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EVALUATION PROGRAM

for

SECONDARY SPACECRAFT CELLS

ACCEPTANCE TEST

OF

Mc DONNELL - DOUGLAS, ASTROPOWER DIVISION

5.0 AMPERE - HOUR SILVER - ZINC CELLS

prepared for

GODDARD SPACE FLIGHT CENTER

CONTRACT W12,397

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QUALITY EVALUATION LABORATORY

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DEPARTMENT OF THE NAVY
NAVAL AMMUNITION DEPOT
QUALITY EVALUATION DEPARTMENT
CRANE, INDIANA 47522

EVALUATION PROGRAM
FOR
SECONDARY SPACECRAFT CELLS

ACCEPTANCE TEST
OF
McDONNELL-DOUGLAS, ASTROPOWER DIVISION
5.0 AMPERE-HOUR SILVER-ZINC CELLS

QE/C 70-294 9 APRIL 1970

PREPARED BY

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By direction

Enclosure (1)

QE/C 70-294

REPORT BRIEF

ASTROPOWER 5.0 AMPERE-HOUR SEALED SILVER-ZINC SECONDARY SPACECRAFT CELLS

Ref: (a) NASA Purchase Order W12-397
(b) NASA ltr BRA/VBK/pad of 25 September 1961 w/BUWEPS first end FQ-1:WSK of 2 October 1961 to CO NAD Crane

I. TEST ASSIGNMENT

A. In compliance with references (a) and (b), 98 Astropower 5.0 ampere-hour cells, with an inorganic separator material, were constructed for NASA, Lewis Research Center, under contract NAS 3-10924. NAD Crane received these cells for evaluation of the cells' inorganic separator on various test programs; which are the synchronous, IMP, and 90-minute life cycling orbits, the constant potential, 120 percent recharge and the 30-day stand separator tests. Prior to the placement of the cells on these programs, the cells were evaluated for physical defects, seal quality, and ampere-hour capacity as outlined in the acceptance test procedure (Appendix I). This report covers the acceptance test phase of the evaluation program.

II. RESULTS

A. Leakage was detected in 82 cells prior to the capacity tests and in 60 cells after the capacity tests.

B. There were 41 cells that failed to deliver the required capacity of 5.5 ampere-hours.

III. COMMENTS

A. NASA, Lewis was informed that 41.8 percent of the cells did not meet the minimum capacity requirement; they then requested that 90 cells be placed on the various test programs as stated in the test assignment with eight cells held in reserve. NASA, Lewis felt that the information obtained from these tests would be meaningful in the evaluation of the cells' inorganic separator.

QE/C 70-294

RESULTS OF ACCEPTANCE TESTS OF 5.0 AMPERE-HOUR SEALED SILVER-ZINC SECONDARY SPACECRAFT CELLS MANUFACTURED BY THE ASTROPOWER DIVISION OF McDONNELL-DOUGLAS

I. INTRODUCTION

A. The Astropower Division of McDonnell-Douglas has developed an inorganic separator material which they incorporated into the construction of 5.0 ampere-hour silver-zinc cells (one cell is shown in Photograph 1). NAD Crane received 98 cells for evaluation of their inorganic separator on various test programs; which are the synchronous, IMP, and 90-minute life cycling orbits, also the constant potential, 120 percent recharge and the 30-day stand separator tests. Prior to the placement of the cells on these programs, they were subjected to acceptance tests in which each cell was tested for seal quality, physical defects, and ampere-hour capacity as outlined in the acceptance test procedure furnished by NASA, Goddard Space Flight Center (Appendix I).

II. CELL FORMATION

A. In accordance with instructions from McDonnell-Douglas Corporation (Appendix II), 73 cells were filled and formed at NAD Crane. The other 25 cells (serial numbers 3-1 through 3-25) were received filled and formed.

III. TEST CONDITIONS

A. All acceptance tests and formation cycles were performed at an ambient temperature between 23° C and 27° C, at existing relative humidity and atmospheric pressure.

IV. CAPACITY TESTS

A. Each cell was required to deliver a minimum of 5.5 ampere-hours when discharged at 2.5 amperes to 1.0 volt following the second charge at 350 milliamperes to 2.05 volts. There were 41 cells that did not meet this requirement. It was noted that cells that failed to meet this requirement had, in many instances, consecutive serial numbers. These results are listed in Table I.

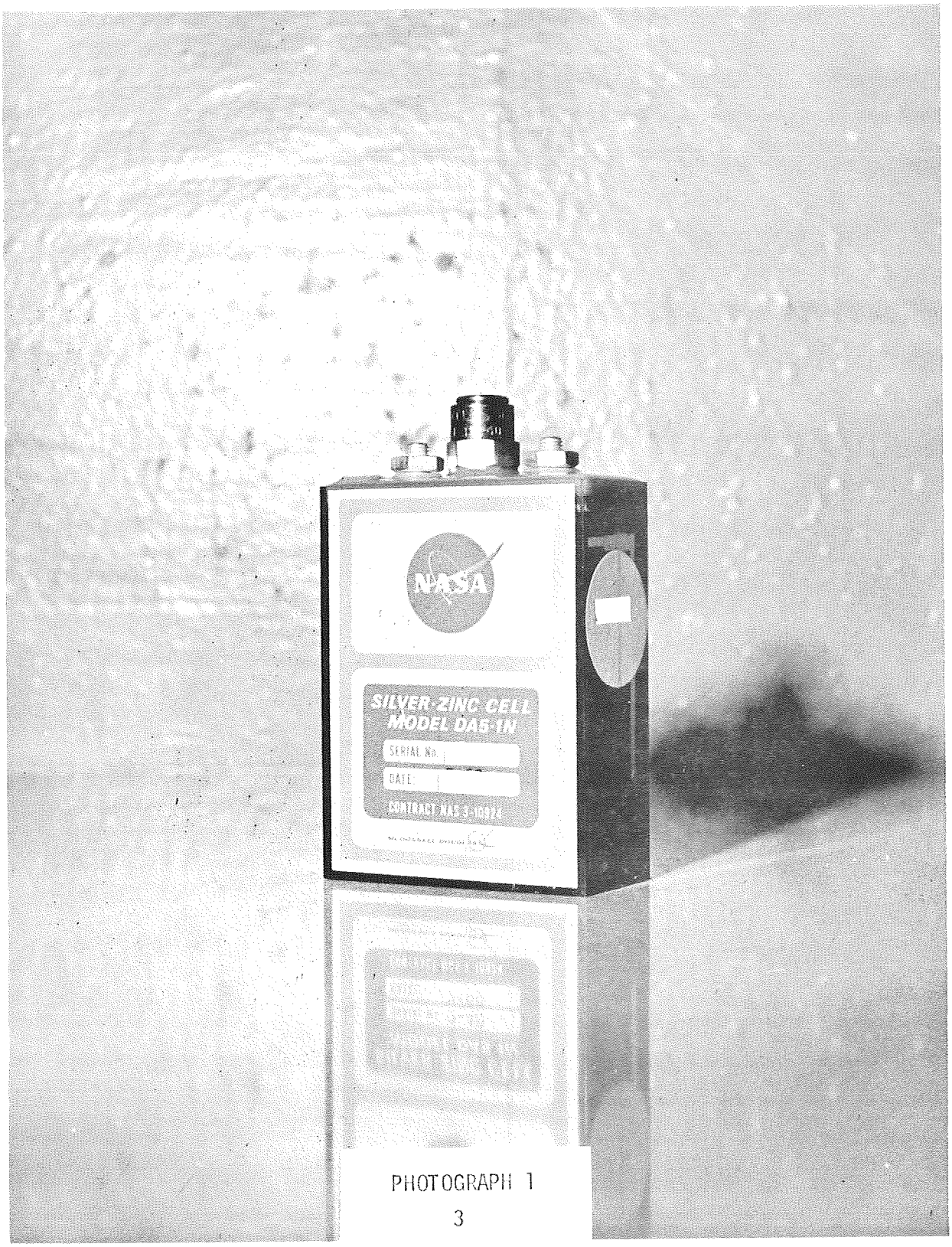
B. NASA, Lewis was informed that 41.8 percent of the cells failed to meet the minimum capacity requirement. NASA, Lewis requested that 90 cells be placed on the various test programs previously stated in the introduction and that eight cells be held in reserve.

V. PHYSICAL AND WEIGHT MEASURES

A. Each cell was weighed before and after the capacity tests. The cell dimensions, initial weight, and final weight are recorded in Table II.

VI. CASE INSPECTION AND LEAK TESTS

A. Visual inspection of the molded plastic case showed no defects before or after capacity tests. The terminals, fill port, and relief valve were checked by visual inspection and phenolphthalein solution for leaks. Prior to testing, nine cells had visible leaks and an additional 73 had leaks detected by phenolphthalein solution. After capacity tests, phenolphthalein solution detected 60 cells that leaked. Leakage mainly occurred in the fill ports of the cells. Terminal leakage was detected in 23 cells after capacity tests, 16 of these cells were in the group with serial numbers 3-1 through 3-25. The results of these tests are listed in Table III.



PHOTOGRAPH 1

TABLE I
CAPACITY TEST

Serial Number	AMPERE-HOURS IN AND OUT First Charge	First Discharge	Second Charge	Second Discharge	Third Charge	Third Discharge
3-1	6.68	6.12	6.05	6.03	4.99	4.31
3-2	6.64	6.10	6.11	5.93	5.07	4.42
3-3	6.60	6.01	5.91	5.76	4.96	4.18
3-4	6.70	6.01	6.13	5.86	4.74	4.21
3-5	6.53	5.84	6.04	5.83	4.94	4.28
3-6	6.55	5.86	5.76	5.54	4.83	4.00
3-7	6.63	6.10	6.04	5.76	4.67	4.04
3-8	6.65	6.10	6.00	5.79	5.08	4.49
3-9	6.73	6.13	6.32	6.09	5.03	4.44
3-10	6.74	6.11	6.35	5.91	4.95	4.34
3-11	6.55	5.87	5.87	5.71	5.01	4.19
3-12	6.53	5.86	6.32	6.00	4.78	4.09
3-13	6.59	5.88	5.99	5.76	4.91	4.22
3-14	6.55	5.89	6.07	5.75	4.85	4.13
3-15	6.48	5.84	6.14	5.85	4.80	4.24
3-16	6.63	5.89	6.09	5.90	4.93	4.31
3-17	6.41	5.83	5.81	5.54	4.53	3.77
3-18	6.59	5.87	6.25	5.99	5.01	4.31
3-19	6.51	5.85	5.96	5.72	4.74	4.17
3-20	6.48	5.87	6.11	5.80	4.67	4.13
3-21	5.97	5.59	5.86	5.30 *	5.33	4.20
3-22	6.13	5.78	5.77	5.14 *	5.38	4.36
3-23	6.11	5.74	5.89	5.18 *	5.32	3.90
3-24	6.07	5.72	5.81	5.47 *	5.72	4.54
3-25	6.14	5.83	5.96	5.41 *	5.61	4.46

* Less than 5.5 ampere-hours.

TABLE I (Contd)

Serial Number	AMPERE-HOURS IN AND OUT First Charge	First Discharge	Second Charge	Second Discharge	Third Charge	Third Discharge
4-1	5.68	6.52 **	6.22	5.72	6.07	5.18
4-2	5.80	6.71 **	6.34	5.78	6.12	5.22
4-3	5.50	6.11 **	5.93	5.42 *	5.70	4.75
4-4	5.58	6.26 **	5.95	5.60	5.88	4.80
4-5	5.57	6.07 **	5.97	5.51	5.93	4.87
4-6	5.83	6.44 **	6.09	5.56	5.88	4.78
4-7	5.98	6.47 **	6.27	5.82	6.26	5.37
4-8	5.86	6.33 **	6.05	5.68	5.91	4.84
4-9	6.72	6.94 **	6.70	6.30	6.55	5.58
4-10	6.57	6.64 **	6.38	5.96	6.90	4.83
4-11	5.90	6.24 **	6.00	5.63	5.83	4.88
4-12	6.12	6.73 **	6.15	5.72	6.00	5.15
4-13	5.67	6.11 **	5.98	5.67	5.82	4.81
4-14	5.98	6.65 **	6.21	5.68	6.06	5.22
4-15	5.61	5.88 **	6.20	5.41 *	5.69	4.75
4-16	6.20	5.78	6.02	5.31 *	5.61	4.38
4-17	6.03	5.67	5.86	5.03 *	5.41	4.28
4-18	6.00	5.04	5.40	4.62 *	4.86	3.84
4-19	5.89	5.49	5.63	4.87 *	5.21	4.12
4-20	5.92	5.68	6.00	5.31 *	5.62	4.50
4-21	5.86	5.53	5.89	5.11 *	5.46	4.50
4-22	5.82	5.59	5.90	5.11 *	5.34	4.36
4-23	5.65	5.55	5.85	5.10 *	5.38	4.40

* Less than 5.5 ampere-hours.

** Cells were not depleted of residual capacity with a 0.5 ohm resistor prior to start of capacity tests.

TABLE I (Contd)

Serial Number	AMPERE-HOURS IN AND OUT First Charge	First Discharge	Second Charge	Second Discharge	Third Charge	Third Discharge
5-1	5.50	5.29	5.59	4.82 *	5.11	4.01
5-2	5.66	5.31	5.62	4.82 *	5.16	4.01
5-3	5.64	5.41	5.78	5.04 *	5.28	3.95
5-4	5.78	5.36	5.64	5.02 *	5.33	4.36
5-5	5.87	5.57	5.94	5.20 *	5.49	4.51
5-6	6.14	5.87	6.07	5.43 *	5.81	4.94
5-7	6.01	5.77	5.82	5.24 *	5.64	4.77
5-8	6.09	5.76	5.90	5.03 *	5.55	4.43
5-9	5.88	5.73	5.78	5.04 *	5.41	4.47
5-10	5.96	5.75	5.83	5.07 *	5.45	4.44
5-11	5.96	5.73	5.78	5.03 *	5.52	4.65
5-12	6.05	5.77	5.80	5.08 *	5.44	4.61
5-13	7.23	7.02	7.00	6.60	6.70	5.57
5-14	7.16	6.84	6.85	6.23	6.40	5.44
5-15	6.87	6.47	6.49	5.95	6.00	5.11
5-16	7.00	6.63	6.61	6.06	6.25	5.36
5-17	6.85	6.58	6.67	6.19	6.16	5.06
5-18	7.25	7.06	7.04	6.61	6.75	5.67
5-19	7.25	6.96	6.94	6.50	6.59	5.50
5-20	6.90	6.65	6.68	6.25	6.39	5.39
5-21	7.24	6.99	6.88	6.34	6.36	5.30
5-22	7.27	7.01	7.07	6.57	6.74	5.78
5-23	7.26	7.20	7.28	6.87	6.98	5.82
5-24	7.44	7.12	7.05	6.66	6.80	5.67
5-25	7.26	6.94	6.89	6.41	6.60	5.58

* Less than 5.5 ampere-hours.

TABLE I (Contd)

Serial Number	AMPERE-HOURS IN AND OUT First Charge	First Discharge	Second Charge	Second Discharge	Third Charge	Third Discharge
6-1	5.41	5.27	5.19	5.05 *	5.11	4.05
6-2	5.48	5.26	4.97	4.68 *	4.74	3.69
6-3	5.78	5.66	5.62	5.47 *	5.64	4.25
6-4	5.27	5.17	5.11	5.00 *	5.03	4.05
6-5	7.86	7.81	7.85	7.32	7.46	6.16
6-6	7.57	7.49	7.49	7.05	7.49	5.16
6-7	4.93	4.80	4.71	4.58 *	4.61	3.56
6-8	5.63	5.48	5.30	5.13 *	5.25	4.30
6-9	5.25	5.12	5.11	4.96 *	4.96	3.99
6-10	4.70	4.59	4.49	4.17 *	4.22	3.69
6-11	5.42	5.25	5.16	5.03 *	5.12	4.21
6-12	5.47	5.41	5.28	5.19 *	5.49	4.21
6-13	5.51	5.37	5.27	5.14 *	5.25	4.10
6-14	7.74	7.62	7.75	7.30	7.35	6.22
6-15	7.88	7.82	7.83	7.44	7.61	6.31
6-16	6.61	6.47	6.56	6.42	6.47	5.42
6-17	5.04	4.91	4.60	4.13 *	4.81	3.97
6-18	4.98	4.88	4.91	4.79 *	4.86	3.86
6-19	6.69	6.48	6.40	6.24	6.37	5.08
6-20	6.46	6.30	6.30	6.18	6.29	4.85
6-21	6.11	5.95	5.98	5.60	5.11	4.28
6-22	5.34	5.19	5.04	4.67 *	4.55	3.85
6-23	7.85	7.63	7.83	7.32	7.09	5.62
6-24	7.85	7.65	7.73	7.23	6.95	5.51
6-25	6.63	6.42	6.36	5.99	5.51	4.72

* Less than 5.5 ampere-hours.

TABLE II
PHYSICAL AND WEIGHT MEASURES

Serial Number	Height (Inches)	Depth (Inches)	Width (Inches)	Weight Initial (Grams)	Weight Final (Grams)
3-1	3.344	1.054	2.287	231.5	232.1
3-2	3.360	1.057	2.284	230.4	230.7
3-3	3.334	1.048	2.292	230.2	231.8
3-4	3.340	1.050	2.277	231.5	232.0
3-5	3.337	1.065	2.280	231.4	231.8
3-6	3.350	1.045	2.288	230.1	230.6
3-7	3.342	1.049	2.282	230.8	231.3
3-8	3.348	1.056	2.280	230.3	230.7
3-9	3.343	1.055	2.276	231.6	232.1
3-10	3.340	1.056	2.284	230.9	231.2
3-11	3.353	1.060	2.279	231.2	231.5
3-12	3.356	1.048	2.281	231.1	231.5
3-13	3.355	1.052	2.286	231.7	231.2
3-14	3.340	1.061	2.285	229.6	229.9
3-15	3.344	1.055	2.280	231.5	229.9
3-16	3.344	1.059	2.281	230.6	231.1
3-17	3.363	1.050	2.284	230.7	231.0
3-18	3.343	1.056	2.291	230.8	231.2
3-19	3.355	1.055	2.283	230.3	231.0
3-20	3.341	1.048	2.280	230.3	230.7
3-21	3.340	1.060	2.278	231.4	231.3
3-22	3.335	1.059	2.282	230.1	229.8
3-23	3.344	1.080	2.284	230.9	230.8
3-24	3.338	1.068	2.283	231.9	231.8
3-25	3.344	1.065	2.287	229.2	228.6

TABLE II (Contd)

Serial Number	Height (Inches)	Depth (Inches)	Width (Inches)	Weight Initial (Grams)	Weight Final (Grams)
4-1	3.348	1.041	2.279	*	230.3
4-2	3.331	1.043	2.279	*	230.0
4-3	3.344	1.043	2.278	*	226.8
4-4	3.346	1.042	2.279	*	229.3
4-5	3.343	1.042	2.278	*	228.7
4-6	3.341	1.042	2.277	*	227.5
4-7	3.348	1.042	2.280	*	230.0
4-8	3.343	1.041	2.279	*	226.0
4-9	3.345	1.041	2.279	*	226.3
4-10	3.353	1.043	2.278	*	227.9
4-11	3.345	1.041	2.279	*	227.7
4-12	3.343	1.040	2.279	*	227.9
4-13	3.343	1.041	2.278	*	229.1
4-14	3.343	1.041	2.280	*	231.4
4-15	3.349	1.042	2.278	*	227.8
4-16	3.343	1.043	2.278	233.4	233.4
4-17	3.344	1.042	2.278	228.2	228.1
4-18	3.345	1.040	2.280	229.0	229.0
4-19	3.351	1.043	2.279	228.9	228.9
4-20	3.345	1.041	2.277	227.4	227.4
4-21	3.341	1.040	2.280	225.8	225.7
4-22	3.348	1.043	2.280	228.2	228.2
4-23	3.348	1.042	2.279	231.0	231.0

* Weights not available.

TABLE II (Contd)

Serial Number	Height (Inches)	Depth (Inches)	Width (Inches)	Weight Initial (Grams)	Weight Final (Grams)
5-1	3.349	1.040	2.278	228.3	228.3
5-2	3.344	1.038	2.279	226.2	226.2
5-3	3.350	1.040	2.281	228.2	228.2
5-4	3.345	1.040	2.280	229.1	229.1
5-5	3.344	1.037	2.279	228.2	228.2
5-6	3.349	1.040	2.281	226.7	226.5
5-7	3.341	1.039	2.281	225.3	225.3
5-8	3.344	1.039	2.279	228.2	228.1
5-9	3.346	1.040	2.281	229.2	229.2
5-10	3.351	1.040	2.280	227.7	227.7
5-11	3.350	1.040	2.280	228.6	228.6
5-12	3.344	1.040	2.279	229.1	229.1
5-13	3.350	1.038	2.281	231.9	232.0
5-14	3.343	1.040	2.280	230.9	230.8
5-15	3.348	1.040	2.281	231.2	231.2
5-16	3.341	1.039	2.281	231.1	231.1
5-17	3.351	1.040	2.281	229.7	229.8
5-18	3.347	1.040	2.280	231.5	231.5
5-19	3.340	1.039	2.281	230.3	230.2
5-20	3.350	1.041	2.278	230.1	230.0
5-21	3.352	1.039	2.280	231.2	231.0
5-22	3.346	1.039	2.280	230.3	230.1
5-23	3.344	1.038	2.279	231.3	231.3
5-24	3.341	1.039	2.276	231.5	231.4
5-25	3.352	1.041	2.281	231.9	231.9

TABLE II (Contd)

Serial Number	Height (Inches)	Depth (Inches)	Width (Inches)	Weight Initial (Grams)	Weight Final (Grams)
6-1	3.339	1.036	2.277	239.1	239.1
6-2	3.345	1.038	2.281	235.8	235.9
6-3	3.348	1.041	2.280	238.2	238.0
6-4	3.346	1.041	2.280	237.7	237.7
6-5	3.343	1.040	2.279	231.5	231.4
6-6	3.346	1.040	2.277	231.1	231.0
6-7	3.344	1.039	2.280	239.2	239.1
6-8	3.347	1.042	2.273	238.0	238.0
6-9	3.335	1.037	2.277	238.2	238.2
6-10	3.347	1.041	2.279	239.5	239.3
6-11	3.342	1.037	2.280	238.9	238.8
6-12	3.344	1.040	2.281	238.1	238.0
6-13	3.342	1.042	2.280	235.8	235.8
6-14	3.345	1.040	2.280	232.3	232.3
6-15	3.346	1.039	2.281	231.5	231.5
6-16	3.344	1.042	2.279	234.9	234.8
6-17	3.342	1.039	2.280	239.3	239.2
6-18	3.343	1.039	2.279	238.7	238.7
6-19	3.336	1.035	2.276	234.2	234.1
6-20	3.344	1.041	2.277	235.0	234.9
6-21	3.343	1.043	2.279	236.1	236.2
6-22	3.343	1.039	2.282	239.0	239.0
6-23	3.343	1.039	2.281	231.7	231.7
6-24	3.348	1.039	2.281	230.5	230.6
6-25	3.349	1.040	2.280	234.2	234.1

TABLE III
LEAKAGE TESTS

Serial Number	INITIAL Terminals Pos	Terminals Neg	Fill Port	Relief Valve	FINAL Terminals Pos	Terminals Neg	Fill Port	Relief Valve
3-1*	P	P	P		P	P	P	
3-2		P	P			P	P	
3-3		P	P				P	
3-4	P	P		P	P	P	P	
3-5	P	P	P	P	P	P	P	
3-6	P	P		P		P		
3-7		P	P				P	P
3-8*	P	P	P			P	P	P
3-9		P	P					
3-10	P	P	P			P		
3-11		P				P		
3-12		P	P			P	P	
3-13		P	P					
3-14	P	P		P				
3-15	P	P	P	P	P			
3-16	P				P			
3-17	P	P	P	P	P	P	P	
3-18		P	P					
3-19	P				P		P	
3-20*	P	P	P	P	P	P	P	
3-21	P	P	P	P				
3-22	P	P					P	
3-23	P	P	P			P		
3-24		P	P					
3-25	P	P	P		P	P		

P--Phenolphthalein
V--Visual
* Visible leakage within plastic container on arrival at NAD Crane.

TABLE III (Contd)

Serial Number	INITIAL Terminals Pos	Terminals Neg	Fill Port	Relief Valve	FINAL Terminals Pos	Terminals Neg	Fill Port	Relief Valve
4-1		P	P			P		
4-2		P	P					
4-3								
4-4			P					
4-5		P	P					
4-6								
4-7								
4-8								
4-9		P	P					
4-10								
4-11								
4-12		P	P					
4-13		P				P		
4-14			P					
4-15		P	P					
4-16			P				P	
4-17	P		P		P		P	
4-18			P		P	P		
4-19			P					
4-20			P				P	
4-21			P					
4-22			P					
4-23			P				P	

P--Phenolphthalein
V--Visual

TABLE III (Contd)

Serial Number	INITIAL Terminals Pos	Neg	Fill Port	Relief Valve	FINAL Terminals Pos	Neg	Fill Port	Relief Valve
5-1								
5-2			P				P	
5-3			P				P	
5-4			P				P	
5-5			P				P	
5-6			P					
5-7			P				P	
5-8			P				P	
5-9			P				P	
5-10			P				P	
5-11			P					
5-12			P				P	
5-13		P	VP				P	
5-14		P	P				P	
5-15			P				P	P
5-16			VP				P	
5-17		P	VP				P	
5-18	P		P					
5-19								
5-20			P				P	
5-21			VP					
5-22			P				P	P
5-23			P				P	P
5-24			P					
5-25								

P--Phenolphthalein
V--Visual

TABLE III (Contd)

Serial Number	INITIAL Terminals Pos	INITIAL Terminals Neg	INITIAL Fill Port	INITIAL Relief Valve	FINAL Terminals Pos	FINAL Terminals Neg	FINAL Fill Port	FINAL Relief Valve
6-1		P	P				P	
6-2			P			P	P	
6-3		P	P				P	
6-4		P	P				P	
6-5			P				P	
6-6			P					
6-7			P					
6-8		P	P				P	
6-9			P				P	
6-10		P	P					
6-11								
6-12			P					
6-13			P				P	
6-14						P		
6-15			P				P	
6-16			P				P	
6-17			P				P	
6-18							P	
6-19		P				P		
6-20								
6-21			P				P	
6-22			VP				P	
6-23								
6-24							P	
6-25		VP	P				P	

P--Phenolphthalein
V--Visual

APPENDIX I

ACCEPTANCE TEST PROCEDURE FOR ASTROPOWER INORGANIC SEPARATOR CELLS 27 MAY 1968

1. Inspect cell terminals and relief valve for corrosion or leaks (visual and phenolphthalein solution).

2. Inspect cases and epoxy for cracks or defects.

3. Check that all electrode and separator stacks are on bottom of case.

4. Weigh each cell to within one gram.

5. Discharge all cells with a .5 ohm resistor to 1.0 volt.

6. Charge at 350 milliamperes constant current to 2.05 volts, each cell. Record cell voltage after first minute of charge and every 30 minutes thereafter. Record ampere-hours in.

7. Discharge at 1.0 ampere constant current to 1.0 volt each cell. Record cell voltage after first minute of discharge and every 15 minutes thereafter. Record ampere-hours out.

8. Repeat paragraphs 6.0 and 7.0 twice, but with the second and third constant current discharges at 2.5 and 5.0 amperes, respectively.

9. Inspect cell terminals and relief valve for corrosion or leaks (visual and phenolphthalein solution).

10. Discharge all cells with a .5 ohm resistor to 1.0 volt.

11. Weigh each cell to within one gram.

APPENDIX II

INSTRUCTIONS FOR CELL ELECTROLYTE FILLING AND FORMATION

1. Electrolyte Filling

1.1 Raise the valve plunger with fingers and hold it up by inserting about 1/8" of a wooden stick.

1.2 Remove the screw of the filling hole at one corner of the cover.

1.3 Inject 22 cm^3 of 40% KOH by means of a hypodermic needle, through the filling hole, slowly so as to empty the syringe in about 10 minutes and avoid overflow.

1.4 Remove the wooden stick from the valve.

1.5 Apply vacuum for a few minutes so as to remove trapped air bubbles.

1.6 Replace the screw without tightening "O" ring.*

1.7 Let soak for a minimum of 24 hours.

2. Formation

2.1 Charge at 350 milliamperes constant current until the cell terminal voltage reaches 2.05 - 2.07 volts.

2.2 Discharge the cell at one ampere until the cell terminal voltage reaches 1.0 volt.

* Tighten "O" ring after completion of formation.

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