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AVIONICS SYSTEMS ENGINEERING DIVISION INTERNAL NOTE

SHUTTLE ELECTRICAL POWER ANALYSIS PROGRAM (SEPAP) SINGLE STRING CIRCUIT ANALYSIS REPORT

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1.0 SUMMARY

An analysis was conducted of the electrical bus characteristics of one string of the normal three string Shuttle electrical power distribution system. Nominal, minimum, and maximum instantaneous power and voltage levels were determined for each of the 23 Sortie 2A mission phases. A computer program was utilized which contains in its data base models of the distribution network, the fuel cell, and the inverter, plus information on individual component electrical parameters. Although only gross circuit characteristics were determined due to the preliminary nature of the input data, the range of power and voltage levels possible is of interest in the areas of bus and wiring sizing and load management. The results obtained for the single string are considered to be typical of the other two strings of the distribution system. The secondary objective of the effort, familiarity with the analysis computer program and files, was met and will be of benefit when the full computer analysis capability is available.

This single string analysis is the first step in a program to develop the capability at NASA/JSC to conduct detailed electrical power distribution and control system evaluations related to load management, peak power requirements, transient analysis, and contingency planning for the Space Shuttle.

2.0 INTRODUCTION

The Shuttle Electrical Power Analysis Program (SEPAP) provides NASA/JSC with a data base containing information on the electrical characteristics of the Shuttle components and with the capability of conducting power profile evaluations and distribution circuit analyses. This report contains an evaluation of the data obtained from an analysis of the distribution network characteristics of the Shuttle during a typical Sortie 2A mission. A description of the approach utilized in development of the computer program and data base is provided and conclusions are drawn from an analysis of the data. Summary data sheets are provided in the appendix for information to support the detailed discussion on each computer run.

2.1 Purpose

The purpose of this analysis effort was to determine the voltage on each distribution bus and the total power utilized by the components assigned to each bus at specific times during a mission. Based on this information, conclusions can be made regarding load distribution and bus and wiring sizing. Although the data is preliminary due to the status of the information on which the calculations are made, some indication of the adequacy of the system design at this point in the program can be determined.

2.2 Scope

The analysis described in this report is based on information provided to the SEPAP software development personnel

through mid-February 1974. The component power data is based on the official Rockwell Electrical Equipment list, dated October 1973. However, the component mission phase use factors are based on the Rockwell average power profile submitted to JSC in February 1974. In addition, the distribution circuit description is current as of the Orbiter PDR.

Due to computer software limitations at the time the report was initiated, only one string of the normal three string Shuttle power distribution network is evaluated. However, since the three individual strings are similar, one string may be evaluated and the results extrapolated to the other two strings. One string, for the purpose of this report, is defined as being composed of one fuel cell, the main bus and sub-busses associated with that fuel cell and the components normally assigned to these busses. This network string is not connected to any other string for purposes of this analysis.

2.3 General Approach

The computer program used to generate the single string circuit analysis data is based on a nodal solution program developed and utilized during the Apollo missions. The program has been updated to reflect the Shuttle electrical power distribution network and contains models of the fuel cell and the inverter. The power distribution system busses and sub-busses are identified as nodes and the electrical components are identified as loads connected between circuit nodes. By defining the power status of each component at the beginning of each of the 23 Rockwell mission phases, a circuit solution

can be derived for specific times in a Sortie 2A mission. The Sortie Mission 2A Timeline is included for information as table 1. A block diagram of the single string circuit is included as figure 1.

TABLE 1. – SORTIE MISSION 2A TIMELINE

PHASE NUMBER	PHASE NAME	PHASE DURATION			PHASE DURATION	PHASE START TIME		
		HR	MN	SEC	HOURS	HR	MN	SEC
1	Countdown/Launch	00	10	00	.167	00	00	00
2	Ascent to Insertion	00	09	55	.165	00	10	00
3	Coast to Apogee	00	14	23	.240	00	19	55
4	Circularization	00	12	24	.207	00	34	18
5	Phasing	18	35	59	18.600	00	46	42
6	Height Adjustment	03	54	36	3.908	19	22	41
7	Rendezvous	01	37	23	1.623	23	17	11
8	Docking	01	25	25	1.424	24	54	34
9	LSO Refurbish Opers.	20	00	00	20.0	26	19	59
10	Separation	02	49	10	2.819	46	19	59
11	Orbit Transfer	02	10	50	2.181	49	09	09
12	Sortie Exp Ops Begin Day 1	24	00	00	24.0	51	19	59
13	Sortie Exp Ops Begin Day 2	24	00	00	24.0	75	19	59
14	Sortie Exp Ops Begin Day 3	24	00	00	24.0	99	19	59
15	Sortie Exp Ops Begin Day 4	24	00	00	24.0	123	19	59
16	Sortie Exp Ops Begin Day 5	02	00	00	2.0	147	19	59
17	Phasing	16	10	25	16.174	149	19	59
18	Deorbit	00	43	28	.724	165	30	24
19	Entry (400 K Ft.to 47 K Ft.)	00	30	12	.503	166	13	52
20	Descent (47 K Ft. to 16 K Ft.)	00	03	16	.054	166]	47	20
21	Final App. (16 K Ft. to TD)	00	02	39	.044	166	49	59
22	Rollout (TD to STOP ROLL)	00	02	00	.033	166	51	59
23	Post Landing to GSE Connent	00	13	00	.217	166	53	59

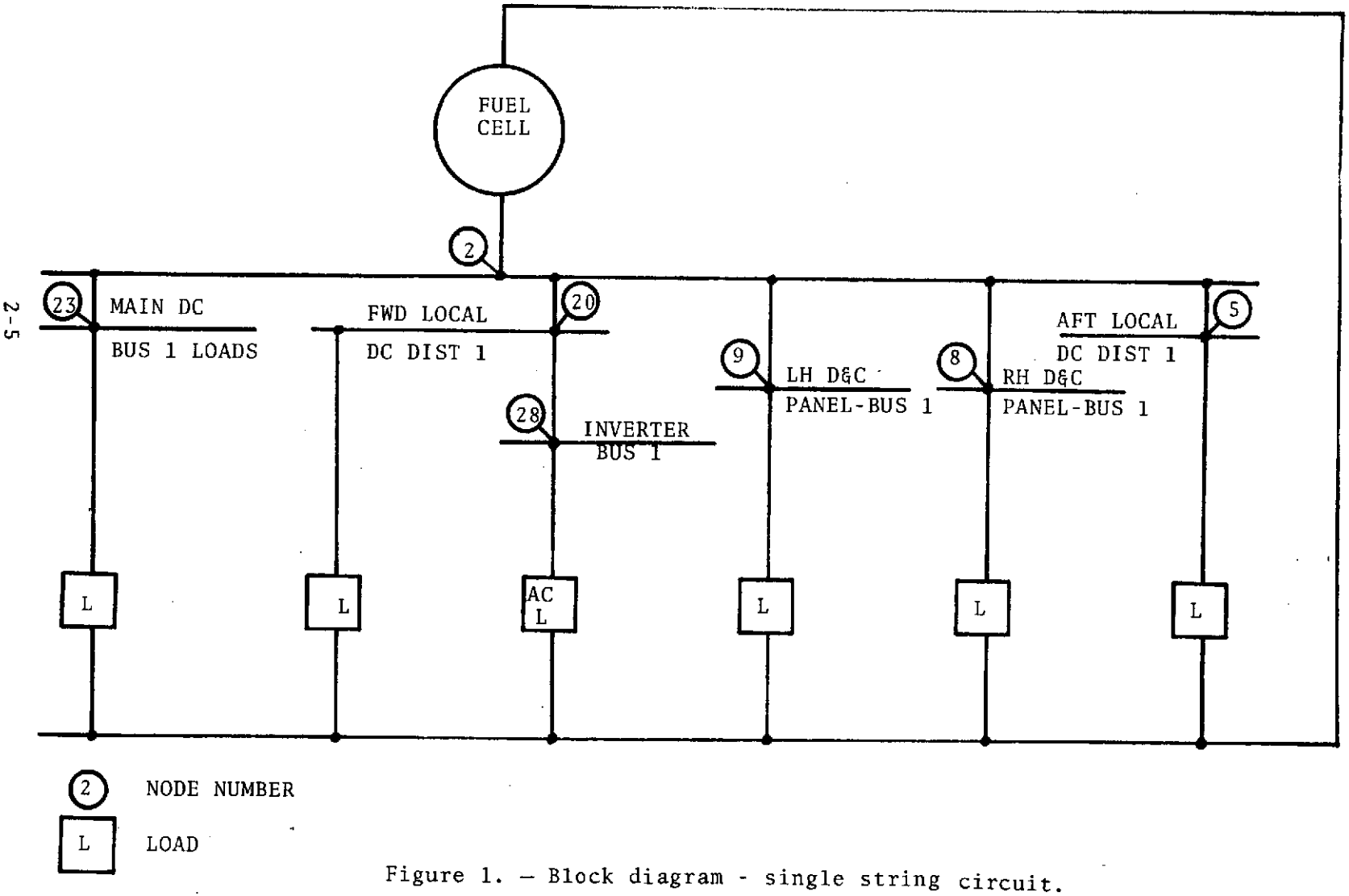

Figure 1. – Block diagram - single string circuit.

3.0 DISCUSSION AND EVALUATION

3.1 General

Six computer runs were made containing data on the distribution circuit parameters at the beginning of each of the 23 Rockwell mission 2A phases. For the first three runs it was assumed that the appropriate number, or at least one of each type of component was assigned in this string. A nominal run was made in which the component "use factors" were the same as in the Rockwell profile. The "use factor" is a weighing factor used to indicate the percent of time a component is operating during a phase and also reflects the number of components normally operating. A maximum value run was made in which it was assumed that if a component's use factor was more than zero for a phase, the use factor was set to be one (1.0) (i.e., 100%). Otherwise, the value was set at zero. Then a minimum value run was made in which all use factors less than one (1.0) in a phase were set to be zero. A second set of three runs was then made in which only those components actually assigned to the fuel cell #1 string were included. Nominal, maximum and minimum value runs were made under these conditions. The first set of runs provides worst case data while the second set provides an insight into the actual circuit conditions expected.

3.2 Detailed Computer Run Evaluations

Each of the six computer runs are discussed in the following paragraphs. The summary data sheets referenced are found in the appendices. The detailed data is available for review if required.

3.2.1 Nominal value run - all components included. In this run, at least one of each type of component was included using the nominal use factor from the Rockwell power profile. The data presented in appendix A includes the largest nominal values expected for any one of the three power distribution strings. The highest instantaneous demand on the fuel was slightly over eight kilowatts (KW) which is well within its capabilities. In addition, the largest demand from the inverters was 2,630 volt-amperes (VA) which is within its capability for a short duration. It is felt that proper balancing and sequencing of the loads should reduce the demand to within acceptable limits at all times under nominal conditions.

3.2.2 Minimum value run - all components included. No noteworthy values or indications were obtained from this run which deleted those components with a use factor less than one in each phase. The data is found in appendix B.

3.2.3 Maximum value run - all components included. The data presented in appendix C defines the worst case instantaneous conditions which might be found on any bus if all components were turned on at the same time. These values are not expected for the following reasons: one component of each type will not be assigned to a bus; components normally operated in sequence will not be on at the same time; many components operated for extremely short durations, i.e., all RCS thrusters, will not be operating at the same time. Although these extreme power and voltage values are not expected, they define a worst case condition which may be considered in the design and sizing of the electrical power distribution system.

3.2.4 Nominal value run - string #1 components only. This run provides the most information regarding the expected load conditions during a typical Sortie 2A mission. Instantaneous power required of the fuel cell and of the inverter are well within their nominal operating range. Nominal voltages and power requirements for each of the sub-busses may be evaluated to determine expected wire and bus sizing requirements. The data, which is found in appendix D, may be considered to be typical of any one of the three distribution strings. Nominal circuit characteristics for strings #2 and #3 are expected to be close to those found in this run for string #1 and less than those values found in appendix A.

3.2.5 Minimum value run - string #1 components only. By evaluating the data in appendix E it may be seen that in a number of phases the minimum instantaneous power required of the fuel cell is less than two kilowatts. Since the load on the fuel cell must be maintained at 2 KW due to voltage regulation considerations, the powering down of an individual string should be carefully monitored to ensure this limitation is observed.

3.2.6 Maximum value run - string #1 components only. The data found in appendix F contains the maximum possible power requirements on the indicated busses and the minumum voltages expected. It should be noted these values are not expected unless by some unforeseen circumstance all loads were activated at the same time. By examining the detailed data for those instances in which the power demands are excessive, it can be seen the condition is unlikely to occur due to the normal procedural order in which the loads are applied. An example would be the payload doors for which the

motors or loads are activated sequentially rather than simultaneously. The data does provide an indication of the maximum loads possible on the busses and these values should be considered in determining bus and wiring sizes.

4.0 EVALUATION SUMMARY

The information presented in the preceding paragraphs and in appendices A through F provide a gross indication of the bus loading expected for a typical Shuttle mission. Payload requirements and their effect on the power distribution system have not been considered. However, the instantaneous power envelopes defined in this analysis effort provide an indication of the system requirements as to bus and wiring sizing. Worst case conditions can be evaluated to insure overload and undervoltage conditions are avoided by design or by procedural control. Table 2 summarizes the maximum and minimum instantaneous power levels seen on the individual busses for each of the six computer runs. Figures 2 and 3 are graphs presenting the fuel cell power levels for each run for each of the 23 mission phases. It should be noted these are instantaneous power levels and should not be considered the power requirement for the entire phase.

The data obtained in this analysis effort should be evaluated with due consideration for the preliminary nature of the input parameters. Further analyses will be conducted as more accurate data is received from the contractors related to component power characteristics and bus assignments. A full three string analysis will be conducted early in Fiscal 1975 and the results provided to interested parties.

TABLE 2. – SINGLE STRING ANALYSIS BUS POWER RANGES

	Runs with All Components Included			Runs with String #1 Components Only		
	Nominal	Minimum	Maximum	Nominal	Minimum	Maximum
Fuel Cell Power	4.89-8.24	2.76-6.53	7.39-14.79	2.98-6.53	1.38-5.31	5.56-11.71
Main DC - Bus 1	4.80-7.95	2.74-6.35	7.16-13.72	2.95-6.36	1.37-5.20	5.43-11.08
Main DC - Bus 1 Loads	.03-.44	.05-.09	.10-.55	.03-.41	.06-.37	.11-.50
R.H. D&C Panel - Bus 1	.64-1.35	.56-1.24	.90-2.19	.03-.55	.34-.45	.50-.69
L.H. D&C PANEL - Bus 1	.27-.91	.05-.65	.71-1.87	.23-.83	.04-.54	.68-2.00
Fwd Local DC Dist. 1	2.75-5.29	1.64-4.06	3.78-7.21	1.74-4.08	.90-3.38	3.12-3.29
Aft Local DC Dist. 1	.15-1.65	.06-1.51	.26-3.01	.17-1.51	.06-1.20	.24-3.29
Inverter Bus 1	1.47-3.12	1.61-2.16	1.34-5.13	.83-1.84	.84-1.06	.77-4.08
Inverter (Volt-Amperes)	1.11-2.63	1.11-1.54	1.11-5.15	.58-1.39	.58-.78	.59-3.88
SEE APPENDICES	A	B	C	D	E	F

NOTE: All values in Kilowatts unless noted

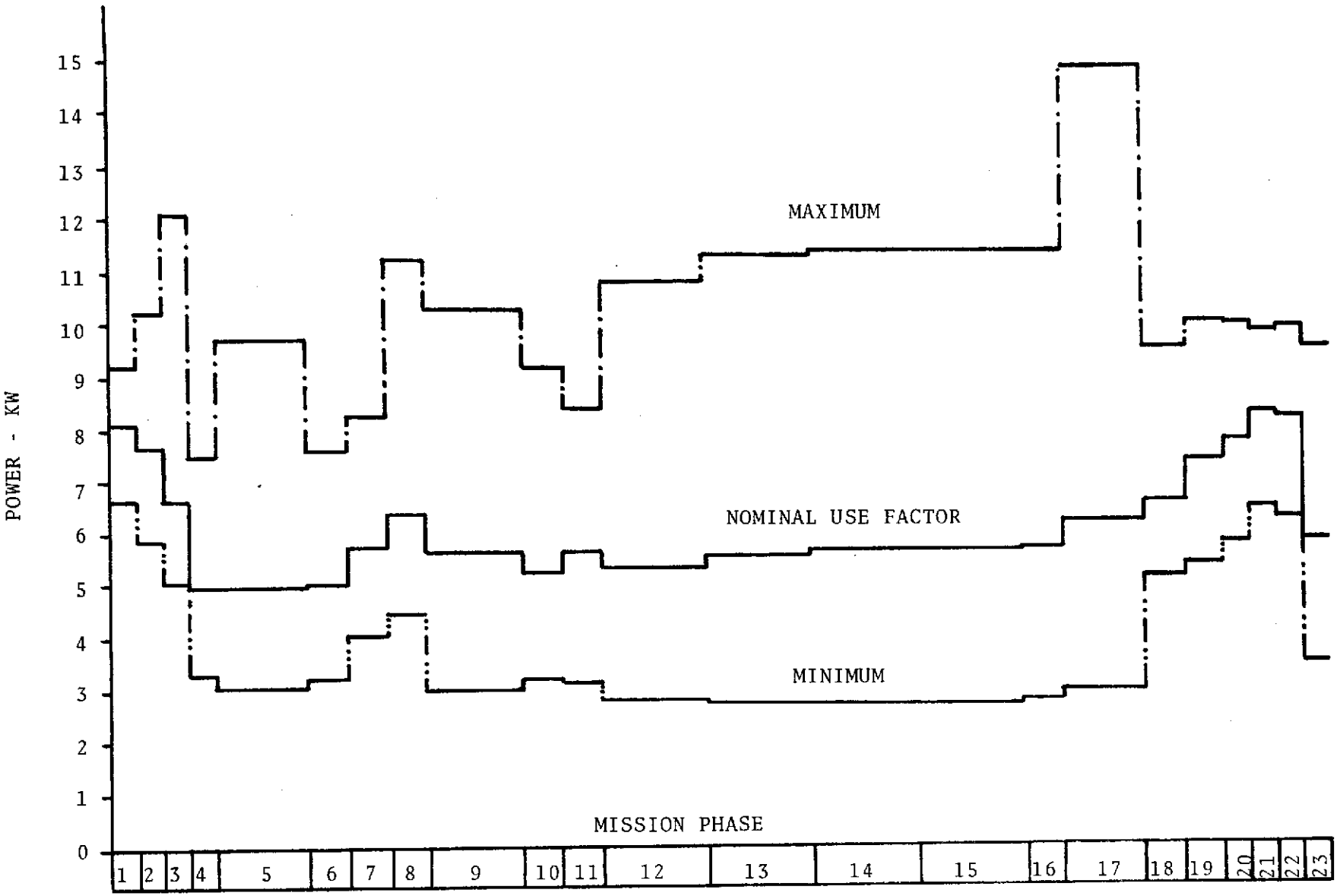

Figure 2. — Power profiles - all components included.

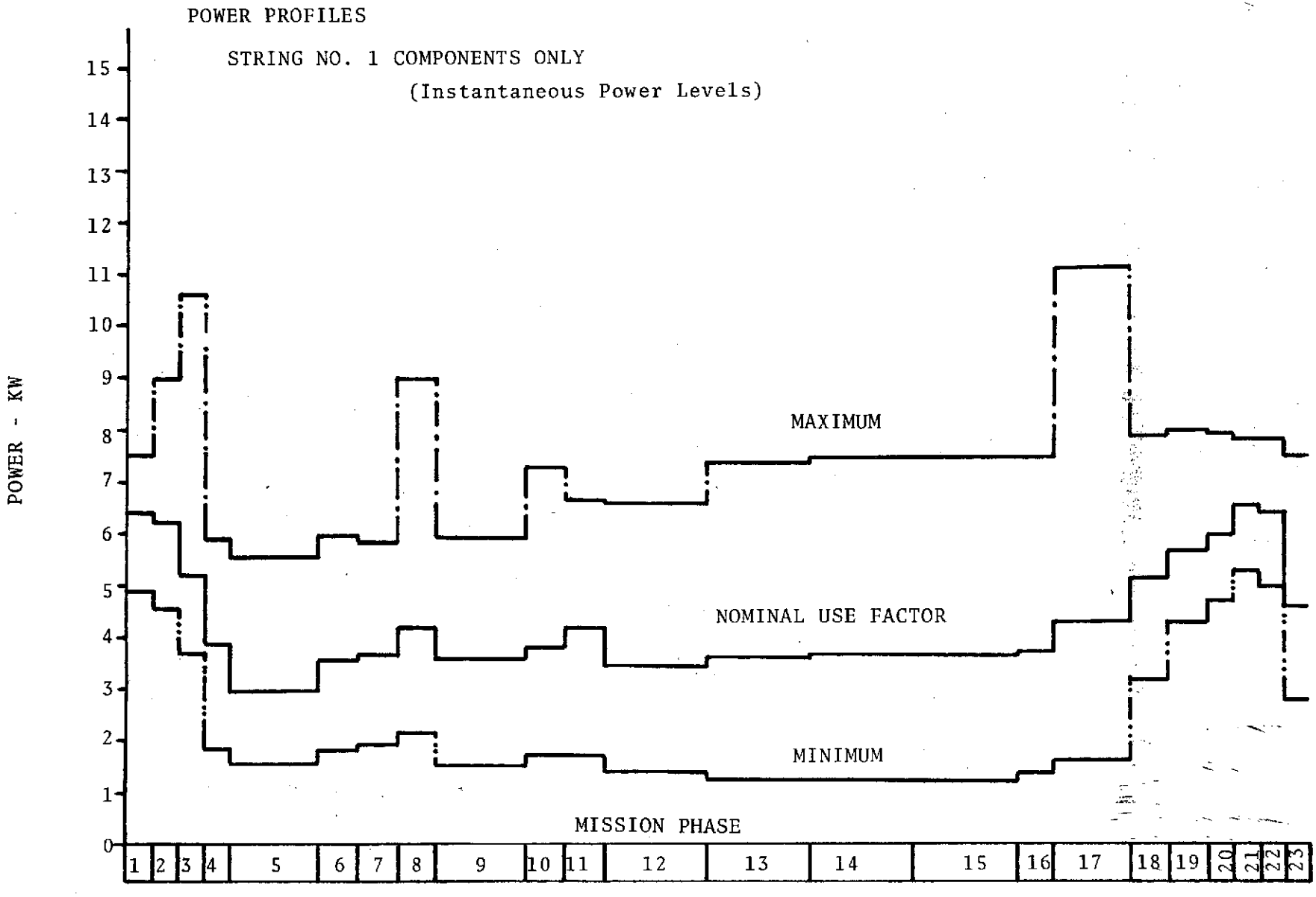

Figure 3. — Power profiles - String No. 1 components only.

APPENDICES

APPENDIX A

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Nominal Values

	BUS NUMBER AND TITLE		PHASE IDENTIFICATION/TIME					
			1	2	3	4	5	6
FUEL CELL	Cumulative Energy KWH		1.343	2.598905	4.166686	5.179585	96.193723	115.460280
	Power-Watts		8042.44	7611.02	6532.42	4893.23	4893.23	4930.030
	Volts		29.6202	29.7378	29.9981	30.5459	30.5459	30.5324
	Amperes		271.52	255.94	217.76	160.19	160.19	161.47
INV.	Volt-Amperes		1776.05	1820.30	1513.42	1176.35	1176.35	1112.06
	Watts		1776.05	1820.30	1513.42	1176.35	1176.35	1112.06
	Main DC Bus 1	V	28.6129	28.7883	29.1902	29.9516	29.9516	29.9333
		P	7768.96	7368.11	6356.41	4798.04	4793.04	4883.22
	Main DC Bus 1 Loads	V	28.6129	28.7882	29.1902	29.9516	29.9516	29.9333
		P	77.75	78.81	80.82	37.13	37.13	85.00
	R. H. D&C Panel Bus 1	V	28.3596	28.5343	28.9418	29.6295	29.6295	29.6388
		P	869.71	865.73	870.35	1155.29	1155.29	1056.84
	L. H D&C Panel Bus 1	V	28.3467	28.5474	28.9502	29.8671	29.8671	29.7901
		P	913.52	832.60	841.20	305.73	305.73	516.55
	Fwd Local DC Dist. 1	V	27.9963	28.1657	28.6209	29.5122	29.5122	29.5206
		P	4119.88	4185.12	3888.99	3094.88	3094.88	2908.17
	Inverter Bus 1	V	27.9955	28.1649	28.6202	29.5116	29.5116	29.5201
		P	2182.66	2262.66	1954.21	1617.78	1617.78	1531.44
	Aft Local DC Dist. 1	V	28.0571	28.3647	29.0012	29.9057	29.9057	29.8660
		P	1648.31	1269.90	579.54	145.11	145.11	212.60
		V						
		P						
		V						
		P						

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Nominal Values

			PHASE IDENTIFICATION/TIME					
			7	8	9	10	11	12
FUEL CELL	Cumulative Energy KWH		124.723	133.713	244.425	259.122	271.272	400.158
	Power-Watts		5706.92	6313.14	5535.61	5213.53	5570.93	5370.24
	Volts		30.2872	30.0592	30.3589	30.4277	30.3370	30.3696
	Amperes		188.43	210.02	182.34	171.34	183.63	176.83
INV.	Volt-Amperes		1533.08	1737.44	1178.30	1123.90	1112.06	1176.26
	Watts		1533.08	1737.44	1178.30	1123.90	1112.06	1176.26
BUS NUMBER AND TITLE	Main DC	V	29.5882	29.2800	29.6824	29.7921	29.6557	29.7136
	Bus 1	P	5575.45	6149.47	5412.33	5104.37	5445.79	5254.11
	Main DC	V	29.5881	29.2798	29.6823	29.7920	29.6557	29.7136
	Bus 1 Loads	P	116.86	439.81	316.97	238.91	83.47	26.96
	R. H. D&C Panel	V	29.2284	28.8952	29.3394	29.4718	29.3413	29.3726
	Bus 1	P	1273.17	1345.95	1218.20	1142.53	1117.10	1212.38
	L.H. D&C Panel	V	29.4373	29.1288	29.5752	29.6406	29.4894	29.6352
	Bus 1	P	537.71	533.18	383.82	543.68	593.82	281.21
	Fwd Local	V	29.1008	28.7597	29.2151	29.3876	29.2630	29.3067
	DC Dist. 1	P	3385.20	3571.02	3257.87	2836.71	2742.83	2845.94
	Inverter	V	29.1001	28.7589	29.2146	29.3871	29.2625	29.3061
	Bus 1	P	2035.45	2244.91	1588.10	533.56	1504.83	1595.27
	Aft Local	V	29.5282	29.2237	29.6289	29.7005	29.3825	29.4483
	DC Dist. 1	P	187.17	173.84	167.43	287.58	848.60	825.74
		V						
		P						
		V						
		P						

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Nominal Values

			PHASE IDENTIFICATION/TIME					
			13	14	15	16	17	18
FUEL CELL	Cumulative Energy KWH		532.445	665.879	799.272	810.481	909.362	914.073
	Power-Watts		5511.98	5559.75	5558.02	5604.83	6113.55	6508.39
	Volts		30.3673	30.3411	30.3508	30.3246	30.1557	30.0048
	Amperes		181.51	183.24	183.13	184.83	202.73	216.91
INV.	Volt-Amperes		1176.26	1176.26	1176.26	1176.26	1224.91	1127.00
	Watts		1176.26	1176.26	1176.26	1176.26	1224.91	1127.00
BUS NUMBER AND TITLE	Main DC	V	29.6939	29.6613	29.6714	29.6389	29.4035	29.2001
	Bus 1	P	5389.73	5435.17	5433.59	5478.09	5961.16	6334.08
	Main DC	V	29.6939	29.6613	29.6714	29.6389	29.4035	29.2000
	Bus 1 Loads	P	26.93	26.88	26.90	26.85	26.54	81.21
	R. H. D&C Panel	V	29.3541	29.3222	29.3325	29.3001	29.1044	28.9250
	Bus 1	P	1207.90	1203.88	1203.50	1201.67	1253.81	963.34
	L.H. D&C Panel	V	29.6182	29.5818	29.5919	29.5449	29.3068	28.9525
	Bus 1	P	271.71	284.64	284.84	336.16	343.25	867.92
	Fwd Local	V	29.2898	29.2593	29.2712	29.2387	28.9681	28.7396
	DC Dist. 1	P	2825.22	2807.07	2796.00	2792.94	3010.28	3158.37
	Inverter	V	29.2892	29.2588	29.2706	29.2381	28.9675	28.7391
	Bus 1	P	1593.54	1590.36	1591.68	1587.98	1621.26	1473.90
	Aft Local	V	29.3740	29.3233	29.3304	29.2983	28.9307	28.8126
	DC Dist. 1	P	993.48	1047.50	1057.32	1055.00	1446.09	1180.14
		V						
		P						
		V						
		P						

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Nominal Values

			PHASE IDENTIFICATION/TIME					
			19	20	21	22	23	
FUEL CELL	Cumulative Energy KWH		917.785	918.198	918.561	918.830	920.129	
	Power-Watts		7379.02	7646.85	8241.75	8143.01	5986.17	
	Volts		29.8024	29.7278	29.5415	29.5751	30.1497	
	Amperes		247.60	257.23	278.99	275.50	198.55	
INV.	Volt-Amperes		2532.75	2566.00	2630.00	2610.00	1755.00	
	Watts		2532.75	2566.00	2630.00	2610.00	1755.00	
BUS NUMBER AND TITLE	Main DC	V	28.8838	28.7735	28.5065	28.5530	29.4131	
	Bus 1	P	7151.56	7401.16	7953.14	7866.17	5839.76	
	Main DC	V	28.8838	28.7734	28.5064	28.5530	29.4131	
	Bus 1 Loads	P	79.20	78.41	77.32	77.17	82.10	
	R.H. D&C Panel	V	28.6891	28.5551	28.2901	28.3362	29.2716	
	Bus 1	P	676.26	755.03	741.16	743.73	640.81	
	L.H. D&C Panel	V	28.6517	28.5539	28.2915	28.3377	29.2717	
	Bus 1	P	805.09	759.08	736.15	738.55	501.22	
	Fwd Local	V	28.1780	28.0635	27.7064	27.7548	28.8875	
	DC Dist. 1	P	4747.02	4755.28	5290.52	5287.23	3623.23	
	Inverter	V	28.1769	28.0623	27.7053	27.7537	28.8867	
	Bus 1	P	3105.48	3118.70	3112.96	3101.13	2315.68	
	Aft Local	V	28.6499	28.4706	28.1931	28.2692	29.2716	
	DC Dist. 1	P	708.37	911.53	933.78	847.89	1048.45	
		V						
		P						
		V						
		P						

APPENDIX B

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Minimum Values

BUS NUMBER AND TITLE			PHASE IDENTIFICATION/TIME					
			1	2	3	4	5	6
FUEL CELL	Cumulative Energy KWH		1.0897	2.050	3.244	3.915	59.119	71.617
	Power-Watts		6525.15	5817.04	4977.44	3240.33	2967.95	3198.25
	Volts		30.0398	30.2468	30.5150	31.1565	31.2536	31.1732
	Amperes		217.22	192.32	163.11	104.00	94.96	102.60
INV.	Volt-Amperes		1283.00	1203.00	1185.00	1112.00	1112.00	1112.00
	Watts		1283.00	1203.00	1185.00	1112.00	1112.00	1112.00
	Main DC	V	29.2339	29.5333	29.9098	30.7707	30.9013	30.7917
	Bus 1	P	6350.10	5679.55	4878.80	3200.54	2934.49	3159.06
	Main DC	V	29.2339	29.5333	29.9098	30.7707	--	30.7917
	Bus 1 Loads	P	54.36	55.20	56.97	60.55	--	60.25
	R.H. D&C Panel	V	29.0181	29.3153	29.6979	30.5151	30.6463	30.5328
	Bus 1	P	754.10	773.71	761.76	944.01	946.22	956.85
	L.H. D&C Panel	V	29.0501	29.3841	29.7587	30.7198	30.8880	30.7432
	Bus 1	P	646.54	530.81	544.43	189.26	49.87	180.54
	Fwd Local	V	28.7554	29.0647	29.4385	30.5182	30.6478	30.5391
	DC Dist. 1	P	3283.47	3251.11	3311.01	1838.88	1854.35	1841.20
	Inverter	V	28.7548	29.0641	29.4380	30.5177	30.6473	30.5386
	Bus 1	P	1680.60	1613.58	1631.08	1625.25	1638.91	1627.28
	Aft Local	V	28.7346	29.2104	29.8644	30.7262	30.8827	30.7620
	DC Dist. 1	P	1516.63	997.11	143.24	144.41	60.81	96.52
		V						
		P						
		V						
		P						

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SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Minimum Values

			PHASE IDENTIFICATION/TIME					
			7	8	9	10	11	12
FUEL CELL	Cumulative Energy KWH		78.194	84.493	142.849	151.892	158.702	225.611
	Power-Watts		4052.00	4423.53	2917.80	3207.82	3122.67	2787.87
	Volts		30.8847	30.7175	31.2728	31.1687	31.2259	31.3222
	Amperes		131.20	144.01	93.30	102.92	100.00	89.01
INV.	Volt-Amperes		1532.00	1540.00	1112.00	1112.00	1112.00	1112.00
	Watts		1532.00	1540.00	1112.00	1112.00	1112.00	1112.00
BUS NUMBER AND TITLE	Main DC Bus 1	V	30.3979	30.1832	30.9266	30.7869	30.8549	30.9920
		P	3988.19	4346.33	2885.50	3168.48	3085.83	2758.48
	Main DC Bus 1 Loads	V	30.3979	30.1831	--	30.7869	30.8549	--
		P	94.17	409.72	--	60.24	60.80	--
	R.H. D&C Panel Bus 1	V	30.0752	29.8410	30.6518	30.5082	30.5905	30.7403
		P	1175.23	1236.34	1019.92	1029.14	979.32	936.55
	L.H. D&C Panel Bus 1	V	30.3386	30.1224	30.8896	30.7011	30.7770	30.9682
		P	217.93	221.75	138.57	318.88	290.42	89.23
	Fwd Local DC Dist. 1	V	30.0680	29.8541	30.7022	30.5619	30.6310	30.7670
		P	2367.85	2344.86	1644.40	1641.09	1637.22	1651.81
	Inverter Bus 1	V	30.0673	29.8534	30.7016	30.5613	30.6305	30.7665
		P	2160.46	2140.41	1644.37	1641.07	1637.19	1651.78
	Aft Local DC Dist. 1	V	30.3686	30.1541	30.8896	30.7572	30.8252	30.9733
		P	94.06	92.95	60.91	96.49	96.91	61.17
		V						
		P						
		V						
		P						

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SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Minimum Values

			PHASE IDENTIFICATION/TIME					
			13	14	15	16	17	18
FUEL CELL	Cumulative Energy KWH		291.959	358.307	424.655	430.239	478.215	481.850
	Power-Watts		2764.50	2764.50	2764.50	2792.11	2966.22	5020.16
	Volts		31.3560	31.3560	31.3560	31.3460	31.2543	30.4992
	Amperes		88.16	88.16	88.16	89.07	94.91	164.60
INV.	Volt-Amperes		1112.00	1112.00	1112.00	1112.00	1112.00	1124.00
	Watts		1112.00	1112.00	1112.00	1112.00	1112.00	1124.00
BUS NUMBER AND TITLE	Main DC Bus 1	V	31.0289	31.0289	31.0289	31.0155	30.9022	29.8885
		P	2735.66	2735.66	2735.66	2762.68	2932.81	4919.74
	Main DC Bus 1 Loads	V	--	--	--	--	--	29.8885
		P	--	--	--	--	--	56.91
	R.H. D&C Panel Bus 1	V	30.7770	30.7770	30.7770	30.7637	30.6535	29.6419
		P	938.79	938.79	938.79	937.98	922.98	885.21
	L.H. D&C Panel Bus 1	V	31.0129	31.0129	31.0129	30.9917	30.8752	29.7446
		P	60.08	60.08	60.08	89.36	100.83	518.22
	Fwd Local DC Dist. 1	V	30.8037	30.8037	30.8037	30.7904	30.6487	29.4320
		P	1655.50	1655.50	1655.50	1654.06	1854.43	3206.72
	Inverter Bus 1	V	30.8032	30.8032	30.8032	30.7899	30.6481	29.4315
		P	1655.47	1655.47	1655.47	1654.03	1638.97	1527.54
	Aft Local DC Dist. 1	V	31.0102	31.0102	31.0102	30.9969	30.8925	29.8274
		P	61.31	61.31	61.31	61.26	31.64	192.73
		V						
		P						
		V						
		P						

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SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Minimum Values

			PHASE IDENTIFICATION/TIME					
			19	20	21	22	23	
FUEL CELL	Cumulative Energy KWH		484.535	484.844	485.127	485.332	486.183	
	Power-Watts		5339.75	5720.22	6415.44	6221.78	3920.51	
	Volts		30.4291	30.2824	30.0748	30.1267	30.8990	
	Amperes		175.48	188.90	213.32	206.52	126.88	
INV.	Volt-Amperes		1294.00	1350.00	1430.00	1260.00	1175.00	
	Watts		1294.00	1350.00	1430.00	1260.00	1175.00	
BUS NUMBER AND TITLE	Main DC Bus 1	V	29.7781	29.5816	29.2834	29.3605	30.4283	
		P	5225.36	5587.51	6246.94	6063.43	3860.72	
	Main DC Bus 1 Loads	V	29.7781	29.5816	29.2834	29.3605	30.4283	
		P	56.24	55.33	54.85	54.71	58.82	
	R.H. D&C Panel Bus 1	V	29.6215	29.3899	29.0937	29.1703	30.2510	
		P	561.55	682.02	668.34	671.86	649.35	
	L.H. D&C Panel Bus 1	V	29.6341	29.4385	29.1418	29.2186	30.3963	
		P	516.60	509.80	499.58	502.21	117.72	
	Fwd Local DC Dist. 1	V	29.2917	29.0880	28.6906	28.7970	30.1665	
		P	3400.73	3426.15	4059.09	3872.99	1884.74	
	Inverter Bus 1	V	29.2911	29.0874	28.6900	28.7964	30.1659	
		P	1737.53	1785.98	1838.64	1636.05	1676.01	
	Aft Local DC Dist. 1	V	29.5785	29.3101	29.0009	29.0773	30.0771	
		P	624.04	841.14	866.01	870.58	1116.52	
		V						
		P						
		V						
		P						

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SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Maximum Values

			PHASE IDENTIFICATION/TIME					
			1	2	3	4	5	6
FUEL CELL	Cumulative Energy KWH		1.534	3.220	6.105	7.636	187.290	216.570
	Power-Watts		9188.18	10216.89	12021.06	7395.16	9658.75	7492.34
	Volts		29.2085	28.8400	28.3492	29.7979	28.9518	29.7709
	Amperes		314.57	354.26	424.04	248.18	333.62	251.67
INV.	Volt-Amperes		2148.00	3668.00	4468.00	1118.00	1393.00	1118.00
	Watts		2148.00	3668.00	4468.00	1118.00	1393.00	1118.00
BUS NUMBER AND TITLE	Main DC	V	28.0415	27.5257	26.7760	28.8772	27.7141	28.8372
	Bus 1	P	8820.99	9751.33	11354.03	7166.38	9245.86	7257.19
	Main DC	V	28.0414	27.5256	26.7760	28.8771	27.7141	28.8372
	Bus 1 Loads	P	124.43	120.03	113.58	131.77	121.60	131.50
	R.H. D&C Panel	V	27.7419	27.2316	26.4929	28.4947	27.0644	28.4451
	Bus 1	P	1006.23	969.55	907.97	1319.39	2128.68	1350.21
	L.H. D&C Panel	V	27.7307	27.2383	26.1524	28.6029	27.4394	28.5581
	Bus 1	P	1043.48	947.53	1974.66	949.73	912.62	965.11
	Fwd Local	V	27.3363	26.5912	25.6955	28.3053	26.8455	28.2608
	DC Dist. 1	P	4600.13	5930.27	6626.50	3863.60	5564.94	3887.70
	Inverter	V	27.3354	26.5897	25.6938	28.3048	26.8449	28.2603
	Bus 1	P	2499.59	3942.53	4432.04	1425.19	1591.06	1420.83
	Aft Local	V	27.3987	26.9912	26.2829	28.6161	27.6193	28.5697
	DC Dist. 1	P	1861.60	1524.89	1370.20	789.87	276.85	807.95
		V						
		P						
		V						
		P						

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SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Maximum Values

			PHASE IDENTIFICATION/TIME					
			7	8	9	10	11	12
FUEL CELL	Cumulative Energy KWH		229.869	245.798	450.572	476.169	494.425	751.802
	Power-Watts		8194.23	11186.28	10238.70	9080.08	8370.32	10724.04
	Volts		29.5586	28.5186	28.8341	29.1709	29.4953	28.7039
	Amperes		277.22	392.25	355.09	311.27	283.78	373.61
INV.	Volt-Amperes		1738.00	5146.00	1593.00	1926.00	1118.00	1393.00
	Watts		1738.00	5146.00	1593.00	1926.00	1118.00	1393.00
BUS NUMBER AND TITLE	Main DC	V	28.5301	27.0633	27.5168	28.0161	28.4424	27.3178
	Bus 1	P	7909.01	10615.46	9770.81	8720.52	8071.56	10206.38
	Main DC	V	28.5300	27.0632	27.5166	28.0159	28.4424	27.3178
	Bus 1 Loads	P	159.94	491.67	551.20	447.63	128.13	118.35
	R.H. D&C Panel	V	28.0731	26.6194	26.8545	27.6012	27.9935	26.6271
	Bus 1	P	1553.07	1430.79	2153.11	1386.39	1521.34	2226.58
	L.H. D&C Panel	V	28.2539	26.7970	27.2588	27.7307	28.1570	27.0733
	Bus 1	P	944.66	863.93	851.41	958.04	972.87	801.34
	Fwd Local	V	27.8514	25.8973	26.6214	27.3178	27.8740	26.4617
	DC Dist. 1	P	4511.43	7206.88	5688.74	4552.50	3781.94	5407.11
	Inverter	V	27.8506	25.8953	26.6207	27.3170	27.8735	26.4611
	Bus 1	P	2115.49	5135.01	1780.93	2247.47	1382.15	1546.05
	Aft Local	V	28.3326	26.9707	27.4226	27.6011	27.9249	26.8284
	DC Dist. 1	P	591.40	264.17	272.92	1210.83	1527.70	1387.98
		V						
		P						
		V						
		P						

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SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Maximum Values

BUS NUMBER AND TITLE		PHASE IDENTIFICATION/TIME					
		13	14	15	16	17	18
FUEL CELL	Cumulative Energy KWH	1021.945	1293.968	1565.991	1588.683	1827.836	1834.675
	Power-Watts	11255.99	11334.29	11334.29	11346.09	14786.28	9445.82
	Volts	28.5596	28.5382	28.5382	28.5350	27.6282	29.1022
	Amperes	394.12	397.16	397.16	397.62	535.19	324.57
INV.	Volt-Amperes	1393.00	1393.00	1393.00	1393.00	3393.00	1130.00
	Watts	1393.00	1393.00	1393.00	1393.00	3393.00	1130.00
Main DC	V	27.0974	27.0647	27.0647	27.0598	25.6427	27.8980
Bus 1	P	10679.72	10749.17	10749.17	10759.62	13723.57	9055.21
Main DC	V	27.0974	27.0647	27.0647	27.0598	25.6427	27.8979
Bus 1 Loads	P	116.28	116.07	116.07	116.04	104.03	123.48
R.H. D&C Panel	V	26.4123	26.3804	26.3804	26.3756	25.0598	27.5590
Bus 1	P	2190.79	2185.51	2185.51	2184.71	1768.55	1131.11
L.H. D&C Panel	V	26.8329	26.8006	26.8006	26.7913	25.0258	27.5717
Bus 1	P	859.23	857.16	857.16	870.92	1868.98	1089.26
Fwd Local	V	26.2482	26.2165	26.2165	26.2118	24.5425	27.3092
DC Dist. 1	P	5319.82	5306.98	5306.98	5305.19	6444.31	3837.61
Inverter	V	26.2476	26.2160	26.2160	26.2112	24.5412	27.3087
Bus 1	P	1520.82	1517.14	1517.14	1516.72	3122.88	1340.50
Aft Local	V	26.4145	26.3494	26.3494	26.3446	24.4764	26.9606
DC Dist. 1	P	1906.74	1992.34	1992.34	1991.62	3017.66	2671.43
	V						
	P						
	V						
	P						

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SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - All Components Included - Maximum Values

BUS NUMBER AND TITLE			PHASE IDENTIFICATION/TIME					
			19	20	21	22	23	
INV. FUEL CELL	Cumulative Energy KWH		1839.677	1840.212	1840.642	1840.965	1843.019	
	Power-Watts		9943.97	9905.84	9776.94	9782.31	9463.55	
	Volts		28.9164	28.9308	28.9790	28.9770	29.0956	
	Amperes		343.89	342.40	337.38	337.59	325.26	
	Volt-Amperes		3623.00	3830.00	3430.00	3560.00	3175.00	
	Watts		3623.00	3830.00	3430.00	3560.00	3175.00	
	Main DC	V	27.6406	27.6605	27.7273	27.7246	27.8889	
	Bus 1	P	9505.06	9470.98	9354.93	9359.45	9071.32	
	Main DC	V	27.6406	27.6604	27.7273	27.7245	27.8888	
	Bus 1 Loads	P	120.79	121.25	122.02	121.67	123.42	
	R.H. D&C Panel	V	27.3622	27.3896	27.4558	27.4531	27.6359	
	Bus 1	P	922.45	898.18	902.53	902.35	846.40	
	L.H. D&C Panel	V	27.3201	27.4218	27.4932	27.4904	27.6780	
	Bus 1	P	1060.18	792.31	779.39	779.24	706.77	
	Fwd Local	V	26.7093	26.6736	26.7417	26.7188	26.9378	
	DC Dist. 1	P	5936.84	6282.59	6290.62	6413.72	6114.69	
	Inverter	V	26.7078	26.6720	26.7403	26.7173	26.9365	
	Bus 1	P	3931.43	4132.18	3742.16	3869.62	3528.74	
	Aft Local	V	27.2176	27.2746	27.3817	27.4224	27.5323	
	DC Dist. 1	P	1217.00	1112.63	1000.52	875.93	1037.83	
		V						
		P						
		V						
		P						

APPENDIX D

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Nominal Values

BUS NUMBER AND TITLE			PHASE IDENTIFICATION/TIME					
			1	2	3	4	5	6
FUEL CELL	Cumulative Energy KWH		1.070	2.105	3.360	4.169	59.667	73.582
	Power-Watts		6408.03	6272.01	5231.08	3910.29	2984.27	3558.02
	Volts		30.07	30.1133	30.47	30.9028	31.2474	31.0367
	Amperes		213.09	208.28	171.69	126.54	95.50	114.69
INV.	Volt-Amperes		1107.05	1231.30	924.42	583.00	580.15	580.06
	Watts		1107.05	1231.30	924.42	583.00	580.15	580.06
	Main DC	V	29.2810	29.3406	29.8311	30.4333	30.8931	30.6114
	Bus 1	P	6239.69	6110.76	5121.80	3850.81	2950.20	3508.92
	Main DC	V	29.2810	29.3405	29.8310	30.4333	30.8931	30.6113
	Bus 1 Loads	P	81.54	81.44	84.57	87.87	39.26	88.64
	R.H. D&C Panel	V	29.1447	29.2050	29.7043	30.3059	30.7765	30.4950
	Bus 1	P	480.75	479.44	455.90	467.69	434.46	429.73
	L.H. D&C Panel	V	29.0449	29.1316	29.6230	30.2712	30.8166	30.4791
	Bus 1	P	830.14	737.07	746.33	594.34	258.12	487.89
	Fwd Local	V	28.7806	28.8212	29.3656	30.1051	30.6150	30.2970
	DC Dist. 1	P	3437.24	3572.78	3262.42	2358.20	2031.93	2272.73
	Inverter	V	28.7801	28.8206	29.3651	30.1048	30.6147	30.2968
	Bus 1	P	1459.44	1622.79	1275.60	846.49	871.50	853.21
	Aft Local	V	28.8476	28.9639	29.6682	30.3365	30.8506	30.5488
	DC Dist. 1	P	830.14	1153.37	510.85	810.59	138.42	202.05
		V						
		P						
		V						
		P						

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SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Nominal Values

INV. FUEL CELL

BUS NUMBER AND TITLE		PHASE IDENTIFICATION/TIME					
		7	8	9	10	11	12
Cumulative Energy KWH		79.488	85.501	157.408	168.107	177.291	260.125
Power-Watts		3639.02	4222.27	3595.37	3795.33	4210.78	3451.41
Volts		31.0367	30.8251	31.0225	30.9466	30.8292	31.0771
Amperes		117.25	136.98	115.90	122.64	136.58	111.06
Volt-Amperes		580.06	774.62	581.50	582.70	580.06	580.06
Watts		580.06	774.62	581.50	582.70	580.06	580.06
Main DC	V	30.6017	30.3169	30.5926	30.4916	30.3224	30.6651
Bus 1	P	3587.70	4152.53	3545.73	3739.50	4141.64	3405.91
Main DC	V	30.6017	30.3168	30.5925	30.4915	30.3224	30.6651
Bus 1 Loads	P	88.60	408.52	263.12	236.30	87.39	29.00
R.H. D&C Panel	V	30.4735	30.1674	30.4620	30.3532	30.1958	30.5525
Bus 1	P	472.96	546.17	481.67	508.78	462.95	416.54
L.H. D&C Panel	V	30.4567	30.1860	30.4900	30.3618	30.1664	30.5903
Bus 1	P	534.60	478.69	378.50	477.29	569.74	227.07
Fwd Local	V	30.2860	29.9655	30.2835	30.1857	30.0269	30.4179
DC Dist. 1	P	2281.70	2513.30	2233.90	2203.67	2118.03	1794.49
Inverter	V	30.2858	29.9651	30.2832	30.1854	30.0266	30.4176
Bus 1	P	852.75	1107.61	854.76	850.76	838.25	860.14
Aft Local	V	30.5456	30.2635	30.5423	30.4027	30.0486	30.3961
DC Dist. 1	P	181.20	171.04	378.50	285.82	869.92	864.33
	V						
	P						
	V						
	P						

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SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Nominal Values

BUS NUMBER AND TITLE			PHASE IDENTIFICATION/TIME					
			13	14	15	16	17	18
FUEL CELL	Cumulative Energy KWH		346.555	434.369	522.044	529.453	600.049	603.813
	Power-Watts		3601.26	3658.91	3653.14	3704.33	4364.79	5198.34
	Volts		31.0506	31.0294	31.0315	31.0126	30.7751	30.4334
	Amperes		115.98	117.92	117.72	119.45	141.83	170.81
INV.	Volt-Amperes		580.06	580.06	580.06	580.06	628.71	595.00
	Watts		580.06	580.06	580.06	580.06	628.71	595.00
Main DC Bus 1		V	30.6203	30.5919	30.5947	30.5695	30.2489	29.7997
		P	3551.62	3607.24	3602.00	3651.33	4290.24	5089.85
Main DC Bus 1 Loads		V	30.6203	30.5919	30.5947	30.5695	30.2489	29.7996
		P	28.93	28.53	28.90	28.50	28.05	84.08
R.H. D&C Panel Bus 1		V	30.5085	30.4805	30.4837	30.4585	30.1468	29.6916
		P	413.00	411.09	409.76	409.08	372.77	388.48
L.H. D&C Panel Bus 1		V	30.5483	30.5160	30.5188	30.4786	30.1568	29.5758
		P	266.54	280.46	280.51	335.37	336.37	801.44
Fwd Local DC Dist. 1		V	30.3756	30.3491	30.3539	30.3288	29.9707	29.4333
		P	1773.90	1759.23	1744.61	1742.08	1992.02	2573.48
Inverter Bus 1		V	30.3753	30.3488	30.3536	30.3285	29.9704	29.4330
		P	857.62	856.49	856.34	855.28	903.35	829.41
Aft Local DC Dist. 1		V	30.2951	30.2481	30.2478	30.2228	29.7666	29.4178
		P	1041.47	1099.37	1109.26	1107.43	1517.52	1187.48
		V						
		P						
		V						
		P						

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components OnTy - Nominal Values

BUS NUMBER AND TITLE			PHASE IDENTIFICATION/TIME					
			19	20	21	22	23	
FUEL CELL	Cumulative Energy KWH		606.672	606.995	607.282	607.494	608.490	
	Power-Watts		5684.66	5973.39	6538.89	6431.37	4589.59	
	Volts		30.2954	30.1982	30.0417	30.0706	30.6571	
	Amperes		187.64	197.81	217.66	213.88	149.71	
INV.	Volt-Amperes		1361.00	1392.00	1384.00	1364.00	886.00	
	Watts		1361.00	1392.00	1384.00	1364.00	886.00	
	Main DC Bus 1	V	29.5992	29.4643	29.2342	29.2771	30.1016	
		P	5553.72	5828.11	6362.97	6261.45	4506.48	
	Main DC Bus 1 Loads	V	29.5992	29.4643	29.2341	29.2771	30.1016	
		P	82.88	82.31	81.00	81.18	86.08	
	R.H. D&C Panel Bus 1	V	29.4870	29.3251	29.0960	29.1387	29.9980	
		P	400.85	494.43	486.80	488.29	419.66	
	L.H. D&C Panel Bus 1	V	29.3919	29.2699	29.0440	29.0866	29.9980	
		P	737.66	688.87	668.72	670.68	376.66	
	Fwd Local DC Dist. 1	V	29.0900	28.9508	28.6366	28.6822	29.7334	
		P	3535.76	3548.35	4083.80	4072.12	2613.25	
	Inverter Bus 1	V	29.0894	28.9502	28.6360	28.6816	29.7330	
		P	1814.82	1837.25	1787.41	1767.79	1247.69	
	Aft Local DC Dist. 1	V	29.3665	29.1611	28.9265	28.9999	29.7814	
		P	722.42	934.70	940.74	849.78	1008.24	
		V						
		P						
		V						
		P						

APPENDIX E

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Minimum Values

BUS NUMBER AND TITLE		PHASE IDENTIFICATION/TIME					
		1	2	3	4	5	6
INV. FUEL CELL	Cumulative Energy KWH	0.824	1.571	2.472	2.853	32.855	39.919
	Power-Watts	4935.66	4523.33	3756.49	1840.82	1612.99	1807.60
	Volts	30.5697	30.7193	30.9614	31.6728	31.7547	31.6848
	Amperes	161.46	147.25	121.33	58.12	50.80	57.05
	Volt-Amperes	614.00	614.00	596.00	580.00	580.00	580.00
	Watts	614.00	614.00	596.00	580.00	580.00	580.00
Main DC Bus 1	V	29.9707	30.1730	30.5113	31.4571	31.5663	31.4731
	P	4838.97	4443.08	3702.10	1828.32	1603.42	1795.54
Main DC Bus 1 Loads	V	29.9707	30.1730	30.5112	31.4571	--	31.4731
	P	57.15	58.09	59.43	62.97	--	63.02
R.H. D&C Panel Bus 1	V	29.8569	30.0585	30.4046	31.3603	31.4708	31.3763
	P	411.25	416.82	392.47	367.59	363.90	367.97
L.H. D&C Panel Bus 1	V	29.8199	30.0587	30.3956	31.4199	31.5563	31.4384
	P	544.49	416.14	425.52	141.49	38.09	132.22
Fwd. Local DC Dist. 1	V	29.6067	29.8066	30.1443	31.3068	31.4154	31.3227
	P	2571.63	2606.35	2640.32	1123.51	1131.63	1124.80
Inverter Bus 1	V	29.6064	29.8063	30.1440	31.3065	31.4151	31.3224
	P	872.48	884.18	878.90	898.73	905.29	899.79
Aft Local DC Dist. 1	V	29.5861	29.8876	30.4650	31.4192	31.5473	31.4428
	P	1202.85	901.71	149.05	125.84	63.45	100.84
	V						
	P						
	V						
	P						

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Minimum Values

BUS NUMBER AND TITLE		PHASE IDENTIFICATION/TIME					
		7	8	9	10	11	12
INV. FUEL CELL	Cumulative Energy KWH	43.023	46.172	76.590	81.574	85.355	119.119
	Power-Watts	1912.56	2211.41	1520.89	1768.13	1733.46	1406.85
	Volts	31.6614	31.5549	31.7876	31.6990	31.7249	31.8282
	Amperes	60.41	70.08	47.85	55.78	54.64	44.20
	Volt-Amperes	580.00	580.00	580.00	580.00	580.00	580.00
	Watts	580.00	580.00	580.00	580.00	580.00	580.00
Main DC Bus 1	V	31.4373	31.2949	31.6101	31.4921	31.5221	31.6642
	P	1899.07	2193.24	1512.40	1756.59	1722.35	1399.60
Main DC Bus 1 Loads	V	31.4372	31.2948	--	31.4921	31.5221	--
	P	62.91	373.75	--	63.07	63.16	--
R.H. D&C Panel Bus 1	V	31.3307	31.1761	31.4997	31.3768	31.4166	31.5727
	P	404.28	448.40	421.25	437.95	401.49	349.80
L.H. D&C Panel Bus 1	V	31.3841	31.2548	31.5805	31.4273	31.4573	31.6462
	P	201.92	151.81	113.11	246.40	246.87	68.94
Fwd Local DC Dist. 1	V	31.2870	31.1453	31.4891	31.3715	31.4015	31.5430
	P	1122.38	1112.03	909.24	902.65	904.32	912.32
Inverter Bus 1	V	31.2867	31.1450	31.4889	31.3712	31.4012	31.5427
	P	897.88	889.56	909.23	902.64	904.31	912.31
Aft Local DC Dist. 1	V	31.4070	31.2646	31.5911	31.4617	31.4918	31.6451
	P	100.61	99.92	63.63	100.96	101.15	63.85
	V						
	P						
	V						
	P						

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Minimum Values

BUS NUMBER AND TITLE			PHASE IDENTIFICATION/TIME					
			13	14	15	16	17	18
FUEL CELL	Cumulative Energy KWH		152.170	185.230	218.290	221.104	247.156	249.843
	Power-Watts		1377.12	1377.50	1377.50	1406.85	1610.72	3711.16
	Volts		31.8387	31.8431	31.8431	31.8282	31.7556	30.9786
	Amperes		43.25	43.26	43.26	44.20	50.72	119.80
INV.	Volt-Amperes		580.00	580.00	580.00	580.00	580.00	592.00
	Watts		580.00	580.00	580.00	580.00	580.00	592.00
	Main DC Bus 1	V	31.6782	31.6826	31.6826	31.6642	31.5674	30.5342
		P	1370.18	1370.56	1370.56	1399.60	1601.17	3658.12
	Main DC Bus 1 Loads	V	--	--	--	--	--	30.5341
		P	--	--	--	--	--	59.50
	R.H. D&C Panel Bus 1	V	31.5867	31.5910	31.5910	31.5727	31.4785	30.4421
		P	350.11	350.21	350.21	349.80	338.91	339.32
	L.H. D&C Panel Bus 1	V	31.6682	31.6726	31.6726	31.6462	31.5435	30.4172
		P	38.36	38.37	38.37	68.94	91.31	430.81
	Fwd Local DC Dist. 1	V	31.5570	31.5613	31.5613	31.5430	31.4165	30.1708
		P	913.31	913.49	913.49	912.32	1131.32	2616.29
	Inverter Bus 1	V	31.5567	31.5610	31.5610	31.5427	31.4162	30.1705
		P	913.30	913.49	913.49	912.31	904.96	851.78
	Aft Local DC Dist. 1	V	31.6592	31.6635	31.6635	31.6451	31.5575	30.4791
		P	63.90	63.92	63.92	63.85	33.02	177.59
		V						
		P						
		V						
		P						

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Minimum Values

BUS NUMBER AND TITLE			PHASE IDENTIFICATION/TIME					
			19	20	21	22	23	
FUEL CELL	Cumulative Energy KWH		252.017	252.271	252.505	252.673	253.273	
	Power-Watts		4322.12	4705.36	5316.66	5112.48	2762.93	
	Volts		30.7901	30.6550	30.4374	30.5104	31.3316	
	Amperes		140.37	153.49	174.68	167.57	88.18	
INV.	Volt-Amperes		728.00	784.00	784.00	614.00	586.00	
	Watts		728.00	784.00	784.00	614.00	586.00	
	Main DC	V	30.2693	30.0855	29.7894	29.8887	31.0045	
	Bus 1	P	4249.10	4617.86	5203.30	5008.40	2734.19	
	Main DC	V	30.2693	30.0855	29.7894	29.8887	31.0045	
	Bus 1 Loads	P	58.36	57.48	56.27	56.91	61.25	
	R.H. D&C Panel	V	30.1733	29.9609	29.6660	29.7649	30.8961	
	Bus 1	P	350.70	452.03	443.17	446.13	405.26	
	L.H. D&C Panel	V	30.1546	29.9715	29.6765	29.7754	30.9755	
	Bus 1	P	418.80	413.73	405.62	408.33	108.82	
	Fwd Local	V	29.8828	29.6906	29.3064	29.4363	30.8550	
	DC Dist. 1	P	2756.43	2798.63	3378.18	3178.12	1100.36	
	Inverter	V	29.8824	29.6903	29.3060	29.4361	30.8548	
	Bus 1	P	1025.44	1089.82	1061.42	840.77	882.01	
	Aft Local	V	30.0736	29.8165	29.5160	29.6144	30.6836	
	DC Dist. 1	P	622.18	847.97	853.00	858.70	1040.79	
		V						
		P						
		V						
		P						

APPENDIX F

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Maximum Values

BUS NUMBER AND TITLE			PHASE IDENTIFICATION/TIME					
			1	2	3	4	5	6
INV. FUEL CELL	Cumulative Energy KWH		1.256	2.751	5.312	6.531	109.925	133.251
	Power-Watts		7522.16	9060.64	10669.87	5889.23	5558.82	5968.70
	Volts		29.7663	29.2441	28.7185	30.1764	30.2992	30.1999
	Amperes		252.71	309.83	371.53	195.16	183.46	197.64
	Volt-Amperes		1479.00	3079.00	3879.00	586.00	586.00	586.00
	Watts		1479.00	3079.00	3879.00	586.00	586.00	586.00
	Main DC	V	28.8288	28.0946	27.3401	29.4524	29.6186	29.4667
	Bus 1	P	7285.42	8704.65	10157.57	5748.08	5434.05	5823.89
	Main DC	V	28.8287	28.0946	27.3401	29.4524	29.6185	29.4667
	Bus 1 Loads	P	131.78	125.12	118.17	137.49	139.01	137.59
	R.H. D&C Panel	V	28.6599	27.9301	27.1882	29.2767	29.4292	29.2873
	Bus 1	P	585.95	556.49	500.21	622.72	674.65	636.18
	L.H. D&C Panel	V	28.5447	27.8361	26.7353	29.1861	29.3526	29.1949
	Bus 1	P	981.58	871.44	1957.67	940.89	945.19	960.66
	Fwd Local	V	28.2337	27.2475	26.3559	28.9810	29.1391	28.9897
	DC Dist. 1	P	4010.08	5508.85	6191.19	3260.51	3334.50	3300.38
	Inverter	V	28.2330	27.2462	26.3543	28.9807	29.1388	28.9894
	Bus 1	P	1859.79	3506.02	4082.97	799.30	807.94	799.66
	Aft Local	V	28.3436	27.6030	26.9554	29.2207	29.5314	29.2349
	DC Dist. 1	P	1453.47	1434.42	1096.35	715.57	272.15	716.26
		V						
		P						
		V						
		P						

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Maximum Values

BUS NUMBER AND TITLE			PHASE IDENTIFICATION/TIME					
			7	8	9	10	11	12
INV. FUEL CELL	Cumulative Energy KWH		142.693	155.502	273.797	294.422	309.159	471.153
	Power-Watts		5818.07	8994.91	5914.73	7316.36	6757.11	6749.75
	Volts		30.2465	29.2028	30.1694	29.8198	29.9353	29.9759
	Amperes		192.36	308.02	196.05	245.35	225.72	225.17
	Volt-Amperes		586.00	3586.00	586.00	986.00	586.00	586.00
	Watts		586.00	3586.00	586.00	986.00	586.00	586.00
	Main DC	V	29.5328	28.0601	29.4421	28.9095	29.0978	29.1405
	Bus 1	P	5680.74	8643.04	5772.29	7093.10	6567.99	6561.45
	Main DC	V	29.5328	28.0599	29.4419	28.9093	29.0978	29.1404
	Bus 1 Loads	P	138.06	474.88	495.42	451.38	133.98	134.27
	R.H. D&C Panel	V	29.3393	27.8650	29.2455	28.7085	28.9061	28.9480
	Bus 1	P	687.39	658.28	696.07	698.74	670.94	674.57
	L.H. D&C Panel	V	29.2604	27.8110	29.1735	28.6414	28.8191	28.8853
	Bus 1	P	964.98	838.82	948.60	929.71	972.45	892.34
	Fwd Local	V	29.0547	27.1024	28.9655	28.3686	28.6268	28.6687
	DC Dist. 1	P	3315.00	6195.02	3294.85	3662.11	3218.09	3227.64
	Inverter	V	29.0545	27.1009	28.9652	28.3682	28.6265	28.6685
	Bus 1	P	803.05	4009.10	798.32	1267.38	779.59	781.99
	Aft Local	V	29.3704	27.9774	29.3554	28.4946	28.6084	28.6317
	DC Dist. 1	P	504.26	244.44	268.92	1249.65	1480.23	1539.73
		V						
		P						
		V						
		P						

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Maximum Values

BUS NUMBER AND TITLE			PHASE IDENTIFICATION/TIME					
			13	14	15	16	17	18
INV. FUEL CELL	Cumulative Energy KWH		648.678	828.485	1008.291	1023.304	1212.601	1218.391
	Power-Watts		7396.87	7491.94	7491.94	7506.24	11708.78	7885.44
	Volts		29.7974	29.7710	29.7710	29.7670	28.4354	29.6113
	Amperes		248.24	251.65	251.65	252.17	411.77	266.30
	Volt-Amperes		586.00	586.00	586.00	586.00	2586.00	598.00
	Watts		586.00	586.00	586.00	586.00	2586.00	598.00
	Main DC	V	28.8765	28.8374	28.8374	28.8315	26.9077	28.6234
	Bus 1	P	7168.34	7256.81	7256.81	7270.17	11079.50	7622.31
	Main DC	V	28.8764	28.8373	28.8373	28.8314	26.9077	28.6233
	Bus 1 Loads	P	132.11	131.50	131.50	131.46	114.42	129.70
	R.H. D&C Panel	V	28.6857	28.6469	28.6469	28.6410	26.7351	28.4654
	Bus 1	P	662.41	660.61	660.61	660.34	558.59	544.21
	L.H. D&C Panel	V	28.6002	28.5614	28.5614	28.5509	26.2789	28.3159
	Bus 1	P	956.71	954.12	954.12	969.72	2000.52	1053.94
	Fwd Local	V	28.4090	28.3705	28.3705	28.3647	26.1438	28.1603
	DC Dist. 1	P	3169.21	3160.81	3160.81	3159.60	4766.40	3112.16
	Inverter	V	28.4087	28.3703	28.3703	28.3645	26.1428	28.1600
	Bus 1	P	767.67	765.77	765.77	765.54	2732.46	769.43
	Aft Local	V	28.1617	28.0881	28.0881	28.0824	25.6952	27.7255
	DC Dist. 1	P	2127.83	2224.71	2224.71	2223.80	3293.47	2631.43
		V						
		P						
		V						
		P						

Date 4/8/74

SEPAP CIRCUIT ANALYSIS DATA SHEET

Run Description Single String - String #1 Components Only - Maximum Values

BUS NUMBER AND TITLE		PHASE IDENTIFICATION/TIME					
		19	20	21	22	23	
FUEL CELL	Cumulative Energy KWH	1222.420	1222.848	1223.191	1223.449	1225.073	
	Power-Watts	8010.36	7921.77	7808.40	7823.12	7484.04	
	Volts	29.6246	29.6507	29.6826	29.6784	29.7732	
	Amperes	270.40	267.17	263.06	263.60	251.37	
INV.	Volt-Amperes	2034.00	2184.00	1784.00	1914.00	1586.00	
	Watts	2034.00	2184.00	1784.00	1914.00	1586.00	
Main DC Bus 1	V	28.6214	28.6595	28.7066	28.7005	28.8406	
	P	7739.07	7657.18	7551.43	7565.48	7249.78	
Main DC Bus 1 Loads	V	28.6214	28.6595	28.7066	28.7005	28.8406	
	P	129.68	130.28	130.26	130.56	131.86	
R.H. D&C Panel Bus 1	V	28.4597	28.4818	28.5286	28.5225	28.6733	
	P	557.31	612.84	614.86	614.60	580.78	
L.H. D&C Panel Bus 1	V	28.3186	28.4418	28.4938	28.4877	28.6437	
	P	1038.13	749.88	734.27	733.95	682.72	
Fwd Local DC Dist. 1	V	27.9342	27.9215	27.9743	27.9459	28.1394	
	P	4581.75	4918.00	4889.38	5032.93	4709.36	
Inverter Bus 1	V	27.9333	27.9206	27.9735	27.9451	28.1387	
	P	2476.79	2650.04	2188.80	2337.82	1976.82	
Aft Local DC Dist. 1	V	28.1900	28.2943	28.3621	28.4011	28.5061	
	P	1285.54	1092.54	1032.89	898.84	1008.05	
	V						
	P						
	V						
	P						

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