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Systems Division

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CONTRACT END ITEM DETAIL SPECIFICATION  
(PRIME EQUIPMENT)

LIBRARY

PERFORMANCE/DESIGN

MAY 08 1974

and

Lunar Science Institute

PRODUCT CONFIGURATION REQUIREMENTS

for

APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE (ALSEP)

SYSTEM

S/N6

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JAN 7 1977

LUNAR SCIENCE INSTITUTE

GESSNER

MSC/GE

Approved:

C. J. Weatherred

Bendix ALSEP Program Director

Date:

9 October 1968

Approved:

John H. Sanford

NASA/MSC Lunar Surface  
Project Office

Date:

11/18/68

Contract NAS 9-5829



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## 1.0 SCOPE

This part of this specification establishes the requirements for performance, design, test and qualification of one type-model-series of equipment identified as the Apollo Lunar Surface Experiments Package (ALSEP). The ALSEP will be used to obtain long-term scientific measurements of various physical and environmental properties of the moon in implementation of the scientific objectives of the Apollo Program. The ALSEP includes an array of scientific experiment instruments with their supporting subsystems, to be transported to the lunar surface aboard the Lunar Module (LM). The ALSEP equipment will remain on the lunar surface after the astronauts' departure. Scientific and engineering data will be transmitted for a maximum period of two years to the Manned Space Flight Network (MSFN) by each of the ALSEP flight articles.

1.1 Associated Personnel, Equipment and Facilities. - ALSEP will be carried to the moon aboard the Apollo Lunar Module (LM) after launch from Kennedy Space Center. The system will be deployed on the the lunar surface by the LM crew, and, after the crew's departure in the LM Ascent Stage, will be under the exclusive control of the Apollo Mission Control Center (MCC). Two-way radio communications with ALSEP, for the transmission of ground commands and the reception of telemetry, will be established and maintained by the Manned Space Flight Network (MSFN). MSFN coverage will be continuous for the first 45 days of ALSEP lunar operation, providing expeditious command control and real time data display, as well as continuous recording of the telemetry data stream. Thereafter, command access and real time data display will be provided for about two hours out of each eight-hour period. Exceptions are the times of lunar sunrise and sunset, when continuous coverage will be reinstated for periods of approximately 48 hours for intensive investigation of the lunar environment effects of rapid changes in local solar radiation. Significant events, such as lunar quakes or intense sunspot activity may warrant arrangement for other periods of continuous coverage.

Recording of the telemetry data will be provided continuously for the operational life of ALSEP. Scientific and engineering data will be separately recorded for each experiment along with time marks, accurate to one second and with a resolution of one millisecond.



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Real time display at MCC will include:

1. Command word transmitted
2. Command verification from ALSEP
3. Selected engineering data
4. Selected experiment data

Automatic limit indicators (visual and audible alarms) will be provided to alert operators to out-of-tolerance conditions of engineering parameters being monitored in real time.

## 2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. Unless otherwise stated, the applicable issue of each document shall be that in effect on 1 June 1966, or, if issued subsequent to 1 June 1966, the original issue. In the event of conflict between documents referenced here and detailed content of Sections 3, 4, and 5, the detailed requirements of Sections 3, 4, and 5 shall be considered as superseding.



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Specifications

NASA

Military

MIL-W-6858C

Welding, Resistance, Aluminum,  
Magnesium, Non-Hardening Steels or  
Alloys, Nickel Alloys, Heat-Resisting  
Alloys, and Titanium Alloys, Spot and  
Seam

Grumman

LSP 360-11  
11 February 1966

Scientific Equipment Performance and  
Interface Specifications

✓ LIS-360-22101  
IRN-4

Materials Compatibility, Interface  
Control Specification for

✓ LIS-360-22102  
IRN-1 thru 10 and  
IRN-C1

Mass Properties, Interface Control  
Specification for

✓ LIS-360-22302  
IRN-8

Environmental Conditions Induced by LM  
on the Scientific Equipment in the Descent  
Stage, Interface Control Specification for

LIS-360-22503

Electrical Interface Requirements  
of the LM/RTG Cask Shield Temperature  
Transducer



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LIS-360-22402  
IRN-A5

Environmental Constraints Imposed by LM on  
the Radioisotope Thermoelectric Generator  
Fuel Cask (RTG)

LSP 390-8A  
3 December 1965

Connectors, Miniature Circular, Electrical  
Power Subsystem Design Control Specifications.

Bendix

AL 770000  
19 January 1968

Electromagnetic Interference Control  
Requirements for the ALSEP

IC 314103  
9 June 1967

Interface Control Specification for Magnetometer  
Experiment Subsystem for ALSEP

IC 314104  
23 May 1967

Interface Control Specification for Solar  
Wind Spectrometer Experiment Subsystem  
for ALSEP

IC 314105  
14 February 1967

Interface Control Specification for Supra-  
thermal Ion Detector Experiment for ALSEP

IC 314106  
8 June 1967

Interface Control Specification for Passive  
Seismic Experiment Subsystem for ALSEP

IC 314110  
3 May 1967

Interface Control Specification for ALSEP  
Ground Support Equipment

IC 314114  
4 January 1967

Interface Control Specification for Apollo  
Lunar Hand Tools for ALSEP

IC 314115  
16 June 1967

Interface Control Specification for MSFN/  
ALSEP

IC 314116  
27 July 1966

Interface Control Specification for ASTRONAUT/  
ALSEP

IC 314117  
1 June 1966

Interface Control Specification for KSC/ALSEP  
Operations

IC 314118  
2 May 1967

Interface Control Specification for MSFN/  
MCC /ALSEP Operations

AL 270000  
16 December 1966

Technical Performance Specification for  
Passive Seismic Experiment



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IC 314119  
12 October 1966

Interface Control Specification for Electrical  
Power Subsystem (GFE Items) (SNAP-27  
Integrated Power Unit System)

IC 314121  
29 March 1967

Interface Control Specification for GRAPHITE  
LM Fuel Cask (GLFC) (Snap 27 Integrated  
Power Unit System)

Standards

Military

MIL-STD-130B

Identification Marking of U. S. Military  
Property

MIL-STD-143A

Specification and Standards Order of  
Precedence for the Selection of

MIL-STD-810B

Environmental Test Methods for Aerospace  
and Ground Equipment

MS 24123A

Plate, Identification

MS 33586 A

Metals, Definition of Dissimilar

Other Publications

NASA

ASPO-RQA-11  
20 May 1965

Qualification Test Program Guidelines

NPC 200-2  
20 April 1962

Quality Program Provisions for Space  
System Contractor

Exhibit A, Appendix I  
NAS 9-5829  
June 1965

ALSEP Implementation Instructions  
for NPC 200-2



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DS-4	Separation of Redundant Paths
DS-5	Transistors - Selection of Types
DS-8	Mechanical Rigging Devices
DS-9	Protection of Spacecraft Electrical and Mechanical Systems from Debris
DS-12	Single Point Failures
DS-13	Electrical and Electronic Devices - Protection from Reverse Polarity and/or Other Improper Electrical Inputs
DS-25	Wire Bundles—Protective Coatings
PS-2	Control of Time - Sensitive Components
PS-5	Protection of Electrical/Electronic Assemblies from Moisture Damage
PS-6	Ultrasonic Cleaning Electrical and Electronic Assemblies
PS-8	Application of Previous Qualification Tests
PS-9	Acceleration Recording Instruments - Shipment of Spacecraft and Related Equipment
PS-10	Protective Covers or Caps for Receptacles and Plug - Electrical
PS-11	Direct Procurement of Parts
DS-21	Meteoroid Environment in Near-Earth Cislunar and Near Lunar Space



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PS-30  
30 June 1966

Pyrotechnic Initiating Elements - Preflight  
Lot Verification Tests at Launch Sites

PS-21

Identification Requirements - Explosive  
Devices

NASA SP-87

Proceedings of the Apollo Unified S-Band  
Technical Conference held at Goddard Space  
Flight Center July 14-15, 1965

NPC 200-4  
August 1964

Quality Requirements for Hand Soldering  
of Electrical Connections

Grumman

LID-360-22801  
16 July 1967

Mechanical Interface

LID-360-22811  
Rev B

LM/ALSEP Structural Interface (LM Descent  
Stage) (LM-4)

LED 520-1F  
15 May 1966

Design Criteria and Environment for  
the LM

Bendix

2333032  
Rev F

ALSEP Program Thermal Vacuum  
Integrated System Test Procedure

2333034  
Rev H

ALSEP Program Integrated System Test  
Procedure for Flight Configurations 1 & 2

2333049 Rev. A

ALSEP System No 1 and 2 (Stowed)  
Magnetic Properties Test (Procedure)

2333087  
Rev E

EMI Test Procedure for ALSEP System  
Configuration A



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2334328 24 May 1968	ALSEP Procedure Subpackage No. 1 Qualification Shock Test
2334330 21 May 1968	ALSEP Procedure Subpackage No. 2 Acceleration Qualification Test
2334331 24 May 1968	ALSEP Procedure Subpackage No. 2 Qualification Shock Test
2338179 Rev. A	ALSEP Deployed System Thermal Vacuum Test Procedure
2334343 21 May 1968	ALSEP Procedure Subpackage No. 1 Acceleration Qualification Test
2334345	Mission Simulation Test Procedure (Qual Only)
2334346 15 May 1968	ALSEP Program Subpackage No 1 Assembly Design Limit Qualification Vibration Test (Procedure)
2334348 15 May 1968	ALSEP Program Subpackage No. 2 Assembly Design Limit Qualification Vibration Test (Procedure)
2334389 23 April 1968	ALSEP Subsystem Installation/Removal Procedure for Thermal/Vacuum Test Setup
2337925 Rev. C	ALSEP Program Central Station Power Dissipation Test Procedure
2337938 Rev. B	ALSEP Subpackage No. 1 Assembly Mass Properties Determination (Procedure)
2337939 5 April 1968	ALSEP Subpackage No. 2 Assembly Mass Properties Determination (Procedure)
2338607 Rev. B	Procedure for Vibration Environment Acceptance Test on Subpackage No. 1 Assembly



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2338606	Procedure for Vibration Environment Acceptance Test on Subpackage No. 2 Assembly
2338178 Rev. B	ALSEP System Stray Field Magnetic Properties Test (Procedure)
2338600	Modified IST (Procedure) for Subpackage No. 1 Stowed Configuration
ATM-241 Rev. B 27 April 1967	Acceptable Parts List
ATM-242 Rev. D 1 July 1968	Approved Materials List
ATM-785 31 July 1968	ALSEP Qual SA Model Qualification Test Plan
2338612	VSWR - Antenna
2338622	Antenna Aiming Mechanism Functional Test
2338192	Subpackage 1 & 2 Tumble Test
2338193	Timer Start
2338063	Boydolt Test
2338623	Tool Fit Checks
2337945	SIDE Experiment Thermal/Vacuum Soak



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### 3.0 REQUIREMENTS

3.1 Performance. - The following paragraphs establish the performance requirements of the ALSEP system, subsystems, and associated equipment. The ALSEP shall be designed to be compatible with the LM vehicle requirements in accordance with GAEC Document LSP 360-11. The ALSEP Flight System shall not weigh more than 289 pounds. In this weight, there shall be provided 51.87 pounds allocation for GFE experiments; 18.01 pounds allocation for CFE ALHT; 68.17 pounds allocation for GFE Radioisotope Thermoelectric Generator (RTG), and connecting cable, RTG Fuel Cask and RTG Fuel Capsule; 5 pounds allocation for GAEC RTG Fuel Cask mounting. The remaining 145.95 pounds shall be the maximum allowable weight for all CFE ALSEP flight equipment including subsystems, interface provisions, and all ALSEP mounting equipment required for ALSEP transportation in the Lunar Module (LM).

3.1.1 Operational Characteristics. - The ALSEP is a package of scientific instruments and supporting subsystems that will be transported to the moon aboard the LM descent stage in two compartments of the scientific equipment (SEQ) bay. The ALSEP shall be capable of being placed on the lunar surface by the astronaut and of transmitting lunar geophysical and environmental information for a period of at least 1 year after scheduled departure of the spacecraft. In general, the ALSEP shall be self-sufficient; however, it shall be designed to permit the astronaut to provide optimum placement of various combinations of experiments, to emplant sensors, and to start operation. The ALSEP system includes the following subsystems as defined by the specified paragraphs of this specification: Electrical Power Subsystem (paragraph 3.4.1 herein); Data Subsystem (paragraph 3.4.2 herein); Structure/Thermal Subsystem (paragraph 3.4.3 herein); and LGE subsystem (paragraph 3.4.14 herein).

A specific combination of experiment subsystems has been selected for this configuration as follows:

- (a) Magnetometer Experiment Subsystem\*
- (b) Suprathermal Ion Detector Experiment/Cold Cathode Gauge Experiment Subsystem\*
- (c) Passive Seismic Experiment Subsystem

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\*GFE



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(d) Solar Wind Experiment Subsystem\*

The ALSEP shall not interfere with the installation of the LM descent stage SEQ bay thermal "door" prior to launch, the functional characteristics of the door during translunar flight, nor with the replacement of the door on the lunar surface.

The ALSEP shall be capable of transmitting 1060 bps to earth when operating with a 30 foot MSFN antenna. The data processor shall have the capability to format and process data to be transmitted at 530 and 1060 bps. The calculated uplink probability of command error shall be less than  $10^{-9}$ . The uplink probability of accepting and delivering a correct command shall be no less than 0.999.

With nominal link parameters the telemetry downlink performance shall be such that the calculated probability of bit error is less than  $10^{-4}$ . The calculated probability of bit error shall be no greater than  $10^{-3}$  when based on a linear addition of all worst case link parameters.

The system shall contain a timer which shall generate events which shall be converted to back-up commands by the command decoder. The timer shall also automatically terminate ALSEP transmissions  $720 \pm 30$  days after initial set-up on the lunar surface. (1 day = 24 hours.)

Provisions shall be included for turning the transmitter off and on by command from earth. When both transmitters are turned off by command the system shall include provisions for surviving the lunar environment.

**3.1.1.1 Mission Requirements.** - The ALSEP shall be capable of being transported to the moon aboard the LM, placed on the lunar surface by the crew and remaining on the moon in a functioning status after the scheduled departure of the crew. Each ALSEP shall be capable of operating in accordance with the specified performance requirements without interference at MSFN while up to two other ALSEPs are operating. ALSEP communication operation shall not interfere with Apollo communications.

**3.1.1.2 Prelaunch Operations.** - Installation of the ALSEP in LM shall take place in the Manned Spacecraft Operations Building (with the exception of placing the RTG fuel capsule into the fuel cask as further defined in paragraph 3.1.2.2.1 herein).

There will be no checkout of ALSEP after its installation into the LM. Prelaunch operations cooling will be provided by NASA for the removal of heat generated by the RTG fuel cask while in the Spacecraft LM Adapter (SLA).



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3.1.1.3 Translunar flight. - The ALSEP system shall be non-operative during flight to the moon. The rejection of RTG fuel cask heat after launch shall be primarily by radiation, such that not more than 100 BTU/hour is transmitted to the LM by direct radiation or conduction as defined by LIS 360-22402. The instrumentation shall be in accordance with LIS 360-22503. There shall be no necessity for checkout or servicing of ALSEP equipment aboard the LM during this phase of flight.

3.1.1.4 Lunar Surface Operation. - The ALSEP system shall be capable of being extracted from the LM, assembled, deployed and checked out by the flight crew in accordance with the specific performance requirements of this specification and the human factors requirements of paragraph 3.1.2.6 herein. The ALSEP system shall be capable of being properly deployed when the sun elevation angle lies between  $7^{\circ}$  and  $45^{\circ}$ . LM thermal integrity shall be ensured following ALSEP removal by replacing the thermal door of the SEQ bay.

3.1.1.4.1 Unloading from LM. - Adequate means shall be provided to permit the unloading of the ALSEP to the lunar surface by the flight crew.

Design shall provide for independent extraction, deployment, and use of the Apollo Lunar Hand Tools (ALHT) on the lunar surface. The ALSEP shall be designed to be withdrawn from the LM Descent Stage scientific equipment compartments in accordance with referenced Interface Control Specifications and LID 360-22811. All extraction and deployment of ALSEP, RTG and experiments shall be capable of being accomplished by hand carry methods.

3.1.1.4.2 RTG Fueling. - During ALSEP/ALHT unloading, a thermal protector shall be provided between the fuel cask and the astronaut. A special tool shall be provided for use after unloading the ALSEP to allow the astronaut to transfer the fuel capsule from the cask to the RTG. The ALSEP shall be designed to provide protection to the crew from the thermal hazard involved in the removal and handling of the RTG fuel capsule and deployment of the RTG.

3.1.1.4.3 Surface transportation. - The ALSEP (either with the ALHT or separately) shall be capable of being transported to the point of emplacement by the handle grips, and also by use of a bar to which the two parts of ALSEP are attached.

3.1.1.4.4 ALSEP Deployment. - The ALSEP shall be designed in such a manner that deployment and setup time shall be less than 90 minutes as a goal. Deployment and setup is defined as extraction of the ALSEP from the LM, transportation and setup of the experiments, and return of the crew member to the LM.



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In the deployed configuration the ALSEP shall consist of the central station, the RTG power supply in close proximity and the emplaced experiments. The central station is defined as the data subsystem including supporting structure and thermal control, the power conditioning unit including supporting structure and thermal control, all interconnecting cables between the central station and the nearest element of each emplaced experiment and the experiment tie-down structure. A volume of approximately 7" x 5" x 2" shall be allocated for experiment electronics which can be packaged more effectively in the central station. These experiment electronics are not, however, a part of the central station.

The deployment distance shall be no less than 300 feet from the LM. The design of ALSEP shall ensure reception of data in the case of partial deployment of experiments.

3.1.1.4.5 Lunar location. - The ALSEP shall be designed to operate when transmitting from a lunar location of  $\pm 5^\circ$  from the equator and  $\pm 45^\circ$  from the prime meridian on the earth side.

3.1.1.4.6 MSFN. - The MSFN will be utilized for receiving ALSEP data and for transmitting ALSEP commands. The MSFN system will maintain communications, receive and record data transmitted to earth from each ALSEP. Frequency allocations will be made within the band of 2275 to 2280 MHz for ALSEP down-link. The up-link for ALSEP command shall be established on 2119 MHz. The MSFN will be capable of simultaneous reception and handling of data from a maximum of three different ALSEPs operating from the Apollo landing area. Data transmitted from the ALSEP will be received by the MSFN 30-foot diameter parabolic antennas and recorded at the MSFN ground stations. An 85-foot antenna will be made available on special request for unique transmission requirements. This arrangement will be made compatible with Apollo operations. Existing MSFN 10 KW command transmitters will be utilized. Where applicable, the requirements of NASA SP-87 shall apply.

3.1.1.5 Test level and sequence. - All functional testing shall provide identification of a failure to the replaceable component level of equipment. Unless otherwise specified, the qualification test sequence shall conform to the test sequence for aerospace and ground equipment in MIL-STD-810.



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3.1.1.6 Performance verification. - Except for the Passive Seismic, each experiment's performance shall be verified with a verification of calibration test during system acceptance test, and on the lunar surface prior to lunar operation. The implementation of these tests shall be identical. The implementation shall excite the sensor, if possible, otherwise the excitation shall be applied close to the sensor. The requirements of PS-30 shall apply.

3.1.1.7 Engineering status data. - The ALSEP shall provide engineering data capable of being used for failure analysis and operational status evaluation.

3.1.1.8 Dust accretion. - The ALSEP shall provide a measurement of lunar dust accretion over the ALSEP as an engineering status measurement.

3.1.1.9 Thermal surface degradation. - The ALSEP shall provide the thermal control necessary for successful ALSEP performance when radiative properties of surfaces exposed to solar radiation are altered by a 100 percent dust cover or degraded by a one-year exposure to ultraviolet radiation and vacuum. The effects of dust accretion shall not be included in the thermal design of those particle experiments in which the sensor has a low tolerance to dust.

3.1.2 Operability. -

3.1.2.1 Reliability. - The ALSEP shall have as a design goal an overall reliability of 0.90 for a 1 year lunar operation. Reliability shall be a prime consideration in design, development, and fabrication. Redundancy will be utilized in achieving both the reliability and crew safety goals. The design will provide maximum resistance to single point catastrophic failures. Specific operating life periods for the various experiment subsystems shall be as specified in the applicable subparagraphs of paragraph 3.2.2 herein. The requirements of DS-12, DS-4, DS-9, and DS-25 shall apply.



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3.1.2.2 Maintainability. - Equipment arrangements, accessibility, and interchangeability features shall be incorporated into the design to allow efficient preflight servicing and maintenance. Maintenance

of the ALSEP system shall be performed at the subsystem level for the experiments and at the component level for all other subsystems.

3.1.2.2.1 Service and access. - The RTG fuel cask shall be accessible on the launch pad for RTG fuel capsule loading operations. The cask mounting on LM shall permit insertion and withdrawal of the RTG fuel capsule at any time prior to removal of the LM work platforms. Installation of ALSEP Subpackages I and II into LM shall be accomplished by means of an installation fixture (LID 360-22801). The installation fixture shall interface with LM, ALSEP and the BxA GSE and it shall provide support and alignment of ALSEP throughout the installation process.

The installation fixture will be furnished by Grumman and the respective interfaces shall be controlled by a Grumman interface document. The requirements of DS-8 shall apply.

3.1.2.3 Useful life. - The ALSEP shall be designed to perform as specified herein, during all phases of lunar day and night, for a period of no less than 1 year. The requirements of PS-2 Apply.

3.1.2.4 Environment requirements. - The ALSEP shall be designed to be capable of successfully performing the required mission during or after, as applicable, being subjected to the most severe environmental conditions



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shown herein or any logical combination of these environments applied simultaneously. The most severe environment values shown herein are minimum design requirements.

3.1.2.4.1 Mission environment phases. - The mission is divided into seven phases for the purpose of defining the environmental conditions. These phases and the environments expected for each are shown in Table I.

3.1.2.4.2 Lunar surface environment. - The lunar surface environment shall be as defined by Document LED 520-1; however, the meteoroid environment shall be as defined in Document DS-21.

3.1.2.4.3 Special environments. - Deployment of the Suprathermal Ion Detector on the lunar surface relative to other ALSEP equipment shall be such that, at its operative location, the contaminant static electric field due to ALSEP, is less than 1.0 volt/meter. The system and the collective subsystems shall not produce a magnetic field at the magnetometer deployed location greater than 0.25 gamma. The magnetometer sensor shall not be exposed to a magnetic field greater than 1.0 gauss from the time of the last deperm of the LSM to the time of deployment.

3.1.2.5 Ground handling and transportability. - Shipping containers shall be specially designed to protect the ALSEP subpackages and the associated instrumentation for monitoring the transportation and storage environment. Containers shall meet the design requirements of LED 520-1 with respect to transportation, ground handling and storage. The requirements of PS-9 also apply. Provisions shall be made for real time recording of temperature and shock during transportation. Monitoring devices shall also record humidity and, on the magnetometer only, the magnetic field intensity to which the equipment is exposed.

3.1.2.6 Human Performance. - Crew-System performance requirements of ALSEP include the selection, by the LM crew, of a suitable site for emplacement of the system upon the lunar surface. The crew will also be required to perform such tasks as unloading ALSEP from LM, fueling the RTG, transporting the system to the deployment site, deploying, leveling and orienting the Central Station and experiment instruments, erecting and pointing the antenna, and connecting the RTG cable to the Central Station. Contingency operations may include actuating the astronaut control switches,



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TABLE I

## ALSEP SYSTEM ENVIRONMENTS

Environment Considered	Storage Unpackaged	Storage Packaged	Movement to the Pad	Factory & Assembly Bldg. Checkout	Launch Pad Environment	Flight	Lunar Operations
Humidity	15 to 50% relative	N/A (Applied to Pkg.)	15 to 100% relative	Max. 50%	Max. 50%	N/A	N/A
Rain	N/A	N/A (Applied to Pkg.)	N/A	N/A	N/A	N/A	N/A
Salt-Spray	N/A	N/A (Applied to Pkg.)	N/A	N/A	N/A	N/A	N/A
Sand and Dust	N/A	N/A (Applied to Pkg.)	N/A	N/A	N/A	N/A	LED 520-1
Fungus	N/A	N/A (Applied to Pkg.)	N/A	N/A	N/A	N/A	N/A
Ozone	N/A	N/A (Applied to Pkg.)	N/A	N/A	N/A	N/A	N/A
Hazardous Gases	N/A	N/A (Applied to Pkg.)	N/A	N/A	N/A	N/A	N/A
E. M. I.	N/A	N/A (Applied to Pkg.)	N/A	L M Std.	L M Std.	N/A	AL 770000
Acceleration	1.0g thru axis	2.67g Vert. with 1 g. lateral	1.0g Vert.	N/A	N/A	LIS 360-22302 LIS 360-22402	N/A
Vibration	N/A	LED 520-1	LED 520-1	N/A	N/A	LIS 360-22302 LIS 360-22402	N/A
Shock	LIS 360-22302 LIS 360-22402	LED 520-1	LED 520-1	N/A	N/A	LIS 360-22402	12 inch free fall onto a hard surface under lunar gravity
Temperature	-20°F to +110°F	-65°F to 160°F	+50°F to 100°F	+50°F to +100°F	+50°F to 100°F	LIS 360-22302 LIS 360-22402	LED 520-1
Radiation	N/A	N/A	N/A	Negligible	Negligible	Less than lunar opn's.	LED 520-1
Solar Radiation	360 BTU/ft <sup>2</sup> hr, 6 hr/day	N/A	N/A	N/A	N/A	N/A	LED 520-1
Meteoroids	N/A	N/A	N/A	N/A	N/A	N/A	DS-21
Pressure	Ambient	Sea level to 50,000ft	Ambient	Ambient	Ambient	<1 x 10 <sup>-8</sup> m.m. Hg	LED 520-1
Acoustics	N/A	N/A	N/A	N/A	N/A	LED 520-1	N/A



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provided for overriding the PCU holdoff circuit, switching transmitters and data processors, and activating the experiments. All ALSEP mechanisms, including electrical connectors, shall be designed for operation within the constraints of the suited astronaut's capabilities.

3.1.2.7 Safety. - The design of ALSEP shall give careful consideration to the requirements of safety for personnel and equipment, including the effects of the Extravehicular Mobility Unit (EMU) as a constraint on the astronaut's movements.

3.1.2.7.1 Personnel safety. - The safety of the LM crew member, while unloading, transporting and deploying the ALSEP on the lunar surface, and of other personnel while handling ALSEP before launch, are prime design considerations. The equipment design shall avoid the use of sharp edges and corners and dangerous protuberances. Inherent protection of personnel from contact with high-temperature surfaces and hazardous electrical potentials shall be provided. Special thermal shielding shall protect the astronaut while he is handling, or working around, the fuel cask and RTG.

3.1.2.7.2 Fail-safe. - The design of ALSEP shall reflect application of the results of failure mode analyses of switches, relays and other bi-static (and multi-state) devices. The requirements of DS-12 shall apply.

3.1.2.8 Induced Environment. - The ALSEP shall be capable of proper performance after having been subjected to the induced environments stated below:

(a) Earth Launch and Boost Phases, Random Vibration  
X Axis (Subpackage No. 1 only)

10 - 200 cps	3 db/octave roll-up (From $G^2 = .00089$ )
200 - 400 cps	0.018 $G^2$ /cps level
400 - 600 cps	3 db/octave roll-off
600 - 1300 cps	0.012 $G^2$ /cps level
1300 - 2000 cps	9 db/octave roll-off



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Y Axis (Subpackage 1 and 2)

10 - 200 cps	3db/octave roll-up (from $G^2 = .0003$ )
200 - 1500 cps	0.006 $G^2$ /cps level
1500 - 2000 cps	9 db/octave roll-off

Z Axis (Subpackage 1 and 2)

10 - 100 cps	6 db/octave roll-up (from $G^2 = .000054$ )
100 - 800 cps	0.006 $G^2$ /cps level
800 - 1000 cps	9 db/octave roll-up
1000 - 1600 cps	0.012 $G^2$ /cps level
1600 - 2000 cps	9 db/octave roll-off

X Axis (Subpackage No. 2 only)

10 - 155 cps	3 db/octave roll-up (from $G^2 = .001$ )
155 - 200 cps	21 db/octave roll-up
200 - 230 cps	0.077 $G^2$ /cps level
230 - 280 cps	21 db/octave roll-off
280 - 400 cps	0.018 $G^2$ /cps level
400 - 600 cps	3 db/octave roll-off
600 - 1300 cps	0.012 $G^2$ /cps level
1300 - 2000 cps	9 db/octave roll-off

b. Lunar Descent, Random Vibration

X Axis, Y Axis, Z Axis (Subpackages 1 and 2)

10 - 20 cps	12 db/octave roll-up (from $G^2 = .00041$ )
20 - 100 cps	0.005 $G^2$ /cps level
100 - 120 cps	12 db/octave roll-off
120 - 2000 cps	0.003 $G^2$ /cps level



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c. Launch and Boost and Lunar Descent, Sinusoidal

X, Y, Z Axis (Subpackages 1 and 2)

5 - 12 cps	0.154 inch D/A
12 - 100 cps	1.16 G peak

Sweep rate =  $3/4$  octave/minute

d. RTG Cask, Earth Launch and Boost Phase  
Random Vibration

X Axis, Y Axis, Z Axis

20 - 100 cps	9 db/octave roll-up (from $G^2 = .00085$ )
100 - 500 cps	$0.089 G^2$ /cps level
500 - 2000 cps	6 db/octave roll-off

e. RTG Cask, Earth Launch and Boost Sinusoidal

X Axis, Y Axis, Z Axis

5 - 17.5 cps	0.154 inch D/A
17.5 - 100 cps	2.3 G peak

Sweep rate = 3 octaves/minute

f. RTG Cask, Lunar Descent, Random Vibration

X Axis, Y Axis, Z Axis

10 - 20 cps	12 db/octave roll-up (from $G^2 = .00041$ )
20 - 100 cps	$0.006 G^2$ /cps level
100 - 120 cps	12 db/octave roll-off
120 - 2000 cps	$0.003 G^2$ /cps level



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g RTG Cask, Lunar Descent, Sinusoidal

X Axis, Y Axis, Z Axis

5 - 30 cps	0.023 inch D/A
30 - 100 cps	1.1 G

Sweep rate = 1 octave/minute

3.2 Interface Requirements

3.2.1 System interface requirements

3.2.1.1 LM Spacecraft/ALSEP interface - The ALSEP will be transported to the moon aboard the LM vehicle in the specially provided compartments in the SEQ Bay of the LM descent stage. The description of these compartments shall be defined by Document LID-360-22811. They provide a volume of approximately 15 cubic feet. Depending on the manner in which the LM lands on the moon, the lower edges of these compartments can be 18 inches to 60 inches above the lunar surface.

3.2.1.2 Other interfaces - The ALSEP shall also interface with KSC for installation as defined in IC 314117. The characteristics of the MSFN interface shall be as defined in IC 314115 and IC 314118. The astronaut interface shall be as defined in IC 314116. The interface with the GSE shall be as defined in IC 314110.

3.2.1.3 Interface Control Drawings (ICD) - The ICD's which contractually define the interface for the ALSEP are as follows:

2332264	Interface Control Drawing Hand Tool Envelope
17 May 1968	
2334552	Interface Bendix/GE Fuel Cask
26 Sept 1967	
2323518	Interface Control Drawing Stowed Envelope
26 April 1968	Magnetometer



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2331500	Interface Control Drawing - Electrical Magnetometer
10 April 1967	Experiment
2323521	Interface Control Drawing - Mechanical -
13 Feb 1967	Suprathermal Ion Detector Exp/CCGE
2323589	Interface Control Drawing - Electrical -
15 Feb 1957	Suprathermal Ion Detector Exp/CCGE.
2323638	Mechanical Interface Control Passive
18 Oct 1967	Seismic Experiment
2331510	Interface Control Drawing - Electrical, Passive
15 Feb 1967	Seismic Experiment
2331514	Interface Control Drawing Central Electronics
13 July 1967	Passive Seismic Experiment
2334515	Overall Electrical Interface Description,
8 June 1967	Passive Seismic Experiment
2323792	Interface Control Drawing, Solar Wind Experiment
1 April 1968	
2331508	Interface Control Drawing, Electrical - Solar Wind
14 April 1967	Experiment
LID 360-22809	RTG Fuel Cask Mounting Interface
not dated	
LID 360-22811	LM/ALSEP Structural Interface (SEQ)
Rev. B	

3.2.2 Subsystem interface requirements

3.2.2.1 Electrical power subsystem interface definition -

In transit and when deployed on the lunar surface the RTG shall be mounted on a multipurpose pallet. The PCU shall be located within the central station electronics compartment and will be electrically interconnected to the RTG at the deployment site. Thermal control of the PCU shall be provided by the central station. The interface between the CFE and GFE items of the electrical power subsystem is defined by IC314119.



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3.2.2.1.1 Mechanical Interface - The fuel cask shall be mounted between LM and the SLA as defined by IC314121. It shall be vertically oriented with the top and bottom of the cask barrel attached to a special mounted frame which in turn is fastened to LM. Means shall be provided to protect the astronaut from the hot cask during ALSEP unloading. Means shall also be provided for rotating the cask to permit direct access to the fuel capsule for transfer to the RTG. The RTG fuel cask shall be mounted to the LM Descent Stage.

3.2.2.1.2 Thermal Interface - The RTG fuel cask induced thermal conditions on LM shall be in accordance with the requirements defined in paragraph 3.1.1.3 herein.

3.2.2.1.3 Electrical Interface - The interface between the electrical power subsystem and the data subsystem shall be at the output of the PCU. Facilities shall be provided at this interface for transmission of:

- (a) 14 items of engineering status information for which the signal conditioning is performed in the data subsystem.
- (b) 6 sources of power and a return, as follows:

Nominal	Tolerance Limits
+29 V DC	+28.59 to +29.40 V DC
+15 V DC	+14.80 to +15.30 V DC
+12 V DC	+11.85 to +12.10 V DC
+ 5 V DC	+ 4.85 to + 5.25 V DC
- 6 V DC	- 5.85 to - 6.15 V DC
-12 V DC	-11.80 to -12.40 V DC

- (c) 2 commands for "PCU #1 SELECT" and "PCU #2 SELECT".

3.2.2.1.4 RTG/PCU Interface - The interface between the RTG and PCU shall be at the connector between the RTG cable and Subpackage #1. The RTG output power to the PCU shall be no less than 63 watts and no more than 74 watts at 16 vdc.

3.2.2.2 Data Subsystem Interfaces

3.2.2.2.1 Mechanical Interface - The data subsystem electronics shall mechanically interface only with the thermal plate, which in turn interfaces with the structure system.

3.2.2.2.2 Electrical Interface - The data subsystem in providing the facilities for coordinating the flow of power and data throughout the system, shall interface electrically with the power subsystem and the various experiments in accordance with the following requirements.



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3.2.2.2.2.1 Electrical Power Subsystem Interface - The data subsystem shall accept from the power subsystem the power lines and measurement data defined in 3.2.2.1.3.

3.2.2.2.2.2 Experiment Interface - All circuitry shall be set to initial safe condition prior to initial activation on the lunar surface. The data subsystem shall supply to each experiment primary power as well as command, control and timing signals and shall accept analog and digital data for processing. The digital and analog data signals received from the experiments shall be suitably processed for RF transmission. The characteristics of the power, digital, analog, command, and control signals shall be as specified below.

3.2.2.2.2.2.1 Experiment Power - Power available at the Central Station experiment connector for each experiment shall be individually controlled by ground command to provide either: (a) operational power or (b) thermal survival power at 29 VDC nominal. Power circuit protection shall be provided for each experiment as specified in paragraph 3.3.1.6.

3.2.2.2.2.2.2 Control, Timing and Data Signals - Experiments shall be provided synchronizing pulses to coordinate their operation and the flow of data throughout the system. Additional pulses representing specific operational commands shall also be provided. All digital signals between ALSEP subsystems shall have the following common characteristics:

- Amplitude of "ON" state:  $+4.0 \pm 1.5$  volts
- Amplitude of "OFF" state:  $+0.2 \pm 0.2$  volts

The characteristics of these control, timing and data signals shall be as specified below:

A. Frame mark pulse

The leading edge of the frame mark pulse shall designate the start of the basic ALSEP frame of telemetry data. The pulse shall have a nominal "ON" duration of 118 microseconds and shall be available to all experiments except Solar Wind. In addition to this pulse, a signal having the same electrical characteristics, but designating



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only the even data frames shall be supplied to the Passive Seismic and Suprathermal Ion Detector experiments.

B. Data clock pulse

This shall be a repetitive square wave pulse of 50% duty cycle which is used to synchronize the data bit rate from each experiment. The frequency of this pulse shall be programmed by command pulses to correspond with stated system operating modes as follows:

<u>System Operating Mode</u>	<u>Data Clock Pulse Frequency</u>
Slow Data Rate	530 bps
Normal Data Rate	1,060 bps

C. Demand Pulse

A pulse whose leading edge represents a demand for read-out of a 10-bit data word from the experiment to the data subsystem, shall be provided. The demand pulse "ON" state has nominal duration of 0.01 second.

D. Data Pulses

Data pulses shall have the same characteristics as data clock pulses. When ALSEP is operating in either of the two modes listed in B above, a data word shall consist of a series of 10 data pulses, most significant bit first, having a frequency corresponding to the relevant data clock pulse frequency: sixty-four of these words shall comprise a basic ALSEP data frame (See A above).



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E. Command Pulses

Special lines shall be provided for pulses representative of operational commands. A command is signaled by an "OFF" state for a nominal duration of 20 milliseconds on one of these lines.

3.2.2.2.2.3 Analog Signals - The data subsystem shall provide facilities for accepting from certain experiments analog data signals having amplitudes from 0.0 to 5.0 volts and for converting these sequentially into equivalent 8-bit digital signals suitable for transmission with the other digital data.

3.2.2.2.3 Data Subsystem/Structure/Thermal Subsystem Interface. - The Data Subsystem shall provide for monitoring up to 28 temperature status measurements from the Central Station, exclusive of PCU.

The Data Subsystem shall provide switching for the following:

- (a) a 10-watt thermostatically controlled heater consisting of resistors mounted on the thermal plate. Provision shall be made to inhibit this heater by ground command.
- (b) a heater which dissipates approximately the same as either transmitter and which is located in the same general location as the transmitters. This heater shall be automatically energized at any time both transmitters are off.
- (c) a heater which dissipates approximately the same as the command receiver and which is located in the same general location as the receiver. This heater shall be automatically energized should the receiver power protection circuit open.
- (d) a 10-watt heater and a 5-watt heater, each to consist of resistors mounted on the thermal plate. These heaters shall be controlled by ground command.

3.2.2.3 Magnetometer Experiment Interfaces. - The external interfaces of the Magnetometer Experiment are defined by IC314103.

3.2.2.4 Suprathermal Ion Detector Experiment Interfaces. - The external interfaces of the Suprathermal Ion Detector Experiment are defined by IC314105.

3.2.2.5 Passive Seismic Experiment Interfaces. - The external interfaces of the Passive Seismic Experiment are defined by IC314106.

3.2.2.6 Solar Wind Experiment Interfaces. - The external interfaces of the Solar Wind Experiment are defined by IC314104.

3.2.2.7 ALHT Interface. - The external interface of the ALHT are defined by IC314114.



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3.3 Design and Construction.

3.3.1 General Design Features.

3.3.1.1 Volume. - The mounting provisions and envelope dimensions of the equipment to be stowed in the LM descent stage are shown in LID 360-22811.

3.3.1.2 Weight. - ALSEP shall weigh no more than 289 pounds including the LGE subsystem. The packaging of ALSEP shall be designed so that the weight in each of the LM descent stage scientific equipment compartments shall be between 75 and 122 pounds.

3.3.1.3 C.G. Location. - The center of gravity of each of the two subpackages shall be within a sphere of 5 inch radius for compartment weights of less than 105 pounds, of 3.75 inch radius for compartment weights of 115 pounds or greater, and of proportional radius for intermediate weights with center located in ALSEP coordinates at  $X_A = 10.985$ ,  $Y_A = 12.445$ ,  $Z_A = 12.045$ .

3.3.1.4 Form Factor. - LID 360-22811 defines the form factor of the compartments in the SEQ Bay.

3.3.1.5 Factors of Safety. - The following guidelines shall be used for factors of safety:

- (a) Tie-down bracketry, safety factor of 3.0 with respect to ultimate.
- (b) Tie-down pins and bolts, safety factor of 3.0 with respect to ultimate.
- (c) Structure and parts, safety factor of 1.5 with respect to ultimate, 1.1 yield.

3.3.1.6 Power Circuit Protection. - Power circuit protection shall be provided to ensure operation of the ALSEP data subsystem and all remaining experiment subsystems if a failure occurs within any experiment subsystem. In addition, circuit protection shall be provided to prevent subsystem damage during periods of severe power overloads which reduce the operating voltages. Control of power through the command link shall be provided.

3.3.1.6.1 Ripple-Off Delay. - The data subsystem shall provide a means for permitting turn on of experiments with turn-on transient of a duration of up to 120 milliseconds and a peak power transient of up to 13 watts.



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3.3.1.7 Voltage polarity reversal. - The equipment design shall eliminate the possibilities of subsystems being damaged by a reversal of primary voltage polarity. The requirements of DS-13 shall apply.

3.3.1.8 Power distribution. - ALSEP power distribution voltage below the nominal operating voltage shall not damage any ALSEP equipment.

3.3.1.9 Test equipment. - Test equipment shall be designed so that failure within the equipment or interruption of power will not cause failure or damage to the equipment being tested, and failure of the equipment being tested will not cause failure or damage to the test equipment.

3.3.1.10 Mechanical locks. - All handling devices utilized for ALSEP flight equipment shall have positive mechanical locking provisions to prevent accidental release of the equipment.

3.3.1.11 Mechanical rigging devices. - The requirements of DS-8 shall apply.

3.3.1.12 Moisture damage. - The requirements of PS-5 shall apply.

3.3.2 Selection of Specifications and standards. - Standard processes used during equipment fabrication shall conform or be equivalent to applicable Government standards. The order of precedence for selection of specifications and standards shall conform to MIL-STD-143; however, the contractor may submit in-house fabrication specifications for NASA approval. Contractor submitted in-house fabrication controls or specifications should be as encompassing as the most commonly used Government specifications and standards referenced in paragraph 3.3.3.

3.3.3 Materials, parts, and processes. - Materials, parts, and processes shall be in accordance with ATM241 and ATM242, shall be compatible with the intended use, and shall be compatible with the environment requirements specified in 3.1.2.4 herein



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3.3.3.1 Materials. - Materials used in the fabrication of all components shall be of the highest quality compatible with design requirements specified herein. In general, the following types of material shall not be used without prior written approval of NASA:

- (a) Flammable materials
- (b) Toxic materials
- (c) Unstable materials
- (d) Plastic - (only epoxy resin-based compounds, teflon, and mylar shall be used).
- (e) Dissimilar metals in direct contact which tend toward active electrolytic or galvanic corrosion.

3.3.3.2 Protective treatment. - All materials used which are not inherently corrosive-resistant shall be treated to resist any corrosive effects resulting from environmental conditions specified herein. Protective coatings shall not crack, chip, peel, or scale with age when subjected to the environmental extremes specified. Finishing, coating, and marking materials shall conform to ICD LIS-360-22101.

3.3.3.3 Soldering. - NPC 200-4 shall apply for hand soldering of all electrical connections.

3.3.3.4 Welding. - Resistance welding (spot and seam) shall conform to MIL-W-6858.

3.3.3.5 Ultrasonic cleaning. - The requirements of PS-6 shall apply.

3.3.4 Standard Mechanical parts - - NASA standard parts, Air Force-Navy (AN) or Military Standards (MS) or Joint Air Force-Navy (JAN) shall be used where applicable.

3.3.4.1 Standardization. - Maximum economic standardization of parts and components shall be provided. Where identical or similar functions are performed in more than one application within the system, effort shall be made to use only one item design for all system applications.



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3.3.4.2 Electrical Connectors. - Where applicable, electrical connectors shall conform to LSP 390-8. Document PS-10 shall apply.

3.3.4.3 Parts procurement. - The requirements of PS-8 and PS-11 shall apply.

3.3.4.4 Transistors. - The requirements of DS-5 shall apply.

3.3.5 Moisture and Fungus Resistance. - Materials which are not nutrients for fungus shall be used whenever possible. The use of materials which are nutrients for fungus shall not be prohibited in hermetically sealed assemblies and in other accepted and qualified uses such as paper capacitors and treated transformers. If it is necessary to use fungus nutrient materials in other than such qualified application, these materials shall be treated with a process which will render the resulting exposed surface fungus resistant.

3.3.6 Corrosion of Metal parts. - Metals shall be corrosion-resistant type or suitably treated to resist corrosive conditions likely to be met in storage or normal service. Unless suitably protected against electrolytic corrosion, dissimilar metals, as defined in MS 33586, shall not be used in direct physical contact.

3.3.7 Interchangeability and Replaceability. - Interchangeability and replaceability shall be compatible with the requirements of paragraph 3.1.2.2 herein. Items of equipment with the same part numbers shall be physically and functionally interchangeable.

3.3.8 Workmanship. - The ALSEP shall be constructed, finished, and assembled in accordance with highest standards.

3.3.9 Electromagnetic interference (EMI).

3.3.9.1 Operation. - Electrical and electronic equipment shall perform as specified herein when operating either independently or in conjunction with other equipment with which there are electrical connections, or which may be installed nearby. This requires that the operation of such equipment shall not be adversely affected by interference voltages and fields reaching it from external sources and also requires that such equipment shall not, in itself, be a source of interference which might adversely affect the operation of other equipments. These general criteria ensure that the system will meet the requirements of the overall system acceptance criteria, and electromagnetic compatibility as specified in the performance specifications. In addition to these general requirements, the system shall satisfy the requirements of paragraph 3.1.2.4 and Specification AL770000.



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3.3.9.2 Transient interference. - Transient or short duration interference resulting from the operation of electrical or electro-mechanical devices shall not compromise the performance requirements as specified herein.

3.3.9.3 Interference-free design. - Interference control shall be considered in the basic design of all subsystem electronic and electrical equipment and specialized equipment such as simulation sources and GSE. The design shall be such that, before interference control components are applied, the amount of interference internally generated and propagated shall be the minimum achievable. The application of interference control components (e.g., filtering, shielding, bonding) shall conform to good engineering practice and, wherever practical, shall be an integral part of the subsystem or component.

3.3.9.4 Power and signal grounding - The signal return, power return, and chassis grounds for each experiment shall each be furnished separately and shall be isolated from each other by no less than one megohm. Signal returns and power returns within data and power subsystems shall be separated and isolated where possible. These return paths shall be interconnected only at the common system ground located in the data subsystem. The absence of deleterious ground-loops shall be determined at the system test level.

3.3.9.5 Filtering. - Filters shall be provided at each component or subsystem, as required, to prevent internally generated electrical interference signals from being conducted out of the component or subsystem.

3.3.9.6 Conductor shielding. - Shielding, as necessary, shall be grounded to the basic structure or chassis at one or both ends as required for each continuous length of shielded wire except for coaxial cables. A coaxial cable being employed as an r. f. transmission line shall use the outer conductor for signal return and shall have both ends of the outer conductor connector-grounded.

3.3.10 Identification and marking. - The ALSEP shall be marked for identification in accordance with MIL-STD-130. The nameplate shall conform to Standard MS 24123. Explosive devices shall be marked in accordance with the requirements of PS-21. Identification and marking shall not alter thermal properties.



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3.3.10.1 Nameplate Data. - The nameplate shall include but not be limited to the following data:

- (a) Item nomenclature
- (b) Item part number
- (c) Item serial number

3.3.11 Storage. - The ALSEP shall have a shelf life of 2 years. Shelf life is defined as a storage period in a controlled environment of 50°F to 80°F and a relative humidity of no more than 50 per cent following acceptance and prior to installation in the LM for flight. Storage shall ensure protection from dust and grease. PS-2 shall apply.

3.4 Requirements of Sub-Areas. - Deployable dust covers shall be included in the design of all particle experiment. Designs of all CFE experiments shall permit them to be leveled on the lunar surface within  $\pm 5^\circ$  of true horizontal.

Test connections shall be provided as necessary for each experiment to permit functional testing of the experiment independent of the flight system cable connectors.

3.4.1 Electrical Power Subsystem. -

3.4.1.1 Composition. - The electrical power subsystem shall consist of the following components:

(a) GFE Components:

- (1) Unfueled generator - a SNAP 27 type of RTG
- (2) RTG fuel capsule assembly - an encapsulated radioisotopic heat source or fuel.
- (3) Graphite lunar fuel cask - a container for the fuel capsule assembly during translunar flight.
- (4) Cable - from RTG to Central Station
- (5) Fuel capsule flight handling tool.



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- (b) CFE Components
- (1) PCU
  - (2) Fuel cask mounting and protection device
  - (3) Cask dome and removal tool
  - (4) Cable storage reel
  - (5) Cable connector/plug/shorting switch

3.4.1.1 Electrical Design Criteria. - The PCU shall control the generator by holding the output voltage at a nominal value of 16 volts. The RTG/PCU shall provide at the PCU output connector the conditioned DC power specified in paragraph 3.2.2.1.3 having the following characteristics:

Ripple: Less than 200 millivolts, peak to peak, on all output voltages.

Transient

Response: The nominal voltage output to the experiments shall be maintained with a rate of change of load current of 0.25 ampere/millisecond. For a change greater than 0.25 ampere/millisecond, the output voltage to the experiments shall remain between 28.0 and 30.0 volts and recover the nominal value within 50 milliseconds.



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3.4.1.2 Weight. - The weight of the subsystem shall be no more than 94.36 pounds apportioned as follows:

GFE: 68.17 pounds  
CFE: 26.19 pounds

3.4.1.3 Performance Monitoring Sensors. - The electrical power subsystem shall provide the sensors and transducers for the measurement of RTG temperatures. These sensors shall be integral with the GFE RTG. The output of these sensors shall be compatible with the analog data circuits in the data subsystem.

3.4.2 Data Subsystem. - The data subsystem consists of the following components: antenna, including aiming mechanism, diplexer and switch, command receiver, command decoder, data processor, transmitters, and power distribution and signal conditioning unit. The data subsystem shall receive, decode, and distribute commands from the MSFN to the deployed units of the ALSEP. It shall also accept and process experimental data and status information from the ALSEP experiments and system status information from the thermal, data, and power subsystems. This information shall be processed into a digital telemetry format and transmitted back to the earth as an S-band signal.

3.4.2.1 Operational Characteristics. - The data subsystem shall be capable of simultaneous reception of commands and the transmission of data.

The data subsystem shall accept experiment data and engineering status data from the subsystems. These data shall be conditioned, processed, formatted as necessary and transmitted to earth. The transmitted carrier shall be phase modulated in a manner that requires minimum modification to the MSNF. The data subsystem shall also receive commands from earth. These shall be processed and distributed to the proper ALSEP subsystem or component.

The acceptance of a false command shall not create a crew safety hazard. The antenna design shall be such that the astronaut can point and align the antenna in the correct direction from a standing position. A selected code word shall be used at start of the subcommutation sequence.



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The data subsystem shall generate a bit stream which uniquely identifies the specific ALSEP System. The data subsystem shall provide means to verify via the bit stream that a command has been received and properly decoded.

3.4.2.1.1 Reception. - The data subsystem shall receive transmission from earth MSFN sites on a frequency of  $2119 \text{ MHz} \pm .001$  percent using a 10-KW transmitter, a 30-foot diameter antenna, and a deviation of  $\pm 3$  radians ( $+0.3$ ,  $-0$  radians). The command formatting shall minimize required modifications to existing command facilities of the MSFN. The data subsystem shall provide a capability to decode and distribute no less than 100 discrete logic commands to the proper subsystems.

3.4.2.1.2 Transmission. - The data subsystem shall accept from the experiments and transmit digital data signals. The transmitted data shall be split-phase modulated. The carrier frequency shall be pre-set to frequencies of 2276.5 MHz. Absence of data from any experiment, for any reason, shall not compromise the ability of the subsystem to transmit the remaining data. The ALSEP signal shall be received at MSFN using a 30-foot diameter antenna.

3.4.2.1.3 Modes of Operation. - The data subsystem shall be capable of operating in separate modes as defined by Table II.

3.4.2.1.4 Synchronization. - The telemetry format shall contain 30 bits for synchronization and identification purposes.

TABLE II  
DATA SUBSYSTEM MODES OF OPERATION

Mode	Frame Time	Experimental Data and Status Information	Mode Activation/Deactivation
Normal	32/53 Sec.	1060 bits per second	Command/command
Slow	64/53 Sec.	530 bits per second	Command/command



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3.4.2.1.5 Power distribution. - the data subsystem shall accept power as described in paragraph 3.2.2.1.3 from the electrical power subsystem and switch the 29-volt power lines ON and OFF to the users by command from the earth.

3.4.2.1.5.1 Overload protection. - Overload protection shall be provided in the +29-volt power lead to each experiment as specified in paragraph 3.3.1.6 herein.

3.4.2.1.6 Redundancy. - Redundancy shall be employed within the data subsystem to ensure its operation for the required useful life. The techniques employed shall range from duplication of a component to providing back-up of critical signal paths within a component.

3.4.2.2 Data subsystem design and construction. -

3.4.2.2.1 Weight. - The weight of the data subsystem including cabling and thermal container shall be no more than 25.00 pounds.

3.4.2.2.2 Power. - The data subsystem shall require no more than 25.0 watts.

3.4.3 Structure/thermal subsystem. -

3.4.3.1 Composition. - The structure/thermal subsystem shall consist of the following:

- (a) Pallet supporting the RTG, ALHT, and SIDE/CCGE.
- (b) A shield to protect the RTG during lunar transportation
- (c) Supporting framework around and under the data subsystem electronics
- (d) Upper structure which serves as a thermal sunshade for the central station when deployed, and as a support for the experiments when stowed; experiment tie down fittings are included
- (e) Dust detector installed on the upper structure
- (f) LM mounting structure to support RTG fuel cask
- (g) ALSEP deployment and handling tools.



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The structure/thermal subsystem shall provide support and shock and vibration isolation, as necessary, for the supported equipment. Each individual deployed subsystem within the ALSEP shall provide its own thermal control and where electrical power is required to effect thermal control, that power shall be included within the power allocation for the subsystem.

3.4.3.2 Operational characteristics. - The data subsystem, PCU and where practical all of the experiments shall be mounted on one of the two mounting structures, fitted and secured as a single package in one compartment. The RTG, other experiments, and the ALHT shall be similarly mounted, fitted, and secured in the other compartment. The inner surface of the sunshade shall have an emissivity of no more than 0.05. The outer surface shall have an  $\epsilon$  ratio of no more than 0.22 at the time of lunar deployment.

3.4.3.3 Weight. - The weight of the structure/thermal subsystem shall be no more than 67.00 pounds.

3.4.4 Magnetometer experiment. - The GFE magnetometer experiment subsystem is defined by IC 314103.

3.4.5 Suprathemal ion detector experiment. - The GFE suprathemal ion detector experiment subsystem is defined by IC 314105.

3.4.6 Solar Wind Experiment. - The GFE solar wind experiment subsystem is defined by IC 314104.

3.4.7 Passive seismic experiment. - The requirements for the passive seismic experiment shall be as specified in AL270000 and IC 314106.

3.4.8 ALHT (Apollo Lunar Hand Tools) Subsystem. -

3.4.8.1 Tool Carrier. - The tool carrier shall be removable from LM in two modes: as a separate unit and as an integral part of ALSEP. The tool carrier shall be capable of maintaining the integrity of the tools, and shall facilitate use by the astronaut in performing the geological traverse subsequent to removal from LM. Provisions shall be made to carry all of the tools listed below, any subset, or combination of tools on the tool carrier.



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ALHT (SEB-39101165)

Hand Tool Carrier (SEB-39100647)

Sample Carrying Bag

Color Chart

Staff W/Camera Mount (SEB-39100370)

Surveying Instrument (SEB-39101200)

Instrument Guard

Scriber/Brush/Hand Lens (SEB-39100406)

Gnomon (SEB-39100317)

Scoop(small) (SEB-39100310)

3.4.8.1.1 Design and Construction. - The tool carrier shall be designed for efficient stowage in ALSEP. This subsystem shall be constructed in such a manner that the flight crew can remove it from ALSEP, before or after extraction of ALSEP from LM and perform the requisite operations.

3.4.8.1.2 Size and Form Factor. - The tool carrier shall have dimensions of no more than 6 inches by 17 inches by 19 inches with a supporting leg at right angles at one end having dimensions of no more than 1 inch by 19 inches by 12 inches.



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#### 4.0 QUALITY ASSURANCE PROVISIONS

The quality control provisions shall be in accordance with NPC 200-2 as amended by Exhibit A, Appendix I, NAS 9-5829.

4.1 Compliance. - Compliance with the requirements of Section 3.0 shall be by inspection, demonstration, test and analysis and those items to be determined by test shall be:

<u>Requirement</u>	<u>Requirement Paragraphs</u>	<u>Compliance Paragraphs</u>
Translunar flight	3.1.1.3	4.2.14, 4.2.15
Environment	3.1.2.4	4.2.3, 4.2.14, 4.2.15, 4.2.16, 4.2.18, 4.2.19, 4.2.20
Electromagnetic Interference	3.3.9	4.2.2
Performance	Applicable subparagraphs of 3.2.2 and 3.4	4.2.1, 4.2.4, 4.2.5, 4.2.6, 4.2.7, 4.2.8, 4.2.9, 4.2.10, 4.2.11, 4.2.12, 4.2.13, 4.2.17

4.2 Test/Verification. - The performance capability of the ALSEP design shall be verified by following the procedures identified in the following subparagraphs. Unless otherwise specified, the sequence of tests shall be as described in ATM-785.

4.2.1 Crosstalk. - Verify that each of the ALSEP subsystem command-data links operates without interference from or to other subsystem command-data links by performing procedure 2333032.

4.2.2 EMI. - Verify that the ALSEP is not susceptible to interference from other systems and that it will not interfere with other systems by performing procedure 2333087.

4.2.3 Thermal-Vacuum. - Verify that in the integrated ALSEP system each subsystem operates properly with all other subsystems under lunar environmental conditions by performing procedure 2333032 in conjunction with procedure 2338179 and with procedure 2334389.



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4.2.4 Power Dissipation. - Test to determine the power consumption of the ALSEP central station and to calibrate current and voltage sensors under various load conditions by performing procedure 2337925.

4.2.5 Experiment Reaction. - Verify that each experiment reacts appropriately to commands introduced into the ALSEP central station by performing procedure 2333034, Paragraphs 6.5, 6.6, 6.7, 6.8, 6.9, and 6.14.

4.2.6 Data Transmission. - Verify that data generated within the experiments are transmitted properly through the ALSEP central station by performing procedure 2333034 Paragraphs 6.5, 6.6, 6.7, 6.8, 6.9, and 6.14.

4.2.7 Antenna Performance. - Verify that command and telemetry data may be received by or transmitted from the ALSEP central station through the antenna cable and the ALSEP antenna by performing procedure 2333034 Paragraph 6.11.

4.2.8 Ripple-Off. - Verify that the ripple-off circuitry will function properly under the variety of experiment power consumption and reserve power conditions available for this ALSEP configuration by performing procedure 2333034 Paragraph 6.13.

4.2.9 Transmitter Power. - Verify the transmitter power output by performing procedure 2333034 Paragraph 6.5.3.

4.2.10 Transmitter Frequency. - Verify the transmitter output frequency by performing procedure 2333034 Paragraph 6.5.3.

4.2.11 Housekeeping Data. - Verify the housekeeping data by performing procedure 2333034 Paragraph 6.5.3.

4.2.12 Data Rates. - Verify the downlink data rates by performing procedure 2333034 Paragraph 6.5.4.

4.2.13 Astronaut Switches. - Verify the functioning of the Astronaut Experiment Power Switches by performing procedure 2333034 Paragraph 6.5.8.



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4. 2. 14 Vibration, 3 Axis.

4. 2. 14. 1 Subpackage No. 1, Stowed. - Verify that the subpackage will withstand the required vibration levels by performing procedure 2338182

4. 2. 14. 2 Subpackage No. 2, Stowed. - Verify that the subpackage will withstand the required vibration levels by performing procedure 2338181

4. 2. 15 Magnetic Properties - Stowed. - Verify that the magnetic fields associated with each subpackage do not exceed the requirements specified by performing procedure 2333049.

4. 2. 16 Magnetic Properties - Deployed. - Verify that the magnetic fields associated with the deployed ALSEP do not exceed the requirements specified by performing procedure 2338178.

4. 2. 17 Mass Properties.

4. 2. 17. 1 Subpackage No. 1. - Test to determine the weight and c. g. location by performing procedure 2337938.

4. 2. 17. 2 Subpackage No. 2. - Test to determine the weight and c. g. location by performing procedure 2337939.



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5.0 PREPARATION FOR DELIVERY

Requirements for preparation of the produced hardware for delivery and shipment are contained in 5.0 of Part II of this specification.



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CONTRACT END ITEM DETAIL SPECIFICATION  
PART II

PRODUCT CONFIGURATION AND ACCEPTANCE TEST

REQUIREMENTS  
for the

APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE (ALSEP)

SYSTEM



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## 1.0 SCOPE

This specification establishes the requirements for identification and acceptance of Flight Model 2 of the Apollo Lunar Surface Experiments Package (ALSEP) System to be formally accepted by the National Aeronautics and Space Administration.

1.1 Product Configuration Baseline Acceptance. - The product configuration baseline shall be established by FACI of this item.

## 2.0 APPLICABLE DOCUMENTS

The following documents of exact issue shown form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and other detail content of Sections 3, 4, 5 and 10 to follow, the detail contents of Sections 3, 4, 5 and 10 shall be considered a superseding requirement.

### SPECIFICATIONS

#### Military

MIL-D-3464C  
19 November 1963

Desiccants, Activated, Bagged, Packaging  
Use and Static Dehumidification

#### Bendix

AL770000  
19 January 1968

Electromagnetic Interference Control  
Requirements for the ALSEP

IC 314103D  
9 June 1967

Interface Control Specification for  
Magnetometer Experiment Subsystem

IC 314104A  
25 October 1967

Interface Control Specification for  
Solar Wind Experiment Subsystem

IC 314105A  
14 February 1967

Interface Control Specification for  
Suprathermal Ion Detector Experiment

IC 314106B  
8 June 1967

Interface Control Specification for  
Passive Seismic Experiment Subsystem

IC 314115 (1)  
16 June 1967

Interface Control Specification for  
MSFN/ALSEP



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STANDARDS

Military

MIL-STD-129D  
Change Notice 2  
1 July 1965

Marking for Shipment and Storage

DRAWINGS

Bendix

2332914 Rev F

Shipping Container Subpackage No. 1  
Assembly

2332915 Rev F

Shipping Container Subpackage No. 2  
Assembly

2335698

ALSEP System Flight No. 2

BULLETINS

Air Force - Navy Aeronautical

ANA No. 445  
12 July 1963

Engineering Changes to Weapons  
Systems, Equipments, and Facilities

OTHER PUBLICATIONS

NASA

NPC 200-2  
20 April 1962

Quality Program Provisions  
for Space System Contractor

Exhibit A,  
Appendix I  
NAS9-5829  
June 1965

ALSEP Implementation  
Instructions for  
NPC-200-2

Grumman

LED 520-1F  
15 May 1966

Design Criteria and Environment for  
for the LM



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Bendix

2337168	Preservation, Packaging, Handling, Storing, and Shipping Instructions Flight System Hard- ware (Flight Model No. 2)
2337162 1 July 1968	Preservation, Packaging, Handling, Storing, and Shipping Instructions, Flight No. 2, ALSEP Flight Hardware. Fuel Cask and Mounting Structure Part No. 2337960.
2333032 Rev. D	ALSEP Program Thermal Vacuum Integrated System Test Procedure
2333034 Rev. D	ALSEP Program Integrated System Test Procedure for Flight Configurations 1 and 2
2337938 6 April 1968	ALSEP Subpackage No. 1 Assembly Mass Properties Determination
2337939 5 April 1968	ALSEP Subpackage No. 2 Assembly Mass Properties Determination
2333049 16 April 1968	ALSEP Subpackage No. 1 or 2 (Stowed) Magnetic Properties Test
2338178 Rev. A	ALSEP System Stray Field Magnetic Properties Test (Procedure)



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2338192 24 June 1968 2333087 Rev C	Tumble Test of ALSEP Subpackages No. 1 and No. 2 (procedure). EMI Test Procedure for ALSEP System Configuration A
2337925 Rev A April 4, 1968	ALSEP Program Central Station Power Dissipation Test Procedure
2338181 24 May 1968	ALSEP Program Sub-Package No. 1 Assembly Vibration Acceptance Test (Procedure)
2338182 24 May 1968	ALSEP Program Sub-Package No. 2 Assembly Vibration Acceptance Test (Procedure)
2338179 13 June 1968	ALSEP Deployed System Thermal Vacuum Test Procedure
MP 61 7 March 1968	Application of Z-93 Thermal Coating
MP 64 6 November 1967	Application of S-13G Thermal Coating
MP 71 25 January 1968	Application of 3M 400 Series Coating
MI8 20 June 1968	Cleansing of Aluminized Surfaces

(Copies of specifications, standards, drawings, bulletins, and publications required for suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

### 3.0 REQUIREMENTS

#### 3.1 Performance

3.1.1 Weight - Subpackage No. 1 weight shall be 75 to 122 pounds. Subpackage No. 2 weight shall be 75 to 102 pounds. The cask mount weight shall not be greater than 19.6 pounds.

3.1.2 C.G. Location - The center of gravity of each of the two subpackages shall be within a sphere of 5 inch radius for compartment weights of less than 105 pounds, of 3.75 inch radius for compartment weights of 115 pounds or greater, and of proportional radius for intermediate weights, with center located in ALSEP coordinates, at  $X_A = 10.985$ ,  $Y_A = 12.445$ ,  $Z_A = 12.045$ .



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3.1.3 Vibration - The ALSEP shall be capable of performing properly after having been subjected to vibration levels stated as follows:

a. Earth Launch and Boost Phases, Random Vibration

X Axis (Subpackage No. 1 only)

10 - 200 cps	3 db/octave roll-up (from $G^2 = .00089$ )
200 - 400 cps	$0.018 G^2$ /cps level
400 - 600 cps	3 db/octave roll-off
600 - 1300 cps	$0.012 G^2$ /cps level
1300 - 2000 cps	9 db/octave roll-off

Y Axis (Subpackage No. 1 and 2)

10 - 200 cps	3 db/octave roll-up (from $G^2 = .0003$ )
200 - 1500 cps	$0.006 G^2$ /cps level
1500 - 2000 cps	9 db/octave roll-off

Z Axis (Subpackage No. 1 and 2)

10 - 100 cps	6 db/octave roll-up (from $G^2 = .000054$ )
100 - 800 cps	$0.006 G^2$ /cps level
800 - 1000 cps	9 db/octave roll-up
1000 - 1600 cps	$0.012 G^2$ /cps level
1600 - 2000 cps	9 db/octave roll-off

X Axis (Subpackage No. 2 only)

10 - 155 cps	3 db/octave roll-up (from $G^2 = .001$ )
155 - 200 cps	21 db/octave roll-up
200 - 230 cps	$0.077 G^2$ /cps level
230 - 280 cps	21 db/octave roll-off
280 - 400 cps	$0.018 G^2$ /cps level
400 - 600 cps	3 db/octave roll-off
600 - 1300 cps	$0.012 G^2$ /cps level
1300 - 2000 cps	9 db/octave roll-off

Note: Each axis to be run at least 2.5 minutes.



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b. Lunar Descent, Random Vibration

X Axis, Y Axis, Z Axis (Subpackages No. 1 and 2)

10 - 20 cps	12 db/octave roll-up (from $G^2 = .00041$ )
20 - 100 cps	0.006 $G^2$ /cps level
100 - 120 cps	12 db/octave roll-off
120 - 2000 cps	0.003 $G^2$ /cps level

Note: Each axis to be run at least 12.5 minutes.

c. Launch and Boost and Lunar Descent, Sinusoidal

X, Y, Z Axis (Subpackages No. 1 and 2)

5 - 12 cps	0.154 inch D.A.
12 - 100 cps	1.16 G peak

Sweep rate = 3/4 octave/minute

One total sweep required (0-100 cps)

d. RTG Cask, Earth Launch and Boost Phase Random Vibration

X Axis, Y Axis, Z Axis

20 - 100 cps	9 db/octave roll-up (from $G^2 = .00085$ )
100 - 500 cps	0.089 $G^2$ /cps level
500 - 2000 cps	6 db/octave roll-off

Note: Each axis to be run at least 2.5 minutes.

e. RTG Cask, Earth Launch and Boost Sinusoidal

X Axis, Y Axis, Z Axis

5 - 17.5 cps	0.154 inch D.A.
17.5 - 100 cps	2.3 G

Sweep rate = 3 octaves/minute

One total sweep required (0-100 cps)



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f. RTG Cask, Lunar Descent, Random Vibration

X Axis, Y Axis, Z Axis

10 - 20 cps	12 db/octave roll-up (from $G^2 = .00041$ )
20 - 100 cps	$0.006 G^2$ /cps level
100 - 120 cps	12 db/octave roll-off
120-2000 cps	$0.003 G^2$ /cps level

Note: Each axis to be run at least 12.5 minutes.

g. RTG Cask, Lunar Descent, Sinusoidal

X Axis, Y Axis, Z Axis

5 - 30 cps	0.023 inch D.A.
30 - 100 cps	1.1 G

Sweep rate = 1 octave/minute

One total sweep required (0-100 cps)

3.1.4 Thermal-Vacuum - The ALSEP shall be capable of performing properly while under environmental conditions of temperature and pressure simulating those existing on the lunar surface as defined in LED 520-1.

3.1.5 Magnetic Properties - The ALSEP central station and each experiment shall have a magnetic permanence of not more than 10γ in any axis and a magnetic remanence of not more than 50γ in any axis after having been subjected to a magnetic field of 25 gauss. All of these fields shall be measured at 10 feet from the item under test.

3.1.6 Power - The ALSEP shall be capable of proper operation under the variety of subsystem operating modes which have been identified for this configuration and when supplied with at least 68 watts at 16 vdc.

3.1.7 Experiment Performance - Each experiment shall respond properly to commands and shall generate scientific data and housekeeping data as required by the individual experiment interface specifications IC 314103, IC 314104, IC 314105 and IC 314106.



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3.1.8 Astronaut Switches. - The ALSEP switches provided for astronaut use shall perform their intended function as stated herein.

3.1.8.1 Switch No. 1 - This switch shall override the power hold-off circuit in the PCU. The hold-off circuit shall prevent operational power from being applied to the data subsystem and experiments until the RTG reaches adequate power level.

3.1.8.2 Switches No. 2 and No. 3 - These switches are to provide contingency capability in event of data subsystem failure. Switch No. 2 shall manually select data processor Y, turn on transmitter B and reset the receiver circuit breaker. Switch No. 3 shall switch each of the four experiments to operate.

3.1.9 Data Rates. - The downlink data rates shall be  $1060 \pm 0.01\%$  bits per second (nominal data rate) and  $530 \pm 0.05\%$  bits per second (slow data rate).

3.1.10 Data Transmission. - The digital and analog data signal received from the experiments shall be suitably processed for RF transmission as specified in IC314115.

3.1.11 Transmitter Power. - The power output from the ALSEP transmitter shall be 1.0 watt minimum measured at the transmitter output connector.

3.1.12 Transmitter Frequency. - The transmitter output frequency shall be 2276.5 MHz. The frequency accuracy and stability shall be better than  $\pm 0.0025$  percent per year under all operating conditions.

3.1.13 Crosstalk - Each ALSEP subsystem command-data link shall operate as specified in paragraph 3.1.7 without interfering with the operation of any other ALSEP subsystem command-data link.

3.1.14 EMI - The ALSEP shall conform to the requirements of Paragraph 1.4 of AL770000.

3.2 Product Configuration

3.2.1 Manufacturing Drawings. - The configuration of this contract end item shall be in accordance with Bendix Drawing No. 2335698 and with the drawings, engineering data, and procedures assembled thereunder.



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3.2.2 Government-Furnished Property List - The following items of GFP are specified for incorporation into the CEI during the manufacturing process and are included on the drawings assembled under Bendix Drawing No. 2335698

Item	Part Number
Lunar Surface Magnetometer	2330657 (Bendix)
IPU	47E300779 (G. E.)
Solar Wind Spectrometer	2330658 (Bendix)
Suprathermal Ion Detector	2330660 (Bendix)
Tool Carrier Set (ALHT)	SGB39101165 (NASA-MSD)
Tool	47E300452 (G. E.)

3.2.3 Standards of Manufacturing, Manufacturing Processes and Production - The standards and procedures required for the ALSEP are identified in manufacturing drawings as stated in Paragraph 3.2.1.

#### 4.0 QUALITY ASSURANCE

The quality control provisions shall be in accordance with NPC 200-2 as amended by Exhibit A, Appendix I, NAS 9-5829. The contractor responsible for the manufacture of this CEI is responsible for accomplishment of each test/verification required herein. The tests shall be performed at the place of manufacture.

##### 4.1 Product Performance and Configuration Requirements/ Quality Verification Cross Reference Index

Requirement Paragraph	Verification Paragraph
3.1.1 Weight	4.2.17 Mass Properties
3.1.2 C.G. Location	4.2.17 Mass Properties
3.1.3 Vibration	4.2.14 Vibration, 3 Axis
3.1.4 Thermal Vacuum	4.2.4 Thermal Vacuum
3.1.5 Magnetic Properties	4.2.15 Magnetic Properties - Stowed 4.2.16 Magnetic Properties - Deployed
3.1.6 Power	4.2.5 Power Dissipation 4.2.9 Ripple-Off
3.1.7 Experiment Performance	4.2.6 Experiment Reaction 4.2.11 Housekeeping Data



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3.1.8 Astronaut Switches

4.2.13 Astronaut Switches

3.1.9 Data Rates

4.2.12 Data Rates

3.1.10 Data Transmission

4.2.7 Data Transmission

4.2.8 Antenna Performance

3.1.11 Transmitter Power

4.2.10 Transmitter Power

3.1.12 Transmitter Frequency

4.2.11 Transmitter Frequency

3.1.13 Crosstalk

4.2.2 Crosstalk

3.1.14 EMI

4.2.3 EMI

4.2 Test/Verifications

4.2.1 Drawing compliance - Verification that the ALSEP has been fabricated and assembled to conform to Drawing 2335698 shall be accomplished by inspection at the time and place of acceptance. Drawing requirements which cannot be verified by inspection of the fully-assembled ALSEP shall be verified by reference to certified in-process production or inspection records. Freedom from any loose electrical and mechanical connections and from loose parts and material shall be demonstrated by performing procedure 2338192.

4.2.2 Crosstalk - Verify that each of the ALSEP subsystem command-data links operates without interference from or to other subsystem command-data links as a part of the thermal vacuum test, paragraph 4.2.4.

4.2.3 EMI - Verify that the ALSEP is not susceptible to interference from other systems and that it will not interfere with other systems by performing procedure 2333087.

4.2.4 Thermal-Vacuum - Verify that, in the integrated ALSEP system, each subsystem operates properly with all other subsystems under lunar environmental conditions by performing procedure 2333032 in conjunction with procedure 2338179.

4.2.5 Power Dissipation - Test to determine the power consumption of the ALSEP central station and to calibrate current and voltage sensors, associated with power, under various load conditions by performing procedure 2337925.

4.2.6 Experiment Reaction - Verify that each experiment reacts appropriately to commands introduced into the ALSEP central station by performing procedure 2333034, Paragraphs 6.5, 6.6, 6.7, 6.8, 6.9, and 6.14.



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4.2.7 Data Transmission - Verify that data generated within the experiments are transmitted properly through the ALSEP central station by performing procedure 2333034 Paragraphs 6.5, 6.6, 6.7, 6.8, 6.9, and 6.14.

4.2.8 Antenna Performance - Verify that command and telemetry data may be received by or transmitted from the ALSEP central station through the antenna cable and the ALSEP antenna by performing procedure 2333034 Paragraph 6.11.

4.2.9 Ripple-Off - Verify that the ripple-off circuitry will function properly under the variety of experiment power consumption and reserve power conditions available for this ALSEP configuration by performing procedure 2333034 Paragraph 6.13.

4.2.10 Transmitter Power - Verify the transmitter power output by performing procedure 2333034 Paragraph 6.5.3.

4.2.11 Transmitter Frequency - Verify the transmitter output frequency by performing procedure 2333034 Paragraph 6.5.3.

4.2.12 Housekeeping Data - Verify the housekeeping data by performing procedure 2333034 Paragraph 6.5.3.

4.2.13 Data Rates - Verify the downlink data rates by performing procedure 2333034 Paragraph 6.5.4.

4.2.14 Astronaut Switches - Verify the functioning of the Astronaut Experiment Power Switches by performing procedure 2333034 Paragraph 6.5.8.

4.2.15 Vibration, 3 Axis

4.2.15.1 Subpackage No. 1, Stowed - Verify that the subpackage will withstand the required vibration levels by performing procedure 2338181.

4.2.15.2 Subpackage No. 2, Stowed - Verify that the subpackage will withstand the required vibration levels by performing procedure 2338182.

4.2.16 Magnetic Properties - Stowed - Verify that the magnetic fields associated with each subpackage do not exceed the requirements specified by performing procedure 2333049.



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4.2.17 Magnetic Properties - Deployed - Verify that the magnetic fields associated with the deployed ALSEP do not exceed the requirements specified by performing procedure 2338178.

4.2.18 Mass Properties

4.2.18.1 Subpackage No. 1 - Test to determine the weight and c.g. location by performing procedure 2337938.

4.2.18.2 Subpackage No. 2 - Test to determine the weight and c.g. location by performing procedure 2337939.

5.0 PREPARATION FOR DELIVERY

5.1 Preservation and Packaging

5.1.1 Cleaning - The ALSEP shall be inspected visually for scratches and discoloration. Surfaces which require refinishing, touch-up or cleaning shall be processed as follows:

5.1.1.1 Z-93 Thermal Coatings - Process per Paragraph 2.8 of MP 61.

5.1.1.2 S-13G Thermal Coatings - Process per Paragraph 2.12 of MP 64.

5.1.1.3 400 Series Coating - Process per Paragraph 2.11 of MP 71.

5.1.1.4 Aluminized Surfaces - Process per MI8.

5.1.2 Drying - As required by Subparagraphs of 5.1.1.

5.1.3 Levels of Packaging - Preservation and packaging requirements are specified for shipment to the point of intended use, for extended storage under cover in an environment of 50° to 80°F and a relative humidity of no more than 50%, and not for redistribution.

5.1.3.1 Immediate Use - Not applicable.

5.1.3.2 Limited Storage - Not applicable.

5.1.3.3 Extended Storage



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5.1.3.3.1 Subpackage No. 1 - This portion of the CEI shall be base mounted in Shipping Container, 2332914. This container shall be adequate as the exterior shipping container. This container shall be equipped with temperature and impact recording devices, and with a magnetic sensor probe. The magnetic sensor probe shall be wired to a connector mounted on the exterior of the shipping container. This container shall be capable of being pressurized to a pressure of 1.0 psig. The pressure during storage shall not be allowed to fall below -1.5 psig. The container shall include activated desiccants conforming to MIL-D-3464, Type 2, which desiccants shall not be permitted to come into contact with any part of Subpackage No. 1. A humidity indicator visible from the exterior shall be provided. Installation of Subpackage No. 1, activation of recording devices, and pressurization procedure shall conform to 2337168.

5.1.3.3.2 Subpackage No. 2 - This portion of the CEI shall be base mounted in Shipping Container, 2332915. This container shall be adequate as the exterior shipping container. This container shall be equipped with temperature, impact, and triaxis magnetic recording devices. This container shall be capable of being pressurized to a pressure of 1.0 psig. The pressure during storage shall not be allowed to fall below -1.6 psig. The container shall include activated desiccants conforming to MIL-D-3464, Type 2, which shall not be permitted to come into contact with any part of Subpackage No. 2. A humidity indicator visible from the exterior shall be provided. Installation of Subpackage No. 2, activation of recording devices, and pressurization procedure shall conform to 2337168.

5.1.3.3.3 Cask Mount - The cask mount shall be wrapped and packaged for shipment as described in 2337162.

5.1.3.4 Intermediate Packaging - Not applicable.

5.2 Packing

5.2.1 Domestic Shipment

5.2.1.1 Air

5.2.1.1.1 Subpackages 1 and 2 - These items shall be handled, shipped, and stored in an upright position. During shipment they shall be securely restrained and tied down to prevent shifting.

5.2.1.1.2 Cask Mount - This item shall be packed separately in an exterior container as required in 2337162.

5.2.1.1.3 Documents - Except for handling and unpacking instructions, which will be affixed to the exterior of the shipping container, the documents required by NPC 200-2 Paragraph 11.6f will be packed separately from the container for immediate use at the destination point.



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5.2.1.2 Surface - Same as 5.2.1.1 Air

5.2.2 Overseas Shipment - Not applicable.

5.3 Shipment

5.3.1 Marking - The exterior container shall be marked for identification, handling, storage, required environment, and precautions as directed in 2337168, and 2337162 following the provisions of MIL-STD-129.

## 6.0 NOTES

6.1 Manuals - The following listed manuals are necessary for the maintenance, handling and transportation of the ALSEP and should be obtained from the procuring agency:

ALSEP Flight System Familiarization Manual	ALSEP-MT-03
ALSEP Flight System Maintenance Manual	ALSEP-LS-04
ALSEP System Test Equipment Maintenance Manual	ALSEP-LS-06
ALSEP Transportation and Handling Manual	ALSEP-LS-03

6.2 Specification Preparation - This specification was prepared in accordance with the format and content requirements of Exhibit II of NPC 500-1 as modified by MSC Supplement #1 Revision B - dated 26 April 1965.