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APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

ALSEP POWER BUDGET

ATM-449

Revision N

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Prepared for

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by

**Aerospace
Systems Division**



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Summary

This issue of the ALSEP power budget provides the information available at the beginning of January 1969 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.

Table I lists the measurements of input power required by the Data Subsystem components, together with the latest estimates of power demand for the remaining electrical units associated with the Central Station. 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:

1. Operational Mode (i. e. , when the operational power line is energized)
 - a. 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'. The power value equivalent to the mean functional power demand averaged over any 10-minute period is listed under "Average".
 - b. 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.

- c. Functional plus Thermal Support 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.
- d. Maximum Intermittent - the largest of the peak instantaneous 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 (c) may be borrowed on a time-shared basis from some other item of equipment. If the power required is not constant during the specified mode, the range of variation is listed under maximum and minimum values.
- e. Maximum Transient - the instantaneous peak value of the most severe transient (non-functional) power demand associated with any operational mode or transfer between modes. The value listed under "duration" is normally the length of time the transient demand exceeds the value under heading (c) for that equipment.

2. 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.

ALSEP System Power Balance.

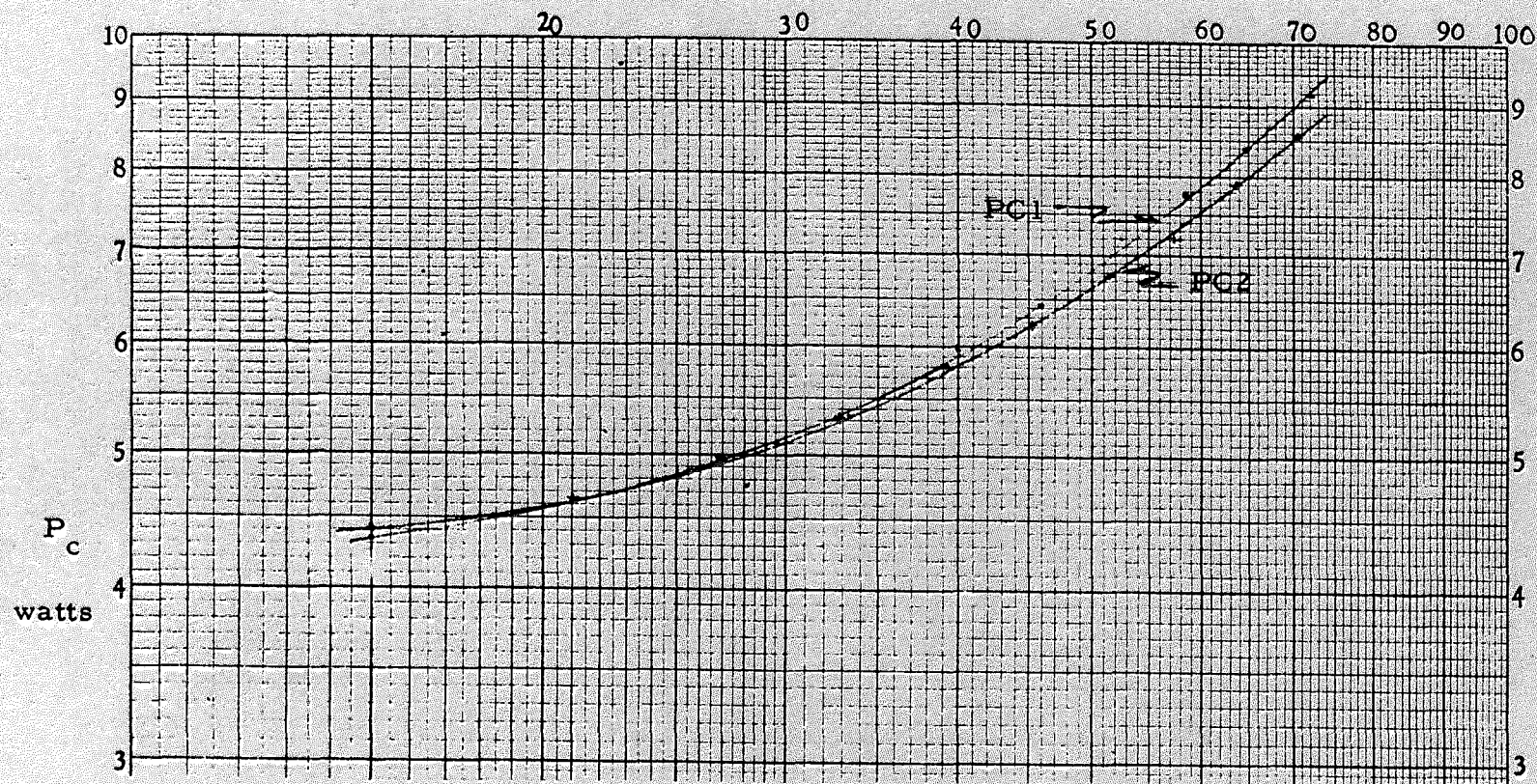
For budgetary purposes, the power required by ALSEP at lunar midnight represents the maximum continuous load on the power source. This value is shown in Table V for each ALSEP flight system together with other important operational and intermittent modes.

TABLE I
**CENTRAL STATION POWER USAGE
(Mean Values for Flight Units)**

<u>Equipment</u>	<u>Operating Mode</u>	<u>Power Demand (watts)</u>
Receiver	Operating	0.7
	Inactive (Heater ON)	1.2
Command Decoder	Operating	1.2
Data Processor	Operating	1.9
PDU	Unloaded	1.4
	Full Load	1.8
Dust Detector	Operating	0.2
Transmitter	Operating	
	- Midnight	6.6
	- Noon	8.6
	Both Transmitters Inactive (Heater ON)	8.4
Diplexer Switch (Xmtr B only)		0.1
PSE Electronics	Operating	3.7
PCU	Operating	Variable*

*PCU Power Demand includes conversion losses (see Figure 1) plus a minimum of 0.8 watts for "ripple-off" reserve.

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



Derived equations: $P_{C1} = 3.9 + 0.0205 P'_{in} + 0.000759 (P'_{in})^2$

$P_{C2} = 4.0 + 0.0234 P'_{in} + 0.000605 (P'_{in})^2$

Figure 1: PCU Conversion Loss Test Results.

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TABLE II - EXPERIMENT POWER, FLIGHT SYSTEMS 1 AND 2

Experiment No. Designation:	Experiment Subsystem				Total	Notes
	1 PSE	2 LSM	3 SWS	4 SIDE		
<u>Operate Mode</u>						
(a) Functional Power						
-Minimum Instantaneous	4.4	2.7	3.2	5.7		
-Maximum Instantaneous	4.4	5.8	6.2	6.5	22.9	
-Average (over 10 min.)	4.4	4.2	4.7	6.0	19.3	
(b) Thermal Support Power						
-Minimum	0.2 ⁽⁵⁾	0.0	0.0	0.0	0.2	
-Maximum	2.4	5.0	2.8	4.0	14.2	
-Control Temp. (°F)	126+1	95	77	32+15	----	
(c) Peak Value of (a) + (b)	6.8	10.8	6.2 ⁽⁶⁾	10.5	34.3	
(d) Max. Intermittent (Time Shared)						(1) Levelling Mode
-Minimum Instantaneous	----	7.2	----	----		(2) Survey Mode
-Maximum Instantaneous	8.0 ⁽¹⁾	12.2 ⁽²⁾	8.7 ⁽³⁾	12.0 ⁽³⁾		(3) Dust Cover Off
-Duration (seconds)	Var.	3.0	15	2.5		(4) Power On
-Average Power for Mode	7.4	9.7				(5) Auto Mode
(e) Maximum Transient						(6) Heaters Time
-Peak Amplitude	11.6 ⁽⁴⁾	11.0 ⁽⁴⁾	10.5 ⁽⁴⁾	13 ⁽⁴⁾		Shared
-Duration (seconds)	0.002	0.120	0.140	0.050		
<u>Standby Mode</u>						
Minimum Power	4.5	----	4.0	2.0	10.5	
Maximum Power	4.5	----	4.0	6.0	14.5	
Control Temperature	----	----	----	32+15		
Sensor Power	0.7					
Central Station Power	3.8					



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TABLE III - EXPERIMENT POWER: FLIGHT SYSTEM 3

Experiment No. Designation:	Experiment Subsystem				Total	Notes
	1 HFE	2 PSE	3 CCGE	4 CPLEE		
<u>Operate Mode</u>						
(a) Functional Power						
-Minimum Instantaneous	3.5	4.4	-	2.8		
-Maximum Instantaneous	5.0	4.4	2.0	3.0	14.4	
-Average (over 10 min.)	3.8	4.4	2.0	2.9	13.1	
(b) Thermal Support Power						
- Minimum	0.0	0.2 ⁽⁴⁾	0.0	0.0	0.2	
-Maximum	4.2	2.4 ⁽⁴⁾	5.0	3.0	14.6	
-Control Temp. (°F)	90 _± 50	126 _± 1	25 _± 5	32 _± 18		
(c) Peak Value of (a) + (b)	9.2	6.8	7.0	6.0	29.0	
(d) Max. Intermittent Power						
-Maximum Instantaneous	10.1 ⁽¹⁾	8.0 ⁽²⁾				(1) Mode II, Lunar Night
-Duration	2600 hrs	Var.				(2) Levelling Mode
-Average for Mode		7.4				
(e) Max Transient						
-Peak Amplitude	9.0 ⁽³⁾	11.6 ⁽³⁾	13.0 ⁽³⁾	7.0 ⁽³⁾		(3) Power ON
-Duration (second)	0.5	0.002	0.120	0.037		(4) AUTO Mode
<u>Standby Mode</u>						
Minimum Power	4.2	4.5	0.0	0.0	8.7	
Maximum Power	4.2	4.5	4.8	4.5	18.0	
Control Temperature (°F)				32 _± 18		
Sensor Power	-	0.7				



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TABLE IV -

EXPERIMENT POWER: FLIGHT SYSTEM 4

Experiment No. Designation:	Experiment Subsystem				Total	Notes
	1 PSE	2 ASE	3 SIDE	4 CPLEE		
<u>Operate Mode</u>						
(a) Functional Power						
-Minimum Instantaneous	4.4	4.0	5.7	2.8		
-Maximum Instantaneous	4.4	7.6	6.5	3.0	13.9 ⁽²⁾	
-Average (over 10 min.)	4.4	5.8	6.0	2.9	13.3 ⁽²⁾	
(b) Thermal Support Power						
-Minimum	0.2 ⁽³⁾		0.0	0.0	0.2	
-Maximum	2.4 ⁽³⁾		4.0	3.0	12.5 ⁽²⁾	
-Control Temp. (°F)	125		32+15	32+18		(1) Leveling Mod (2) ASE on Standl (3) Auto Mode (4) Power ON (5) Dust Cover O
(c) Peak Value of (a) + (b)	6.8	7.6	10.5	6.0	26.4 ⁽²⁾	
(d) Max. Intermittent Power						
-Maximum Instantaneous	8.0 ⁽¹⁾	7.6 ⁽⁴⁾	12.0 ⁽⁵⁾			
-Duration (seconds)	Var	0.002	2.5			
-Average for Mode	7.4					
(e) Maximum Transient						
-Peak Amplitude	11.6 ⁽⁴⁾		13 ⁽⁴⁾	7.0 ⁽⁴⁾		
-Duration (Second)	0.002		0.050	0.037		
<u>Standby Mode</u>						
Minimum Power	4.5	0.3	2.0	0.0	6.8	
Maximum Power	4.5	3.1	6.0	4.5	18.1	
Control Temperature (°F)	-	-4+4	32+15	32+18		
Sensor Power	0.7		-	-		

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TABLE V - ALSEP SYSTEM POWER DEMANDS

System Mode	ALSEP I & II	Power Demand (watts)	
		ALSEP III	ALSEP IV
<u>Initial Turn-On (Exp.Stby, Xmtr OFF)</u>			
Low temperature	34.8	38.9	38.9
High temperature	30.3	28.6	26.3
<u>Normal Operation (Peak)</u>			
Lunar Noon	44.9	36.2	35.1
Lunar Midnight	58.0	49.1	46.3
<u>Intermittent Modes</u>			
Magnetometer			
Flip (Day)	49.4	--	--
Flip (Night)	56.3	--	--
Survey (Day Only)	52.0	--	--
Heat Flow			
Mode II (Day)	--	35.3	--
Mode II (Night)	--	50.1	--
Mode III (Day Only)	--	39.0	--
Active Seismic			
Warm-up	--	--	42.2
Operate			
Low temperature	--	--	40.0
High temperature	--	--	32.8