This ATM is in response to Action Item 0615-38B.

This is a preliminary analysis of ALSEP system test requirements and some recommendations for acceptance testing of the ALSEP system at BxS and KSC.

This action item was initiated by MSC (Phil Maloney) and was prompted by a concern that MSC system test philosophy and the PI test requirement are getting further apart.

This report has been revised to incorporate the latest additions, revisions, and corrections to the original data.

Further reports will be as agreed by MSC (Phil Maloney) and BxS (Al Schorken).

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INTRODUCTION

The approach to this Action Item is to first look at the subsystem inputs and outputs as presently developed. This list will be the opinion of the PE's as influenced by the PI's. The Interface Control Specification and the Subsystem Specification plus discussions with PE's are the input sources.

Where available, GSE specification documents are reviewed.

Unfortunately, we have received only one formal Test Requirement from a PI at this date.

We have proceeded to recommend test sequences where information is known (Active Seismic). In most cases, however, the material developed here is preliminary and will have to be verified and modified by all concerned. As these critiques are incorporated, test requirements can be firmed.

A specific statement of test philosophy has been published as ATR-14, and is a complement to this ATM. (ATR-14, The ALSEP Test Program, was generated for presentation at the August 11, 1966 PI Interface meeting at Houston, Texas).

SYSTEM TEST SET

The System Test Set is a semi-automatic "GO NO GO" type tester.

The System Test Set has two basic functions, to generate commands for ALSEP (up link data) and receive RF data from ALSEP (down link data); demodulate this data for processing in the program processor.

When commands are selected from the command control panel and enabled by the programmer processor, they then modulate an RF source for transmission to the ALSEP central station. The ALSEP central station will send back a command verification signal. This signal verifies that the commands received are correct.

When RF data is received by the system test set it is demodulated to NRZ-C data plus clock and routed to the programmer processor for processing. The program in core memory will determine what data processing will take place. This has not been completely firmed up. As a minimum, it will compare the data to a tolerance stored in core memory and print out the out of tolerance readings on a high speed printer. The print out is in alpha numeric. All commands and received data will be stored on a magnetic tape unit. This data is picked up at the input to the demodulator. This tape is utilized to record all down- and up-link data for future diagnostic evaluation. The evaluation procedure has yet to be determined.

A computer program will be required to load the 4096 x 32-bit word core memory with the desired test program.

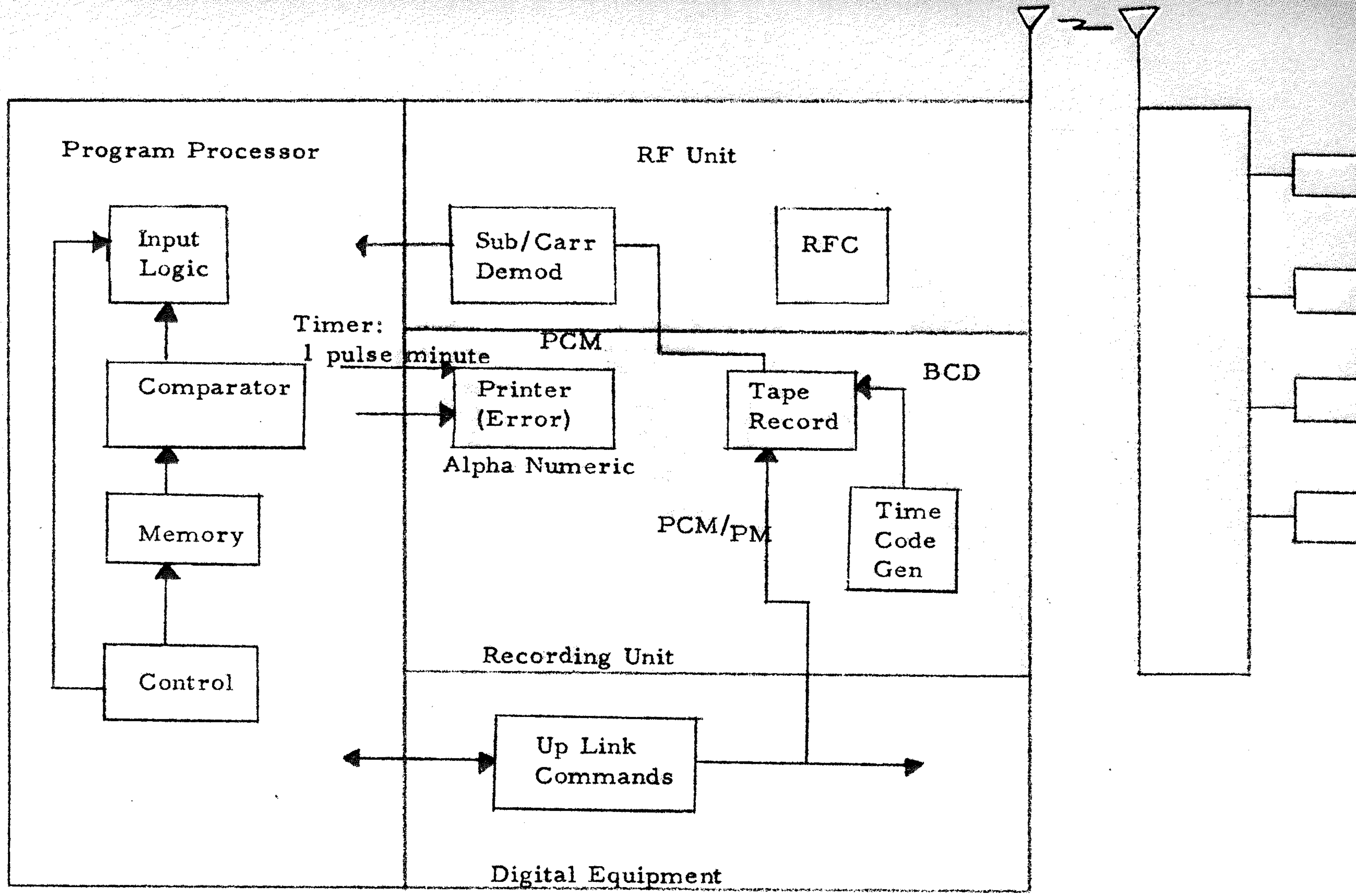
The system test set program for semi-automatic operation is stored in the memory. A major task is to compose the program for the memory. Upon examination of the various experiment test requirements, the Magnetometer has by far the longest test time, due to the automatic sequences initiated by two of the commands ('site survey' and 'flip/calibrate initiate').

Fault Isolation to the Component Level in the System Test Set

The title of this paragraph is in the contract as a System Test Set requirement. The System Test Set has this capability if it is sent information that truly monitored the component performance. From our inspection of housekeeping signal allocations, there has been no discipline on the part of the PI's to isolate their component performance via housekeeping temelctry.

At the present time, if a certain component failed it may or may not be identified. This depends on the chance that a particular unique housekeeping signal change is correlated with the failure.

The actual isolation of faults cannot be a unique feature of the System Test Set. This attribute is really a function of what the subsystems can deliver in terms of housekeeping reports on each function, together with the diagnostic sophistication of the program directing the STS.



Sigure 1. - System Test Set

SYSTEM TEST TIME*

Solar Wind Experiment

8 minutes running time. Mainly housekeeping subcommutation.

Magnetometer Experiment

5 hours 21 minutes running time. Mainly for command verifications.

Passive Seismic Experiment

30 minutes running time. Mainly verification of thermal control by-pass ON-OFF command.

Suprathermal Ion Detector

Approximately 2.25 hours running time. Mainly for housekeeping subcommutation.

Active Seismic Experiment

42 minutes running time. Mainly command verifications.

Charged Particle Experiment

39 minutes running time. Mainly command verification.

Heat Flow Experiment

To be determined.

Central Station

5 minutes running time. Mainly command verifications.

*Detail breakdown and basis for times shown in System Level Test section of this report.

Passive Seismic Experiment

The Passive Seismic Experiment has only one mode of operation. This mode is modified by 7 gain and calibration commands from the ground via the central station. The word frame is 43 - 10 bit words, 2 of which are subcommutated twice. One data point for odd central data frames and one for even.

All housekeeping data points are sent in analog form to the central station to be subcommutated in the housekeeping word of the central station main frame.

Recommended Test

43 Data Points each Frame. This must be repeated twice because of the subcommutated words.

The above test must be repeated each time one of the 15 ground commands are received. The commands are as follows:

	COMMAND	FUNCTIONS
1.	Uncage	1
2.	Feedback Filter: In-Out	2
3.	Leveling Mode: Auto-Command	2
4.	Leveling Speed: Hi-Lo	2
5.	Leveling Direction: CL-CCL	2
6.	Coarse Sensor: In-Out	2
7.	Leveling Power A Motor: On-Off	2
8.	Leveling Power B Motor: On-Off	2
9.	Leveling Power Z Motor: On-Off	2
10.	Gain Change, LPH	4
11.	Gain Change, LPZ	4
12.	Gain Change, SPZ	4
13.	Calibration, LP	2

SYSTEM LEVEL TEST

Solar Wind Experiment

The Solar Wind Experiment has only one mode of operation, although the seven sensors are internally programmed to fourteen voltage levels for proton detection and seven voltage levels for electron detection. The basic data frame consists of 186 ten-bit words, some of which are sub-commutated 16 times to provide housekeeping data. The data words are transmitted in four of the 64 central station data frame word positions, so a complete sequence of data occupies 16 x 186 x 1/4 = 744 C. S. frames.

Recommended Test

32 Data Points of the First 186 word Frame.

It is only necessary to look at 32 of the 168 data words because each sensor is stepped through a different voltage sequencer. Data will be taken only at the lowest and highest voltage step. The next 15 frames will contain the same data. The data should be zero wind plus noise as the dust cover will be on during test.

16 Housekeeping Data Points per Frame for 16 Frames.

This housekeeping data will be A/D converter calibration, temperature sensors and current calibration. Each subcommutation will be printed out in an alpha numeric code. This is 256 data words. This could be a maximum of 256 channels, each channel requiring normal decoding.

2 Control Words Each Frame.

These points must be recorded as they contain the subframe number.

The only command sent to this experiment is for dust cover removal, the test technique for verifying which has yet to be established. The ON and OFF command received by the central station and acted on by the central station will be verified by data being received.

No sensor simulators will be required because of the built-in calibrator (electronics only) in the experiment.

At this time it is believed that a nitrogen purge will be required during system test. This is believed to prevent arcing of high voltage electrodes.

14. Calibration, SP 2

15. Thermostat Bypass: On-Off 2

No sensor simulator will be required during system test as caged sensor outputs are known. The uncage command could not be sent in the earth's gravity.

Suprathermal Ion Detector

The Suprathermal Ion Detector Experiment contains two experiments. The experiments are Suprathermal Ion Detector Experiment (SIDE) and Cold Cathode Gauge Experiment (CCGE). Both experiments can be programmed by ground command to operate simultaneously and the data of both is intermixed in the SIDE data word frame.

The SIDE data word frame is 10 - 10 bit words. The words are transmitted 5 words per central station data frame thus taking 2 central frames to transmit one SIDE format. All housekeeping and experiment status data is sent in the experiment data format. 2 of the 10 words are subcommutated 128 times. Time required to send one housekeeping and status subcommutated frame is 256 central station data frames - approximate time, 154 seconds. One of the housekeeping points, ground plane voltage, and one of the status points, ground plane step, is automatically stepped through 23 steps, one per 128 subcommutator frame. During this ground plane voltage stepping mode only, two subcommutator words will require monitoring to verify function. The housekeeping subcommutation word frame of 128 words contains 25 housekeeping data points and the CCIG signal repeated over and over again throughout the frame. The status subcommutator word frame of 128 words contains nine status signals repeated over and over again throughout the frame.

Recommended Tests

1 SIDE sequence = 2 ALSEP frames

1 SIDE format = 128 SIDE sequences

= 256 ALSEP frames.

There are 15 commands, and internal programming of a voltage to 23 levels, one level per SIDE format.

1. Ground plane stepper On/Off
2. Reset SIDE frame counter at 10
3. Reset SIDE frame counter at 39
4. Reset velocity filter counter at 9
5. Reset SIDE frame counter at 79
6. Commands 4 and 5 together
7. X 10 accumulation interval

8. Master reset

9. Velocity filter voltage On/Off

10. L.E. C.P.A. voltage On/Off

11. H.E. C.P.A. voltage On/Off

12. Continuous calibration

13. CCIG high voltage On/Off

14. Channeltron® high voltage On/Off

15. Reset input command register

Test Sequence:

1. Check dust cover and seal before and after commands.

2. Apply Commands 9, 10, 11, 13, 14; check supplies; re-apply; check supplies; re-apply, monitor all HK points.

3. Apply Command 6 without "execute command", check CIR, then Command 15 and "execute command", check CIR.

4. Apply Command 6, check format for 10 velocity filter steps and 80 frames per sequence.

5. Apply Command 3, check for 20 velocity filter steps and 40 frames per sequence. Check GPS and GPV steps through 23 sequences.

6. Apply Command 1, check that GPS and GPV do not step, re-apply and check that stepping re-commences.

7. Apply Command 7, and check that data read-out occurs only every 10th frame.

8. Apply Command 12 and check for continuous cal sequence.

9. Apply Command 8, check for normal format.

10. Apply Command 5, check for 80 frames per sequence.

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Magnetometer Experiment

The Magnetometer Experiment has three modes of operation, site survey, measure and calibrate. These modes are modified by 7 commands received from ground by way of the central station. There is one spare command link. The 16 housekeeping data points are subcommutated, and transmitted one per frame. The housekeeping word is 10 bits long - 2 flag data bits, 7 data bits and one sub-commutator start indication bit. In summary, the experiment sends 7 - 10 bit words to the central station for transmission per system frame, 6 are data words (3 signals each twice per frame) and one is housekeeping. The housekeeping word is subcommutated 16 times, and contains 25 flag data bits plus 8 housekeeping signals.

Magnetometer Commands

1. Range selection.

   Three ranges (± 100, ± 200, ± 400 γ) selected by repeated application of command.

   Starts in range 1, then successive applications of command cycles to 2, 3, 1, 2, 3, ... etc.

   Flag data once per 16 ALSEP cycles.

2. Range offset.

   Three offsets of each polarity (25%, 50%, 75% of full scale) selected on same basis as above; cycle runs 0, + 25%, +50%, +75%, 0, -25%, -50%, -75%, 0, +25%, ... etc.

   Flag data once per 16 ALSEP cycles.

3. Range offset hold.

   Locks in the offset selected by (2) in one axis and transfers operation of range offset command to next axis. Initially this is in X axis, then transfers to Y, then Z, then back to X.

4. Flip-calibrate inhibit.

   Inhibits the automatic (12 - hourly) and commanded flip-calibrate cycles.

   Reapplication of command restores automatic cycle and normal operation of Command 5.

11. Apply Command 4, check for 10 velocity filter steps.

12. Apply Command 2, check for 11 frames per sequence.

Times:

1.	2 x 256	=	512	ALSEP	frames
2.	25 x 256	=	6400	"	"
3.	2 x 256	=	512	"	"
4.	320	=	320	"	"
5.	25 x 80	=	2000	"	"
6.	4 x 80	=	320	"	"
7.	1 x 80	=	80	"	"
8.	2 x 16	=	32	"	"
9.	2 x 256	=	512	"	"
10.	2 x 160	=	320	"	"
11.	1 x 160	=	160	"	"
12.	2 x 22	=	44	"	"
	Total		11212	"	"
	or		6770	seconds	
+	83 command applications at 5 seconds each	=	415	seconds	
+	16 readout select and monitor at 15 seconds each	=	915	seconds	
			8100	seconds	
		=		2 hours 15 minutes	

No sensor simulator will be used during system test as internal calibration of the electronics is included. The SIDE requires external vacuum equipment and a radioactive source for end-to-end testing. The CCIG (a cold cathode vacuum gauge will be evacuated and sealed at the subcontractor. It will then operate as a conventional gauge. On the moon the seal will be exploded off.

7th cal. phase	As 1st		8 m
8th cal. phase	As 1st		8 m
		Total time 32 m 30 s	
Normal measurement	11 h 48 m	(back to initial conditions)	

Site Survey Sequence, Times

Subsequence 1

1st cal. phase	8 m
2nd cal. phase	8 m
Flip X + 180°	10 s
Flip Y + 180°	10 s
Flip Z + 180°	10 s
Reverse offset all axes	
3rd cal. phase	8 m
4th cal. phase	8 m
Measurement	5 m
Flip X - 180°	10 s
Flip Y - 90°	10 s
Flip Z - 90°	10 s
X axis offset (+ ve) all axes	
Measurements	5 m
Flip X + 180°	10 s
Flip Y + 90°	10 s
Flip Z + 90°	10 s

5. Flip-calibrate initiate.

Gives opportunity for flip-calibrate sequences in addition to normal automatic sequences.

6. Spare.

7. Filter failure bypass.

Equipment contains analog prefilter and digital filter. Operation of command bypasses majority of latter. Second application of command restores filter.

8. Site survey initiate.

Initiates each of 3 subsequences (pre-programmed) at end of each sub-sequence, system is in scientific mode. Reapplication of command starts next sub-sequence.

Flip-calibrate sequence time.

1st cal. phase	20 seconds/step, 8 steps, 3 axes	8 m
2nd cal. phase	As 1st	8 m
X flip	10 seconds	
Y flip	10 seconds	
Z flip	10 seconds	
3rd cal. phase	As 1st	8 m
4th cal. phase	As 1st	8 m
	Total time 32 m 30 s	
Normal measurement	11 h 48 m (5 m in SS mode)	
5th cal. phase	As 1st	8 m
6th cal. phase	As 1st	8 m
Z flip	10 seconds	
Y flip	10 seconds	
Z flip	10 seconds	

Reverse X axis offset

- ve Y offset on Y axis

- ve Z offset on Z axis

Subsequence 1 Total time 43 m 30 s

Monitor temp. and verify thermal equilibrium

Subsequence 2

1st cal. phase	8 m
2nd cal. phase	8 m
Flip X - 180°	10 s
Flip Y - 180°	10 s
Flip Z - 180°	10 s
Reverse offsets all axes	
3rd cal. phase	8 m
4th cal. phase	8 m
Measurements	5 m
Flip X + 180°	10 s
Flip Y + 180°	10 s
Flip Z + 180°	10 s
Flip X - 90	10 s
Flip Y -180	10 s
Flip Z - 90	10 s
Gimbal Z 90°	10 s
Y axis offset (+ ve) all axes	
Measurements	5 m

Flip X + 90	10 s
Flip Y + 180	10 s
Flip Z + 90	10 s
- ve X offset on X axis	
Reverse offset on Y axis	
- ve Z offset on Z axis	

Subsequence 2 Total time 43 m 40 s

Monitor temp. and verify thermal equilibrium.

Subsequence 3

1st cal. phase	8 m
2nd cal. phase	8 m
Flip X - 180°	10 s
Flip Y - 180°	10 s
Flip Z - 180°	10 s
Reverse offsets all axes	
3rd cal. phase	8 m
4th cal. phase	8 m
Measurements	5 m
Flip X + 180°	10 s
Flip Y + 180°	10 s
Flip Z + 180°	10 s
Flip X - 90°	10 s
Flip Y - 90°	10 s
Flip Z - 180°	10 s

Gimbal X 90°	10 s
Gimbal Y 90°	10 s
Z axis offset (+ ve) all axes	
Measurements	5 m
Flip X + 90°	10 s
Flip Y + 90°	10 s
Flip Z + 180°	10 s
- ve X offset on X axis	
- ve Y offset on Y axis	
Reverse offset on Z axis	
1st cal. phase	8 m
2nd cal. phase	8 m
Flip X - 180°	10 s
Flip Y - 180°	10 s
Flip Z - 180°	10 s
Reverse offsets all axes	
3rd cal. phase	8 m
4th cal. phase	8 m
Measurements	5 m

Subsequence 3 Total time 8 m 50 s

Total time for subsequences 1, 2 and 3 234 minutes

= 3 hours 54 min.

Magnetometer Test Time (Full Checkout)

Command

1. Range selection 4 applications per cycle ∴ 4 x 16 ALSEP frames.

2. Range offset and
3. Range offset hold: } 8 applications for each axis per cycle: 8 x 3 x 16 ALSEP frames.

4. Flip-calibrate inhibit
5. Flip-calibrate initiate }

Checked out by following sequence:

Apply Command No. 4

Apply Command No. 5

Monitor Magnetometer outputs and flip position bits for 16 1/2 minutes to ensure no change.

Apply Command No. 5

Monitor Magnetometer outputs and flip position bits for first flip/calibrate sequence — 32 1/2 minutes.

Apply Command No. 5

Monitor Magnetometer outputs and flip position bits for second flip/calibrate sequence — 32 1/2 minutes.

Total time — about 82 minutes.

6. Spare.

7. Filter failure bypass - 2 applications per cycle ∴ 2 x 16 ALSEP frames.

8. Site survey — 3 applications per cycle.

Total time — 3 hours 54 minutes.

1	64 frames	480 frames ≈ 5 minutes	
2, 3	384 frames		
7	32 frames		
4, 5			1 hour 22 minutes
8			3 hours 54 minutes
Total time for complete test sequence			5 hours 21 minutes

At the end of the site survey test sequence, the gimballing mechanism on each sensor must be re-cocked.

Magnetometer Test Time (Limited Checkout)

Command

1.	Range selection	1 application	16 ALSEP frames
2.	Range offset and	Apply 2, 3, 2 Monitor for 1 format after each	48 " "
3.	Range offset hold		
4.	Flip-calibrate inhibit and		
5.	Flip-calibrate initiate		
	Apply 4, 5	Monitor for two formats	32 " "
	Apply 4, 5	Monitor flip/cal. first sequence	32 1/2 " "
6.	Spare		
7.	Filter failure bypass — as for full checkout		32 ALSEP frames
8.	Site survey — first sequence only		43 1/2 minutes

Total time ≈ 78 minutes

No sensor simulator will be used in system test but a sensor stimulator (flux tanks) will be used. The flux tanks are manually operated; their setting accuracy, repeatability, and operability in vacuum are questionable at this time.

CENTRAL STATION

The central station will have many of its functions verified during the system test of the experiment such as: Command Receiver, Command Verification, Data Processor Operation, etc. The following tests must be run to insure the current operation of the remaining subsystems.

Recommended Test

22 Command Verification Tests. The following commands must be sent from the ground and execution verified.

DP 3	Normal Data Rate
DP 4	Slow Data Rate
DP 5	Reset "X" and "Y" Processor
PD 1	Transmitter "A" select
PD 2	Transmitter ON
PD 3	Transmitter OFF
PD 4	Transmitter "B" select
PD 5	Central Station Heater 1 ON
PD 6	Central Station Heater 1 OFF
PD 7	Central Station Heater 2 ON
PD 8	Central Station Heater 2 OFF
PD 9	Central Station Heater 3 ON
PD 10	Central Station Heater 3 OFF
PD 11	Central Station Heater 4 ON
PD 12	Central Station Heater 4 OFF
PD 13	Central Station Heater 5 ON
PD 14	Central Station Heater 5 OFF

PD 15 Data Processor "X" ON

PD 16 Data Processor "Y" ON

PC 1 Power Conditioning Unit Set

PC2 Power Conditioning Unit Reset

90 Housekeeping words, one per main frame. Housekeeping word is subcommutated 90 times, according to the following table.

Channel (Frame) Assignments for the Analog Multiplexer Housekeeping Word 33

(Frame) Channel	ID	Word Name	Location	Measurement	Range	Accuracy
1	CE-3	Converter Input Voltage	Central Station	Current	0 to 10 A DC	±1%
2	CE-1	.25 V DC Calibration	C. S.	Voltage		
3	CE-2	4.75 V DC Calibration	C. S.	Voltage		
4	STT-3	Temperature	Thermal Plate	Temperature	-50°F to 200°F	±10°F
5	CE-4	Input Current	C. S.	Current	0 to 10 A DC	±1%
6	RT-1	Temperature	RTG Hot Frame	Temperature	1000° to 1400°F	±5°F
7	RT-4	Temperature	RTG Cold Frame	Temperature	600° to 1000°F	±5°F
8	CE-5	Shunt Reg. No. 1 Current	C. S.	Current	0 to 10 A DC	±1%
9	CB-1	Command Demodulator (Decoder) 1 KC Sub-carrier	Central Station Bistatic	Bistatic	Present	—
10	CB-2	PCU Power Osc. No. 1	C. S. Bistatic	Bistatic	On	—
11	CB-3	PCU Power Osc. No. 2	C. S. Bistatic	Bistatic	On	—
12	CB-4	Power Distribution Experiment No. 1 and No. 2	C. S. Bistatic	Bistatic	Off	—
13	CE-6	Shunt Reg. No. 2 Current	C. S.	Current	0 to 10 A DC	±1%

Channel (Frame) Assignments for the Analog Multiplexer Housekeeping Word 33 (Continued)

(Frame) Channel	ID	Word Name	Location	Measurement	Range	Accuracy
14	CB-5	Power Distribution Expts. No. 3, 4, 5	C. S. Bistatic	Bistatic	Off	—
15	STT-10	Temperature	Primary Structure Bottom	Temperature	-200°F to $+200^{\circ}$F	$\pm 15^{\circ}$F
16	ET-1	Local Osc. Crystal A	C. S.	Temperature	-50°F to $+200^{\circ}$F	$\pm 10^{\circ}$F
17	ET-2	Local Osc. Crystal B	C. S.	Temperature	-50°F to $+200^{\circ}$F	$\pm 10^{\circ}$F
18	ET-3	Transmitter A Crystal	C. S.	Temperature	-50°F to $+200^{\circ}$F	$\pm 10^{\circ}$F
19	ET-4	Transmitter A Heat Sink	C. S.	Temperature	-50°F to $+200^{\circ}$F	$\pm 10^{\circ}$F
20	CE-7	PCU Output Voltages No. 1 (29)	C. S.	Voltage	0 to 35 V DC	±1%
21	CE-13	Pre-limiting Level, Rcvr.	C. S.	Dbm Level	-101 to -81 Dbm	±5%
22	CE-18	RF Level 2nd Power Amp. Trans. A	C. S.	Power	0 to 3.5 w	±2%
23	PS-1	Long Period Amp. Gain (X and Y)	Passive Seismic Electronics in C. S.	Bistatic	Off/On	—
24	PS-2	Long Period Amp. Gain (X and Y)	Passive Seismic Electronics in C. S.	Bistatic	Off/On	—
25	DA-2	Temperature	Dust Accretion	Temperature		
25*	CP-1*	Switchable Power Supply Voltage	Charged Particle Electronics in C. S.	Voltage		

Channel (Frame) Assignments for the Analog Multiplexer Housekeeping Word 33 (Continued)

(Frame) Channel	ID	Word Name	Location	Measurement	Range	Accuracy
26	DA-5	Cell Voltage	Dust Accretion	Voltage		
27	STT-1	Temperature	Sunshield	Temperature	-300°F to +300°F	±15°F
28	STT-4	Temperature	Thermal Plate	Temperature	-50°F to +200°F	±10°F
29	AS-1	Temperature	Active Seismic Electronics in C. S.	Temperature		
30	HF-1		Heat Flow			
31	ET-5	Transmitter B Crystal	C. S.	Temperature	-50° to +200°F	±10°F
32	ET-6	Transmitter B Heat Sink	C. S.	Temperature	-50° to +200°F	±10°F
33	ET-7	Data Processor X, Base	C. S.	Temperature	-50°F to +200°F	±10°F
34	ET-8	Data Processor X, Internal	C. S.	Temperature	-50°F to +200°F	±10°F
35	CE-8	PCU Output Voltages No. 2 (15)	C. S.	Voltage	0 to 18 V DC	±1%
36	CE-14	Local Osc. Level, Rcvr	C. S.	Power	.25 to 2 mw	±5%
37	RT-2	Temperature	RTG Hot Frame	Temperature	1000°F to 1400°F	±5°F
38	PS-3	Long Period Amp. Gain (Z)	Passive Seismic Electronics in C. S.	Bistatic	Off/On	—

Channel (Frame) Assignments for the Analog Multiplexer Housekeeping Word 33 (Continued)

(Frame) Channel	ID	Word Name	Location	Measurement	Range	Accuracy
39	PS-4	Long Period Amp. Gain (Z)	Passive Seismic Electronics in C. S.	Bistatic	Off/On	—
40	DA-3	Temperature	Dust Accretion	Temperature		
40*	CP-3*	Channeltron No. 2 Power Supply Voltage	Charged Particle Electronics in C. S.	Voltage		
41	DA-6	Cell Voltage	Dust Accretion	Voltage		
41*	CP-6*	Temperature No. 2	Charged Particle Electronics in C. S.	Temperature		
42	STT-2	Temperature	Sunshield	Temperature	-300° to $+300^\circ$F	$\pm 15^\circ$F
43	STT-5	Temperature	Sunshield	Temperature		
44	AS-2	Temperature	Active Seismic Electronics in C. S.			
45	HF-2		Heat Flow			
46	ET-9	Data Processor Y, Base	C. S.	Temperature	-50°F to $+200^\circ$F	$\pm 10^\circ$F
47	ET-10	Data Processor Y, Internal	C. S.	Temperature	-50°F to $+200^\circ$F	$\pm 10^\circ$F
48	ET-11	Command Decoder, Base	C. S.	Temperature	-50°F to $+200^\circ$F	$\pm 10^\circ$F
49	ET-12	Command Decoder, Internal	C. S.	Temperature	-50°F to $+200^\circ$F	$\pm 10^\circ$F

Channel (Frame) Assignments for the Analog Multiplexer Housekeeping Word 33 (Continued)

(Frame) Channel	ID	Word Name	Location	Measurement	Range	Accuracy
50	CE-9	PCU Output Voltage No. 3 (12)	C. S.	Voltage	0 to 15 V DC	±1%
51	CE-15	RF Output, Transmitter A	C. S.	Power	0 to 1 w	±2%
52	RT-3	Temperature	RTG Hot Frame	Temperature	1000° to 1400°F	$\pm 5^{\circ}$F
53	PS-5	Level Direction	Passive Seismic Electronics in C. S.	Bistatic	Off/On	—
54	PS-6	Level Speed	Passive Seismic Electronics in C. S.	Bistatic	Off/On	—
55	AS-3	Temperature	Active Seismic Electronics in C. S.	Temperature		
56	HF-3	Heat Flow				
57	HF-6	Heat Flow				
58	STT-6	Temperature	Thermal Plate	Temperature	-50°F to $+200^{\circ}$F	$\pm 10^{\circ}$F
59	STT-8	Temperature	Primary Structure Sides	Temperature	-300°F to $+300^{\circ}$F	$\pm 15^{\circ}$F
60	STT-12	Temperature	Inner Multilayer Insulation	Temperature	-50°F to $+150^{\circ}$F	$\pm 10^{\circ}$F
61	ET-13	Command Demodulator VCO	C. S.	Temperature	-50°F to $+200^{\circ}$F	$\pm 10^{\circ}$F
62	ET-14	Temperature	Power Distribution, Base	Temperature	-50°F to $+200^{\circ}$F	$\pm 10^{\circ}$F

Channel (Frame) Assignments for the Analog Multiplexer Housekeeping Word 33 (Continued)

(Frame) Channel	ID	Word Name	Location	Measurement	Range	Accuracy
63	ET-15	Temperature	Power Distribution, Internal	Temperature	-50°F to +200°F	±10°F
64	ET-16	Power Osc. No. 1	PCU	Temperature	0 to 125°F	±10°F
65	CE-10	PCU Output Voltage No. 4 (5)	C. S.	Voltage	0 to 6 V DC	±1%
66	CE-16	RF Output Transmitter B	C. S.	Power	0 to 1 w	±2%
67	RT-5	Temperature	RTG Cold Frame	Temperature	600° to 1000°F	±5°F
68	PS-7	Short Period Amp. Gain (Z)	Passive Seismic Electronics in C. S.	Bistatic	Off/On	—
69	PS-8	Short Period Amp. Gain (Z)	Passive Seismic Electronics in C. S.	Bistatic	Off/On	—
70	PD-1	Temperature	Power Dissipator	Temperature	-100°F to +600°F	±20°F
71	STT-7	Temperature	Thermal Plate	Temperature	-50°F to 200°F	±10°F
72	STT-13	Temperature	Outer Multilayer Insulation	Temperature	-300°F to +300°F	±15°F
73	AS-4	Spare	Active Seismic Electronics in C. S.			
74	HF-4		Heat Flow			
75	HF-7		Heat Flow			
76	ET-17	Power Osc. No. 2	PCU	Temperature	0 to 125°F	±10°F

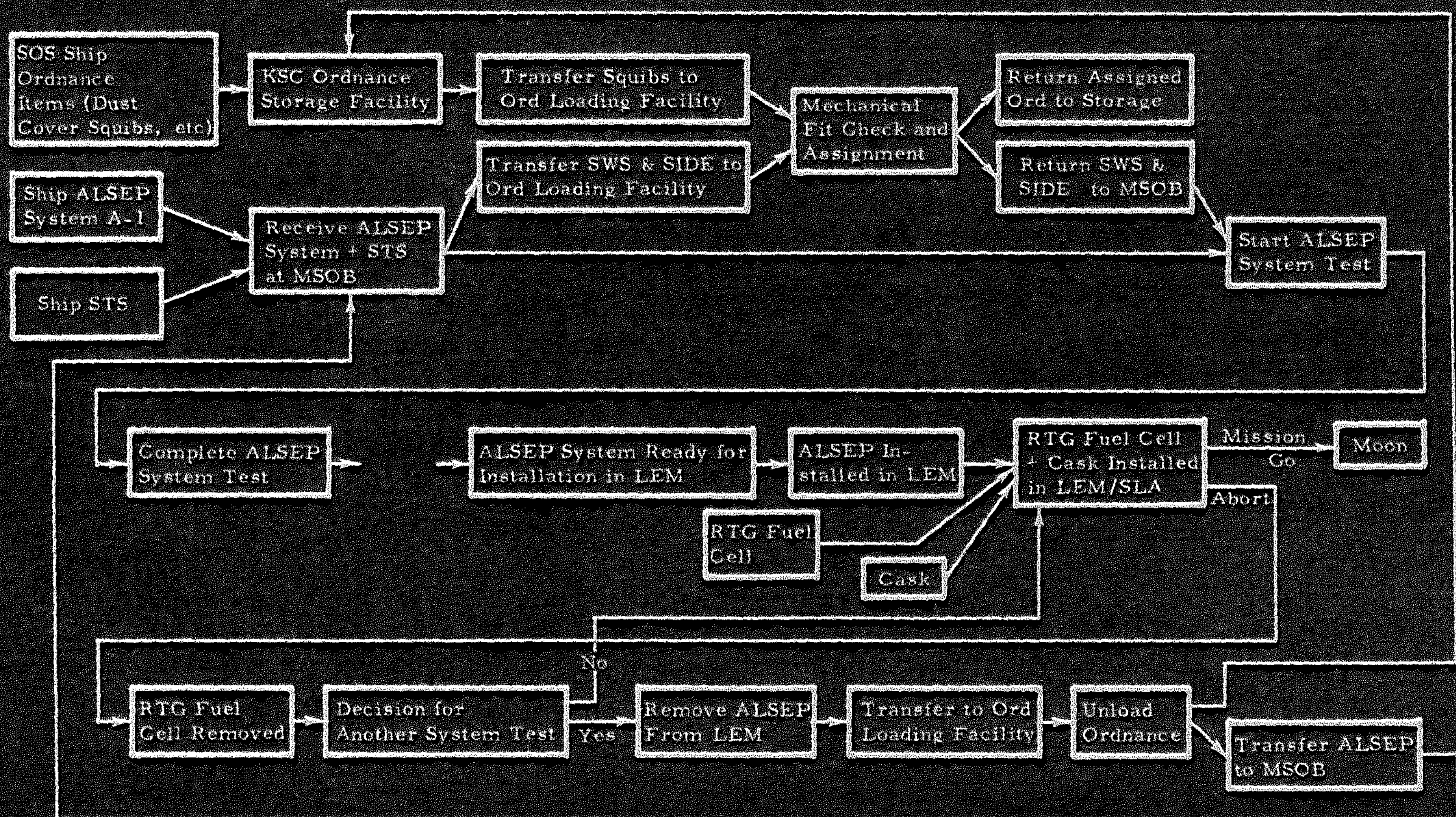
Channel (Frame) Assignments for the Analog Multiplexer Housekeeping Word 33 (Continued)

(Frame) Channel	ID	Word Name	Location	Measurement	Range	Accuracy
77	ET-18	Regulator No. 1	PCU	Temperature	0 to 125°F	±10°F
78	ET-19	Regulator No. 2	PCU	Temperature	0 to 125°F	±10°F
79	CE-11	Output Voltage No. 5 (-12)	PCU	Voltage	0 to -15 V DC	±1%
80	CE-12	Output Voltage No. 6 (-6)	PCU	Voltage	0 to -7.5 V DC	±1%
81	CE-17	RF Level 2nd Power Amp. Trans. A	C. S.	Power	0 to 3.5 w	±2%
82	RT-6	Temperature	RTG Cold Frame	Temperature	600° to 1000°F	±5%
83	DA-1	Temperature	Dust Accretion	Temperature		
83*	CP-4*	DC-DC Converter Voltage	Charged Particle Electronics in C. S.	Voltage		
84	DA-4	Cell Voltage	Dust Accretion	Voltage		
85	PD-2	Temperature	Power Dissipator	Temperature	-100°F to 600°F	±20°F
86	HF-5		Heat Flow			
87	STT-9	Temperature	Primary Structures Sides	Temperature	-300°F to +300°F	±15°F
88	STT-11	Temperature	Primary Structures Bottom	Temperature	-200°F to +200°F	±15°F

Channel (Frame) Assignments for the Analog Multiplexer Housekeeping Word 33 (Continued)

(Frame) Channel	ID	Word Name	Location	Measurement	Range	Accuracy
89	CP-2	Channeltron No. 1 Power Supply Voltage	Charged Particle Electronics in C. S.	Voltage		
90	CP-5	Temperature No. 1	Charged Particle Electronics in C. S.	Temperature		

*Array B



Array A KSC Sequence

Active Seismic Experiment

The Active Seismic Experiment has two modes of operation — data and housekeeping mode. The output data frame of this experiment is not sent through the central system data processor but is sent directly to the central system transmitter section and then the Active Seismic Command replaces all other data from the Data Processor.

In the data mode, the Active Seismic word data frame is 64 - 21 bit words. The first word is the 21 bit control word. The other 63 - 21 bit words are seismic data from the three sensors.

The housekeeping mode word frame is 64 - 21 bit words. The first word is the 21 bit control word. The other 63 words contain the 16 housekeeping data points, 5 of which are from the central station.

During the off mode, 4 analog signals are sent to the central station to be transmitted to ground as housekeeping points within the C.S. housekeeping format.

Recommended Tests

9 Commands

1. Arm grenades
2. Sequential fire
3. Fire grenade 1
4. Fire grenade 2
5. Fire grenade 3
6. Fire grenade 4
7. Set engineering data mode
8. Set seismic data mode
9. Geophone calibrate

Repetition of the sequence "arm grenades", "sequential fire" will fire the grenades in order 1, 2, 3, 4. Substitution of "fire grenade" commands for "sequential fire" commands permits firing of grenades in any order.

On switch-on, the system will start in the engineering data mode. Application of "arm grenades", "geophone calibrate" or "set seismic data" commands will set the system in the seismic data mode. The system will stay in this mode until either 5 seconds from the receipt of a thumper fire signal or 5 minutes after either a "sequential fire" or "fire grenade" command; at this time, the system will revert to the engineering data mode.

Application of a "geophone calibrate" command sets the system in the seismic data mode and applies a pulse stimulus to the three geophones simultaneously.

Commands 1-6 will require 8 x 5 = 40 minutes checkout time.

Commands 7, 8, and 9 will require about 1 minute checkout time.

Checkout of the thumper operation will require about 1 minute.

Total test time: 42 minutes.

A sensor simulator will be used with the Mortar box. This simulator will replace the grenades and firing tubes and will control a 30 MHz oscillator.

ACTIVE SEISMIC EXPERIMENT SYSTEM TEST SEQUENCE AT KSC

The system test of the Active Seismic Experiment is presently planned without live ordnance. The mechanical functional units of this experiment will be checked at Bendix and Cape Kennedy using a dummy Grenade and Launcher Assembly (GLA). The electrical function test will be as described herein, using the Active Seismic Sensor Simulator. The real time sequence will be:

1. The high explosive GLA will be shipped from Space Ordnance Systems to the Ordnance Storage Facility at Cape Kennedy.

2. The ALSEP system and system test set will be delivered to the MSOB building.

3. A GLA is sent to the Ordnance Loading Facility.

4. The Active Seismic Experiment (ASE) is sent from the MSOB to the Ordnance Loading Facility.

5. A mechanical fit check is made between the GLA and the ASE and the GLA is assigned to this ASE model.

6. The ASE is sent back to the MSOB.

7. The GLA is returned to the Ordnance Storage Facility.

8. The ALSEP system test using the dummy GLA is performed in the MSOB.

9. After the test, the ALSEP system will be sent to the Ordnance Loading Facility.

10. A verification of GLA circuit checker is made with the dummy GLA. An electrical circuit check is made on the live GLA and alignment sensor. (This is a new requirement and the equipment design has not been made).

11. The high explosive GLA will be loaded into the ASE.

12. After this operation, the ALSEP system will be installed in LEM.

13. The cask and RTG fuel cell will be installed in the LEM/SLA while on the pad at about t - 9 hours.

BACK UP

Charged-Particle Lunar Environment Experiment

The Charged Particle Experiment has only one mode of operation, although the sensors will be manually (ground command) or automatically stepped to 8 different voltage levels and a calibration sequence is built in.

The experiment word frame is 6 - 20 bit words which are transmitted by the central station 6- 10 bit words per main frame. The 6 - 20 bit words contain sensor data and identification bits only. All 6 housekeeping data points are sent to the central station in analog form for transmission in the subcommutated housekeeping word.

Recommended Test

1 CPLEE sequence = 2 ALSEP frames

1 CPLEE format = 16 CPLEE sequences

= 32 ALSEP frames.

Housekeeping: 6 signals in CS housekeeping subcommutator:

i) switchable power supply voltage

ii) Channeltron® power supply No. 1 voltage

iii) Channeltron® power supply No. 2 voltage

iv) dc-dc converter voltage

v) Temperature No. 1

vi) Temperature No. 2

8 commands:

1. Thermal control bypass ON
2. Thermal control bypass OFF
3. Dust cover removal

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4. Automatic voltage level sequencer ON

5. Step voltage level

6. Automatic voltage level sequencer OFF

7. Channeltron® p.s. voltage increase ON

8. Channeltron® p.s. voltage increase OFF

Checkout times

Commands 1 and 2 — approximately 1/2 hour to see temperature change.

Command 3 — Checkout procedure not yet established, but should require not more than 2 CS housekeeping telemetry frame (180 ALSEP frames) time ≈ 2 minutes.

Commands 4, 5, 6 — Requires 8 complete formats, each 32 ALSEP frames; total time ≈ 2 1/2 minutes.

Commands 7 and 8 — 5 CS housekeeping telemetry frames (450 ALSEP frames) time ≈ 4 1/2 minutes.

Overall test time — 39 minutes.

No sensor simulator will be required as experiment has built-in calibration of the electronics.

A vacuum system will be required if the Channeltrons® are energized.

This experiment is a back-up for both Array A and B, but is included within Array B at present provided that weight targets are met.

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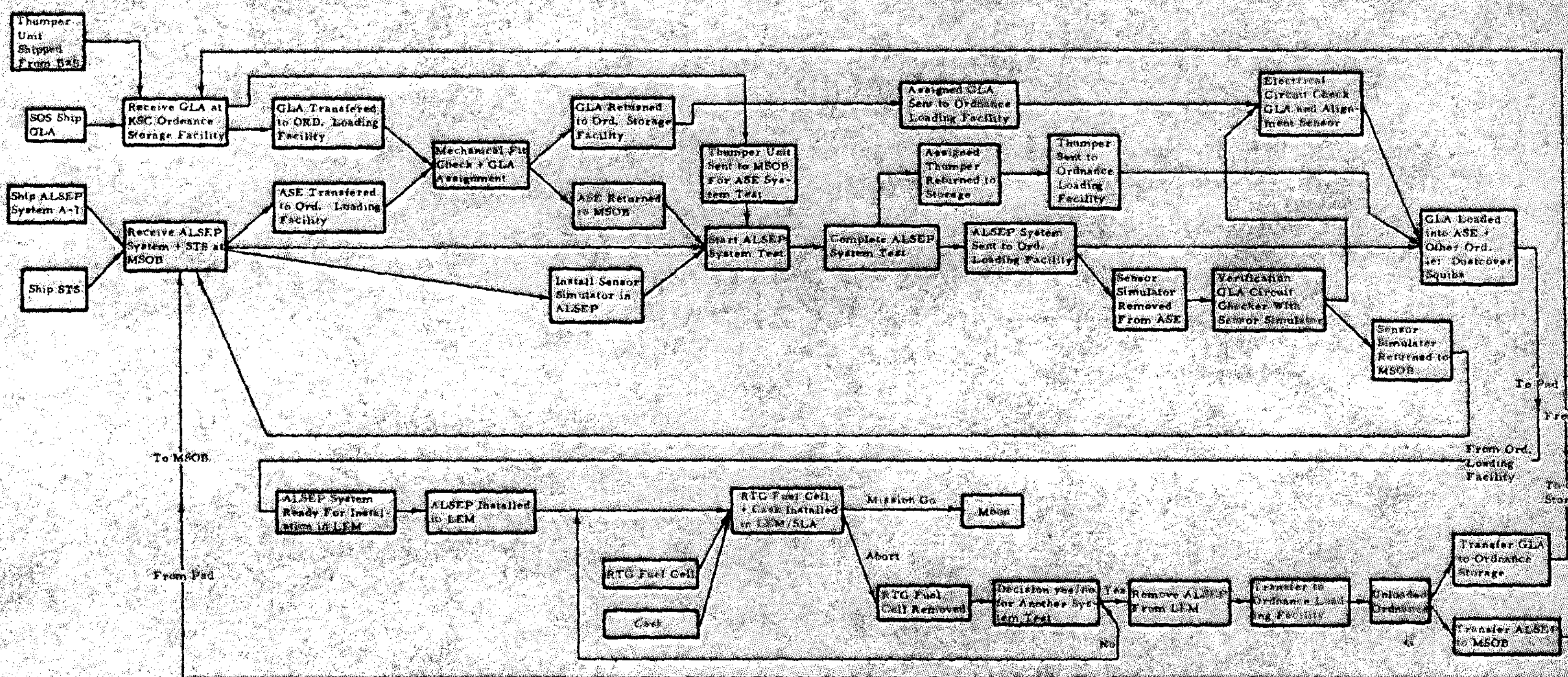

[redacted] Array B KSC Sequence

PERIPHERAL EQUIPMENT REQUIRED FOR SYSTEM TEST AT BxS AND KSC

ARRAY A

Solar Wind Experiment

A dry nitrogen purge must be used to prevent arcing in sensor unit.

Magnetometer Experiment

Flux tanks will be required during operation of Magnetometer. The flux tanks are manually controlled. An electrical control problem exists at this time regarding setting accuracy and repeatability.

Suprathermal Ion Detector

Vacuum equipment must be used to check the sensor provided no electrical connections are interrupted.

ARRAY B

No other peripheral equipment is contemplated for this array.

BACK-UP EXPERIMENT

Charged Particle Experiment

This experiment will be system tested as part of Array B within the proviso on the previous page.

Vacuum equipment similar to that for the SIDE (above) will be required.

VACUUM SYSTEMS DURING SYSTEM TEST

In the particle experiment tests (Solar Wind, Charged Particle, Suprathermal Ion Detector, Cold Cathode Ion Gage), an end to end test requires a vacuum enclosure around the sensing elements. The electrical connections to the system are broken after the test in order to remove the experiment from a chamber. A basic ground rule for final acceptance tests and prelaunch tests at Cape Kennedy is that "NO CONNECTION MAY BE BROKEN AFTER THE SYSTEM TEST." We believe there is no possible test set up to lead the ALSEP experiment electrical connectors out of the vacuum chamber and still be compatible with this ground rule.

The requirements at Cape Kennedy can be met in one of three ways. The first is that we back off from an end to end test with the use of a sensor simulator; the second is to make the vacuum enclosure part of the experiment itself; the third is to place the whole system in a vacuum chamber. The resolution of this problem is only needed now for the Suprathermal Ion Detector Experiment. The Solar Wind and Charged Particle have internal calibration of the electronics.

It had been proposed that a bell jar be put over the experiment and a groove cut in the bell jar plate to allow the flight cable to extend out. The seal would be made by pressure and some sort of plastic cement. This has been investigated and it was found that the bonding between the plastic H-film and copper foil is not sufficient to prevent ambient pressure from forcing its way between the plastic and foil. This separation of the plastic from the foil could cause undue stress on the foil during subsequent operations.

MAGNETOMETER FLUX TANKS

The Magnetometer operation requires flux tanks to null out the earth's field. It is our present understanding that these flux tanks are not proved operable in a high vacuum chamber. The problems are out gassing and thermal. At present there is no detailed information on this. If our present understanding is correct, the present time schedule would probably preclude designing new flux tanks for a vacuum environment. Another problem is magnetic interference from other units in a system test under vacuum. The basic way magnetic interference is minimized is to increase the deployment distance. It is now approximately 50 feet. There are no chambers large enough to fully deploy ALSEP. We intend to run the experiment in proximity to other experiments on a 14' x 14' lunar surface simulation and in a 20' x 27' vacuum chamber. This is at variance with PI requirements now. It is our belief that a less than end to end test must be devised for the Magnetometer Experiment.

The present plans for reeling the cable is by starting a loop from the middle. This results in an astatic winding and cancellation of EM fields. Thus a less than full deployment will minimize cross coupling; at least that caused by cables.

ARRAY A FUNCTIONAL TESTS AT SUBSYSTEM LEVEL

These test lists are compiled from subsystem specifications. Subsystem test lists are submitted as background. The lists were used in checking system test requirements.

SOLAR WIND SPECTROMETER FUNCTIONAL TESTS

1. Calibration (Programmed in the Experiment).
2. Command Dust Cover Removal.
3. Check Cover Release.
4. Check Modulator Grid Voltages.
5. Check Power Input.
6. Power Required for Dust Cover Removal.
7. Pulse Wave Shape Test (Timing and Wave Shapes).
8. Demand Line (worst case wave shape).
9. D. C. voltage tests of Static Inverter at filter output.
10. Synchronous demodulator output tests.
11. Logarithmic A/PWM converter input/output tests.
12. Programmer functions test.
    - a. Housekeeping data readout tests
    - b. Programmer sequence verification
    - c. 256 kHz frequency test
    - d. 2 kHz test
13. Tests at minimum and maximum power supply voltages.

PASSIVE SEISMIC EXPERIMENT FUNCTIONAL TESTS

1. Check Power Input

2. Test for 14 of 15 Command Inputs

    Coarse sensor in/out

    Level direction

    Level speed

    Level (auto-command)

    Level power A on/off

    Level power B on/off

    Level power Z on/off

    Gain LP H

    Gain LP Z

    Gain SP

    Filter in/out

    Cal. LP

    Cal. SP

    Uncage (not to be applied)

    Thermostat bypass on/off

3. Programmer Functions Test

4. Attenuator Tests

    a. 0 dB

    b. 10 dB

    c. 20 dB

    d. 30 dB

5. Leveling Unit Servo Test

6. Tide Servo Unit Test

7. 3 kHz Oscillator Tests

8. A/D Converter Tests

9. Tests of seismometer instrument outputs in clamped state

10. Thermal Control Tests

11. Tests at maximum and minimum power supply voltages.

SUPRATHERMAL ION DETECTOR EXPERIMENT SUBSYSTEM FUNCTIONAL TESTS

1. Command Function Tests

   a. Ground Plane Stepper ON/OFF.

   b. Reset SIDE frame counter to 10.

   c. Reset SIDE frame counter to 39.

   d. Reset velocity filter counter to 9.

   e. Reset SIDE frame counter to 79.

   f. Reset SIDE frame counter to 79, and reset velocity counter at 9.

   g. X 10 Accumulation interval

   h. Master Reset

   i. Velocity filter volts ON/OFF

   j. L.E. CPA volts ON/OFF

   k. H.E. CPA volts ON/OFF

   l. Force continuous calibration

   m. CCIG H.V. ON/OFF

   n. Channeltron H.V. ON/OFF

   o. Reset Input Command Register.

2. Check Power Input

3. Logarithmic A/D Converter Tests

4. Check Data Format

   Words

   1. Side Frame Counter

   2. Housekeeping

3. Monitor No. 1 HE CPA

4. & 5. 20 bits high energy ion count data

6. Status

7. Monitor No. 2 Vel Sel Voltage

8. Monitor No. 3 LE CPA voltage

9. 20 bits of low energy ion
10. count data

5. Tests at minimum and maximum power supply voltages.

6. Verify functions of 128 SIDE frame format.

7. Timing and control pulses test (worst case possibilities) by degrading pulse shape of command trigger.

MAGNETOMETER EXPERIMENT SUBSYSTEM FUNCTIONAL TESTS

1. Test 7 Command Functions

   (a) Site survey

   (b) Flip/calibrate initiate

   (c) Steady field offset

   (d) Steady field offset hold

   (e) Filter failure by-pass on/off

   (f) Range selection

   (g) Flip/calibrate inhibit

2. Check Power Input

3. Verify operation of Flip and Calibration Offset Subsystem

4. Verify data format — data sampled during word times 5, 17, 19, 21, 49, 51, and 53

   For Word 5*

   (a) Temp. No. 1

   (b) Temp. No. 2

   (c) Temp. No. 3

   (d) Temp. No. 4

   (e) Temp. No. 5

   (f) Level Sensor No. 1

   (g) Level Sensor No. 2

   (h) D. C. Power

*Engineering data commutated within the experiment and placed only in Word Slot 5. Engineering data will be read out once every 16 data frames.

(i) Flip and gimbal position status bits

(j) Flip power status bits

(k) Range status bits

(l) Offset status bits

(m) Mode bit

(n) Filter status bit

Words 17 and 49 represent two successive readouts of X-axis of Magnetometer.

Words 19 and 51 — Y-Axis of Magnetometer.

Words 21 and 53 — Z-Axis of Magnetometer.

5. Check Flipper 1, 2, and 3.

6. Check Sensor Electronics 1, 2, and 3.

7. Check Filter 1, 2, and 3.

8. Programmer Function Tests.

9. A/D Converter Tests.

10. Tests at Minimum and Maximum Power Supply Voltage.