APOLLO PROGRAM

LUNAR SURFACE EQUIPMENT STATUS

3 JUNE 1974

NOTE: Discussions of closed problems will be deleted from subsequent issues.

Italics indicate change from previous issue.

W. F. Eichelman
Experiments Manager

TABLE OF CONTENTS

TABLE OF CONTENTS
(concluded)

APOLLO LUNAR SURFACE EQUIPMENT STATUS
1.0 INTRODUCTION

Scientific data gathering equipment and related communications and power equipment were deployed on the lunar surface by the crew on each of the six Apollo lunar landing missions from July 20, 1969, (Apollo 11 mission) through December 12, 1972, (Apollo 17 mission). This report covers the performance of the deployed equipment which was designed to continue to provide data after the return of the crew to Earth.

The report is divided into three sections, section one being the Introduction. The second section is an overall summary in the form of a graphic presentation of the time history of the percent of full capability of the instruments from the time of deployment on the lunar surface, with a gross indication of when changes occurred. The third section discusses each problem encountered. Problems are arranged in chronological order, by subject and number, along with a cross index by experiments to a chronological listing of problems.

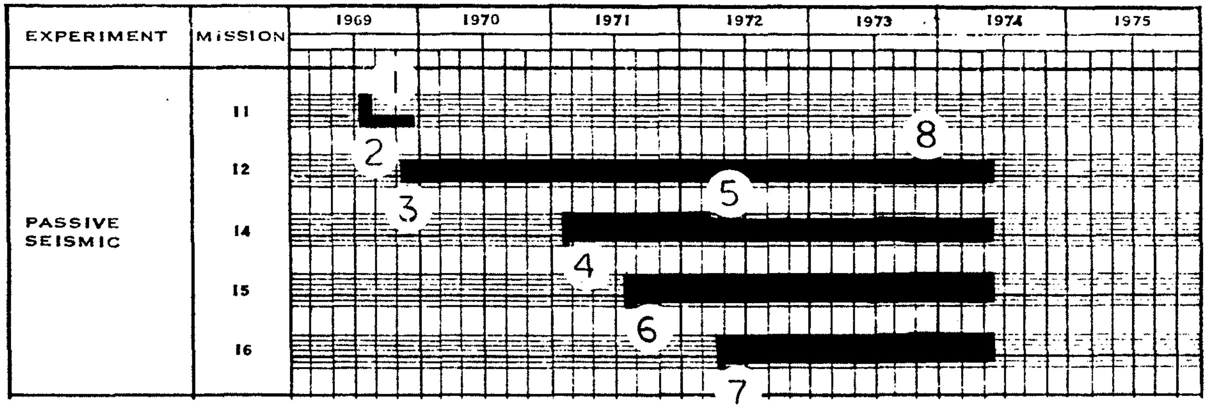
This issue of the Apollo Lunar Surface Equipment Status Report updates previous issues of the report. Problems which have been *CLOSED* in previous issues of the report are not included in the discussion portion of Section 3.0. However, the date of the issue in which the *CLOSED* discussion last appeared is so indicated in the Chronological Listing of Problems at the end of Section 3.1.

MISSION	LAUNCH DATE	LUNAR SURFACE DATA		
		START	END	
			UPLINK	DOWNLINK
11	Jul. 16, 1969	Jul. 21, 1969	Aug. 25, 1969	Dec. 14, 1969
12	Nov. 14, 1969	Nov. 19, 1969		
14	Jan. 31, 1971	Feb. 5, 1971		
15	Jul. 26, 1971	Jul. 31, 1971		
16	Apr. 16, 1972	Apr. 21, 1972		
17	Dec. 7, 1972	Dec. 12, 1972		

APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

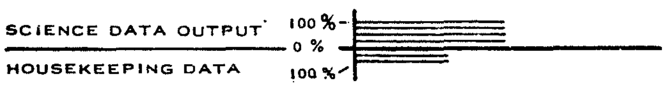
2.1 PASSIVE SEISMIC EXPERIMENT

TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	11	27 Aug 69	PSE STANDBY mode. Station 11 operated for 20 earth days before loss of the C/S's command uplink terminated seismometer functions such as leveling, gain adjustments, and calibration.
2	12	19 Nov 69	SPZ component displaying reduced sensivity at low signal levels. The station's other three seismometers (LPX, LPY, LPZ) have operated properly since initial activation.

LEGEND :



2.1 PASSIVE SEISMIC EXPERIMENT (continued)

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
3	12	22 Nov 69	Thermal control problems. These thermal disturbances are most intense near times of sunrise and sunset, and are believed to be due to thermal contraction and expansion of the aluminized Mylar shroud that covers the sensor unit, or the cable connecting the sensor unit to the C/S, or both.
4	14	12 Feb 71	Thermal control problems. The modified thermal shroud used on Apollo 14 provided improved thermal control over Apollo 12. It was found that if the heater was commanded OFF for lunar day and in AUTO for lunar night, the PSE temperature was within the expected range for Apollo 14.
5	14	20 Mar 72	LPZ axis inoperative. Analysis of the problem indicated failure was either component failure or wire connection problem. It was concluded that the failure was random rather than generic.
6	15	13 Aug 71	Thermal control degradation. Review of lunar surface photographs showed that the periphery of the thermal shroud did not lie flat on the lunar surface. The incomplete deployment of the shroud resulted in excessive thermal leaks and loss of tidal data. For subsequent missions crew training emphasized the need for the periphery of the shroud to be flat on the surface.
7	16	24 Apr 72	High temperature during lunar day. Photographs of the deployed experiment, television coverage of the lunar module ascent, and comments by the crew indicate the following as possible causes of the problems: (a) some raised portions of the shroud, (b) dirt on the shroud from crew traffic subsequent to the photography, (c) debris from lift-off, and (d) possible contact of the experiment with the lunar surface. Any of the above items could cause degraded thermal control, resulting in higher temperatures during lunar day.

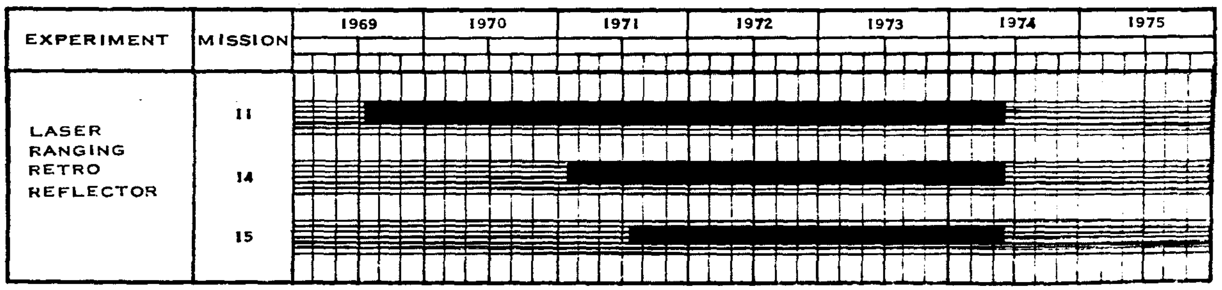
2.1 PASSIVE SEISMIC EXPERIMENT (concluded)

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
8	12	28 Dec 73	Sporadic loss of long period z-axis data during lunar night operation. The anomaly was noted during real-time support periods and characterized by lack of data (quiescent level) on the analog helicorder and no observed response to calibration commands. The anomaly occurred during three successive lunar night periods (28 Dec 73 to 02 Jan 74, 23 Jan 74 to 02 Feb 74, and 22 Feb 74 to 03 Mar 74). All data have been valid since 03 Mar 74.

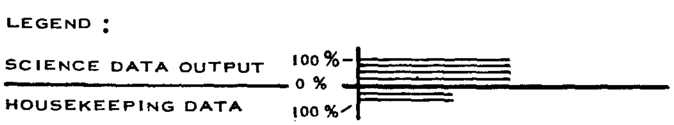
APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

2.2 LASER RANGING RETRO REFLECTOR

TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



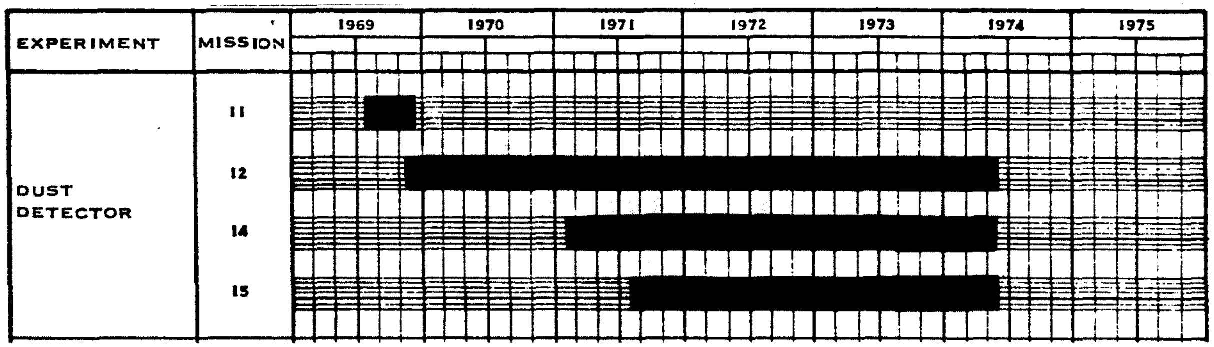
ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	11 & 14	N/A	Performance of both the 100 element arrays (Apollo 11 and 14) has been nominal since their initial deployment.
2	15	31 Jul 71	Resultant data from the 300 element array indicates that its performance is comparable but not superior to the 100 element arrays.



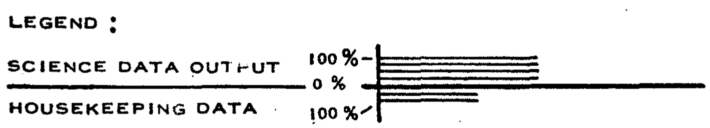
APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

2.3 DUST DETECTOR EXPERIMENT

TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



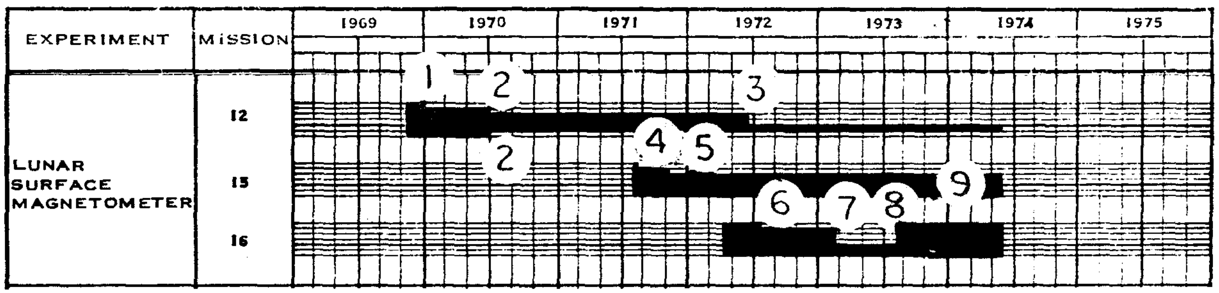
The Dust Detector Experiment functions as a basic engineering measurement to characterize the long term lunar surface environmental effects (e.g. degradation due to solar radiation effects) on solar cells and dust accretion on the ALSEP central stations. The performance of the experiments has been nominal since initial deployment. The data continues to be processed for long term analysis.



APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

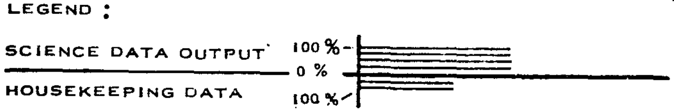
2.4 LUNAR SURFACE MAGNETOMETER

TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	12	22 Dec 69	Y-axis data offset. A bias shift of approximately 75 percent occurs during lunar day when temperatures reach or exceed 60°C. The data returns to normal as the temperature decreases to about 35°C. The failure is suspected to be due to a resistance change in the bias circuitry, and is probably caused by a partially open weld, sensor connection, or a flexible cable. The bias command has been used for compensating the data in real time.
2	12	29 Jun 70	Science and engineering data static and invalid. It appears that the static engineering data during the lunar night, the erratic flip calibration data, and no current to the Y axis flip motor are all caused by open welds in the circuitry. Reinspection by three independent teams, repair as required, and the improvements in thermal control were implemented to alleviate the problem for subsequent missions.

LEGEND :



2.4 LUNAR SURFACE MAGNETOMETER (continued)

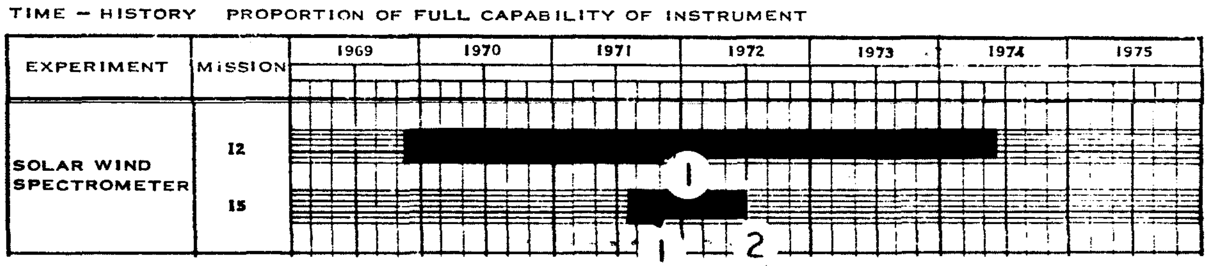
ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
3	12	14 Jun 72	Suspension of flip-cals. Due to the static data output from the instrument the Principal Investigator requested that flip calibration sequences be terminated. Flip calibrations would be performed again if science data indicated the need.
4	15	30 Aug 71	Y-axis sensor head failed to flip on command. Normal calibration could not be provided because of the Y-axis flip problem, a modified data processing program was written, utilizing the solar wind spectrometer data to fulfill the calibration requirements.
5	15	02 Nov 71	Y-axis sensor data loss. To be useful, data from all three axes are required. Data output continues to be recorded and archived in hopes that a method to correlate and analyze the data will be developed at some future date.
6	16	24 Jul 72	Failure of all three axes to flip. Analysis of the data indicated the problem was due to an elevated temperature at lunar noon conditions.
7	16	15 Feb 73	Intermittent loss of science data. Over a period of several months the instrument's output varied from dynamic, valid data to a static condition. Attempts were made to correct the situation by ground command with no positive results obtained.
8	16	17 Aug 73	Data processed by the Principal Investigator since 17 Aug 73 indicates that the instrument has returned to a fully operational condition. Return of the science data is not fully explicable at this time but can be partially attributed to prolonged "cold soak" periods during lunar night.

2.4 LUNAR SURFACE MAGNETOMETER (concluded)

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
9	15	09 Dec 73	Loss of all scientific and engineering data. Attempts were made to correct the anomaly by ground command, but all data remains incoherent since initial date of the occurrence. The instrument remains in the power ON condition while investigation of this anomaly continues.

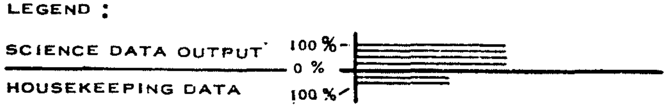
APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

2.5 SOLAR WIND SPECTROMETER



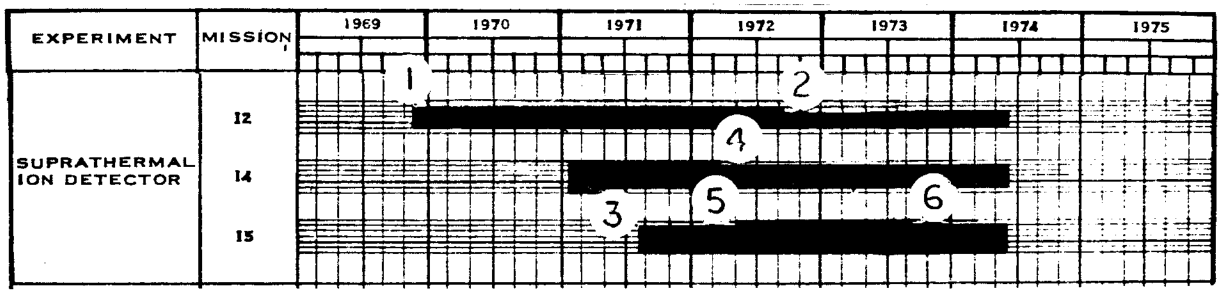
ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	12 & 15	5 Nov 71	Intermittent modulation drop in proton energy levels 13 and 14. This thermally induced problem (which occurs each lunation) is attributed to a circuit which was used soley for ground test purposes.
2	15	30 Jun 72	Loss of experiment science and engineering data. Data analysis indicated high voltage arcing was occuring in the experiment's electronics causing excessive power consumption. Since the additional power consumption could not be tolerated by the Apollo 15 ALSEP system it was decided to leave the instrument in STANDBY mode indefinitely. The SWS is commanded to OPERATE select periodically to ascertain any change in the instrument status.

LEGEND:

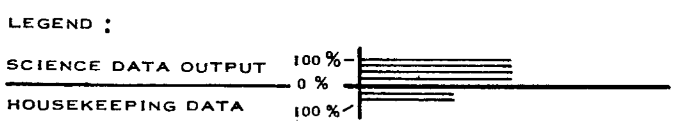


2.6 SUPRATHERMAL ION DETECTOR

TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	12	20 Nov 69	CCIG failure, high voltage arcing problems. Ground tests verified that a transistor failed in high voltage control circuit. A slower response transistor operated satisfactorily in the environment with reasonable margins. Appropriate modifications were made to Apollo 14 SIDE/CCIG.
2	12	9 Sep 72	Intermittent failure of digital electronics to process data. High voltage arcing occurs at elevated lunar day temperatures. The instrument is now commanded to OFF when the internal temperature approaches 55^{o}C.

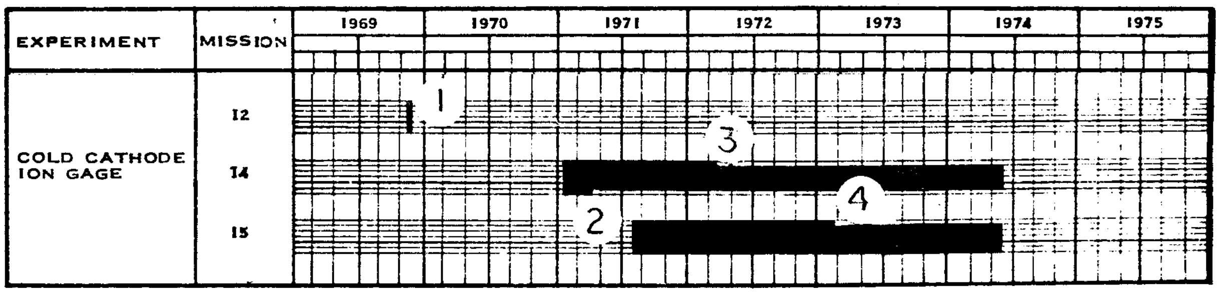


2.6 SUPRATHERMAL ION DETECTOR (concluded)

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
3	14	5 Apr 71	Loss of positive section data, analog-to-digital converter. The cause appears to be intermittent connection in one of the modules of the analog-to-digital converter and does not appear to be temperature dependent. Anomaly precludes processing of any positive value data inputs to the A/D converter.
4	14	29 Mar 72	Anomalous STANDBY operation of SIDE. The mode change problem is attributed to arcing or corona in the high voltage supply at elevated temperatures. The experiment is now commanded to STANDBY when the internal temperature approaches 85°C to preclude spurious mode changes.
5	15	1 May 72	Full instrument operation instituted. Prior to 20 Oct 72 the Apollo 15 SIDE had been cycled to STANDBY during lunar day due to previous problems with Apollo 12 SIDE. Based on data accumulated since deployment, it was decided to leave the instrument ON for the complete lunation.
6	15	13 Sep 73	Cyclic commanding required to preclude spurious mode changes above 85°C. Internal high voltage arcing caused -3.5 KV power supply to trip OFF. Instrument is now cycled to STANDBY during lunar day to preclude arcing.

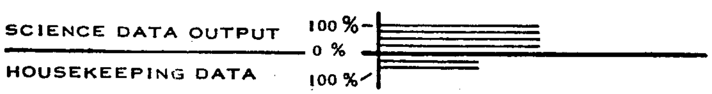
2.7 COLD CATHODE ION GAGE

TIME - HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	12	20 Nov 69	CCIG failure, high voltage arcing problems. Ground tests verified that a transistor failed in high voltage control circuit. A slower response transistor operated satisfactorily in the environment with reasonable margins. Appropriate modifications were made to Apollo 14 SIDE/CCIG.
2	14	5 Apr 71	Loss of positive section data, analog-to-digital converter. The cause appears to be an intermittent connection in one of the modules of the analog-to-digital converter and does not appear to be temperature dependent. Anomaly precludes processing of any positive value data inputs to the A/D converter.

LEGEND :



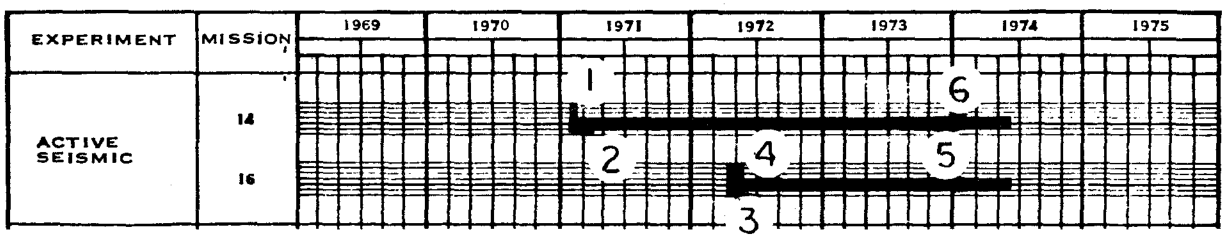
2.7 COLD CATHODE ION GAGE (concluded)

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
3	14	29 Mar 72	Anomalous STANDBY operation of SIDE. The mode change problem is attributed to arcing or corona in the high voltage supply at elevated temperatures. The experiment is now commanded to STANDBY when the internal temperature approaches 85°C to preclude spurious mode changes.
4	15	22 Feb 73	Intermittent science data. Preliminary analysis indicates that the most probable cause is one of the instrument's 15 relays. These reed relays perform functions that control the gauge's calibration currents, ranging and gain change functions, and grounding the instrument during calibration. Currently no plans exist for continued investigation of this anomaly, as the scientific data are useable when obtained.

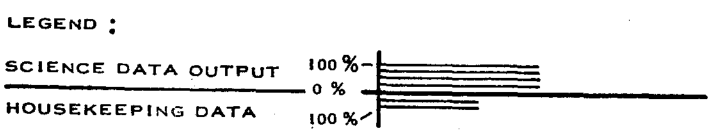
APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

2.8 ACTIVE SEISMIC EXPERIMENT

TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	14	5 Feb 71	Thumper misfired five of eighteen times. The problem was attributed to dirt on the firing switch actuator bearing surface. The situation was subsequently corrected for the Apollo 16 mission.
2	14	26 Mar 71	Geophone #3 data is noisy due to transistor failure in #3 amplifier. Data is recoverable to some extent via analysis.
3	16	23 May 72	Mortar package pitched down 9 degrees as a result of launching grenade #2. The grenade #2 range wire probably fouled during launch, producing a downward force. Normal real-time event data was not received during flight of grenade #2.



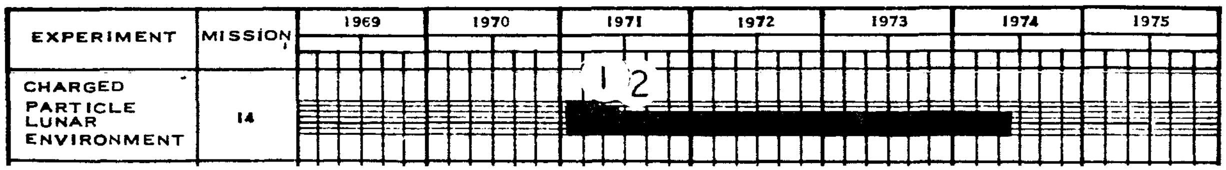
2.8 ACTIVE SEISMIC EXPERIMENT (concluded)

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
4	16	23 May 72	Pitch sensor offscale HIGH after launching of grenade #3. Data implies there was a sensor circuit failure. Detonation of grenade #4 successfully accomplished. Grenade #1 was not fired due to the uncertainty of the mortar pallet position. Launching of grenade #1 may be attempted, as a final experiment, should Apollo 16 ALSEP termination be considered.
5	14&16	07 Dec 73	Weekly 30-minute passive listening periods terminated per Apollo 14 ALSEP, SMEAR 86 and Apollo 16 ALSEP, SMEAR 27. The instruments will remain in STANDBY and OFF respectively with periodic high bit rate checks to verify functional capability.
6	14	03 Jan 74	During the monthly operation check of the experiment on 3 January 1974 the data from Geophone #2 appeared to be invalid. On 9 January 1974 another operational check was conducted to further investigate the problem. Two geophone calibrations were commanded. The data indicated a response to the commanded pulses, but the response was improper. Analysis implies a failure in the amplifier channel 2 circuitry.

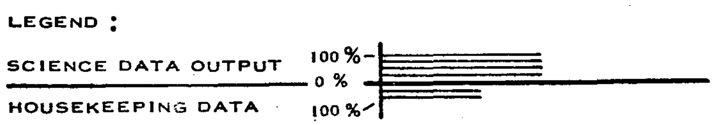
APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

2.9 CHARGED PARTICLE LUNAR ENVIRONMENT EXPERIMENT

TIME – HISTORY   PROPORTION OF FULL CAPABILITY OF INSTRUMENT



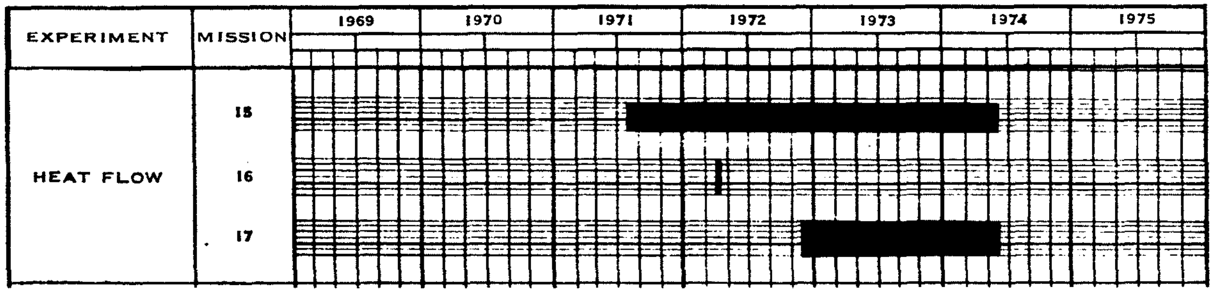
ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	14	8 Apr 71	Loss of analyzer B data. Analysis indicates that the most probable cause of failure was a short in the high voltage filter. The instrument continues operation on analyzer A.
2	14	6 Jun 71	Analyzer A data decay and undervoltage condition. The problem appears to be caused by the analyzer B anomaly. Further analysis of anomaly impossible since analyzers not separable by command. Instrument is operated satisfactorily in a locked low voltage range (-35 vdc) and is commanded to STANDBY when high voltage decays below 2280 vdc. This operational mode results in operation for approximately 50 percent of each lunation.



APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

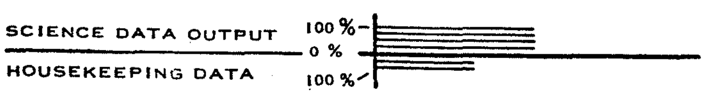
2.10 HEAT FLOW EXPERIMENT

TIME – HISTORY   PROPORTION OF FULL CAPABILITY OF INSTRUMENT



ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	15	31 Jul 71	Probe #2 not inserted to full depth due to problems with Apollo Lunar Surface Drill (ALSD). Probe #2 still provides useful data to estimate heat flow in the lunar subsurface. Drill bore stems were redesigned for Apollo 16 and 17 missions.
2	16	21 Apr 72	Electrical cable severed during initial deployment by crew. Contingency repair plan proposed was denied due to higher mission priorities. Cable strain relief provisions were implemented on all cables for the Apollo 17 mission.
3	17	N/A	Nominal deployment and full experiment operation.

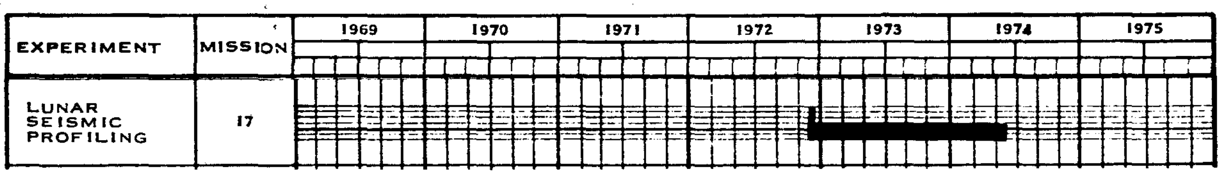
LEGEND :



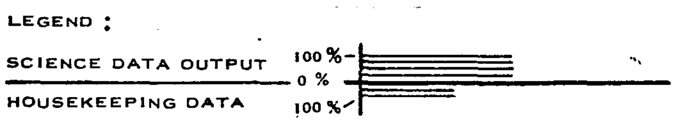
APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

2.11 LUNAR SEISMIC PROFILING EXPERIMENT

TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



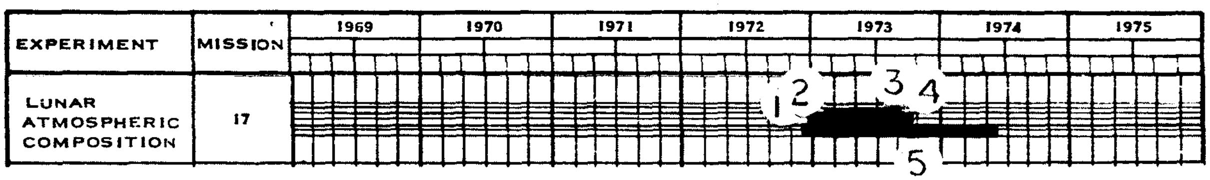
ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	17	N/A	Initial scientific objective accomplished with detonation of eight explosive packages. Instrument is currently commanded ON weekly for a 30-minute passive listening period (NOTE: Operation of the LSPE precludes data from the other four experiments, therefore, LSPE operation is limited).



APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

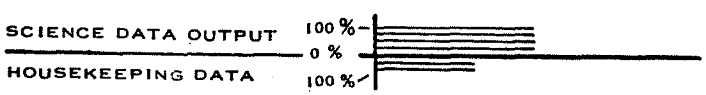
2.12 LUNAR ATMOSPHERIC COMPOSITION EXPERIMENT

TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	17	17 Dec 72	Excessive temperature with cover ON. Both an error in thermal design and temperature sensitive components limit experiment operation to temperatures below 125°F. This situation precluded instrument operation during elevated lunar day temperatures.
2	17	18 Dec 72	Zero offset in data output of mass channels, cause of this background offset remains undetermined. The data are useable with additional processing during data reduction.
3	17	18 Sep 72	Loss of intermediate mass range output caused loss of approximately 12 percent of experiment data. Subsequent multiple failures of the instrument precluded further analysis of the problem.

LEGEND :



2.12 LUNAR ATMOSPHERIC COMPOSITION EXPERIMENT (continued)

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
4	17	23 Sep 73	Filament #1 failure. The filament accumulated nearly 3000 hours of operation before failure, which was well within the predicted range for operating life. The instrument was re-configured to the redundant filament and continued to operate until the loss of all science data on 17 October 1973.
5	17	17 Oct 73	Loss of science data. Preliminary results of troubleshooting and analysis indicate that the multiplier high voltage power supply apparently failed. The instrument is currently being cycled from ON to OFF to maintain the electronics temperature below the previously established 125°F limit, while future troubleshooting or termination of instrument operation is considered.
6	17	18 Jan 74	An operational status check of the LACE was performed. Experiment telemetry data did indicate some change during the 30 minutes that the multiplier high voltage power supply was operated, but no significant improvement since initial occurrence of the anomaly on 17 October 1973 was noted. The instrument's filament #2 was not commanded ON. The instrument was returned to its previous configuration. Periodic checks will be made to determine if any change in performance has occurred.
7	17	20 Mar 74	A sequence of operational commands were executed by the experiment during real-time support 20 March 1974. Telemetry data indicated that the LACE accomplished one complete scientific data sweep before experiencing a breakdown of the experiment's high voltage power supply (the multiplier high voltage and filament #2 were operated for a 35-minute period). The LACE will continue to be cycled from ON to OFF to maintain the electronics temperature below the previously established 125°F limit.

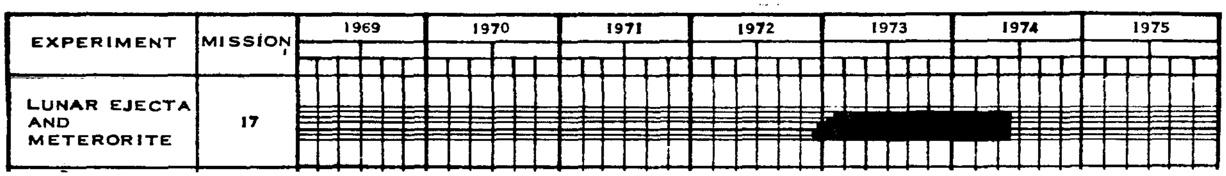
2.12 LUNAR ATMOSPHERIC COMPOSITION EXPERIMENT (concluded)

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
8	17	20 May 74	The instrument was operated for a six-minute period to assess its performance. The high voltage power supply exhibited the same status as during the previous check on 20 March 1974.

APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

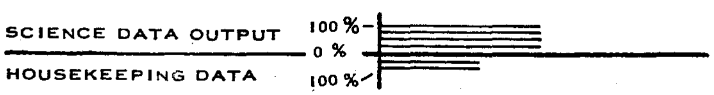
2.13 LUNAR EJECTA AND METEORITE EXPERIMENT

TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	17	17 Dec 72	Excessive temperature. The experiment is experiencing a higher temperature profile than expected due to an error in calculation of thermal control and difference in thermal conditions at the Apollo 17 site from the design site. The instrument is operated at temperatures below 196°F. This operational plan results in monitoring of about 75 percent of each lunation.

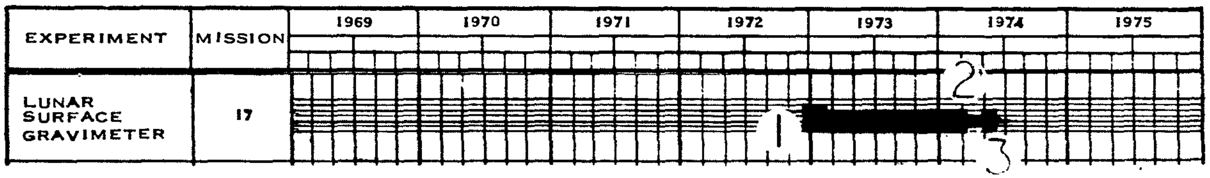
LEGEND:



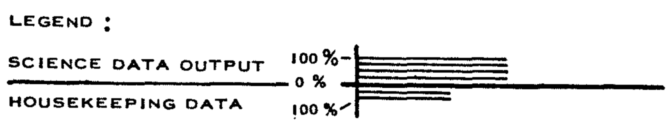
APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

2.14 LUNAR SURFACE GRAVIMETER

TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	17	12 Dec 72	Sensor beam cannot be stabilized in the null position because 1/6-g mass weights were too light. Weights were light because of an error in calculations converting from 1-g to 1/6-g requirements. Several re-configurations of the instrument have been made during the past year. The beam has been centered by applying a load on the beam through the mass support springs by partial caging of the mass weight assembly. Signals being received are being processed and analyzed for seismic, free mode, and gravity wave information.



APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

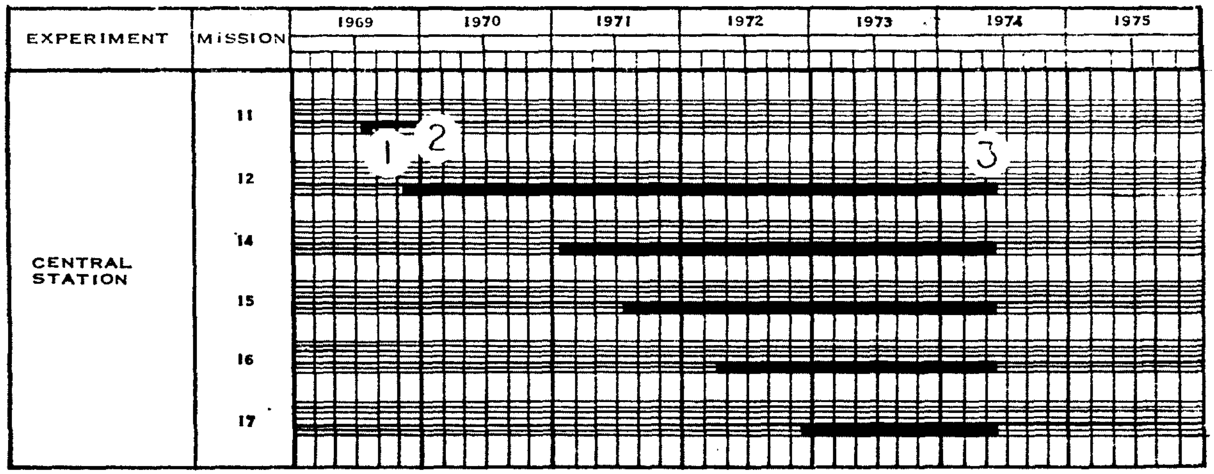
2.14 LUNAR SURFACE GRAVIMETER (concluded)

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
2	17	15 Mar 74	The instrument's Heater Box heater circuit failed full ON during the 16th lunar night. This anomaly caused the sensor temperature (DG-04) to increase above a stabilized temperature of 49.207°C and eventually drift offscale HIGH (transducer range is approximately 48.2 to 52.0°C). Useful science data could not be obtained from the instrument without the sensor assembly temperature maintained rigorously at 49.2°C.
3	17	20 Apr 74	The LSG regained thermal stability. The experiment's sensor temperature has remained stabilized at 49.2°C since 20 April 1974.

APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

2.15 CENTRAL STATION ELECTRONICS

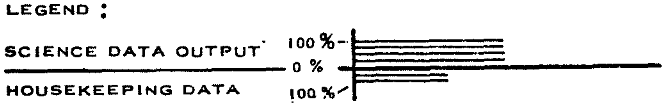
TIME – HISTORY PROPORTION OF FULL CAPABILITY OF INSTRUMENT



Note: All central station data is considered housekeeping rather than science data.

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
1	11	25 Aug 69	Command loss capability. The inability to command the ALSEP central station was attributed to a component failure in the central station command decoder. The failure mode was considered unique to Apollo 11 ALSEP since future ALSEPs would maintain a benign thermal environment by comparison.

LEGEND :



2.15 CENTRAL STATION ELECTRONICS (concluded)

ITEM	APOLLO MISSION	INITIAL DATE OF OCCURRENCE	STATUS
2	11	14 Dec 69	Loss of downlink. The Apollo 11 ALSEP apparently responded to a transmitter OFF command or experienced an additional failure. In either case, the system had fulfilled its initial mission requirement. NASA subsequently directed that no attempts be made to command the system ON so that the frequency could be used for future ALSEP systems.
3	12	3 May 74	Loss of downlink signal modulation. Apparent failure of data processor Y. Operation of data processor X, transmitter A, and transmitter B appear normal. Central station currently functioning normally with transmitter B and data processor X selected. Investigation of processor Y anomaly in progress.
4	12 thru 17		Performance of the Apollo 12 thru 17 Central Stations has been essentially nominal since deployment. Although the original design requirement for ALSEP was a one year life, much longer useful lifetimes are being realized.

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS

This section provides a chronological listing of problems encountered with the ALSEP stations. Although the original design requirement for ALSEP was a one year life, much longer useful lifetimes are being realized. Problems in this section, therefore, cover the period from deployment of Apollo 11 ALSEP (21 July 1969).

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
1	11	PSE	Level Indicator Not Stable	21 Jul 69	Apollo 11 Mission, 5-Day Report, Jul 69
2	11	PSE & C/S	Leveling Motor Inadvertently Triggered	21 Jul 69	Apollo 11 Mission, 5-Day Report, Jul 69
3	11	PSE & C/S	Thermal Control	21 Jul-3 Aug 69	Apollo Experience Report Thermal Design of ALSEP, Dec 71, NASA TN D-6738
4	11	C/S	Data Processor X Selected	23 Aug 69	EASEP 30-Day Report, Sep 69
5	11	C/S	Command Capability Loss	25 Aug 69	Apollo 11 Mission Report, Nov 69, Section 11.4.4
6	11	PSE	PSE STANDBY Mode	27 Aug 69	EASEP 30-Day Report, Sep 69
7	11	C/S	Power Dissipation Module Failure	16 Sep 69	Daily Science Report, 17 Sep 69
8	12	RTG	Fuel Element Difficult to Remove From Cask	EVA (19 Nov 69)	Apollo 12 Mission Report, Mar 70, Section 14.3.3

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS

(continued)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
9	12	C/S	Shorting Plug Ammeter Did Not Indicate RTG Current During Deployment	EVA (19 Nov 69)	Apollo 12 P & D List, 16 Dec 69, Item GFE-7
10	12	PSE	Deployment Difficulties	EVA (19 Nov 69)	Apollo 12 Mission Report, Mar 70, Section 14.3.4
11	12	SIDE	Dust Covers Deployed Prematurely	EVA (19 Nov 69)	Apollo 12 P & D List, 16 Dec 69, Item GFE-15
12	12	SIDE/ CCIG	Deployment Difficulties	EVA (19 Nov 69)	Apollo 12 Mission Report, Mar 70, Section 14.3.5
13	12	PSE	SPZ Displaying Reduced Sensivity at Low Signal Levels	19 Nov 69	Apollo 12 P & D List, 20 Aug 70, Item ALSEP-9
14	12	PSE	Negative Square Wave Like Pulses Appeared on SPZ Data Channel	19 Nov 69	Apollo 12 P & D List, 20 Aug 70, Item ALSEP-10
15	12	SIDE/ CCIG	High Voltage Arcing Problems (CCIG Failure)	20 Nov 69	Apollo 12 P & D List, 20 Aug 70, Item ALSEP-5
16	12	PSE	LPZ Displaying Unstable Period & a Long Time Constant After Releveling	22 Nov 69	Apollo 12 P & D List, 20 Aug 70, Item ALSEP-4

3.1 CHRONOLOGICAL LISTING OF PROBLEMS
(continued)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
17	12	LSM	Loss of Data above 50°C (Digital Filter Problem)	22 Nov 69	Apollo 12 P & D List, 20 Aug 70, Item ALSEP-6
18	12	C/S	Failure Timer Functions	4 Dec 69	Apollo 12 P & D List, 26 Mar 70, Item ALSEP-2
19	12	LSM	X, Y, & Z Sensor Data Dropped Offscale Unexpectedly & Science Data was Lost	11 Dec 69	Apollo 12 P & D List, 20 Aug 70, Item ALSEP-7
20	11	C/S	Loss of Downlink	14 Dec 69	Apollo 12 SMEAR, ALSEP 16
21	12	SIDE	High Voltage Power Supply Arcing	22 Dec 69	Apollo 12 P & D List, 20 Aug 70, Item ALSEP-5
22	12	LSM	Science Data Offset Y-axis	22 Dec 69	Apollo 12 P & D List, 20 Aug 70, Item ALSEP-8
23	12	LSM	Temperature Range Exceeded Predictions	23 Dec 69	Apollo 12 P & D List, 20 Aug 70, Item ALSEP-14
24	12	C/S	Systematic Spurious CVW's	27 Dec 69	Apollo 12 P & D List, 26 Mar 70, Item ALSEP-3
25	12	PSE	Temperature Range Exceeded	25 Jan 70	Apollo 15 P & D List, 13 Sep 71, Item ALSEP-4

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS

(continued)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
26	12	C/S	Transmitter A Switched Out of Service	30 Jan 70	Apollo P & D List, 20 Aug 70, Item ALSEP-11
27	12	SIDE	Limited Operating Time During Lunar Noon (55°C Maximum)	18 Mar 70	Apollo 12 SMEARS, ALSEP 42, 66 & 73
28	12	PSE	LPX & LPY Shroud Noise	14 Jun 70	Apollo 12 SMEAR, ALSEP 46
29	12	LSM	Flip Cal Data Undefinable	14 Jun 70	Apollo 12 P & D List, 8 Oct 70, Item ALSEP-13
30	12	LSM	Y-axis Sensor Head Failure	29 Jun 70	Apollo 12 P & D List, 8 Oct 70, Item ALSEP-13
31	12	PSE	Thermal Effect of Lunar Seasonal Cycle	29 Jun 70	Apollo 12 P & D List, 20 Aug 70, Item ALSEP-12
32	12	LSM	Science & Engineering Data Static & Invalid	30 Jun 70	Apollo 12 P & D List, 8 Oct 70, Item ALSEP-13
33	12	C/S	Transmitter Switch from B to A	1 Sep 70	Apollo 12 P & D List, 8 Oct 70, Item ALSEP-15
34	12	C/S	Transmitter A Intermittent	13 Dec 70	Apollo 12 P & D List, 8 Oct 70, Item ALSEP-15

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
35	14	RTG Cask	Difficult to Latch RTG Dome Removal Tool in Cask Dome	EVA (5 Feb 71)	Apollo 14 P & D List, 12 Apr 71, Item ALSEP-13
36	14	SIDE	SIDE Boyd Bolt Blocked due to Compacted Lunar Dirt	EVA (5 Feb 71)	Apollo 14 P & D List, 12 Apr 71, Item ALSEP-2
37	14	SIDE/ CCIG	Difficult to Deploy	EVA (5 Feb 71)	Apollo 14 P & D List, 26 Mar 71, Item ALSEP-3
38	14	ASE	Geophone and Flag Easy to Knock Over	EVA (5 Feb 71)	Apollo 14 P & D List, 12 Mar 71, Item ALSEP-11
39	14	C/S	Sunshield Sags	EVA (5 Feb 71)	Apollo 14 P & D List, 26 Mar 71, Item ALSEP-10
40	14	ASE	Thumper Misfired Five of Eighteen Times	EVA (5 Feb 71)	Apollo 14 Mission Re-port, May 71, Section 14.4.1
41	14	C/S	Received Signal Strength Lower Than Expected	EVA (5 Feb 71)	Apollo 14 P & D List, 26 Mar 71, Item ALSEP-6

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS

(continued)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
42	14	SIDE	Exhibited Noisy Data During Initial Turn ON	6 Feb 71	Apollo 14 Mission Report, May 71, Section 14.4.2
43	14	C/S	12-hour Timer Pulses Did Not Occur	7 Feb 71	Apollo 14 Mission Report, May 71, Section 14.4.4
44	14	PSE	Y-axis Levelling Intermittent & Sluggish	9 Feb 71	Apollo 14 Mission Report, May 71, Section 14.4.5
45	14	PSE	Thermal Control Problem	12 Feb 71	Apollo 14 P & D List, 26 Mar 71, Item ALSEP-15
46	14	C/S	Systematic Spurious CVW's	16 Feb 71	Apollo 12 P & D List, 26 Mar 70, Item ALSEP-3
47	14	PSE	Long Period Vertical Feedback Filter Not Operating	2 Mar 71	Apollo 14 Mission Report, May 71, Section 14.4.6
48	14	ASE	Geophone 3 Data Noisy	26 Mar 71	Apollo 14 P & D List, 15 Jul 71, Item ALSEP-18 Apollo 14 Mission Anomaly Report No. 6, Dec 72

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS
(continued)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
49	14	SIDE/ CCIG	Analog to Digital Converter Positive Section Data Loss	5 Apr 71	Apollo 14 Mission Report, May 71, Section 14.4.8
50	14	CPLEE	Analyzer B Data Loss	8 Apr 71	Apollo 14 Mission Report, May 71, Section 14.4.9
51	14	CPLEE	Analyzer A Data Decay and Undervoltage Condition	6 Jun 71	Apollo 14 P & D List, 15 Jul 71, Item ALSEP-21
52	15	C/S	Rear Curtain Retainer Removal Lanyard Broke	EVA (31 Jul 71)	Apollo 15 Mission Report, Dec 71, Section 14.4.2
53	15	SIDE/ CCIG	Experiment Connector was Difficult to Mate	EVA (31 Jul 71)	Apollo 15 P & D List, 13 Sep 71, Item ALSEP-17
54	15	C/S	Shorting Switch Actuated Early	EVA (31 Jul 71)	Apollo 15 P & D List, 8 Oct 71, Item ALSEP-18
55	15	SIDE/ CCIG	Intermittent Lock of UHT in Fitting of SIDE/CCIG Experiment	EVA (31 Jul 71)	Apollo 15 Mission Report, Dec 71, Section 14.4.3
56	15	HFE	Subpallet Boyd Bolts Did Not Release Immediately	EVA (31 Jul 71)	Apollo 15 P & D List, 13 Sep 71, Item ALSEP-13

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS

(continued)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
57	15	PSE	LPZ Axis Leveling Difficulties	1 Aug 71	Apollo 15 SMEAR, SX-194
58	15	C/S	Systematic Spurious CVW's	5 Aug 71	Apollo 12 P & D List, 26 Mar 70, Item ALSEP-3
59	15	HFE	Probe 2 Reference Temperature Measurement Intermittent	7 Aug 71	Apollo 15 P & D List, 30 Nov 71, Item ALSEP-25
60	15	PSE	Thermal Control Degradation	13 Aug 71	Apollo 15 P & D List, 13 Sep 71, Item ALSEP-4
61	15	C/S	Loss of Science Data Due to Experiment Ripple Off	19 Aug 71	Apollo 15 SMEAR, ALSEP 16
62	15	LSM	Y-axis Sensor Head Failure to Flip On Command	30 Aug 71	Apollo 15 P & D List, 23 Feb 72, Item ALSEP-26
63	14	SIDE/ CCIG	Lunar Noon & Arcing Constraints	20 Oct 71	Apollo 14 SMEAR, ALSEP 58
64	15	LSM	Y-axis Sensor Data Loss	2 Nov 71	Apollo 15 P & D List, 14 Jan 72, Item ALSEP-27
65	12 15	SWS SWS	Intermittent Modulation Drop in Proton Energy Levels 13 and 14	5 Nov 71	Apollo 15 P & D List, 14 Jan 72, Item ALSEP-28

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS
(continued)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
66	15	SIDE/ CCIG	Limited Operating Time During Lunar Noon (85°C Maximum)	16 Dec 71	Apollo 15 SMEAR, ALSEP 36
67	14	ASE	-60°C Minimum Operating Temperature	10 Feb 72	Apollo 14 SMEAR, ALSEP 67
68	15	C/S	Lunar Night Operating Temperature Limits	18 Feb 72	Apollo 15 SMEAR, ALSEP 40
69	14	PSE	LPZ Axis Inoperative	20 Mar 72	Apollo 14 SMEAR, ALSEP 72
70	16	Subpackage 2	Fell OFF Carry Bar	EVA (21 Apr 72)	Apollo 16 P & D List, 26 Jun 72, Item ALSEP-1
71	16	HFE	Electrical Cable Broke	EVA (21 Apr 72)	Apollo 16 Mission Report, Aug 72, Section 14.4.1
72	16	ASE	Number 3 Spike on Mortar Package Did Not Deploy	EVA (21 Apr 72)	Apollo 16 Mission Report, Aug 72, Section 14.4.2
73	16	ASE	Thumper Cables Stiff to Deploy	EVA (21 Apr 72)	Apollo 16 P & D List, 16 May 72, Item ALSEP-6

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS

(continued)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
74	16	ASE	Mortar Box Roll Angle Telemetry Offscale HIGH	23 Apr 72	Apollo 16 Mission Report, Aug 72, Section 14.4.3
75	16	PSE	Temperature HIGH During Lunar Day	24 Apr 72	Apollo 16 P & D List, 16 May 72, Item ALSEP-11
76	16	ASE	Pitch Sensor Offscale HIGH After Launching 3rd Grenade	23 May 72	Apollo 16 Mission Report, Aug 72, Section 14.4.12
77	16	ASE	Mortar Package Pitched Down 9 Degrees as a Result of Launching Grenade 2	23 May 72	Apollo 16 P & D List, 13 Jun 72, Item ALSEP-17
78	12	LSM	Flip Cal Suspension	14 Jun 72	Apollo 12 SMEAR, ALSEP 76
79	12	SWS	AC Calibrate Measurements LOW (Sequence 15)	20 Jun 72	Apollo 12 SMEAR, ALSEP 77
80	16	C/S	Systematic Spurious CVW's	29 Jun 72	Apollo 12 P & D List, 26 Mar 70, Item ALSEP-3
81	15	SWS	Loss of Experiment, Science and Engineering	30 Jun 72	Apollo 15 SMEAR, ALSEP 42
82	16	LSM	Failure of all 3 Axes to Flip	24 Jul 72	Apollo 16 SMEAR, ALSEP 23
83	12	SIDE/ CCIG	Intermittent Failure of Digital Electronics to Process Data	9 Sep 72	Apollo 12 SMEAR, ALSEP 80

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS

(continued)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
84	12	PSE	LPX Axis Leveling in Auto Mode Balky	4 Dec 72	Apollo 12 SMEAR, ALSEP 81
85	16	PSE	LPY Axis Leveling in Forced and Auto Mode Balky	4 Dec 72	Apollo 16 SMEAR, ALSEP 24
86	17	RTG	Cask Dome Removal was Difficult	EVA (12 Dec 72)	Apollo 17 Mission Report, Mar 73, Section 15.4.4
87	17	C/S	Downlink Signal Strength Fluctuations	EVA (12 Dec 72)	Apollo 17 P & D List, 12 Jan 73, Item SX-1
88	17	LSG	Sensor Beam Cannot be Stabilized in the Null Position	EVA (12 Dec 72)	Lunar Surface Equipment Status Report, 1 Mar 73, Section 4.2 Apollo 17 Mission Report, Mar 73, Section 15.4.1
89	17	C/S	Power Dissipation Module HIGH Temperature	EVA (13 Dec 72)	ALSEP Status Report, 14 Dec 72
90	17	LEAM	Excessive Temperature	17 Dec 72	Lunar Surface Equipment Status Report, 1 Dec 73, Section 4.4 Apollo 17 Mission Report, Mar 73, Section 15.4.3

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS

(continued)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
91	17	LACE	Excessive Temperature with Covers ON	17 Dec 72	Lunar Surface Equipment Status Report, 1 Dec 73, Section 4.3
92	17	LACE	Zero Offset in Data Output of Mass Channels	18 Dec 72	Lunar Surface Equipment Status Report, 18 Sep 73, Section 4.5 Apollo 17 Mission Report, Mar 73, Section 15.4.5
93	17	LACE	Mode Change - Sweep Lock	8 Jan 73	ALSEP Status Report, 9 Jan 73
94	16	LSM	Loss of Science Data	15 Feb 73	Apollo 16 SMEAR, ALSEP 25
95	16	C/S	Transmitter B and Processor Y Selected	26 Mar 73	ALSEP Status Report, 30 Mar 73
96	14	SIDE/ CCIG	Anomalous STANDBY Operations	15 Apr 73	Apollo 14 SMEAR, ALSEP 71
97	17	LACE	Limited Operation During Lunar Day (125°F Maximum)	5 Jun 73	Lunar Surface Equipment Status Report, 1 Dec 73, Section 4.3
98	14	CCIG	Intermittent Night Time Science Data Since 2/19/72.	1 Jul 73	Lunar Surface Equipment Status Report, 18 Sep 73, Section 4.6

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.1 CHRONOLOGICAL LISTING OF PROBLEMS

(concluded)

SEQUENCE NUMBER	APOLLO MISSION	EXPERIMENT OR SYSTEM	PROBLEM	INITIAL DATE OF OCCURRENCE	DISCUSSION REFERENCE
99	15	CCIG	Intermittent Nighttime Science Data Since 2/22/73	1 Jul 73	Lunar Surface Equipment Status Report, 18 Sep 73, Section 4.7
100	17	LACE	Loss of Intermediate Mass Range Output	18 Sep 73	Lunar Surface Equipment Status Report, 1 Dec 73, Section 4.8
101	17	LACE	Filament #1 Failure	23 Sep 73	Lunar Surface Equipment Status Report, 1 Dec 73, Section 4.9
102	14	PSE	Intermittent Digital Data From 9/30/73 Thru 10/5/73	30 Sep 73	Apollo 14 SMEAR, ALSEP 85
103	17	LACE	Loss of Science Data	17 Oct 73	Lunar Surface Equipment Status Report, 1 Mar 74, Section 4.10
104	15	LSM	Loss of Scientific and Engineering Data	10 Dec 73	Apollo 15 SMEAR, ALSEP 48
105	12	PSE	Intermittent Real-Time Z Axis Data	28 Dec 73	ALSEP Status Report, 4 Jan 74
106	14	ASE	Loss of Geophone #2 Data	03 Jan 74	Apollo 14 SMEAR, ALSEP 87
107	*17*	*LSG*	*Loss of Thermal Stability*	*15 Mar 74*	*Lunar Surface Equipment Status Report, 3 June 74, Section 3.2*
108	*12*	*C/S*	*Loss of Downlink Modulation*	*03 May 74*	*Apollo 12 SMEAR, ALSEP 82*

APOLLO LUNAR SURFACE EQUIPMENT STATUS

SECTION 3.1.1 CROSS INDEX BY EXPERIMENTS TO CHRONOLOGICAL LISTING OF PROBLEMS

EQUIPMENT	APOLLO MISSION	PROBLEM NUMBER SECTION 3.1
ACTIVE SEISMIC	14	38, 40, 48, 67, 106
	16	72, 73, 74, 76, 77
CENTRAL STATION	11	2, 3, 4, 5, 7, 20
	12	9, 18, 24, 26, 33, 34, *108*
	14	39, 41, 43, 46
	15	52, 54, 58, 61, 68
	16	80, 95
	17	87, 89
CHARGED PARTICLE LUNAR ENVIRONEMNT	14	50, 51
COLD CATHODE ION GAGE	12	12, 15, 83
	14	37, 49, 98
	15	53, 55, 66, 99
DUST DETECTOR	11	
	12	
	14	
	15	
HEAT FLOW	15	56, 59
	16	71
	17	
LASER RANGING RETRO REFLECTOR	11	
	14	
	15	
LUNAR ATMOSPHERIC COMPOSITION	17	91, 92, 93, 97,100,101,103
LUNAR EJECTA AND METEORITE	17	90
LUNAR SEISMIC PROFILING	17	
LUNAR SURFACE GRAVIMETER	17	88, *107*

APOLLO LUNAR SURFACE EQUIPMENT STATUS
SECTION 3.1.1 CROSS INDEX BY EXPERIMENTS TO CHRONOLOGICAL LISTING OF PROBLEMS
(concluded)

EQUIPMENT	APOLLO MISSION	PROBLEM NUMBER SECTION 3.1
LUNAR SURFACE MAGNETOMETER	12	17, 19, 22, 23, 29, 30, 32, 78
	15	62, 64, 104
	16	82, 94
PASSIVE SEISMIC	11	1, 2, 3, 6
	12	10, 13, 14, 16, 25, 28, 31, 84, 105
	14	44, 45, 47, 69, 102
	15	57, 60
	16	75, 85
RADIOISOTOPE THERMOELECTRIC GENERATOR	12	8
	14	35
	15	
	16	
	17	86
SOLAR WIND SPECTROMETER	12	65, 79
	15	65, 81
SUPRATHERMAL ION DETECTOR	12	11, 12, 15, 21, 27, 83
	14	36, 37, 42, 49, 63, 96
	15	53, 55, 66

APOLLO LUNAR SURFACE EQUIPMENT STATUS
3.2 LUNAR SURFACE GRAVIMETER SENSOR BEAM

Problem Date	Problem
Initial: 12 December 1972 (1st lunar day)	Lunar Surface Gravimeter Experiment
Presence throughout lunar cycle	Lunar surface gravimeter sensor beam cannot be stabilized in the null position.
	Sensor beam could not be center balanced in normal configuration because 1/6-g weights were too light. Weights were too light because of an error in calculations converting from 1-g to 1/6-g requirements.

Remarks:

Cause: Following the initial experiment turn-on, the set-up procedure of nulling the sensor beam in the proper stable position between capacitor plates could not be accomplished.

When the command was given to add any or all of the nulling masses to the sensor beam assembly, the data indicated that the beam would not move away from the upper capacitor plate. The only way to bring the beam down was by caging it against the lower capacitor plate.

During the second and third extravehicular activities, the Lunar Module Pilot rapped the exposed top plate on the gimbal; rocked the experiment in all directions; releveled the instrument, working the base well against the surface; and verified the sunshade tilt. This was done in an attempt to free a mass/weight assembly or sensor beam thought to have been caught or bound. No apparent change or improvement was detected.

Review of sensor development test records revealed that an error in arithmetic resulted in the sensor mass weights being about 2 percent lighter than the proper nominal weight for 1/6-g operation of the flight unit. The sensor mechanism allows ground command adjustment of up to ± 1.5 percent from nominal to compensate for possible inaccuracies. Unfortunately, the 2 percent error in weight made in initial conversion calculations from 1-g to 1/6-g mass exceeded this for the qualification unit and was also passed on to the flight unit final calculations.

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.2 LUNAR SURFACE GRAVIMETER SENSOR BEAM

(continued)

INITIAL: 12 December 1972
(1st lunar day)

Lunar Surface Gravimeter Experiment

Activity: Several reconfigurations of the instrument have been implemented in an effort to determine if the LSG is functioning. The following chronology provides a synopsis of operations.

DATE	CONFIGURATION	RESULTS
12 Dec 72	Following initial deployment the sensor beam could not be nulled in the proper stable position. Open loop mode.	Operation for first 45-days revealed no seismic signal, but possible free mode signal detected with beam centered by pulling down on the mass-adding/caging mechanism. Suspected electronic problems prompted scheduled reconfiguration.
06 Apr 73	The post amplifier gain was reduced from step 15 to step 10 in attempt to operate the instrument in a non-saturated condition. For the final configuration the instrument was returned to the higher gain configuration (step 15) with the beam centered and the integrator shorted for open loop mode operation.	Lower gain setting unsaturated the LSG amplifier and showed background noise higher than the PSE and LSPE instruments. Terminator crossing showed consistent thermoelastic events when shifting between the LSG and LSPE. LSG WAS DETECTING SIGNALS FROM LOCAL EVENTS.

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.2 LUNAR SURFACE GRAVIMETER SENSOR BEAM

(continued)

DATE	CONFIGURATION	RESULTS
19 Apr 73	The LSG beam was re-centered to improve its response by lowering the instruments resonant frequency. The seismic high gain amplifier was reconfigured to step 11. Open loop mode.	Lowered instrument natural frequency to about 2.2 Hz with Q ≈25, seismic bandpass 1 Hz to 16 Hz. Sensitivity calculated for signal and noise averaged over one second, 3.5A. Signal-to-noise improvement of noisy seismic channel accomplished by filtering; of free-mode channel by smoothing power spectrum through stacking multi-day records and averaging out noise.
26 Sep 73	Data was gathered to determine the spring constant of the beam assembly. The post-amplifier gain was returned to step 15. The instrument was configured to closed loop operation with integrator mode, normal; bias circuit, IN; and seismic gain high.	Calculated response of instrument showed closed loop gain for free mode output ≈40 db (100X) down from design closed loop, sharply peaked at ≈21 minutes rather than designed broad band. Commenced recording lunar solid-body tidal data. Processed data tape for moderate sized lunar event recorded all PSE's 21 Aug 73. Filtering revealed event, but primary and secondary wave arrivals not practical to pick. Power spectral density analysis of 40-days data from free mode channel showed no predominant periodicities.

3.2 LUNAR SURFACE GRAVIMETER SENSOR BEAM (continued)

DATE	CONFIGURATION	RESULTS
30 Nov 73	The beam was re-centered using the mass caging mechanism in an effort to obtain a lower resonant frequency. The instrument was configured to the closed loop mode with the integrator mode, normal; bias, IN; and post amplifier gain at increment 15.	Lowered natural frequency from 2.2 Hz to 1.5 and increased free mode response to longer period signals. Tidal output roughly followed calculated lunar tides with overriding higher frequency distortion (temperature effect?). Tidal output failed ≃13 Nov 73 as shown by constant -80 microgal reading. Continued analysis of free mode data by power spectral density revealed no periodicities.
07 Dec 73	The instrument was exercised to determine whether or not the high gain amplifier system was going into oscillation. At the conclusion of the test the LSG was left in the integrator shorted mode (open loop), seismic gain, HIGH; bias, OUT; and post amplifier gain at increment 15.	No determination of why tidal output (feedback configuration) failed. Returned to open loop operation to continue recording seismic and free mode data. Univ. of Maryland received PDP-11 computer (late December 73) to assist in correlation studies from LSG data tapes. Analysis of feedback loop failure continues. Power spectral density analysis of free mode data continues utilizing 80 continuous days, 10 Dec 73 thru 28 Feb 74.

3.2 LUNAR SURFACE GRAVIMETER SENSOR BEAM
(continued)

DATE	CONFIGURATION	RESULTS
15 Mar 74	The instrument's Heater Box heater circuit failed full ON during the 16th lunar night. This anomaly caused the sensor temperature (DG-04) to increase above a stabilized temperature of $49.207^{\circ}C$ and eventually drift off-scale HIGH (temperature transducer range is approximately 48.2 to $52.0^{\circ}C$). Useful scientific data cannot be obtained from the instrument unless the sensor assembly temperature can be maintained rigorously.	The instrument will not automatically control the sensor temperature. Troubleshooting subsequent to the anomaly indicated that while the LSG slave heater could be turned ON and OFF by ground command, and therefore change the temperature of the sensor assembly, thermal control could not be re-established to the degree required for useful science information.
10 Apr 74	An attempt was made to configure the instrument for lunar night operation. The intent of the change was to drive the beam to a new position (approximately +5.8 Vdc as indicated by DG-01 at $49^{\circ}C$) using the coarse/vernier slew motors. It was expected that the instrument would stabilize at about $79^{\circ}C$ during lunar night and the accompanying temperature drift of the sensor would eventually re-center the beam at 0.0 Vdc. This operation mode would provide a means of measuring gravity wave coincident signals during some portion of lunar night. Final configuration was integrator shorted mode (open loop); seismic gain LOW; bias OUT; post amplifier gain at increment 7; and, slave heater ON.	The attempt to drive the beam to a seismic output (DG-01 value) of +5.8 Vdc was not successful. Four gross slew up commands were executed. These commands changed the seismic output from a value of -1.03 to +0.92 Vdc in successively smaller increments. It was decided to delay any further attempts to change the beam position until a more efficient method of change could be proposed and agreed upon.

APOLLO LUNAR SURFACE EQUIPMENT STATUS

3.2 LUNAR SURFACE GRAVIMETER SENSOR BEAM
(concluded)

DATE	CONFIGURATION	RESULTS
20 Apr 74	The LSG regained thermal stabilization. No attempts to reconcile the instrument operation had been made since the 10 Apr 74 re-configuration. It was decided to return the experiment to its operational mode prior to the 15 Mar 74 anomaly. Final configuration was seismic gain HIGH, integrator shorted (open loop), bias OUT, post amplifier gain at increment 15, slave heater ON, coarse and fine screws driven to the extreme lower position, tilt servo motors in an intermediate position, and sensor beam near center.	The sensor beam was returned to a position near null using the slew motors and the north/south tilt servo motors. The post amplifier was returned to gain step 15 and did not appear to saturate. The instrument sensor temperature (DG-04) has remained stabilized at 49.2°C since 20 April.

APOLLO LUNAR SURFACE EQUIPMENT STATUS
APPENDIX A - LOSS OF ALSEP DOWNLINK DATA HISTORY

A.1 INTRODUCTION

Prior to 15 April 1973, the participating Spaceflight Tracking and Data Network ground stations receive/record equipment capability was restricted to receiving and recording of up to four ALSEP downlink data streams simultaneously. This limitation was resolved by the acquisition and implementation of additional receive/record equipments, enabling the primary supporting stations (those with 30-foot antennas) to receive and record up to six downlink data streams simultaneously.

A.2 ALSEP DATA LOSS HISTORY*

Spaceflight Tracking and Data Network ground station coverage for receiving and recording of the ALSEP downlink data stream was not available at the following times due to either programmatic or equipment constraints.

**NOTE: Only data losses subsequent to 1 November 1973 are listed herein. See the 1 December 1973 issue of this document for prior data outages.*

APOLLO LUNAR SURFACE EQUIPMENT STATUS
A.2 ALSEP DATA LOSS HISTORY

DATE	GROUND STATION	TIME (G.m.t.)	ALSEP SYSTEM	DATA TIME LOSS
1973				
06 Nov	BDA	LOS 06/1857 AOS 06/2034	15	1^h37^m
06 Nov	BDA	LOS 06/2033 AOS 06/2218	12	1^h45^m
15 Nov	TAN	LOS 15/2142 AOS 15/2223	14	41^m
18 Nov	HSK	LOS 18/2040 AOS 18/2140	14	1^h00^m
18 Nov	HSK	LOS 18/2140 AOS 18/2240	17	1^h00^m
18 Nov	HSK/CRO	LOS 18/2240 AOS 18/2350	12	1^h10^m
20 Nov	ULA	LOS 20/1835 AOS 20/1950	17	1^h15^m
21 Nov	MIL	LOS 21/1020 AOS 21/1244	15 & 17	2^h24^m
26 Nov	CRO/VAN	LOS 26/0948 AOS 26/1100	12	1^h12^m
26 Nov	VAN	LOS 26/1100 AOS 26/1200	14	1^h00^m
26 Nov	VAN	LOS 26/1200 AOS 26/1300	15	1^h00^m
26 Nov	VAN	LOS 26/1300 AOS 26/1352	16	52^m
28 Nov	ACN/MAD	LOS 28/1347 AOS 28/1442	14	55^m

APOLLO LUNAR SURFACE EQUIPMENT STATUS
A.2 ALSEP DATA LOSS HISTORY (continued)

DATE	GROUND STATION	TIME (G.m.t.)	ALSEP SYSTEM	DATA TIME LOSS
28 Nov	MAD/MIL	LOS 28/1442 AOS 28/1520	12	38^m
29 Nov	MIL/GDS	LOS 29/0023 AOS 29/0040	12 & 15	17^m
29 Nov	ACN/TAN	LOS 29/1306 AOS 29/1450	12	1^h44^m
30 Nov	CRO/MAD	LOS 30/1225 AOS 30/1342	12	1^h17^m
30 Nov	MAD/TAN	LOS 30/1342 AOS 30/1500	14	1^h18^m
01 Dec	GWM/MAD	LOS 01/1249 AOS 01/1308	14-17	19^m
01 Dec	GWM/MAD	LOS 01/1249 AOS 01/1515	12	2^h26^m
01 Dec	MAD/ACN	LOS 01/1515 AOS 01/1607	14	52^m
06 Dec	MIL	LOS 06/2156 AOS 06/2340	14	1^h44^m
10 Dec	ACN	LOS 10/0124 AOS 10/0552	ALL	4^h28^m
12 Dec	MIL	LOS 12/0333 AOS 12/0413	15	40^m
18 Dec	MIL	LOS 18/0754 AOS 18/1518	17	7^h24^m
24 Dec	MIL	LOS 24/1250 AOS 24/1558	ALL	3^h08^m

APOLLO LUNAR SURFACE EQUIPMENT STATUS
A.2 ALSEP DATA LOSS HISTORY (continued)

DATE	GROUND STATION	TIME (G.m.t.)	ALSEP SYSTEM	DATA TIME LOSS
1974				
04 Jan	ROS	LOS 04/0227 AOS 04/0353	17	1^h26^m
12 Jan	GWM/TAN	LOS 12/1855 AOS 12/1910	ALL	15^m
13 Jan	QUI	LOS 13/0625 AOS 13/0627	17	02^m
13 Jan	QUI	LOS 13/0648:06 AOS 13/0648:50	17	01^m44^s
19 Jan	HSK	LOS 19/1946 AOS 19/1951	16	05^m
19 Jan	HSK	LOS 19/1948 AOS 19/1951	17	03^m
24 Jan	MIL	LOS 24/2122 AOS 24/2254	ALL Data Questionable	1^h32^m
25 Jan	MIL	LOS 25/2355 AOS 25/2358	12	03^m
28 Jan	MIL	LOS 28/1814 AOS 28/1816	16	02^m
01 Feb	MAD	LOS 01/1535 AOS 01/1600	12	25^m
10 Feb	MIL	LOS 10/0809 AOS 10/0814	17	05^m
15 Feb	ACN	LOS 15/0827 AOS 15/0852	14	25^m
17 Feb	QUI	LOS 17/15:19:10 AOS 17/15:23:00	ALL	03^m50^s
27 Feb	MIL	LOS 27/2208 AOS 27/2236	16	28^m

APOLLO LUNAR SURFACE EQUIPMENT STATUS
A.2 ALSEP DATA LOSS HISTORY
(continued)

DATE	GROUND STATION	TIME (G.m.t.)	ALSEP SYSTEM	DATA TIME LOSS
04 Mar	GWM	LOS 04/0455 AOS 04/0514	17	19^m
04 Mar	TAN	LOS 04/1327 AOS 04/1502	14	1^h35^m
05 Mar	MIL	LOS 05/2122 AOS 06/0113	17	3^h51^m
09 Mar	TAN	LOS 09/0011 AOS 09/0245	16	2^h34^m
09 Mar	ROS	LOS 09/1040 AOS 09/1118	17	38^m
10 Mar	AGO	LOS 10/0929 AOS 10/0939	ALL	10^m
14 Mar	CRO	LOS 14/1711 AOS 14/1719	15	08^m
16 Mar	ROS	LOS 16/1011 AOS 16/1017	ALL	06^m
16 Mar	ROS	LOS 16/1021 AOS 16/1026	ALL	05^m
17 Mar	QUI	LOS 17/1117 AOS 17/1125	12-15-16-17	08^m
17 Mar	QUI	LOS 17/1117 AOS 17/1144	14	27^m
25 Mar	ACN	LOS 25/1011:40 AOS 25/1014:00	14	02^m20^s
27 Mar	GWM	LOS 27/0906 AOS 27/1030	ALL	1^h24^m
01 Apr	MAD	LOS 01/1728 AOS 01/1749	16	21^m
01 Apr	MAD/CYI	LOS 01/1728 AOS 01/1806	12 & 15	38^m

APOLLO LUNAR SURFACE EQUIPMENT STATUS
A.2 ALSEP DATA LOSS HISTORY
(concluded)

DATE	GROUND STATION	TIME (G.m.t.)	ALSEP SYSTEM	DATA TIME LOSS
01 Apr	CYI	LOS 01/1928 AOS 01/2125	14	1^h57^m
03 Apr	MAD/GDS	LOS 03/0202 AOS 03/0232	ALL	30^m
04 Apr	GDS	LOS 04/0932 AOS 04/0934	15	02^m
04 Apr	GDS	LOS 04/0933 AOS 04/0948	12	15^m
04 Apr	CRO	LOS 04/1436 AOS 04/1440	16	04^m
06 Apr	HAW	LOS 06/0538 AOS 06/0552	16	14^m
12 Apr	ACN	LOS 12/2354 AOS 13/0318	14,15,16,17	3^h24^m
14 Apr	CRO/MAD	LOS 14/0203 AOS 14/0211	ALL	08^m
23 Apr	BDA	LOS 23/1412:00 AOS 23/1421:30	14	09^m30^s
03 May	GWM	LOS 03/1259:36 AOS 03/1341:15	12	41^m39^s
04 May	MIL	LOS 04/0143 AOS 04/0350	16	2^h07^m
05 May	GWM	LOS 05/1138 AOS 05/1140	15	02^m
15 May	ACN	LOS 15/0150 AOS 15/0200	14	10^m
15 May	HAW	LOS 15/2040:20 AOS 15/2044:36	ALL	04^m06^s
20 May	MAD	LOS 20/0955:05 AOS 20/0958:08	ALL	03^m05^s
23 May	GDS	LOS 23/2215 AOS 23/2228	ALL	13^m

APPENDIX B - ALSEP RTG STATUS

The ALSEP Radioisotope Thermoelectric Generators are experiencing an expected but progressive gradual degradation. Cumulative operation of Apollo 12 and 14 ALSEP stations alone have provided nearly eight years of continuous operation, exceeding the initial design requirement of one year each. Figure B-1 illustrates the power regression of the ALSEP RTGs over their total period of lunar operation.

Current reserve power levels of ALSEPs 12 and 15 are decreasing at a rate of about 0.25 watt per lunation. At this rate, action must be taken to increase reserve power on ALSEP 15 to avoid loss of scientific data. Empirical data, obtained during the continuous support period since deployment of the ALSEP 15 package, shows that the system's overload detection circuitry ripples experiments to STANDBY at a reserve power level of 1.7 watts. With an assumed ripple OFF reserve power level of 2.0 watts for ALSEP 12 action will have to be taken as required to avoid science data losses.

The projected time period before critical reserve power level is reached does not consider the catastrophic effect of execution of several spurious commands (e.g., power switching commands of heaters, power dumps, experiment ON/OFF). Therefore, based on current RTG power degradation rates and execution of spurious commands the following experiment re-configuration has been proposed to be effected at the earliest possible date in order to increase the margin of reserve power during the lunar night.

1. ALSEP 12 Lunar Surface Magnetometer (LSM) be commanded OFF

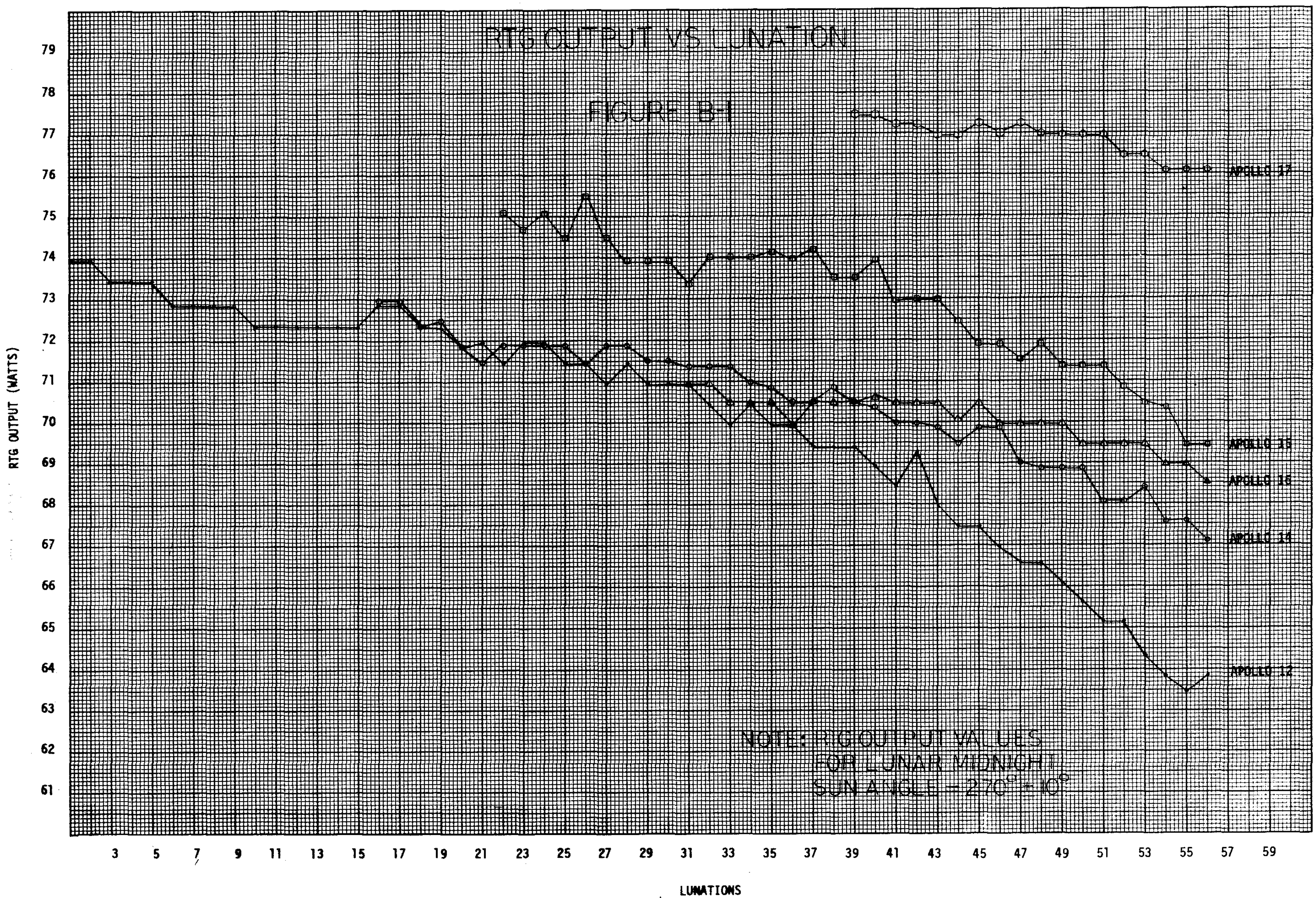
2. ALSEP 15 Lunar Surface Magnetometer (LSM) be commanded OFF

3. ALSEP 15 Solar Wind Spectrometer (SWS) be commanded OFF

The experiments selected for turn OFF have not returned any valid science data for extended periods and are considered to have a very low probability of yielding any future scientific data.

Another advantage from this recommended operational change should be noted: the additional reserve power will cause the Central Station on each ALSEP to run warmer at night (8-10 degrees), thus guaranteeing that the average thermal plate temperature of the Central Station will be above -10°F during the lunar night.

The implementation of ALSEP 12 and ALSEP 15 experiment termination is the first step to insure the long term operation of the systems at reduced power levels with the maximum return of science data. Future guidelines for operation of ALSEPs are currently being formulated but will remain flexible to accommodate the system's thermal and power requirements at some future date.



RTG OUTPUT VS LUNATION
FIGURE B-1
APOLLO 17
APOLLO 15
APOLLO 16
APOLLO 14
APOLLO 12
NOTE: RTG OUTPUT VALUES FOR LUNAR MIDNIGHT SUN ANGLE = 270° ± 10°
RTG OUTPUT (WATTS)
79
78
77
76
75
74
73
72
71
70
69
68
67
66
65
64
63
62
61
LUNATIONS
3
5
7
9
11
13
15
17
19
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APPENDIX C - ABBREVIATIONS AND ACRONYMS

ACN	Ascension Island, United Kingdom (30')
A/D	Analog-to-Digital
AGO	Santiago, Chile (40')
ALSEP	Apollo Lunar Surface Experiments Package
AOS	Acquisition of Signal
ASE	Active Seismic Experiment
BDA	Bermuda, United Kingdom (30')
BUR	Johannesburg, South Africa (40')
CCIG	Cold Cathode Ion Gauge
CMD	Octal Command Number
CPLEE	Charged Particle Lunar Environment Experiment
CRO	Carnarvon, Australia (30')
C/S	Central Station
CVW	Command Verification Word
CYI	Canary Islands, Spain (30')
EVA	Extravehicular Activity
GDS	Goldstone, California, U.S.A. (85')
GWM	Guam, U.S.A. (30')
HAW	Kokee Park, Hawaii, U.S.A. (30')
HBR	High Bit Rate
HFE	Heat Flow Experiment
HSK	Honeysuckle Creek, Australia (85')
LACE	Lunar Atmospheric Composition Experiment
LEAM	Lunar Ejecta and Meteorite Experiment
LM	Lunar Module
LOS	Loss of Signal
LP	Long Period (PSE sensors)
LSG	Lunar Surface Gravimeter
LSM	Lunar Surface Magnetometer
LSPE	Lunar Seismic Profiling Experiment
MAD	Madrid, Spain (85')
MIL	Merritt Island, Florida, U.S.A. (30')
ORR	Orroral Valley, Australia (85')

APPENDIX C - ABBREVIATIONS AND ACRONYMS (concluded)

P & D	Problem and Discrepancy List
PI	Principal Investigator
PSE	Passive Seismic Experiment
QUI	Quito, Ecquador (40')
ROS	Rosman, North Carolina, U.S.A. (85')
RTG	Radioisotope Thermoelectric Generator
SIDE	Suprathermal Ion Detector Experiment
SMEAR	Span/Mission Evaluation Action Request
SP	Short Period (PSE sensor)
SWS	Solar Wind Spectrometer
TAN	Tannanarive, Malagasy Republic (40')
TEX	Corpus Christi, Texas, U.S.A. (30')
TM	Telemetry
UHT	Universal Handling Tool
ULA	Fairbanks, Alaska, U.S.A. (85' & 40')
VAN	Vanguard, Tracking Ship, U.S.A. (30')
XMTR	Transmitter

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APOLLO PROGRAM-LUNAR SURFACE EQUIPMENT STATUS

AC/G. Abbey
TA/T. Calio
TN/L. Haskin
TN3/W. Eichelman (6)
TN3/R. Baldwin
TN3/J. Bates
PA/G. Lunney
WA/D. Arabian
WA2/J. Lobb
WA2/R. Blount
EA/M. Faget
EA3/R. Gardiner
EA3/D. Gerke
ED/D. Grimm
ED1/V. Melliff
ED1/J. Lowery
PHO F222/E. Carr
C30/W. Rowe
FS/J. Stokes
FS4/M. Ward
FA/H. Tindall
CA/K. Kleinknecht
CA/E. Kranz
CF5/J. Hannigan
CF5/K. Kundel
CF5/R. Keely
CF5/A. Larsen
DA/R. Johnston

NASA HEADQUARTERS

SM/N. W. Hinners
SM/F. Roberson
SM/Dr. J. Hanley

APOLLO DATA ARCHIVING GROUP

Dr. N. Toksoz
Dr. P. Coleman
Dr. D. Anderson
Dr. I. Adler
GSFC 601/L. Davis (NSSDC)
GSFC 601/R. Vostreys (NSSDC)

AEC/W. C. Remini
JPL/Dr. P. Mason

BENDIX CORPORATION

R. W. Schaeffer
B. J. Rusky
D. Fithian
W. Tosh
J. McNaughton

ALSEP PRINCIPAL INVESTIGATORS

Dr. P. Dyal
Dr. J. Freeman
Dr. K. Hills
Dr. J. Hoffman
Dr. R. Kovach
Dr. M. Langseth
Dr. J. Larson
Dr. G. Latham
Dr. D. Reasoner
Dr. C. Snyder
Dr. C. Sonett
Dr. J. Weber
O. Berg
J. Carroll