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Report 2354

BASELINE AND VERIFICATION TESTS OF THE UNIQUE MOBILITY, INC. ELECTREK 2+2

by
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and
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March 1982

U.S. ARMY MOBILITY EQUIPMENT
RESEARCH AND DEVELOPMENT COMMAND
FORT BELVOIR, VIRGINIA

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The Electrek 2+2 by Unique Mobility, Inc. is a custom-designed vehicle with a molded fiberglass and polycarbonate body. It was tested by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM) at Fort Belvoir, Virginia, as part of the Department of Energy (DOE) project to characterize the state-of-the-art of electric vehicles. The vehicle is powered by 16 6-volt lead-acid batteries through a transistorized controller to a 32-hp modified shunt wound electric motor. It has 4-speed manual transmission and disc brakes in front with drum in the rear and is equipped with regenerative deceleration.

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PREFACE

The electric and hybrid vehicle test was conducted by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM) under the guidance of the U.S. Department of Energy (DOE).

Michael E. Johnson, P.E., of VSE Corporation was responsible for aspects of calibration of the signal conditioning circuits and recording instruments and for tabulations, plotting, and preparation of the report.

Computer programming and data tabulation and analysis were performed by Guy Woodward of Control Data Corporation and Arthur Nickless of the Systems Technology and Management Division, Management Information Systems Directorate, MERADCOM.

Aubrey Thomas, James A. Queen, and Calvin T. Bushrod of the Environmental and Field Division, Product Assurance and Testing Directorate, assisted in vehicle operation and data collection.

CONTENTS

CONTENTS (Cont'd)

ILLUSTRATIONS

ILLUSTRATIONS (Cont'd)

ILLUSTRATIONS (Cont'd)

TABLES

BASELINE AND VERIFICATION TESTS OF THE

UNIQUE MOBILITY, INC. ELECTREK 2+2

I. SUMMARY

Unique Mobility, Inc. is the manufacturer of the Electrek, Model 2+2, electric vehicle. The vehicle was tested under the direction of MERADCOM from 8 August 1980 to 29 May 1981. The tests are part of a Department of Energy project to assess advances in electric vehicle design. This report presents the performance test results on the Electrek 2+2.

The Unique Mobility Electrek 2+2 is custom designed as an electric vehicle. The Electrek 2+2 has a fiberglass and polycarbonate body that has an enclosed battery tunnel running up the center of the vehicle and a motor compartment which is almost completely enclosed on the underside.

The propulsion system is made up of a Soleq controller, a specially modified General Electric shunt wound 32-hp electric motor, and 16 6-V Globe-Union batteries. The Electrek 2+2 has regenerative braking. Further details of the vehicle are included in the Vehicle Summary Data Sheet, Appendix A.

The results of the testing are given in Table 1. For the SAE J227a cycle tests, there are two groupings of tests: One in which the coast portion of the tests was not used for regenerative braking, and one in which it was. When the coast portion was used for regenerative braking, ranges varied depending on which gears were used, so this information is also included in the table. For more detail concerning the effect of regenerative braking on the cycle tests, see Section VI, Test Procedures, paragraph d, Range Tests (Driving Cycles). Tests were run with the maximum controller current limit adjusted from the nominal 300A maximum to a nominal 360A maximum. These tests are included for completeness in Appendix B. Also, two C-cycle tests, run in first gear only, and two D-cycle tests run in first and second gear only were performed. These results appear in Appendix C. The effect of using these lower gear ranges can be noted by comparison with the results of Table 1.

II. INTRODUCTION

The vehicle tested and the data presented in this report are in support of Public Law 94-413 enacted by Congress on 17 September 1976. The law requires the Department of Energy to develop data characterizing the state-of-the-art with respect to electric and hybrid vehicles. The data so developed are to serve as a baseline to compare improvements in elec-

Table 1. Test Results (Metric)

Date	Test Type	Gears Used	Range (km)	Cycles	Battery Energy (d.c.) Disch (kWh)	Battery Energy (d.c.) Chg (kWh)	Energy From Charger Into Battery (kWh)	Energy Into Charger* (a.c.) (kWh)	Charger Efficiency (%)	Vehicle Energy Economy (kWh/km)	Start of Test Time	Start of Test Wind (km/h)	Start of Test Temp (°C)	End of Test Time	End of Test Wind (km/h)	End of Test Temp (°C)
3 Sep 80	56.3 km/h	3rd	99.8		12.88	0.14	12.35	13	95	0.130	0950	calm	23.9	1140	calm	29.4
10 Sep 80	72.4 km/h	3rd	71.3		11.39	0.49	21.61	22	98	0.309	1250	16.7	23.9	1345	14.8	25.6
12 Sep 80	56.3 km/h	2nd	102.5		13.33	0.86	69.3	71	98	0.693	0745	calm	12.8	1005	calm	18.3
16 Sep 80	72.4 km/h	3rd	76.3		11.94	0.49		19.9		0.261	0720	calm	16.7	0825	calm	17.8
17 Sep 80	88.5 km/h	4th	50.0		9.79	0.06		18.7		0.374	0745	calm	23.3	0820	calm	23.9
18 Sep 80	88.5 km/h	4th	44.1		9.48	0.06		20.8		0.472	0715	calm	22.8	0743	calm	22.8
25 Sep 80	88.5 km/h	4th	47.0		9.80	0.06	15.79	19.8	80	0.421	1240	calm	23.9	1320	calm	24.4
16 Oct 80	"C" Cycle	1st	63.4	125	15.66	3.56	19.55	20.5	95	0.323	0748	calm	17.8	1048	calm	23.9
17 Oct 80	"C" Cycle	1st & 2nd	81.6	150	17.03	1.75	25.83	27.2	75	0.333	0915	calm	20.0	1248	calm	25.6
23 Oct 80	"D" Cycle	1, 2, 3	64.8	41	13.15	1.07	21.83	26.6	82	0.410	0845	calm	6.7	1015	calm	16.1
1 Dec 80	"B" Cycle	1st	89.6	284	16.36	2.69	37.37	39.2	95	0.438	1000	4.8	9.4	1550	4.8	16.7
8 Dec 80	40.2 km/h		150.1		15.9	0.86	20.04	36	77	0.173	0800	calm	5.6	1145	4.8	12.2
10 Dec 80	40.2 km/h		140.1		15.21	0.93	25.75	39.5	65	0.282	0835	9.6	9.4	1205	9.6	10.0
17 Feb 81	"B" Cycle	1st	86.4	266	20.06	2.44	37.08				0930	8.0	11.1	1500	3.2	16.7
27 Mar 81	"B" Cycle	1st	85.9	263	17.41		37.6	40.4	93	0.470	0835	8.0	11.1	1420	1.2	15.0

*In some instances the battery charger overcharged the battery by remaining in high-charge mode.

tric and hybrid vehicle technologies, to assist in establishing performance standards for electric and hybrid vehicles, and to help guide future research and development activities.

MERADCOM, under the direction of the Electric and Hybrid Research, Development, and Demonstration Office, Division of Transportation Energy Conservation, DOE, has conducted track tests of electric vehicles to measure their performance characteristics and vehicle component efficiencies. The tests were conducted using a DOE test procedure "ERDA-EHV-TEP," described in Appendix A of MERADCOM Report 2244.[1] This procedure uses the "Electric Vehicle Test Procedure SAE J227a," revised February 1976. U.S. customary units were used in the collection, and reduction of data are shown in Table 2. The units were converted to the Internation System of Units for presentation in this report. U.S. customary units are presented in parentheses. Number values are truncated to reflect nominal values except where the precision is required.

III. OBJECTIVES

The characteristics of interest for the Unique Mobility Electrek 2+2 electric vehicle are: range at constant speed, range when operated in a selected driving pattern, maximum acceleration, gradeability limit, road energy, road power, and vehicle energy economy.

IV. TEST VEHICLE DESCRIPTION

a. Description. The Unique Mobility Electrek Model 2+2 electric vehicle was designed as an electric vehicle. The body is of fiberglass and polycarbonate (Figures 1 and 2). The motor area, in the front of the vehicle, is almost completely shielded with underbody. Also located in this area is the battery charger, the controller, the auxiliary battery, and the motor and traction battery tunnel blowers (Figures 3, 4, and 5). The traction battery consists of 16 6-V Globe-Union EV4-19 batteries, configured as 4 groups of 4 batteries in each of 4 sections of a flexible "muffin" style battery tray which slides into the vehicle battery tunnel (Figures 6, 7, and 8). The tunnel is sealed at the rear with a door (Figure 9). Clearly visible is the aluminum air inlet tube for the ventilation system.

(1) The Electrek, true to its 2+2 designation, has two full-sized front passenger seats and two smaller rear seats. The door windows, both driver and passenger side, are unusual. They are composed of two sections. One is fixed, and the other is shaped like the slice of a pie, positioned as a large vent window, pivoting at its apex at the top of the door and swinging back to open (Figure 10). The whole interior is upholstered in a tan velour. The Electrek has the standard instrumentation found in an internal combustion engine auto: speedometer, odometer, directional signal and high beams light controls, hazard light switch,

[1] E. J. Dowgiallo, Jr., C. E. Bailey, Jr., I. R. Snellings, and W. H. Blake, "Baseline Tests of the EVA Metro Electric Passenger Vehicle," MERADCOM Report 2244 (July 1978).

Table 2.. Test Results (U.S. Customary Units)

Date	Test Type	Gears Used	Range (mi)	Cycles	Battery Energy (d.c.) Disch (kWh)	Battery Energy (d.c.) Chg (kWh)	Energy From Charger Into Battery (kWh)	Energy Into Charger* (a.c.) (kWh)	Charger Efficiency (%)	Vehicle Energy Economy (kWh/mi)	Start of Test Time	Start of Test Wind (mi/h)	Start of Test Temp (°F)	End of Test Time	End of Test Wind (mi/h)	End of Test Temp (°F)
3 Sep 80	35 mi/h	3rd	62.0		12.88	0.14	12.35	13	95	0.210	0950	calm	75	1140	calm	85
10 Sep 80	45 mi/h	3rd	44.3		11.39	0.49	21.61	22	98	0.496	1250	10.4	75	1345	0.2	78
12 Sep 80	35 mi/h	2nd	63.7		13.33	0.86	69.3	71	98	1.115	0745	calm	55	1005	calm	65
16 Sep 80	45 mi/h	3rd	47.4		11.94	0.49		19.9		0.481	0720	calm	62	0825	calm	64
17 Sep 80	55 mi/h	4th	31.1		9.79	0.06		18.7		0.602	0745	calm	74	0820	calm	75
18 Sep 80	55 mi/h	4th	27.4		9.48	0.06		20.8		0.759	0715	calm	73	0743	calm	73
25 Sep 80	55 mi/h	4th	29.2		9.80	0.06	15.79	19.8	80	0.679	1240	calm	75	1320	calm	76
16 Oct 80	"C" Cycle	1st	49.4	125	15.66	3.56	19.55	20.5	95	0.520	0748	calm	64	1048	calm	75
17 Oct 80	"C" Cycle	1st & 2nd	50.7	150	17.03	1.75	25.83	27.2	95	0.536	0915	calm	68	1248	calm	78
23 Oct 80	"D" Cycle	1, 2, 3	40.3	41	13.15	1.07	21.83	26.6	82	0.660	0845	calm	44	1015	calm	52
1 Dec 80	"B" Cycle	1st	55.7	284	16.36	2.69	37.37	39.2	95	0.704	1000	3	49	1550	3	62
8 Dec 80	25 mi/h		93.3		15.9	0.86	20.04	26	77	0.279	0800	calm	42	1145	3	54
10 Dec 80	25 mi/h		87.1		15.21	0.93	25.75	39.5	65	0.454	0835	6	49	1205	6	50
17 Feb 81	"B" Cycle	1st	43.7	266	20.06	2.44	37.08				0930	5	52	1500	2	62
27 Mar 81	"B" Cycle	1st	53.4	263	17.41		37.6	40.4	93	0.757	0835	5	52	1420	8	59

*In some instances the battery charger overcharged the battery by remaining in high-charge mode.

Figure 1. Front of Electrek 2+2.

Figure 2. Rear of Electrek 2+2.

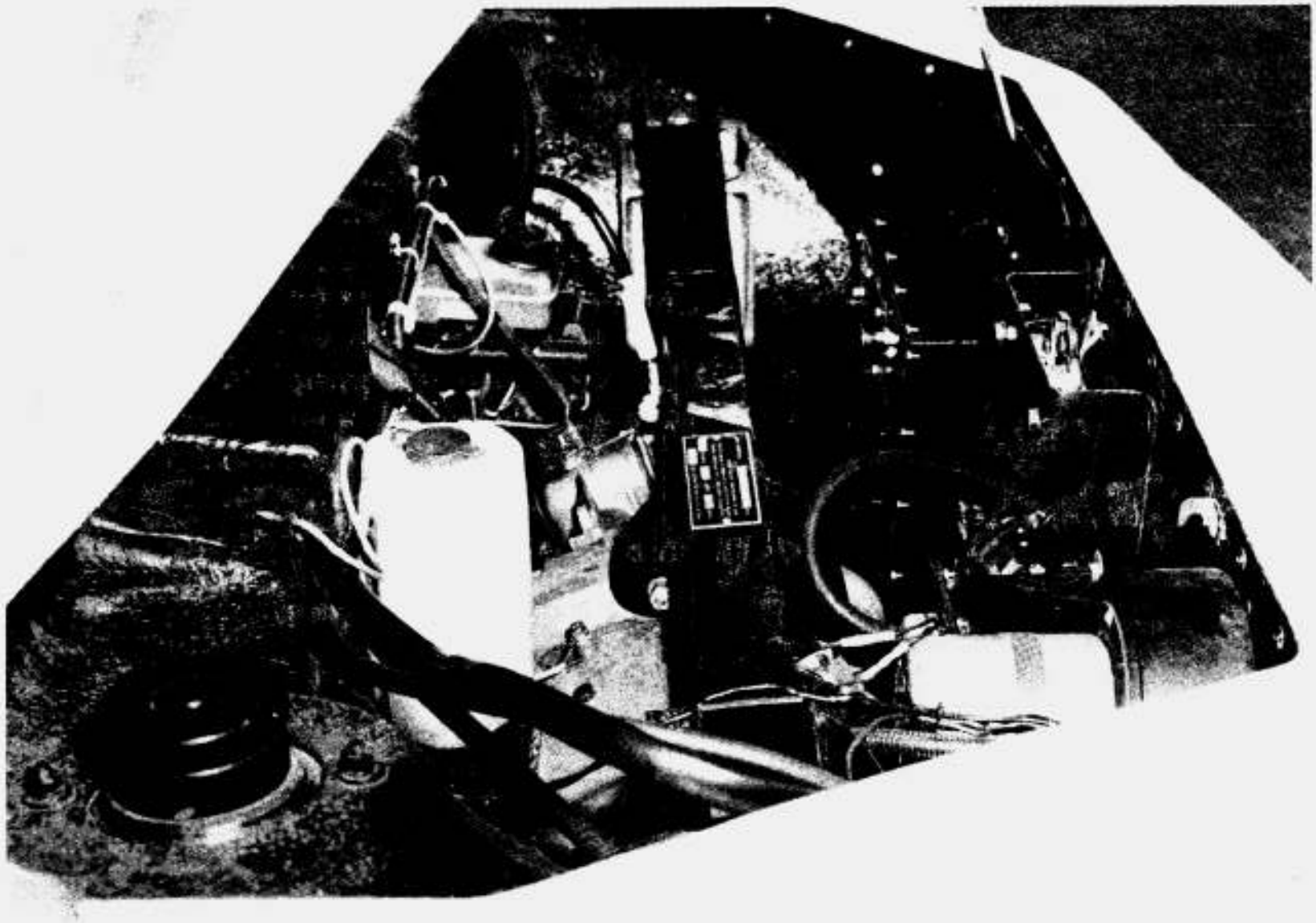


Figure 3. Motor compartment from right side.

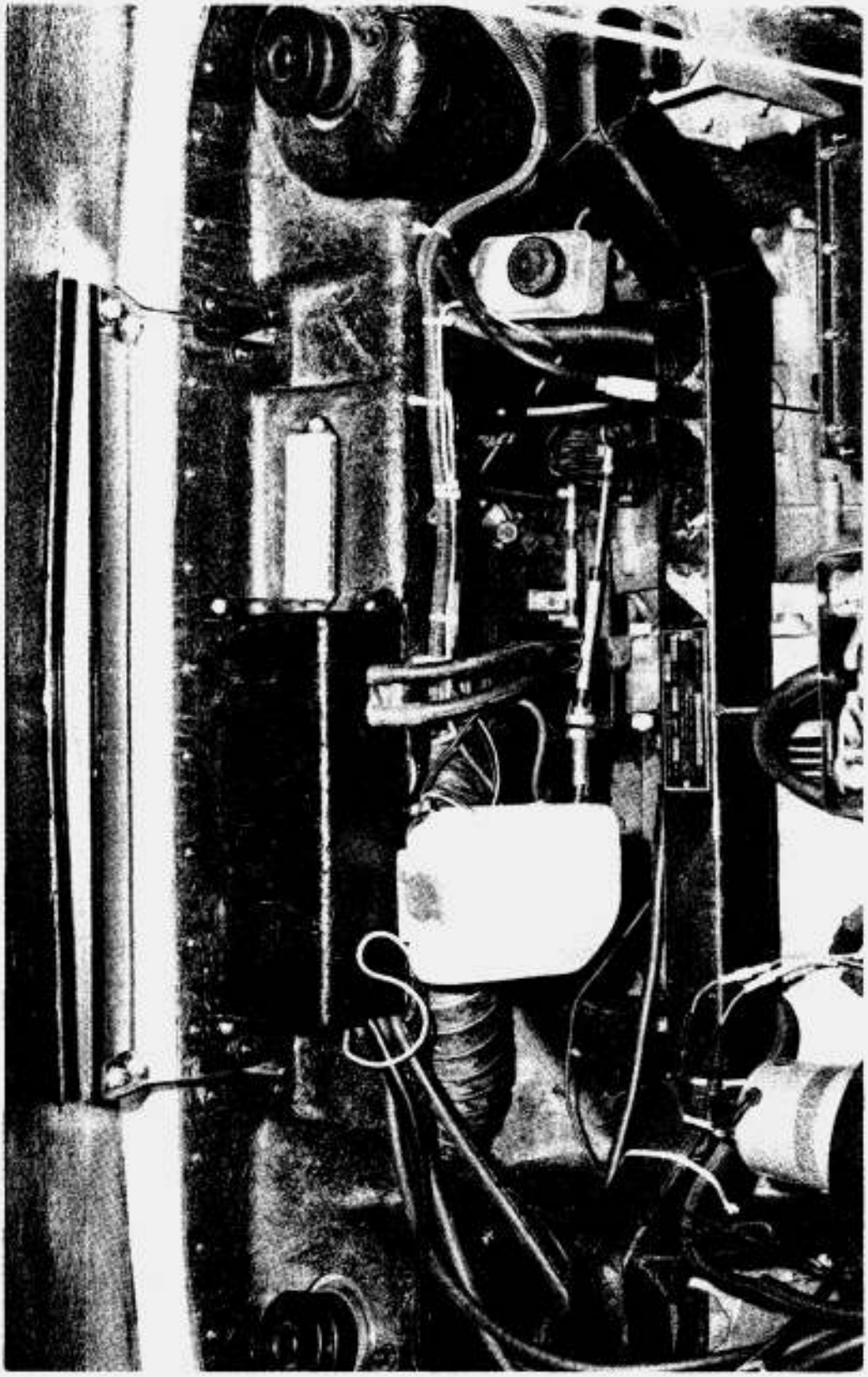


Figure 4. Motor compartment from front.

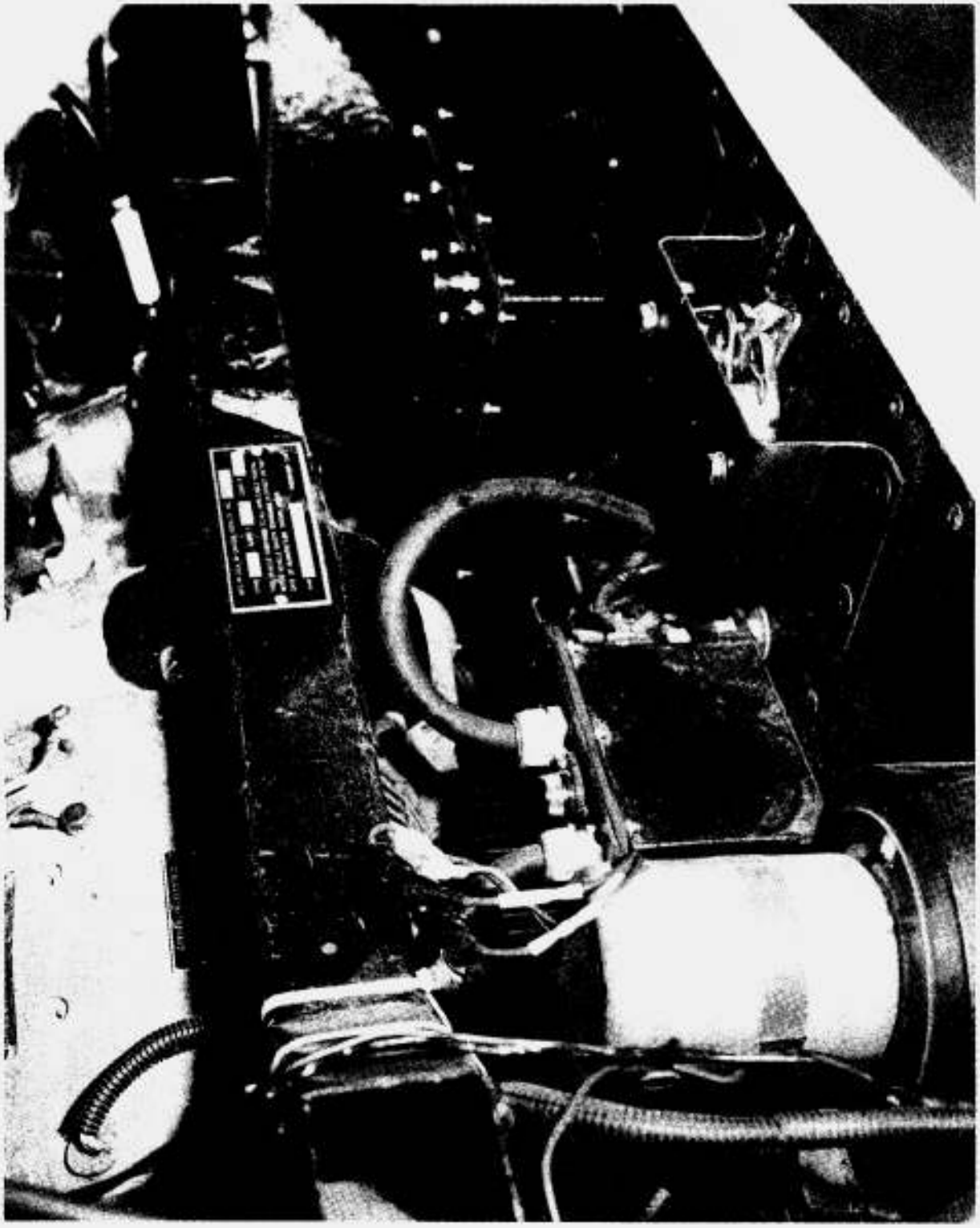


Figure 5. Closeup of motor from right side.

Figure 6. Electrek 2+2 battery pack extracted from tunnel.

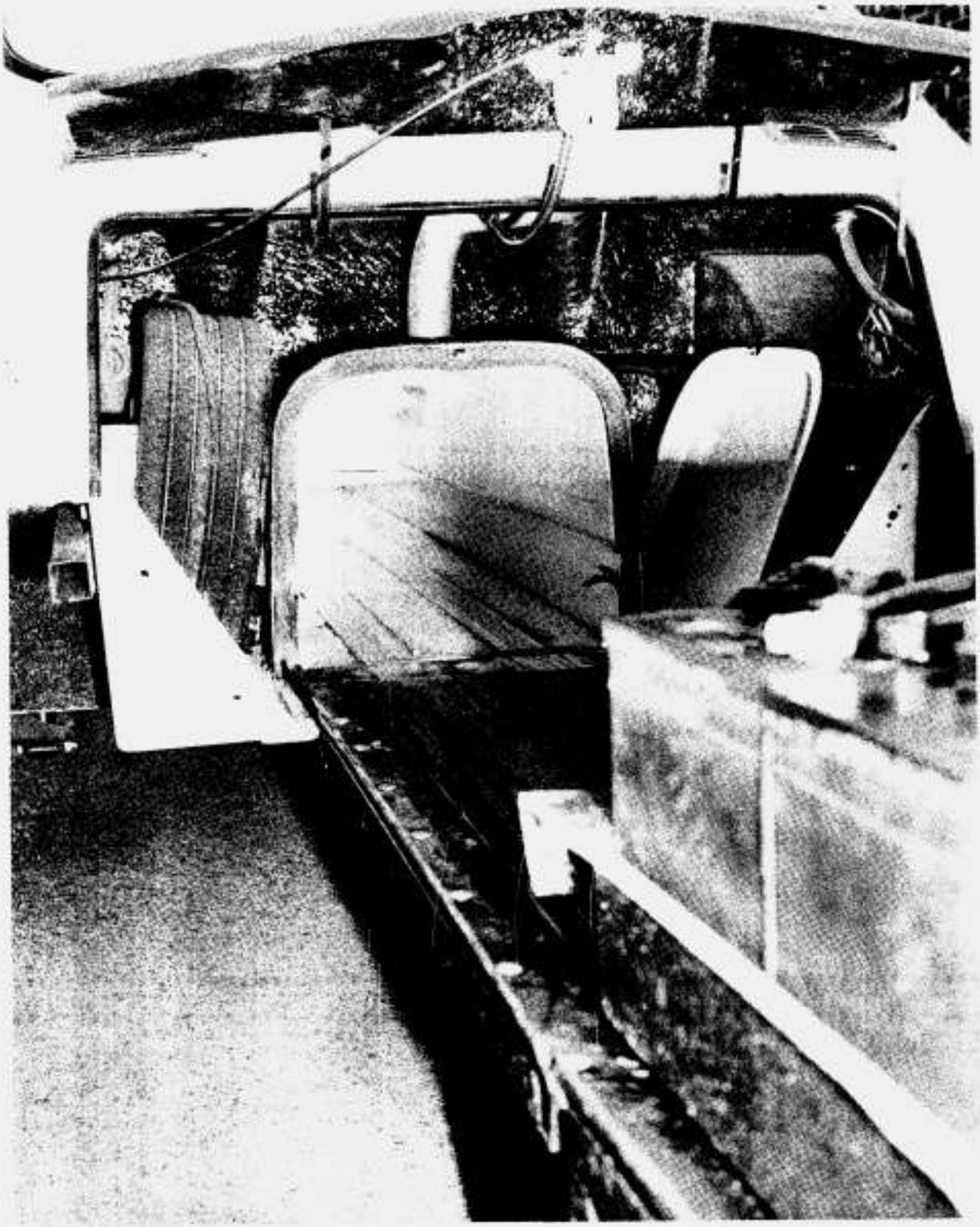


Figure 7. Closeup of enclosed battery pack tunnel.

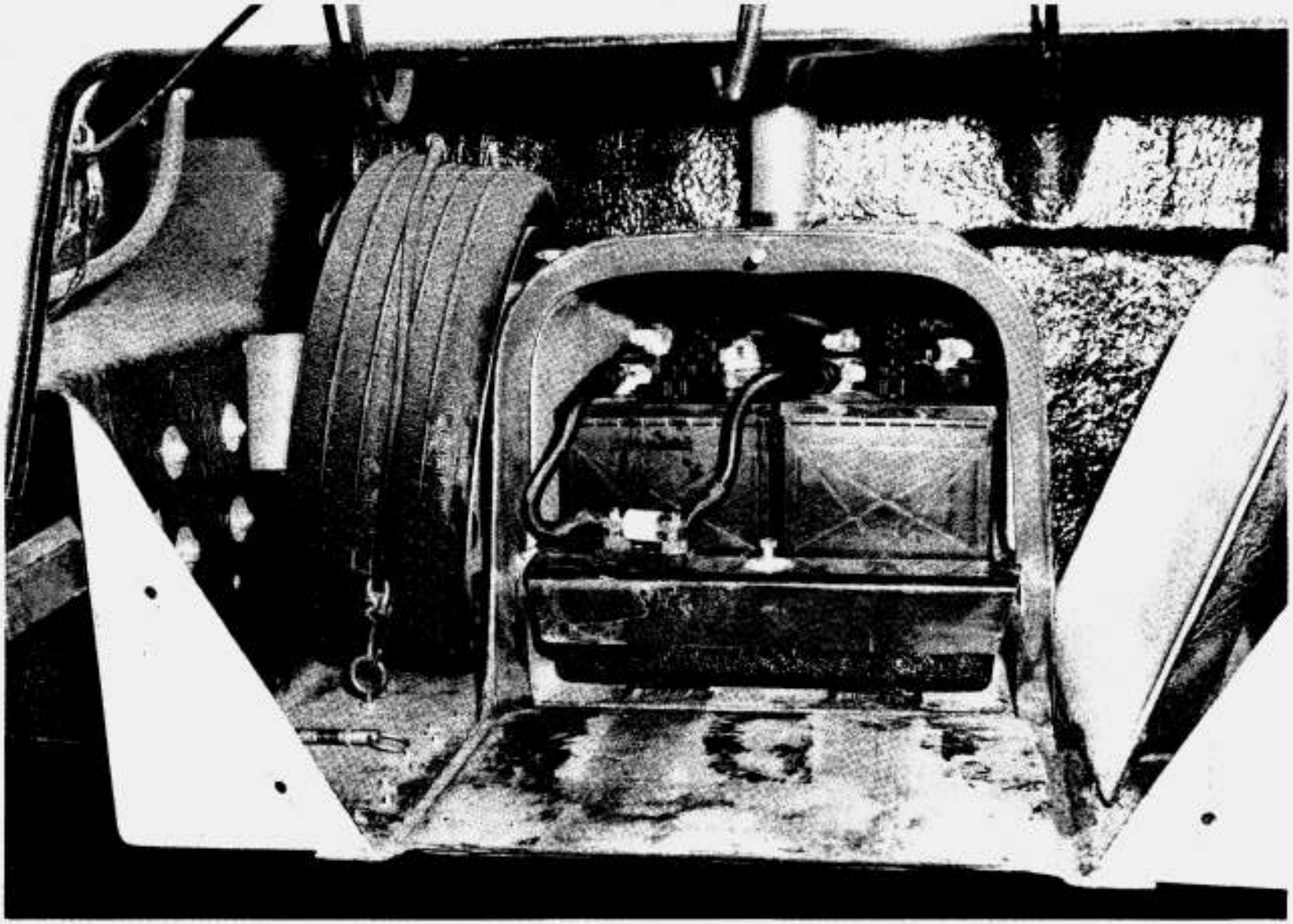


Figure 8. Battery pack in battery pack tunnel.

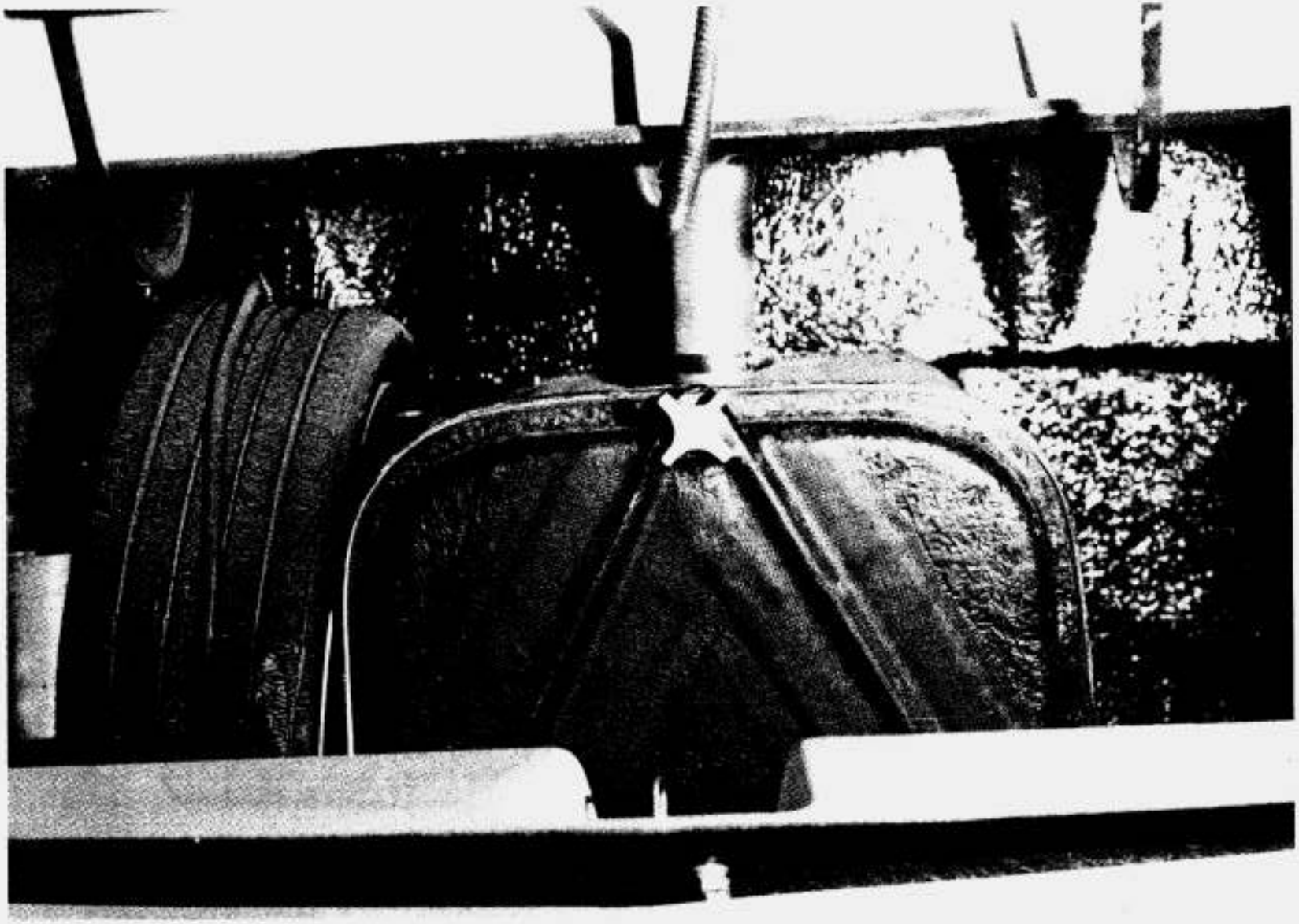


Figure 9. Closed battery pack tunnel.

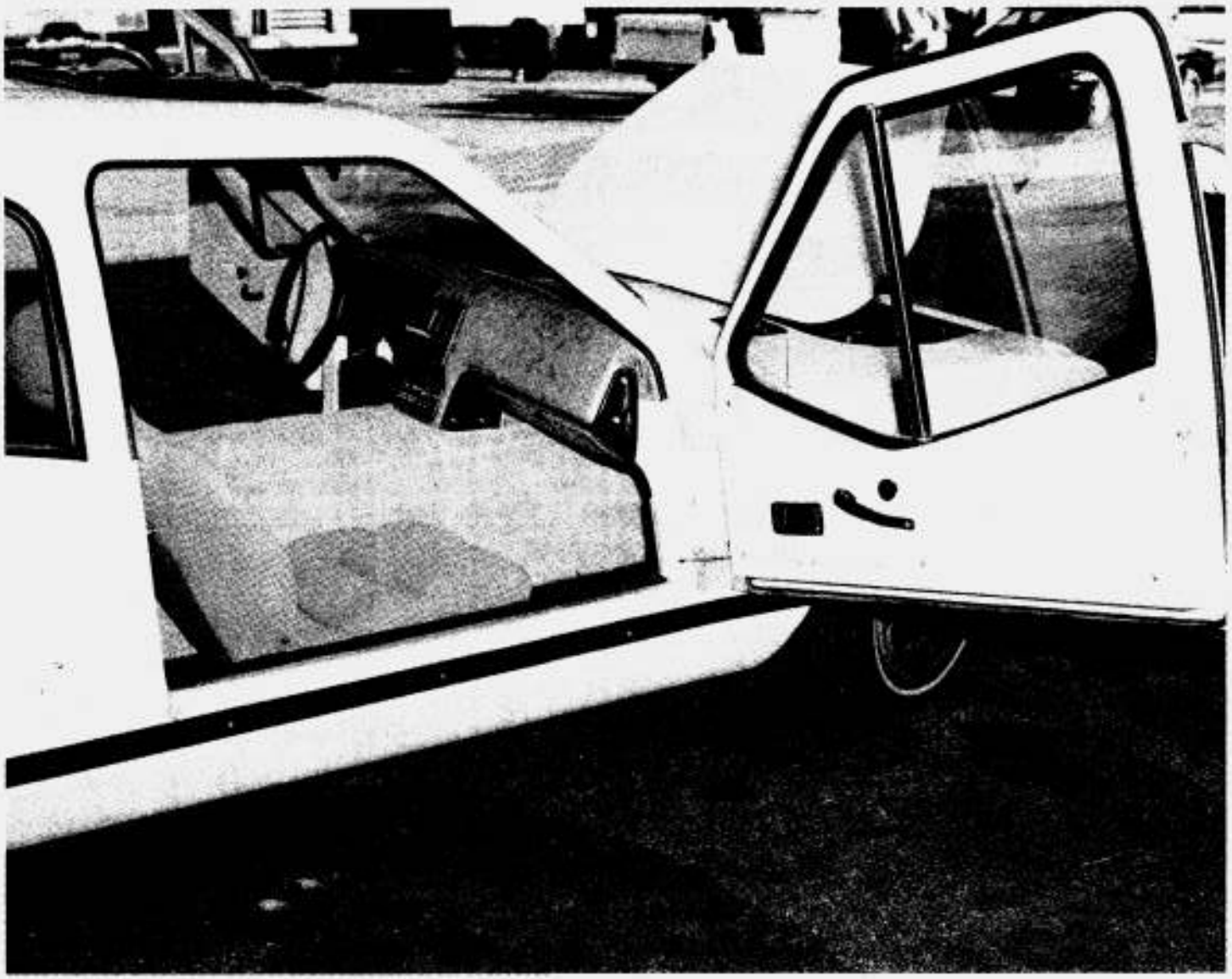


Figure 10. Electrek 2+2 interior from right side.

and hand-brakes-engaged light. It also contains a complement of electric vehicle instrumentation consisting of: motor temperature overheat light, d.c. voltmeter (indicating traction battery voltage), d.c. ampmeter (indicating traction battery current), an Anderson Power Products battery capacity meter, and seven indicators LEDS (Figure 11).

(2) The Anderson Power Products battery capacity meter is designed to show the state of charge of the Electrek traction battery. The meter is calibrated to the Electrek's traction battery system, including the effect of the cables. The unit is designed with the specific charge-discharge characteristics of the vehicle's Globe-Union batteries in order to obtain battery capacity by monitoring traction battery voltage over time and extrapolating ampere-hours into and out of the battery.

(3) The seven light-emitting diodes (LED) monitoring specific traction system conditions are defined as follows:

- Power On: Traction system activated.
- Battery Rev: Traction battery polarity incorrect.
- Low Voltage: Traction battery voltage below approximately 78 V, with prolonged operation in the current limit mode.
- High Voltage: Traction battery voltage excessive.
- Arm Chopper: Armature current being limited by chopping, r/min which is most likely to occur at low motor r/min.
- Logic Off: Any controller failure affecting the logic, and thus the operation of the controller itself.
- Overheat: An overheating condition of the controller.

b. **Operating Characteristics.** The Electrek has a standard accelerator, brake, clutch, and steering configuration. The vehicle uses a Soleq controller, which controls field current to maximize the efficiency of a GE shunt wound d.c. motor which was modified by Soleq for use with its controller (Figure 12). The controller uses a transistor chopper circuit to current-limit the armature current. This current-limit function occurs during the low-r/min, high-torque period of acceleration from a standing start, when it would be possible to draw excessive armature currents. A similar condition exists when the traction battery is nearly depleted and the traction battery currents become great enough to require armature current limiting. These situations are evident when the Armature Chopper LED comes on. Most control of the motor performance is done by adjusting the field of the motor, taking advantage of the characteristics of a shunt controlled motor. An added benefit of using a shunt motor is a more easily implemented regeneration braking scheme. The Soleq battery charger

Figure 11. Electrek 2+2 indicators.

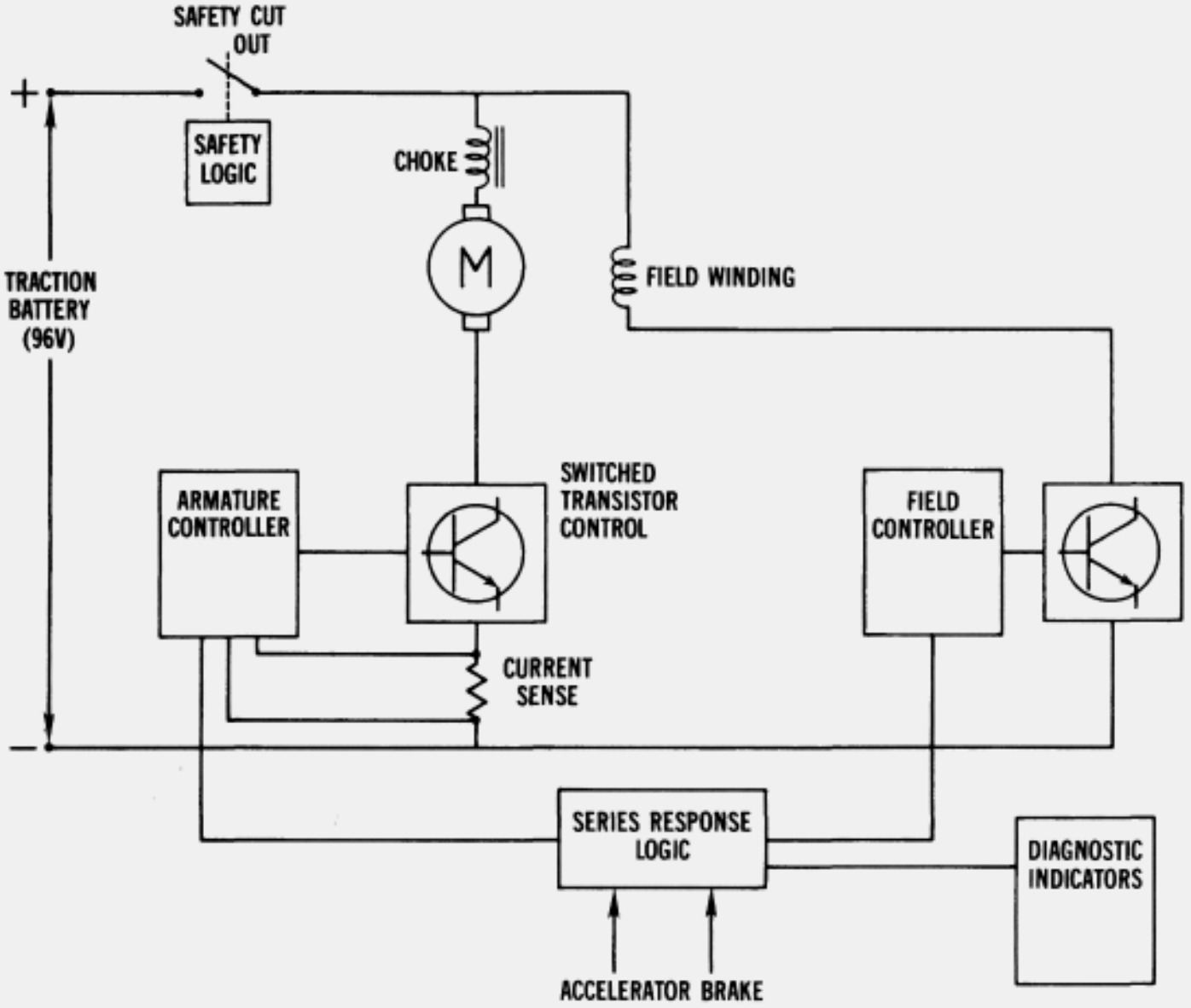


Figure 12. Unique Mobility Electrek controller pictorial.

is a 115-V unit with a transformerless design which uses a ground fault current sensor to open the a.c. circuit to the charger in case the a.c. circuit develops an unbalanced current of more than 4-5 mA (Figure 13). The Unique Mobility Electrek 2+2 uses a small motorcycle-style 12-V battery for the auxiliary system. There is a d.c.-d.c. converter (also made by Soleq) which is designed to provide most of the necessary accessory current and charge the auxiliary battery.

V. INSTRUMENTATION

The Electrek was instrumented with a Labeco fifth wheel to provide accurate speed and range information. The traction battery voltage and current were monitored and preconditioned for the recorder. These data were electronically multiplied to give an instantaneous power and then were averaged. Other averaged outputs are the average traction battery voltage, average current, and average power. An Ohio Semitronics Hall Effect Watthour meter was also used to provide a concurrent reading of traction system power and energy during the tests and during recharge of the traction battery. These data are recorded on a Lockheed Store 7 FM recorder. Details of the recorder are given in Appendix D of MERADCOM Report 2244.

VI. TEST PROCEDURES

The tests were performed at the MERADCOM test facility, Fort Belvoir, and at the Aberdeen Proving Ground (APG) test facility at Aberdeen, Maryland. When the vehicle was delivered to MERADCOM, the pretest checks described in Appendix F of MERADCOM Report 2244 were conducted. A shakedown run was performed to familiarize the driver with the operating characteristics of the vehicle and to verify proper operation of all instrumentation systems. All tests were run in accordance with the DOE Electric and Hybrid Vehicle Test and Evaluation Procedures, Appendix A of MERADCOM Report 2244. All tests were performed with a full load of 227 kg (500 lb).

a. **Maximum Speed.** The maximum speed of the vehicle is measured during the acceleration coast-down tests. It is defined as the maximum speed that can be reached on the Aberdeen Proving Ground 3-mi straightaway track under full power.

b. **Maximum Cruise Speed.** The MERADCOM facility has a 2.0-km (1.24-mi) loop with a total of 1.46 km (0.91 mi) at a 1-percent grade, 0.36 km (0.23 mi) at a 3-percent grade, 0.23 km (0.14 mi) at a 5-percent grade. The maximum maintainable speed on this partially level track is measured. If the vehicle's maximum speed exceeds the safe limits of the MERADCOM Test Track, the 3-mi track at APG is used.

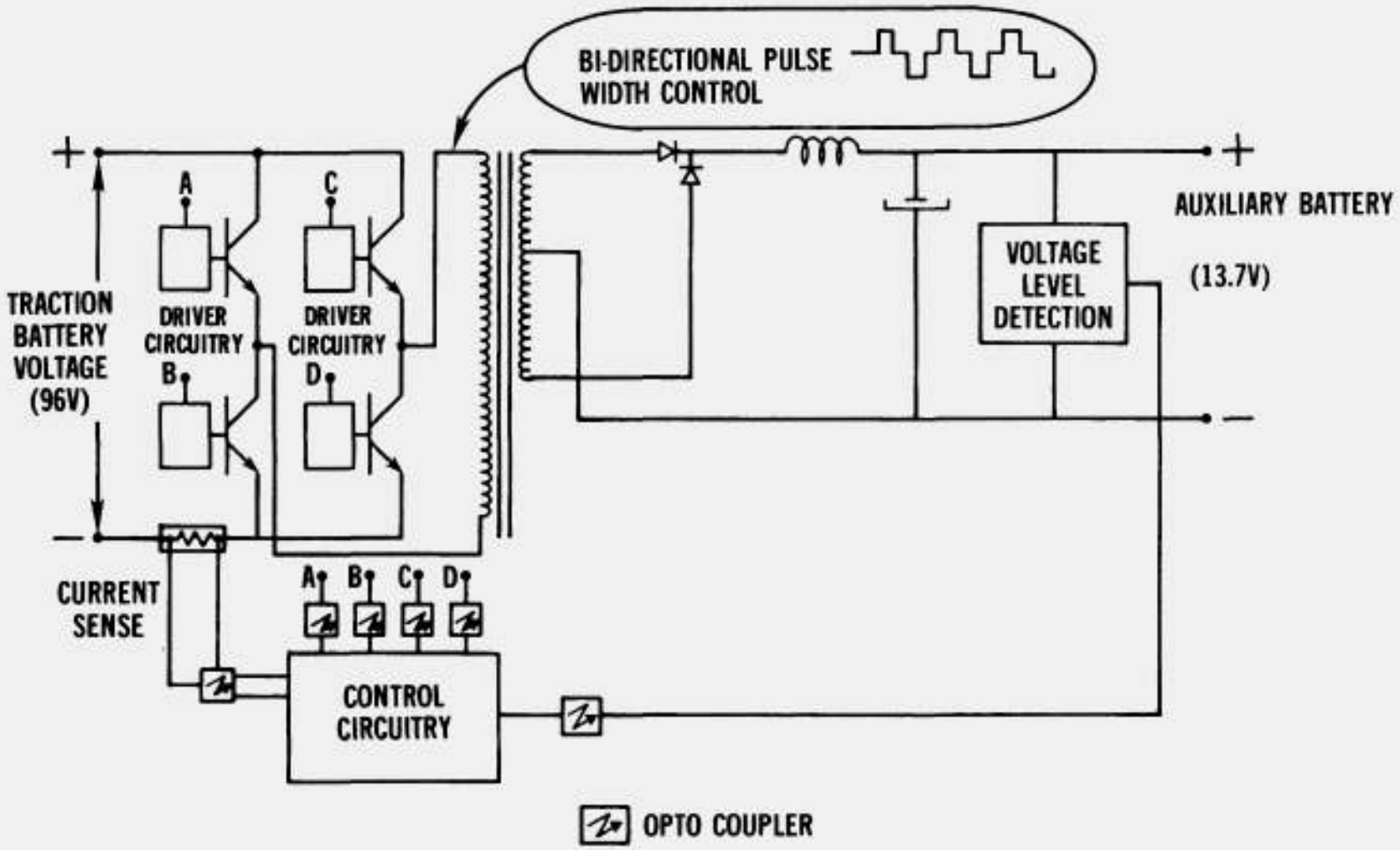


Figure 13. Unique Mobility Electrek auxiliary battery charger pictorial.

c. **Range Tests (Constant Speed).** Range tests at a constant 25, 35, 45, and 55 mi/h are carried out on the MERADCOM loop. The vehicle is driven until it can no longer maintain at least 95 percent of the designated test speed on the level portion of the loop.

d. **Range Tests (Driving Cycles).** The vehicle is tested on a level track, driving the SAE J227a simulated city-like acceleration, cruise, coast, brake, and idle cycle repetitively, until the vehicle can no longer meet acceleration to time requirements. The Unique Mobility Electrek 2+2 was run through B-Cycle (20 mi/h), C-Cycle (30 mi/h), and D-Cycle (45 mi/h) tests. For further information concerning cycle test details and selection criteria see MERADCOM Report 2244, Appendix A.

The "Coast" portion of the cycle testing of the Unique Mobility Electrek 2+2 posed something of a dilemma, since the vehicle does not coast, but rather regeneratively brakes during this period. In a "C" cycle, this regeneration braking action can cause the average cycle distance to be reduced by approximately 100 ft per cycle, and in a "D" cycle by approximately 400 ft per cycle. However, the additional energy obtained through regeneration more than offsets this difference. Those tests which were run without regenerative braking during the coast-down portion of the cycle test are given in Appendix C. It must be noted that the coast portions of these tests were performed with the clutch disengaged; that is, with the vehicle "freewheeling" so that motor regeneration or windage is not acting to decelerate the vehicle. Also during the B-cycle tests with regeneration, the vehicle undergoes a sharp decelerative jerk when the driver's foot is removed rapidly from the accelerator to commence the coast portion of the test. After that initial sharp deceleration, the deceleration softens rapidly. It was necessary to accept this somewhat unnatural situation because the test speed was too low to use second gear optimally, though second gear results in a softer regeneration. The "C" and "D" cycles did not have this problem.

e. **Maximum Acceleration.** Maximum acceleration is calculated from the recorded time and velocity data. The tests are conducted on the 3-mi straightaway at APG. The vehicle is maximally accelerated within manufacturer's recommended standards for the vehicle, allowed to cruise a short time at that speed, and then allowed to free-wheel coast down to a stop. The vehicle is run through this cycle repetitively, until the traction battery is discharged, then the test is terminated. This test is performed with the vehicle instrumented as indicated in Section V.

Computer analysis is used to determine which of the cycles corresponds to 0-, 40-, and 80-percent states of battery discharge.

f. **Gradeability.** Gradeability is the grade in percent in which the vehicle is able to traverse at any selected speed. It is calculated from maximum acceleration tests by using the equation:

$$G = 100 \tan (\sin^{-1} 0.0455a_n) \%$$

where:

a_n = acceleration in miles per hour per second.

g. **Coast-Down Tests.** As indicated above, the coast-down tests are an intimate part of the acceleration tests. The following data result:

- Road Energy Consumption: Road energy is a measure of the energy consumed overcoming the vehicle's aerodynamic and rolling resistance.

The road energy for the vehicle at various speeds and the losses in the drive train were determined from coast-down tests. Road energy E_n is calculated from the following equation:

$$E_n = 9.07 \times 10^{-5} \, W \, \frac{V_{n-1} - V_n}{t_n - t_{n-1}} \, \frac{kWh}{mi}$$

where:

V = vehicle speed, mi/h
W = gross vehicle weight, lb
t = time, s

$$\frac{V_{n-1} - V_n}{t_n - t_{n-1}} = a, \text{ mi/h/s.}$$

- Road Power Requirements. Road power is a measure of vehicle aerodynamic and rolling resistance. The road power, P_n, required to propel a vehicle at speed n is determined from coast-down tests. The following equation was used:

$$P_n = 6.08 \times 10^{-5} \, W \left(\frac{V_{n-1}^2 - V_n^2}{t_n - t_{n-1}} \right) kW$$

where: W = Gross Vehicle Test Weight, lb
V = Vehicle Speed, mi/h
t = Time, s.

h. **Tractive Force Tests.** The maximum-grade capability of the test vehicle is determined from tractive force tests by towing a field dynamometer at approximately 1.6 km/h (1 mi/h) while the test vehicle is being driven with wide-open throttle. The force is measured by the dynamometer instrumentation from a load cell attached between the vehicles. The test is run with the batteries 0, 40, and 80 percent discharged. From the results of the tractive force tests, the gradeability limit is obtained. It is calculated from:

$$\text{Gradeability limit in percent} = 100 \tan \left(\sin^{-1} \frac{P}{W} \right)$$

where: P = tractive force (lb)
W = gross vehicle weight (lb).

VII. TEST RESULTS AND DISCUSSION

The data collected from all range tests are summarized in Table 1. The table shows the test data, type of test, environmental condition, the range test results, energy into and out of the battery, and the energy into the charger. These data are used to determine vehicle range, energy economy, and efficiencies.

a. **Maximum Speed.** The Unique Mobility Electrek 2+2 had an average maximum speed of 110.2 km/h (68.5 mi/h). This maximum cruise speed was beyond that which could be measured on the MERADCOM Test Track and was checked at APG.

b. **Range (Constant Speed and Driving Cycles).** The Unique Mobility Electrek 2+2 was tested at constant speeds: 40.2 km/h (25 mi/h), 56.3 km/h (35 mi/h), 72.4 km/h (45 mi/h), and 88.5 km/h (55 mi/h). It was also tested under "B," "C," and "D" driving cycles. All test results are summarized in Table 1. Velocity, voltage, current, and power curves for the third cycle and the next to last cycle, representatives of each type of driving cycle test, are given in Figures 14 through 37. Figures 14 to 21 are from the schedule "B" cycle test performed on 19 February. Figures 22 to 29 are from the schedule "C" cycle test performed on 29 May. Figures 30 to 37 are from the schedule "D" cycle test performed on 12 November. The numerical results are tabulated in Appendix D.

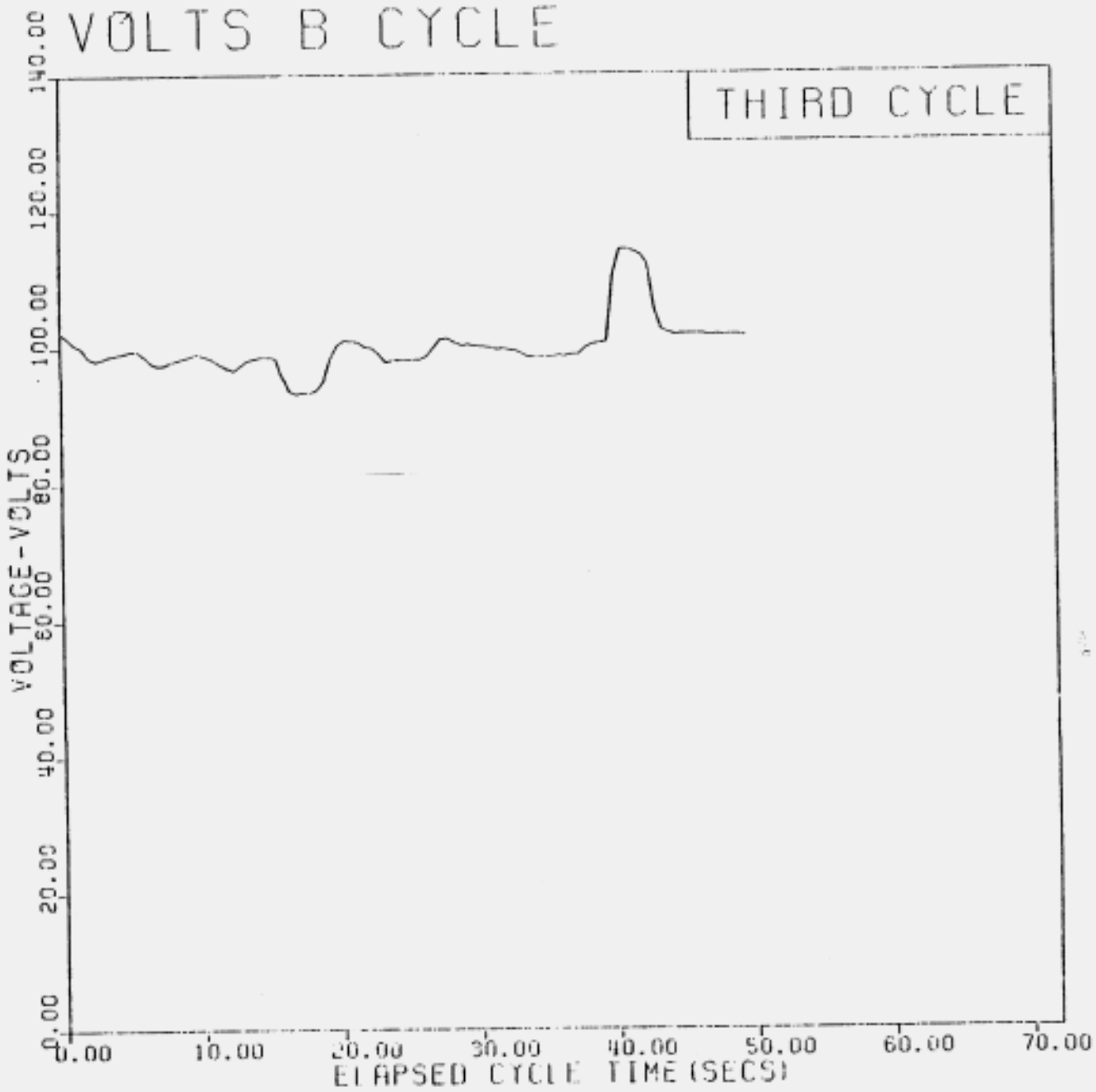


Figure 14. Driving cycle test curve: Voltage, B cycle, 3rd cycle.

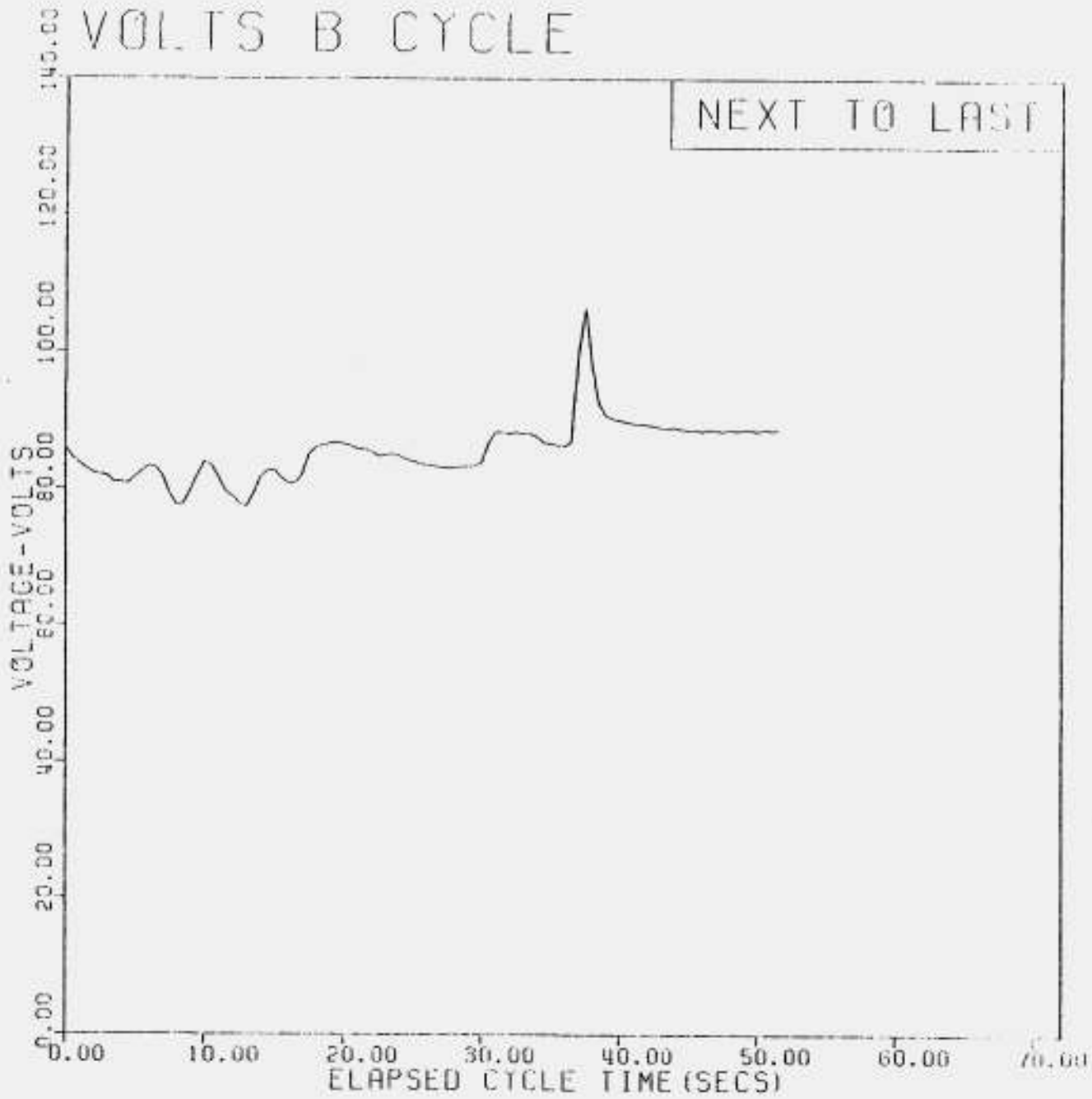


Figure 15. Driving cycle test curve: Voltage, B cycle, next-to-last cycle.

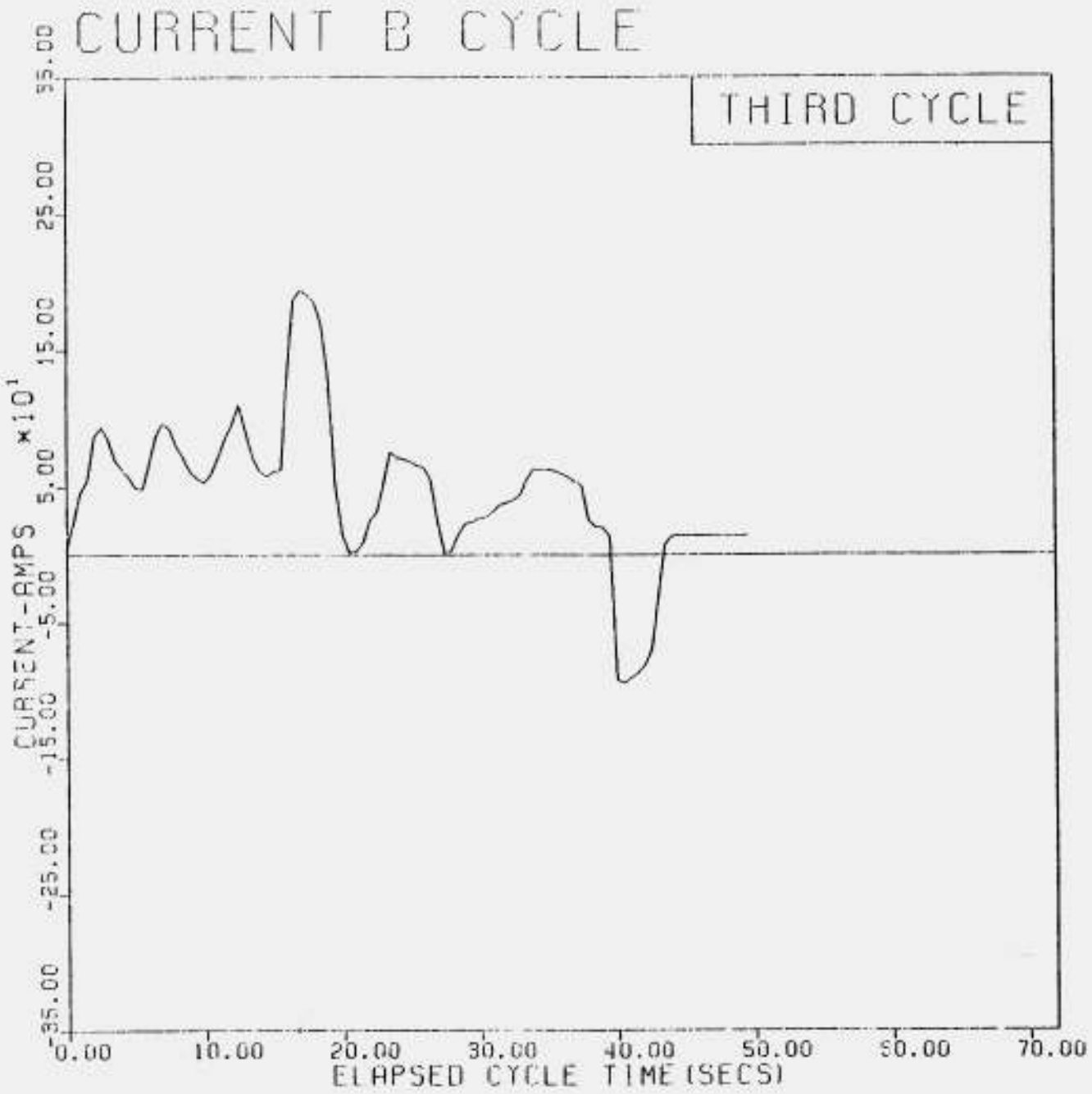


Figure 16. Driving cycle test curve: Current, B cycle, 3rd cycle.

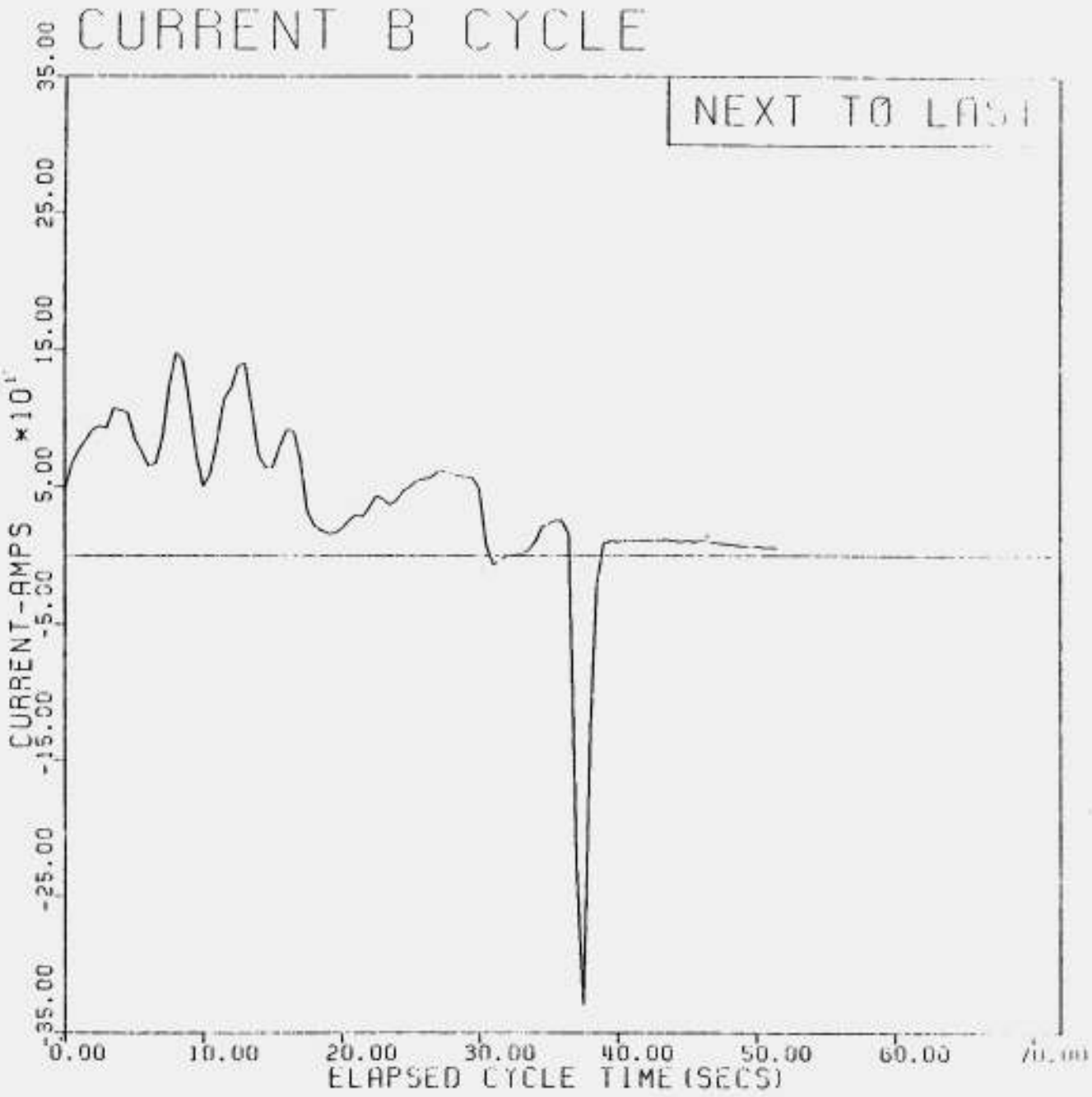


Figure 17. Driving cycle test curve: Current, B cycle, next-to-last cycle.

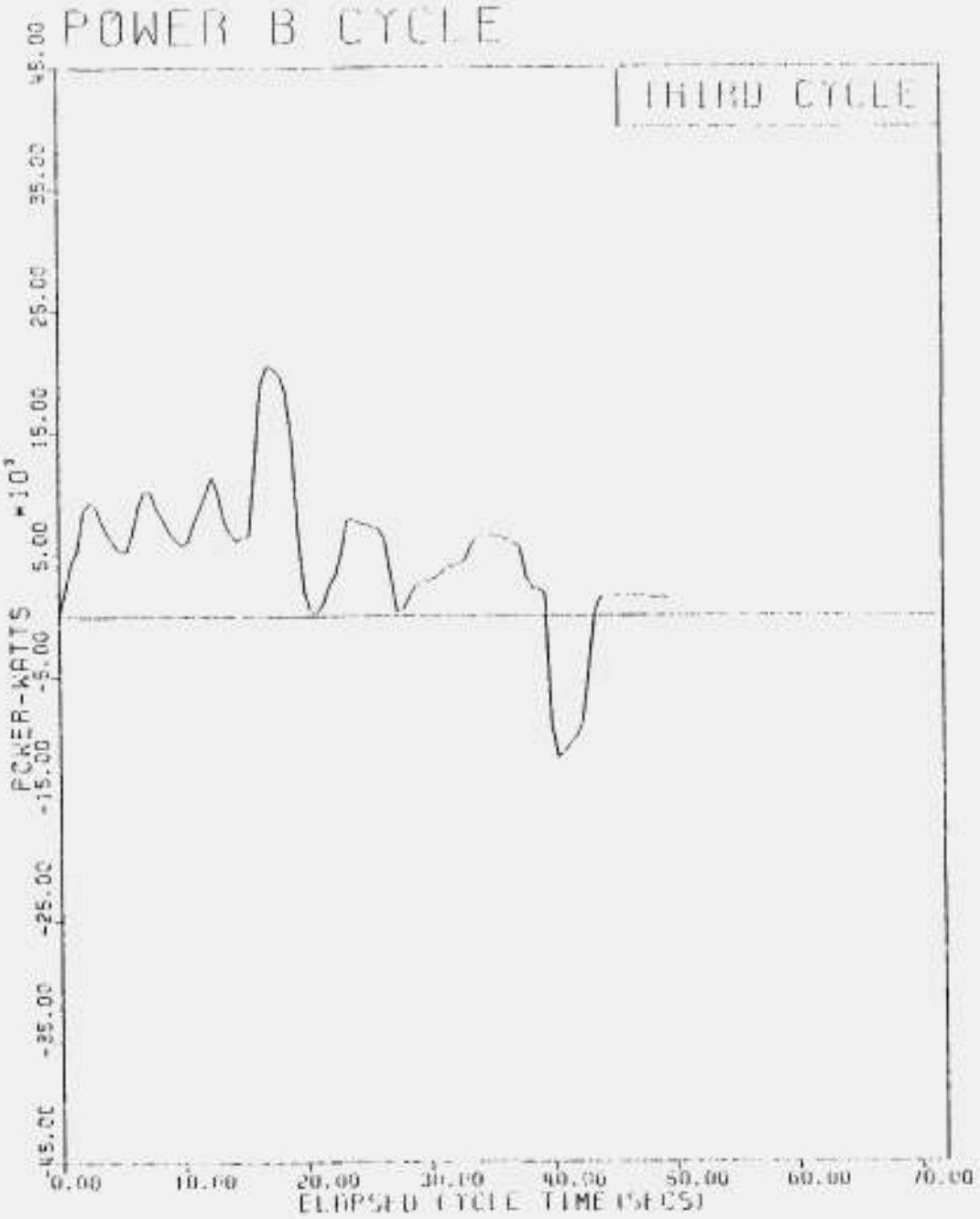


Figure 18. Driving cycle test curve: Power, B cycle, 3rd cycle.

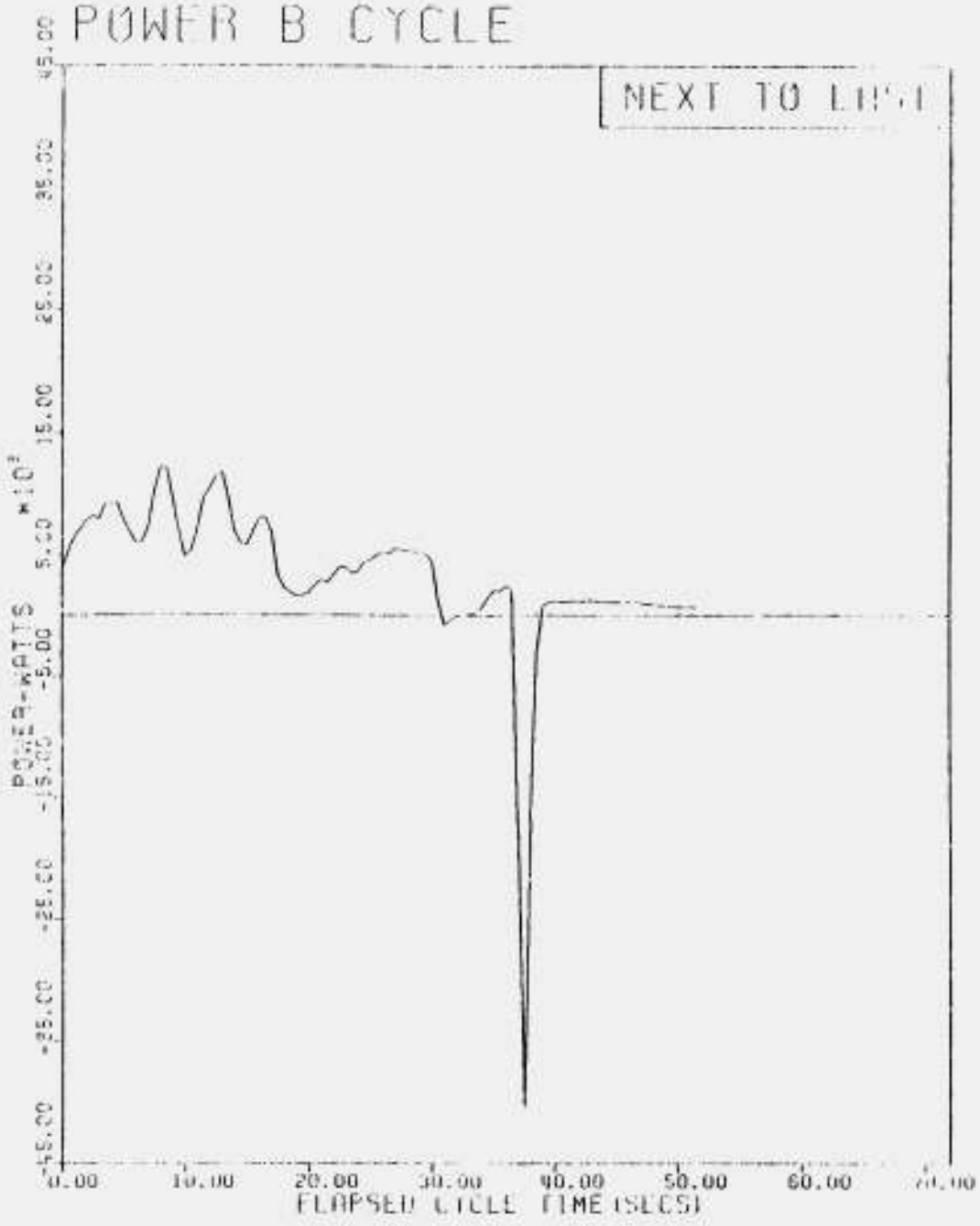


Figure 19. Driving cycle test curve: Power, B cycle, next-to-last cycle.

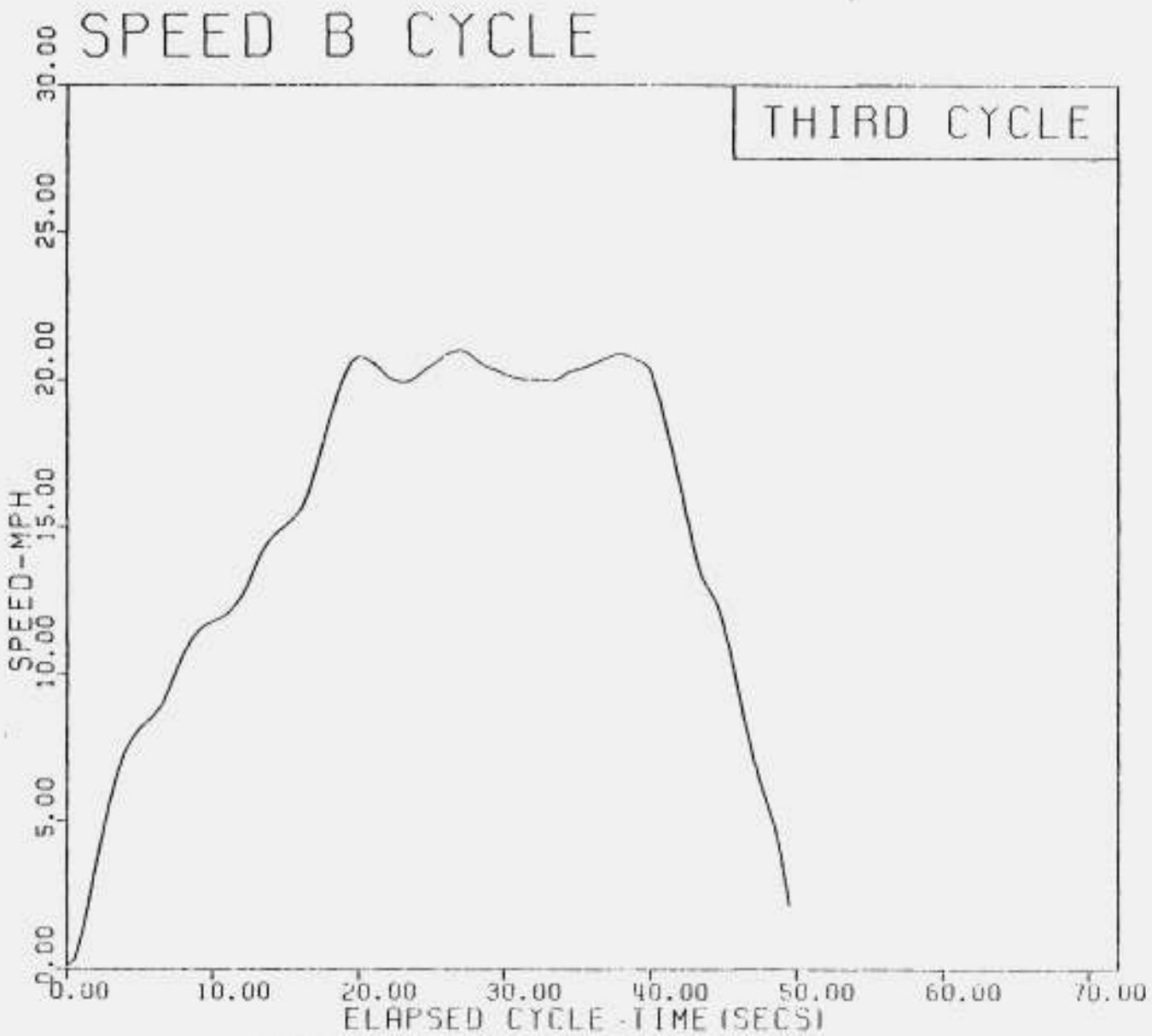


Figure 20. Driving cycle test curve: Speed, B cycle, 3rd cycle.

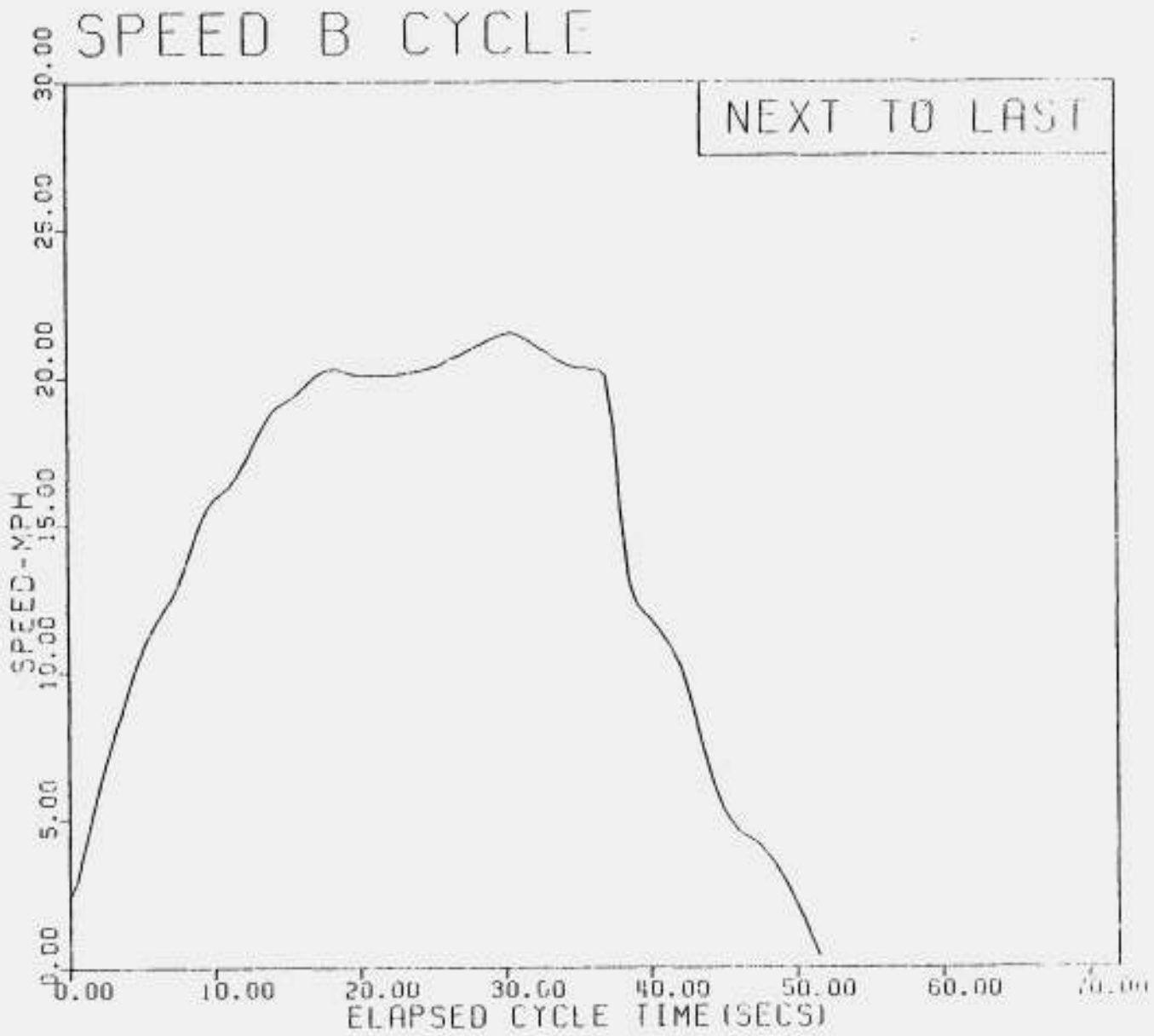


Figure 21. Driving cycle test curve: Speed, B cycle, next-to-last cycle.

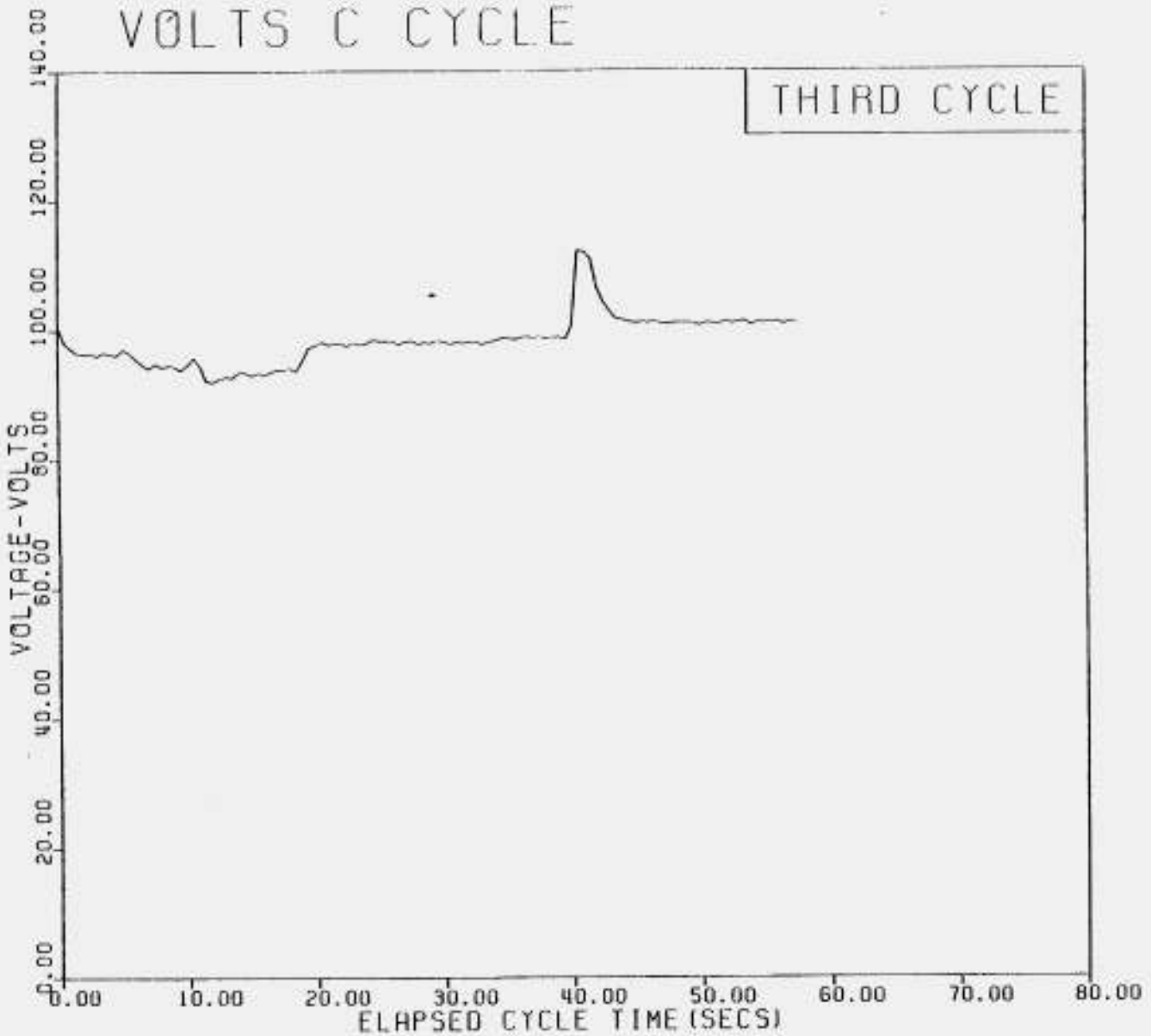


Figure 22. Driving cycle test curve: Voltage, C cycle, 3rd cycle.

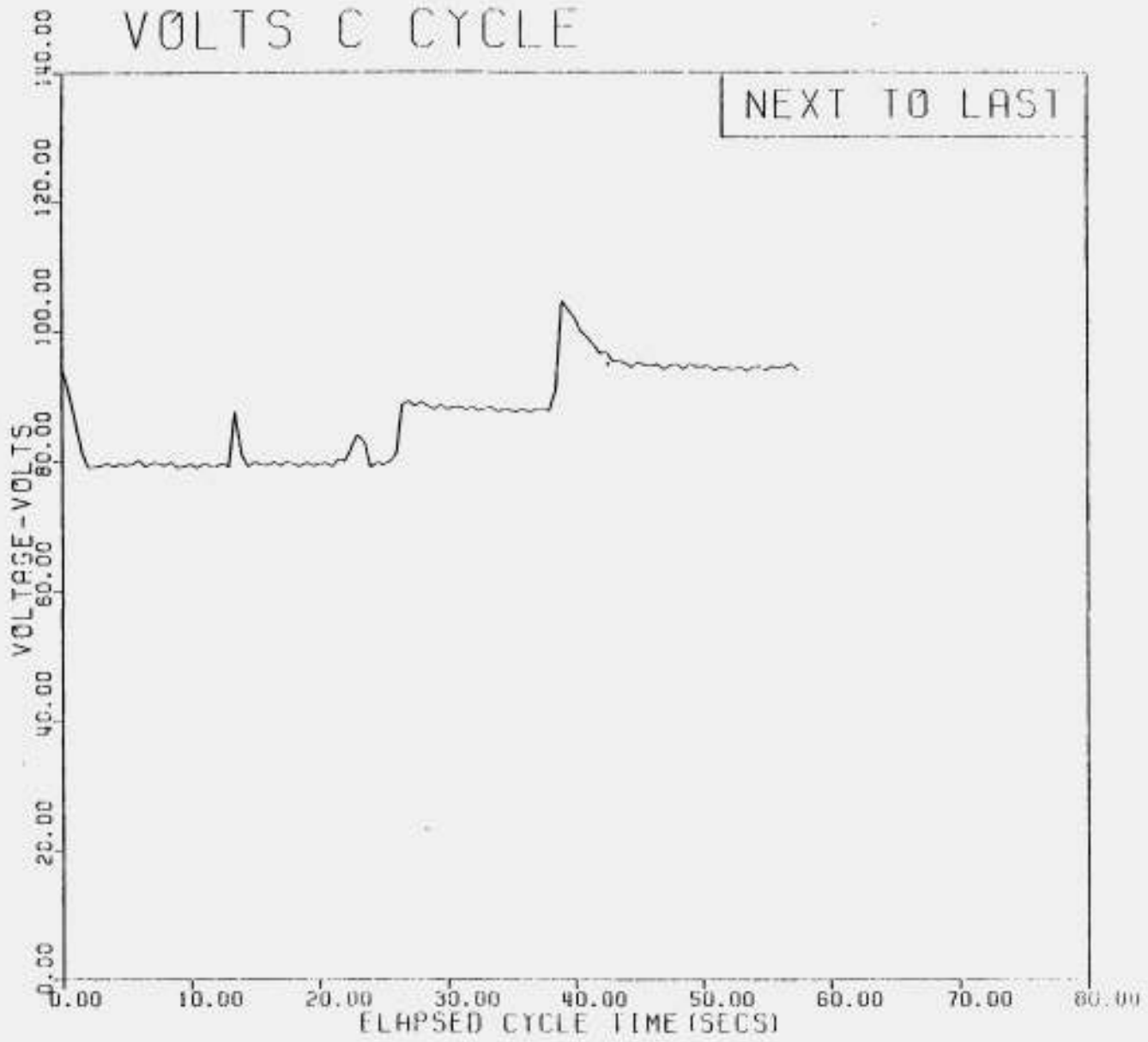


Figure 23. Driving cycle test curve: Voltage, C cycle, next-to-last cycle.

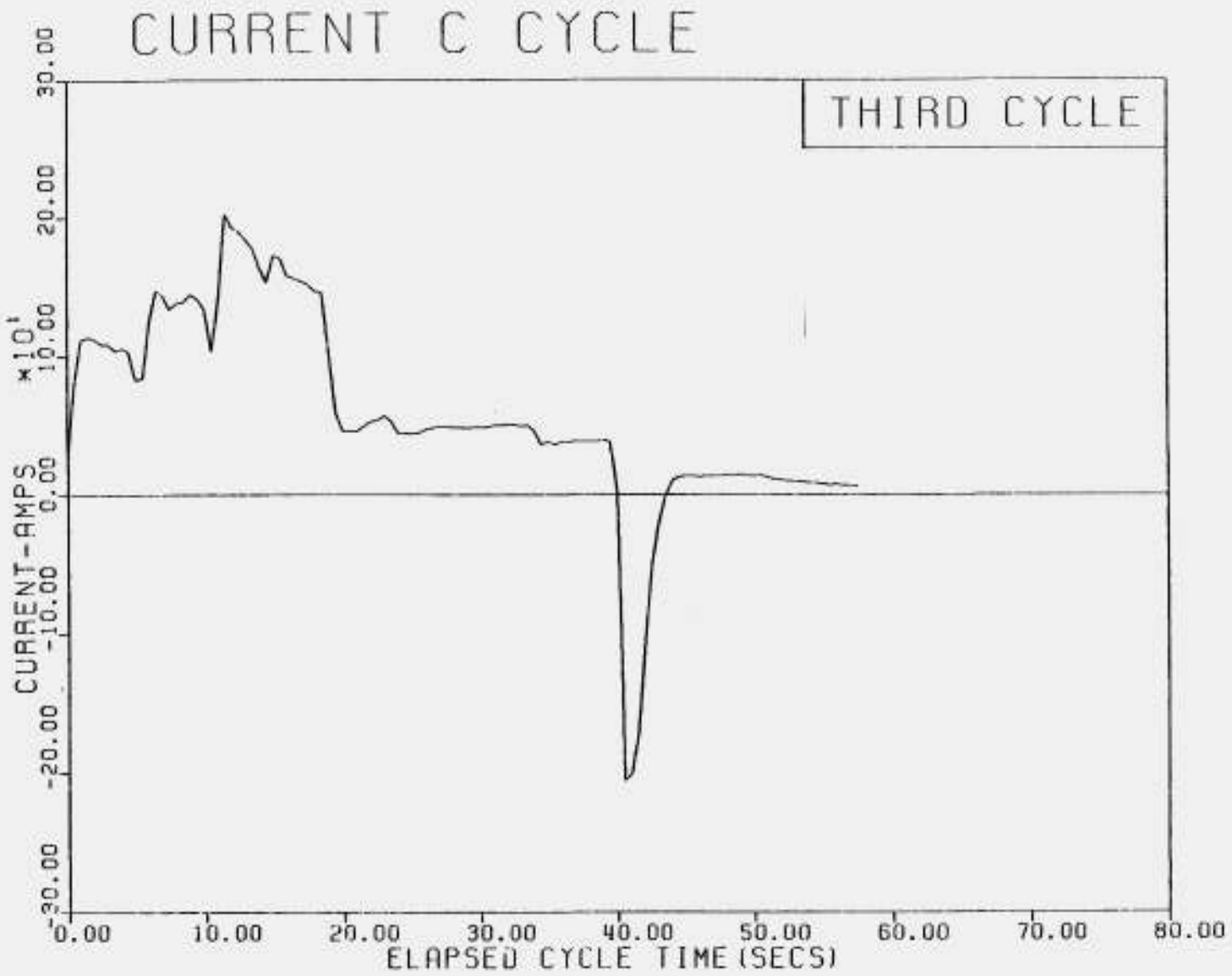


Figure 24. Driving cycle test curve: Current, C cycle, 3rd cycle.

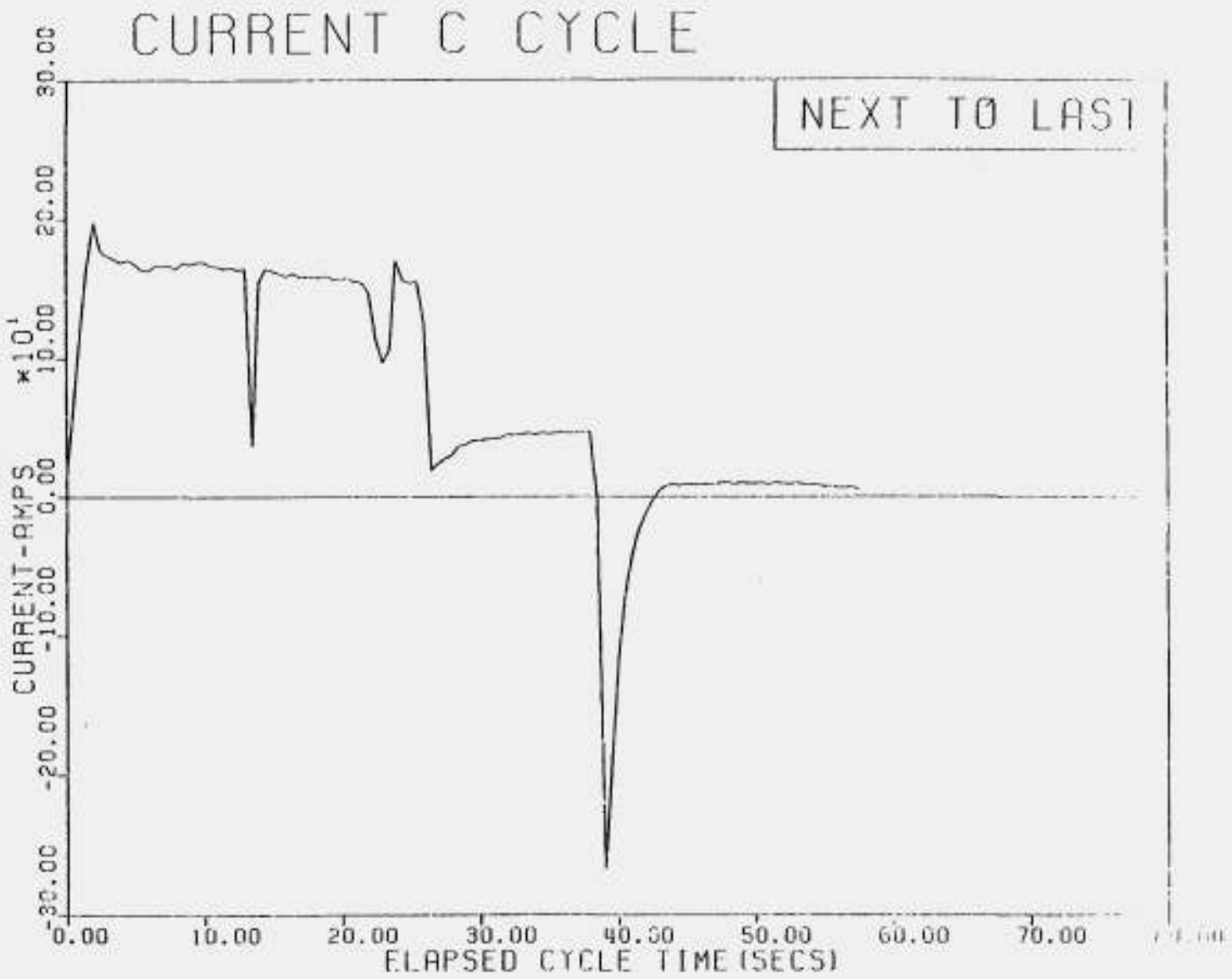


Figure 25. Driving cycle test curve: Current, C cycle, next-to-last cycle.

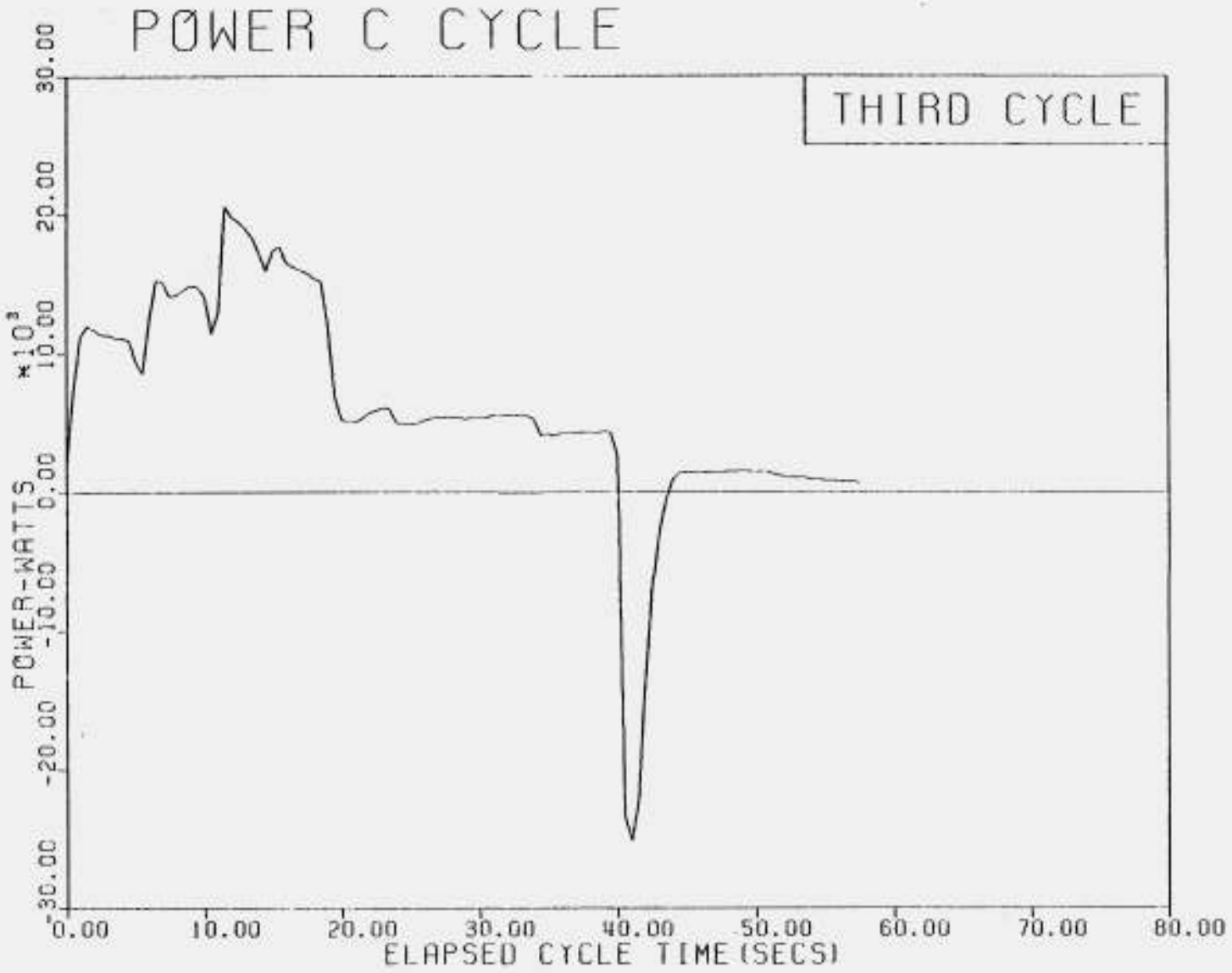


Figure 26. Driving cycle test curve: Power, C cycle, 3rd cycle.

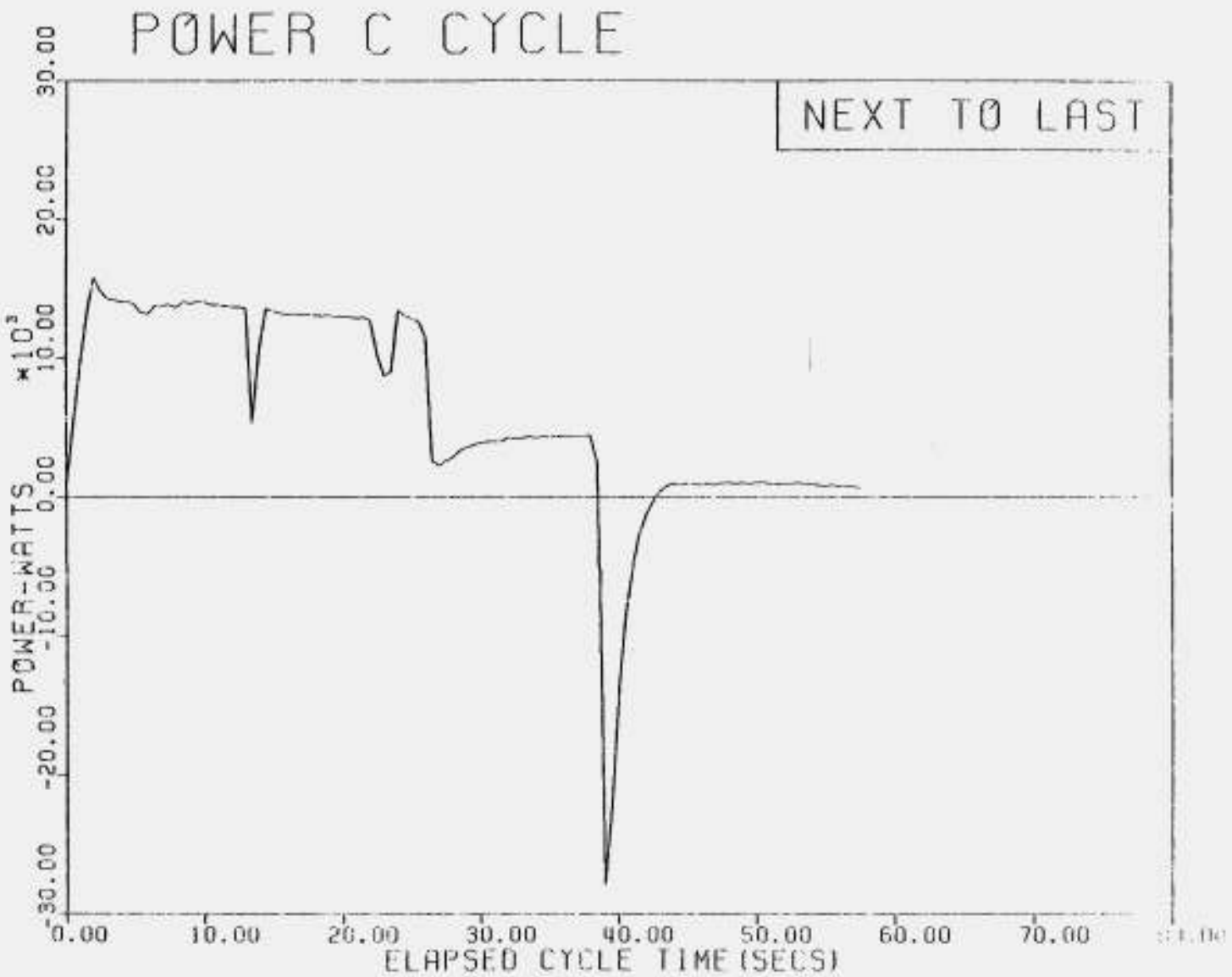


Figure 27. Driving cycle test curve: Power, C cycle, next-to-last cycle.

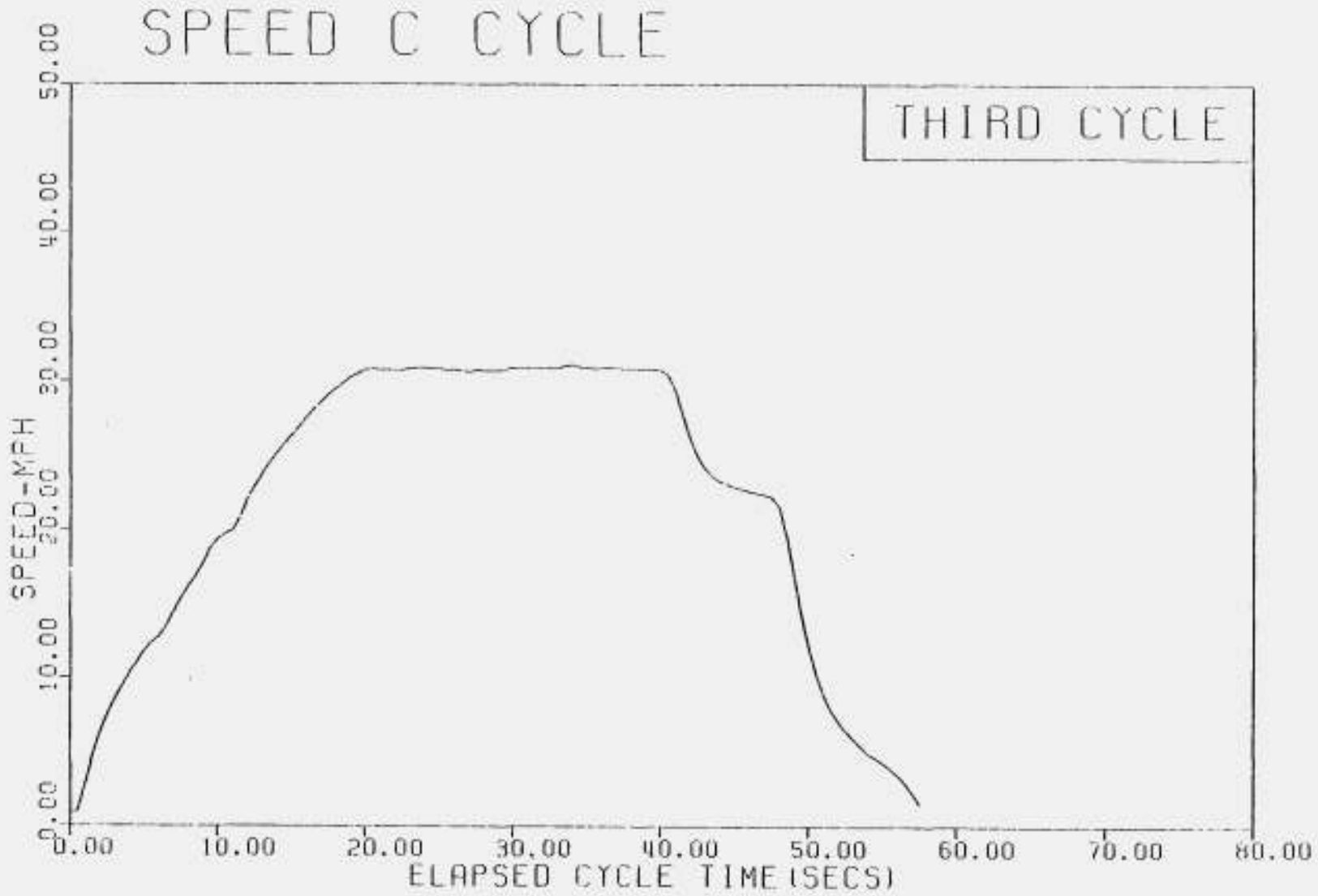


Figure 28. Driving cycle test curve: Speed, C cycle, 3rd cycle.

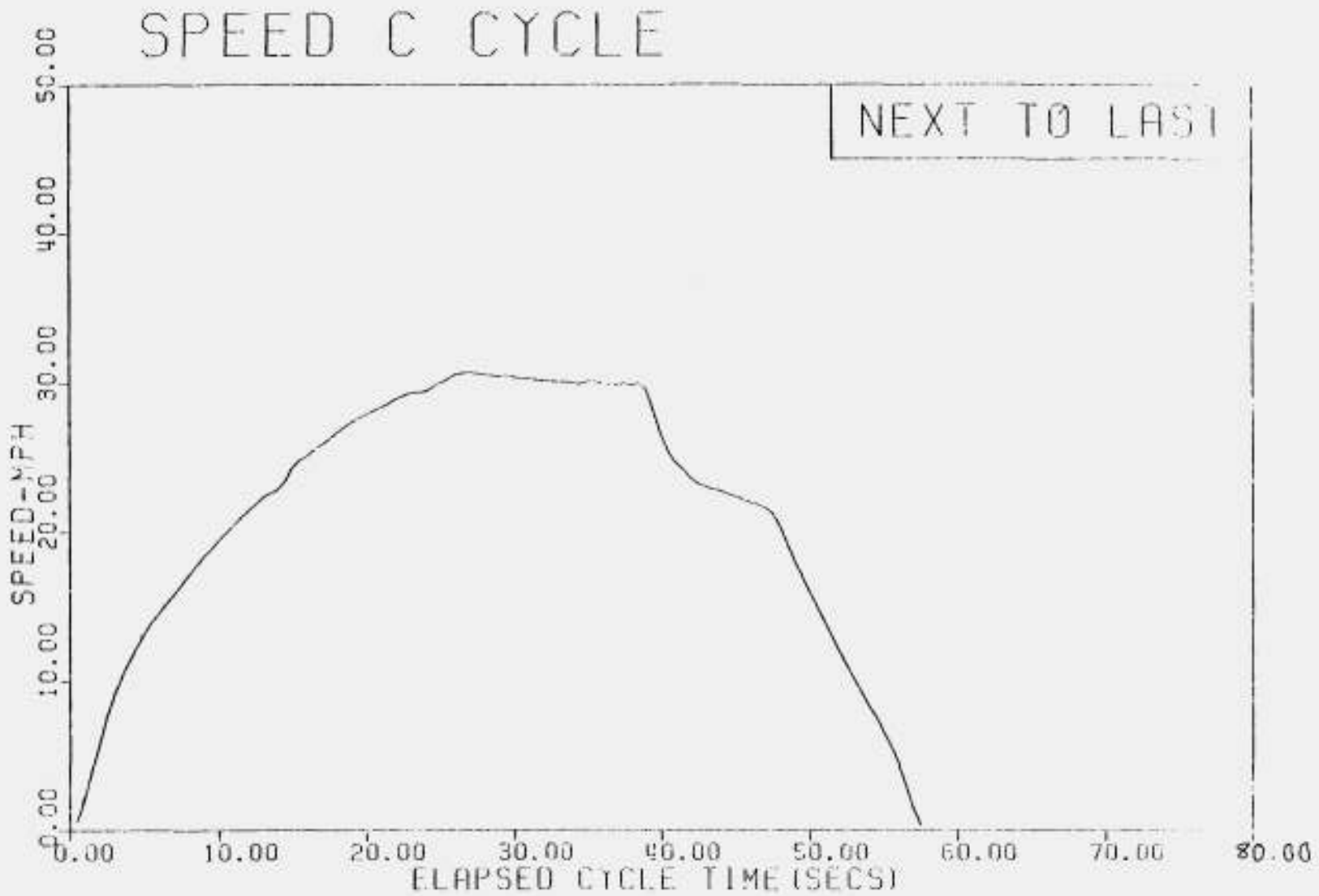


Figure 29. Driving cycle test curve: Speed, C cycle, next-to-last cycle.

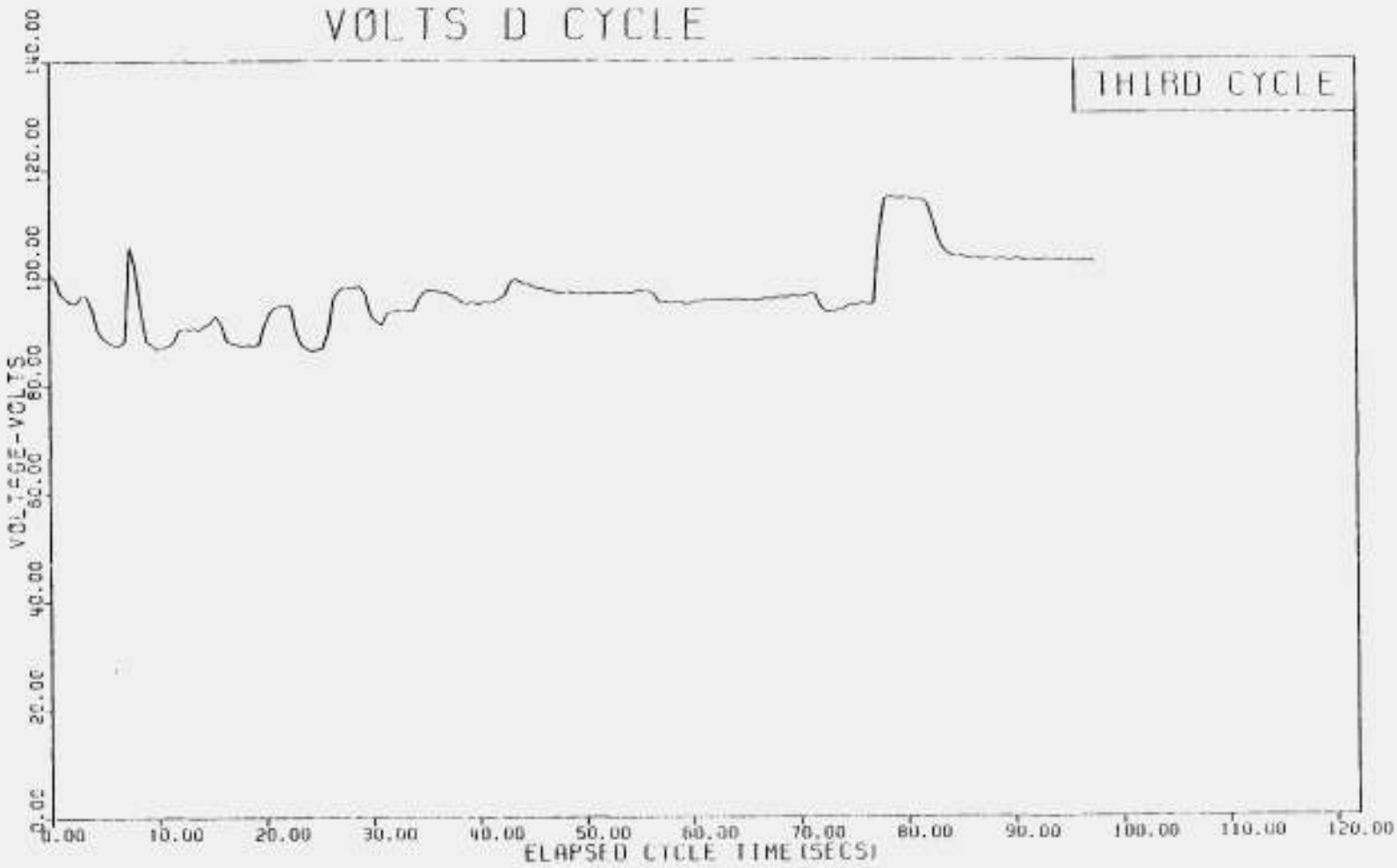


Figure 30. Driving cycle test curve: Voltage, D cycle, 3rd cycle.

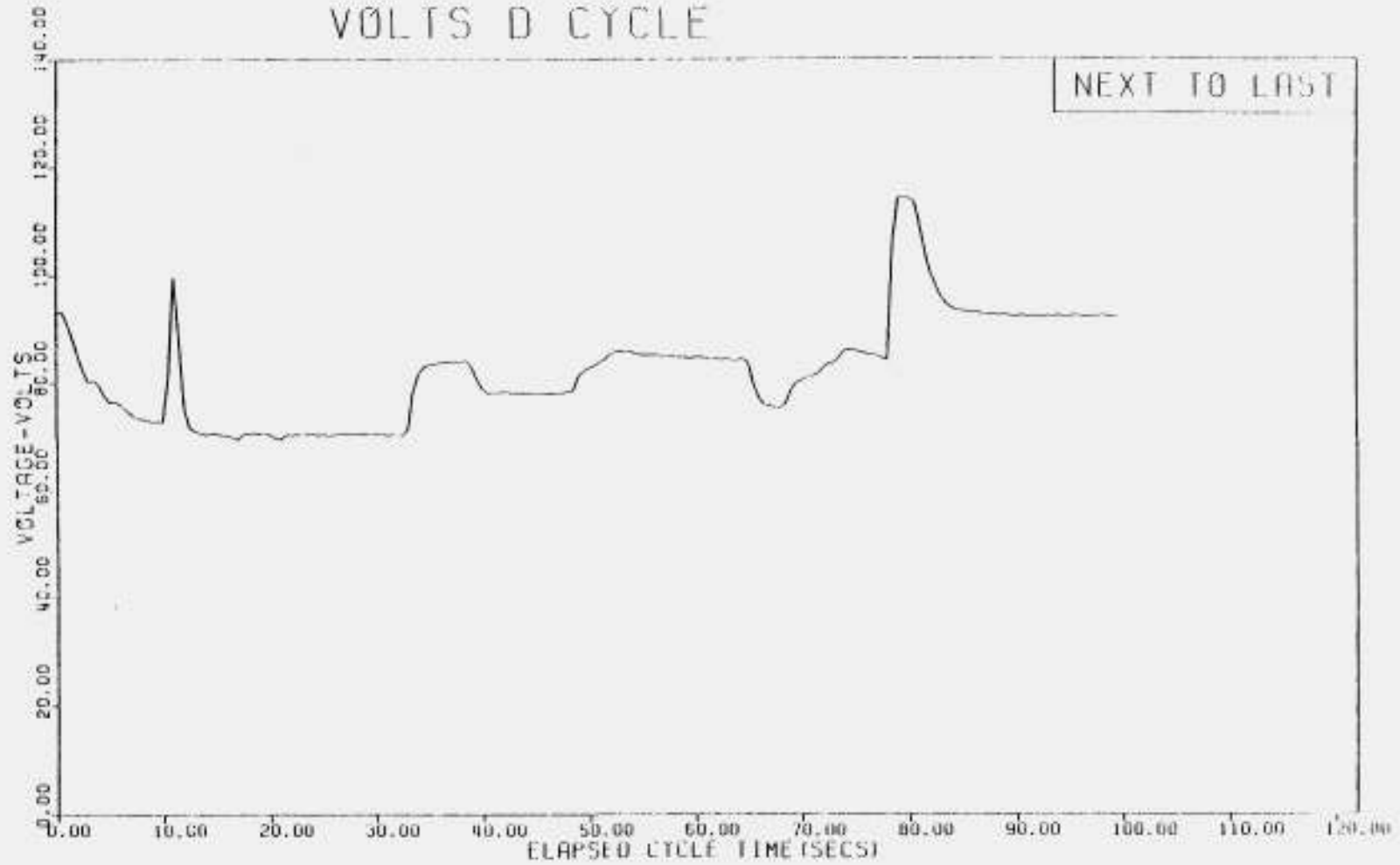


Figure 31. Driving cycle test curve: Voltage, D cycle, next-to-last cycle.

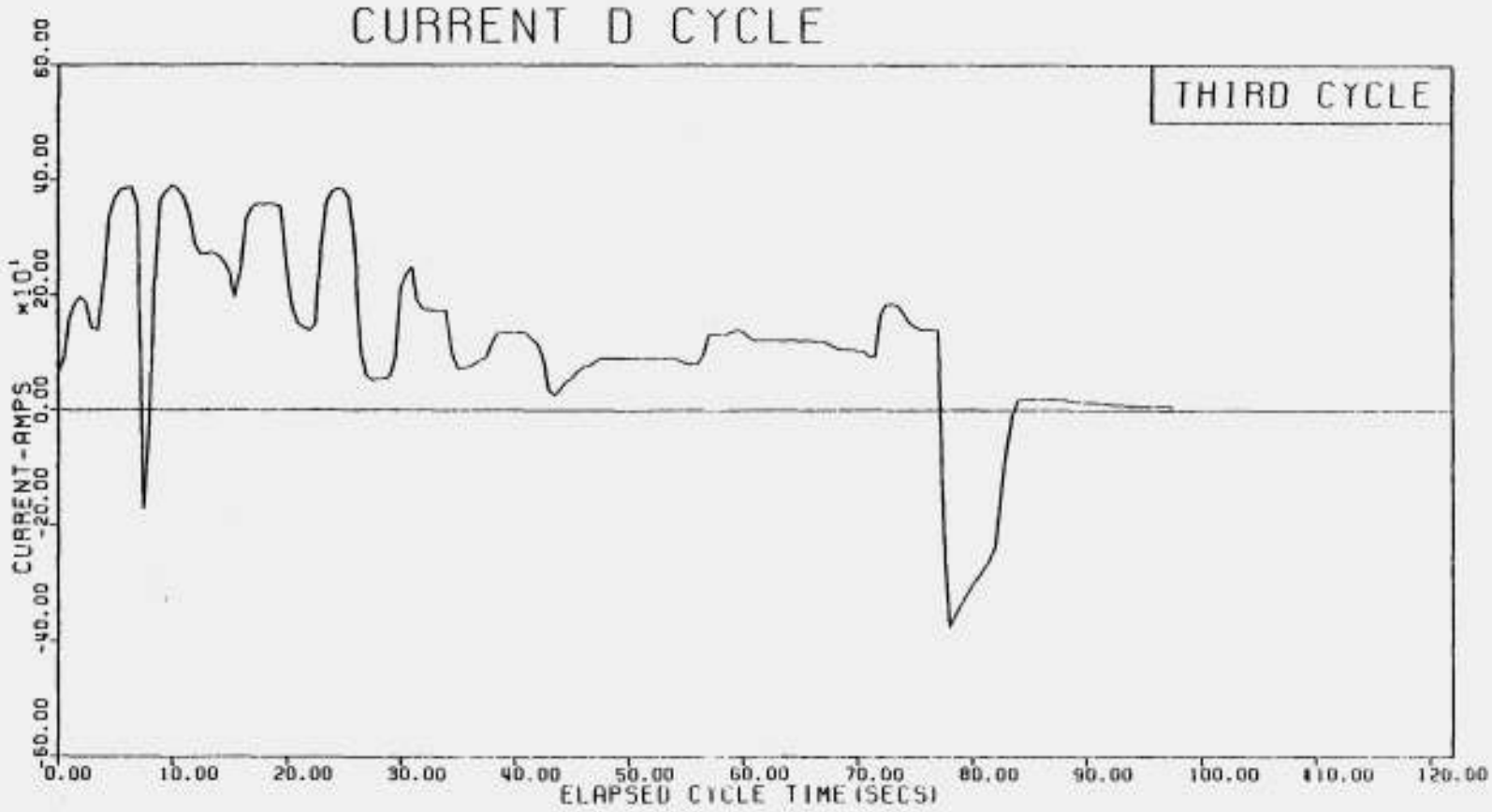


Figure 32. Driving cycle test curve: Current, D cycle, 3rd cycle.

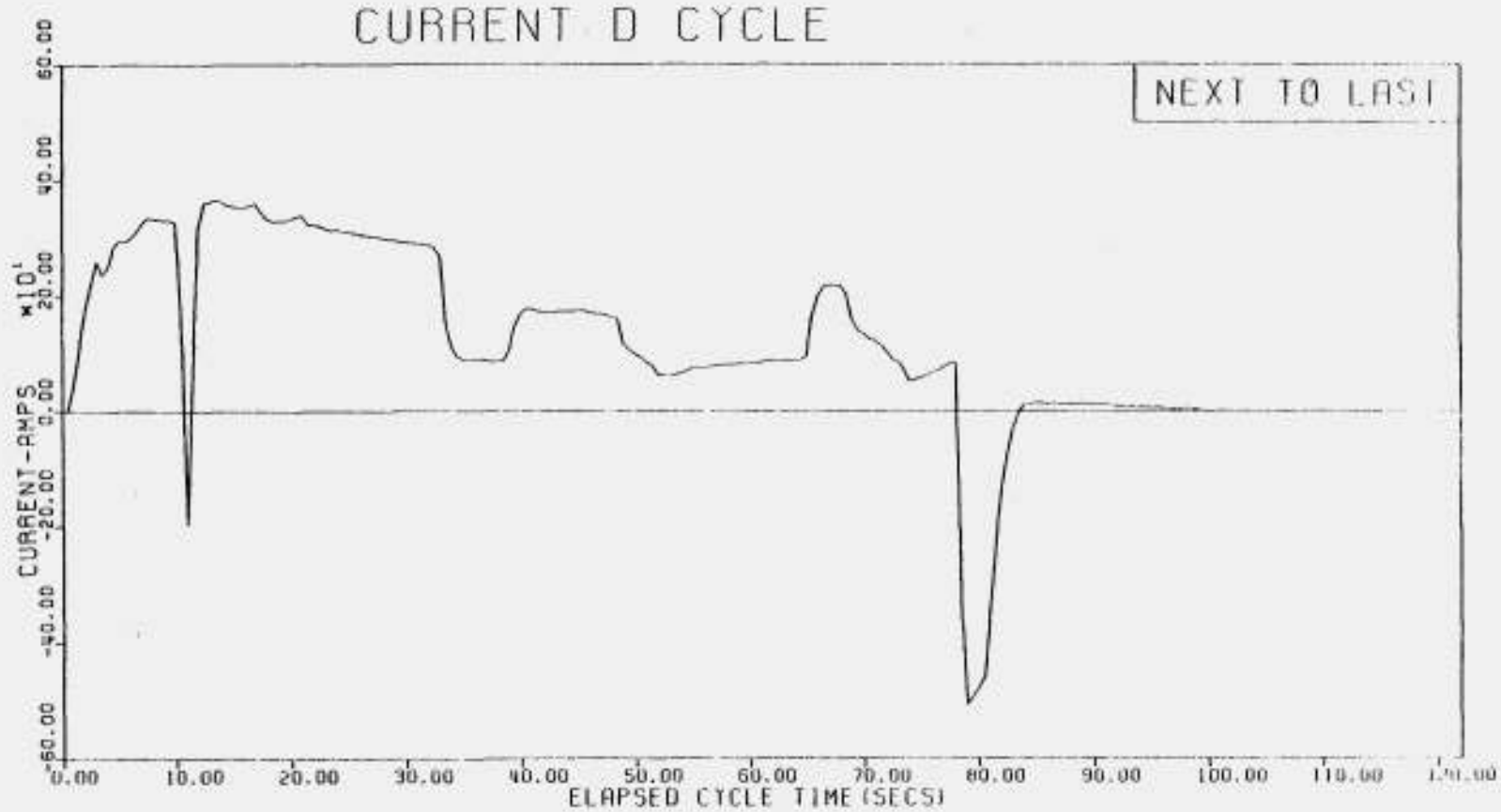


Figure 33. Driving cycle test curve: Current, D cycle, next-to-last cycle.

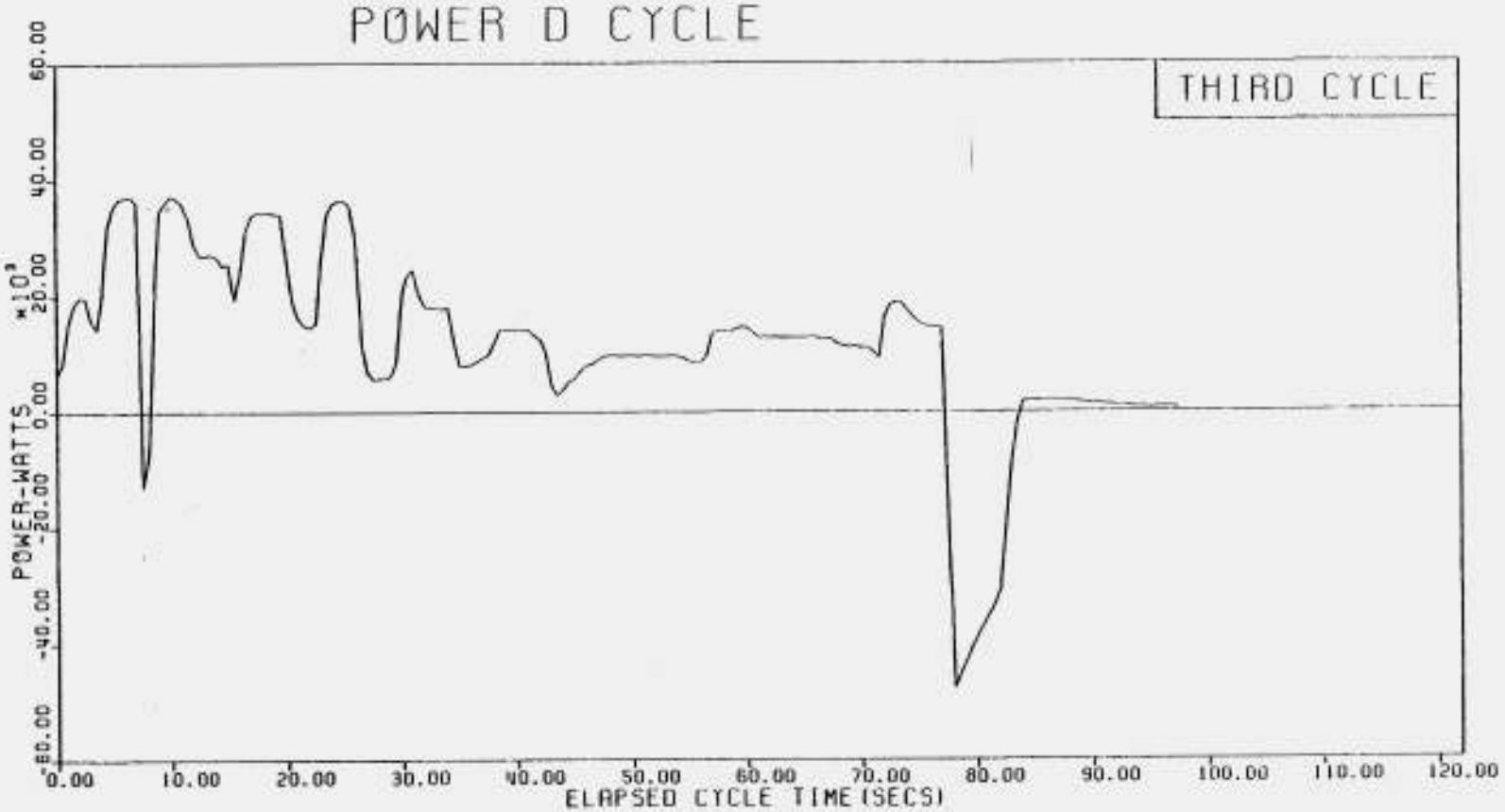


Figure 34. Driving cycle test curve: Power, D cycle, 3rd cycle.

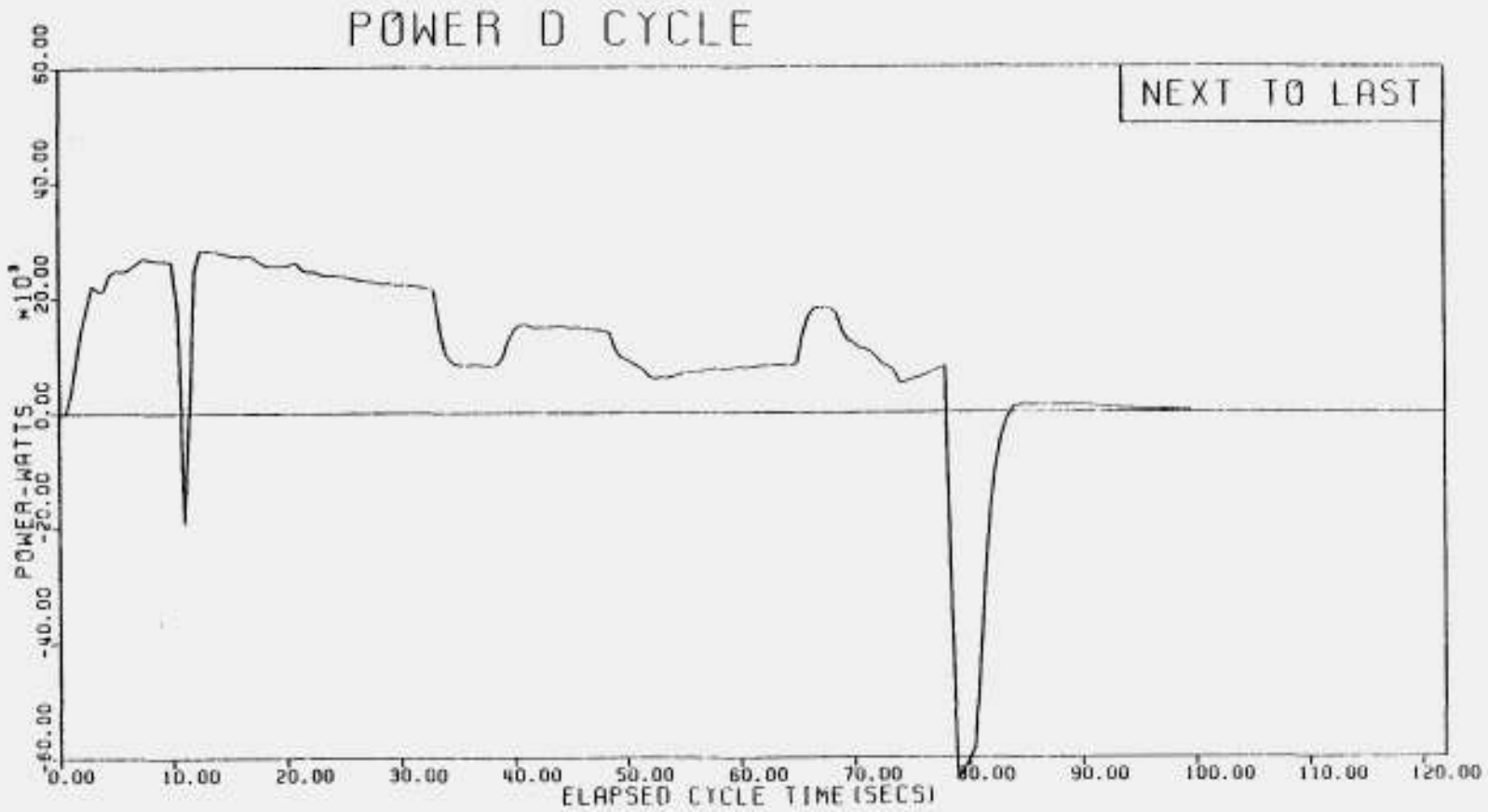


Figure 35. Driving cycle test curve: Power, D cycle, next-to-last cycle.

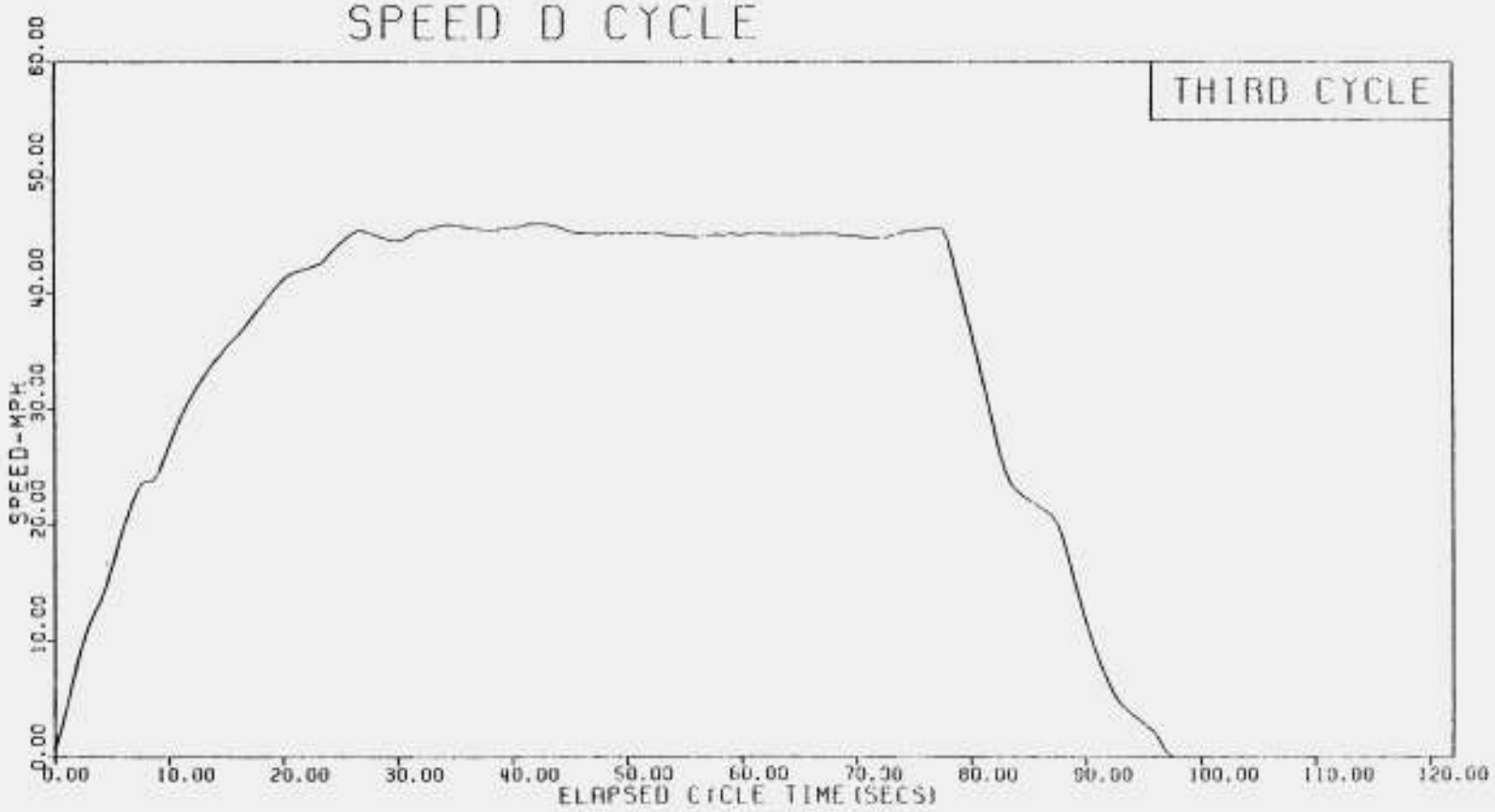


Figure 36. Driving cycle test curve: Speed, D cycle, 3rd cycle.

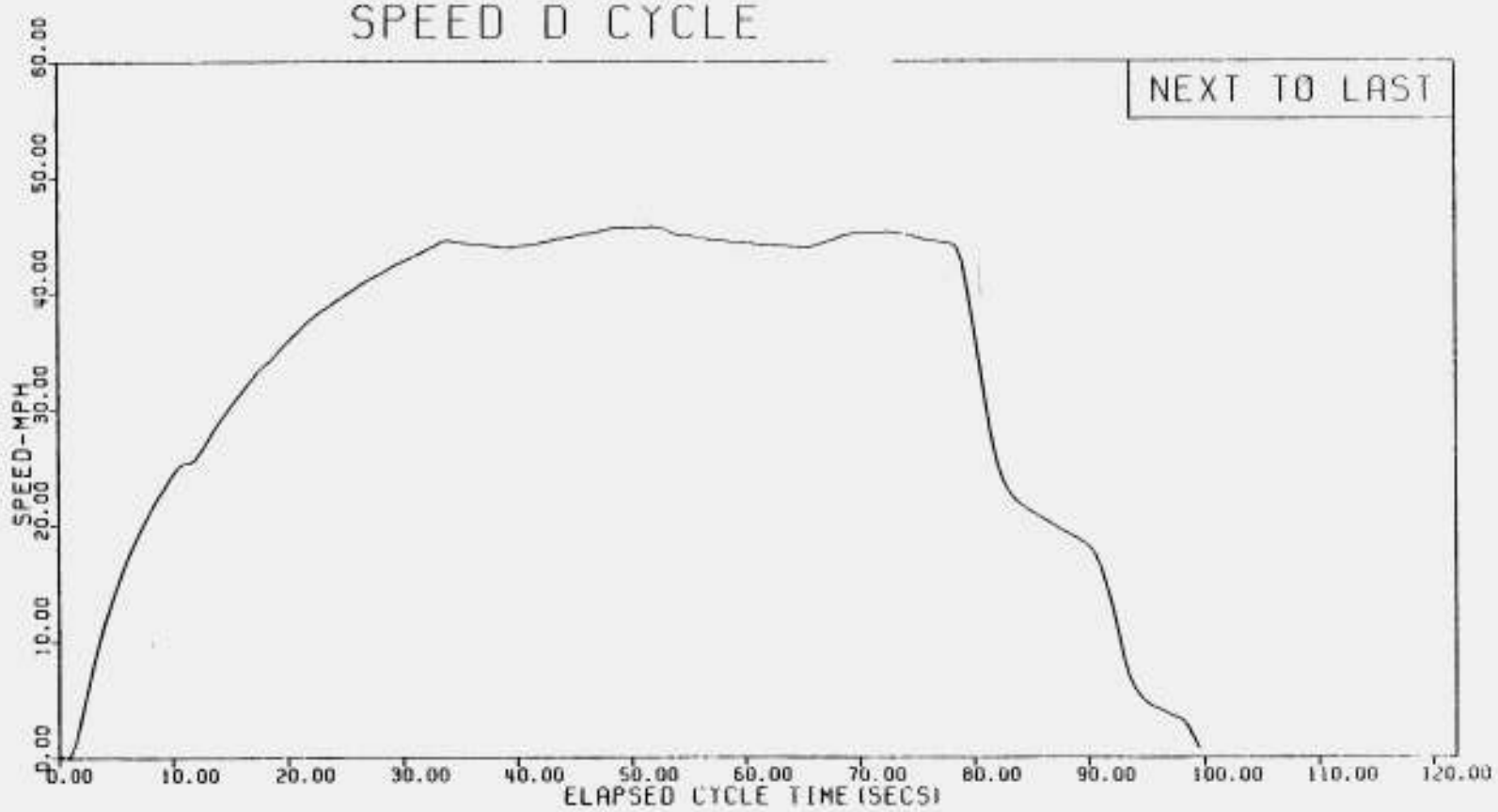


Figure 37. Driving cycle test curve: Speed, D cycle, next-to-last cycle.

c. **Maximum Acceleration.** The Unique Mobility Electrek 2+2 accelerated to 50 km/h (31.1 mi/h) in 9.3 s and to 80.4 km/h (50 mi/h) in 30 s, both times being an average.

- **Velocity.** Velocity versus time of the Electrek 2+2 are given for 0-, 40-, and 80-percent depths of discharge (DOD) in Figure 38.

- **Acceleration vs Velocity.** Figure 39 shows acceleration versus velocity for 0-, 40-, and 80-percent DOD for the vehicle.

- **Gradeability at Speed.** Figure 40 gives the Electrek 2+2 gradeability at speed for 0-, 40-, and 80-percent DOD of the traction battery.

d. **Coast-Down Tests.** From the coast-downs, the velocity versus time (Figure 41) was obtained for the 0-, 40-, and 80-percent DOD. The coast-down portion of the acceleration coast-down tests yielded the following results:

- **Road Energy Consumption.** The road energy consumption of the Electrek is shown in Figure 42.

- **Road Power.** The road power requirements for the Unique Mobility vehicle are shown in Figure 43. The data for the maximum acceleration and coast-down test figures are tabulated in Appendix E.

e. **Gradeability Limit.** The Unique Mobility Electrek 2+2 displayed the capability to negotiate a grade based on the results obtained at 0-, 40-, and 80-percent DOD (Table 3). The traction force data for the Electrek are given for first gear and reverse gear as well as for the three states of discharge.

Table 3. Gradeability Limit Test Results

Gear	Tractive Force (lb)	Gradeability Limit (%)
0% DOD First	1467.5	48.2
Reverse	1336	43.0
40% DOD First	1486	49.0
Reverse	1312.5	42.1
80% DOD First	1318	42.4
Reverse	1265	40.4

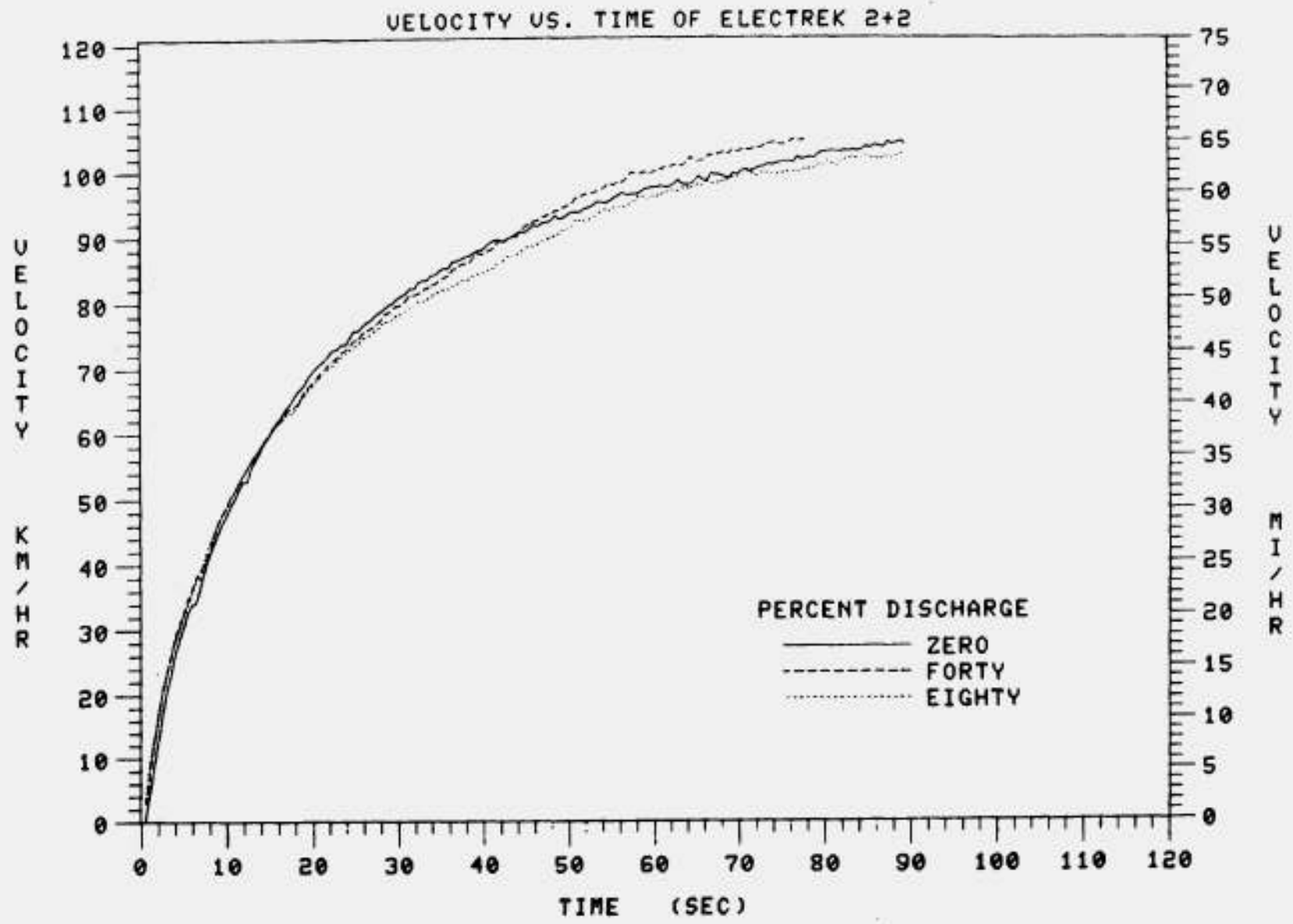


Figure 38. Velocity vs time, Electrek 2+2.

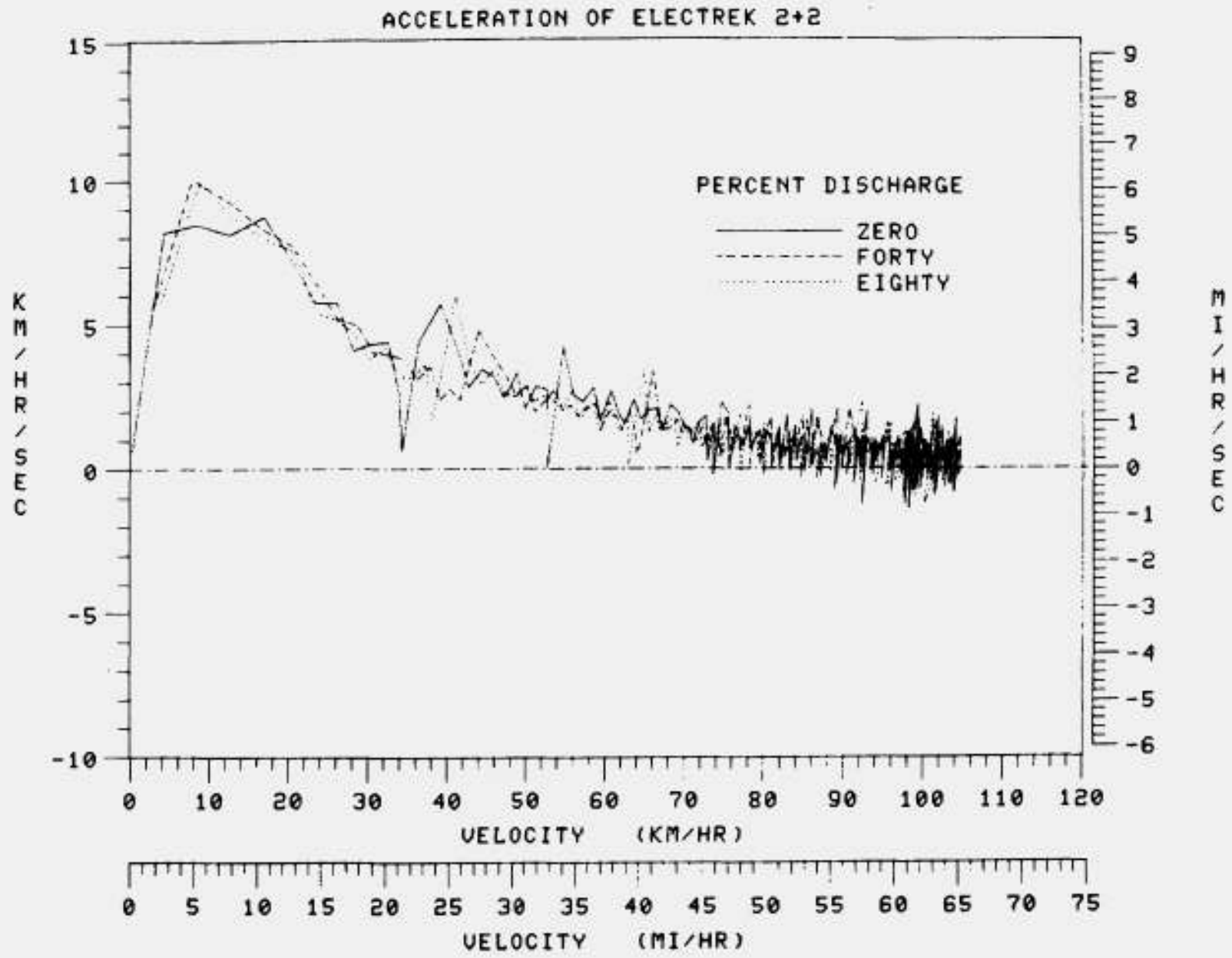


Figure 39. Acceleration of Electrek 2+2.

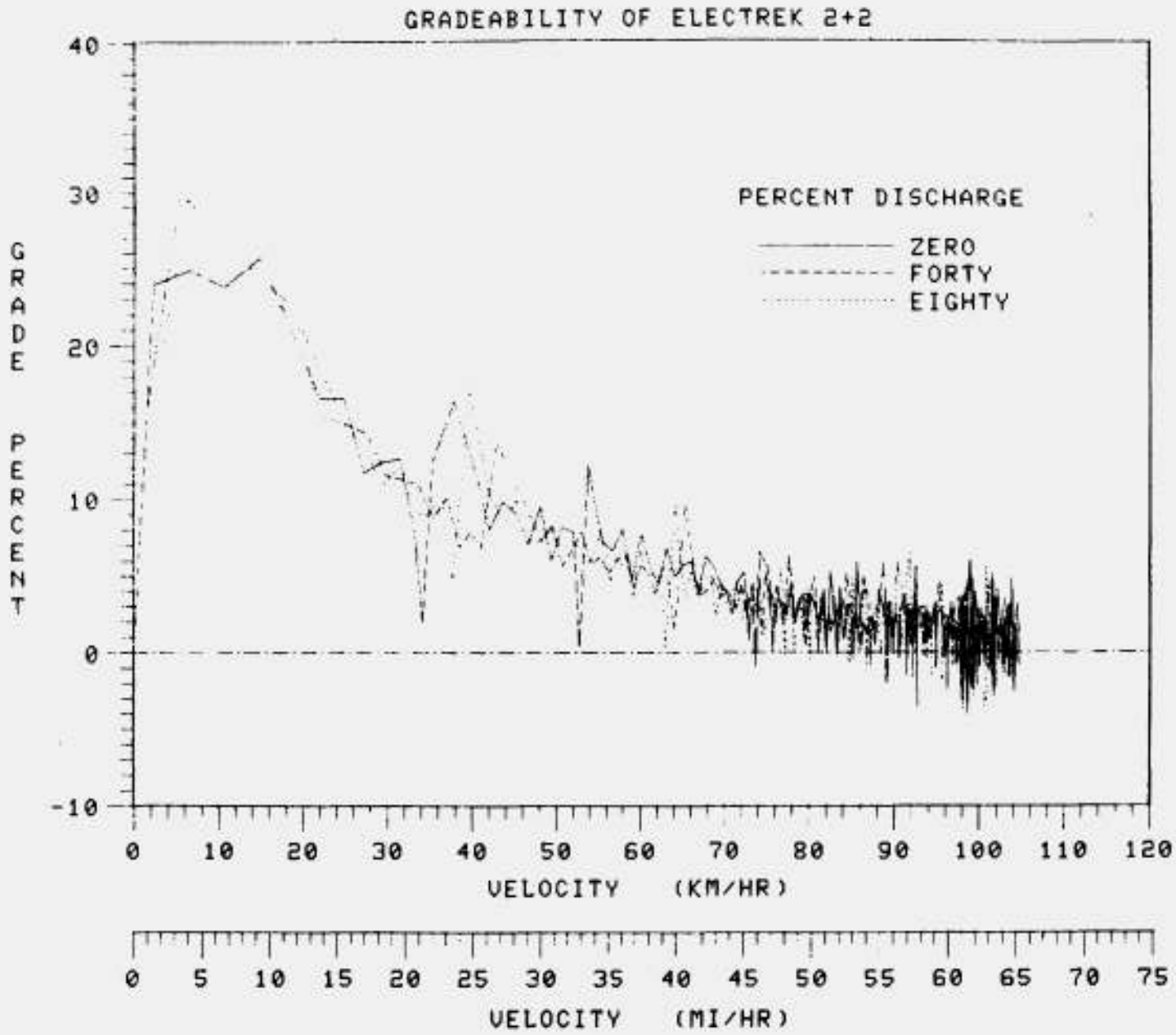


Figure 40. Gradeability of Electrek 2+2.

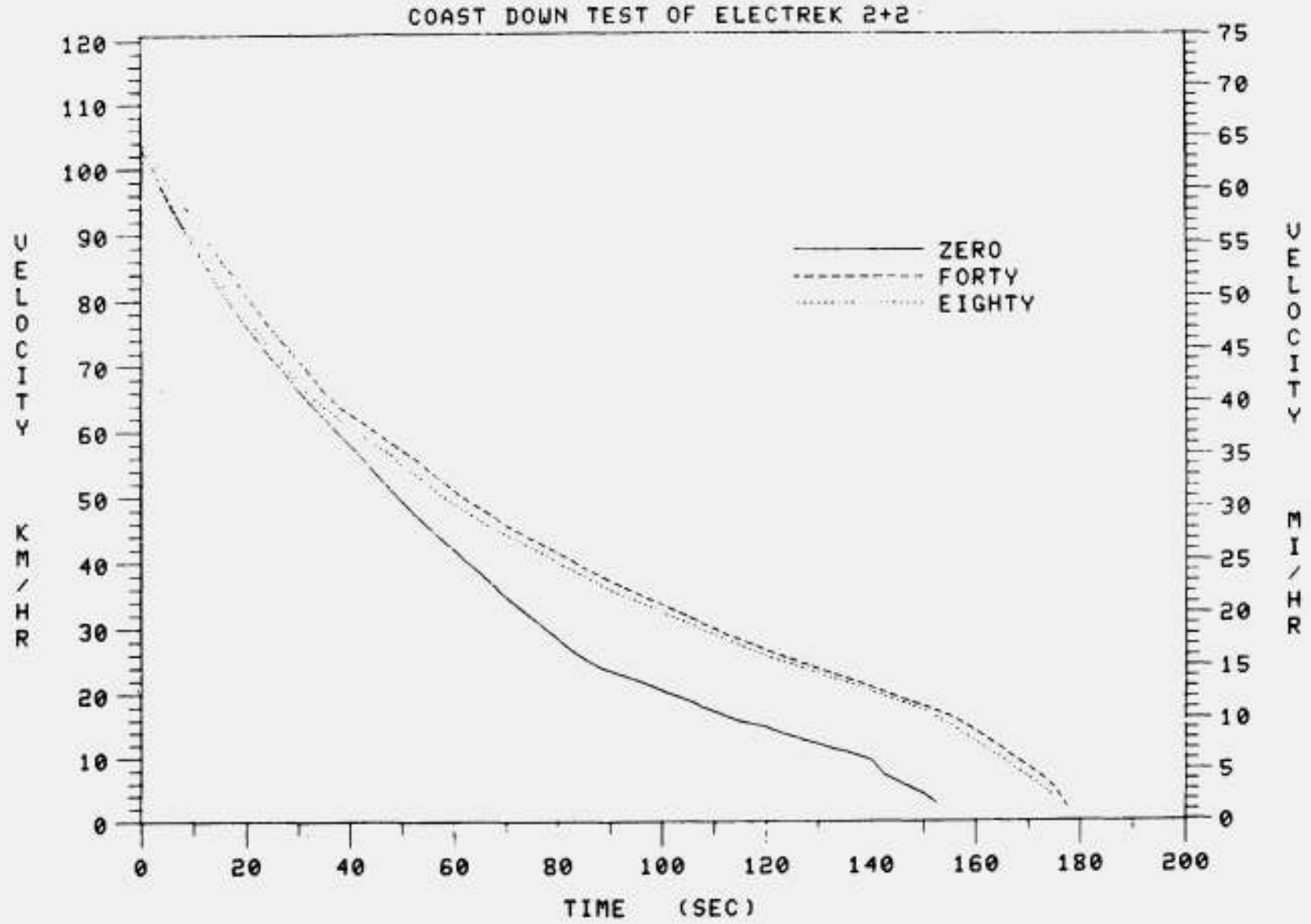


Figure 41. Coast-down test of Electrek 2+2.

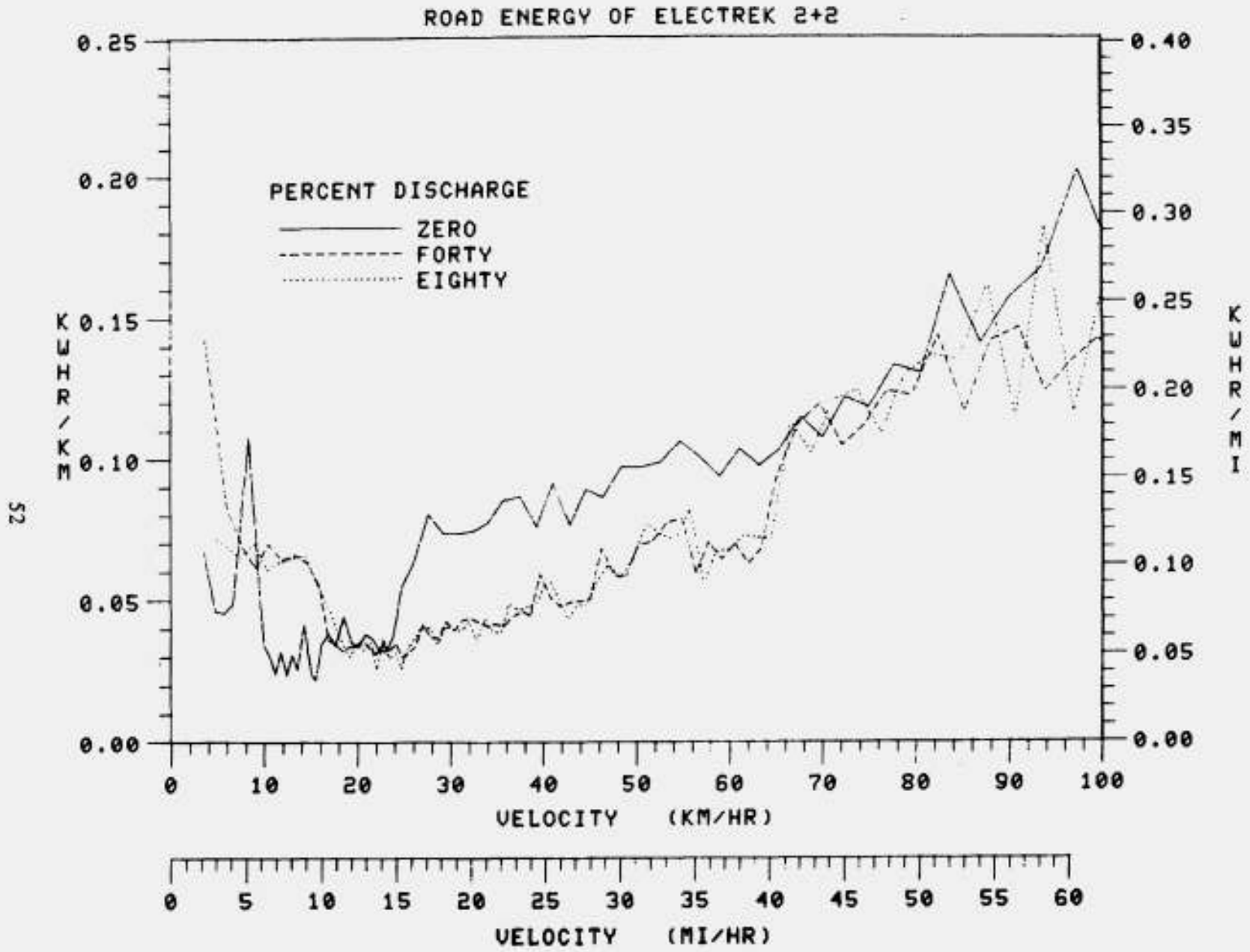


Figure 42. Road energy of Electrek 2+2.

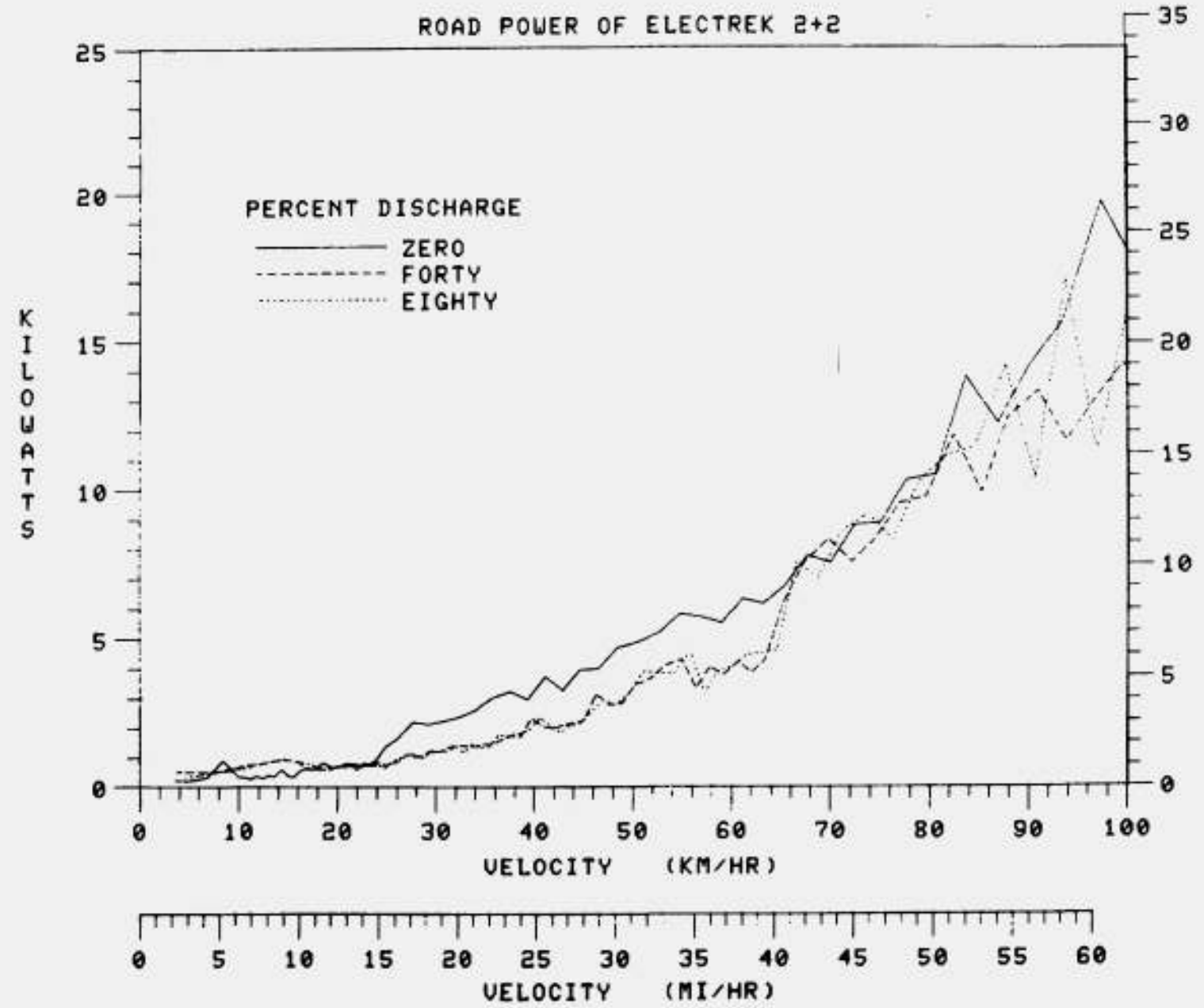


Figure 43. Road power of Electrek 2+2.

f. **Indicated Energy Economy.** SAE J227a defines energy economy as, "the vehicle range in various operating modes divided into the a.c. energy required to return the battery to its original state of charge." The test procedure monitored electrical power transfer at three points. A rotating watt-hour meter measured the 60-Hz a.c. input to the charger. A Hall-effect device measured the energy into the battery, and a Hall-effect device also measured the energy out of the battery. The constant-speed battery performance is given in Figure 44.

Charger efficiency is the ratio of output d.c. energy to input a.c. energy expressed as a percentage. The Hall-effect devices responded from d.c. to frequencies beyond 5 kHz with an accuracy of ±2 percent of full scale (6 kW).

VIII. COMPONENT PERFORMANCE AND EFFICIENCY

a. **Battery Charger.** The on-board battery charger of the Electrek 2+2 had a tendency occasionally to overcharge the propulsion battery. To overcome the problem, most of the charging was done in conjunction with a timer to guarantee no overcharge. Except for the occasional overcharge conditions, the battery charger exhibited a high efficiency.

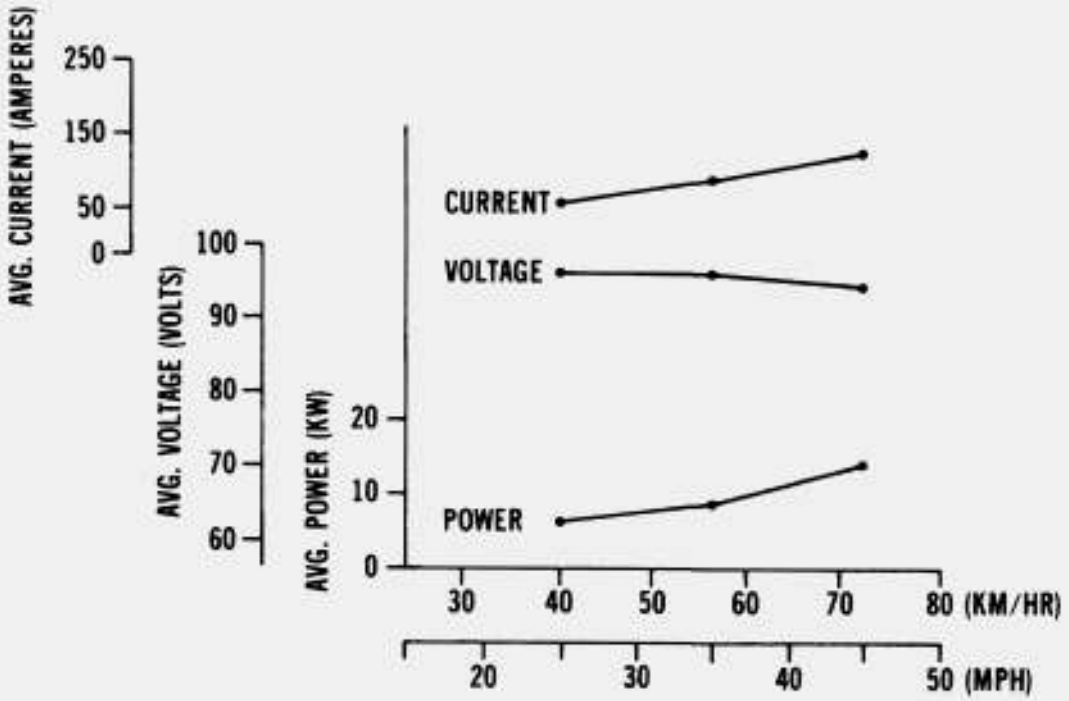
b. **Battery Characteristics.** The Electrek 2+2 uses 16 Globe-Union EV4-19 6-V batteries. A standard discharge (75-A constant current discharge down to 1.5 V/cell) yielded 120 min discharge time (92 percent of the 130-min rating) indicating that the battery pack capacity was well within the 80 percent required for testing. Figure 44 gives the battery performance data for the Globe-Union EV4-19 batteries in the Electrek 2+2 for the first and last 25 percent of the 25-, 35-, and 45-mi/h range runs.

IX. RELIABILITY

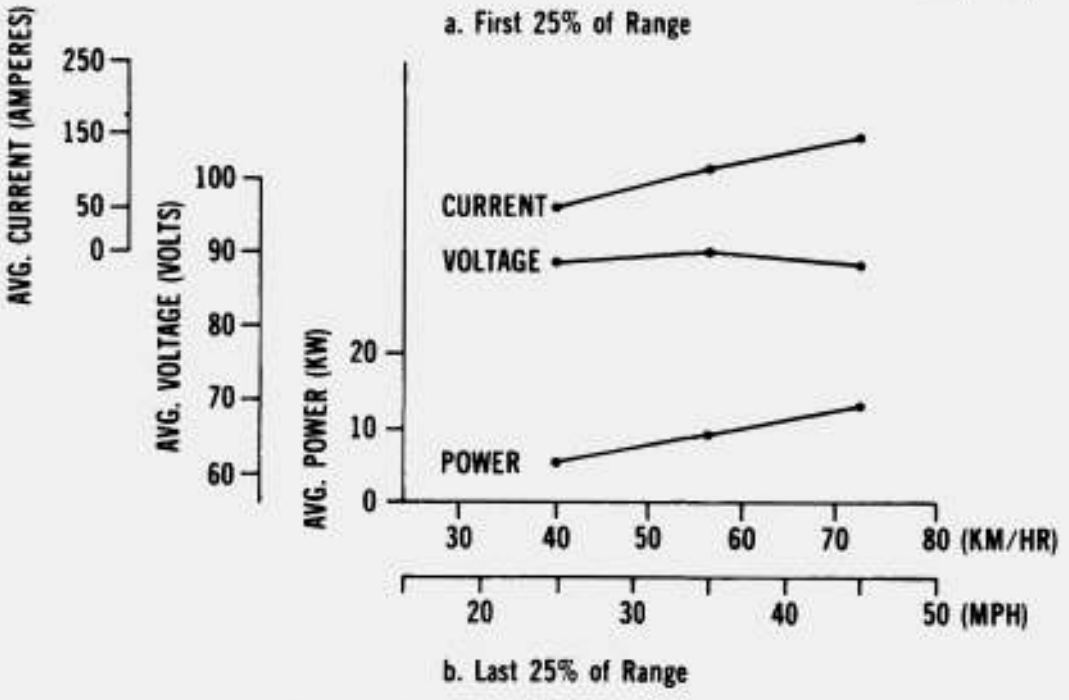
The original on-board charger was replaced because of an inability to fully charge the traction battery. The replacement charger met charging criteria; however, on occasion it would not terminate charge automatically, requiring the use of a timer to prevent overcharging.

X. VERIFICATION TEST RESULTS

The Electrek 2+2 was also tested under the DOE Market Demonstration Program which establishes criteria for the Self-Certification and Verification Procedures for Electric and Hybrid Vehicles (Appendix F). The following are the verification test results performed at MERADCOM (paragraphs referenced to the DOE "Performance Standards for Demonstrations" as published in the Federal Register, 12 February 1980, Part IV):



a. First 25% of Range



b. Last 25% of Range

Figure 44. Constant-speed battery performance.

475.10 (a) Acceleration: 0-50 km/h (31.1 mi/h) in 9.3 s.

(b) Gradeability at Speed: At 25 km/h (15 mi/h) the vehicle can traverse a 15.8-percent grade based on calculations from acceleration tests.

(c) Gradeability Limit: Calculations based on drawbar-pull test indicate a 42.3-percent forward and a 40.3-percent reverse gradeability for at least 20 s.

(d) Forward Speed Capability: Forward speed of 80 km/h (50 mi/h) was maintained for more than 5 min on the level (± 1-percent grade) portion of the MERADCOM Test Track.

(e) Range: SAE J227a Cycle "C" on level (± 1-percent terrain yielded 81.6 km (50.7 mi) and 150 cycles, and the SAE J227a Cycle "D" over the same terrain yielded 63.7 km (39.6 mi) and 40 cycles.

(f) Battery Recharge Time: After an 80-percent discharge, recharged with on-board charger (16 A Max, 110 Va.c.) for 10 h; after recharge the vehicle operated for 63.5 km (39.5 mi) to a SAE J227a Cycle "C" regime.

(g) Recharge Control: Current Limit, voltage comparator.

(h) Energy Consumption: The vehicle uses only electrical energy.

(i) Battery:
- (1) Warranty: 1 yr from date of purchase.
- (2) Type: Lead-Acid, Globe Union EV4-19.
- (3) Capacity: 150 Ah (120 min. at 75 A rate).
- (4) Voltage: 96 V (16 6-V modules connected in series).

(j) State-of-Charge Meter: The vehicle is not equipped with a state-of-charge meter.

(k) Odometer: The vehicle is equipped with an odometer.

(l) Passenger Comfort Heater: Electric heater made by Unique Mobility rated at 4000 Btu/h.

(m) Documentation: Operations manual and electrical drawings were submitted but no maintenance manual or parts list.

(n) Emissions: Did not evaluate.

(o) Safety, etc.: The Department of Transportation (DOT) is performing these evaluations. However, MERADCOM performed the following limited checks for design intent:

(1) Electrical isolation: The electric system is completely isolated from the vehicle chassis.

(2) Safety Standards 208 and 301: DOT will check compliance.

(3) Battery Caps: Standard golf-cart industry type. Flame barrier characteristics were not tested.

(4) Ventilation of Battery Compartment: The battery compartment is vented by a 105-ft^3/min fan which draws outside air into the front and exhaust air out of the rear of the compartment. The fan vents during charging and also when the vehicle is operating. It is sufficient to change the air in the compartment 20 times per minute. During normal maintenance the battery pack is removed from the vehicle.

(5) Battery Emergency Disconnect: None; however, this vehicle is equipped with a manual transmission and the electric motor can be disconnected from the mechanical drive system by depressing the clutch.

(6) Parked Temperature Effect: Parked vehicle for 8 h at each of the temperatures, 25°C and 50°C. Subsequent operation revealed no apparent damage to vehicle or hazard to persons.

APPENDIX A

VEHICLE SUMMARY DATA SHEET

1. Vehicle Manufacturer:
   Unique Mobility, Inc.
   3700 South Jason Street
   Englewood, Colorado 80110

2. Vehicle Description:
   Name: Electrek — Model: 2+2
   Availability: 30 days — Price: $25,000.00

3. Vehicle Weight:
   Curb Wt: 1,292.7 kg (2850 lb) — Passengers Wt:
   Driver Wt: 68.0 kg (150 lb) — Payload Wt: 226.8 kg (500 lb)
   Gross Wt: 1,519.5 kg (3350 lb)

4. Vehicle Size:
   Wheelbase: 2.426 m (95.5 in.) — Length: 4.356 m (171.5 in.)
   Headroom: 0.914 m (36 in.) — Width: 1.702 m (67 in.)
   Legroom: 1.270 m (50 in.)

5. Auxiliaries & Options:
   No. Lights: 15 — Type & Function: Standard Automotive
   Windshield Wipers: Yes — Windshield Washers: Yes
   Defroster: Yes — Heater: Yes
   Radio: Yes — Fuel Gage: Yes — Ampmeter: Yes
   Tachometer: No — Speedometer: Yes
   Odometer: Yes — No. Mirrors: 2
   Power Steering: Yes — Power Brakes: No
   Transmission Type: 4 Speed & Reverse Manual

6. Propulsion Batteries:
   - Type: Lead-Acid
   - No. of Modules: 16
   - No. Cells: 48
   - Ah Capacity: 150 @ 2-h rate
   - Battery Wt: 29.94 kg (66 lb) each
   - Battery Rate: 2 h
   - Battery Cycles: 250 to 350

   Manufacturer: Globe-Union
   S/N: EV4-19
   Battery Voltage: 96 V
   Battery Size: 0.2635 m x 0.1826 m x 0.2699 m (10-3/8 in. x 7-3/16 in. x 10-5/8 in.)

7. Auxiliary Battery:
   - Type: Lead-Acid
   - No. Cells: 6
   - Ah Capacity: 15
   - Battery Rate: 2 h
   - Battery Wt: 3.63 kg (8 lb)

   Manufacturer: Wisco
   Battery Voltage: 6 V
   Battery Size: 0.1588 m x 0.0762 m x 0.1334 m (6¼ in. x 3 in. x 5¼ in.)

8. Controller:
   - Type: Hybrid Armature Field Transistor
   - Voltage Rating: 120 V
   - Size: 0.6604 m x 0.3175 m (26 in. x 12.5 in. x 6 in.)

   Manufacturer: Unique Mobility

   Current Rating: 400 A
   Weight: 28.58 kg (63 lb)

9. Propulsion Motor:
   - Type: Shunt
   - Insulation Class: F
   - Current Rating: 175 A
   - Max. 5-Min. Rating:
   - Weight: 102 kg (225 lb)
   - Max. Speed: 6500 r/min

   Manufacturer: General Electric
   Voltage Rating: 165 V
   Hp Rating: 23.87 kW (32 hp)
   Size: 0.2794 m (11 in.) dia, 0.4064 m (16 in.) long
   Rated Speed: 5925 r/min

10. Body:
    - Type: Passenger
    - No. Doors: 2
    - No. Windows: 6
    - No. Seats: 4

    Manufacturer: UMI
    Type: UMI Manufactured
    Type: Glass & Polycarbonate
    Type: Bucket

11. Chassis:

Type Frame: Unibody
Type Material: FRP
Type Springs: Double Coil
Axle Type Front: McPherson
Drive Line Ratio: 3.60 in 4th
Type Brakes Rear: Drum
Tire Type: 3-ply radial
Size: P165/75R13
Rolling Radius: 0.2819 m (11.1 in.)

Manufacturer: UMI
Type Shocks: Linear Hydraulic
Axle Type Rear: Trailing Arm
Axle Manufacturer: VW
Type Brakes Front: Disc
Regenerative Brakes: Yes
Manufacturer: Goodyear
Pressure: 241.32 kPa (35 lb/in.^{2})

12. Battery Charger:

Type Chopper
On or Off Board: On
Peak Current: 15 A
Size: 0.2032 m x 0.3048 m x 0.1524 m (8 in. x 12 in. x 6 in.)
Automatic Turn Off: Yes

Manufacturer: UMI
Input Voltage: 110 V
Recharger Timer: Automatic
Weight: 13.61 kg (30 lb)

APPENDIX B

360A CONTROLLER TEST RESULTS

Date	Test Type	Gears Used	Range (km)	Cycles	Battery Energy (d.c.) Disch (kWh)	Battery Energy (d.c.) Chg (kWh)	Energy From Charger Into Battery (kWh)	Energy Into Charger (a.c.) (kWh)	Charger Efficiency (%)	Vehicle Energy Economy (kWh/km)	Start of Test Time	Start of Test Wind (km/h)	Start of Test Temp (°C)	End of Test Time	End of Test Wind (km/h)	End of Test Temp (°C)
3 Nov 80	45-mi/h range	1, 2, 3	83.5 (51.9 miles)		12.39		14.08				0905	calm	7.2 (45°F)	1015	calm	8.3 (47°F)
5 Nov 80	35-mi/h range	1, 2	122.4 (76.1 miles)		14.05		17.62	21.3	83	0.174 (0.280 kWh/mi)	0825	8.0 (5 mi/h)	11.7 (53°F)	1040	11.3 (7 mi/h)	12.2 (54°F)
12 Nov 80	D Cycle	1, 2	64.8 (40.3 mi)	42	14.01	2.21	16.79	19.4	87	0.299 (4.81 kWh/mi)	0855	11.3 (7 mi/h) 16.1 (10 mi/h) gusts	5.6 (42°F)	1035	16.1-19.3 (10-12 mi/h) gusts	8.9 (48°F)

APPENDIX C

NON-REGENERATIVE BRAKING CYCLE TEST RESULTS

Date	Test Type	Gears Used	Range (km)	Cycles	Battery Energy (d.c.) Disch (kWh)	Battery Energy (d.c.) Chg (kWh)	Energy From Charger Into Battery (kWh)	Energy Into Charger (a.c.) (kWh)	Vehicle Charger Efficiency (%)	Vehicle Energy Economy (kWh/km)	Start of Test Time	Start of Test Wind (km/h)	Start of Test Temp (°C)	End of Test Time	End of Test Wind (km/h)	End of Test Temp (°C)
29 Sep 80	C Cycle	1	55.7 (34.6 mi)	101	12.1	0.66	18.87	19.3	98	0.346 (0.558 kWh/mi)	0800		14.4 (58°F)	1000		16.7 (62°F)
30 Sep 80	C Cycle	1	59.4 (36.9 mi)	105	12.26	0.67	30.87	35	88	0.589 (0.948 kWh/mi)	0825	8.0 (5 mi/h)	18.3 (65°F)	1105	8.0 (5 mi/h)	21.1 (70°F)
6 Oct 80	D Cycle	1, 2	49.6 (30.8 mi)	31	9.79	0.23	14.91	15.8	94	0.318 (0.513 kWh/mi)	0840	4.8-8.0 (3-5 mi/h)	12.2 (54°F)	1010	4.8-8.0 (3-5 mi/h)	16.7 (62°F)
7 Oct 80	D Cycle	1, 2	51.5 (32.0 mi)	31	9.90	0.24	17.09	18.0	95	0.350 (0.563 kWh/mi)	0840	calm	11.1 (52°F)	0945	calm	16.7 (62°F)

APPENDIX D

DRIVING CYCLE DATA

B-CYCLE CYCLE 3

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
.50	.09	102.38	5.29	.1621
1.00	.29	101.57	24.98	2.2043
1.50	1.17	100.57	46.22	4.3303
2.00	2.37	100.05	54.27	5.3458
2.50	3.57	98.69	86.82	8.7667
3.00	4.76	98.18	93.66	9.3145
3.50	5.86	98.47	85.42	9.0518
4.00	6.76	98.95	69.61	7.7680
4.50	7.39	99.07	62.46	6.7022
5.00	7.82	99.26	57.13	5.9644
5.50	8.15	99.61	49.14	5.3998
6.00	8.38	99.63	48.55	5.3439
6.50	8.62	98.86	66.92	6.8252
7.00	8.99	97.89	87.86	9.1021
7.50	9.52	97.54	96.47	10.3077
8.00	10.15	97.63	92.66	10.1847
8.50	10.71	97.99	79.61	8.8040
9.00	11.14	98.34	70.91	8.0065
9.50	11.47	98.61	60.43	6.9705
10.00	11.66	98.93	55.79	6.3277
10.50	11.80	99.09	53.23	5.8377
11.00	11.90	98.72	59.62	6.1637
11.50	12.06	98.29	72.04	7.7214
12.00	12.34	97.64	84.87	8.8878
12.50	12.69	97.20	95.61	10.1251
13.00	13.20	96.68	109.91	11.4405
13.50	13.81	97.39	88.79	10.0561
14.00	14.31	98.10	70.34	7.8388
14.50	14.65	98.44	60.87	6.7712
15.00	14.87	98.59	57.53	6.2140
15.50	15.09	98.59	61.38	6.5103
16.00	15.31	98.51	62.06	6.6053
16.50	15.57	95.90	131.22	12.4504
17.00	16.12	93.69	186.30	19.1750
17.50	16.96	93.22	193.55	20.4849
18.00	17.87	93.38	190.27	20.2278
18.50	18.75	93.44	185.65	19.7377
19.00	19.52	93.76	170.50	18.3272
19.50	20.17	95.21	131.47	14.9100
20.00	20.65	98.31	51.92	6.8215
20.50	20.82	100.28	13.80	2.0105
21.00	20.74	100.95	2.05	.4081
21.50	20.58	100.90	2.54	.2776
22.00	20.36	100.79	8.99	.9428
22.50	20.10	100.10	25.32	2.4838

B-CYCLE CYCLE 3

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
23.00	19.96	99.93	30.77	3.3893
23.50	19.94	99.03	51.83	5.2973
24.00	19.98	97.80	75.68	7.9096
24.50	20.13	98.07	71.26	7.9115
25.00	20.34	98.08	70.21	7.6581
25.50	20.49	98.09	68.30	7.5351
26.00	20.67	98.24	65.30	7.2798
26.50	20.86	98.19	64.00	7.1960
27.00	20.97	98.71	55.34	6.3650
27.50	21.03	100.03	24.38	3.4471
28.00	20.95	101.16	1.05	.4118
28.50	20.75	101.28	3.40	.4826
29.00	20.55	100.71	14.91	1.4944
29.50	20.42	100.30	23.16	2.5713
30.00	20.33	100.38	24.05	2.6906
30.50	20.21	100.19	27.02	2.9049
31.00	20.11	100.12	27.75	3.0297
31.50	20.06	99.95	31.27	3.3912
32.00	20.03	99.70	36.70	3.9352
32.50	20.02	99.77	37.98	4.1234
33.00	20.08	99.57	39.86	4.1533
33.50	19.97	99.44	43.38	4.4980
34.00	19.99	98.92	55.47	5.6998
34.50	20.13	98.51	62.38	6.4190
35.00	20.29	98.67	62.03	6.5867
35.50	20.36	98.45	62.32	6.6184
36.00	20.43	98.47	61.56	6.4805
36.50	20.54	98.68	59.66	6.4544
37.00	20.65	98.60	57.09	6.1730
37.50	20.76	98.94	53.67	5.9010
38.00	20.86	98.86	50.84	5.6625
38.50	20.88	99.89	25.58	3.1732
39.00	20.81	100.44	20.43	2.2807
39.50	20.70	100.47	19.76	2.2210
40.00	20.60	100.76	13.40	1.8297
40.50	20.39	110.58	-92.04	-9.1077
41.00	19.62	114.16	-94.04	-11.6511
41.50	18.58	114.21	-90.21	-11.1461
42.00	17.56	113.93	-86.57	-10.4884
42.50	16.45	113.43	-81.14	-9.8866
43.00	15.31	112.09	-69.27	-8.6792
43.50	14.16	105.69	-31.44	-4.2632
44.00	13.29	102.50	6.60	.2981
44.50	12.86	102.01	13.08	1.5204
45.00	12.47	101.72	14.07	1.5260

B-CYCLE CYCLE 3

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
45.50	11.73	101.83	13.59	1.6024
46.00	10.66	101.77	13.78	1.5987
46.50	9.46	101.81	13.63	1.5875
47.00	8.31	101.80	13.43	1.6658
47.50	7.25	101.56	13.89	1.5894
48.00	6.31	101.68	13.62	1.6061
48.50	5.58	101.65	13.62	1.5391
49.00	4.86	101.66	13.73	1.4645
49.50	3.78	101.73	13.25	1.5652
50.00	2.17	101.54	13.80	1.4627

B-CYCLE CYCLE N-1

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
.50	2.46	86.00	48.00	3.8607
1.00	2.96	84.55	67.15	5.3402
1.50	4.01	83.69	77.34	6.5028
2.00	5.08	82.91	84.70	7.2053
2.50	6.02	82.33	91.99	7.8686
3.00	6.89	81.97	94.36	8.1295
3.50	7.71	81.91	92.84	7.8854
4.00	8.48	80.94	107.34	9.1245
4.50	9.28	80.89	106.32	9.1282
5.00	10.02	80.70	104.31	9.2326
5.50	10.69	81.75	86.59	7.8705
6.00	11.24	82.48	76.11	6.8904
6.50	11.67	83.26	65.53	5.9998
7.00	12.07	83.13	67.32	6.0389
7.50	12.44	81.74	86.95	7.3637
8.00	12.92	79.24	125.44	10.3170
8.50	13.57	77.60	148.04	12.1616
9.00	14.29	77.73	143.02	12.2101
9.50	14.99	79.66	109.95	9.6164
10.00	15.52	82.13	72.54	6.9202
10.50	15.86	83.87	50.90	4.9079
11.00	16.07	83.38	59.82	5.3048
11.50	16.26	81.64	84.52	7.1270
12.00	16.61	79.58	114.28	9.7170
12.50	17.04	78.78	122.35	10.4679
13.00	17.49	77.65	138.75	11.4722
13.50	18.00	77.37	140.71	11.9194
14.00	18.46	79.41	107.06	9.7524
14.50	18.84	81.83	73.23	7.0153
15.00	19.09	82.60	64.45	5.9047
15.50	19.19	82.74	64.32	5.7911
16.00	19.35	81.54	80.58	6.9463
16.50	19.57	80.69	91.79	8.0456
17.00	19.81	80.75	90.58	8.0568
17.50	20.06	82.01	70.05	6.7898
18.00	20.20	84.96	32.29	3.2943
18.50	20.28	86.03	21.79	2.2639
19.00	20.30	86.31	18.54	1.9471
19.50	20.22	86.60	15.78	1.5857
20.00	20.16	86.76	15.91	1.6583
20.50	20.09	86.48	19.97	1.8614
21.00	20.07	86.21	25.57	2.4428
21.50	20.10	85.77	29.87	2.9030
22.00	20.09	85.74	28.67	2.6682
22.50	20.08	85.43	35.39	3.2794

B-CYCLE CYCLE N-1

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
23.00	20.09	84.69	43.58	3.9427
23.50	20.13	84.86	40.75	3.9520
24.00	20.19	85.10	36.75	3.4340
24.50	20.20	84.84	40.44	3.6446
25.00	20.25	84.34	47.72	4.3675
25.50	20.33	84.10	50.58	4.5539
26.00	20.40	83.70	55.23	5.0197
26.50	20.53	83.53	55.78	5.1520
27.00	20.67	83.38	57.02	5.0905
27.50	20.76	83.24	60.87	5.5153
28.00	20.90	83.09	60.96	5.4110
28.50	21.03	83.09	59.37	5.2861
29.00	21.13	83.31	57.92	5.2489
29.50	21.27	83.27	57.66	5.2246
30.00	21.39	83.35	56.92	5.0979
30.50	21.49	83.89	49.10	4.4178
31.00	21.52	86.79	8.04	1.1534
31.50	21.46	88.35	-6.55	-.7341
32.00	21.31	88.32	-2.94	-.3857
32.50	21.12	88.12	-.10	-.0708
33.00	20.99	88.30	.41	.0112
33.50	20.82	88.14	1.56	.0578
34.00	20.65	88.10	3.99	.2012
34.50	20.52	87.67	9.38	.5758
35.00	20.39	86.81	20.39	1.4012
35.50	20.36	86.61	23.62	2.0291
36.00	20.34	86.35	25.47	1.9304
36.50	20.27	86.34	25.63	2.4223
37.00	20.28	86.89	14.99	2.0962
37.50	20.08	100.11	-225.80	-18.8955
38.00	18.39	106.50	-329.05	-40.2804
38.50	15.36	97.66	-126.32	-16.4118
39.00	13.16	92.56	-21.16	-3.1154
39.50	12.37	90.79	8.79	.7565
40.00	12.06	90.26	10.73	1.0993
40.50	11.82	90.15	10.20	1.1403
41.00	11.54	89.83	10.45	1.1217
41.50	11.19	89.61	10.72	1.0378
42.00	10.84	89.59	10.65	1.1869
42.50	10.33	89.36	11.08	1.1049
43.00	9.54	89.30	10.79	1.1664
43.50	8.66	89.05	10.93	1.1776
44.00	7.69	88.87	11.27	1.1217
44.50	6.75	89.07	10.39	1.1608
45.00	5.97	88.82	10.19	1.0658

B-CYCLE

CYCLE N-1

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
45.50	5.36	88.69	10.37	1.0267
46.00	4.94	88.71	10.15	1.0043
46.50	4.64	88.55	10.49	1.0378
47.00	4.44	88.70	10.08	1.1087
47.50	4.33	88.62	9.19	.9950
48.00	4.12	88.54	8.74	.8776
48.50	3.83	88.69	7.84	.8739
49.00	3.49	88.64	7.60	.7751
49.50	3.09	88.70	7.00	.7639
50.00	2.62	88.66	6.66	.7434
50.50	2.12	88.55	7.14	.6652
51.00	1.58	88.77	6.18	.6596
51.50	.99	88.65	5.99	.6335
52.00	.40	88.72	5.55	.6186

C-CYCLE CYCLE 3 C-CYCLE CYCLE 3

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)	ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
.50	.80	100.60	24.36	1.9769	23.00	30.76	97.56	54.08	5.9866
1.00	1.02	98.04	79.57	7.5332	23.50	30.83	97.99	56.97	6.1190
1.50	2.82	97.12	112.23	11.1965	24.00	30.92	97.74	53.65	6.0296
2.00	4.69	96.45	113.90	11.9939	24.50	30.88	97.91	45.02	5.0476
2.50	6.23	96.32	112.53	11.7200	25.00	30.87	98.50	44.89	4.9321
3.00	7.51	96.46	108.35	11.3250	25.50	30.83	98.30	44.67	4.9246
3.50	8.55	96.05	108.73	11.3548	26.00	30.77	98.27	45.14	4.9880
4.00	9.47	96.61	103.85	11.1536	26.50	30.82	98.35	47.63	5.1836
4.50	10.33	96.33	105.48	11.1107	27.00	30.71	97.84	48.72	5.3476
5.00	11.06	96.15	102.76	10.9524	27.50	30.66	98.23	49.43	5.4072
5.50	11.83	97.04	82.75	9.3965	28.00	30.75	98.40	49.41	5.4166
6.00	12.40	96.54	83.82	8.6028	28.50	30.72	97.90	49.00	5.3867
6.50	12.82	95.63	124.95	12.3349	29.00	30.69	98.10	48.94	5.3923
7.00	13.57	94.67	147.30	15.3013	29.50	30.71	98.00	48.68	5.3197
7.50	14.45	94.05	143.47	15.0907	30.00	30.81	98.37	49.22	5.3849
8.00	15.33	94.78	133.98	14.0771	30.50	30.92	98.26	49.04	5.4035
8.50	16.14	94.31	138.58	14.2373	31.00	30.90	97.83	49.21	5.3867
9.00	16.83	94.48	139.16	14.5802	31.50	30.87	98.22	50.41	5.5433
9.50	17.75	94.41	144.56	14.9062	32.00	30.87	97.99	50.65	5.5638
10.00	18.76	93.81	141.00	14.7926	32.50	30.84	98.33	51.01	5.6066
10.50	19.36	94.57	133.35	14.0827	33.00	30.86	98.33	51.23	5.5973
11.00	19.68	95.69	103.51	11.5039	33.50	30.91	97.76	50.05	5.5265
11.50	19.93	94.41	141.20	12.9908	34.00	31.06	98.19	50.71	5.5414
12.00	20.84	92.14	202.30	20.6023	34.50	31.10	98.37	46.30	5.2936
12.50	22.05	91.97	193.04	19.8141	35.00	30.97	98.69	36.85	4.1178
13.00	22.88	92.54	189.75	19.4266	35.50	30.91	98.85	38.40	4.2539
13.50	23.71	92.85	184.09	18.9402	36.00	30.87	98.47	36.79	4.1048
14.00	24.44	92.57	177.79	18.3459	36.50	30.92	98.80	38.55	4.2855
14.50	25.11	93.49	164.33	17.2018	37.00	30.96	98.99	38.70	4.2650
15.00	25.73	93.42	153.71	15.9925	37.50	30.88	98.76	38.80	4.2781
15.50	26.29	92.96	172.50	17.4645	38.00	30.84	98.92	39.14	4.3601
16.00	26.88	93.42	170.46	17.7068	38.50	30.85	98.70	38.85	4.3340
16.50	27.53	93.09	158.04	16.4751	39.00	30.82	98.76	38.99	4.3209
17.00	28.09	93.59	156.09	16.2161	39.50	30.83	98.93	39.55	4.3787
17.50	28.62	93.89	153.97	16.0186	40.00	30.81	98.55	39.00	4.3526
18.00	29.09	93.78	151.93	15.8193	40.50	30.75	100.40	2.06	2.6514
18.50	29.49	94.08	147.09	15.4037	41.00	30.39	112.28	-205.67	-23.3655
19.00	29.92	93.69	145.87	15.1895	41.50	29.26	112.10	-201.55	-25.1002
19.50	30.30	95.34	103.34	12.0722	42.00	27.62	110.95	-172.31	-22.1786
20.00	30.57	97.34	59.33	6.8289	42.50	26.08	106.42	-105.20	-13.7752
20.50	30.74	97.61	46.39	5.2731	43.00	24.98	104.06	-51.08	-6.8830
21.00	30.78	98.16	46.43	5.0979	43.50	24.08	102.80	-20.83	-2.8695
21.50	30.74	97.74	46.13	5.0886	44.00	23.55	101.66	-1.28	-.5292
22.00	30.74	97.91	49.28	5.3476	44.50	23.27	101.52	9.90	.8795
22.50	30.76	97.98	53.12	5.7631	45.00	23.06	101.17	13.16	1.3956

C-CYCLE

CYCLE 3

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
45.50	22.87	100.97	13.31	1.4385
46.00	22.75	101.13	13.30	1.4329
46.50	22.61	101.03	13.22	1.4198
47.00	22.49	101.19	13.73	1.4739
47.50	22.38	100.92	13.39	1.4310
48.00	22.18	100.83	13.73	1.4701
48.50	21.48	100.99	14.16	1.5223
49.00	19.66	100.96	13.97	1.5130
49.50	17.07	101.05	14.27	1.5372
50.00	14.44	100.90	14.05	1.5186
50.50	12.11	100.56	13.54	1.4683
51.00	10.31	101.02	14.01	1.5018
51.50	8.95	100.94	12.55	1.4105
52.00	7.91	100.76	11.18	1.2391
52.50	7.14	101.16	10.58	1.1459
53.00	6.54	100.92	9.75	1.0677
53.50	6.00	101.09	9.53	1.0434
54.00	5.43	101.35	9.68	1.0602
54.50	5.00	100.64	8.57	.9521
55.00	4.68	101.10	8.42	.9410
55.50	4.37	101.02	7.74	.8683
56.00	3.97	101.02	7.18	.8254
56.50	3.52	101.19	7.29	.8105
57.00	2.98	100.82	6.53	.7379
57.50	2.37	101.12	6.47	.7434
58.00	1.54	101.15	6.11	.6913

C-CYCLE CYCLE N-1 C-CYCLE CYCLE N-1

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)	ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
.50	1.52	94.37	14.48	.9298	23.00	29.12	82.15	114.50	10.3095
1.00	.67	90.91	65.11	5.1557	23.50	29.30	84.06	97.19	8.7090
1.50	2.16	86.54	119.28	9.3798	24.00	29.34	83.01	105.31	9.0444
2.00	3.98	81.61	165.71	13.2181	24.50	29.38	79.12	170.12	13.4901
2.50	5.89	79.06	198.14	15.8025	25.00	29.67	79.78	156.21	13.0784
3.00	7.67	79.23	177.34	14.8354	25.50	29.94	79.46	154.20	12.8529
3.50	9.10	79.30	173.53	14.3119	26.00	30.19	79.89	155.04	12.6945
4.00	10.34	79.69	170.87	14.2019	26.50	30.49	81.18	125.11	11.5710
4.50	11.37	79.23	168.83	14.0529	27.00	30.65	88.82	18.90	2.5955
5.00	12.28	79.59	170.33	14.1125	27.50	30.69	89.38	24.00	2.2378
5.50	13.17	79.40	167.87	13.8516	28.00	30.65	88.58	27.51	2.6198
6.00	13.93	79.63	163.50	13.2516	28.50	30.56	89.25	30.13	2.8545
6.50	14.61	80.16	162.86	13.2237	29.00	30.50	88.61	36.47	3.3409
7.00	15.21	79.16	166.74	13.7827	29.50	30.47	88.13	37.65	3.5682
7.50	15.83	79.82	166.20	13.7939	30.00	30.51	88.75	40.34	3.7694
8.00	16.52	79.66	166.61	13.8330	30.50	30.41	88.12	40.75	3.8458
8.50	17.16	79.40	163.78	13.6429	31.00	30.24	88.44	41.57	3.9334
9.00	17.76	79.93	168.66	14.0324	31.50	30.28	88.47	42.04	3.9688
9.50	18.34	79.10	167.42	13.9467	32.00	30.22	88.02	42.47	3.9688
10.00	18.86	79.20	168.83	14.0603	32.50	30.15	88.48	45.16	4.2408
10.50	19.43	79.58	169.01	14.0547	33.00	30.16	87.83	44.63	4.2036
11.00	19.96	78.99	166.54	13.8609	33.50	30.05	88.22	45.16	4.2222
11.50	20.44	79.62	165.75	13.8516	34.00	30.03	88.35	45.85	4.3284
12.00	20.96	79.43	164.63	13.7417	34.50	30.01	87.83	45.23	4.2688
12.50	21.41	79.25	165.00	13.6821	35.00	29.90	88.21	45.98	4.3303
13.00	21.85	79.75	163.61	13.7175	35.50	30.04	87.93	45.55	4.3023
13.50	22.30	79.07	164.36	13.5833	36.00	30.07	87.82	45.83	4.3359
14.00	22.61	87.68	37.37	5.3700	36.50	29.94	88.25	46.73	4.4011
14.50	22.78	81.05	154.54	10.5723	37.00	29.85	87.59	45.87	4.3265
15.00	23.36	79.22	163.95	13.5777	37.50	29.83	88.16	46.02	4.3545
15.50	24.28	79.93	163.16	13.4231	38.00	29.94	88.11	46.43	4.3768
16.00	24.79	79.48	160.80	13.2740	38.50	29.87	87.88	46.88	4.4346
16.50	25.09	79.42	159.09	13.1585	39.00	29.94	90.96	-2.98	2.4148
17.00	25.50	79.91	161.04	13.2181	39.50	29.58	104.75	-266.79	-27.7964
17.50	25.86	79.26	158.68	13.1343	40.00	28.13	103.44	-189.40	-22.1302
18.00	26.21	79.95	158.47	13.1492	40.50	26.57	102.11	-117.95	-13.7734
18.50	26.63	79.63	158.36	13.0951	41.00	25.32	99.85	-72.27	-8.3829
19.00	26.99	79.23	157.89	13.0504	41.50	24.59	99.14	-44.93	-5.1315
19.50	27.36	79.78	159.17	13.0970	42.00	24.15	97.87	-24.08	-2.7893
20.00	27.64	79.26	156.77	12.9852	42.50	23.62	96.55	-12.04	-1.3770
20.50	27.89	79.62	157.18	12.9815	43.00	23.25	96.75	-2.49	-.3727
21.00	28.17	79.69	157.42	12.9610	43.50	23.01	95.37	4.73	.3615
21.50	28.37	79.25	154.91	12.8809	44.00	22.84	95.37	7.33	.7509
22.00	28.61	80.26	154.27	12.9405	44.50	22.73	95.23	8.94	.9298
22.50	28.89	80.02	148.09	12.7337	45.00	22.53	94.51	7.95	.8273

C-CYCLE

CYCLE M-1

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
45.50	22.35	95.29	9.19	.9316
46.00	22.22	94.77	8.70	.8962
46.50	22.01	94.74	8.46	.8739
47.00	21.84	95.00	9.06	.9279
47.50	21.64	94.15	8.36	.8608
48.00	21.28	94.83	9.75	1.0174
48.50	20.48	94.96	9.77	1.0248
49.00	19.29	94.24	9.15	.9559
49.50	18.12	94.96	9.83	1.0136
50.00	17.05	94.60	9.39	.9615
50.50	15.99	94.58	9.68	.9987
51.00	14.99	94.73	9.92	1.0453
51.50	14.01	94.07	8.96	.9205
52.00	13.03	94.55	9.75	.8925
52.50	12.05	94.30	9.34	.9670
53.00	11.06	94.18	9.23	.9577
53.50	10.13	94.58	9.83	1.0024
54.00	9.23	93.95	8.87	.9261
54.50	8.37	94.51	8.76	.8925
55.00	7.53	94.71	8.38	.8702
55.50	6.56	94.08	7.31	.7639
56.00	5.58	94.68	7.65	.8310
56.50	4.49	94.44	6.53	.7267
57.00	3.07	94.60	6.39	.7006
57.50	1.51	95.06	6.92	.7285
58.00	.37	94.09	5.70	.6242

D-CYCLE CYCLE 3 D-CYCLE CYCLE 3

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)	ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
.50	.71	100.68	65.81	6.2867	23.00	42.23	94.70	148.95	15.1578
1.00	2.29	99.78	89.92	8.5394	23.50	42.43	90.03	283.60	25.7487
1.50	4.17	97.12	158.67	15.2621	24.00	42.72	87.51	359.45	33.9471
2.00	6.24	96.18	185.75	18.6272	24.50	43.23	86.80	379.86	35.8886
2.50	8.25	95.36	197.41	19.8849	25.00	43.82	86.41	384.71	36.4066
3.00	9.94	95.35	188.21	19.8346	25.50	44.33	86.61	384.42	36.4514
3.50	11.41	96.70	142.80	15.8248	26.00	44.74	86.89	369.49	35.6166
4.00	12.49	96.47	139.85	14.3659	26.50	45.12	89.80	279.98	29.8367
4.50	13.44	94.03	220.04	21.0271	27.00	45.40	96.10	99.18	11.8151
5.00	14.76	90.15	337.47	32.1956	27.50	45.42	97.48	60.72	6.9221
5.50	16.39	88.66	368.31	35.4880	28.00	45.27	98.18	51.74	5.6737
6.00	18.12	88.12	382.96	36.7551	28.50	45.11	98.15	54.08	5.8488
6.50	19.72	87.52	386.82	37.0495	29.00	44.90	98.06	54.06	5.8600
7.00	21.13	87.38	387.21	37.0513	29.50	44.73	98.27	57.23	6.1526
7.50	22.46	88.18	356.11	36.1066	30.00	44.62	96.87	92.98	8.5506
8.00	23.46	105.77	-170.91	-12.9014	30.50	44.57	92.81	210.17	20.1644
8.50	23.79	101.72	-21.24	-7.4028	31.00	44.69	91.69	236.68	23.5593
9.00	23.77	93.61	225.54	19.1191	31.50	44.91	91.08	247.97	24.5953
9.50	24.31	88.20	365.40	34.7222	32.00	45.31	93.26	189.53	20.2017
10.00	25.54	87.47	379.63	36.0153	32.50	45.53	93.56	176.37	18.2452
10.50	26.81	86.74	390.87	37.2023	33.00	45.49	93.70	174.10	17.9546
11.00	27.99	86.95	385.12	36.7513	33.50	45.66	93.75	174.42	17.9899
11.50	29.16	87.26	372.23	35.9334	34.00	45.78	93.62	173.58	17.7943
12.00	30.18	87.91	343.86	33.5540	34.50	45.88	93.84	174.18	17.9769
12.50	31.11	89.98	288.06	29.0448	35.00	46.00	96.19	102.46	12.2678
13.00	31.94	90.38	270.89	27.0027	35.50	45.90	97.27	72.70	7.9450
13.50	32.66	90.38	271.57	26.9691	36.00	45.83	97.56	73.53	7.9730
14.00	33.41	90.45	274.14	27.2244	36.50	45.74	97.42	75.29	8.0810
14.50	34.03	90.32	269.18	26.7828	37.00	45.62	97.28	81.13	8.6643
15.00	34.61	90.99	257.74	25.3201	37.50	45.60	97.13	87.74	9.2829
15.50	35.28	91.50	238.93	25.4543	38.00	45.49	96.64	93.34	9.7990
16.00	35.80	92.78	196.99	19.4526	38.50	45.43	96.06	117.34	11.8505
16.50	36.26	91.43	245.33	23.7345	39.00	45.52	95.29	135.27	14.0752
17.00	36.78	88.42	330.80	31.1540	39.50	45.57	95.14	135.07	14.0994
17.50	37.38	87.81	352.53	33.7775	40.00	45.69	95.39	135.62	14.1758
18.00	38.12	87.56	359.45	34.4260	40.50	45.75	95.05	134.73	14.0976
18.50	38.77	87.27	358.37	34.3216	41.00	45.75	95.26	135.16	14.0510
19.00	39.39	87.55	359.15	34.4371	41.50	45.90	95.22	134.72	14.0883
19.50	40.03	87.36	358.20	34.2191	42.00	45.99	95.43	124.03	13.1417
20.00	40.59	87.47	354.02	34.0906	42.50	45.99	96.01	117.43	12.5119
20.50	41.16	91.03	247.42	26.5275	43.00	46.02	96.68	90.23	10.2652
21.00	41.54	93.15	180.27	18.9514	43.50	46.00	98.98	34.67	4.5855
21.50	41.78	94.39	151.28	16.0913	44.00	45.90	99.57	25.65	2.8918
22.00	41.98	94.71	144.00	14.9659	44.50	45.74	98.96	37.34	3.8384
22.50	42.06	94.81	138.95	14.6454	45.00	45.58	98.82	48.94	5.2377

D-CYCLE CYCLE 3 D-CYCLE CYCLE 3

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)	ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
45.50	45.42	98.44	54.69	5.7911	68.00	45.16	95.78	115.78	12.2660
46.00	45.28	97.87	67.11	7.0208	68.50	45.16	96.25	109.63	11.6231
46.50	45.27	97.86	75.54	8.0047	69.00	45.12	96.19	106.25	11.3138
47.00	45.26	97.53	76.66	8.1798	69.50	45.01	96.23	105.56	11.1238
47.50	45.18	97.27	85.04	8.8729	70.00	45.00	96.45	106.35	11.2337
48.00	45.16	97.03	90.77	9.5978	70.50	44.96	96.23	104.29	11.0101
48.50	45.20	96.96	90.66	9.6704	71.00	44.88	96.40	103.89	11.0586
49.00	45.27	97.16	91.38	9.6797	71.50	44.86	96.76	93.78	10.2946
49.50	45.25	96.92	90.79	9.6443	72.00	44.80	96.66	93.42	9.3294
50.00	45.15	96.89	90.72	9.6704	72.50	44.77	94.55	162.68	16.0596
50.50	45.19	96.96	91.08	9.7002	73.00	44.83	93.40	182.64	18.4073
51.00	45.23	96.80	90.57	9.5605	73.50	44.94	93.36	184.86	18.8769
51.50	45.21	97.09	91.23	9.6555	74.00	45.13	93.64	181.74	18.6701
52.00	45.27	96.93	90.89	9.6592	74.50	45.28	93.79	168.90	17.5297
52.50	45.24	96.85	90.51	9.5661	75.00	45.39	94.55	153.22	16.1882
53.00	45.20	97.11	91.38	9.6164	75.50	45.52	94.72	146.28	15.2677
53.50	45.20	96.85	90.98	9.6294	76.00	45.51	94.82	140.31	14.6845
54.00	45.10	96.92	91.41	9.6667	76.50	45.54	95.11	140.55	14.6677
54.50	45.04	96.98	90.78	9.6164	77.00	45.59	94.81	139.05	14.4833
55.00	44.99	96.91	86.28	9.3071	77.50	45.60	95.00	138.57	14.5261
55.50	44.98	97.52	81.28	8.7351	78.00	45.59	107.50	-205.91	-16.8850
56.00	44.96	97.32	80.48	8.6177	78.50	44.64	114.26	-374.92	-47.6292
56.50	44.88	97.28	80.37	8.6344	79.00	42.73	114.63	-354.72	-45.2200
57.00	44.88	96.89	97.37	9.7468	79.50	40.69	114.38	-336.27	-42.9505
57.50	44.93	95.37	131.86	13.5162	80.00	38.64	114.38	-318.78	-40.6773
58.00	45.11	95.53	133.28	13.9485	80.50	36.65	114.55	-302.25	-38.5587
58.50	45.08	95.37	133.10	13.8833	81.00	34.61	114.28	-288.90	-36.7625
59.00	45.04	95.23	132.52	13.7249	81.50	32.52	114.34	-274.16	-34.9253
59.50	45.13	95.33	135.60	14.0789	82.00	30.48	114.19	-260.61	-33.0602
60.00	45.11	94.97	139.87	14.4814	82.50	28.33	113.30	-234.74	-30.3454
60.50	45.06	95.14	137.42	14.3696	83.00	26.25	110.25	-143.66	-19.2533
61.00	45.14	95.48	128.01	13.5516	83.50	24.59	107.06	-62.70	-8.9232
61.50	45.16	95.45	121.50	12.7262	84.00	23.51	105.16	-8.00	-1.8745
62.00	45.17	95.79	121.94	12.7653	84.50	22.92	104.19	18.09	1.7068
62.50	45.19	95.71	121.57	12.7206	85.00	22.50	103.76	18.51	1.9397
63.00	45.12	95.61	121.54	12.7840	85.50	22.15	103.79	18.87	2.0123
63.50	45.12	95.82	122.15	12.7448	86.00	21.83	103.52	18.43	1.9359
64.00	45.10	95.57	121.29	12.7113	86.50	21.48	103.39	18.41	1.9304
64.50	45.09	95.75	121.58	12.7150	87.00	21.18	103.52	18.93	2.0440
65.00	45.12	95.75	121.67	12.7337	87.50	20.88	103.11	18.84	1.9453
65.50	45.09	95.61	121.15	12.7355	88.00	20.05	103.28	19.06	1.9881
66.00	45.15	95.82	121.99	12.7933	88.50	18.71	103.21	17.29	1.7906
66.50	45.17	95.60	120.59	12.7560	89.00	16.87	103.00	15.83	1.6919
67.00	45.13	95.75	119.79	12.5455	89.50	15.02	103.28	15.43	1.6192
67.50	45.17	95.86	119.73	12.5958	90.00	13.27	102.93	13.83	1.4720

D-CYCLE

CYCLE 3

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
90.50	11.57	103.04	13.25	1.3676
91.00	10.02	103.20	12.83	1.3844
91.50	8.60	102.82	11.53	1.2167
92.00	7.35	103.11	11.43	1.2055
92.50	6.24	102.94	10.37	1.0602
93.00	5.22	102.89	9.42	1.0565
93.50	4.53	103.17	9.02	.9708
94.00	4.08	102.77	7.79	.8217
94.50	3.65	102.97	7.64	.7658
95.00	3.30	103.04	7.34	.8478
95.50	2.91	102.82	6.51	.6466
96.00	2.52	103.04	6.69	.6950
96.50	2.06	102.69	6.91	.7080
97.00	1.21	102.82	6.55	.6801
97.50	.38	102.97	6.59	.6782
98.00	.06	102.63	5.69	.6074

D-CYCLE CYCLE N-1 D-CYCLE CYCLE N-1

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)	ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
.50	.27	92.78	-.15	.0410	23.00	38.03	70.33	320.89	24.5580
1.00	.02	93.10	.65	.0373	23.50	38.40	70.34	316.92	24.1891
1.50	.21	91.16	46.53	3.1135	24.00	38.72	70.28	313.23	23.9432
2.00	1.29	88.17	113.21	9.0406	24.50	39.08	70.38	314.22	24.0140
2.50	3.31	84.95	174.17	14.6044	25.00	39.45	70.22	312.08	23.7866
3.00	5.49	82.26	219.03	18.4018	25.50	39.77	70.28	310.72	23.7363
3.50	7.66	80.16	260.29	22.2084	26.00	40.11	70.24	309.12	23.5984
4.00	9.72	80.54	235.78	21.2843	26.50	40.41	70.17	307.32	23.2668
4.50	11.48	79.58	250.32	21.3234	27.00	40.73	70.47	305.00	23.1457
5.00	12.98	77.67	283.48	24.0233	27.50	41.04	70.37	303.22	22.9183
5.50	14.39	76.50	295.35	24.8003	28.00	41.34	70.30	301.83	22.8475
6.00	15.76	76.58	293.74	24.7444	28.50	41.62	70.37	299.90	22.6612
6.50	16.99	76.04	298.59	24.7649	29.00	41.86	70.25	298.16	22.4283
7.00	18.08	75.14	308.74	25.4096	29.50	42.14	70.47	296.96	22.4618
7.50	19.13	74.29	323.49	26.2014	30.00	42.46	70.47	294.40	22.3221
8.00	20.14	73.45	333.54	26.8629	30.50	42.72	70.28	292.88	22.2289
8.50	21.08	73.36	333.29	26.7940	31.00	42.96	70.36	292.39	22.2867
9.00	21.99	73.22	331.48	26.5350	31.50	43.16	70.17	290.56	22.0668
9.50	22.79	72.83	330.34	26.5014	32.00	43.38	70.29	289.55	21.9625
10.00	23.56	72.94	330.21	26.4176	32.50	43.67	70.30	287.99	21.7985
10.50	24.33	72.88	326.34	26.2667	33.00	43.89	70.22	284.91	21.6625
11.00	25.00	81.17	156.93	17.6117	33.50	44.11	71.20	267.94	21.3159
11.50	25.40	99.64	-195.52	-19.1340	34.00	44.44	78.19	153.72	14.3678
12.00	25.42	88.85	68.81	.5925	34.50	44.61	81.51	108.80	10.2182
12.50	25.68	75.41	316.00	24.4761	35.00	44.52	82.92	93.28	8.7947
13.00	26.41	71.64	360.34	28.2082	35.50	44.38	83.27	88.52	8.2525
13.50	27.20	70.98	362.25	28.1784	36.00	44.33	83.48	88.68	8.2189
14.00	28.00	70.63	365.35	28.3442	36.50	44.32	83.70	88.48	8.2432
14.50	28.76	70.34	362.55	28.0666	37.00	44.24	83.77	88.56	8.2879
15.00	29.46	70.40	357.31	27.6846	37.50	44.22	83.98	87.45	8.2338
15.50	30.16	70.54	354.81	27.4815	38.00	44.17	83.94	86.25	8.1481
16.00	30.80	70.16	353.31	27.2654	38.50	44.09	84.01	86.49	8.0773
16.50	31.42	70.22	353.37	27.1685	39.00	44.05	84.14	87.99	8.1910
17.00	32.04	69.77	355.92	27.2691	39.50	43.96	82.95	107.36	9.4468
17.50	32.65	69.40	359.10	27.3287	40.00	43.95	80.58	145.55	12.5287
18.00	33.29	70.29	343.61	26.4996	40.50	44.06	78.94	166.54	14.2765
18.50	33.76	70.52	332.63	25.8959	41.00	44.12	78.12	177.29	15.1541
19.00	34.16	70.73	327.91	25.5400	41.50	44.16	78.21	176.89	15.2528
19.50	34.71	70.44	328.79	25.4617	42.00	44.22	78.16	172.80	14.8429
20.00	35.23	70.37	328.90	25.5046	42.50	44.31	78.25	171.62	14.8205
20.50	35.76	70.31	332.05	25.5344	43.00	44.43	78.20	171.97	14.8317
21.00	36.26	69.66	337.27	25.8828	43.50	44.52	78.04	172.28	14.8280
21.50	36.71	69.40	339.24	25.9574	44.00	44.68	78.16	173.17	14.8951
22.00	37.19	70.28	324.44	24.8431	44.50	44.77	77.93	172.68	14.8764
22.50	37.64	70.18	321.77	24.5990	45.00	44.78	77.94	173.01	14.8615

D-CYCLE

CYCLE N-1

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
45.50	44.89	77.91	172.75	14.7497
46.00	45.04	77.92	172.57	14.7982
46.50	45.14	78.08	171.31	14.7255
47.00	45.17	78.04	168.48	14.5448
47.50	45.23	78.05	167.85	14.4330
48.00	45.39	78.23	166.06	14.3752
48.50	45.51	78.34	162.38	14.1050
49.00	45.59	78.59	159.98	13.9299
49.50	45.68	81.29	116.25	10.9952
50.00	45.66	82.18	105.06	9.6369
50.50	45.67	82.83	98.36	9.2214
51.00	45.65	83.22	92.26	8.6177
51.50	45.59	83.83	83.70	8.0065
52.00	45.72	84.32	77.94	7.4494
52.50	45.74	85.31	63.18	6.2215
53.00	45.63	85.62	61.76	5.9252
53.50	45.53	85.75	61.71	5.9588
54.00	45.29	85.80	62.08	5.9550
54.50	45.10	85.65	65.74	6.2122
55.00	44.99	85.23	68.95	6.4879
55.50	45.01	85.14	73.50	6.8550
56.00	44.96	85.11	74.25	7.0637
56.50	44.81	85.10	74.59	7.0861
57.00	44.74	85.10	76.04	7.1270
57.50	44.66	84.74	77.65	7.3451
58.00	44.61	84.79	79.89	7.5016
58.50	44.58	84.83	80.44	7.5761
59.00	44.49	84.67	80.29	7.5109
59.50	44.43	84.71	81.30	7.6115
60.00	44.41	84.64	81.49	7.6842
60.50	44.35	84.65	81.75	7.7866
61.00	44.34	84.79	82.20	7.6860
61.50	44.27	84.51	83.53	7.7550
62.00	44.19	84.31	86.07	7.9748
62.50	44.20	84.45	86.78	8.0922
63.00	44.16	84.31	86.87	8.1034
63.50	44.12	84.37	87.19	8.2264
64.00	44.08	84.23	86.72	8.1519
64.50	44.05	84.22	86.97	8.1388
65.00	44.06	84.37	87.39	8.1220
65.50	43.97	83.79	95.35	8.5264
66.00	43.93	79.85	164.14	13.4920
66.50	44.04	77.30	196.92	16.5329
67.00	44.18	75.90	215.50	17.8968
67.50	44.37	75.70	218.06	18.0943

D-CYCLE

CYCLE N-1

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
68.00	44.55	75.40	217.37	17.9769
68.50	44.72	75.33	217.12	18.0179
69.00	44.92	76.10	200.58	17.1385
69.50	45.04	78.56	156.42	14.0491
70.00	45.14	79.97	139.26	12.4523
70.50	45.25	80.37	132.70	11.9846
71.00	45.26	80.97	124.13	11.1536
71.50	45.26	81.21	121.38	10.9635
72.00	45.26	81.60	113.45	10.3561
72.50	45.26	82.60	101.58	9.4766
73.00	45.28	83.52	87.54	8.2972
73.50	45.23	83.71	85.19	7.9357
74.00	45.17	84.60	72.09	7.2090
74.50	45.10	85.91	52.11	5.1091
75.00	44.99	86.10	54.62	5.1818
75.50	44.87	85.93	58.40	5.6215
76.00	44.71	85.60	61.77	5.8712
76.50	44.60	85.42	66.84	6.2401
77.00	44.54	85.22	70.00	6.5886
77.50	44.46	84.95	75.86	7.0842
78.00	44.37	84.63	81.12	7.5277
78.50	44.30	84.24	82.03	7.8668
79.00	44.11	106.41	-360.39	-33.5390
79.50	42.69	114.16	-505.85	-63.8900
80.00	39.94	114.19	-491.68	-62.1963
80.50	36.97	114.06	-476.81	-60.3759
81.00	33.75	113.57	-458.61	-58.3151
81.50	30.41	109.52	-345.67	-44.5454
82.00	27.54	104.65	-225.06	-28.0778
82.50	25.38	100.55	-132.66	-16.1584
83.00	23.91	98.06	-72.19	-8.6792
83.50	22.97	95.86	-30.57	-3.8943
84.00	22.30	94.62	-3.95	-.7882
84.50	21.85	93.76	11.68	1.0453
85.00	21.49	93.26	12.34	1.2074
85.50	21.17	93.23	12.74	1.2652
86.00	20.89	93.06	12.50	1.2316
86.50	20.58	92.92	12.37	1.2447
87.00	20.29	92.88	12.67	1.2391
87.50	19.99	92.62	12.23	1.2391
88.00	19.67	92.54	12.35	1.2186
88.50	19.41	92.58	12.44	1.2316
89.00	19.11	92.37	12.13	1.1646
89.50	18.83	92.47	12.62	1.2484
90.00	18.56	92.29	12.18	1.1776

D-CYCLE

CYCLE N-1

ELAPSED TIME (SEC)	VELOCITY (MI/HR)	VOLTAGE (VOLTS)	CURRENT (AMPS)	POWER (KW)
90.50	18.22	92.14	12.25	1.1981
91.00	17.64	92.32	11.75	1.1701
91.50	16.56	92.12	10.55	1.0732
92.00	15.00	92.21	10.28	.9801
92.50	13.14	92.13	9.29	.9447
93.00	10.90	92.06	8.42	.8366
93.50	8.58	92.23	8.13	.8329
94.00	6.92	92.13	6.80	.6652
94.50	5.94	92.27	6.59	.6596
95.00	5.25	92.12	6.01	.6037
95.50	4.75	92.07	5.24	.5534
96.00	4.42	92.32	5.53	.5758
96.50	4.19	92.16	4.91	.5143
97.00	3.93	92.09	4.29	.4826
97.50	3.68	92.12	4.18	.4714
98.00	3.51	92.10	3.54	.4062
98.50	3.28	92.27	4.86	.5254
99.00	2.73	92.15	4.08	.4360
99.50	1.82	92.04	3.48	.4099
100.00	.80	92.18	3.66	.3671

APPENDIX E

DATA FROM MAXIMUM ACCELERATION AND COAST DOWN

0% (CYCLE 1)

ACCELERATION AND % GRADEABILITY VS VELOCITY

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
.50	.31	.62	1.78	.16
1.00	4.39	8.17	23.93	2.35
1.50	8.62	8.45	24.81	6.51
2.00	12.67	8.10	23.73	10.65
2.50	17.02	8.70	25.60	14.85
3.00	20.59	7.15	20.80	18.81
3.50	23.45	5.71	16.51	22.02
4.00	26.30	5.70	16.47	24.88
4.50	28.34	4.07	11.69	27.32
5.00	30.49	4.30	12.36	29.42
5.50	32.67	4.37	12.54	31.58
6.00	33.99	2.62	7.49	33.33
6.50	34.30	.63	1.80	34.14
7.00	36.47	4.34	12.45	35.38
7.50	39.29	5.65	16.32	37.88
8.00	41.37	4.15	11.90	40.33
8.50	42.77	2.80	8.00	42.07
9.00	44.47	3.41	9.76	43.62
9.50	46.04	3.15	9.00	45.26
10.00	47.27	2.45	7.00	46.66
10.50	48.92	3.29	9.43	48.09
11.00	49.96	2.09	5.98	49.44
11.50	51.38	2.83	8.09	50.67
12.00	52.74	2.73	7.79	52.06
12.50	52.76	.04	.12	52.75
13.00	54.86	4.20	12.05	53.81
13.50	56.13	2.53	7.22	55.49
14.00	57.28	2.30	6.58	56.70
14.50	58.67	2.78	7.94	57.97
15.00	59.50	1.66	4.74	59.08
15.50	60.83	2.67	7.64	60.17
16.00	61.78	1.88	5.38	61.31
16.50	62.55	1.56	4.44	62.17
17.00	63.73	2.36	6.73	63.14
17.50	64.59	1.70	4.86	64.16
18.00	65.58	1.99	5.68	65.08
18.50	66.61	2.06	5.89	66.10
19.00	67.27	1.32	3.75	66.94
19.50	68.36	2.19	6.25	67.82
20.00	69.32	1.92	5.47	68.84
20.50	70.07	1.50	4.29	69.70
21.00	70.72	1.28	3.66	70.39
21.50	71.14	.85	2.43	70.93
22.00	71.94	1.59	4.53	71.54
22.50	72.84	1.81	5.17	72.39
23.00	72.97	.26	.75	72.91
23.50	73.76	1.57	4.47	73.36
24.00	73.60	-.32	-.90	73.68
24.50	74.74	2.28	6.52	74.17

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
25.00	75.68	1.88	5.38	75.21
25.50	75.70	.04	.12	75.69
26.00	76.46	1.49	4.26	76.08
26.50	76.96	1.01	2.88	76.70
27.00	77.37	.83	2.37	77.16
27.50	78.09	1.43	4.08	77.73
28.00	78.42	.67	1.92	78.25
28.50	78.93	1.01	2.88	78.68
29.00	79.59	1.33	3.78	79.26
29.50	79.83	.47	1.35	79.71
30.00	80.48	1.30	3.72	80.15
30.50	80.97	.98	2.79	80.73
31.00	81.31	.67	1.92	81.14
31.50	82.02	1.43	4.08	81.66
32.00	82.00	-.04	-.12	82.01
32.50	82.92	1.84	5.26	82.46
33.00	83.23	.61	1.74	83.07
33.50	83.23	.01	.03	83.23
34.00	83.97	1.48	4.23	83.60
34.50	84.10	.25	.72	84.04
35.00	84.63	1.05	3.00	84.36
35.50	85.16	1.07	3.06	84.89
36.00	85.09	-.15	-.42	85.13
36.50	86.12	2.06	5.89	85.61
37.00	86.17	.09	.27	86.14
37.50	86.50	.66	1.89	86.33
38.00	86.74	.48	1.38	86.62
38.50	86.98	.47	1.35	86.86
39.00	87.35	.74	2.10	87.16
39.50	87.73	.76	2.16	87.54
40.00	87.79	.14	.39	87.76
40.50	88.49	1.40	3.99	88.14
41.00	88.96	.94	2.67	88.73
41.50	89.30	.67	1.92	89.13
42.00	89.38	.17	.48	89.34
42.50	89.12	-.53	-1.50	89.25
43.00	89.59	.95	2.70	89.36
43.50	89.81	.44	1.26	89.70
44.00	90.25	.86	2.46	90.03
44.50	90.57	.64	1.83	90.41
45.00	90.44	-.25	-.72	90.50
45.50	90.93	.98	2.79	90.68
46.00	91.57	1.28	3.66	91.25
46.50	91.30	-.54	-1.53	91.44
47.00	91.84	1.07	3.06	91.57
47.50	91.93	.18	.51	91.88
48.00	92.05	.24	.69	91.99
48.50	93.03	1.96	5.59	92.54
49.00	92.41	-1.24	-3.54	92.72
49.50	92.61	.41	1.17	92.51

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
50.00	93.11	.99	2.82	92.86
50.50	93.48	.75	2.13	93.29
51.00	93.42	-.12	-.33	93.45
51.50	93.46	.06	.18	93.44
52.00	93.98	1.04	2.97	93.72
52.50	94.11	.27	.78	94.04
53.00	94.45	.67	1.92	94.28
53.50	94.99	1.07	3.06	94.72
54.00	94.93	-.11	-.30	94.96
54.50	94.74	-.39	-1.11	94.84
55.00	95.17	.86	2.46	94.95
55.50	95.65	.96	2.73	95.41
56.00	96.03	.77	2.19	95.84
56.50	96.44	.82	2.34	96.24
57.00	96.01	-.86	-2.46	96.23
57.50	96.17	.32	.90	96.09
58.00	96.19	.03	.09	96.18
58.50	96.35	.33	.93	96.27
59.00	96.91	1.12	3.18	96.63
59.50	97.06	.31	.87	96.98
60.00	97.24	.36	1.02	97.15
60.50	97.17	-.14	-.39	97.20
61.00	97.44	.55	1.56	97.31
61.50	97.32	-.24	-.69	97.38
62.00	97.27	-.09	-.27	97.30
62.50	97.74	.94	2.67	97.51
63.00	98.37	1.26	3.60	98.06
63.50	97.73	-1.28	-3.66	98.05
64.00	97.67	-.12	-.33	97.70
64.50	97.66	-.02	-.06	97.67
65.00	98.17	1.02	2.91	97.92
65.50	98.97	1.59	4.53	98.57
66.00	98.25	-1.43	-4.08	98.61
66.50	98.32	.14	.39	98.29
67.00	99.41	2.18	6.22	98.87
67.50	99.10	-.62	-1.77	99.26
68.00	99.21	.21	.60	99.15
68.50	98.80	-.81	-2.31	99.00
69.00	98.67	-.26	-.75	98.73
69.50	99.44	1.54	4.38	99.05
70.00	99.08	-.72	-2.04	99.26
70.50	99.76	1.37	3.90	99.42
71.00	100.02	.51	1.44	99.89
71.50	99.64	-.76	-2.16	99.83
72.00	99.92	.56	1.59	99.78
72.50	100.25	.67	1.92	100.08
73.00	100.39	.28	.81	100.32
73.50	100.78	.77	2.19	100.59
74.00	100.62	-.33	-.93	100.70
74.50	100.96	.69	1.98	100.79

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AV^. VEL. (KM/HR)
75.00	101.07	.21	.60	101.02
75.50	101.26	.39	1.11	101.17
76.00	101.26	-.01	-.03	101.26
76.50	101.05	-.42	-1.20	101.15
77.00	101.95	1.80	5.14	101.50
77.50	101.56	-.77	-2.19	101.76
78.00	101.70	.27	.78	101.63
78.50	101.87	.34	.96	101.78
79.00	101.67	-.40	-1.14	101.77
79.50	102.38	1.43	4.08	102.03
80.00	102.63	.49	1.41	102.51
80.50	102.65	.04	.12	102.64
81.00	102.93	.56	1.59	102.79
81.50	102.79	-.27	-.78	102.86
82.00	102.69	-.20	-.57	102.74
82.50	102.92	.44	1.26	102.80
83.00	102.81	-.21	-.60	102.86
83.50	102.95	.28	.81	102.88
84.00	102.82	-.27	-.78	102.88
84.50	102.95	.27	.78	102.88
85.00	103.48	1.06	3.03	103.22
85.50	103.22	-.53	-1.50	103.35
86.00	103.76	1.08	3.09	103.49
86.50	103.48	-.57	-1.62	103.62
87.00	103.30	-.35	-.99	103.39
87.50	104.16	1.72	4.89	103.73
88.00	103.84	-.65	-1.86	104.00
88.50	104.04	.40	1.14	103.94
89.00	104.33	.58	1.65	104.18
89.50	103.89	-.87	-2.49	104.11

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40% (CYCLE 8)

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
.50	2.97	5.57	16.07	1.58
1.00	7.99	10.04	29.86	5.48
1.50	12.62	9.25	27.33	10.30
2.00	16.76	8.29	24.32	14.69
2.50	20.61	7.70	22.50	18.69
3.00	23.76	6.28	18.20	22.18
3.50	26.33	5.16	14.86	25.04
4.00	28.81	4.95	14.24	27.57
4.50	30.81	4.01	11.50	29.81
5.00	32.77	3.91	11.23	31.79
5.50	34.66	3.78	10.83	33.71
6.00	36.18	3.05	8.73	35.42
6.50	37.93	3.50	10.04	37.06
7.00	39.13	2.39	6.82	38.53
7.50	40.45	2.73	7.79	39.81
8.00	41.68	2.38	6.79	41.09
8.50	44.06	4.77	13.71	42.87
9.00	45.98	3.84	11.01	45.02
9.50	47.56	3.16	9.03	46.77
10.00	48.81	2.49	7.13	48.19
10.50	50.24	2.86	8.18	49.53
11.00	51.22	1.96	5.59	50.73
11.50	52.36	2.28	6.52	51.79
12.00	53.72	2.73	7.79	53.04
12.50	54.73	2.01	5.74	54.23
13.00	55.81	2.17	6.19	55.27
13.50	56.71	1.80	5.14	56.26
14.00	57.77	2.12	6.04	57.24
14.50	58.88	2.22	6.34	58.33
15.00	59.61	1.46	4.17	59.25
15.50	60.60	1.97	5.62	60.10
16.00	61.50	1.80	5.14	61.05
16.50	62.17	1.35	3.84	61.83
17.00	63.16	1.98	5.65	62.66
17.50	63.82	1.33	3.78	63.49
18.00	64.07	.51	1.44	63.95
18.50	64.51	.87	2.49	64.29
19.00	66.17	3.33	9.52	65.34
19.50	67.01	1.67	4.77	66.59
20.00	67.67	1.33	3.78	67.34
20.50	68.38	1.41	4.02	68.02
21.00	69.22	1.69	4.83	68.80
21.50	69.84	1.23	3.51	69.53
22.00	70.55	1.41	4.02	70.19
22.50	71.17	1.25	3.57	70.86
23.00	71.65	.96	2.73	71.41
23.50	72.41	1.53	4.35	72.03
24.00	72.81	.80	2.28	72.61
24.50	73.56	1.49	4.26	73.19

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ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
25.00	74.27	1.41	4.02	73.91
25.50	74.45	.38	1.08	74.36
26.00	75.36	1.82	5.20	74.91
26.50	75.74	.76	2.16	75.55
27.00	76.11	.73	2.07	75.93
27.50	76.74	1.27	3.63	76.42
28.00	77.05	.61	1.74	76.90
28.50	78.14	2.19	6.25	77.60
29.00	78.47	.65	1.86	78.31
29.50	79.09	1.24	3.54	78.78
30.00	79.53	.87	2.49	79.31
30.50	79.58	.12	.33	79.56
31.00	80.20	1.23	3.51	79.89
31.50	81.06	1.72	4.89	80.63
32.00	81.06	0.00	0.00	81.06
32.50	81.24	.37	1.05	81.15
33.00	81.84	1.19	3.39	81.54
33.50	82.07	.46	1.32	81.95
34.00	82.48	.83	2.37	82.28
34.50	82.75	.53	1.50	82.61
35.00	83.11	.73	2.07	82.93
35.50	83.64	1.05	3.00	83.37
36.00	84.01	.75	2.13	83.82
36.50	84.90	1.79	5.10	84.46
37.00	85.18	.56	1.59	85.04
37.50	85.67	.97	2.76	85.42
38.00	85.88	.43	1.23	85.77
38.50	85.89	.01	.03	85.88
39.00	86.78	1.78	5.07	86.33
39.50	87.31	1.07	3.06	87.05
40.00	87.17	-.29	-.84	87.24
40.50	87.57	.80	2.28	87.37
41.00	87.82	.52	1.47	87.69
41.50	88.30	.96	2.73	88.06
42.00	89.32	2.03	5.80	88.81
42.50	88.95	-.74	-2.10	89.13
43.00	89.54	1.18	3.36	89.24
43.50	89.83	.58	1.65	89.68
44.00	89.79	-.07	-.21	89.81
44.50	90.80	2.02	5.77	90.30
45.00	91.39	1.17	3.33	91.09
45.50	91.64	.51	1.44	91.51
46.00	92.11	.94	2.67	91.87
46.50	92.14	.07	.21	92.12
47.00	92.66	1.04	2.97	92.40
47.50	92.93	.54	1.53	92.80
48.00	93.21	.56	1.59	93.07
48.50	93.64	.86	2.46	93.43
49.00	93.75	.21	.60	93.70
49.50	94.18	.87	2.49	93.97

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ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
50.00	94.47	.58	1.65	94.33
50.50	94.81	.66	1.89	94.64
51.00	95.60	1.59	4.53	95.20
51.50	95.81	.41	1.17	95.70
52.00	96.10	.59	1.68	95.95
52.50	96.31	.41	1.17	96.20
53.00	96.36	.11	.30	96.33
53.50	96.66	.61	1.74	96.51
54.00	96.81	.29	.84	96.74
54.50	97.35	1.08	3.09	97.08
55.00	97.98	1.26	3.60	97.67
55.50	97.59	-.78	-2.22	97.79
56.00	98.20	1.22	3.48	97.98
56.50	98.01	-.39	-1.11	98.11
57.00	98.72	1.42	4.05	98.37
57.50	99.56	1.68	4.80	99.14
58.00	99.32	-.48	-1.38	99.44
58.50	99.28	-.07	-.21	99.38
59.00	99.57	.57	1.62	99.43
59.50	99.29	-.56	-1.59	99.43
60.00	99.53	.48	1.38	99.41
60.50	99.81	.57	1.62	99.67
61.00	99.87	.12	.33	99.84
61.50	100.38	1.02	2.91	100.13
62.00	100.38	0.00	0.00	100.38
62.50	100.67	.58	1.65	100.53
63.00	100.69	.04	.12	100.68
63.50	100.58	-.22	-.63	100.64
64.00	101.10	1.03	2.94	100.84
64.50	101.96	1.73	4.92	101.53
65.00	101.47	-.98	-2.79	101.72
65.50	101.33	-.28	-.81	101.40
66.00	101.41	.17	.48	101.37
66.50	102.03	1.23	3.51	101.72
67.00	102.26	.45	1.29	102.14
67.50	102.17	-.17	-.48	102.21
68.00	102.54	.74	2.10	102.36
68.50	102.72	.37	1.05	102.63
69.00	102.49	-.47	-1.35	102.61
69.50	103.11	1.24	3.54	102.80
70.00	102.76	-.71	-2.01	102.93
70.50	103.05	.59	1.68	102.90
71.00	103.11	.12	.33	103.08
71.50	103.06	-.09	-.27	103.08
72.00	103.22	.32	.90	103.14
72.50	103.36	.27	.78	103.29
73.00	103.47	.22	.63	103.41
73.50	103.94	.95	2.70	103.70
74.00	104.04	.20	.57	103.99
74.50	104.21	.35	.99	104.13

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
75.00	103.81	-.80	-2.28	104.01
75.50	103.88	.13	.36	103.84
76.00	104.13	.51	1.44	104.00
76.50	104.68	1.09	3.12	104.40
77.00	104.53	-.29	-.84	104.60
77.50	104.42	-.21	-.60	104.48
78.00	104.74	.64	1.83	104.58

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
75.00	103.81	-.80	-2.28	104.01
75.50	103.88	.13	.36	103.84
76.00	104.13	.51	1.44	104.00
76.50	104.68	1.09	3.12	104.40
77.00	104.53	-.29	-.84	104.60
77.50	104.42	-.21	-.60	104.48
78.00	104.74	.64	1.83	104.58

80% (CYCLE 14)

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
.50	3.82	5.66	16.35	2.40
1.00	8.79	9.94	29.55	6.31
1.50	13.14	8.69	25.57	10.96
2.00	17.10	7.92	23.18	15.12
2.50	20.85	7.50	21.89	18.98
3.00	23.53	5.37	15.48	22.19
3.50	26.11	5.16	14.86	24.82
4.00	28.44	4.65	13.37	27.28
4.50	30.33	3.78	10.83	29.38
5.00	32.41	4.17	11.96	31.37
5.50	34.00	3.18	9.09	33.20
6.00	35.56	3.11	8.91	34.78
6.50	37.34	3.57	10.22	36.45
7.00	38.18	1.67	4.77	37.76
7.50	41.13	5.91	17.10	39.66
8.00	42.95	3.63	10.40	42.04
8.50	44.40	2.89	8.28	43.67
9.00	46.13	3.46	9.92	45.26
9.50	47.41	2.57	7.34	46.77
10.00	48.66	2.50	7.16	48.04
10.50	50.08	2.83	8.09	49.37
11.00	51.24	2.32	6.61	50.66
11.50	52.49	2.51	7.19	51.86
12.00	53.65	2.32	6.61	53.07
12.50	54.66	2.01	5.74	54.15
13.00	56.02	2.73	7.79	55.34
13.50	56.83	1.63	4.65	56.43
14.00	57.89	2.12	6.04	57.36
14.50	58.83	1.88	5.38	58.36
15.00	59.46	1.26	3.60	59.15
15.50	60.62	2.30	6.58	60.04
16.00	61.38	1.53	4.35	61.00
16.50	62.03	1.30	3.72	61.71
17.00	62.91	1.76	5.01	62.47
17.50	62.95	.08	.24	62.93
18.00	63.34	.77	2.19	63.15
18.50	65.02	3.36	9.61	64.18
19.00	65.64	1.24	3.54	65.33
19.50	66.56	1.85	5.29	66.10
20.00	67.15	1.18	3.36	66.86
20.50	67.95	1.59	4.53	67.55
21.00	68.83	1.77	5.04	68.39
21.50	69.21	.76	2.16	69.02
22.00	69.97	1.53	4.35	69.59
22.50	70.48	1.01	2.88	70.22
23.00	71.11	1.27	3.63	70.80
23.50	71.91	1.60	4.56	71.51
24.00	72.27	.71	2.01	72.09
24.50	72.85	1.17	3.33	72.56

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
25.00	73.34	.98	2.79	73.09
25.50	73.74	.81	2.31	73.54
26.00	74.57	1.64	4.68	74.15
26.50	74.76	.39	1.11	74.66
27.00	75.23	.94	2.67	74.99
27.50	75.89	1.32	3.75	75.56
28.00	76.21	.64	1.83	76.05
28.50	77.15	1.89	5.41	76.68
29.00	77.10	-.12	-.33	77.12
29.50	77.43	.66	1.89	77.26
30.00	78.20	1.54	4.38	77.81
30.50	78.22	.04	.12	78.21
31.00	78.70	.96	2.73	78.46
31.50	79.20	1.01	2.88	78.95
32.00	79.38	.36	1.02	79.29
32.50	80.14	1.53	4.35	79.76
33.00	80.03	-.23	-.66	80.08
33.50	80.35	.65	1.86	80.19
34.00	80.97	1.23	3.51	80.66
34.50	81.09	.24	.69	81.03
35.00	81.70	1.22	3.48	81.39
35.50	81.91	.42	1.20	81.80
36.00	81.97	.12	.33	81.94
36.50	82.43	.92	2.61	82.20
37.00	82.60	.36	1.02	82.52
37.50	83.23	1.24	3.54	82.91
38.00	83.39	.34	.96	83.31
38.50	83.34	-.12	-.33	83.36
39.00	83.96	1.25	3.57	83.65
39.50	84.12	.32	.90	84.04
40.00	84.29	.34	.96	84.20
40.50	84.81	1.05	3.00	84.55
41.00	84.65	-.33	-.93	84.73
41.50	85.50	1.69	4.83	85.07
42.00	85.72	.44	1.26	85.61
42.50	86.18	.92	2.61	85.95
43.00	86.93	1.50	4.29	86.55
43.50	86.74	-.38	-1.08	86.83
44.00	87.14	.80	2.28	86.94
44.50	87.48	.67	1.92	87.31
45.00	87.96	.96	2.73	87.72
45.50	88.45	.99	2.82	88.20
46.00	88.38	-.14	-.39	88.42
46.50	88.61	.45	1.29	88.49
47.00	89.22	1.22	3.48	88.91
47.50	89.23	.02	.06	89.22
48.00	89.84	1.22	3.48	89.53
48.50	89.92	.17	.48	89.88
49.00	90.29	.73	2.07	90.10
49.50	90.76	.95	2.70	90.52

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
50.00	90.82	.12	.33	90.79
50.50	91.26	.89	2.55	91.04
51.00	92.40	2.27	6.49	91.83
51.50	92.12	-.57	-1.62	92.26
52.00	92.15	.07	.21	92.14
52.50	92.28	.25	.72	92.22
53.00	92.60	.64	1.83	92.44
53.50	93.07	.94	2.67	92.84
54.00	93.60	1.06	3.03	93.34
54.50	93.88	.56	1.59	93.74
55.00	93.72	-.33	-.93	93.80
55.50	94.16	.88	2.52	93.94
56.00	94.46	.61	1.74	94.31
56.50	94.18	-.56	-1.59	94.32
57.00	94.50	.62	1.77	94.34
57.50	94.78	.57	1.62	94.64
58.00	95.18	.81	2.31	94.98
58.50	95.96	1.56	4.44	95.57
59.00	95.74	-.45	-1.29	95.85
59.50	95.42	-.63	-1.80	95.58
60.00	95.83	.82	2.34	95.63
60.50	95.76	-.14	-.39	95.80
61.00	96.05	.57	1.62	95.91
61.50	96.40	.71	2.01	96.22
62.00	96.69	.58	1.65	96.54
62.50	96.84	.31	.87	96.77
63.00	96.61	-.47	-1.35	96.72
63.50	97.08	.95	2.70	96.84
64.00	97.23	.31	.87	97.16
64.50	97.03	-.41	-1.17	97.13
65.00	97.37	.68	1.95	97.20
65.50	97.66	.58	1.65	97.51
66.00	97.60	-.11	-.30	97.63
66.50	98.15	1.08	3.09	97.88
67.00	97.80	-.69	-1.98	97.97
67.50	97.72	-.16	-.45	97.76
68.00	98.27	1.09	3.12	97.99
68.50	98.18	-.17	-.48	98.23
69.00	98.60	.84	2.40	98.39
69.50	98.78	.35	.99	98.69
70.00	98.72	-.12	-.33	98.75
70.50	98.83	.21	.60	98.77
71.00	99.54	1.43	4.08	99.18
71.50	99.59	.09	.27	99.56
72.00	99.07	-1.03	-2.94	99.33
72.50	98.97	-.20	-.57	99.02
73.00	99.58	1.22	3.48	99.28
73.50	99.36	-.45	-1.29	99.47
74.00	99.16	-.40	-1.14	99.26
74.50	99.17	.02	.06	99.16

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ACCEL. (KM/HR/SEC)	GRADE (%)	AVG. VEL. (KM/HR)
75.00	99.30	.27	.78	99.24
75.50	99.48	.36	1.02	99.39
76.00	99.53	.08	.24	99.50
76.50	99.54	.02	.06	99.53
77.00	99.63	.18	.51	99.58
77.50	99.61	-.03	-.09	99.62
78.00	100.10	.98	2.79	99.85
78.50	99.95	-.31	-.87	100.02
79.00	100.17	.45	1.29	100.06
79.50	100.61	.87	2.49	100.39
80.00	100.50	-.22	-.63	100.55
80.50	101.27	1.55	4.41	100.89
81.00	100.91	-.72	-2.04	101.09
81.50	100.30	-1.22	-3.48	100.61
82.00	101.27	1.94	5.53	100.79
82.50	101.51	.47	1.35	101.39
83.00	101.80	.58	1.65	101.65
83.50	101.71	-.17	-.48	101.76
84.00	101.62	-.18	-.51	101.67
84.50	101.72	.19	.54	101.67
85.00	102.11	.78	2.22	101.91
85.50	101.72	-.77	-2.19	101.92
86.00	101.74	.02	.06	101.73
86.50	101.46	-.56	-1.59	101.60
87.00	101.74	.56	1.59	101.60
87.50	101.96	.45	1.29	101.85
88.00	101.54	-.84	-2.40	101.75
88.50	101.96	.83	2.37	101.75
89.00	102.20	.48	1.38	102.08
89.50	102.44	.48	1.38	102.32

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0% (CYCLE 1)

ROAD POWER ROAD ENERGY VS VELOCITY

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ROAD ENERGY (KWH/KM)	ROAD POWER (KW)	AVG. VEL. (KM/HR)
0.00	103.14	.0815	8.4194	103.31
2.50	99.54	.1689	17.1178	101.34
5.00	95.24	.2015	19.6261	97.39
7.50	91.69	.1669	15.6036	93.47
10.00	88.35	.1566	14.0945	90.02
12.50	85.36	.1405	12.2048	86.85
15.00	81.85	.1645	13.7510	83.61
17.50	79.09	.1299	10.4531	80.47
20.00	76.26	.1326	10.3008	77.67
22.50	73.75	.1180	8.8539	75.00
25.00	71.16	.1213	8.7856	72.45
27.50	68.88	.1072	7.5048	70.02
30.00	66.44	.1143	7.7365	67.66
32.50	64.25	.1030	6.7295	65.35
35.00	62.18	.0973	6.1507	63.21
37.50	59.98	.1032	6.3048	61.08
40.00	57.99	.0934	5.5060	58.98
42.50	55.86	.1000	5.6933	56.92
45.00	53.60	.1059	5.7982	54.73
47.50	51.50	.0985	5.1781	52.55
50.00	49.44	.0968	4.8858	50.47
52.50	47.38	.0968	4.6862	48.41
55.00	45.54	.0859	3.9929	46.46
57.50	43.65	.0889	3.9649	44.60
60.00	42.02	.0763	3.2689	42.84
62.50	40.08	.0911	3.7412	41.05
65.00	38.47	.0756	2.9682	39.28
67.50	36.63	.0864	3.2459	37.55
70.00	34.82	.0850	3.0351	35.73
72.50	33.17	.0773	2.6280	34.00
75.00	31.60	.0741	2.3994	32.39
77.50	30.03	.0733	2.2602	30.82
80.00	28.47	.0733	2.1456	29.25
82.50	26.76	.0803	2.2165	27.62
85.00	25.41	.0635	1.6556	26.09
87.50	24.25	.0546	1.3550	24.83
90.00	23.45	.0373	.8893	23.85
92.50	22.76	.0324	.7476	23.11
95.00	22.07	.0326	.7307	22.42
97.50	21.29	.0365	.7924	21.68
100.00	20.47	.0383	.7993	20.88
102.50	19.75	.0338	.6805	20.11
105.00	19.00	.0353	.6843	19.38
107.50	18.05	.0445	.8236	18.53
110.00	17.33	.0341	.6029	17.69
112.50	16.51	.0383	.6477	16.92
115.00	15.78	.0346	.5582	16.14
117.50	15.31	.0220	.3416	15.54
120.00	14.79	.0244	.3679	15.05

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ROAD ENERGY (KWH/KM)	ROAD POWER (KW)	AVG. VEL. (KM/HR)
122.50	13.90	.0417	.5986	14.34
125.00	13.34	.0259	.3532	13.62
127.50	12.68	.0311	.4049	13.01
130.00	12.17	.0240	.2977	12.43
132.50	11.49	.0321	.3798	11.83
135.00	10.97	.0244	.2745	11.23
137.50	10.32	.0304	.3233	10.64
140.00	9.58	.0348	.3464	9.95
142.50	7.28	.1077	.9077	8.43
145.00	6.24	.0489	.3307	6.76
147.50	5.27	.0457	.2629	5.75
150.00	4.28	.0462	.2206	4.78
152.50	2.85	.0674	.2404	3.57

40% (CYCLE 8)

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ROAD ENERGY (KWH/KM)	ROAD POWER (KW)	AVG. VEL. (KM/HR)
0.00	103.81	.2186	22.7911	104.28
2.50	101.03	.1306	13.3805	102.42
5.00	97.99	.1425	14.1800	99.51
7.50	95.14	.1339	12.9259	96.57
10.00	92.51	.1237	11.6086	93.82
12.50	89.40	.1460	13.2747	90.95
15.00	86.39	.1413	12.4157	87.89
17.50	83.91	.1161	9.8835	85.15
20.00	80.86	.1432	11.8011	82.39
22.50	78.26	.1220	9.7066	79.56
25.00	75.63	.1235	9.5016	76.95
27.50	73.26	.1114	8.2918	74.45
30.00	71.03	.1045	7.5368	72.15
32.50	68.50	.1190	8.3046	69.77
35.00	66.12	.1116	7.5135	67.31
37.50	64.13	.0936	6.0954	65.12
40.00	62.68	.0677	4.2904	63.41
42.50	61.35	.0625	3.8750	62.02
45.00	59.88	.0694	4.2064	60.61
47.50	58.51	.0640	3.7862	59.19
50.00	57.02	.0699	4.0374	57.77
52.50	55.77	.0590	3.3286	56.39
55.00	54.10	.0783	4.3004	54.93
57.50	52.46	.0771	4.1051	53.28
60.00	50.96	.0704	3.6393	51.71
62.50	49.49	.0689	3.4604	50.22
65.00	48.26	.0578	2.8243	48.87
67.50	47.01	.0585	2.7880	47.63
70.00	45.56	.0679	3.1435	46.29
72.50	44.50	.0501	2.2575	45.03
75.00	43.44	.0496	2.1825	43.97
77.50	42.39	.0491	2.1090	42.91
80.00	41.38	.0477	1.9963	41.88
82.50	40.30	.0506	2.0674	40.84
85.00	39.04	.0590	2.3414	39.67
87.50	38.09	.0445	1.7144	38.57
90.00	37.11	.0462	1.7365	37.60
92.50	36.17	.0440	1.6107	36.64
95.00	35.30	.0410	1.4650	35.74
97.50	34.41	.0417	1.4547	34.85
100.00	33.54	.0410	1.3927	33.97
102.50	32.64	.0422	1.3972	33.09
105.00	31.71	.0437	1.4062	32.17
107.50	30.78	.0432	1.3503	31.24
110.00	29.94	.0395	1.1998	30.36
112.50	29.03	.0427	1.2598	29.49
115.00	28.25	.0368	1.0539	28.64
117.50	27.46	.0370	1.0318	27.85
120.00	26.57	.0417	1.1275	27.01

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ROAD ENERGY (KWH/KM)	ROAD POWER (KW)	AVG. VEL. (KM/HR)
122.50	25.85	.0338	.8868	26.21
125.00	25.17	.0319	.8127	25.51
127.50	24.53	.0299	.7426	24.85
130.00	23.79	.0348	.8414	24.16
132.50	23.09	.0328	.7700	23.44
135.00	22.35	.0348	.7912	22.72
137.50	21.68	.0314	.6905	22.02
140.00	20.97	.0333	.7110	21.33
142.50	20.20	.0363	.7473	20.59
145.00	19.47	.0341	.6760	19.84
147.50	18.75	.0338	.6466	19.11
150.00	18.06	.0324	.5955	18.41
152.50	17.33	.0346	.6118	17.69
155.00	16.56	.0361	.6108	16.94
157.50	15.39	.0546	.8719	15.98
160.00	14.05	.0632	.9307	14.72
162.50	12.64	.0662	.8831	13.34
165.00	11.27	.0642	.7675	11.95
167.50	9.78	.0699	.7356	10.53
170.00	8.47	.0615	.5612	9.13
172.50	7.00	.0689	.5331	7.74
175.00	5.25	.0825	.5051	6.12
177.50	2.20	.1427	.5317	3.72

80% (CYCLE 14)

ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ROAD ENERGY (KWH/KM)	ROAD POWER (KW)	AVG. VEL. (KM/HR)
0.00	101.51	.1148	11.6856	101.76
2.50	98.15	.1578	15.7544	99.83
5.00	95.68	.1161	11.2491	96.92
7.50	91.82	.1813	16.9936	93.75
10.00	89.38	.1143	10.3593	90.60
12.50	85.95	.1613	14.1370	87.66
15.00	83.08	.1346	11.3747	84.51
17.50	80.17	.1363	11.1274	81.63
20.00	77.42	.1294	10.1966	78.88
22.50	75.10	.1087	8.2865	76.26
25.00	72.46	.1240	9.1469	73.78
27.50	69.89	.1205	8.5779	71.18
30.00	67.72	.1020	7.0179	68.81
32.50	65.32	.1129	7.5072	66.52
35.00	63.79	.0714	4.6074	64.56
37.50	62.27	.0716	4.5142	63.03
40.00	60.73	.0724	4.4500	61.50
42.50	59.29	.0674	4.0458	60.01
45.00	57.87	.0667	3.9061	58.58
47.50	56.70	.0551	3.1547	57.28
50.00	54.96	.0817	4.5634	55.83
52.50	53.45	.0709	3.8416	54.20
55.00	51.90	.0726	3.8243	52.67
57.50	50.27	.0766	3.9108	51.08
60.00	48.90	.0642	3.1837	49.58
62.50	47.68	.0573	2.7667	48.29
65.00	46.35	.0622	2.9260	47.02
67.50	45.15	.0563	2.5762	45.75
70.00	44.13	.0482	2.1498	44.64
72.50	43.10	.0482	2.1004	43.61
75.00	42.18	.0432	1.8429	42.64
77.50	41.11	.0501	2.0879	41.65
80.00	39.87	.0583	2.3600	40.49
82.50	38.83	.0489	1.9241	39.35
85.00	37.81	.0477	1.8265	38.32
87.50	36.82	.0464	1.7327	37.32
90.00	35.79	.0487	1.7663	36.31
92.50	34.97	.0385	1.3630	35.38
95.00	34.14	.0390	1.3482	34.55
97.50	33.21	.0435	1.4636	33.67
100.00	32.45	.0358	1.1756	32.83
102.50	31.54	.0427	1.3668	31.99
105.00	30.70	.0395	1.2295	31.12
107.50	29.85	.0398	1.2036	30.27
110.00	28.97	.0410	1.2067	29.41
112.50	28.24	.0346	.9890	28.61
115.00	27.38	.0403	1.1194	27.81
117.50	26.50	.0412	1.1111	26.94
120.00	25.72	.0368	.9608	26.11

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ELAPSED TIME (SEC)	VELOCITY (KM/HR)	ROAD ENERGY (KWH/KM)	ROAD POWER (KW)	AVG. VEL. (KM/HR)
122.50	25.01	.0331	.8394	25.37
125.00	24.46	.0262	.6475	24.73
127.50	23.78	.0316	.7624	24.12
130.00	23.14	.0301	.7068	23.46
132.50	22.36	.0365	.8315	22.75
135.00	21.80	.0262	.5781	22.08
137.50	21.05	.0356	.7619	21.42
140.00	20.35	.0328	.6798	20.70
142.50	19.58	.0358	.7149	19.96
145.00	18.94	.0304	.5850	19.26
147.50	18.23	.0333	.6195	18.58
150.00	17.38	.0398	.7078	17.80
152.50	16.35	.0482	.8122	16.87
155.00	15.17	.0553	.8720	15.76
157.50	13.77	.0657	.9508	14.47
160.00	12.39	.0650	.8497	13.08
162.50	11.03	.0637	.7462	11.71
165.00	9.74	.0608	.6310	10.39
167.50	8.24	.0701	.6306	8.99
170.00	6.86	.0650	.4905	7.55
172.50	5.39	.0689	.4221	6.13
175.00	3.86	.0721	.3335	4.62

APPENDIX F

ELECTRIC AND HYBRID VEHICLE VERIFICATION PROCEDURES

BACKGROUND

The Department of Energy is required by Public Law 94-413 to issue performance standards for vehicles used in the Electric and Hybrid Vehicle (EHV) Market Demonstration. On 30 May 1978, DOE published a final rule in the Federal Register (Vol. 43, No. 104) promulgating the first Performance Standards. This rule was effective on 3 July 1978, and prescribed minimum performance standards for electric and hybrid vehicles to be purchased or leased for the first phase of a demonstration program under the Electric and Hybrid Research and Development Act of 1976. Performance Standards are updated from time to time and the current rule was published in the Federal Register on 12 February 1980 (Vol. 45, No. 30).

Manufacturers who certify that their vehicles meet the latest requirements of the DOE Performance Standards may offer those vehicles for the DOE Market Demonstration Program. DOE reserves the right to verify, by independent test, the manufacturer's self-certification. The test procedures used for DOE performance tests are based on SAE Test Procedures J227a. Safety inspection and testing services are provided by the Department of Transportation/National Highway and Traffic Safety Administration (DOT/NHTSA) through an interagency agreement. Performance testing is performed by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM) through an interagency agreement. During verification testing, vehicle component or subsystem failures will be brought to the attention of the manufacturer immediately. Repeated or multiple component or subsystem failures experienced during test are grounds for invalidating the self-certification of the vehicle for purpose of the DOE Market Demonstration Program.

CERTIFICATION PROCESS

A manufacturer can certify an existing vehicle as meeting the DOE Standards (which include applicable NHTSA safety standards by reference) at any time by submitting a letter of certification and providing the required data on the vehicle to the Department of Energy Director of Electric and Hybrid Vehicles Division or his designee.

VERIFICATION PROCESS

Should DOE elect to verify the certification, arrangements will be made with the manufacturer for delivery of the vehicle to a DOE-specified site for testing. (Details of scheduling priorities are described in the following section.) Several basic types of tests may be involved:

- DOE-Sponsored Performance Tests by the U.S. Army MERADCOM.
- DOE-Sponsored Safety Inspection by DOT/NHTSA.
- DOE-Sponsored Safety Compliance Testing by the Research Division of DOT/NHTSA.
- DOT/NHTSA Safety Compliance Test (independent of DOE).

One important principle followed by DOE during testing is to allow the Facility Manager to work with manufacturers to overcome the normal problems that occur during inspection and testing. To ensure impartial treatment of manufacturers during the test sequence, limits have been set for the Test Facility Manager concerning how many vehicle component or subsystem failures can be allowed before certification is invalidated. DOE will objectively evaluate the impact of all failures during the testing phase so that vehicles are not unfairly penalized for minor and easily correctable failures. The Test Facility Manager, however, has an obligation to conduct the testing thoroughly and to adhere to a tight schedule.

Manufacturers may be notified from time to time by the Test Facility Manager of potential and actual problems. When these problems do not involve components or subsystem failures, where failure is defined as a vehicle being below the required standard, such notification would not necessarily invalidate the certification.

TEST FACILITY SCHEDULING GUIDELINES

Vehicles will be scheduled for testing by the Test Facility Manager on a first-come, first-served basis, with certain exceptions as noted below. Scheduling is dependent upon the ability of the manufacturer to provide a vehicle for testing. The Test Facility Manager will request the manufacturer to provide a certified vehicle for testing within 60 days from the date of the request. If a vehicle is not received at the Test Facility within the 60-day period, the self-certification will be returned and the vehicle will be removed from the self-certification list.

The primary function of certification testing is to ensure that vehicles available to the Market Demonstration Program fully satisfy the applicable DOE Performance Standards. For this reason, it is necessary to establish a set of priority testing categories for vehicles selected or being considered for selection by demonstration site operators. The categories are listed below in decreasing order of priority for testing:

1. Certified vehicles which have not been verified but have been purchased by and delivered to site operators.

2. Certified vehicles purchased by, but not delivered to site operators for demonstration.

3. Certified vehicles that have been modified subsequent to verification testing and have been delivered to site operators.* On request by DOE, the manufacturer will furnish DOE with technical information about each modification in sufficient detail to determine if reverification tests are needed.

4. Certified vehicles that are being considered for puchase by a site operator.

5. Certified vehicles that are available for test but are not under consideration by a site operator.

Vehicle test schedules are sensitive to the requirements of the Market Demonstration Program, and rescheduling by the Test Facility Manager may be required to meet changing needs. Vehicles delivered late or taken out of test because of operational failure may be rescheduled on a lower priority basis by the Test Facility Manager with approval of the DOE Test Manager. On-site rectification of a vehicle problem by the manufacturer within a 5-working-day period described below may avoid the necessity for rescheduling.

VEHICLE MODIFICATION/REPAIR GUIDELINES

The guidelines provided in this section are for use by the Test Facility Manager. Exceptions to these guidelines require the approval of the Director of the DOE Electric and Hybrid Vehicle Division or his designee. The intent of these guidelines is to facilitate the establishment of a clear basis for validating or invalidating a manufacturer self-certification. Subsystem failures may raise questions as to the relevance of the results of the validation testing. It is also important that the test facilities not be used for development and test engineering. Vehicles that experience repeated failures of the same component or subsystems must be upgraded before verification testing can be rescheduled. Rescheduling will be

* The manufacturer is responsible for notifying the DOE Director of the Electric and Hybrid Vehicle Division or his designee of all modifications to the verified production configuration.

contingent on the submission and acceptance of evidence, obtained by the manufacturer through testing, that the cause of failure has been corrected. The Test Facility Manager will determine when significant repairs should be and have been made.

VEHICLE MODIFICATIONS/REPAIRS ON OR NEAR THE TEST FACILITY

A. Only those modifications or repairs that can be completed within 5 working days by the manufacturer or his designee will be allowed. If the repairs cannot be completed within this period, the vehicle must be removed from the test facility unless DOE programmatic requirements dictate that it is in the best interest of the Government that a waiver be granted by the Director of the Electric and Hybrid Vehicles Division or his designee.

B. All failures requiring repair, whether significant or insignificant, will be recorded by the Test Facility Manager or his designee. For all repairs the manufacturer must submit (to the Test Facility Manager) written explanation of the failure modes and the corrective action taken within 15 days after completion of corrective action. Failed components or subsystems must be replaced by an identical part except in those cases where the component or subsystem design is inadequate. In the latter case, the manufacturer may substitute a readily available component or system when the manufacturer can provide assurance of improved reliability and performance.

C. Three on-site repairs to correct a significant power-train failure are allowed. A fourth failure will invalidate the vehicle certification, and the Facility Manager will order the vehicle to be returned to the manufacturer unless DOE programmatic requirements dictate that a waiver be granted by the Director of the Electric and Hybrid Vehicles Division or his designee.

D. Subject to overriding priority considerations, testing will be resumed as soon as repairs are completed.

VEHICLES RETURNED TO THE MANUFACTURER BECAUSE OF FAILURE IN TEST

A. A letter invalidating the certification will be issued to the manufacturer and DOE will notify site operators of the invalidation. A report including the vehicle failures will be provided by DOE to members of the public requesting such a report. Vehicles that are part of the Market Demonstration Program (based on the manufacturer's self-certification) which fail the verification tests will have their certification invalidated until successful correction of the defects is completed. Future funding to site operators for the invalidated vehicle model will be suspended until corrections are completed.

B. A one-time voluntary withdrawal of a vehicle from test by a manufacturer to correct problems is allowed for a period not to exceed 60 days. The vehicle will be re-scheduled for testing based on priorities at the time of resubmittal. No action will be taken to invalidate the certification during the voluntary withdrawal period unless there is a clear case of user safety involved or the manufacturer fails to offer the vehicle for test after 60 days.

C. Before a vehicle can be resubmitted for testing, the manufacturer must provide to the Director of the Electric and Hybrid Vehicles Division, or his designee, appropriate evidence that modifications and/or repairs have been made. The manufacturer must also provide substantiating test data to show that the vehicle can meet all DOE Performance Standards.

D. Repaired vehicles returned by the manufacturer may be required to undergo the complete series of verification tests regardless of the portion of testing completed prior to invalidation of certification. The Test Facility Manager with the approval of DOE will determine the necessity for such retesting.

GROUNDS FOR INVALIDATING CERTIFICATION

1. A vehicle will be returned to the manufacturer after four significant power-train failures or a single power-train failure that cannot be corrected, and its certification will be invalidated.

2. A vehicle that fails to meet applicable DOE Performance Standards will have its certification invalidated. (The standards include documentation and warranty provisions.)

3. A vehicle that fails to comply with applicable DOT/NHTSA Safety Regulations will have its certification invalidated.

4. If a manufacturer fails to commit to and follow a reasonable schedule (defined in the following section) to provide a vehicle for testing when requested by DOE, the vehicle will have its certification invalidated.

SUMMARY OF RESPONSIBILITY OF MANUFACTURERS

Manufacturers must self-certify their production vehicles to participate in the DOE Market Demonstration Program. They must also commit to a reasonable schedule to provide a vehicle for verification testing upon request from the DOE designated Test Facility Manager. If this delivery cannot be made within 60 days after receipt of such a request, the self-certification letter will be returned and the vehicle will be removed from the self-certified list.

Manufacturers must provide required and necessary information to document the vehicle configuration:

- Vehicle Summary Data Sheets,
- Operator's Manual, and
- Service and Maintenance Manual including a parts list.

This information may be in draft form, but it must be complete enough to be useful should any mechanical or electrical difficulty develop in the vehicle.

The manufacturer will notify the Director of the Electric and Hybrid Vehicles Division or his designee of all modifications to previously verified production configurations within 30 days of the sale of such modified vehicles to DOE site operators. If it is requested, the manufacturer shall furnish the DOE Test Manager with technical informatiqn about each modification in sufficient detail to determine if reverification tests are needed.

For vehicles receiving an invalidation of certification, the manufacturer must provide to the Director of the Electric and Hybrid Vehicles Division appropriate evidence that modifications and/or repairs have been made and must also provide substantiating test data to show that the vehicle can meet all DOE Performance Standards prior to resubmittal of the vehicle for test. Following successful verification testing, vehicles already in DOE site operator fleets must be modified and/or repaired in the same manner as the vehicle successfully tested. A modification and/or repair schedule acceptable to the Director of the Electric and Hybrid Vehicles Division must be developed and followed by the manufacturer as a condition for validation of the manufacturers certification.

DOE NOTIFICATION DOCUMENTATION

DOE will notify manufacturers of actions taken during the verification testing process, including but not limited to:

- Receipt of self-certification.
- Notification of vehicle failure.
- Validation of invalidation of certification.
- Final Test Report.

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