NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ALSEP HANDBOOK
FOR
APOLLO 12 FLIGHT CREW

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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ALSEP HANDBOOK FOR APOLLO 12 FLIGHT CREW

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1.0 INTRODUCTION

The most compelling scientific reason for the instrumented study of the moon is the fact that the history of the earth cannot be reliably inferred unless its early relationships to the moon are known. The determination whether the moon was once a part of the earth split away by resonance-amplified tides or whether the moon is a "captured planet" is vital in tracing the evolution of the earth. By studying the moon's geology, seismology, magnetic and electrical fields and its thermal characteristics, much can be determined regarding its origin and history. Correlating this data with information known about the earth, analogies may be drawn and we may learn how the solar system, the earth and the continents on which we live were formed.

In order to obtain long-term measurements of various physical and environmental properties of the moon, complex scientific instruments have been developed for deployment on the lunar surface by Apollo astronauts. These experiments are contained in Apollo Lunar Surface Experiments Packages (ALSEP's) which will remain on the moon after the return of the astronauts and will transmit scientific and engineering data to the Manned Space Flight Network (MSFN). Each ALSEP is a self-contained unit containing a structure/thermo subsystem, and electrical power subsystem, a data subsystem and four experiments. There are a total of eight experiments in varying combinations of four each for three flight packages. The two subpackages which comprise the ALSEP Flight 1 unit are shown in Figures 1.0-1 and 1.0-2. Figure 1.0-3 is a picture of the Flight #1 (Apollo 12) ALSEP partially deployed for a review at KSC. The electrical power and data subsystems are described in Section 2.0 while the experiments to be carried are described in Section 3.0. Information on experiments to be carried on later flights is not included in this handbook.

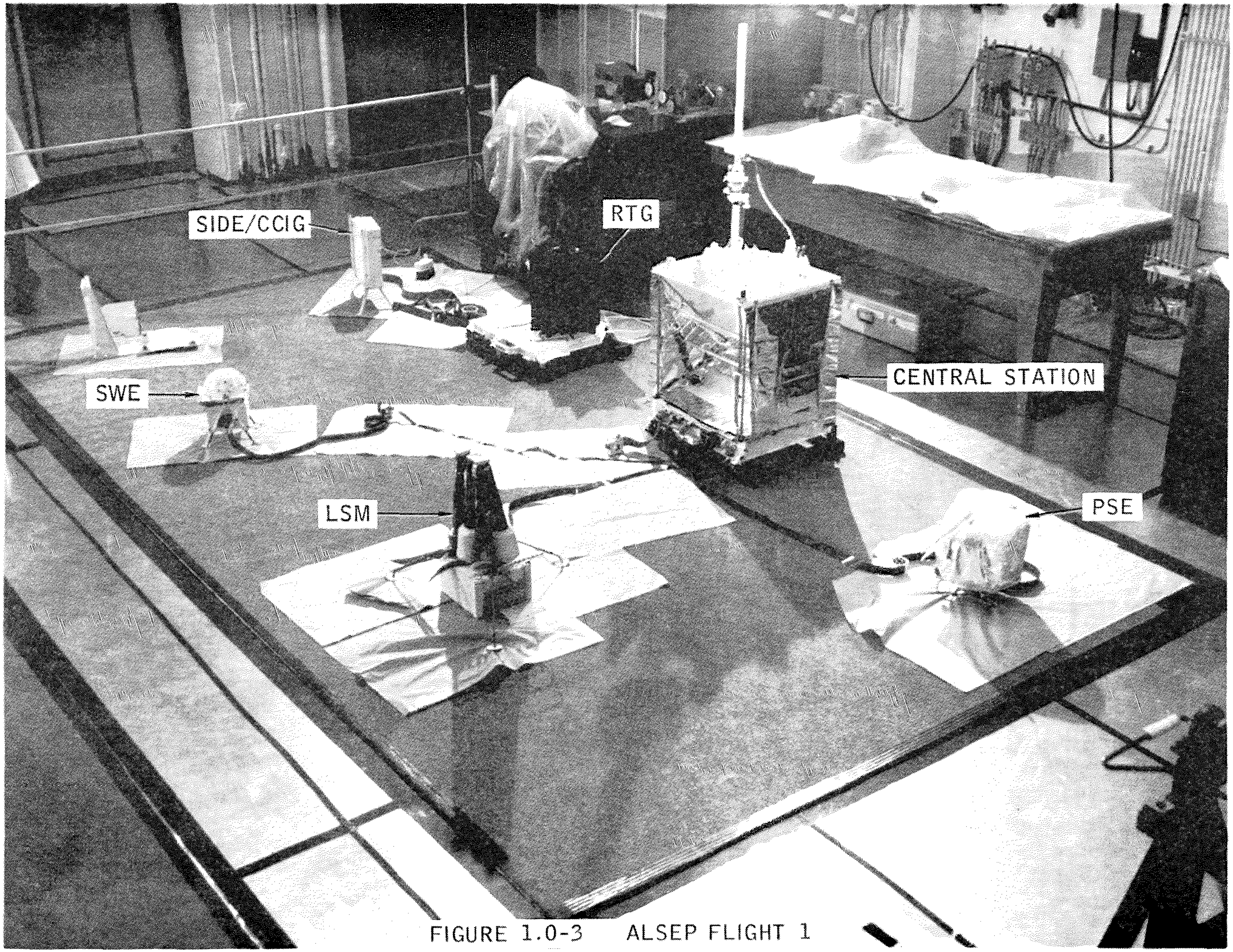


FIGURE 1.0-3 ALSEP FLIGHT 1

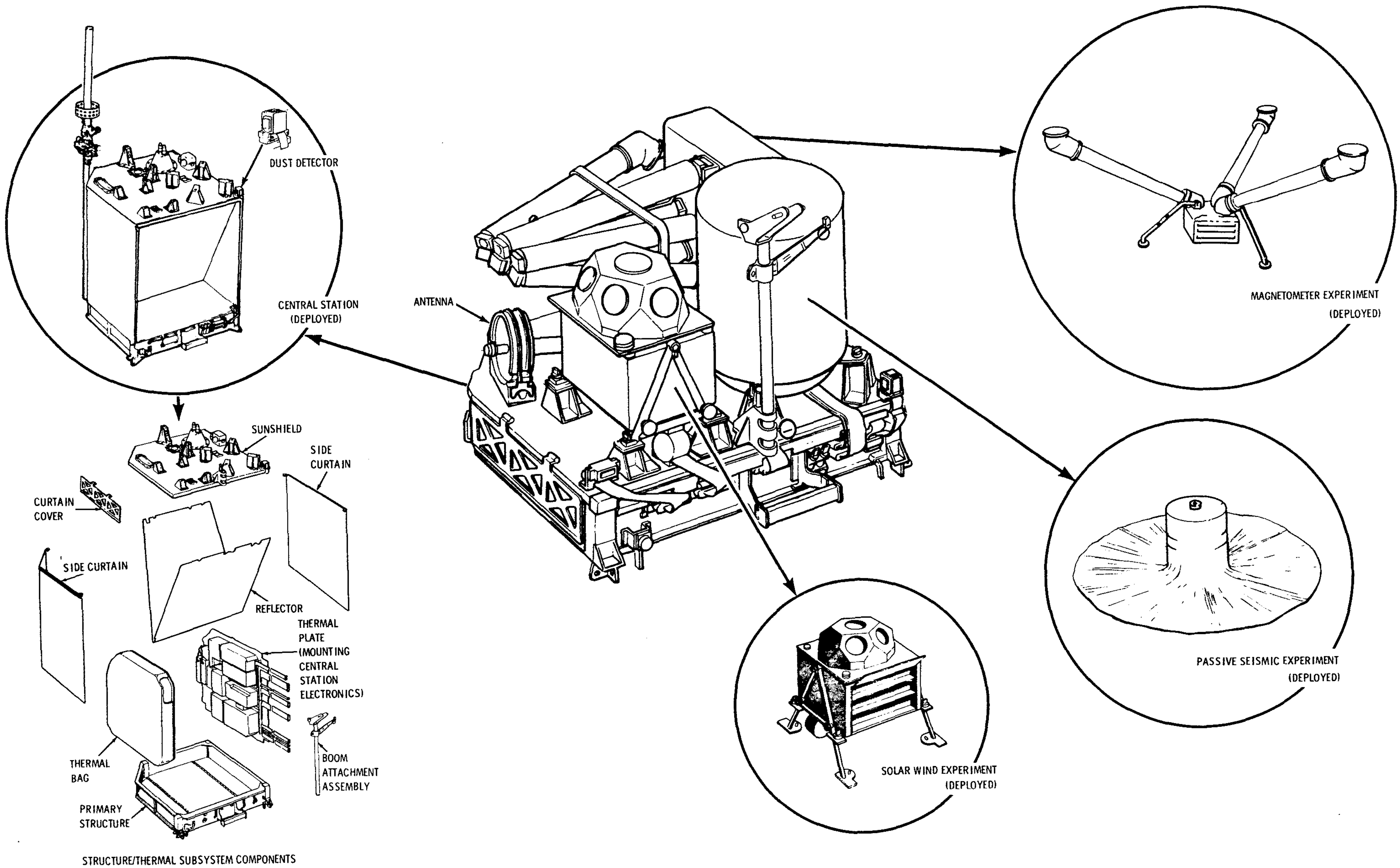


Figure 1.0-1 ALSEP Subpackage No. 1 (Flight 1)

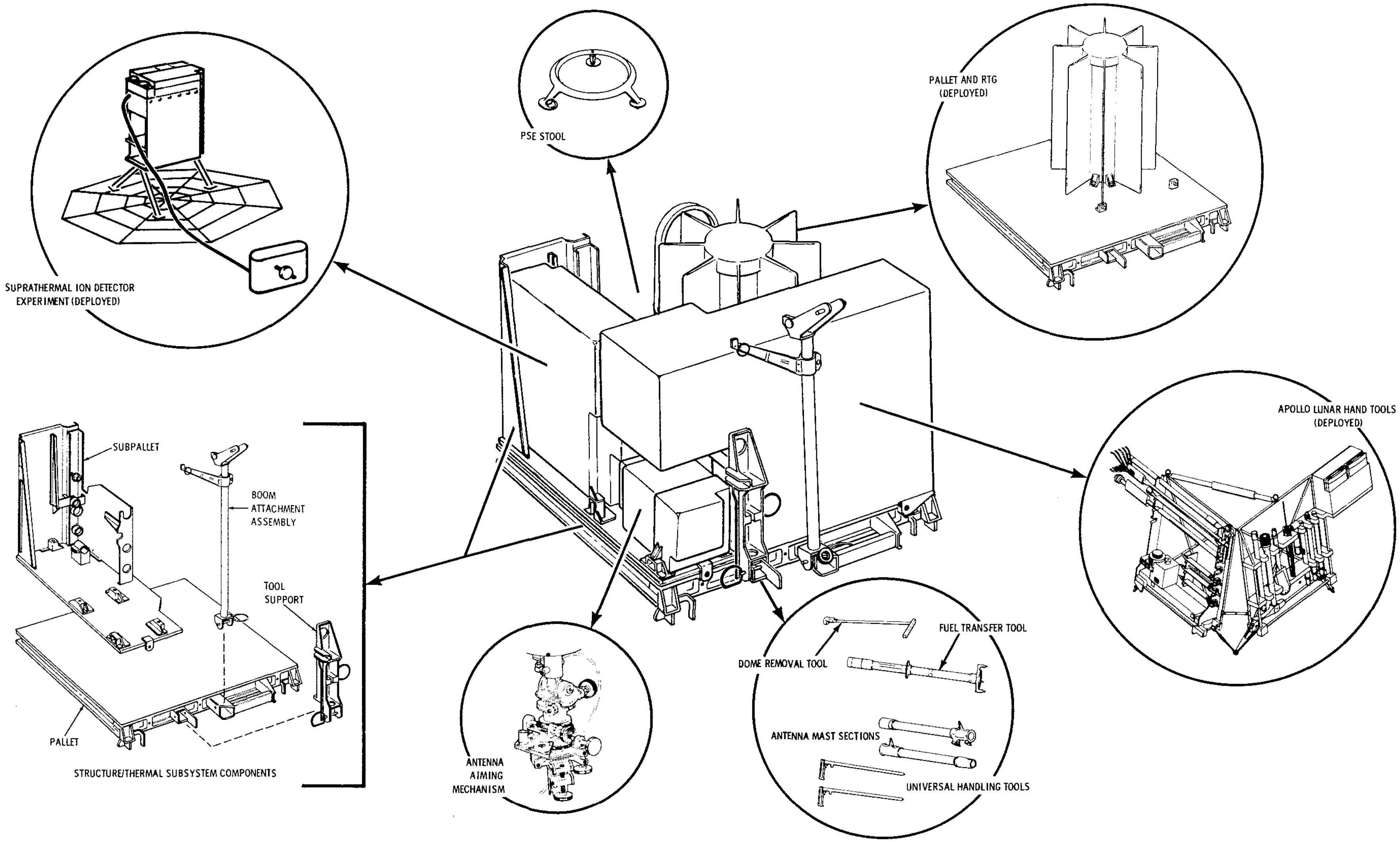


Figure 1.0-2 ALSEP Subpackage No. 2 (Flight 1)

2.0 POWER AND INSTRUMENTATION

2.1 ELECTRICAL POWER SUBSYSTEM (EPS)

The EPS provides the electrical power for lunar operation of ALSEP. Primary electric power is developed by thermoelectric action with thermal energy supplied by a radioisotope source. This primary power is converted, regulated and filtered to provide six operating voltages for the ALSEP experiment and support subsystems.

The major components of the EPS are a radioisotope thermoelectric generator (RTG) assembly, a fuel capsule assembly (FCA), a power conditioning unit (PCU) and a fuel cask. For power generation the radioisotope source (FCA) is removed from the cask, in which it was transported to the moon, and is placed in the RTG. The capsule thermal energy is applied to the RTG hot frame (inner case) which results in a temperature difference between the hot frame and RTG cold frame (outer case). This causes the thermoelectric couple assembly (thermopile) to develop electrical energy through thermoelectric action. Figure 2.1-1 provides a cut-away view of the RTG. Excess heat from the thermopile is conducted through the cold frame to the thermal radiator (heat rejection fins) for dissipation into the lunar environment. This maintains the cold frame at a lower temperature than the hot frame so thermoelectric action is maintained. Figure 2.1-2 shows the fuel cask and Figures 2.1-3 and 2.1-4 show the FCA.

The RTG supplies power to the PCU which performs voltage conversion, voltage regulation and RTG protection. The PCU contains redundant power conditioners which convert the RTG 16 volt input to six operating voltages. In addition to controlling the output voltages, the PCU through a shunt voltage regulator maintains a constant load on the RTG to prevent generator overheating. All PCU output voltages are channeled through the power distribution unit (PDU) which is part of the data subsystem for power switching and distribution.

2.2 CENTRAL STATION

The Central Station is essentially ALSEP subpackage No. 1 without the experiments mounted on it. It is composed of the data subsystem, helical antenna, power conditioning unit, experiment electronics and the dust detector. There are provisions for thermal control of the electronics, for alignment of the antenna, for electrical connections to the experiments and the RTG, and for the activation switches. Figure 2.2-1 shows the Central Station in the deployed configuration and Figure 2.2-2 shows the location of the data subsystem components. The following paragraphs provide additional data on some components of the Central Station.

RTG CUTAWAY

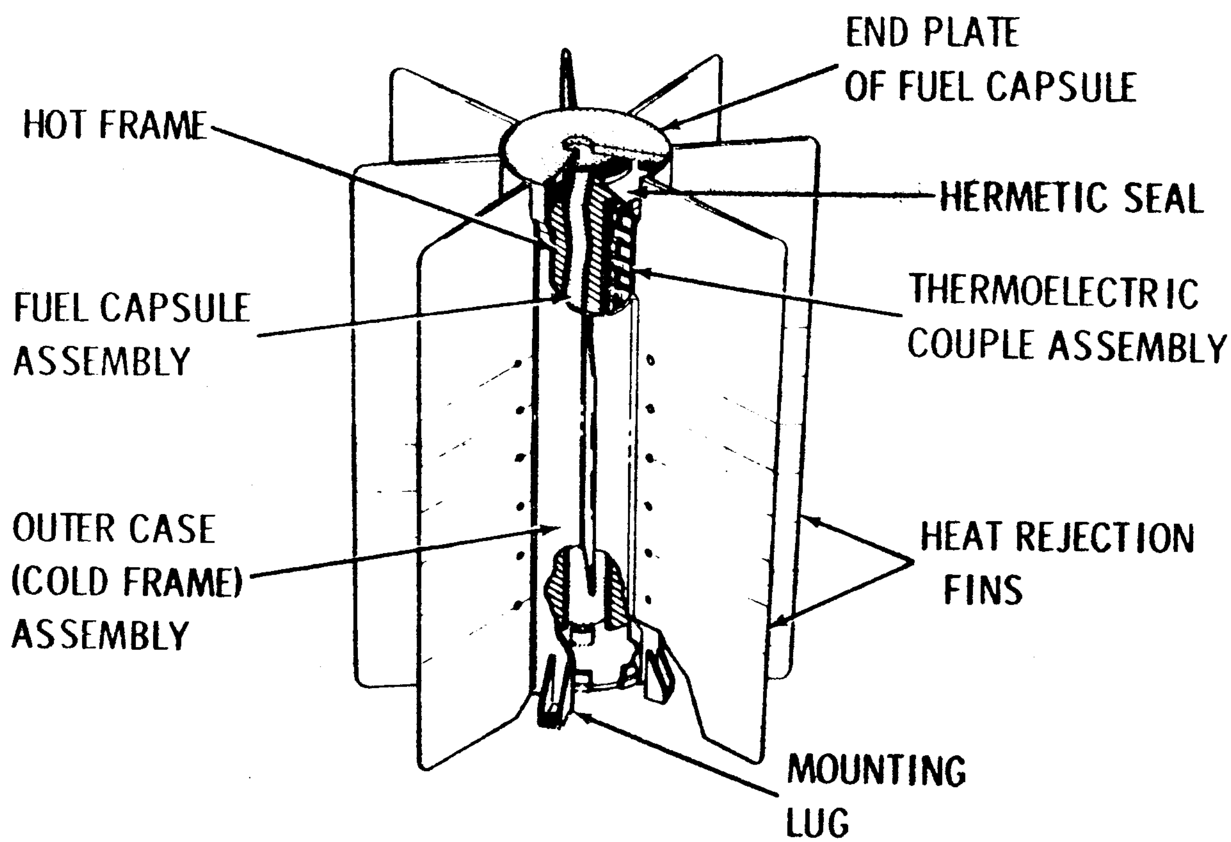


FIGURE 2.1-1

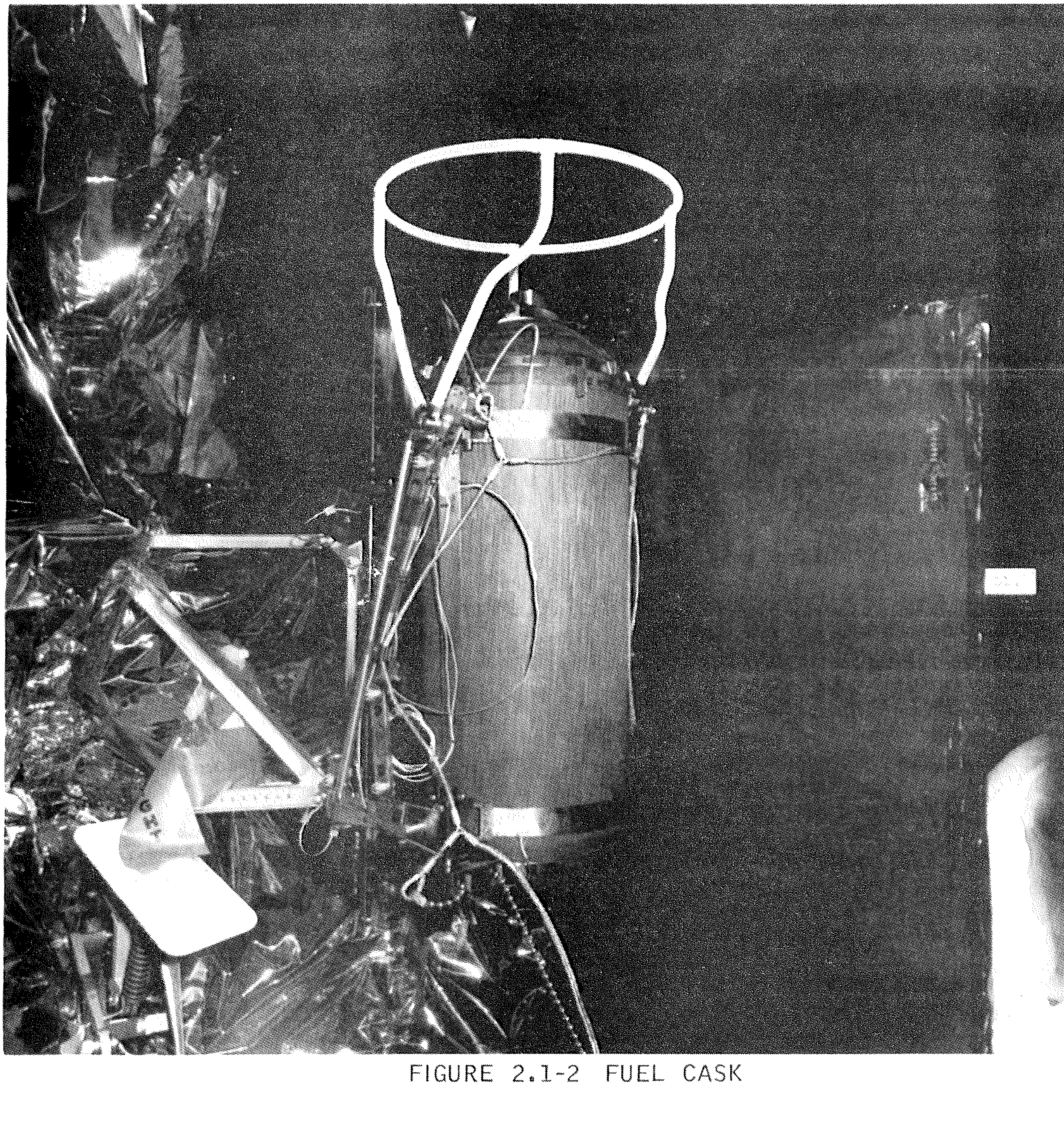


FIGURE 2.1-2 FUEL CASK

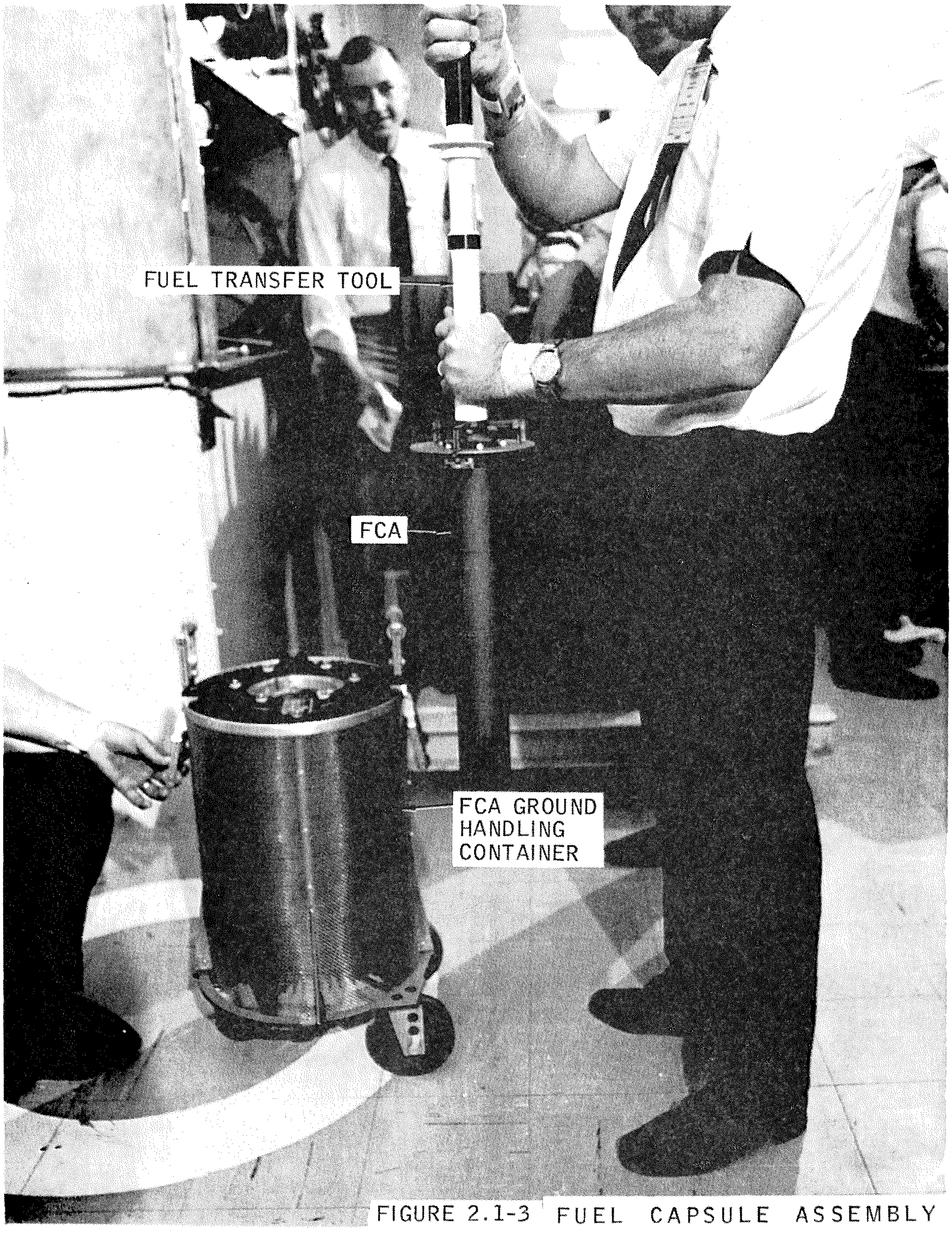


FIGURE 2.1-3 FUEL CAPSULE ASSEMBLY

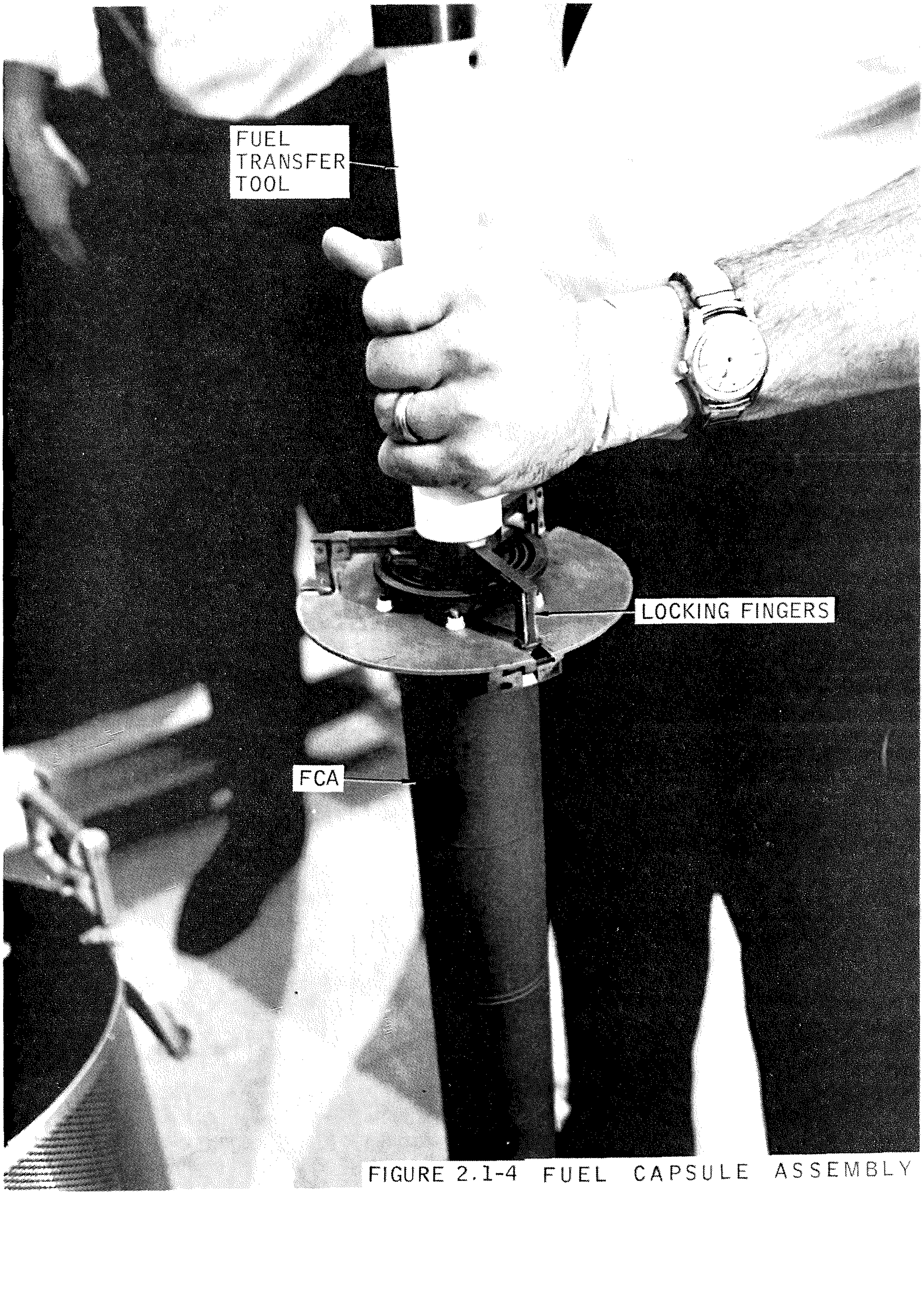


FIGURE 2.1-4 FUEL CAPSULE ASSEMBLY

CENTRAL STATION DEPLOYED CONFIGURATION

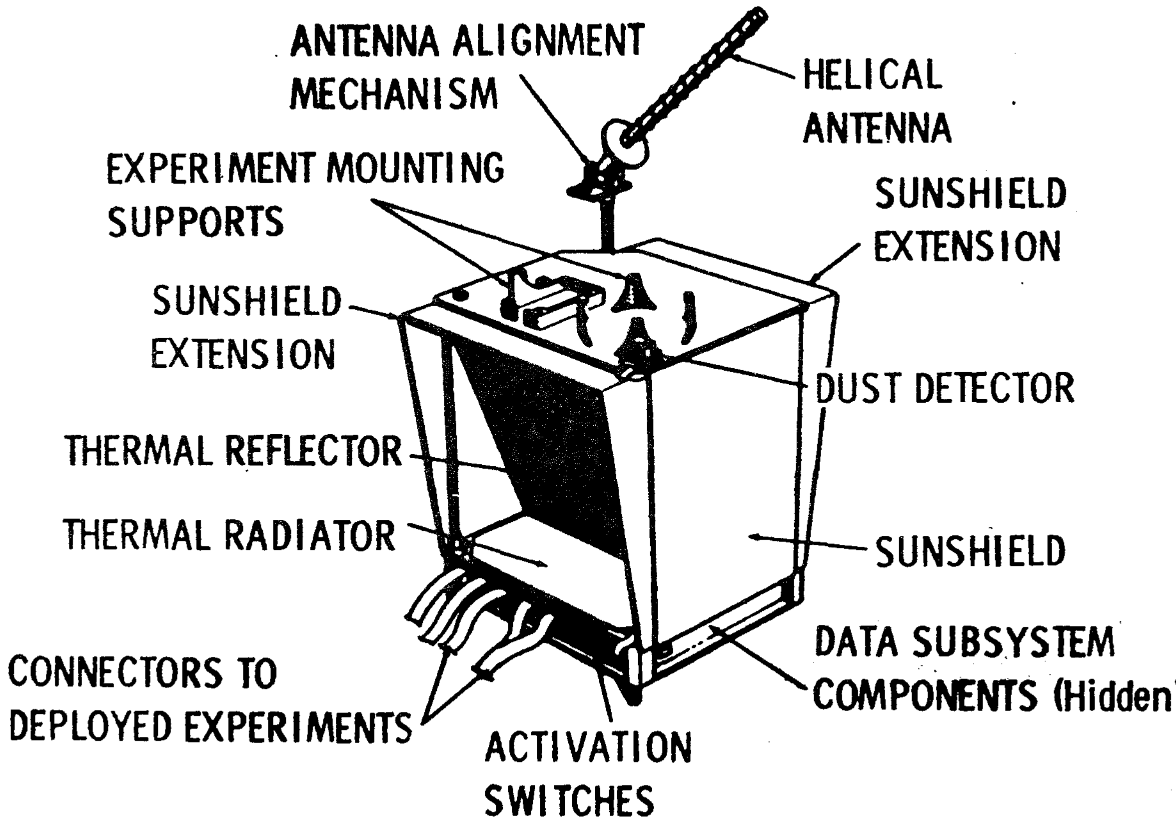


FIGURE 2.2-1

CENTRAL STATION
DATA SUBSYSTEM COMPONENTS

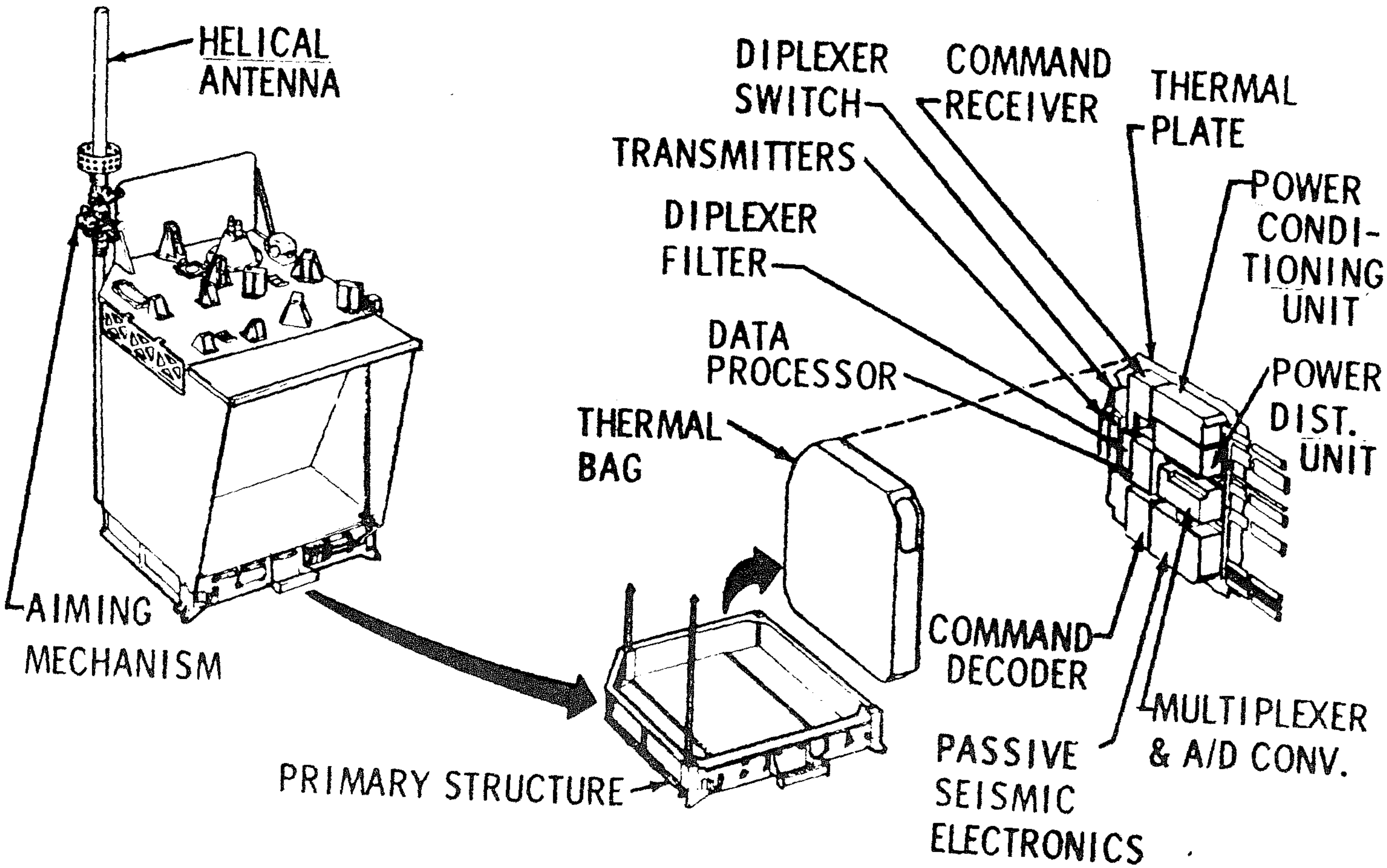


FIGURE 2.2-2

2.2.1 Data Subsystem

The data subsystem is the focal point for control of ALSEP experiments and the collection, processing and transmission of scientific and engineering data to the MSFN. Its primary functions are:

a. Reception and decoding of uplink commands.

b. Timing and control of experiment subsystems.

c. Collection and transmission of downlink scientific and engineering data.

d. Control of the EPS through the power distribution and signal conditioner.

2.2.2 Antenna

The antenna is a modified axial helix designed to receive and transmit a right hand circularly polarized S-band signal. An aiming mechanism is provided and it and the antenna are stowed separately on the ALSEP. Deployment is simplified since the interface between the antenna and the aiming mechanism is a quick-action connection. Figure 2.2.2-1 provides a detailed view of the antenna aiming mechanism.

The assembly may be leveled by reference to a circular bubble level and the sun-shadow null may be obtained by reference to the sun shadowgraph. A two-gimbal system positions the antenna in azimuth and elevation. The azimuth is set in reference to a sun shadowgraph and the elevation is set in reference to a circular bubble level to position the antenna to a predetermined angle in elevation and azimuth. The azimuth and sun-shadow adjustments are on a common axis.

2.2.3 Dust Detector

A dust detector is mounted on the Central Station to obtain data for assessment of dust accretion on ALSEP and to provide a measure of thermal degradation on the thermal surfaces. The instrument is primarily composed of three photocells, orientated on three sides of the package to face the ecliptic path of the sun, and their associated electronics. Dust accumulation on the surfaces of the solar cells will reduce the solar illumination detected by the cells. Figure 2.2.3-1 shows the dust detector.

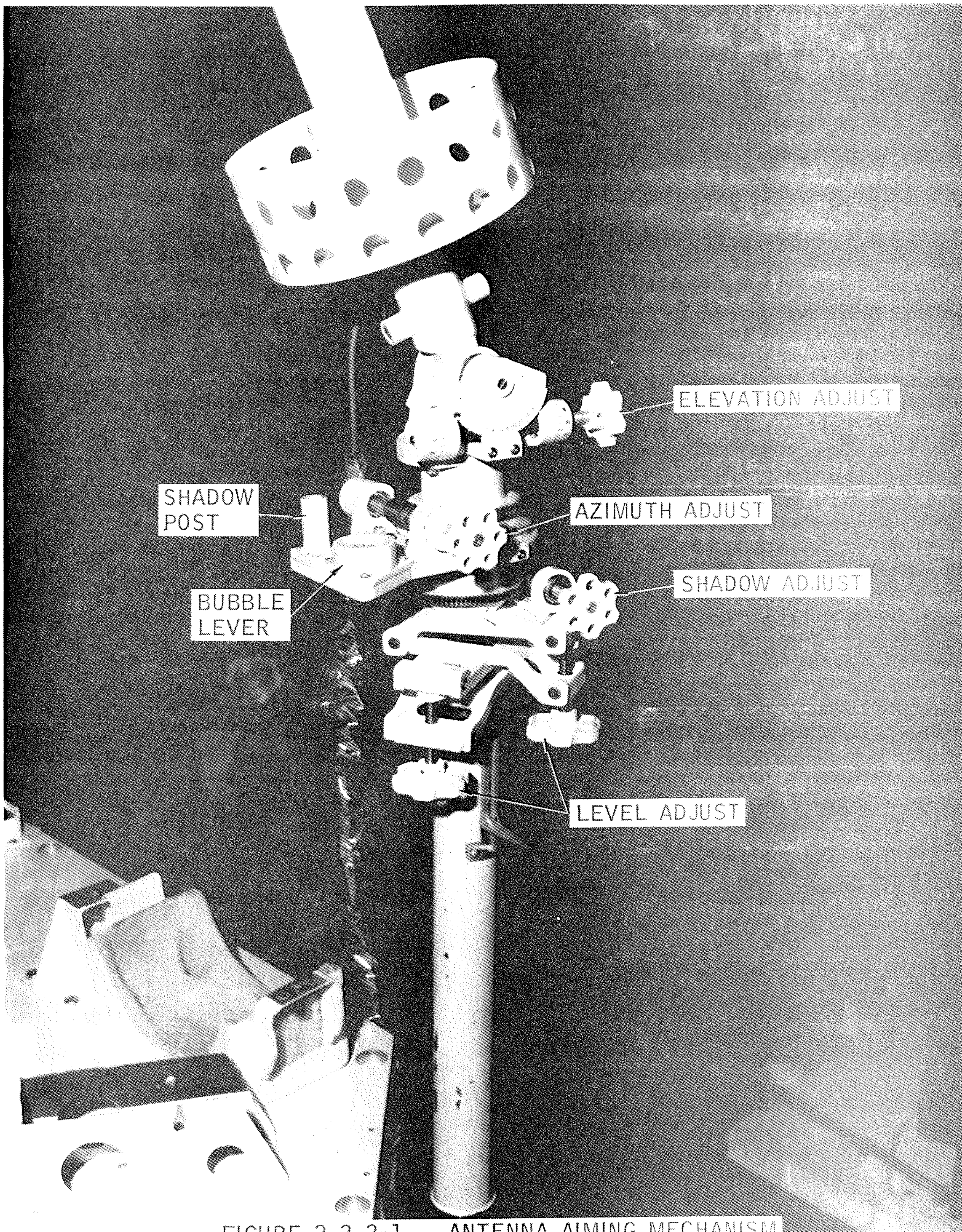
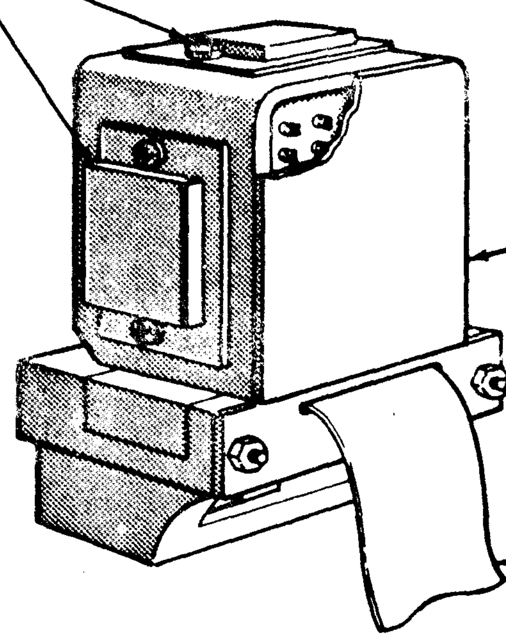


FIGURE 2.2.2-1   ANTENNA AIMING MECHANISM



Dust Detector

Figure 2.2.3-1

2.2.4 Astronaut Switches

The ALSEP is designed to become operational automatically after fueling of the RTG. However, three manual control switches are mounted on the ALSEP Central Station for activation by the astronaut in the event of problems. Their functions are:

Switch #1 - Subsequent to ALSEP deployment and connection of the cable from the RTG to the Central Station, the PCU will start automatically. The PCU has a hold-off circuit which prevents PCU turn-on until the RTG output reaches approximately 36 watts. Switch #1 overrides the PCU power hold-off circuit and will turn the ALSEP on. Under normal conditions, Switch #1 will only be activated just prior to the astronaut leaving the deployment site for the LM.

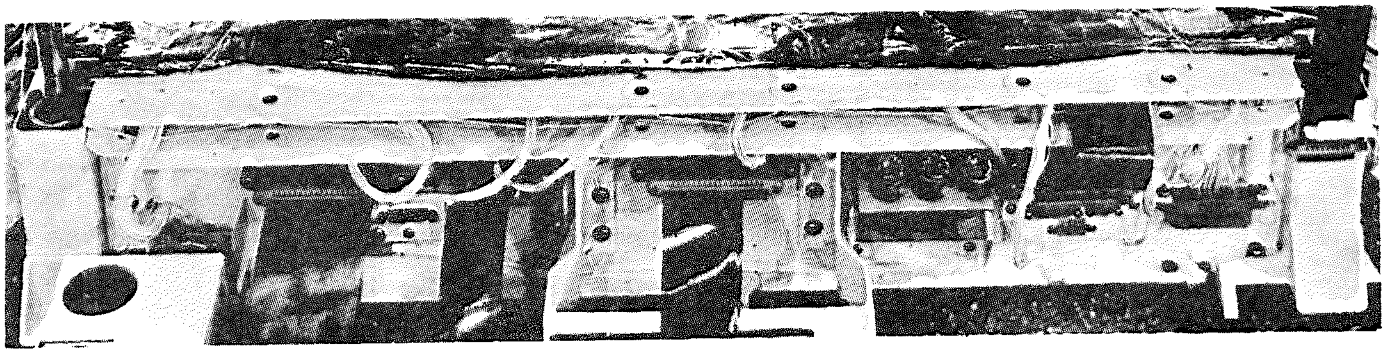
Switch #2 - This switch provides a manual contingency capability in the event of a data subsystem failure. This switch manually selects Transmitter B, Data Processor Y and resets the command receiver circuit breaker.

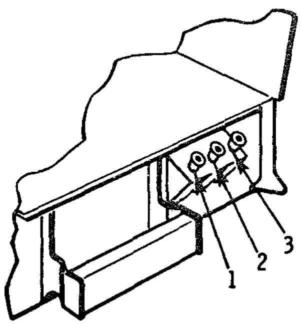
Switch #3 - This switch also provides a manual contingency capability by which the astronaut may activate the experiments sequentially at approximately 0.1 second intervals.

All switches interface with the Universal Handling Tool (UHT), rotate clock-wise and have visual indicators to show switch position.

Figure 2.2.4-1 is a picture of the three astronaut switches.

ASTRONAUT SWITCHES





- SWITCHES INTERFACE WITH UHT
- ALL SWITCHES ROT CW
- VISUAL INDICATORS SHOW SWITCH POS

SWITCH NUMBER	QTY/TYPE/ROT	FUNCTION
1	1/SPST/180° NON-MOMENTARY	DISABLES THE HOLD-OFF CIRCUIT. MUST BE OPERATED BY THE ASTRONAUT
2	1/SPST/180° MOMENTARY	(A) TURN XMTR B ON (B) TURN DATA PROCESSOR Y ON (C) RESET RCVR
3	4/SPST/270° MOMENTARY	MECHANICALLY GANGED & OPERATED SEQUENTIALLY TO ACTIVATE EXPER OPER SEL POWER SWITCHES (IN 1, 2, 4, 3 ORDER) AT ≈ 0.1 SEC INTERVALS

FIGURE 2.2.4-1

3.0 EXPERIMENTS

The Flight No. 1 ALSEP is comprised of the following experiments:

NASA No.	Experiment
S031	Passive Seismic (PSE)
S034	Lunar Surface Magnetometer (LSM)
S035	Solar Wind (SWE)
S036	Suprathermal Ion Detector (SIDE)
S038	Cold Cathode Ion Gauge (CCIG) - carried as part of the SIDE

These experiments are discussed in detail in this section and their deployment is discussed in Section 4.0. Each experiment is mounted on an ALSEP subpallet for transport to the moon and is deployed on the lunar surface by the astronaut. Each experiment is connected to the ALSEP central station by a cable for power, commanded functions, certain electronics and all data handling/transmission. All experiments function automatically after deployment.

Certain tools for the lunar geology experiment are stowed on the ALSEP, but are not discussed in this handbook.

3.1 PASSIVE SEISMIC EXPERIMENT (PSE)

3.1.1 Principal Investigator

Dr. Gary Latham, Lamont-Doherty Geological Observatory

3.1.2 Objective

The objective of the PSE is to monitor lunar seismic activity and to detect meteoroid impacts and free oscillations of the moon.

The instrument is designed to measure elastic waves on the moon from any naturally occurring seismic event; i.e., does the moon release energy in the form of moonquakes. The question is, if the moon is active, how active; are moonquakes confined to certain regions or randomly distributed; are they shallow or deep; are they associated with certain types of surface features; what is the mechanism of energy release (focal mechanism) - rupture, sudden change in volume, etc.? From these facts something can be inferred about the internal energy regime of the moon and the nature of major crustal stress patterns that may exist.

The instrument is also designed to measure tidal deformations and changes in gravity at the lunar surface. This data will be used to: a) Determine the internal structure of the moon; b) Determine the gross physical properties of the whole moon from tides (and free oscillations if they occur during the experiment); c) Determine near-lunar meteoroid flux.

The PSE will measure the very slowly varying signals associated with free oscillations and tides. Free oscillations of a spherical body can be excited by a large moonquake. These are motions in which the entire moon vibrates as a single body. The fundamental spherical mode (radial vibration) has a period of 15 minutes.

Meteoroid impact will very likely be an important source of seismic energy on the moon. Under the most optimistic circumstances, about 1 impact per day will be detected. Most of these will strike within 10 to 20 km of ALSEP. Under the most pessimistic circumstances, only one per month will be detected.

3.1.3 Approach

In the study of the earth, seismic methods have proven to be the most powerful method for determining its internal structure. This method may be briefly described as follows: By measurement of the velocity with which various types of elastic waves travel through a body (body waves) and over its surface (surface waves), we can determine its internal structure. Rough locations for moonquakes or meteoroid impacts can be obtained from a single triaxial seismometer, but the power of the method is greatly increased by having two or more stations. Based on assumed lunar models, an attempt will be made to relate these events to surface features and lunar tectonics and to determine the internal structure of the moon.

Each PSE is comprised of 3 long period (LP) and a short period (SP) seismometer, an electrical power and a data subsystem, and a thermal control system.

In the LP seismometer, low frequency (approximately 250 to .3 second periods) motion of the lunar surface caused by seismic activity is detected by tri-axial, orthogonal displacement amplitude type sensors. Two separate outputs may be produced by each axis of the LP seismometer. The primary output is proportional to the amplitude of the low frequency seismic motion and the secondary output is proportional to the tidal motion.

In the SP seismometer, the higher frequency (approximately 5 to .04 second periods) vertical motion of the lunar surface is detected by a displacement velocity sensor. The SP seismometer yields a seismic output proportional to seismic motion in the vertical axis of the instrument.

3.1.4 Experiment Description

The PSE is comprised of four major physical components. The sensor assembly, leveling stool, and thermal shroud are all deployed together by the astronaut on the lunar surface. A separate electronics assembly is located in the ALSEP Central Station, and provides the electrical interface with the ground station.

The PSE sensor assembly is generally cylindrical in form with a hemispherical base which permits rough leveling of the sensor upon the leveling stool during deployment by the astronaut. The PSE leveling stool is a short tripod with three thermo-electrical insulators on its upper end. These insulators and the sensor itself, form a ball and socket joint which permits manual leveling to within five degrees of vertical by sighting a ball level on the sensor. The PSE thermal shroud, which has a removable girdle, has the shape of a flat-crowned wide-brimmed hat. The crown portion covers the sensor, while the brim portion (5 feet in diameter) covers the adjacent lunar surface. Alignment after deploying the shroud is read off by azimuth gnomon and compass rose.

The sensor and thermal shroud are contained in ALSEP subpackage No. 1 and the leveling stool is mounted in subpackage No. 2. The PSE is electrically connected to the ALSEP by a pair of 10-foot, 27-conductor flat cables which are contained on a reel mechanism during stowage on subpackage No. 1.

Figure 3.1.4-1 is a picture of a partially deployed PSE and Figure 3.1.4-2 is a picture of the PSE in the stowed configuration. Figure 3.1.4-3 provides detailed views of the PSE LP sensors.

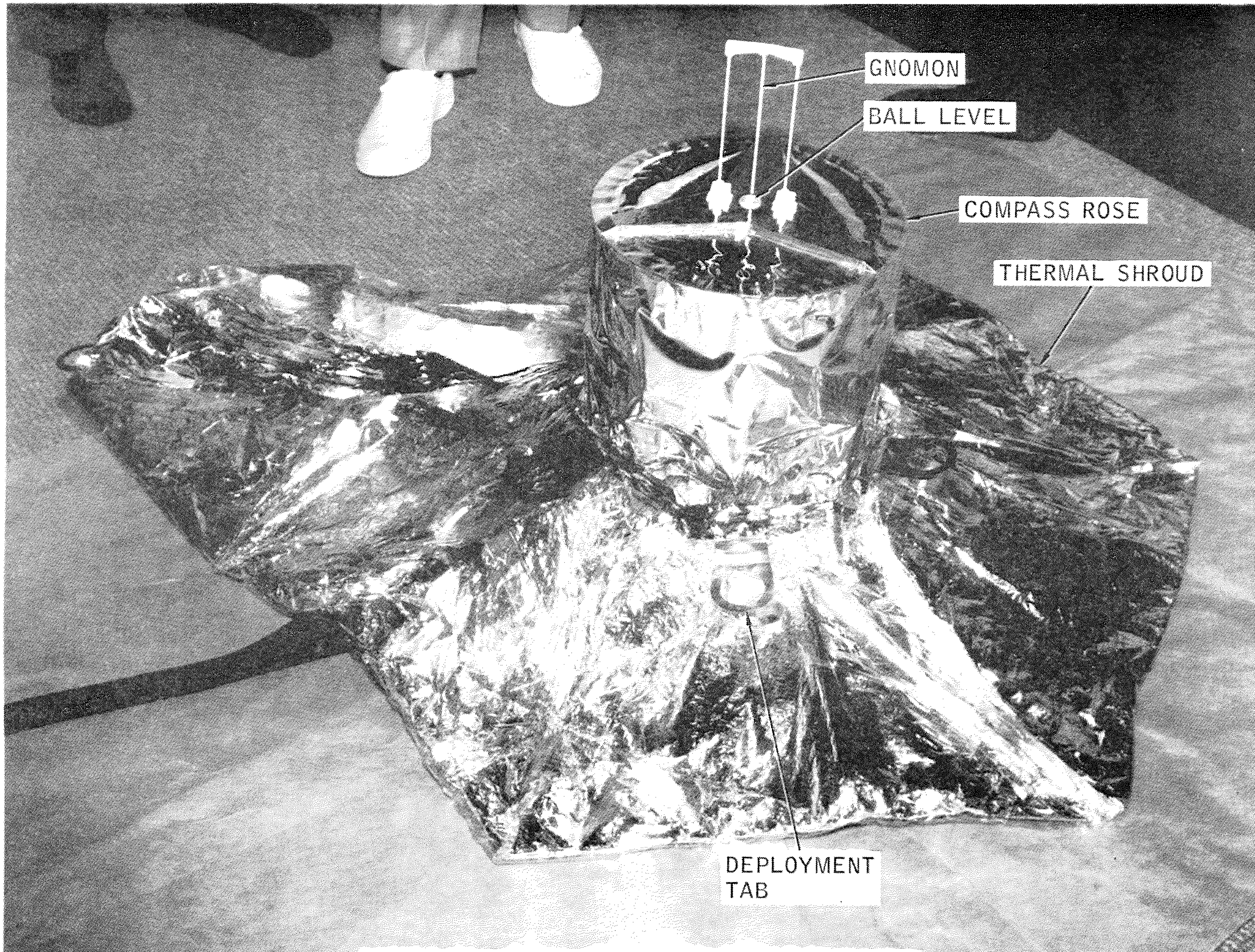


FIGURE 3.1.4-1 PSE (PARTIALLY DEPLOYED)

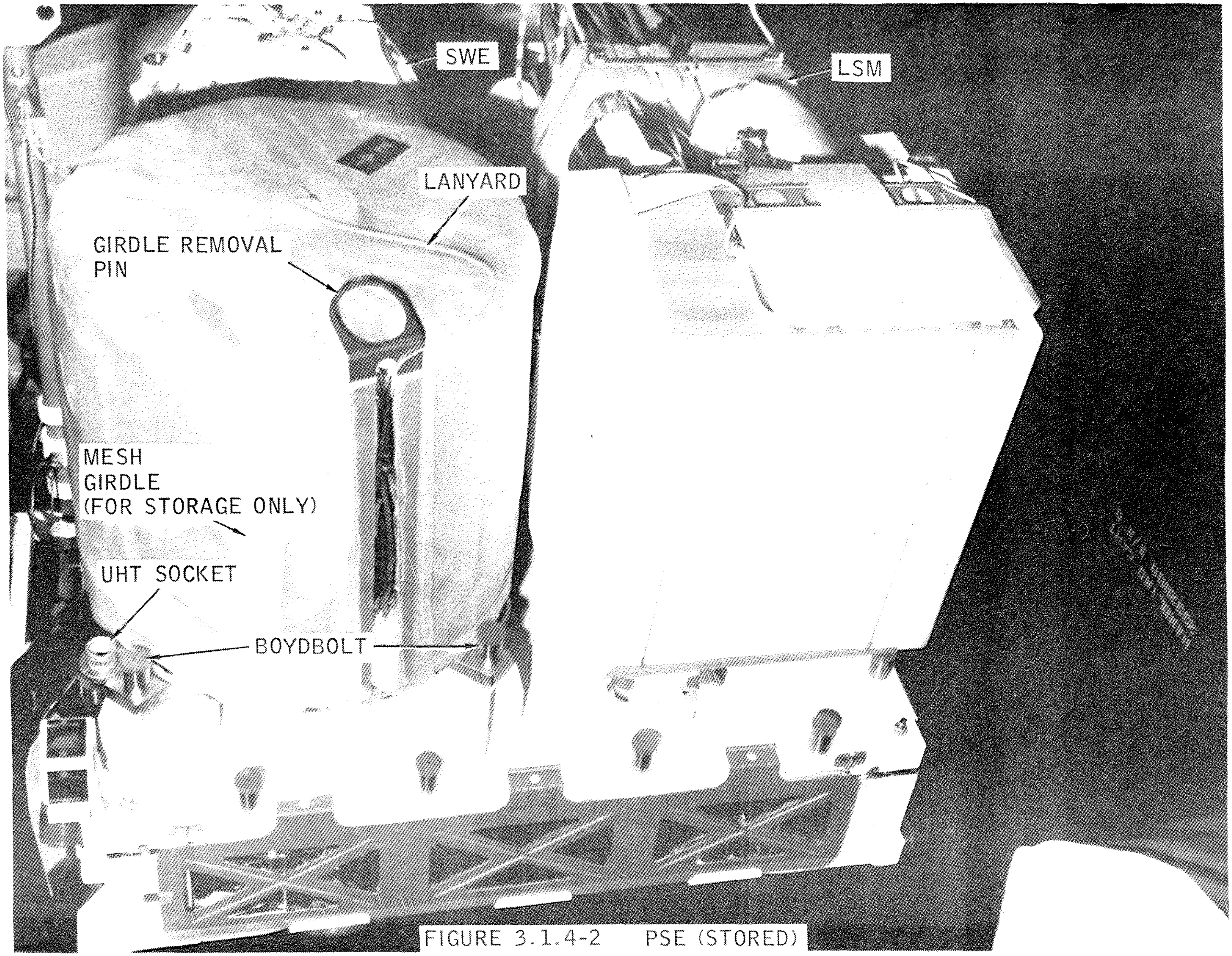


FIGURE 3.1.4-2 PSE (STORED)

PSE LP SENSOR DETAILS

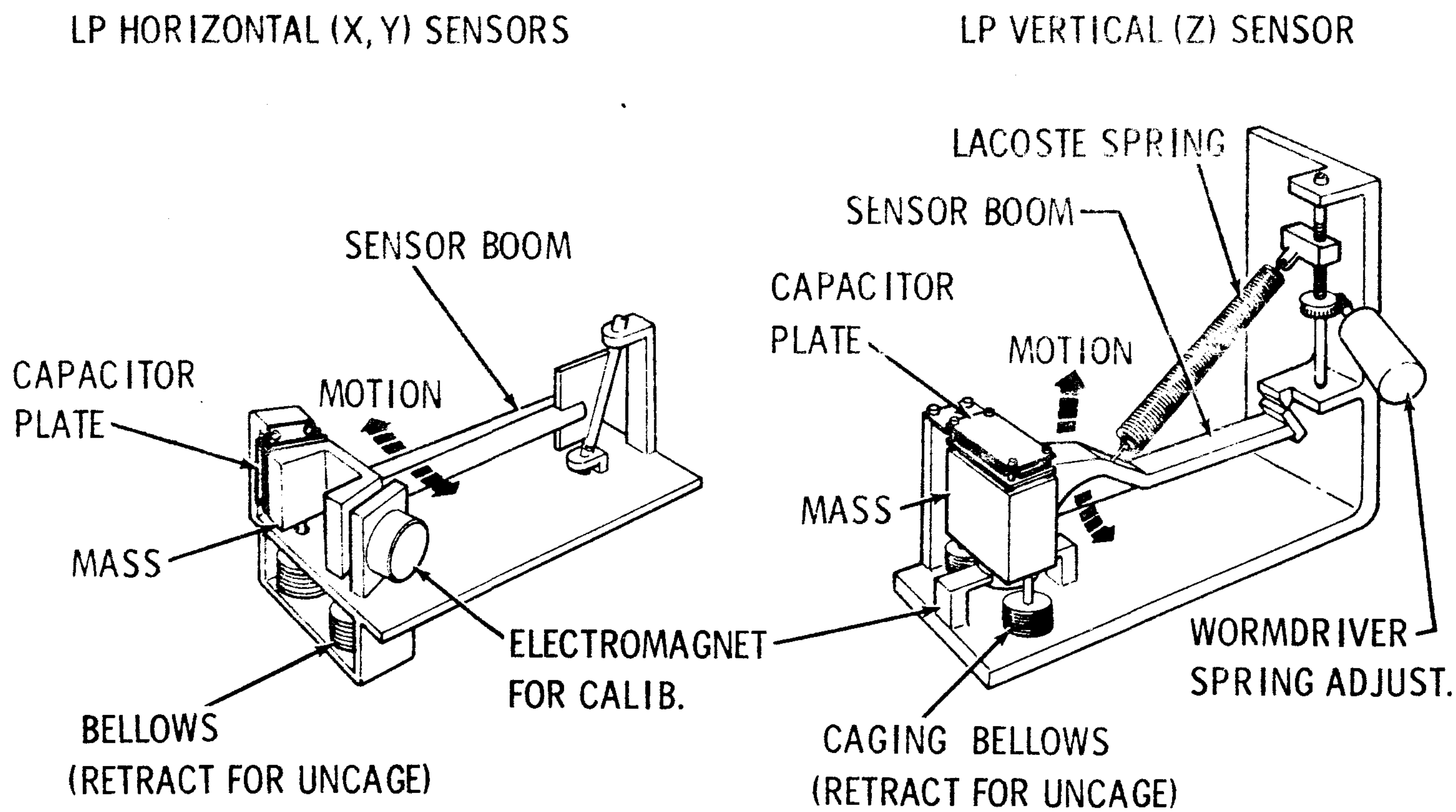


FIGURE 3.1.4-2

3.2 LUNAR SURFACE MAGNETOMETER (LSM) EXPERIMENT

3.2.1 Principal Investigator

Dr. Charles P. Sonett
NASA-Ames Research Center

3.2.2 Objective

The objective of the LSM is to measure the moon's magnetic field vector and its variation with time. When operating in the normal mode, the instrument provides data on the interaction between the solar wind and the moon's magnetic field, the moon's gross electrical diffusivity, and the structure of the earth's magnetic tail at 240,000 miles. The instrument also has a special site-survey mode to measure the local magnetic gradient. The purpose of the site-survey is to identify and locate any magnetic influences permanently inherent in the deployment site so that they will not effect interpretation of normal mode data.

In addition to providing data on the magnetic fields, the LSM will detect buried anomalies such as iron-composition rocks and will determine the electrical properties of the lunar interior. This data will help resolve the fundamental question of whether or not the moon has a molten core and will help reconstruct the geological evolution of the moon.

3.2.3 Approach

Three orthogonally located flux gate sensors, called X, Y and Z, are employed in measuring the magnetic flux with three identical signal processing channels. The magnetic sensors, in conjunction with the sensor electronics, provide signal outputs proportional to the incident magnetic field components parallel to their respective axes. Each sensor is mounted on a three-foot boom and these booms have a common base and relative angles that form an orthogonal set of axes. Each sensor may be rotated in 90° and 180° steps about an axis normal to its sensing direction and each boom may be rotated 90° about its longitudinal axis.

In the normal mode, the three sensing axes are in an orthogonal configuration. By rotating all sensors 180°, any zero drift effects may be removed. This will enable a calibration determination to be made ensuring the accuracy of the measurements.

In the site-survey mode, the sensing axes of all three sensors are aligned parallel in each of the three orthogonal axes in turn. These measurements allow a determination of the magnetic field gradient at the LSM site. This measurement will reveal any local field anomalies.

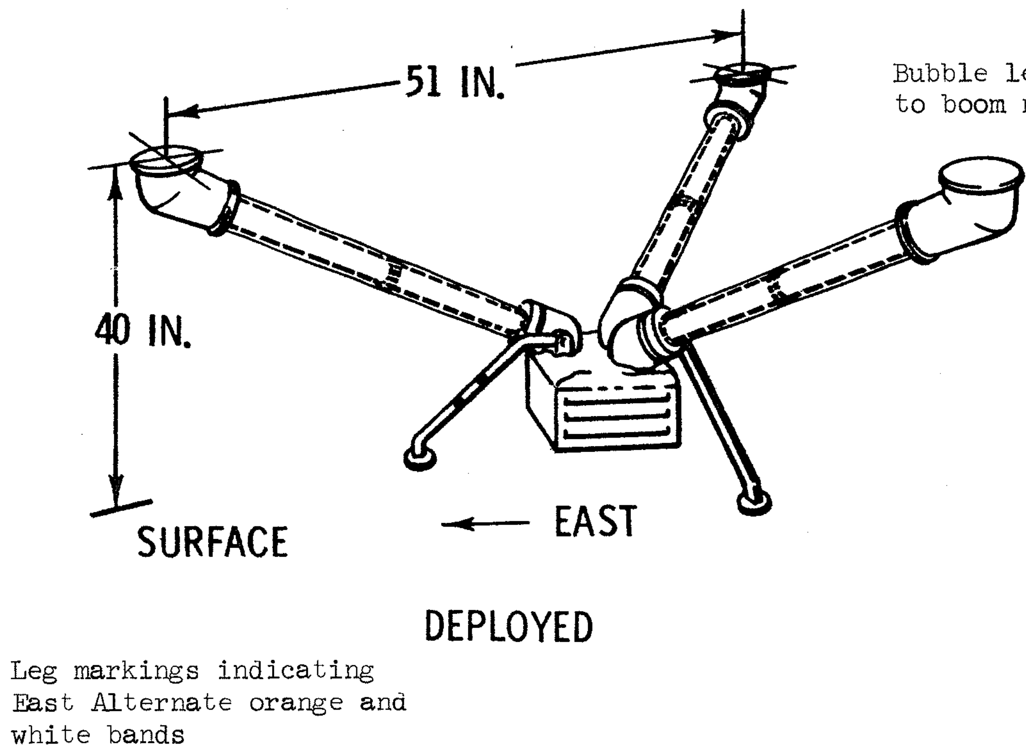
3.2.4 Experiment Description

The LSM consists of three magnetic sensors, each mounted in a sensor head and located at the ends of three-foot long support arms. The support arms extend from a base structure called the electronics/gimbal-flip unit (EGFU), which is a rectangular box. Three adjustable leveling legs are attached to the EGFU to support the LSM on the lunar surface. A flat H-film cable electrically connects the LSM to the ALSEP Central Station for power and control/data functions. This cable is contained in an enclosed reel which stows under the LSM on subpackage No. 1.

A shadowgraph and a bubble level are mounted on the upper surface of the EGFU. The shadowgraph is used by the astronaut in LSM deployment to align the LSM into an east-west emplacement. The bubble level is used to position the LSM parallel to the lunar surface.

Figure 3.2.4-1 depicts a deployed LSM and Figure 3.2.4-2 is a picture of the LSM in the stowed configuration. Figure 3.2.4-3 provides a pictorial view of the LSM sensor.

LUNAR SURFACE MAGNETOMETER EXPERIMENT SUBSYSTEM



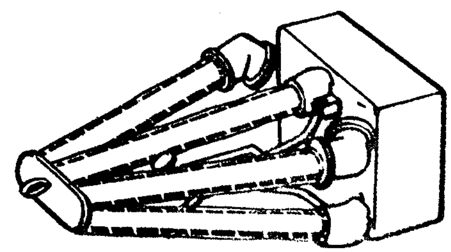


Figure 3.2.4-1

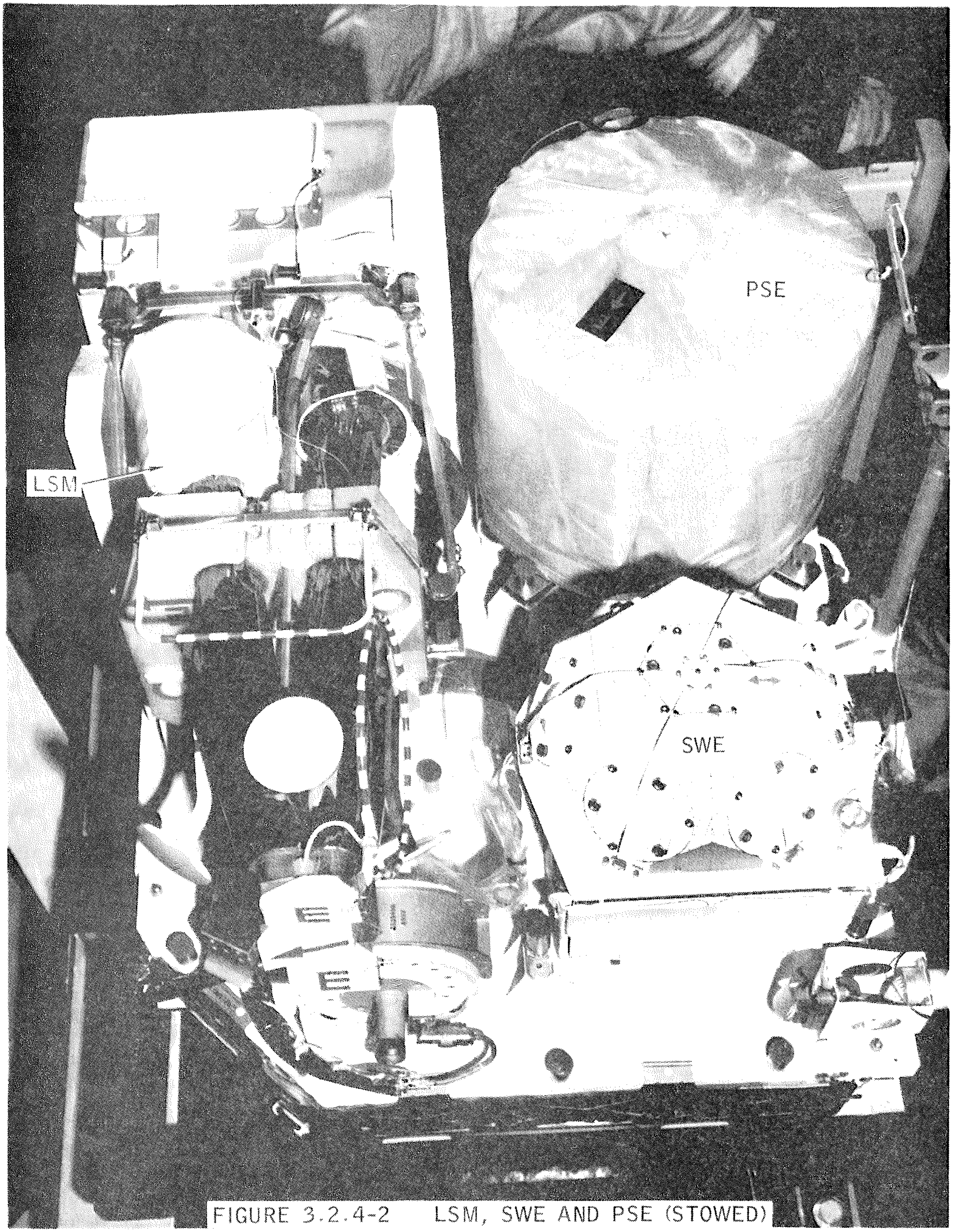


FIGURE 3.2.4-2 LSM, SWE AND PSE (STOWED)

LSM SENSOR DETAILS

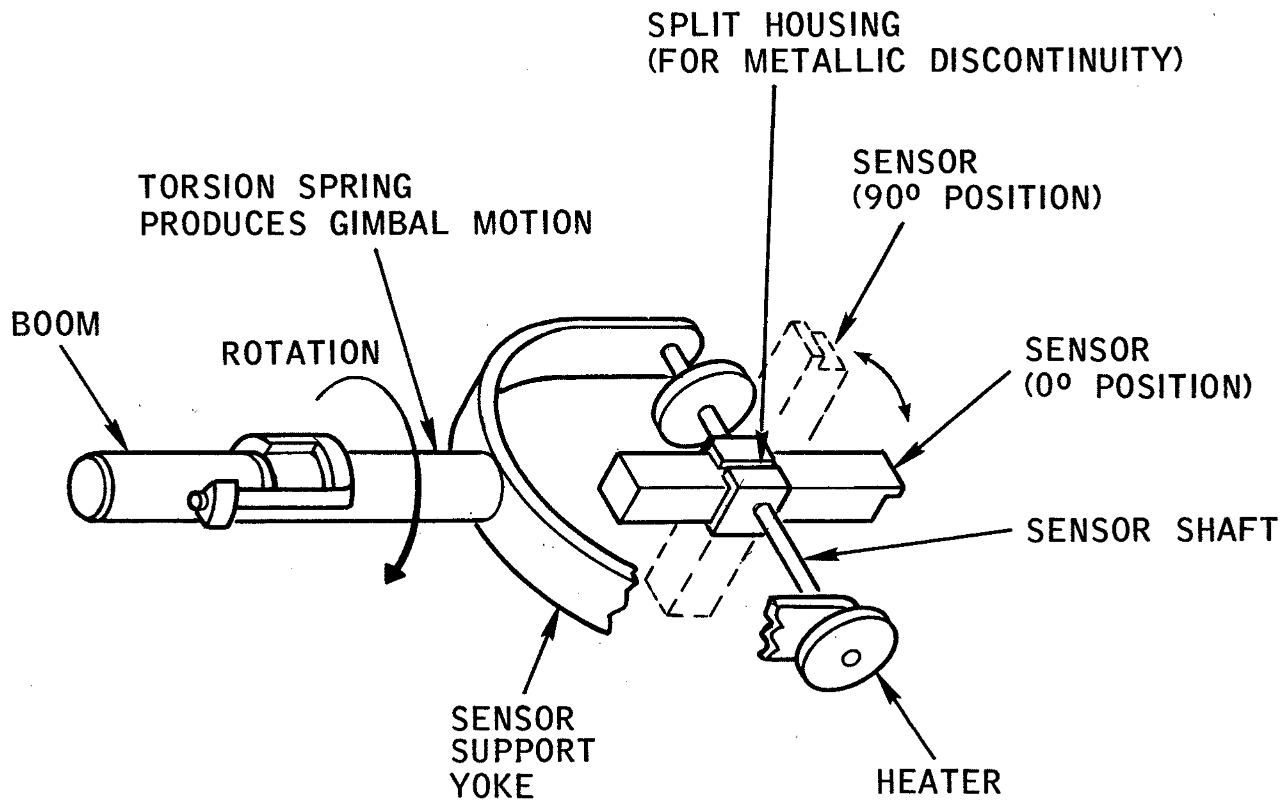


FIGURE 3.2.4-3

3.3 SOLAR WIND EXPERIMENT (SWE)

3.3.1 Principal Investigator:

Dr. Conway W. Snyder
Jet Propulsion Laboratory

3.3.2 Objective

The SWE, or Solar Wind Spectrometer (SWS) as it is also known, will measure energies, densities, incidence angles and temporal variations of the solar wind plasma that strikes the surface of the moon. The solar wind is a flow of electrons, protons and other charged particles from the sun into space which could be responsible for a number of important phenomena on the lunar surface. From the data obtained by this experiment the following questions may be answered:

a. What is the interaction between the solar wind and the moon's magnetic field? The LSM experiment will furnish additional data.

b. What is the moon's gross electrical conductivity?

c. Is there a lunar atmosphere?

d. What are the properties of the earth's magnetospheric tail at the lunar surface?

e. Is there a lunar shock wave through which the solar wind must pass?

f. Is the solar wind the source of a mysterious luminescence or glow occasionally observed by earth based astronomers?

3.3.3 Approach

The sensing devices on the SWE are seven Faraday cups which open toward different but slightly overlapping portions of the lunar sky. These cups collect and detect the solar wind electrons and protons and this data is processed and fed to the ALSEP data subsystem for transmission to the earth. With the knowledge of the positioning of the SWE on the lunar surface, the direction of the bulk of the charged particles can be deduced.

Each Faraday cup measures the current produced by the charged particle flux entering it. Voltages on the modulation grids of the cups are changed in sign and varied so that the cups will differentiate between electrons and protons and between particles having different energies. Each cup has 14 energy ranges for protons and seven energy ranges for electrons. A complete measurement of all energy ranges for all cups is made every 28 seconds, so that the time variations in the solar wind can be determined.

3.3.4 Equipment Description

The SWE consists of a sensor assembly, electronics assembly, thermal control assembly and leg assembly, and is fully automatic in operation. A 20-conductor flat cable, which is housed in a reel stowed beneath the SWE, provides electrical connection between the SWE and the ALSEP Central Station.

The sensor assembly consists of seven Faraday cups arranged in the hexagonal cupola configuration. One cup is mounted on each of the six sides of the cupola and one is mounted on the top so it faces upward after deployment on the lunar surface. Thin, spring loaded covers protect the cups from contamination by dust during handling, lunar deployment and LM take-off. After LM take-off and in response to earth command, the covers are released and ejected.

The electronic assembly contains all the circuits required to modulate the plasma flux entering the Faraday cups and to convert cup output signals, calibration data and operation data into the appropriate format for the ALSEP data subsystem. The thermal control assembly maintains the electronics within the proper temperature range through the use of three radiators, a sunshield and insulation. The leg assembly is a tubular A-frame which is extended manually during deployment.

During deployment the SWE is rough aligned east-west by an arrow on the sensor. Due to A-frame construction, the SWE has a pendulum effect about the east-west axis and this is used for rough-leveling. The SWE contains a sun sensor which provides data by telemetry on the leveling about the N-S axis. No other leveling is required.

Figure 3.3.4-1 is a picture of the deployed SWE and Figure 3.3.4-2 provides a detailed view of the SWE Faraday-type sensor cup. See Figure 3.2.4-2 for the SWE stowed on Subpallet No. 1.

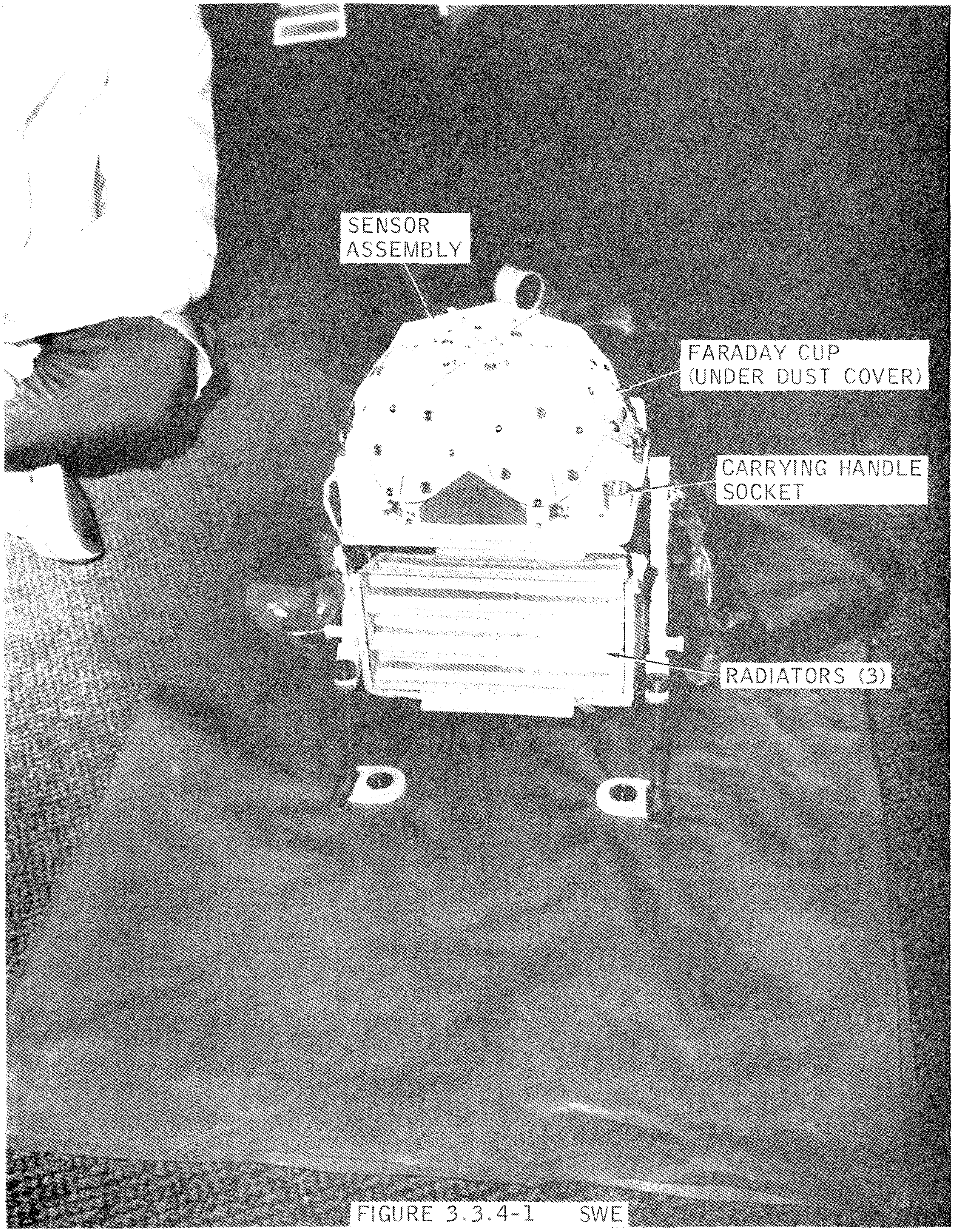


FIGURE 3.3.4-1 SWE

SWE FARADAY-TYPE SENSOR CUP

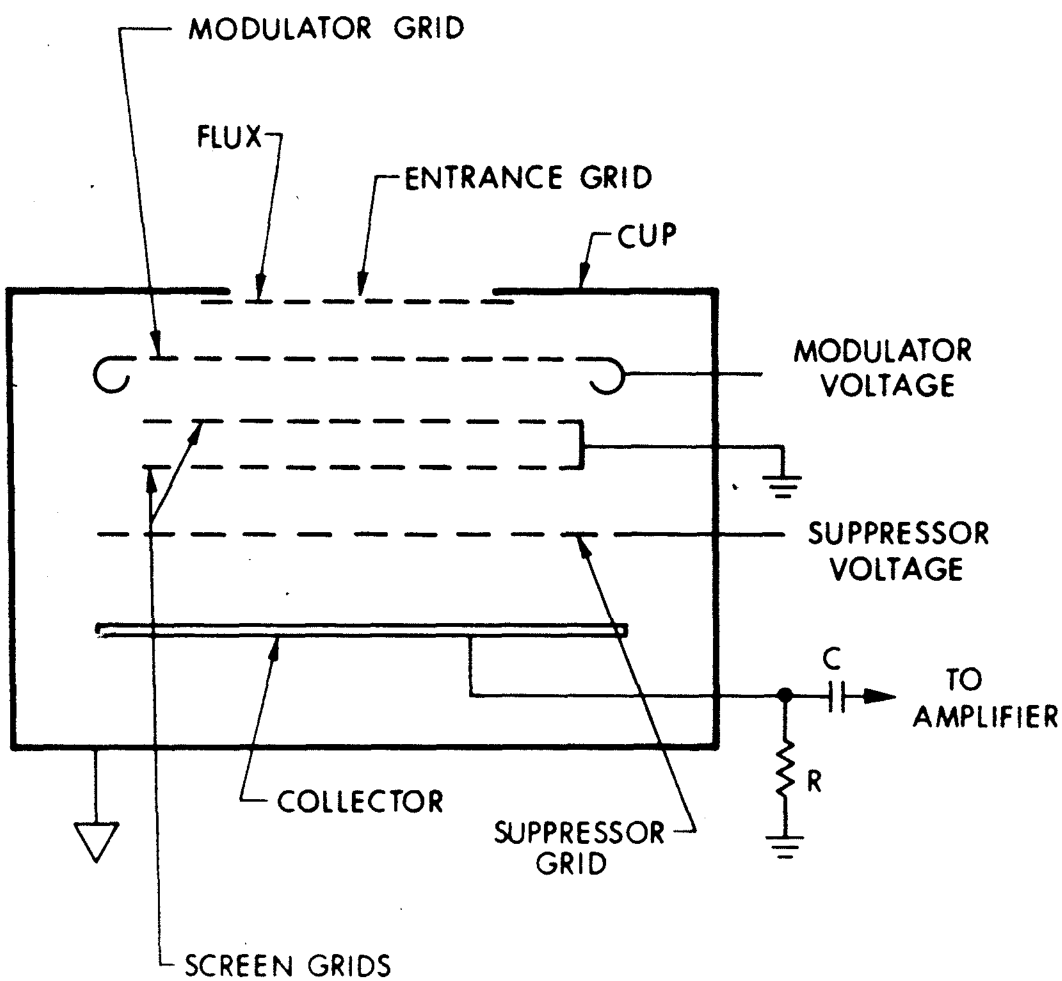


FIGURE 3.3.4-2

3.4 SUPRATHERMAL ION DETECTOR EXPERIMENT (SIDE)

3.4.1 Principal Investigator

Dr. John Freeman (SIDE)
Rice University

Dr. Francis S. Johnson (CCIG)
Southwest Center for Advanced Studies

3.4.2 Objective

The SIDE comprises the suprathermal ion detector and the cold cathode ion gauge (CCIG). Its objective is to measure the ionic environment of the moon by detecting the ions resulting from the ultra-violet ionization of the lunar atmosphere and the free streaming and thermalized solar wind. The suprathermal ion detector will measure the flux, composition, energy and velocity of low energy positive ions and the high-energy solar wind flux of positive ions. The CCIG will measure the density of any lunar ambient atmosphere and any variations with time or solar activity it may have. This data will provide information in the following areas:

a. Determination of the interaction between ions reaching the moon from outer space and those captured by the lunar gravity versus those that escape.

b. Are secondary ions generated by impact of incoming ions on surface materials?

c. Determination of whether volcanic processes exist on the moon.

d. What are the ambient electric field effects?

e. What is the rate of loss of contaminants left in the landing area by the astronauts and the LM?

f. What is the pressure of the ambient lunar atmosphere?

3.4.3 Approach

The suprathermal ion detector uses two curved plate analyzers to detect and count ions. The low energy analyzer has a velocity filter of crossed electric and magnetic fields. This curved plate analyzer passes ions with discrete energies and the velocity filter passes ions with discrete velocities, permitting determination of mass as well as number density. The second curved plate analyzer, without a velocity filter, detects higher energy particles, primarily solar wind protons. Only the number of particles in selected energy levels are measured by this analyzer since particle mass cannot be determined without a velocity filter.

The suprathermal ion detector is emplaced on a wire mesh ground screen on the lunar surface and a known and variable voltage is applied between the electronics and ground plane to overcome any local electric field effects. If local electric fields exist, they will be offset at one of the ground plane voltage steps. By accumulating ion count data at differenc ground plane potentials, an estimate of local electric fields and their effects on ion characteristics can be made.

The CCIG will determine the pressure of the ambient lunar atmosphere by measuring the density of neutral atoms and the temperature of the gauge at the time of measurement. Charged particles entering the sensor are deflected into elongated spiral paths by a combination of magnetic and electrostatic fields enhancing the probability of collision with the more numerous neutral atoms entering the sensor. Ions produced by these collisions and free ions are collected by the sensor electrodes which create the electrostatic field. The ions resulting from collisions within the CCIG greatly outnumber the free ions and results in a minute current flow which can be detected. Knowledge of the amount of current and the temperature allows calculation of atmospheric pressure.

3.4.4 Experiment Description

The SIDE consists of a velocity filter, a low energy curved plate analyzer ion detector, a high energy curved plate analyzer ion detector, a CCIG, a wire mesh ground plane, and associated electronics.

The package structure consists of an internal chassis which mounts the electronics and ion detectors. The outer case is made up of the suprathermal ion detector dust cover, the legs, the ground screen storage tube and the CCIG. After the screen is removed from its storage tube and placed on the lunar surface, three folding legs on the base of the experiment chassis are extended to form a low tripod. The CCIG, which is connected to the experiment by a short cable, is removed from the outer case during deployment and placed off the ground plane. Both the suprathermal ion detector and the CCIG have dust covers which are released by ground command. The flat tape cable connecting the experiment to the ALSEP Central Station is housed in a reel which is stowed at the base of the SIDE.

A bullseye leveling gauge is mounted on top of the detector to allow the astronaut to level the device within 5° of level during deployment. An arrow is painted on top of the experiment which must be aligned east or west toward the subearth point. Final alignment is made by ensuring shadows on the long sides of the detector are equal.

The CCIG orifice must be aligned within 20° of the north-south line so it has a clear field of view away from all other subsystems and the LM.

Figure 3.4.4-1 depicts the deployed SIDE and CCIG and Figure 3.4.4-2 is a picture of the SIDE in the stowed configuration. Figure 3.4.4-3 is a functional diagram of the suprathermal ion detector and the internal arrangement of the CCIG is shown in Figures 3.4.4-4.

SUPRATHERMAL ION DETECTOR EXPERIMENT
(SIDE)

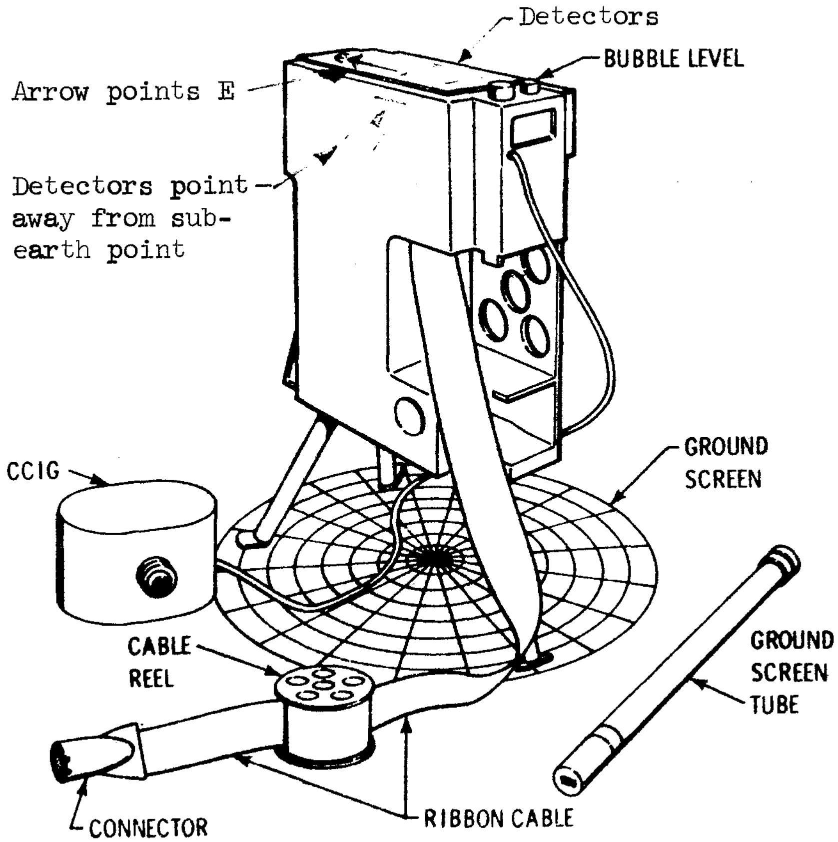


Figure 3.4.4-1

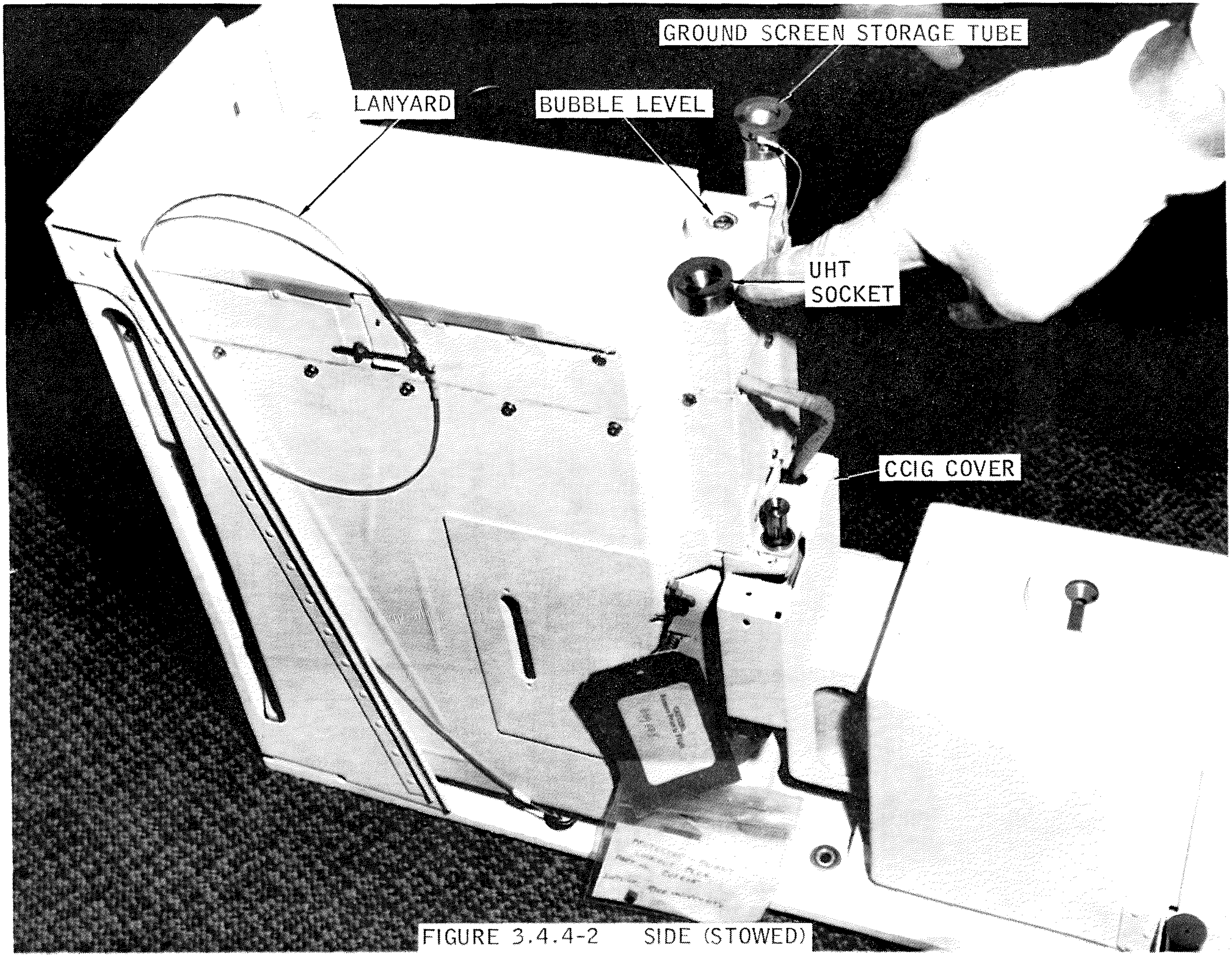


FIGURE 3.4.4-2 SIDE (STOWED)

SUPRATHERMAL ION DETECTOR FUNCTIONAL DIAGRAM

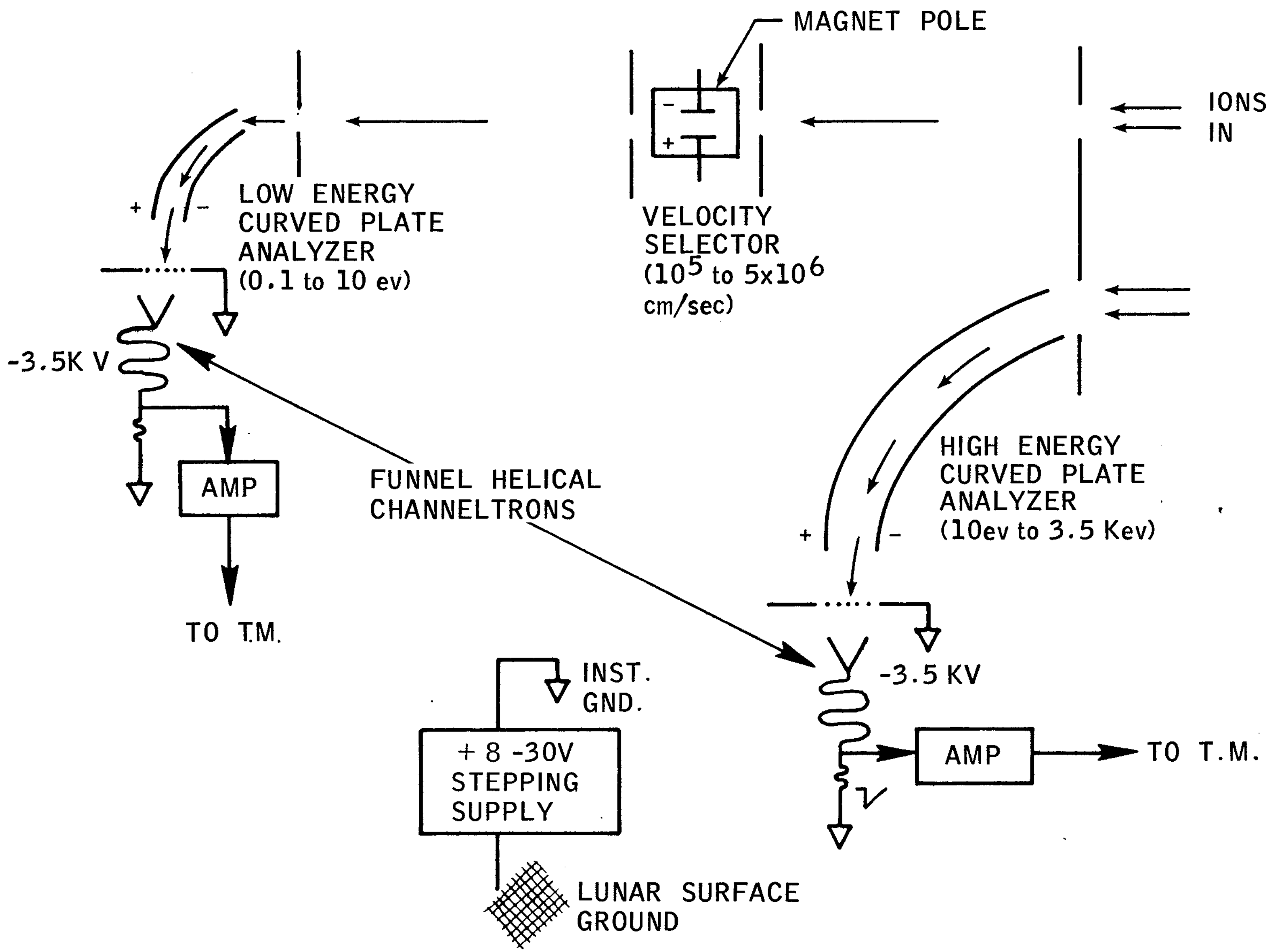


FIGURE 3.4.4-3

CCIG INSTRUMENT

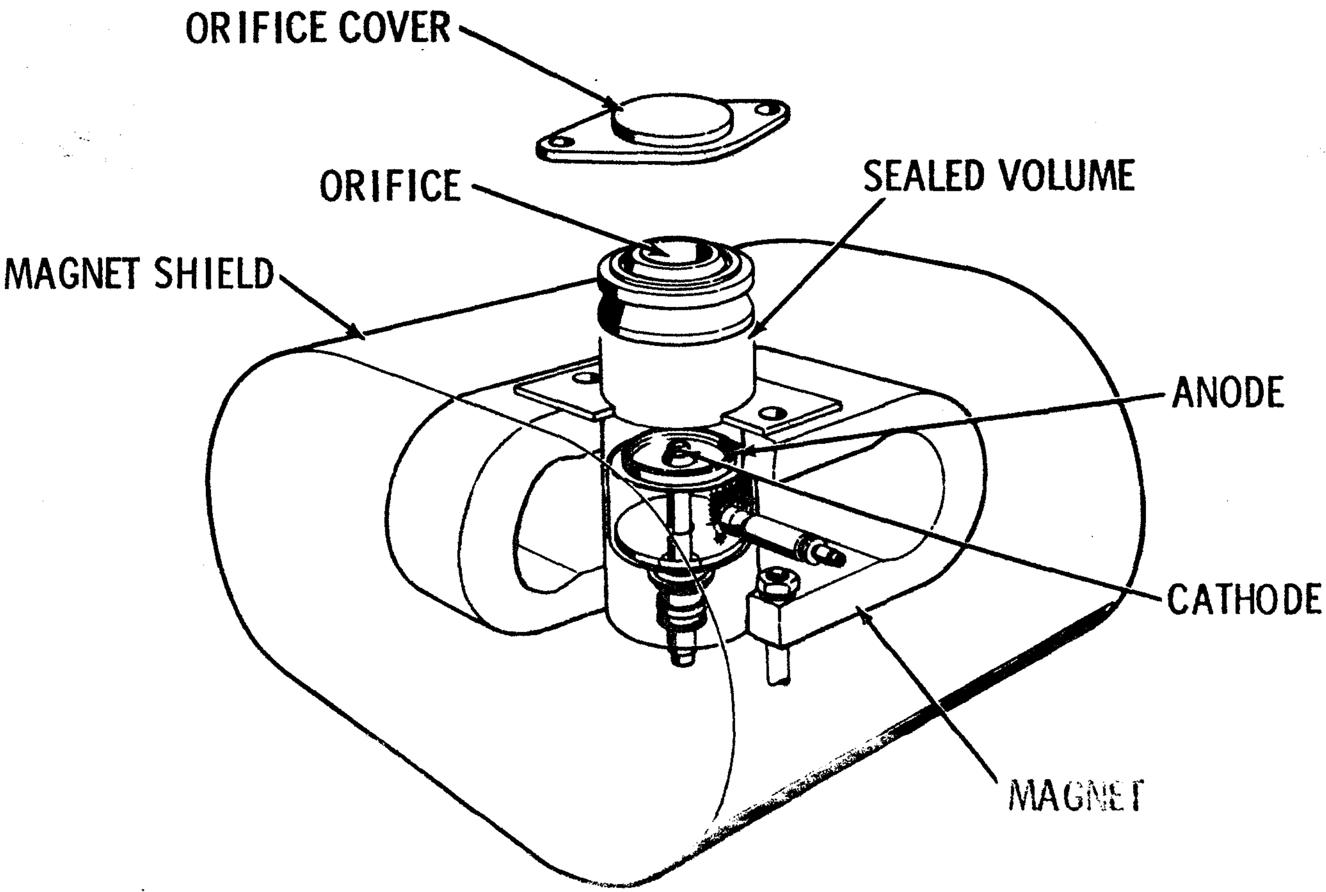


Figure 3.4.4-4

4.0 ALSEP DEPLOYMENT

The ALSEP is deployed on the lunar surface by completing the following tasks:

a. Remove ALSEP equipment from the LM SEQ Bay.

b. Fuel the RTG.

c. Transport the ALSEP to the emplacement area.

d. Deploy subpackages Nos. 1 and 2.

e. Deploy the experiments.

f. Align the antenna.

The tools used in deployment are discussed in Section 4.1 and the deployment geometry and general constraints are provided in Section 4.2. Deployment procedures are covered in Section 4.3.

4.1 DEPLOYMENT TOOLS

Three special tools are used in the deployment of the ALSEP. They are shown in Figures 4.1-1 and 4.1-2 and are listed below:

a. Universal Handling Tool (UHT)

b. Dome Removal Tool (DRT)

c. Fuel Transfer Tool (FTT)

The UHT is a general purpose device and two are included in the tool complement stowed on the ALSEP subpackage No. 2. The insertion end of the UHT is designed to fit both the carry sockets on the ALSEP instruments and structural units and the Boydbolt fasteners. The head is equipped with a spring-loaded ball lock for positive retention in the carry sockets. A trigger at the handle end is used to release this lock. The UHT is used for such tasks as:

a. Handling and positioning ALSEP units.

b. Transporting and emplacing experiment subsystem.

c. Releasing Boydbolt fasteners.

d. Removing pull pins and releasing Deutsch fasteners.

e. Actuating the auxiliary "astronaut" switches.

The DRT is used to remove the top from the RTG fuel cask, providing access to the fuel capsule. The FTT is used to transfer the fuel capsule from the cask to the RTG. Both tools are discarded after use.

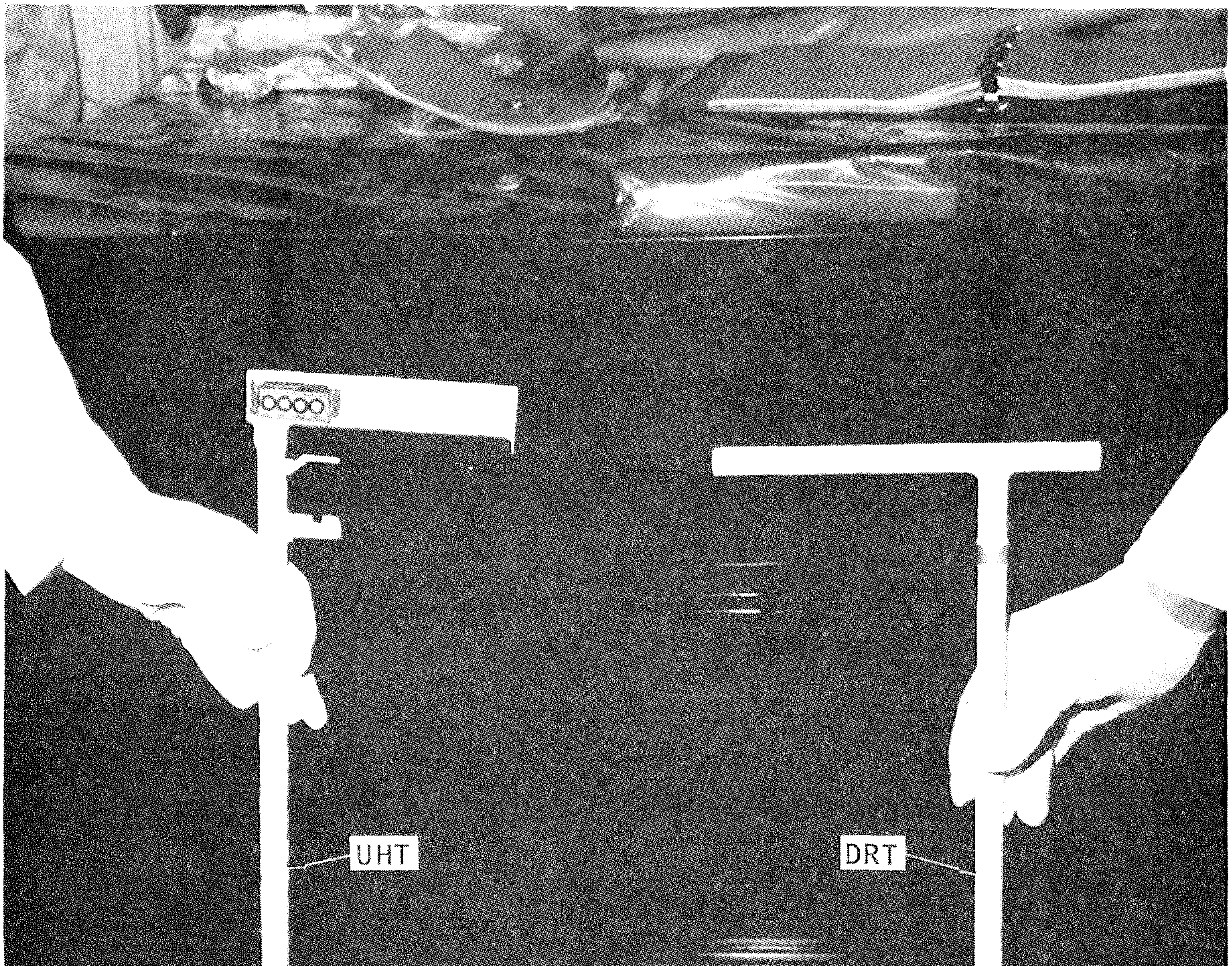


FIGURE 4.1-1 UHT AND DRT

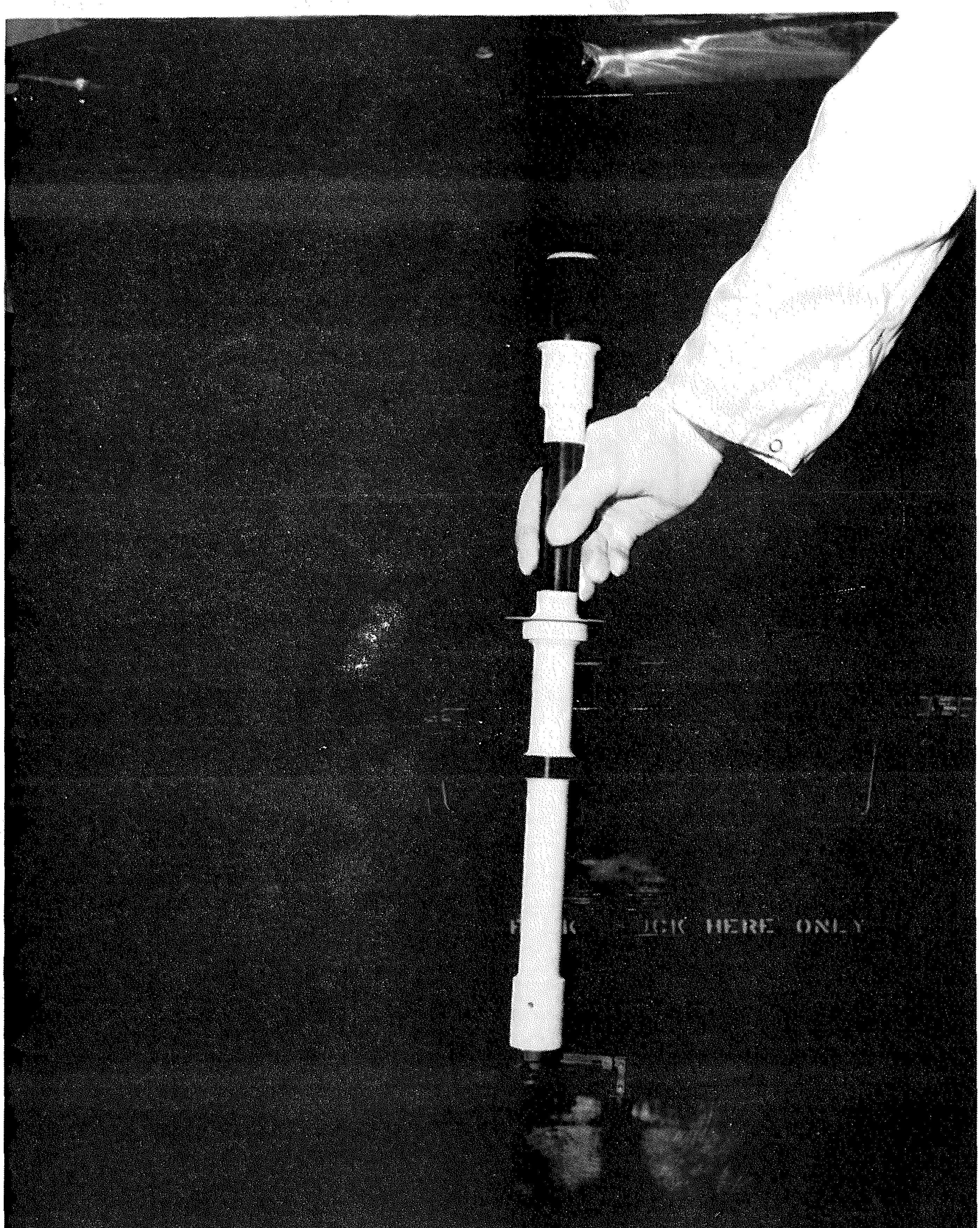


FIGURE 4.1-2 FTT

4.2 DEPLOYMENT GEOMETRY AND CONSTRAINTS

The ALSEP deployment geometry is flexible although definite geometric constraints exist and are defined. Figure 4.2-1 shows a very general deployment configuration and 4.2-2 shows one solution to the geometric constraints. Individual items have specific alignment criteria, but deployment flexibility is derived from the fact the relationships between item location is variable. Tables 4.2-1 through 4.2-7 provide more detailed information on the deployment constraints on individual items.

A general constraint for deployment is that the astronaut should not stretch the electrical cables taut during deployment. Deploying equipment at maximum cable length with cables taut could result in connector problems.

DEPLOYMENT FOR ALSEP 1

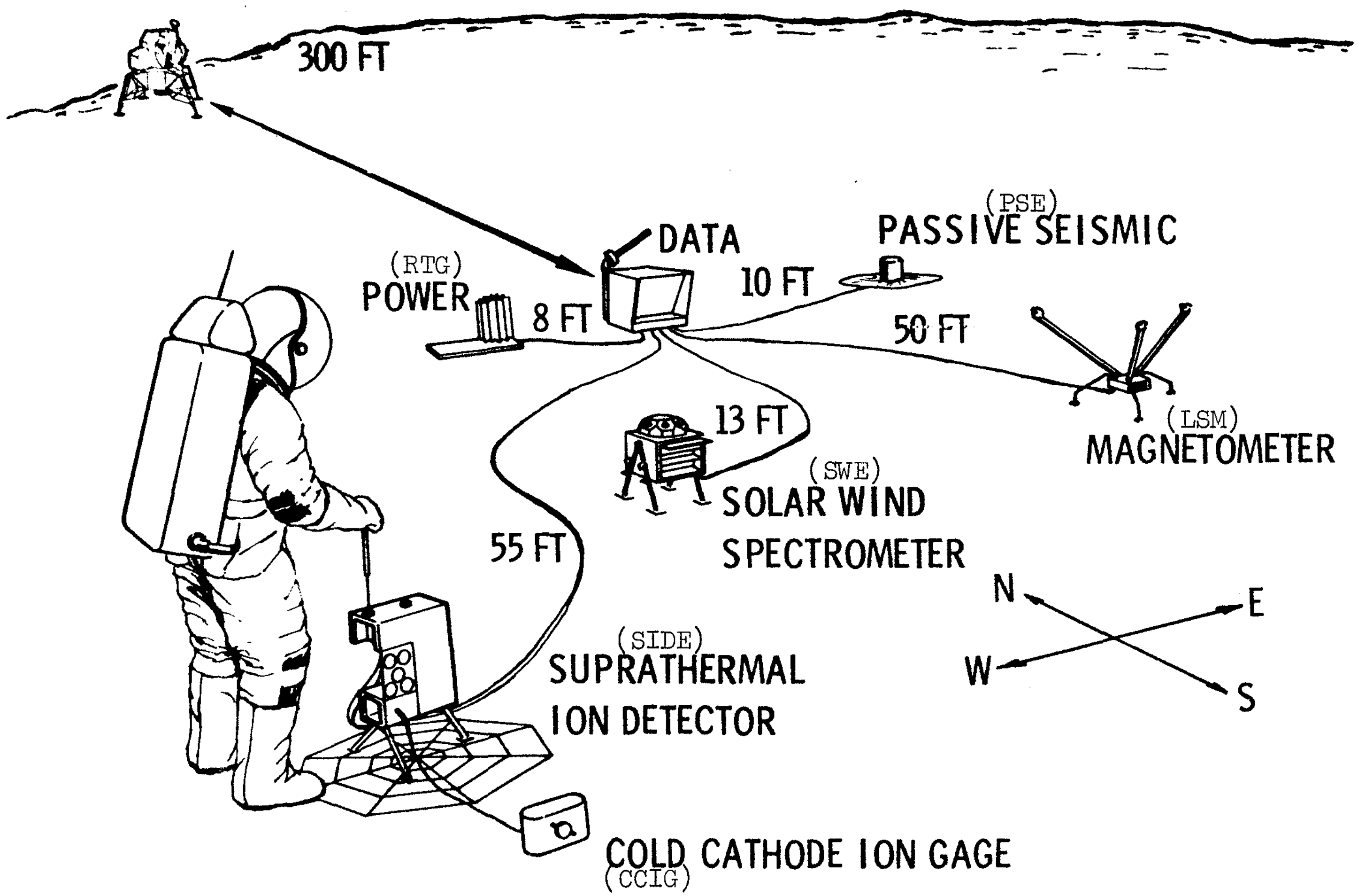
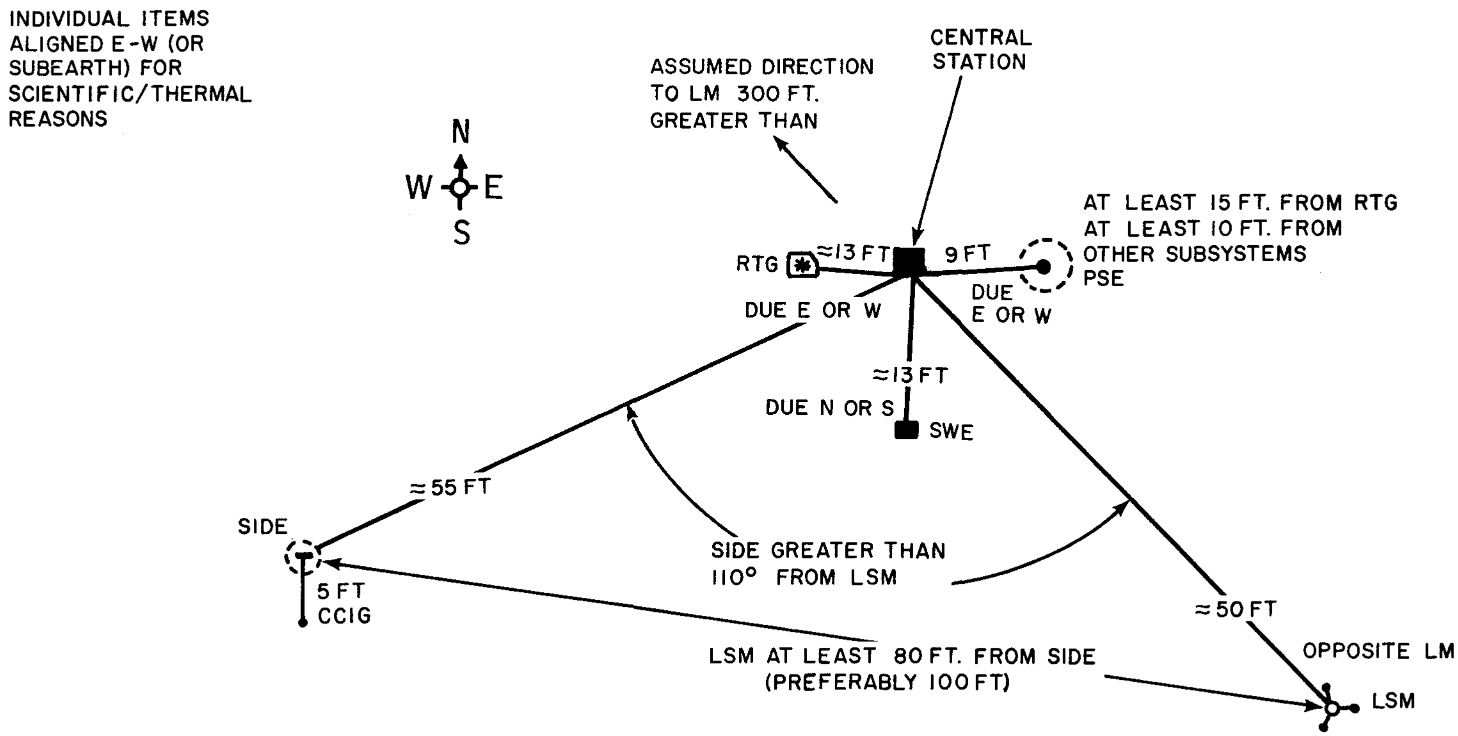


Figure 4.2-1

ALSEP 1 SYSTEM GEOMETRY



SHOWS ONE SOLUTION TO THE GEOMETRIC CONSTRAINTS

FIGURE 4.2-2

TABLE 4.2-1 CENTRAL STATION DEPLOYMENT CONSTRAINTS

Parameter	Constraint
Central Station - to - LM Separation	300 feet. This distance is required to keep ALSEP out of the LM ascent blast area.
Central Station Orientation from LM	Must not be due East or West.
Central Station Deployment Site	Approximately horizontal, as eyeballed by astronaut to provide stable base for antenna. Astronaut must avoid craters and slipes which would degrade thermal control of unit.
Central Station Leveling	$\pm 2.5^{\circ}$ of vertical as noted by astronaut on bubble level.
Central Station Alignment	$\pm 1^{\circ}$ East-West as aligned by astronaut using partial compass rose. Alignment affects thermal control capability of Subpackage #1. Closed or curtained sides of Central Station must face East-West.
Interrelation	Central Station, as with most ALSEP subsystems, requires clear field-of-view for both thermal control and scientific data reasons. Central Station must not be shaded from the sun more than absolutely necessary prior to deployment. ALSEP design allows deployment when sun angle is between 7 and 45 degrees. ALSEP may be removed from LM when bottom of SEQ Bay is from 18 to 60 inches from lunar surface and with a 15-degree tilt in any direction.

TABLE 4.2-2 RTG DEPLOYMENT CONSTRAINTS

Parameter	Constraint
Separation between RTG and Central Station	9 to 13 feet. Limited by 13-foot cable. Hot RTG should be away from Subpackage #1 to avoid contact with astronaut, and to provide maximum heat radiation to free space.
RTG Orientation from Central Station	East or West of Subpackage #1 $\pm$ 20° as eyeballed by astronaut to minimize thermal load on Subpackage #1.
RTG Deployment Site	Horizontal site. Pallet must be horizontal $\pm$ 10°, as eyeballed by astronaut. No mechanical provisions for astronaut to level RTG. Astronaut will avoid craters and slopes which impede dissipation of heat from RTG.
Interrelation	RTG requires maximum view of space to maximize heat radiation. Astronaut will read ammeter on shorting switch box, connect RTG to Central Station, actuate switch.

TABLE 4.2-3 ANTENNA DEPLOYMENT CONSTRAINTS

Parameter	Constraint
Site Selection	Attached to Central Station
Antenna Leveling	$\pm 0.25^\circ$ of vertical. Astronaut will use bubble level to adjust. Level adjustment interacts with alignment.
Antenna Alignment	$\pm 0.25^\circ$ of East-West line, with reference to sun line. Astronaut will use sun dial to align.
Antenna Azimuth Setting	Astronaut will set dial to value indicated on Antenna Aiming Tables for landing site chosen.
Antenna Elevation Setting	Astronaut will set dial to value indicated on Antenna Aiming Tables for landing site chosen.
Special Requirements	1. Maximum Allowed Errors for Astronaut Alignment: a. Scale Setting: 0.25° b. Leveling: 0.50° c. Shadow Alignment: 0.70° d. Overall Mean: 1.16°

TABLE 4.2-4 PSE DEPLOYMENT CONSTRAINTS

Parameter	Constraint
PSE - to - Central Station Separation	8 to 10 feet. Limited by 10-foot cable. 8-feet minimum separation due to thermal heat from RTG.
PSE Orientation from Central Station	Due East or West or Central Station as eyeballed by astronaut. Must be out of field-of-view of Central Station radiator.
PSE Deployment Site	Approximately level spot, free from loose material.
PSE Leveling	Must be coarse leveled by astronaut with ± 5 degrees of vertical because 5 degrees is the limit of the automatic, fine-leveling gimbal system.
PSE Alignment	Astronaut must rough align so that a shadow from the center to the edge does not fall on the areas indicated. Fine alignment reading will be performed by the astronaut after removing girdle and spreading the thermal shroud. Astronaut will read and record, to the nearest degree, the intersection of the shadow of the gnomon on the compass rose. Final azimuth alignment must be known within ± 5 degrees accuracy with reference to lunar North or South.
Interrelation	PSE must be no less than 10 feet from other units to minimize pickup of stray vibrations by PSE.

TABLE 4.2-5 LSM DEPLOYMENT CONSTRAINTS

Parameter	Constraint
Seperation between LSM and Central Station	40 to 55 feet. Limited by 55-foot cable. Separation required to minimize EMI effects on LSM sensors.
LSM Orientation from Central Station	On opposite side of Subpackage #1 from LM $\pm$ 20° as eyeballed by astronaut. Required to minimize magnetic and EMI influences on LSM.
LSM Deployment Site	Approximately horizontal site free from loose material. Astronaut will eyeball site for maximum stability for experiment.
LSM Leveling	$\pm$ 3° of vertical. Support legs adjusted by astronaut using bubble level on LSM.
LSM Alignment	$\pm$ 3° of East-West sun line. Set by astronaut using color-coded leg towards East, then Shadowgraph. Astronaut must read Shadowgraph within $\pm$ 1°. Alignment is critical because thermal control is critical and the exact alignment is required to interpret LSM scientific data.
Interrelation	LSM must be 80 feet, preferably 100 feet from SIDE/CCGE which contains strong magnet. Magnet could perturbate LSM scientific data if closer. LSM Site Survey must not be performed while astronauts are still on lunar surface.

TABLE 4.2-6 SWE DEPLOYMENT CONSTRAINTS

Parameter	Constraint
SWE - to - Central Station Separation	12 to 13.5 feet. Limited by 15-ft. cable.
SWE Orientation from Central Station	Approximately due North or South. Less than 30° from N-S line. Astronaut must eyeball direction.
SWE Deployment Site	Approximately horizontal site to avoid thermal perturbations. Astronaut must eyeball site.
SWE Leveling	$\pm 5^{\circ}$ of vertical about its E-W hinge axis. Due to A-frame construction, there is a pendulum effect about E-W axis. SWE should swing freely. If not, the Astronaut may nudge it with handling tool. No leveling about N-S axis is necessary since N-S orientation is determined from sun sensor TM data.
SWE Alignment	$\pm 5^{\circ}$ of East-West. Rough align by making arrow point E or W with respect to sun line. Louvered side (radiator) must be away from RTG and Subpackage #1 due to thermal control requirement.

TABLE 4.2-7 SIDE/CCIG DEPLOYMENT CONSTRAINTS

Parameter	Constraint
SIDE - to - Central Station Separation	50 to 60 feet. Limited by 60-foot cable. Minimum 50 feet needed to minimize EMI on LSM experiment.
SIDE Orientation from LSM	110° from LSM site. SIDE - LSM separation must be 80 feet minimum, preferably 100 feet.
SIDE Site Selection	Smooth as eyeballed by astronaut to allow ground screen and SIDE emplacement.
SIDE Leveling	Must be $\pm 5^{\circ}$ of vertical. Astronaut will utilize bubble level during emplacement.
SIDE Alignment	$\pm 5^{\circ}$ of East-West line, with respect to sun line to satisfy SIDE thermal and scientific data - gathering requirements. Astronaut will align unit utilizing direction marking which indicates which end of the experiment must face the sub-earth point. The large side areas of the experiment must face in a N-S direction for proper thermal control. Final alignment by astronaut utilizing shadows on long sides of SIDE.
CCIG - SIDE Separation	3.5 to 4 feet, limited by cable. CCIG must be off the SIDE ground screen.
CCIG Alignment	Orifice must be $\pm 20^{\circ}$ of North-South line, oriented so it has a clear field of view, away from all other subsystems and the LM.
Interrelation	CCIG includes a strong magnet which would affect LSM if separation is not at least 80 feet.

4.3 Deployment Procedures

Two man deployment is planned for the ALSEP Flight No. 1 configuration based on the following assumptions and conditions:

a. LM SEQ oriented toward the sun (lunar east)

b. Commander and LM Pilot maintain constant voice contact during deployment with each other and with MCC.

c. The task sequence is based on information supplied by NASA Flight Crew Support Divison on May 30, 1969.

Table 4.3-1 presents a task sequence for each astronaut during ALSEP deployment. The time line is not presented in this table. It is expected that this deployment sequence will change as additional deployment exercises are performed by the astronauts.

Table 4.3-1 ALSEP
Deployment Task Sequence

CDR ACTIVITIES	LMP ACTIVITIES
	P1.0 <u>OPEN SEQ BAY DOOR</u>
	P1.1 Remove thermal shielding covering door lanyard
	P1.2 Retrieve door lanyard and walk 10 feet from LM deploying lanyard.
	P1.3 Pull white section of lanyard until SEQ and astronaut doors open fully.
C1.0 <u>REMOVE PACKAGE NO.1</u>	P1.4 Stow lanyard on -Z gear struts.
C1.1 Retrieve package No. 1 deployment lanyard.	
C1.2 Walk 10 feet from LM deploying lanyard.	
C1.3 Pull white section of lanyard to unlock and pull package No.1 from the SEQ. Bay. Insure boom is extended fully.	
C1.4 Lower package No.1 to lunar surface by alternately pulling and releasing the black 1 white section of lanyard.	
C1.5 Walk to package No.1	P2.0 <u>REMOVE PACKAGE NO. 2</u>
C1.6 Disconnect deployment lanyard from package No. 1.	P2.1 Retrieve package No. 2 deployment lanyard.
C1.7 Pull boom cable release D-ring.	P2.2 Walk 10 feet from LM deploying lany
C1.8 Place lanyard behind Package No.1.	
C1.9 Remove boom attachment assembly from package No.1 by pulling pip pin. Discard assembly and pin under LM.	
C1.10 Remove package No. 1 to a position clear of the SEQ. bay working area.	

CDR ACTIVITIES	LMP ACTIVITIES
	P2.3 Pull white section of lanyard to unlock and pull package No. 1 from the SEQ. bay. Insure boom is extended fully.
	P2.4 Lower package No. 2 to Lunar Surface by alternately pulling and releasing black/white section of lanyard.
	P2.5 Walk to package No. 2.
	P2.6 Disconnect deployment lanyard from package No. 2
	P2.7 Pull boom cable release D-ring.
	P2.8 Place lanyard behind package No. 2.
	P2.9 Pull pip pins to release ALHT carrier (2) boom attachment assembly (1) sub pallet (1) universal, handling tools (1), and dome removal tool (1).
	P2.10 Remove boom attachment assembly and discard under LM.
	P2.11 Reposition package No. 2 near the fuel cask for RTG fueling.
C2.0 <u>STOW BOOMS</u>	P3.0 Remove ALHT Carrier
C2.1 Stow package No. 2 boom by pulling black/white boom stowage lanyard until boom is fully retracted.	P3.1 Remove and discard green pins, lanyards and D-Rings.
	P3.2 Lift ALHT carrier from package No. 2.
C2.2 Stow package No.1 boom by pulling black/white boom stowage lanyard until boom is fully retracted.	P3.3.0 Expand ALHT carrier.
	P3.3.1 Unfold legs to the fully deployed detent positions.
C3.0 <u>STRIP PACKAGE NO.2.</u>	
C3.1 Remove one UHT and stow in package No. Two UHT socket.	P3.3.2 Pull apex leg out to the fully deployed detent position.
C3.2 Remove other UHT and tether.	P3.3.3 Remove the green safety clip from the ALHT carrier underside.
C3.3 Remove tool stowage bracket.	
	P3.3.4 Remove the gold pins
C3.4 Remove and mate mask/carry box sections.	P3.3.5 Unfold ALHT carrier.
C3.5 Install antenna mask/carry bar on package No. 1.	

CDR ACTIVITIES	LMP ACTIVITIES
	P4.0 PREPARED FOR RTG FUELING
	P4.1 Remove DRT and FTT from package No.2 and stow in ALHT carrier.
C3.6 Tip package No.2 to fueling position	P5.0 FUEL RTG
C3.7 Release two subpallet Boyd bolts	P5.1 Retrieve cask lanyard from astronaut safety door.
C3.8 Remove subpallet from package No. 2 and place on surface clear of fuel cask area.	P5.2 Walk 10 feet from fuel cask deployi cask lanyard.
C4.0 MONITOR SAFETY	P5.3 Pull lanyard to cut left uplock pin, dome spline and cut right uplock pin.
C4.1 Retrieve DRT from ALHT carrier	P5.4 Tilt cask down into position for fuel element removal.
	P5.5 Stow lanyard on -y gear strut.
C4.2 Pass DRT to LMP	P5.6 Receive DRT from CDR.
	P5.7 Mate DRT with dome locking mechanism and pull outward on DRT to insure it is locked in place.
	P5.8 Press inward on DRT and rotate dome locking mechanism 150° clockwise.
C4.3 Retrieve and open FTT.	P5.9 Remove dome and discard DRT/dome.
C4.4 Transfer FTT to LM Pilot	P5.10 Receive FTT from Commander
	P5.11 Insert FTT fingers into fuel capsul head.
	P5.12 Engage FTT fingers in fuel capsule head by rotating knob clockwise
	P5.13 Withdraw fuel capsule from fuel cas
	P5.14 Turn to Package No. 2.
	P5.15 Lower fuel capsule into Radioisoto Thermoelectric Generator (RTG)
	P5.16 Report RTG fueled.

P5.17 Disengage FTT fingers from fuel capsule head by counter-rotation of knob.

P5.18 Discard FTT.

C5.0 PREPARE FOR TRAVERSE

C5.1 Retrieve subpallet and ALHT carrier and place near MESA.

C5.2 Retrieve tongs, gnomon, hammer, extension handle, and bay dispensers from MESA and stow on ALHT carrier.

C5.3 Reorientate TV camera to view ALSEP deployment area

P6.0 PREPARE FOR TRAVERSE

P6.1 Retrieve SEQ. door lanyard

P6.2 Pull black/white section of lanyard until SEQ. and astronaut safety doors are fully closed.

P6.3 Discard lanyard under LM.

P6.4 Tilt package to carry orientation.

P6.5 Remove UHT from package No. 2 and tether.

P6.6 Carry package No. 2 to package No.

P6.7 Connect package No. 2 to carry bar/ package No. 1.

C6.0 TRAVERSE TO DEPLOYMENT SITE

C6.1 Carry ALHT and subpallet to a suitable ALSEP deployment site approximately 300 feet from the LM for a N.W. or S.E. site or 350 feet for a N.E. or S.W. site. Rest in route.

C6.2 Place ALHT carrier and subpallet on surface in a convenient location.

P7.0 TRAVERSE TO DEPLOYMENT SITE

P7.1 Carry the ALSEP packages to the ALSEP deployment site. Rest in route.

P7.2 Place packages on surface with package No. 2 in its final location properly oriented.

C7.0 CONNECT SIDE/CCIG TO PACKAGE NO.1.

C7.1 Use UHT to release four Boyd bolts on SIDE/CCIG.

C7.2 Engage UHT in SIDE/CCIG carry socket

P8.0 CONNECT RTG TO PACKAGE NO. 1.

P8.1 Disengage carry bar from Package No.

P8.2 Lift Package No. 1 and emplace approximately 10 feet from Package No. 2 on E-W axis.

C7.3 Use UHT to remove SIDE/CCIG from Subpallet.

C7.4 Remove left, front guide.

C7.5 Pull SIDE/CCIG cable reel from cavity and drop reel to surface.

C7.6 Pull lanyard to remove leg-release pull pin and dust cover safety pin.

C7.7 Lower SIDE/CCIG to lunar surface.

C7.8 Use UHT to remove pull pin on SIDE/CCIG cable cradle and retrieve SIDE/CCIG connector from cable cradle.

C7.9 Walk to Package No. 1.

C7.10 Remove SIDE/CCIG connector dust cover and discard.

C7.11 Remove Central Station connector dust cover and discard.

C7.12 Mate SIDE/CCIG cable to Central Station.

C8.0 <u>DEPLOY PSE STOOL</u>

C8.1 Disengage carry bar from Package No. 1.

C8.2 Stow antenna mast/carry bar on Subpallet taper fitting.

C8.3 Use UHT to remove pull pin on PSE leveling stool and discard pull pin.

C8.4 Engage UHT in PSE leveling stool socket.

C8.5 Remove PSE leveling stool from Subpallet and walk To ALHT Carrier.

C8.6 Remove gnomon from SLHT carrier and carry PSE stool and gnomon near PSE deployment site.

P8.3 Return to Package No.2

P8.4 Use stowed UHT as a handle to rotate Package No. 2 to the deploye[d] position and align on E-W axis.

P8.5 Use UHT to release three Boyd bolts on RTG cable reel.

P8.6 Engage UHT in RTG cable reel carry socket.

P8.7 Use UHT to remove RTG cable reel fr[om] Package No. 2 and walk to Package No. 1, deploying power cable.

P8.8 Remove shorting switch pull pin and discard.

P8.9 Grasp shorting switch assembly.

P8.10 Disengage UHT from RTG cable reel and discard cable reel.

P8.11 Report ammeter reading.

P8.12 Remove shorting switch assembly dust cover and discard.

P8.13 Remove Central Station connector dust cover and discard.

P8.14 Mate power cable to Central Station and lock.

P8.15 Actuate shorting switch assembly pushbutton.

P8.16 Report opening of shorting switch.

P9.0 <u>EMPLACE PACKAGE NO. 1</u>

P9.1 Engage UHT in Package No. 1 UHT socket.

P9.2 Use UHT as a handle to rotate Pack[age] No. 1 to the deployed position and align on E-W axis.

CDR ACTIVITIES	LMP ACTIVITIES
C8.7 Place gnomon on surface clear of deployment site.	P9.3 Verify shorting switch ammeter indicating zero.
C8.8 Place PSE stool on surface in position for PSE Deployment.	P10.0 REMOVE AND DEPLOY PSE
C9.0 REMOVE AND DEPLOY SWE	P10.1 Use UHT to release four Boyd bolts on PSE.
C9.1 Use UHT to release four Boyd bolts on SWS.	P10.2 Engage UHT in PSE carry socket.
C9.2 Engage UHT in SWS carry socket.	P10.3 Use UHT to remove PSE from Sunshield and carry PSE to leveling stool.
C9.3 Use UHT to remove SWS from sunshield and carry SWS 13 feet from Central Station.	P10.4 Remove PSE girdle and discard.
	P10.5 Emplace PSE on leveling stool and align.
C9.4 Extend four leveling legs to locked position.	P10.6 Use UHT to deploy thermal shroud.
C9.5 Emplace SWS on lunar surface and align by observing shadow cast on sensor head.	P10.7 Use UHT to level PSE.
	P10.8 Report Alignment.
C9.6 Check thermal door open and facing away from central station.	P10.9 Photograph deployed PSE
C10.0 REMOVE LSM FROM CENTRAL STATION	P10.10 Pickup gnomon and walk to LSM
C10.1 Use UHT to release two Boyd bolts on LSM.	
C10.2 Pull handle of upper support bracket fully upward, and then forward.	
C10.3 Continue to lift upper support bracket/brace assembly clear of LSM and discard.	
C10.4 Grasp lift-off handle, pull fully upward, and remove LSM from sunshield.	
C10.5 Carry LSM approximately 10 feet toward the LSM deployment site.	
C10.6 Retrieve carry handle and rotate LSM to vertical position.	
C10.7 Place LSM on surface.	

CDR ACTIVITIES	LMP ACTIVITIES

C11.0 RELEASE SUNSHIELD BOYD BOLTS

C11.1 Release Boyd bolts on forward-left edge of central station.

C11.2 Release Boyd bolt on SIDE connector housing and insure housing falls free from central station.

C11.3 Release Boyd bolts on west side of central station.

C11.4 Use UHT to remove antenna cable restraint and deploy cable.

C11.5 Release Boyd bolt on left antenna stowage bracket.

C11.6 Release Boyd bolts on back side of central station.

C11.7 Release Boyd bolt on right antenna stowage bracket.

C11.8 Release Boyd bolts on right side of central station.

C11.9 Release Boyd bolts on right-front side of central station.

C11.10 Walk to a position behind the central station.

C11.11 Visually check sunshield clear to extend

C11.12 Release two interior Boyd bolts.

C12.0 DEPLOY CENTRAL STATION SUNSHIELD

C12.1 Use UHT to restrain sunshield and deploy center Boyd bolt.

C12.2 Control sunshield extension with UHT.

C12.3 Complete sunshield deployment using manual assist.

C12.4 Remove three sunshield curtain covers and discard.

P11.0 DEPLOY LSM

P11.1 Place gnomon on surface near LSM.

P11.2 Lift LSM from surface with carry handle using left hand, retrieve liftoff handle with right hand and transfer LSM to right hand.

P11.3 Retrieve gnomon from surface.

P11.4 Carry LSM and gnomon to LSM deployment site 50 feet from central station.

P11.5 Place gnomon on lunar surface.

P11.6 Grasp carry handle and rotate LSM to vertical position.

P11.7 Grasp handle of lower half of upper support bracket, remove bracket frc LSM and discard.

P11.8 Deploy three lunar support legs.

P11.9 Rotate LSM so color-coded Z-lunar support leg is oriented eastward and lower LSM to lunar surface.

P11.10 Use UHT to remove and discard foan packing.

P11.11 Use UHT to extend Y-sensor arm.

P11.12 Use UHT to extend Z-sensor arm.

P11.13 Use UHT to extend X-sensor arm.

P11.14 Retrieve PRA cover lanyard D-ring

P11.15 Pull PRA cover from LSM and discai

P11.16 Check LSM free of packing materia and pieces.

P11.17 Check PRA thermal doors open

P11.18 Align LSM by grasping nearest door and rotating LSM until gnomon dot shadow is centered on shadow graph

P11.19 Observing bubble level, use UHT tc level LSM.

CDR ACTIVITIES

C12.5 Check proper deployment of side curtains

C13.0 ASSEMBLE ANTENNA

C13.1 Retrieve antenna mast from Subpallet.

C13.2 Install antenna mast on Central Station.

C13.3 Return to central station and release antenna mechanism housing Boyd bolts

C13.4 Engage UHT in aiming mechanism housing carry socket.

C13.5 Use UHT to lift aiming mechanism housing from Subpallet.

C13.6 Remove cover from aiming mechanism housing and discard.

C13.7 Install aiming mechanism on antenna mast.

C13.8 Disengage UHT from aiming mechanism housing.

C13.9 Remove aiming mechanism housing and packaging and discard.

C13.10 Rotate antenna tie-down brackets retrieve antenna and install on aiming mechanism.

C14.0 ORIENT ANTENNA

C14.1 Enter azimuth offset.

C14.2 Enter elevation offset.

C14.3 Observing bubble level, adjust leveling knobs.

C14.4 Observing sun compass adjust alignment knob.

C15.0 COMPLETE ALSEP DEPLOYMENT

C15.1 Use UHT to turn on Astronaut Switch No. 1.

C15.2 Request transmitter turn-on.

LMP ACTIVITIES

P11.19 Check bubble level and shadowgraph for level and alignment, and report alignment to within 1° of azimuth orientation.

P11.20 Photograph deployed LSM.

P11.21 Retrieve gnomon and return to cent station.

P12.0 PHOTOGRAPH SWE

P12.1 Place gnomon on surface near SWE

P12.2 Photograph deployed SWE

P12.3 Retrieve gnomon and walk to SIDE/CC

P13.0 DEPLOY SIDE/CCIG

P13.1 Engage UHT in SIDE/CCIG carry socke

P13.2 Carry SIDE/CCIG to deployment site approximately 55 feet from Central station.

P13.3 Place gnomon on surface.

P13.4 Place SIDE/CCIG on surface.

P13.5 Engage UHT in ground screen socket, rotate clockwise, and lift ground screen from tube.

P13.6 Check ground screen cable deployment.

P13.7 Emplace ground screen on lunar surface.

P13.8 Use UHT to release CCIG cover Deutsch fastener.

P13.9 Engage UHT in SIDE/CCIG carry socke and lift SIDE/CCIG from surface.

P13.10 Remove CCIG cover assembly and discard.

P13.11 Use lanyard to remove CCIG from stowage cavity.

P13.12 Emplace SIDE on ground screen wit respect to subearth point. Use lan yard to lower CCIG to lunar surface

CDR ACTIVITIES	LMP ACTIVITIES
C15.3 Recheck antenna orientation	P13.13 Orient CCIG orifice and release cable.
C15.4 Receive confirmation of receipt of RF signal and useful data. Untether UHT from EMU.	P13.14 Level SIDE and align by observing shadow cast on side of experiment.
	P13.15 Photograph deployed SIDE and CCIG
	P13.16 Retrieve gnomon and return to central station.

CDR ACTIVITIES	LMP ACTIVITIES
C15.3 Recheck antenna orientation	P13.13 Orient CCIG orifice and release cable.
C15.4 Receive confirmation of receipt of RF signal and useful data. Untether UHT from EMU.	P13.14 Level SIDE and align by observing shadow cast on side of experiment.
	P13.15 Photograph deployed SIDE and CCIG
	P13.16 Retrieve gnomon and return to central station.

5.0 GLOSSARY

Abbreviation	Definition
A/D	Analog to Digital
ALHT	Apollo Lunar Hand Tools
ALSD	Apollo Lunar Surface Drill
ALSEP	Apollo Lunar Surface Experiments Package
AMU	Atomic Mass Unit
ASE	Active Seismic Experiment
ASI	Apollo Standard Initiator
BxA	Bendix Aerospace Systems Division
CCGE	Cold Cathode Gauge Experiment
CCIG	Cold Cathode Ion Gauge
CFE	Contractor Furnished Equipment
CM	Command Module
CPA	Curved Plate Analyzer
CPLEE	Charged Particle Lunar Environment Experiment
CS	Central Station
DRT	Dome Removal Tool
DS/S	Data Subsystem
EGFU	Electronics/Gimbal-Flip Unit
EMU	Extravehicular Mobility Unit
EPS	Electrical Power Subsystem
FCA	Fuel Capsule Assembly
FET	Field Effect Transistor
FTT	Fuel Transfer Tool
GFE	Government Furnished Equipment
GHz	Gigahertz