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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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APOLLO MISSION J-3

(APOLLO 17)

MISSION SCIENCE PLANNING DOCUMENT

PRELIMINARY

APRIL 24, 1972

SCIENCE MISSIONS SUPPORT DIVISION
SCIENCE AND APPLICATIONS DIRECTORATE
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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Prepared by TRW Systems
for
SCIENCE MISSIONS SUPPORT DIVISION
SCIENCE AND APPLICATIONS DIRECTORATE
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

Contract NAS 9-12330

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(Apollo 17)

PRELIMINARY

SUBMITTED BY:

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ACKNOWLEDGEMENT

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- Section II, Experiment Descriptions: Apollo Lunar Surface Experiment Package (ALSEP) equipment descriptions supplied by the Bendix Aerospace Systems Group and the SIM bay experiment descriptions supplied by North American Rockwell, Downey.
- Section III, Photographic Plan: Science Requirements and Operations Branch/TD5, supported by the General Electric Company; the Mapping Sciences Branch/TF5; and the Photographic Technology Division/JL.
- Section IV, Lunar Surface Science Plan: Systems Engineering Division/PD, the USGS Center of Astrogeology, and Bellcomm, Inc.
- Section V, Science Recovery Plan: Science Requirements and Operations Branch/TD5, supported by the General Electric Company.
- Section VI, Lunar Receiving Laboratory Plan: Lunar Receiving Laboratory/TL.
- Appendix E, Film Characteristics and Processing Test Data: Photographic Technology Division/JL.

The information and advice provided by other organizations and individuals, too numerous to list, are also gratefully acknowledged.

INTRODUCTION

The Mission Science Planning Document (MSPD) is intended primarily as a science overview for use by experiment Principal Investigators, members of the scientific community, and personnel involved in planning science activities for the Apollo Mission J-3. It is also intended to provide detailed interim data for use in implementing the science requirements presented in the MSC-controlled J-3 Mission Requirements Document (MRD) until such data are published in other MSC-controlled documents. Such documents include the Apollo 17 Flight Plan, Apollo 17 Lunar Surface Procedures, Apollo 17 Flight Mission Rules, Apollo Operations Handbook, and CSM/LM Spacecraft Operational Data Book. The MRD contains the science and operational requirements for science experiments and science-related detailed objectives assigned to the mission; the other documents present detailed hardware data and procedures for implementing these requirements. In case of conflicts, the MRD and other controlled documents take precedence over the MSPD.

The MSPD is divided into six sections: Section I, General Mission Science Planning; Section II, Experiment Descriptions; Section III, Photographic Plan; Section IV, Lunar Surface Science Plan; Section V, Science Recovery Plan; and Section VI, Lunar Receiving Laboratory Plan. These sections contain detailed data which supplement science requirements incorporated in Sections 4 and 5 of the MRD. The MSPD also contains five appendixes: Appendix A, Acronyms and Abbreviations; Appendix B, Glossary; Appendix C, References; Appendix D, Distribution; and Appendix E, Film Characteristics and Processing Test Data.

The publication schedule for the MSPD has been coordinated with other MSC organizations to optimize the availability and use of science data for preparation of MSC-controlled documents. Nominal MSPD publication dates for each mission are L-9 months (Preliminary), L-5 months (Final), and L-2 1/2 months (Revision). Schedules and contents will be changed as necessary to satisfy user needs and availability of data.

All proposed changes to and requests for additional copies of the MSPD should be submitted in writing to the following representative of the Science Missions Support Division, Science and Applications Directorate, Manned Spacecraft Center, Houston, Texas:

Mr. Richard R. Baldwin/TD5
Mission Science Manager

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SECTION I

GENERAL MISSION SCIENCE PLANNING

1.1 GENERAL

This section contains general information for the Apollo Mission J-3 (Apollo 17). It includes a summary of science-oriented mission characteristics; a brief description of the Taurus-Littrow landing site; a listing of each assigned experiment and detailed objective (DO) that is science related, and their cognizant Principal Investigator (PI) and Point-of-Contact at the Manned Spacecraft Center (MSC); and a prioritized list of these experiments and detailed objectives.

Data presented in this section are intended primarily as general information for experiment PI's and members of the scientific community. Much of the data are subject to constant change until launch because of the dynamic nature of the Apollo Spacecraft Program. For official planning data, reference should be made to MSC-controlled documents as they become available. These documents include the J-3 Mission Requirements Document (MRD) (Reference 1), Apollo 17 Flight Plan (Reference 2), and Apollo 17 Lunar Surface Procedures (Reference 3). The J-3 MRD contains approved mission science requirements; the other documents provide detailed information for implementing these requirements. In case of conflict, data in controlled documents take precedence over data in this section.

1.2 MISSION DESCRIPTION

1.2.1 J-3 MISSION CHARACTERISTICS

The J-3 Mission is the last of the three J-series missions and, correspondingly, the last lunar mission scheduled in the Apollo Program. This mission series has incorporated certain spacecraft hardware and crew equipment modifications including an advanced and comprehensive science equipment complement, both command and service module (CSM) and lunar surface experiments, to provide the capabilities for a much greater mission science return than has been possible on previous Apollo missions, notably the G- and H-series missions.

The major changes in the science payload for the J-3 Mission as compared to that planned for the J-2 Mission (Apollo 16) are

a) Deletion of the UV Photography-Earth and Moon (S-177) command module (CM) experiment

b) Deletion of the Gegenschein from Lunar Orbit (S-178) CM experiment

c) Deletion of the Gamma-Ray Spectrometer (S-160) CSM SIM (Scientific Instrument Module) bay experiment

d) Deletion of the X-Ray Fluorescence (S-161) CSM SIM bay experiment

e) Deletion of the Alpha Particle Spectrometer (S-162) CSM SIM bay experiment

f) Deletion of the Mass Spectrometer (S-165) CSM SIM bay experiment

g) Deletion of the Bistatic Radar (S-170) CSM SIM bay experiment

h) Deletion of the CSM SIM bay Subsatellite and its three experiments

    1) S-Band Transponder (S-164)

    2) Particle Shadows/Boundary Layer (S-173)

    3) Magnetometer (S-174)

i) Deletion of the Passive Seismic (S-031) Apollo Lunar Surface Experiments Package (ALSEP) experiment

j) Deletion of the Active Seismic (S-033) ALSEP experiment

k) Deletion of the Lunar Surface Magnetometer (S-034) ALSEP experiment

l) Deletion of the Solar Wind Composition (S-080) lunar surface experiment

m) Deletion of the Cosmic Ray Detector (Sheets) (S-152) lunar surface experiment

n) Deletion of the Portable Magnetometer (S-198) lunar surface experiment

o) Deletion of the Far UV Camera/Spectroscope (S-201) lunar surface experiment

p) Modification of Soil Mechanics (S-200) lunar surface experiment - from active to passive.

q) Addition of the Far UV Spectrometer (S-169) CSM SIM bay experiment

r) Addition of the IR Scanning Radiometer (S-171) CSM SIM bay experiment

s) Addition of the Lunar Sounder (S-209) CSM SIM bay experiment

t) Addition of the Traverse Gravimeter (S-199) lunar surface experiment

u) Addition of the Lunar Ejecta and Meteorites (S-202) ALSEP experiment

v) Addition of the Lunar Seismic Profiling (S-203) ALSEP experiment.

w) Addition of the Surface Electrical Properties (S-204) lunar surface experiment

x) Addition of the Lunar Atmospheric Composition (S-205) ALSEP experiment

y) Addition of the Lunar Surface Gravimeter (S-207) ALSEP experiment

An effort is also being made to develop a neutron flux monitor experiment and, simultaneously, to gain approval for its addition to the lunar surface science payload for the J-3 Mission.

The nominal launch date for the J-3 Mission is December 6, 1972 with the lift-off scheduled for 9:36 pm EST. This will be the first night launch in the Apollo Program. The lunar landing is to be performed in the Taurus-Littrow region of the moon. The current status of lunar surface exploration activities is described in Section IV.

1.2.2 LANDING SITE DESCRIPTION

Taurus-Littrow, the J-3 Mission landing area (Reference 4), is located in the northeastern portion of the moon (20°10' N latitude, 30° 48' E longitude) and is on the southeastern rim of Mare Serenitatis in a dark deposit between massif units of the southwestern Taurus Mountains, south of Littrow Crater. The precise landing coordinates are being determined.

The Taurus-Littrow area is characterized by massif units of the Taurus Mountains, which are believed to be ancient highland crustal blocks (pre-Imbrian in geologic age) which were emplaced by faulting and uplifting at the time of the formation of the Serenitatis basin. A large landslide or debris flow on a mountainside, approximately 5 kilometers southwest of the landing site, offers an excellent opportunity to sample the very old massif materials and younger ejecta without climbing the mountains. The lowlands between the massif units have dark deposits, believed to be among the moon's youngest surface units. The deposits are believed to be volcanic (pyroclastic) mantle which may have originated deep within the moon.

This region is geologically complex and it offers a number of surface rocks which apparently vary in age, albedo, composition and origin. The Apollo 17 landing site is approximately 750 kilometers east of Apollo 15 landing site and 750 kilometers north of the Apollo 11 landing site. Valuable data from the Taurus-Littrow site will be important in understanding the development of the northeastern area of the moon.

1.2.3 PRIMARY MISSION SCIENCE OBJECTIVES

Primary science objectives are extracted from the official list of primary mission objectives, assigned by the Office of Manned Space Flight (OMSF), that are listed in the Apollo Flight Mission Assignments (AFMA) directive (Reference 5) and Mission Implementation Plan (MIP) (Reference 6). These primary objectives are to

a) Perform selenological inspection, survey, and sampling of materials and surface features in a preselected ares of the Taurus-Littrow region.

b) Emplace and activate surface experiments.

c) Conduct in-flight experiments and photographic tasks.

These objectives have, in turn, been subdivided into individual experiments and detailed objectives. Experiments are those technical investigations which have been recommended and assigned a number (e.g., S-059, Lunar Geology Investigation) by the Manned Space Flight Experiments Board (MSFEB), and which have been subsequently assigned to the Apollo Program for flight by the Associate Administrator for Manned Space Flight. Detailed objectives (such as Service Module Orbital Photographic Tasks) represent scientific, engineering, medical, or operational investigations that provide important data and experience useful for the development of hardware and/or procedures for application to future space missions. The Apollo Program Director approves the assignment of experiments and detailed objectives to specific Apollo missions.

Only those experiments and detailed objectives of a science nature are discussed in this document. Detailed objectives and experiments for all disciplines as well as operational tests to be performed on the J-3 Mission as authorized by the Apollo 17 MIP (Reference 6) are listed and detailed in the J-3 MRD (Reference 1) published by the Systems Engineering Division of the Apollo Spacecraft Program Office (ASPO). Changes in mission assignment of experiments, detailed objectives, and operational tests are governed by the MIP and Configuration Control Board (CCB) directives approved by the Apollo Program Director.

1.2.4 MISSION SCIENCE-ORIENTED EXPERIMENTS AND DETAILED OBJECTIVES

The science-oriented experiments and detailed objectives assigned to this mission have been divided into three groups: those to be performed from the CM; those to be performed from the SM; and those to be performed on the lunar surface. Command module experiments and objectives are listed in Table 1-1, service module experiments and objectives are listed in Table 1-2, and lunar surface experiments are listed in Table 1-3. These tables also list the PI or Chairman of the PI Team, as applicable, and the Manned Spacecraft Center/Science and Applications Directorate (S&AD) Point-of-Contact assigned to each experiment or objective. The official CCB-controlled mission requirements (functional test objectives, test conditions, data requirements, etc.) for these experiments and objectives appear in the J-3 MRD.

Any questions that arise concerning the science or operational requirements of a particular experiment or objective should be directed to the S&AD Point-of-Contact who represents the science interface between MSC and the PI. Questions concerning integration of these experiments and objectives into mission and program planning should be referred to the

Science Mission Manager for the J-3 Mission, Mr. Richard R. Baldwin/TD5. Mr. Baldwin represents the S&AD science interface with the ASPO J-3 Mission Staff Engineer, Mr. Stanley M. Blackmer/PD12, who has the overall responsibility for integration of all mission requirements.

1.3 CONDUCT OF MISSION SCIENCE ACTIVITIES

1.3.1 EARTH ORBIT SCIENCE ACTIVITIES

There will be no scientific activities conducted from earth orbit. The nominal 90-nautical mile earth parking orbit will be used in preparation for translunar injection (TLI). The TLI burn will occur nominally in the second revolution after insertion of the Apollo spacecraft and S-IVB stage into earth orbit. The injection is to occur over the Atlantic Ocean; this is the first Atlantic injection during the Apollo Program.

1.3.2 TRANSLUNAR COAST SCIENCE ACTIVITIES

During translunar coast the spent S-IVB stage instrument unit (IU) assembly will be guided to impact the lunar surface. Two impact locations are under consideration. The first location is on the far side of the moon near the center of the disc, at approximately 0° latitude and 180° longitude. The second location being considered is on the eastern limb of the moon in the neighborhood of 0° latitude and 80° E longitude (Figure 1-1). The S-IVB impact provides a known seismic stimulus for sensors of the Passive Seismic Experiment (S-031) previously emplaced on Apollo 12, 14, 15 and 16.

1.3.3 LUNAR SCIENCE ACTIVITIES

1.3.3.1 Lunar Orbit Science Activities

The Scientific Instrument Module (SIM) door is scheduled for jettison approximately 4.5 hours before lunar orbit insertion (LOI). This door protects the SIM bay experiment sensors and cameras from adverse mission environments (launch, service propulsion system (SPS) contamination, etc.). Jettison prior to LOI keeps hazardous debris out of lunar orbit and prevents any subsequent CSM or Subsatellite (launched during Apollo 15 and 16) recontact. The SPS LOI burn will place the docked CSM/lunar module (LM) into a 170- by 60-nautical mile lunar orbit. A second SPS retrograde burn to perform descent orbit insertion (DOI) will place the docked CSM/LM into a 60- by 9-nautical mile elliptical orbit. From this orbit LM undocking and subsequent lunar descent will occur. Undocking will occur at approximately TBD hours after this burn. During this TBD time period the IR Scanning Radiometer, Far UV Spectrometer, and cameras will be scanning the lunar surface and the CSM and LM S-Band Transponder experiments will be performed. LM touchdown at the Taurus-Littrow landing site will occur at TBD hours after LOI.

Shortly before LM touchdown (TBD hours), a third SPS burn (posigrade) will be performed to circularize the CSM orbit at 60 nautical miles. The SIM bay experiment (including lunar sounder) and photographic activities, CM photographic activities, and CSM S-band transponder experiments will be performed. Orbital science data gathering will continue through the LM lunar surface stay period until approximately TBD hours prior to ascent stage lift-off. A CSM lunar orbit plane change is scheduled approximately TBD hours prior to ascent stage lift-off in readiness for CSM/LM rendezvous. Ascent stage lift-off will occur at TBD* hours after LOI.

A second plane change may be performed TBD hours after lift-off to increase lunar surface photographic and sensor coverage for the remainder of the mission. The SIM bay experiment sensors and cameras are then reactivated. CM photographic activities and the CSM S-band experiment are also conducted.

After docking and completion of crew/equipment/lunar samples transfer and stowing activities, the LM ascent stage will be undocked and propelled/guided to impact on the lunar surface at approximately 20° N latitude, 30° E longitude (Figure 1-1) as a known seismic stimulus for the ALSEP Lunar Seismic Profiling Experiment. LM ascent stage S-Band experiment data will be obtained prior to impact.

The approximate TBD time period between LOI and DOI is devoted primarily to CSM/LM tracking verification in order to form the basis for a DOI-commit decision. The total time period available in lunar orbit during which CSM/SIM experiments and photography can be performed is approximately TBD hours as measured from DOI to TEI.

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*Times indicated may be converted approximately to the number of CSM orbits elapsed after LOI by utilizing a period of 2 hours per orbit corresponding to the nominal 60-nautical mile CSM orbit.

1.3.3.2 Lunar Surface Science Activities

Three extravehicular activity (EVA) traverses are to be performed. These EVA's are planned for a duration of 7 hours each. The current status of surface science activities and planning appears in Section IV of this document. Preliminary traverse planning for the Taurus-Littrow landing area has just begun, consequently, detailed traverse plans will not be presented until the next document issue.

The following information contained in this document will be used to develop the J-3 Mission surface science plan:

a) Lunar surface science experiments to be deployed and conducted as identified and described in Sections I and II, respectively.

b) Lunar surface science photography requirements as identified in Section III.

c) Lunar traverse and geological requirements as identified in Section IV.

1.3.4 TRANSEARTH COAST SCIENCE ACTIVITIES

Scheduled transearth coast science activities include Far UV Spectrometer measurements and additional photography activities performed from the CM and SIM. An EVA period lasting approximately 45 minutes is performed by the CM pilot after TEI to retrieve two film cassettes from the SIM cameras and the optical recorder of the lunar sounder experiment. Pacific Ocean splashdown will nominally occur on December 19, 1972.

1.4 PRIORITY OF SCIENCE EXPERIMENTS AND DETAILED OBJECTIVES

The specification of science priorities is subject to the approval of the Associate Administrator for the Office of Space Sciences and Applications (OSSA) and the concurrence of the Apollo Program Office (APO). Recommendations for prioritization are made to OSSA by the Apollo Lunar Exploration Office. The priorities listed in this document are those appearing in the Apollo 17 MIP (Reference 6).

Science experiments and detailed objectives to be performed on the J-3 Mission are listed in Table 1-4 in descending order of priority. The order of priority presented is based upon such considerations as: (1) the science value of the experiment or detailed objective and the corresponding science benefits expected; (2) the results obtained from previous missions; (3) unachieved science objectives from previous missions; (4) changes made in the science payload since previous missions; (5) the science opportunity for the mission such as a particular landing site or astronomical conditions; (6) hardware which is flown the first time; and (7) the role of the experiment or objective in the integrated science plan for the Apollo Program and future space programs to be undertaken.

This prioritization benefits premission planning activities and is also of significance when any of the science experiments or detailed objectives cannot be accomplished as planned because of some contingency or abnormal situation (excessive ALSEP setup time, LRV deployment difficulty, etc.) occurring during the mission with a resulting impact on such major mission considerations as consumables reserves, crew participation in the science activities, and adherence to the mission timeline. This priority listing is provided to facilitate the assessment of the relative importance of each experiment or objective which will, in turn, aid in the real-time replanning and rescheduling of science activities. The information presented is intended to maximize the science return from the mission if a contingency situation arises where tradeoffs must be made and assessed quickly and efficiently in terms of crew, spacecraft, and mission constraints.

Table 1-1. J-3 Command Module Science Experiments/Objectives and Cognizant Science Personnel

LUNAR ORBIT EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
--	CM Photographic Tasks (Detailed Objective), includes use of: • Hasselblad Electric Camera • Maurer Data Acquisition Camera • 35-mm Nikon Camera	<u>CSM Orbital Science Photographic Team</u> Mr. Frederick J. Doyle, Chairman Topographic Division U.S. Geological Survey 1340 Old Chainbridge Road McLean, Virginia 22101 (202) 343-9445	Mr. Samuel N. Hardee, Jr./TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-176	Apollo Window Meteoroid	Mr. Burton G. Cour-Palais/TN6 Geology Branch Planetary and Earth Sciences Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4757	Mr. Samuel N. Hardee, Jr./TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

Table 1-1. J-3 Command Module Science Experiments/Objectives and Cognizant Science Personnel (Continued)

LUNAR ORBIT EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
-	Visual Observations from Lunar Orbit (Detailed Objective)	Dr. Farouk El-Baz Lunar Exploration Department Bellcomm, Inc. 955 L'Enfant Plaza North, S.W. Washington, D.C. 20546 (202) 484-7636	Mr. Samuel N. Hardee, Jr./TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

Table 1-2. J-3 Service Module Science Experiments/Objectives and Cognizant Science Personnel

LUNAR ORBIT EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
--	SM Orbital Photographic Tasks (Detailed Objective), includes use of: • 24-Inch Panoramic Camera • 3-Inch Mapping Camera • 3-Inch Stellar Camera • Laser Altimeter	CSM Orbital Science Photographic Team Mr. Frederick J. Doyle, Chairman Topographic Division U.S. Geological Survey 1340 Old Chainbridge Road McLean, Virginia 22101 (202) 343-9445 Laser Altimeter Data Analysis Dr. William M. Kaula Institute of Geophysics and Planetary Physics University of California at Los Angeles Los Angeles, California 90024 (203) 825-4363	Mr. Samuel N. Hardee, Jr./TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

Table 1-2. J-3 Service Module Science Experiments/Objectives and Cognizant Science Personnel (Continued)

LUNAR ORBIT EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
S-164	S-Band Transponder • CSM • LM	Mr. William L. Sjogren Mail Code 156-251 Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103 (213) 354-4868	Mr. Patrick E. Lafferty/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-169	Far UV Spectrometer	Mr. William G. Fastie Physics Department The John Hopkins University Baltimore, Maryland 21218 (301) 366-3300 Ext. 371	Mr. Samuel N. Hardee, Jr./TD4 Experiment Development and Integration Branch Science Mission Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-171	IR Scanning Radiometer	Dr. Frank J. Low Lunar and Planetary Laboratory University of Arizona Tucson, Arizona 85727 (602) 884-2727	Mr. Patrick E. Lafferty/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

Table 1-2. J-3 Service Module Science Experiments/Objectives and Cognizant Science Personnel (Continued)

LUNAR ORBIT EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
S-209	Lunar Sounder	Dr. Roger Phillips, Team Chairman Mail Code 183-501 Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103 (213) 354-4973	Mr. Vernon M. Dauphin/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

Table 1-3. J-3 Lunar Surface Science Experiments and Cognizant Science Personnel

LUNAR SURFACE EXPERIMENT		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
S-037	Heat Flow (Apollo 17 ALSEP Experiment)	Dr. Marcus E. Langseth Lamont-Doherty Geological Observatory Columbia University Palisades, New York 10964 (914) 359-2900 Ext. 335	Mr. Wilbert F. Eichelman/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-059	Lunar Geology Investigation	Dr. William R. Muehlberger Center of Astrogeology United States Geological Survey Flagstaff, Arizona 86001 (602) 774-1483	Mr. Martin L. Miller/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-199	Traverse Gravimeter	Dr. Manik Talwani Lamont-Doherty Geological Observatory Columbia University Palisades, New York 10964 (914) 359-2900 Ext. 224	Mr. Timothy T. White/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

Table 1-3. J-3 Lunar Surface Science Experiments and Cognizant Science Personnel (Continued)

LUNAR SURFACE EXPERIMENT		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
S-200	Soil Mechanics (Passive Experiment)	Dr. James K. Mitchell 440 Davis Hall University of California Berkeley, California 94726 (415) 642-1262	Mr. Martin L. Miller/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-202	Lunar Ejecta and Meteorites (Apollo 17 ALSEP Experiment)	Dr. Otto E. Berg, Code 641 Goddard Space Flight Center Greenbelt, Maryland 20771 (301) 982-5920 Ext. 5906	Mr. Wilbert F. Eichelman/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-203	Lunar Seismic Profiling (Apollo 17 ALSEP Experiment)	Dr. Robert L. Kovach Department of Geophysics Stanford University Stanford, California 94305 (415) 321-2300 Ext. 4827	Mr. Wilbert F. Eichelman/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

Table 1-3. J-3 Lunar Surface Science Experiments and Cognizant Science Personnel (Continued)

LUNAR SURFACE EXPERIMENT		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
S-204	Surface Electrical Properties	Dr. M. Gene Simmons, MIT-54-314 Massachusetts Institute of Technology Cambridge, Massachusetts 02137 (617) 864-6900 Ext. 6393	Mr. Timothy T. White/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-205	Lunar Atmospheric Composition (Apollo 17 ALSEP Experiment)	Dr. John H. Hoffman Atmospheric and Space Sciences University of Texas at Dallas Dallas, Texas 75230 (214) 231-1471 Ext. 322	Mr. Martin L. Miller/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-207	Lunar Surface Gravimeter (Apollo 17 ALSEP Experiment)	Dr. Joseph Weber Department of Physics and Astronomy University of Maryland College Park, Maryland 20742 (301) 454-3526	Mr. Wilbert F. Eichelman/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

Table 1-4. J-3 Mission Science Experiments/Objectives Priority*

LUNAR SURFACE EXPERIMENTS	PRIORITY
Documented Samples - Collection of Highland Material (Part of Lunar Geology Investigation/S-059)	1
Apollo 17 ALSEP	2
• Heat Flow (S-037)	2.1
• Lunar Surface Gravimeter (S-207)	2.2
• Lunar Seismic Profiling (S-203)	2.3
• Lunar Atmospheric Composition (S-205)	2.4
• Lunar Ejecta and Meteorites (S-202)	2.5
Drill Core Sample (Part of Lunar Geology Investigation/S-059)	3
Lunar Geology Investigation (S-059)	4
Surface Electrical Properties (S-204)	5
Traverse Gravimeter (S-199)	6
The Soil Mechanics Experiment (S-200) has not been prioritized since it is passive for the J-3 Mission. Data will be derived from data collected for other experiments and operations accomplished during this mission.	

LUNAR ORBIT EXPERIMENTS/OBJECTIVES	PRIORITY
SM Orbital Photographic Tasks (DO)	1
Lunar Sounder (S-209)	2
S-Band Transponder (CSM/LM) (S-164)	3
Far UV Spectrometer (S-169)	4
IR Scanning Radiometer (S-171)	5
CM Photographic Tasks (DO)	6
Visual Observations from Lunar Orbit (DO)	7
The Apollo Window Meteoroid Experiment (S-176) has not been prioritized since it is passive and does not impact mission planning, crew operations, spacecraft consumables, or mission timeline.	

*Priorities are presented in the Apollo 17 MIP (Reference 6).

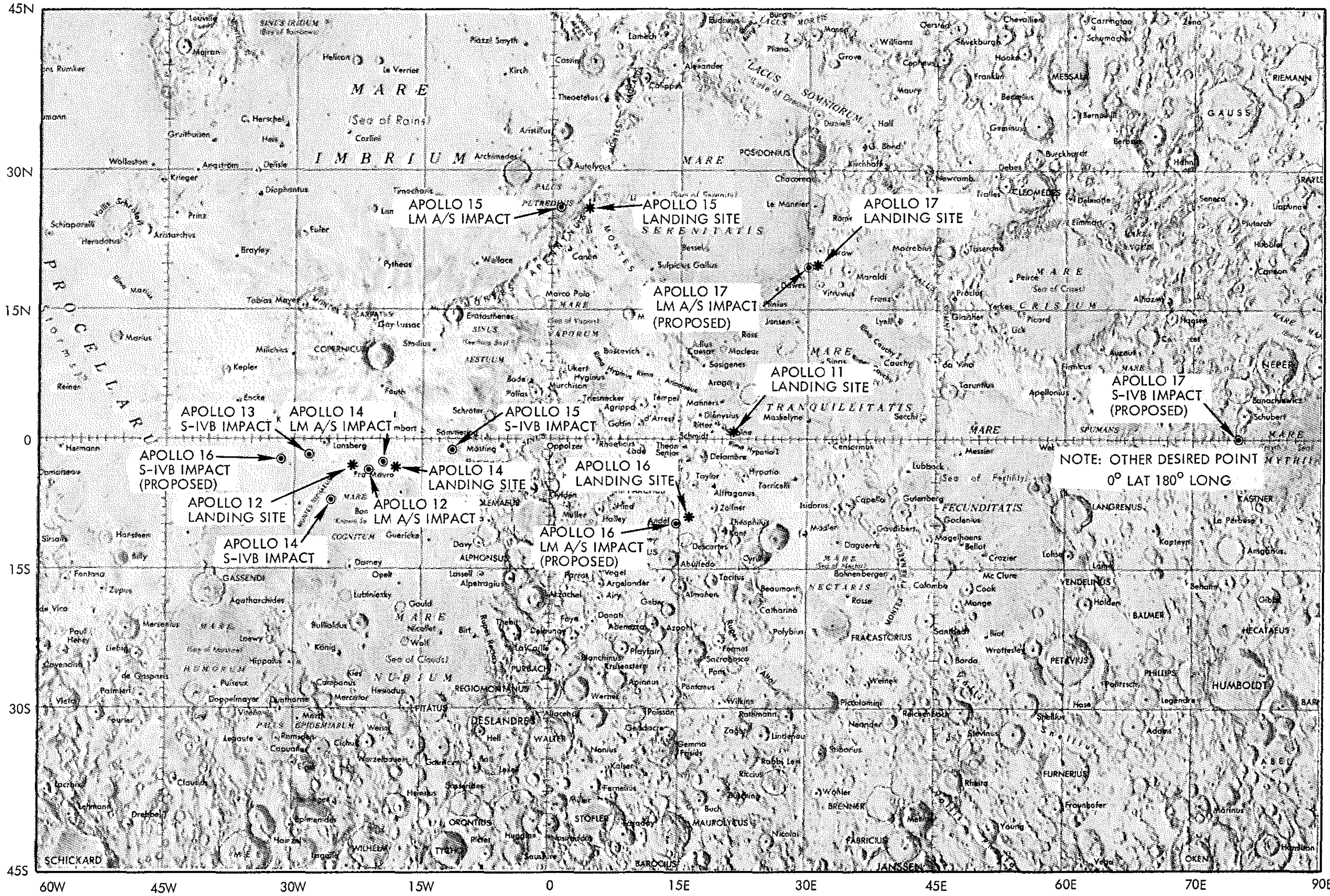


Figure 1-1. Lunar Impact Points of Spent S-IVB and LM Ascent Stages

SECTION II

EXPERIMENT DESCRIPTIONS

2.1 GENERAL

This section contains brief physical and functional descriptions of each science-related experiment and detailed objective (DO) assigned to Apollo Mission J-3; it also identifies the deployment interfaces, major support hardware, and crew activities associated with these experiments and DO's as well as their science purpose and rationale. Science equipment and sensors for lunar orbit activities are summarized in Table 2-1; those for lunar surface activities are summarized in Table 2-2. Science experiments and DO equipment, deployment interface details, and support hardware are illustrated in Figures 2-1 through 2-28. Standard facility equipment, such as cameras used to satisfy the photographic requirements of these experiments and DO's, is identified but not described.

Information presented in this section is general in nature and covers science hardware data most of which are available or proposed for inclusion in a number of other documents. This information is intended as an overview to familiarize each Principal Investigator (PI) and members of the scientific community with the science hardware planned for use during the mission. Personnel responsible for detailed hardware planning should use data published in MSC-controlled documents as they become available. These documents include the CSM/LM Spacecraft Operational Data Book, Volume V, ALSEP Data Book (Reference 7); and Volume VI, CSM Experiments Data Book for J-Missions (Reference 8). Noncontrolled documents which contain detailed hardware information include the Apollo Operations Handbook, Block II Spacecraft, Volume I, Spacecraft Description (Reference 9); Apollo 17 ALSEP Array E, Flight System Familiarization Manual (Reference 10); and Photo Equipment for Manned Space Flight Handbook (Reference 11).

2.2 LUNAR ORBIT SCIENCE EXPERIMENTS AND DETAILED OBJECTIVES

2.2.1 COMMAND MODULE SCIENCE EXPERIMENTS AND DETAILED OBJECTIVES

2.2.1.1 Command Module Photographic Tasks (Detailed Objective)

a) Purpose - The purposes of the Command Module (CM) Photographic Tasks detailed objective are to obtain photographs of lunar surface features of scientific interest from lunar orbit and transearth coast, and to obtain photographs of low brightness astronomical and terrestial sources.

Photographic activities in the following categories will be conducted:

1) Lunar surface photography in lunar orbit:

Photographs are to be obtained of lunar surface areas of high scientific interest, and of specific segments of the lunar surface in earthshine and in low light levels near the terminator. This photography will complement that accomplished by the panoramic and mapping cameras installed in the Scientific Instrument Module (SIM) bay.

2) Dim light photography:

Photographs are to be obtained of diffuse galactic light from selected celestial subjects, the solar corona, and the zodiacal light while in lunar orbit.

In addition to these photography activities, comet photographs will be obtained if the appropriate combination of trajectory and celestial conditions exist. Such conditions have not yet been identified.

b) Rationale - Photographs of the diffuse galactic light of celestial subjects and the zodiacal light will identify the extent, locations, configurations, and light levels of these astronomical sources, by photographing them while free of the masking effect of terrestrial scattered sunlight. Photographs taken in the lunar double umbra can isolate each of these sources and can also take advantage of the increased parallax along the earth-moon baseline. Analysis of these photographs has application to the study of the description of matter in the local region of our galaxy. The location of interplanetary and interstellar concentrations of matter is of importance to future long-range space flights.

Photographs of the solar corona taken in lunar orbit after CSM sunset and before CSM sunrise will enable the study of the pattern of energy outflow from the sun. This will be done by photographing the sun's outermost region while the solar disc is occulted by the moon, and at several positions of solar rotation on its axis.

Photographs of the earth limb taken when the spacecraft passes through the earth's umbra* will enable the study of terrestrial atmospheric effects. These photographs taken during solar eclipse by the earth will record the selective transmission of sunlight through the earth's atmosphere.

Lunar surface photography taken from the CM in lunar orbit will complement SIM bay photography by photographing surface areas in low light levels near the terminator, and in earthshine, and other surface areas of scientific interest. These photographs will be taken of specific targets at distances, attitudes, and sun incidence angles which are not feasible for the SIM cameras due to their operational altitude and attitude constraints. Photographs of designated targets at different sun incidence angles will provide information on the reflective properties of the lunar surface. Terminator photographs are a valuable source of data on crater density and provide maximum detail for distinguishing small surface features.

c) Experiment Equipment - These tasks involve the use of the following operational CM photography equipment: the 16-mm data acquisition camera with 18-mm lens (CM sextant is used with the data acquisition camera (DAC) for possible comet photography); the 70-mm Hasselblad electric camera with 80-mm and 250-mm lenses; a 35-mm Nikon camera with 55-mm lens; camera mounting brackets; and camera hoods or spacecraft window shades for dim light photography tasks.

d) Crew Activities - Crew participation is required to operate the cameras and to change lenses and camera settings; to record such specific photograph identification items as ground elapsed time (GET), frame number, magazine number, and exposure time; and to control the reaction control system (RCS) jet firings to achieve and maintain the specified spacecraft attitude and attitude rates. The RCS jets will be inhibited during dim light photographic sequences to eliminate undesired illumination from this source.

*Dependent upon favorable trajectory conditions

2.2.1.2 Apollo Window Meteoroid (S-176)

a) Purpose - The purpose of this experiment is to obtain data pertaining to the meteoroid cratering flux for masses of 10^{-12} grams and larger. This particle flux is the predominant mechanism for the degradation of surfaces exposed to the space environment.

b) Rationale - The particle flux data acquired in conjunction with laboratory, simulation, and analytical studies will furnish design criteria for future spacecraft protective surfaces and allow a better understanding of the micrometeorite environment of space.

c) Experiment Equipment - This experiment is completely passive. The CM windows, composed of fused silica, are used as the meteoroid detecting surfaces. High magnification scanning studies of these windows conducted before and after flight will yield the data desired.

d) Crew Activities - None required.

2.2.1.3 Visual Observations From Lunar Orbit (Detailed Objective)

a) Purpose - The purpose of the Visual Observations from Lunar Orbit detailed objective is to make and record visual observations of particular lunar surface features and processes to complement photographic and other remote sensed data.

b) Rationale - The human eye has a resolution of approximately 30 meters from the nominal 60 NM circular orbit, which is adequate for observations of regional distribution and tectonic trends. The eye also offers an advantage because of its continuous stereo viewing capability over a large field of view.

With regard to color perception and sensitivity, the eye can distinguish small color differences with a precision equal to or better than the most accurate photoelectric spectrophotometers. This capability is best utilized in deciphering color differences between lunar surface units under varying sun angles which may appear in ordinary photographs as "hard shadows" or "washed-out regions".

c) Experiment Equipment - (Binoculars, tape recorder, graphics and charts). Observations on far side passes will be recorded on the onboard tape recorder, near side passes observations will be relayed by real-time voice communications to the Mission Control Center (MCC). When appropriate, the visual observations will be supplemented by marking onboard graphics and charts.

d) Crew Activities - Observations will be made by the command module pilot (CMP) from the available CSM windows without disturbing SIM operations.

2.2.2 SERVICE MODULE SCIENCE EXPERIMENTS AND DETAILED OBJECTIVES

2.2.2.1 SM Orbital Photographic Tasks (Detailed Objective)

a) 24-Inch Panoramic Camera

1) Purpose - The purpose of the SIM 24-Inch Panoramic Camera (Figures 2-1 through 2-3) is to obtain high-resolution panoramic photographs with stereoscopic and monoscopic coverage of the lunar surface. Panoramic camera photographs taken of the lunar surface overflown by the CSM will aid the principal investigators of the other SIM experiments to correlate their sensor data with lunar surface terrain features. The camera will provide 1- to 2-meter resolution photography from an orbital altitude of 60 nautical miles.

2) Rationale - Landing site analysis and selection conducted well in advance of future lunar missions can significantly improve the efficiency of activities performed on the lunar surface. Analysis of high resolution photography can provide confidence in the operational suitability of landing sites or exploration areas. The identification and photogrammetric studies of features representing high scientific interest in the vicinity of candidate landing areas reduces the time needed for the conduct of scientific activities during the lunar missions and also provides important inputs to the site selection process.

3) Experiment Equipment - The panoramic camera is composed of four main components: (1) a roll frame assembly that rotates continuously in the cross-track scan direction during camera operation (panoramic scanning); (2) a gimbal assembly which tilts fore and aft to provide stereo coverage as well as forward motion compensation (FMC); (3) the main frame; and (4) a gaseous nitrogen (GN_2) pressure vessel assembly. The camera optics system, camera/film drive and control system, and film cassette complete the camera system.

The panoramic camera is mounted in the CSM SIM bay between the two SIM shelves. It is designed to operate in its SIM-installed position without the use of a deployment subsystem. Protection of the camera lens from CSM contamination sources such as effluent dumps and RCS/Service Propulsion System (SPS) firings is provided by stowing the lens face-inward to the SIM. This stowage position is automatically achieved when off-nominal lens and/or outside thermal control surface temperature conditions are experienced and the camera control is set to STANDBY. Thermal conditions to achieve lens stowage are preflight predicted and verified by inflight monitoring of temperature telemetry channels. Operational precautions must also be observed to protect the camera's velocity-to-height (V/h) and automatic exposure control (AEC) sensors from excessive exposure to direct solar radiation since these sensors have neither a face-inward stowage capability nor a protective cover.

4) Crew Activities - CM camera controls are available for the crew to activate/deactivate camera heaters; supply/remove primary camera power; select operate/standby operational modes; supply film roller torque to prevent film slack during launch, translunar injection (TLI), and SPS-powered flight phases; activate the five-film frame advance cycle required daily (if camera is not operated in that 24-hour period) to prevent film "set" after film loading; increase/decrease the width of the camera exposure slit; initiate the V/h override function if required and select the stereoscopic or monoscopic mode of operation. One CM crew display of the "barber pole"/gray talkback type is provided to verify camera operational status. The film cassette is retrieved by a crewman EVA during the transearth portion of the mission.

b) 3-Inch Mapping Camera

1) Purpose - The purpose of the 3-Inch Mapping Camera (Figures 2-1, 2-2, and 2-4) is to obtain high-quality metric photographs of the lunar surface and stellar photographs exposed simultaneously with the metric photographs. Metric photographs will be obtained using the 3-inch cartographic lens, and star-field photographs will be obtained using the 3-inch stellar camera lens. The mapping camera provides concurrent supporting photography for the SIM panoramic camera. Mapping camera photographs taken of the lunar surface overflown by the CSM will also aid the PI's of the other SIM experiments to correlate their sensor data with lunar surface terrain features. In addition, the stellar camera is operated*, if the laser

*The metric camera also operates during this dark side period of altimeter operation since there is no way to decouple the operation of the stellar camera from the metric camera. The metric imagery obtained is useless due to the absence of sunlight for terrain feature illumination.

altimeter is not operating in the decoupled mode, on the lunar dark side in conjunction with laser altimeter operation as film budgets permit. These time-correlated stellar photographs are used to provide a reference for the determination of the pointing vector for both the metric camera will provide 20-meter resolution photography from an orbital altitude of 60 nautical miles. Although prime mission photography is to be performed in lunar orbit, it is also planned to obtain wide-area photographs of the lunar surface during transearth coast to extend selenodetic control and mapping.

2) Rationale - Metric camera photographs provide a means for establishing a selenodetic mapping network. This network will provide positional reference on the moon and will also form a basis for subsequent photogrammetric determination of the lunar gravitational field through re-section of camera position with respect to the control network.

Metric camera photographs also form the basis of specialized cartographic maps ranging from small scale flight charts used for lunar surface operations to medium scale topographic charts used for planning lunar surface operations. These maps and photographs provide additional data on the form, distribution, and relative abundance of major lunar surface features, and provide the terrain profile information needed to plan future lunar exploration missions.

Wide angle metric photographs taken of the lunar surface following TEI will enable the extension of selenodetic control to greater areas of the moon by relating features near the eastern limb and features at high latitudes on the near side to features near the equator. Successive photographs on the same mission provide perspective changes, primarily in longitude. Photographs from different missions provide perspective changes, primarily in latitude, due to different selenodetic inclinations.

Stellar photographs provide precision camera inertial pointing information for postflight imagery interpretation.

3) Experiment Equipment - The mapping camera system is composed of two individual camera subsystems: the metric (terrain mapping) camera, which performs the cartographic function, and the stellar camera. These subsystems have been integrated into a single unit that has the optical axis relationship necessary to satisfy the precision mapping camera and laser altimeter postmission attitude (pointing) determination requirements. This system also uses the GN_2 pressure vessel assembly, shared with the SIM panoramic camera, as a source of GN_2 to provide an inert and pressurized atmosphere within the camera to minimize potential static electrical discharge which could expose areas on the film. The camera optics system,

film drive/exposure/takeup system, and removable cassette (containing both metric and stellar camera film) complete the camera system.

The mapping camera system is mounted on the top shelf in the CSM SIM bay, and is deployed on a rail-type mechanism when acquiring photography data in order to provide an unobstructed field-of-view for the stellar camera (ensures that the star field photographed is not obscured by either the lunar horizon or the SM mold line). A protective cover attached to the SIM shelf protects the metric camera lens and laser altimeter optics from spacecraft contaminants produced during RCS/SPS firings and effluent dumps as well as from direct sunlight impingement. This cover has provisions for multiple opening and closing cycles. A multiple-opening protective cover that opens and closes automatically by mapping camera deployment and retraction, respectively, is also provided to protect the lens of the stellar camera.

4) Crew Activities - CM camera controls are furnished for the crew to activate/deactivate the image motion compensation (IMC) switch and increment the camera V/h control signal (five incremental steps are possible before recycling); and to activate and extend/retract the camera system on its deployment rails. Controls are also supplied to actuate the metric camera lens/altimeter optics protective cover when required. Two CM crew displays of the barber pole/gray talkback type are provided to verify camera operational status (fully extended/retracted). A third CM talkback display indicates the deployment status of the metric camera lens/altimeter optics protective cover. The film cassette is retrieved by a crewman EVA during TEC after photography operations are complete.

c) Laser Altimeter

1) Purpose - The purpose of the Laser Altimeter (Figures 2-1, 2-2, and 2-4a) is to obtain ranging data to determine the altitude of the CSM above the lunar surface. These time-correlated ranging data, acquired with 1-meter resolution, are used to support mapping and panoramic camera photography, to provide precision altitude data for other orbital experiments, and to relate and define lunar topographical features (15 meter resolution) for a better definition of lunar shape.

2) Rationale - The determination of the moon's gravitational field from analysis of Lunar Orbiter perturbations, of which the main result was the discovery of the mascons, is of great importance to the study of the moon's structure and evolution. However, the lack of accurate topographic elevations, thus far, have made it difficult to draw inferences as to internal structure because the contribution to the gravitational field of the visible topography could not be subtracted out accurately.

Then too, the spectrum of the long wave variations in lunar topography itself is of significance in deriving the makeup of the lunar structure. The laser altimeter supplies accurate topographic elevations to add further information to these studies.

Laser-determined altitudes are also used in conjunction with MSFN tracking from earth to determine improved lunar orbits. The variations in topographic elevation are then determined by subtracting the laser altitudes from the orbital radial coordinates.

3) Experiment Equipment - The laser altimeter is hard-mounted and aligned to the mapping camera subsystem mounted on the top shelf in the CSM SIM bay, and shares with the metric camera a SIM-shelf mounted optics protective cover. The altimeter/camera system is deployed on a rail-type mechanism when operating. The altimeter can operate in either of two modes as follows: When the metric camera is operating, the altimeter automatically emits a laser pulse to correspond to a midframe ranging for each film frame exposed by the metric camera (approximately 1 ranging pulse every 24 seconds). The altimeter is also capable of operating in a decoupled mode (from the metric camera) which allows for independent ranging measurements* (one every 20 seconds) when the metric camera is inoperative. Stellar camera photography to provide a precise spacecraft attitude reference is not obtained when the altimeter operates in the decoupled mode.

4) Crew Activities - CM controls are provided to activate/deactivate the altimeter. No CM displays are supplied specifically for the laser altimeter although they are furnished for the mapping camera subsystem.

2.2.2.2 S-Band Transponder (CSM/LM) (S-164)

a) Purpose - The purpose of the S-Band Transponder Experiment is to obtain S-band doppler resolver tracking data to determine the distribution of mass along the lunar surface ground track.

This experiment requires unperturbed (by nongravitational forces) doppler S-band resolver tracking data from the CSM and LM during the unpowered portions of lunar flight. However, unbalanced torques produced in maintaining SIM bay attitude do not seriously degrade S-band data. Tracking data are to be obtained from the docked CSM/LM while in the 170- by

*Independent ranging is also referred to as "solo operation"

60-nautical mile elliptical orbit, the 60-nautical mile circular orbit, and the lower altitude portion of the 60- by 9-nautical mile elliptical orbit; from the undocked CSM during the unpowered portions of the 60-nautical mile circular orbit; from the undocked LM during the unpowered portions of lunar descent; and from the LM ascent stage during the unpowered portion of its descent trajectory to lunar surface impact. The low altitude (<16 kilometers) doppler data obtained from the CSM/LM in the 60- by 9-nautical mile elliptical orbit provides a complete front side, low altitude tracking pass.

b) Rationale - Accurate measurements of the spacecraft's lunar orbit over meaningful periods of time will allow the formulation of a lunar mass model for the J-3 Mission ground track. Data obtained in the J-3 Mission when combined with data obtained on previous Apollo missions will provide inputs to the scientific community for the synthesis of a basic model for such considerations as lunar origin and subsurface structure. Data obtained from tracking an object at less than 16 kilometers is the most valuable data source.

c) Experiment Equipment - No flight hardware is required to conduct this experiment other than the use of the CMS and LM S-band communications system transponders.

d) Crew Activities - None required.

2.2.2.3 Far UV Spectrometer (S-169)

a) Purpose - The purposes of the Far UV Spectrometer Experiment are to determine the atomic composition, density, and scale height for each constituent in the lunar atmosphere and to investigate far ultraviolet (UV) radiation from the lunar surface and galactic sources. Data will be obtained while the CSM is in lunar orbit (60- by 9-nautical mile and 60- by 60-nautical mile orbits) and during transearth coast, under seven conditions identified as Modes I through VII. (Figure 2-5a and b)

b) Rationale - The experiment will provide data on spectral emission from lunar atmospheric species by resonance reradiation of absorbed solar flux in the spectral range of 1175 to 1675 Å. It is expected that the following elements and their corresponding ground state resonance lines will be detected; hydrogen (1216 Å), carbon (1657 Å), nitrogen (1200 Å), oxygen (1304 Å), krypton (1236 Å), and xenon (1470 Å). Xenon, especially, is expected to be detected in concentrations as high as 10^7 atoms/cm^3 at the lunar surface.

Mode I - Data will be collected with the CSM +X axis aligned to the velocity vector and the SIM bay centerline aligned to the nadir. Data will be collected during one 60- by 9-nautical mile orbit and during 60- by 60-nautical mile orbits with emphasis on the 15-minute period spanning CSM sunset terminator crossing.

Mode II - Data will be collected with the CSM -X axis aligned to the velocity vector and the SIM bay centerline aligned to the nadir. Data will be collected during 60- by 60-nautical mile lunar orbits, with emphasis on the 15-minute period spanning CSM sunrise terminator crossing.

Modes I and II will permit observation of the lunar atmosphere during predawn and postsunset periods, whereby the lunar atmosphere is illuminated, the lunar surface is not, and resonantly scattered radiation can be observed. Remaining operation time in Modes I and II will provide a measure of the lunar albedo and, possibly, lunar phosphorescene.

Mode III - Data will be collected during one 60- by 9-nautical mile orbit and one 60- by 60-nautical mile orbit. In Mode III the Far UV Spectrometer optical axis will point within 100 ±5 degrees of the sun, and at an angle ±30 degrees to the plane of the ecliptic.

In Mode III operation, the Far UV Spectrometer looks through a long atmospheric path against a galactic background, maximizing instrument signal strength.

Mode IV - While the spececraft is on the far side of the moon, the Far UV Spectrometer optical axis will be pointed toward earth to observe far UV emission from the earth.

Mode V - The CSM +X axis will be aligned to the velocity vector and the Far UV Spectrometer optical axis will be pointed away from the moon. By varying the orientation to the orbital plane, the Far UV Spectrometer will observe approximately half of the celestial sphere while the CSM is in the lunar shadow, to monitor solar system, galactic, and extragalactic sources of far UV emission.

Mode VI - The data will be collected during transearth coast with the Far UV Spectrometer axis aligned to different celestial coordinate positions.

Mode VII - The Far UV Spectrometer will be operated during transearth coast while the CSM is in Passive Thermal Control (PTC) and data will be collected for six 1-hour periods. Both Modes VI and VII are designed to investigate the presence and distribution of atomic hydrogen between the earth and the moon, as well as to determine the far UV emission of galactic and extragalactic sources.

c) Experiment Equipment. The instrument to be used (Figure 2-5c and d) is a 0.5-meter focal length Ebert mirror spectrometer consisting of a baffle, entrance and exit slits, collecting optics, scan drive mechanism, and electronics. The instrument is mounted to the bottom shelf in the SIM bay and is provided with a protective cover to shield the detecting elements from direct sunlight impingement and contamination from spacecraft effluent sources. This cover can be opened and closed as required by controls operated from the CM.

d) Crew Activities - CM controls are furnished for the crew to activate/deactivate the instrument as well as open and close the Far UV Spectrometer protective cover. A CM talkback display is provided to indicate the deployment status of the protective cover.

2.2.2.4 IR Scanning Radiometer (S-171)

a) Purpose - The purpose of the IR Scanning Radiometer Experiment is to measure, at the orbiting CSM, the thermal emission from the lunar surface in order to obtain a high resolution surface temperature map.

b) Rationale - A surface temperature map of the surveyed portions of the moon is expected to have a higher resolution than has been possible before. Previous data obtained from the unilluminated portion of the near side of the moon will be improved, and it will be possible to gather emission data from the far side of the moon which has never been surveyed before in the infrared (IR) spectrum. This resulting temperature map will permit the calculation of cooling curves for various lunar regions and, hence, to the characterization of such lunar surface physical parameters as the thermal conductivity, the bulk density, and the specific heat.

In addition, the data obtained will be used to locate, identify, and study anomalously hot or cold regions at a high spatial resolution over relatively long term surface cooling periods. Such regional anomalies may be indicative of surface rock fields, crustal structural differences, volcanic activity, fissures emitting "hot" gases, and the like. The establishment of positive indications of whether or not the moon has internal heat sources will also be possible.

The lunar surface thermal and physical properties derived from the formulated cooling curves will infer the subsurface structure composition.

c) Experiment Equipment - The IR Scanning Radiometer, housed and mounted on the bottom shelf of the CSM SIM bay, consists of an optical scanning unit and a bolometer with supporting electronics.

The optical scanning unit (Figure 2-6) consists of a folded cassegrain telescope, field-of-view baffles, and a rotating mirror with drive motor and gear box. The rotating mirror provides a cross-track scanning capability of 162 degrees. The thermister bolometer is optically coupled to a silicon immersion lens.

The electronics unit divides the three scientific temperature telemetry channels into three ranges: 0 - 160°K; 0 - 250°K; and 0 - 400°K. During operation, these electronics are clamped once per scan when the radiometer is viewing deep space at the beginning of the scanning cycle. This effect will be estimated during the 60- by 9-nautical mile orbit from succeeding or previous scans since deep space will not be "seen" by the radiometer below an altitude of approximately 40 nautical miles.

A sensor protective cover, operated from the CM when required, is provided to protect the optical scanning unit from direct sunlight impingement and spacecraft contamination sources such as effluent liquids and RCS exhaust products.

d) Crew Activities - CM controls are furnished for the crew to activate/deactivate the instrument as well as to open and close the radiometer protective cover. A CM talkback display is provided to indicate the deployment status of the protective cover.

2.2.2.5 Lunar Sounder (S-209)

a) Purpose - The purposes of the Lunar Sounder Experiment are to obtain stratigraphic, structural, tectonic, and topographic data, via electromagnetic soundings, of the lunar surface and subsurface; to obtain measurements of ambient electromagnetic noise levels in the lunar environment; and to measure the lunar occultation of electromagnetic waves.

Electromagnetic sounding will be performed in the high frequency (HF) and very high frequency (VHF) electromagnetic bands. All data will be acquired in the 60-nautical mile circular CSM orbit.

b) Rationale - The lunar sounder data will permit the development of a circumlunar geological model of the lunar interior to a depth of 1.3 kilometers. The geological model will be developed from the electromagnetic sounding of the moon which will yield a cross-sectional physical model of scattering centers derived from contrast in lunar electrical conductivity, dielectric constant, and magnetic permeability. The model will then be interpreted in terms of the surface and depth distributions for the above measured lunar parameters.

The relative elevation between points separated by a few kilometers will be measured to a maximum accuracy of 1/10 of the wavelength of the centers of each frequency band (i.e., 0.2 meters VHF, 2 meters HF-2 and 6 meters HF-1). These data in conjunction with the photographs, altitude measurements, surface gravity measurements, etc., will yield an absolute topographic profile. The lunar surface profile along the great circles covered during the Lunar Sounder Experiment will be developed with greater accuracy than was possible previously. The lunar sounder data may be used as a base of reference for the laser and IR scanner selenographic mapping investigation on the far side of the moon.

The experience gained in technology and analyses from the sounder experiment will be invaluable in designing electromagnetic experiments for future space missions such as detection of surface or near surface water on Mars and mapping major geologic units on Mars and Venus and topside sounding of Jupiter.

c) Experiment Equipment - The lunar sounder can be divided into three functional parts: (1) the coherent synthetic aperture radar (CSAR), (2) optical recorder, and (3) the antennas, a retractable dipole for HF frequencies and a yagi for VHF. The CSAR and optical recorder are located in the CSM SIM Bay (Figure 2-1) and the antennas are mounted to the base of the SIM (Figure 2-7).

The CSAR functionally operates in two separate modes. The HF mode is where the lunar surface is sounded with pulses of 5 and 15 MHz and the VHF mode is where the 150 MHz frequency is used. The CSAR consists of programmer and frequency reference, modulator (chirp generator), power supply, 5-15 MHz transmitter, 150 MHz transmitter, transmit/receive switches, and three receivers for the 5, 15, and 150 MHz signals.

The optical recorder's primary function is to process the CSAR output, record it on film, and time reference it for later data reduction and analyses. The primary components are a cathode-ray tube and film cassette.

The HF antenna is a dipole, having a total span of 80 feet. The VHF is a yagi configuration having a single reflector, a driven element, and five directors. The VHF antenna is displaced 20-degrees from the SIM Bay ℄ and is deployed when the Spacecraft LM Adapter (SLA) panels are opened.

d) Crew Activities - CM controls are furnished for the crew to deploy, retract, or jettison the HF antennas, to activate/deactivate the sounder, and to select the modes of operation - VHF OPERATE, HF OPERATE, and HF RECEIVE ONLY. In the HF or VHF OPERATE mode the frequency selected is transmitted and recorded;* in the HF RECEIVE ONLY mode the transmitter is off and HF is received only. This mode is used for monitoring electromagnetic background noises from galactic sources and the moon occultation effect as well as electromagnetic waves emanating from the Surface Electrical Properties Experiment and the corresponding lunar occultation effect. The film cassette from the sounder optical recorder is retrieved during the TEC EVA operation at the same time that the mapping camera and panoramic camera film cassettes are retrieved.

2.3 LUNAR SURFACE SCIENCE EXPERIMENTS

2.3.1 APOLLO 17 LUNAR SURFACE EXPERIMENTS PACKAGE (ALSEP)

This collection of five lunar surface telemetered experiments is designed to operate for two years or more obtaining lunar thermal, seismic, gravitational, atmospheric and meteorite environment data. This ALSEP array

ed on the Optical Recorder film.

is the last such automated geophysical observatory to be deployed on the moon during the Apollo program. The data from these experiments will form the bases of fundamental lunar geophysical, astrophysical, and other investigations which will contribute to the knowledge and understanding of the moon and its environment in the solar system. These data, in concert with the results from previously deployed ALSEP's and other science experiments conducted during the Apollo Program, are expected to enable the development of a detailed account of the physical processes that were involved in the formation and history of the solar system as well as to provide the data base for consistent geophysical, geological, and other models of the moon and solar system.

Data from ALSEP's operating at different locations on the moon enable the determination of directional, spatial, and temporal distributions of the measured phenomena, thus permitting the dynamical aspects of geophysical and geological theories to be derived or verified.

ALSEP's were deployed and successfully operated during Apollo 11, 12, 14, and 15 and are planned for Apollo Missions J-2 and J-3. The Apollo 12, 14, and 15 ALSEP's are presently operating and simultaneously acquiring data at their respective locations on the moon.

Individual Apollo 17 ALSEP experiments are described in the following subparagraphs.

2.3.1.1 ALSEP Central Station

Although not an experiment, the ALSEP Central Station (Figure 2-8), in conjunction with the SNAP 27 nuclear power source, interfaces functionally with the array of Apollo 17 ALSEP surface experiments and supports all of their subsystems requirements. The experiments which it supports are the Lunar Heat Flow Experiment (S-037), Lunar Ejecta and Meteorites Experiment (S-202), Lunar Seismic Profiling Experiment (S-203), Lunar Atmospheric Composition Experiment (S-205), and the Lunar Surface Gravimeter Experiment (S-207).

The central station consists of the communication subsystem transmitters and receivers (including antenna), the data subsystem, and the electronics subsystems for the experiments. Thermal control provisions, shielding and housing are also provided for these subsystems. A switch panel is available by which the astronaut can activate the central station if activation cannot be accomplished by ground commands. Electrical power 75 watts-dc for the data and experiment subsystems is provided by the SNAP 27 radioisotope thermoelectric generator (RTG), and a power conditioning unit. Each ALSEP experiment interfaces electrically with the central station by means of flat, ribbon-like conductor cabling.

The ALSEP central station and experiments in the undeployed and unassembled configuration (Figures 2-9 and 2-10) are stored in the LM Scientific Equipment (SEQ) Bay* (Figure 2-11); the RTG fuel capsule is attached to the outside of the LM descent stage (Figure 2-12).

Special tools used in assembly of the central station and RTG include the fuel transfer tool, the universal handling tool, and the dome removal tool (Figures 2-13 and 2-14).

Photographs of the deployed central station and ALSEP experiments are taken with the 70-mm Hasselblad electric data camera and its 60-mm lens.

The astronauts assemble, deploy, level, align, and activate these experiments and the central station (Figure 2-15). Other activities such as central station antenna leveling and pointing are also performed.

2.3.1.2 Heat Flow Experiment (S-037)

a) Purpose - The purpose of the Heat Flow Experiment is to determine the rate of heat loss from the lunar interior. Specific experiment objectives related to this purpose are:

- Measurement of the subsurface vertical temperature gradients in the lunar surface layer as a function of time.
- Measurement of the absolute temperature of the lunar subsurface as a function of time.
- Determination of the thermal conductivity of the lunar subsurface material.
- Measurement of the brightness temperature of the local lunar surface.

*Figure 2-10 depicts LM descent stage storage of other lunar surface science equipment as well.

b) Rationale - This experiment is designed to measure the heat flux through the upper 2.4 meters of the lunar surface. This will provide data on lunar soil thermal conductivity, contribute to the resolution of issues concerning lunar internal heating processes, and establish constraints on the interior temperature and composition of the moon. The HFE was deployed on Apollo 15 and is planned to be deployed on Apollo Missions J-2 and J-3. The Apollo 15 Heat Flow Experiment now has results from one complete lunation and in addition, data from six conductivity measurements. Preliminary results indicate that the heat flow from the interior of the moon outward is about 3.3×10^{-6} watts/cm^2, one-half the average heat flow of the earth. From this it can be deduced that the relative amounts of heat producing elements, U, Th, K, are about the same as that of the earth. Although the temperature sensors were not deployed to their full planned depth, the low thermal conductivity of the lunar regolith permits a successful heat flow measurement to be made. The diurnal temperature variation measured at the surface is 271°C (from -185°C to +86°C), but at a meter below the surface these variations are on the order of a few thousandths of a degree. The Principal Investigator concludes that lunar surface material is an excellent insulator.

c) Experiment Equipment - The heat flow experiment equipment consists of two probes each about 1.2 meters in length, a special tool for probe insertion, radiation shields for each probe, and an electronics package which is cable-connected to the probes and the ALSEP central station (Figure 2-16).

d) Crew Activities - Two holes are drilled in the lunar surface to a depth of about 2.6 meters, using the Apollo Lunar Surface Drill (ALSD). The bore stems are used for the drilling and then remain in the holes to provide a casing to prevent wall collapse during the probe insertion. One probe is inserted into each hole to the desired depth using the special tool for probe insertion. The exact depth of each probe is recorded, the radiation shields are installed over each probe, and the electronics box/probe assembly is connected to the ALSEP central station by a flat cable (Figure 2-17). The MCC will then have control of the experiment when the central station is activated.

The relative placement of the probes with respect to the HFE electronics package, central station, and other ALSEP experiments is shown in Figure 2-15.

2.3.1.3 Lunar Ejecta and Meteorites Experiment (S-202)

a) Purpose - The purpose of the Lunar Ejecta and Meteorites Experiment is to measure physical parameters of primary cosmic dust particle impacts on sensors in cislunar space, and of lunar ejecta emanating from the sites of meteorite impacts on the lunar surface. Specific experiment objectives related to the purpose are:

- Determination of the background and long-term variations of cosmic dust influx rates in cislunar space.
- Determination of the extent and nature of lunar ejecta produced by meteorite impacts on the lunar surface.
- Determination of the relative contributions of comets and asteroids to the earth's meteoroid ensemble.
- Study of possible correlations between the associated ejecta events and the times of earth's crossings of cometary orbital planes and meteor streams.
- Determination of the extent of contribution of interstellar particles toward the maintenance of the zodiacal cloud as the solar system passes through galactic space.
- Investigation of the existence of an effect called "earth focusing of dust particles."

b) Rationale - The history of in situ measurements of the spatial distribution of cosmic dust covers almost two decades. Still a severe disagreement concerning the cosmic dust influx rates near the earth persists. The two extremes of this disagreement are defined by zodiacal light measurements on the low spatial density end and microphone measurements on the high spatial density end. The conclusions drawn from each of these two types of measurements are persistently exposed to questions and criticism due to assumptions concerning the cosmic particle characteristics.

In addition, the experiment will measure the extent and nature of the lunar ejecta which is crucial to our full understanding of the origin and nature of the lunar soil.

The Lunar Ejecta and Meteorites (LEAM) experiment is related to, and is complementary with, similar experiments carried on Pioneers 8 and 9.

c) Experiment Equipment - The equipment consists of one deployable unit with detector plates, ALSEP central station electronics, and the cable and Astromate connector for mating the external unit with the central station (Figure 2-18). A cover provided to shield the detector plates from dirt particles produced during LM ascent stage lift-off is jettisoned by earth command at a suitable time after lift-off.

The external unit components or sensors consist of suppressor and collector plates, impact plates, film frames and microphones.

The measurement parameters are

Particle velocity range: 1 to 75 kilometers per second
Particle energy range: 1 to 1000 ergs
Particle momentum range: 2.5 x 10^{-5} to 7 x 10^{-4} dyne-seconds
Primary particle frequency of measurement: 10^{-4} impacts per square meter per second.
Angular resolution of radiant: ± 26 degrees
Sensor field of view: ± 60 degrees

d) Crew Activities - The LEAM external unit (Figure 2-18b) is erected and deployed on the lunar surface approximately 8 meters south of the ALSEP central station (Figure 2-15). The unit is aligned to ± 5 degrees of the sun shadow line using the gnomon and leveled to ± 5 degrees using the bubble level indicator. The cable and Astromate connector are then mated to the central station. The MCC will control the experiment upon activation of the central station.

2.3.1.4 Lunar Seismic Profiling Experiment (S-203)

a) Purpose - The purposes of the Lunar Seismic Profiling Experiment are to acquire data on the physical properties of the lunar near-surface materials and to monitor moonquakes or impacts of meteorites. Specific experiment objectives related to these purposes are

- Measurement of the lunar seismic signals produced by detonation of explosive charges on the lunar surface.
- Monitoring of natural seismic activity resulting from moonquakes or meteorite impacts on the lunar surface.

- Recording of the seismic signals resulting from ascent of the LM from the lunar surface.
- Recording of the seismic signals resulting from impact of the spent LM ascent stage on the lunar surface.

b) Rationale - Seismology is a key tool in determining the present geological characteristics of the moon and its evolutionary history. The passive seismometers deployed during previous Apollo missions have yielded important information on the lunar interior to depths greater than 20 kilometers. The artificial sources used in the seismic profiling experiment provide seismic energy usable in determining lunar interior layering at shallower depths.

The known locations and energies of LM ascent from the lunar surface and planned impact of the spent LM ascent stage on the lunar surface will provide valuable calibration data for experiment data analysis as well as providing additional artificial sources for seismic profiling.

This experiment is expected to provide more accurate seismic wave velocities than the active seismic experiments deployed during Apollo 14 and planned for Apollo Mission J-2. The configuration of the geophone array (Figure 2-15) allows a determination of the seismic wave approach azimuth which could not be determined with the geophone arrays used on previous missions.

The experiment will yield important detailed information on the geologic characteristics of the lunar surface and subsurface to depths of approximately 3 kilometers.

c) Experiment Equipment - The lunar seismic equipment consists of four geophones, marker flags, geophone module with marker flag, an electronics package in the ALSEP central station, transmitter antenna, and eight explosive packages (Figure 2-19a through c).

The explosive package major components are: receiving antenna, receiver, explosive train, signal processor, and firing pulse generator.

d) Crew Activities - The geophones and geophone module will be deployed, marked with flags, and photographed during EVA I. The transmitting antenna will be deployed and the antenna cable and geophone cables will be mated with the experiment electronics package in the ALSEP central station. The explosive packages will be deployed at designated sites during the lunar traverses.

The explosive packages will be placed on the surface, antennas extended, and armed by pulling the three rings in designated order. The explosive package configuration is shown in Figure 2-19b.

2.3.1.5 Lunar Atmospheric Composition Experiment (S-205)

a) Purpose - The purposes of the Lunar Atmospheric Composition Experiment are to obtain data on the composition of the lunar ambient atmosphere in the mass range of 1 to 110 AMU at the lunar surface, and to detect transient changes in composition due to venting of gases from the lunar surface or from other sources. Specific experiment objectives related to these purposes are:

- The acquisition of data to determine the average natural distribution of gases in the lunar atmosphere.
- The acquisition of data to determine the variations in the natural distribution over one or more lunations.
- The acquisition of data on short-term transient changes in the lunar atmospheric composition.

b) Rationale - Measurements of the lunar ambient atmosphere in the mass range of 1 to 110 AMU at the lunar surface, and the detection of transient changes in composition due to venting of gases from the surface or from man-made sources, and possibly from solar wind phenomena are important in investigating the lunar environment. Such measurements are important in verifying such premises as that noble gases, carbon dioxide, carbon monoxide, hydrogen sulfide, ammonia, sulphur dioxide, and water vapor may be released by lunar volcanism and from rocks and magma. The mechanisms of release of gases from the surface (e.g., solar wind bombardment) can, perhaps, be affirmed when the effluent gases are known. Likewise, data on gases released from the lunar interior will afford some knowledge of the chemical processes underlying the lunar surface.

This experiment will augment the data obtained from the Mass Spectrometer lunar orbital experiments conducted during Apollo 15 and planned for Apollo Mission J-2, and will provide valuable data for use in the investigations to understand the origin of the lunar atmosphere and the analytical studies of the transport processes occurring in the lunar exosphere.

c) Experiment Equipment - The lunar surface mass spectrometer unit (Figure 2-20), contains three sensors. These sensors are Neir-type 90-degree magnetic sector field mass analyzers. Sensor characteristics are

Sensor Range: 1-4 AMU, 12-48 AMU, and 40-110 AMU.

Other major components of the mass spectrometer unit are the electronics, heaters, deployable dust cover (opened by MCC after ascent stage lift-off), and a ribbon cable connector to the ALSEP central station.

d) Crew Activities - A crewman will transfer and emplace the mass spectrometer unit on the lunar surface approximately 15 meters northeast of the ALSEP central station, level it to within ±15 degrees, and mate the cable to the central station.

2.3.1.6 Lunar Surface Gravimeter Experiment (S-207)

a) Purpose - The purpose is to obtain highly accurate measurements of lunar surface gravitational acceleration and its temporal variations at a selected point on the lunar surface. Specific experiment objectives related to this purpose are:

- Determination of the value of lunar gravity relative to earth gravity with an accuracy of approximately 1 part in 10^5.
- Determination of the magnitude of lunar surface deformation due to tidal forces.
- Measurement of vertical components of lunar natural seismicity.
- Monitoring of free oscillations of the moon which may be induced by gravitational radiation from cosmic sources.

b) Rationale - The observations of the lunar tides, search for free oscillations, establishment of lunar "g" relative to earth "g" to within 1 part in 10^5, and the use of the moon as a detector of gravitational waves can all be accomplished by telemetering readings of lunar surface gravity made with a sensitive gravimeter.

Precise measurements of the acceleration due to gravity on the lunar surface over a period of months will establish the deformation of the moon due to the tidal forces. Conclusions may then be drawn concerning the internal constitution of the moon.

These observations will also make use of the moon as a mass quadrupole detector for gravitational waves. The lunar free oscillations may be observed to be excited by such waves if the power spectrum is sufficiently intense over the frequencies of certain of the moon's normal modes. Simultaneous observation of the earth's excitation will make it very likely that the effects are due to gravitational waves.

This experiment partly overlaps the lunar passive seismometer experiment in that it yields vertical acceleration and seismic data. The difference is primarily that a different frequency range is covered, which is of prime interest in the study of geophysics and the general physics of relativity. These seismic data yield information on the collective motion and internal structure of the moon as a whole. In addition, the Lunar Traverse Gravimeter experiment, also planned for the Apollo Mission J-3, is expected to complement the Lunar Surface Gravimeter (LSG) experiment.

c) Experiment Equipment - The Lunar Surface Gravimeter (Figure 2-21) consists of electronics, sensors (spring mass suspension capaciter plates), sunshield, ribbon cable to the central station, and central station electronics.

d) Crew Activities - The LSG will be deployed approximately 8 meters west of the ALSEP central station. The deployment consists of leveling within ±3 degrees, alignment within ±3 degrees using the sunshield shadow, and mating the cable to the ALSEP central station.

2.3.2 OTHER SURFACE EXPERIMENTS

2.3.2.1 Lunar Geology Investigation (S-059)

a) Purpose - The purposes of the Lunar Geology Investigation Experiment are to obtain a better understanding of the Taurus-Littrow highlands area and the processes which have modified the highland surface through the study of documented lunar geological features and returned lunar samples.

b) Rationale - The collection of geological samples, photography, and verbal descriptions of geological features are planned to provide data for lunar geological studies that will increase the knowledge of the physical makeup of the moon, its history, the nature and history of the solar system, and the history of the earth. The samples and photographs obtained on this mission will augment the data obtained during Apollo 11, 12, 14, 15, and planned for J-2, and are expected to provide valuable information for use in the interpretation of the geological history of the moon.

c) Experiment Equipment - The major equipment used for this experiment (Figures 2-22a through 2-22g) are: hammer; tongs; extension handle; large sampling scoop; rake; gnomon/photometric chart; sample scale (located in the LM ascent stage); core tubes*/caps with follower tool; documented sample bags: padded sample bags**, sample collection bags; special sample containers (a nominal SESC and a CSVC**); sample return bags; and sample return containers. A 2.6-meter core sample is obtained with the use of the ALSD. The ALSD equipment (Figure 2-16) used in acquiring the deep core sample includes the power head and spindle, core stem adapter, treadle, core stem rack, core stem extractor, core stem dispenser, three 0.87-meter core stem sections, open core bit, a core stem wrench (same wrench as used with the bore stems of the Heat Flow Experiment), and a core stem vise mounted on the LRV aft pallet.

The hand tools (hammer, tongs, etc.) used for this experiment are the standard Apollo hand tools (ALHT). Attachment of tools and collection bags to the PLSS is shown in Figure 2-23. The Lunar Geology Equipment/LRV interface is shown in Figure 2-24.

*Also called "drive" tubes
**Padded Sample Bags and CSVC are being considered for J-3.

Photography requirements for this experiment are satisfied with the use of the 70-mm Hasselblad electric data camera (60-mm lens and 500-mm lens). The Ground-Commanded Television Assembly (GCTA) provides real-time ground and science support for the geology activities.

d) Crew Activities - The astronauts select sites (if not previously designated) of geologic interest, obtain and document the required standard and special geologic samples, and perform the required geological photography and observations.

2.3.2.2 Traverse Gravimeter (S-199)

a) Purpose - The purposes of the Traverse Gravimeter Experiment are to make a high accuracy relative survey of the lunar gravitational field in the lunar landing area and to make an earth-moon gravity tie. Specific experiment objectives related to these purposes are

(1) Measure the value of gravity, relative to the value at a lunar base station, at selected known locations along the lunar traverse.

(2) Measure the value of gravity at a known point on the lunar surface (base station) relative to the value of gravity at a known point on earth.

b) Rationale - Gravimetry is a major tool of geophysical exploration on earth. The interpretation of gravity anomalies on earth has led to major discoveries such as isostasy, tectogenes, lateral density variations in crust and mantle, strength of mantle, geometry of geosynclines, margins, batholiths, and figure of the earth.

The first application of gravimetry to the moon, satellite tracking, provided an important contribution to lunar tectonics, the discovery of gravity anomalies correlated with ringed maria. Future satellite gravity studies of the moon will probably contribute to the further understanding of large scale structures (>50 kilometers). However, only lunar surface gravimetry can lead to the finer resolution required for exploring such features as mare ridges, edge effects of mascons, craters, rilles, scarps, thickness variations in the regolith and lava flows, density variations in the basement, and maria-highland interfaces.

c) Experiment Equipment - Experiment equipment (Figures 2-25 and 2-26) consists of a portable gravimeter, transported on the LRV to the selected sites, with traverse measurements taken with the instrument mounted on the LRV. Selected measurements will be obtained with the instrument on the lunar surface.

d) Crew Activities - A crewman will activate the appropriate switches at each measurement site, in the required sequence, and read and report to MCC the numbers that appear in the instrument's digital display register.

2.3.2.3 Soil Mechanics Experiment (S-200)

a) Purpose - The purpose of the Soil Mechanics Experiment is to obtain in situ data on the physical characteristics and mechanical properties of the lunar soil at the lunar surface and subsurface at different locations on the moon.

b) Rationale - The Soil Mechanics Experiment will provide data that will enable determination of the compositional, textural, and mechanical properties of lunar soils and their variations with depth, in lateral directions, and between Apollo landing sites. These data are essential to the verification or modification of existing theories or to the formulation of new theories of lunar history and lunar processes. The in situ characteristics of the unconsolidated surface materials can provide an invaluable record of the past influences of time, stress, and environment. Of particular importance are such characteristics as particle size, shape, distribution, density, strength and compressibility, and their variations from point-to-point.

c) Experiment Equipment - The Soil Mechanics Experiment for the J-3 Mission is to be completely passive and will require no experiment-unique equipment or activities as was done on the Apollo 15 and planned J-2 Missions. Experiment data (Figure 2-27) will be derived from visual observations of the crew, lunar surface photography of crewman/LRV/LM induced soil impressions and natural surface features, and returned lunar samples, especially core tube and soil samples.

d) Crew Activities - No special crew activities are required.

2.3.2.4 Surface Electrical Properties (S-204)

a) Purpose - The purpose of the Surface Electrical Properties Experiment is to obtain data about the electromagnetic energy transmission, absorption and reflection characteristics of the lunar surface and subsurface for use in the development of a geological model of the upper layers of the moon. The experiment is designed to determine layering in the lunar surface, to search for the presence of water below the surface, and to measure electrical properties of the lunar material in situ.

b) Rationale - This experiment will provide data on the electrical properties of the lunar surface as a function of depth. The frequency range of the experiment has been selected to allow determination of layering and scattering over a range of depths from a few meters to a few kilometers. It may be possible to determine the thickness of the outer layer of regolith at the landing site. This subsurface topographic information holds considerable implications for the history of the outer few kilometers of the moon.

The transmitter will produce continuous waves at 1, 2.1, 4, 8.1, 16, and 32.1 MHz successively. The multiple wavelengths will make it possible to measure the size and number of scattered bodies in the lunar subsurface. Any moisture present will easily be detected by this experiment since minute amounts of water in rocks or subsoil change the electrical conductivity by several orders of magnitude.

c) Experiment Equipment - The experiment equipment (Figures 2-28a and 2-28b) consists of a deployable self-contained transmitter, multiple frequency transmitter antenna, portable receiver/recorder on the Lunar Rover Vehicle (LRV), wide bandwidth mutually orthogonal receiver antenna, and a retrievable data recording device.

d) Crew Activities - The crew will transport and set up the transmitter on the lunar surface approximately 100 meters from the LM, then deploy the antennas (Figure 2-28c). The receiver/recorder will be emplaced on the LRV. The crew will establish the location of the LRV in relation to the transmitter for each data stop during the traverse. Wheel turns will be counted for distance and azimuth will be recorded using the navigation system. The recorder will be recovered from the receiver upon completion of the lunar traverses for return to the earth.

Table 2-1. Lunar Orbit Science Experiments - Equipment/Operation Summary

EXP. NO.	TITLE/OBJECTIVE	SPACECRAFT LOCATION/ DEPLOYMENT	OPERATING TIME	MEASUREMENT & CONSIDERATION	EQUIPMENT
	CM Photographic Tasks (Detailed Objective)	Command Module	See Table 3-2.		• 70-mm Hasselblad Electric Camera/80-mm Lens/250-mm Lens • 16-mm Data Acquisition Camera/ 18-mm Lens • 35-mm Nikon Camera/55-mm Lens • Window Mounting Bracket • Sextant Optical Adapter
	• Dim Light Photography				
	a) Diffuse galactic light of celestial subjects			Photographs of the north galactic pole, north ecliptic pole, north celestial pole, and the Gum Nebula, taken in lunar double umbra (lunar umbra <u>and</u> no earthshine).	a) 35/55-mm Lens/Red and blue filters
	b) Zodiacal light			Photographs of the zodiacal light as the CSM approaches sunrise in lunar orbit: outer zodiacal light (directions out of the ecliptic plane); inner zodiacal light (in ecliptic plane).	b) 35/55-mm Lens/ Polarizing filter
	c) Solar corona			Photographs of the solar corona taken in lunar orbit after CSM sunset and before CSM sunrise.	c) DAC/18-mm Lens 35/55-mm Lens HEC/80-mm Lens
	d) Earth limb			Photographs of the earth limb taken when the S/C passes through the earth's umbra (solar eclipse).	d) DAC/18-mm Lens
	• Lunar Surface Photography				
	a) In low light levels near the terminator			Photographs of areas on the lunar surface taken from the CM in lunar orbit.	a) HEC/80-mm & 250-mm Lenses
	b) In earthshine	NOTE: HEC - Hasselblad Electric Camera DAC - Data Acquisition Camera 35 - Nikon Camera			b) 35/55-mm Lens (Fixed)
	c) Of targets of scientific interest				c) HEC/250-mm Lens HEC/80-mm Lens

Table 2-1. Lunar Orbit Science Experiments - Equipment/Operation Summary (Continued)

EXP. NO.	TITLE/OBJECTIVE	SPACECRAFT LOCATION/ DEPLOYMENT	OPERATING TIME	MEASUREMENT & CONSIDERATION	EQUIPMENT
—	SM Orbital Photographic Tasks (Detailed Objective)	Service Module (SIM Bay)			
	24-Inch Panoramic Camera	Deployment - None	Camera Cassette contains 6500 feet of film providing capability of 165 minutes of operation	Photographic Subject-Lunar Surface Film frame format: 5 feet x 5 inches. Concurrent operation of 3-inch mapping camera is desired.	24-Inch Panoramic Camera • Roll Frame Assembly • Gimbal Assembly • Main Frame • GN_2 Pressure Vessel Assy. • Film Cassette • CM Crew-Operated Switches • CM Crew Display
	3-Inch Mapping Camera	Deployment - Rail Type-Mechanism	Camera Cassette contains 1500 feet of metric film and 510 feet of stellar film providing capability of 25 hours of operation or approximately 4200 frames of photography each.	Metric film format: 4.5 in. x 4.5 in. Stellar film format: 35-mm • Photography Subject - • Lunar surface with simultaneous stellar photography and frame-coupled laser altimeter measurements • Wide angle photographs of the lunar surface following TEI • Operation is desired whenever panoramic camera operates	3-Inch Mapping Camera • Metric Camera • Stellar Camera Glare Shield • GN_2 Pressure Vessel Assy. • Film Cassette • CM Crew-Operated Switches • CM Crew Displays • Metric Camera Optics Protective Shield (Shared with Laser Altimeter) • Stellar Camera Optics Protective Shield
	Laser Altimeter	Deployment - Rail Type Mechanism. (Mounted to Mapping Camera)	Minimum operation: whenever the Mapping Camera is operating	• Range from CSM to lunar surface with 1-meter resolution • To be supported on the lunar darkside by stellar camera as film budget permits	Laser Altimeter • CM Crew-Operated Switch • Optics Protective Shield (Shared with Mapping Camera)

Table 2-1. Lunar Orbit Science Experiments - Equipment/Operation Summary (Continued)

EXP. NO.	TITLE/OBJECTIVE	SPACECRAFT LOCATION/ DEPLOYMENT	OPERATING TIME	MEASUREMENT & CONSIDERATION	EQUIPMENT
S-164	S-Band Transponder (CSM/LM)	• Command and Service Module • Lunar Module Deployment - None	Front Side Passes in order of science priority: CSM/LM 60 x 9 NM; LM Descent: LM Ascent stage to impact; CSM and CSM/LM 60 x 60 NM; CSM/ LM 60 x 170 NM (Unpowered Flight)	• Doppler Tracking Data of CSM, docked CSM/LM, and LM • Tracking data below 16 NM altitude are most useful	• S-Band Communications Subsystem
S-169	Far UV Spectrometer	Service Module (SIM Bay) Deployment - None	Lunar Orbit • Mode I 5 orbits 60 x 60 NM 1 orbit 60 x 9 NM • Mode II 5 orbits 60 x 60 NM • Mode III 1 orbit 60 x 9 NM 1 orbit 60 x 60 NM • Mode IV 60 x 60 NM orbit 2 periods of 15-30 minutes (just past sunset terminator) • Mode V 13 orbits 60 x 60 NM Darkside passes Note: Part of Mode V Data may be	Obtain data on spectral emissions in the form of pulse counts in the spectral region from 1175Å to 1675 Å. Mode I - CSM +X axis aligned to velocity vector - SIM Bay ℄ aligned to nadir. Mode II- CSM -X axis aligned to velocity vector - SIM Bay ℄ aligned to nadir. Mode III-The Far UV Spectrometer optical axis will point within 100 ±5 degrees of the sun and at an angle TBD to the plane of the ecliptic. Mode IV- The Far UV Spectrometer optical axis will be pointed toward the earth while the CSM is beyond the sunset terminator on the lunar near side. Mode V - CSM +X axis will be aligned to the velocity vector and the Far UV Spectrometer optical axis will be pointed away from the moon.	• 1/2 Meter Focal Length Ebert Spectrometer • Baffle • Entrance-Exit Slits • Collecting Optics • Scan Drive Mechanism • Electronics • Thermal Protection Shield • CM Crew-Operated Switches • CM Display

Table 2-1. Lunar Orbit Science Experiments - Equipment/Operation Summary (Continued)

EXP. NO.	TITLE/OBJECTIVE	SPACECRAFT LOCATION/ DEPLOYMENT	OPERATING TIME	MEASUREMENT & CONSIDERATION	EQUIPMENT
S-169	Far UV Spectrometer (Cont'd)		obtained during TEC if all Data cannot be obtained during Lunar Orbits. • Mode VI Transearth Coast (TEC) Minimum of 8 hours 1 hour at each selected (8) celestial coordinate position. • Mode VII Transearth Coast (TEC) Six 1 hour periods	Mode VI - Transearth Coast - The Far UV Spectrometer optical axis will be aligned to selected coordinate positions Mode VII- Transearth coast - CSM is in Passive Thermal Control (PTC). Far UV Spectrometer will be operated for six 1-hour periods	

S-171	Infrared Scanning Radiometer	Service Module (SIM Bay)
		Deployment - None
			4-hour segments spaced 24 ±2 hrs apart	• The selected measurement range of 40° - 400°K is divided into three channels for telemetering 0-160°, 0-250°, 0-400°K
				• Exposed radiometer FOV must not be pointed to direct sunlight
				• ISR required 30 min. warm up prior to data collection
				• Deep space reference on each sweep only when altitude is equal or greater than 40 NM
					• Optical Scanning Unit
					  • Folded Cassegrain Telescope
					  • FOV Baffles
					  • Scan Drive
					  • Primary & Secondary Mirrors
					• Bolometer
					• IR Lens
					• Electronics
					• Protective Cover
					• CM Crew-Operated Switches
					• CM Displays

Table 2-1. Lunar Orbit Science Experiments - Equipment/Operation Summary (Continued)

EXP. NO.	TITLE/OBJECTIVE	SPACECRAFT LOCATION/ DEPLOYMENT	OPERATING TIME	MEASUREMENT & CONSIDERATION	EQUIPMENT
S-209	Lunar Sounder	Service Module (SIM Bay) VHF Antenna - Deployed during TLC for remainder of mission HF Antennas - Deployed for data gathering in lunar orbit after LOI	Sounding Mode • VHF - 2 continuous orbits 60 x 60 NM • HF - 2 continuous orbits 60 x 60 NM • HF Receive Only (Listening Mode) 4 orbits 60 x 60 NM 2 orbits when Surface Electrical Prop. Experiment (SEP) is ON 2 orbits (SEP) OFF. • Individual Sounding Targets VHF & HF in operate mode	HF-1: 5 MHz, HF-2: 15 MHz, and VHF: 150 MHz signals	• Coherent Synthetic Aperture Radar (CSAR) • Optical Recorder Film Cassette (Recovered during EVA) • HF Antennas • VHF Antenna • Electronics • CM Crew-Operated Switches • CM Displays

Table 2-2. Lunar Surface Science Equipment Summary

EXP. NO.	EXPERIMENT	CENTRAL STATION INTERFACE	EQUIPMENT
---	ALSEP Central Station	---	• ALSEP Communications Subsystem (including antenna) • ALSEP Data Subsystems • Electronics Subsystem for ALSEP Seismic Profiling Experiment • Housing and Thermal Protection for Above Subsystems • Astronaut Switch Panel • RTG Power Source and Power Conditioning Unit • 70-mm Hasselblad Electric Data Camera/60-mm Lens

S-037	Heat Flow Experiment (Apollo 17 ALSEP)	Yes	• Apollo Lunar Surface Drill
			  • Power Head and Spindle
			  • Bore Stems (6)
			    • 1.37 meter Sections (2)
			    • 0.71 meter Sections (4)
			  • Bore Bits (2)
			  • Bore Stem Wrench
			• Heat Probes (2)
			  • Radiation Shields (6)
			  • Probe Emplacement Tool
			  • Electronics Package
			  • 70-mm Hasselblad Electric Data Camera/60-mm Lens

Table 2-2. Lunar Surface Science Equipment Summary (Continued)

EXP. NO.	EXPERIMENT/OBJECTIVE	CENTRAL STATION INTERFACE	EQUIPMENT
S-059	Lunar Geology Investigation	No	• PLSS-Mounted Tool Carriers (2) • Hammer • Extension Handles (2) • 32-Inch Tongs (2) • Lunar Surface Rake • Large Sampling Scoop • Gnomon with Photometric Chart • Sample Scale (LM Ascent Stage) • Core Tubes* (9) • Core Tube Cap Dispensers (5) • Surface Sampler Devices (2)** • UHT • Core Tube Follower Tools (2) • Core Tube Stowage Bag (Used for contingency stowage only) • Documented Sample Bag Dispenser(7) • Three 20-Bag Documented Sample Bag Dispensers in ALSRC No. 1 • Four 20-Bag Documented Sample Bag Dispensers in ALSRC No. 2 • Padded Sample Bags (2)** • Sample Collection Bags (4) • One in each ALSRC • Two on LRV AFT Pallet

*One core tube sample is to be returned in CSVC** as pristine core sample.
**Being considered for J-3 Mission.

Table 2-2. Lunar Surface Science Equipment Summary (Continued)

EXP. NO.	EXPERIMENT	CENTRAL STATION INTERFACE	EQUIPMENT

S-059 (Continued)	Lunar Geology Investigation	No	• Extra Sample Collection Bag* (4)
			• Sample Containment Bag (6)*
			• Sample Return Bag (1)
			• Apollo Lunar Sample Return Container (2)
			• Special Environmental Sample Container (1)
			• Core Sample Vacuum Container (CSVC)** (1)
			• Apollo Lunar Surface Drill
			    • Power Head and Spindle
			    • Core Stem Sections (3)
			    • Core Stem Caps and Retainer Dispenser (1)
			    • Coring Adapter
			    • Bore Stem Wrench
			    • Core Stem Vise
			    • Treadle
			    • Drill String Rack
			    • Core Stem Extractor
			• 70-mm Hasselblad Electric Data Camera
			    • 60-mm Lens
			• 70-mm Hasselblad Electric Data Camera with 500-mm lens**

*Extra sample collection bag is same configuration as sample collection bag with exception of no external or internal pockets. Sample collection bags are placed inside sample containment bags.

**Being considered for J-3 Mission.

Table 2-2. Lunar Surface Science Equipment Summary (Continued)

EXP. NO.	EXPERIMENT	CENTRAL STATION INTERFACE	EQUIPMENT

S-059 (Continued)	Lunar Geology Investigation	No	• Science Support
			  • Lunar Surface 16-mm Data Acquisition Camera (Battery Operated)/10-mm Lens
			  • GCTA
			  • LRV

S-199	Traverse Gravimeter	No	• Traverse Gravimeter • LRV Rear Pallet Stowage • 70-mm Hasselblad Electric Data Camera/60-mm Lens

S-200	Soil Mechanics
	(As a passive experiment)
		No	• S-059 Equipment
			• 70-mm Hasselblad Electric Data Camera/60-mm Lens
			• Science Support
			  • GCTA
			  • LRV

Table 2-2. Lunar Surface Science Equipment Summary (Continued)

EXP. NO.	EXPERIMENT/OBJECTIVE	CENTRAL STATION INTERFACE	EQUIPMENT

S-202	Lunar Ejecta and Meteorites (Apollo 17 ALSEP)	Yes	• LEAM Assembly
			  • Supressor and Collector Plates
			  • Impact Plates
			  • Film Frames
			  • Electronics
			  • Thermal Control Assembly
			  • Microphone
			  • Deployable Cover
			• Central Station Electronics
			• Connecting Cable
			• 70-mm Hasselblad Electric Data Camera/60-mm Lens

S-203	Lunar Seismic Profiling (Apollo 17 ALSEP)	Yes	• Geophone Assembly
			  • Geophones (4)
			  • Geophone Module (1)
			  • Connecting Cables
			  • Flags (5)
			• Explosive Package Assembly (8)
			  • Receiving Antenna
			  • Receiver and Signal Processor
			  • Firing Circuits
			  • Explosive Train

Table 2-2. Lunar Surface Science Equipment Summary (Continued)

EXP. NO.	EXPERIMENT/OBJECTIVE	CENTRAL STATION INTERFACE	EQUIPMENT

S-203 (Continued)	Lunar Seismic Profiling (Apollo 17 ALSEP)	Yes	• Pull Pins (3)
			    • Safe/Arm Timer
			    • Thermal Battery and Timer
			    • Shorting Plug
			• Central Electronics Assembly
			    • Transmitting Antenna
			    • Transmitter
			• 70-mm Hasselblad Electric Data Camera/60-mm Lens (Deployment of Geophones and Explosive Pkgs.)
			• GCTA

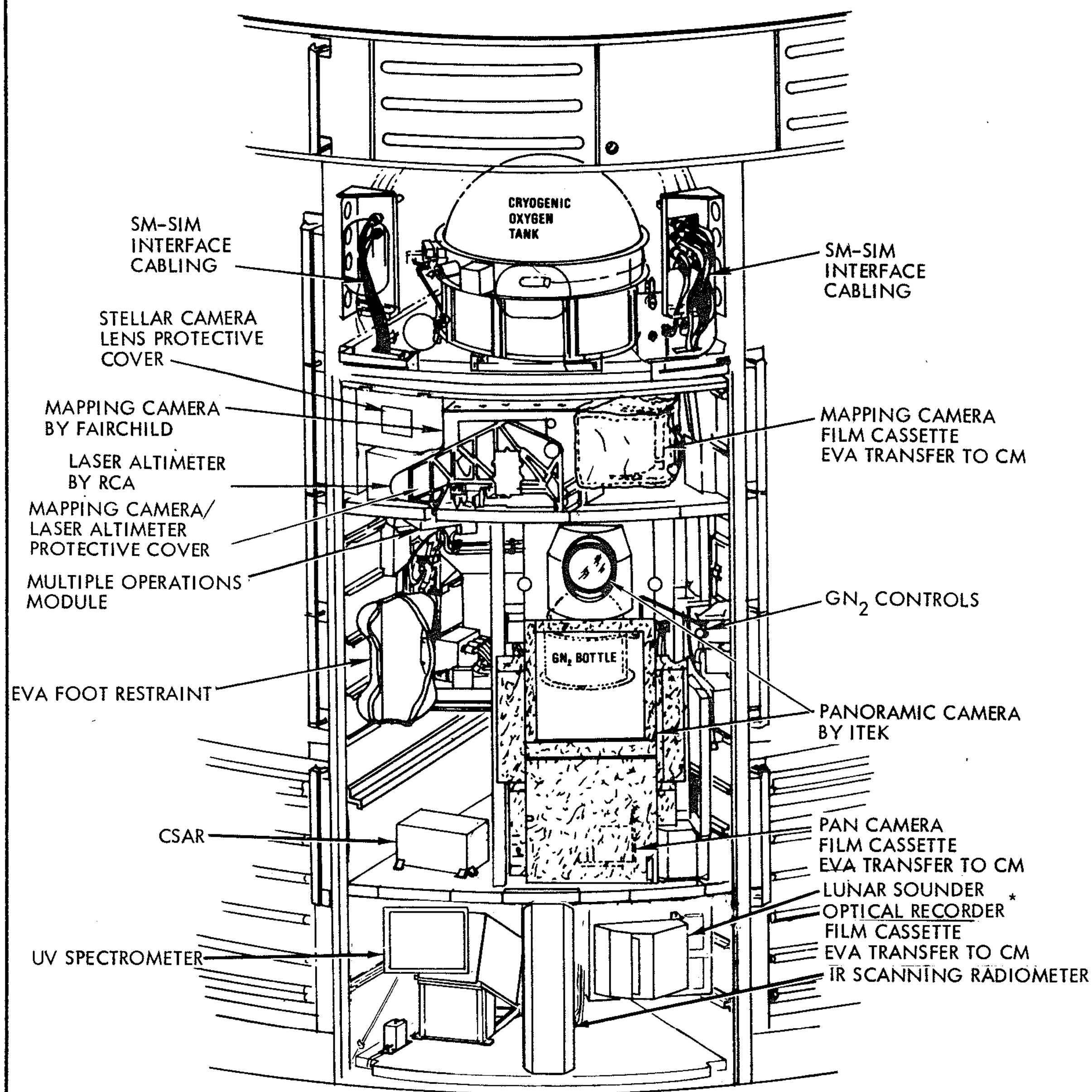
S-204	Surface Electrical Properties	No	• SEP Transmitter Assembly
			    • Dipole Antennas (2)
			    • Solar Panel
			    • Electronics
			• 70-mm Hasselblad Electric Data Camera/60-mm Lens
			• SEP Receiver Assembly
			    • Antenna and Mast
			    • Recorder
			    • Battery
			    • Electronics

Table 2-2. Lunar Surface Science Equipment Summary (Continued)

EXP. NO.	EXPERIMENT/OBJECTIVE	CENTRAL STATION INTERFACE	EQUIPMENT

S-205	Lunar Atmospheric Composition (Apollo 17 ALSEP)	Yes	• Lunar Mass Spectrometer Assembly
			  • Analyzer
			  • Connector Cable
			  • Electronics
			• Dust Cover
			• 70-mm Hasselblad Electric Data Camera/60-mm Lens

S-207	Lunar Surface Gravimeter (Apollo 17 ALSEP)	Yes	• Lunar Surface Gravimeter Assembly
			  • Electronics Package
			  • Connector Cable
			• Sunshade
			• 70-mm Hasselblad Electric Data Camera/60-mm Lens



NOTES: (1) SIM DOOR SHOWN REMOVED

(2) PROTECTIVE COVERS FOR MAPPING CAMERA, LASER ALTIMETER, IR SCANNING RADIOMETER, AND UV SPECTROMETER SHOWN IN CLOSED POSITION

Figure 2-1. J-3 Mission SIM Bay Experiment Sensors and Cameras

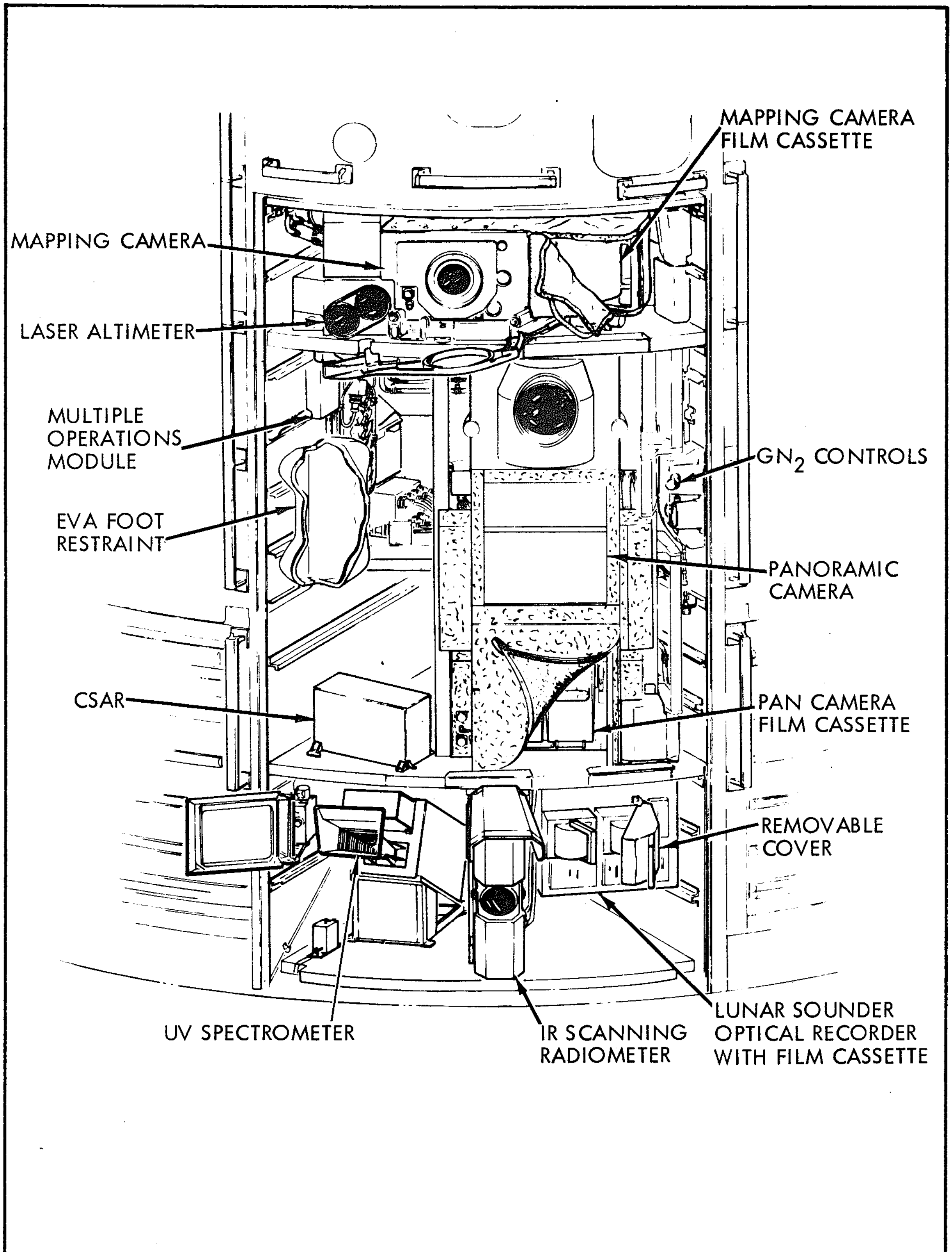


Figure 2-2. J-3 Deployed SIM Bay Experiment Sensors and Camera Protective Covers.

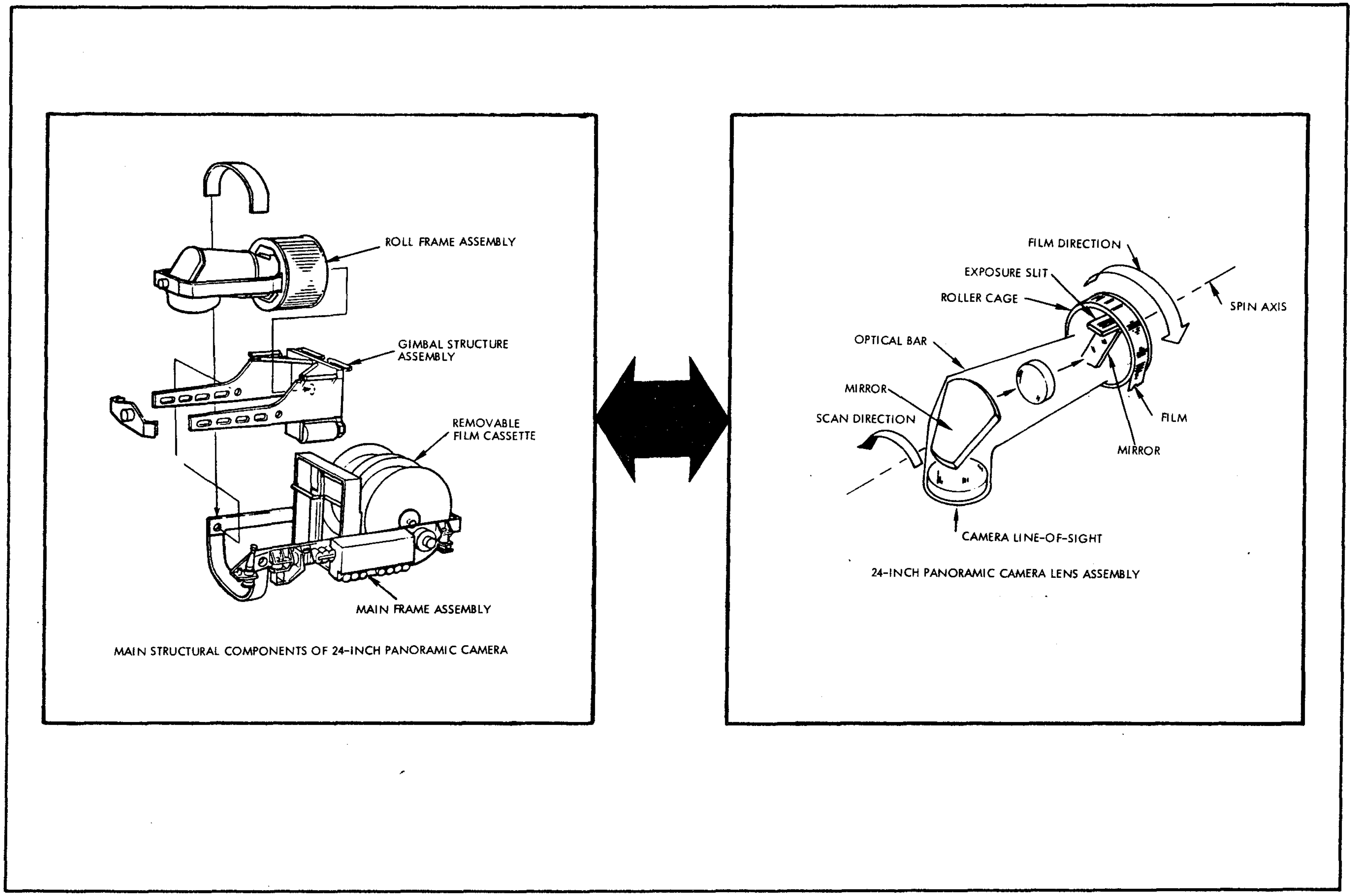


Figure 2-3(a). SIM Bay 24-Inch Panoramic Camera - Structure/Lens Detail

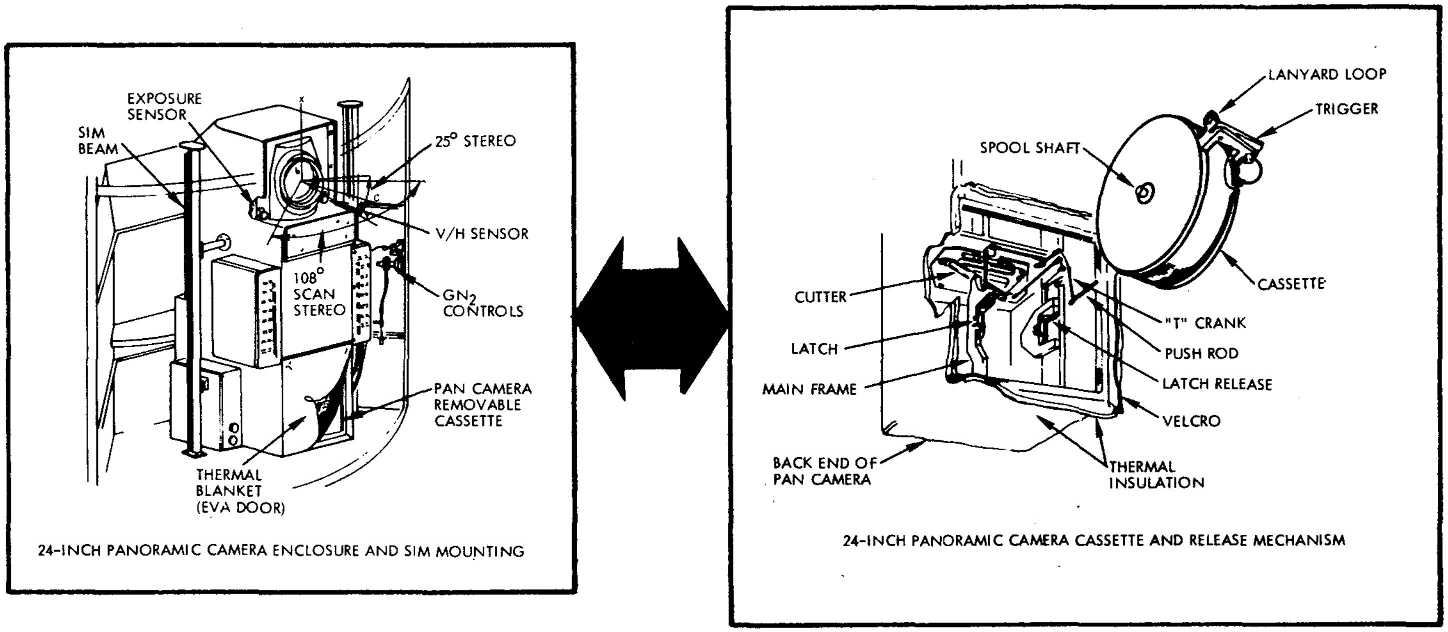


Figure 2-3(b). SIM Bay 24-Inch Panoramic Camera Cassette Installation Detail

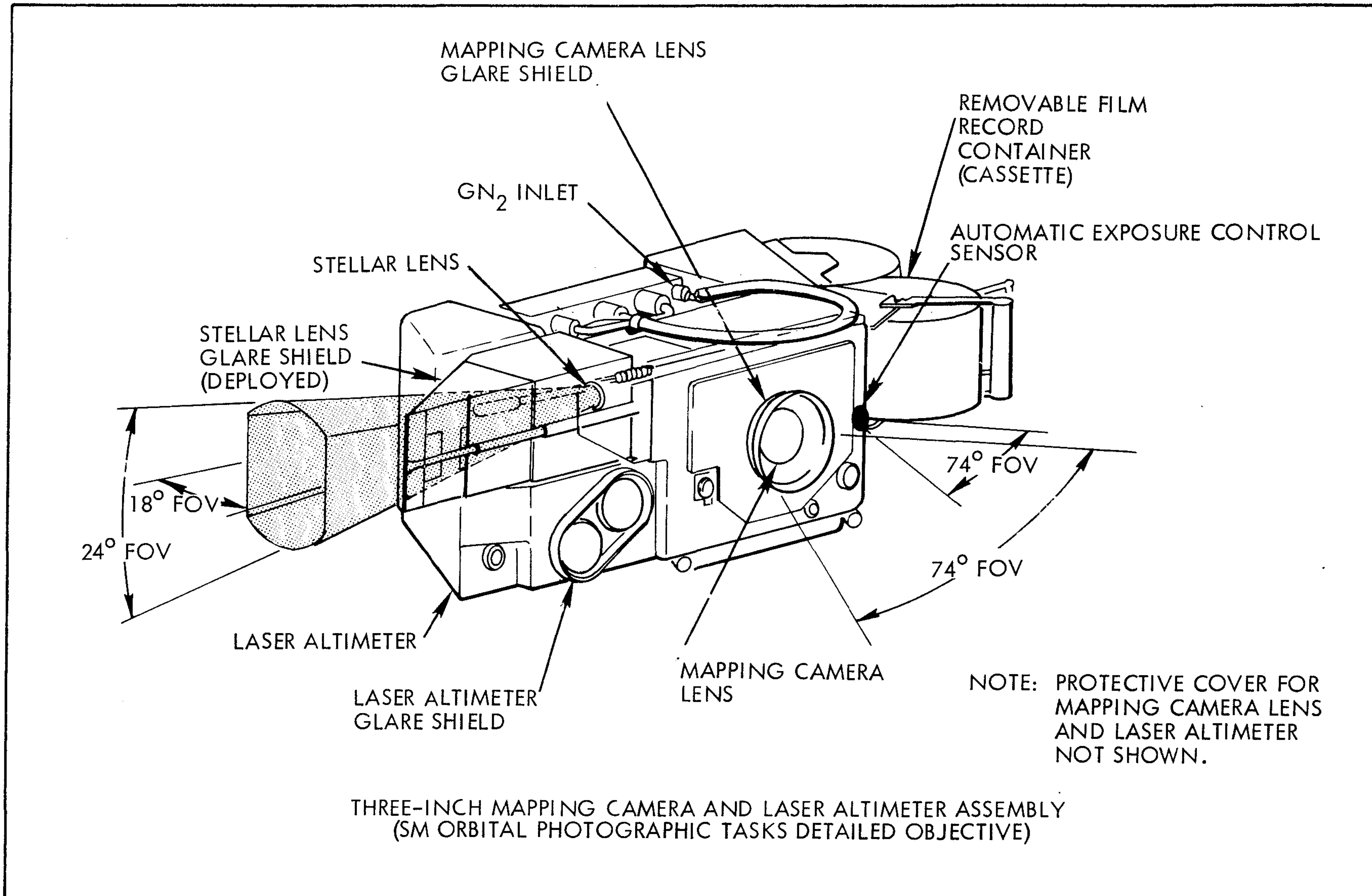
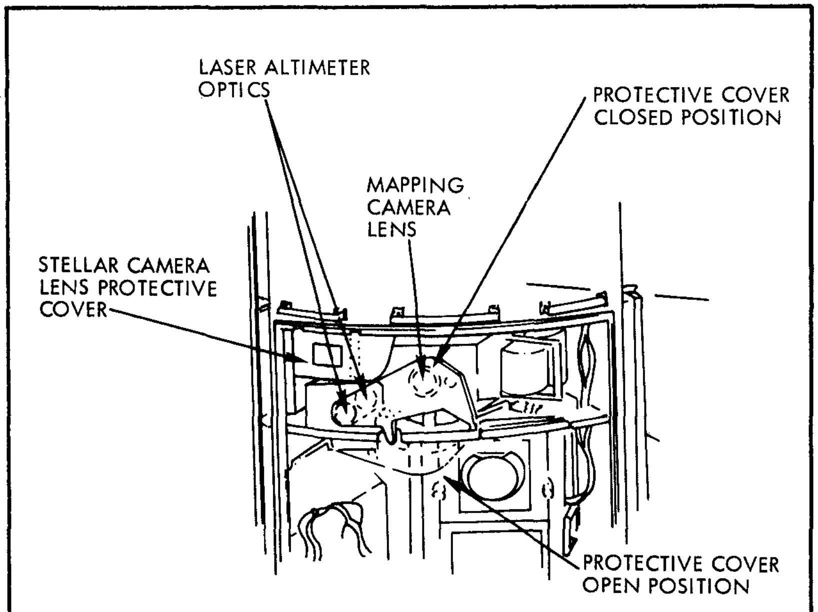


Figure 2-4(a). SIM Bay 3-Inch Mapping Camera Assembly - Mapping Camera/Stellar Camera/ Laser Altimeter Detail



MAPPING CAMERA/LASER ALTIMETER/STELLAR CAMERA PROTECTIVE COVER CONCEPTS

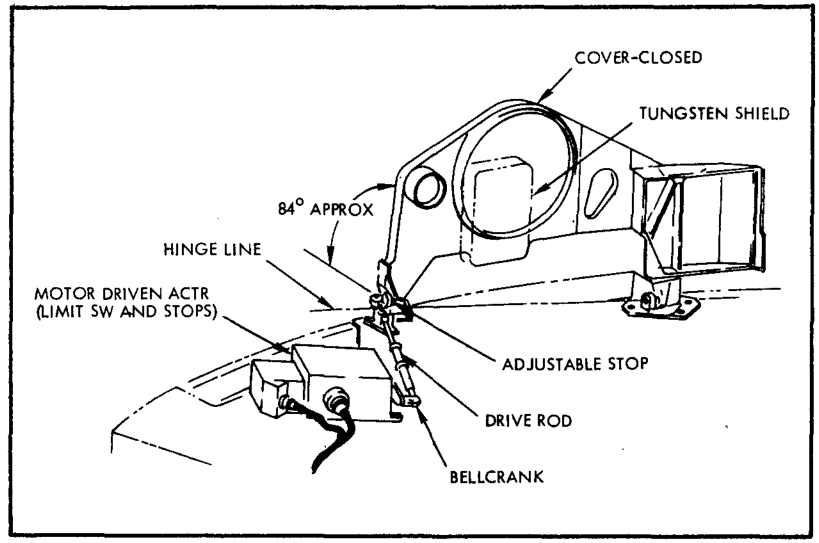


Figure 2-4(b). SIM Bay 3-Inch Mapping Camera Assembly - Protective Cover Detail

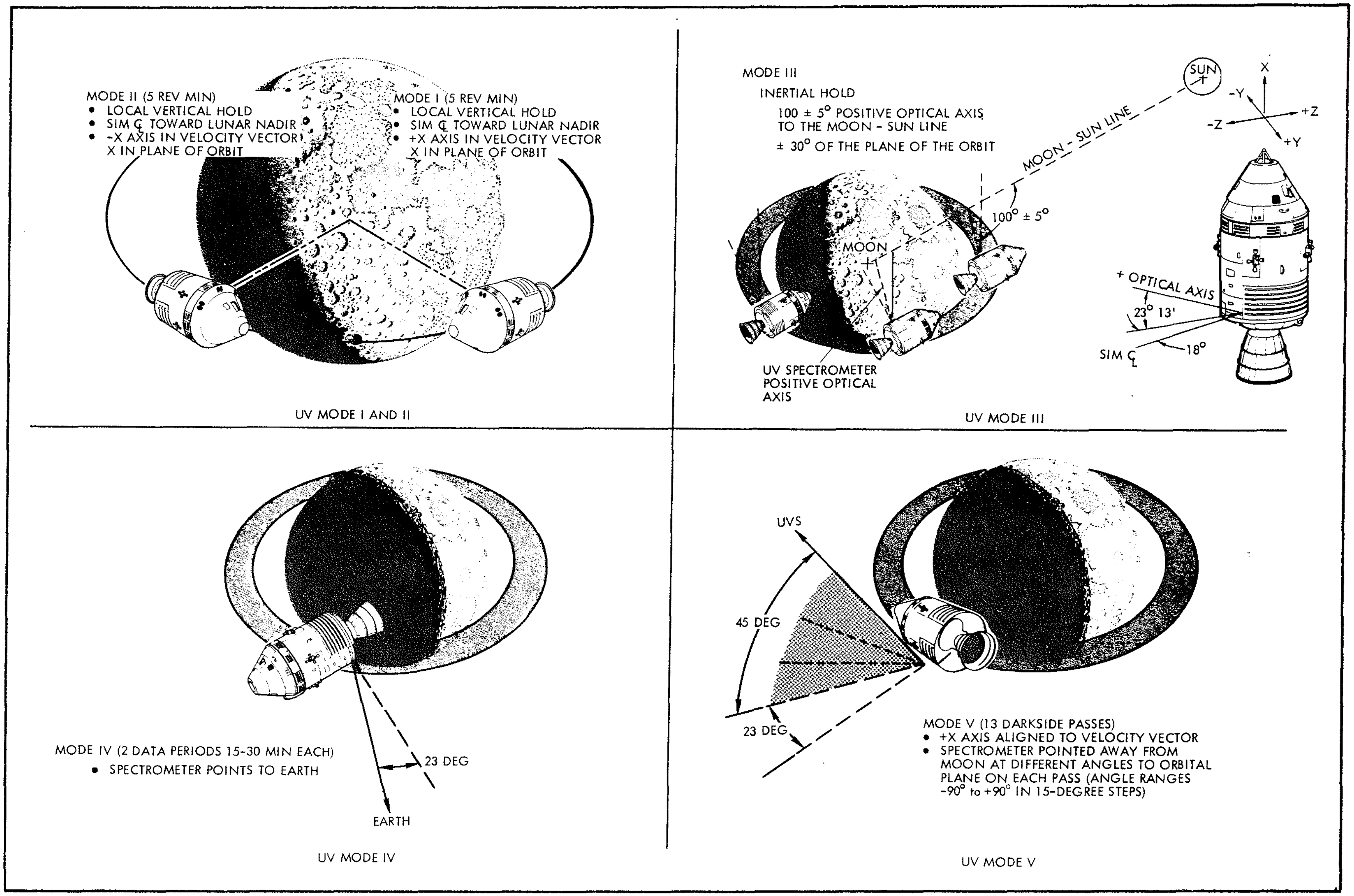


Figure 2-5(a). Far UV Spectrometer - Modes of Operation

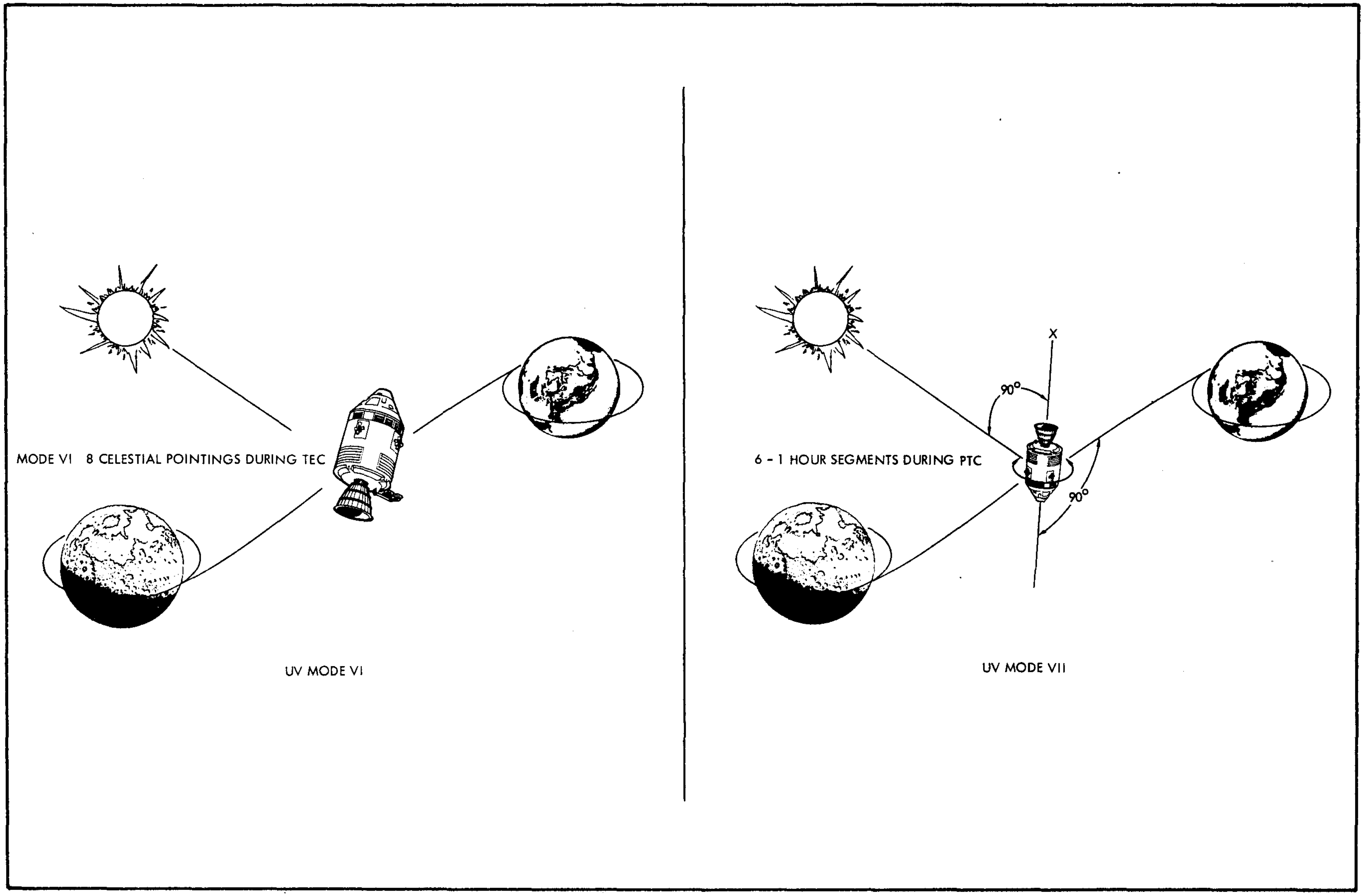


Figure 2-5(b). Far UV Spectrometer - Modes of Operation

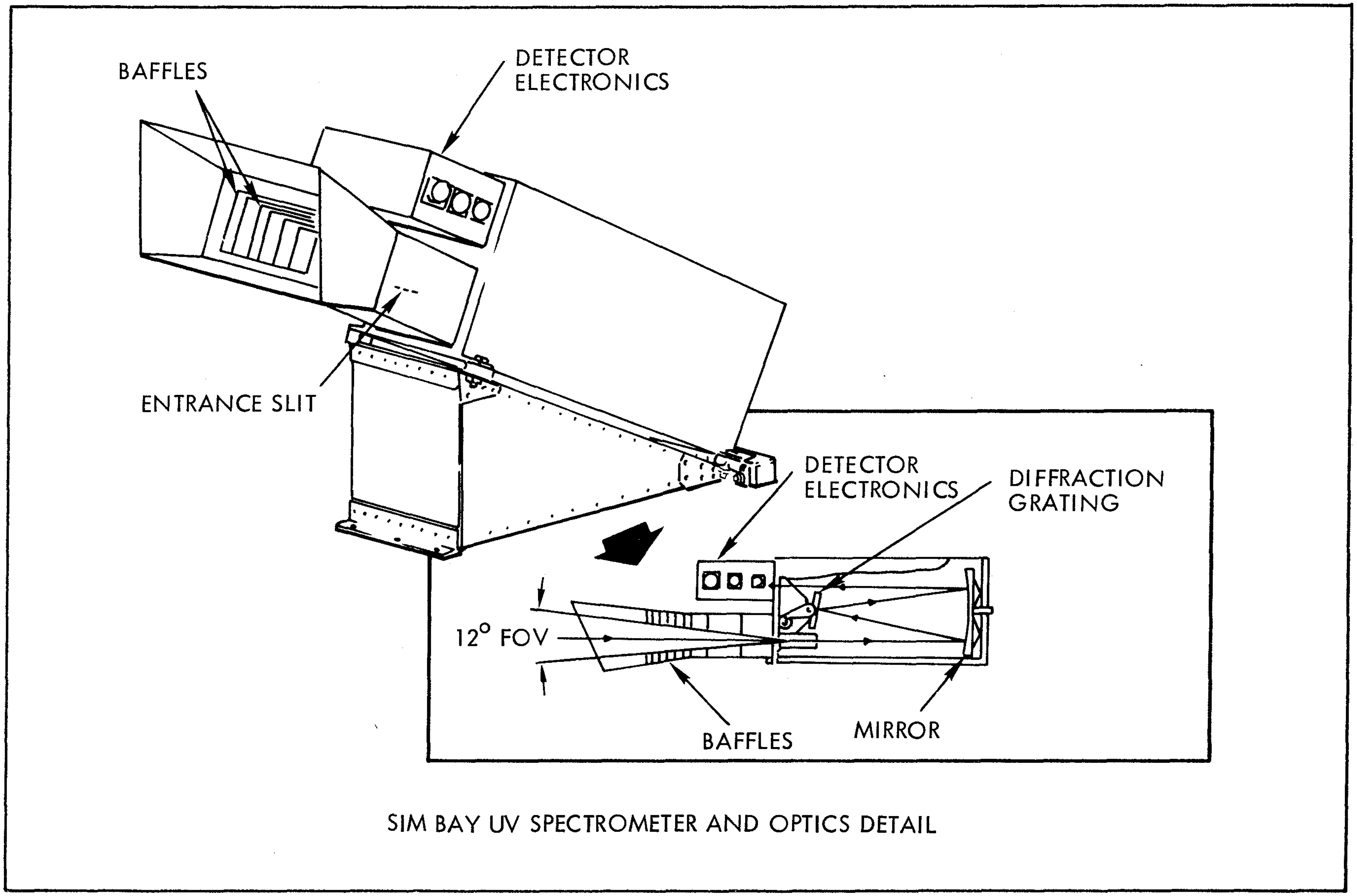


Figure 2-5(c). Far UV Spectrometer Assembly - Sensor Optics Detail

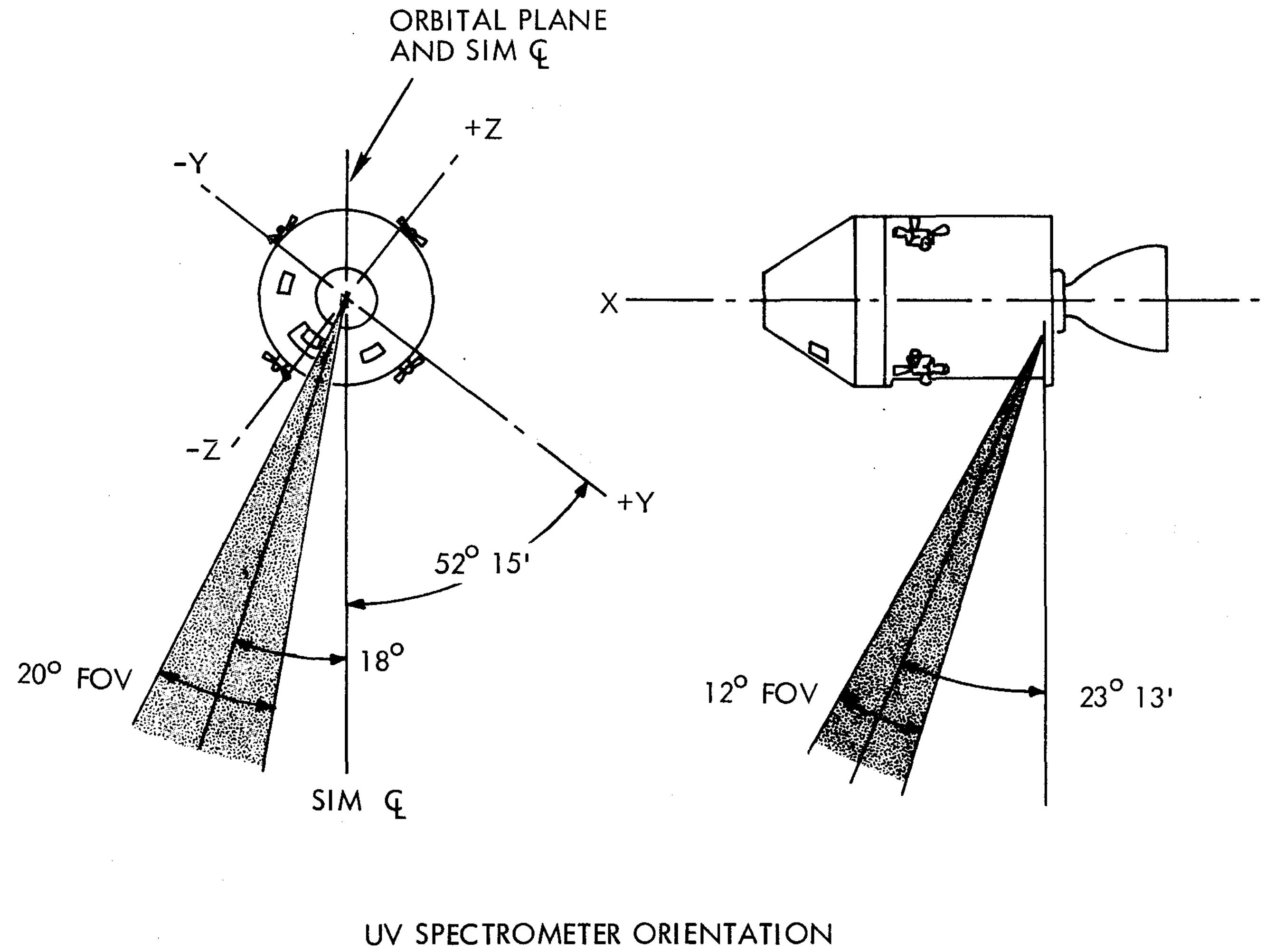


Figure 2-5(d). Far UV Spectrometer - Orientation

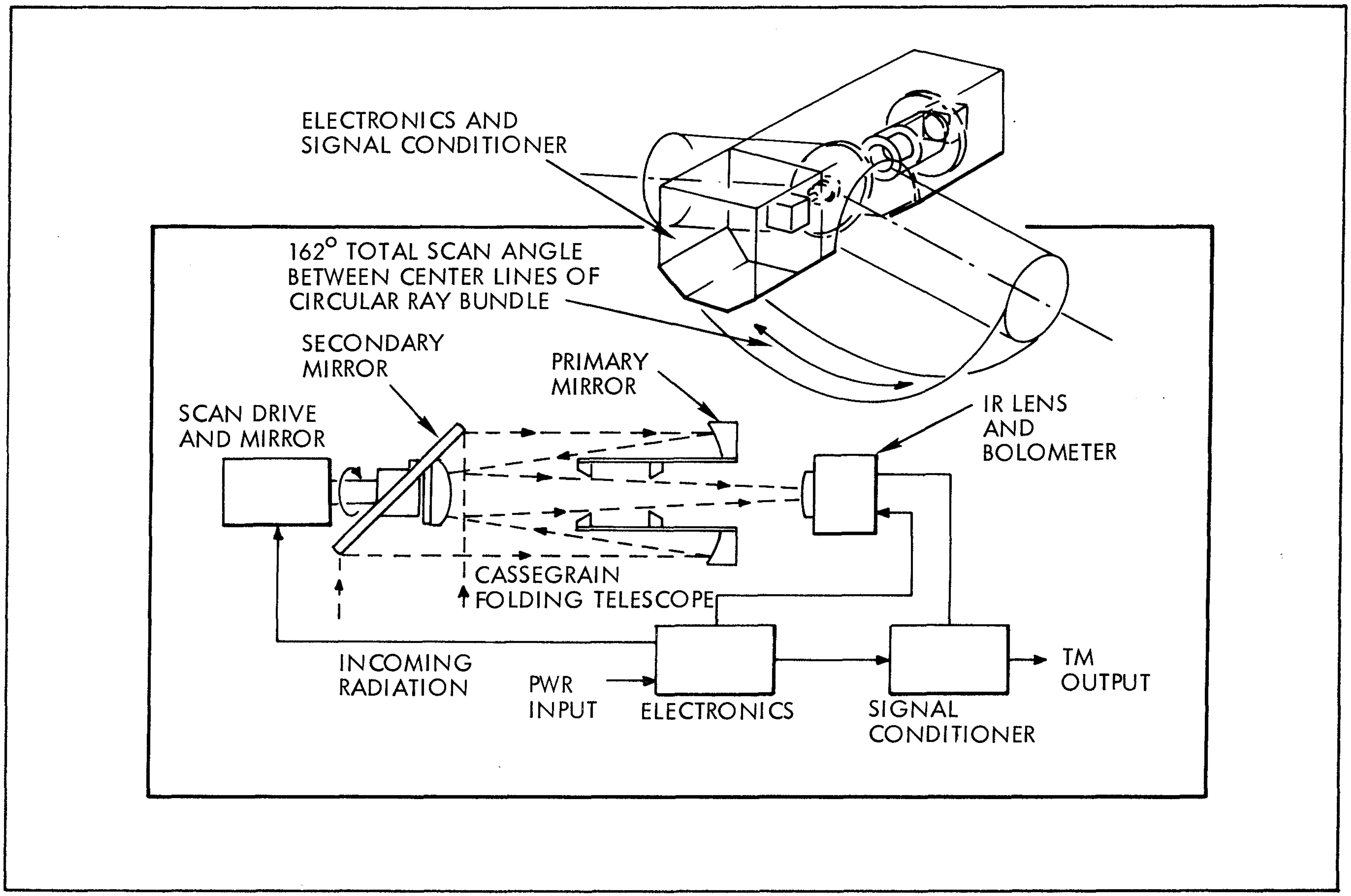


Figure 2-6(a). Infrared Scanning Radiometer Assembly - Detector Detail

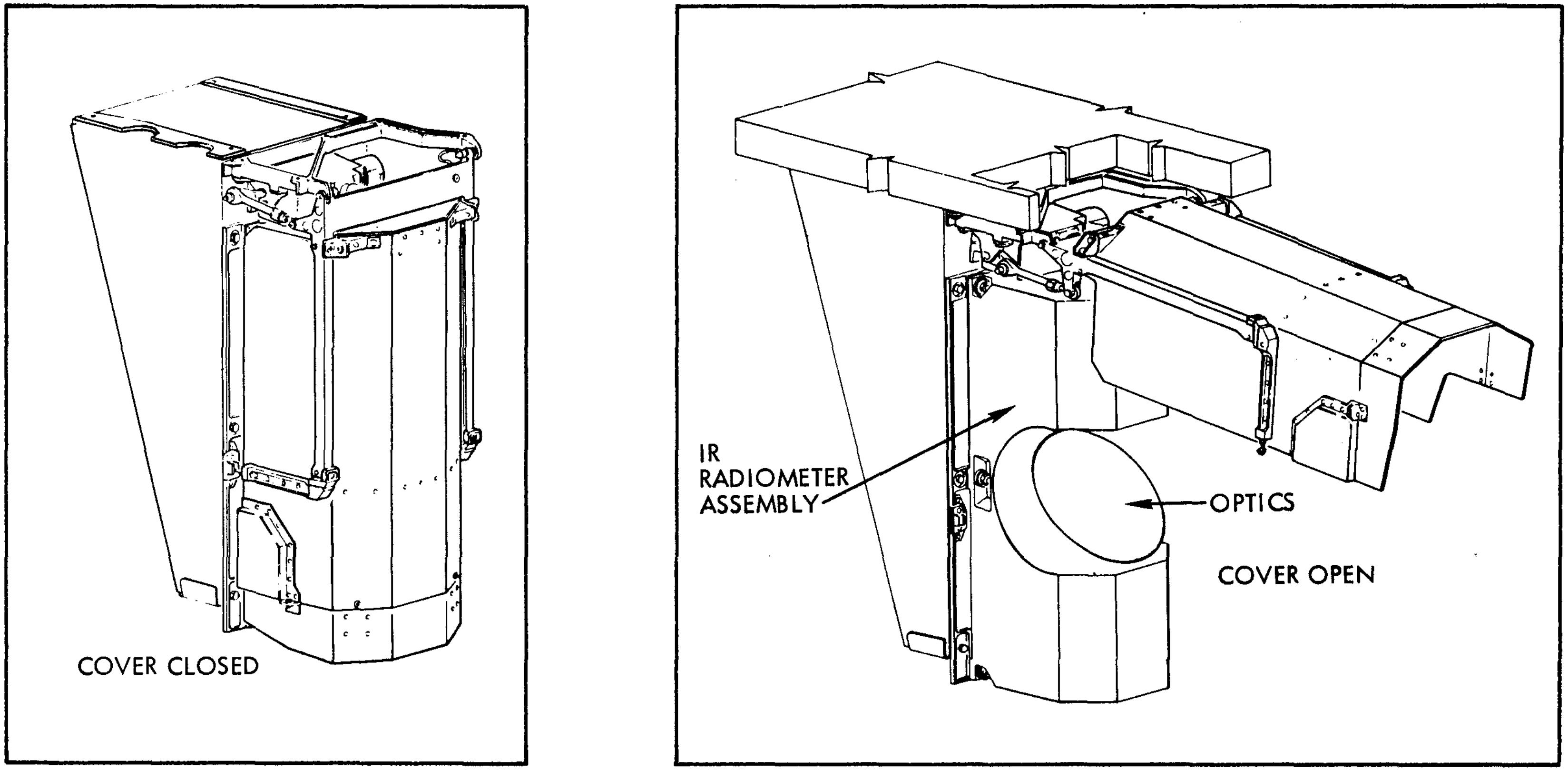


Figure 2-6(b). Infrared Scanning Radiometer - Protective Cover Detail

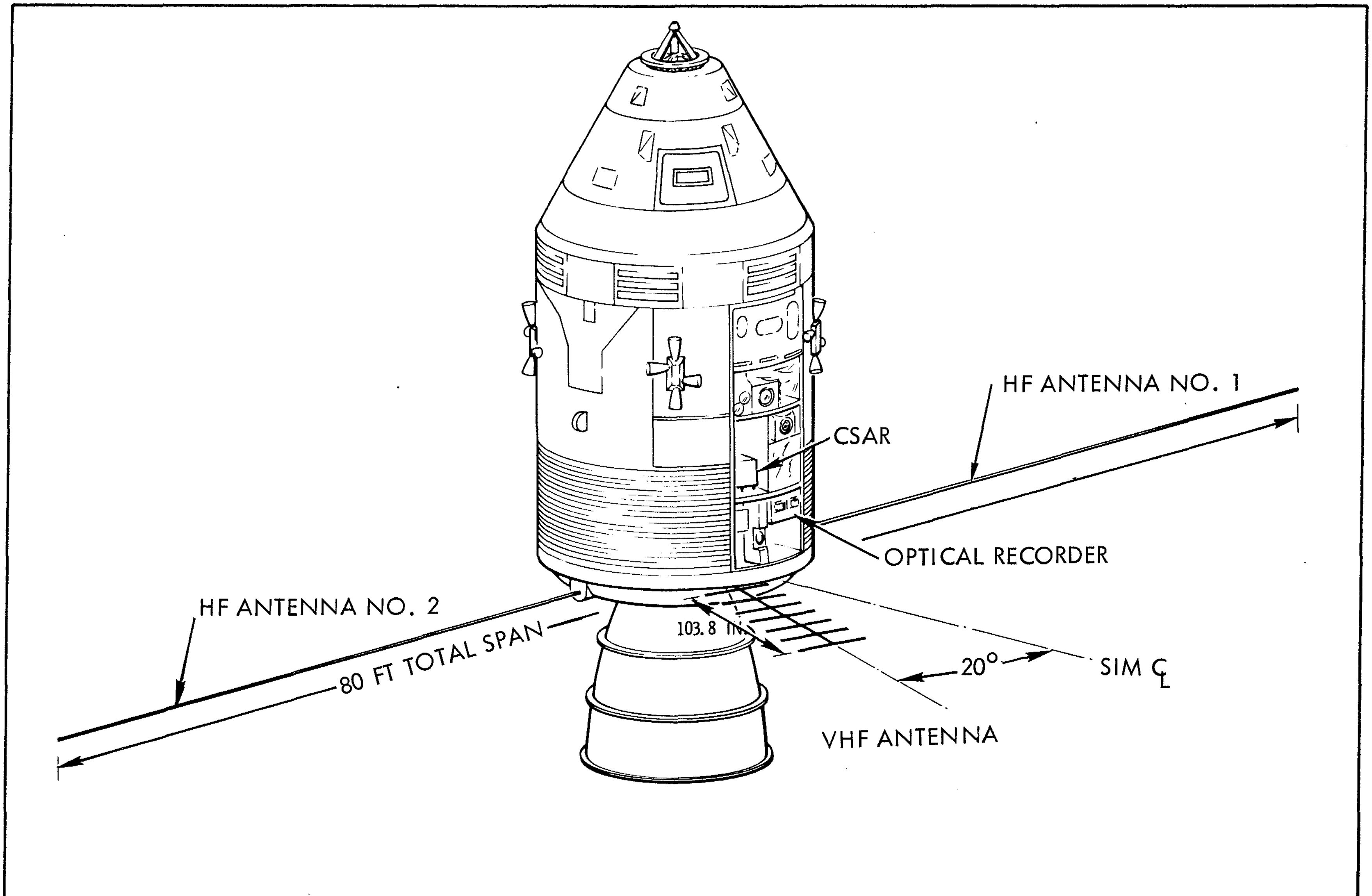


Figure 2-7(a). Lunar Sounder - Antennas Extended/Orientation

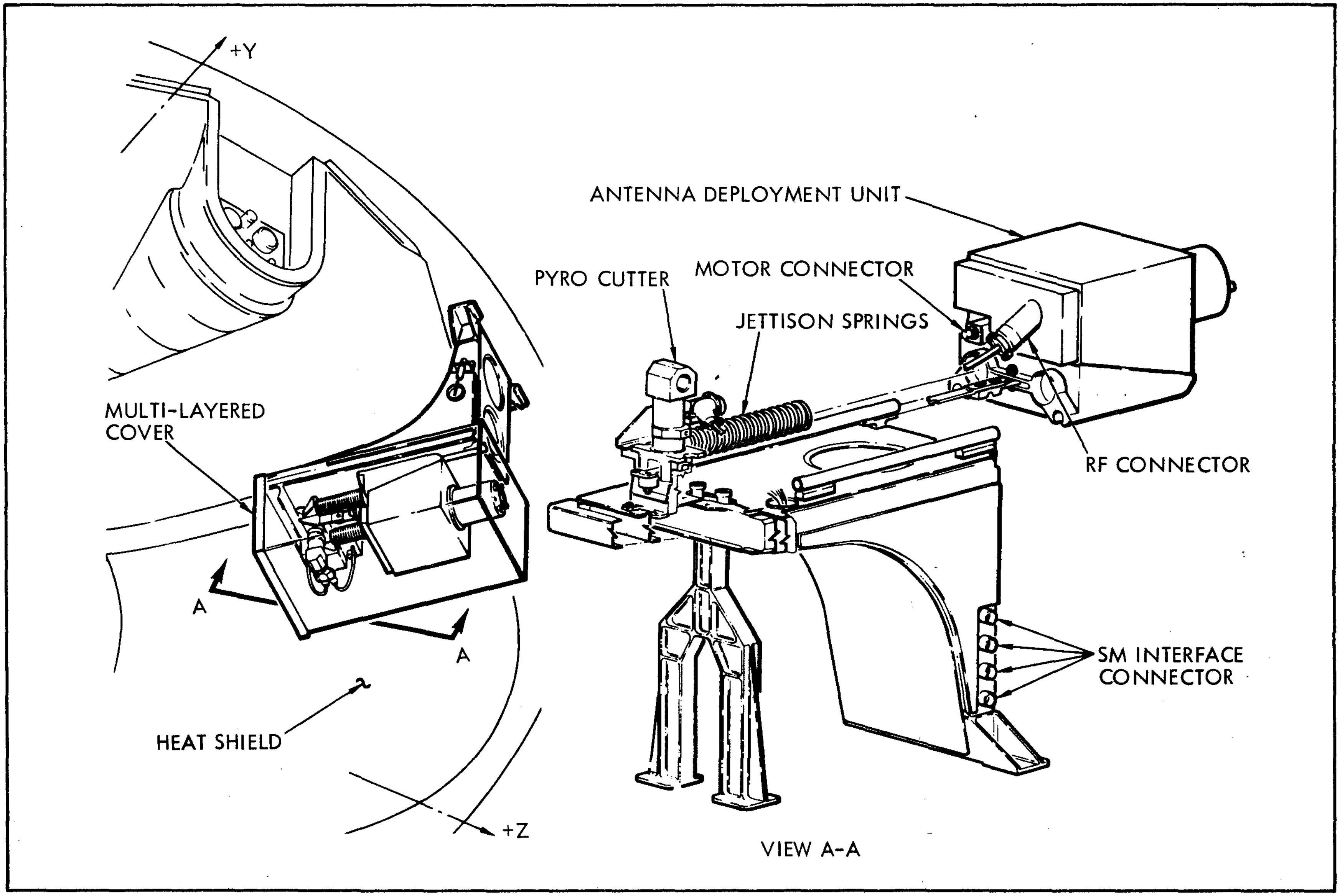


Figure 2-7(b). Lunar Sounder HF Antenna Assembly - Detail

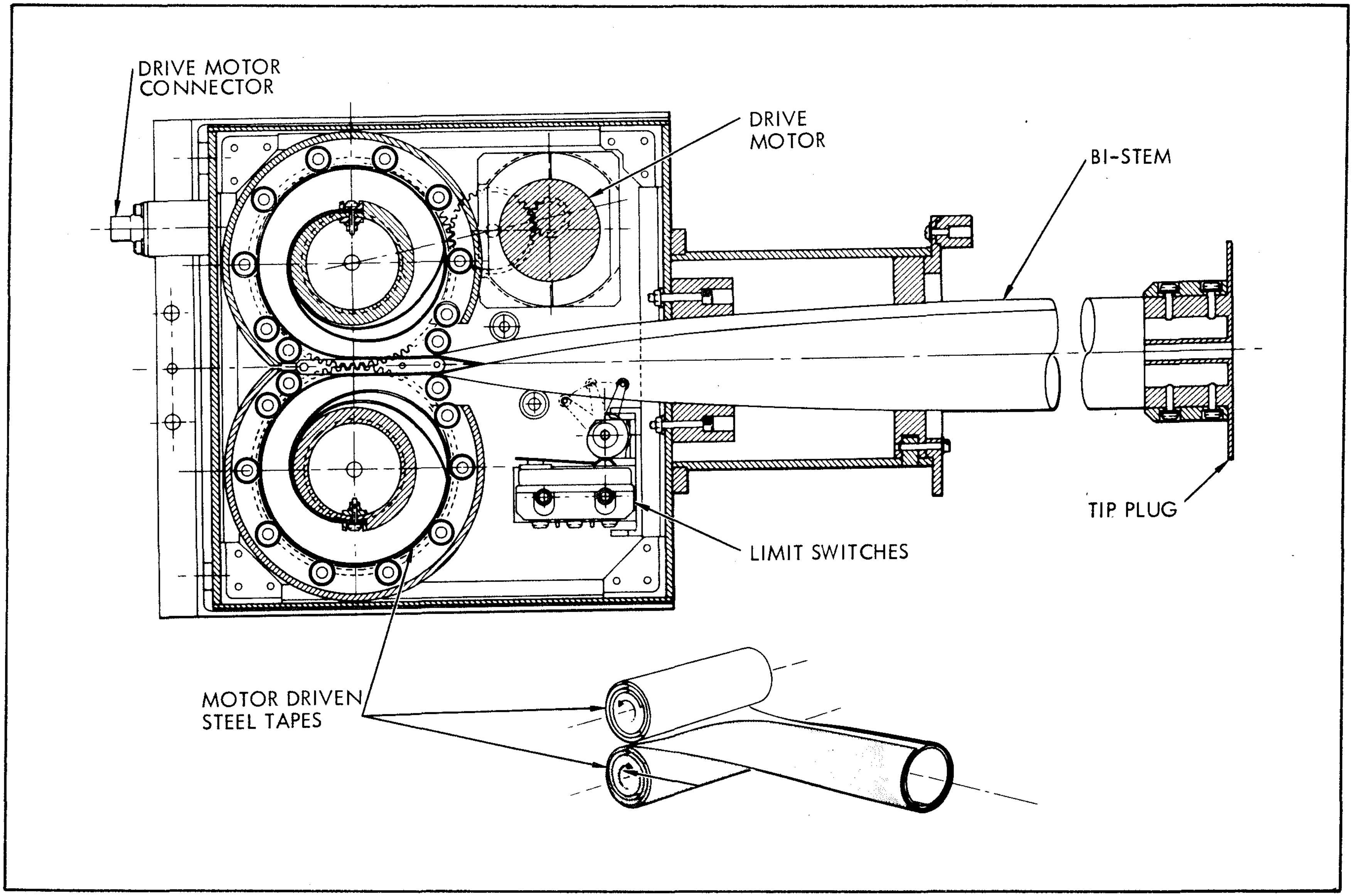


Figure 2-7(c). Lunar Sounder HF Antenna Deployment Mechanism

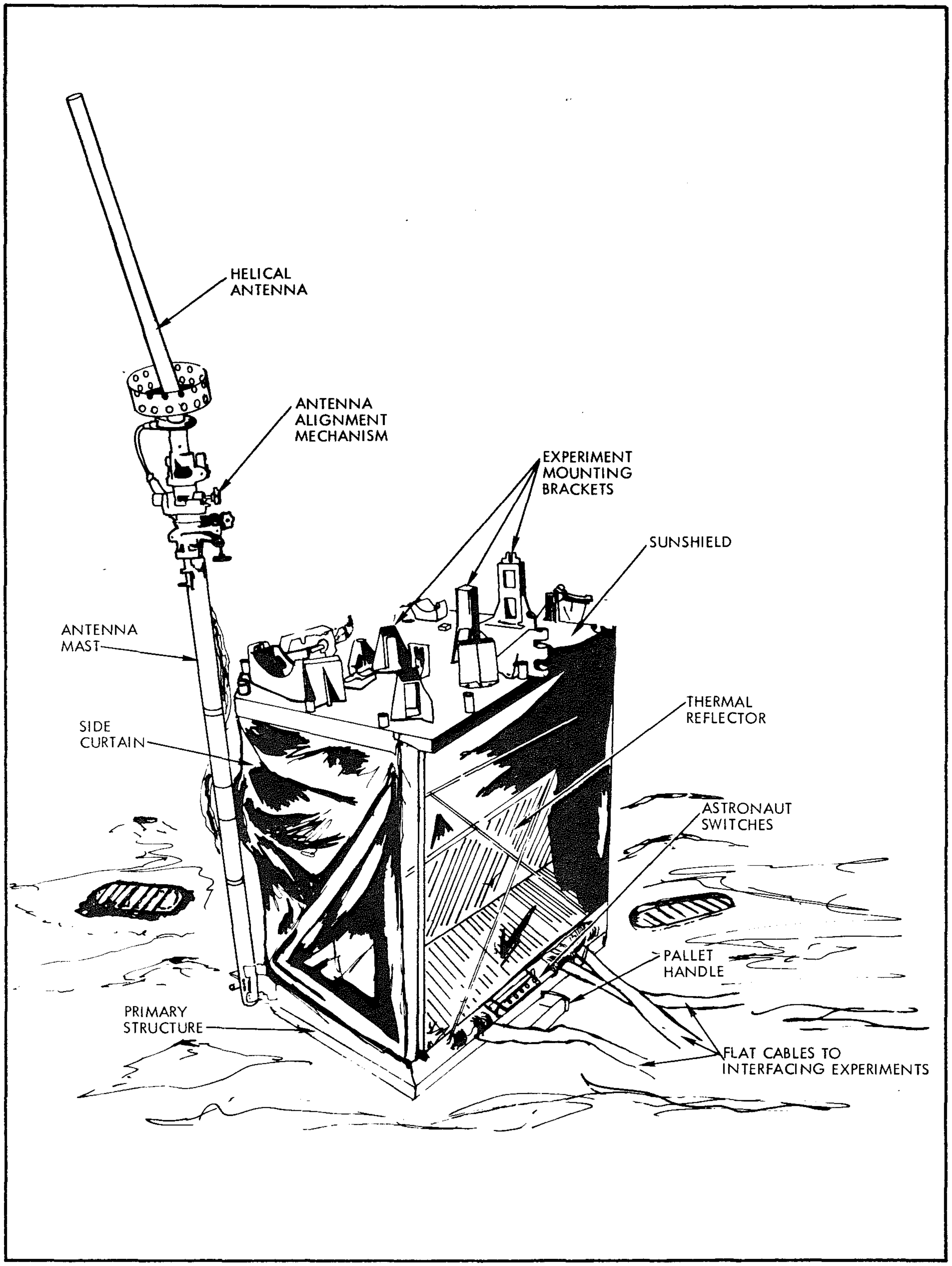


Figure 2-8(a). Apollo 17 ALSEP Central Station

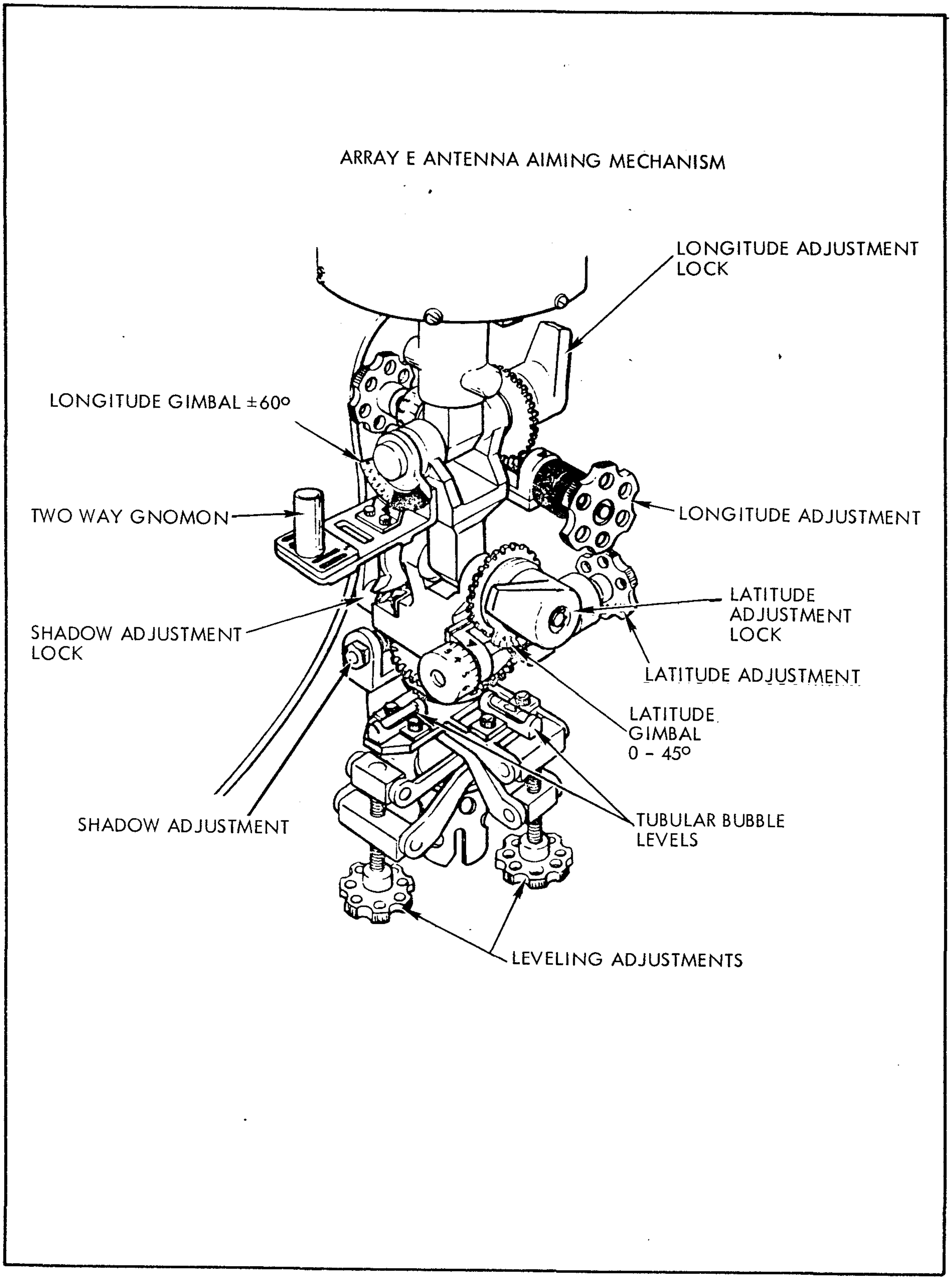


Figure 2-8(b). Apollo 17 ALSEP Helical Antenna - Detail

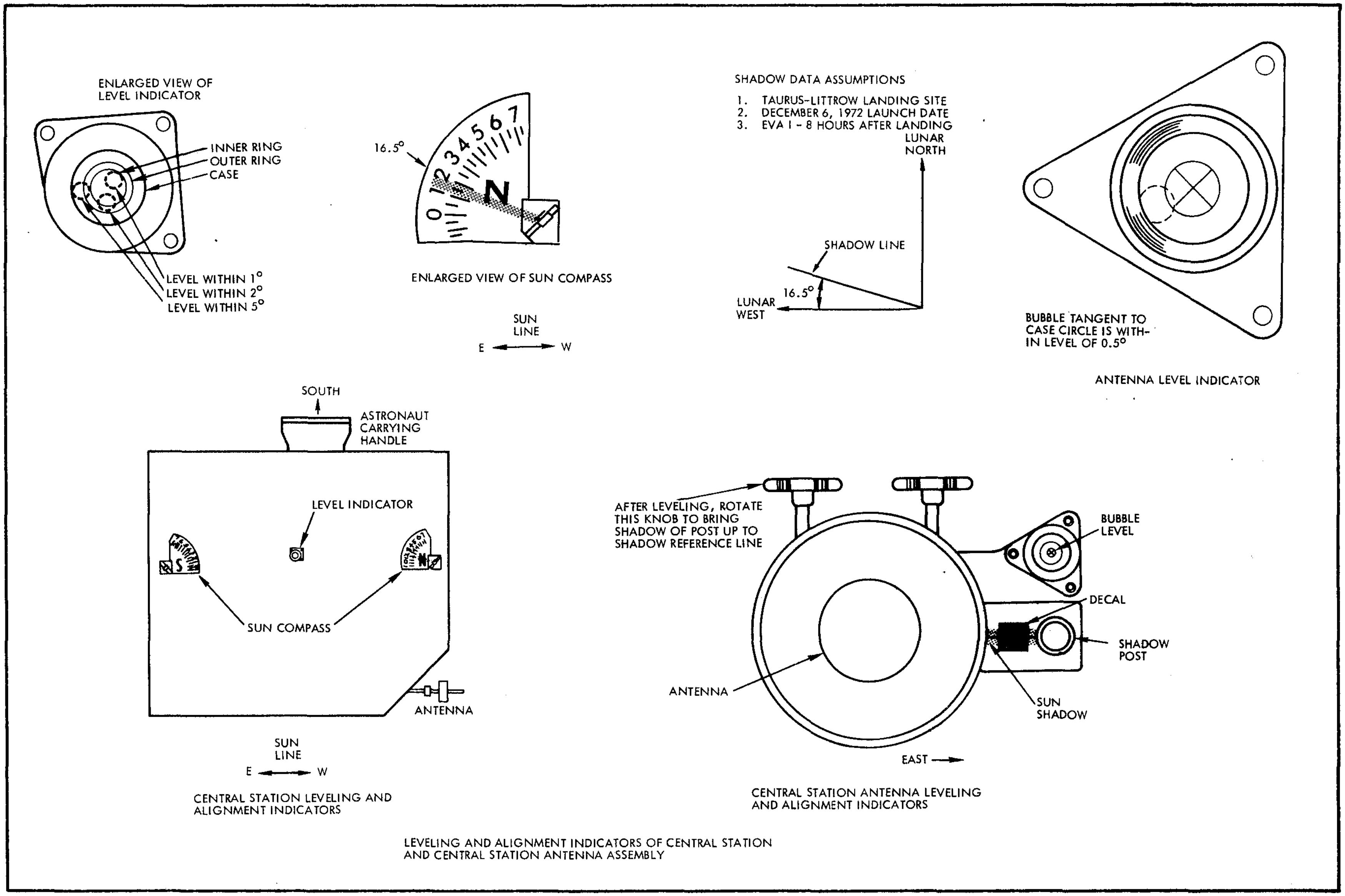
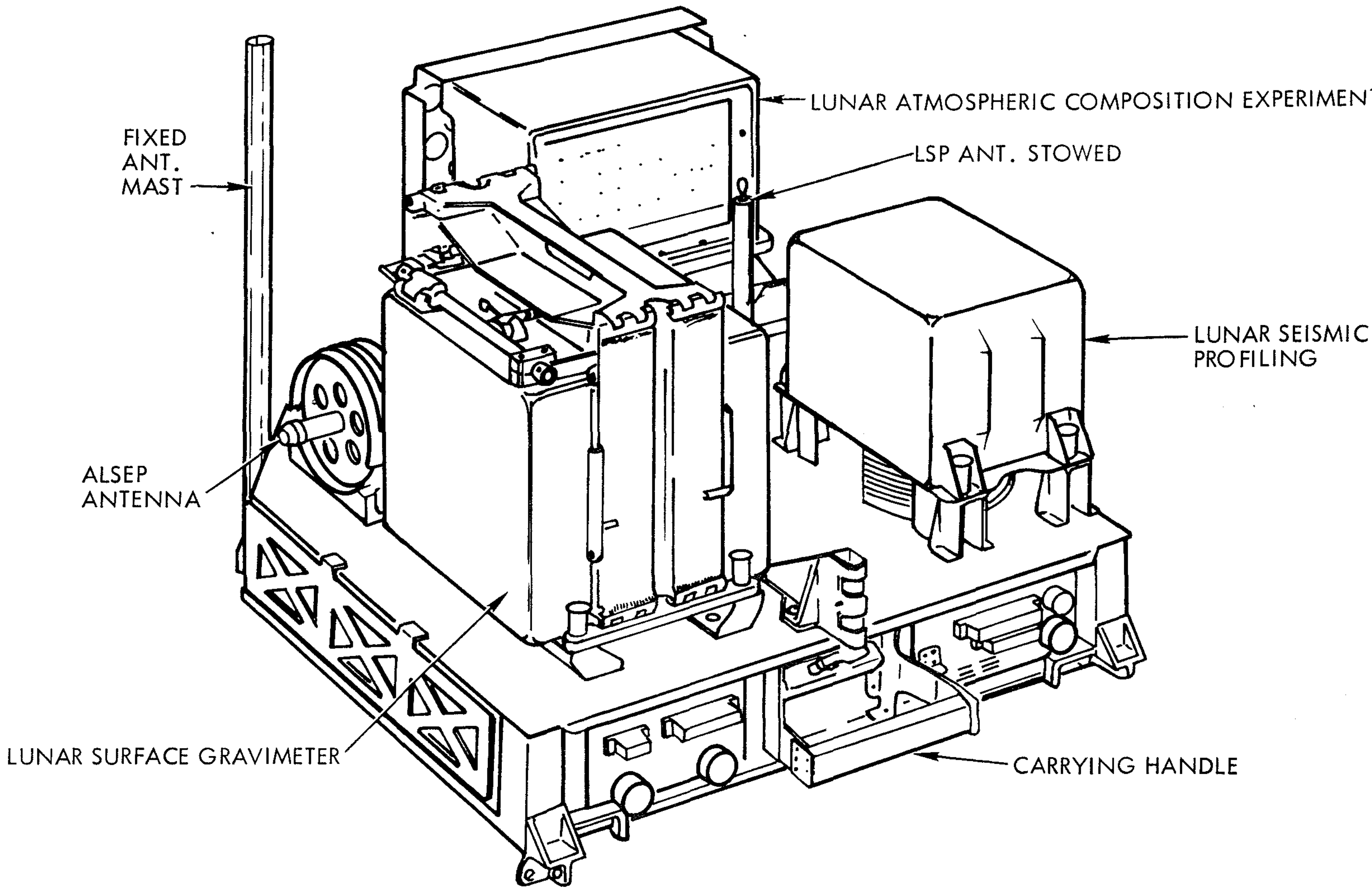


Figure 2-8(c). Apollo 17 ALSEP Central Station Leveling and Alignment



ALSEP SUBPACKAGE NUMBER 1

Figure 2-9. Apollo 17 Lunar Surface Experiment Subpackage No. 1

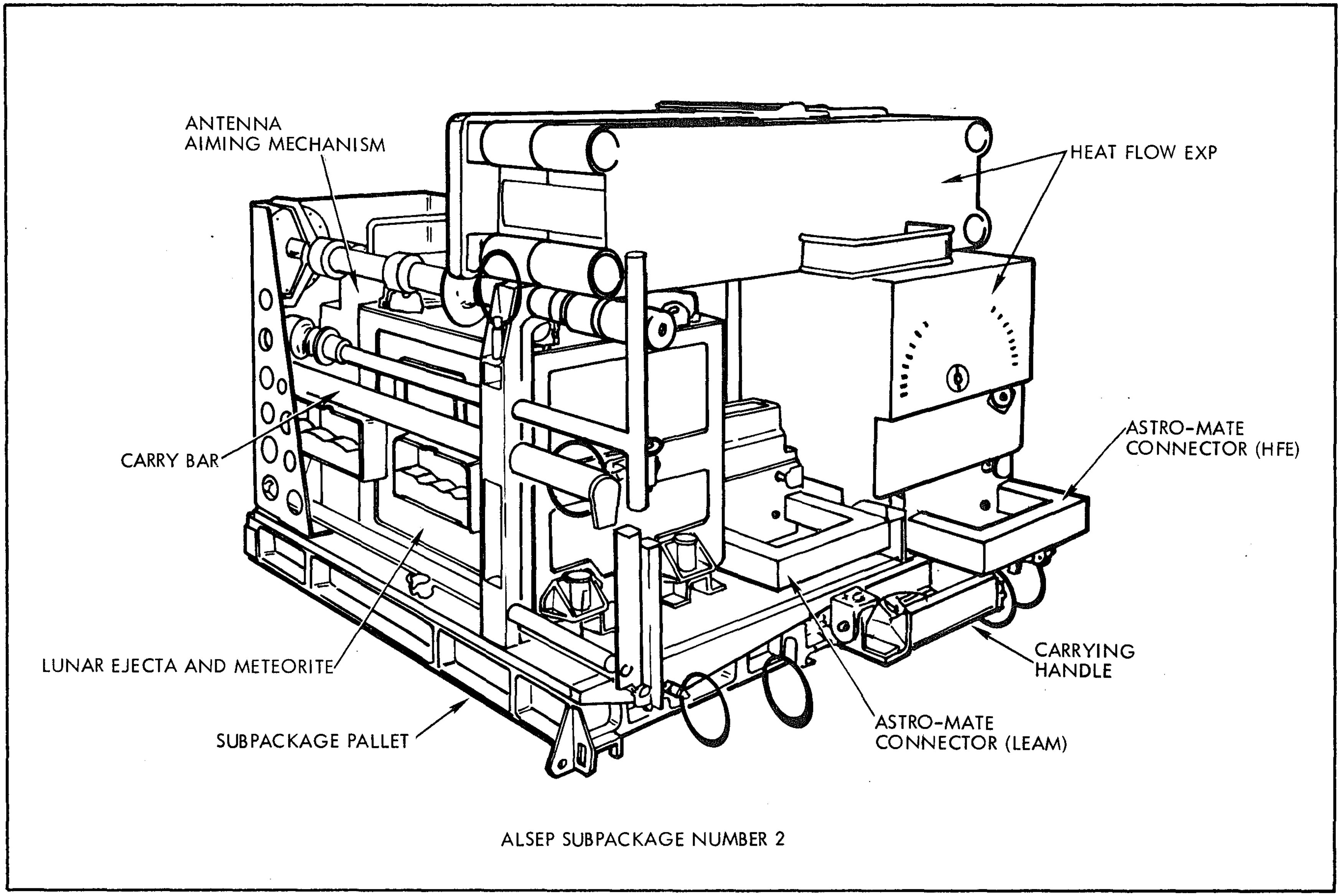
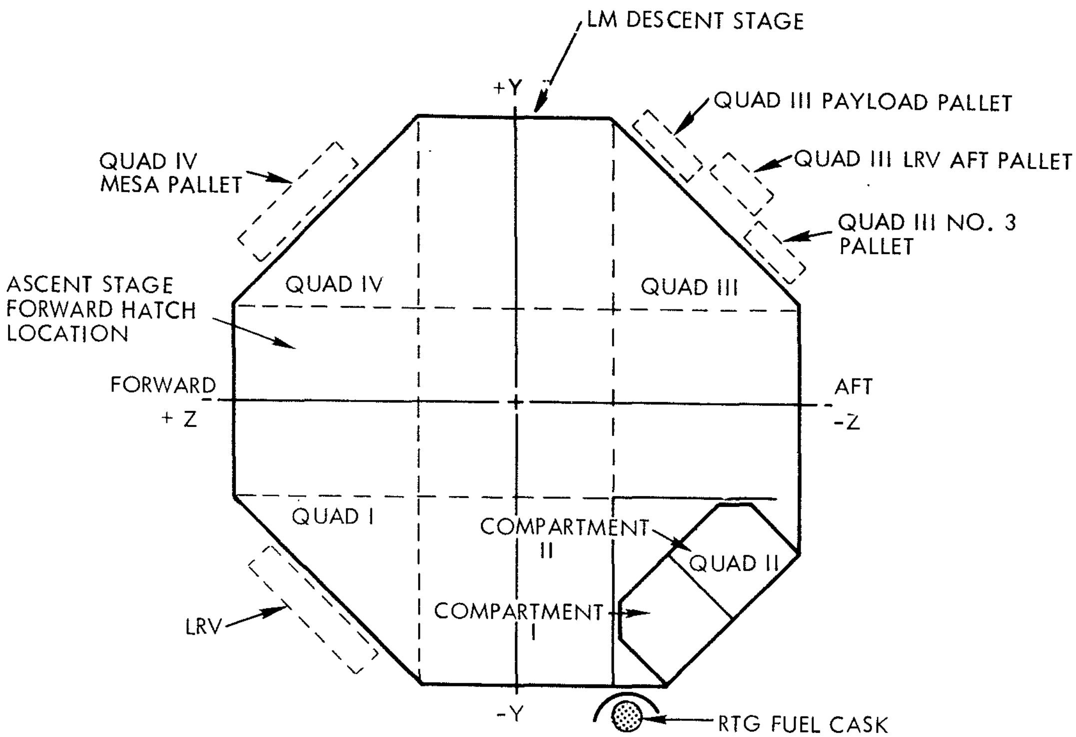


Figure 2-10. Apollo 17 Lunar Surface Experiment Subpackage No. 2



QUAD I
- LUNAR ROVING VEHICLE

QUAD II SEQ BAY
- APOLLO 17 ALSEP
  - SUBPACKAGE NO. 1
  - SUBPACKAGE NO. 2

QUAD III PAYLOAD PALLET
- SURFACE ELECTRICAL PROPERTIES EXPERIMENT
- LUNAR SEISMIC PROFILING CHARGES

QUAD III NO. 3 PALLET
- UNUSED

QUAD IV MESA PALLET
- LUNAR SURFACE DRILL ASSEMBLY
- 16-MM DATA ACQUISITION CAMERA AND STAFF
- LUNAR SURFACE ELECTRIC HASSELBLAD CAMERA
- CAMERA ACCESSORIES
- GROUND-COMMANDED TV CAMERA, CONTROL UNIT, AND ACCESSORIES
- SAMPLE RETURN CONTAINERS (2)
- SAMPLE COLLECTION BAGS (2)
- EXTRA SAMPLE COLLECTION BAGS (4)
- LUNAR SURFACE RAKE

QUAD III LRV AFT PALLET
- LARGE SAMPLING SCOOP
- GNOMON/COLOR PATCH
- HAMMER
- 32-INCH TONGS (2)
- TOOL EXTENSION HANDLE (2)
- LUNAR GRAVITY TRAVERSE EXPERIMENT

Figure 2-11. LM Descent Stage Stowage of Surface Science Equipment

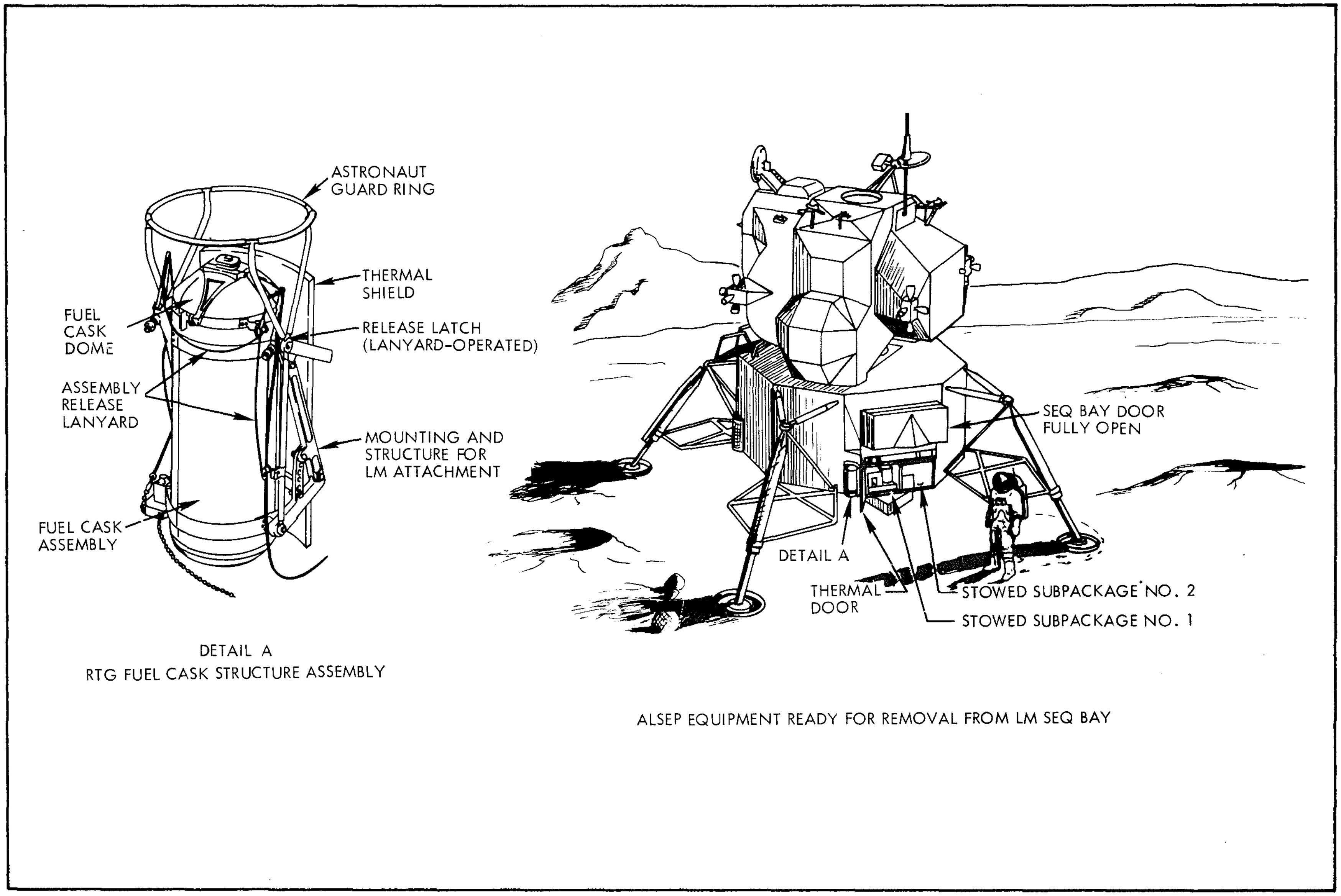


Figure 2-12. LM Mounting of RTG Fuel Cask and ALSEP Subpackages

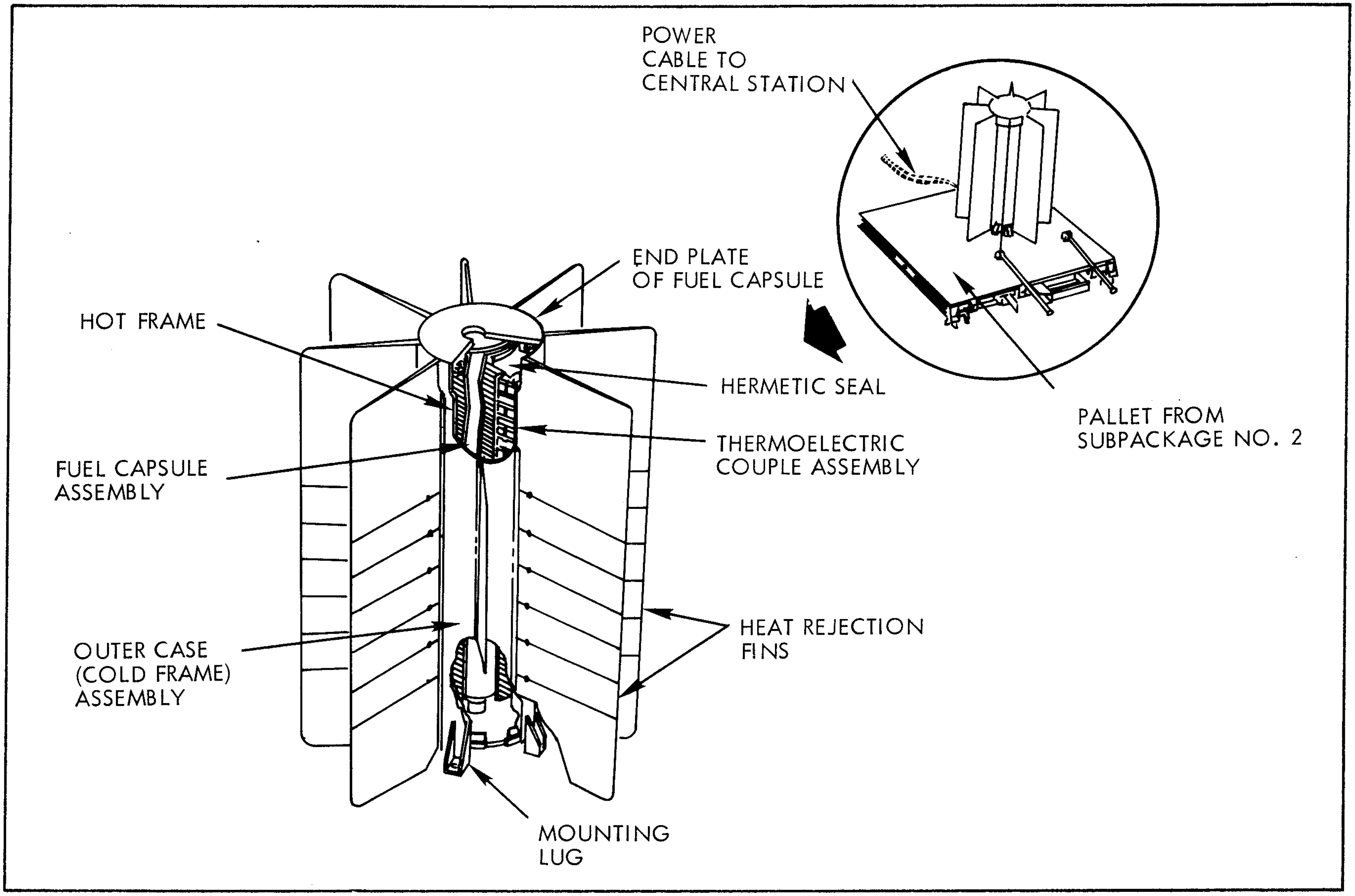


Figure 2-13. ALSEP RTG Assembly

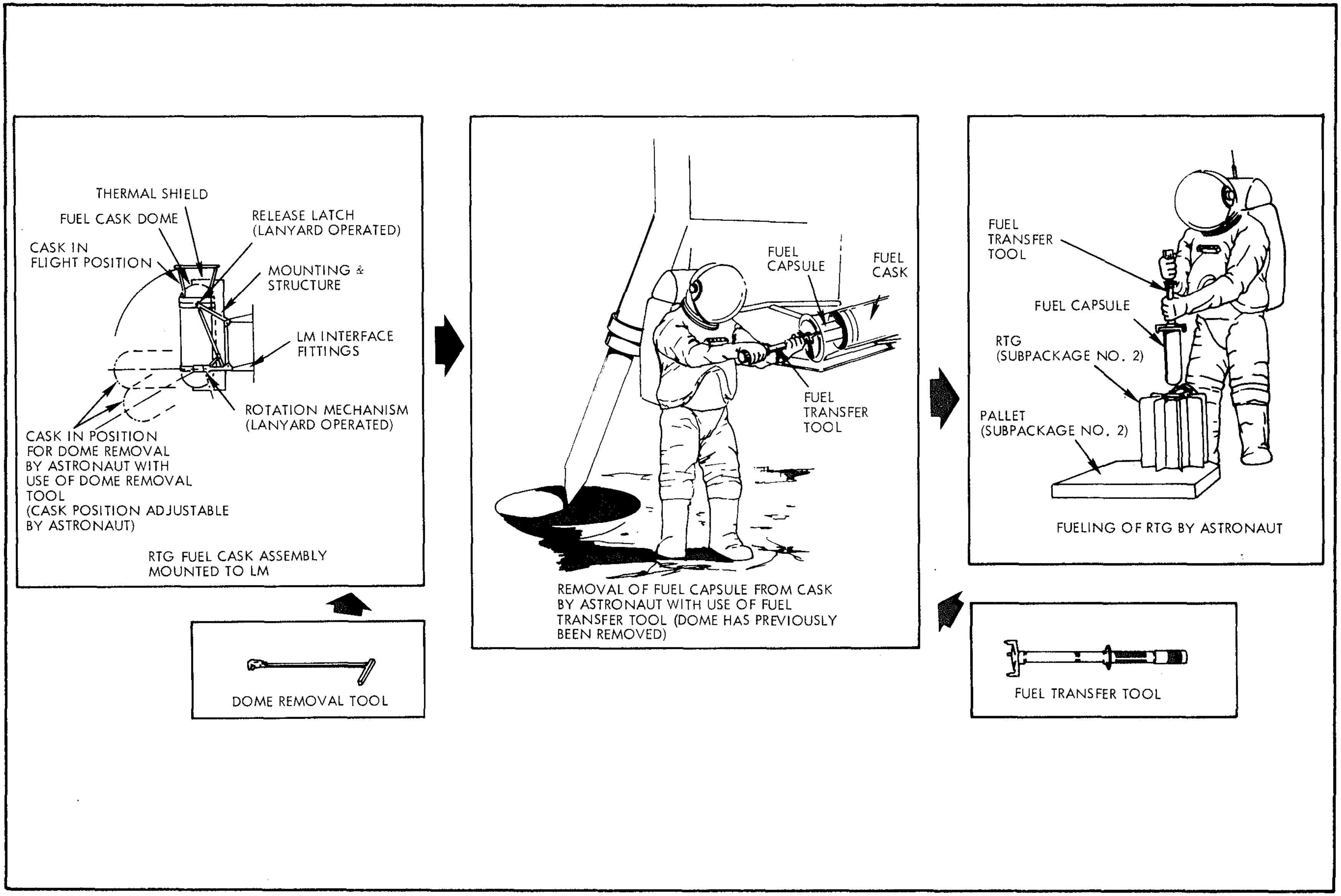


Figure 2-14. ALSEP RTG Fuel Transfer Activities

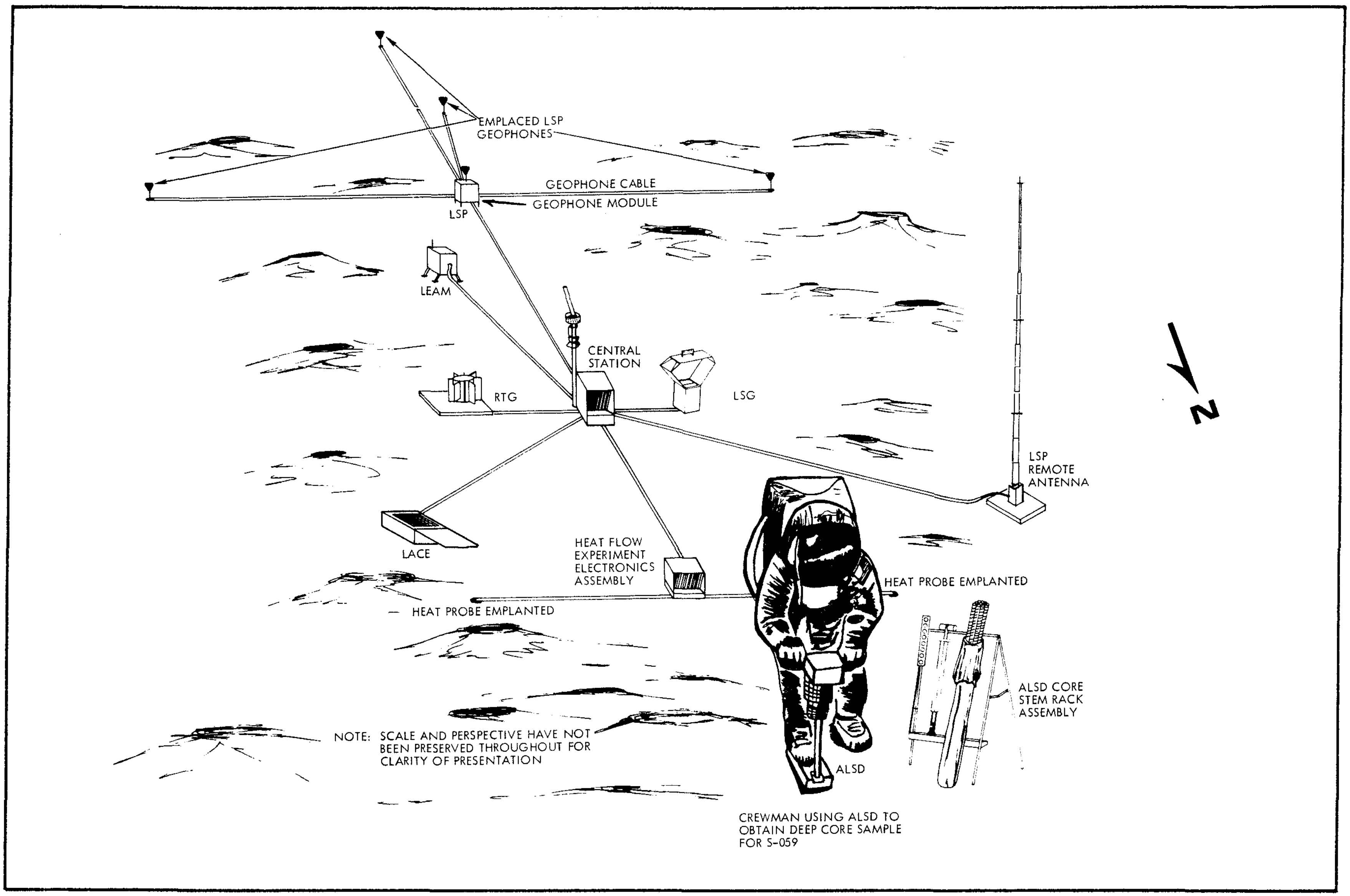


Figure 2-15. Apollo 17 ALSEP Experiment Deployment

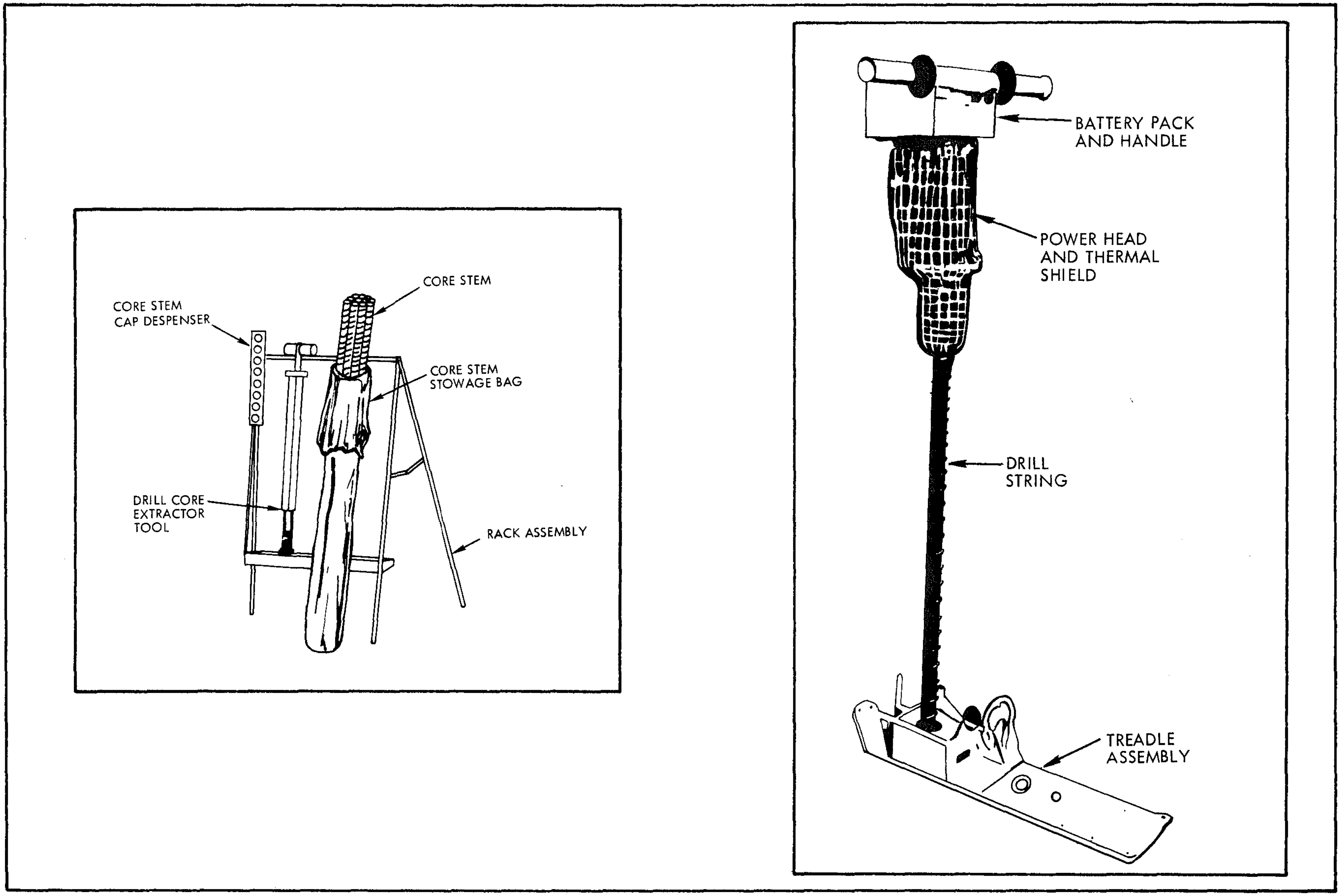
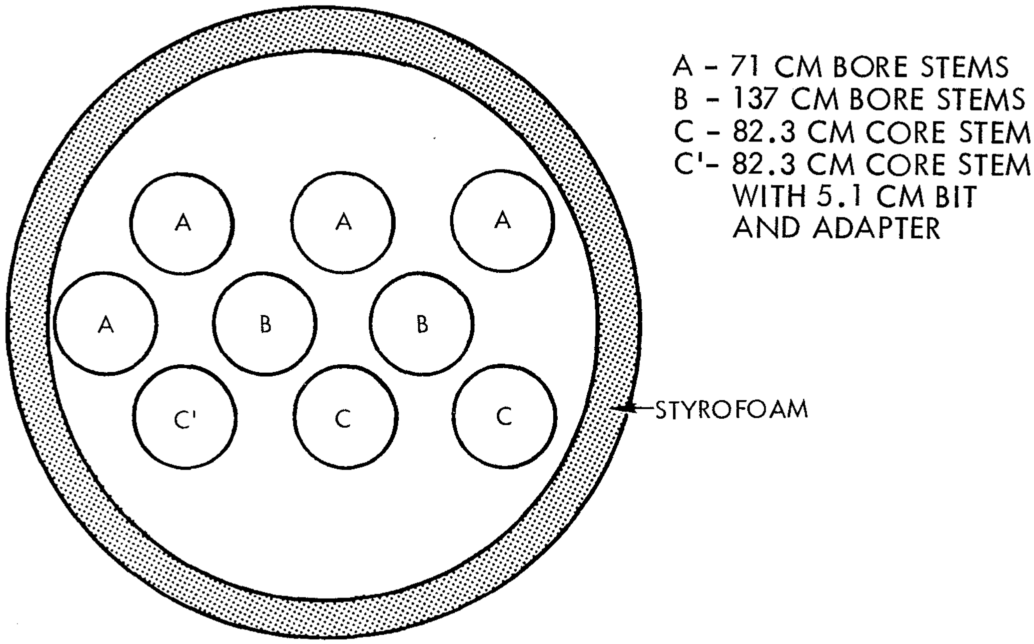


Figure 2-16(a). Apollo Lunar Surface Drill Assembly - Component Identification



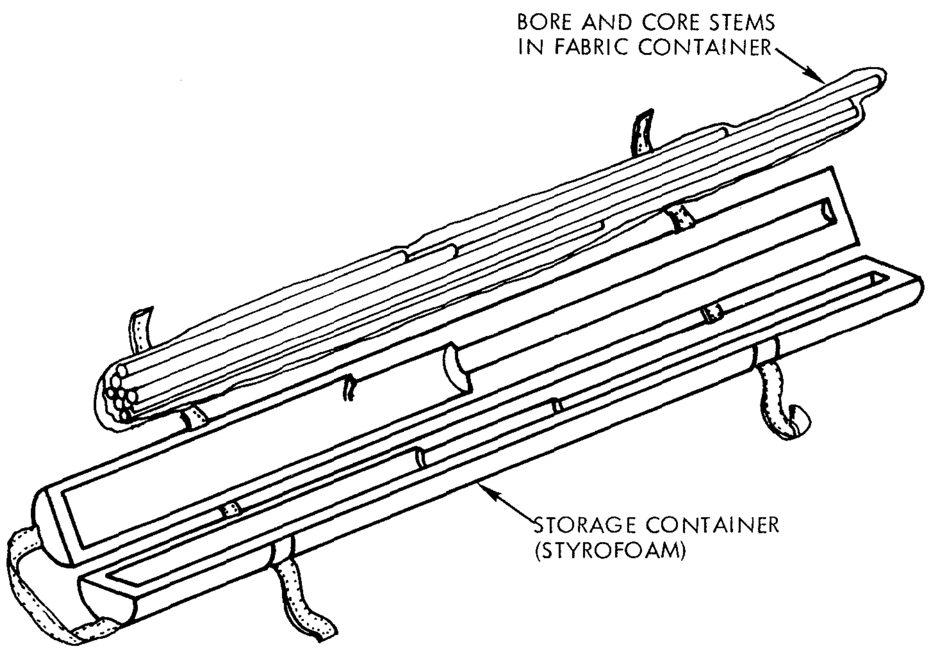


Figure 2-16(b). Apollo Lunar Surface Drill Assembly - Bore Stem/ Core Stem MESA Stowage Detail

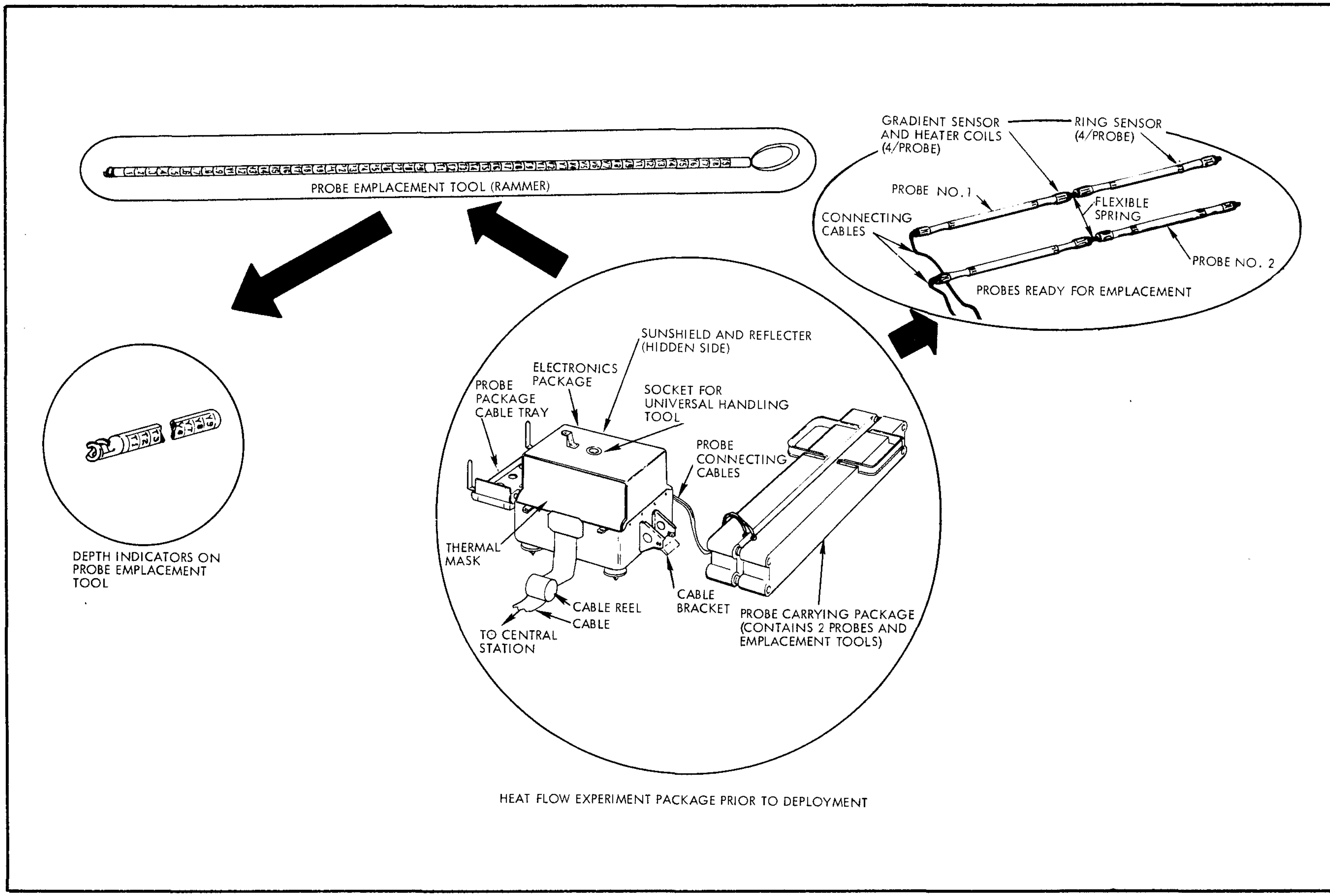


Figure 2-17(a). Heat Flow Experiment - Component Identification

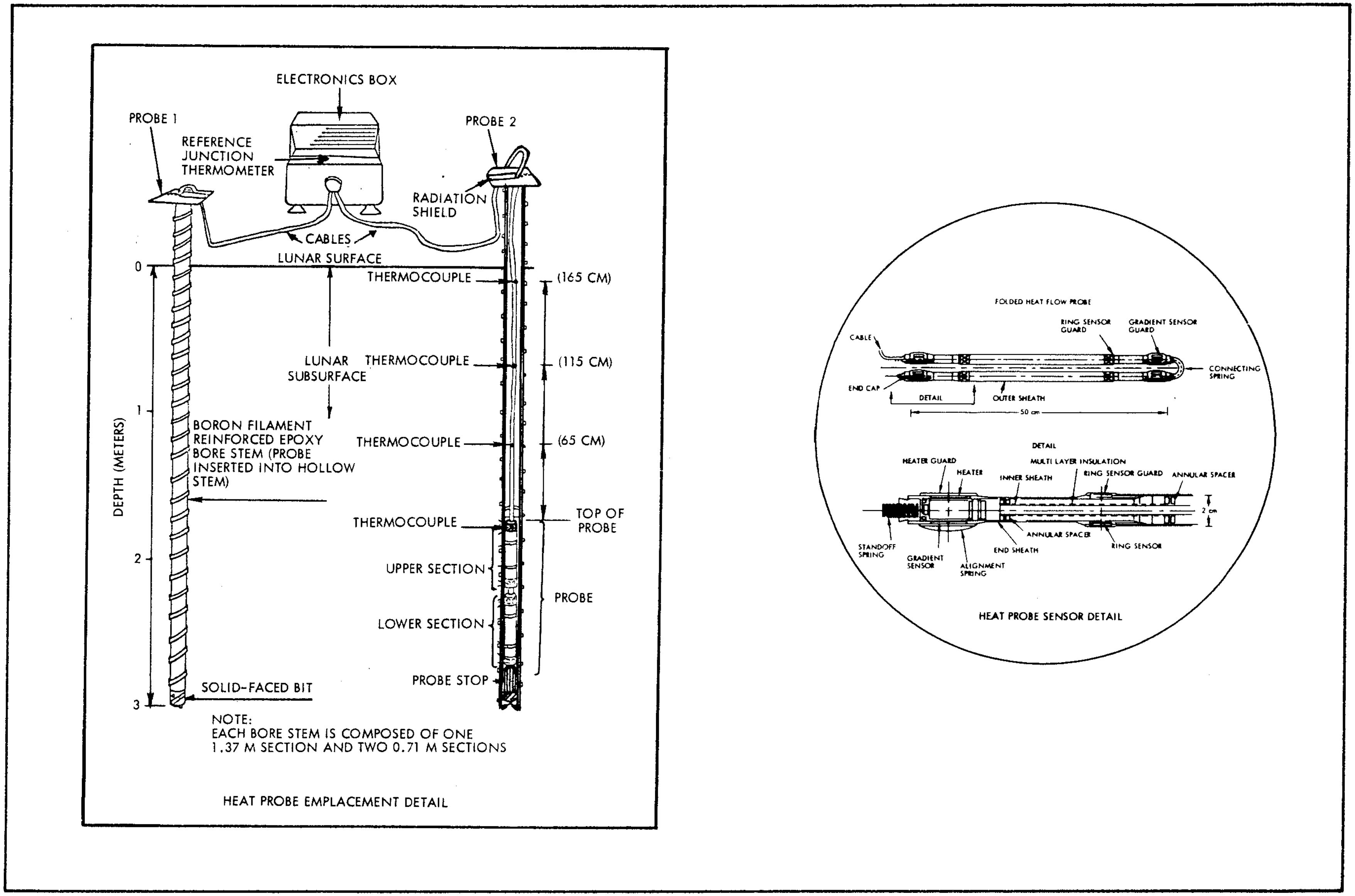


Figure 2-17(b). Heat Flow Experiment - Heat Probe Emplacement/Sensor Details

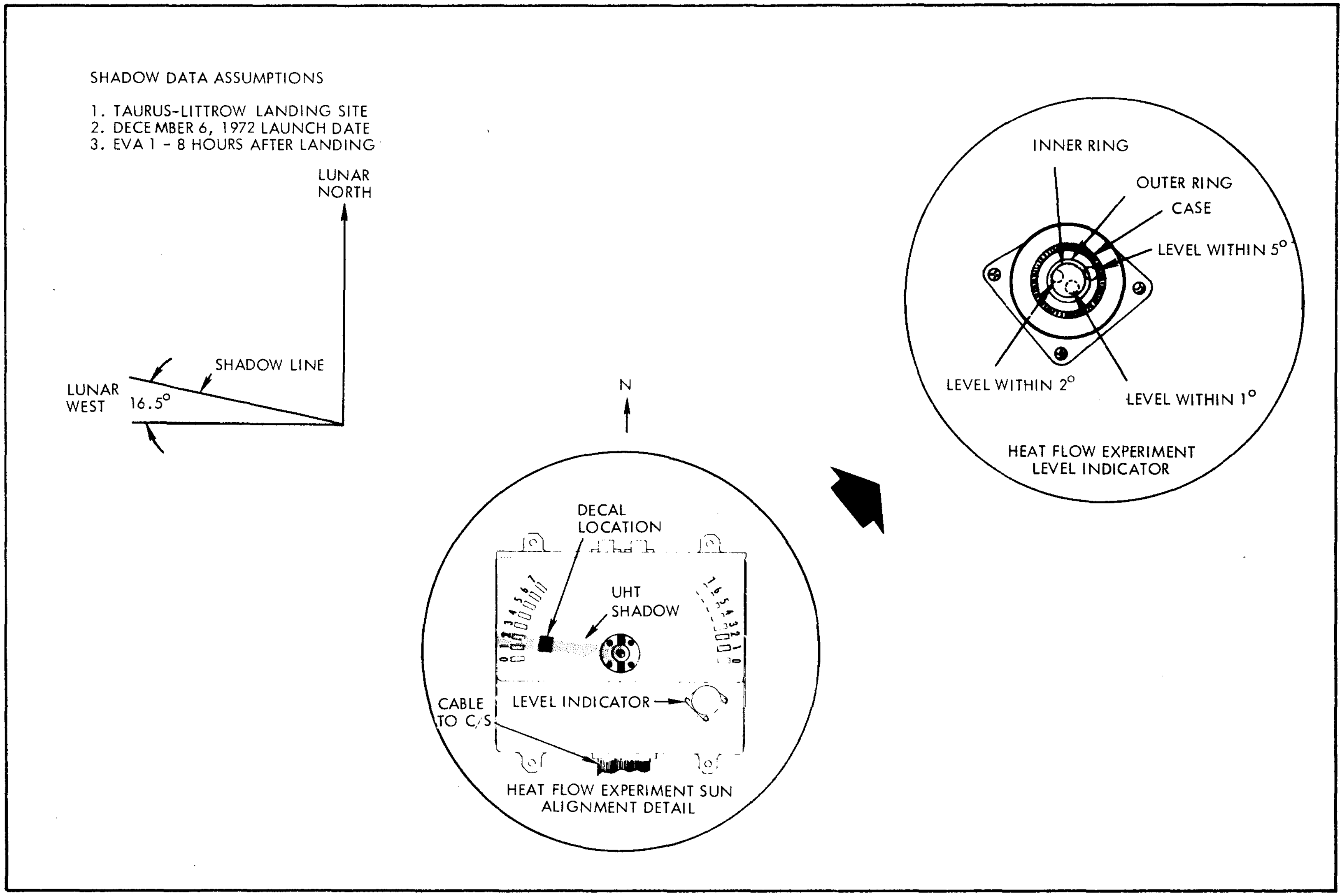


Figure 2-17(c). Heat Flow Experiment - Alignment/Leveling Detail

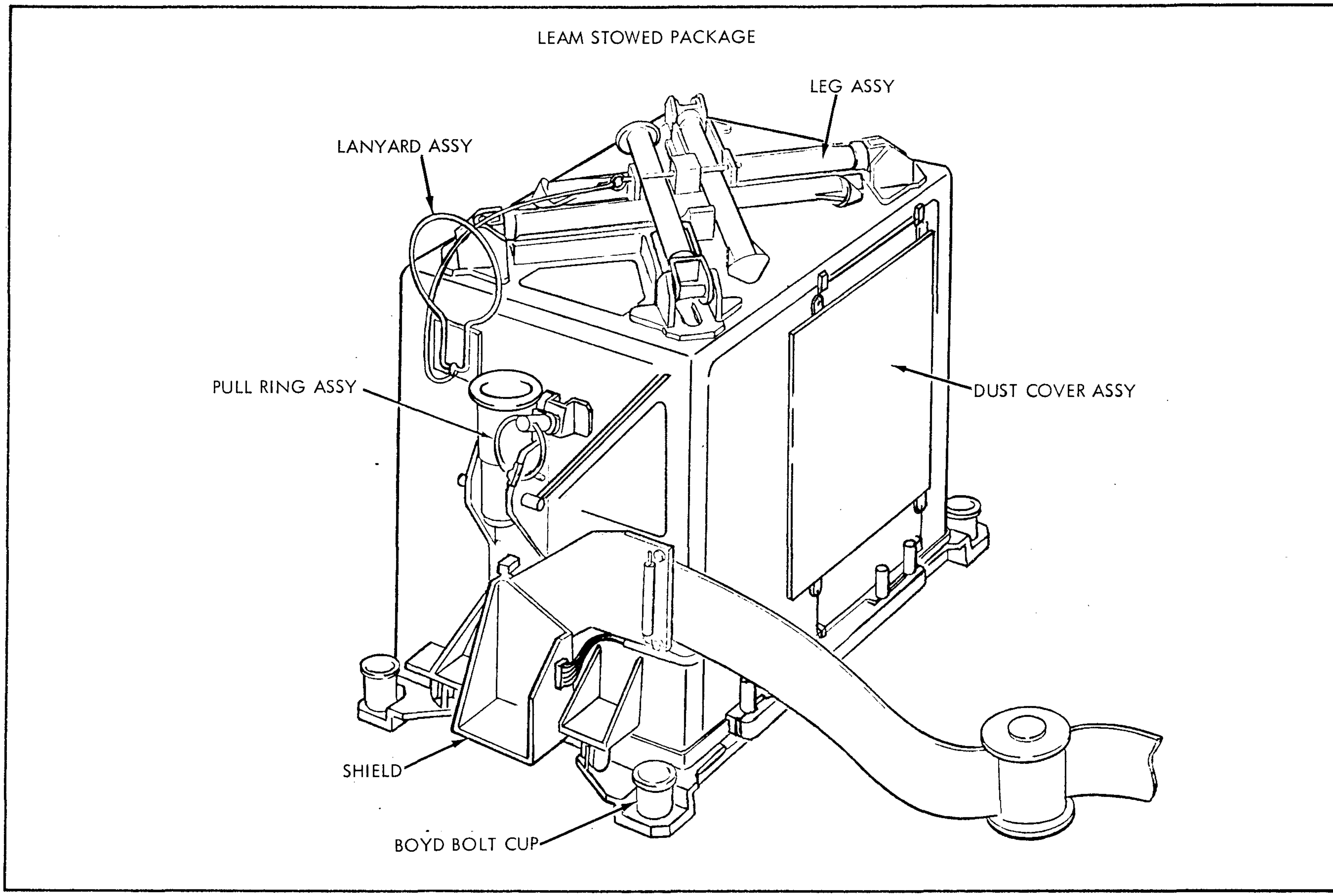


Figure 2-18(a). Lunar Ejecta and Meteorite Experiment - Stowed Configuration

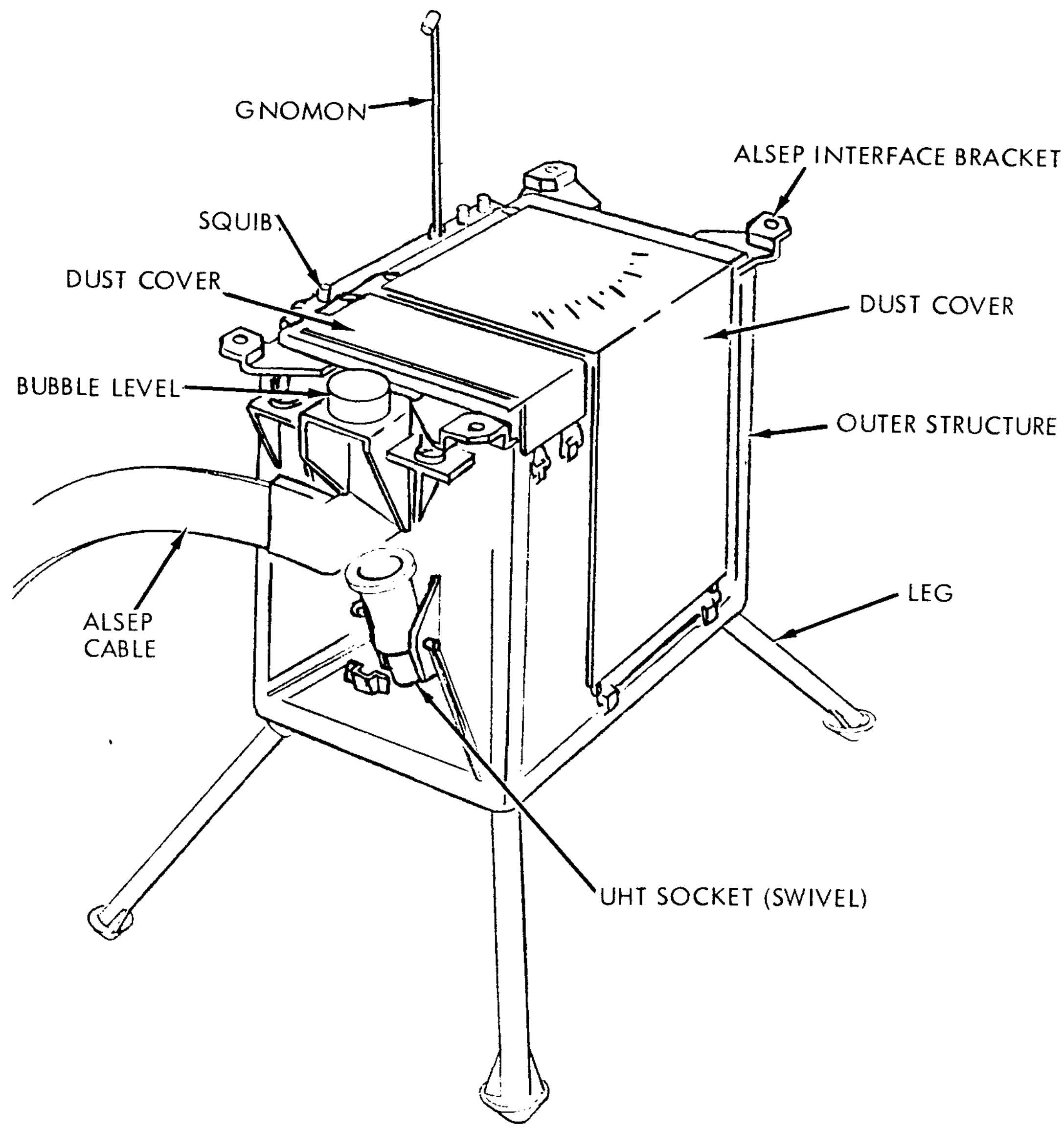


Figure 2-18(b). Lunar Ejecta and Meteorite Experiment - Deployed Configuration

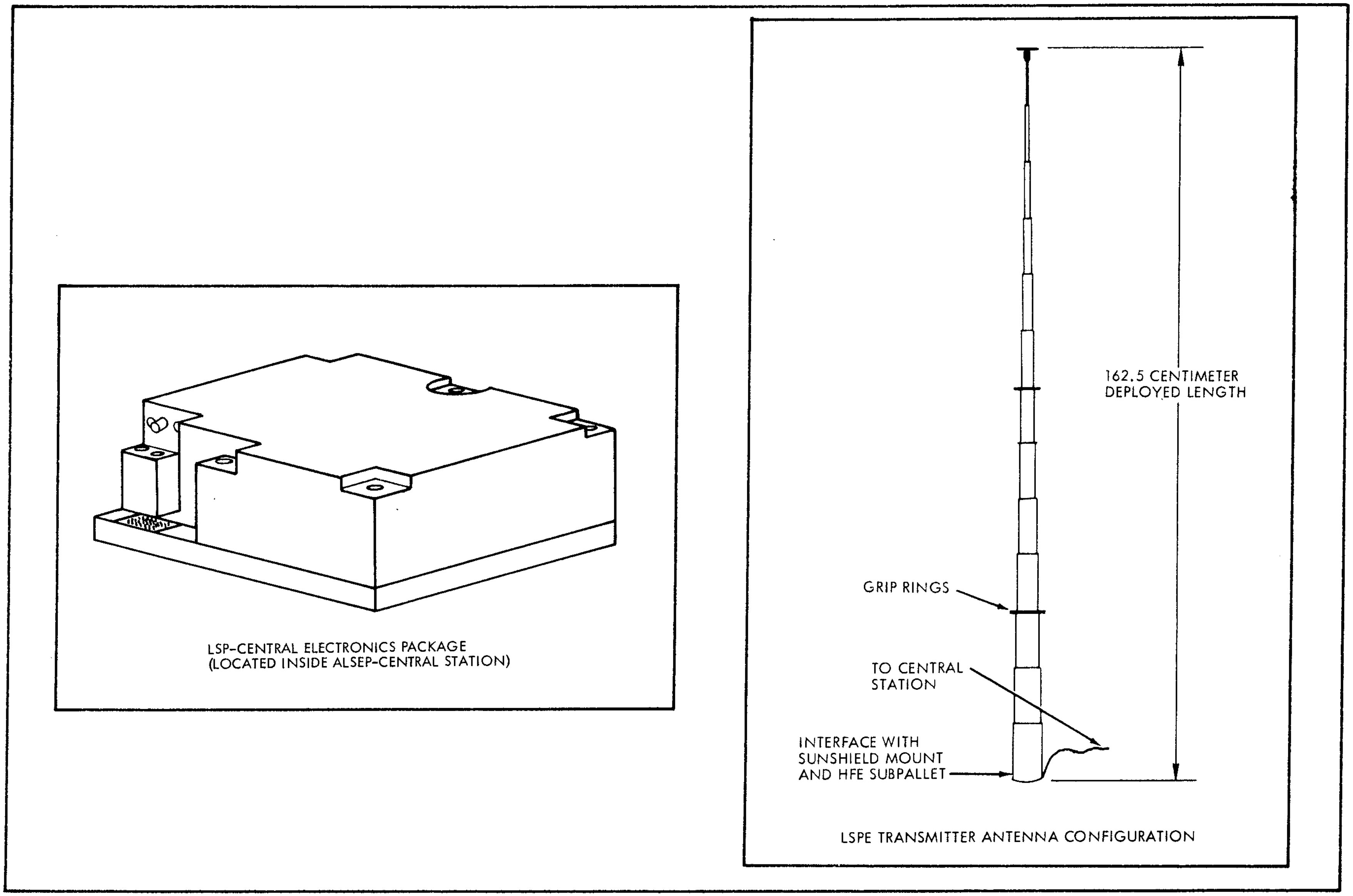


Figure 2-19(a). Lunar Seismic Profiling Experiment - Central Electronics Package - LSP Antenna Configuration

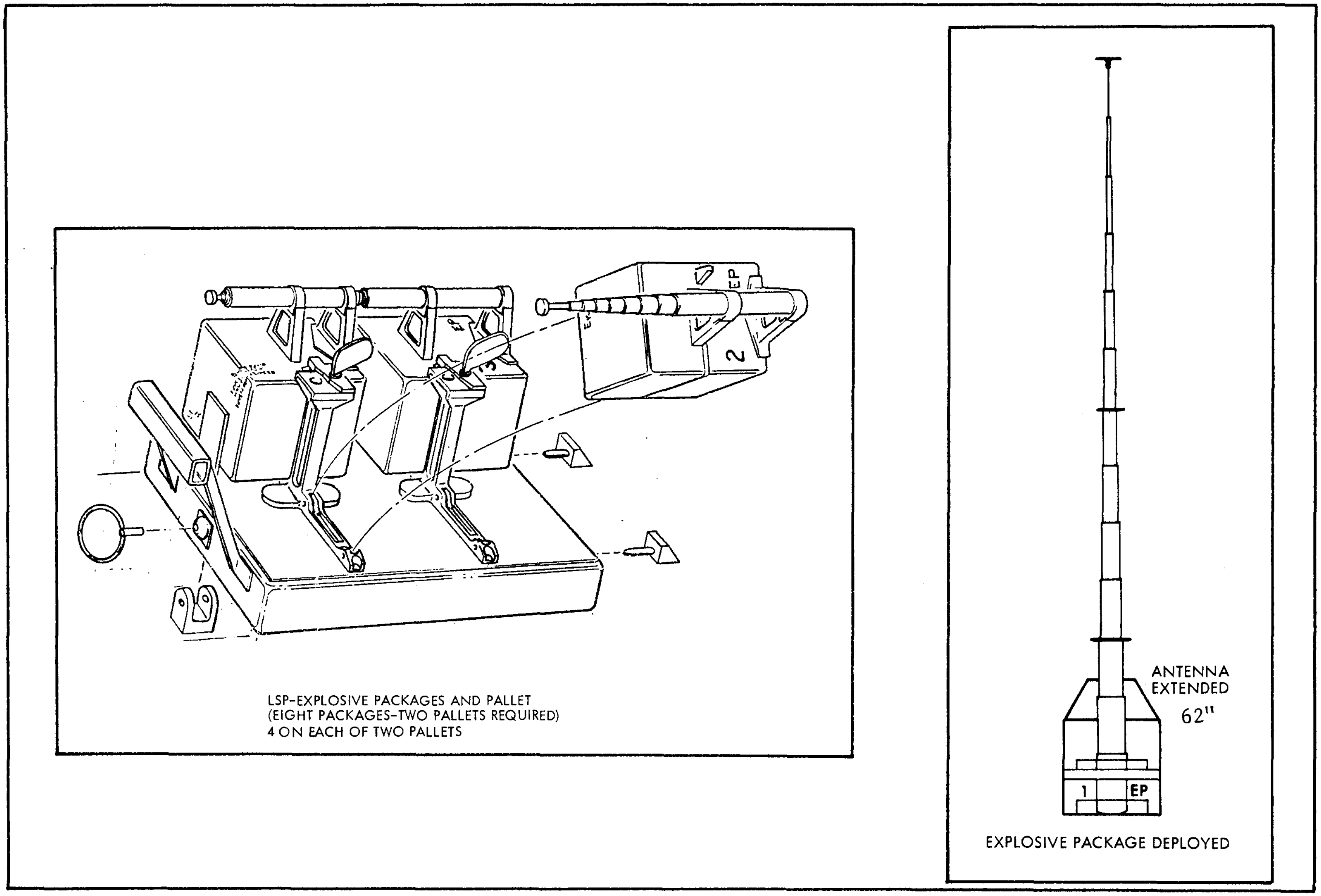


Figure 2-19(b). Lunar Seismic Profiling Experiment - Explosive Package Stowed on Pallet - Deployed Configuration

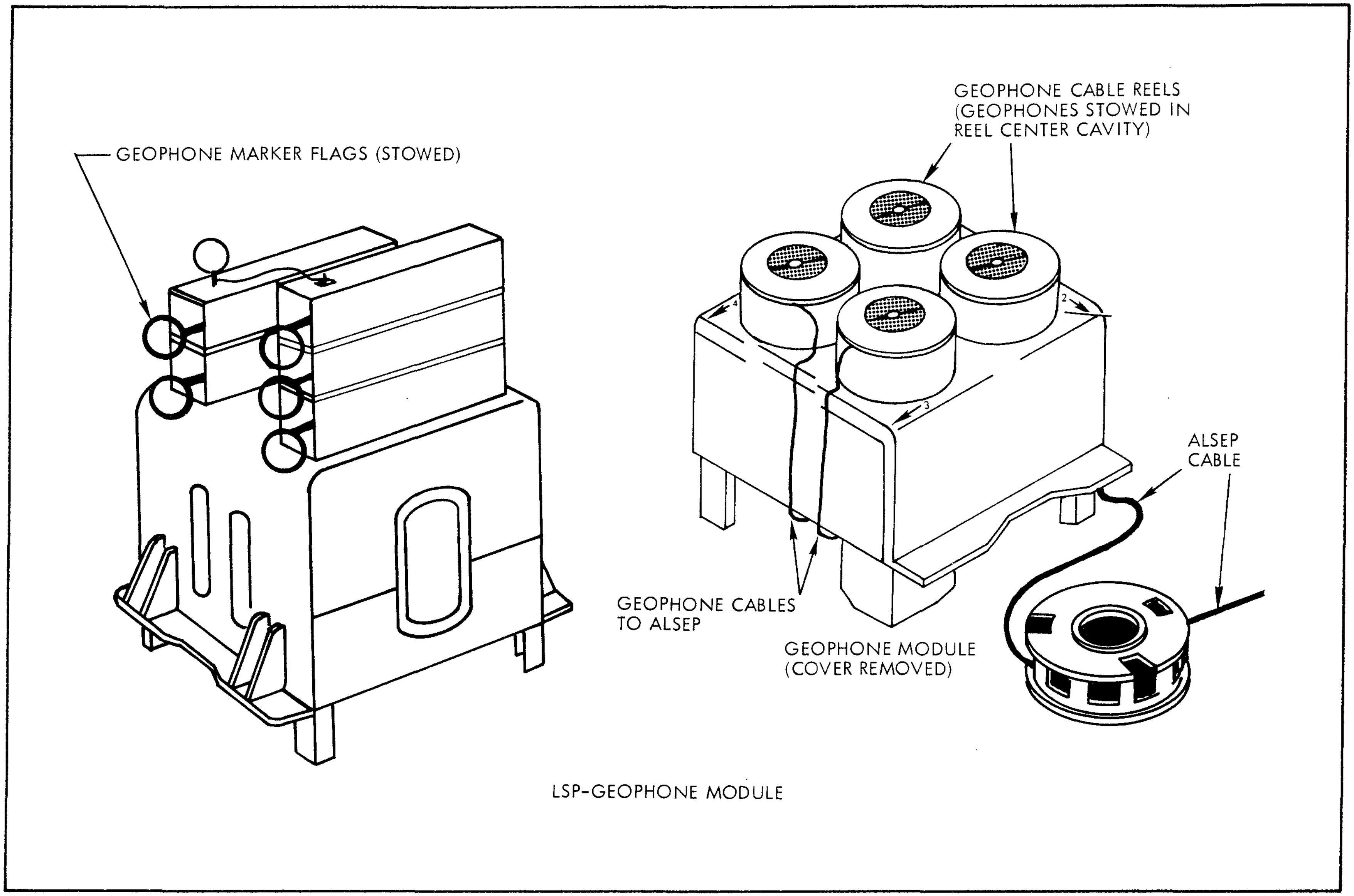


Figure 2-19(c). Lunar Seismic Profiling Experiment - Geophone Module and Cable Reels

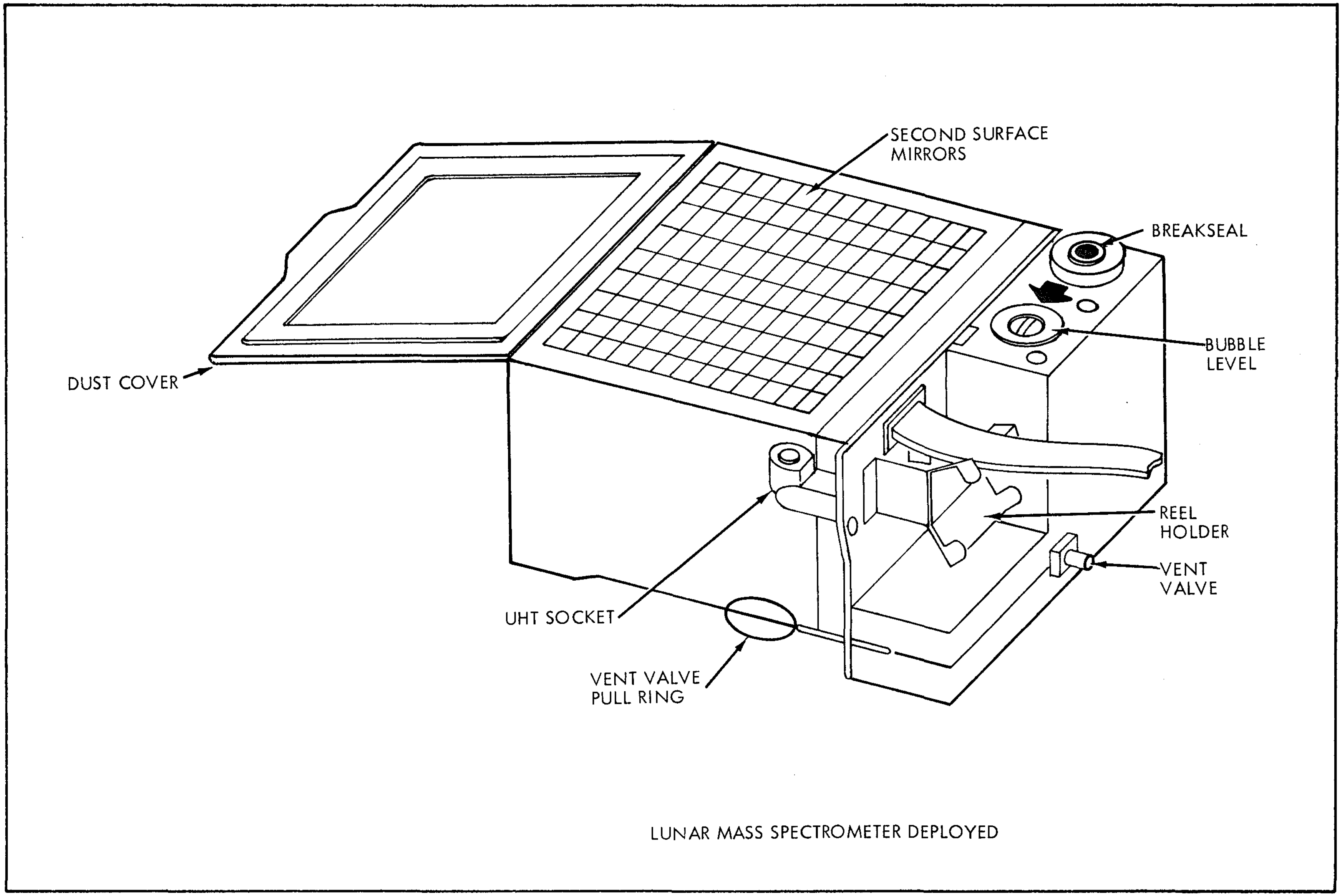


Figure 2-20. Lunar Atmospheric Composition Experiment (Lunar Mass Spectrometer) Deployed Configuration

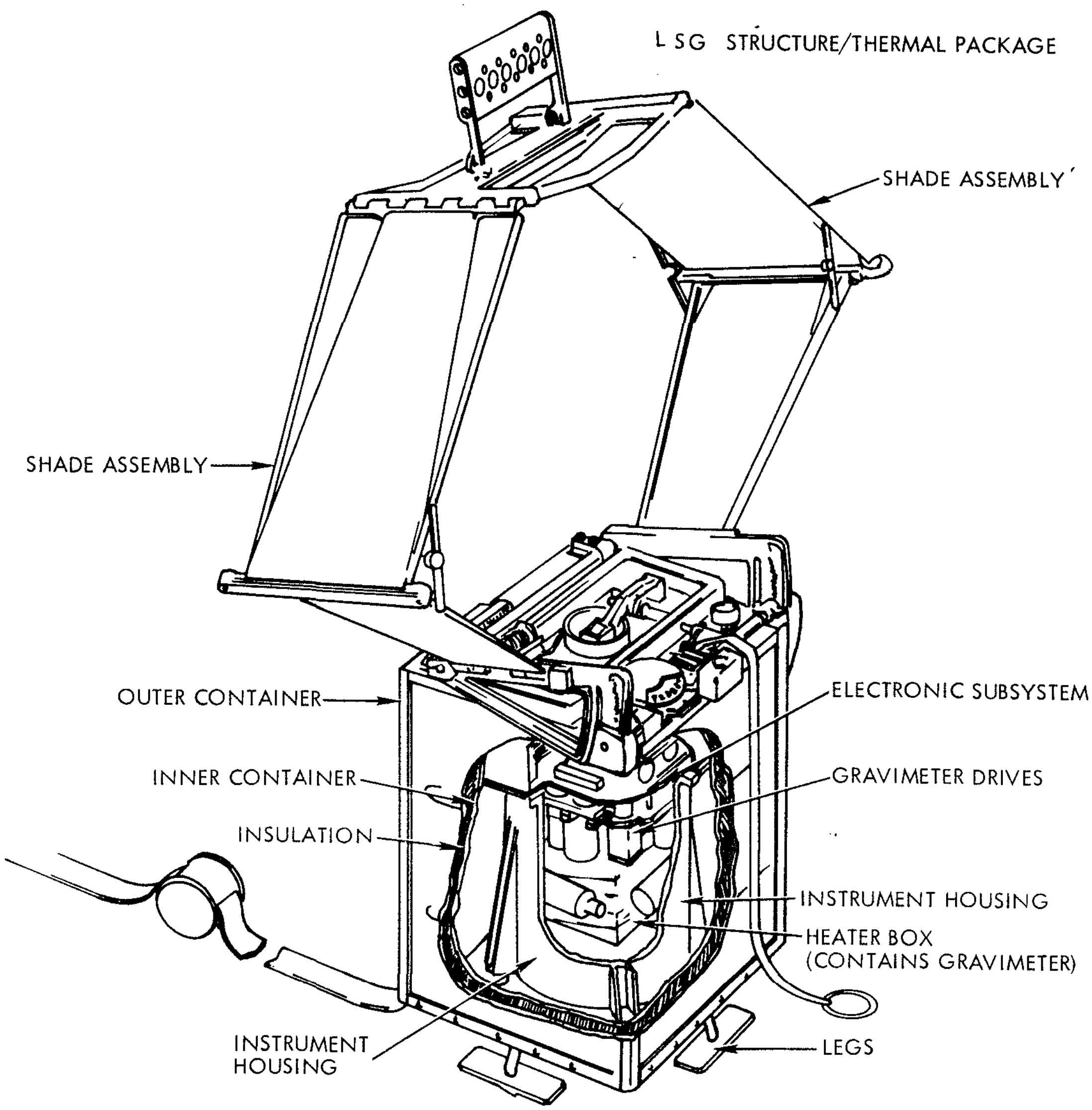


Figure 2-21. Lunar Surface Gravimeter Experiment - Gravimeter Instrument - Detail

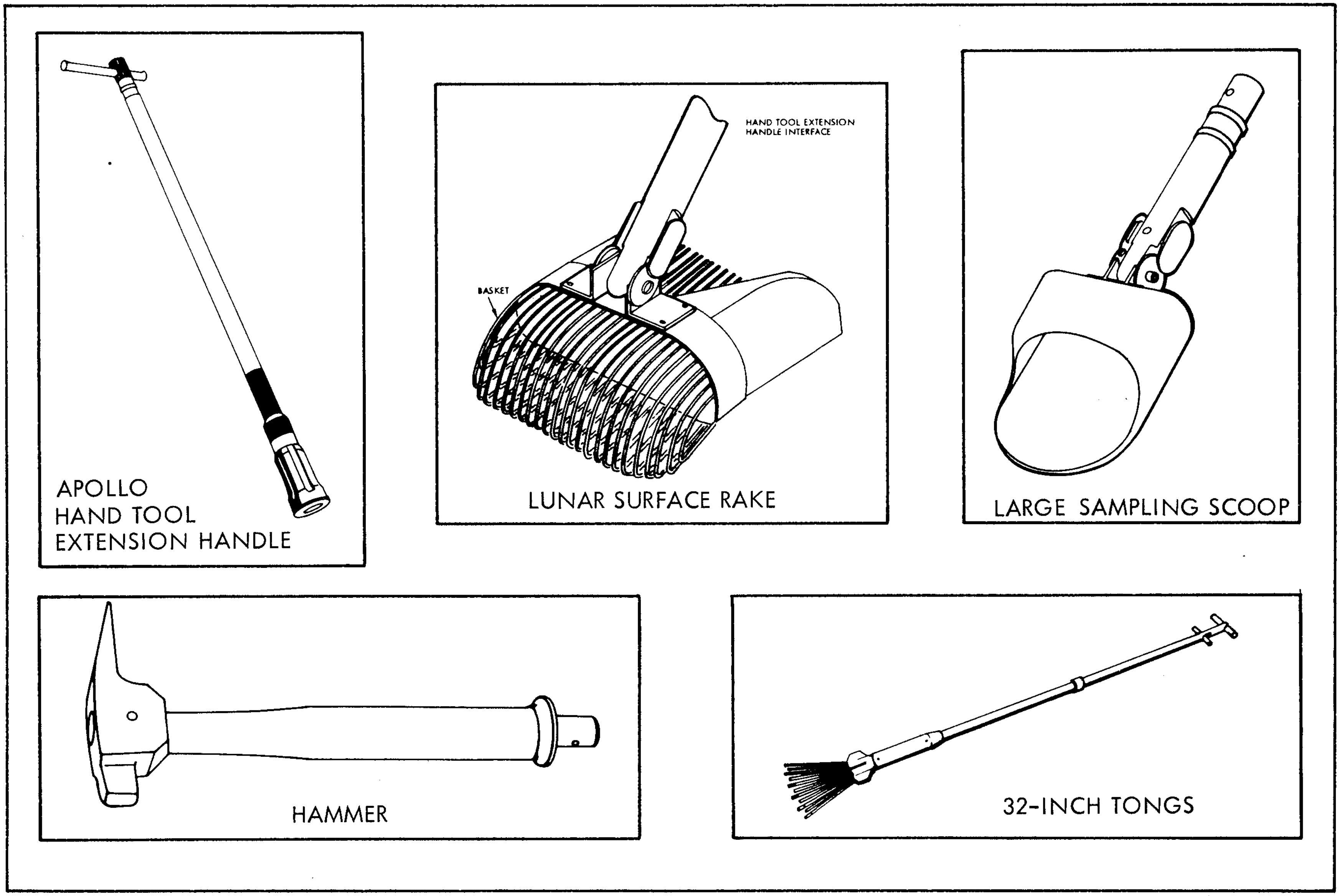


Figure 2-22(a). Lunar Geology Equipment - Apollo Lunar Hand Tools

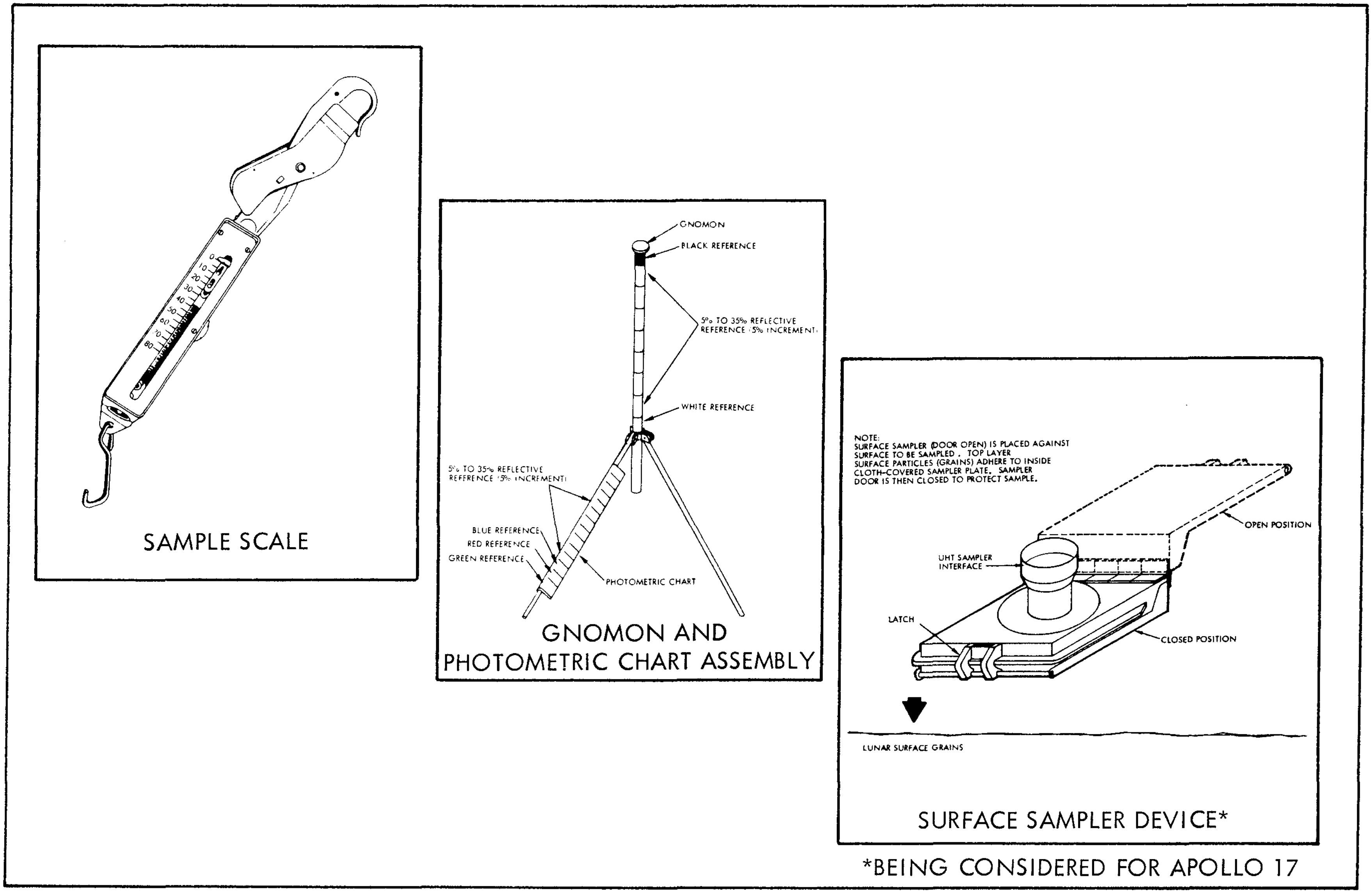


Figure 2-22(b). Lunar Geology Equipment - Sample Scale, Gnomon/Photometric Chart, and Surface Sampler

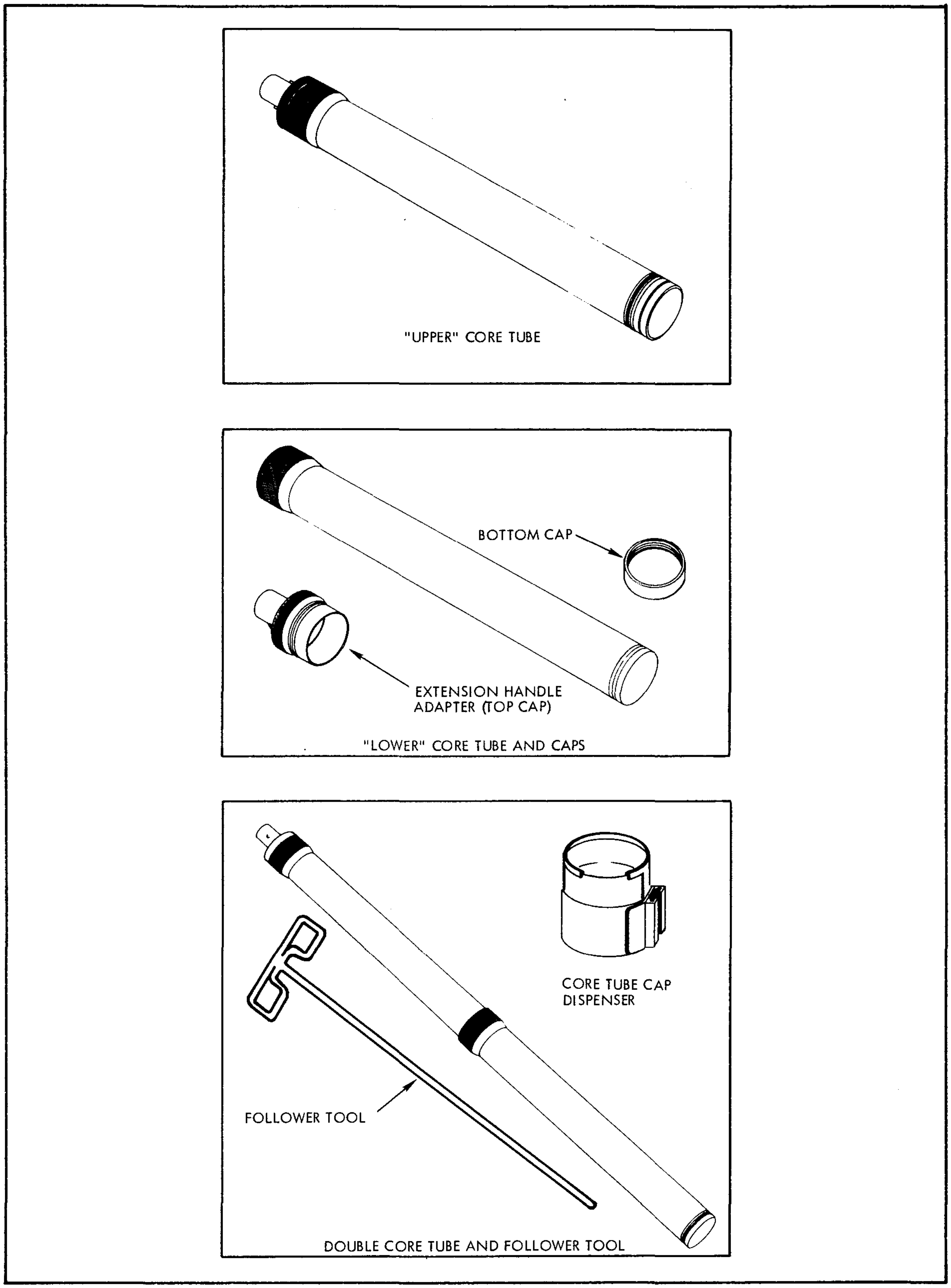


Figure 2-22(c). Lunar Geology Equipment - Core (Drive) Tubes

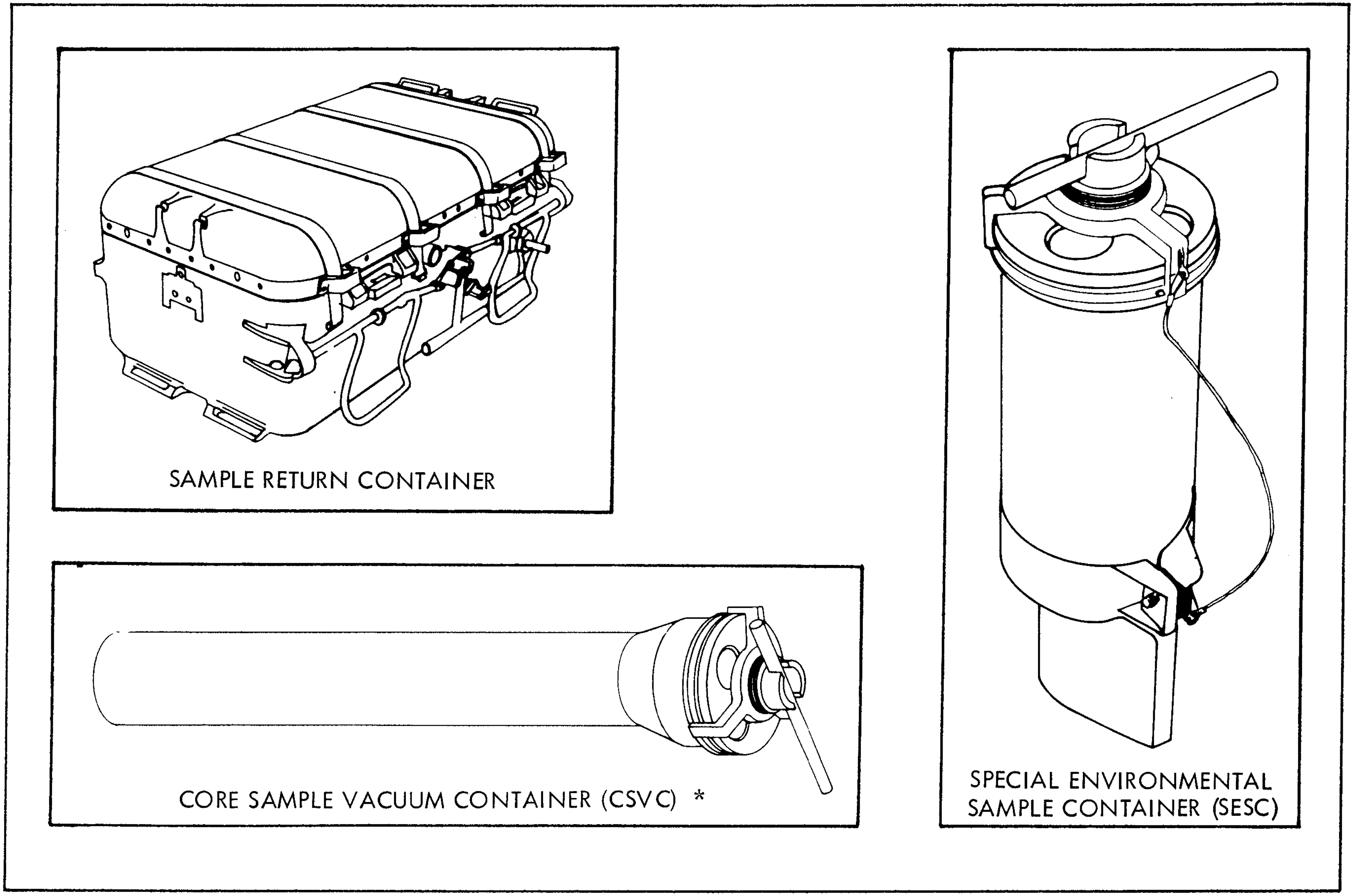


Figure 2-22(d). Lunar Geology Equipment - Sample Containers

*Being Considered for J-3

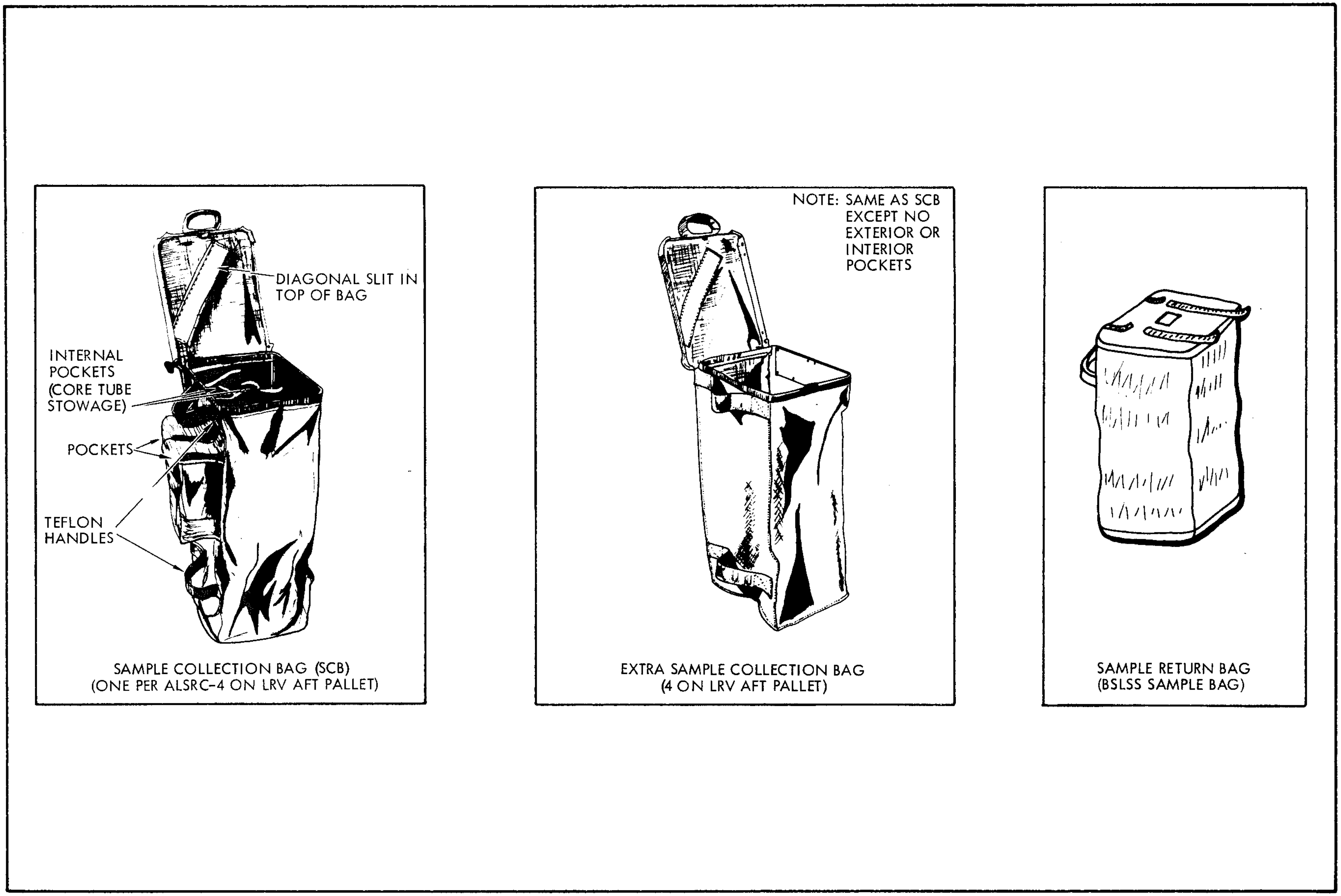


Figure 2-22(e). Lunar Geology Equipment - Large Sample Bags

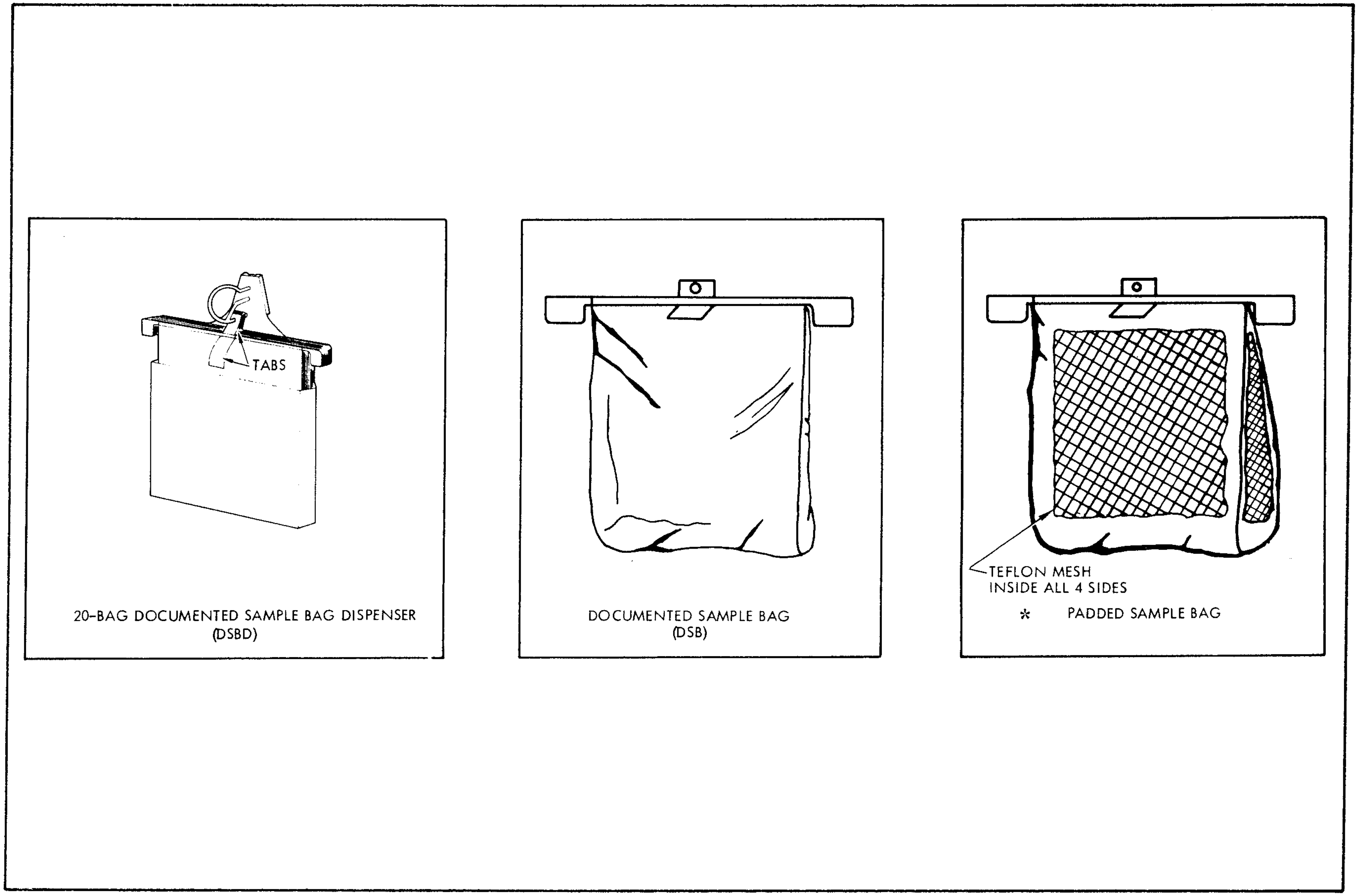


Figure 2-22(f). Lunar Geology Equipment - Small Sample Bags

*Being Considered for J-3

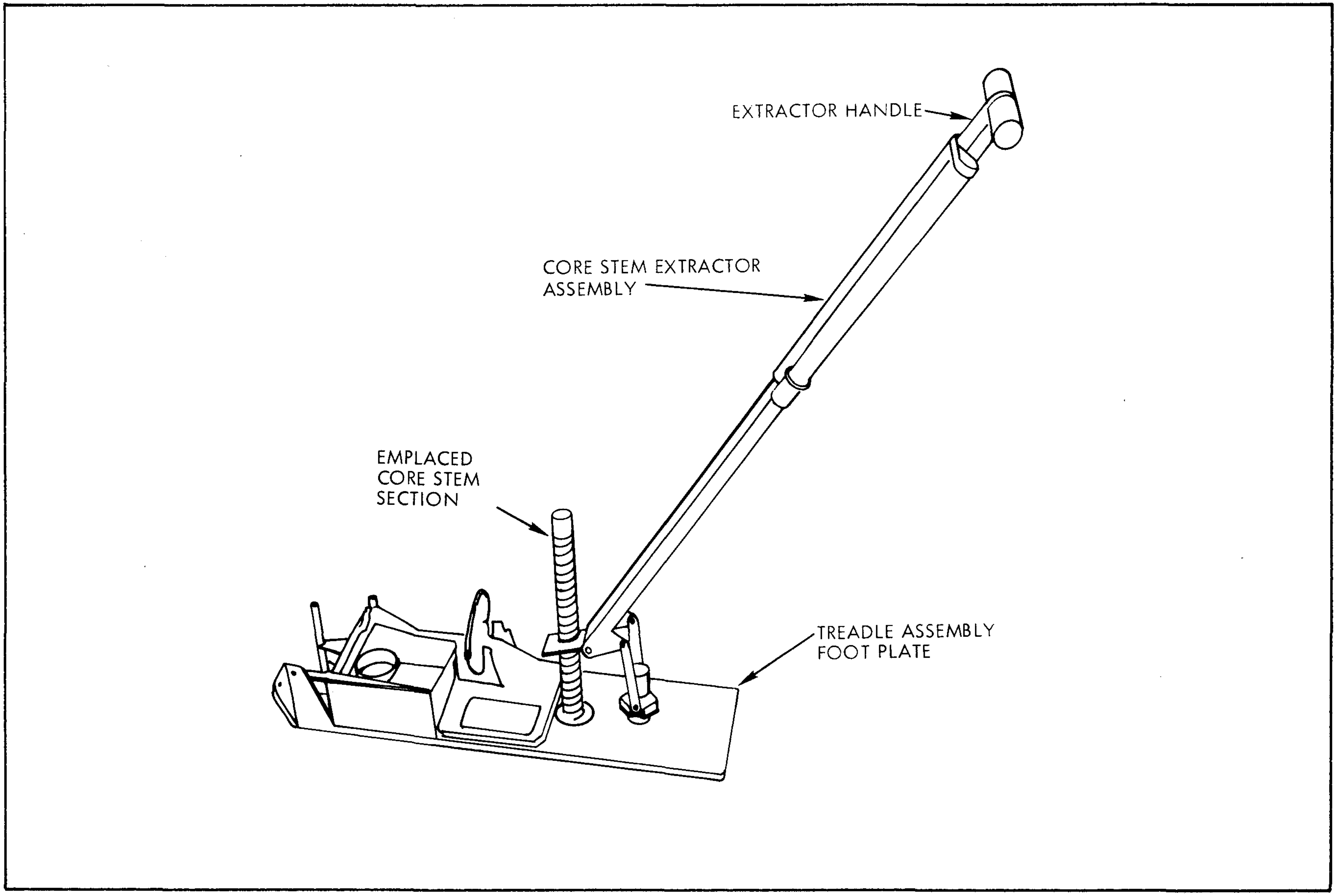
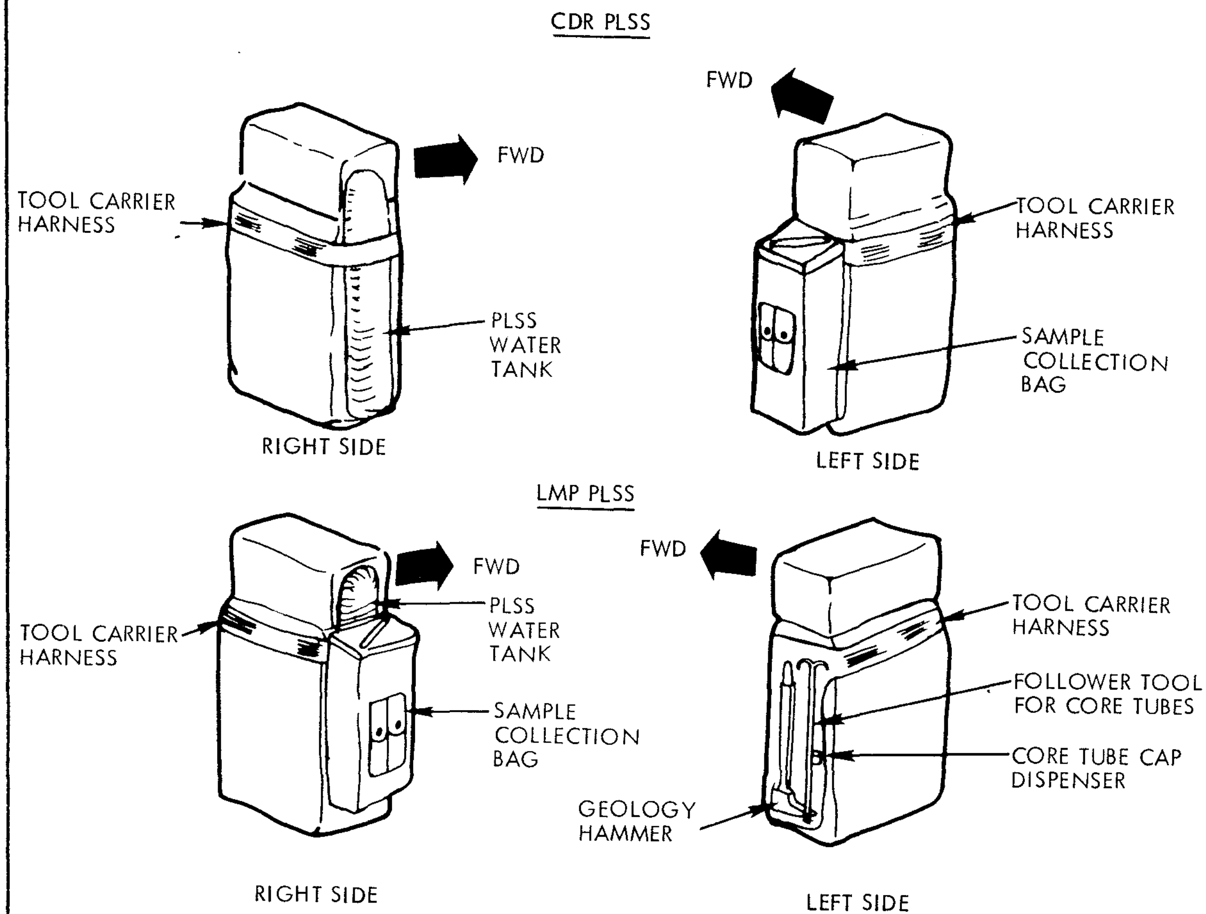


Figure 2-22(g). Apollo Lunar Surface Drill Assembly - Treadle/Core Stem Extractor Detail

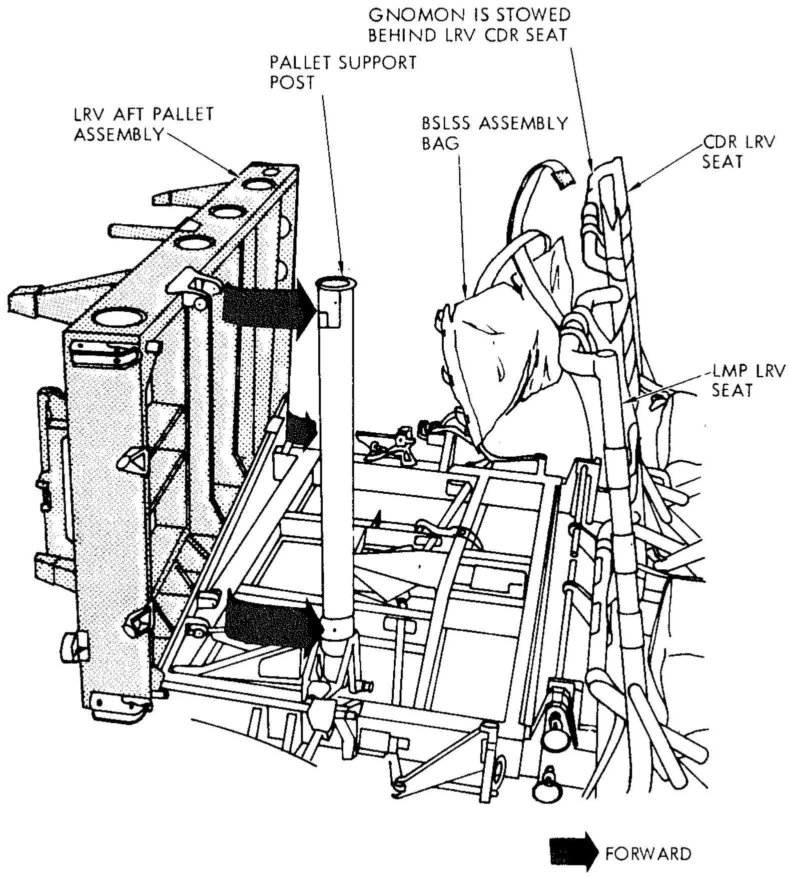
PLSS TOOL CARRIER FOR GEOLOGY ACTIVITIES



NOTES:

1. TOOL CARRIER DESIGNED FOR EMERGENCY SELF-DOFFING VIA QUICK-DISCONNECT LANYARDS ACCESSIBLE TO WEARER.
2. DOCUMENTED SAMPLE BAG DISPENSERS TO BE ATTACHED TO CREWMAN HASSELBLAD CAMERA.
3. CORE TUBES CARRIED IN SAMPLE COLLECTION BAG.
4. SAMPLE COLLECTION BAG MAY BE MOUNTED TO RIGHT SIDE OF THE CDR PLSS TOOL CARRIER IN A CONTINGENCY MODE.

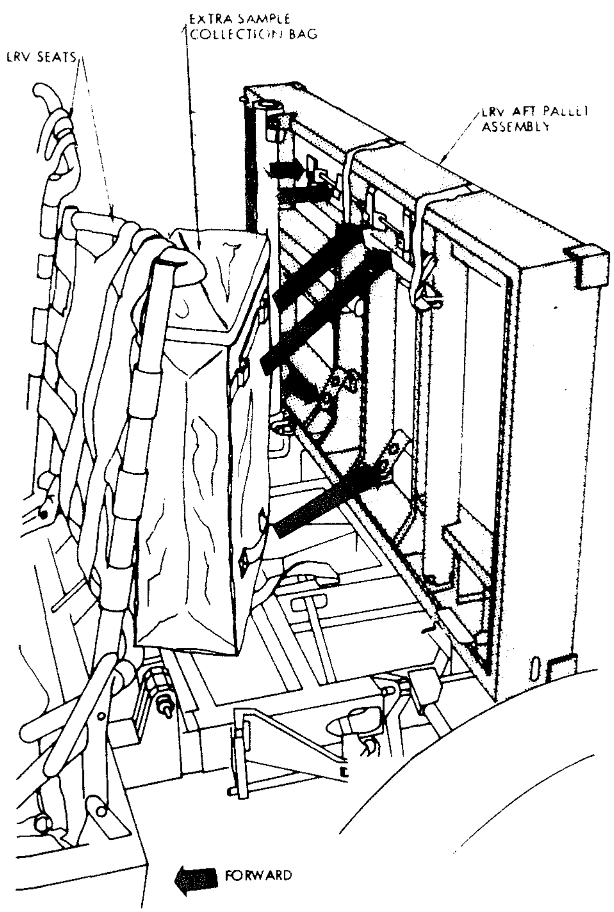
Figure 2-23. PLSS Geology Tool Carrier



MOUNTING OF LRV AFT PALLET TO LRV

STOWAGE DETAILS TBD

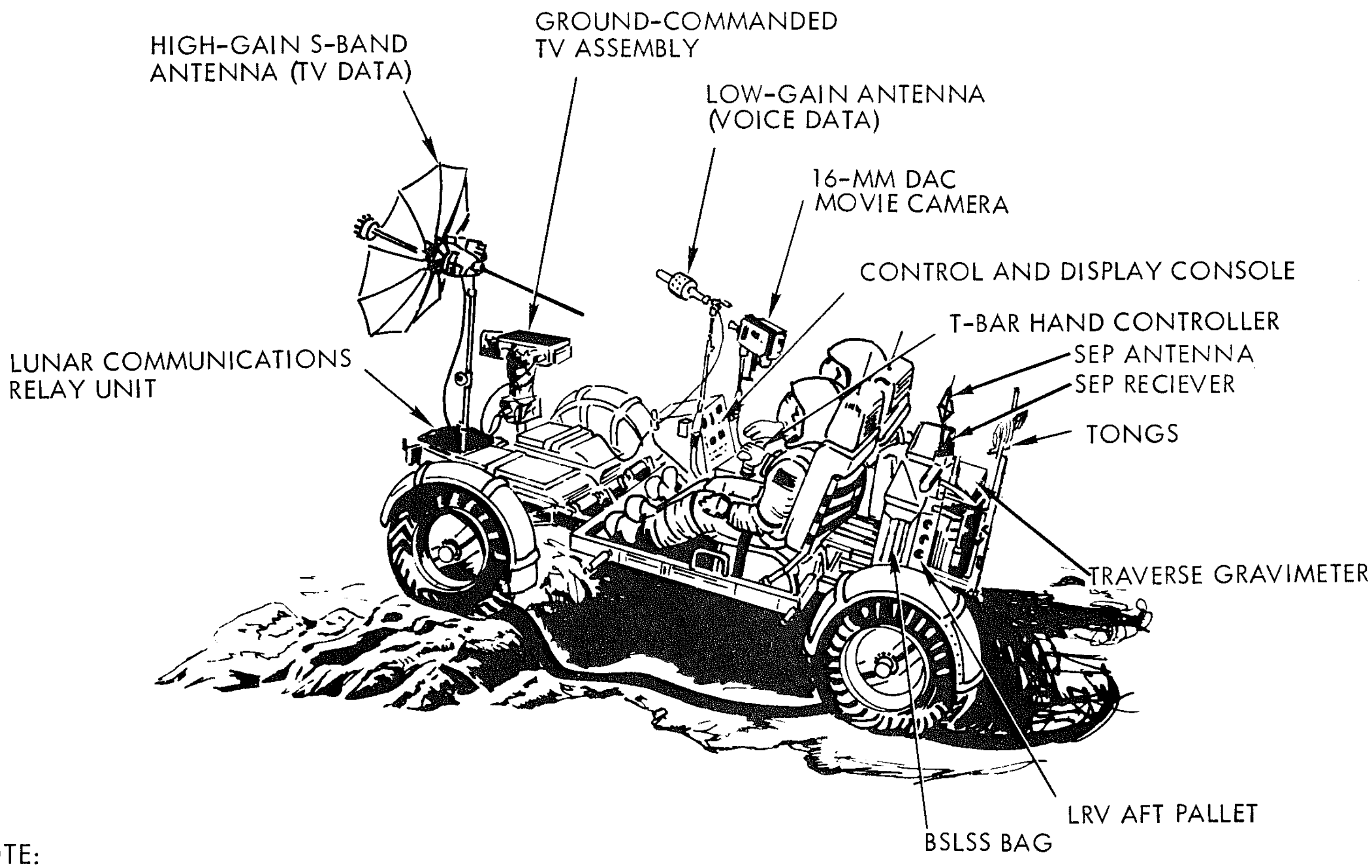
Figure 2-24(a). Lunar Geology Equipment/LRV Interface - LRV Aft (Geology) Pallet and Pallet Equipment Mounting



MOUNTING OF EXTRA SAMPLE COLLECTION BAGS TO LRV AFT PALLET

STOWAGE DETAILS TBD

Figure 2-24(b). Lunar Geology Equipment/LRV Interface - Sample Collection Bag Mounting to LRV Aft Pallet



NOTE:
HAND TOOL CARRIER WILL NOT BE CARRIED ON APOLLO 17.
LRV AFT PALLET STOWAGE DETAILS TBD.

Figure 2-25. Lunar Roving Vehicle (LRV)

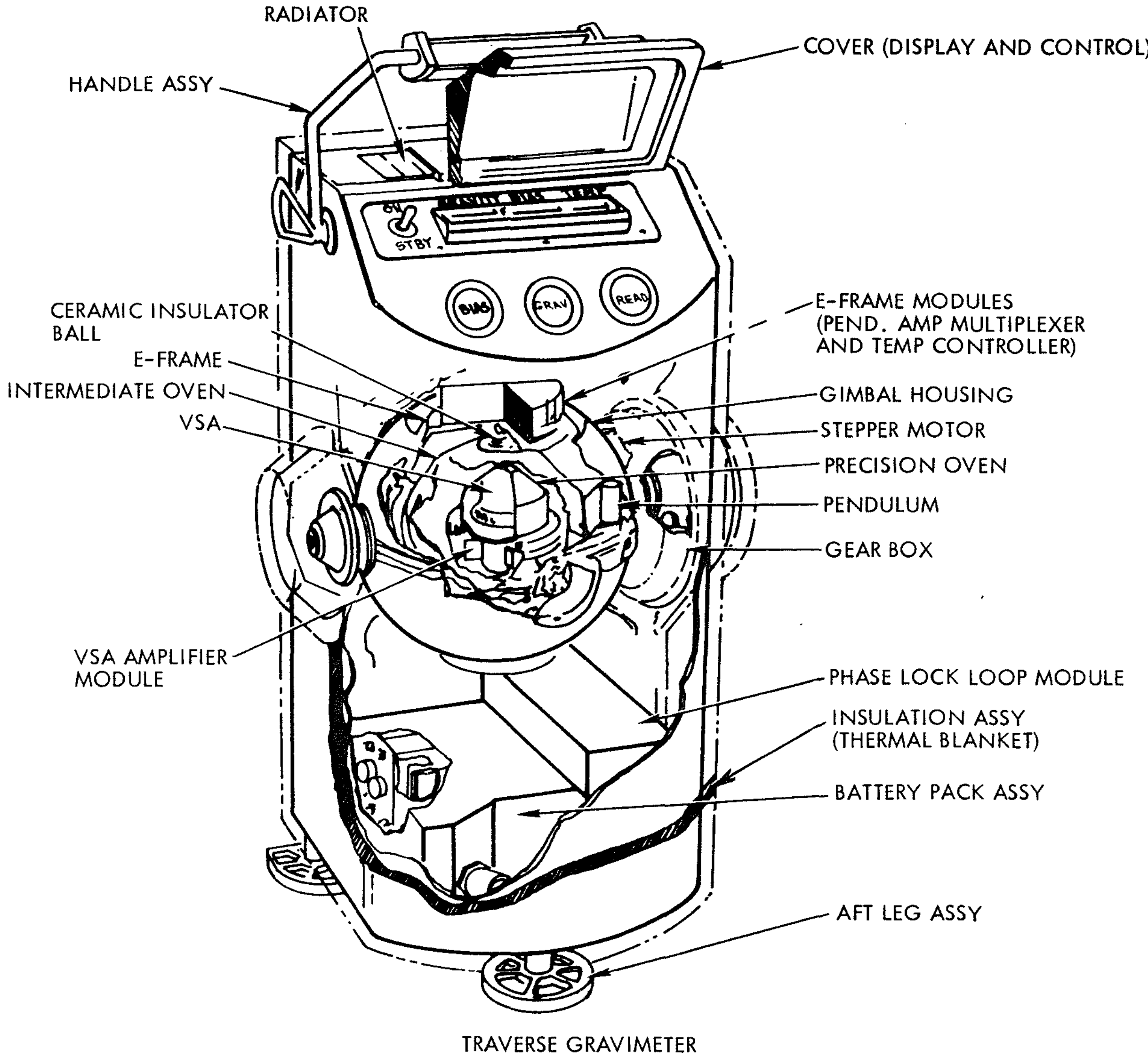


Figure 2-26(a). Traverse Gravimeter Experiment - Detailed Drawing

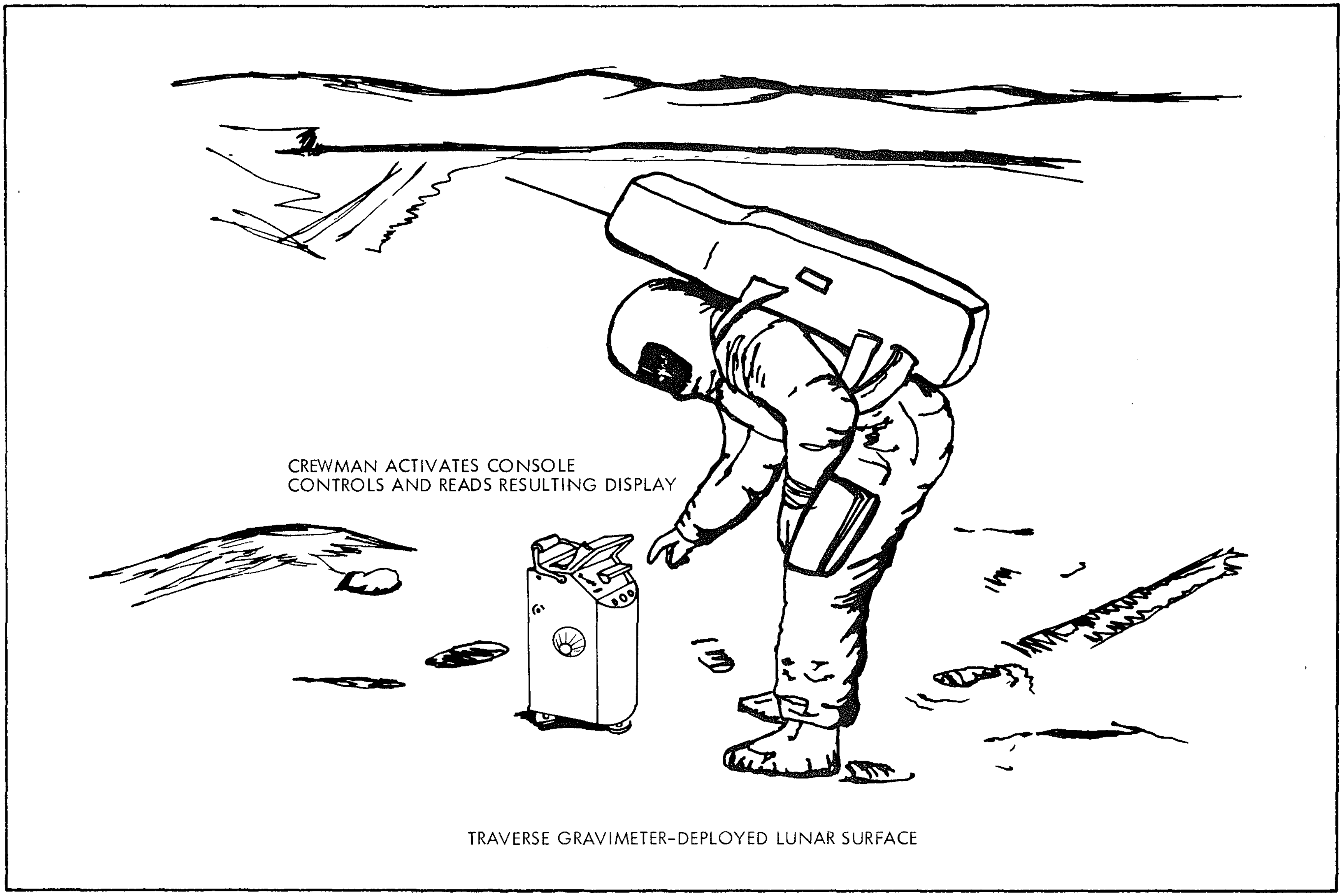


Figure 2-26(b). Traverse Gravimeter Experiment as Deployed on Lunar Surface in Vicinity of LM

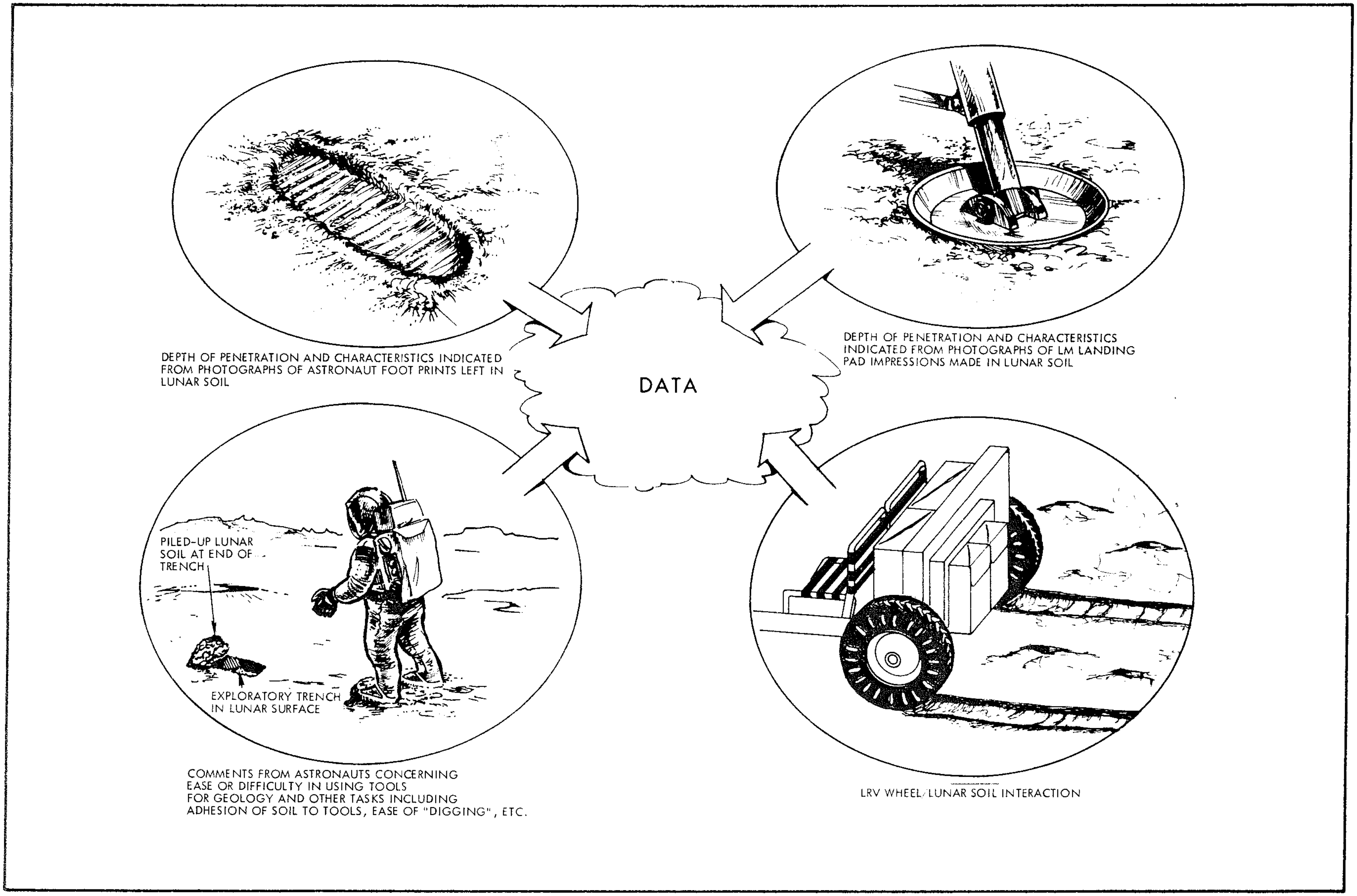


Figure 2-27. Soil Mechanics Experiment - Data Sources

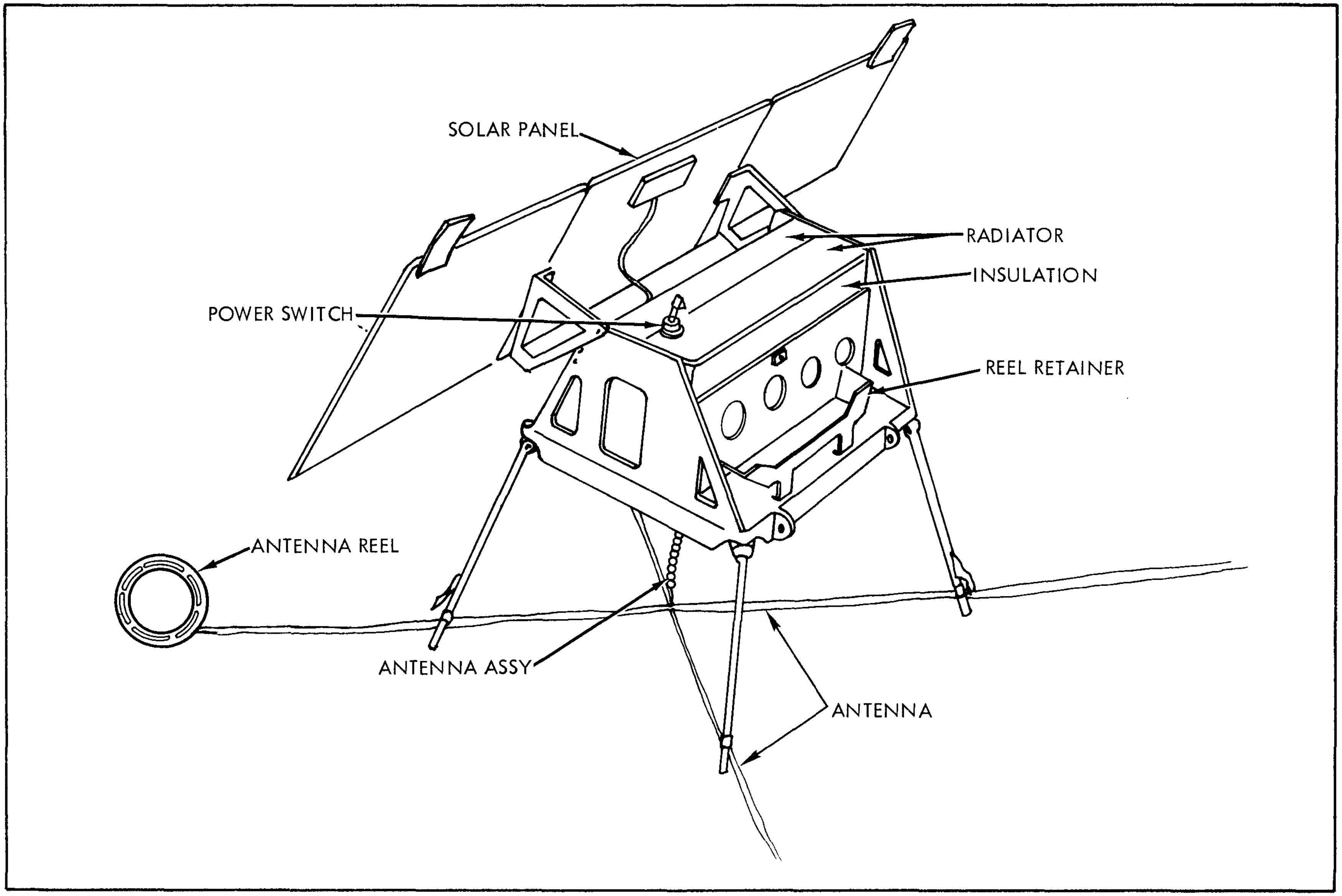


Figure 2-28(a). Surface Electrical Properties Experiment - Transmitter Deployed Configuration

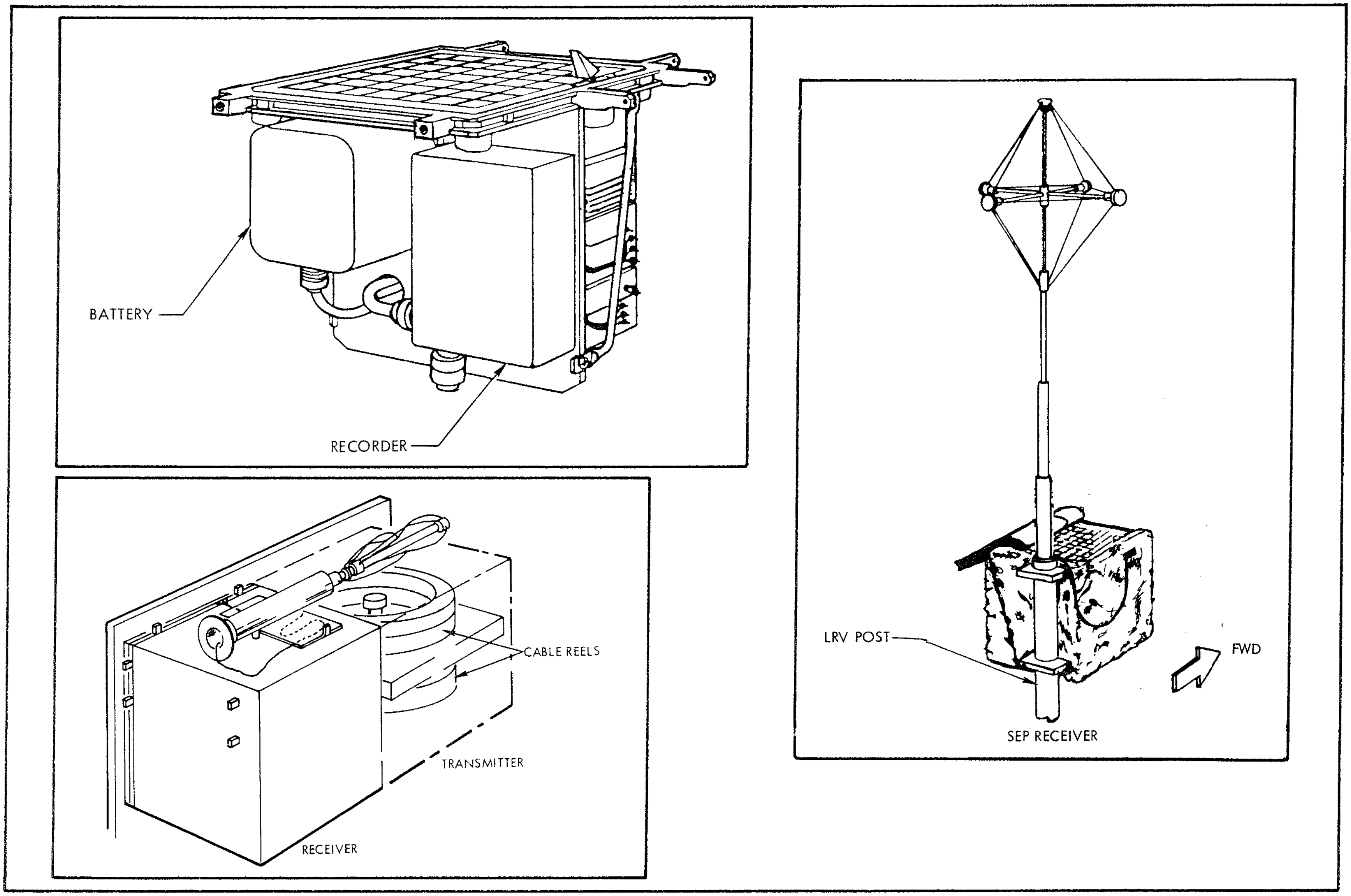


Figure 2-28(b). Surface Electrical Properties Experiment Receiver Recorder (Detail, Stowed Configuration, and Deployed Configuration)

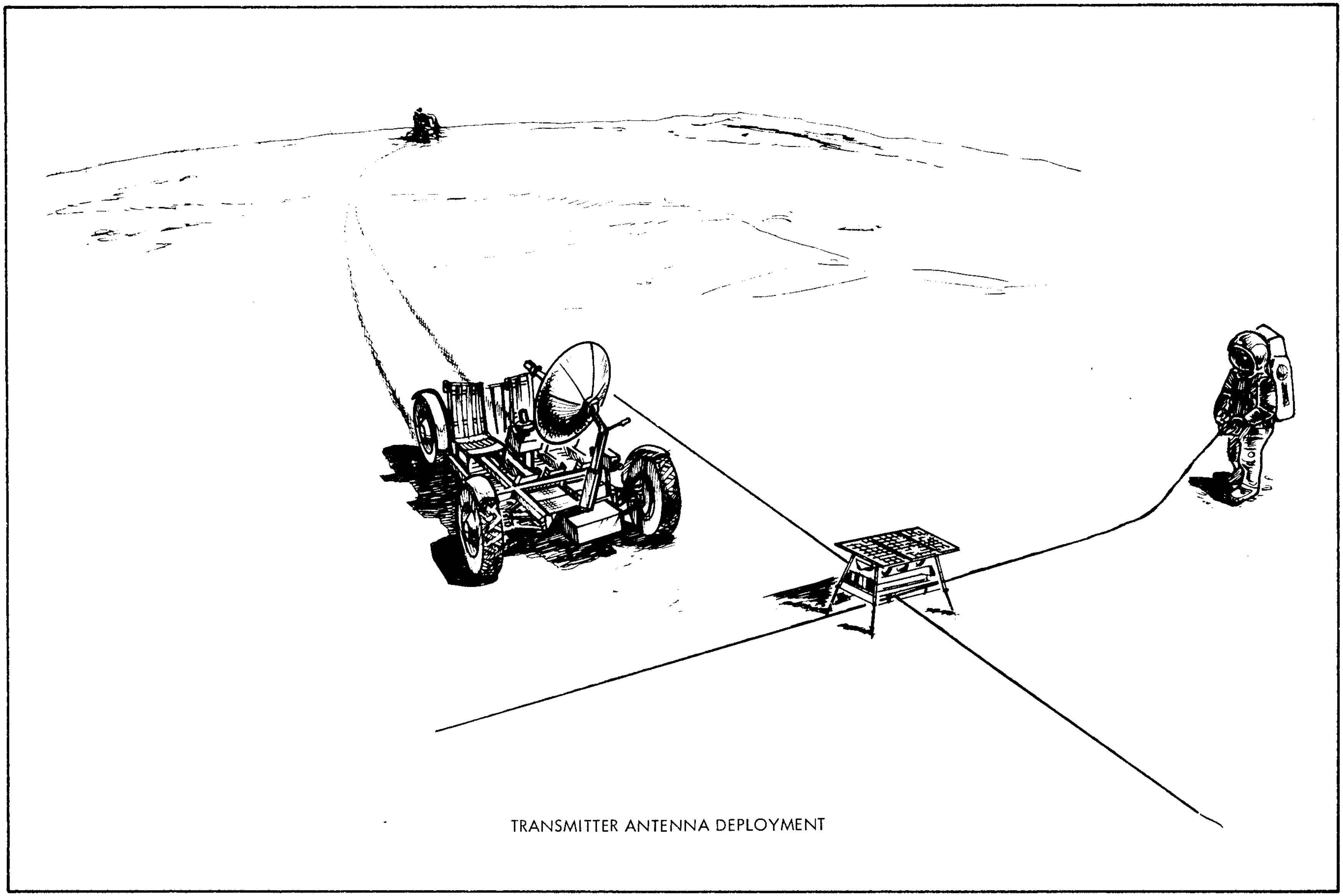


Figure 2-28(c). Surface Electrical Properties Experiment - Transmitter Antenna Deployment

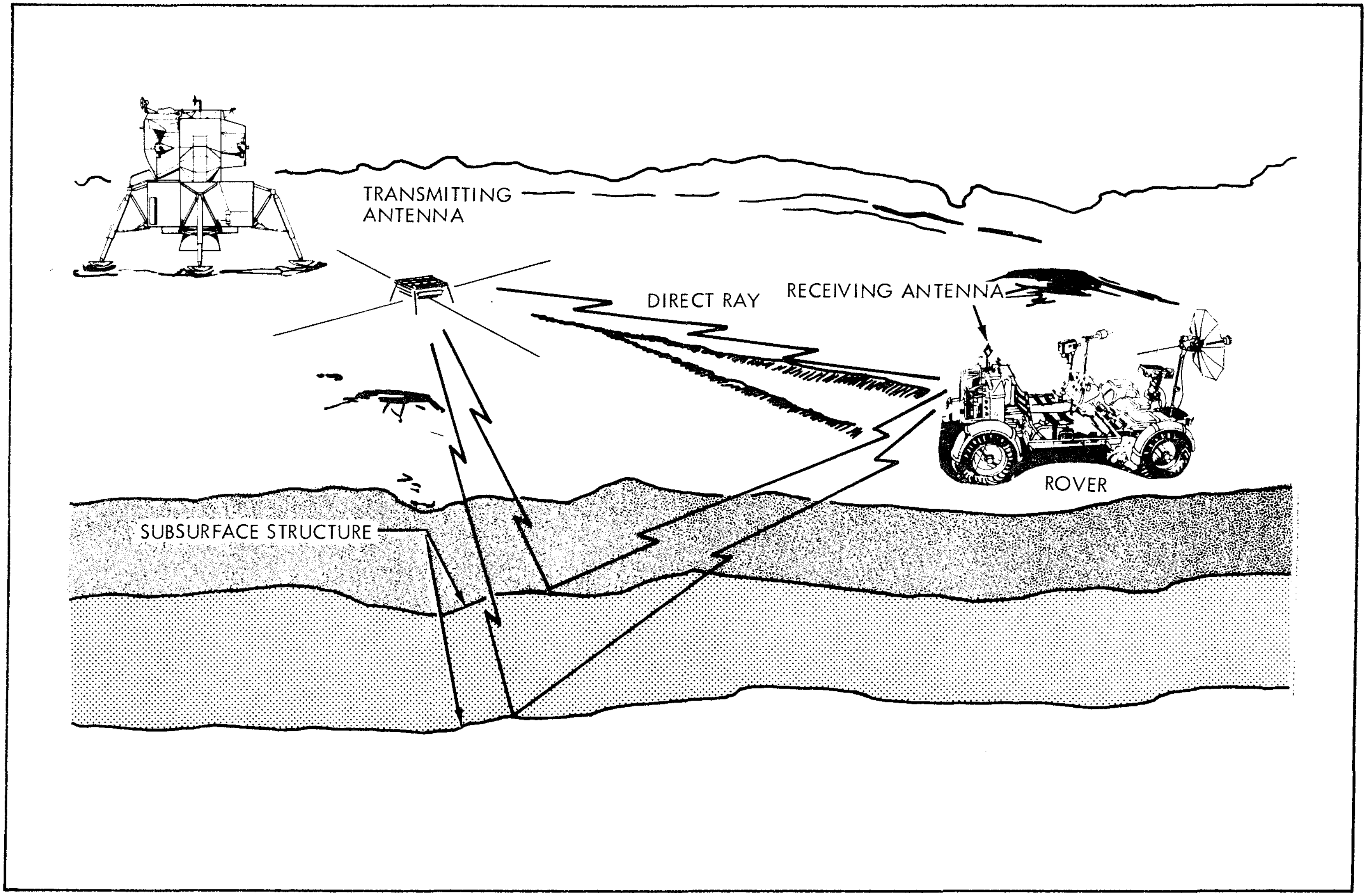


Figure 2-28(d). Surface Electrical Properties Experiment - Operational Configuration on Lunar Surface

SECTION III

PHOTOGRAPHIC PLAN

3.1 GENERAL

Data in this section were provided by the Science Requirements and Operations Branch/TD5, Mapping Sciences Branch/TF5, and Photographic Technology Division/JL. This section identifies and describes the types of photographic films which will be flown on Apollo Mission J-3, correlates photographic requirements to planned science experiments and science-related detailed objectives, and specifies photographic film reproduction requirements. Detailed descriptions, general properties, and processing test data for each film type are presented in Appendix E.

Detailed photographic data in this section are provided for experiment Principal Investigators, members of the scientific community, and personnel responsible for planning science photographic activities. These data are intended for use in implementing the photographic requirements related to science activities as presented in the MSC-controlled J-3 Mission Requirements Document (Reference 1) until such data are published in other MSC-controlled documents. These documents include the Apollo 17 Flight Plan (Reference 2) and the Apollo 17 Lunar Surface Procedures (Reference 3).

3.2 SUMMARY OF FILM TYPES

Table 3-1 lists the film types that will fly on Apollo Mission J-3, and a brief description of each. Detailed information on these films, presented in Appendix E, includes film characteristics, suggested exposure indexes, image-structure properties, emulsion characteristics, and typical density-log exposure curves. These data are the result of processing tests performed mostly by the film supplier, and reflect averages based on many different samples of the same film type. Thus, the data are accurate as to reflecting general film and emulsion characteristics, but should not be used for precise sensitometric comparisons with any single sample of film. The detailed film descriptions presented should serve to indicate the film processing capabilities of the Photographic Technology Division (PTD) at the Manned Spacecraft Center (MSC), and aid in the selection of film types and processing techniques for the fulfilling of science-related mission photographic requirements.

3.3 PHOTOGRAPHIC/SCIENCE REQUIREMENTS CORRELATION

Tables 3-2 and 3-3 present detailed photographic requirements for lunar orbital and lunar surface science activities, respectively. A listing of photographic equipment and film codes is given with each table. Entries in the "exposure parameters" column refer to aperture stop, duration of exposure (seconds), and focus distance (feet), respectively. Film processing requirements are referenced to the appropriate page of Appendix E on which that particular film is described.

The PTD performs sensitometric exposures of each film-type scheduled to be used on a particular mission for comparison with the manufacturer's sensitometric standards and to establish film processing controls. The Film Sensitometric Calibration, Processing, Handling, and Equipment Capabilities Document (Reference 12) provides detailed information on these sensitometric calibrations, and describes a procedure for the coordination of special photographic requirements with the PTD.

3.4 PHOTOGRAPHIC REPRODUCTION REQUIREMENTS

Table 3-4 presents the postmission reproduction requirements for imagery obtained from science-related photography to be performed on the J-3 Mission.

Table 3-1. Apollo Mission J-3 Flight Films

NUMBER	CHARACTERISTIC	TYPICAL FLIGHT APPLICATION
2485	Very high-speed BW	Low light level astronomy
3400	Intermediate-speed aerial BW	Lunar surface photography from lunar orbit
3401	Medium-speed, fine grain aerial BW	Documentation photography of geological samples
3414*	Low-speed BW	Lunar surface photography from lunar orbit and transearth coast
SO-168 (ASA 160)	High-speed color exterior	Photography of the deployed Apollo Lunar Surface Experiments Package (ALSEP)
SO-368	Medium-speed color exterior	Color photography performed of the lunar surface
SO-394	Television (recording) BW	Recording of lunar sounder radar echoes (from optical recorder CRT)

*Previously designated SO-349 and 3404.

Table 3-2. Lunar Orbit Science Photographic Requirements

Notes: The following notes apply to all pages of Table 3-2.

Camera Nomenclature:

DAC - 16-mm data acquisition camera
HEC - 70-mm Hasselblad electric camera
35 - 35-mm Nikon camera
MC - 3-Inch mapping camera
SC - 3-Inch stellar camera
PC - 24-Inch panoramic camera

Film Nomenclature:

CEX - Color exterior (SO-368)
BW - Black and white (3400 and 3401)
LBW - Low-speed black and white (3414, formerly SO-349 and 3404)
VHBW - Very high-speed black and white (2485)
TVBW - Television (recording) black and white (SO-394)

All photographs are mandatory except those designated as highly desirable (HD) or otherwise qualified.

Film type processing is specified by reference to the page number in Appendix E (e.g., E-5) for that film.

Exposure parameters are preliminary and based on previous mission photography where possible. Final values are subject to change by the Crew Procedures Division and the Photographic Technology Division. The parameters are listed sequentially as aperture stop (including f- and T-stop), exposure time in seconds, and focus distance in feet.

Table 3-2. Lunar Orbit Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
SM Orbital Photographic Tasks (Detailed Objective)	High-resolution photographs with stereo coverage (25-degree convergence angle) and limited monoscopic coverage of potential landing sites and exploration areas on the moon*	PC/24-Inch Lens**	LBW(3414, formerly SO-349 and 3404)/E-4	Automatic Exposure Control
	High-quality metric photographs of the lunar surface, based on 78 percent forward overlap between successive frames and 55 percent sidelap between consecutive photographic revolutions	MC/3-Inch Lens**	BW(3400)/E-2	Automatic Exposure Control
	Stellar photographs time-correlated with the metric photographs of the lunar surface	SC/3-Inch Lens	BW(3401)/E-3	f/2.8, 1.5 sec, ∞

*For photographic sequences see Section IV of the J-3 Mission Requirements Document.

**The 24-Inch Panoramic Camera has automatic V/h compensation from 45 to 80 NM and a manual override for 55 and 60 NM settings. V/h compensation altitude range for the 3-Inch Mapping Camera is ±10 NM from a nominal altitude of 60 NM, manually adjustable by crew. Prelaunch adjustment provides operation from 40 to 80 NM.

Table 3-2. Lunar Orbit Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
CM Photographic Tasks (Detailed Objective)	TBD series of solar corona photographs taken after CSM sunset and before CSM sunrise in lunar orbit, each series to consist of:			
	(a) Seven photographs taken at the following times:	HEC/80-mm Lens/ window mounting bracket	VHBW(2485)/ E-1	f/2.8, (as indicated below), ∞
	From CSM Sunset (Sec) / Prior to CSM Sunrise (Sec)			
	10 / -10			1/60
	20 / -20			1/30
	30 / -30			1/8
	40 / -40			1/2
	50 / -50			1
	60 / -60			4
	75 / -75			10
	(b) approximately 120 frames, during the following intervals: (HD)	DAC/18-mm Lens/ window mounting bracket	VHBW(2485)/ E-1	T/1.0 (f/.95), 1/30, ∞, frame cycle rate of 1 frame per second

Table 3-2. Lunar Orbit Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
CM Photographic Tasks (Detailed Objective) (Continued)	5 sec after to 120 sec after CSM sunset; 120 sec before to 5 sec before CSM sunrise			
	Four photographs of the moon through the CM RH rendezvous window, for calibration purposes*	HEC/80-mm Lens/ window mounting bracket	VHBW(2485)/ E-1	f/2.8, (1/500, 1/250, 1/125, 1/60), ∞
	Photographs of zodiacal light in TBD directions out of the ecliptic plane, taken prior to CSM sunrise	35/55-mm Lens/ window mounting bracket (two-position)	VHBW(2485)/ E-1	f/1.2, TBD, ∞
	TBD photographs of zodiacal light taken prior to CSM sunrise with the spacecraft in orbital rate**	35/55-mm Lens/ window mounting bracket, polarization filter	VHBW(2485)/ E-1	f/1.2, TBD, ∞
	TBD photographs taken of selected celestial targets	35/55-mm Lens (fixed)/window mounting bracket, light shield	VHBW(2485)/ E-1	f/1.2, TBD, ∞

*Photographs to be taken during transearth coast prior to the CSM EVA.

**For these photographs the CSM attitude rate will be matched to the lunar orbital rate holding the +X axis aligned near the forward-looking local horizontal such that a small portion of the camera's field-of-view is fixed on the lunar surface.

Table 3-2. Lunar Orbit Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
CM Photographic Tasks (Detailed Objective) (Continued)	Two series of photographs of the earth's limb during solar eclipse by the earth, each series to consist of the following:			
	Beginning when the sun appears to set:			
	Seven photographs of the earth's limb	HEC/80-mm Lens/ window mounting bracket	VHBW(2485)/ E-1	f/2.8, (same as for solar corona photographs), ∞
	Approximately 180 frames of the earth's limb	DAC/18-mm Lens/ window mounting bracket	VHBW(2485)/ E-1	T/1.0 (f/.95), shutter speeds same as for solar corona photographs, ∞, frame cycle rate of 1 frame per second
	Beginning 3 minutes prior to computed sunrise: same as above			
	Three photographs of a comet, if one is in a favorable position	DAC/18-mm Lens/ optical adapter to the CSM sextant	VHBW(2485)/ E-1	T/1.0 (f/.95), (60, 20, 5), ∞

Table 3-2. Lunar Orbit Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
CM Photographic Tasks (Detailed Objective) (Continued)	Photographs of specific areas* in low light levels near the terminator**	HEC/250-mm Lens	VHBW(2485)/ E-1	*
	Photographs of the lunar surface in earthshine, at approximately 30-second intervals, from terminator crossing to 8 minutes after terminator crossing	35/55-mm Lens (fixed)	VHBW(2485)/ E-1	f/1.2, 1/8, ∞
	Photographs of specific* areas of the lunar surface, providing 60 percent forward overlap	HEC/250-mm Lens	CEX (SO-368)/ E-6	*

*For identification of photographic targets and exposure parameters, refer to Section IV of the J-3 Mission Requirements Document.

**Photographs of 10 terminator crossings mandatory, an additional 10 crossings highly desirable.

Table 3-2. Lunar Orbit Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Lunar Sounder (S-209)	Optical Recorder Cathode Ray Tube (CRT) containing optical representation of HF and VHF radar echoes.	12.3-Centimeter Lens	TVBW (SO-394)/ TBD	Automatic Exposure Control, CRT Sweep Time Fixed
Lunar Sounder (S-209) Far UV Spectrometer (S-169) IR Scanning Radiometer (S-171) S-Band Transponder (CSM/LM) (S-164)	* * * *	PC/24-Inch Lens MC/3-Inch Lens SC/3-Inch Lens	LBW (3414, formerly SO-349 and 3404)/E-4 BW (3400)/E-2 BW (3401)/E-3	Automatic Exposure Control Automatic Exposure Control f/2.8, 1.5 sec, ∞

*Copies of appropriate Mapping Camera and/or Panoramic Camera photographs taken of the ground track overflown during periods of experiment operation.

Table 3-3. Lunar Surface Science Photographic Requirements

Notes: The following notes apply to all pages of Table 3-3.

Camera Nomenclature:

DAC - 16-mm data acquisition camera
LDAC - Lunar surface 16-mm data acquisition camera (battery operated)
HEDC - 70-mm Hasselblad electric data camera (with reseau)
LFLC* - Long focal length camera (HEDC specially adapted for use with a 500-mm lens, permanently focused at 1 kilometer)
GCTA - Ground Commanded Television Assembly

Film Nomenclature:

CEX - Color exterior (SO-368)
HCEX - High-speed color extension (SO-168) (ASA 160)
BW - Medium-speed black and white (3401)

All photographs are mandatory except those designated as highly desirable (HD) or otherwise noted.

Film type processing is specified by reference to the page number in Appendix E (e.g., E-5) for that film.

Exposure parameters are preliminary based on previous mission photography. Final values are subject to change by the Crew Procedures Division and the Photographic Technology Division. The parameters are listed sequentially as aperture stop (including f- and T-stop), exposure time in seconds, and focus distance in feet. DECAL refers to a decal on the camera showing aperture stops for different viewing angles relative to the sun.

*Use of long focal length camera is under consideration.

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
ALSEP/Central Station (C/S)*	One photograph of the C/S, taken from 7 feet behind the C/S looking south	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/11, 1/250, 7
	One photograph of the C/S, taken from 7 feet looking north to show the positions of the switches	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/11, 1/250, 7
	Panoramic photographs (as required) from the vicinity of the C/S to show entire ALSEP deployed	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/11, 1/250, 11
Radioisotope Thermoelectric Generator (RTG) (ALSEP)*	One photograph of the RTG on its pallet, taken 7 feet from the RTG	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/11, 1/250, 7

*Photographs desired but not listed as a science requirement in the J-3 Mission Requirements Document. The C/S and RTG are not experiments or DO's but provide only subsystems support to the Apollo 17 ALSEP Array.

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Heat Flow (S-037) (ALSEP)	One photograph of each bore stem with probe emplaced, taken down-sun from 11 feet	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/11, 1/250, 11
	One photograph of HFE electronics package cross-sun from 7 feet (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/11, 1/250, 7
	One stereo pair of each bore stem with probe emplaced, taken cross-sun from 7 feet	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/11, 1/250, 7
Lunar Geology Investigation (S-059)	For documented samples:	HEDC/60-mm Lens	BW (3401)/E-3	
	<u>Before Sampling</u>:			
	One photograph down-sun from 11 feet			f/11, 1/250, 11
	A stereo pair cross-sun from 7 feet, including the photometric chart			f/8, 1/250, 7

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Lunar Geology Investigation (S-059) (Continued)	<u>After Sampling</u>: One photograph of the sampled area cross-sun from 7 feet from approximately the same place as the stereo pair before sampling			f/5.6, 1/250, 7
	<u>Before or After Sampling</u>: One location photograph cross-sun from 15 feet, including sample area, some identifiable landmark (LRV or LM), and the horizon			f/5.6, 1/250, 74
	For mountains and interior structure of large craters: Short base (at least one-tenth of distance to target) stereo telephoto coverage of distant mountain slopes	LFLC/500-mm Lens	BW (3401)/E-3	(f/11 down-sun, f/8 cross-sun), 1/250, 1 kilometer (fixed)

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Lunar Geology Investigation (S-059) (Continued)	Photographs showing effects of changing illumination on mountain slopes Horizontal panoramas of all outcrop bands Vertical panoramas from crater rim to floor through most continuous outcrop zone visible (photographs of crater interiors to be taken from same point as HEDC pans)			
	For panoramas of LM area and each station stop: Each set to contain 15 to 20 overlapped photographs for 360-degree coverage, with horizon near top of each photograph (down-sun photograph must include astronaut's shadow)	HEDC/60-mm Lens	BW (3401)/E-3	DECAL, 1/250, 74

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Lunar Geology Investigation (S-059) (Continued)	Second panorama or partial panorama of each station stop sampling area, with at least a 20-meter baseline oriented East-West (HD)			
	For flight line panoramas of boulders: Panoramic photographs taken along a baseline parallel to the boulder being photographed, with at least 50 percent overlap for stereoscopic coverage	HEDC/60-mm Lens	BW (3401)/E-3	DECAL, 1/250, 74
	Close up stereo pairs of details of rocks and soil textures, structures, sampling sites, using tongs or scoop to establish distance to object being photographed	HEDC/60-mm Lens	BW (3401)/E-3	DECAL, 1/250, 27 Inches

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Lunar Geology Investigation (S-059) (Continued)	For core tubes:	HEDC/60-mm Lens	BW (3401)/E-3	
	One location photograph down-sun from 15 feet after core tubes are emplaced, including core tube, horizon, and gnomon with photometric chart			f/11, 1/250, 15
	One stereo pair of imbedded core tube, cross-sun from 7 feet			f/8, 1/250, 7
	For TV Coverage:	GCTA/12.5 - to 75-mm Zoom Lens	N/A	f/2.2 to f/22 by manual control, 30 frames per second video format
	A television full panorama at each major geological site, including LM and ALSEP sites (pauses will be made in the scan to permit Polaroid hard copies to be made)			

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Traverse Gravimeter (S-199)	Panoramic photographs (15 to 20 for overlapping 360-degree coverage) at each measurement site	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	DECAL, 1/250, 74
Soil Mechanics* (S-200) (Passive on Apollo 17)	Television coverage during exploratory trench excavation (HD)	GCTA/12.5- to 75-mm Zoom Lens	N/A	
	One photograph of the lunar surface showing DPS exhaust impingement erosive craters taken cross-sun at 11 feet from the center of the LM (HD)	HEDC/60-mm Lens	BW (3401)/E-3	
	Photographs of the course traversed before and after traverses for ALSEP deployment (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	

*Soil Mechanics photographs are HD and require no specific crew tasks. Photographs are to be obtained only in support of other operational tasks.

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Soil Mechanics* (S-200) (Continued)	Photographs of an astronaut's footprint during traverse for ALSEP deployment (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	
	Photographs of the LM exterior showing any soil accumulation on the vertical surfaces (HD)	HEDC/60-mm Lens	BW(3401)/E-3	
	Photographs of natural slopes, boulders, ridges, crater walls, and embankments in the vicinity of the landing site (HD)	HEDC/60-mm Lens	BW(3401)/E-3	
	Photographs of the lunar soil-LRV interactions (HD)	HEDC/60-mm Lens	BW(3401)/E-3	
	Photographs of each LM footpad and surrounding lunar soil showing LM footpad-lunar soil interaction (HD)	HEDC/60-mm Lens	BW(3401)/E-3	

*Soil Mechanics photographs are designated as HD and require no specific crew tasks. Photographs are to be obtained only in support of other operational tasks.

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Lunar Ejecta and Meteorites (S-202) (ALSEP)	One photograph of the deployed experiment showing the bubble level and shadowgraph taken cross-sun from 3 feet (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/8, 1/250, 3
	One photograph of the deployed experiment, down-sun from 11 feet (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/11, 1/250, 11
	One location photograph of the experiment, showing the C/S or other recognizable object (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	DECAL, 1/250, 74
Lunar Seismic Profiling (S-203) (ALSEP)	Six photographs: one photograph of each of the three outer geophones, taken from each of two positions within the equilateral triangle of geophones - positions 7.6 meters from center of triangle in directions	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	DECAL, 1/250, 74

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Lunar Seismic Profiling (S-203) (ALSEP) (Continued)	30 degrees south of east and 30 degrees south of west			
	*Panoramic photographs (15 to 20 for overlapping 360-degree coverage) taken from a point near center geophone	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	DECAL, 1/250, 74
Surface Electrical Properties (S-204)	Photographs of the receiver/antenna showing the mounting arrangement and orientation	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	TBD
	Panoramic photographs of the deployed transmitter/antenna showing the layout and orientation of the antenna and the position of the parked LRV, which is at the traverse starting point, with respect to the transmitter package	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	TBD

*Geological Panorama will suffice.

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Surface Electrical Properties (S-204) (Continued)	Photographs from end of two orthogonal antenna legs showing crew member at the opposite end			
Lunar Atmospheric Composition (S-205) (ALSEP)	One photograph of the deployed experiment showing the entrance aperture after cover removal, the bubble level, the vent valve, and the cable as it leaves the instrument, from 3 feet	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	DECAL, 1/250, 3
	*Panoramic photographs showing the lunar terrain surrounding the LACE	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	DECAL, 1/250, 74

*Geological Panorama will suffice.

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Lunar Surface Gravimeter (S-207) (ALSEP)	One photograph of the instrument cross-sun from 3 feet, showing bubble level, uncaging flag, and sunshade alignment shadow	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/5.6, 1/250, 3
	One photograph of the instrument from 7 feet showing the C/S in the background	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	DECAL, 1/250, 7

Table 3-4. Photographic Reproduction Requirements*

ITEM	LUNAR SURFACE ONLY	ORBITAL AND LUNAR SURFACE	ORBITAL ONLY	TOTAL
*The photographic reproduction requirements are TBD				

Table 3-3. Lunar Surface Science Photographic Requirements (Continued)

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Lunar Surface Gravimeter (S-207) (ALSEP)	One photograph of the instrument cross-sun from 3 feet, showing bubble level, uncaging flag, and sunshade alignment shadow	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	f/5.6, 1/250, 3
	One photograph of the instrument from 7 feet showing the C/S in the background	HEDC/60-mm Lens	HCEX (SO-168)/ E-5	DECAL, 1/250, 7

Table 3-4. Photographic Reproduction Requirements *

ITEM	LUNAR SURFACE ONLY	ORBITAL AND LUNAR SURFACE	ORBITAL ONLY	TOTAL
*The photographic reproduction requirements are TBD				

SECTION IV

LUNAR SURFACE SCIENCE PLAN

4.1 GENERAL

Lunar surface activities planned for the Apollo Mission J-3 are defined in this section. Included are descriptions of the landing site and rationale for its selection, identification of lunar surface experiments, and science-related detailed objectives and listings of lunar surface activities.

Detailed data contained in this section are provided for experiment Principal Investigators, members of the scientific community, and personnel responsible for planning science activities on the lunar surface. These data are intended for use in implementing the lunar surface science requirements presented in the MSC-controlled J-3 Mission Requirements Document (Reference 1) until such data are published in other MSC-controlled documents. Such documents include the Apollo 17 Flight Plan (Reference 2), Apollo 17 Lunar Surface Procedures (Reference 3), and Apollo 17 Flight Mission Rules (Reference 13).

4.2 LANDING SITE GEOLOGICAL RATIONALE

4.2.1 INTRODUCTION

Taurus-Littrow is the landing site selected for the Apollo Mission J-3 and is located on the southeastern rim of Mare Serenitatis in a dark deposit area between massif units of the southwestern Taurus Mountains, south of Littrow Crater. The site is about 750 kilometers east of the Apollo 15 landing site and about the same distance north of the Apollo 11 landing site. The relationship between Taurus-Littrow and previous Apollo landing sites is shown in Figure 4-1. More detailed views of the Taurus-Littrow area and proposed landing site are shown in Figures 4-2 and 4-3.

4.2.2 GEOLOGICAL RATIONALE

The massif units of the Taurus Mountains are believed to be ancient highland crustal blocks (pre-Imbrian in geologic age) which were emplaced by faulting and uplifting at the time of formation of the Serenitatis basin.

However, thin ejecta (because of the vast distances) from the younger impacts of Crisium and Imbrium may have mantled some of the massif units. Fresh and blocky slopes in excess of 25 degrees are common, which indicates that later debris movements have exposed the original massif surfaces. A large landslide or debris flow approximately 5 kilometers southwest of the landing site offers an excellent opportunity to sample both the very old massif materials and younger ejecta materials.

The dark deposit areas which occupy the low-lands between, and in a few cases atop the massif units, are believed to be among the youngest lunar surface units. They are characterized by a smooth appearance and lack of large blocks as indicated by photogeologic analysis and earth-based radar studies. This deposit is associated with numerous dark halo craters and is believed to be a volcanic (pyroclastic) mantle which may have originated deep within the moon. It offers, therefore, an opportunity to sample a relatively young volcanic material which will shed light on the composition as well as thermal history of the lunar interior.

The Taurus-Littrow site is geologically complex and it offers a number of rock types for sampling which apparently vary in age, albedo, composition, and origin. Geological units of Taurus-Littrow area are shown in Figure 4-4.

4.3 LUNAR SURFACE PLANNING DATA

4.3.1 EXPERIMENTS IDENTIFICATION

Table 4-1 lists detailed activities for implementing the lunar surface science requirements presented in the J-3 MRD (Reference 1). Data listed in each column are described below. These data are for use only until photographic activities and crew procedures/timelines are published in the Apollo 17 Flight Plan (Reference 2) and the Apollo 17 Lunar Surface Procedures (Reference 3).

a) Experiment (Number) and Activity (Priority). Includes each activity and its priority. The priorities assigned to each activity are based on the following definition presented in the J-3 Mission Requirements Document (Reference 1).

1) Mandatory (M) - A mandatory item is essential for evaluation.

2) Highly Desirable (HD) - A highly desirable item furnishes information which aids evaluation of the objective or experiment. These items supply information which is available from alternate sources or which is not required for evaluation of essential parts of the objective or experiments.

b) Astronaut Activities. Lists activities required by the astronauts to support the experiment activity. A description of the hand tools and equipment available to accomplish these activities appears in Section II of this document.

c) Photographs. Indicates the general photographic activity required. Detailed photographic requirements are defined in Section III of this document.

d) Stowage. Indicates the container on the LRV in which the sample may be stowed. Containers will be identified in the Apollo 17 Lunar Surface Procedures (Reference 3).

e) Rationale/Remarks. Provides additional information pertinent to the development of detailed timelines and procedures.

4.3.2 PRIORITY FOR GEOLOGICAL INVESTIGATIONS

The priorities of the major geological features of the landing site are TBD.

4.3.3 LRV TRAVERSE ROUTE TERRAIN PROFILES

These data are TBD.

4.3.4 TRAVERSE PLANNING GUIDELINES AND CONSTRAINTS

The guidelines and constraints listed below are taken from EVA Traverse Planning Parameters, Apollo J-Missions (Reference 14). These guidelines and constraints will be used in the development of the mission traverse.

NOTE

Values specified are subject to change by MSC or MSFC based on previous Apollo experience and data, additional knowledge gained about the Apollo 17 landing site and the LRV, and crew simulations.

a) Lunar Surface Stay-Time: Up to 73 hours.

b) EVA Durations: Three 7 hour EVA's (current plans).

c) LRV Riding Speed: 8 kilometers per hour, average.

d) Walking Speed: 2.5 kilometers per hour, average.

e) BSLSS Ride-/Walk-Back Limit: If a Portable Life Support System (PLSS) failure should occur during a traverse, the Buddy Secondary Life Support System (BSLSS) will be used to provide the capability of returning to the LM. The BSLSS can provide 0.95 hours of LRV ride time. For a walking traverse, the distance limit is 3.4 kilometers, with an emergency walking speed of 3.6 kilometers per hour.

f) PLSS Walk-Back Limit: Failure of the LRV during a traverse requires that the crew have the capability to walk back to the LM. The PLSS walk-back capability is defined by the consumables remaining and the walk-back speed. The actual limits are a function of time. (up to 1 hr, 3.6 KM/hr at 1560 BTU/hr; over 1 hr, 2.7 KM/hr at 1290 BTU/hr)

g) LRV Total Distance Capability: 76 kilometers, based on battery capability.

h) Overhead Times for Traverse Station Stops:

LRV Traverses: Minor Stop without TV (up to 15 minutes) - 3 minutes
Major Stop which includes TV (15 minutes and longer) - 6.8 minutes

Walking Traverses: All Stops - 3 minutes

i) Map Correction Factor: To determine the actual traverse distances, the map traverse distance (linear distance) is multiplied by 1.1. This factor is a function of the type of terrain encountered in the landing site.

4.4 LUNAR SURFACE ACTIVITIES

4.4.1 LANDING SITE EXPERIMENTS

The Apollo Lunar Surface Experiments Package (ALSEP) Experiments are accomplished or deployed in the area around the landing site. The Surface Electrical Properties Experiment is to be deployed approximately 100 meters from the landing site, the signal receiver/recorder unit is mounted on the

Lunar Rover Vehicle (LRV) and the surface electrical properties measurements will be obtained and recorded in the immediate area of the experiment and at designated points during the traverses. The Traverse Gravimeter Experiment is a portable unit carried on the LRV and operated at designated points during the traverses. The explosive packages (8) for the Lunar Seismic Profiling Experiment will be deployed at designated points during the traverses. Geological samples will be collected at the crew's discretion in the vicinity of the landing site. Figure 4-5 shows the ALSEP deployment.

4.4.2 PRELIMINARY NOMINAL TRAVERSES

Figure 4-6 shows "first cut" preliminary traverses for the Taurus-Littrow landing site. The traverses shown are based on geological considerations only and will be changed considerably when coordinated with the Lunar Surface Planning Group.

Table 4-1. Experiment Activities

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
Lunar Geology Investigation (S-059) 1. <u>Crater Sampling</u> Rim sampling (soil and rocks). (M) 20 to 50 m diameter craters.	<u>TBD</u>	<u>TBD</u>	<u>TBD</u>	<u>TBD</u>
2. <u>Boulder Sampling</u>	<u>TBD</u>	<u>TBD</u>	<u>TBD</u>	<u>TBD</u>
3. <u>Rock and Soil Sampling</u> Contingency sample. (M, if circumstances arise)	In event of actual contingency, collect loose sample of lunar material. Take photographs.	Location photo. (HD) Photo through LM window will be satisfactory if sample area is in view.	Suitable return container	This lunar surface material will provide a lunar sample for earth return only if the lunar stay is terminated early in the first EVA period.
Documented samples. (M) and (HD) At each major geological site on traverses and from each geological unit.	Scoop 100 to 200 gm of soil and rocks. Where rocks are too large, chips will be obtained. (M)	Documented Sample Photography. (M)	In pre-numbered bags in an SRC or sample collection bag. If too large, store in collection bag.	The intent is to obtain samples representative of the landing area. The photographs will show sample orientation, buried depth, relationship to other geologic features, and location with respect to the LM or other

Table 4-1. Experiment Activities (Continued)

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
Documented samples. (Continued) Rake/soil samples at: TBD	Collect rake/soil sample including 1-kg rock from 1 to 4 cm diameter and 1-kg soil sample from each rake/soil area. (M) (Take Photographs)			recognizable features. Photographs with gnomon and photometric chart will show orientation with respect to sun, lunar local vertical, and colorimetric properties; stereo-pairs will be obtained for precise photogrammetric measurements of features.
Additional samples to maximize amount of material returned. (M)	Collect samples of particular interest in order of priority. In SRC's: a) small rocks; and b) soil. In SRC's: a) 15 to 20 cm equidimensional rocks; and b) 5 to 15 cm equidimensional rocks; and c) soil. Collect near end of available sampling time on each EVA. Take photographs.	Documented Sample Photography. (M)	Loose in SRC's and SCB's.	15 to 20 cm diameter: The intent is to obtain information on the radiation history of the sun by providing a large sample with exposed and unexposed external areas. The photographs will record the exposed parts of the rock and the location of the sample area. 5 to 15 cm diameter: Similar to above. Several small rocks may be more valuable than one large rock because of higher statistical significance of more samples.

Table 4-1. Experiment Activities (Continued)

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
2 lunar environment soil samples. (M4) *CSVC >1 km from LM.	Collect single core tube sample and seal in CSVC.* Collect soil sample from bottom of trench at least 10 cm deep and seal in SESC. Fill SESC to near capacity. Take photographs.	Documented Sample Photography. (M) Small exploratory trench photographs will suffice. (M)	CSVC* in an SRC. In SESC.	These samples will be the only truly virgin vacuum samples from the moon and will provide biologically pure samples for gas analysis and for chemical and microphysical analyses.
Single and Double Core Tube Samples (M)	Obtain core tube sample. Report number and order of multiple core tubes. Take photographs.	Standard Core Tube Photography. (M)	In an SRC or sample collection bag.	This activity will provide a sample for determining stratigraphy and soil-type distribution to depths of approximately 0.6 meters in the lunar surface at selected locations (expected multiple layer areas). Thin edges of rays and ejecta blankets are preferable. The photographs will record the surface characteristics and location of the sample area.

*Being considered for the Apollo 17 Mission

Table 4-1. Experiment Activities (Continued)

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
2.6-meter drill core. (M) On flat surface <20 to 30 m from HFE. No crater >5 m between HFE and drill site.	Obtain sample using Apollo lunar surface drill. Take photographs.	Standard Core Tube Photography. (M)	Stow 2 drill stem sections in Beta cloth bag.	This core will provide the only deep sample of regolith and will help to determine stratigraphy in the sample area.
4. <u>Lunar Field Relationships</u> Lunar surface features and field relationships. (M) Photographs will be of distant targets.	Examine and describe following types of field relationships: a) surface patterns of linear features or other surface textures; b) rock surfaces that show textures such as layering, fracturing or color variations, and structures too large to return; c) craters that show a range of size, freshness, and degradation; d) rock-soil contacts such as	Features and field relationships will be photographed at crew discretion using 60-mm or 500-mm lens. Short base stereo pair of targets of opportunity using 60-mm lens. (HD) Include scale (gnomon, LRV, etc.) in photo when possible.	N/A	Geologic feature color and texture differences infers age, origin, and composition of features. Undisturbed surface samples will provide statistically unbiased sample of local regolith.

Table 4-1. Experiment Activities (Continued)

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
Lunar Field Relationships (Continued)	fillets banked against rocks, especially those banked against rocks on one of two sides; e) boundary zone between hillside and relatively level ground at its base; and f) disturbed (footprints, wheel-tracks, trenches) and undisturbed surface material.			
5. Panoramic Photographic Sequences (M)	Take panoramic photographs based on following criteria: a) geological features of interest along traverse; b) from high elevation points from which unobstructed horizon can be seen; c) items of crew interest; d) one set per traverse station;	15 photographs are (M) per panorama to provide 360 degree, overlapped coverage. Additional 5 photographs per panorama are (HD). Second panorama per traverse station is (HD).	N/A	These photographs, when joined as mosaics, will provide accurate map control data.

Table 4-1. Experiment Activities (Continued)

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
Panoramic Photographic Sequences (M) (Continued)	e) second panoramic per traverse station with as wide a stereo base as practical within sampling area.			
6. 3 Panoramic Photograph Sequences at LM (M). 6 m from LM at three positions approximately 120 degrees apart.	Take photographs.	15 photographs are (M) per panorama to provide 360 degree, overlapped coverage. Additional 5 photographs per panorama are (HD).	N/A	These photographs, when joined as mosaics, will provide accurate map control data.
7. Organic Control Sample 2 organic control samples. (M)	Seal the organic control sample at the beginning of each EVA on which an SRC is used.	N/A	In each SRC.	These samples will permit a determination of the contamination within each SRC.

Table 4-1. Experiment Activities (Continued)

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
Apollo 17 ALSEP Central Station (C/S) and Radioisotope Thermoelectric Generator (RTG) (M)	Deploy and activate the C/S and RTG: Subpackages 1 and 2 and the radioisotope fuel source will be removed from the LM; the fuel source will be placed in the RTG on subpackage 2; subpackages 1 and 2 will be attached to the antenna mast and carried barbell style to the deployment site; the lunar surface drill will be transported on the LRV; the experiments will be removed from the subpackages, assembled, and cables connected at the deployment site; the antenna on subpackage 1 will be erected on the C/S and pointed toward earth; the transmitter will be turned ON.	4 photographs: 2 of the C/S 1 of the RTG 1 of the entire deployed ALSEP	N/A	91 meters from LM; during the first EVA. The astronaut pushes a switch which removes the shorting plug and reports this action to the MCC. After sufficient time for safe power build-up, the MCC requests the astronaut to put switch 1 in the ON position. This applies power to the C/S and the transmitter is turned ON automatically if it was in the ON condition at launch; if not, the ground will command individual experiments ON; if this fails, or if the transmitter fails to go ON by ground command, the astronauts will manually activate the appropriate switches on the C/S.

Table 4-1. Experiment Activities (Continued)

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
Heat Flow (S-037) (M)	Deploy, level, and align the electronics package. Drill 2 holes 2.6 meters deep and 12 meters apart with lunar surface drill; insert 1 sensor probe into each hole and report the appropriate marking to determine the probe depth.	7 photographs: 1 of each drilled hole with probes inserted; 1 of the electronics package; 1 stereo pair of each bore stem.	N/A	Part of Apollo 17 ALSEP array.
Traverse Gravimeter (S-199) (M)	Perform measurements at selected sites during traverse.	At each measurement site, a photographic panorama will be obtained*	N/A	The Portable Gravimeter is mounted on the LRV aft pallet for transport during all traverses.
Soil Mechanics (S-200) (Passive Experiment)	No experiment unique activities required			

*Geological panorama will suffice.

Table 4-1. Experiment Activities (Continued)

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
Lunar Ejecta and Meteorites (S-202) (M)	Erect and deploy on lunar surface approximately 8 meters south of ALSEP Central Station align and level to ±5°.	2 photographs 1 cross-sun from 3 feet showing bubble level and shadowgraph (HD) 1 from southeast from 7 feet with the Central Station in the background (HD)	N/A	Part of Apollo 17 ALSEP array.
Lunar Seismic Profiling (S-203) (M)	Deploy the geophones and geophone modules (Figure 4-6). The eight explosive packages will be deployed during the traverses.	6 single photographs and 1 panorama* from inside the geophone triangle	N/A	Part of Apollo 17 ALSEP array/
Surface Electrical Properties (S-204) (M)	Mount the receiver and loop antenna on LRV. Deploy transmitter package approximately 100 m from LM. Unreel transmitter dipole antenna in orthogonal	Photographs of receiver and antenna on LRV. Panoramic photographs of transmitter and deployed antenna.	Recorder with tape in LM	Recordings to be made on 2 LRV traverses.

*Geological Panorama will suffice if taken from inside geophone triangle.

Table 4-1. Experiment Activities (Continued)

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
Surface Electrical Properties (S-204) (M) (Continued)	directions on level lunar surface. Turn equipment power on and turn recorder ON during LRV traverses. Remove recorder and tape at the end of EVA III. Turn equipment power OFF at conclusion.	Photographs of final LRV position. Panoramic photographs of each major site.		
Lunar Atmospheric Composition (S-205) (M) (LACE)	Deploy the mass spectrometer unit approximately 15 meters NE of the ALSEP Central Station. Level to ±15°.	One photograph of the deployed experiment from 3 feet. Panoramic photographs showing lunar terrain around the LACE*	N/A	Part of Apollo 17 ALSEP array.
Lunar Surface Gravimeter (S-207) (M)	Deploy approximately 8 meters west of ALSEP Central Station. Align to within ±3 degrees. Level within ±3 degrees.	One photograph cross-sun from 3 feet showing bubble level, uncaging flag, and sunshade alignment shadow	N/A	Part of Apollo 17 ALSEP array.

*Geological panorama will suffice.

Table 4-1. Experiment Activities (Continued)

Experiment No. Activity (Priority)	Astronaut Activities	Photographs	Stowage	Remarks
Lunar Surface Gravimeter (S-207) (M) (Continued)		One photograph of the instrument from 7 feet showing the Central Station in the background		

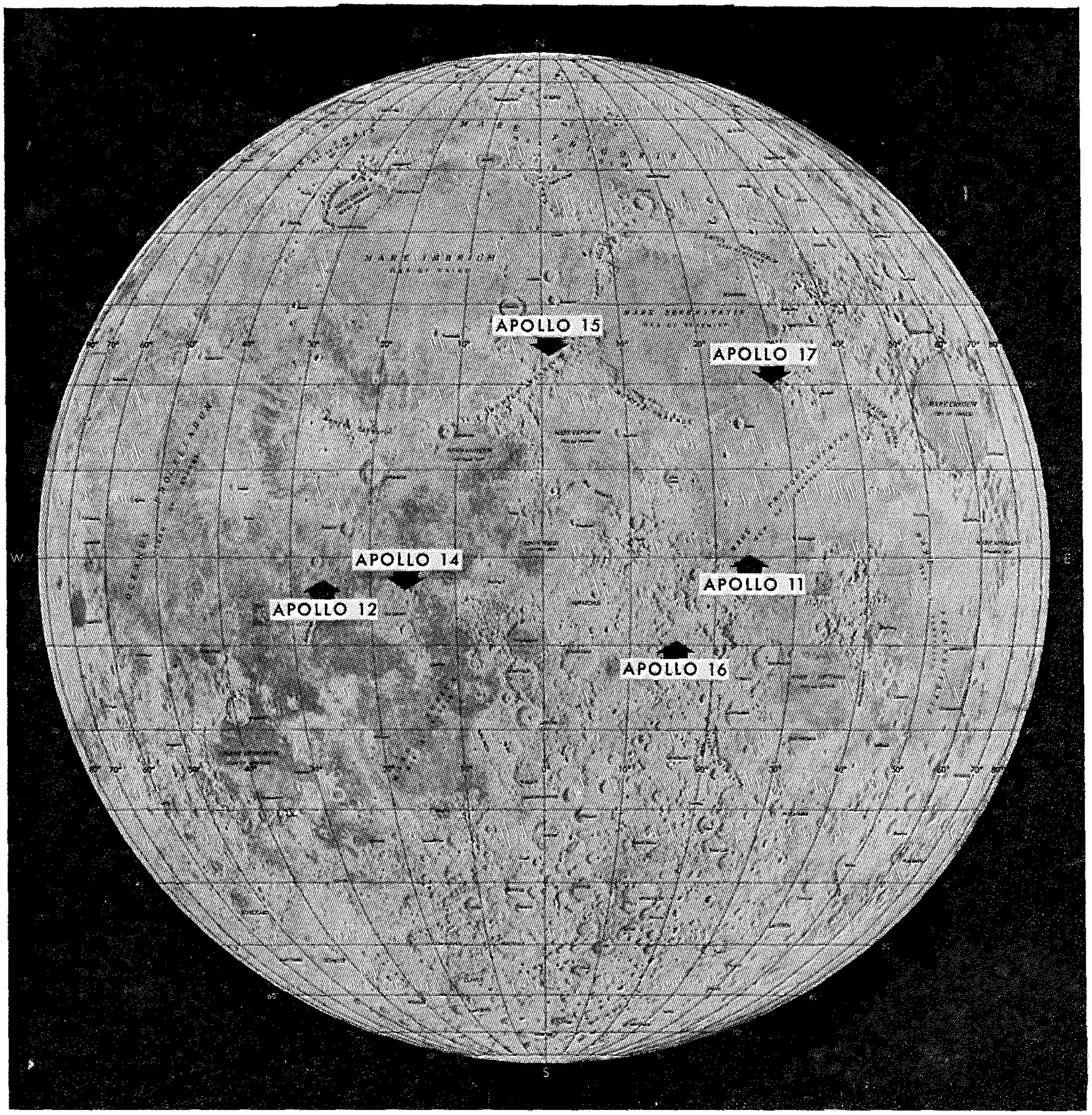


Figure 4-1. Apollo 17 Lunar Landing Site in Taurus-Littrow Area in Relationship to Previous Lunar Landing Sites.

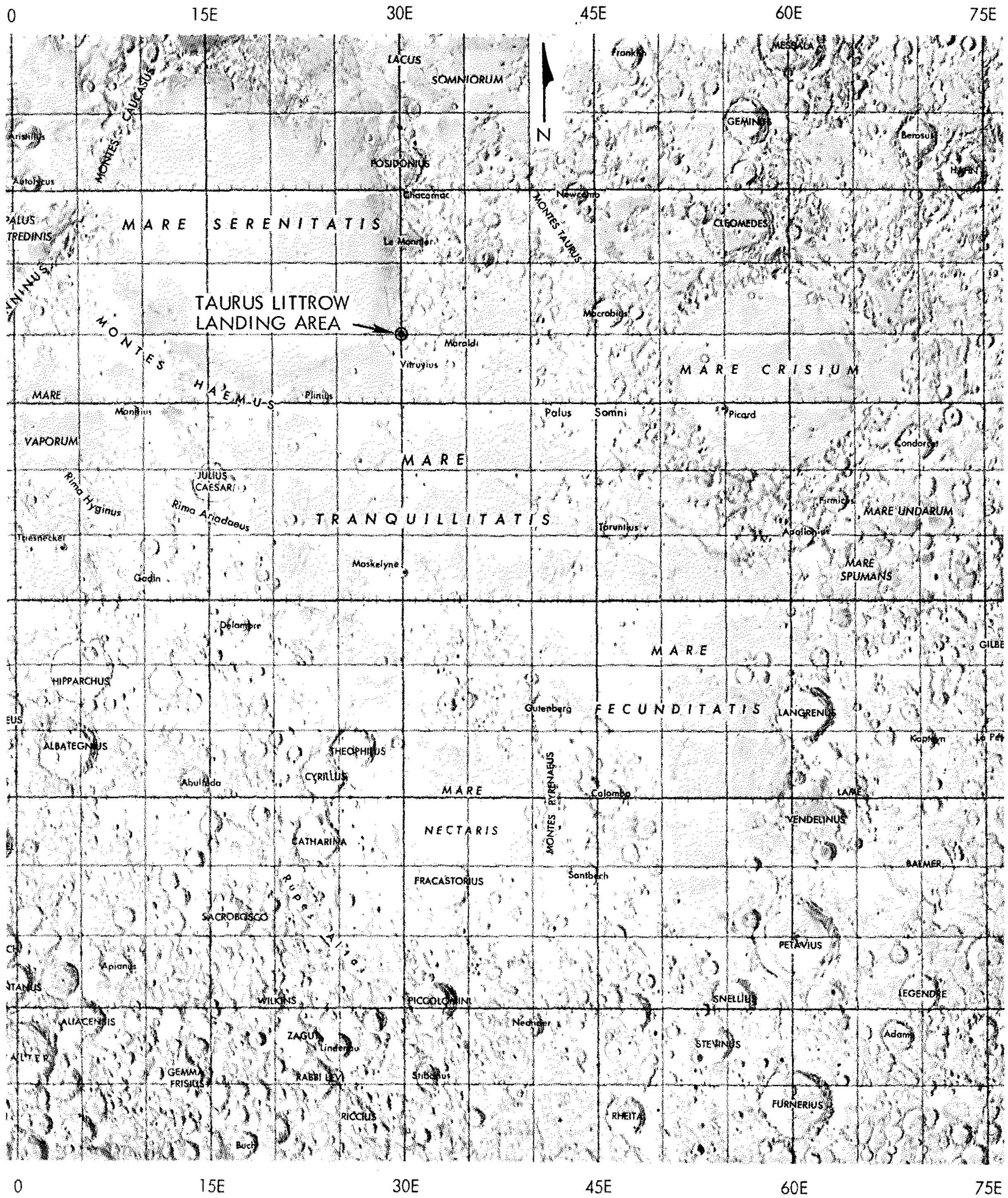


Figure 4-2. LM Lunar Landing Site in the Taurus-Littrow Area

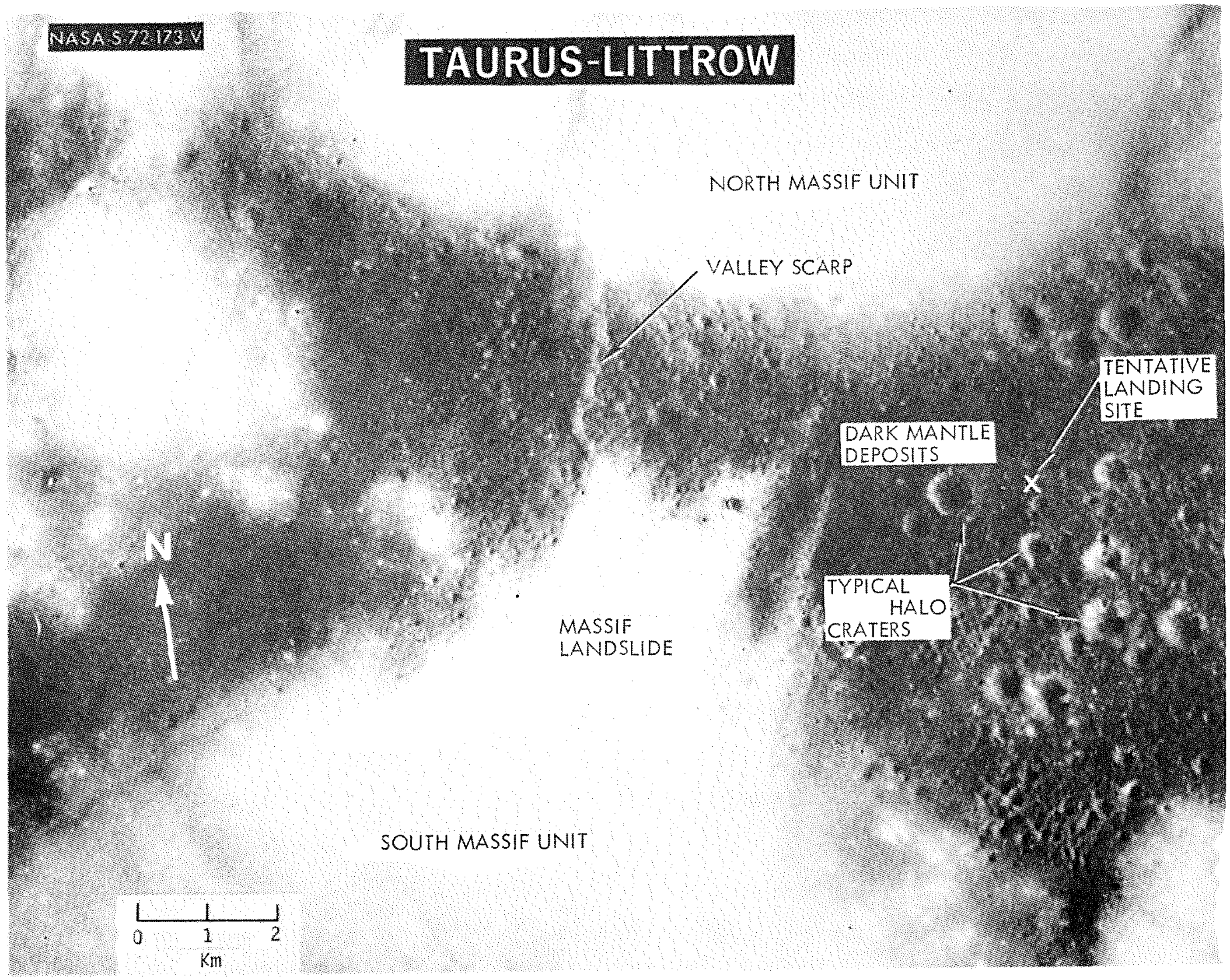


Figure 4-3. Important Geological Features in Magnified View of Taurus-Littrow

TO BE SUPPLIED

Figure 4-4. Geology Units of the Taurus-Littrow Landing Area

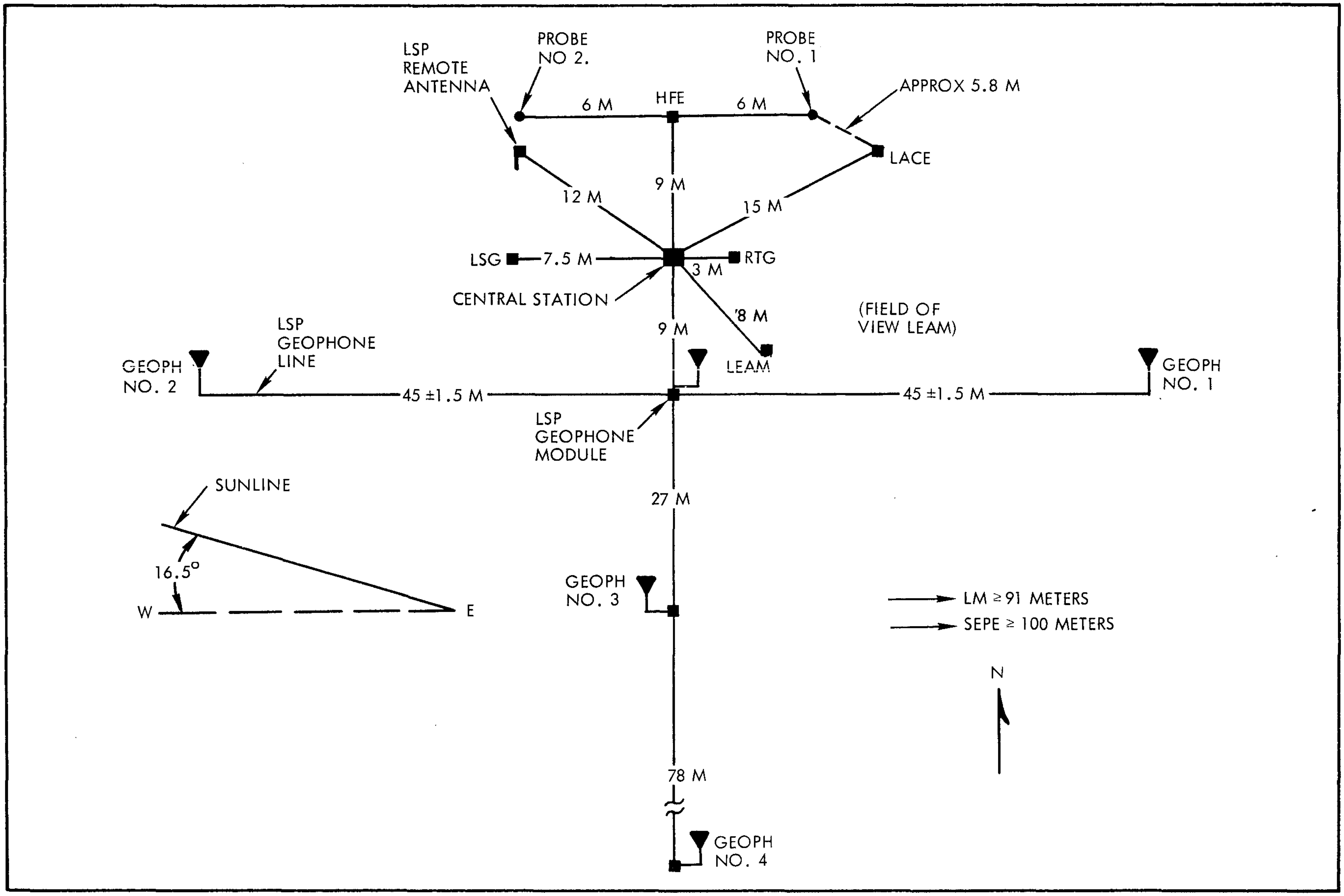


Figure 4-5. Apollo 17 ALSEP Deployment

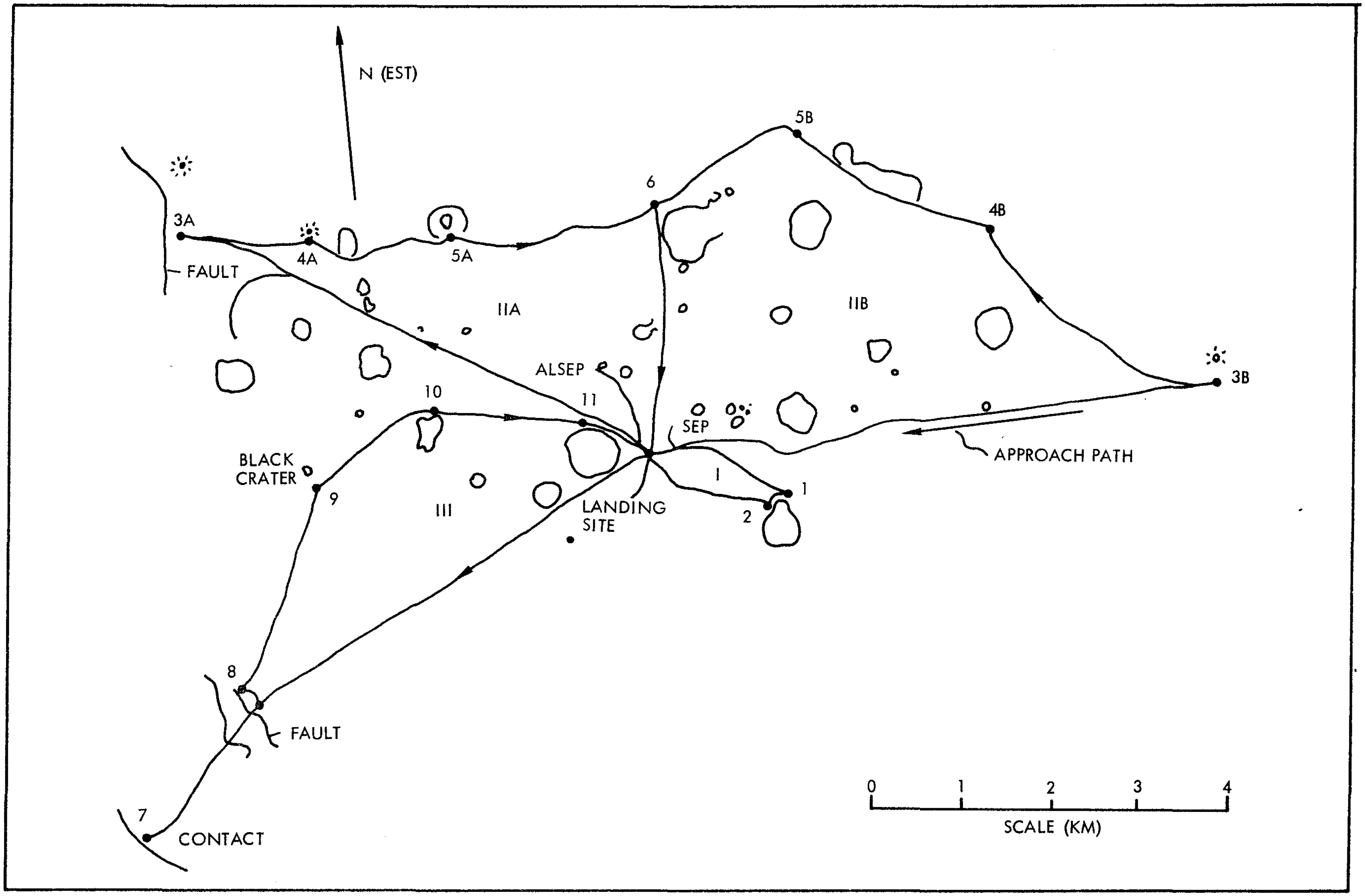


Figure 4-6. Apollo 17 Taurus-Littrow Preliminary LRV Traverses

SECTION V

SCIENCE RECOVERY PLAN

5.1 GENERAL

This section was provided by the Science Requirements and Operations Branch/TD5, supported by the General Electric Company. It defines requirements of the Science and Applications Directorate (S&AD) for the return of time-critical scientific data and equipment from the splashdown recovery zone to the Lunar Receiving Laboratory (LRL) at the Manned Spacecraft Center (MSC), Houston, Texas. Guidelines for preparation and transportation of the data and equipment are presented in Paragraphs 5.2.1 and 5.2.2. Transportation priorities are specified in Table 5-1.

Data contained in this section are provided for experiment Principal Investigators, members of the scientific community, and personnel involved in planning for the recovery of equipment and lunar samples returned from the mission. These data are intended for use in implementing the science requirements presented in the MSC-controlled J-2 Mission Requirements Document (Reference 1) until such data are published in other MSC-controlled documents. These documents include the Apollo 17 Flight Mission Rules (Reference 13) and Recovery Requirements-Apollo 17 (Reference 15).

5.2 PREPARATION AND TRANSPORTATION REQUIREMENTS

5.2.1 PREPARATION OF DATA AND EQUIPMENT FOR RETURN TO MSC

5.2.1.1 Decontamination

Because of the MSC decision to discontinue quarantine precautions and procedures for the crew and other items returned from the moon, it is no longer necessary to specify decontamination requirements as has been the case on previous Apollo G- and H-Missions. The precautions and requirements associated with the processing of returned lunar samples, however, are still in effect.

5.2.1.2 Shipping Containers

Shipping containers to protect items from excessive shock and temperature during handling and flight will be provided by the Landing and Recovery Division.

5.2.2 TRANSPORTATION REQUIREMENTS

5.2.2.1 Flight Operations

Flight operations from the recovery zone to Ellington Air Force Base (EAFB), Houston, must be conducted with multiple or similar items divided between two aircraft to minimize the scientific impact involved if an aircraft should be lost.

5.2.2.2 Transfer of Items from EAFB to the LRL

Transporting of time-critical items from EAFB to the LRL will be accomplished by motor vehicle. Transfer of items from the couriers to LRL personnel will be accomplished at this time.

Table 5-1. J-3 Mission Scientific Data and Equipment Recovery Requirements Matrix

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Sample Return Container (SRC) No. 1, S/N TBD	1	Flight No. 1	The SRC's are not to be opened prior to delivery to the LRL.
• Sample Collection Bag No. 1	1		
• Small Documented Geological Samples (EVA No. 1)	60 (max.)		
• Core Tube Samples (EVA No. 1)	2		One upper core tube section and one lower core tube section.
• Organic Control Sample	1		The organic control sample installed in each SRC prior to flight will remain in the container throughout the mission.
• Deep Drill Core Sample (EVA No. 1)	6		Drill core is returned in two sections; each section is composed of three joined core stem sections. Beta cloth bag is used as return container.

Table 5-1. J-3 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Extra Sample Collection Bag No. 5 (EVA No. 1)	Large Geo-logical Samples	Flight No. 1 or 2	
• SRC No. 2, S/N <u>TBD</u>	1	Flight No. 2	The SRC's are not to be opened prior to delivery to the LRL.
• Sample Collection Bag No. 2	1		
• Small Documented Geological Samples (EVA No. 2)	40 (max.)		
• Core Tube Samples (EVA No. 2)	3		One upper core tube sections and two lower core tube sections.
• Environmental Soil Sample (SESC No. <u>TBD</u>) (EVA No. 2)	1		
• Core Sample Vacuum Container (EVA No. 2)*	1		Contains an upper core tube sample to be kept in a pristine state.

*Proposed for Apollo 17

Table 5-1. J-3 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Organic Control Sample	1	Flight No. 2	The organic control sample installed in each SRC prior to flight will remain in the container throughout the mission.
• Extra Sample Collection Bag No. 6 (EVA No. 2)	Large Geological Samples	Flight No. 1 or No. 2	
• Sample Collection Bag No. 3 (EVA No. 3)	1		Flight assignment of collection bags and other data articles will be largely determined by the science value attached to the articles. Collection bags to be placed in special return containers similar to those used for the SRC's.
• Small Documented Geological Samples (EVA No. 3)	40 (max.)		
• Core Tube Samples (EVA No. 3)	3		One upper core tube section and two lower core tube sections.
• Extra Sample Collection Bag No. 7 (EVA No. 3)	Large Geological Samples		

Table 5-1. J-3 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Extra Sample Collection Bags No. 4 and No. 8	Geological Samples	Flight No. 1 or No. 2	May be used as required on any of the three EVA's. Bags containing large rocks and sample overflow are to be divided equally between the two flights.
• Sample Return Bag (BSLSS Sample Bag or "Large Rock Bag")	Geological Samples		Contains sample overflow from each of the three EVA's especially extra large samples as "football-size" rocks.
• Padded Bag Rock Samples*	2	Flight No. 1 or No. 2	Sample return stowage and containers are TBD.
• Surface Samples*	2		Collected in Surface Sampler Device

*Being considered for Apollo 17

Table 5-1. J-3 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Contingency Soil Sample	1	Flight No. 1 (if obtained)	Will be obtained only if lunar surface stay time and corresponding EVA period is foreshortened to the extent that a documented sample cannot be acquired. Sample to be scooped up with a DSB and then restowed in a suitable container.
• CM Data Recorder Reproducer Tape	1	Remove from CM upon receipt at LRL	The data recorder reproducer tape is the only record of telemetry transmissions during CM reentry.
• DSEA Tape From LM	1	Flight No. 2	The DSEA is hermatically sealed. The complete unit must be returned from the LM. At recovery, the unit must be placed in a magnetic-shielded container for shipment to the LRL.

Table 5-1. J-3 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Magazine/Cassettes from following camera systems:		Flight No. 1 or No. 2	The film magazines and cassettes will be placed in specially constructed containers at the recovery zone and then returned to EAFB. The total number of magazines and cassettes returned, except as noted, will be divided equally between the two flights and will remain in the custody of the Photographic Technology Division (PTD) couriers until arrival at MSC. All film data will be processed through bonded storage before being released to the PTD for development.
• 16-mm Data Acquisition Camera (Maurer)	18* Magazines		
• 70-mm Hasselblad Electric Data Camera (With Reseau)	12* Magazines		
• 70-mm Hasselblad Electric Camera	6* Magazines 18* Magazines (Total)		
• 35-mm Nikon Camera	4* Cassettes		
• 3-Inch Mapping Camera	1** Cassette	Determined at time of CM recovery.	
• 24-Inch Panoramic Camera	1 Cassette		

*Indicated magazine/cassettes contain imagery data supporting other J-3 Mission operational tests and detailed objectives as well as those imagery data related to science objectives and science support activities.

**Cassette contains 1 roll of 5-inch metric camera film and 1 roll of 35-mm stellar camera film.

Table 5-1. J-3 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Astronaut Flight Logs	-	Flight No. 1 with the astronauts.	Flight logs contain information vital to the interpretation and analysis of lunar surface activities as well as information related to mission operations and other mission objectives. Transcripts of the flight logs should be made available as quickly as possible after return to MSC.
• Film Magazine from Lunar Sounder Optical Recorder	1 Magazine	Flight No. 1	
• Recorder and Tape from Surface Electrical Properties Experiment	1	TBD	

SECTION VI

LUNAR RECEIVING LABORATORY PLAN

6.1 GENERAL

This section was provided by the Lunar Receiving Laboratory (LRL)/TL. It defines requirements of the LRL as related to the preliminary examination, preparation, processing, and documentation of lunar samples returned from the Apollo J-3 Mission. Also included are requirements stipulating curator inventory control procedures, contamination avoidance safeguards and monitoring procedures, reporting of sample processing status, and security measures to be employed.

Requirements presented in this section are provided for experiment Principal Investigators (PI), members of the scientific community, and for personnel responsible for lunar sample operations in the LRL. Reference should be made to appropriate documents for detailed data. Such documents include the Lunar Receiving Laboratory Mission Plan (Reference 16) and an array of LRL procedural documents.

6.2 SCOPE

This section defines those requirements which the LRL must meet for a successful preliminary sample examination prior to sample distribution. The samples are then routed to the sample investigation teams for the conduct of more detailed and exhaustive examinations and experiments. It addresses only those laboratory objectives pertaining to the physical characterization of the lunar sample, preparation of the sample and derivative subsamples, its long-term protection and storage, and the conduct of time-critical experiments.

These requirements are binding upon the LRL and the Lunar Samples Preliminary Examination Team (LSPET) unless defined in terms of target objectives. To illustrate, minimum levels of contamination, an example of a target objective, will be sought but cannot be guaranteed.

6.3 PRELIMINARY EXAMINATION

6.3.1 PURPOSE

The preliminary examination is intended to gain a general understanding of the materials returned from the moon. This should

a) Provide the basic information by which samples can be distributed for intensive scientific study according to a plan developed by the LSAPT.

b) Provide a basic catalog of lunar samples and a summary of analytical data that scientific investigators need to carry out and interpret their research.

c) Provide a summary description for the scientific public-at-large.

The preliminary examination period is also used to

a) Provide the basic inventory of lunar materials from each mission.

b) Perform certain time-critical experiments such as measurements of short-lived radioactivity.

c) Perform certain experiments that can only be conducted in the sequence of preliminary examination procedures, such as determining the composition of gases in an Apollo Lunar Sample Return Container (ALSRC).

d) Perform experiments that depend on examining whole rock surfaces, such as photometric measurements supporting the Lunar Geology Investigation Experiment and surface-impact pit counting.

e) Prepare certain samples for rapid distribution to Principal Investigators.

6.3.2 SURFACE TRAVERSE INFORMATION

6.3.2.1 Real-Time Analysis

Members of the Preliminary Examination Team (PET) will watch and listen to the surface traverses as they proceed. They will be responsible for preparing

a) A preliminary traverse map

b) A preliminary inventory of samples

c) An annotated transcript of surface activities.

d) A list of the contents of each individual Sample Return Container (SRC).

e) A list of priorities for the order of processing of films depicting surface activity.

The PET will also identify useful still pictures to be produced from video tapes and provide early photographic data reductions.

6.3.2.2 Surface Photography

Surface photography will be returned immediately to the Photographic Laboratory and developed on a rush basis with three sets of 8- x 10-inch photographs to be transmitted immediately to the PET. The PET will be responsible for

a) Assembling panoramic photographs.

b) Associating photographic sites with the traverse map.

c) Identifying rocks that are "documented".

d) Making comparisons with TV and voice coverage.

e) Establishing a sequence of lunar surface activities that can be used as a basis for debriefing the crew.

6.3.2.3 Crew Debriefing

The crew will be debriefed by a small group of the PET as the sample collection bags are processed. The purpose of debriefing is to consolidate as much of the information as can be gained by association with the surface photography used in the debriefing. The debriefing may also include reruns of the video tapes.

6.3.3 PRELIMINARY DESCRIPTION PHASING

6.3.3.1 Container Opening

The two ALSRC's will be processed in the Sterile Nitrogen Atmosphere Processing (SNAP) line. If the ALSRC's have held a vacuum, they may be punctured for the gas analysis experiment. The core tubes will be removed and loaded into stretch cans and stored for later analysis.

Individual documented rocks and fines will be inventoried and processed according to operating procedures in the SNAP and Non-Sterile Nitrogen Processing Line (NNPL) processing lines.

Each sample collection bag (SCB) will be processed in the NNPL, unless a special circumstance exists that makes their processing in the SNAP line more desirable.

6.3.3.2 Inventory

An inventory photograph, weight, and brief description will be made as each rock or fines sample is unpacked.

6.3.3.3 Dusting

Rocks will be dusted by nitrogen jets prior to taking the documentary photograph.

6.3.3.4 Orthogonal Photography

A set of six orthogonal color photographs will be taken as soon as rocks are dusted off. These photographs will be used to assist in the early sample description phases. All photographs will be processed in the MSC Photographic Laboratory.

6.3.3.5 Models

Aluminum shells will be made of all suitable rocks at an early convenient time, probably concurrent with the photographic activity.

6.3.3.6 Macroscopic Descriptions

Macroscopic descriptions will be made in the processing line only when photographs have been received (expected to be two days after orthogonal photographs are taken). Procedures to be used are described in the SNAP line and NNPL documents.

6.3.3.7 Documentary Photography

A full set of 32 black and white and 6 color documentary photographs will be taken of each rock weighing greater than 50 grams. Reduced photographic coverage will be obtained on smaller rocks. All photographs will be processed in the MSC Photographic Laboratory.

6.3.3.8 Lunar Location and Orientation

Sample location should be determined primarily from surface documentation. Priority for early sample work will be given to those rocks for which surface locations are unknown, but which may be shown in some of the lunar surface photographs. The Lunar Geology Investigation Experiment Team will attempt to determine surface orientations by comparison of lunar surface photography with rocks viewed in the laboratory.

6.3.3.9 Additional Analyses

When sufficient rocks have been described to establish the general nature of the return, and the lunar location and orientation data are known, the PET will present a summary geologic map and rock description to the LSAPT. On the basis of this presentation, a number of samples may be selected for chipping, for thin section preparation, and for chemical or other analyses.

6.3.3.10 PI Experiments

The PI experiments listed below will be carried out as they can be conveniently worked into the sample processing schedule. They will be conducted according to their priorities for rapid access to sample.

a) Short-lived radioactive gases; R. Davis

b) Rock surface examination; D. Morrison, F. Horz, and J. Hartung

c) Rock location and orientation; geology investigation teams

6.3.3.11 LSAPT Interaction

Data will be submitted to the LSAPT in a coherent form as it is developed. These data will consist of:

a) Rock descriptions; a summary of the surface features, gross morphology, and the petrography (where available) of each rock.

b) Chemical and other analyses as they become available.

c) Photographs; a set of six color photographs of each rock. The complete stereo sets will be transmitted to the curator for use by the LSAPT.

d) Anomalies in the operation of the processing line.

e) Summary descriptions made, as required, by the PET and LSAPT.

After rock descriptions are completed, the LSAPT will prepare the sample allocation plan and submit it to NASA management for approval.

6.4 SAMPLE PROCESSING

Specific operating procedures for sample inventory processing and analyses are found in appropriate procedures documents.

Most specific decisions to perform analyses during the preliminary examination period are made in real time. Specific requirements suggested by the LSAPT, the LSPET, or the curator, are considered as sample allocations are made, and will be approved by the curator, with the advice and approval of the LSAPT.

6.4.1 INBOUND REQUIREMENTS FOR LUNAR SAMPLES

The ALSRC's and SCB's in the command module will be placed in Teflon bags and sealed by Landing and Recovery Division personnel aboard the recovery carrier. These seals are not to be broken until the containers have been entered into the appropriate nitrogen processing line.

6.4.2 PROCESSING STEPS

A generalized sample and data flow diagram for the preliminary examination is delineated in Figure 6-1.

All returned samples will be numbered, weighed, described, and photographed. Portions of selected samples will be taken for detailed analysis.

After a split of unsieved fines is removed from each fines sample and stored as an uncontaminated reserve, the remaining material will be sieved on a 1-centimeter sieve.

Fines samples will be further separated into fractions of less than 1 mm, 1 to 2 mm, 2 to 4 mm, and 4 to 10 mm. These fractions will be given individual sample numbers.

Each fragment retained on a 1-centimeter sieve will constitute a unique sample.

Each unique sample will be assigned a separate number and canned separately with a numbered tag placed inside the can; the number tag will be identical to the last three digits of the sample number.

Complete photographic records will be obtained on each rock sample greater than 50 grams. An abbreviated sequence will be taken on each smaller rock and on all groups of coarse fines.

Samples of fines having a volume greater than approximately 250 cubic centimeters will be split as soon as possible into fractions of less than 250 cubic centimeters and stored separately.

Rocks will be chipped in accordance with a chipping plan to be prepared after initial descriptions are available. Chipping will be carried out in such a way that fragments will not be scattered and lose their genealogy. Rock chipping will be documented to clearly show the orientation and location of the chip with respect to the main rock.

Models will be made of all rocks with a mass greater than 50 grams, unless the rocks are fragile or have unique or damageable features.

Each core tube will be considered a separate sample. X-rays will be obtained of each core prior to opening.

Each Special Environment Sample Container (SESC) will be separately numbered, canned, and stored until it can be transferred to an appropriate sampling facility.

6.5 OPERATING CONDITIONS

6.5.1 GENERAL

The SNAP line and NNPL cabinets, tools, and containers in which lunar samples are processed are constructed primarily of stainless steel, aluminum, and Teflon. Samples shall not be contacted by any other material.

Every possible effort will be made to assure that sample processing areas are clean. Tools, containers, and outbound sample return containers will be given special attention. Known sources of contaminants will be removed where possible and characterized where removal is not possible. All cabinets will be precleaned to level CP-2 and all tools to level CP-7, as described in MSC 03243.

Introduction into the processing cabinetry of materials cleaned to lower levels can be done only by waiver. A complete record will be developed of materials which come in contact with the lunar sample and which could be sources of contamination.

Sample handling should minimize the diffusion of material to mixed states and avoid cross contamination of samples. Rocks will be handled with extreme care to minimize surface abrasion. Dust will be removed by blowing or vacuuming, not by brushing. If several fines fractions are to be split from the same source sample, coarse fractions will be split before fine fractions.

6.5.2 SAMPLE INVENTORY, TRACKING, AND CONTROL

The disposition of material according to size will be

a) Samples greater than 50 grams in weight will be designated as rocks, given unique numbers, and subjected to full inventory, photographic, and descriptive treatment.

b) Samples retained on a 1-centimeter screen by less than 50 grams in weight will be individually numbered, tracked, canned, and inventoried but not given full photographic and descriptive treatment.

c) Material between 1 mm and 1 centimeter in size will be designated as coarse fines and further separated according to sizes of 1 to 2 mm, 2 to 4 mm, and 4 to 10 mm. Each size range (from each bag or box) will be numbered, inventoried, and canned separately.

d) Material less than 1 mm in size will be designated as fine fines and that fraction from each bag or box will be numbered, inventoried, and canned separately.

Numbering will be in accordance with a predesignated block scheme established by the curator.

Inventory activity will include the assignment of a number and the acquisition of a photograph simultaneously showing the sample, its number, and weight.

All items such as core tubes, bits, SESC's, etc., will be numbered and weighed.

A data package will be prepared for each separate sample (each unique generic number). This data package will accompany the sample and include the full treatment accorded to that sample.

Trackings of samples will be recorded in three ways. Every transaction will be recorded in the Preliminary Analysis Computation Retrieval and Transmission (PACRAT) computer system (MSC 03287), in hardcopy of the PACRAT operator's log, and on the sample status board. Transfers from one processing area to another will require prior approval of the curator and Chairman of the PET and also be subject to normal transfer procedures with sign-off by delivering and receiving Area Test Directors on the Lunar Sample Custody Transfer Form. The curator must approve all sample transfer forms.

A printout of the contents of each cabinet, according to PACRAT, will be made each day. A daily inventory check against the PACRAT listing will be performed to verify the location of samples in the cabinet lines.

At the end of the preliminary examination, a full inventory will be made and all samples and data packages turned over to the curator. Any remaining sample from biological characterization will be returned to the curator.

6.6 CONTAMINATION MONITORING

6.6.1 ORGANIC CONTROL SAMPLES

Two pieces of Yorkmesh (organic control samples) will be provided with each SRC and both will be subjected to F-250 processing. One will be retained and the other taken to the moon and back in the SRC.

Analysis of portions will be performed. Additional Yorkmesh monitors cleaned along with SRC components will be available for distribution as needed.

6.6.2 ORGANIC CONTAMINATION

The level of organic contamination will be determined by measuring the amount of organic material remaining in the final flush solution resulting from cabinet cleaning. No monitors will be exposed during sample processing. Known sources of organic contamination will be analyzed. During the mission, samples of N_2 will be bubbled through an organic solvent, which will subsequently be analyzed by gas chromatography.

6.6.3 GAS MONITORING

Periodic monitoring of inlet N_2 (from supply truck) will be performed by the Gas Analysis Laboratory.

The N_2 environment of the cabinets in which samples are handled (SNAP line and NNPL) will be monitored for

a) Moisture (alumina sensor)

b) Oxygen (paramagnetic meter)

c) CO, CO_2, Ar, O_2, H_2, and methane (CH_4) (gas chromatography).

The target level of contamination by each of these gases during sample operations is given in Reference 16. A permanent record will be obtained on the level of contaminants in each processing area.

6.6.4 PARTICULATE MONITORING

The nature and size distribution of particulate matter in the sample processing areas will be monitored and samples will be taken for a permanent reference. After cabinet cleaning, and prior to and following operations, particle size distribution will be measured using a Royco or πCM particle counter. Prior to introduction of lunar samples, fallout coupons will be exposed in the cabinets. One set of these coupons will be preserved for a permanent record. The other set will be analyzed by microscopy and microbe techniques in the LRL or at the White Sands Test Facilities (WSTF).

6.7 DATA ACQUISITION, FLOW, AND DISTRIBUTION

All data and photographs will be acquired according to the procedures specified for the various laboratories. All film, hardcopy, photographs, copies of data packages, operational records, etc., will be transferred regularly to the Data Control Room. Copies and distribution will be made only from the Data Control Room and in strict accordance with MSC 03288, Operating Procedures for Data and Photo Control.

6.7.1 REPORTING

6.7.1.1 PET Results

Results of the preliminary examination will be reported as follows:

a) Weekly summary reports.

b) Periodic summary reports for management levels at MSC and NASA Headquarters.

c) A summary report on the entire examination for publication in a scientific journal.

d) Briefings to the LSAPT as required for proper understanding of the results and as an aid to sample allocation.

e) Scientific results briefing by the PET when significant amounts of data are available to warrant it. This would be at the discretion of the PET Vice-Chairman.

6.7.1.2 Contamination Control Report

A comprehensive report on the results of contamination monitoring will be prepared following the mission.

6.7.1.3 Sample Catalog

A complete catalog of the samples including descriptions, photographs, and attendant analyses will be published following the mission.

6.7.1.4 LRL Mission Reports

A daily LRL status and progress report will be prepared and distributed to MSC management and other interested parties, during the first 15 days of peak mission operations.

6.8 MISSION SECURITY OPERATIONS

A security guard station will be established in the Airlock, Room 174, to control access, by access list, to the Sample Operations Area. All other accesses to the area will be secured and only opened under emergency conditions. The station will be manned 24 hours/7 days per week until all lunar samples have been transferred to the Sample Packaging Facility for secure storage.

6.9 LUNAR GEOLOGY INVESTIGATION EXPERIMENT INTERFACE

The PET members of the Lunar Geology Investigation Experiment will examine models and actual lunar rocks to determine surface orientation and location. Models will be handled solely in the Building 250 trailer complex. Actual rocks may be examined either in the SNAP line or in the NNPL.

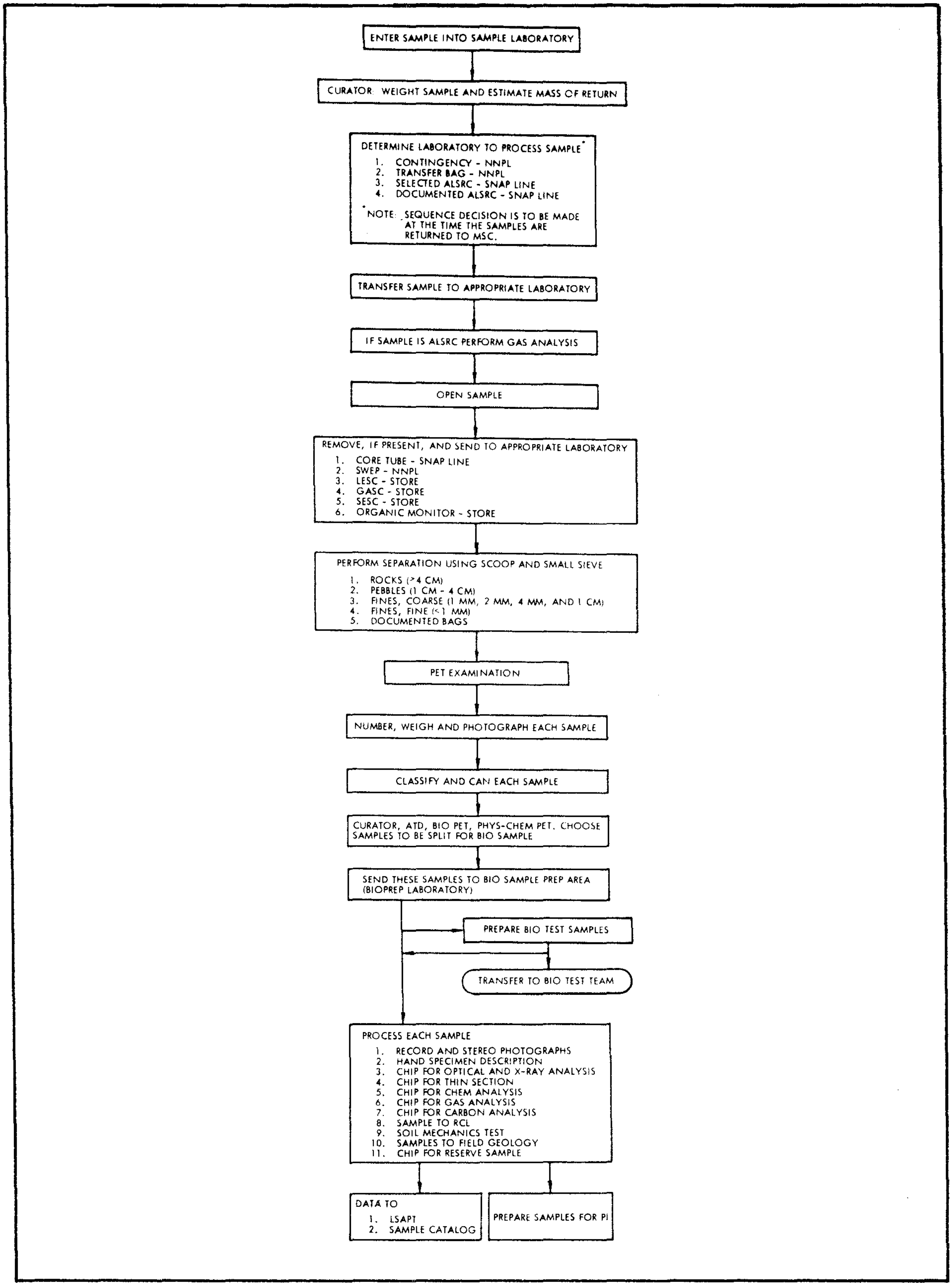


Figure 6-1. General Sample Flow Diagram

APPENDIX A

ACRONYMS AND ABBREVIATIONS

Å	Angstrom Unit (1×10^{-10}m)
ac	Alternating Current
ACTR	Actuator
AEC	Automatic Exposure Control
AFMA	Apollo Flight Mission Assignments
ALSD	Apollo Lunar Surface Drill
ALSEP	Apollo Lunar Surface Experiments Package
ALHT	Apollo Lunar Hand Tools
ALSRC	Apollo Lunar Sample Return Container (also called SRC)
AM	Amplitude Modulated
AMU	Atomic Mass Unit
APO	Apollo Program Office
Ar	Argon
ASA	American Standards Association
ASPO	Apollo Spacecraft Program Office
ASSY	Assembly
ATD	Area Test Director
BSLSS	Buddy Secondary Life Support System
BW	Black and White
C	Centigrade
CCB	Configuration Control Board
CDR	Commander

CEX	Color Exterior
℄	Center Line
CM	Command Module
cm	Centimeter
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
C/S	ALSEP Central Station
CSAR	Coherent Synthetic Aperture Radar
CSM	Command and Service Module
CSVC	Core Sample Vacuum Container
DAC	Data Acquisition Camera
Decl.	Declination (measured in celestial coordinates)
DIA	Diameter
DO	Detailed Objective
DOI	Descent Orbit Insertion
DPS	Descent Propulsion System
DSEA	Data Storage Electronics Assembly
E	East
EAFB	Ellington Air Force Base
EMI	Electromagnetic Interference
EP	Explosive Package
EVA	Extravehicular Activity
Ex	Example

f	Camera Aperture Opening Reference (also T)
FMC	Forward Motion Compensation
FOV	Field of View
FWD	Forward
GASC	Gas Analysis Sample Container
GCTA	Ground-Commanded Television Assembly
GEOPH	Geophone
GET	Ground Elapsed Time
gm	Gram
GN_2	Gaseous Nitrogen
H_2	Hydrogen
HBW	High-Speed Black and White
HCEX	High-Speed Color Exterior
HD	Highly Desirable
HEC	Hasselblad Electric Camera
HEDC	Hasselblad Electric Data Camera
HF	High Frequency
HFE	Heat Flow Experiment
HFE	Heat Flow Electronics
hr	Hour
ID	Identification
IMC	Image Motion Compensation

IR	Infrared
ISR	Infrared Scanning Radiometer
IU	Instrument Unit
JPL	Jet Propulsion Laboratory
K	Kelvin
K	Potassium
keV	One Thousand Electron Volts
kg	Kilogram
km	Kilometer
KSC	Kennedy Space Center
LACE	Lunar Atmospheric Composition Experiment
LBW	Low-Speed Black and White
LCRU	Lunar Communications Relay Unit
LDAC	Lunar Surface 16-mm Data Acquisition Camera
LEAM	Lunar Ejecta and Meteorites (Experiment)
LESC	Lunar Environment Sample Container
LM	Lunar Module
LMP	Lunar Module Pilot
LOI	Lunar Orbit Insertion
LRL	Lunar Receiving Laboratory
LRV	Lunar Roving Vehicle
LSAPT	Lunar Samples Analysis and Planning Team

LSG	Lunar Surface Gravimeter
LSP	Lunar Seismic Profiling
LSPE	Lunar Seismic Profiling Experiment
m	Meter, milli
M	Mandatory
MAX	Maximum
MC	Mapping Camera
MCC	Mission Control Center
MESA	Modularized Equipment Stowage Assembly
MeV	One Million Electron Volts
MHz	Megahertz
MIN	Minimum
min	Minute
MIP	Mission Implementation Plan
mm	Millimeter
MRD	Mission Requirements Document
MSC	Manned Spacecraft Center
MSFEB	Manned Space Flight Experiments Board
MSFN	Manned Space Flight Network
MSPD	Mission Science Planning Document
N	North
N_2	Nitrogen
N/A	Not Applicable

NM	Nautical Mile
NNPL	Nonsterile Nitrogen Processing Line
No.	Number
NW	Northwest
O_2	Oxygen
OMSF	Office of Manned Space Flight
OSSA	Office of Space Science and Application
PACRAT	Preliminary Analysis Computation Retrieval and Transmission
PC	Panoramic Camera
PDU	Power Distribution Unit
PET	Preliminary Examination Team
PI	Principal Investigator
PKG	Package
PLSS	Portable Life Support System
PM	Pulse Modulated
ppm	Parts Per Million
PSCB	Padded Sample Collection Bag
PTD	Photographic Technology Division
PWR	Power
R. Asc.	Right Ascension (measured in celestial coordinates)
RCA	Radio Corporation of America
RCL	Radiation Counting Laboratory

RCS	Reaction Control System
REV	Revolution
RH	Right Hand
RTG	Radioisotope Thermoelectric Generator
S	South
SA	Saturn Apollo
S&AD	Science and Applications Directorate
SC	Stellar Camera
S/C	Spacecraft
SCB	Sample Collection Bag
SE	Southeast
SEP	Surface Electrical Properties Experiment
sec	Second
SESC	Special Environmental Sample Container
SEQ	Scientific Equipment Bay
SIM	Scientific Instrument Module
SLA	Spacecraft LM Adapter
SM	Service Module
SNAP	Sterile Nitrogen Atmosphere Processing (Line)
SO	Special Order
SPS	Service Propulsion System
SRC	Sample Return Container (also known as ALSRC)
SSD	Surface Sampler Device
SSW	South by Southwest
SW	Southwest

SW	Switch
SWEP	Solar Wind Experiment Package
T	Camera Aperture Opening Reference (also f)
TBD	To Be Determined
TEC	Transearth Coast
TEI	Transearth Injection
TGE	Traverse Gravimeter Experiment
TH	Thorium
TV	Television
U	Uranium
UHT	Universal Hand Tool
USGS	United States Geological Survey
UTD	University of Texas at Dallas
UV	Ultraviolet
V/h	Velocity-to-Height
VHBW	Very High-Speed Black and White
VHF	Very High Frequency
VSA	Vertical Sensing Assembly
W	West
WSTF	White Sands Test Facility
X_S	SM Station Designation

h	Hour (superscript)
m	Minute (superscript)
°	Degrees
35	35-mm Nikon Camera
≥	Greater Than or Equal To
<	Less Than
∞	"Infinite" focus distance

APPENDIX B

GLOSSARY

ALBEDO	The amount of electromagnetic radiation reflected by a body expressed as a percentage of the radiation incident on the body, commonly used with reference to the relative brightness of a body or geologic structure.
ANGSTROM UNIT	A unit of length equal to 10^{-10} meters or 10^{-4} microns commonly used in specifying wavelengths of electromagnetic radiation.
APERTURE	A small opening such as a camera shutter through which light rays pass to expose film when the shutter is open.
ATTENUATION	Decrease in intensity usually of wave phenomena such as light or sound.
BASEMENT	A compact, firm rock underlying less firmly consolidated earth (or lunar) materials.
BOLOMETER	A very sensitive resistance thermometer used in the detection of weak thermal radiation, especially adapted to the study of infrared spectra.
BRECCIA	A coarse-grained clastic rock (rocks formed of fragments of pre-existing rocks).
CARTOGRAPHIC	Related to the production of accurately scaled maps as of the moon's surface.
CASSETTE	Container of photographic film as from the 24-Inch Panoramic Camera or 3-Inch Mapping Camera.
CHIRP GENERATOR	A device for producing pulses of electromagnetic radiation, each pulse consisting of a sweep over a preset frequency range. (Lunar Sounder Experiment)
CISLUNAR	Pertaining to the space between the earth and moon or the moon's orbit.
COHERENT SYNTHETIC APERTURE RADAR (CSAR)	A generator of phase-controlled radar pulses (either HF or VHF range) with aperture control provided by the motion of the spacecraft past the lunar surface. (Lunar Sounder Experiment)
COLORIMETRIC	Pertaining to the measurement of the intensities of different colors as of lunar surface materials.

CONVERGENCE ANGLE	Angle between the lines of sight from two photographic stations to the photographed subject. The merging of these separate photographs results in stereoscopic imagery of the subject.
CROSS-SUN	A direction approximately 90 degrees to the solar vector, used in specifying lunar surface photography requirements.
CROSS-TRACK	In a plane perpendicular to the instantaneous direction of a spacecraft's ground track.
DIELECTRIC CONSTANT	A measure of the tendency of an insulating (dielectric) medium such as the lunar crust to resist an external electric field by polarization of the electric charge within the dielectric medium. (Lunar Sounder and SEP Experiments)
DIFFUSE DENSITY	The degree of darkening of a photographic film approximately proportional to the mass of metallic silver per unit area.
DIPOLE ANTENNA	A deployable (80 foot length) antenna used for the transmission and receiving of the HF signals for the Lunar Sounder Experiment.
DOPPLER TRACKING	A continuous-wave, trajectory-measuring system using the doppler effect caused by a target moving relative to a ground transmitter and receiving stations.
DOWN-SUN	In the same direction as the solar vector and used in specifying lunar surface photography requirements.
EARTHSHINE	Illumination of the moon's surface by sunlight reflected from the earth.
EBERT SPECTROMETER	A device which disperses electromagnetic radiation by reflection of a fixed radiation beam from a rotatable diffraction grating. (Far UV Spectrometer)
ECLIPTIC PLANE	The plane defined by the earth's orbit about the sun.
EFFLUENT	Any liquid or gaseous substance discharged from the spacecraft such as waste water, urine, fuel cell purge products, etc.
EJECTA	Lunar material thrown out (as resulting from meteoroid impact of volcanic action).

EXOSPHERE	Outer fringe region of the atmosphere.
EXPOSURE	The product of illumination (luminous flux per unit area) and the time interval during which a photographic film is subjected to the illumination.
FAR UV	The region of the UV radiation spectrum lying between 2000 Å and 400 Å (border of X-ray region).
FIELD	A region or space in which a given effect (e.g., force) exists such as a magnetic or gravity field. Such an effect is usually expressed in scalar form although the vector form is required for analyses performed with respect to a coordinate system.
FIELD OF VIEW	The capture area locus of electromagnetic radiation referenced to the opening of a sensor element within which the sensor can efficiently detect and register such radiation on a recording device. Usually expressed in degrees and most commonly used with reference to the imagery area in space "seen" by the lens of an optical instrument such as a camera.
FILLET	Debris (soil) piled up against rock is called a fillet.
FLUORESCENCE	Emission of radiant energy is response to the absorption of radiant energy at a different wavelength.
FLUX	The rate of transfer of particles, or energy across a given surface.
GALACTIC	Pertaining to a galaxy in the universe such as the Milky Way.
GAMMA	The average slope of the diffuse density versus the relative $\log_{10}$ exposure curve (see Appendix E) used in specifying photographic film processing requirements.
GENEALOGY	The history of the origin, formation, and subsequent changes incurred in a particular lunar sample.
GEODESY	The science which deals mathematically with the exact size and shape of the earth and other planets, the planet's external gravity field, and with surveys of such precision that overall size and shape of the earth or planet must be taken into consideration.

GEOPHONE	A small detection device implanted in the lunar surface during the deployment of the LSPE to record subsurface transmissions of seismic energy from artificial and natural sources.
GEOPHYSICAL	Pertaining to the physics of the earth, moon, and other planetary bodies, as well as their surrounding environment.
GNOMON	A rod pivoted about a free bearing that is used on the lunar surface to indicate the local vertical, to give sun position, and to serve as a distance scale when photographing lunar samples "in situ". Color and reflectance scales are provided on the rod and on one leg of the gnomon for a colorimetric reference.
GRADIENT	The spatial rate of change of a function. For example, the change in local lunar surface magnetic field strength with distance (as from the LM).
GRANITIC	Having the characteristics of granite rock.
GROUND STATE RESONANCE LINE	The atomic transition (either absorption or radiation) between the ground state and the first excited state of an atom.
IGNEOUS ROCK	Rock formed from molten material as from volcanic processes.
IMBRIAN AGE	The oldest of the four major lunar time-stratigraphic units is called the Imbrian System. The Imbrian Age represents the period during which the Imbrian System developed, that is, a very short interval of time during the formation of the Imbrium Basin.
IN SITU	In place or natural locale.
J-3 MISSION	The third mission of a class of Apollo missions (J-series) in the Apollo Program providing the capability for extended lunar surface staytimes, longer mission duration, improved surface mobility and communications, more extensive surface science experiments and exploration, and an orbital science payload package (SIM).

KINESCOPE	A motion picture made from a television camera sequence.
LIBRATION POINT	One of five theoretical locations in space of the rotating earth-moon system where the gravitational attraction forces of the moon and earth are equal. It is believed that interplanetary dust and other forms of particulate matter collect at these points and that reflected sunlight from these particles can indicate their presence either by direct observation or by photographic imagery.
LIMB	The outer edge of the apparent disc of a celestial body, as the moon or earth, or a portion of the edge.
LITHOLOGY	The character of a rock formation.
LUNATION	The interval between two successive passages of the moon through conjunction or opposition respectively; therefore, the period of the moon phases.
MAGMATIC	Pertaining to molten material or mass from which igneous rock results by cooling and crystallization.
MAGNETIC PERMEABILITY	The property of a magnetizable substance that determines the degree in which it modifies the magnetic flux in the region occupied by it in a magnetic field.
MARE	A large dark flat area on the lunar surface (Lunar Sea).
MARIA	Plural form of mare.
MASCONS	Large mass concentrations beneath the surface of the moon that affect the gravity measurements of the lunar surface.
MASSIF	A principal mountain mass; a block of the earth or lunar crust bounded by faults or flexures and displaced as a unit without internal change.
MASS SPECTROMETER	An instrument which differentiates chemical species in terms of their different isotopic masses.
METEORITIC	Pertaining to material apparently originating from meteoroids.

METRIC PHOTOGRAPHY	Recording of surface topography by means of photography, together with an appropriate network of coordinates, to form the basis of accurate measurements and reference points for precise photographic mapping.
MICROSCOPIC	Of such a size as to be observed, if at all, only under optical magnification.
MORPHOLOGY	The external structure of rocks in relation to the development of erosional forms or topographic features.
NADIR	That point on the earth (or moon) vertically below the observer.
NONFRIABLE ROCK	Rock that is not easily crumbled or pulverized.
OCCULTATION	The shutting off of the light of one celestial body by the intervention of another as the eclipse of a star or planet by the moon.
PANORAMA	Lunar surface photographs taken from a point to portray lunar surface features 360 degrees around that point.
PARALLAX	The apparent displacement of an object as seen from two different points not on a straight line with the object.
PETROGRAPHY	Systematic description of rocks based on observations in the field (e.g., on the moon), on returned specimens, and on thin microscopic sections.
POLARIMETRIC	Referring to the measurement of the intensity of polarized light in a partially polarized light beam or the measurement of the extent of polarization.
POSIGRADE	Lunar orbital motion in the direction of lunar rotation.
PYROCLASTIC DETRITUS	Material formed by fragmentation as a result of volcanic or igneous action.
RAY	Bright material extending radially outward from fresh lunar craters that is composed of ejecta from the formation of the crater.

REGOLITH	The unconsolidated residual material that resides on the solid surface of the moon (or earth).
RESEAU	A system of lines (small "crosses") forming small squares of standard size that is photographed by a separate exposure on the same film with the particular image photographed so as to facilitate the measurement of distances.
RESONANCE RERADIATION	Radiation by an atom of energy which was previously absorbed, and at a frequency identical to that of absorption.
RETROGRADE	Lunar orbital motion opposite the direction of lunar rotation.
S-BAND	A frequency band used in radar and communications extending from 2.00 to 4.00 kilomegahertz.
SCALE HEIGHT	The height above the lunar surface at which the density of an individual atmospheric species is reduced to 1/e of its value at the surface.
SCARP	A line of cliffs produced by faulting or erosion.
SCATTERING CENTERS	Accumulations or concentrations of materials within the moon that strongly reflect radar waves.
SEISMIC	Related to mechanical vibration within the surface of the earth or moon resulting from, for example, impact of meteoroids on the surface.
SENSITOMETRIC	Pertaining to the measurement of the light response characteristics of photographic film under controlled conditions of exposure and development.
SHOCKED ROCKS	Rocks which have been formed by or subjected to the extremes of temperature and pressure present during major lunar evolutionary events.
SIDELAP	Overlap of two aerial photographic strips in a direction perpendicular to the length of the strips.
SOLAR CORONA	A halo, pearly white in color, surrounding the sun; its full extent can be seen during a total solar eclipse.

SPATIAL	Pertaining to the location of points referenced to three-dimensional space as contrasted with temporal (pertaining to time) locations.
SPECTROMETER	An instrument which disperses radiation into energy bands (or, in a mass spectrometer, particles into mass groups) and indicates the flux in each band or group.
SPECTROSCOPIC	Referring to measurements made with a spectrometer.
SPECTRUM	The totality of wavelengths (or frequencies) of electromagnetic radiation.
STELLAR	Of or pertaining to stars. The stellar camera composing a part of the 3-Inch Mapping Camera is used to photograph star fields for use in establishing a precision spacecraft attitude reference to provide postmission camera pointing data.
STEREO	A type of photography in which photographs taken of the same subject area from different angles are combined to produce visible features in three-dimensional relief.
STRATIGRAPHIC	Relating to geology that deals with the origin, composition, distribution, and succession of strata.
TALKBACK DISPLAY	A CM crew cue display associated typically with an event or operation activity which exhibits a striped or "barber pole" color scheme format during the execution of the event or activity and a grey color when the event or activity has been properly completed.
TECTONIC	Geological structure features as a whole.
TEKTITE	Glassy bodies of probable meteoritic origin and of rounded but indefinite shape that are found in various places on the earth.
TEMPORAL	Referring to the passage or measurement of time.
TERMINATOR	The line separating the illuminated and the darkened areas of a body such as the earth or moon which is not self-luminous.

TERRA	Those portions of the lunar surface other than the maria; the lighter areas of the moon.
THERMISTOR	Electrical resistor made of material whose resistance varies sharply in a known manner with the temperature.
TIDAL	Referring to the seismic movement of layers forming the outer portion of the lunar surface or within the lunar mantle as a result of the gravitational attraction of the earth and other planetary bodies. Similar in nature to the tidal movements of the earth's oceans.
TIMELINE	A detailed schedule of astronaut or mission activities indicating the activity and time at which it is to occur within the mission.
TOPOGRAPHIC	Pertaining to the accurate graphical description, usually on maps or charts, of the physical features of an area on the earth or moon.
TRANSEARTH	During transit from the moon to the earth..
TRANSIENT	An initial, short-lived effect preceding the obtainment of operating equilibrium of a system. For example, the initial current surge that occurs when an electrical system is energized.
TRANSLUNAR	During transit from the earth to the moon
TRANSPONDER	A combined receiver and transmitter whose function is to transmit signals automatically when triggered by an interrogator.
UMBRA	The dark central portion of the shadow of a large body such as the earth or moon.
UP-SUN	Into the direction of the solar vector, used in specifying lunar surface photography requirements.
VECTOR	A physical quantity requiring both magnitude and direction for its specification, as magnetic force field and spacecraft velocity vectors.
WAVELENGTH	The distance between maxima (or minima) of a periodic phenomenon such as an electromagnetic wave.

YAGI ANTENNA — A highly directional and selective shortwave antenna used to transmit and receive the VHF signals for the Lunar Sounder Experiment.

ZERO PHASE — A photographic orientation in which the camera, subject, and sun are coplanar with the camera between the sun and the subject.

ZODIACAL LIGHT — A faint glow extending around the entire zodiac but showing most prominently in the neighborhood of the sun. (It may be seen in the west after twilight and in the east before dawn as a diffuse glow. The glow may be sunlight reflected from a great number of particles of meteoritic size in or near the ecliptic in the planetoid belt.)

APPENDIX C

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APPENDIX D

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NOTES TO APPENDIX E

1. The density-log exposure (D-log E) curves presented in this appendix describe the results of a specific set of processing conditions for a specific emulsion batch. Because of changes in characteristics between different batches of emulsion, and because of changes in available film-development chemistries and hardware, it is not possible to provide on a current basis curves which specify detailed capabilities of the PTD. The D-log E curves in this appendix reflect general sensitometric data from the film supplier or data derived in establishing development controls for previous Apollo flight films. These curves are not intended to specify particular development processes for flight films, but are included for the purpose of facilitating communication between scientific investigators and the PTD in order to determine optimum film types and processing.

   Further background information regarding photographic films and development processes can be obtained from the document referenced below.*

2. Films to be exposed by the SIM bay cameras will be developed in a spray-type Fultron processor acquired for this purpose.

3. Appendix E, Film Characteristics and Processing Test Data, was provided by the Photographic Technology Division/JL.

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*K. R. Erb and D. J. Kelch, "An Introduction to Photography in the Earth Sciences," Data Corporation, DTN-69-11, Technical Note, November 1969.

ACRONYMS AND ABBREVIATIONS FOR APPENDIX E

ASA	American Standards Association
C	Centigrade
cm	Centimeter
CRT	Cathode Ray Tube
F	Fahrenheit
fpm	Feet per minute
K	Kelvin
m	Milli
min	Minute
mm	Millimeter
MS	Medium-speed
No.	Number
PTD	Photographic Technology Division
R.L.E.	Relative $\log_{10}$ Exposure
RMS	Root Mean Square
sec	Second
SO	Special Order
°	Degree
'	Minute (superscript)
"	Second (superscript)
γ	Gamma
μ	Micron

APPENDIX E

FILM CHARACTERISTICS AND PROCESSING TEST DATA

CONTENTS

*Kodak Panatomic-X Aerial Film Type SO-164 is identical to Kodak Panatomic-X Aerial Film Type 3400 except for the backing material. It has been selected because it is readily available in 16-mm format.

KODAK HIGH SPEED RECORDING FILM TYPE 2485

(Estar-AH Base)

(This material was obtained from manufacturer's published information unless a specific test source is referenced.)

FILM CHARACTERISTICS*

An extremely high-speed, panchromatic film with extended red sensitivity. It is especially recommended for a wide variety of photorecording applications where weak signals of extremely short duration must be recorded, or where very high writing speeds are required. Speed and contrast can be varied over a very wide range for such a high-speed film by selecting the most suitable combination of developer time and temperature.

The varied uses of this film include: a wide range of photo instrumentation with all types of light sources; CRT recording with all phosphors, especially blue-emitting phosphors; high-speed photography at low light levels; streamer-chamber photography; medical-science applications, such as pupillography; photography of re-entry phenomena;and other applications which require fleeting signals be recorded on a "go-or-no-go" basis.

BASE

This film has a 4.0-mil Estar-AH polyester base with fast-drying PX backing. The 0.10 density of this base reduces light piping and provides halation protection.

EXPOSURE

Suggested aerial exposure indexes for mechanized processing will be found in the tables which follow.

Aerial exposure indexes are designed for use with the Kodak Aerial Exposure Computer, Kodak Publication No. R-10. Aerial exposure indexes are not equivalent to, and should not be confused with, the conventional film speeds used in pictorial photography.

IMAGE STRUCTURE CHARACTERISTICS; MX-641 chemicals, 2 developer racks, 3 fpm

Characteristic	Value**	Classification
Resolving Power		
Test-object contrast 1000:1	58 lines/mm	Moderately low
Test-object contrast 1.6:1	21 lines/mm	
RMS Granularity (at net density of 1.0)	18	Coarse

* This material describes the general characteristics of this film type. Sensitometric curves describe the results of a specific set of processing conditions on a specific emulsion batch. Experimenters are reminded that results may change somewhat from one emulsion to the next. Specific characteristics are determined for mission films as far as possible in advance of actual mission.

** Interpolated from Kodak published data for results obtained at PTD for MX-641 chemistry.

MECHANIZED PROCESSING
The Kodak Versamat Film Processor, Model 11 C-M, can be used to process this film using Kodak Versamat 641 chemicals.

PROCESSING CHEMICALS:
- Kodak Versamat 641 Developer Starter
- Kodak Versamat 641 Developer and Replenisher
- Kodak Versamat 641 Fixer and Replenisher

PROCESSING SEQUENCES WITH KODAK VERSAMAT CHEMICALS:

Processing Step	Number of Racks	Path Length (feet)	Temperature
Develop	2	4 or 8	85°F ± ½°F
Fix*	3	12	85°F, nominal
Wash	2	8	80° to 82°F
Dry			120° to 145°F **

* Fixer replenisher should be introduced into tank No. 3 of the processor.

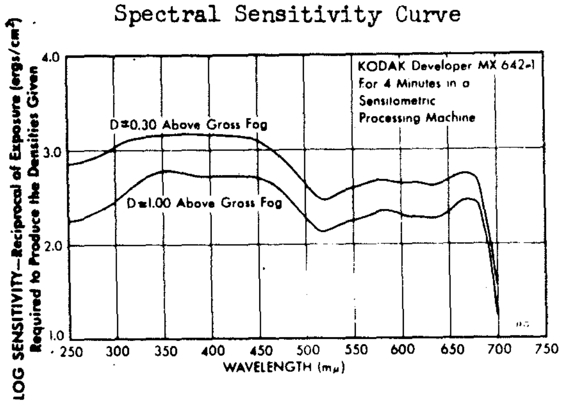
** The temperature of the dryer may require adjustment, depending upon the ambient temperature conditions in the processing area. Set temperature approximately 5 degrees above temperature required to dry clear film.

SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK VERSAMAT 641 CHEMICALS AT 85°F PROCESSING:

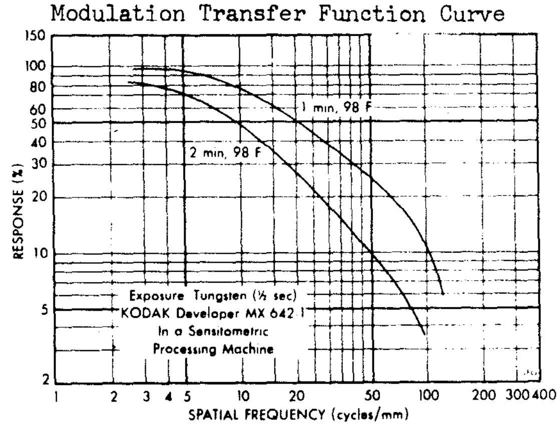
Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Exposure Index
3	2	1.45	2350 (ASA)
4.5	2	1.05	---
6	2	0.66	---

KODAK HIGH SPEED RECORDING FILM TYPE 2485
(Estar-AH Base)

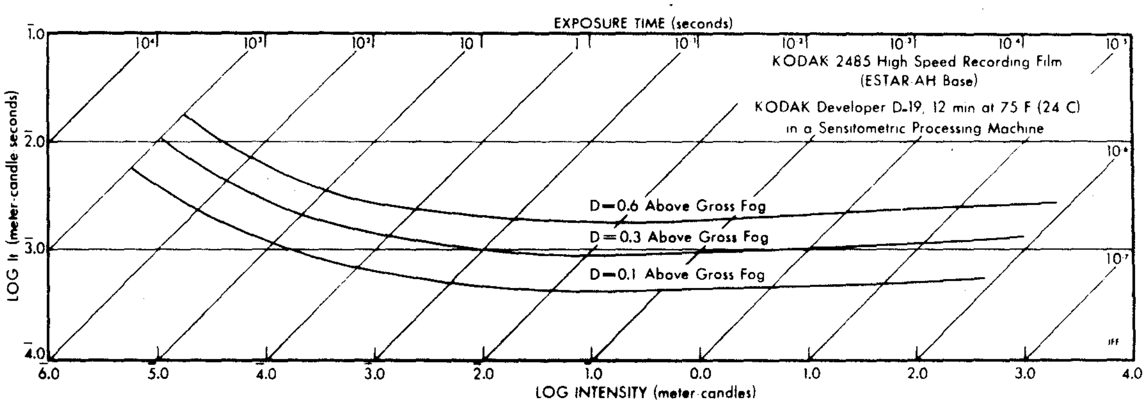
Spectral Sensitivity Curve



Modulation Transfer Function Curve



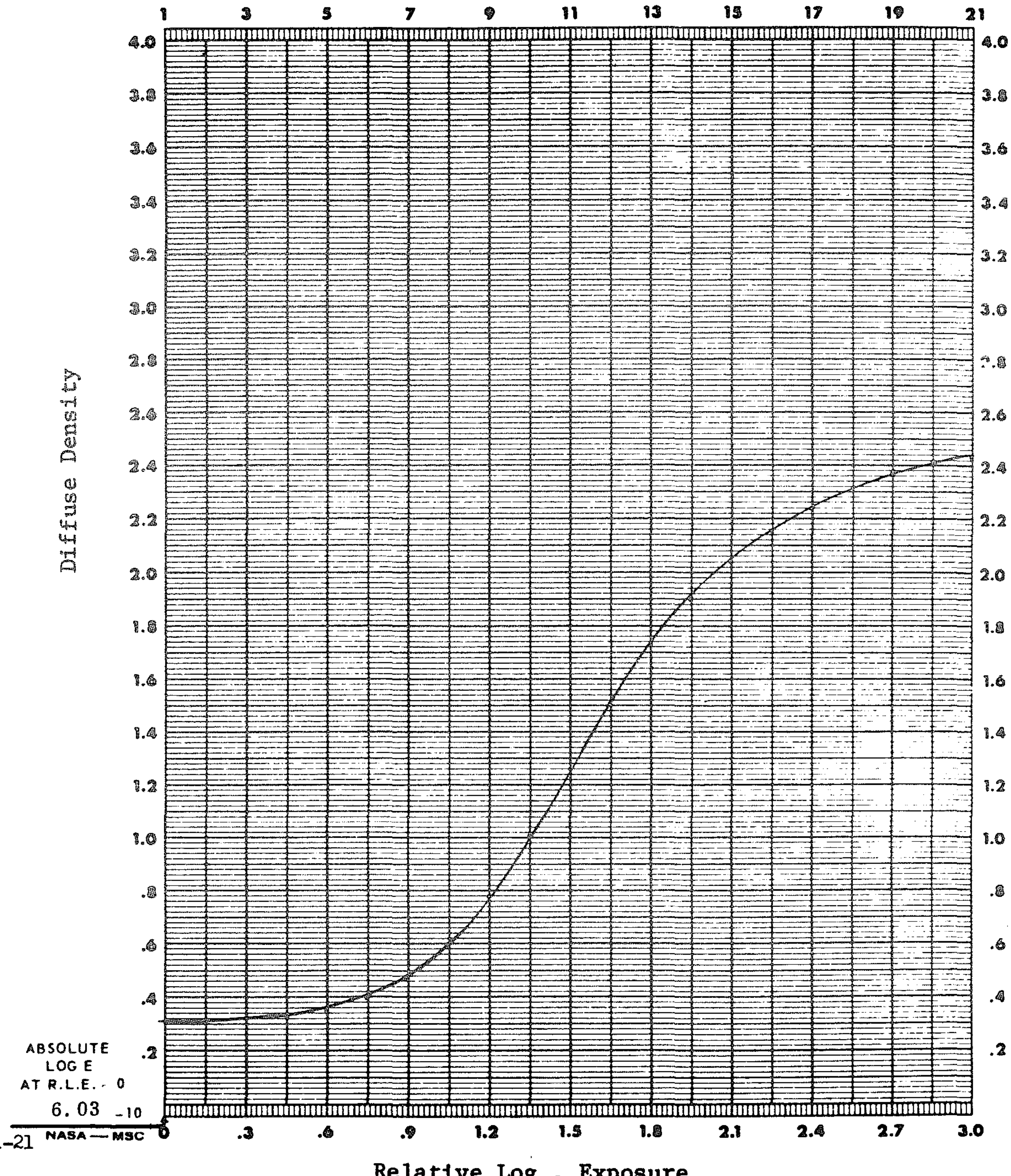
Reciprocity Curve



DATE June 1971 CONTROL # G TASK ______ PREPARED BY ______

FILM 2485 EMULSION # 33-1 MFG ______ EXPIRATION DATE ______

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Vmt 11C-M #1	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE TD 403	D-MAX
TIME 1/100 SEC.	SPEED 2 TANKS 4 FPM	APERTURE SIZE 4 MM	GAMMA 1.68
FILTER 4750 K + SCW+1.0ND	TEMP °F 85 TIME	FILTER Visual	BASE + FOG .32

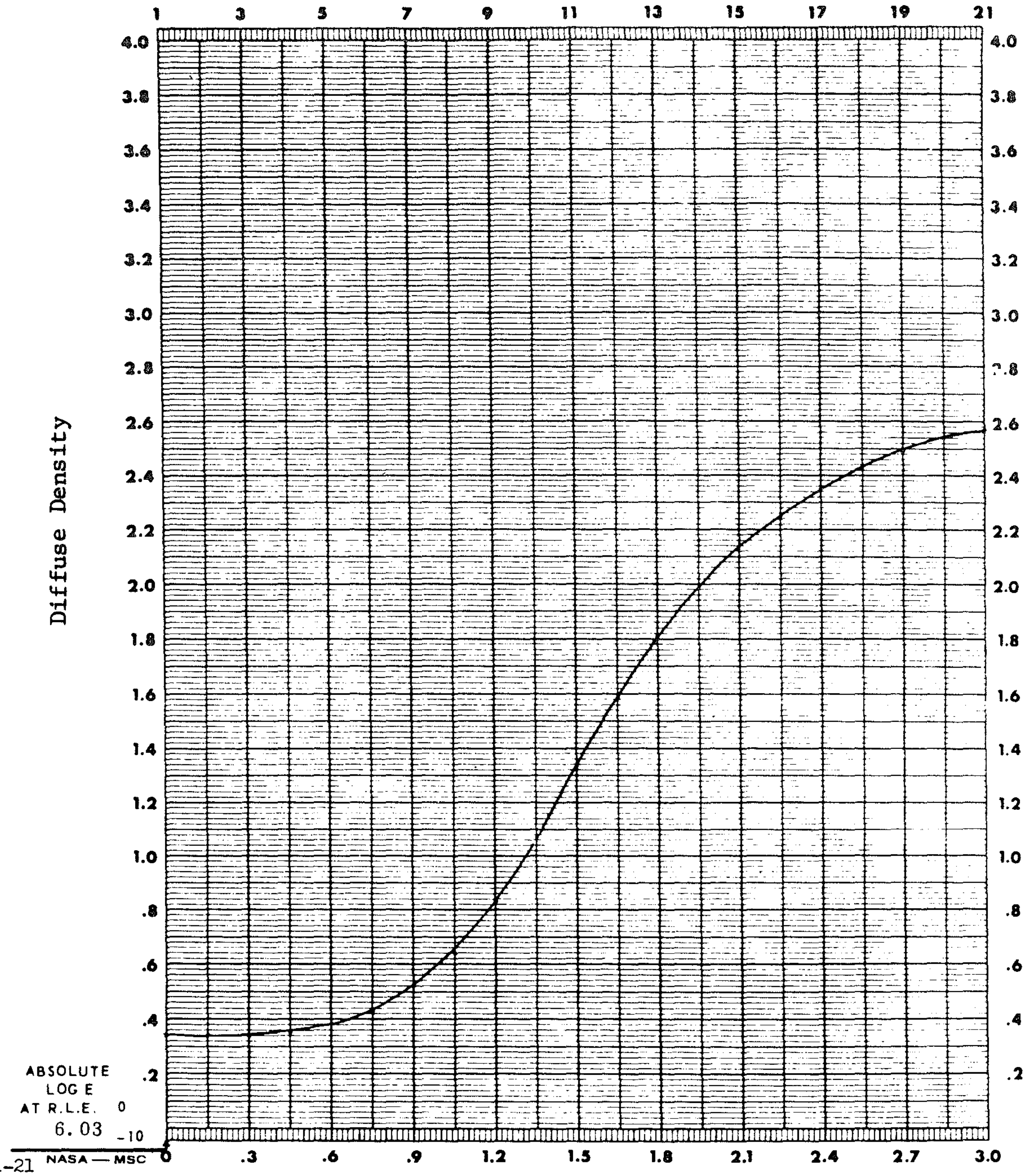


T71-21

DATE June 1971 CONTROL # G TASK ______ PREPARED BY ______

FILM 2485 EMULSION # 33-1 MFG ______ EXPIRATION DATE ______

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Vmt. 11C-M	INSTRUMENT TD 403	SPEED ( )
ILLUMINANT 2850 K	CHEMISTRY MX-641	TYPE DD	D-MAX
TIME 1/100 SEC.	SPEED 2 TANKS 4 FPM	APERTURE SIZE 4 MM	GAMMA
FILTER 4750 + SCW + 1.0ND	TEMP °F 85 TIME	FILTER Visual	BASE + FOG .32



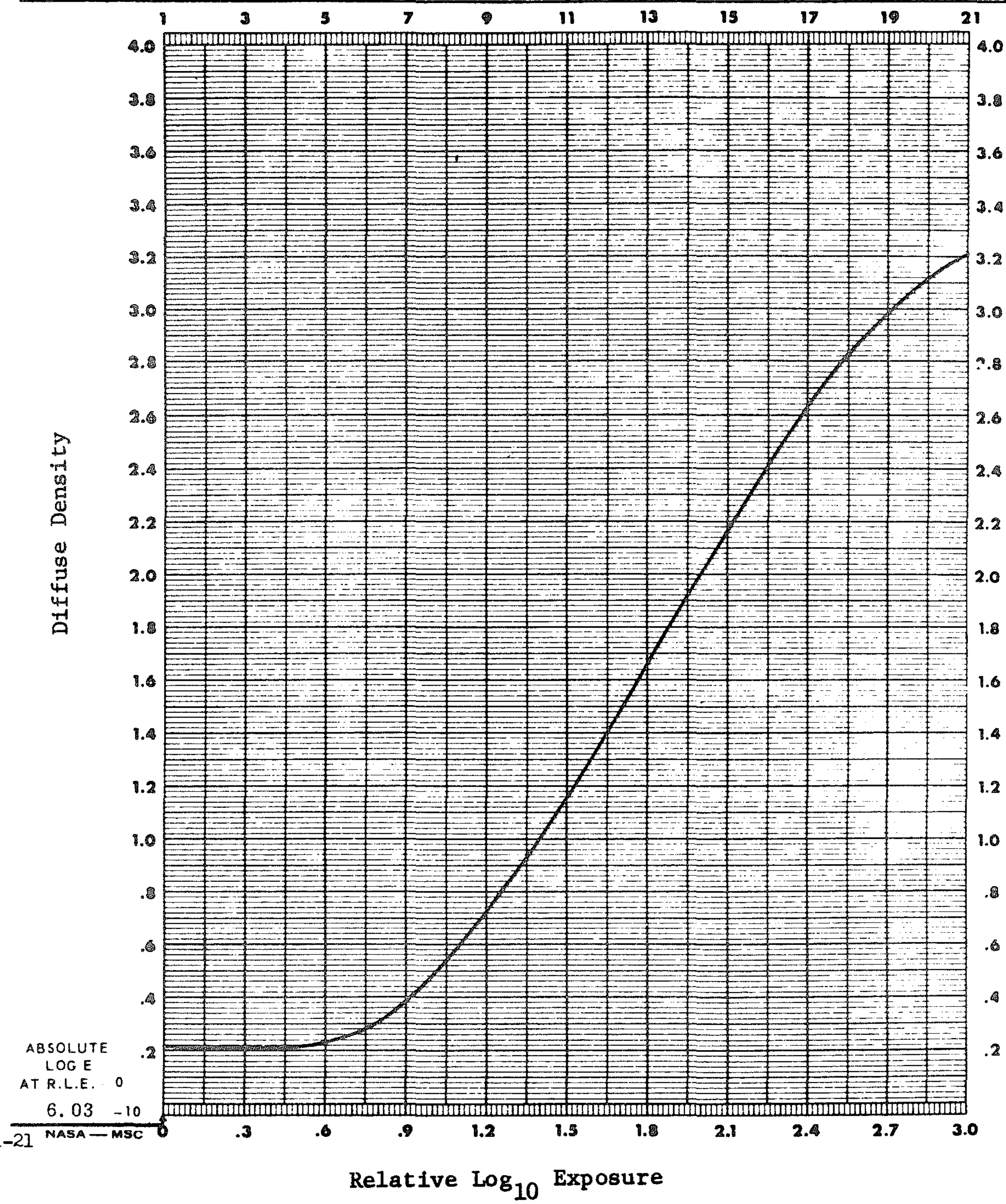
T71-21 NASA — MSC

Relative Log_{10} Exposure

DATE June 1971 CONTROL # H TASK ______ PREPARED BY ______

FILM 2485 EMULSION # 26-1 (16mm) MFG ______ EXPIRATION DATE ______

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Houston	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY D-19	TYPE TD 203	D-MAX
TIME 1/100 SEC.	SPEED ___ TANKS ___ FPM	APERTURE SIZE 4 MM	GAMMA 1.7
FILTER 4750°K+SCW+1.0ND	TEMP °F 85 TIME 6 min	FILTER Visual	BASE + FOG .23



T71-21

KODAK PANATOMIC-X AERIAL FILM TYPE 3400
(Estar Thin Base)

(This material was obtained from manufacturer's published information unless a specific test source is referenced.)

FILM CHARACTERISTICS*

A panchromatic, negative camera film that has intermediate speed, high contrast, and extended red sensitivity. The high acutance and very high resolution of this film favor a small-negative format. The emulsion, coated on a 2.5-mil Estar base (for dimensional stability and tear resistance), is hardened for high-temperature, rapid processing in a continuous processing machine, such as the Kodak Versamat Film Processor, Model 11.

Note: This film is not normally used in commercial aerial cameras available in today's market. It is designed for use in certain military cameras that have been specially constructed or modified to handle thin-base films.

BASE

This film has a 2.5-mil Estar polyester base with a dyed gel backing. The total nominal thickness of this film is 2.89 mils.

EXPOSURE

Suggested aerial exposure indexes for mechanized processing will be found in the tables which follow.
Aerial exposure indexes are designed for use with the Kodak Aerial Exposure Computer, Kodak Publication No. R-10. Aerial exposure indexes are not equivalent to, and should not be confused with, the conventional film speeds used in pictorial photography.

IMAGE-STRUCTURE CHARACTERISTICS; MX-641 chemicals with 2 developer racks at 10 fpm

Characteristic	Value	Classification
Resolving Power		
Test-object contrast 1000:1	200 lines/mm	Very high
Test-object contrast 1.6:1	80 lines/mm	
RMS Granularity (at net density of 1.0)	18	Very fine

* This material describes the general characteristics of this film type. Sensitometric curves describe the results of a specific set of processing conditions on a specific emulsion batch. Experimenters are reminded that results may change somewhat from one emulsion to the next. Specific characteristics are determined for mission films as far as possible in advance of actual mission.

MECHANIZED PROCESSING

This film should be processed in equipment made especially for this purpose. Conventional rewind equipment is not recommended, because of the physical characteristics of the Estar thin base. Continuous-type processing machines--such as spray, deep tank, or roller transport--are best for processing this film.

The Kodak Versamat Film Processor, Model 11, can be used to process this film using Kodak Versamat 641 chemicals.

PROCESSING CHEMICALS:

Kodak Versamat 641 Developer Starter
Kodak Versamat 641 Developer Replenisher
Kodak Versamat 641 Fixer and Replenisher

PROCESSING SEQUENCES WITH KODAK VERSAMAT CHEMICALS:

Processing Step	Number of Racks	Path Length (feet)	Temperature
Develop	1 or 2	4 or 8	85°F ± ½°F
Fix*	3	12	85°F, nominal
Wash	2	8	80° to 82°F
Dry			120° to 145°F**

* Fixer replenisher should be introduced into tank No. 3 of the processor.

** The temperature of the dryer may require adjustment, depending upon the ambient temperature conditions in the processing area. Set temperature approximately 5 degrees above temperature required to dry clear film.

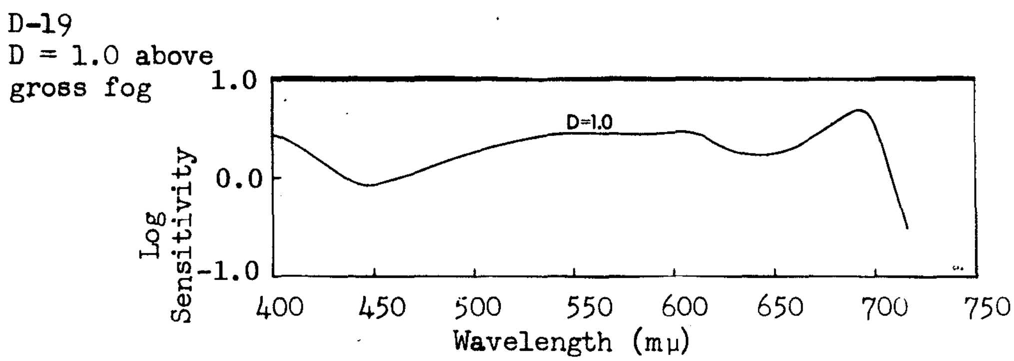
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK VERSAMAT 641 CHEMICALS AT 85°F PROCESSING TEMPERATURE:

Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Aerial Exposure Index
5	1	2.80	16
	2	2.90	20
10	1	2.30	10
	2	2.60	12
15*	1	1.90	6.4
	2	2.30	10
20*	1	1.60	6.4
	2	2.20	8

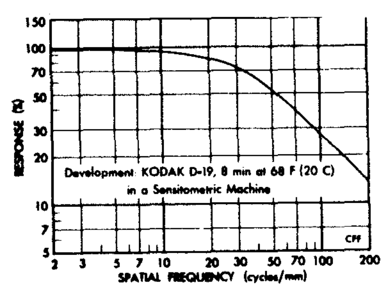
* Represents condition where fixing, washing, or drying problems exist

KODAK PANATOMIC-X AERIAL FILM 3400
(Estar Thin Base)

Spectral Sensitivity Curve



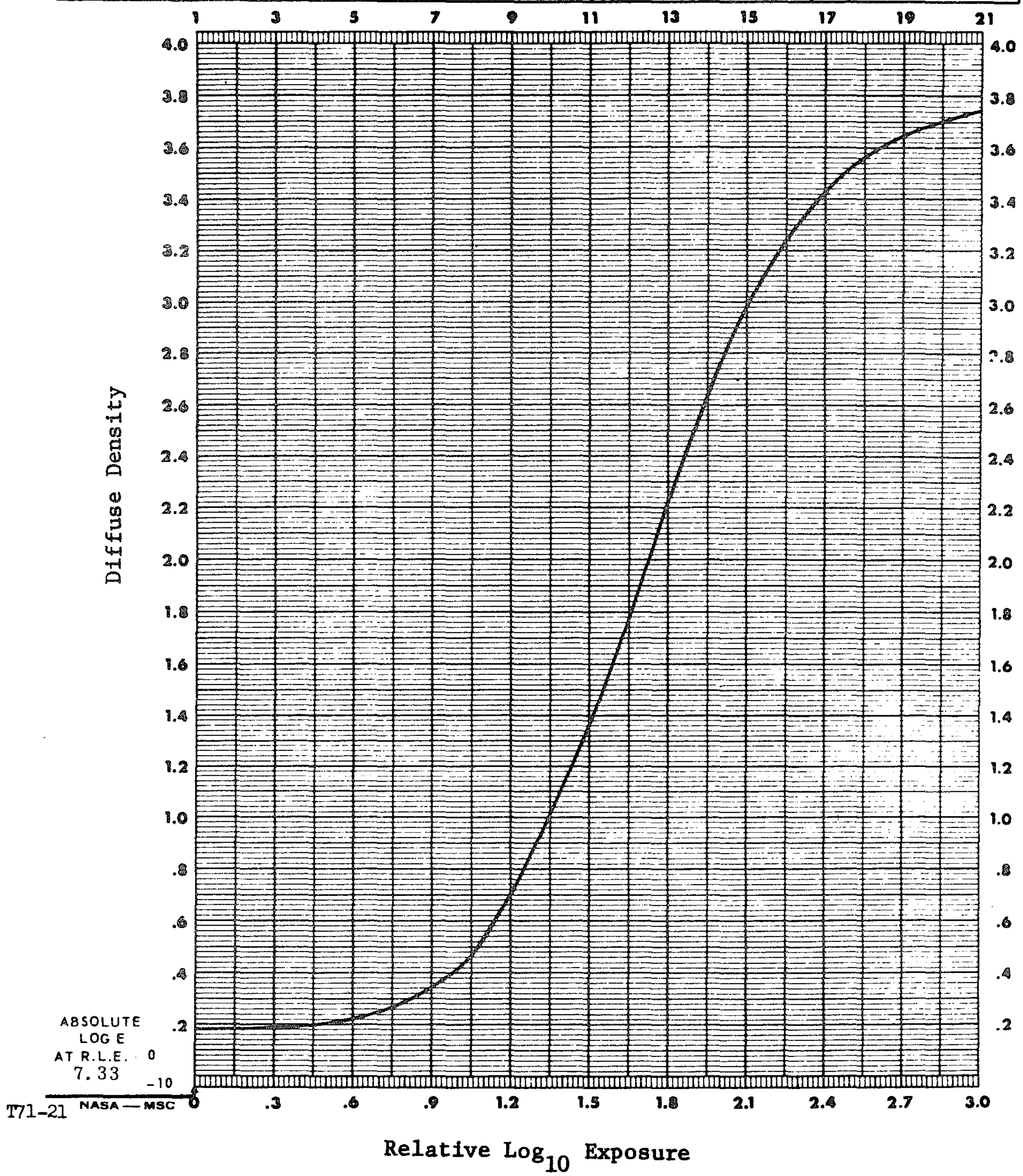
Modulation Transfer Function Curve



DATE June 1971 CONTROL # A TASK PREPARED BY

FILM 3400 EMULSION # 235-7 MFG EXPIRATION DATE

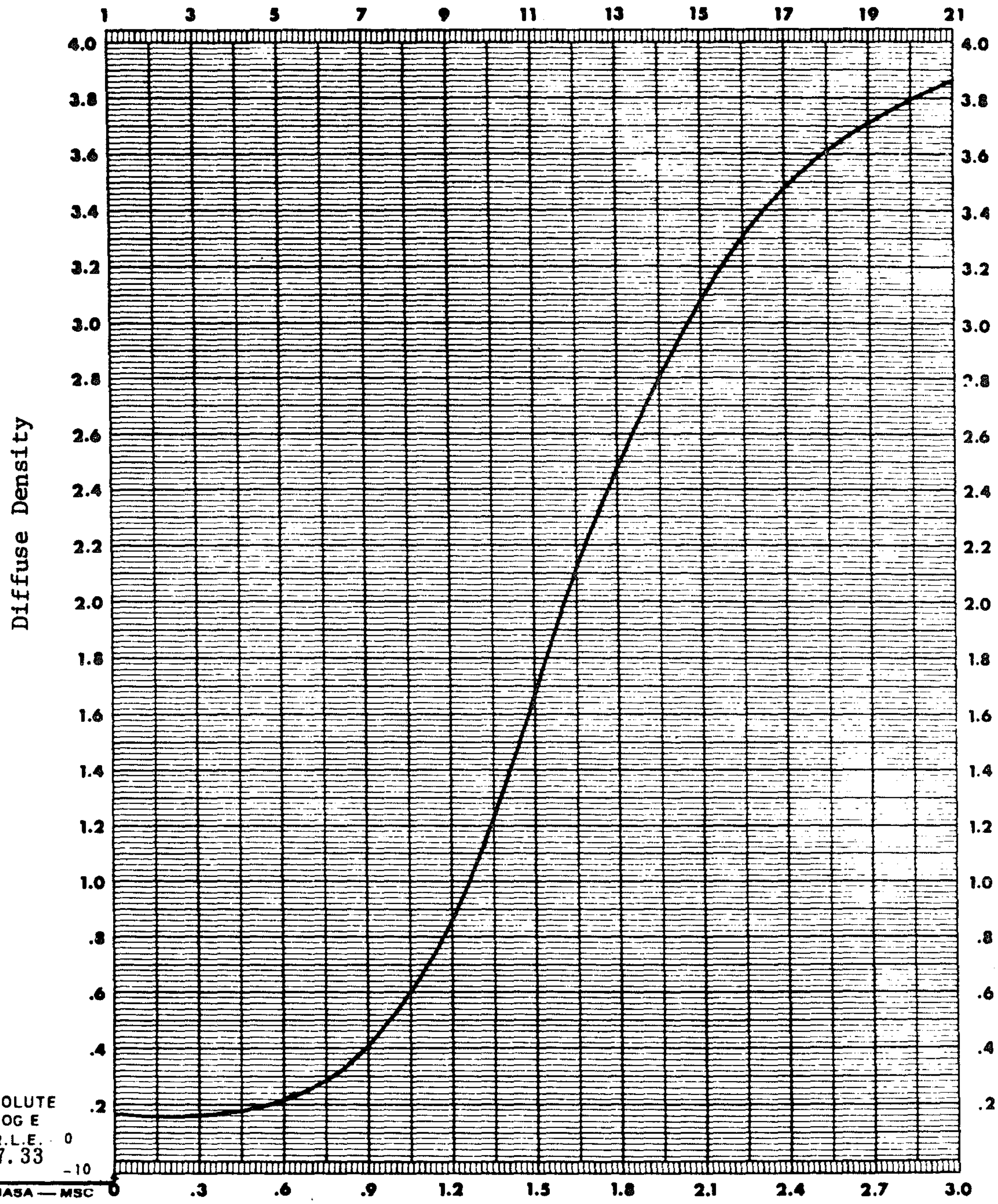
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Vmt 11C-MM #1	INSTRUMENT TD 403	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD	D-MAX
TIME 1/50 SEC.	SPEED 2 TANKS 5.75 FPM	APERTURE SIZE 4 MM	GAMMA
FILTER 4750°K + SCW	TEMP °F 85 TIME	FILTER Visual	BASE + FOG .19



DATE ~~June 1971~~ CONTROL # A TASK ______ PREPARED BY ______

FILM 3400 EMULSION # 224-7 (70mm) MFG ______ EXPIRATION DATE ______

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Vmt 11C-M #2	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE TD 403	D-MAX
TIME 1/50 SEC.	SPEED 2 TANKS 6 FPM	APERTURE SIZE 4 MM	GAMMA
FILTER LC5900 + SCW	TEMP °F 85 TIME	FILTER Visual	BASE + FOG



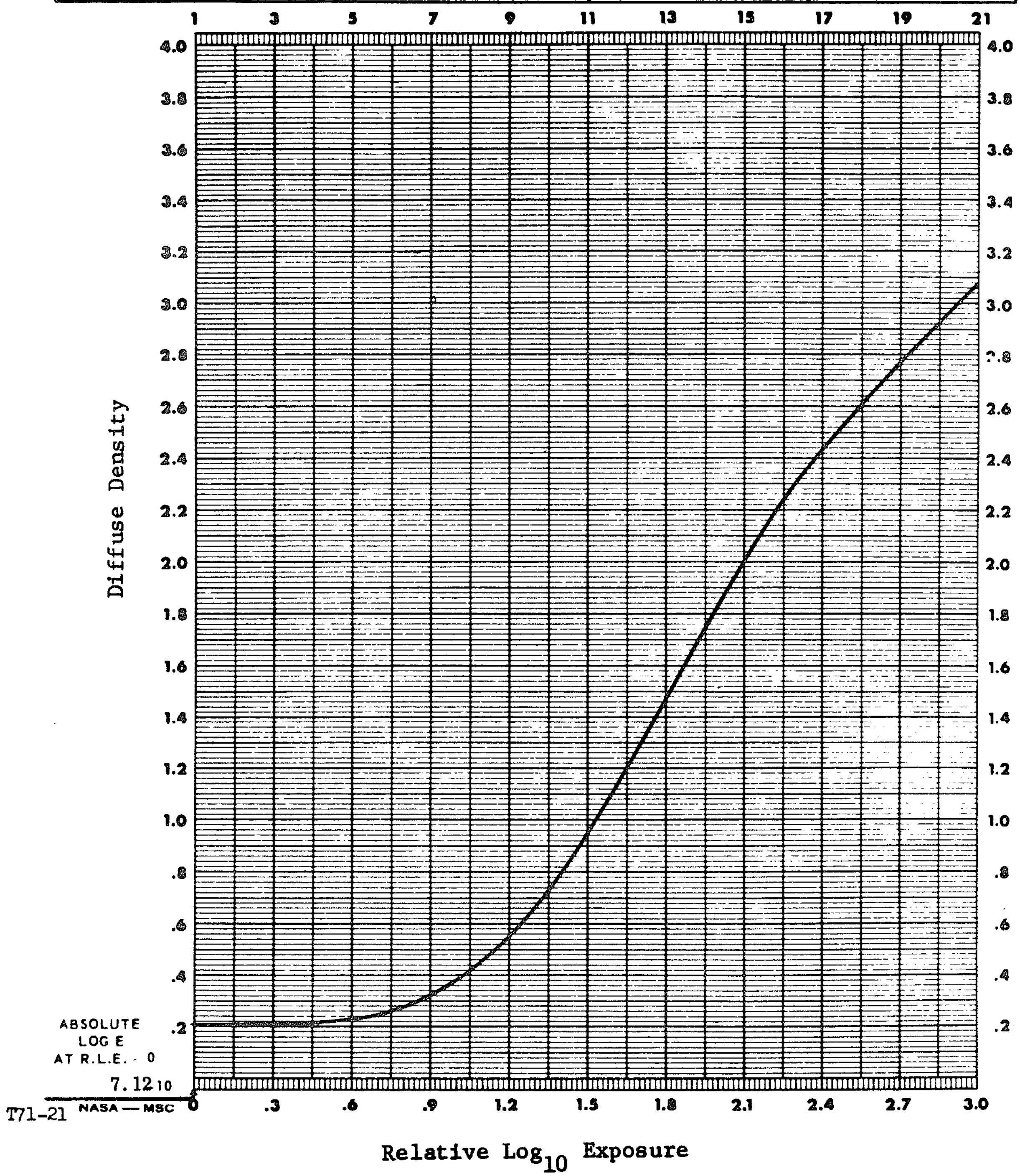
T71-21 NASA — MSC

Relative Log_{10} Exposure

DATE June 1971 CONTROL # B TASK ______ PREPARED BY ______

FILM 3400 EMULSION # 205 MFG ______ EXPIRATION DATE ______

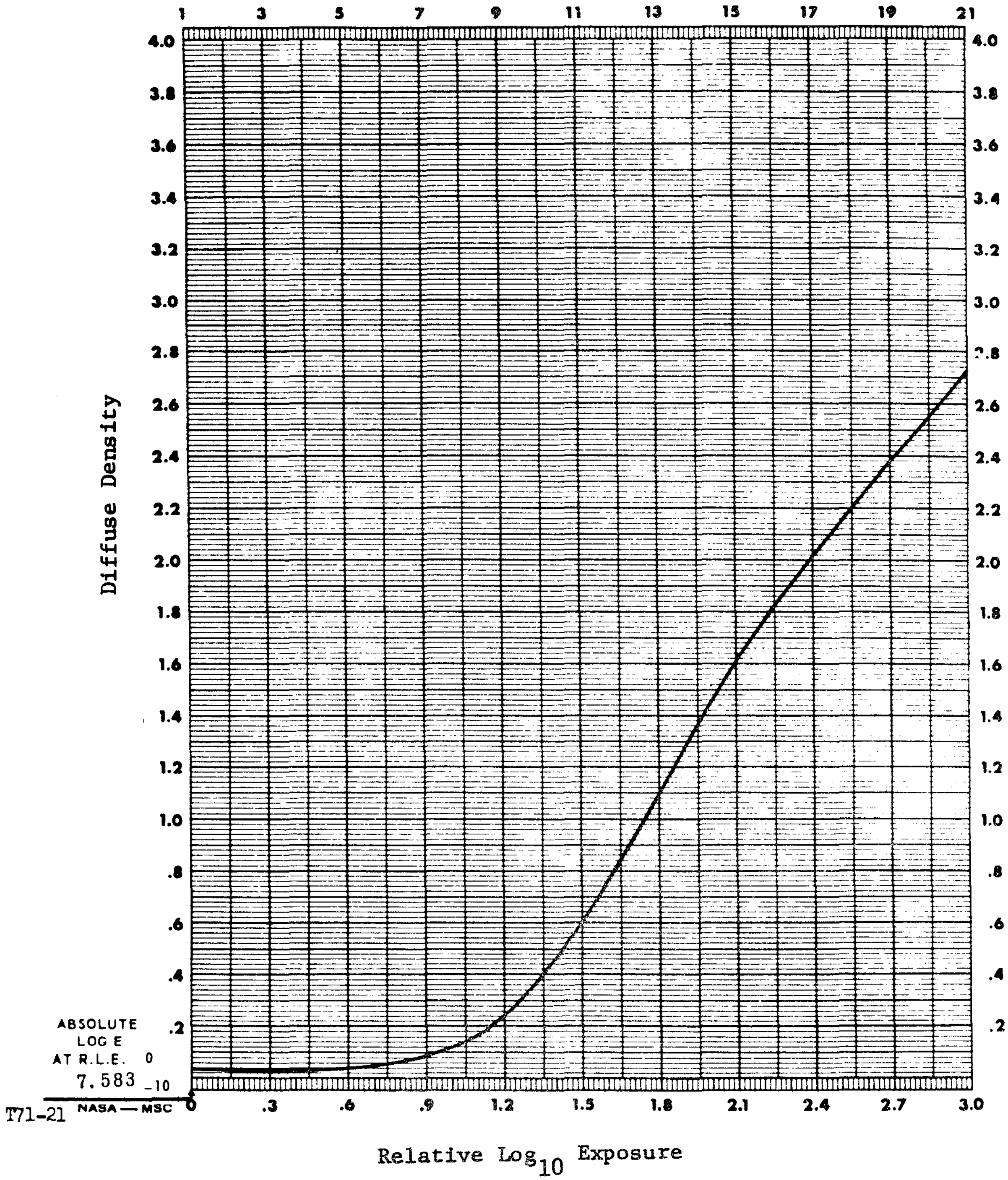
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Fultron	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-819	TYPE TD 403	D-MAX
TIME 1/100 SEC.	SPEED ____ TANKS 20 FPM	APERTURE SIZE 4 MM Visual	GAMMA
FILTER 4750 K+ Wr 12	TEMP °F ____ TIME ____	FILTER	BASE + FOG



DATE June 1971 CONTROL # K TASK ________ PREPARED BY ________

FILM SO-164 EMULSION # 01-01 MFG ________ EXPIRATION DATE ________

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Houston	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 K	CHEMISTRY D-19	TYPE TD 203	D-MAX
TIME 1/25 SEC.	SPEED ____ TANKS ____ FPM	APERTURE SIZE 4 MM	GAMMA 1.70
FILTER 5500°K	TEMP °F 75 TIME 54"	FILTER Status A visual	BASE + FOG .05



KODAK PLUS-X AERIAL FILM TYPE 3401
(Estar Thin Base)

(This material was obtained from manufacturer's published information unless a specific test source is referenced.)

FILM CHARACTERISTICS*

A panchromatic, negative camera film that has high contrast, medium speed, high acutance, fine grain, and extended red sensitivity. The emulsion is coated on a 2.5-mil Estar base which provides tear resistance and dimensional stability. This film is suitable for high-temperature processing in continuous-processing machines, such as the Kodak Versamat Processor, Model 11.

Note: This film is not normally used in the aerial cameras available in today's market. It is designed for use in certain military cameras that have been specially constructed or modified to handle thin-base films.

BASE

This film has a 2.5-mil Estar polyester base with a dyed gel backing. The total nominal thickness is 3.06 mils.

EXPOSURE

Suggested aerial exposure indexes for mechanized processing will be found in the tables which follow.

Aerial exposure indexes are designed for use with the Kodak Aerial Exposure Computer, Kodak Publication No. R-10. Aerial exposure indexes are not equivalent to, and should not be confused with, the conventional film speeds used in pictorial photography.

IMAGE-STRUCTURE CHARACTERISTICS; MX-641 chemicals with 2 developer racks at 10 fpm

Characteristic	Value**	Classification
Resolving Power		
Test-object contrast 1000:1	100 lines/mm	High
Test-object contrast 1.6:1	50 lines/mm	
RMS Granularity (at net density of 1.0)	32	Medium

*This material describes the general characteristics of this film type. Sensitometric curves describe the results of a specific set of processing conditions on a specific emulsion batch. Experimenters are reminded that results may change somewhat from one emulsion to the next. Specific characteristics are determined for mission films as far as possible in advance of actual mission.

** Interpolated from Kodak published data for results obtained at PTD for MX-641 chemistry.

MECHANIZED PROCESSING

This film should be processed in equipment made especially for this purpose. Conventional rewind equipment is not recommended, because of the physical characteristics of the Estar thin base. Continuous-type processing machines--such as spray, deep tank, or roller transport--are best for processing this film.

The Kodak Versamat Film Processor, Model 11, can be used to process this film using Kodak Versamat 641 chemicals.

PROCESSING CHEMICALS:

- Kodak Versamat 641 Developer and Starter
- Kodak Versamat 641 Developer and Replenisher
- Kodak Versamat 641 Fixer and Replenisher

PROCESSING SEQUENCES WITH KODAK VERSAMAT CHEMICALS:

Processing Step	Number of Racks	Path Length (feet)	Temperature
Develop	2	4 or 8	$85^{o}F \pm \frac{1}{2}^{o}F$
Fix*	3	12	$85^{o}F$, nominal
Wash	2	8	$80^{o}F$ to $82^{o}F$
Dry			$120^{o}F$ to $145^{o}F$**

* Fixer replenisher should be introduced into tank No. 3 of the processor.

** The temperature of the dryer may require adjustment, depending upon the ambient temperature conditions in the processing area. Set temperature approximately 5 degrees above temperature required to dry clear film.

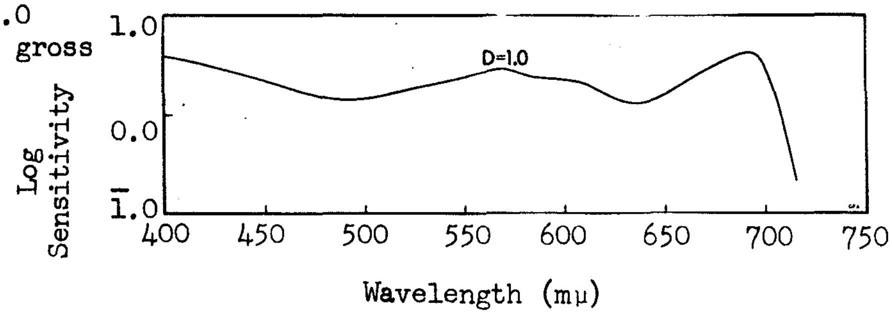
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK VERSAMAT 641 CHEMICALS AT $85^{o}F$ PROCESSING TEMPERATURE

Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Aerial Exposure Index
5	2	2.61	64
10	2	2.27	50
15	2	1.87	40
20	2	1.52	32

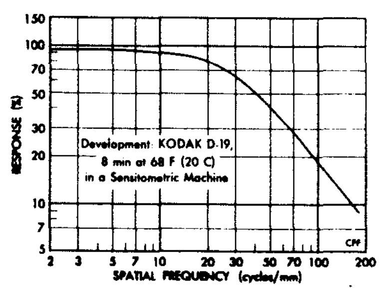
KODAK PLUS-X AERIAL FILM 3401
(Estar Thin Base)

D-19
D = 1.0
above gross
fog

Spectral Sensitivity Curve



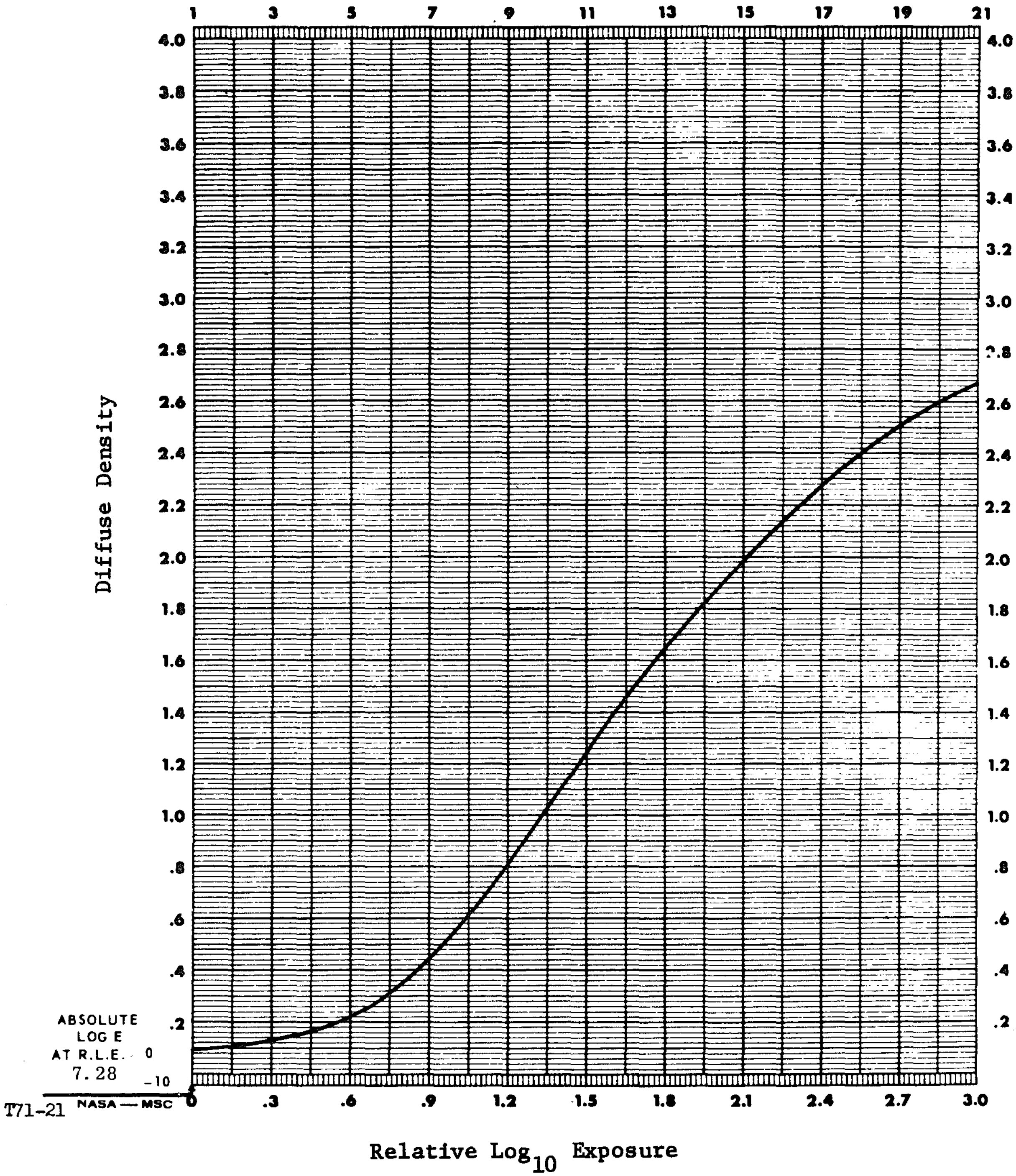
Modulation Transfer Function Curve



DATE June 1971. CONTROL # C TASK ______ PREPARED BY ______

FILM 3401 EMULSION # 331-2 MFG ______ EXPIRATION DATE ______

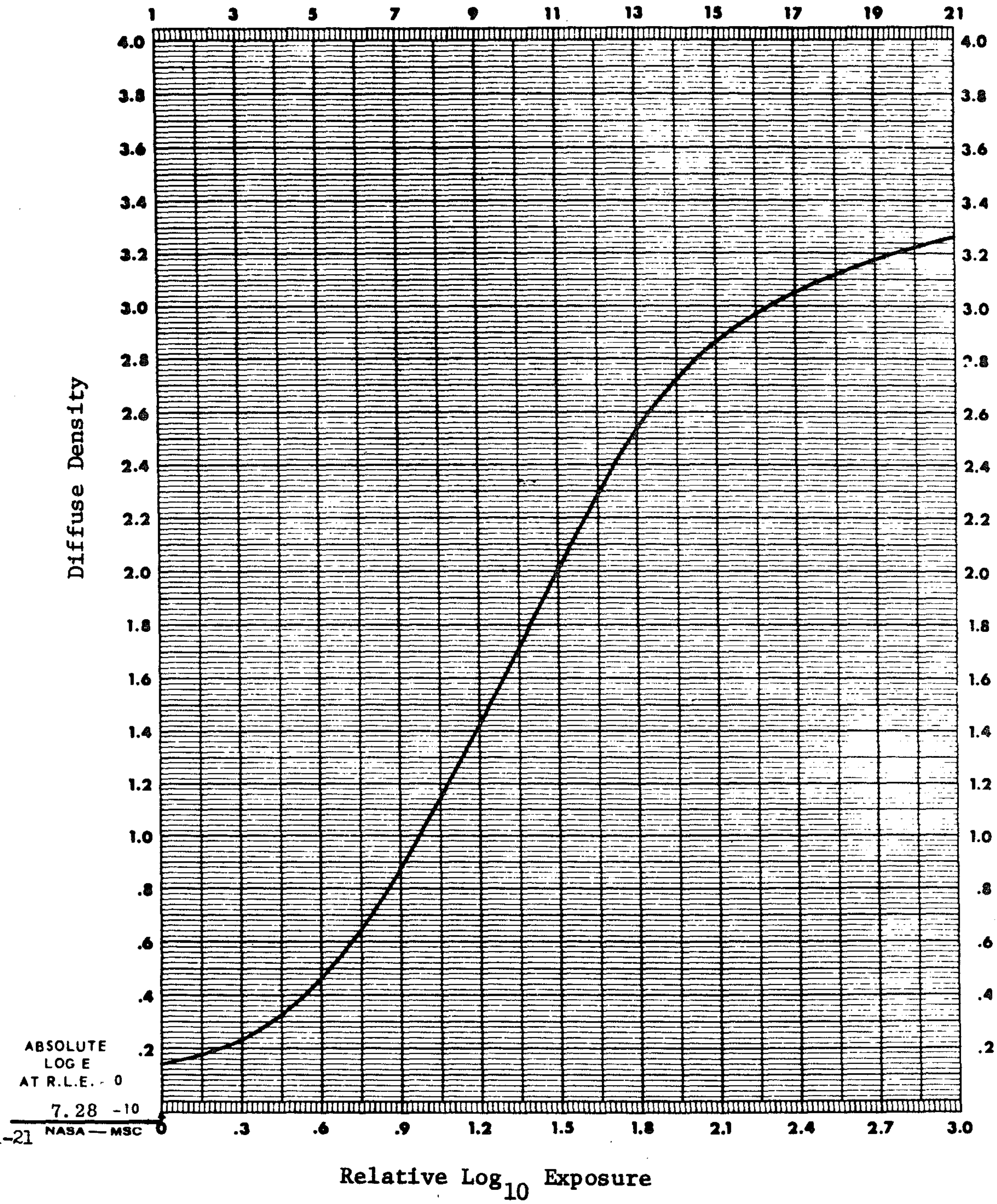
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Vmt 11C-M	INSTRUMENT TD 403	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD	D-MAX
TIME 1/50 SEC.	SPEED 1 TANKS 10.25 FPM	APERTURE SIZE # MM	GAMMA 1.39
FILTER 5500°K	TEMP °F 85 TIME	FILTER Visual	BASE + FOG .10



DATE June 1971 CONTROL # D TASK ______ PREPARED BY ______

FILM 3401 EMULSION # 294-6 (35mm) MFG ______ EXPIRATION DATE ______

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Hi-Speed	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY D-19	TYPE TD 217 DR	D-MAX
TIME 1/50 SEC.	SPEED ___ TANKS ___ FPM	APERTURE SIZE 4 MM	GAMMA
FILTER 5500°K	TEMP °F 76 TIME 8'50"	FILTER Visual	BASE + FOG

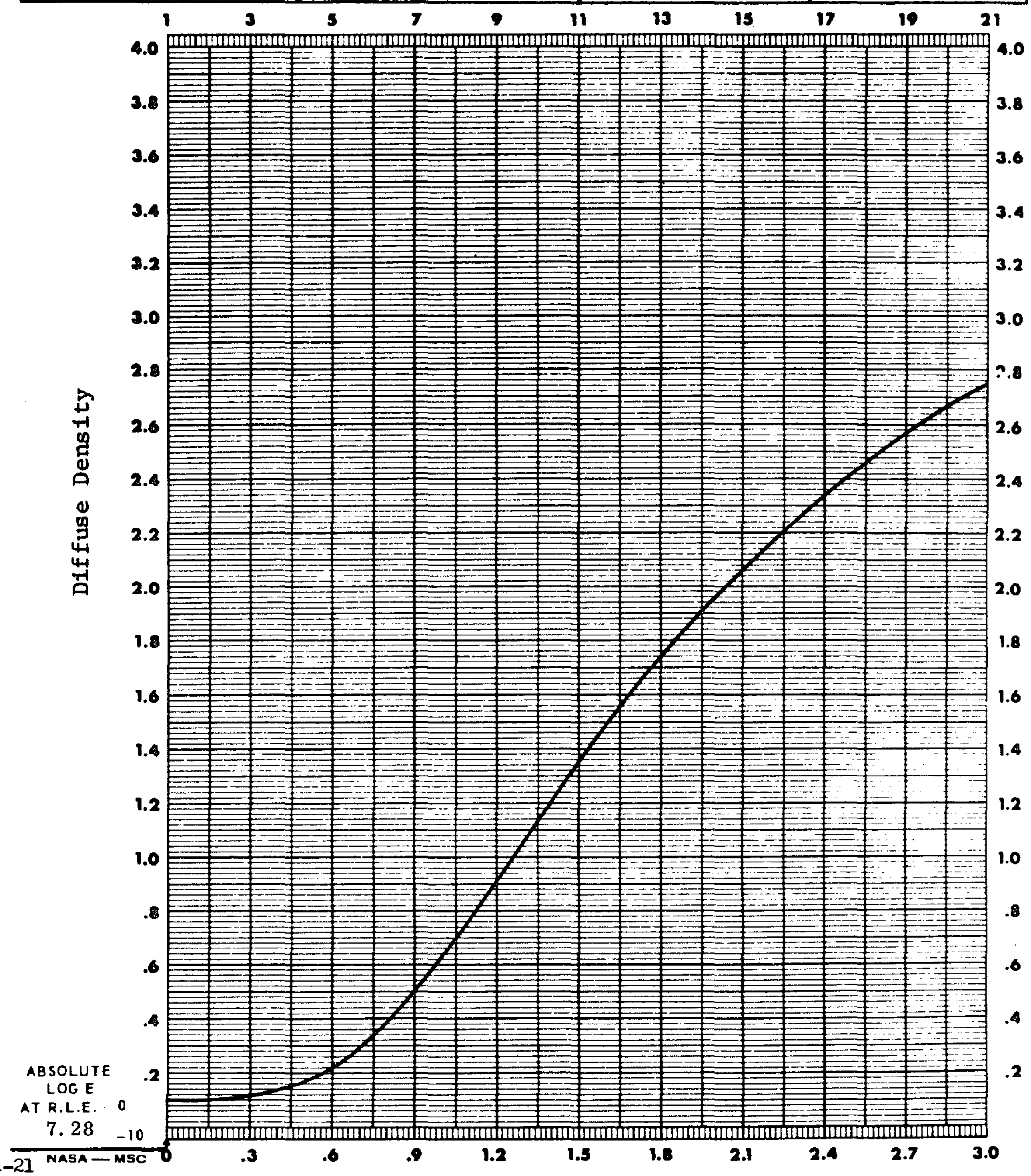


T71-21 NASA — MSC

DATE June 1971 CONTROL # C TASK ______ PREPARED BY ______

FILM 3401 EMULSION # 294-6 MFG ______ EXPIRATION DATE ______

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Vmt 11C-M	INSTRUMENT TD 403	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD	D-MAX
TIME 1/50 SEC.	SPEED 1 TANKS 10 FPM	APERTURE SIZE 4 MM	GAMMA 1.41
FILTER 5500°K	TEMP °F 85 TIME	FILTER M-58 Visual	BASE + FOG .10



T71-21 NASA — MSC

Relative Log_{10} Exposure

KODAK HIGH DEFINITION AERIAL FILM TYPE 3414 (Formerly SO-349 and 3404) (Estar Thin Base)

(This material was obtained from manufacturer's published information unless a specific test source is referenced.)

FILM CHARACTERISTICS*
A panchromatic, negative camera film that has slow speed, high contrast, extended red sensitivity, maximum definition, and extremely fine grain. This film is designed for extremely high-altitude, stable-platform aerial photography. The emulsion is hardened for high-temperature, rapid processing and is coated on a 2.5-mil Estar base for dimensional stability and tear resistance.

Note: This film is not recommended for use in aerial cameras commonly available on today's market. It is designed for use in cameras that have been specially constructed or modified to handle the thinner-based films.

BASE
This film has a 2.5-mil Estar polyester base with a dyed gel backing. The total nominal thickness of this film is 3.0 mils.

EXPOSURE
Suggested aerial exposure indexes for mechanized processing will be found in the tables which follow.
Aerial exposure indexes are designed for use with the Kodak Aerial Exposure Computer, Kodak Publication No. R-10. Aerial exposure indexes are not equivalent to, and should not be confused with, the conventional film speeds used in pictorial photography.

IMAGE-STRUCTURE CHARACTERISTICS; D-19 chemicals with 8-minute development at 68°F

Characteristic	Value	Classification
Resolving Power		
Test-object contrast 1000:1	630 lines/mm	Extremely High
Test-object contrast 1.6:1	250 lines/mm	Extremely High
RMS Granularity (at net density of 1.0)	9	

* This material describes the general characteristics of this film type. Sensitometric curves describe the results of a specific set of processing conditions on a specific emulsion batch. Experimenters are reminded that results may change somewhat from one emulsion to the next. Specific characteristics are determined for mission films as far as possible in advance of actual mission.

MECHANIZED PROCESSING

This film should be processed in equipment made especially for this purpose. Conventional rewind equipment is not recommended, because of the physical characteristics of the Estar thin base. Continuous-type processing machines--such as spray, deep tank, or roller transport--are best for processing this film.

The Kodak Versamat Film Processor, Model 11, equipped with a Kodak Versamat Stop Bath Kit, Model 11, can be used to process this film using Kodak Versamat 641 chemicals.

PROCESSING CHEMICALS:

Kodak Versamat 641 Developer Starter
Kodak Versamat 641 Developer Replenisher
Kodak Stop Bath SB-5a or Kodak Indicator Stop Bath
Kodak Versamat 641 Fixer and Replenisher

PROCESSING SEQUENCES WITH KODAK VERSAMAT CHEMICALS:

Processing Step	Number of Racks	Path Length (feet)	Temperature
Develop	2	8	$95^{\circ} \pm \frac{1}{2}^{\circ}F$
Stop Bath	1	4	$95^{\circ}F$
Fixer*	2	8	$95^{\circ}F$
Wash	2	8	90° to $92^{\circ}F$
Dry		8	120° to $145^{\circ}F$**

* The fixer replenisher is introduced into machine tank No. 5 (second fixer tank).

** For optimum physical quality, dryer temperature should be the minimum required. The temperature of the dryer may require adjustment, depending upon the ambient temperature conditions in the processing area. Set temperature 5 degrees above temperature required to dry clear film.

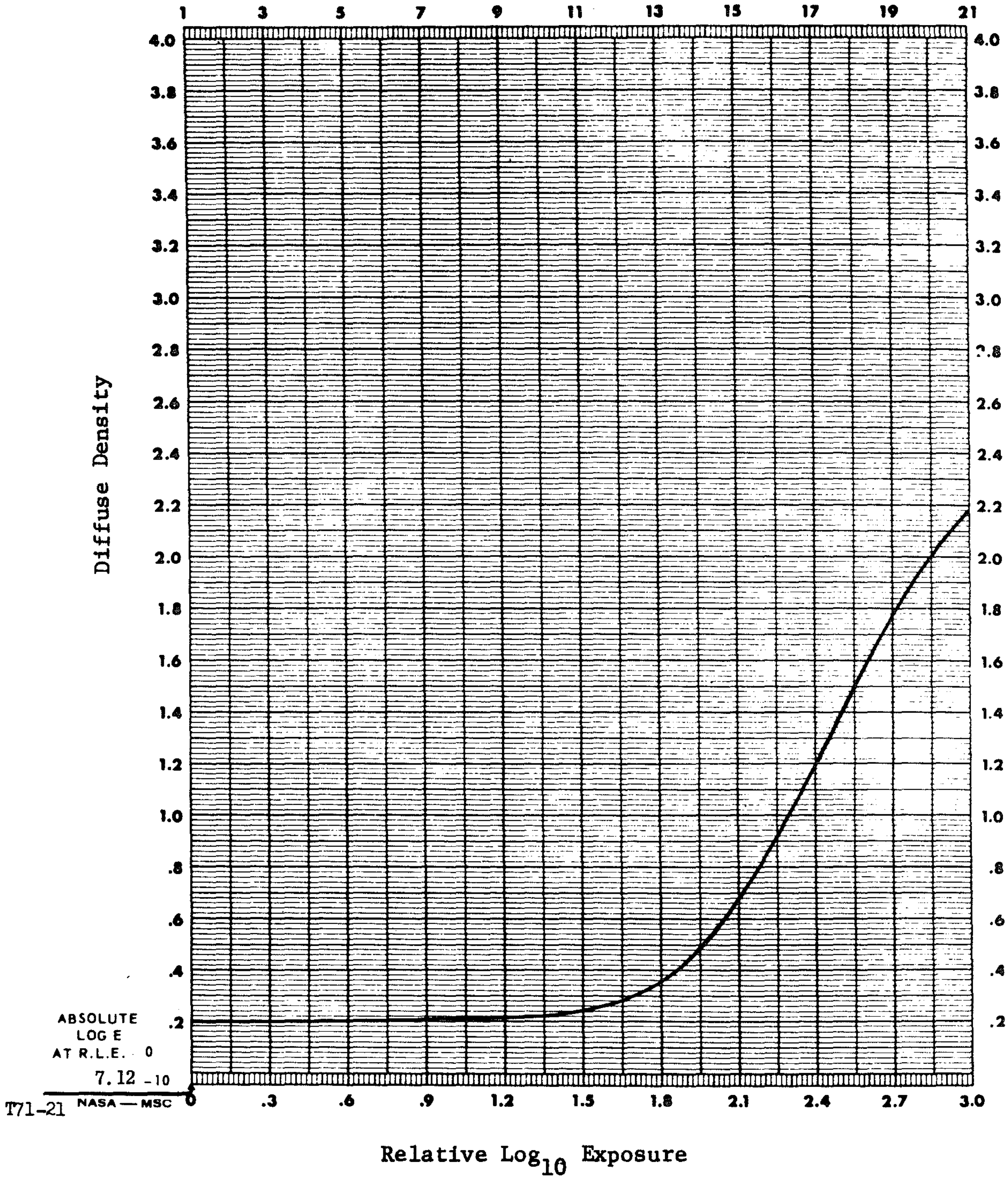
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK VERSAMAT 641 CHEMICALS AT 95°F PROCESSING TEMPERATURE:

Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Aerial Exposure Index
5	1	2.38	6.61
	2	2.00	10.23
10	1	2.50	4.68
	2	2.31	7.08
15	1	2.48	3.55
	2	2.30	5.62
20	1	2.15	2.69
	2	2.44	5.12

DATE June 1971 CONTROL # E TASK ____ PREPARED BY ____

FILM 3414 EMULSION # ____ MFG ____ EXPIRATION DATE ____

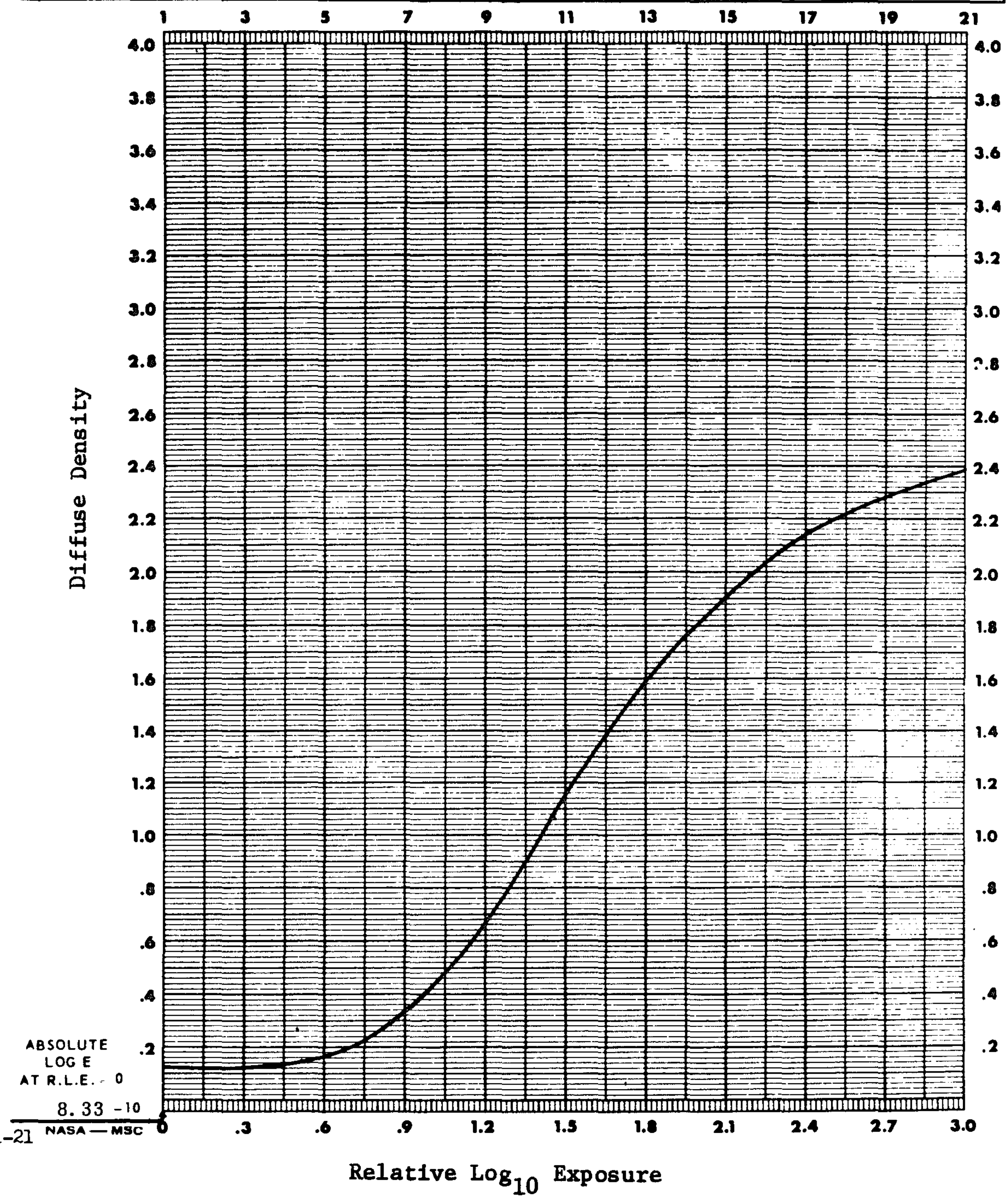
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Fultron	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-819	TYPE TD 403	D-MAX
TIME 1/100 SEC.	SPEED ____ TANKS 20 FPM	APERTURE SIZE 4 MM	GAMMA
FILTER 4750 °K	TEMP °F ____ TIME ____	FILTER Visual	BASE + FOG



DATE June 1971 CONTROL # F TASK ____ PREPARED BY ____

FILM SO-349 EMULSION # 9-1 MFG ____ EXPIRATION DATE ____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Vmt 11C-M#1	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY G4-L	TYPE TD 403	D-MAX
TIME 1/5 SEC.	SPEED 2 TANKS 8.25 FPM	APERTURE SIZE 4 MM	GAMMA 1.7
FILTER 4750°K + SCW	TEMP °F 80 TIME	FILTER Visual	BASE + FOG



T71-21

KODAK EKTACHROME EF FILM TYPE SO-168
(Estar Thin Base)

(This material was obtained from manufacturer's published information unless a specific test source is referenced.)

FILM CHARACTERISTICS*
A high-speed, color-reversal film for low level reconnaissance and mapping. This film has a 2.5-mil Estar base and high dimensional stability.

Note: This film is not available for use in commercial aerial cameras. It is a Special Order item designed for use in certain military cameras that have been constructed or modified to handle thin-base films.

BASE
This film has a 2.5-mil Estar polyester base with clear gel backing.

EXPOSURE
Suggested aerial exposure indexes for mechanized processing will be found in the tables which follow.
Aerial exposure indexes are designed for use with the Kodak Aerial Exposure Computer, Kodak Publication No. R-10. Aerial exposure indexes are not equivalent to, and should not be confused with, the conventional film speeds used in pictorial photography.

IMAGE-STRUCTURE CHARACTERISTICS; EA-4 chemicals at 3.2 fpm

Characteristic	Value	Classification
Resolving Power		
Test-object contrast 1000:1	80 lines/mm	Medium
Test-object contrast 1.6:1	36 lines/mm	Low
RMS Granularity (at net density of 1.0)	15	

MECHANIZED PROCESSING
The Kodak Ektachrome RT Processor, Model 1411, can be used to process this film using Kodak EA-4 chemicals.

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* This material describes the general characteristics of this film type. Sensitometric curves describe the results of a specific set of processing conditions on a specific emulsion batch. Experimenters are reminded that results may change somewhat from one emulsion to the next. Specific characteristics are determined for mission films as far as possible in advance of actual mission.

PROCESSING SEQUENCES WITH KODAK PROCESS EA-4 CHEMICALS:

Processing Step	Number of Racks	Time	Temperature
Prehardener	1 & 2	2'30"	95° ± 1°F
Neutralizer	3	1'15"	97° ± 3°F
First Developer	4 & 5	2'30"	100° ± ½°F
First Stop	6	1'15"	100° ± 1°F
Wash	7	1'15"	88° to 95°F
Color Developer	8 & 9	2'30"	110° ± 1°F
Second Stop	10	1'15"	110° ± 1°F
Wash	11	1'15"	88° to 95°F
Bleach	12	1'15"	110° ± 1°F
Fix	13	1'15"	110° ± 1°F
Wash	14	1'15"	88° to 95°F
Dryer		2'30"	125° ± 5°F

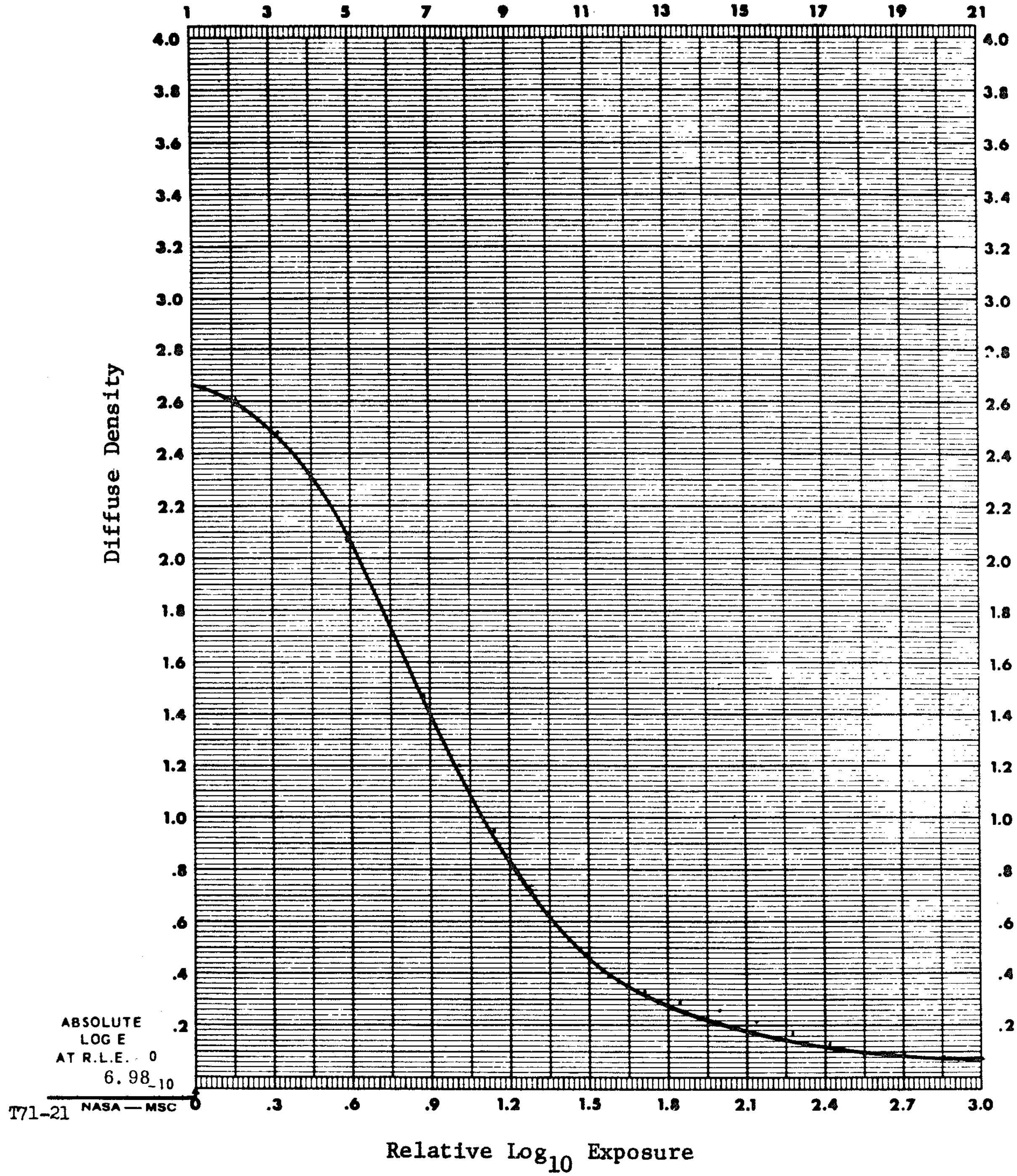
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK PROCESS EA-4 CHEMICALS AT 93.8°F:

Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Exposure Index
3.2	2	1.51	148 (ASA)

DATE June 1970 CONTROL # P TASK PREPARED BY

FILM SO-168 EMULSION # 6-1 (16mm) MFG EXPIRATION DATE

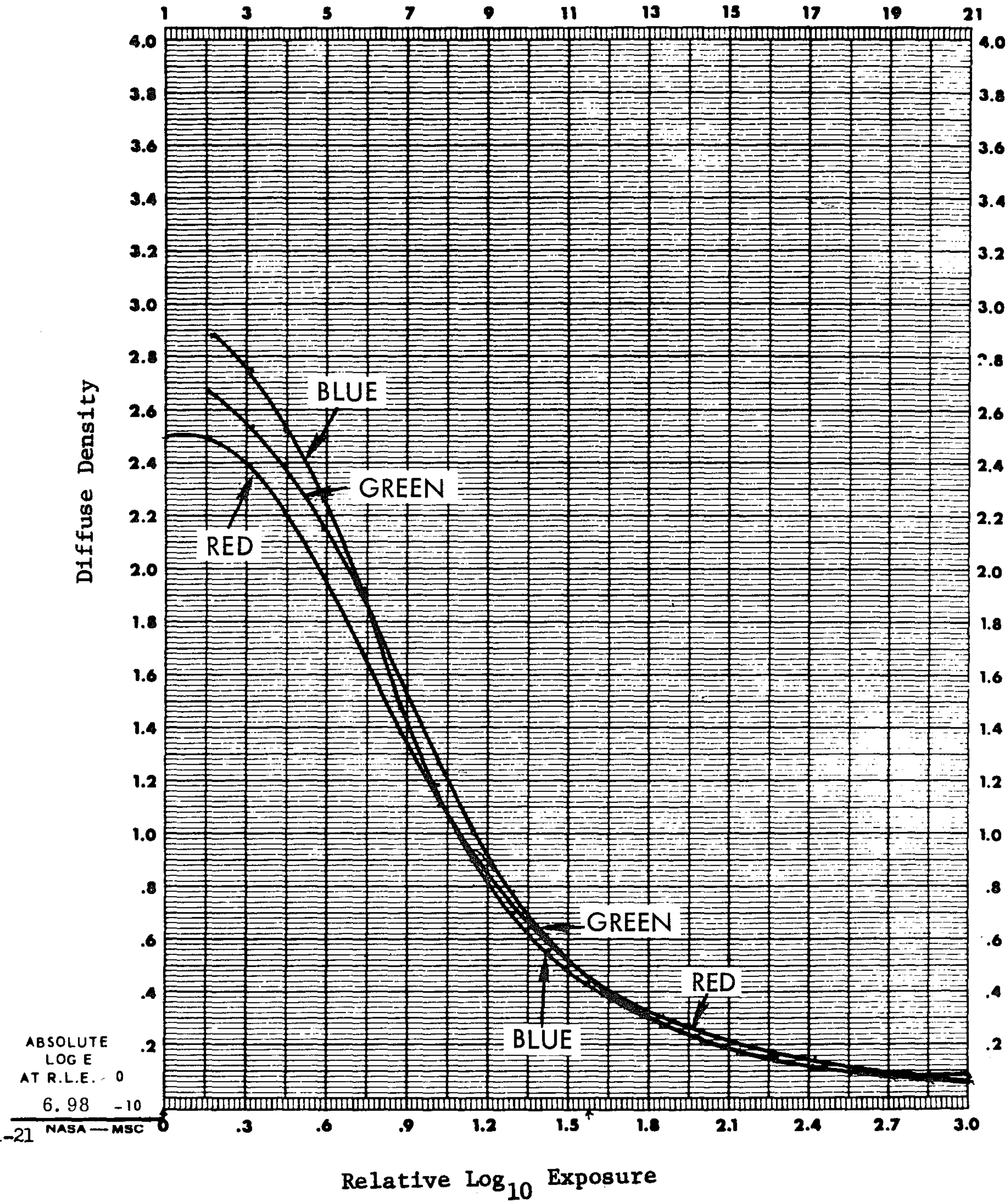
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR RAM	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY ME-4	TYPE TD 203	D-MAX
TIME 1/100 SEC.	SPEED TANKS FPM	APERTURE SIZE 4 MM	GAMMA
FILTER C5900	TEMP °F TIME	FILTER Visual	BASE + FOG



DATE June 1970 CONTROL # P TASK ______ PREPARED BY ______

FILM SO-168 EMULSION # 6-1 (16mm) MFG ______ EXPIRATION DATE ______

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR RAM	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY ME-4	TYPE TD 203	D-MAX
TIME 1/100 SEC.	SPEED ____ TANKS ____ FPM	APERTURE SIZE 4 MM	GAMMA
FILTER C5900	TEMP °F ____ TIME ____	FILTER Status A	BASE + FOG



T71-21

KODAK EKTACHROME MS FILM TYPE SO-368
(Estar Thin Base)

(This material was obtained from manufacturer's published information unless a specific test source is referenced.)

FILM CHARACTERISTICS*

A medium-speed, color-reversal film for low-altitude mapping and reconnaissance. This film has an antihalation undercoating. The physical characteristics, exposure, image-structure characteristics, and mechanized processing of this film are the same as those given for Kodak Aerial Color Film Type 2448.

Note: This film is not available for use in commercial aerial cameras. It is a Special Order item designed for use in certain military cameras that have been constructed or modified to handle thin-base films.

BASE

This film has a 2.5-mil Estar polyester base with fast-drying (PX) backing.

EXPOSURE

Suggested aerial exposure indexes for mechanized processing will be found in the tables which follow.

Aerial exposure indexes are designed for use with the Kodak Aerial Exposure Computer, Kodak Publication No. R-10. Aerial exposure indexes are not equivalent to, and should not be confused with, the conventional film speeds used in pictorial photography.

IMAGE-STRUCTURE CHARACTERISTICS; Kodak EA-4 chemicals with 2 developer racks at 3.2 fpm

Characteristic	Value	Classification
Resolving Power		
Test-object contrast 1000:1	80 lines/mm	Medium
Test-object contrast 1.6:1	36 lines/mm	Low
RMS Granularity (at net density of 1.0)	12	

* This material describes the general characteristics of this film type. Sensitometric curves describe the results of a specific set of processing conditions on a specific emulsion batch. Experimenters are reminded that results may change somewhat from one emulsion to the next. Specific characteristics are determined for mission films as far as possible in advance of actual mission.

MECHANIZED PROCESSING

The Kodak Versamat Film Processor, Model 1411, can be used to process this film using Kodak Versamat EA-4 chemicals.

PROCESSING SEQUENCES WITH KODAK EA-4 CHEMICALS:

Processing Step	Number of Racks	Time	Temperature
Prehardener	1 & 2	2'30"	95° ± 1°F
Neutralizer	3	1'15"	97° ± 3°F
First Developer	4 & 5	2'30"	100° ± ½°F
First Stop	6	1'15"	100° ± 1°F
Wash	7	1'15"	88° to 95°F
Color Developer	8 & 9	2'30"	110° ± 1°F
Second Stop	10	1'15"	110° ± 1°F
Wash	11	1'15"	88° to 95°F
Bleach	12	1'15"	110° ± 1°F
Fix	13	1'15"	110° ± 1°F
Wash	14	1'15"	88° to 95°F
Dryer		2'30"	125° ± 5°F

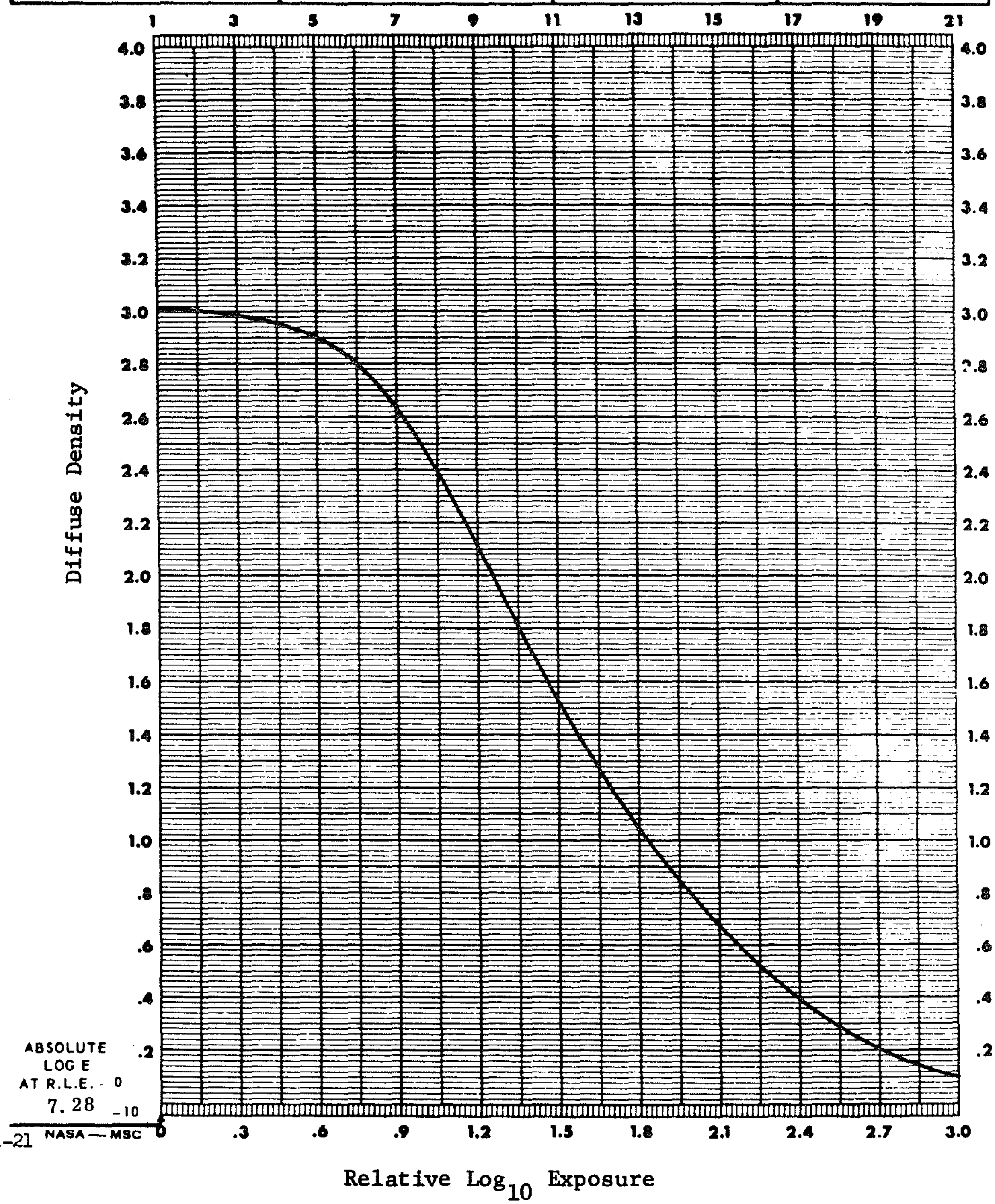
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK EA-4 CHEMICALS AT 109°F PROCESSING TEMPERATURE:

Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Aerial Exposure Index
3.2	2	1.93	6

DATE June 1971 CONTROL # M TASK ______ PREPARED BY ______

FILM SO-368 EMULSION # 16-31(16mm) MFG ______ EXPIRATION DATE ______

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Hi-Speed	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY ME-2A	TYPE TD 203	D-MAX
TIME 1/50 SEC.	SPEED ____ TANKS 34 FPM	APERTURE SIZE 4 MM	GAMMA 1.8
FILTER 5500°K	TEMP °F 74.5 TIME	FILTER Visual	BASE + FOG

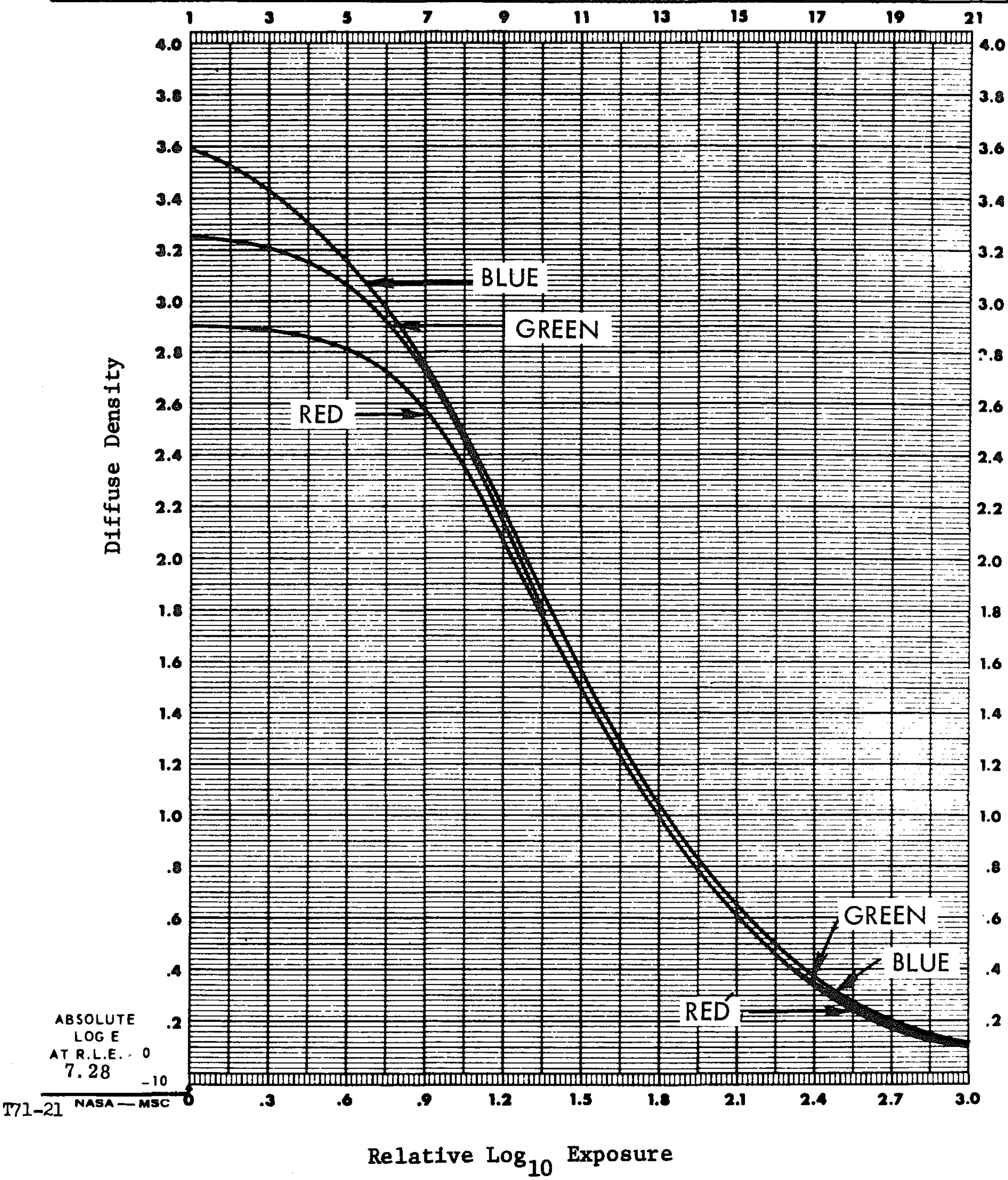


T71-21

DATE June 1971 CONTROL # M TASK PREPARED BY

FILM SO-368 EMULSION # 16-31 MFG EXPIRATION DATE

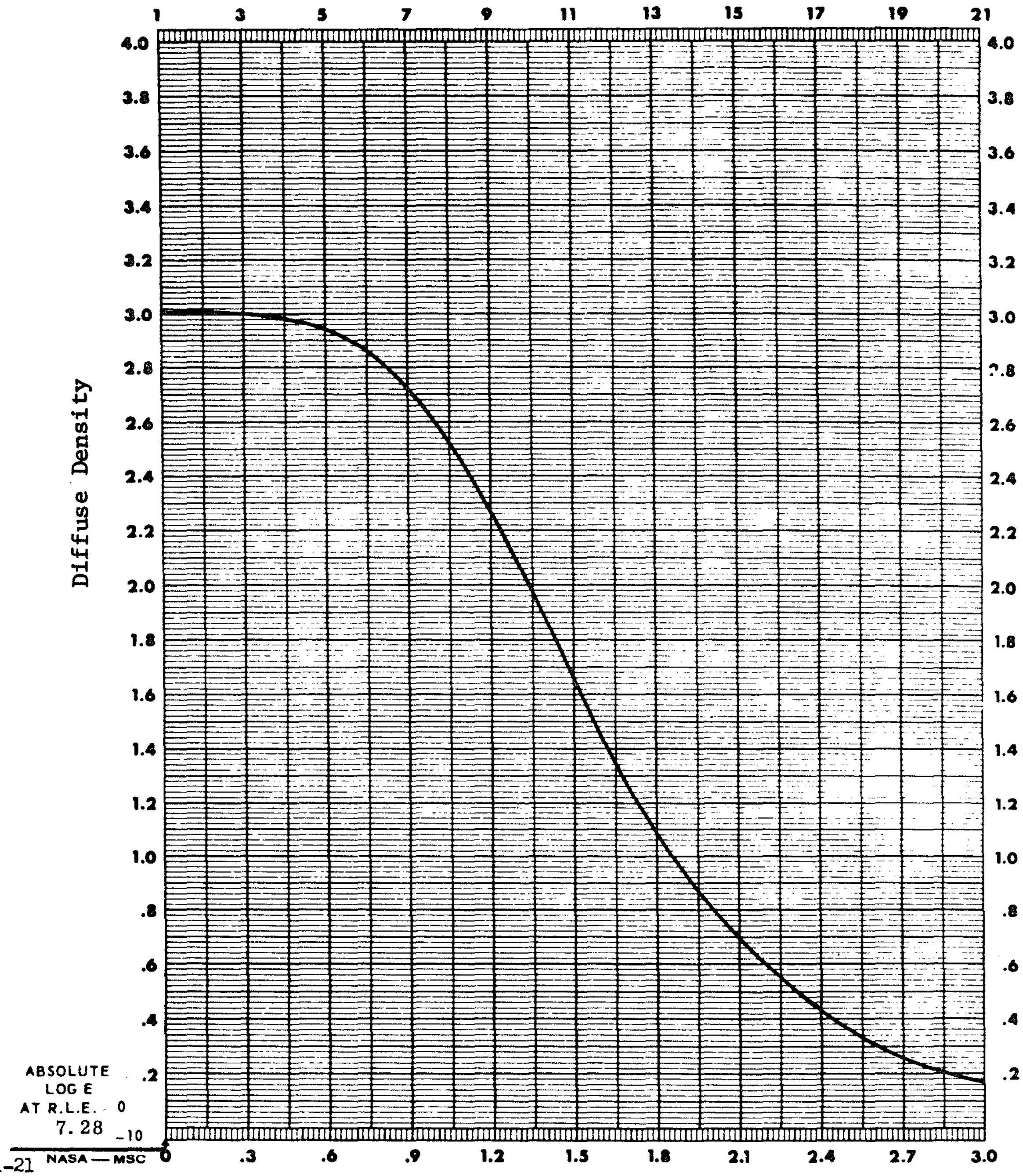
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Hi-Speed	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY ME-2A	TYPE TD 203	D-MAX
TIME 1/50 SEC.	SPEED TANKS 34 FPM	APERTURE SIZE 4 MM	GAMMA
FILTER 5500 K	TEMP °F 74.5 TIME	FILTER Status A	BASE + FOG



DATE June 1971 CONTROL # N TASK ______ PREPARED BY ______

FILM SO-368 EMULSION # 17-31 (70mm) MFG ______ EXPIRATION DATE ______

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Hi-Speed	INSTRUMENT Quantascan	SPEED (ASA) 58
ILLUMINANT 2850 °K	CHEMISTRY ME-2A	TYPE	D-MAX
TIME 1/50 SEC.	SPEED ______ TANKS 3 1/2 FPM	APERTURE SIZE ______ MM	GAMMA
FILTER 5500 °K	TEMP °F 74.5 TIME	FILTER Visual	BASE + FOG



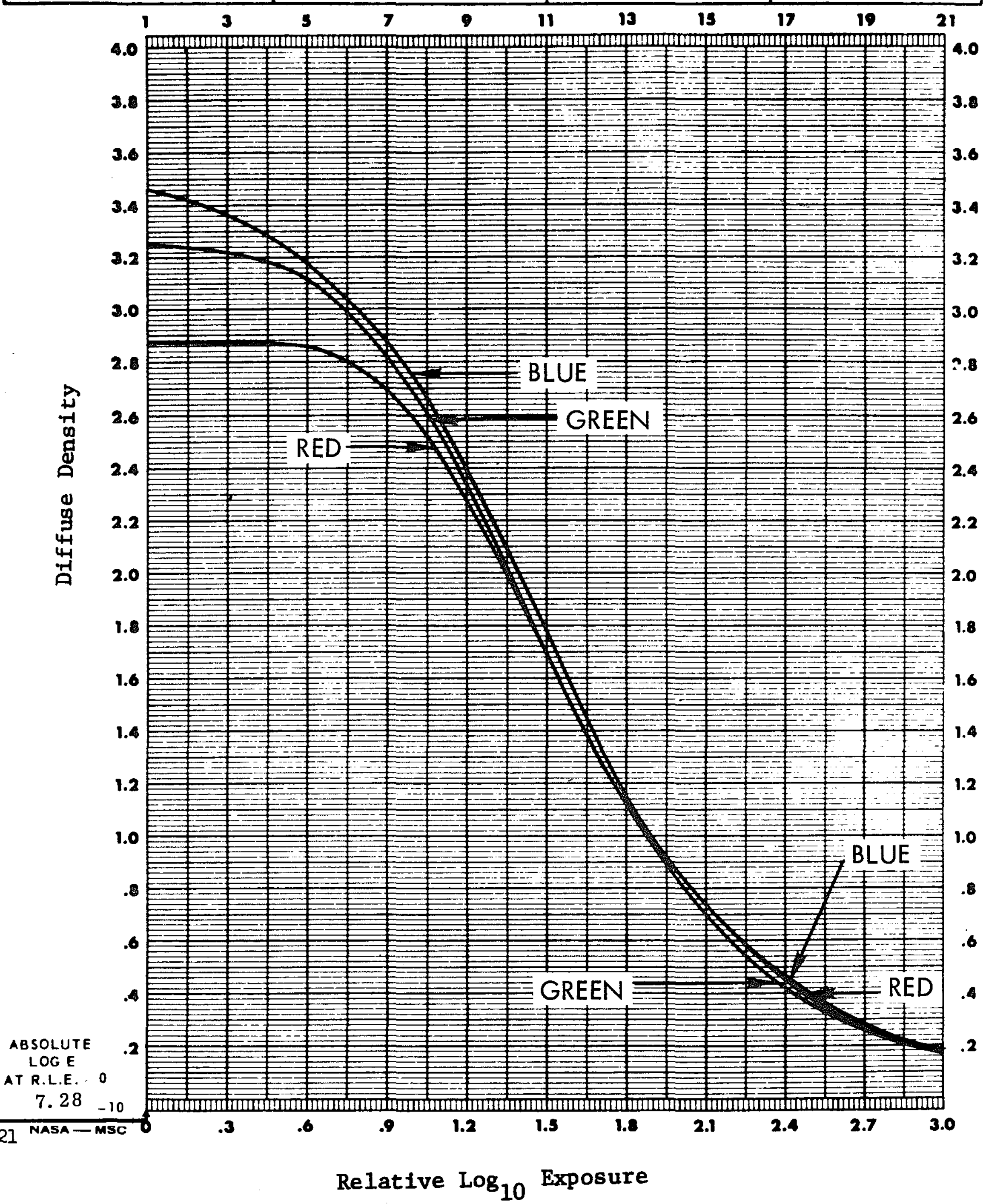
T71-21

Relative Log_{10} Exposure

DATE June 1971 CONTROL # N TASK ______ PREPARED BY ______

FILM SO-368 EMULSION # 17-31 (70mm) MFG ______ EXPIRATION DATE ______

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B	PROCESSOR Hi-Speed	INSTRUMENT Quantascan	SPEED (ASA) 58
ILLUMINANT 2850 °K	CHEMISTRY ME-2A	TYPE	D-MAX
TIME 1/50 SEC.	SPEED ___ TANKS 3 1/2 FPM	APERTURE SIZE ___ MM	GAMMA
FILTER 5500 °K	TEMP °F 74.5 TIME	FILTER Status A	BASE + FOG



T71-21 NASA — MSC

KODAK TV RECORDING FILM TYPE SO-394

Description TBD

☆ U.S. GOVERNMENT PRINTING OFFICE: 1972—779-263/851