APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

ALSEP POWER BUDGET

ATM-449

Revision O

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by

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Summary

This issue of the ALSEP power budget provides the information available at the end of June 1970 on the power requirements of the major ALSEP components and the resulting composite system power usage for the deliverable systems. The data reflect measurements made during testing of qualification and flight equipment.

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ALSEP Equipment Power Demands

The power requirements of the various equipment subdivisions are presented in Tables I through IV. All values are given in watts.

Table I lists the measurements of input power required by the Data Subsystem components.

Figure 1 shows the results of tests performed on the PCU to determine the conversion efficiency of that unit. The measured values of conversion loss are somewhat less than earlier estimates. The difference in efficiency of the two converters appears to be a normal characteristic of the PCU design. The full results of these tests were reported in ATM-753 and ATM-783.

Tables II through IV present the latest information on experiment power demands grouped by flight system. The power values are tabulated for both operational and standby modes under headings having the following meanings:

Operate Mode (i. e., when the operational power line is energized)

1. Functional power - that power required to perform the normal (routine) scientific data-gathering functions of the instrument. If this power requirement is not constant, the highest instantaneous demand at any point in the operational cycle is listed under "Maximum Instantaneous" and the lowest value is listed under "Minimum Instantaneous".

2. Thermal support power - that power which must be provided upon demand to an instrument solely for purposes of thermal control or support of the sensors and electronics. This power demand varies in accordance with

   - The temperature of the equipment being thermally controlled,

   - the technique of thermal control, e. g., proportional, bang-bang, time-share, etc.

   The maximum and minimum values of this power are both listed, together with the control temperatures.

3. Total power - represents the power demand during "normal" operation when full thermal support power is being used. The values listed represent the maximum instantaneous values of power demand under these conditions.

4. Intermittent Modes - the largest of the peak power demands associated with the intermittent (commandable, non-normal) operational modes of an experiment. Any increment of power required by an experiment during an intermittent mode in excess of that listed under (3) may be borrowed on a time-shared basis from some other item of equipment.

5. Power on Transient - the instantaneous peak value of the transient power demand associated with switching on the experiment. The value listed under "duration" is normally the length of time the transient demand exceeds the value under heading (3) for that equipment.

Standby Mode (i. e., when the Standby power line is energized)

If the Standby power demand of an instrument is not constant, the limits of variation are listed under "maximum" and minimum". Any variation in this power is usually a function of ambient temperature. Where relevant, the control temperature is listed.

Typical power profiles for each experiment are shown in Figures 2 through 9.

ALSEP System Power Balance

For budgetary purposes, the power required by ALSEP at lunar midnight represents the maximum continuous load on the power source. This value is shown in Table VII for each ALSEP flight system together with other important operational and intermittent modes. All values are given in watts. A diagram of power usage for Array A-2 is shown in Figure 10.

TABLE 1

DATA SUBSYSTEM POWER USAGE

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Equipment	Operating Mode	Power Demand (watts)		
		A, B, C	A2	D
Receiver	Operating	0.70	0.82	1.8
	Inactive (Heater ON)	1.20	1.20	----
Command Decoder	Operating	1.20	1.25	1.25
Data Processor Analog	Operating	1.20	1.4	1.4
Data Processor Digital	Operating	0.50	0.50	0.50
PDU	Unloaded (expts Off)	1.4	1.4	1.4
	Mean (Day)	1.7	2.0	1.8
	Full Load (Night)	2.0	2.4	2.2
Dust Detector*	Operating	0.2	0.2	----
	Non-Operating	0.05	0.05	----
Transmitter	Operating			
	- Night	7.5	10.0	10.0
	- Day	8.5	10.8	10.8
	Both Transmitters Inactive (Heater ON)	8.4	8.4	8.4
Diplexer Switch (Xmtr B only)		0.1	0.1	0.1
Timer		0.0	0.24	0.24
Operating Total	Day	14.5	17.3	17.9
	Night	13.6	16.9	17.5

2.8

3.3

PSC 9.6

14.1

*DTREM on C and A2

TABLE II EXPERIMENT POWER ARRAY A (FLT 1)

Experiment No. / Designation:	Experiment Subsystem 1 PSE	2 LSM	3 SWS	4 SIDE	TOTAL	NOTES
Operate Mode						
. Functional Power						
(a) Maximum	4.4*	5.5	6.2	6.5	22.6	(1) Leveling
(b) Minimum	4.4*	3.5	3.2	5.7	16.8	(2) Survey mode
						(3) Heaters time shared
						(4) Dust cover OFF
:. Thermal Support						
(a) Minimum	0.2	0.0	0.0	0.0	0.2	*3.6 watts of this dissipated
(b) Maximum	2.4	5.3	3.6	4.0	15.3	in Central Station
(c) Control Temp. (°F)	126±1	95	77	32±15	—	
3. Total Power						**3.8 wats of this dissipated
1(a) + 2(b)	6.8	10.8	6.0(3)	10.5	34.1	in the Central Station
4. Intermittent Modes						
(a) Maximum	8.0(1)	10.3(2)	8.7(4)	12.0(4)	—	
(b) Duration of Max. (Secs)	VAR	3	4±2	2.5	—	
5. Power On Transient						
(a) Maximum	11.6	11.0	10.5	13.0	—	
(b) Duration (Secs)	0.002	0.12	0.14	0.05	—	
Standby Mode						
1. Minimum	4.5**	—	3.6	2.0	10.1	
2. Maximum	4.5**	—	3.6	6.0	14.1	
3. Control Temp. (°F)	—	—	—	32±15	—	

TABLE III EXPERIMENT POWER ARRAY B (FLT 3)

Experiment No. / Designation:	Experiment Subsystem 1 HFE	2 PSE	3 CCGE	4 CPLEE	TOTAL	NOTES
Operate Mode						
1. Functional Power						
(a) Maximum	5.1(1)	4.4*	2.0	3.0	14.5	(1) Mode I
(b) Minimum	3.5(1)	4.4*	2.0	2.5	12.4	(2) Mode II Lunar Night
						(3) Leveling
2. Thermal Support						
(a) Minimum	0.0	0.2	0.0	0.0	0.2	*3.6 watts of this dissipated
(b) Maximum	4.7	2.4	5.0	2.9	15.0	in Central Station
(c) Control Temp (°F)	90±50	126±1	25±5	32±5	—	
3. Total Power						**3.8 watts of this dissipated
1(a) + 2 (b)	9.8	6.8	7.0	5.9	29.5	in Central Station
4. Intermittent Modes						
(a) Maximum	10.2(2)	8.0(3)	—	—	—	
(b) Duration of Max. (Secs)	VAR	VAR	—	—	—	
5. Power On Transient						
(a) Maximum	8.7	11.6	13.0	7.0	—	
(b) Duration (Secs)	0.06	0.002	0.12	0.037	—	
Standby Mode						
1. Minimum	4.2	4.5**	0.0	0.0	8.7	
2. Maximum	4.2	4.5**	4.8	4.5	18.0	
3. Control Temp. (°F)	—	—	—	32±18	—	

TABLE IV EXPERIMENT POWER ARRAY C (FLT 4)

Experiment No. / Designation:	Experiment Subsystem 1 PSE	2 ASE	3 SIDE	4 CPLEE	TOTAL	NOTES
		+				
Operate Mode						
1. Functional Power						
(a) Maximum	4.4 *	5.5	6.5	3.0	14.2	
(b) Minimum	4.4 *	3.5	5.7	2.5	12.9	
2. Thermal Support						
(a) Minimum	0.04	-	0.0	0.0	0.3(3)	
(b) Maximum	5.7	-	4.0	2.9	15.7(3)	
(c) Control Temp. (^{o}F)	126± 1	-	32± 15	32± 18	-	
3. Total Power						
1. (a) + 2(b)	10.1	5.5	10.5	5.9	29.6(3)	
4. Intermittent Modes						
(a) Maximum	10.2(1)	7.0(4)	12.0(2)	-	-	
(b) Duration of Max. (Secs)	Var.	Var.	2.5	-	-	
5. Power On Transient						
(a) Maximum	11.6	7.6	13	7.0	-	
(b) Duration (Secs)	0.090	0.002	0.05	0.037	-	
Standby Mode						
1. Minimum	5.0**	0.3	2.0	0.0	7.3	
2. Maximum	5.0**	3.1	6.0	4.5	18.6	
3. Control Temp. (^{o}F)	-	-4± 4	32± 15	32± 18	-	

(1) Forced Heater On
(2) Dust Cover Off
(3) ASE on Standby
(4) ASE Warm Up

*3.6 watts of this dissipated in Central Station

**4.4 watts of this dissipated in Central Station

+All operate mode power dissipated in Central Station.

TABLE V EXPERIMENT POWER ARRAY A2 (FLT 2A)

Experiment No. / Designation:	Experiment Subsystem 1 PSE	2 LSM	3 SWS	4 SIDE	5 HFE	TOTAL	NOTES
Operate Mode							
1. Functional Power							
(a) Maximum	4.4*	5.5	6.2	6.5	5.1(5)	27.7	
(b) Minimum	4.4*	3.5	3.2	5.7	3.5(5)	20.3	
2. Thermal Support							
(a) Minimum	0.04	0.0	0.0	0.0	0.0	0.04	
(b) Maximum	5.7	5.3	3.6	4.0	4.7	23.3	
(c) Control Temp. (^{o}F)	126 ± 1	95	77	32 ± 15	90 ± 50	-	
3. Total Power							
1. (a) + 2(b)	10.1	10.8	6.0(3)	10.5	9.8	47.2	
4. Intermittent Modes							
(a) Maximum	10.2(1)	10.3(2)	8.7(4)	12.0(4)	10.2(6)	-	
(b) Duration of Max. (Secs)	Var.	3	4±2	2.5	Var.	-	
5. Power On Transient							
(a) Maximum	11.6	11.0	10.5	13.0	8.7	-	
(b) Duration (Secs)	0.080	0.12	0.14	0.05	0.06	-	
Standby Mode							
1. Minimum	5.0**	-	3.6	2.0	4.2	14.8	
2. Maximum	5.0**	-	3.6	6.0	4.2	18.8	
3. Control Temp. (^{o}F)	-	-	-	32 ± 15	-	-	

(1) Forced Heater On
(2) Survey Mode
(3) Heaters time Shared
(4) Dust Cover Off
(5) Mode I
(6) Mode II Lunar Night

**4.4 watts of this dissipated in central station

*3.6 watts of this dissipated in central station

TABLE VI EXPERIMENT POWER ARRAY D (FLT 5)

Experiment No. / Designation:	Experiment Subsystem 1 PSE	2 ASE	3 LSM	4 HFE	TOTAL	NOTES
Operate Mode		+				
1. Functional Power						
(a) Maximum	4.4*	5.5	5.5	5.1(3)	15.3	
(b) Minimum	4.4*	3.5	3.5	3.5(3)	11.7	
2. Thermal Support						
(a) Minimum	0.04	-	0.0	0.0	0.3(5)	
(b) Maximum	5.7	-	5.3	4.7	18.8(5)	
(c) Control Temp. (°F)	126± 1	-	95	90± 50	-	
3. Total Power						
1. (a) + 2(b)	10.1	5.5	10.8	9.8	33.8(5)	
4. Intermittent Modes						
(a) Maximum	10.2(1)	7.0(6)	10.3(2)	10.2(4)	-	
(b) Duration of Max. (Secs)	Var.	Var.	3	Var.	-	
5. Power On Transient						
(a) Maximum	11.6	7.6	11.0	8.7	-	
(b) Duration (Secs)	0.090	0.002	0.12	0.06	-	
Standby Mode						
1. Minimum	5.0**	0.3	-	4.2	9.5	
2. Maximum	5.0**	3.1	-	4.2	12.3	
3. Control Temp. (°F)	-	-4± 4	-	-	-	

(1) Forced Heater
(2) Survey Mode
(3) Mode I
(4) Mode II Lunar Night
(5) ASE on Standby
(6) ASE Warm Up

**4.4 watts of this dissipated in central station

+All operate mode power dissipated in central station

*3.6 watts of this dissipated in central station

TABLE VII ALSEP SYSTEM POWER DEMANDS

System Mode	Array A	Array B	Array C	Array A2	Array D
Initial Turn On (Expts Stby, Day only)					
Transmitter On	29.3	27.8	26.8	37.8	32.7
Transmitter Off	29.7	28.2	26.4	35.2	30.1
Normal Operation (Peak)					
Lunar Day	43.3	34.4	34.2	52.0	39.0
Lunar Night	55.1	49.7	50.1	73.5	59.1
Intermittent Modes - Change in Power*					
LSM					
(a) Flip Lunar Day	+4.3	—	—	+4.3	+4.2
(b) Flip Lunar Night	-1.3	—	—	-1.3	-1.2
(c) Survey Lunar Day	+4.5	—	—	+4.5	+4.3
(d) Survey Lunar Night	-0.6	—	—	-0.6	-0.6
HFE					
(a) Mode II Lunar Day	—	+0.5	—	+0.5	+0.5
(b) Mode II Lunar Night	—	+0.4	—	+0.4	+0.4
(c) Mode III Lunar Day	—	+1.8	—	+1.8	+1.8
ASE**					
(a) Warm up Lunar Night (All other Expts on standby)	—	—	-7.9	—	+0.5
(b) Operate Lunar Night (All other Expts on standby)	—	—	-9.5	—	-1.1
(c) Operate Lunar Day (All other Expts on standby)	—	—	-1.9	—	-0.7
(d) Warm up Lunar Night (All Expts operating)	—	—	+4.3	—	+4.3
(e) Operate Lunar Night (All Expts operating)	—	—	+3.8	—	+3.7
(f) Operate Lunar Day (All Expts operating)	—	—	+5.6	—	+5.6

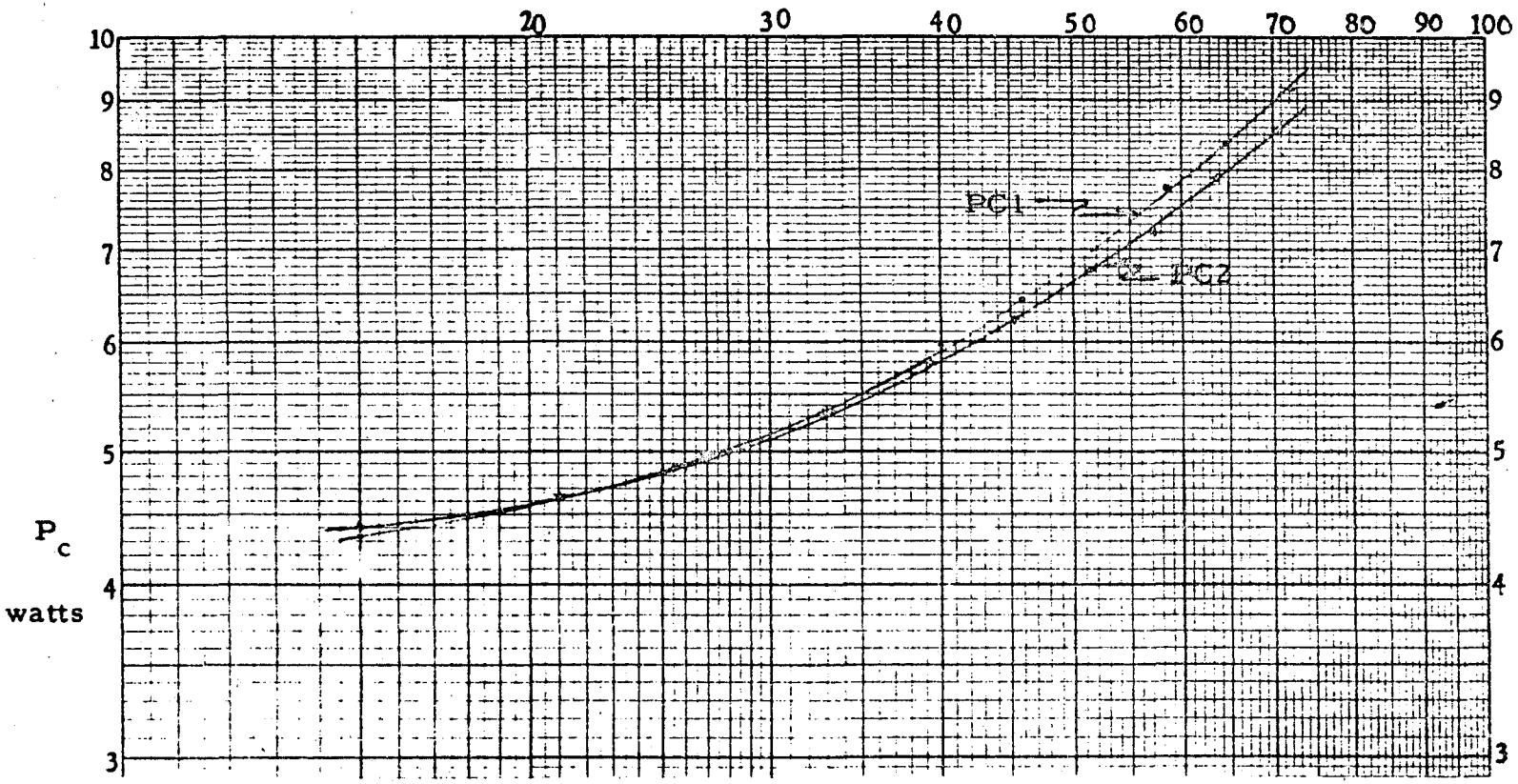
TABLE VIII ALSEP SYSTEM POWER DEMANDS (CONT.)

System Mode	Array A	Array B	Array C	Array A2	Array D
PSE					
(a) Leveling Lunar Night	—	—	-3.1	-3.2	-3.1
(b) Leveling Lunar Day	—	—	+3.1	+3.2	+3.2
(c) Forced Heater Lunar Night	—	—	+0.1	+0.1	+0.1

*'Intermittent Mode'minus'Normal Operation'

**ASE is always in standby and all other expts operating except as noted in ASE Intermittent Modes

P'_{in} (Input Power minus reserve Power) watts



Derived equations: $P_{C_1} = 3.9 + 0.0205\ P'_{in} + 0.000759\ (P'_{in})^2$

$P_{C_2} = 4.0 + 0.0234\ P'_{in} + 0.000605\ (P'_{in})^2$

Figure 1: PCU Conversion Loss Test Results.

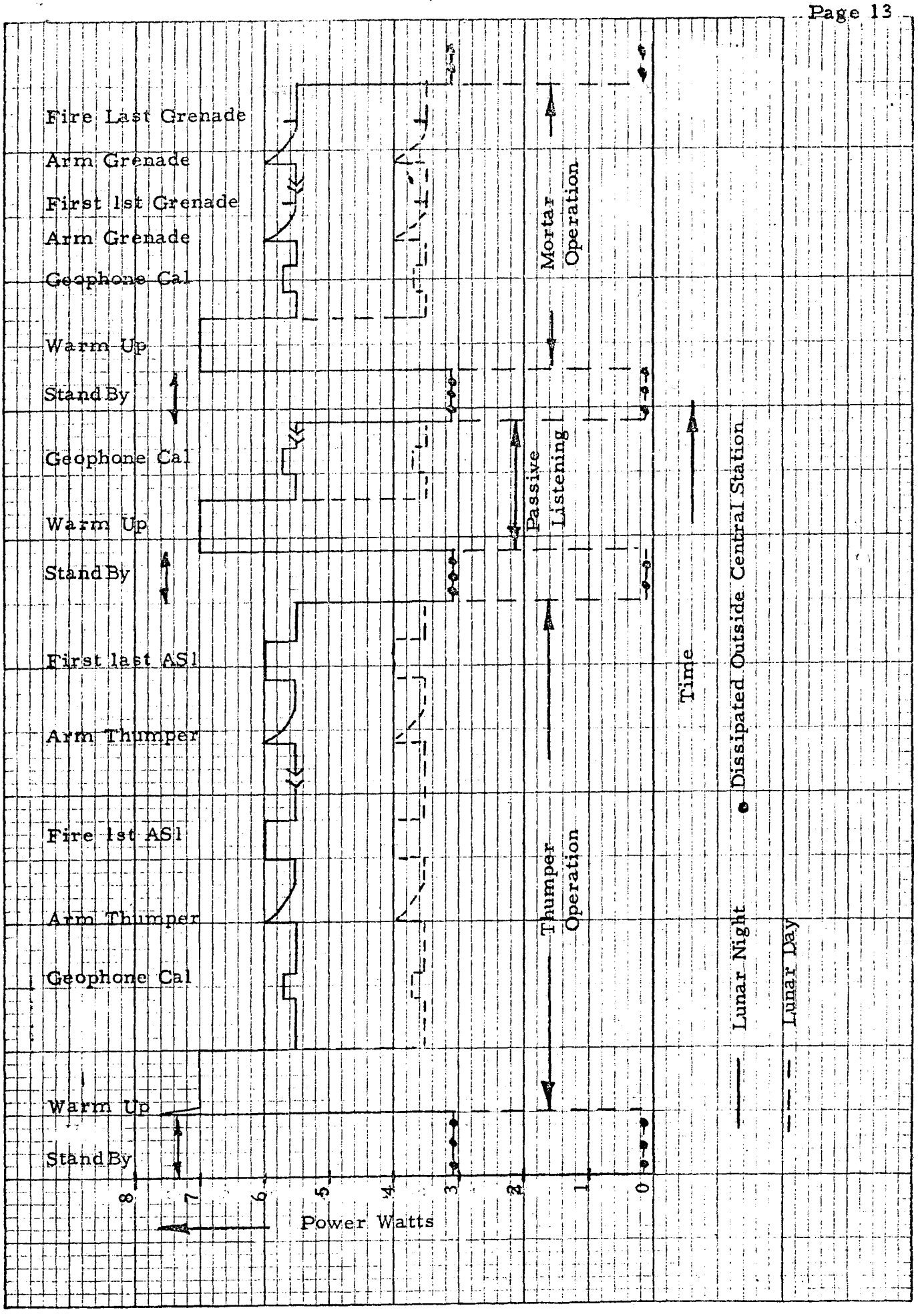

Fire Last Grenade
Arm Grenade
First 1st Grenade
Arm Grenade
Geophone Cal
Warm Up
Stand By
Geophone Cal
Warm Up
Stand By
First last ASI
Arm Thumper
Fire 1st ASI
Arm Thumper
Geophone Cal
Warm Up
Stand By
Mortar Operation
Passive Listening
Thumper Operation
Time
Dissipated Outside Central Station
Lunar Night
Lunar Day
Power Watts
8
7
6
5
4
3
2
1
0

Figure 3
PSE Power Profile (+29V Bus)
(Array C, A2 & D)

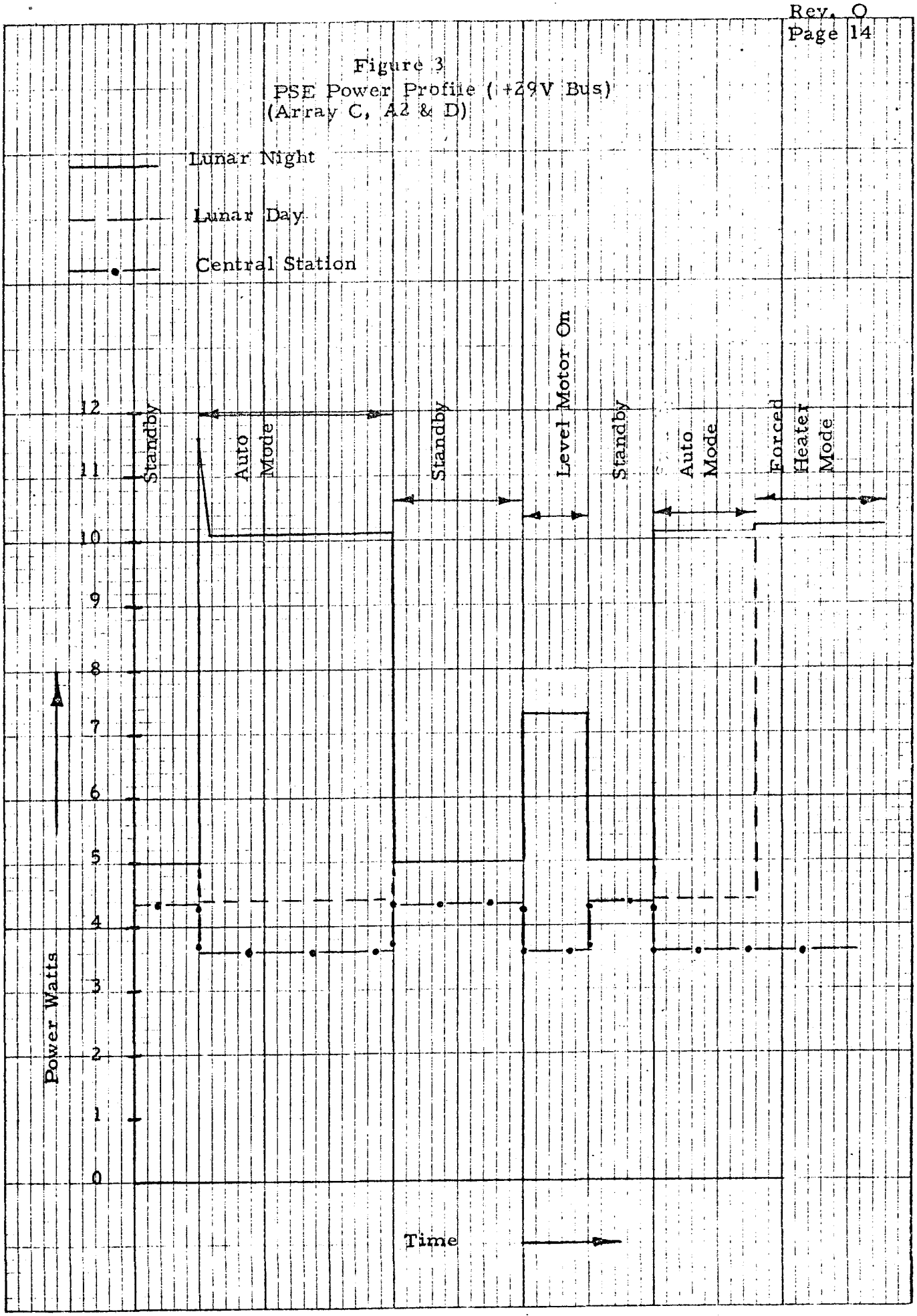


Figure 4
CPLEE Power Profile (+29V Bus)

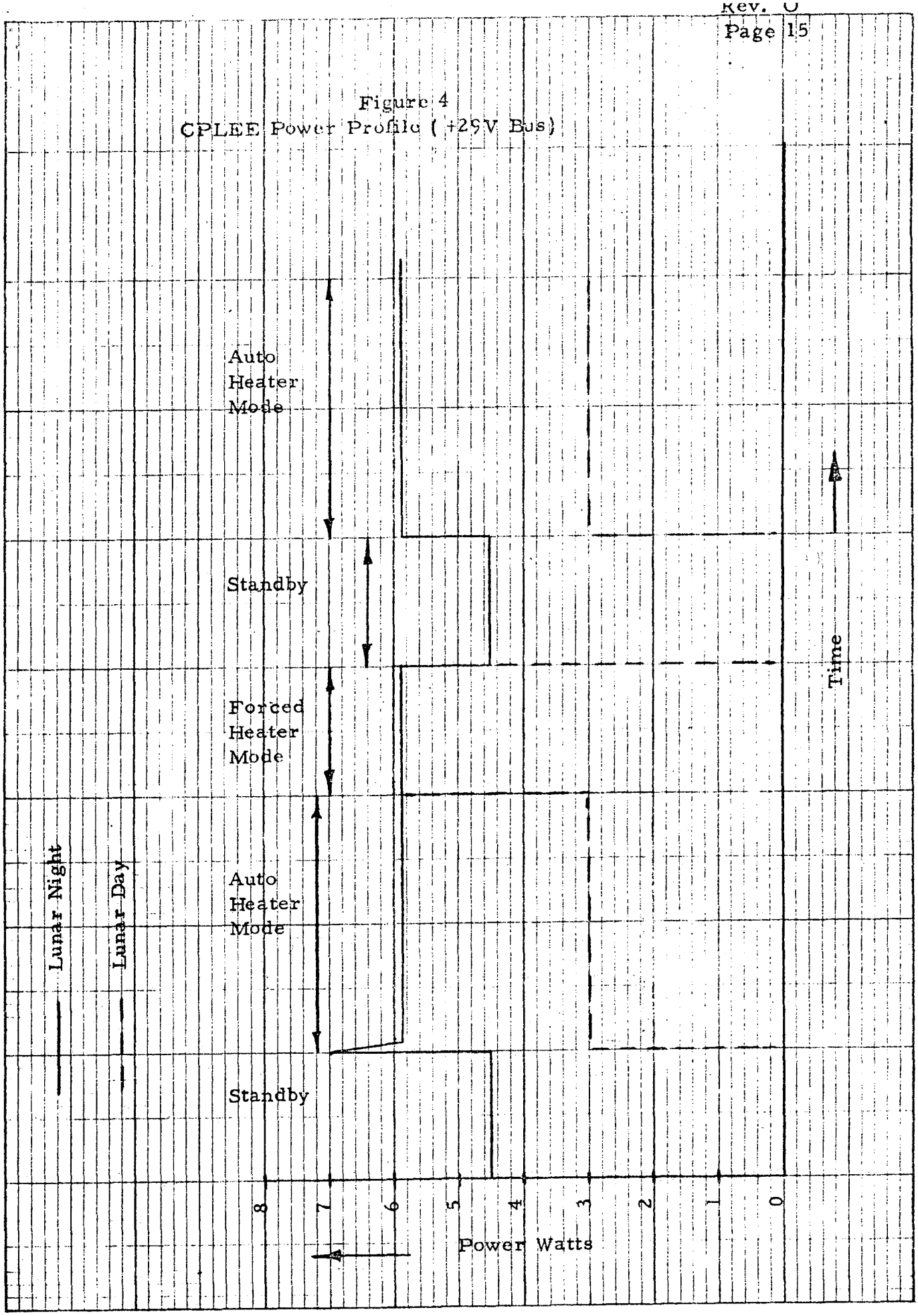


Figure 5
LSM Power Profile (+29V Bus)

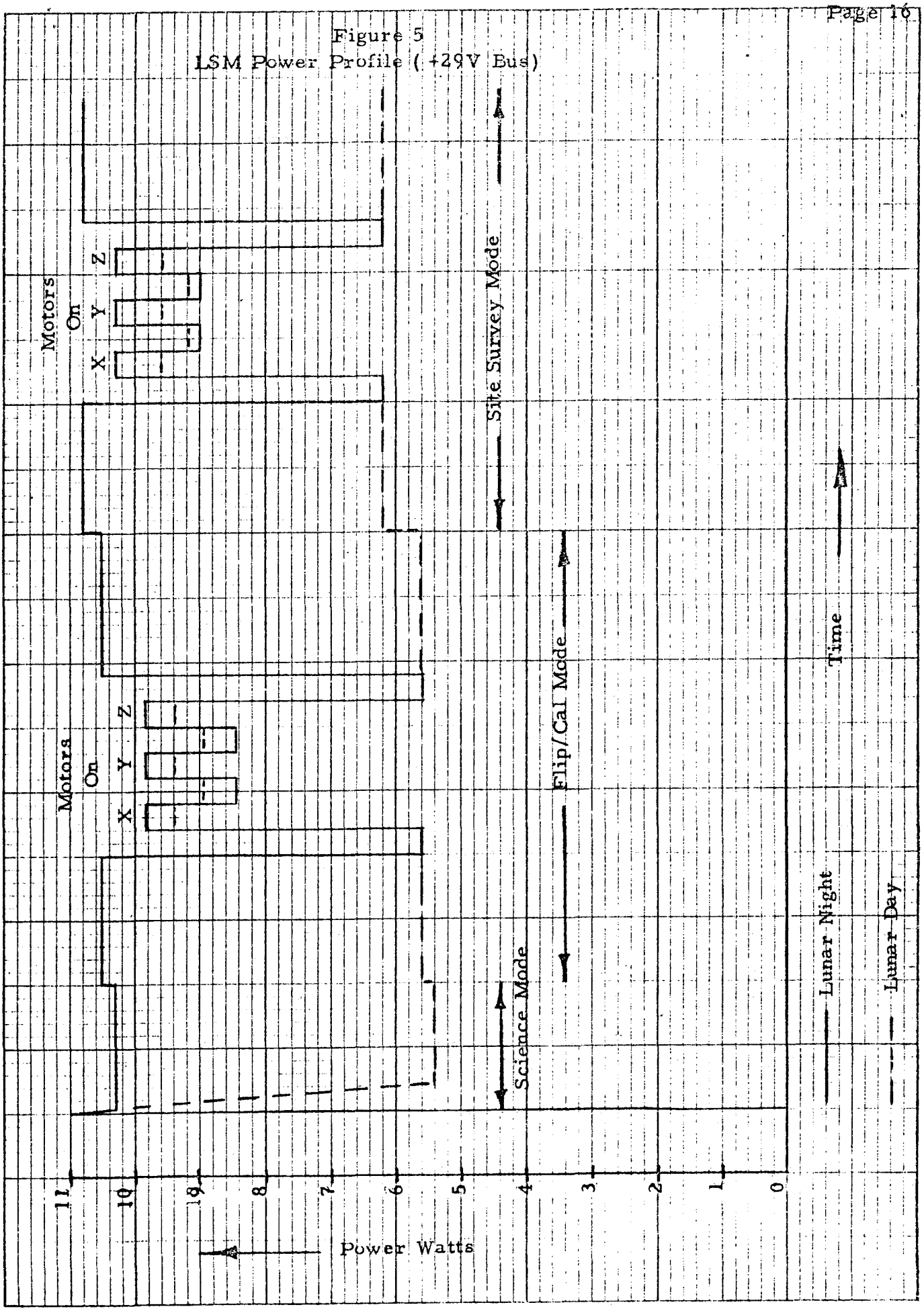


Figure 6 SIDE Power Profile

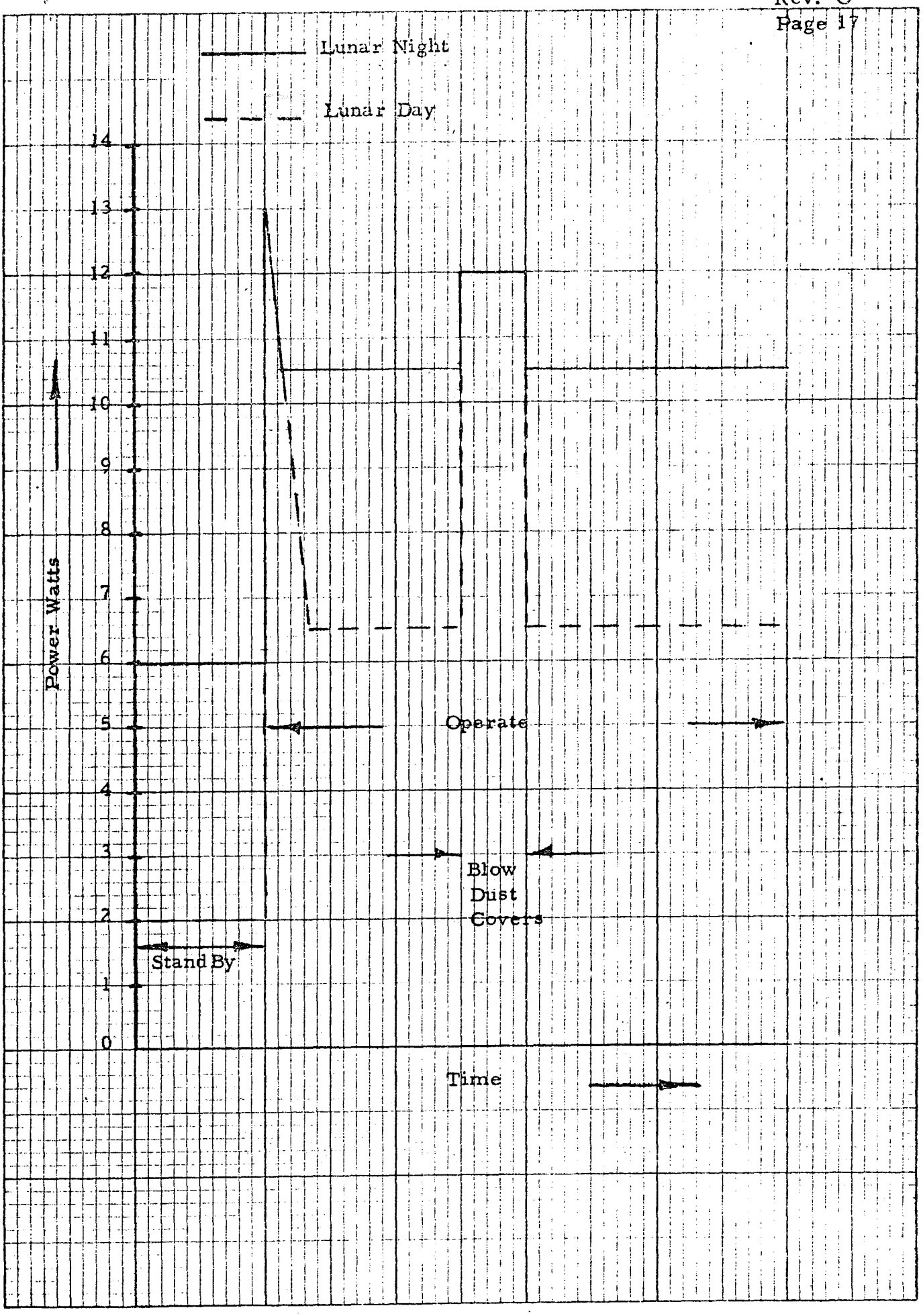


Figure 7
SWS Power Profile (29V Bus)

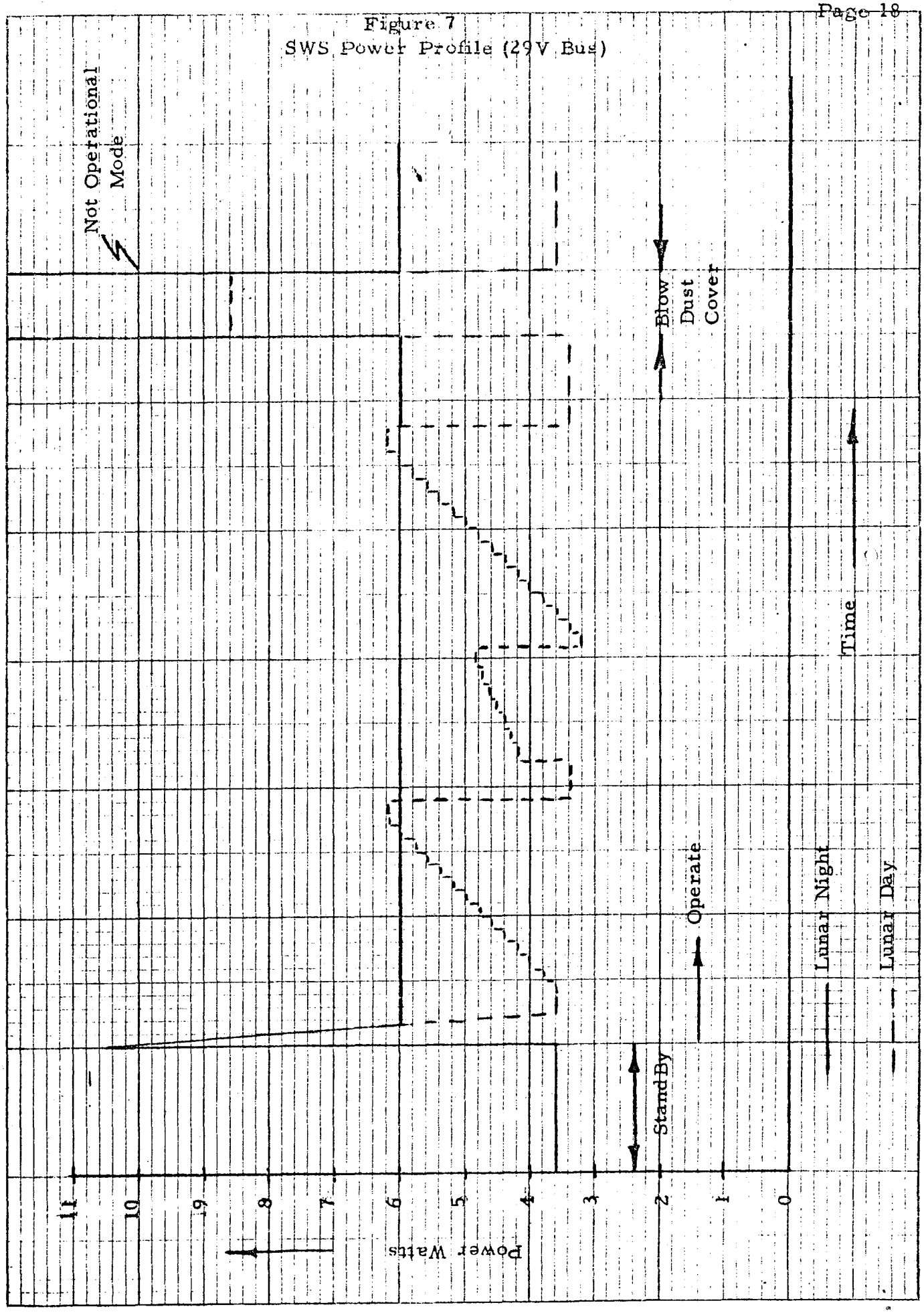


Figure 8 HFE Power Profile (29V Bus)

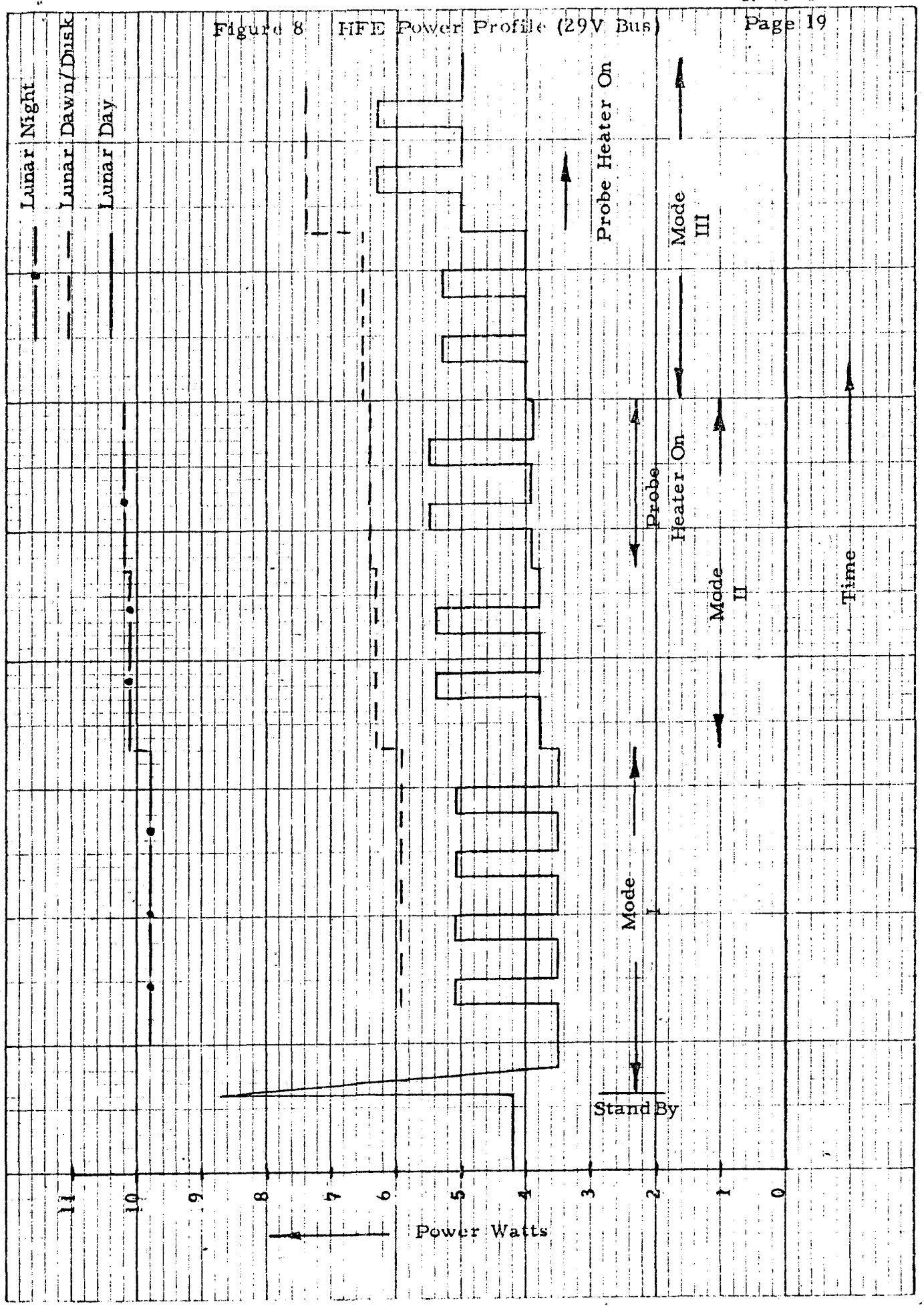


Figure 9
CCGE Power Profile (29V Bus)

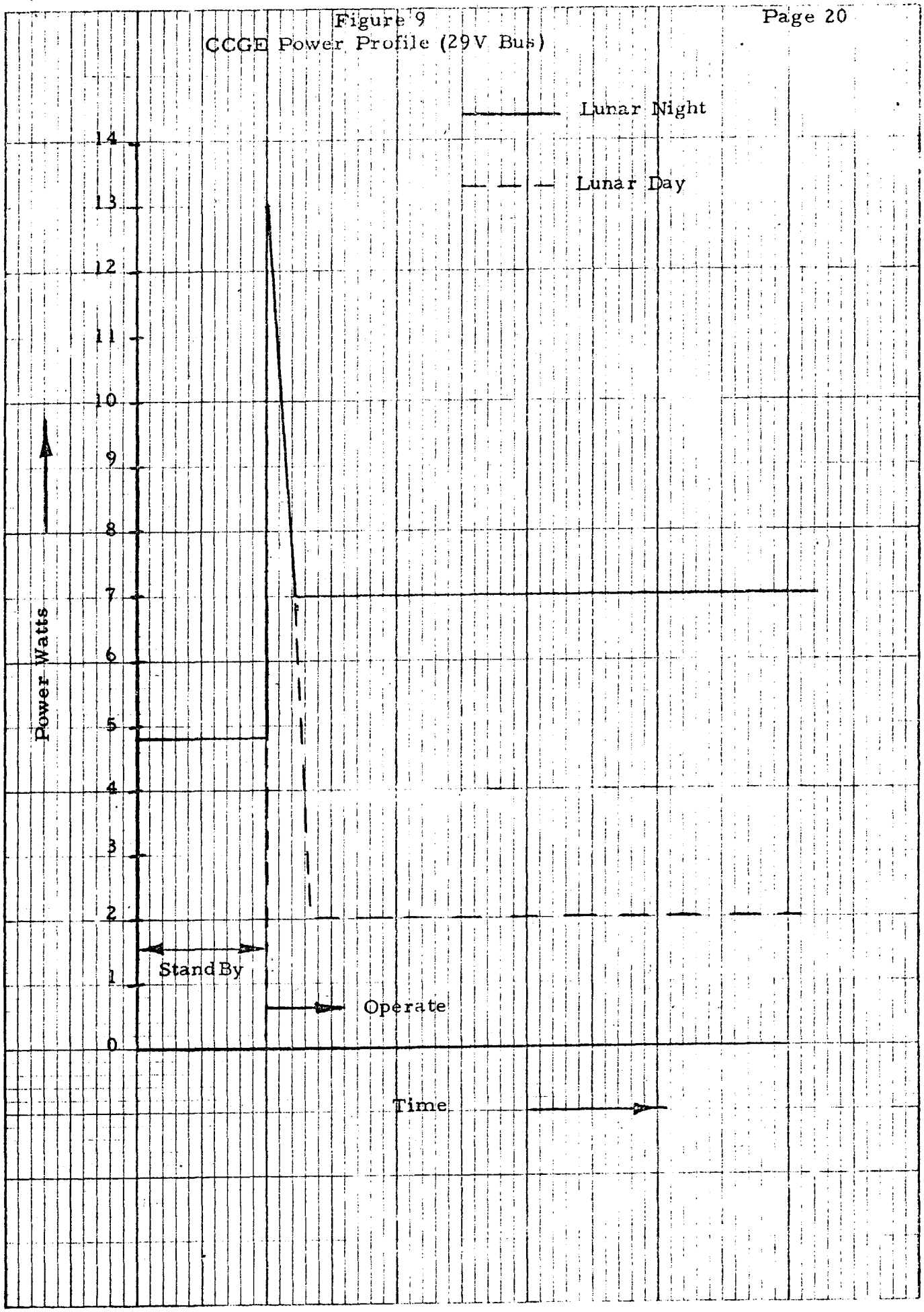


Figure 10 Array A2 Power