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LONG-LIFE, RECHARGEABLE NICKEL-ZINC BATTERY

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I. SUMMARY

There is presently interest in commercial type nickel-zinc batteries for use as power sources for short-range urban transit vehicles. One very formidable difficulty with the nickel-zinc system is the deterioration of the cellulose separator currently in use resulting in limited life for the system. In the 1960's flexible inorganic separators were developed for use in AgZn cells that have been reported to possess the required properties of physical strength, microstructure, and chemical stability that the nickel-zinc system so desperately requires. In this study a production version of the flexible inorganic separator was evaluated to determine whether it offers a means for improving the life of the nickel-zinc system.

Multiplate nickel-zinc cells of 7-10 AL capacities of different electrode separator configurations were constructed and tested. The nickel-zinc cells employing the inorganic separator encasing the zinc electrode, the nickel electrode, or both electrodes had shorter lives than state-of-the-art cells using Visking and cellophane separation. Cells with the inorganic separation all fell below 70% of their theoretical capacity within 30 cycles, while the cells constructed with the 'state-of-the-art' separation required 80 cycles. The mode of failure of the cells using the ceramic separator was irreversible capacity degradation due to zinc loss through cracks developed in the inorganic separator. Zinc loss through the separator was minimized with the use of combinations of the inorganic separator with Visking and cellophane. The best cells using the combined separation delivered 130 duty cycles before degrading to 70% of their theoretical capacity.

The energy densities of the cells constructed in this work were in the 25-29 Wh/lb range.

II. INTRODUCTION

The secondary nickel-zinc system is still in the development stage in spite of the fact that the system was first described some 75 years ago.[1] The problems of zinc dendrite growth and zinc electrode shape change have not been successfully solved to the point of yielding electrodes with adequate life. Separator materials with the proper properties and sufficient stability in the battery environment are still not available. Various electrochemical shortcomings of the nickel electrode (e.g., poor charge acceptance) causes severe performance problems in the system, both on its life and on its short-term performance.

Along with some of the above-mentioned technical difficulties, which are formidable, the nickel-zinc battery must be able to compete with other already very successful secondary systems in the market place. These are lead-acid and nickel-cadmium systems. The nickel-zinc system is still in the research and development; it must also compete with other 'emerging' systems, like molten salt systems, zinc-air, etc. These competitive factors have slowed the development of a truly practical nickel-zinc system.

Since the mid-1960's there has been renewed interest in the nickel-zinc system for use in electric vehicles. This was a result of public concern over environmental quality which was being degraded by emissions from the internal combustion engine powered passenger vehicle. In addition, the energy crisis, particularly the shortage of petroleum has focused attention on alternate energy sources in an effort to take pressure off dwindling petroleum reserves.[2] Battery powered vehicles would do much to reduce both of these problems.

The nickel-zinc alkaline storage battery shows promise for use in the near future for short-range urban transit if it could meet the requirements of an energy density in the range of 30 Wh/lb, a cost of $1-2/lb, and a cycle life in excess of 300 duty cycles.[3]

Of all the difficulties facing the nickel-zinc system, the life limitation due to the degradation of the cellulose separation used, which are the most efficient ones currently available, is perhaps the single most important problem. Since the early 1960's, there have been a number of company-funded and government-funded research programs which have led to the development of flexible inorganic separators[4] which have the required properties of physical strength, microstructure, and resistance to the battery environment, for the silver-zinc system.

In this work, a production version of the flexible inorganic separator was evaluated in practical nickel-zinc cells to determine whether it is a promising material for use in a nickel-zinc cell meeting commercial requirements.

III. EXPERIMENTAL

A. Nickel Electrode Preparation

The nickel electrodes used in this work were prepared from nickel plaques of 76.5% porosity. The plaques were made by sintering Inco 287 powder onto a 20-mesh, wire-woven, nickel screen at 1675°F for 10 minutes. These plaques were cut to 1.9 x 3.6 sizes; coined and current collector tabs were welded on. They were loaded with nickel active mass using one of Gould's private processes to 7.4 Ah/in.^{3} The final thickness of the electrodes was 50 mils. Each electrode in the above-mentioned sizes had actual capacities of 2.5 Ah. The finished electrodes weighed about 21 g each.

B. Zinc Electrode Preparation

Zinc electrodes used in this study, unless otherwise stated, were prepared in accordance with NASA specifications BFDO 1001 to 1017. In outline form, the procedure consisted of placing a piece of potassium titanate paper (0.1 g/in.^{2}) sprayed on one side with a 1% PVA solution, wet side up in a 1.9 x 3.6 in. double acting mold. Then one-half of the quantity of ZnO (New Jersey Zinc USP 12 grade) containing 2 w/o Mallinckrodt analytical reagent grade HgO was placed in the mold. At that point, the grid material was placed in the mold (Ag Distex, 5 Ag 38 - 1/0 that weighed 0.53 g/in.^{2}). The remainder of the ZnO was placed on top of the grid and another piece of potassium titanate paper, this time wet side down, was placed on it and the mold closed and pressed at 4 tons/in.^{2} The resulting mass had a density of 50 g/in.^{3} and a thickness of 70 mils. The electrode weights were in the 24 g range.

C Inorganic Separator and Application to Electrodes

The inorganic separator used in this study is a NASA proprietary material under license from McDonnel Douglas Corp. The separators were cut from a 91-pound roll of the material, prepared in a production run.

Briefly, the separator consisted of a thin layer of an inorganic material and a PPO binder deposited on to one side of fuel cell grade, porous asbestos matrix by a continuous dipping technique. The asbestos was lightly impregnated with PPO.

The separator encased either or both the zinc and nickel electrodes. This was done by first cutting the separator 0.25 in. larger than the electrode. The edges of the separator were coated with epoxy by dipping in a 20% by volume solution of Fuller's FE 7004 epoxy in MEK. After curing, the separator with the ceramic facing down was placed on

a table; the electrode to be encased was placed on top of it, and a bead of epoxy was put on three sides, all sides but not the top. Another piece of separator was placed on top of this, this time with the ceramic side facing up. The whole package was inverted to allow the epoxy to flow and then allowed to cure under a 5 lb load on a Plexiglass plate.

D. Cell Construction

Cells were fabricated with either four nickel electrodes and three zinc electrodes or three nickel electrodes and two zinc electrodes. The electrode packs, to be described in detail in other sections, were assembled in SZR-18 commercial silver-zinc hardware, 2.31 in. w x 0.74 in. d x 4.9 in. h. The total weight of the hardware was 60.4 g.

E. Cell Testing

The testing of the cells consisted of three main areas: autocycling, reconditioning, and capacity check.

1. Autocycling – All automatic cycling, except where otherwise stated, was a constant current charge at C/10 to a time cut-off to approximately 100% of the actual cell capacity at the particular cycle in question. Discharges were performed at approximately C/2 to 100% depth, 0.4V cut-off voltage. The work was done on fully automatic test equipment.
2. Reconditioning – After approximately 30 automatic cycles, starting with fully discharged cells, the zinc active material built up during the autocycling was discharged at 0.2 A until the cell reached 0.0V. Then, 40% KOH was added to restore the original cell weight.
3. Capacity Check – After reconditioning, cells were charged 16 hours at C/10 then discharged at C/5 to 1V. This was repeated at least three times. All the test data for autocycling and capacity checks are given in the various Appendices.

IV. DISCUSSION AND RESULTS

A. Selection of Cell Construction Variables

Since the main thrust of the program was the design and construction of nickel-zinc cells of practical commercial value, it was desirable to use positive electrodes with maximum thickness and with a minimum negative/positive active material ratio in order to achieve a cell with the best possible energy density, lowest cost, while still maintaining satisfactory performance at high rates.

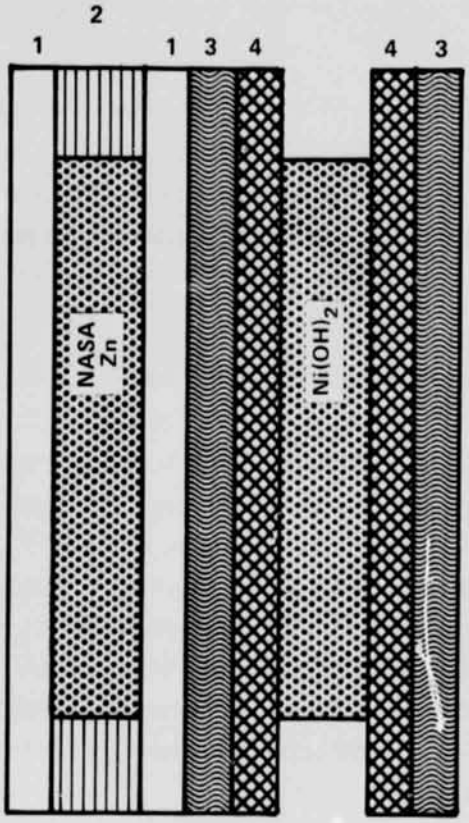
To determine the most suitable thickness of positive electrode and negative/positive ratio, two plate cells with positive electrodes 25, 42, and 52 mils thick, each with negative/positive active material weight ratios of 2.5, 3.5, and 5.0 to 1 were tested. There were three cells in each group; the average cell efficiencies at 1C and 4C discharges are given in Appendix I. The electrode sizes in this portion of the work were 1.5 x 1.5 in. The separator configuration is shown in Figure 1.

An anlysis of the data indicated that there was no effect of N/P ratio in the range studied on cell efficiency at the 1C discharge. There was no effect of overcharge in the range studied on cell efficiency at the 1C discharge. No important effect of electrode thickness on cell efficiency at the 1C discharge rate. At the 4C discharge, the 25 mil nickel electrodes had far higher efficiencies than the 50 mil electrodes, 65% vs 15%. As far as estimating effects on cell life over the nine test cycles, it was observed that the cell efficiency degraded faster with the use of the thicker electrodes, probably due to the higher charge and discharge current density that must necessarily be employed with the thick electrodes. In addition, the lower the negative/positive active material weight ratio, the higher the cell degradation rate. However, cells with thicker electrodes and high N/P ratios did not degrade substantially.

Since it was the goal of the program to fabricate practical nickel-zinc batteries for use at about the 1C discharge rate, the two plate cell data collected; namely, the cell voltages, efficiencies and component geometries, was used to estimate the anticipated energy density on a unit volume basis of nickel-zinc cells. This is shown in Figure 2 for a configuration identical to that shown in Figure 1. The energy density is shown to increase markedly with increasing electrode thickness. This is a consequence of the relatively larger volume of separator required when thinner electrodes are employed. It was on this basis that the 50 mil electrodes were selected for use in nickel-zinc cells and for further investigation.

B. Cell Testing for Design Verification

The above-described testing of small two plate cells defined the thickness of the nickel electrode to be used. A 50 mil positive electrode was selected mainly on the basis



1. Ceramic Separator
2. Epoxy Seal
3. Cellophane, Two Perpendicular Wraps
4. Pellon Non-Woven Nylon, One Wrap

Figure 1. Electrode and Separator Configuration for Two-Plate Cells

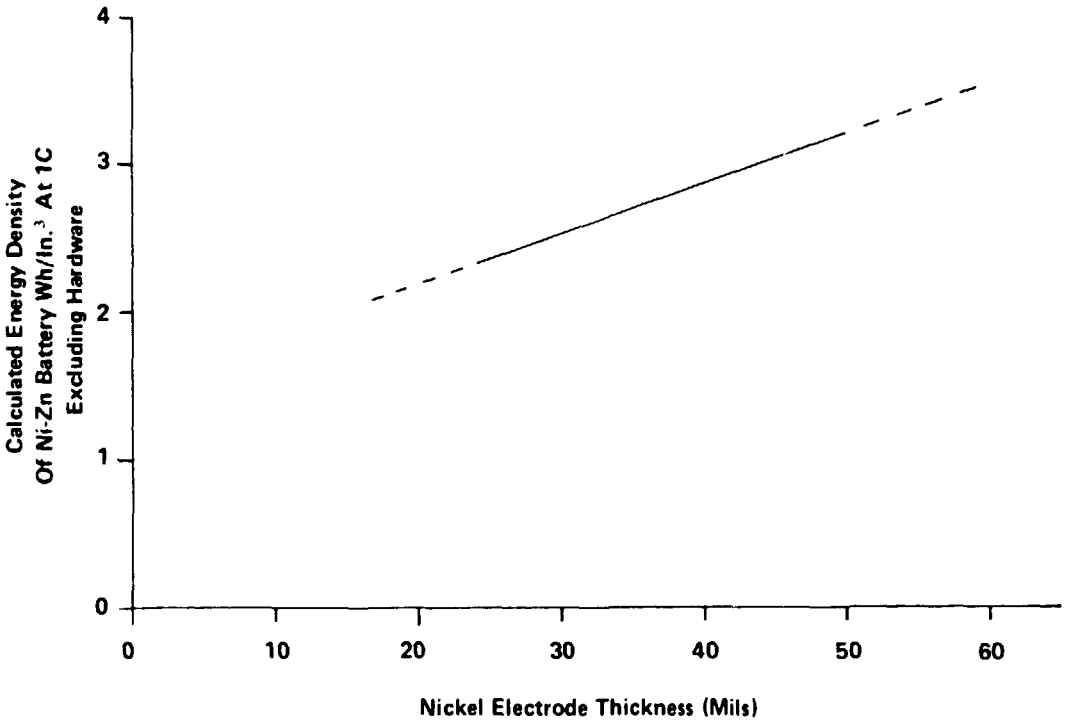


Figure 2. Calculated Energy Density Of Nickel-Zinc Cells
As A Function Of Nickel Electrode Thickness

of energy density. Further, the testing of small cells indicated that the negative/positive active material weight ratio might be important from a cell efficiency and cell life point of view. These factors were further investigated by constructing and testing nine multi-plate cells employing the 90 mil electrodes and three levels of negative/positive active material weight ratio, 2.5, 3.5, 4.5 to 1. The cells were constructed using four 50 mil positive electrodes and three zinc electrodes in the separator arrangement shown in Figure 1. The cell hardware used was as described above.

The cells had initial capacities in the 10 Ah range. The capacity maintenance cycles are given in Figure 3. The cycle testing in between the capacity measurement cycles shown was to 100% depth (to 1V) at about 5 A. Complete test data for these cells are given in Appendix II. The loss in cell capacity with cycling with cells containing the ceramic separation was very large compared to cells using conventional cellulose type separation. The capacity loss was irreversible. There was no evidence of internal shorts or electrolyte deficiency effects in the cells. The results confirmed the earlier observation that the negative/positive active material weight ratio is related to cell life. Here cells with the highest ratios, 4.5:1, performed at the highest level of output throughout the testing.

Autopsies performed on several cells indicated cracking of the ceramic membrane near the epoxy bonds that enclosed the zinc electrode (see Figure 4). This permitted the loss of active material from the zinc electrode during cycling. The remaining zinc active material in the bag corresponded approximately to the capacity of the cells. The cracking was a result of the strains induced in the membrane as a result of the dimensional changes in the zinc electrode resulting during the cycle testing. This was perhaps made more severe than usually encountered due to the severe test regime used here; namely, 100% charge followed by a discharge to 100% depth.

The cells tested had the average peak energy densities shown in Table 1.

Table 1. Energy Density of 10 Ah Nickel-Zinc Cells With Inorganic Separation

N/P Ratio	Wh/Lb	Wh/In.^{3}
2.5:1	29	2.3
3.5:1	25	2.0
4.5:1	26	2.2

In spite of some experimental inconsistency in the data, there is only a small decrease in energy density with increasing negative/positive active material weight ratio.

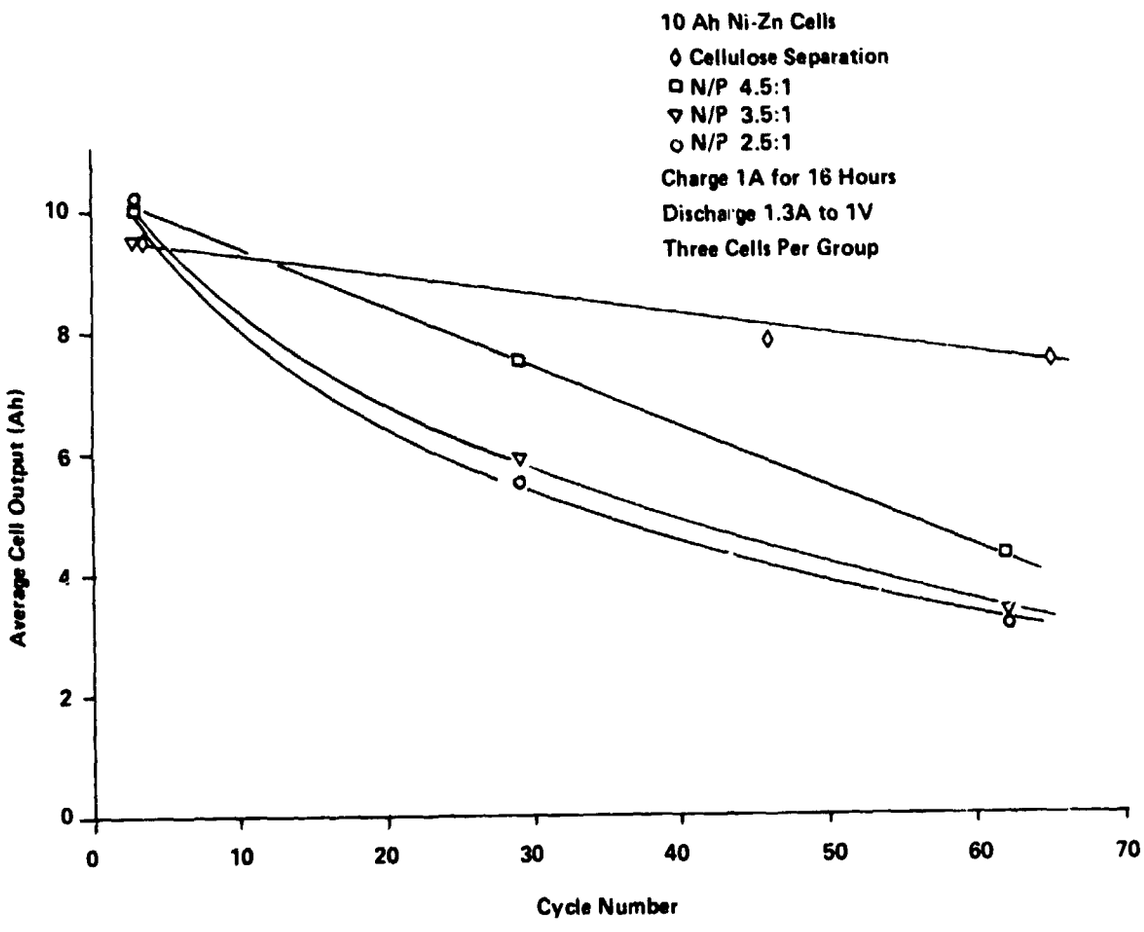


Figure 3. Capacity Maintenance Curves Of 10 Ah Nickel-Zinc Cells With Inorganic Separation Compared To Cells With Conventional Separation

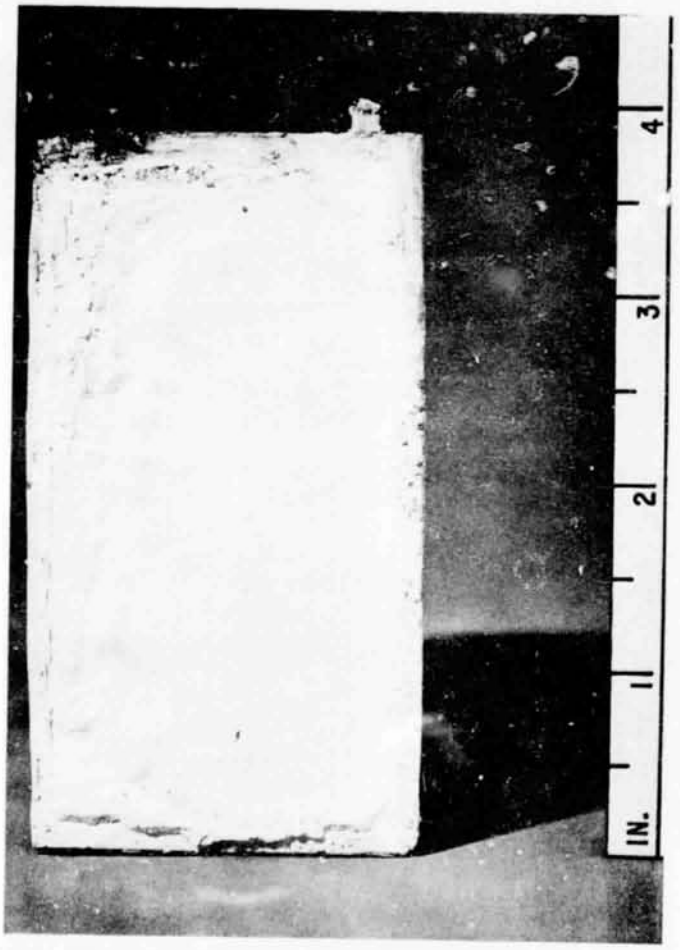


Figure 4. A Zinc Electrode, Encased In Ceramic Separator, After 63 Cycles

Nickel-zinc cells with energy densities in excess of 25 Wh/lb and 2.0 Ah/in.^{3} can be constructed with 50 mil positive electrodes. The negative/positive active material weight ratio should be in the range of 4.5:1 for best performance.

C. Effect of Testing Regime on Cycle Life

Cells employing the inorganic separator had a rather short useful life. These cells were charged at approximately C/10 to high levels of overcharge (see Appendix II) based on the actual capacity of the cell at the particular time. The discharges were always to 100% depth. It was suggested[5] that perhaps this type of test regime was not suitable for the zinc electrode and separator. Silver-zinc cells employing this type of separator material were always operated at fractional depths-of-discharge, e.g., 40%, for a rather large number of cycles (1000+).[6] Perhaps the use of a test regime along these lines would extend the life of nickel-zinc cells beyond the levels shown in Figure 3.

Therefore, five additional cells were constructed of a design very close to that used above. The overall cell configuration was once again as shown in Figure 1; but, for the case at hand, three 43 mil nickel electrodes and two zinc electrodes were used. The cell capacities were in the 7 Ah range. The cells were cycle tested using a 1.15 A charge to 1.91 V or a 6-hour cut-off, whichever occurred first. The cells were discharged at 2.4 A for two hours or to 1.0V, whichever occurred first. In this group of cells, the electrolyte was 45% KOH. After addition of the required amount of electrolyte, the cells were heated at 50°C for 24 hours prior to the start of cycle testing.

The capacity maintenance cycle data for this group of cells is given in Figure 5. A comparison of this data with Figure 3 indicates that this modified cycle regime, which consists of partial charges and discharges, did nothing to improve the useful life of the nickel-zinc cells. The complete cycle data for this group of cells is given in Appendix III.

D. Testing of Other Cell Configurations

In view of the observation of severe capacity degradation within a rather small number of cycles, presumably due to the cracking of the membrane, attempts were made to reduce the strain on the membrane by using other separator arrangements. Also, efforts were made to minimize zinc active material losses by using basically the same zinc electrode separator configuration as above, but in combination with other separator materials.

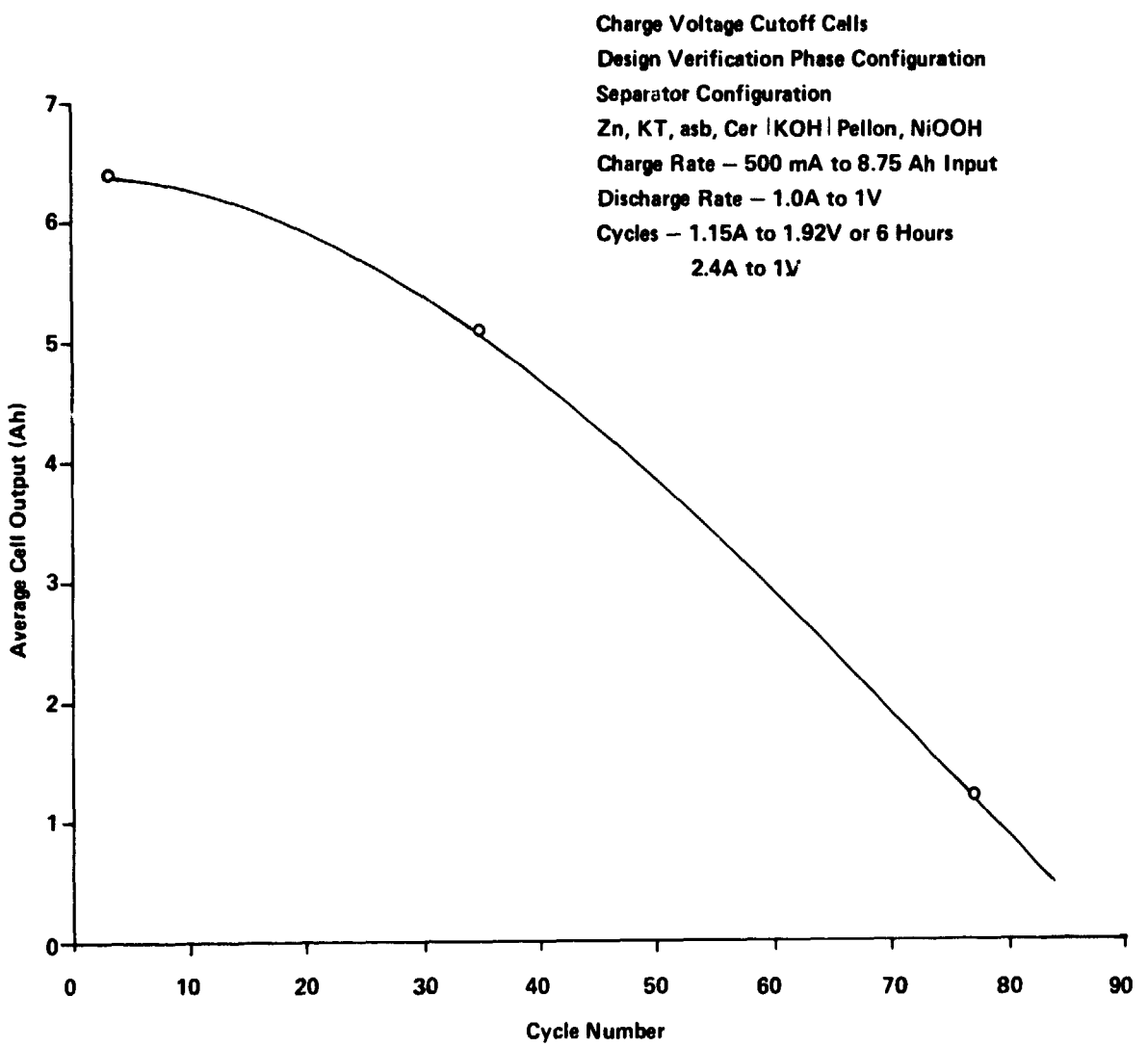


Figure 5. Capacity Maintenance Cycles Of Nickel-Zinc Cells Using A Partial Charge And Partial Discharge

1. Bagged Positive Electrode

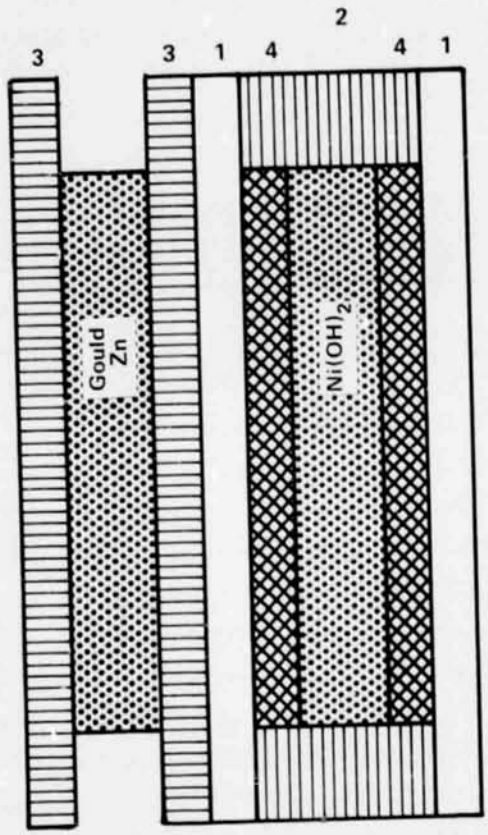
A positive electrode in the ceramic bag rather than a zinc electrode would relieve the strains on the separator since its structure is more substantial; and, therefore, there would not be as severe dimensional changes as with the zinc electrode. Figure 6 shows the electrode-separator configuration designated 'bagged positive'. In this particular configuration, the nickel electrode was wrapped with Pellon and was contained in the inorganic separator bag. Each cell contained three nickel electrodes of this construction. Two zinc electrodes, Gould production types, contained in Visking tubing were used in each cell. The capacity maintenance data is given in Figure 7. The complete cycle test data are given in Appendix IV. These cells were somewhat lower in capacity, 6.2 Ah, than the expected 7 Ah. However, these cells were improved in terms of capacity degradation compared to the cells used in the design verification described above.

2. Both Electrodes Bagged

In view of the belief that the rate of capacity decay is related to separator weakening with cycling, the use of additional separation would enhance life. A group of cells (2) was constructed in which both electrodes were encased in the ceramic separator. A schematic representation of this separator-electrode configuration is shown in Figure 8. The zinc electrode was prepared according to NASA specifications, the nickel electrode was wrapped once with Pellon non-woven nylon prior to being inserted into the ceramic separator bag. Each cell contained three nickel and two zinc electrodes of the arrangement shown in Figure 8. The theoretical capacity of the cells was, therefore, in the 7 Ah range. The capacity maintenance curve is given in Figure 9. All discharges were to 100% depth. Complete test data is given in Appendix V. The cells with both electrodes bagged perform better than those with the negative electrode bagged but poorer than those with positive electrode bagged.

3. Bagged Negative Electrode

Another group of cells (2) contained a zinc electrode in a ceramic bag as described for several of the configurations above. In this particular case the nickel electrodes were wrapped with Pellon non-woven nylon once, then with two perpendicular wraps of cellophane, and then inserted in a Visking tube. This electrode separator arrangement is shown in Figure 10. The cells were constructed with three positive and two negative electrodes. The theoretical capacity was in the 7 Ah range. The capacity maintenance curve is shown in Figure 11. The complete cycle data is given in Appendix VI. The rate of degradation of these cells is approximately the same as those designated bagged positive, however, since the bagged negative cells have higher initial capacities they perform at a higher output level. These cells were generally speaking, the best cells of the groups constructed with bagged electrodes.



1. Ceramic Separator
2. Epoxy Seal
3. Visking Sausage Casing
4. Pellon Non-Woven Nylon, One Wrap

Figure 6. Electrode And Separator Configuration For Ceramic Separator On Nickel Electrode, Designated Bagged Positive

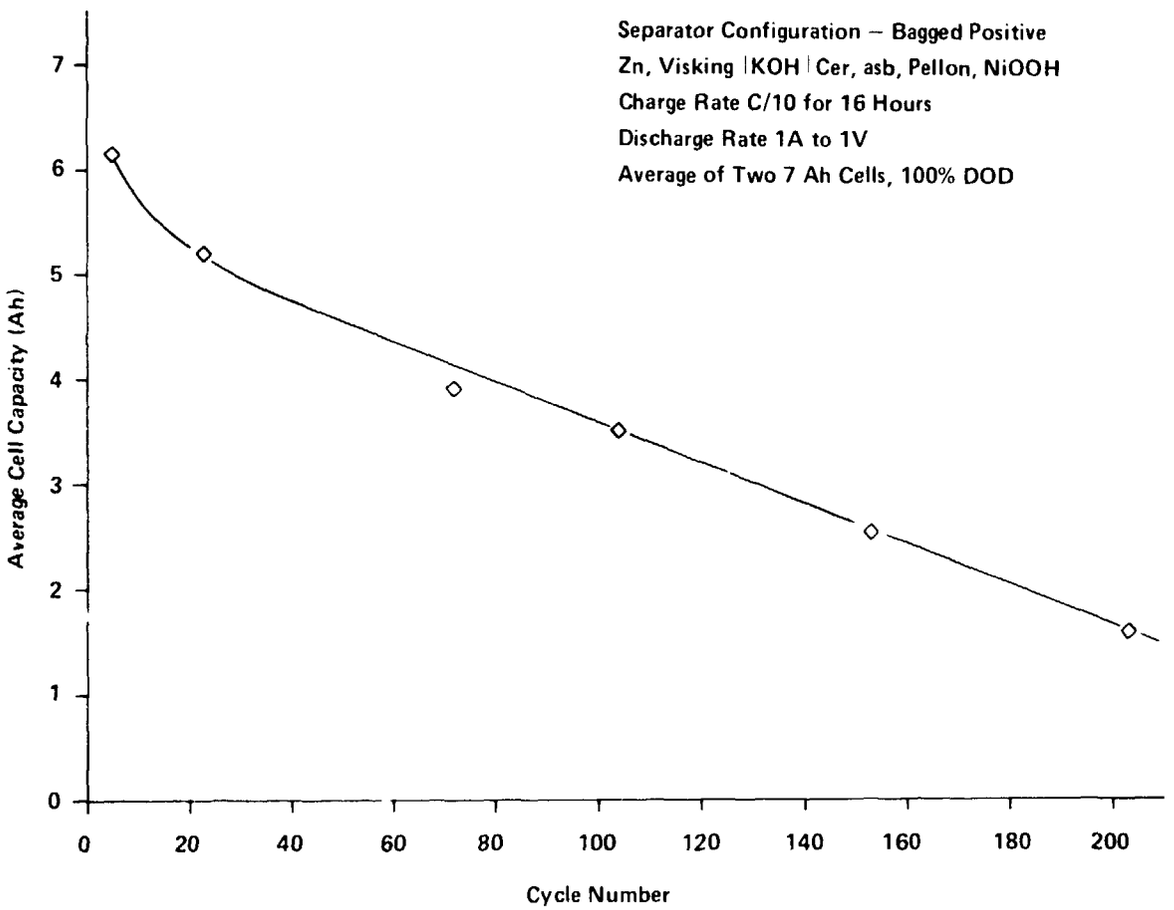
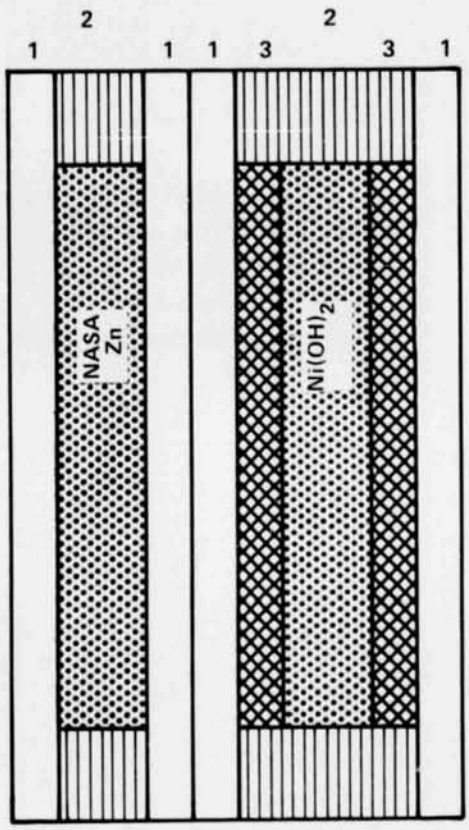


Figure 7. Capacity Maintenance Cycles Of Cells With Positive Electrode Encased With Ceramic Separator



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2. Epoxy Seal
3. Pellon Non-Woven Nylon, One Wrap

Figure 8. Electrode And Separator Configuration Of Ceramic Separator On Both Electrodes, Designated Both Electrodes Bagged

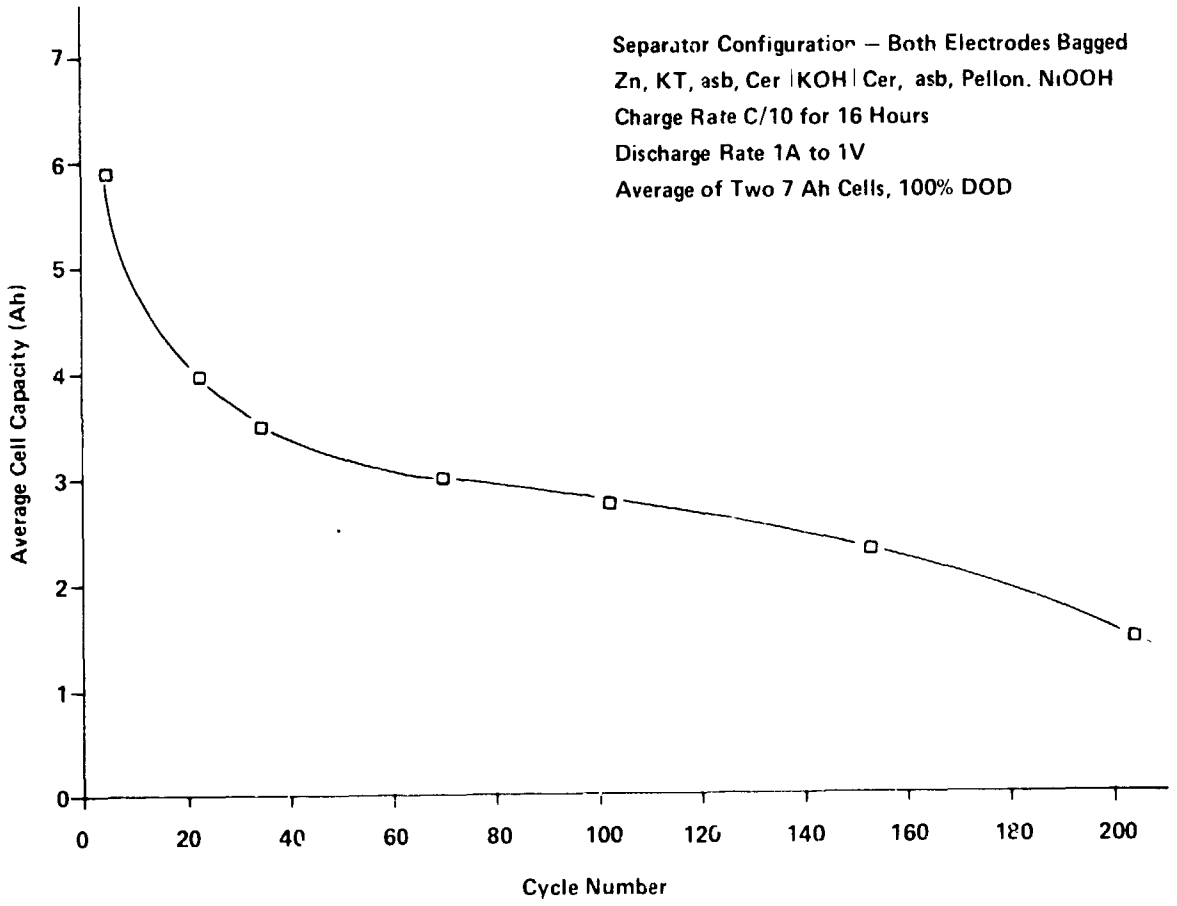

Figure 9. Capacity Maintenance Cycles Of Cells With Both Electrodes Encased With Ceramic Separator

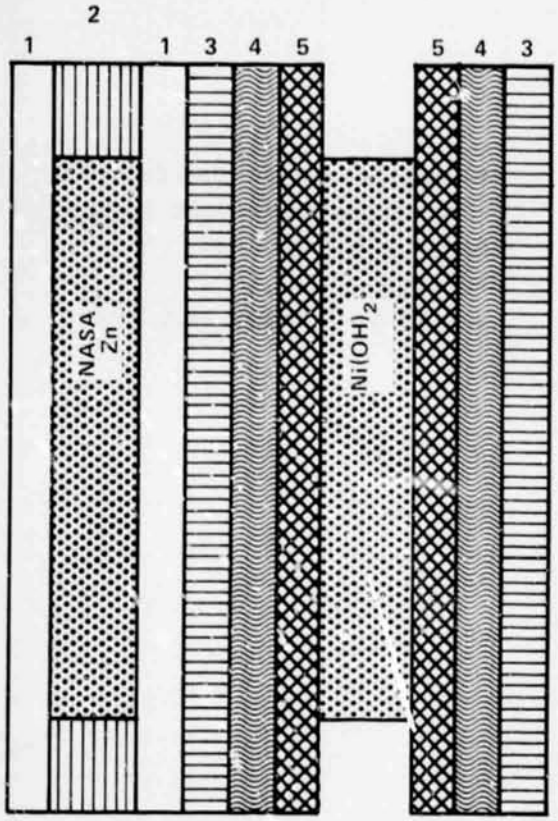

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Figure 10. Electrode And Separator Configuration For Ceramic Separator On Zinc Electrode And Conventional Organic Separators On Nickel Electrode

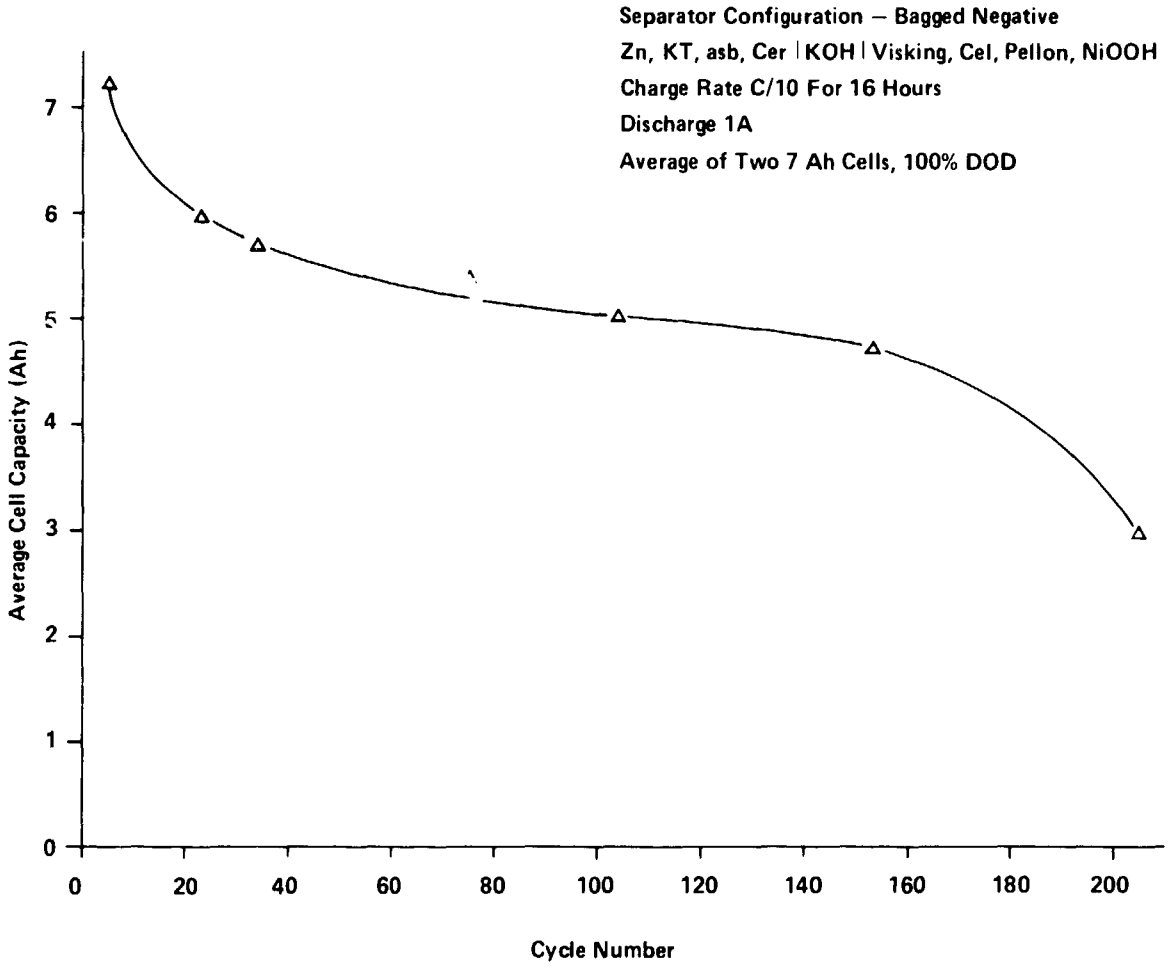


Figure 11. Capacity Maintenance Cycles Of Cells With Negative Electrodes Encased In Ceramic Separator

4. Layers Inorganic

Because the epoxy bonding of two sections of ceramic separators to form the bag causes the cracking of the ceramic bag when the electrode swells, a group of cells was constructed in which the ceramic separator was used as a layer rather than as a bag. The zinc electrode was, however, contained in a Visking envelope. The separator-electrode configuration is shown schematically in Figure 12. Capacity maintenance data is shown in Figure 13. All discharges were to 100% depth. Complete cycle data are given in Appendix VII. This group of cells also performed well above the cells in the design verification portion of the work. They were also in the performance range of the other cells tested that were constructed with the cellulose separation.

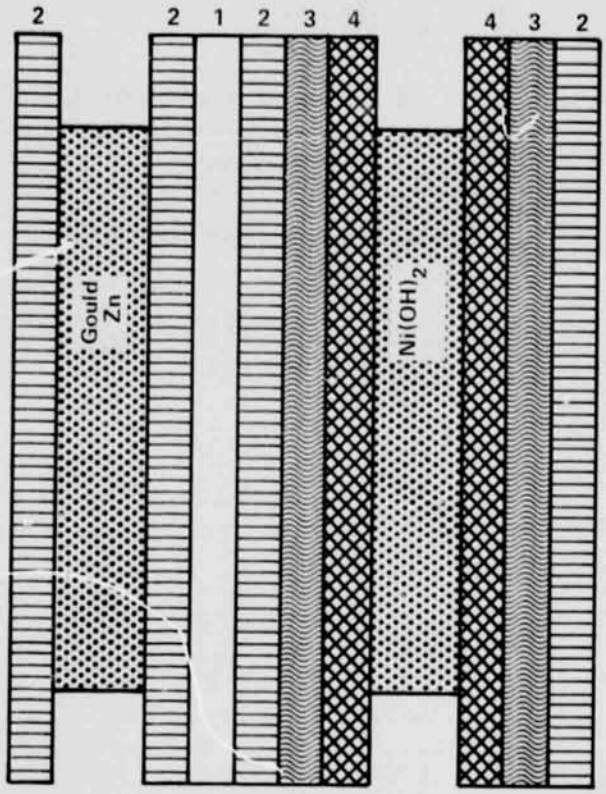
5. Control Group – Standard Separation

To provide data to form a basis of comparison of all the above-described information, a group of cells was constructed and tested that contained only cellophane and Visking separation. The electrode-separator configuration is shown in Figure 14. These cells comprise the control group and are state-of-the-art nickel-zinc cells employing all organic separation. The electrode and separator arrangement is simply a zinc electrode inserted in a Visking sausage casing tube and a nickel first wrapped once with Pellon non-woven nylon then with two perpendicular wraps of cellophane and finally inserted in another Visking sausage casing tube. The cells were constructed with four nickel electrodes and three zinc electrodes making the theoretical capacity approximately 10 Ah. The capacity maintenance test data for this group of cells is given in Figure 15. The best cell of the group at the particular cycle is shown. The complete cycle data is shown in Appendix VIII.

A very rapid decay in cell output is noted with this group of cells also, but not as severe as the groups of cells using ceramic separation exclusively.

6. Comparison of Cycle Lives of Nickel-Zinc Cells with Different Separator Configurations

A comparison of the cycle life data obtained for all the groups of cells tested in this work is made in Figure 16. The comparison is made in terms of cell efficiency, output/theoretical capacity, since both 10 Ah and 7 Ah cells were constructed and tested. After testing for about 205 cycles it seems that, first of all, the use of a combination of organic separation, Visking and cellophane, along with the inorganic separation were the best cells tested in the program. The performance of the cells with the combined separator was better than cells using either type of separator alone. Also, the use of a positive electrode encased in inorganic separator is a performance handicap irrespective of the type of zinc electrode used. Further, the use of ceramic separator alone, in any of the configurations



1. Ceramic Separator
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3. Cellophane, Two Perpendicular Wraps
4. Pellon Non-Woven Nylon, One Wrap

Figure 12. Electrode And Separator Configuration Of Ceramic Separator Used As Layers, Designated Layers Inorganic

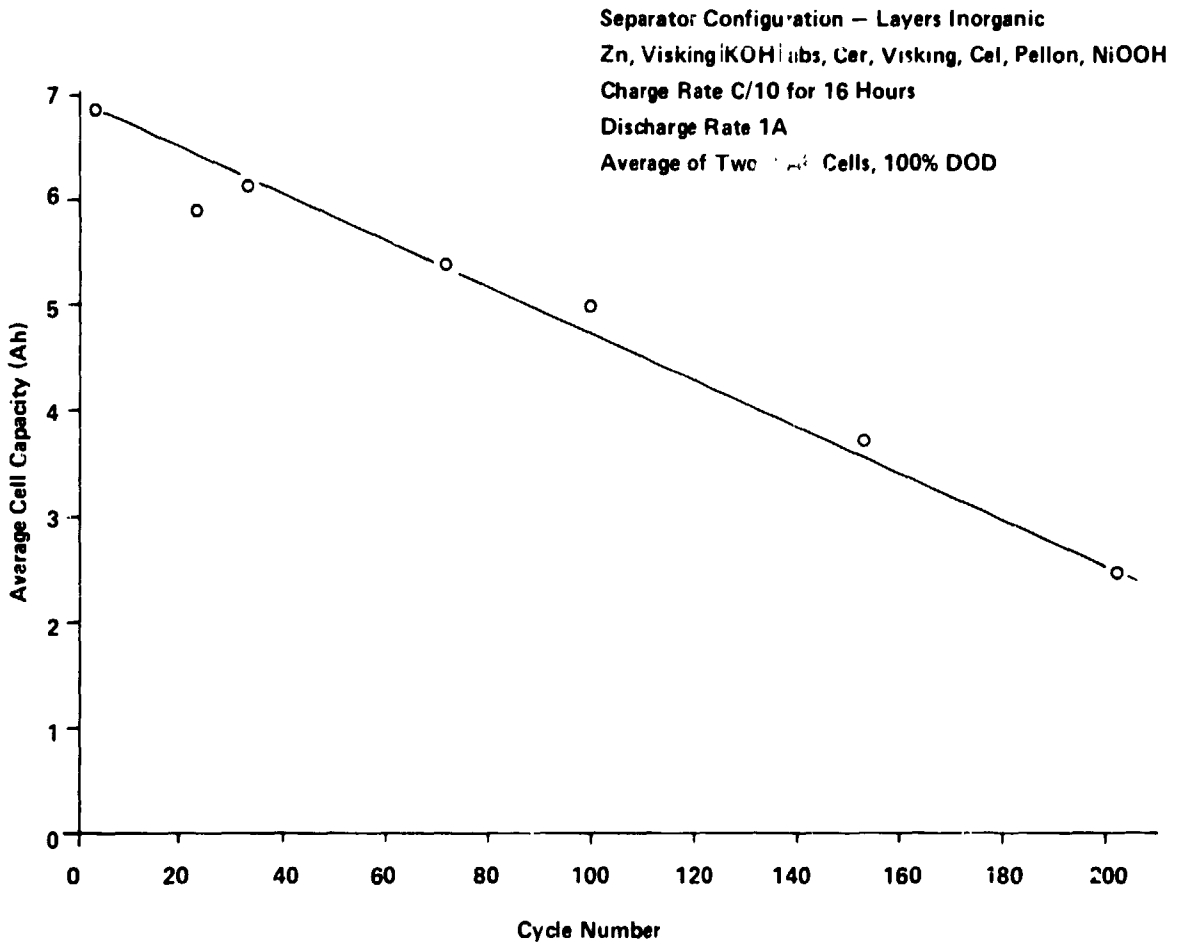
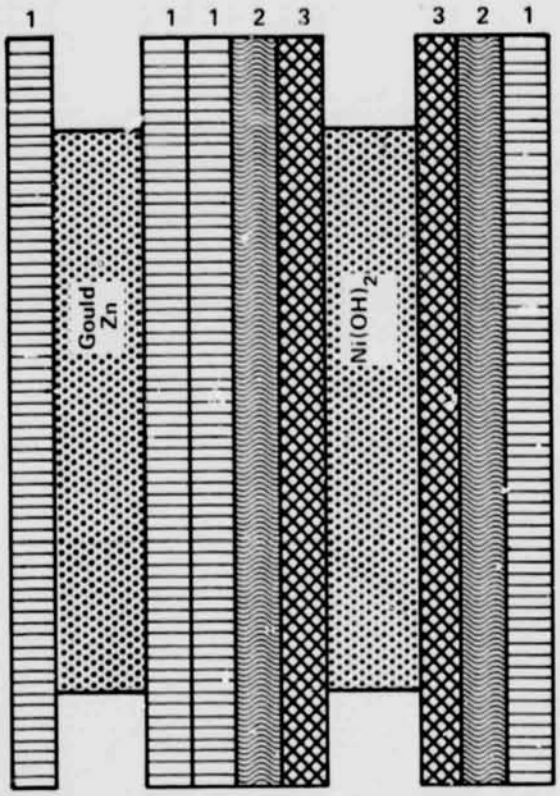


Figure 13. Capacity Maintenance Cycles Of Cells With Ceramic Separator Used As Layers



1. Visking Sausage Casing
2. Cellophane, Two Perpendicular Wraps
3. Pellon Non-Woven Nylon, One Wrap

Figure 14. Electrode And Separator Configuration Using Standard Separation

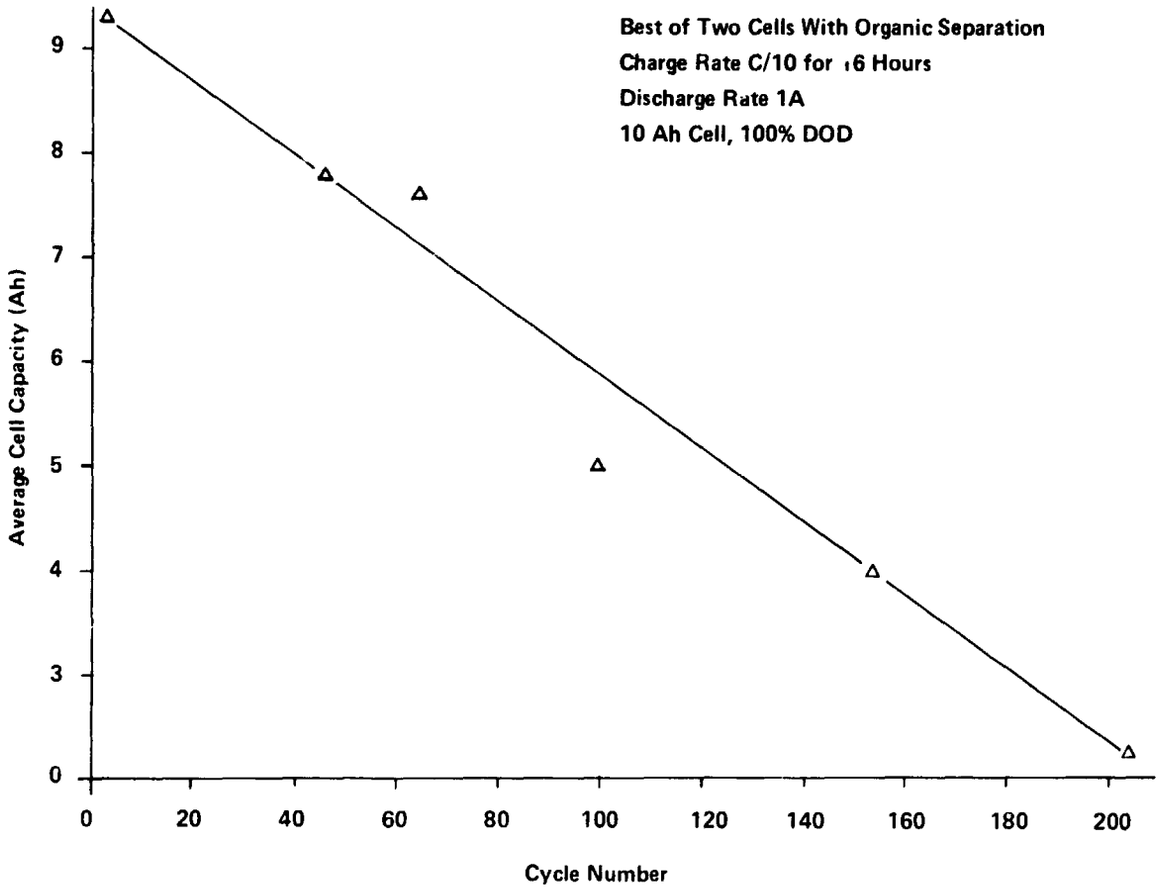


Figure 15. Capacity Maintenance Cycles Of Cells
With Standard Separation

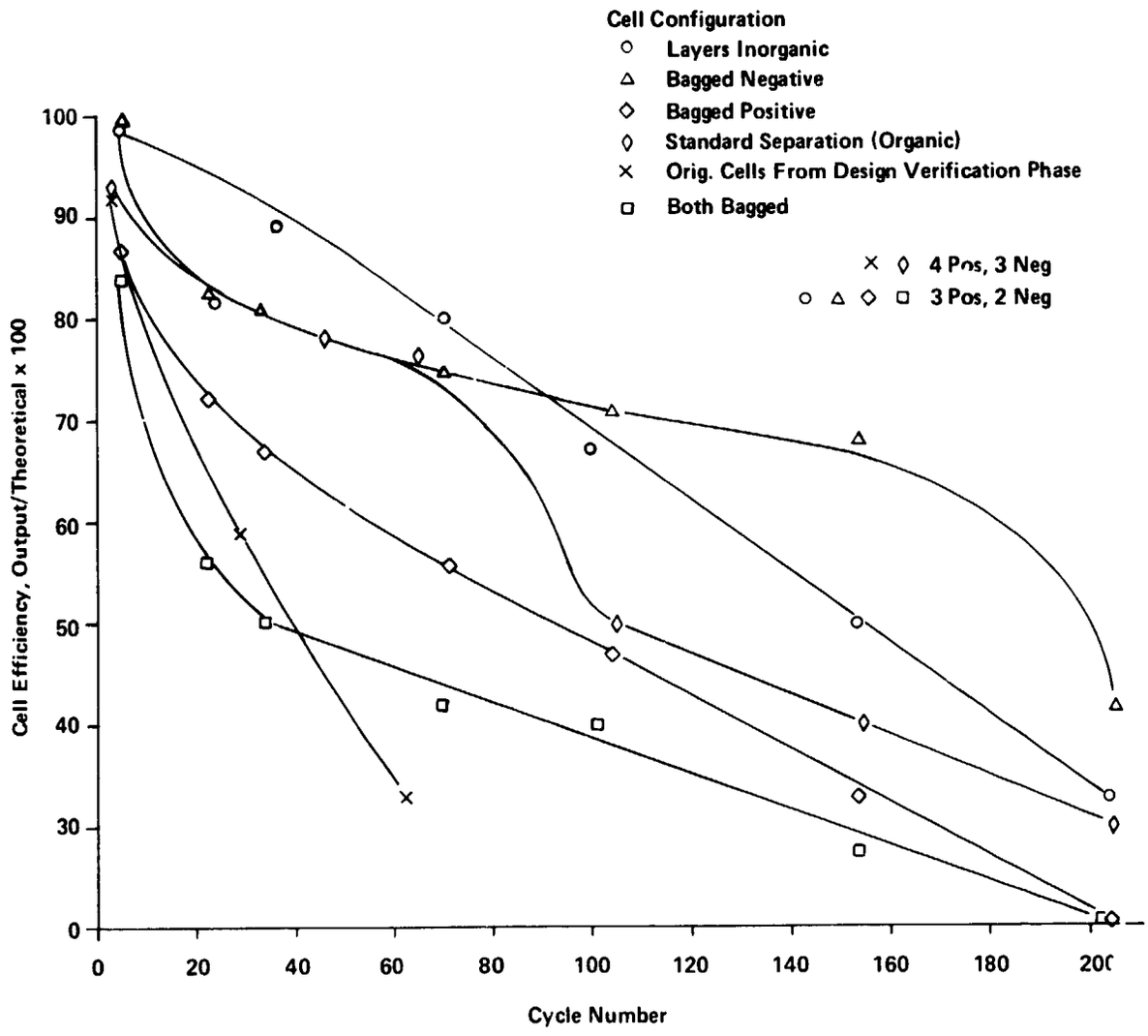


Figure 16. Comparison Of Efficiencies Of Nickel-Zinc Cells With Different Separator Configurations

tested here offer no improvement as far as cycle life is concerned over state-of-the-art organic separation. In addition the ceramic separator encased zinc electrode (uncharged active mass) offers no performance advantages over production zinc electrodes. This is independent of test regime since no important improvements in performance were observed using a test regime which consisted of partial charges and discharges.

V. CONCLUSIONS

Nickel-zinc cells using NASA inorganic separator enclosing the zinc electrode, the nickel electrode, or both electrodes had shorter useful lives than 'standard cells' using Visking and cellophane separation. The cells using the inorganic separation fell below 70% of their theoretical (based on weight gain of the positive electrodes) capacity within 30 duty cycles at 100% DOD. It required about 80 similar cycles for 'standard cells' using Visking and cellophane separation. This capacity loss for the cells with inorganic separator was not a consequence of the test regime since alternate regimes consisting of partial charges and discharges did little to improve the useful lives of the cells. The mode of failure of all the above-mentioned cells was by irreversible capacity loss, due to cracking of the inorganic separation which resulted in the loss of zinc active material. In order to avoid this difficulty cells were constructed with combinations of inorganic separation and Visking and cellophane. The best group of such cells delivered 130 duty cycles (100% DOD) before degrading to 70% of its theoretical capacity as compared to the above-mentioned 80 cycles for the cells with standard separation. After 205 duty cycles this particular group of cells was still delivering 42% of its theoretical capacity.

The above observations were the important ones as far as the purpose of the work was concerned. During the course of the study a number of other useful bits of information about nickel-zinc cells was uncovered. In the testing of small (1.5 x 1.5 in.) cells there was:

1. No effect of N/P ratio in the range 2.5 to 5.0 to 1 on cell efficiency.
2. There was no effect of overcharge (0-40%) on cell efficiency at the 1C discharge.
3. There was no important difference in the efficiency of positive electrodes of 25-50 mils thick at the 1C discharge rate.
4. At the 4C discharge rate the 50 mil positive electrodes had lower efficiencies than the 25 mil electrodes, 15% vs 65%.
5. The cell efficiencies degraded faster with cycling with the use of the thicker electrodes.
6. Also the cells with lower N/P ratios had higher degradation rates.

The last two observations were confirmed by the testing of 10 Ah cells.

VI. REFERENCES

1. T. Michalowski, German Patent No. 112351 (1899).

2. H.J. Schwartz, 'Electric Vehicle Battery Research and Development', Electrochemical Society Meeting, October 7-11, 1973.

3. G.A. Mueller, ed., 'The Gould Battery Handbook', p. 389, Gould Inc., (1973).

4. G. Moe and F.C. Arrance, 'Zinc-Silver Oxide Batteries', A. Fleischer and J.J. Lander editors, p. 295, John Wiley and Sons Inc., New York (1971).

5. Private communication with T. J. Nagle and D.G. Sohis.

6. A. Hiny, 'Development of a Heat-Sterilizable 40 Ah Sealed Silver-Zinc Cell', NAS3-10928, p. 66.

VII. CELLS FOR DELIVERY

The following number and types of cells were delivered to NASA/Lewis:

- 10, 7 Ah cells with standard separation
- 12, 7 Ah cells designated 'bagged negative'
- 13, 7 Ah cells designated 'both bagged'

Appendix I. TEST DATA FOR SELECTION OF CELL CONSTRUCTION VARIABLES.

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Table 2

CELL CONSTRUCTION VARIABLES AND LEVELS

		Symbol		
		-	0	+
X_1	Positive Electrode Thickness (mils)	25	42	52
X_2	Negative/Positive Ratio	2.5	3.5	5.0

CELL EFFICIENCIES

Exp. #	Variables X_1	Variables X_2	Cycle 1 100% 1C	Cycle 2 120% 1C	Cycle 3 140% 1C	Cycle 4 100% 4C	Cycle 5 120% 4C	Cycle 6 140% 4C	Cycle 7 100% 1C	Cycle 8 120% 1C	Cycle 9 140% 1C
1	+	+	81	83	84	25	22	00	78	70	64
2	0	+	69	72	70	34	38	24	67	67	65
3	-	+	82	86	89	67	69	67	88	86	87
4	+	0	64	63	59	9	10	10	57	51	43
5	0	0	80	84	85	17	00	00	63	57	62
6	-	0	82	85	86	68	64	62	67	63	76
7	+	-	84	86	57	16	16	15	50	40	40
8	0	-	84	87	72	4	6	3	63	56	51
9	-	-	70	73	73	45	48	41	72	67	65

Appendix II. TEST DATA FOR DESIGN VERIFICATION

TABLE 3

TEST DATA FOR NI ZN CELLS

Cell Number: NL-1
Cell Weight: 0.565 lbs.
N/P Ratio: 2.5/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	1.00	13.4	1.25	8.27	1.94		12.0
2	0.825	14.0	1.25	10.00	1.97		
3	0.950	15.4	2.00	10.37	2.22	7.8	
4	0.815	11.1	2.00	9.50	2.24		14.0
5	0.670	11.4	10.00	5.90	2.13		11.4
6	0.900	16.4	10.00	5.20	1.91	11.8	
7	0.800	13.0	1.30	7.90	1.88		
8	0.800	13.20	1.30	8.00	1.86		19.0
9	1.00	6.25	5.00	NOT	RECORDED		
10	1.00	10.00	5.00	NOT	RECORDED		
11	1.00	10.00	5.00	5.58	1.84		
12	1.00	10.00	5.00	5.62	1.84		
13	1.00	10.00	5.00	5.31	1.86		
14	1.00	10.00	5.00	5.46	1.86		
15	1.00	10.00	5.00	4.86	1.87		
16	1.00	10.00	5.00	5.15	1.86		
17	1.00	10.00	5.00	4.82	1.86		
18	1.00	10.00	5.00	4.61	1.86		
19	1.00	10.00	5.00	4.48	1.85		
20	1.00	10.00	5.00	3.97	1.85		
21	1.00	10.00	5.00	3.95	1.85		
22	1.00	10.00	5.00	3.88	1.85		
23	1.00	10.00	5.00	3.87	1.84		
24	1.00	10.00	5.00	3.91	1.83		
25	1.00	10.00	5.00	3.68	1.84		
26	1.00	10.00	5.00	3.73	1.83		
27	1.00	6.25	5.00	3.57	1.85		
28	RECONDITIONING		CYCLE				
29	0.88	14.22	1.30	5.42	1.82	7.0	
30	0.96	13.44	1.30	3.40	1.81		15.0
31	0.60	11.40	1.3	4.05	1.82		17.5
32	0.40	16.00	1.30	4.37	1.82		16.6
33	0.52	4.94	4.68	2.81	1.82		
34	0.52	4.94	4.68	3.08	1.82		
35	0.52	4.94	4.68	3.08	1.83		
36	0.52	4.94	4.68	3.04	1.83		
37	0.52	4.94	4.68	3.10	1.83		
38	0.52	4.94	4.68	2.94	1.83		
39	0.52	4.94	4.68	2.99	1.83		
40	0.52	4.94	4.68	2.92	1.83		
41	0.52	4.94	4.68	2.91	1.84		
42	0.52	4.94	4.68	2.87	1.84		
43	0.52	4.94	4.68	2.89	1.84		
44	0.52	4.94	4.68	3.07	1.84		
45	0.52	4.94	4.68	2.99	1.84		
46-58	0.52	4.94	4.68	NOT	RECORDED		
59	0.52	4.94	4.68	2.66	1.83		
60	RECONDITIONING		CYCLE				
61	0.60	10.30	1.30	3.03	1.82	8.6	
62	0.70	13.07	1.00	3.58	1.82		
63	0.50	8.00	1.00	3.33	1.82		

TABLE 4

TEST DATA FOR NI ZN CELLS

Cell Number: NL-2
Cell Weight: 0.565 lbs.
N/P Ratio: 2.5/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOCV	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	1.00	13.4	1.25	8.23	1.94		12.0
2	0.825	14.0	1.25	9.83	1.96		
3	0.950	15.4	2.00	10.20	2.14	7.3	
4	0.815	11.1	2.00	9.17	1.96		13.0
5	0.670	11.4	10.00	6.97	1.90		10.4
6	0.900	16.4	10.00	6.50	1.88	11.0	
7	0.800	13.0	1.30	8.40	1.88		
8	0.800	13.20	1.30	8.45	1.88		16.0
9	1.00	6.25	5.00	N O T	R E C O R D E D		
10	1.00	10.00	5.00	N O T	R E C O R D E D		
11	1.00	10.00	5.00	5.91	1.84		
12	1.00	10.00	5.00	5.97	1.85		
13	1.00	10.00	5.00	5.78	1.86		
14	1.00	10.00	5.00	5.90	1.86		
15	1.00	10.00	5.00	5.31	1.87		
16	1.00	10.00	5.00	5.75	1.86		
17	1.00	10.00	5.00	5.55	1.87		
18	1.00	10.00	5.00	5.38	1.86		
19	1.00	10.00	5.00	5.15	1.86		
20	1.00	10.00	5.00	4.54	1.86		
21	1.00	10.00	5.00	4.39	1.84		
22	1.00	10.00	5.00	4.36	1.84		
23	1.00	10.00	5.00	4.39	1.85		
24	1.00	10.00	5.00	4.34	1.84		
25	1.00	10.00	5.00	4.22	1.85		
26	1.00	10.00	5.00	4.12	1.84		
27	1.00	6.25	5.00	3.90	1.84		
28	RECONDITIONING		CYCLE				
29	0.88	14.22	1.30	5.53	1.82	7.3	
30	0.96	13.44	1.30	3.64	1.82		14.8
31	0.60	11.40	1.3	4.12	1.82		16.5
32	0.40	16.00	1.30	4.37	1.82		16.0
33	0.52	4.94	4.68	2.78	1.82		
34	0.52	4.94	4.68	3.05	1.83		
35	0.52	4.94	4.68	3.08	1.83		
36	0.52	4.94	4.68	2.96	1.82		
37	0.52	4.94	4.68	2.93	1.82		
38	0.52	4.94	4.68	2.89	1.82		
39	0.52	4.94	4.68	2.87	1.82		
40	0.52	4.94	4.68	2.97	1.83		
41	0.52	4.94	4.68	2.91	1.84		
42	0.52	4.94	4.68	3.03	1.83		
43	0.52	4.94	4.68	3.04	1.84		
44	0.52	4.94	4.68	3.10	1.83		
45	0.52	4.94	4.68	2.98	1.84		
46-58	0.52	4.94	4.68	N O T	R E C O R D E D		
59	0.52	4.94	4.68	2.90	1.85		
60	RECONDITIONING		CYCLE				
61	0.60	10.30	1.30	2.93	1.82	8.0	
62	0.70	13.07	1.00	3.17	1.82		
63	0.50	8.00	1.00	3.08	1.83		

TABLE 5

TEST DATA FOR NI ZN CELLS

Cell Number: NL-3
Cell Weight: 0.566 lbs.
N/P Ratio: 2.5/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	1.00	13.4	1.25	7.90	1.949		14.0
2	0.825	14.0	1.25	9.65	1.990		
3	0.950	15.4	2.00	10.17	2.27	8.8	
4	0.815	11.1	2.00	9.23	2.21		14.5
5	0.670	11.4	10.00	6.50	1.97		11.9
6	0.900	16.4	10.00	5.90	1.89	11.6	
7	0.800	13.0	1.30	8.18	1.91		
8	0.800	13.20	1.30	8.32	1.87		18.0
9	1.00	6.25	5.00	N O T	R E C O R D E D		
10	1.00	10.00	5.00	N O T	R E C O R D E D		
11	1.00	10.00	5.00	5.81	1.85		
12	1.00	10.00	5.00	6.09	1.86		
13	1.00	10.00	5.00	5.77	1.87		
14	1.00	10.00	5.00	5.99	1.87		
15	1.00	10.00	5.00	5.21	1.88		
16	1.00	10.00	5.00	5.56	1.87		
17	1.00	10.00	5.00	5.10	1.86		
18	1.00	10.00	5.00	5.00	1.87		
19	1.00	10.00	5.00	4.77	1.86		
20	1.00	10.00	5.00	4.26	1.87		
21	1.00	10.00	5.00	4.10	1.86		
22	1.00	10.00	5.00	3.99	1.85		
23	1.00	10.00	5.00	3.95	1.86		
24	1.00	10.00	5.00	3.95	1.84		
25	1.00	10.00	5.00	3.78	1.84		
26	1.00	10.00	5.00	3.66	1.84		
27	1.00	6.25	5.00	3.50	1.85		
28	RECONDITIONING		CYCLE				
29	0.88	14.22	1.30	5.63	1.82	0.9	
30	0.96	13.44	1.30	3.51	1.81		16.3
31	0.60	11.40	1.3	3.68	1.81		18.0
32	0.40	16.00	1.30	4.36	1.82		17.1
33	0.52	4.94	4.68	2.40	1.81		
34	0.52	4.94	4.68	2.79	1.82		
35	0.52	4.94	4.68	2.70	1.82		
36	0.52	4.94	4.68	2.82	1.82		
37	0.52	4.94	4.68	2.75	1.81		
38	0.52	4.94	4.68	2.92	1.83		
39	0.52	4.94	4.68	2.75	1.82		
40	0.52	4.94	4.68	2.66	1.82		
41	0.52	4.94	4.68	2.61	1.82		
42	0.52	4.94	4.68	2.84	1.83		
43	0.52	4.94	4.68	2.77	1.82		
44	0.52	4.94	4.68	2.83	1.82		
45	0.52	4.94	4.68	2.72	1.82		
46-58	0.52	4.94	4.68	N O T	R E C O R D E D		
59	0.52	4.94	4.68	2.44	1.82		
60	RECONDITIONING		CYCLE				
61	0.60	10.30	1.30	2.86	1.81	8.6	
62	0.70	13.07	1.00	3.17	1.82		
63	0.50	8.00	1.00	3.00	1.82		

TABLE 6

TEST DATA FOR NI ZN CELLS

Cell Number: NL-4
Cell Weight: 0.599 lbs.
N/P Ratio: 3.5/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	1.00	13.4	1.25	7.79	1.95		14.0
2	0.825	14.0	1.25	9.31	1.96		
3	0.950	15.4	2.00	9.47	1.99	9.2	
4	0.815	11.1	2.00	8.73	2.01		15.5
5	0.670	11.4	10.00	5.05	1.97		14.0
6	0.900	16.4	10.00	5.10	1.87	12.4	
7	0.800	13.0	1.30	8.00	1.86		
8	0.800	13.20	1.30	8.32	1.93		17.0
9	1.00	6.25	5.00	NOT	RECORDED		
10	1.00	10.00	5.00	NOT	RECORDED		
11	1.00	10.00	5.00	6.81	1.91		
12	1.00	10.00	5.00	6.61	1.89		
13	1.00	10.00	5.00	5.67	1.91		
14	1.00	10.00	5.00	5.92	1.89		
15	1.00	10.00	5.00	5.13	1.90		
16	1.00	10.00	5.00	5.45	1.89		
17	1.00	10.00	5.00	5.15	1.90		
18	1.00	10.00	5.00	5.03	1.89		
19	1.00	10.00	5.00	4.87	1.88		
20	1.00	10.00	5.00	4.34	1.88		
21	1.00	10.00	5.00	4.15	1.86		
22	1.00	10.00	5.00	4.08	1.87		
23	1.00	10.00	5.00	4.08	1.88		
24	1.00	10.00	5.00	4.06	1.86		
25	1.00	10.00	5.00	3.88	1.86		
26	1.00	10.00	5.00	3.81	1.84		
27	1.00	6.25	5.00	3.63	1.86		
28	RECONDITIONING		CYCLE				
29	0.88	14.22	1.30	6.39	1.86	7.0	
30	0.96	13.44	1.30	5.53	1.84		23.0
31	0.60	11.40	1.3	5.53	1.84		22.7
32	0.40	16.00	1.30	5.74	1.85		22.7
33	0.52	4.94	4.68	2.94	1.83		
34	0.52	4.94	4.68	2.93	1.84		
35	0.52	4.94	4.68	2.91	1.84		
36	0.52	4.94	4.68	2.92	1.83		
37	0.52	4.94	4.68	2.92	1.84		
38	0.52	4.94	4.68	2.82	1.84		
39	0.52	4.94	4.68	2.84	1.84		
40	0.52	4.94	4.68	2.85	1.84		
41	0.52	4.94	4.68	2.66	1.84		
42	0.52	4.94	4.68	2.64	1.84		
43	0.52	4.94	4.68	2.62	1.83		
44	0.52	4.94	4.68	2.75	1.84		
45	0.52	4.94	4.68	2.60	1.84		
46-58	0.52	4.94	4.68	NOT	RECORDED		
59	0.52	4.94	4.68	2.34	1.83		
60	RECONDITIONING		CYCLE				
61	0.60	10.30	1.30	2.99	1.82	8.0	
62	0.70	13.07	1.00	3.33	1.81		
63	0.50	8.00	1.00	3.50	1.82		

TABLE 7

TEST DATA FOR NI ZN CELLS

Cell Number. NL-5
Cell Weight: 0.602 lbs.
N/P Ratio: 3.5/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ).
1	1.00	13.4	1.25	7.40	1.95		16.0
2	0.825	14.0	1.25	9.29	1.97		
3	0.950	15.4	2.00	9.53	2.03	10.5	
4	0.815	11.1	2.00	8.70	2.04		18.0
5	0.670	11.4	10.00	4.32	2.02		15.8
6	0.900	16.4	10.00	4.27	1.87	15.0	
7	0.800	13.0	1.30	5.70	1.91		
8	0.800	13.20	1.30	7.45	1.88		21.5
9	1.00	6.25	5.00	NOT	RECORDED		
10	1.00	10.00	5.00	NOT	RECORDED		
11	1.00	10.00	5.00	5.71	1.86		
12	1.00	10.00	5.00	5.77	1.87		
13	1.00	10 00	5.00	4.56	1.88		
14	1.00	10.00	5.00	4.83	1.86		
15	1.00	10.00	5.00	3.92	1.86		
16	1.00	10.00	5.00	4.35	1.86		
17	1.00	10.00	5.00	4.09	1.85		
18	1.00	10.00	5.00	4.07	1.85		
19	1.00	10.00	5.00	3.92	1.85		
20	1.00	10.00	5.00	3.39	1.85		
21	1.00	10.00	5.00	3.29	1.85		
22	1.00	10.00	5.00	3.24	1.85		
23	1.00	10.00	5.00	3.27	1.86		
24	1.00	10.00	5.00	3.26	1.86		
25	1.00	10.00	5.00	3.09	1.86		
26	1.00	10.00	5.00	3.07	1.84		
27	00	6.25	5.00	2.97	1.86		
28	RECONDITIONING		CYCLE				
29	0.88	14.22	1.30	5.31	1.84	7.7	
30	0.96	13.44	1.30	5.40	1.82		21.5
31	0.60	11.40	1.3	3.53	1.82		22.6
32	0.40	16.00	1.30	5.86	1.85		21.0
33	0.52	4.94	4.68	2.27	1.82		
34	0.52	4.94	4.68	2.45	1.83		
35	0.52	4.94	4.68	2.53	1.83		
36	0.52	4.94	4.68	2.62	1.84		
37	0.52	4.94	4.68	2.57	1.83		
38	0.52	4.94	4.68	2.66	1.84		
39	0.52	4.94	4.68	2.61	1.83		
40	0.52	4.94	4.68	2.77	1.84		
41	0.52	4.94	4.68	2.63	1.84		
42	0.52	4.94	4.68	2.53	1.84		
43	0.52	4.94	4.68	2.60	1.84		
44	0.52	4.94	4.68	2.72	1.84		
45	0.52	4.94	4.68	2.62	1.85		
46-58	0.52	4.94	4.68	NOT	RECORDED		
59	0.52	4.94	4.68	2.29	1.84		
60	RECONDITIONING		CYCLE				
61	0.60	10.30	1.30	2.71	1.82	8.6	
62	0.70	13.07	1.00	3.00	1.81		
63	0.50	8.00	1.00	2.58	1.82		

TABLE 8

TEST DATA FOR NI ZN CELLS

Cell Number: NL-6
Cell Weight: 0.606 lbs.
N/P Ratio: 3.5/1

Cycle#	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	1.00	13.4	1.25	7.46	1.95		14.0
2	0.825	14.0	1.25	9.21	1.96		
3	0.950	15.4	2.00	9.40	2.00	9.0	
4	0.815	11.1	2.00	8.73	2.03		15.5
5	0.670	11.4	10.00	6.18	1.93		12.4
6	0.900	16.4	10.00	4.90	1.92	13.5	
7	0.800	13.0	1.30	7.09	1.93		
8	0.800	13.20	1.30	7.80	1.93		18.0
9	1.00	6.25	5.00	NOT	RECORDED		
10	1.00	10.00	5.00	NOT	RECORDED		
11	1.00	10.00	5.00	6.10	1.94		
12	1.00	10.00	5.00	6.15	1.92		
13	1.00	10.00	5.00	4.72	1.91		
14	1.00	10.00	5.00	4.99	1.88		
15	1.00	10.00	5.00	4.21	1.89		
16	1.00	10.00	5.00	4.52	1.87		
17	1.00	10.00	5.00	4.21	1.88		
18	1.00	10.00	5.00	4.17	1.87		
19	1.00	10.00	5.00	4.13	1.85		
20	1.00	10.00	5.00	3.79	1.86		
21	1.00	10.00	5.00	3.61	1.86		
22	1.00	10.00	5.00	3.56	1.86		
23	1.00	10.00	5.00	3.51	1.86		
24	1.00	10.00	5.00	3.44	1.84		
25	1.00	10.00	5.00	3.36	1.85		
26	1.00	10.00	5.00	3.29	1.85		
27	1.00	6.25	5.00	3.17	1.86		
28	RECONDITIONING		CYCLE				
29	0.88	14.22	1.30	5.96	1.86	7.0	
30	0.96	13.44	1.30	5.09	1.84		24.2
31	0.60	11.40	1.3	5.20	1.84		23.6
32	0.40	16.00	1.30	5.74	1.84		24.2
33	0.52	4.94	4.68	3.00	1.83		
34	0.52	4.94	4.68	3.04	1.83		
35	0.52	4.94	4.68	3.04	1.84		
36	0.52	4.94	4.68	3.00	1.84		
37	0.52	4.94	4.68	3.01	1.84		
38	0.52	4.94	4.68	2.93	1.84		
39	0.52	4.94	4.68	2.94	1.85		
40	0.52	4.94	4.68	2.92	1.85		
41	0.52	4.94	4.68	2.82	1.85		
42	0.52	4.94	4.68	2.80	1.84		
43	0.52	4.94	4.68	2.79	1.84		
44	0.52	4.94	4.68	2.80	1.84		
45	0.52	4.94	4.68	2.68	1.84		
46-58	0.52	4.94	4.68	NOT	RECORDED		
59	0.52	4.94	4.68	2.29	1.84		
60	RECONDITIONING		CYCLE				
61	0.60	10.30	1.30	2.86	1.81	8.3	
62	0.70	13.07	1.00	3.50	1.82		
63	0.50	8.00	1.00	2.92	1.80		

TABLE 9

TEST DATA FOR NI ZN CELLS

Cell Number: NL-7
Cell Weight: 0.627 lbs.
N/P Ratio: 4.5/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	1.00	13.4	1.25	7.92	1.94		12.5
2	0.825	14.0	1.25	9.58	1.95		
3	0.950	15.4	2.00	10.17	1.96	7.7	
4	0.815	11.1	2.00	9.17	1.95		12.5
5	0.670	11.4	10.00	7.88	1.94		11.0
6	0.900	16.4	10.00	8.03	1.93	10.9	
7	0.800	13.0	1.30	9.24	1.93		
8	0.800	13.20	1.30	9.97	1.98		13.0
9	1.00	6.25	5.00	NOT	RECORDED		
10	1.00	10.00	5.00	NOT	RECORDED		
11	1.00	10.00	5.00	8.12	1.98		
12	1.00	10.00	5.00	8.18	2.03		
13	1.00	10.00	5.00	6.89	2.03		
14	1.00	10.00	5.00	7.28	1.96		
15	1.00	10.00	5.00	6.30	1.97		
16	1.00	10.00	5.00	6.92	1.92		
17	1.00	10.00	5.00	6.52	1.93		
18	1.00	10.00	5.00	6.51	1.92		
19	1.00	10.00	5.00	6.35	1.91		
20	1.00	10.00	5.00	5.61	1.91		
21	1.00	10.00	5.00	5.32	1.91		
22	1.00	10.00	5.00	5.12	1.90		
23	1.00	10.00	5.00	5.10	1.88		
24	1.00	10.00	5.00	5.07	1.88		
25	1.00	10.00	5.00	4.86	1.88		
26	1.00	10.00	5.00	4.76	1.87		
27	1.00	6.25	5.00	4.41	1.88		
28	RECONDITIONING		CYCLE				
29	0.88	14.22	1.30	8.02	1.85	6.7	
30	0.96	13.44	1.30	4.98	1.83		18.4
31	0.60	11.40	1.3	5.85	1.84		19.2
32	0.40	16.00	1.30	6.11	1.84		18.4
33	0.52	4.94	4.68	3.30	1.82		
34	0.52	4.94	4.68	3.50	1.84		
35	0.52	4.94	4.68	3.46	1.84		
36	0.52	4.94	4.68	3.52	1.84		
37	0.52	4.94	4.68	3.47	1.84		
38	0.52	4.94	4.68	3.49	1.85		
39	0.52	4.94	4.68	3.61	1.85		
40	0.52	4.94	4.68	3.54	1.85		
41	0.52	4.94	4.68	3.44	1.85		
42	0.52	4.94	4.68	3.55	1.86		
43	0.52	4.94	4.68	3.48	1.84		
44	0.52	4.94	4.68	3.39	1.84		
45	0.52	4.94	4.68	3.10	1.84		
46-58	0.52	4.94	4.68	NOT	RECORDED		
59	0.52	4.94	4.68	2.55	1.82		
60	RECONDITIONING		CYCLE				
61	0.60	10.30	1.30	4.23	1.84	7.8	
62	0.70	13.07	1.00	4.92	1.83		
63	0.50	8.00	1.00	3.75	1.83		

TABLE 10

TEST DATA FOR NI ZN CELLS

Cell Number: NL-8
Cell Weight: 0.630 lbs.
N/P Ratio: 4.5/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	1.00	13.4	1.25	7.90	1.94		12.5
2	0.825	14.0	1.25	9.92	1.94		
3	0.950	15.4	2.00	10.26	1.97	7.7	
4	0.815	11.1	2.00	9.60	1.97		12.5
5	0.670	11.4	10.00	7.10	1.96		11.0
6	0.900	16.4	10.00	7.37	1.94	11.3	
7	0.800	13.0	1.30	8.70	1.94		
8	0.800	13.20	1.30	9.51	1.95		13.0
9	1.00	6.25	5.00	NOT	RECORDED		
10	1.00	10.00	5.00	NOT.	RECORDED		
11	1.00	10.00	5.00	7.27	2.05		
12	1.00	10.00	5.00	7.45	1.95		
13	1.00	10.00	5.00	6.48	1.95		
14	1.00	10.00	5.00	6.68	1.91		
15	1.00	10.00	5.00	5.76	1.92		
16	1.00	10.00	5.00	6.26	1.89		
17	1.00	10.00	5.00	5.94	1.89		
18	1.00	10.00	5.00	5.87	1.89		
19	1.00	10.00	5.00	5.68	1.89		
20	1.00	10.00	5.00	4.95	1.90		
21	1.00	10.00	5.00	4.81	1.88		
22	1.00	10.00	5.00	4.70	1.87		
23	1.00	10.00	5.00	4.59	1.87		
24	1.00	10.00	5.00	4.53	1.86		
25	1.00	10.00	5.00	4.35	1.87		
26	1.00	10.00	5.00	4.37	1.86		
27	1.00	6.25	5.00	4.01	1.87		
28	RECONDITIONING		CYCLE				
29	0.88	14.22	1.30	5.63	1.83	6.6	
30	0.96	13.44	1.30	3.62	1.81		15.5
31	0.60	11.40	1.30	3.79	1.81		17.7
32	0.40	16.00	1.30	3.77	1.81		16.4
33	0.52	4.94	4.68	2.46	1.82		
34	0.52	4.94	4.68	2.56	1.81		
35	0.52	4.94	4.68	2.81	1.81		
36	0.52	4.94	4.68	2.92	1.82		
37	0.52	4.94	4.68	3.02	1.83		
38	0.52	4.94	4.68	2.99	1.83		
39	0.52	4.94	4.68	2.82	1.82		
40	0.52	4.94	4.68	2.99	1.82		
41	0.52	4.94	4.68	2.97	1.83		
42	0.52	4.94	4.68	3.08	1.83		
43	0.52	4.94	4.68	3.15	1.83		
44	0.52	4.94	4.68	3.03	1.82		
45	0.52	4.94	4.68	2.97	1.83		
46-58	0.52	4.94	4.68	NOT	RECORDED		
59	0.52	4.94	4.68	2.53	1.82		
60	RECONDITIONING		CYCLE				
61	0.60	10.30	1.30	2.82	1.82	8.2	
62	0.70	13.07	1.00	3.17	1.80		
63	0.50	8.00	1.00	2.83	1.81		

TABLE 11

TEST DATA FOR NI ZN CELLS

Cell Number: NL-9
Cell Weight: 0.630 lbs.
N/P Ratio: 4.5/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	1.00	13.4	1.25	8.06	1.94		11.5
2	0.825	14.0	1.25	9.83	1.95		
3	0.950	15.4	2.00	10.23	1.96	7.3	
4	0.815	11.1	2.00	9.43	1.96		11.5
5	0.670	11.4	10.00	7.42	1.95		10.5
6	0.900	16.4	10.00	8.40	1.95	10.0	
7	0.800	13.0	1.30	9.09	1.99		
8	0.800	13.20	1.30	9.97	1.97		11.5
9	1.00	6.25	5.00	NOT	RECORDED		
10	1.00	10.00	5.00	NOT	RECORDED		
11	1.00	10.00	5.00	8.01	1.98		
12	1.00	10.00	5.00	8.00	1.99		
13	1.00	10.00	5.00	6.85	2.01		
14	1.00	10.00	5.00	6.99	1.94		
15	1.00	10.00	5.00	6.17	1.93		
16	1.00	10.00	5.00	6.63	1.92		
17	1.00	10.00	5.00	6.38	1.92		
18	1.00	10.00	5.00	6.29	1.91		
19	1.00	10.00	5.00	6.10	1.92		
20	1.00	10.00	5.00	5.19	1.92		
21	1.00	10.00	5.00	4.95	1.90		
22	1.00	10.00	5.00	4.88	1.89		
23	1.00	10.00	5.00	4.82	1.88		
24	1.00	10.00	5.00	4.82	1.87		
25	1.00	10.00	5.00	4.64	1.86		
26	1.00	10.00	5.00	4.58	1.87		
27	1.00	6.25	5.00	4.32	1.87		
28	RECONDITIONING		CYCLE				
29	0.88	14.22	1.30	8.56	1.85	6.3	
30	0.96	13.44	1.30	5.42	1.83		17.0
31	0.60	11.40	1.3	5.20	1.83		18.5
32	0.40	16.00	1.30	6.07	1.83		18.2
33	0.52	4.94	4.68	3.05	1.82		
34	0.52	4.94	4.68	3.39	1.83		
35	0.52	4.94	4.68	3.37	1.83		
36	0.52	4.94	4.68	3.44	1.84		
37	0.52	4.94	4.68	3.40	1.84		
38	0.52	4.94	4.68	3.39	1.84		
39	0.52	4.94	4.68	3.28	1.84		
40	0.52	4.94	4.68	3.48	1.84		
41	0.52	4.94	4.68	3.35	1.84		
42	0.52	4.94	4.68	3.50	1.85		
43	0.52	4.94	4.68	3.51	1.84		
44	0.52	4.94	4.68	3.51	1.83		
45	0.52	4.94	4.68	3.32	1.84		
46-58	0.52	4.94	4.68	NOT	RECORDED		
59	0.52	4.94	4.68	3.46	1.86		
60	RECONDITIONING		CYCLE				
61	0.60	10.30	1.30	4.16	1.84	6.8	
62	0.70	13.07	1.00	4.75	1.85		
63	0.50	8.00	1.00	3.75	1.83		

Appendix III. TEST DATA FOR CELLS USING A MODIFIED CYCLE REGIME.

TABLE 12

TEST DATA FOR NI ZN CELLS

Cell Number: MT-1
Cell Weight: 0.504 lbs.
N/P Ratio: 3.77/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.290	6.96	1.00	3.50	1.86	25.2	
2	0.550	8.23	1.00	5.68	1.92	20.6	34.0
3	0.500	8.75	1.00	6.62	1.94		27.6
4	1.150	4.76	2.40	4.20	1.92	VOLTAGE TERM. CHARGE	
5	1.150	4.0	2.40	3.97	1.92		
6	1.150	3.88	2.40	3.84	1.92		
7	1.150	3.71	2.40	3.70	1.92		
8	1.150	3.67	2.40	3.67	1.92		
9	1.150	3.65	2.40	3.56	1.92		
10	1.150	3.34	2.40	3.31	1.92		
11	1.150	2.97	2.40	3.01	1.92		
12	1.150	3.08	2.40	3.08	1.92		
13	1.150	3.19	2.40	3.17	1.92		
14	1.150	3.17	2.40	3.17	1.92		
15	1.150	3.07	2.40	2.84	1.92		
16	1.150	2.78	2.40	2.78	1.92		
17	1.150	2.57	2.40	2.57	1.92		
18	1.150	2.55	2.40	2.55	1.92		
19	1.150	2.57	2.40	2.57	1.92		
20	1.150	2.68	2.40	2.68	1.92		
21	1.150	2.57	2.40	2.57	1.92		
22	1.150	2.37	2.40	2.37	1.92		
23	1.150	2.21	2.40	2.18	1.92		
24	1.150	2.16	2.40	2.11	1.92		
25	1.150	2.09	2.40	2.07	1.92		
26	1.150	2.08	2.40	2.02	1.92		
27	1.150	2.02	2.40	1.99	1.92		
28	1.150	2.04	2.40	1.99	1.92		
29	1.150	1.97	2.40	1.90	1.92		
30	1.150	1.88	2.40	1.85	1.92		
31	1.150	1.83	2.40	1.80	1.92		
32	1.150	1.94	2.40	1.90	1.92		
33	1.150	1.91	2.40	1.83	1.92		
34	RECONDITIONING		CYCLE				
35	0.470	8.81	1.00	4.50	1.87		29.0
36	0.520	9.10	1.00	4.06	1.83		
37	0.580	10.43	1.00	3.57	1.82		
38	1.150	8.30	1.00	2.33	1.83		
39	1.150	8.30	1.00	2.33	1.81		
40	1.150	8.30	1.00	1.04	1.88		
41	1.150	7.04	2.40	1.95	1.80		
42	1.150	7.04	2.40	1.51	1.80		
43	1.150	7.04	2.40	1.59	1.80		
44	1.150	7.04	2.40	1.32	1.80		26.0
45	1.150	7.04	2.40	1.44	1.82		
46	1.150	7.04	2.40	1.42	1.80		
47	1.150	7.04	2.40	1.27	1.78		
48	1.150	7.04	2.40	1.15	1.75		
49	1.150	7.04	2.40	1.12	1.78		
50	1.150	7.04	2.40	0.912	1.80		
51	1.150	7.04	2.40	0.768	1.80		
52	1.150	7.04	2.40	0.840	1.81		
53	1.150	7.04	2.40	0.840	1.81		
54	1.150	7.04	2.40	0.774	1.78		
55	1.150	7.04	2.40	0.768	1.81		
56	1.150	7.04	2.40	0.744	1.80		
57	1.150	7.04	2.40	0.744	1.81		
58	1.150	7.04	2.40	0.744	1.80		
59	1.150	7.04	2.40	0.744	1.80		
60	1.150	7.04	2.40	0.720	1.80		
61	1.150	7.04	2.40	0.792	1.80		
62	1.150	7.04	2.40	0.792	1.79		
63	1.150	7.04	2.40	0.792	1.80		
64	1.150	7.04	2.40	0.744	1.81		
65	1.150	7.04	2.40	0.696	1.76		
66	1.150	7.04	2.40	0.672	1.81		
67	1.150	7.04	2.40	0.600	1.78		
68	1.150	7.04	2.40	0.672	1.80		
69	1.150	7.04	2.40	0.672	1.79		
70	1.150	7.04	2.40	0.552	1.77		
71-75	1.150	7.04	2.40	NOT	RECORDED		
76	RECONDITIONING		CYCLE				53.0
77	0.500	8.00	0.800	2.46	1.85		
78	0.500	8.00	0.800	2.53	1.85		
79	0.600	10.80	0.800	2.20	1.85		

TABLE 13

TEST DATA FOR NI ZN CELLS

Cell Number: MT-2
Cell Weight: 0.509 lbs.
N/P Ratio: 3.77/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.290	6.96	1.00	3.63	1.87	27.5	
2	0.550	8.23	1.00	5.63	1.94	25.6	37.0
3	0.500	8.75	1.00	6.40	1.94		29.1
4	1.150	4.30	2.40	3.51	1.92	VOLTAGE TERM.	CHARGE
5	1.150	4.00	2.40	3.97	1.92		
6	1.150	3.88	2.40	3.84	1.92		
7	1.150	3.12	2.40	3.12	1.92		
8	1.150	3.12	2.40	3.12	1.92		
9	1.150	3.09	2.40	3.98	1.92		
10	1.150	2.84	2.40	2.84	1.92		
11	1.150	2.34	2.40	2.84	1.92		
12	1.150	2.68	2.40	2.64	1.92		
13	1.150	2.76	2.40	2.75	1.92		
14	1.150	2.81	2.40	2.81	1.92		
15	1.150	2.76	2.40	2.53	1.92		
16	1.150	2.49	2.40	2.48	1.92		
17	1.150	2.39	2.40	2.39	1.92		
18	1.150	2.37	2.40	2.37	1.92		
19	1.150	2.48	2.40	2.48	1.92		
20	1.150	2.65	2.40	2.65	1.92		
21	1.150	2.53	2.40	2.53	1.92		
22	1.150	2.37	2.40	2.37	1.92		
23	1.150	2.21	2.40	2.18	1.92		
24	1.150	2.16	2.40	2.11	1.92		
25	1.150	2.09	2.40	2.07	1.92		
26	1.150	2.08	2.40	2.02	1.92		
27	1.150	2.02	2.40	1.99	1.92		
28	1.150	2.04	2.40	1.90	1.92		
29	1.150	1.91	2.40	1.83	1.92		
30	1.150	1.88	2.40	1.85	1.92		
31	1.150	1.83	2.40	1.80	1.92		
32	1.150	1.94	2.40	1.90	1.92		
33	1.150	1.91	2.40	1.83	1.92		
34	RECONDITIONING		CYCLE				29.5
35	0.470	8.81	1.00	5.29	1.87		
36	0.520	9.10	1.00	5.04	1.86		
37	0.580	10.43	1.00	5.56	1.84		
38	1.150	8.30	1.00	4.07	1.88		
39	1.150	8.30	1.00	4.13	1.89		
40	1.150	8.30	1.00	3.47	1.80		
41	1.150	7.04	2.40	3.41	1.86		
42	1.150	7.04	2.40	3.17	1.86		
43	1.150	7.04	2.40	3.07	1.87		
44	1.150	7.04	2.40	2.93	1.86		24.0
45	1.150	7.04	2.40	3.00	1.87		
46	1.150	7.04	2.40	2.83	1.86		
47	1.150	7.04	2.40	2.68	1.86		
48	1.150	7.04	2.40	2.05	1.85		
49	1.150	7.04	2.40	1.78	1.84		
50	1.150	7.04	2.40	1.20	1.80		
51	1.150	7.04	2.40	0.984	1.80		
52	1.150	7.04	2.40	0.984	1.80		
53	1.150	7.04	2.40	1.008	1.79		
54	1.150	7.04	2.40	0.984	1.80		
55	1.150	7.04	2.40	0.960	1.81		
56	1.150	7.04	2.40	0.912	1.79		
57	1.150	7.04	2.40	0.936	1.81		
58	1.150	7.04	2.40	0.912	1.79		
59	1.150	7.04	2.40	0.936	1.80		
60	1.150	7.04	2.40	0.912	1.81		
61	1.150	7.04	2.40	0.984	1.80		
62	1.150	7.04	2.40	1.008	1.79		
63	1.150	7.04	2.40	0.960	1.79		
64	1.150	7.04	2.40	0.864	1.81		
65	1.150	7.04	2.40	0.888	1.79		
66	1.150	7.04	2.40	0.840	1.80		
67	1.150	7.04	2.40	0.744	1.80		
68	1.150	7.04	2.40	0.696	1.80		
69	1.150	7.04	2.40	0.696	1.78		
70	1.150	7.04	2.40	0.720	1.80		
71-75	1.150	7.04	2.40	NOT	RECORDED		40.0
76	RECONDITIONING		CYCLE				
77	0.500	8.00	0.800	1.27	1.82		
78	0.500	8.00	0.800	1.20	1.81		
79	0.600	10.80	0.800	1.47	1.82		

TABLE 14

TEST DATA FOR NI ZN CELLS

Cell Number: MT-3
Cell Weight: 0.501 lbs.
N/P Ratio: 3.77/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.290	6.96	1.00	3.67	1.86	23.6	
2	0.550	8.23	1.00	5.52	1.92	18.6	32.0
3	0.500	8.75	1.00	6.22	1.93		26.0
4	1.150	4.30	2.40	3.55	1.92	VOLTAGE TERM.	CHARGE
5	1.150	3.45	2.40	3.34	1.92		
6	1.150	3.88	2.40	3.84	1.92		
7	1.150	3.29	2.40	3.28	1.92		
8	1.150	3.29	2.40	3.28	1.92		
9	1.150	3.24	2.40	3.17	1.92		
10	1.150	3.04	2.40	3.01	1.92		
11	1.150	2.97	2.40	3.01	1.92		
12	1.150	2.90	2.40	2.87	1.92		
13	1.150	2.90	2.40	2.90	1.92		
14	1.150	2.95	2.40	2.95	1.92		
15	1.150	2.92	2.40	2.64	1.92		
16	1.150	2.64	2.40	2.64	1.92		
17	1.150	2.57	2.40	2.57	1.92		
18	1.150	2.57	2.40	2.57	1.92		
19	1.150	2.57	2.40	2.57	1.92		
20	1.150	2.65	2.40	2.65	1.92		
21	1.150	2.57	2.40	2.57	1.92		
22	1.150	2.37	2.40	2.37	1.92		
23	1.150	2.21	2.10	2.18	1.92		
24	1.150	2.16	2.40	2.14	1.92		
25	1.150	2.09	2.40	2.07	1.92		
26	1.150	2.08	2.40	2.02	1.92		
27	1.150	2.02	2.40	1.99	1.92		
28	1.150	2.04	2.40	1.99	1.92		
29	1.150	1.97	2.40	1.95	1.92		
30	1.150	1.95	2.40	1.95	1.92		
31	1.150	1.83	2.40	1.80	1.92		
32	1.150	1.94	2.40	2.02	1.92		
33	1.150	1.91	2.40	1.90	1.92		
34	RECONDITIONING		CYCLE				26.8
35	0.470	8.81	1.00	5.67	1.92		
36	0.520	9.10	1.00	4.75	1.90		
37	0.580	10.43	1.00	3.77	1.83		
38	1.150	8.30	1.00	2.39	1.81		
39	1.150	8.30	1.00	2.01	1.84		
40	1.150	8.30	1.00	1.52	1.80		
41	1.150	7.04	2.40	1.87	1.81		
42	1.150	7.04	2.40	1.61	1.79		
43	1.150	7.04	2.40	1.59	1.79		
44	1.150	7.04	2.40	1.54	1.82		34.5
45	1.150	7.04	2.40	1.51	1.82		
46	1.150	7.04	2.40	1.49	1.79		
47	1.150	7.04	2.40	1.44	1.82		
48	1.150	7.04	2.40	1.26	1.81		
49	1.150	7.04	2.40	1.13	1.80		
50	1.150	7.04	2.40	1.008	1.77		
51	1.150	7.04	2.40	0.912	1.79		
52	1.150	7.04	2.40	0.984	1.80		
53	1.150	7.04	2.40	0.912	1.79		
54	1.150	7.04	2.40	0.840	1.78		
55	1.150	7.04	2.40	0.864	1.80		
56	1.150	7.04	2.40	0.888	1.78		
57	1.150	7.04	2.40	0.864	1.77		
58	1.150	7.04	2.40	0.912	1.78		
59	1.150	7.04	2.40	0.864	1.78		
60	1.150	7.04	2.40	0.864	1.77		
61	1.150	7.04	2.40	0.936	1.77		
62	1.150	7.04	2.40	0.960	1.77		
63	1.150	7.04	2.40	0.960	1.78		
64	1.150	7.04	2.40	0.864	1.78		
65	1.150	7.04	2.40	0.912	1.78		
66	1.150	7.04	2.40	0.864	1.97		
67	1.150	7.04	2.40	0.768	1.78		
68	1.150	7.04	2.40	0.768	1.78		
69	1.150	7.04	2.40	0.768	1.77		
70	1.150	7.04	2.40	0.840	1.77		
71-75	1.150	7.04	2.40	NOT	RECORDED		
76	RECONDITIONING		CYCLE				54.0
77	0.500	8.00	0.800	0.870	1.81		
78	0.500	8.00	0.800	1.140	1.82		
79	0.600	10.80	0.800	1.330	1.82		

TABLE 15

TEST DATA FOR NI ZN CELLS

Cell Number: MT-4
Cell Weight: 0.507 lbs.
N/P Ratio: 3.77/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.290	6.96	1.00	3.25	1.87	26.3	[illegible]
2	0.550	8.25	1.00	5.47	1.92	21.0	39.0
3	0.500	8.25	1.00	6.60	1.93		27.1
4	1.150	4.26	2.40	4.20	[illegible]		
5	1.150	4.00	2.40	3.97	1.93		
6	1.150	3.88	2.40	3.84	1.92		
7	1.150	3.77	2.40	3.75	1.93		
8	1.150	3.77	2.40	3.76	1.92		
9	1.150	3.77	2.40	3.74	1.92		
10	1.150	3.49	2.40	3.48	1.92		
11	1.150	3.45	2.40	3.45	1.92		
12	1.150	3.29	2.40	3.23	1.92		
13	1.150	3.39	2.40	3.37	1.92		
14	1.150	3.42	2.40	3.42	1.92		
15	1.150	3.28	2.40	3.01	1.93		
16	1.150	2.95	2.40	2.95	1.92		
17	1.150	2.57	2.40	2.57	1.92		
18	1.150	2.87	2.40	2.87	1.92		
19	1.150	2.92	2.40	2.92	1.92		
20	1.150	3.15	2.40	3.15	1.92		
21	1.150	2.98	2.40	2.98	1.92		
22	1.150	2.70	2.40	2.70	1.92		
23	1.150	2.47	2.40	2.44	1.93		
24	1.150	2.57	2.40	2.32	1.92		
25	1.150	2.30	2.40	2.21	1.93		
26	1.150	2.23	2.40	2.21	1.92		
27	1.150	2.02	2.40	1.99	1.92		
28	1.150	2.04	2.40	1.99	1.92		
29	1.150	1.97	2.40	1.97	1.92		
30	1.150	2.08	2.40	2.04	1.93		
31	1.150	2.11	2.40	2.04	1.92		
32	1.150	1.94	2.40	1.94	1.92		
33	1.150	2.01	2.40	1.99	1.92		
34	RECONDITIONING		CYCLE				[illegible]
35	0.470	8.81	1.00	5.88	1.92		
36	0.520	9.10	1.00	4.20	1.84		
37	0.580	10.43	1.00	3.27	1.81		
38	1.150	8.30	1.00	2.68	1.83		
39	1.150	8.30	1.00	2.58	1.83		
40	1.150	8.30	1.00	1.98	1.82		
41	1.150	7.04	2.40	2.14	1.80		
42	1.150	7.04	2.40	2.02	1.81		
43	1.150	7.04	2.40	1.97	1.82		
44	1.150	7.04	2.40	1.69	1.82		25.0
45	1.150	7.04	2.40	1.99	1.81		
46	1.150	7.04	2.40	2.04	1.82		
47	1.150	7.04	2.40	2.21	1.83		
48	1.150	7.04	2.40	2.01	1.82		
49	1.150	7.04	2.40	1.86	1.82		
50	1.150	7.04	2.40	1.104	1.78		
51	1.150	7.04	2.40	0.960	1.80		
52	1.150	7.04	2.40	1.008	1.80		
53	1.150	7.04	2.40	1.032	1.81		
54	1.150	7.04	2.40	0.984	1.78		
55	1.150	7.04	2.40	0.960	1.78		
56	1.150	7.04	2.40	0.936	1.79		
57	1.150	7.04	2.40	0.864	1.77		
58	1.150	7.04	2.40	0.912	1.77		
59	1.150	7.04	2.40	0.936	1.81		
60	1.150	7.04	2.40	0.840	1.76		
61	1.150	7.04	2.40	0.936	1.78		
62	1.150	7.04	2.40	0.960	1.77		
63	1.150	7.04	2.40	0.960	1.79		
64	1.150	7.04	2.40	0.917	1.78		
65	1.150	7.04	2.40	0.912	1.78		
66	1.150	7.04	2.40	0.864	1.78		
67	1.150	7.04	2.40	0.744	1.77		
68	1.150	7.04	2.40	0.768	1.78		
69	1.150	7.04	2.40	0.768	1.78		
70	1.150	7.04	2.40	0.816	1.77		
71-75	1.150	7.04	2.40	NOT	RECORDED		60.0
76	RECONDITIONING		CYCLE				
77	0.500	8.00	0.800	0.930	1.82		
78	0.500	8.00	0.800	1.300	1.84		
79	0.600	10.80	0.800	1.600	1.84		

TABLE 16

TEST DATA FOR NI ZN CELLS

Cell Number: MT-5
Cell Weight: 0.503 lbs.
N/P Ratio: 3.77/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.290	6.96	1.00	3.63	1.88	77.0	
2	0.550	8.23	1.00	5.42	1.94	43.5	36.0
3	0.500	8.75	1.00	6.17	1.94		32.0
4	1.150	4.30	2.40	3.55	1.92	VOLTAGE	TERM. CHARGE
5	1.150	3.45	2.40	3.34	1.92		
6	1.150	3.35	2.40	3.27	1.92		
7	1.150	3.18	2.40	3.17	1.92		
8	1.150	3.17	2.40	3.17	1.92		
9	1.150	3.15	2.40	3.06	1.92		
10	1.150	2.94	2.40	2.90	1.92		
11	1.150	2.97	2.40	2.95	1.92		
12	1.150	2.84	2.40	2.78	1.92		
13	1.150	2.81	2.40	2.81	1.92		
14	1.150	2.90	2.40	2.90	1.92		
15	1.150	2.84	2.40	2.62	1.92		
16	1.150	2.59	2.40	2.59	1.92		
17	1.150	2.57	2.40	2.51	1.92		
18	1.150	2.57	2.40	2.55	1.92		
19	1.150	2.57	2.40	2.57	1.92		
20	1.150	2.79	2.40	2.79	1.92		
21	1.150	2.87	2.40	2.83	1.92		
22	1.150	2.60	2.40	2.58	1.92		
23	1.150	2.43	2.40	2.37	1.92		
24	1.150	2.32	2.40	2.21	1.92		
25	1.150	2.21	2.40	2.16	1.92		
26	1.150	2.23	2.40	2.16	1.92		
27	1.150	2.35	2.40	2.23	1.92		
28	1.150	2.37	2.40	2.23	1.92		
29	1.150	6.99	2.40	3.63	1.92		
30	1.150	6.99	2.40	3.63	1.92		
31	1.150	6.82	2.40	3.34	1.92		
32	1.150	6.99	2.40	3.27	1.92		
33	1.150	6.99	2.40	2.98	1.92		
34	RECONDITIONING		CYCLE				24.5
35	0.470	8.81	1.00	4.00	1.86		
36	0.520	9.10	1.00	3.47	1.84		
37	0.580	10.43	1.00	2.88	1.82		
38	1.150	8.30	1.00	1.97	1.83		
39	1.150	8.10	1.00	1.84	1.82		
40	1.150	8.50	1.00	1.79	1.83		
41	1.150	7.04	2.40	1.80	1.82		
42	1.150	7.04	2.40	1.54	1.81		
43	1.150	7.04	2.40	1.30	1.80		
44	1.150	7.04	2.40	1.27	1.82		29.0
45	1.150	7.04	2.40	1.25	1.82		
46	1.150	7.04	2.40	1.20	1.80		
47	1.150	7.04	2.40	1.01	1.81		
48	1.150	7.04	2.40	CELL OPENED FOR INSPECTION			

Appendix IV. TEST DATA FOR CELLS WITH BAGGED POSITIVE ELECTRODE.

TABLE 17

TEST DATA FOR NI ZN CELLS

Cell Number: BP-1
Cell Weight: 0.502 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.450	7.12	1.00	4.27	1.95		
2	0.500	8.00	1.00	5.55	1.98		20.0
3	0.550	8.94	1.00	5.78	2.12		
4	0.465	8.95	1.00	5.92	2.20		
5	0.625	10.16	1.00	5.96	2.20		
6	0.600	9.85	1.00	5.68	1.98		20.5
7	0.500	8.00	1.00	5.67	1.97		
8	0.550	10.50	1.00	5.75	1.92	13.0	
9	0.550	8.50	1.00	5.42	1.91		
10	0.550	8.80	1.00	5.30	1.90		
11	0.550	8.80	1.00	5.62	1.99		27.0
12	0.700	7.00	3.00	4.82	1.96		
13	0.700	7.00	3.00	4.61	1.96		
14	0.700	7.00	3.00	4.34	1.96		
15	0.700	7.00	3.00	4.11	1.94		
16	0.700	7.00	3.00	3.98	1.93		
17	0.700	7.00	3.00	3.86	1.92		
18	0.700	7.00	3.00	3.90	1.92		
19	0.700	7.00	3.00	3.90	1.92		
20	0.700	7.00	3.00	3.83	1.92		
21	0.700	7.00	3.00	3.68	1.91		22.0
22	RECONDITIONING		CYCLE				
23	0.440	7.11	1.00	5.08	1.91		
24	0.420	7.35	1.00	5.00	1.92		
25	0.440	7.05	1.00	4.25	1.90		
26	0.400	6.50	1.00	4.67	1.91		
27	0.420	6.79	1.0	4.33	1.88		27.0
28	0.440	7.05	1.00	4.50	1.90		
29	0.500	8.00	1.00	4.42	1.90		
30	0.55	8.80	1.00	4.33	1.91		
31	RECONDITIONING		CYCLE				
32	0.150	7.43	1.00	4.25	1.90		
33	0.500	8.17	1.00	4.50	1.89		
34	0.500	8.00	1.00	4.53	1.91		28.0
35	0.600	6.00	3.00	3.08	1.85		
36	0.600	6.00	3.00	3.59	1.87		
37	0.600	6.00	3.00	3.70	1.89		
38	0.600	6.00	3.00	NOT	RECORDI		
39	0.600	6.00	3.00	3.88	1.90		
40	0.600	6.00	3.00	3.64	1.91		
41	0.600	6.00	3.00	3.93	1.90		
42	0.600	6.00	3.00	3.78	1.85		
43	0.600	6.00	3.00	3.04	1.82		
44	0.600	6.00	3.00	3.76	1.91		
45	0.600	6.00	3.00	3.72	1.92		
46	0.600	6.00	3.00	3.76	1.91		
47	0.600	6.00	3.00	NOT	RECORDED		
48	0.600	6.00	3.00	3.81	1.91		
49	0.600	6.00	3.00	3.69	1.85		
50	0.600	6.00	3.00	NOT	RECORDED		
51	0.600	6.00	3.00	3.67	1.90		
52	0.600	6.00	3.00	3.63	1.90		
53	0.600	6.00	3.00	3.38	1.86		
54 65	0.600	6.00	3.00	NOT	RECORDED		
66	0.600	6.00	3.00	3.05	1.86		
67	0.600	6.00	3.00	3.10	1.88		
68	0.600	6.00	3.00	NOT	RECORDED		
69	RECONDITIONING		CYCLE				

TABLE 17

TEST DATA FOR NI ZN CELLS

Cell Number: BP-1, continued 2
Cell Weight: 0.502 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
70	0.440	7.05	1.00	3.17	1.85		
71	0.700	11.20	1.00	4.08	1.87		
72	0.600	8.10	1.00	2.67	1.85		
73	0.600	9.60	1.00	3.50	1.87		
74	0.600	9.60	1.00	3.75	1.89		
75	0.600	10.00	1.00	3.75	1.90		
76	0.650	10.40	1.00	3.17	1.87		
77	0.600	6.00	3.00	2.53	1.70		22.0
78	0.600	6.00	3.00	2.99	1.86		
79	0.600	6.00	3.00	2.86	1.86		
80	0.600	6.00	3.00	3.22	1.89		
81	0.600	6.00	3.00	NOT	RECORDED		
82	0.600	6.00	3.00	2.81	1.85		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	2.90	1.86		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	2.57	1.84		
92	0.600	6.00	3.00	2.45	1.85		
93	0.600	6.00	3.00	2.49	1.86		
94	0.600	6.00	3.00	2.32	1.82		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	2.01	1.83		
97	0.600	6.00	3.00	NOT	RECORDED		
98	0.600	6.00	3.00	NOT	RECORDED		
99	RECONDITIONING		CYCLE				
100	0.500	8.00	1.00	2.33	1.85		
101	0.400	9.20	1.00	3.00	1.85		
102	0.700	11.31	1.00	2.67	1.87		
103	0.600	9.70	1.00	2.83	1.85		
104	0.500	8.00	1.00	3.00	1.86		
105	0.600	9.96	1.00	3.33	1.88		
106 10	0.600	6.00	3.00	NOT	RECORDED		
111	0.600	6.00	3.00	2.03	1.84		
112	0.600	6.00	3.00	NOT	RECORDED		
113	0.600	6.00	3.00	2.03	1.81		
114-25	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	1.74	1.84		
127	0.600	6.69	3.00	1.61	1.84		
128	0.600	4.20	2.60	1.63	1.82		
129	0.600	4.20	2.60	1.67	1.84		
130	0.600	4.20	2.60	1.54	1.82		
131 14	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	1.39	1.83		
146-48	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING		CYCLE				
150	0.500	8.50	1.00	1.75	1.82	[illegible]	24.0
151	0.600	9.60	1.00	1.60	1.84		
152	0.700	11.20	1.00	2.00	1.83		
153	0.700	11.20	1.00	2.50	1.86		
154	0.700	11.20	1.00	2.50	1.85		
155	0.700	11.20	1.00	2.50	1.85		
156-67	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60	1.34	1.82		
169-80	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	1.15	1.82		
182-88	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	1.10	[illegible]		

TABLE 17

TEST DATA FOR NI ZN CELLS

Cell Number: BP-1, continued 3
Cell Weight: 0.502 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
190	0.600	4.20	2.52	1.02	1.82		
191	0.600	4.20	2.52	1.12	1.83		
192	0.600	4.20	2.52	1.06	1.81		
193	0.600	4.20	2.52	1.09	1.82		
194	0.600	4.20	2.52	1.11	1.83		
195	0.600	4.20	2.52	1.08	1.83		
196	0.600	4.20	2.52	1.08	1.81		
197	0.600	4.20	2.52	1.07	1.82		
198	0.600	4.20	2.52	1.14	1.83		
199	0.600	4.20	2.52	1.19	1.84		
200	0.600	4.20	2.52	1.08	1.82		
201	0.600	4.20	2.52	1.15	1.83		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	1.50	1.83		
204	0.600	9.60	1.00	1.58	1.83		
205	0.700	11.90	1.00	1.58	1.84	12.5	23.0

TABLE 18

TEST DATA FOR NI ZN CELLS

Cell Number: BP-2
Cell Weight: 0.505 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.450	7.12	1.00	4.07	1.93		
2	0.500	8.00	1.00	5.50	1.98		19.4
3	0.550	8.94	1.00	5.83	2.12		
4	0.465	8.95	1.00	6.02	2.19		
5	0.625	10.16	1.00	6.16	2.20		
6	0.600	9.85	1.00	5.96	2.04		19.5
7	0.500	8.00	1.00	5.85	1.97		
8	0.550	10.50	1.00	5.83	1.94	12.5	
9	0.550	8.50	1.00	5.83	1.91		
10	0.550	8.80	1.00	5.40	1.89		
11	0.550	8.80	1.00	5.75	1.98		22.5
12	0.700	7.00	3.00	4.84	1.96		
13	0.700	7.00	3.00	4.61	1.96		
14	0.700	7.00	3.00	4.43	1.95		
15	0.700	7.00	3.00	4.21	1.94		
16	0.700	7.00	3.00	3.98	1.94		
17	0.700	7.00	3.00	3.95	1.92		
18	0.700	7.00	3.00	3.95	1.92		
19	0.700	7.00	3.00	3.61	1.92		
20	0.700	7.00	3.00	3.62	1.92		
21	0.700	7.00	3.00	3.50	1.92		21.0
22	RECONDITIONING		CYCLE				
23	0.440	7.11	1.00	5.25	1.97		
24	0.420	7.35	1.00	5.08	1.98		
25	0.440	7.05	1.00	5.00	1.90		
26	0.400	6.50	1.00	5.00	1.90		
27	0.420	6.79	1.0	4.58	1.90		26.5
28	0.440	7.05	1.00	4.75	1.90		
29	0.500	8.00	1.00	4.67	1.89		
30	0.55	8.80	1.00	4.50	1.89		
31	RECONDITIONING		CYCLE				
32	0.450	7.43	1.00	4.58	1.90		
33	0.500	8.17	1.00	4.83	1.91		
34	0.500	8.00	1.00	4.75	1.92		27.0
35	0.600	6.00	3.00	3.58	1.87		
36	0.600	6.00	3.00	4.05	1.90		
37	0.600	6.00	3.00	4.01	1.91		
38	0.600	6.00	3.00	NOT	RECORDED		
39	0.600	6.00	3.00	4.15	1.93		
40	0.600	6.00	3.00	4.00	1.92		
41	0.600	6.00	3.00	4.20	1.92		
42	0.600	6.00	3.00	4.11	1.87		
43	0.600	6.00	3.00	3.96	1.84		
44	0.600	6.00	3.00	3.94	1.91		
45	0.600	6.00	3.00	3.89	1.90		
46	0.600	6.00	3.00	3.74	1.88		
47	0.600	6.00	3.00	NOT	RECORDED		
48	0.600	6.00	3.00	3.69	1.88		
49	0.600	6.00	3.00	3.69	1.84		
50	0.600	6.00	3.00	NOT	RECORDED		
51	0.600	6.00	3.00	3.52	1.87		
52	0.600	6.00	3.00	3.50	1.88		
53	0.600	6.00	3.00	3.30	1.89		
54-65	0.600	6.00	3.00	NOT	RECORDED		
66	0.600	6.00	3.00	2.94	1.85		
67	0.600	6.00	3.00	2.91	1.87		
68	0.600	6.00	3.00	NOT	RECORDED		
69	RECONDITIONING		CYCLE				

TABLE 18

TEST DATA FOR NI ZN CELLS

Cell Number: BP-2, continued 2
Cell Weight: 0.505 lbs.
N/P Ratio: 2.6/1

Cycle	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
70	0.440	7.05	1.00	2.83	1.85		
71	0.700	11.20	1.00	3.45	1.87		
72	0.600	8.10	1.00	2.83	1.86		
73	0.600	9.60	1.00	2.92	1.85		
74	0.600	9.60	1.00	3.00	1.86		
75	0.600	10.00	1.00	3.25	1.86		
76	0.650	10.40	1.00	3.25	1.87		22.5
77	0.600	6.00	3.00	2.41	1.69		
78	0.600	6.00	3.00	2.83	1.85		
79	0.600	6.00	3.00	2.81	1.84		
80	0.600	6.00	3.00	2.65	1.85		
81	0.600	6.00	3.00	NOT	RECORDED		
82	0.600	6.00	3.00	2.61	1.86		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	3.09	1.87		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	2.46	1.83		
92	0.600	6.00	3.00	2.74	1.86		
93	0.600	6.00	3.00	2.82	1.86		
94	0.600	6.00	3.00	2.76	1.85		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	2.44	1.86		
97	0.600	6.00	3.00	NOT	RECORDED		
98	0.600	6.00	3.00	NOT	RECORDED		
99	RECONDITIONING		CYCLE				
100	0.500	8.00	1.00	2.17	1.85		
101	0.400	9.20	1.00	2.25	1.84		
102	0.700	11.31	1.00	2.50	1.85		
103	0.600	9.70	1.00	3.25	1.87		
104	0.500	8.00	1.00	3.58	1.88		
105	0.600	9.96	1.00	3.17	1.88		
106-10	0.600	6.00	3.00	NOT	RECORDED		
111	0.600	6.00	3.00	2.35	1.83		
112	0.600	6.00	3.00	NOT	RECORDED		
113	0.600	6.00	3.00	2.28	1.80		
114-25	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	1.83	1.84		
127	0.600	6.00	3.00	1.84	1.83		
128	0.600	4.20	2.60	2.07	1.85		
129	0.600	4.20	2.60	1.99	1.85		
130	0.600	4.20	2.60	1.69	1.81		
131-44	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	1.81	1.85		
146-48	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING CYCLE						24.0
150	0.500	8.50	1.00	2.33	1.84	17.0	
151	0.600	9.60	1.00	1.50	1.87		
152	0.700	11.20	1.00	2.50	1.84		
153	0.700	11.20	1.00	2.50	1.86		
154	0.700	11.20	1.00	2.50	1.85		
155	0.700	11.20	1.00	2.50	1.83		
156-67	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60	1.10	1.80		
169 80	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	1.13	1.82		
182-88	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	1.07	1.80		

TABLE 18

TEST DATA FOR NI ZN CELLS

Cell Number: BP-2, continued 3
Cell Weight: 0.505 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
190	0.600	4.20	2.52	1.02	1.81		
191	0.600	4.20	2.52	1.12	1.82		
192	0.600	4.20	2.52	1.00	1.81		
193	0.600	4.20	2.52	1.03	1.81		
194	0.600	4.20	2.52	1.06	1.82		
195	0.600	4.20	2.52	1.07	1.80		
196	0.600	4.20	2.52	1.09	1.81		
197	0.600	4.20	2.52	1.00	1.81		
198	0.600	4.20	2.52	1.11	1.82		
199	0.600	4.20	2.52	1.03	1.81		
200	0.600	4.20	2.52	1.08	1.82		
201	0.600	4.20	2.52	1.00	1.81		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	1.50	1.83		
204	0.600	9.60	1.00	1.42	1.82		
205	0.700	11.90	1.00	1.50	1.84	12.5	23.0

Appendix V. TEST DATA FOR CELLS WITH BOTH ELECTRODES BAGGED.

TABLE 19

TEST DATA FOR NI ZN CELLS

Cell Number: BB-1
Cell Weight: 0.538 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.450	13.00	1.00	5.67	1.99		
2	0.500	8.00	1.00	5.67	2.00		27.0
3	0.550	8.94	1.00	5.78	2.00		
4	0.465	8.95	1.00	5.83	2.03		
5	0.625	10.16	1.00	2.15			
6	0.600	9.85	1.00	5.18	2.32		41.0
7	0.500	8.00	1.00	4.55	2.32		
8	0.550	10.50	1.00	4.50	2.35	54.0	
9	0.550	8.50	1.00	4.00	2.30		
10	0.550	8.80	1.00	3.17	2.28		
11	0.550	8.80	1.00	2.60	2.16		90.0
12	0.700	7.00	3.00	1.55	2.10		
13	0.700	7.00	3.00	1.43	2.10		
14	0.700	7.00	3.00	1.30	1.98		
15	0.700	7.00	3.00	1.16	1.96		
16	0.700	7.00	3.00	1.10	1.94		
17	0.700	7.00	3.00	1.04	1.96		
18	0.700	7.00	3.00	1.66	1.98		
19	0.700	7.00	3.00	1.57	1.98		
20	0.700	7.00	3.00	1.58	1.94		
21	0.700	7.00	3.00	1.55	1.93		43.0
22	RECONDITIONING		CYCLE				
23	0.440	7.11	1.00	3.83	1.91		
24	0.420	7.35	1.00	3.25	1.88		
25	0.440	7.05	1.00	3.17	1.87		
26	0.100	6.50	1.00	3.00	1.87		
27	0.420	6.79	1.0	3.08	1.86		47.0
28	0.440	7.05	1.00	2.42	1.85		
29	0.500	8.00	1.00	2.75	1.88		
30	0.55	8.80	1.00	2.33	1.86		
31	RECONDITIONING		CYCLE				
32	0.460	7.43	1.00	3.87	1.99		
33	0.500	8.17	1.00	3.47	1.90		
34	0.500	8.00	1.00	2.78	1.88		67.0
35	0.600	6.00	3.00	3.25	1.93		
36	0.600	6.00	3.00	2.95	1.94		
37	0.600	6.00	3.00	3.78	1.88		
38	0.600	6.00	3.00	NOT	RECORDED		
39	0.600	6.00	3.00	2.18	1.86		
40	0.600	6.00	3.00	1.92	1.87		
41	0.600	6.00	3.00	1.98	1.85		
42	0.600	6.00	3.00	1.86	1.86		
43	0.600	6.00	3.00	1.41	1.83		
44	0.600	6.00	3.00	1.84	1.86		
45	0.600	6.00	3.00	1.76	1.87		
46	0.600	6.00	3.00	1.52	1.84		
47	0.600	6.00	3.00	NOT	RECORDED		
48	0.600	6.00	3.00	1.65	1.86		
49	0.600	6.00	3.00	1.46	1.83		
50	0.600	6.00	3.00	NOT	RECORDED		
51	0.600	6.00	3.00	1.58	1.85		
52	0.600	6.00	3.00	1.55	1.84		
53	0.600	6.00	3.00	1.46	1.85		
54-65	0.600	6.00	3.00	NOT	RECORDED		
66	0.600	6.00	3.00	1.28	1.82		
67	0.600	6.00	3.00	1.19	1.85		
68	0.600	6.00	3.00	NOT	RECORDED		
69	RECONDITIONING		CYCLE				

TABLE 19

TEST DATA FOR NI ZN CELLS

Cell Number: BB-1, continued 2
Cell Weight: 0.538 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
70	0.440	6.00	3.00	1.98	1.85		
71	0.700	11.20	1.00	3.05	1.85		
72	0.600	8.10	1.00	3.67	1.88		
73	0.600	9.60	1.00	4.92	1.90		
74	0.600	9.60	1.00	4.17	1.90		
75	0.600	10.00	1.00	3.92	1.89		
76	0.650	10.40	1.00	3.17	1.92		24.5
77	0.600	6.00	3.00	2.04	1.69		
78	0.600	6.00	3.00	2.13	1.88		
79	0.600	6.00	3.00	2.21	1.89		
80	0.600	6.00	3.00	2.05	1.89		
81	0.600	6.00	3.00	NOT	RECORDED		
82	0.600	6.00	3.00	2.23	1.88		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	1.79	1.87		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	1.83	1.86		
92	0.600	6.00	3.00	1.97	1.86		
93	0.600	6.00	3.00	1.87	1.87		
94	0.600	6.00	3.00	1.94	1.87		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	1.98	1.84		
97	0.600	6.00	3.00	NOT	RECORDED		
98	0.600	6.00	3.00	NOT	RECORDED		
99	RECONDITIONING		CYCLE				
100	0.500	8.00	1.00	3.20	1.87		
101	0.400	9.20	1.00	2.93	1.85		
102	0.700	11.31	1.00	3.00	1.88		
103	0.600	9.70	1.00	2.75	1.85		
104	0.500	8.00	1.00	2.42	1.85		
105	0.600	9.96	1.00	2.33	1.84		
106-10	0.600	6.00	3.00	NOT	RECORDED		
111	0.600	6.00	3.00	2.14	1.85		
112	0.600	6.00	3.00	NOT	RECORDED		
113	0.600	6.00	3.00	1.93	1.82		
114-25	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	2.06	1.85		
127	0.600	6.00	3.00	2.01	1.83		
128	0.600	4.20	2.60	1.97	1.86		
129	0.600	4.20	2.60	1.87	1.84		
130	0.600	4.20	2.60	1.92	1.86		
131 14	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	1.67	1.86		
146-48	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING		CYCLE				23.0
150	0.500	8.50	1.00	2.33	1.80	14.0	
151	0.600	9.60	1.00	0.83	1.86		
152	0.700	11.20	1.00	2.00	1.83		
153	0.700	11.20	1.00	2.00	1.83		
154	0.700	11.20	1.00	2.00	1.83		
155	0.700	11.20	1.00	2.50	1.84		
156-67	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60	1.64	1.85		
169-80	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	1.41	1.85		
182-88	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	1.26	1.83		

TABLE 19

TEST DATA FOR NI ZN CELLS

Cell Number: BB-1, continued 3
Cell Weight: 0.538 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
190	0.600	4.20	2.52	1.25	1.84		
191	0.600	4.20	2.52	1.34	1.84		
192	0.600	4.20	2.52	1.32	1.83		
193	0.600	4.20	2.52	1.38	1.85		
194	0.600	4.20	2.52	1.28	1.84		
195	0.600	4.20	2.52	1.32	1.84		
196	0.600	4.20	2.52	1.34	1.86		
197	0.600	4.20	2.52	1.27	1.84		
198	0.600	4.20	2.52	1.43	1.86		
199	0.600	4.20	2.52	1.19	1.83		
200	0.600	4.20	2.52	1.21	1.84		
201	0.600	4.20	2.52	1.30	1.86		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	1.50	1.84		
204	0.600	9.60	1.00	1.75	1.85		
205	0.700	11.90	1.00	1.67	1.85	12.5	22.5

TABLE 20

TEST DATA FOR NI ZN CELLS

Cell Number: BB-2
Cell Weight: 0.539 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.450	13.00	1.00	3.27	1.89		
2	0.500	8.00	1.00	CELL SHORTED			
3	0.550	8.94	1.00	NEW CELL ASSEMBLED			
4	0.465	8.95	1.00	4.23	1.98		
5	0.625	10.16	1.00	4.92	2.03		
6	0.600	9.85	1.00	4.86	2.03		34.0
7	0.500	8.00	1.00	4.90	2.02		
8	0.550	10.50	1.00	4.83	2.10	27.5	
9	0.550	8.50	1.00	4.62	2.20		
10	0.550	8.80	1.00	4.10	2.33		
11	0.550	8.80	1.00	4.10	2.33		43.0
12	0.700	7.00	3.00	1.12	2.08		
13	0.700	7.00	3.00	0.86	2.06		
14	0.700	7.00	3.00	0.89	2.00		
15	0.700	7.00	3.00	.78	1.94		
16	0.700	7.00	3.00	.73	1.94		
17	0.700	7.00	3.00	.60	1.94		
18	0.700	7.00	3.00	1.06	1.96		
19	0.700	7.00	3.00	1.05	1.98		
20	0.700	7.00	3.00	1.10	1.94		
21	0.700	7.00	3.00	1.20	1.93		39
22	RECONDITIONING		CYCLE				
23	0.440	7.11	1.00	4.00	1.93		
24	0.420	7.35	1.00	3.17	1.90		
25	0.440	7.05	1.00	3.07	1.89		
26	0.400	6.50	1.00	2.92	1.88		
27	0.420	6.79	1.0	3.00	1.88		85.0
28	0.410	7.05	1.00	3.00	1.87		
29	0.500	8.00	1.00	2.88	1.88		
30	0.55	8.80	1.00	3.00	1.88		
31	RECONDITIONING		CYCLE				
32	0.450	7.43	1.00	3.25	1.95		
33	0.500	8.17	1.00	3.58	1.92		
34	0.500	8.00	1.00	3.42	1.89		52.0
35	0.600	6.00	3.00	2.64	1.89		
36	0.600	6.00	3.00	2.43	1.85		
37	0.600	6.00	3.00	2.32	1.89		
38	0.600	6.00	3.00	NOT	RECORDED		
39	0.600	6.00	3.00	2.22	1.87		
40	0.600	6.00	3.00	2.18	1.82		
41	0.600	6.00	3.00	2.30	1.86		
42	0.600	6.00	3.00	2.13	1.88		
43	0.600	6.00	3.00	1.63	1.83		
44	0.600	6.00	3.00	1.89	1.85		
45	0.600	6.00	3.00	1.95	1.85		
46	0.600	6.00	3.00	1.98	1.86		
47	0.600	6.00	3.00	NOT	RECORDED		
48	0.600	6.00	3.00	1.90	1.85		
49	0.600	6.00	3.00	1.74	1.86		
50	0.600	6.00	3.00	NOT	RECORDED		
51	0.600	6.00	3.00	1.70	1.84		
52	0.600	6.00	3.00	1.79	1.86		
53	0.600	6.00	3.00	1.72	1.85		
1-65	0.600	6.00	3.00	NOT	RECORDED		
66	0.600	6.00	3.00	0.96	1.86		
67	0.600	6.00	3.00	0.92	1.86		
68	0.600	6.00	3.00	NOT	RECORDED		
69	RECONDITIONING		CYCLE				

TABLE 20

TEST DATA FOR NI ZN CELLS

Cell Number: BB 2, continued, 2
Cell Weight: 0.539
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
70	0.440	7.05	1.00	2.33	1.96		
71	0.700	11.20	1.00	2.50	1.88		
72	0.600	8.10	1.00	2.00	1.88		
73	0.600	9.60	1.00	2.06	1.91		
74	0.600	9.60	1.00	2.50	1.89		
75	0.600	10.00	1.00	2.40	1.92		
76	0.650	10.40	1.00	2.25	1.94		36.0
77	0.600	6.00	3.00	1.73	1.65		
78	0.600	6.00	3.00	1.86	1.87		
79	0.600	6.00	3.00	1.77	1.88		
80	0.600	6.00	3.00	1.76	1.90		
81	0.600	6.00	3.00	NOT	RECORDED		
82	0.600	6.00	3.00	1.81	1.87		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	1.70	1.89		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	1.53	1.83		
92	0.600	6.00	3.00	1.52	1.87		
93	0.600	6.00	3.00	1.38	1.85		
94	0.600	6.00	3.00	1.40	1.86		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	1.42	1.86		
97	0.600	6.00	3.00	NOT	RECORDED		
98	0.600	6.00	3.00	NOT	RECORDED		
99	RECONDITIONING		CYCLE				
100	0.500	8.00	1.00	2.25	1.92		
101	0.400	9.20	1.00	2.75	1.92		
102	0.700	11.31	1.00	2.25	1.93		
103	0.600	9.70	1.00	2.4_	1.88		
104	0.500	8.00	1.00	2.33	1.92		
105	0.600	9.96	1.00	2.25	1.90		
106-10	0.600	6.00	3.00	NOT	RECORDED		
111	0.600	6.00	3.00	2.08	1.87		
112	0.600	6.00	3.00	NOT	RECORDED		
113	0.600	6.00	3.00	2.01	1.85		
114-25	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	1.61	1.87		
127	0.600	6.00	3.00	1.48	1.85		
128	0.600	4.20	2.60	1.63	1.89		
129	0.600	4.20	2.60	1.32	1.84		
130	0.600	4.20	2.60	1.39	1.86		
131-44	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	1.10	1.86		
146-48	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING		CYCLE				41.0
150	0.500	8.50	1.00	1.75	1.88		
151	0.600	9.60	1.00	0.92	1.90		
152	0.700	11.20	1.00	2.00	1.88		
153	0.700	11.20	1.00	2.50	1.88		
154	0.700	11.20	1.00	2.00	1.86		
155	0.700	11.20	1.00	2.00	1.86		
156-67	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60	1.33	1.86		
169-80	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	0.87	1.85		
182-88	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	0.75	1.84		

TABLE 20

TEST DATA FOR NI ZN CELLS

Cell Number: BB-2, continued 3
Cell Weight: 0.539 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
190	0.600	4.20	2.52	0.66	1.84		
191	0.600	4.20	2.52	0.69	1.83		
192	0.600	4.20	2.52	0.67	1.83		
193	0.600	4.20	2.52	0.66	1.83		
194	0.600	4.20	2.52	0.65	1.84		
195	0.600	4.20	2.52	0.59	1.83		
196	0.600	4.20	2.52	0.61	1.83		
197	0.600	4.20	2.52	0.56	1.84		
198	0.600	4.20	2.52	0.63	1.83		
199	0.600	4.20	2.52	0.56	1.82		
200	0.600	4.20	2.52	0.61	1.84		
201	0.600	4.20	2.52	0.56	1.83		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	0.83	1.83		
204	0.600	9.60	1.00	1.08	1.86		
205	0.700	11.90	1.00	1.17	1.86	22.5	48.0

Appendix VI. TEST DATA WITH BAGGED NEGATIVE ELECTRODE.

TABLE 21

TEST DATA FOR NI ZN CELLS

Cell Number: BN-1
Cell Weight: 0.536 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.450	13.00	1.00	6.45	1.97		
2	0.500	8.00	1.00	6.73	1.96		20.5
3	0.550	8.94	1.00	7.00	2.00		
4	0.465	8.95	1.00	7.13	2.00		
5	0.625	10.16	1.00	7.14	2.06		
6	0.600	9.85	1.00	6.96	2.08		28.6
7	0.500	8.00	1.00	6.91	2.00		
8	0.550	10.50	1.00	7.25	2.20	76.0	
9	0.550	8.50	1.00	6.78	2.26		
10	0.550	8.80	1.00	6.07	2.00		
11	0.550	8.80	1.00	5.71	2.22		26.5
12	0.700	7.00	3.00	3.80	2.18		
13	0.700	7.00	3.00	2.96	2.16		
14	0.700	7.00	3.00	2.14	2.14		
15	0.700	7.00	3.00	1.85	2.10		
16	0.700	7.00	3.00	1.70	2.08		
17	0.700	7.00	3.00	1.85	2.06		
18	0.700	7.00	3.00	2.20	2.06		
19	0.700	7.00	3.00	2.23	2.06		
20	0.700	7.00	3.00	2.27	2.05		
21	0.700	7.00	3.00	0.09			16.5
22	RECONDITIONING		CYCLE				
23	0.440	7.11	1.00	5.92	2.07		
24	0.420	7.35	1.00	3.83	2.18		
25	0.140	7.05	1.00	3.17	1.97		
26	0.400	6.50	1.00	4.58	1.86		
27	0.420	6.79	1.0	4.25	1.89		47.0
28	0.440	7.05	1.00	4.00	1.89		
29	0.500	8.00	1.00	3.67	1.88		
30	0.55	8.80	1.00	4.93	1.87		
31	RECONDITIONING		CYCLE				
32	0.450	7.43	1.00	5.30	1.90		
33	0.500	8.17	1.00	5.53	1.93		
34	0.500	8.00	1.00	5.00	1.93	74.0	
35	0.600	6.00	3.00	N.R.	1.89		
36	0.600	6.00	3.00	N.R.	1.90		
37	0.600	6.00	3.00	N.R.	1.90		
38	0.600	6.00	3.00	NOT	RECORDED		
39	0.600	6.00	3.00	N.R.	1.88		
40	0.600	6.00	3.00	N.R.	1.89		
41	0.600	6.00	3.00	2.70	1.85		
42	0.600	6.00	3.00	2.70	1.89		
43	0.600	6.00	3.00	1.97	1.81		
44	0.600	6.00	3.00	2.54	1.85		
45	0.600	6.00	3.00	2.46	1.86		
46	0.600	6.00	3.00	2.39	1.86		
47	0.600	6.00	3.00	NOT	RECORDED		
48	0.600	6.00	3.00	2.20	1.85		
49	0.600	6.00	3.00	2.19	1.83		
50	0.600	6.00	3.00	NOT	RECORDED		
51	0.600	6.00	3.00	2.13	1.85		
52	0.600	6.00	3.00	2.18	1.87		
53	0.600	6.00	3.00	2.11	1.86		
54-65	0.600	6.00	3.00	NOT	RECORDED		
66	0.600	6.00	3.00	1.50	1.85		
67	0.600	6.00	3.00	1.45	1.87		
68	0.600	6.00	3.00	NOT	RECORDED		
69	RECONDITIONING		CYCLE				

TABLE 21

TEST DATA FOR NI ZN CELLS

Cell Number: BN-1, continued 2
Cell Weight: 0.536 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
70	0.440	7.05	1.00	5.00	1.85		
71	0.700	11.20	1.00	6.50	1.89		
72	0.600	8.10	1.00	5.83	1.88		
73	0.600	9.60	1.00	5.75	1.88		
74	0.600	9.60	1.00	5.67	1.88		
75	0.600	10.00	1.00	6.20	1.89		
76	0.650	10.40	1.00	6.25	1.89		25.5
77	0.600	6.00	3.00	3.15	1.73		
78	0.600	6.00	3.00	3.94	1.87		
79	0.600	6.00	3.00	3.91	1.88		
80	0.600	6.00	3.00	3.69	1.88		
81	0.600	6.00	3.00	NOT	RECORDED		
82	0.600	6.00	3.00	3.38	1.86		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	3.63	1.87		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	3.25	1.85		
92	0.600	6.00	3.00	3.20	1.84		
93	0.600	6.00	3.00	3.34	1.84		
94	0.600	6.00	3.00	3.35	1.85		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	2.90	1.84		
97	0.600	6.00	3.00	NOT	RECORDED		
98	0.600	6.00	3.00	NOT	RECORDED		
99	RECONDITIONING		CYCLE				
100	0.500	8.00	1.00	5.20	1.87		
101	0.400	9.20	1.00	5.75	1.87		
102	0.700	11.31	1.00	5.75	1.89		
103	0.600	9.70	1.00	5.40	1.87		
104	0.500	8.00	1.00	5.67	1.87		
105	0.600	9.96	1.00	5.67	1.88		
106-10	0.600	6.00	3.00	NOT	RECORDED		
111	0.600	6.00	3.00	4.04	1.88		
112	0.600	6.00	3.00	NOT	RECORDED		
113	0.600	6.00	3.00	3.98	1.87		
114-25	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	3.55	1.86		
127	0.600	6.00	3.00	3.38	1.84		
128	0.600	4.20	2.60	3.36	1.85		
129	0.600	4.20	2.60	3.17	1.88		
130	0.600	4.20	2.60	3.16	1.88		
131-44	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	2.45	1.86		
146-48	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING		CYCLE				67.0
150	0.500	8.50	1.00	3.00	1.87	17.0	
151	0.600	9.60	1.00	3.15	1.88		
152	0.700	11.20	1.00	4.75	1.86		
153	0.700	11.20	1.00	4.50	1.86		
154	0.700	11.20	1.00	5.50	1.87		
155	0.700	11.20	1.00	4.50	1.85		
156-67	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60	2.89	1.87		
169-80	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	2.57	1.86		
182-88	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	2.50	1.87		

TABLE 21

TEST DATA FOR NI ZN CELLS

Cell Number: BN-1, continued 3
Cell Weight: 0.536 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
190	0.600	4.20	2.52	2.83	1.85		
191	0.600	4.20	2.52	2.83	1.88		
192	0.600	4.20	2.52	1.40	1.86		
193	0.600	4.20	2.52	0.00	1.78		
194	0.600	4.20	2.52	1.39	1.84		
195	0.600	4.20	2.52	0.00	1.84		
196	0.600	4.20	2.52	2.52	1.82		
197	0.600	4.20	2.52	2.42	1.84		
198	0.600	4.20	2.52	0.00	1.84		
199	0.600	4.20	2.52	1.84	1.84		
200	0.600	4.20	2.52	2.64	1.85		
201	0.600	4.20	2.52	2.36	1.84		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	3.00	1.84		
204	0.600	9.60	1.00	3.50	1.85		
205	0.700	11.90	1.00	2.75	1.85	12.0	25.0

TABLE 22

TEST DATA FOR NI ZN CELLS

Cell Number: EN-2
Cell Weight: 0.533 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.450	13.00	1.00	6.72	1.96		
2	0.500	8.00	1.00	6.50	1.97		20.5
3	0.550	8.94	1.00	6.65	2.00		
4	0.465	8.95	1.00	6.72	2.00		
5	0.625	10.16	1.00	7.27	2.09		
6	0.600	9.85	1.00	7.07	2.13		30.0
7	0.500	8.00	1.00	6.97	2.06		
8	0.550	10.50	1.00	6.42	2.23	72.0	
9	0.550	8.50	1.00	6.40	2.28		
10	0.550	8.80	1.00	6.00	2.30		
11	0.550	8.80	1.00	5.85	2.22		36.0
12	0.700	7.00	3.00	3.48	2.16		
13	0.700	7.00	3.00	2.66	2.14		
14	0.700	7.00	3.00	2.31	2.10		
15	0.700	7.00	3.00	2.07	2.08		
16	0.700	7.00	3.00	2.17	2.06		
17	0.700	7.00	3.00	.60	2.05		
18	0.700	7.00	3.00	2.27	2.05		
19	0.700	7.00	3.00	1.99	2.06		
20	0.700	7.00	3.00	1.65	2.05		
21	0.700	7.00	3.00	0.99	2.05		25.5
22	RECONDITIONING		CYCLE				
23	0.440	7.11	1.00	6.00	1.96		
24	0.420	7.55	1.00	6.33	2.19		
25	0.140	7.05	1.00	6.07	2.02		
26	0.400	6.50	1.00	5.93	1.92		
27	0.420	6.79	1.0	5.58	1.91		61.0
28	0.140	7.05	1.00	5.25	1.91		
29	0.500	8.00	1.00	5.67	1.92		
30	0.55	8.80	1.00	5.43	1.90		
31	RECONDITIONING		CYCLE				
32	0.450	7.43	1.00	5.20	1.88		
33	0.500	8.17	1.00	6.12	1.91		
34	0.500	8.00	1.00	6.25	1.93		39.0
35	0.600	6.00	3.00	3.91	1.89		
36	0.600	6.00	3.00	3.98	1.91		
37	0.600	6.00	3.00	3.85	1.93		
38	0.600	6.00	3.00	NOT	RECORDED		
39	0.600	6.00	3.00	3.80	1.99		
40	0.600	6.00	3.00	3.98	1.93		
41	0.600	6.00	3.00	4.02	1.90		
42	0.600	6.00	3.00	3.78	1.88		
43	0.600	6.00	3.00	3.35	1.82		
44	0.600	6.00	3.00	3.30	1.88		
45	0.600	6.00	3.00	2.96	1.90		
46	0.600	6.00	3.00	2.88	1.87		
47	0.600	6.00	3.00	NOT	RECORDED		
48	0.600	6.00	3.00	2.67	1.89		
49	0.600	6.00	3.00	2.66	1.88		
50	0.600	6.00	3.00	NOT	RECORDED		
51	0.600	6.00	3.00	2.61	1.88		
52	0.600	6.00	3.00	2.59	1.88		
53	0.600	6.00	3.00	2.49	1.89		
54 65	0.600	6.00	3.00	NOT	RECORDED		
66	0.600	6.00	3.00	1.51	1.88		
67	0.600	6.00	3.00	1.43	1.88		
68	0.600	6.00	3.00	NOT	RECORDED		
69	RECONDITIONING		CYCLE				

TABLE 22

TEST DATA FOR NI ZN CELLS

Cell Number: BN-2, continued 2
Cell Weight: 0.533 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
70	0.440	7.05	1.00	4.25	1.85		
71	0.700	11.20	1.00	5.15	1.87		
72	0.600	8.10	1.00	4.50	1.87		
73	0.600	9.60	1.00	5.10	1.87		
74	0.600	9.60	1.00	4.87	1.88		
75	0.600	10.00	1.00	4.58	1.86		
76	0.650	10.40	1.00	4.75	1.87		42.0
77	0.600	6.00	3.00	3.08	1.63		
78	0.600	6.00	3.00	3.81	1.87		
79	0.600	6.00	3.00	3.72	1.88		
80	0.600	6.00	3.00	3.65	1.89		
81	0.600	6.00	3.00	NOT	RECORDED		
82	0.600	6.00	3.00	3.04	1.88		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	3.69	1.88		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	3.02	1.87		
92	0.600	6.00	3.00	3.01	1.86		
93	0.600	6.00	3.00	2.96	1.87		
94	0.600	6.00	3.00	2.86	1.86		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	2.89	1.87		
97	0.600	6.00	3.00	NOT	RECORDED		
98	0.600	6.00	3.00	NOT	RECORDED		
99	RECONDITIONING		CYCLE				
100	0.500	8.00	1.00	4.58	1.88		
101	0.400	9.20	1.00	4.10	1.87		
102	0.700	11.31	1.00	3.50	1.92		
103	0.600	9.70	1.00	4.30	1.87		
104	0.500	8.00	1.00	4.33	1.87		
105	0.600	9.96	1.00	3.25	1.88		
106-10	0.600	6.00	3.00	NOT	RECORDED		
111	0.600	6.00	3.00	3.30	1.88		
112	0.600	6.00	3.00	NOT	RECORDED		
113	0.600	6.00	3.00	3.25	1.81		
114-25	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	2.93	1.88		
127	0.600	6.00	3.00	2.69	1.84		
128	0.600	4.20	2.60	2.65	1.87		
129	0.600	4.20	2.60	2.61	1.88		
130	0.600	4.20	2.60	2.54	1.88		
131-44	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	2.41	1.87		
146-48	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING		CYCLE				26.0
150	0.500	8.50	1.00	3.00	1.88	14.0	
151	0.600	9.60	1.00	2.25	1.87		
152	0.700	11.20	1.00	4.00	1.85		
153	0.700	11.20	1.00	3.75	1.86		
154	0.700	11.20	1.00	4.00	1.88		
155	0.700	11.20	1.00	4.00	1.88		
156-67	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60	2.34	1.86		
169-80	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	2.04	1.86		
182-88	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	2.01	1.84		

TABLE 22

TEST DATA FOR NI ZN CELLS

Cell Number: BN-2, continued 3
Cell Weight: 0.533 lbs.
N/P Ratio: 3.4/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
190	0.600	4.20	2.52	1.99	1.84		
191	0.600	4.20	2.52	1.99	1.85		
192	0.600	4.20	2.52	1.98	1.84		
193	0.600	4.20	2.52	1.90	1.85		
194	0.600	4.20	2.52	1.92	1.84		
195	0.600	4.20	2.52	1.91	1.85		
196	0.600	4.20	2.52	1.97	1.85		
197	0.600	4.20	2.52	1.94	1.84		
198	0.600	4.20	2.52	1.97	1.85		
199	0.600	4.20	2.52	1.88	1.84		
200	0.600	4.20	2.52	1.96	1.84		
201	0.600	4.20	2.52	1.92	1.85		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	2.25	1.85		
204	0.600	9.60	1.00	2.08	1.85		
205	0.700	11.90	1.00	2.33	1.85	29.0	43.0

Appendix VII. TEST DATA FOR CELLS WITH "LAYERED" CERAMIC SEPARATOR.

TABLE 23

TEST DATA FOR NI ZN CELLS

Cell Number: L-1
Cell Weight: 0.502 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.450	7.12	1.00	3.98	1 .93		
2	0.500	8.00	1.00	6.00	1.97		20.5
3	0.550	8.94	1.00	6.48	2.05		
4	0.465	8.95	1.00	6.67	2.20		
5	0.625	10.16	1.00	6.38	2.25		
6	0.600	9.85	1.00	5.18	2.25		27.0
7	0.500	8.00	1.00	5.13	2.21		
8	0.550	10.50	1.00	5.88	1.92	38.0	
9	0.550	8.50	1.00	5.42	2.10		
10	0.550	8.80	1.00	5.73	2.02		
11	0.550	8.80	1.00	5.66	2.06		25.5
12	0.700	7.00	3.00	3.30	2.03		
13	0.700	7.00	3.00	3.03	2.04		
14	0.700	7.00	3.00	2.44	2.00		
15	0.700	7.00	3.00	2.46	1.98		
16	0.700	7.00	3.00	2.33	1.98		
17	0.700	7.00	3.00	2.31	1.97		
18	0.700	7.00	3.00	3.23	1.96		
19	0.700	7.00	3.00	...	1.96		
20	0.700	7.00	3.00	2.87	1.94		
21	0.700	7.00	3.00	2.65	1.94		25.0
22	RECONDITIONING		CYCLE				
23	0.440	7.11	1.00	5.58	1.95		
24	0.420	7.35	1.00	5.87	2.13		
25	0.440	7.05	1.00	5.58	2.05		
26	0.400	6.50	1.00	5.50	1.97		
27	0.420	6.79	1.0	5.08	1.95		40.0
28	0.440	7.05	1.00	4.83	1.92		
29	0.500	8.00	1.00	4.50	1.93		
30	0.55	8.80	1.00	4.87	1.92		
31	RECONDITIONING		CYCLE				
32	0.450	7.43	1.00	5.42	1.91		
33	0.500	8.17	1.00	6.17	1.96		
34	0.500	8.00	1.00	6.08	1.97		38.0
35	0.600	6.00	3.00	4.27	1.94		
36	0.600	6.00	3.00	4.11	1.96		
37	0.600	6.00	3.00	3.75	1.96		
38	0.600	6.00	3.00	NOT	RECORDED		
39	0.600	6.00	3.00	3.46	1.94		
40	0.600	6.00	3.00	3.40	1.98		
41	0.600	6.00	3.00	3.30	1.93		
42	0.600	6.00	3.00	3.12	1.86		
43	0.600	6.00	3.00	2.52	1.81		
44	0.600	6.00	3.00	2.92	1.96		
45	0.600	6.00	3.00	2.76	1.97		
46	0.600	6.00	3.00	2.68	1.97		
47	0.600	6.00	3.00	NOT	RECORDED		
48	0.600	6.00	3.00	2.56	1.97		
49	0.600	6.00	3.00	2.44	1.84		
50	0.600	6.00	3.00	NOT	RECORDED		
51	0.600	6.00	3.00	2.40	2.04		
52	0.600	6.00	3.00	2.39	2.03		
53	0.600	6.00	3.00	2.31	2.02		
54-65	0.600	6.00	3.00	NOT	RECORDED		
66	0.600	6.00	3.00	1.72	1.95		
67	0.600	6.00	3.00	1.64	2.00		
68	0.600	6.00	3.00	NOT	RECORDED		
69	RECONDITIONING		CYCLE				

TABLE 23

TEST DATA FOR NI ZN CELLS

Cell Number: L-1, continued 2
Cell Weight: 0.502 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
70	0.440	7.05	1.00	4.50	1.87		
71	0.700	11.20	1.00	5.75	1.93		
72	0.600	8.10	1.00	5.25	1.91		
73	0.600	9.60	1.00	5.47	1.92		
74	0.600	9.60	1.00	5.33	1.91		
75	0.600	10.00	1.00	5.42	1.90		
76	0.650	10.40	1.00	5.33	1.90		38.0
77	0.600	6.00	3.00	3.63	1.72		
78	0.600	6.00	3.00	3.67	1.89		
79	0.600	6.00	3.00	3.62	1.90		
80	0.600	6.00	3.00	3.65	1.91		
81	0.600	6.00	3.00	NOT	RECORDED		
82	0.600	6.00	3.00	3.46	1.89		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	3.56	1.89		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	3.28	1.88		
92	0.600	6.00	3.00	3.24	1.88		
93	0.600	6.00	3.00	2.56	1.88		
94	0.600	6.00	3.00	2.79	1.89		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	2.83	1.87		
97	0.600	6.00	3.00	NOT	RECORDED		
98	0.600	6.00	3.00	NOT	RECORDED		
99	RECONDITIONING		CYCLE				
100	0.500	8.00	1.00	4.00	1.95		
101	0.400	9.20	1.00	3.83	1.92		
102	0.700	11.31	1.00	3.25	1.91		
103	0.600	9.70	1.00	3.25	1.92		
104	0.500	8.00	1.00	3.50	1.90		
105	0.600	9.96	1.00	3.50	1.91		
106-10	0.600	6.00	3.00	NOT	RECORDED		
111	0.600	6.00	3.00	2.72	1.88		
112	0.600	6.00	3.00	NOT	RECORDED		
113	0.600	6.00	3.00	2.60	1.83		
114-25	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	2.25	1.87		
127	0.600	6.00	3.00	2.17	1.88		
128	0.600	4.20	2.60	2.13	1.89		
129	0.600	4.20	2.60	2.08	1.91		
130	0.600	4.20	2.60	2.05	1.91		
131-44	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	1.69	1.91		
146-48	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING		CYCLE				44.0
150	0.500	8.50	1 00	3.00	1.90	24.0	
151	0.600	9.60	1.00	3.00	1.98		
152	0.700	11.20	1.00	3.00	1.87		
153	0.700	11.20	1.00	3.50	1.89		
154	0.700	11.20	1.00	2.75	1.88		
155	0.700	11.20	1.00	3.00	1.86		
156-67	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60	1.79	1.88		
169-80	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	1.43	1.90		
182-88	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	1.36	1.91		

TABLE 23

TEST DATA FOR NI ZN CELLS

Cell Number: L-1, continued 3
Cell Weight: 0.502 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
190	0.600	4.20	2.52	1.35	1.92		
191	0.600	4.20	2.52	1.33	1.91		
192	0.600	4.20	2.52	1.32	1.91		
193	0.600	4.20	2.52	1.31	1.90		
194	0.600	4.20	2.52	1.31	1.91		
195	0.600	4.20	2.52	1.28	1.91		
196	0.600	4.20	2.52	1.28	1.91		
197	0.600	4.20	2.52	1.27	1.90		
198	0.600	4.20	2.52	1.31	1.88		
199	0.600	4.20	2.52	1.31	1.90		
200	0.600	4.20	2.52	1.27	1.93		
201	0.600	4.20	2.52	1.25	1.92		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	2.17	1.89		
204	0.600	9.60	1.00	1.92	1.89		
205	0.700	11.90	1.00	1.83	1.88	17.0	49.0

TABLE 24

TEST DATA FOR NI ZN CELLS

Cell Number: L-2
Cell Weight: 0.504 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.450	7.12	1.00	4.20	1.93		
2	0.500	8.00	1.00	6.28	1.97		21.0
3	0.550	8.94	1.00	6.83	2.05		
4	0.465	8.95	1.00	7.00	2.12		
5	0.625	10.16	1.00	6.97	2.30		
6	0.600	9.85	1.00	6.42	2.30		34.0
7	0.500	8.00	1.00	6.33	2.22		
8	0.550	10.50	1.00	6.55	2.09	46.0	
9	0.550	8.50	1.00	5.83	2.19		
10	0.550	8.80	1.00	5.83	2.18		
11	0.550	8.80	1.00	5.73	2.19		29.5
12	0.700	7.00	3.00	3.54	2.12		
13	0.700	7.00	3.00	3.42	2.14		
14	0.700	7.00	3.00	3.00	2.10		
15	0.700	7.00	3.00	2.97	2.10		
16	0.700	7.00	3.00	2.84	2.06		
17	0.700	7.00	3.00	2.59	2.05		
18	0.700	7.00	3.00	3.11	2.04		
19	0.700	7.00	3.00	3.05	2.00		
20	0.700	7.00	3.00	2.81	2.00		
21	0.700	7.00	3.00	2.69	2.00		25.4
22	RECONDITIONING		CYCLE				
23	0.440	7.11	1.00	5.43	1.93		
24	0.420	7.35	1.00	5.92	2.09		
25	0.440	7.05	1.00	5.75	2.05		
26	0.400	6.50	1.00	5.67	1.99		
27	0.420	6.79	1.0	5.37	1.95		40.0
28	0.440	7.05	1.00	5.33	1.95		
29	0.500	8.00	1.00	5.25	1.94		
30	0.55	8.80	1.00	5.37	1.94		
31	RECONDITIONING		CYCLE				
32	0.450	7.43	1.00	5.58	1.90		
33	0.500	8.17	1.00	6.83	1.97		
34	0.500	8.00	1.00	6.75	1.97		36.0
35	0.600	6.00	3.00	5.15	1.96		
36	0.600	6.00	3.00	4.94	1.97		
37	0.600	6.00	3.00	4.75	1.98		
38	0.600	6.00	3.00	NOT	RECORDED		
39	0.600	6.00	3.00	4.46	2.01		
40	0.600	6.00	3.00	4.37	2.00		
41	0.600	6.00	3.00	4.59	2.09		
42	0.600	6.00	3.00	4.17	1.86		
43	0.600	6.00	3.00	3.45	1.83		
44	0.600	6.00	3.00	3.81	2.06		
45	0.600	6.00	3.00	3.71	2.08		
46	0.600	6.00	3.00	3.66	2.10		
47	0.600	6.00	3.00	NOT	RECORDED		
48	0.600	6.00	3.00	3.51	2.06		
49	0.600	6.00	3.00	3.43	1.84		
50	0.600	6.00	3.00	NOT	RECORDED		
51	0.600	6.00	3.00	3.37	2.12		
52	0.600	6.00	3.00	3.31	2.12		
53	0.600	6.00	3.00	3.43	2.11		
54-65	0.600	6.00	3.00	NOT	RECORDED		
66	0.600	6.00	3.00	2.50	1.97		
67	0.600	6.00	3.00	2.36	2.11		
68	0.600	6.00	3.00	NOT	RECORDED		
69	RECONDITIONING		CYCLE				

TABLE 24

TEST DATA FOR NI ZN CELLS

Cell Number: L-2, continued 2
Cell Weight: 0.504 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
70	0.440	7.05	1.00	5.58	1.89		
71	0.700	11.20	1.00	6.25	1.94		
72	0.600	8.10	1.00	5.5[illegible]	1.92		
73	0.600	9.60	1.00	5.[illegible]	1.91		
74	0.600	9.60	1.00	5 [illegible]	1.91		
75	0.600	10.00	1.00	[illegible].8	1.89		
76	0.650	10.40	1.00	[illegible].17	1.90		40.0
77	0.600	6.00	3.00	4.02	1.72		
78	0.600	6.00	3.00	4.02	1.91		
79	0.600	6.00	3.00	3.86	1.91		
80	0.600	6.00	3.00	3.69	1.90		
81	0.600	6.00	3.00	NOT	RECORDED		
82	0.600	6.00	3.00	3.57	1.90		
83	0.600	6.00	3.0[illegible]	NOT	RECORDED		
84	0.600	6.00	3 [illegible]	3.40	1.88		
85-90	0.600	6.00	[illegible].00	NOT	RECORDED		
91	0.600	6.00	3.00	3.02	1.88		
92	0.600	6.00	3.00	2.88	1.88		
93	0.600	6.00	3.00	2.82	1.88		
94	0.600	6.00	3.00	2.71	1.89		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	2.75	1.87		
97	0.600	6.00	3.00	NOT	RECORDED		
98	0.600	6.00	3.00	NOT	RECORDED		
99	RECONDITIONING		CYCLE				
100	0.500	8.00	1.00	5.50	1.93		
101	0.400	9.20	1.00	5.42	1.90		
102	0.700	11.31	1.00	4.67	1.90		
103	0.600	9.70	1.00	4.58	1.88		
104	0.500	8.00	1.00	4.94	1.87		
105	0.600	9.96	1.00	4.00	1.88		
106-10	0.600	6.00	3.00	NOT	RECORDED		
111	0.600	6.00	3.00	3.41	1.87		
112	0.600	6.00	3.00	NOT	RECORDED		
113	0.600	6.00	3.00	3.28	1.84		
114-25	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	3.16	1.88		
127	0.600	6.00	3.00	3.07	1.85		
128	0.600	4.20	2.60	3.09	1.88		
129	0.600	4.20	2.60	2.99	1.90		
130	0.600	4.20	2.60	2.92	1.90		
131-44	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	2.50	1.89		
146-48	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING		CYCLE				33.0
150	0.500	8.50	1.00	3.50	1.88	19.0	
151	0.600	9.60	1.00	3.00	1.90		
152	0.700	11.20	1.00	4.00	1.86		
153	0.700	11.20	1.00	3.75	1.88		
154	0.700	11.20	1.00	3.00	1.87		
155	0.700	11.20	1.00	4.00	1.84		
156-67	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60	2.69	1.88		
169-80	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	2.17	1.86		
182-88	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	2.09	1.88		

TABLE 24

TEST DATA FOR NI ZN CELLS

Cell Number: L-2, continued 3
Cell Weight: 0.504 lbs.
N/P Ratio: 2.6/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
190	0.600	4.20	2.52	2.05	1.89		
191	0.600	4.20	2.52	2.03	1.87		
192	0.600	4.20	2.52	2.01	1.87		
193	0.600	4.20	2.52	1.98	1.87		
194	0.600	4.20	2.52	1.99	1.88		
195	0.600	4.20	2.52	2.00	1.87		
196	0.600	4.20	2.52	1.97	1.88		
197	0.600	4.20	2.52	1.97	1.87		
198	0.600	4.20	2.52	1.97	1.88		
199	0.600	4.20	2.52	1.91	1.88		
200	0.600	4.20	2.52	1.90	1.90		
201	0.600	4.20	2.52	1.92	1.88		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	2.75	1.87		
204	0.600	9.60	1.00	2.78	1.87		
205	0.700	11.90	1.00	2.67	1.86	11.5	36.0

Appendix VIII. TEST DATA FOR CELLS WITH STANDARD SEPARATION.

TABLE 25

TEST DATA FOR NI ZN CELLS

Cell Number: GC-1
Cell Weight: 0.535 lbs.
N/P Ratio: 2.95/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.800	13.00	1.30	7.37	1.96	10.0	17.0
2	0.800	14.63	1.30	8.92	2.22		13.0
3	0.900	15.30	1.30	9.63	2.23		19.0
4	0.900	13.05	1.30	9.21	2.23	8.8	12.5
5	0.900	14.63	1.30	9.10	2.24		13.0
6	0.900	14.40	10.00	6.97	2.23		
7	0.800	16.00	10.00	5.83	2.28		
8	0.800	13.20	1.50	4.75	2.68		19.2
9	0.850	14.63	2.20	5.94	2.08	10.0	
10	0.700	13.13	1.30	7.50	2.20		13.0
11	0.830	14.00	1.30	9.36	2.18	10.5	
12	0.100	14.40	1.30	9.21	2.16		
13	0.650	14.30	1.30	8.84	2.10		15.5
14	0.900	14.40	1.30	8.45	2.12		
15	0.900	14.40	1.30	8.88	2.10	9.3	
16	0.900	14.40	1.30	8.67	2.12		
17	0.900	14.40	1.30	8.67	2.06		
18	0.800	12.80	1.30	8.41	2.05		
19	0.650	10.40	1.30	8.02	2.05		
20	0.600	9.60	1.30	7.84	2.10		18.0
21	0.600	9.60	1.30	7.80	1.94		
22	0.650	10.40	1.30	7.58	1.98		
23	0.800	12.80	1.30	7.58	1.93		
24	0.900	14.40	1.30	8.02	1.94		
25-32	0.800	8.00	4.00	NOT	RECORDED		
33	0.800	8.00	4.00	5.72	2.07		
34-41	0.800	8.00	4.00	NOT	RECORDED		
42	0.800	8.00	4.00	0.00	2.35		
43	0.800	8.00	4.00	0.00	2.60		
44	0.800	8.00	4.00	3.39	1.95		
45	0.800	8.00	4.00	3.04	1.94		
46	0.800	8.00	4.00	2.82	1.90		17.4
47	RECONDITIONING		CYCLE				36.0
48	0.700	12.60	1.00	7.83	2.10		
49	0.700	11.20	1.00	7.17	2.01		
50	0.700	11.20	1.00	6.55	1.97		
51	0.700	11.20	1.00	6.00	1.99		36.0
52	0.625	10.00	1.00	4.15	1.92		
53	0.600	10.50	1.00	6.25	2.01		
54	0.440	7.04	1.00	5.50	1.97		
55	0.400	6.40	1.00	5.17	1.96		
56	0.500	8.00	1.00	5.5	1.99		
57	0.700	11.20	1.00	5.33	1.92		
58	0.700	11.20	1.00	5.20	1.88		
59	0.700	11.20	1.00	5.00	1.89		
60	0.700	11.20	1.00	5.06	1.89		
61	0.700	11.20	1.00	5.10	1.95		
62	0.730	12.00	1.00	4.92	1.89		
63	0.750	12.00	1.00	4.67	1.87		
64	RECONDITIONING		CYCLE				
65	0.600	10.80	1.00	7.62	1.94		
66	0.750	12.38	1.00	7.18	1.91		
67	0.750	12.38	1.00	7.20	1.91		
68 69	0.750	12.40	1.00	NOT	RECORDED		
70	0.750	12.40	1.00	7.22	1.90		
71	0.500	10.50	1.00	5.92	1.89		
72	0.600	9.60	1.00	6.50	1.91		
73	0.700	9.60	1.00	5.37	1.90		

TABLE 25

TEST DATA FOR NI ZN CELLS

Cell Number: GC-1, continued
Cell Weight: 0.535 lbs.
N/P Ratio: 2.95/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
74	0.700	12.00	1.00	5.83	1.89		
75	0.700	11.20	1.00	6.00	1.89		
76	0.700	11.20	1.00	5.33	1.89		
77	0.750	11.20	1.00	6.58	1.90		
78	0.600	6.00	3.00	3.79	1.74		
79	0.600	6.00	3.00	3.79	1.74		
80	0.600	6.00	3.00	3.95	1.88		
81	0.600	6.00	3.00	3.73	1.87		
82	0.600	6.00	3.00	3.62	1.87		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	3.35	1.87		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	2.19	1.83		
92	0.600	6.00	3.00	2.12	1.83		
93	0.600	6.00	3.00	2.00	1.83		
94	0.600	6.00	3.00	1.75	1.81		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	1.81	1.84		
97	RECONDITIONING		CYCLE				
98	0.800	12.80	1.00	3.63	1.89		
99	0.800	12.80	1.00	0.57	1.65		
100	0.800	12.80	1.00	0.32	1.65		
101-125	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	S H O R T E D			

TABLE 26

TEST DATA FOR NI ZN CELLS

Cell Number: GC-2
Cell Weight. 0.548 lbs.
N/P Ratio: 2.95/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.800	15.00	1.30	6.72	1.97	9.8	17.5
2	0.800	14.63	1.30	7.48	2.03		18.5
3	0.900	15.30	1.30	7.91	2.21		19.0
4	0.900	13.05	1.30	6.98	2.25	11.4	20.5
5	0.900	14.63	1 30	6.67	2.24		22.5
6	0.900	14.40	10.00	3.27	2.23		
7	0.800	16.00	10.00	0.00	2.64		
8	0.800	15.20	1.50	5.00	2.28		
9	0.850	14.05	2.20	5.13	2.07		
10	0.700	13.13	1.30	7.15	2.16		19.0
11	0.830	14.00	1.30	7.58	2.16	11.0	
12	0.900	14.40	1.30	6.93	2.05		
13	0.650	14.30	1.30	6.50	1.90		19.5
14	0.900	14.40	1.30	6.18	1.90		
15	0.900	14.40	1.30	6.28	1.93	8.2	
16	0.900	14.40	1.30	5.63	1.99		
17	0.900	14.40	1.30	5.46	1.90		
18	0.800	12.80	1.30	5.31	1.88		
19	0.650	10.40	1.30	5.31	1.88		
20	0.600	9.60	1.30	4.55	1.88		18.6
21	0.600	9.60	1.30	4.55	1.84		
22	0.650	10.40	1.30	4.98	1.86		
23	0.800	12.80	1.30	5.53	1.88		
24	0.900	14.40	1.30	5.42	1.86		
25-32	0.800	8.00	4.00	NOT	RECORDED		
33	0.800	8.00	4.00	1.14	1.90		
34-41	0.800	8.00	4.00	NOT	RECORDED		
42	0.800	8.00	4.00	3.64	1.97		
43	0.800	8.00	4.00	3.67	2.00		
44	0.800	8.00	4.00	3.68	1.95		
45	0.800	8.00	4.00	3.64	1.96		
46	0.800	8.00	4.00	3.60	1.96		
47	RECONDITIONING		CYCLE				31.0
48	0.700	12.60	1.00	3.70	1.98		
49	0.700	11.20	1.00	5.33	1.84		
50	0.700	11.20	1.00	5.12	1.89		
51	0.700	11.20	1.00	5.68	1.90		20.5
52	0.625	10.00	1.00	2.67	1.84		
53	0.600	10.50	1.00	5.08	1.86		
54	0.440	7.04	1.00	4.33	1.86		
55	0.490	6.10	1.00	5.00	1.86		
56	0.500	8.00	1.00	4.42	1.85		
57	0.700	11.20	1.00	5.58	1.87		
58	0.700	11.20	1.00	6.00	1.88		
59	0.700	11.20	1.00	5.67	1.89		
60	0.700	11.20	1.00	5.51	1.89		
61	0.700	11.20	1.00	5.42	1.89		
62	0.730	12.00	1.00	5.80	1.90		
63	0.750	12.00	1.00	5.50	1.88		
64	RECONDITIONING		CYCLE				
65	0.600	10.80	1.00	6.47	1.87		
66	0.750	12.38	1.00	5.00	1.88		
67	0.750	12.38	1.00	5.20	1.88		
68-69	0.750	12.40	1.00	NOT	RECORDED		
70	0.750	12.40	1.00	4.50	1.88		
71	0.500	10.50	1.00	4.00	1.88		
72	0.600	9.60	1.00	5.75	1.92		
73	0.700	9.60	1.00	5.67	1.92		

TABLE 26

TEST DATA FOR NI ZN CELLS

Cell Number: GC-2, continued
Cell Weight: 0.548 lbs.
N/P Ratio: 2.95/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
74	0.700	12.00	1.00	6.75	1.93		
75	0.700	11.20	1.00	6.90	1.92		
76	0.700	11.20	1.00	7.20	1.92		
77	0.750	11.20	1.00	7.25	1.92		
78	0.600	6.00	3.00	4.09	1.75		
79	0.600	6.00	3.00	4.09	1.75		
80	0.600	6.00	3.00	4.15	1.94		
81	0.600	6.00	3.00	4.37	1.95		
82	0.600	6.00	3.00	4.36	1.95		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	4.27	1.94		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	4.39	1.9?		
92	0.600	6.00	3.00	4.25	1.92		
93	0.600	6.00	3.00	4.18	1.93		
94	0.600	6.00	3.00	4.14	1.93		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	3.90	1.91		
97	RECONDITIONING		CYCLE				
98	0.800	12.80	1.00	5.25	1.95		
99	0.800	12.80	1.00	5.25	1.92		
100	0.800	12.80	1.00	4.75	1.92		
101-125	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	3.38	2.01		
127	0.600	6.00	3.00	3.30	1.88		
128	0.600	6.00	3.00	3.29	2.01		
129	0.600	6.00	2.60	2.99	2.00		
130	0.600	6.00	2.60	2.91	2.01		
131-144	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	2.63	2.05		
146-148	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING		CYCLE				28.0
150	0.500	8.50	1.00	3.50	1.99	21.0	
151	0.600	9.60	1.00	3.00	1.98		
152	0.700	11.20	1.00	4.00	1.93		
153	0.700	11.20	1.00	3.75	1.94		
154	0.700	11.20	1.00	4.00	1.96		
155	0.700	11.20	1.00	4.00	1.94		
156-167	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60	3.32	1.89		
169-180	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	1.56	1.89		
182-188	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	1.58	1.91		
190	0.600	4.20	2.52	1.26	1.88		
191	0.600	4.20	2.52	1.52	1.90		
192	0.600	4.20	2.52	1.65	1.93		
193	0.600	4.20	2.52	1.51	1.90		
194	0.600	4.20	2.52	1.26	1.86		
195	0.600	4.20	2.52	1.29	1.88		
196	0.600	4.20	2.52	1.29	1.87		
197	0.600	4.20	2.52	1.37	1.90		
198	0.600	4.20	2.52	1.44	1.92		
199	0.600	4.20	2.52	1.58	1.94		
200	0.600	4.20	2.52	1.86	1.95		
201	0.600	4.20	2.52	1.85	1.95		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	0.50	1.68		
204	0.600	9.60	1.00	2.33	1.97		
205	0.700	11.90	1.00	2.58	1.98	17.5	27.5

TABLE 27

TEST DATA FOR NI ZN CELLS

Cell Number: GI-1
Cell Weight: 0.537 lbs.
N/P Ratio: 2.95/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.800	13.00	1.30	4.88	1.95	15.0	62.0
2	0.800	14.63	1.30	7.30	1.91		13.5
3	0.900	15.30	1.30	7.15	1.87		17.0
4	0.900	13.05	1.30	6.24	1.85	7.0	15.5
5	0.900	14.63	1.30	5.81	1.84		15.5
6	0.900	14.40	10.00	5.00	1.83		
7	0.800	16.00	10.00	4.43	1.85		
8	0.800	13.20	1.50	NOT	RECORDED		
9	0.850	14.03	2.20	4.51	1.85	7.2	
10	0.700	13.13	1.30	3.68	1.83		23.0
11	0.830	14.00	1.30	3.97	1.85	7.6	
12	0.900	14.40	1.30	4.55	1.86		
13	0.650	14.30	1.30	5.09	1.87		
14	0.900	14.40	1.30	4.94	1.86		27.0
15	0.900	14.40	1.30	4.44	1.86	7.0	
16	0.900	14.40	1.30	4.03	1.86		
17	0.900	14.40	1.30	4.12	1.78		
18	0.800	12.80	1.30	4.66	1.88		
19	0.650	10.40	1.30	4.55	1.86		
20	0.600	9.60	1.30	3.68	1.84		18.5
21	0.600	9.60	1.30	3.58	1.86		
22	0.650	10.40	1.30	3.42	1.85		
23	0.800	12.80	1.30	3.90	1.87		
24	0.900	14.40	1.30	4.23	1.88		14.5
25-32	0.800	8.00	4.00	NOT	RECORDED		
33	0.800	8.00	4.00	2.73	1.84		
34-41	0.800	8.00	4.00	NOT	RECORDED		
42	0.800	8.00	4.00	2.73	1.89		
43	0.800	8.00	4.00	2.71	1.90		
44	0.800	8.00	4.00	2.84	1.89		
45	0.800	8.00	4.00	2.87	1.88		
46	0.800	8.00	4.00	3.13	1.89		12.0
47	RECONDITIONING		CYCLE				13.7
48	0.700	12.60	1.00	5.45	1.89		
49	0.700	11.20	1.00	5.10	1.79		
50	0.700	11.20	1.00	5.12	1.88		
51	0.700	11.20	1.00	6.37	1.91		14.0
52	0.625	10.00	1.00	2.88	1.85		
53	0.600	10.50	1.00	3.67	1.85		
54	0.440	7.04	1.00	2.75	1.86		
55	0.400	6.40	1.00	2.50	1.83		
56	0.500	8.00	1.00	3.22	1.85		
57	0.700	11.20	1.00	3.50	1.86		
58	0.700	11.20	1.00	3.00	1.86		
59	0.700	11.20	1.00	3.00	1.85		
60	0.700	11.20	1.00	3.00	1.85		
61	0.700	11.20	1.00	3.00	1.85		
62	0.750	12.00	1.00	3.10	1.85		
63	0.750	12.00	1.00	2.50	1.84		
64	RECONDITIONING		CYCLE				
65	0.600	10.80	1.00	3.47	1.85		
66	0.750	12.38	1.00	4.03	1.89		
67	0.750	12.38	1.00	4.50	1.89		
68-69	0.750	12.40	1.00	NOT	RECORDED		
70	0.750	12.40	1.00	3.45	1.89		
71	0.500	10.50	1.00	3.75	1.88		
72	0.600	9.60	1.00	3.75	1.91		
73	0.700	9.60	1.00	2.00	1.80		

TABLE 27

TEST DATA FOR NI ZN CELLS

Cell Number: GI-1, continued
Cell Weight: 0.537 lbs.
N/P Ratio: 2.95/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
74	0.700	12.00	1.00	1.90	1.86		
75	0.700	11.20	1.00	1.50	1.83		
76	0.700	11.20	1.00	2.00	1.84		
77	0.750	11.20	1.00	1.25	1.85		
78	0.600	6.00	3.00	1.24	1.68		
79	0.600	6.00	3.00	1.39	1.84		
80	0.600	6.00	3.00	1.28	1.83		
81	0.600	6.00	3.00	1.33	1.85		
82	0.600	6.00	3.00	1.06	1.82		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	0.82	1.81		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	0.99	1.83		
92	0.600	6.00	3.00	0.92	1.84		
93	0.600	6.00	3.00	0.94	1.84		
94	0.600	6.00	3.00	0.82	1.83		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	1.08	1.84		
97	RECONDITIONING		CYCLE				
98	0.800	12.80	1.00	1.50	1.85		
99	0.800	12.80	1.00	1.58	1.85		
100	0.800	12.80	1.00	2.07	1.88		
101-125	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	1.50	1.84		
127	0.600	6.00	3.00	1.36	1.85		
128	0.600	6.00	3.00	1.39	1.84		
129	0.600	6.00	2.60	1.34	1.85		
130	0.600	6.00	2.60	1.27	1.85		
131-144	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	1.12	1.84		
146-148	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING		CYCLE				17.0
150	0.500	8.50	1.00	0.75	1.84	14.5	
151	0.600	9.60	1.00	0.50	1.86		
152	0.700	11.20	1.00	1.50	1.78		
153	0.700	11.20	1.00	1.50	1.84		
154	0.700	11.20	1.00	1.50	1.83		
155	0.700	11.20	1.00	1.00	1.83		
156-167	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60				
169-180	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	0.65	1.83		
182-188	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	0.46	1.83		
190	0.600	4.20	2.52	0.45	1.83		
191	0.600	4.20	2.52	0.48	1.84		
192	0.600	4.20	2.52	0.38	1.82		
193	0.600	4.20	2.52	0.44	1.83		
194	0.600	4.20	2.52	0.47	1.84		
195	0.600	4.20	2.52	0.47	1.83		
196	0.600	4.20	2.52	0.47	1.83		
197	0.600	4.20	2.52	0.49	1.84		
198	0.600	4.20	2.52	0.42	1.82		
199	0.600	4.20	2.52	0.41	1.83		
200	0.600	4.20	2.52	0.45	1.83		
201	0.600	4.20	2.52	0.44	1.84		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	0.50	1.83		
204	0.600	9.60	1.00	0.75	1.85		
205	0.700	11.90	1.00	0.83	1.83	12.5	24.0

TABLE 28

TEST DATA FOR NI ZN CELLS

Cell Number: GI 2
Cell Weight: 0.540 lbs.
N/P Ratio: 2.95/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
1	0.800	13.00	1.30	5.85	1.94	12.5	46.0
2	0.800	14.63	1.30	7.97	1.93		17.0
3	0.900	15.30	1.30	7.58	1.86		15.5
4	0.900	13.05	1.30	6.28	1.83	7.4	16.5
5	0.900	14.63	1.30	6.07	1.84		15.5
6	0.900	14.40	10.00	5.10	1.86		
7	0.800	16.00	10.00	4.83	1.91		
8	0.800	13.20	1.50	6.30	1.93		17.0
9	0.850	14.63	2.20	5.35	1.86	6.9	
10	0.700	13.13	1.30	5.63	1.87		16.0
11	0.830	14.00	1.30	4.98	1.88	7.3	
12	0.900	14.40	1.30	6.18	1.87		
13	0.650	14.30	1.30	6.28	1.86		
14	0.900	14.40	1.30	5.96	1.86		20.0
15	0.900	14.40	1.30	6.07	1.86	7.3	
16	0.900	14.40	1.30	5.63	1.86		
17	0.900	14.40	1.30	5.31	1.86		
18	0.800	12.80	1.30	5.20	1.85		
19	0.650	10.40	1.30	4.88	1.90		
20	0.600	9.60	1.30	4.23	1.86		22.5
21	0.600	9.60	1.30	3.86	1.84		
22	0.650	10.40	1.30	3.58	1.86		
23	0.800	12.80	1.30	4.12	1.90		
24	0.900	14.40	1.30	3.90	1.90		
25-32	0.800	8.00	4.00	NOT	RECORDED		
33	0.800	8.00	4.00	2.92	1.86		
34-41	0.800	8.00	4.00	NOT	RECORDED		
42	0.800	8.00	4.00	2.40	1.88		
43	0.800	8.00	4.00	2.28	1.90		
44	0.800	8.00	4.00	2.26	1.89		
45	0.800	8.00	4.00	2.16	1.87		
46	0.800	8.00	4.00	2.20	1.90		14.5
47	RECONDITIONING		CYCLE				33.0
48	0.700	12.60	1.00	4.60	1.89		
49	0.700	11.20	1.00	NOT	RECORDED		
50	0.700	11.20	1.00	3.54	1.87		
51	0.700	11.20	1.00	4.67	1.89		27.0
52	0.625	10.00	1.00	2.07	1.84		
53	0.600	10.50	1.00	3.33	1.86		
54	0.440	7.04	1.00	2.83	1.82		
55	0.400	6.40	1.00	3.50	1.84		
56	0.500	8.00	1.00	3.40	1.85		
57	0.700	11.20	1.00	4.00	1.86		
58	0.700	11.20	1.00	3.50	1.85		
59	0.700	11.20	1.00	2.75	1.85		
60	0.700	11.20	1.00	3.00	1.85		
61	0.700	11.20	1.00	3.50	1.86		
62	0.730	12.00	1.00	3.20	1.86		
63	0.750	12.00	1.00	3.10	1.85		
64	RECONDITIONING		CYCLE				
65	0.600	10.80	1.00	4.08	1.85		
66	0.750	12.38	1.00	3.33	1.88		
67	0.750	12.38	1.00	3.13	1.89		
68-69	0.750	12.40	1.00	NOT	RECORDED		
70	0.750	12.40	1.00	3.45	1.89		
71	0.500	10.50	1.00	2.00	1.88		
72	0.600	9.60	1.00	2.05	1.90		
73	0.700	9.60	1.00	2.00	1.86		

TABLE 28

TEST DATA FOR NI ZN CELLS

Cell Number: GI-2, continued
Cell Weight: 0.540 lbs.
N/P Ratio: 2.95/1

Cycle #	Charge Rate (A)	Input (AH)	Discharge Rate (A)	Capacity (AH)	EOVC	Resistance Charged (mΩ)	Resistance Discharged (mΩ)
74	0.700	12.00	1.00	1.50	1.85		
75	0.700	11.20	1.00	1.50	1.85		
76	0.700	11.20	1.00	2.25	1.87		
77	0.750	11.20	1.00	1.25	1.87		
78	0.600	6.00	3.00	1.26	1.69		
79	0.600	6.00	3.00	1.26	1.69		
80	0.600	6.00	3.00	1.18	1.84		
81	0.600	6.00	3.00	1.20	1.84		
82	0.600	6.00	3.00	1.11	1.84		
83	0.600	6.00	3.00	NOT	RECORDED		
84	0.600	6.00	3.00	1.02	1.85		
85-90	0.600	6.00	3.00	NOT	RECORDED		
91	0.600	6.00	3.00	0.57	1.81		
92	0.600	6.00	3.00	0.15	1.75		
93	0.600	6.00	3.00	0.06	1.75		
94	0.600	6.00	3.00	0.18	1.79		
95	0.600	6.00	3.00	NOT	RECORDED		
96	0.600	6.00	3.00	0.50	1.84		
97	RECONDITIONING		CYCLE				
98	0.800	12.80	1.00	1.33	1.89		
99	0.800	12.80	1.00	1.42	1.87		
100	0.800	12.80	1.00	2.20	1.89		
101-125	0.600	6.00	3.00	NOT	RECORDED		
126	0.600	6.00	3.00	1.14	1.84		
127	0.600	6.00	3.00	1.06	1.81		
128	0.600	6.00	3.00	1.05	1.85		
129	0.600	6.00	2.60	0.78	1.82		
130	0.600	6.00	2.60	0.88	1.84		
131-144	0.600	4.20	2.60	NOT	RECORDED		
145	0.600	4.20	2.60	0.30	1.83		
146-148	0.600	4.20	2.60	NOT	RECORDED		
149	RECONDITIONING		CYCLE				30.0
150	0.500	8.50	1.00	1.25	1.82	17.0	
151	0.600	9.60	1.00	0.50	1.87		
152	0.700	11.20	1.00	2.55	1.84		
153	0.700	11.20	1.00	2.00	1.86		
154	0.700	11.20	1.00	1.50	1.86		
155	0.700	11.20	1.00	1.00	1.81		
156-167	0.600	4.20	2.60	NOT	RECORDED		
168	0.600	4.20	2.60	0.28	1.79		
169-180	0.600	4.20	2.60	NOT	RECORDED		
181	0.600	4.20	2.60	0.10	1.80		
182-188	0.600	4.20	2.60	NOT	RECORDED		
189	0.600	4.20	2.60	0.10	1.80		
190	0.600	4.20	2.52	0.07	1.79		
191	0.600	4.20	2.52	0.09	1.80		
192	0.600	4.20	2.52	0.09	1.80		
193	0.600	4.20	2.52	0.15	1.82		
194	0.600	4.20	2.52	0.14	1.81		
195	0.600	4.20	2.52	0.10	1.81		
196	0.600	4.20	2.52	0.10	1.79		
197	0.600	4.20	2.52	0.11	1.80		
198	0.600	4.20	2.52	0.14	1.81		
199	0.600	4.20	2.52	0.07	1.78		
200	0.600	4.20	2.52	0.11	1.80		
201	0.600	4.20	2.52	0.10	1.80		
202	RECONDITIONING		CYCLE				
203	0.500	8.00	1.00	0.93	1.86		
204	0.600	9.60	1.00	1.00	1.87		
205	0.700	11.90	1.00	1.25	1.87	12.0	23.0