Constr Eqpt Lab, DRDME-H</td>
<td></td>
<td>Washington, DC 20330</td>
</tr>
<tr>
<td></td>
<td>Chief, Ctr Intrus Lab, DRDME-X</td>
<td>1</td>
<td>Mr. William J. Engle</td>
</tr>
<tr>
<td></td>
<td>Chief, Matl Tech Lab, DRDME-V</td>
<td></td>
<td>Chief, Utilities Branch</td>
</tr>
<tr>
<td></td>
<td>Director, Product A&amp;T Directorate, DRDME-T</td>
<td></td>
<td>HQ USAF/PREEU</td>
</tr>
<tr>
<td></td>
<td>CIRCULATE</td>
<td></td>
<td>Washington, DC 20332</td>
</tr>
<tr>
<td>100</td>
<td>Electrochemical Div, DRDME-EC</td>
<td>1</td>
<td>US Air Force</td>
</tr>
<tr>
<td>3</td>
<td>Tech Reports Ofc, DRDME-WP</td>
<td></td>
<td>HQ Air Force Engineering &amp; Services Ctr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Technical Library FL 7050</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tyndall AFB, FL 32403</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. Copies</td>
<td>Addressee</td>
<td>No. Copies</td>
<td>Addressee</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------------------------------------------------</td>
<td>-----------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Department of Transportation Library, FOB 10A, M494-6 800 Independence Ave., SW Washington, DC 20591</td>
<td>1</td>
<td>Department of Transportation Library, FOB 10A, TAD-494.6 800 Independence Ave, SW Washington, DC 20591</td>
</tr>
<tr>
<td>1</td>
<td>Mr. Carl Anderson Energy Technology Demonstration SM-ALC/XAE McClellen AFB, CA 95652</td>
<td>1</td>
<td>A. D. Little ATTN: Brad Underhill 15 Acorn Park Cambridge, MA 02140</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>1</td>
<td>Advanced Ground Systems Eng ATTN: Dr. George Gelb 3270 E. 70th Street Long Beach, CA 90805</td>
</tr>
<tr>
<td>1</td>
<td>Professor Raymond R. Fox School of Engineering and Applied Science George Washington University Washington, DC 20052</td>
<td>1</td>
<td>Airesearch Manufacturing Co ATTN: Bob Rowlett Program Manager 2525 W. 190th Street Torrance, CA 90509</td>
</tr>
<tr>
<td>3</td>
<td>Battronic Truck Corp Third &amp; Walnut St Boyertown, PA 14512</td>
<td>1</td>
<td>Argonne National Labs ATTN: Al Chilenskas 9700 South Cass Avenue Argonne, IL 60439</td>
</tr>
<tr>
<td></td>
<td><strong>Department of Energy</strong></td>
<td>1</td>
<td>Billings Energy Corporation ATTN: Mr. Hadden P.O. Box 555 Provo, UT 84601</td>
</tr>
<tr>
<td>200</td>
<td>ATTN: Walter J. Dippold 1000 Independence Ave Mail Stop SH044 Room 5H063 Forrestal Bldg Washington, DC 20585</td>
<td>1</td>
<td>Booz, Allen &amp; Hamilton Inc John F. Wing Transportation Consulting Div 4330 East West Highway Bethesda, MD 20014</td>
</tr>
<tr>
<td>1</td>
<td>Albert Cook International Lead Zinc Research Organization, Inc 292 Madison Ave New York, NY 10017</td>
<td>1</td>
<td>Borisoff Engineering Co 7726 Burnet Ave Van Nuys, CA 91405</td>
</tr>
<tr>
<td>1</td>
<td>Bernie Wachter DAO Corp 2101 L Street NW Washington, DC 20037</td>
<td>1</td>
<td>Cooper Development Association ATTN: Donald K. Miner, Manager 430 N. Woodward Ave Birmingham, MI 48011</td>
</tr>
<tr>
<td>1</td>
<td>C. Joseph Venuto 3043 Walton Road Plymouth Meeting, PA 19462</td>
<td>1</td>
<td>Cornell University Joe Rosson, Associate Director School of Engineering Phillips Hall Ithaca, NY 14853</td>
</tr>
<tr>
<td>1</td>
<td>J. Hampton Barnett Energy Demonstration &amp; Technology 109 United Bank Building Chattanooga, TN 37401</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>No. Copies</td>
<td>Addressee</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1          | Department of Industry, Trade, & Commerce  
Fred Johnson, Special Vehicle Div  
Transportation Industries Branch  
Ottawa, Canada, K1A085 |
| 1          | Department of Transportation  
Transportation Systems Center  
ATTN: Dr. Norman Rosenburg  
Cambridge, MA 02142 |
| 1          | Electric Power Research Institute  
ATTN: Dr. Fritz R. Kalhammer |
| 1          | Energy Research and Development Corp  
ATTN: R. Childs, President  
9135 Fernwood Drive  
Olmsted Falls, OH 44138 |
| 1          | ESB, Inc.  
5 Penn Center Plaza  
Philadelphia, PA 19103 |
| 1          | General Electric  
Corporate Research & Development  
ATTN: Gene Rowland  
Program Manager  
P.O. Box 8  
Schenectady, NY 12301 |
| 1          | General Research Corporation  
ATTN: John Brennand  
5383 Hollister Avenue  
Santa Barbara, CA 93105 |
| 1          | General Services Administration  
Federal Supply Service  
ATTN: Mel Globeman  
Washington, DC 20406 |
| 1          | General Services Administration  
Federal Supply Service  
ATTN: R. L. Ullrich  
Washington, DC 20406 |
| 2          | Jet Propulsion Laboratory  
ATTN: T. Barber  
4800 Oak Grove Drive  
Pasadena, CA 91103 |
|            | Los Alamos Scientific Labs  
Byron McCormick  
P.O. Box 1663  
Los Alamos, New Mexico 87545 |
|            | NASA — Lewis Research Center  
ATTN: J. S. Fordyce  
MS: 309-1  
21000 Brookpark Road  
Cleveland, OH 44135 |
|            | NASA — Lewis Research Center  
ATTN: H. J. Schwartz  
MS: 500-215  
21000 Brookpark Road  
Cleveland, OH 44135 |
|            | Petro-Electric Motors, Ltd  
ATTN: Victor Wouk, Consultant  
342 Madison Avenue, Suite 831  
New York, NY 10017 |
|            | Purdue University  
IIES  
A.A. Potter Engineering Center  
ATTN: Dr. R. E. Goodson  
W. Lafayette, IN 47907 |
|            | Society of Automotive Engineers, Inc  
William Toth, Staff Engineer  
400 Commonwealth  
Warrendale, PA 15096 |
|            | United States Postal Service  
ATTN: Dick Bowman  
Office of Fleet Mgmt  
Delivery Services Dept  
Washington, DC 20260 |
|            | United States Postal Service  
ATTN: Donn Crane, Director  
Office of Fleet Mgmt  
Delivery Services, Dept  
Washington, DC 20260 |
<table>
<thead>
<tr>
<th>No. Copies</th>
<th>Addressee</th>
</tr>
</thead>
</table>
| 1          | United States Postal Service  
              Research & Development Lab  
              ATTN: Lewis J. Gerlach  
              Program Manager  
              11711 Park Lawn Drive  
              Rockville, MD 20852 |
| 1          | United States Postal Service  
              ATTN: Thomas W. Martin, Manager  
              Vehicle Services Branch  
              Western Region  
              San Bruno, CA 94099 |
| 1          | University of California  
              Jack Bolger  
              Lawrence Berkeley Labs  
              Berkeley, CA 94720 |
| 1          | Westinghouse R&D Center  
              ATTN: G. Frank Pittman, Jr.  
              1310 Beulah Road  
              Pittsburgh, PA 15235 |
| 1          | Marjorie L. McClanahan  
              Chemical Process Unit  
              Materials Technology  
              Aeronutronic Division  
              Ford Aerospace &  
              Communications Corporation  
              Ford Road  
              Newport Beach, CA 92663 |
| 1          | Clinton Christianson  
              Argonne National Laboratory  
              9700 South Lass Avenue  
              Argonne, IL 60439 |
| 1          | F. J. Liles  
              705 Buffalo Drive  
              Arlington, TX 76013 |
| 1          | C. Grandy  
              Union Electric Co.  
              P.O. Box 149  
              St Louis, MO 63166 |