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MSC-04010

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AS-511/CSM-112/LM-10

APOLLO MISSION J-1

(APOLLO 15)

MISSION SCIENCE PLANNING DOCUMENT

REVISION

MAY 15, 1971

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

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MISSION SCIENCE PLANNING DOCUMENT
APOLLO MISSION J-1
(Apollo 15)

REVISION

May 15, 1971

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

Contract NAS 9-8166

MISSION SCIENCE PLANNING DOCUMENT
APOLLO MISSION J-1
(Apollo 15)

REVISION

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ACKNOWLEDGMENT

A number of Manned Spacecraft Center and Contractor organizations were responsible for providing data contained in this document. Acknowledgment is made to the organizations listed below for their valuable support and contributions:

- Section III, Photographic Plan: Science Requirements and Operations Branch/TD5, supported by General Electric Company; Mapping Science Branch/TF5; and Photographic Technology Division/BL.

- Section IV, Lunar Surface Science Plan: Systems Engineering Division/PD, USGS Center of Astrogeology, and Bellcomm, Inc.

- Section VI, Science Recovery Plan: Science Requirements and Operations Branch/TD5, supported by General Electric Company.

- Section VII, Lunar Receiving Laboratory Plan: Lunar Receiving Laboratory/TL.

- Section VIII, Science Contingency Data: Science Requirements and Operations Branch/TD5, supported by General Electric Company.

- Appendix E, Film Characteristics and Processing Test Data: Photographic Technology Division/BL.

Information, advice, and support provided by many other organizations and personnel, 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-1. It is also intended to provide detailed interim data for use in implementing the science requirements presented in the MSC-controlled J-1 Mission Requirements Document (MRD) until such data are published in other MSC-controlled documents. These other documents include the Apollo 15 Flight Plan, Apollo 15 Lunar Surface Procedures, Apollo 15 Photographic and TV Procedures, Apollo 15 Flight Mission Rules, Apollo Operations Handbook, and CSM/LM Spacecraft Operational Data Book. The MRD contains the science and operational requirements for 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 eight sections: Section I, General Mission Science Planning; Section II, Experiment and Equipment Description; Section III, Photographic Plan; Section IV, Lunar Surface Science Plan; Section V, Science Activities Rationale; Section VI, Science Recovery Plan; Section VII, Lunar Receiving Laboratory Plan; and Section VIII, Science Contingency Data. These sections contain detailed data which supplement science requirements incorporated in Sections 4 and 5 of the MRD. The MSPD also includes 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 best satisfy user needs.

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

Mr. Richard R. Baldwin/TD5,
Science Support Engineer

and

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Science Requirements and Operations Branch

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SECTION I

GENERAL MISSION SCIENCE PLANNING

1.1 GENERAL

This section contains general information for the Apollo Mission J-1 (Apollo 15). It includes summarized mission characteristics (science-oriented); a brief description of the Hadley-Apennine landing site; a listing of each assigned experiment and detailed objective (DO) that is science-related, and their cognizant Principal Investigators and Points-of-Contact at the Manned Spacecraft Center (MSC); and a prioritized list of these experiments and detailed objectives. Experiments, DO's and cognizant personnel are presented in three tables: those for the command module are listed in Table 1-1, those for the service module in Table 1-2, and those related to lunar surface activities in Table 1-3. Priorities for assigned experiments and DO's are shown in Table 1-4.

Data presented in this section are intended primarily as general information for experiment Principal Investigators 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-1 Mission Requirements Document (Reference 1), Apollo 15 Flight Plan (Reference 2), Apollo 15 Lunar Surface Procedures (Reference 3), and Apollo 15 Photographic and TV Procedures (Reference 4). The J-1 Mission Requirements Document 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-1 MISSION CHARACTERISTICS

Apollo Mission J-1 is the first of three J-series missions planned for the Apollo Lunar Exploration Program. This mission series incorporates certain spacecraft hardware and crew equipment modifications as well as an enhanced 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. These increased capabilities (References 5, 6, and 7), compared to the results of the highly successful Apollo 14 mission (an H-series mission, H-3), will provide for

a) An extended total mission duration from 9 days to a planned 12.3 days (capability of 16 days)

b) An extended lunar surface stay time from 33.5 hours to a planned 67.3 hours

c) An extended total lunar surface extravehicular activity (EVA) time from 9.3 hours to a planned 20 hours

d) An increased lunar injected payload from 102,100 pounds to 107,350 pounds (control weight)

e) An increased lunar orbital science payload (including photographic and support equipment) from 250 pounds to 1050 pounds (control weight)

f) An increased lunar surface-landed science payload (including the LRV, photographic, and support equipment) from 510 pounds to 1200 pounds (control weight)

g) An increased lunar surface mobility, extravehicular activity (EVA), and exploration capability through the use of an advanced pressure suit, a modified portable life support system (PLSS), and the lunar roving vehicle (LRV) equipped with the lunar communications relay unit (LCRU), and the ground-commanded television assembly (GCTA)

h) Conducting a greater number and variety of scientific experiments and mapping operations from lunar orbit

i) Deployment of the Apollo 15 Lunar Surface Experiment Package (ALSEP) and the conducting of a greater number and variety of lunar geological activities

Nominally, the launch date for the Apollo 15 (J-1 Mission) will be July 26, 1971, with a planned landing in the Apennine Front/Hadley Rille region of the moon. This is an extremely attractive landing site from the standpoint of the lunar geologist in that lunar material for crew sampling is available and accessible at a mare basin/mountain front interface and at one of the lunar rilles. The particular and detailed geological features of interest as well as the detailed lunar surface exploration activities to be performed are described in Section IV of this document.

1.2.2 LANDING SITE DESCRIPTION

The J-1 Mission landing area, termed Hadley-Apennine (Reference 8) is located in the north-central part of the moon (latitude of 26° 04' 54" N, longitude of 3° 39' 30" E)* at the foot of the Apennine Mountains. These mountains rise 4.8 kilometers above the lunar surface and ring the south-eastern edge of the Mare Imbrium (Sea of Rains). In comparison, this great fault scarp is higher than the east face of the Sierra Nevada in the western United States as well as the great Himalayan Front that rises above the plains of India. The actual landing point of interest, however, is near the sinuous Rima Hadley (Hadley Rille) that winds down from the mountains and meanders across the Palus Putredinis (Swamp of Decay) in the Mare Imbrium.

Hadley Rille is a V-shaped sinuous rille that essentially parallels the Apennine Mountain front along the eastern boundary of Mare Imbrium. The rille originates in an elongated depression in an area of domes, possibly volcanic in nature, and generally has a width of about 1.5 kilometers and a depth of about 400 meters until it merges with a second rille approximately 100 kilometers to the north. Fresh exposures, possibly of stratified mare beds, occur along the top of the rille walls from which numerous large rocks have rolled to settle on the floor of the rille. The origin of sinuous rilles is very puzzling to selenographers, and is thought by some to be caused by some type of fluid flow mechanism, possibly volcanic. The Apennine Mountains that rise above the area adjacent to Hadley Rille contain ancient material exposed during the excavation of the Imbrium Basin. Sampling of Apennine material may provide specimens of ancient rocks whose origins predate the formation and filling of the major mare basins.

The Apennine Front, rille rim, the mare itself, an area of numerous and varied secondary crater clusters, and a constructional landform con-

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* These values are used for locating the landing point on a map product. The target point coordinates are 26° 04' 26" N, 3° 39' 14" E (Source: L.O. V 26.1 control data).

stitute major areas of geologic interest that will be sampled by the crew during their traverse activities.

1.2.3 PRIMARY MISSION SCIENCE OBJECTIVES

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

a) Perform selenological inspection, survey, and sampling of materials and surface features in a preselected area of the Hadley-Apennine region.

b) Emplace and activate surface experiments.

c) Conduct in-flight experiments and photographic tasks from lunar orbit.

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 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 other Apollo missions (e.g., Service Module Orbital Photographic Tasks). 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. The lone exception is the Lunar Dust Detector Experiment (M-515) which is classified as an engineering experiment. However, the data expected to be obtained from it are of interest to the scientific community, particularly to the Principal Investigators of the lunar surface experiments. Detailed objectives and experiments for all disciplines as well as operational tests to be performed on the J-1 Mission as authorized by the Apollo 15 Mission Implementation Plan (MIP) (Reference 9) are listed and detailed in the J-1 Mission Requirements Document (Reference 1) published by the Systems Engineering Division of the Apollo Spacecraft Program Office (ASPO). Changes in mission assignments 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 command module (CM); those to be performed from the service module (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 and objectives are listed in Table 1-3. These tables also list the Principal Investigator or Chairman of the Principal Investigator 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-1 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 Principal Investigator. Questions concerning integration of these experiments and objectives into mission and program planning should be referred to the Science Support Engineer for the J-1 Mission, Mr. Richard R. Baldwin/TD5. Mr. Baldwin represents the S&AD science interface with the ASPO J-1 Mission Staff Engineer, Mr. James M. Peacock/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

Earth orbit scientific activities will be primarily concerned with CM ultraviolet (UV) photography of the earth terrestrial, cloud, and water features for planetary "signature" analysis. The nominal 90-nautical mile earth parking orbit will be used. The translunar injection (TLI) burn from this orbit will occur nominally 1.5 revolutions after insertion of the Apollo spacecraft and S-IVB stage into this orbit.

1.3.2 TRANSLUNAR COAST SCIENCE ACTIVITIES

CM UV photography activities will be continued during the translunar coast at specified earth-moon distances to provide additional planetary feature "signature" data. Also, during this coast period, the spent S-IVB stage/instrument unit (IU) assembly will be guided to impact the lunar surface (latitude of 3°39'S, longitude of 7°35'W)* to provide a known seismic stimulus for sensors of the S-031 experiment previously emplaced on Apollo 12 and 14. The details of scheduling the remainder of the mission from just prior to lunar orbit insertion (LOI) through transearth injection (TEI) are still under review by MSC/NASA Headquarters elements; therefore, the discussion presented will represent the approach presented in References 2, 3, and 10 that is subject to change as the planning studies mature.

1.3.3 LUNAR SCIENCE ACTIVITIES

1.3.3.1 Lunar Orbit Science Activities

Jettison of the Scientific Instrument Module (SIM) door is scheduled to occur about 4.5 hours prior to lunar orbit insertion (LOI). This door protects the SIM science sensors and cameras from adverse mission environments (launch, service propulsion system contamination, etc.). Jettison prior to LOI keeps hazardous debris out of lunar orbit and prevents any subsequent CSM or subsatellite recontact. This service propulsion system (SPS) LOI burn will place the docked CSM/lunar module (LM) into a 170- by 60-nautical mile lunar orbit. Four hours later and following acquisition of S-band experiment data and operation of the SIM cameras, a second SPS retrograde burn will occur to place the docked CSM/LM into a 60- by 8-nautical mile orbit from which LM undocking and lunar descent will occur (LM S-band transponder experiment data will be acquired where possible during descent). LM undocking will occur about 17.5 hours after this burn. During this 17.5-hour time period, the SIM bay experiment sensors will be scanning the lunar surface and the CSM S-band transponder experiment will be performed.

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*These values are used for locating the impact point on a map product. (Source: Lunar Orbiter IV photography on Apollo 14 Orbit Monitor Chart)

Shortly after undocking (1.5 hours), the CSM will perform a third SPS burn (posigrade) to circularize its orbit to the 60-nautical mile specification. About 5 hours later*, the SIM subsatellite carrying equipment and sensors to perform the S-164, S-173, and S-174 experiments will be ejected into a near 60-nautical mile circular lunar orbit. The SIM bay experiments and photographic activities, CM photographic activities, and bistatic radar and CSM S-band transponder experiments can then be performed. This orbital science data gathering interval will continue through the LM lunar surface stay period until about 3.5 hours prior to ascent stage lift-off. A CSM lunar orbit plane change is scheduled about 6.5 hours prior to ascent stage lift-off.

After docking and crew/stowables transfer activities are complete, the LM ascent stage is undocked and propelled/guided to impact on the lunar surface (latitude of 26°15'N, longitude of 1°45'E)** as a known seismic stimulus for the ALSEP seismic experiment (S-031) emplaced during the surface phase of this mission.*** LM S-band experiment data will be obtained prior to impact. The SIM bay experiments and cameras are then reactivated. CM photography activities and the bistatic radar and CSM S-band experiments are also conducted. These activities continue until about 2.5 hours prior to TEI (approximately 50 hours available for orbital science data gathering including photography activities from CSM/LM ascent stage rendezvous to TEI). The total time period in lunar orbit in which CM and SIM experiments and photographic tasks can be scheduled is about 141 hours as measured from descent orbit insertion (DOI) to TEI.

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*Delay of the subsatellite launch is being considered until some time just prior to TEI. This time delay, in conjunction with multiple CSM SPS burns performed before subsatellite launch, is expected to result in a more favorable subsatellite launch orbit from the standpoint of increased orbital lifetime. Studies currently indicate that present subsatellite launch conditions result in complete orbital decay after 88 days from launch.

**Source: Lunar Orbiter V Rima Hadley Photo Map - Site 26.1, First Edition, April 1970.

***This impact may also be recorded by S-031 seismic sensors emplaced on the Apollo 12 and Apollo 14 missions.

1.3.3.2 Lunar Surface Science Activities

The LM is planned to touch down at its specified Hadley-North landing point at the Hadley-Apennine landing site about 4.5 hours after CSM undocking (26 hours after LOI) to begin a planned 67.3-hour lunar surface stay. This landing point permits meaningful geologic exploration and sampling from the LRV or from foot traverses if the LRV becomes inoperable. During this time it is planned to accomplish a 30-minute Standup EVA (SEVA) and three 2-man EVA's, 7-hour durations for each of the first two planned EVA's and a 6-hour duration for the last EVA. Traverse information is extracted from Reference 10.

The 30-minute SEVA will be performed by the LM Commander about 1 hour after lunar landing. He will stand on the ascent stage engine cover so that he extends through the LM docking hatch. From this elevated vantage point, he will make visual observations and obtain orientation data pertaining to the landing site, geological features, landmark identity, and suitability of planned traverse routes and experiment deployment sites. Hasselblad 70-mm stereo panoramic photography and long range 500-mm photography of far-field geological features will be performed from this high vantage point.

The first EVA will consist primarily of collection of the contingency sample; collection of documented samples at the Apennine Front with the use of the LRV; deployment of the Apollo 15 Lunar Surface Experiments Package (ALSEP), the Laser Ranging Retro-Reflector Experiment, the Solar Wind Composition Experiment; performing of operational and spacecraft checkout activities; and the conducting of other foot traverse and lunar geological tasks performed in the vicinity of the LM. The LRV traverse to the Apennine Front performed at the beginning of the EVA period will be the shortest (8.7 kilometers)* of the three lunar surface LRV traverses planned. The traverse will begin southward across the mare skirting the edge of the Hadley Rille elbow to the Apennine Front for sampling and exploration. The trek will continue eastward along the Front for a short distance, and then return across the mare to the LM. The second and third EVA's will consist of longer remote traverse exploration performed with the use of the LRV

*Distances quoted represent map distances multiplied by a factor of 1.1 to account for negotiation of the anticipated terrain profile.

and to include detailed lunar geological documentation, sampling, and observation tasks (including soil mechanics) conducted at the specified mandatory science stops and areas and at other stops-of-opportunity.

The second planned EVA and LRV traverse (16.0 kilometers in length)* will be conducted southeastward across the mare and along the west side of a mare secondary crater cluster to the Front. It will then proceed in a more easternly direction to a large fresh crater at the base of the Apennine Front scarp. The traverse will then be reversed with a return route virtually the same as the outgoing route with the exception of scheduled science stops at the crater cluster and in the mare during the inbound trek. The traverse will then terminate at the LM.

The third planned EVA and LRV traverse (11.6 kilometers in length)* will proceed westward along the mare to the edge of Hadley Rille. The traverse then turns northwestward along the rille in the terrace area for a short distance and finally veers in a northeastern direction extending through a complex of craters and large boulders to a scarp and constructional landform feature. Termination of the traverse occurs after the crew returns southward across the more to the LM.

The maximum return distance allowed for crew surface operations from the vicinity of the LM will be extended over that characterized by foot traverses on previous missions through the use of the upgraded PLSS and pressure suit, LRV, GCTA, and LCRU. An additional capability has been added in case of a PLSS failure, i.e., use of the Buddy Secondary Life Support System (BSLSS). Because of the possibility of such a failure, the LRV will never venture more than a return distance of 9.5 kilometers* from the LM at any time. This return distance is based upon an emergency LRV return using the BSLSS. The corresponding maximum allowable return distance for the case of a foot traverse is 3.8 kilometers* based upon a PLSS failure and BSLSS walkback. The total LRV traverse distance accumulated for all three EVA's is not expected to exceed 40 kilometers*. The GCTA carried on the LRV will support the lunar geological exploration activities conducted in the vicinity of the LM as well as the LRV activities conducted on the traverse sorties.

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*Distances quoted represent map distances multiplied by a factor of 1.1 to account for negotiating anticipated terrain profile.

1.3.4 TRANSEARTH COAST SCIENCE ACTIVITIES

Scheduled transearth coast science activities include: gamma-ray measurements of cislunar and cosmological space for background evaluation and cosmological spectrum determination, respectively; X-ray measurements of deep space and the measurement of X-ray flux emitted from selected galactic subjects for background evaluation and subject emission patterns, respectively; alpha particle measurements made concurrently with the X-ray measurements for engineering evaluation; and additional photography activities performed from the CM. In addition, assessments of the spatial extent and constituents of the spacecraft contamination "cloud" and the CSM/SIM radioactive background will be performed through measurements made with the gamma-ray and mass spectrometers, respectively. An EVA period lasting about 45 minutes is scheduled after TEI by the CM pilot to retrieve the SIM cameras' film cassettes. Pacific Ocean splashdown would nominally occur on August 8, 1971.

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 Application (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 appearing in this document are to be listed in the next revision of Reference 9.

Science experiments and detailed objectives to be performed from lunar orbit and on the lunar surface for the J-1 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) changes made in the science payload since previous missions; (4) the science opportunity for the mission such as a particular landing site; (5) hardware which is flown the first time; and (6) the role of the experiment or objective in integrated science planning for future flights and programs.

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

Table 1-1. J-1 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, includes use of: • Hasselblad Electric Camera • Maurer Data Acquisition Camera • 35-mm Camera	CSM Orbital Science Photographic Team Mr. Frederick J. Doyle, Chairman Topographic Division U.S. Geological Survey 1340 Old Chain Bridge 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. B. G. Cour-Palais/TN61 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-1 Command Module Science Experiments/Objectives and Cognizant Science Personnel (Continued)

LUNAR ORBIT EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
S-177	UV Photography-Earth and Moon	Dr. Tobias C. Owen Department of Earth and Space Sciences The State University of New York Stony Brook, New York 11790 (516) 246-5000	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-178	Gegenschein from Lunar Orbit	Mr. Lawrence Dunkelman, Code 613.3 Planetary Optics Section NASA Goddard Space Flight Center Greenbelt, Maryland 20771 (201) 982-4988	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-1 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, includes use of: • 24-Inch Panoramic Camera • 3-Inch Mapping Camera • Laser Altimeter	CSM Orbital Science Photographic Team Mr. Frederick J. Doyle, Chairman Topographic Division U.S. Geological Survey 1340 Old Chain Bridge 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-1 Service Module Science Experiments/Objectives and Cognizant Science Personnel (Continued)

LUNAR ORBIT EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
S-160	Gamma-Ray Spectrometer	Dr. James R. Arnold Chemistry Department University of California at San Diego La Jolla, California 92037 (714) 453-2000 Ext. 1453	Mr. Leo E. James/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-161	X-Ray Fluorescence	Dr. Isidore Adler, Code 641 Theoretical Studies Branch NASA Goddard Space Flight Center Greenbelt, Maryland 20771 (301) 982-5759	Mr. Leo E. James/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-162	Alpha Particle Spectrometer	Dr. Paul Gorenstein American Science and Engineering, Inc. 11 Carleton Street Cambridge, Massachusetts 02142 (617) 868-1600 Ext. 214	Mr. Leo E. James/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

Table 1-2. J-1 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 • Subsatellite • 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-165	Mass Spectrometer	Dr. John H. Hoffman Atmospheric and Space Sciences University of Texas at Dallas P.O. Box 30365 Dallas, Texas 75230 (214) 231-1471 Ext. 322	Mr. Vernon M. Dauphin/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-170	Bistatic Radar	Mr. H. Taylor Howard Stanford Electronics Laboratory Stanford University Stanford, California 94305 (415) 321-2300 Ext. 3537	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-1 Service Module Science Experiments/Objectives and Cognizant Science Personnel (Continued)

LUNAR ORBIT EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
S-173	Particle Shadows/Boundary Layer (Subsatellite)	Dr. Kinsey A. Anderson Space Science Laboratory University of California at Berkeley Berkeley, California 94726 (415) 642-1313	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-174	Magnetometer (Subsatellite)	Dr. Paul J. Coleman, Jr. Department of Planetary and Space Science University of California at Los Angeles Los Angeles, California 90024 (213) 825-1776	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 1-3. J-1 Lunar Surface Science Experiments/Objectives and Cognizant Science Personnel

LUNAR SURFACE EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
-	Contingency Sample Collection	MSC Science Working Panel Subgroup representing LSAPT* Dr. Robert O. Pepin, Chairman School of Physics and Astronomy University of Minnesota Minneapolis, Minnesota 55455 (612) 373-7874	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-031	Passive Seismic (Apollo 15 ALSEP Experiment)	Dr. Gary V. Latham Lamont-Doherty Geological Observatory Columbia University Palisades, New York 10964 (914) 359-2900	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-034	Lunar Surface Magnetometer (Apollo 15 ALSEP Experiment)	Dr. Palmer Dyal, Code N204-4 Space Science Division/ Electrodynamics Branch NASA Ames Research Center Moffett Field, California 94034 (415) 961-1111 Ext. 2706	Mr. Timothy T. White/TD4 Experiment Development and Integration Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

*LSAPT - Lunar Sample Analysis and Planning Team

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

LUNAR SURFACE EXPERIMENT/OBJECTIVE NO.	TITLE	PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
S-035	Solar Wind Spectrometer (Apollo 15 ALSEP Experiment)	Dr. Conway W. Snyder Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103 (213) 354-3744 Ext. 2302	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-036	Suprathermal Ion Detector (Apollo 15 ALSEP Experiment)	Dr. John W. Freeman Department of Space Science Rice University Houston, Texas 77001 (713) 528-4141 Ext. 1297	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-037	Heat Flow (Apollo 15 ALSEP Experiment)	Dr. Marcus E. Langseth Lamont-Doherty Geological Observatory Columbia University Palisades, New York 10964 (914) 359-2900	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-1 Lunar Surface Science Experiments/Objectives and Cognizant Science Personnel (Continued)

LUNAR SURFACE EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
S-058	Cold Cathode Ion Gauge (Apollo 15 ALSEP Experiment)	Dr. Francis S. Johnson University of Texas at Dallas P.O. Box 30365 Dallas, Texas 75230 (214) 231-1471 Ext. 201	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-059	Lunar Geology Investigation	Dr. Gordon A. Swann Center of Astrogeology U.S. Geological Survey 601 E. Cedar Avenue Flagstaff, Arizona 86001 (602) 774-5261 Ext. 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-078	Laser Ranging Retro-Reflector	Dr. James E. Faller Wesleyan University Middletown, Connecticut 06457 (203) 347-4421	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-1 Lunar Surface Science Experiments/Objectives and Cognizant Science Personnel (Continued)

LUNAR SURFACE EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
S-080	Solar Wind Composition	Dr. Johannes Geiss University of Berne Berne, Switzerland	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-200	Soil Mechanics	Dr. James K. Mitchell Department of Civil Engineering 440 Davis Hall University of California at Berkeley 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
M-515	Lunar Dust Detector (Apollo 15 ALSEP Experiment)	Mr. James R. Bates/TD5 Science Requirements and Operations Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-5851	Mr. James R. Bates/TD5 Science Requirements and Operations Branch Science Missions Support Division NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-5851

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

LUNAR SURFACE EXPERIMENT/OBJECTIVE	PRIORITY
Contingency Sample Collection	1
Documented Samples at Apennine Front (Part of Lunar Geology Investigation/ S-059)	2
Apollo 15 ALSEP	3
• Heat Flow Experiment (S-037)	3.1
• Lunar Surface Magnetometer (S-034)	3.2
• Passive Seismic Experiment (S-031)	3.3
• Cold Cathode Ion Gauge (S-058)	3.4
• Solar Wind Spectrometer (S-035)	3.5
• Suprathermal Ion Detector (S-036)	3.6
• Lunar Dust Detector (M-515)	3.7
Drill Core Sample (Part of Lunar Geology Investigation/ S-059)	4
Laser Ranging Retro-Reflector (S-078)	5
Lunar Geology Investigation (S-059)	6
Solar Wind Composition (S-080)	7
Soil Mechanics (S-200)	8

LUNAR ORBIT EXPERIMENT/OBJECTIVE	PRIORITY
Gamma-Ray Spectrometer (S-160)	1
X-Ray Fluorescence (S-161)	2
SM Orbital Photographic Tasks	3
Subsatellite	4
• Particle Shadows/Boundary Layer (S-173)	4.1
• Magnetometer (S-174)	4.2
• S-Band Transponder (S-164)	4.3
Bistatic Radar (S-170)	5
S-Band Transponder (CSM/LM) (S-164)	6
Alpha Particle Spectrometer (S-162)	7
Mass Spectrometer (S-165)	8
UV Photography - Earth and Moon (S-177)	9
Gegenschein from Lunar Orbit (S-178)	10
CM Photographic Tasks	11

NOTE: The Apollo Window Meteoroid Experiment (S-176) is not prioritized since it is passive and does not impact mission planning, crew activity, or spacecraft operations.

*Priorities are as to be presented in the next revision of the Mission Implementation Plan for the Apollo 15 Mission (Reference 9) and as stated in the following memorandum: "J-Mission Experiment Priorities," dated 4 May 1971, to TM (Manager, Lunar Missions Office) from MAL (Assistant Director, Apollo Lunar Exploration, Apollo Program Office).

SECTION II

EXPERIMENT AND EQUIPMENT DESCRIPTION

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-1; it also identifies deployment interfaces and major support hardware for these experiments and DO's. 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 2-41. Standard facility equipment, such as cameras used to satisfy the photographic requirements of these experiment 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 Principal Investigators 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 11), and Volume VI, CSM Experiments Data Book for J-Missions (Reference 12). Noncontrolled documents which contain detailed hardware information include the Apollo Operations Handbook, Block II Spacecraft, Volume I, Spacecraft Descriptions (Reference 13), Apollo Lunar Surface Experiments Package (ALSEP), Flight System Familiarization Manual (Reference 14), and Photo Equipment Handbook for Manned Space Flight (Reference 15).

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

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 terrestrial sources.

Photographic activities in the following categories will be conducted:

a) 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.

b) Dim light photography in lunar orbit:

Photographs are to be obtained of diffuse galactic light of celestial subjects, solar corona, lunar libration region, and zodiacal light.

c) Lunar surface photography during transearth coast:

Wide-area photographs are to be obtained of the lunar surface to extend selenodetic control and mapping.

d) Terrestrial and comet photography:

Photographs of the earth limb during solar eclipse by the earth, and comet photographs if appropriate trajectory and celestial conditions exist.

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 DAC for possible comet photography); the Hasselblad electric camera with 80-mm and 250-mm lens; a 35-mm camera with 55-mm lens; camera mounting brackets; and camera hoods or spacecraft window shades for dim light photography tasks. 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 for control of the reaction control system (RCS) jet firings to achieve and maintain the specified spacecraft attitude and attitude rates and to eliminate undesired illumination from the RCS during dim light photography activities.

2.2.1.2 Apollo Window Meteoroid (S-176)

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.

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

2.2.1.3 UV Photography - Earth and Moon (S-177)

The purpose of this experiment is to obtain ultraviolet (UV) photographs of the earth and moon for use in the study of planetary atmospheres, and for the investigation of short wavelength radiation from the lunar surface. It is planned to obtain color photographs of the same objects photographed in both the UV and visible spectra to aid in photography interpretation. The short wavelength studies of the lunar surface will aid in the search for lunar surface color differences and for the presence of possible fluorescence.

Photography is performed with the Hasselblad electric camera mounted in a special window bracket installed beside the right hand (RH) side window of the CM. This window has been designed to transmit a larger fraction of the incident UV radiation than the standard CM window. For UV photography on black and white film, a 105-mm lens and a ring slide assembly containing four band-pass filters are used with the camera. Three of the filters admit electromagnetic radiation in different regions of the UV spectrum and one filter admits electromagnetic radiation in the visible region of the spectrum. Color photography will be performed with the same camera and the visible spectrum filter. Crew participation is required to install the special bracket, mount and operate the camera, attach the filter slide, change filters and lens, and record the beginning and ending time of photographic exposure. The crew is also required to achieve and maintain the proper spacecraft attitude and attitude rates for each photographic sequence.

2.2.1.4 Gegenschein from Lunar Orbit (S-178)

The purpose of this experiment is to make photographic observations to determine if, and to what extent, reflection from dust particles at the Moulton point contributes to the gegenschein. Photographs will be taken in the direction of the antisolar vector, in the direction of the Moulton point, and midway between the antisolar and Moulton point directions.

Photography is to be performed by means of the 35-mm camera with its 55-mm lens while the CSM is in total darkness in lunar orbit. Window shades and a darkened spacecraft will be required to minimize effects of stray spacecraft light. The crew is required to maneuver the spacecraft to the proper attitude, inhibit RCS jets after the spacecraft attitude rates have damped below a specified level, operate the camera, and record the start and stop times of each of the required photographic exposures.

2.2.2 SERVICE MODULE SCIENCE EXPERIMENTS AND DETAILED OBJECTIVES

2.2.2.1 SM Orbital Photographic Tasks

The purpose of the SM Orbital Photographic Tasks detailed objective is to obtain high resolution panoramic and high quality metric lunar surface photographs and altitude data from lunar orbit to aid in the overall exploration of the moon. This detailed objective makes use of two camera assemblies and a laser altimeter mounted in the service module (SM) scientific instrument module (SIM) bay to obtain the required photographic and altitude data: They are the 24-Inch Panoramic Camera and 3-Inch Mapping Camera (with laser altimeter) assemblies.

a) 24-Inch Panoramic Camera. 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 also will aid the PI's for the other SIM experiments to correlate their experiment data with lunar surface terrain features. The camera will provide a 1- to 2-meter resolution photography from an orbital altitude of 60 nautical miles.

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 (provides GN_2 for certain film roller gas bearings). This GN_2 pressure vessel assembly is also used by the 3-Inch Mapping Camera. The camera optics system, camera/film drive and control system, and film cassette complete the camera system. The film cassette must be retrieved by a crewman extravehicular activity (EVA) during the transearth portion of the mission.

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 outside thermal control surface temperature conditions are experienced. Operational precautions must also be observed to protect the camera's V/h and AEC sensors from excess exposure to direct solar radiation since they cannot be protected by stowage as is the camera lens.

CM camera controls are available for the crew to activate/deactivate camera heaters; supply/remove primary camera power; select operate/standby operation modes; supply film roller torque to prevent film slack during launch, transluanr injection (TLI), and SPS-powered flight phases; activate the five-film frame advance cycle required daily (if camera was not operated in that 24-hour period) to prevent film set after film loading; increase/decrease the width of the camera exposure slit; and select the stereo or monoscopic mode of operation. One CM crew display of the "barber pole"/gray talkback type is provided to verify camera operational status.

b) <u>3-Inch Mapping Camera.</u> 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 also 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 for the other SIM experiments to correlate their experiment data with lunar surface terrain features. In addition, the stellar camera is operated on the lunar dark side in conjunction with the laser altimeter as film budgets permit. These time-correlated stellar photographs are used to provide a reference for the determination of the laser altimeter pointing vector (as well as the cartographic lens pointing vector for metric camera light side photography). The metric camera will provide 20-meter resolution photography from an orbital altitude of 60 nautical miles.

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 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 cameras to minimize potential static electrical corona discharge which could expose areas on the film. The camera optics system, film drive/exposure/takeup system, and a removable cassette (containing both metric and stellar camera film) complete the camera system. The film cassette is to be retrieved by a crewman EVA after photography operations are complete.

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 mapping camera lens and laser altimeter optics from spacecraft contamination sources during RCS/SPS firings and effluent dumps. This cover has provisions for multiple opening and closing cycles. A multiple opening and closing cover has also been recently provided to protect the stellar camera lens.

CM camera controls are furnished for the crew to activate/deactivate camera heaters and camera functions, to activate/deactivate the image motion compensation (IMC) switch and increment the camera velocity-to-height (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 lens/altimeter optics contamination cover when required. Two CM crew displays of the barber pole/gray talkback type are provided to verify camera operational status and to indicate the mapping camera system deployment status (fully extended/retracted). A third CM talkback display is also provided to indicate the deployment status of the lens/altimeter contamination cover.

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

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 mapping 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 mapping camera is operating, the altimeter automatically emits a laser pulse to correspond to a midframe ranging for each film frame exposed by the mapping camera. The altimeter is also capable of operating in a decoupled mode (from the mapping camera) which allows for independent ranging measurements (one every 20 seconds) when the mapping camera is inoperative.

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 Gamma-Ray Spectrometer (S-160)

The purpose of the Gamma-Ray Spectrometer Experiment assembly (Figures 2-1, 2-2, and 2-5) is to obtain data relating to the origin and evolution of the moon by determining the degree of chemical differentiation the moon has undergone during its development and to determine the composition of the lunar surface. Cosmological gamma-ray flux (to determine effect of lunar occultation on galactic flux change), cislunar space radiation flux, and the CSM/SIM radioactivity background flux measurements will be made during transearth coast to determine the contribution of these data to the experiment data. This instrument is capable of measuring gamma radiation in the energy range from 0.1 to 10 million electron volts.

The experiment sensing assembly is composed of three major subassemblies: (1) the gamma-ray detector; (2) the gamma-ray electronics; and (3) the thermal shield and experiment support bracketry. When gathering prime data, it is deployed from the CSM SIM bay on a boom by a mechanism to remove the detector from the influence of the CSM radiation environment. The fully deployed distance is 25 feet beyond the SM mold line when the detector is in its primary operational mode. Extensions of the boom to intermediate distances of 15 feet, 8 feet, and in the fully stowed positions are to be performed during transearth coast to obtain measurements required to assess the radiation background contributed by the CSM/SIM. The experiment assembly (including the boom deployment mechanism) is suspended from the bottom of the first shelf in the SIM bay. A protective box-like cover has been mounted to the SIM shelf and completely encloses the detector when it is fully retracted. The cover door opens automatically when the boom is extended and closes when it is retracted. This cover shields the instrument from the thermal environment produced by RCS engines that fire over the SIM bay.

CM controls are available for the crew to extend, retract, and jettison the boom. The crew may select any approximate intermediate boom position for the detector by monitoring the elapsed time* of boom extension or retraction. CM controls are provided for the crew to activate/deactivate the detector, incrementally alter the sensitivity (gain) of the detector, and select one of two detector counting modes. Two CM crew displays of the barber pole/gray talkback type are associated with boom status. They indicate the state of boom deployment (fully extended or retracted) and jettison (jettison complete or not).

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*Boom extension and retraction rates will be determined in real time by the crew through a combination of ground tests conducted on flight hardware and inflight operational tests conducted prior to experiment operation.

2.2.2.3 X-Ray Fluorescence (S-161)

The purposes of the X-Ray Fluorescence Experiment assembly (Figures 2-1, 2-2, and 2-6) are to measure the instantaneous fluorescent X-ray flux from the lunar surface; to monitor both the direct solar X-ray flux which produces this fluorescence and the background galactic X-ray flux in order to obtain a gross analysis of the elemental composition of the lunar surface materials; and to measure the X-ray flux of selected galactic objects for X-ray astronomy investigations. A separate assembly (Figure 2-7) termed the Solar Monitor, mounted in the SM bay (Bay IV) opposite the SIM, measures the solar X-ray flux. Background galactic X-ray flux, monitored at selected intervals both in lunar orbit and during transearth coast, is measured by the fluorescence X-ray sensor. This instrument is capable of detecting X-rays in the energy range from 1 to 6 kiloelectron volts.

The X-ray fluorescence sensing assembly consists of three gas-filled (P-10) proportional counter detectors, mechanical collimators, calibration sources for in-flight calibration, a temperature monitor, and associated electronics. A magnesium passive filter covers one detector and an aluminum passive filter covers the second detector; no filter is provided for the third or "bare" detector. This assembly is mounted in the same enclosure that houses the Alpha Particle Spectrometer Experiment. The combined package is mounted on the shelf forming the bottom of the CSM SIM bay. A protective cover (shared with the Alpha Particle Spectrometer Experiment) shields sensitive detector elements from spacecraft contamination sources. The cover mechanism provides multiple opening and closing cycles.

The solar monitor sensor has a view direction 180 degrees displaced from that of the X-ray fluorescence sensor. The solar monitor is provided with a door to shield its detector elements from adverse thermal contamination and launch environments encountered prior to LOI. This door, provided with only a one-time opening capability, is deployed in lunar orbit.

The X-Ray Fluorescence Experiment is designed to acquire data in its SIM-installed position. CM controls are available for the crew to activate/

deactivate the experiment (including heaters) and to deploy (open) the solar monitor door. Additional controls are provided to open and close the experiment detectors protective cover (shared with the Alpha Particle Spectrometer Experiment), when required. There are no CM displays for crew monitoring of the experiment itself. There is, however, one CM display of the barber pole/gray talkback type to indicate the deployment status of the protective cover.

2.2.2.4 Alpha Particle Spectrometer (S-162)

The purpose of the Alpha Particle Spectrometer Experiment assembly (Figures 2-1, 2-2, and 2-6) is to obtain data on the gross rate of lunar surface radon evolution and on localized sources of enhanced radon emission for use in constructing a radiation map showing lunar surface inhomogeneities. Alpha particles to be detected are those emitted from radon gas isotopes (Rn^{220}, Rn^{222}, and their daughter products). Measurements of deep space background alpha particle emission will also be made during lunar orbit and transearth coast concurrent with X-ray experiment operation. The experiment is capable of detecting alpha particles in the energy range from 3.5 to 7.5 million electron volts.

The alpha particle sensing assembly is composed of an array of 10 silicon barrier detectors, supporting electronics, and temperature monitors housed in the same enclosure as the X-ray fluorescence experiment assembly. This assembly is shielded from spacecraft contamination sources by the same cover that shields the X-ray fluorescence detectors.

The Alpha Particle Spectrometer Experiment is designed to acquire data in its SIM-installed position. CM controls are provided for the crew to activate/deactivate the experiment. As for the X-ray experiment, a CM control is furnished for the deployment of the shield protecting the experiment detectors from spacecraft contamination sources. There are no CM displays for crew monitoring of the experiment itself. The protective cover deployment status is indicated on the same talkback display shared with the X-ray experiment.

2.2.2.5 Mass Spectrometer (S-165)

The purposes of the Mass Spectrometer Experiment (Figures 2-1, 2-2, and 2-8) are to obtain data on the composition of the lunar ambient atmosphere, to determine areas of lunar volcanism, and to determine levels of contamination in the vicinity of the CSM. During transearth coast, the mass spectrometer will obtain data on the amount of local contamination caused by the spacecraft. This instrument has the capability of identifying species possessing an atomic mass from 12 to 28 AMU's* with its Number 1 ion counter and from 28 to 66 AMU's with its Number 2 ion counter.

The spectrometer experiment assembly consists of the mass spectrometer itself, its associated electronic components, and a boom deployment mechanism. A SIM shelf-mounted shield, to protect the spectrometer from spacecraft contamination sources when in its SIM-stowed position, opens and closes automatically when the boom is extended and retracted, respectively.

When gathering prime data, the spectrometer assembly is fully deployed on a boom by its deployment mechanism to remove the mass spectrometer from the influence of CSM contaminant sources. This fully deployed distance is 24 feet past the SM mold line. The spectrometer is also fully deployed for periods of ion source heater operation. The spectrometer is to be operated at various intermediate boom positions (including the stowed position) for specified periods during transearth coast to determine the gradient of constituents forming the CSM contamination "cloud." Photographs of the deployed spectrometer are taken from the CM at specified periods with the CM 16-mm DAC camera and 18-mm lens to determine the boom "twist" characteristics.

The mass spectrometer's spacecraft attitude requirements are unique with respect to those of the other SIM bay sensors and cameras in that its ion scoop is designed to acquire atmospheric constituents for sampling when the CSM's aft end is aligned along the positive direction of orbital motion (i.e., the CSM's nose aligned approximately to the direction of the negative spacecraft velocity vector). This operational attitude is termed -X direction operation and is the normal altitude for crew sleep

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*AMU - atomic mass unit

periods. The attitude used for operation of the other SIM bay sensors and cameras is with the CSM's nose aligned to the direction of the positive spacecraft velocity vector or +X direction operation. For both +X and -X operation, the SIM bay is aligned along the nadir. A period of +X direction operation for the mass spectrometer is scheduled on a noninterfering basis, however, for comparison/evaluation purposes.

The experiment assembly (including the deployment mechanism) is suspended from the bottom of the first shelf of the SIM bay. The gamma-ray and mass spectrometers are separated by approximately 15 feet if both are in the fully deployed position simultaneously.

CM controls are provided to extend, retract, and jettison the boom. The crew may select any approximate intermediate boom position for the spectrometer by monitoring the elapsed time* of boom extension or retraction. CM controls are provided for the crew to activate/deactivate the spectrometer, select high and low spectrometer sensitivity modes, select high and low spectrometer discrimination modes, and activate/deactivate the spectrometer ion source heaters. Two CM crew displays of the barber pole/gray talkback type are associated with boom status. They indicate the state of boom deployment (fully extended or retracted) and jettison (jettison complete or not).

2.2.2.6 Subsatellite

The subsatellite (Figures 2-1, 2-2, and 2-9), deployed from the CSM SIM bay while in lunar orbit, is the host carrier for three experiments to be conducted over a planned 1-year period. These experiments are the S-Band Transponder Experiment (S-164), Particle Shadows/Boundary Layer Experiment (S-173), and the Subsatellite Magnetometer Experiment (S-174).

The basic subsatellite elements are the subsatellite, a launch platform, and a mechanism to deploy the subsatellite and launch platform from the CSM SIM bay. The deployment mechanism provides for a subsatellite launch position that is clear of the SM mold line. The launch platform is retracted after launch. A box-like container similar to a "mail box" completely encloses the subsatellite, launch platform, and deployment

*Boom extension and retraction rates will be determined in real time by the crew through a combination of ground tests conducted on flight hardware and inflight operational tests conducted prior to experiment operation.

mechanism within the SIM bay. This container protects the subsatellite from spacecraft contamination sources prior to deployment. A door at the outboard end of the container automatically opens when the launch platform is extended and closes when it is retracted.

After the proper SIM bay launch attitude is achieved, the subsatellite launch platform then deploys the subsatellite in such a manner that its spin axis is approximately perpendicular to the ecliptic plane. The nominal linear launch velocity of the subsatellite is approximately 4 feet per second relative to the CSM to achieve the desired launch clearance. The subsatellite is provided an initial spin rate of 140 revolutions per minute for attitude stabilization by the launch platform. After complete satellite boom deployment, this spin rate is expected to stabilize at approximately 12 revolutions per minute. The subsatellite has three equally spaced, folded booms mounted around the base of the subsatellite which deploy automatically after launch to a length of 5 feet. The subsatellite magnetometer is mounted at the end of one boom, whereas the other two booms are provided to achieve the desired spin-stabilization characteristics for the subsatellite.

The subsatellite itself consists of charged particle detectors, a biaxial flux gate magnetometer, an optical solar aspect system (for subsatellite attitude determination), data storage unit, power system, command decoder, and an S-band communications system. Details of the subsatellite particle detectors are presented in Figure 2-10. CM controls are provided to deploy and launch the subsatellite as well as to retract the deployment mechanism back into the SIM bay. One multipurpose CM display of the barber pole/gray talkback type for the crew verifies launch of the subsatellite and full retraction of the deployment mechanism.

In addition to operation of the CM subsatellite launch controls, the crew is required to achieve and maintain the proper CSM attitude necessary for subsatellite launch. The crew will also obtain photographs of the launched subsatellite to verify boom deployment and operational attitude with the CM 16-mm DAC using the 75-mm lens and ring sight.

a) S-Band Transponder (S-164). The purpose of the subsatellite S-Band Transponder Experiment is to obtain data to study the lunar gravitational field. The location of regions possessing gravitational anomalies (e.g., mascons) is of paramount interest. The data obtained will consist of S-band doppler tracking measurements of the subsatellite in lunar orbit.

This experiment requires no flight hardware other than the subsatellite S-band transponder communications subsystem.

b) Particle Shadows/Boundary Layer (S-173). The purposes of the Particle Shadows/Boundary Layer Experiment (Figure 2-11) are to obtain data to study the formation and dynamics of the earth's magnetosphere, the interaction of plasmas with the moon, and the physics of solar flares. The data will consist of charged particle measurements made by the subsatellite in lunar orbit.

The subsatellite charged particle detectors and corresponding subsatellite support systems are used to conduct this experiment. Two types of particle detectors are used: telescope detectors and spherical electrostatic detectors.

The two silicon nuclear particle telescope detectors ("A" and "B") are capable of detecting both protons and electrons. Each telescope detector is composed of two subdetectors in series. The second subdetector in each series performs the anticoincidence function of counting particles that pass through the first subdetector. Both telescope detectors have the same number of electron counting channels (4) and proton counting channels (6). Telescope detector "A" detects electrons in the energy range from 20 to 320 kiloelectron volts and protons in the energy range from 50 kiloelectron volts to 2.0 million electron volts. Telescope detector "B" has foil covering its entrance aperture. This increases the detector's ability to count electrons and protons in the lower energy regions of an electron energy spectrum of 20 to 320 kiloelectron volts and proton energy spectrum of 320 kiloelectron volts to 2.3 million electron volts.

The subsatellite also has four spherical electrostatic analyzer detectors that are used to detect electrons. The A1 analyzer has one electron counting channel available for detecting electrons in the energy range from 0.58 to 0.65 kiloelectron volts. The A2 analyzer, also with one electron counting channel, detects electrons in the energy range from 1.93 to 2.17 kiloelectron volts. Analyzer A3 has two electron counting channels that detect electrons in the energy range from 5.72 to 6.40 kiloelectron volts and 5.65 to 6.55 kiloelectron volts, respectively. Analyzer A4 has five parallel funnel channeltrons that detect electrons in the energy range from 13.6 to 15.0 kiloelectron volts.

c) Subsatellite Magnetometer (S-174). The purposes of the Subsatellite Magnetometer Experiment (Figure 2-11) are to obtain data on the physical and electrical properties of the moon and the interaction of plasmas with the moon. The data will consist of magnetic field measurements made by the subsatellite in lunar orbit.

The subsatellite magnetometer, magnetic sector generator, and subsatellite support subsystems are used for this experiment. The magnetometer that acquires the prime data for this experiment is of the biaxial flux gate type and is boom-deployed from the subsatellite. This magnetometer measures the magnitude and polarity of two mutually orthogonal vector components: one parallel and the other perpendicular to the spin axis of the subsatellite. Rotation of the subsatellite in conjunction with the magnetic sector generator (generates 8 pulses every other revolution which divides the rotation time period into equal time increments over a rotational rate range from 7 to 14 revolutions per minute) provides the third vector component. The magnetometer acquires magnetic field data over a dynamic range of $\pm 50\gamma$ in the low operating mode range and $\pm 200\gamma$ in the high operating mode range.

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

This S-Band Transponder Experiment, to be conducted with the CSM and LM S-band transponders, is very similar to the experiment to be conducted on the subsatellite. Its purpose is to obtain S-band doppler resolver tracking data to determine the distribution of mass along the lunar surface ground track. The main difference of this experiment compared to the subsatellite S-band transponder experiment is that the total tracking period available is short-term.

This experiment is to acquire unperturbed (by non-gravitational forces) doppler S-band resolver tracking data from the CSM and LM during the unpowered portions of lunar flight. Tracking data are to be obtained from the docked CSM/LM while in the 170- by 60-nautical mile elliptical orbit, the 60-nautical mile circular orbit, and the lower altitude protion of the 60- by 8-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 doppler data obtained with the LM are especially valuable.

No flight hardware is required to conduct this experiment other than the use of the CSM and LM S-band communications system transponder.

2.2.2.8 Bistatic Radar (S-170)

The purpose of the Bistatic Radar Experiment (Downlink Bistatic Radar Observations of the Moon) is to obtain S-band and very high frequency (VHF) downlink bistatic radar data reflected from the lunar crust. These data are used to obtain information relative to lunar surface roughness, surface shape, regolith thickness, and surface electrical properties (measurement of the Brewster Angle will indicate the surface material dielectric constant) of the upper few meters of the lunar surface.

The experiment requires no flight hardware other than the CSM S-band (use of high-gain antenna preferred with omnidirectional antenna acceptable) and VHF (VHF scimitar antenna) communications subsystems. The crew is required to maintain a specific spacecraft and antenna pointing attitude (toward the lunar surface) during the time that bistatic measurements are being obtained.

2.3 LUNAR SURFACE SCIENCE EXPERIMENTS AND DETAILED OBJECTIVES

2.3.1 ALSEP EXPERIMENTS

2.3.1.1 ALSEP Central Station

The ALSEP Central Station (Figures 2-12 and 2-13) in conjunction with the SNAP 27 nuclear power source, though not an experiment, is required functionally by the array of surface experiments (Apollo 15 ALSEP) with which it interfaces, since it provides all of their required subsystems support. The experiments which it supports are the Passive Seismic Experiment (S-031), Lunar Surface Magnetometer Experiment (S-034), Solar Wind Spectrometer Experiment (S-035), Suprathermal Ion Detector Experiment (S-036), Heat Flow Experiment (S-037), Cold Cathode Ion Gauge Experiment (S-058), and the Lunar Dust Detector Experiment (M-515).

The central station consists of the communication subsystem transmitters and receivers (including antenna), the data subsystem, the electronics subsystem for the passive seismic experiment, thermal control provisions, shielding and housing for these subsystems, and a switch panel by which the astronaut can activate the central station if activation cannot be accomplished by ground commands. Electrical power (direct current) 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 2-14 and 2-15) are stored in the LM Scientific Equipment (SEQ) Bay (Figure 2-16); the RTG fuel capsule is attached to the outside of the LM descent stage (Figures 2-17 and 2-18).

Special tools used in assembly of the central station and RTG (Figures 2-19 and 2-20) include the fuel transfer tool, the universal handling tool, and the dome removal tool.

Photographic requirements of the deployed central station and ALSEP experiments (Figure 2-21) are accomplished with the Hasselblad electric data camera and its 60-mm lens, except as noted.

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

2.3.1.2 Passive Seismic Experiment (S-031)

The purpose of the Passive Seismic Experiment (PSE) is to measure seismic signals from all external and internal sources of seismic energy on the moon. These data will be used to determine the internal structure of the moon, the rate of energy release, and the numbers and masses of meteoroids impacting the lunar surface. This experiment uses the lunar surface impacts of the spent S-IVB and LM ascent stages as external calibration sources for the emplaced seismometers. Seismometer response to known mass and velocity of the spent stages at surface impact as well as the impact point lunar coordinates enables the computation of energy generated at impact, the point of energy application, and the corresponding seismic wave velocity.

Seismic data collected at several different locations on the lunar surface by more than one simultaneously active and widely dispersed instrument will increase the statistical significance of the data and improve the directional information obtained. The PSE to be deployed on the J-1 mission is a component of this network concept. The network is also composed of those PSE's previously emplaced and active on the moon and those to be emplaced on future J-missions.

The Passive Seismic Experiment (Figures 2-22 through 2-24) consists of two seismic assemblies: a long-period (LP) seismometer (triaxial, orthogonal) with a seismic frequency response from 0.004 to 3 Hertz (80-decibel dynamic range); and a short-period (SP) seismometer (uniaxial, vertical motion) with a seismic frequency response from 0.05 to 20 Hertz (80-decibel dynamic range). The minimum detectable signals of the PSE seismometers are 0.3 mμ at a frequency of 1 Hertz. These seismometers are housed in a drum-shaped enclosure rounded on the bottom (Figure 2-22). This enclosure rests on a support structure (stool) covered by a thermal shroud after deployment (Figure 2-23). The PSE electronics package located in the central station is cable-connected to the sensor assembly (Figure 2-24).

2.3.1.3 Lunar Surface Magnetometer (S-034)

The purpose of the Lunar Surface Magnetometer (LSM) is to measure the magnitude and temporal variations of the lunar surface magnetic field vector in order to determine the internal electrical properties of the moon.

The LSM equipment (Figure 2-25) consists of three boom-mounted flux gate magnetometers deployed from an electronics package emplaced on the lunar surface. These sensors are capable of full-scale measurement ranges of $\pm 50^{\gamma}$, $\pm 100^{\gamma}$, or $\pm 200^{\gamma}$ (range to be used is selected by earth commands) with a resolution and accuracy of 0.2 and 0.5 percent of full scale, respectively. The boom-mounted sensors can be rotated by small, automatically programmed electric motors to perform the magnetic field site survey. The electronics package is cable-connected to the central station. A tent-shaped mylar shroud that attaches to each of the boom arms is deployed by the crewman after LSM leveling and alignment to shade the LSM electronics package.

2.3.1.4 Solar Wind Spectrometer (S-035)

The purpose of the Solar Wind Spectrometer (SWS) Experiment is to measure energies, densities, incidence angles, and temporal variations of the electron and proton components of the solar wind plasma that strike the surface of the moon. These data will aid in establishing: the existence of the solar wind at the lunar surface; the general properties of the solar wind; and the properties of the earth's magnetospheric tail. Electrons can be detected in the energy range from 6.2 to 817 electron volts and 10.5 to 1376 electron volts. Protons are detected in the range from 45 to 5700 electron volts and 75 to 9600 electron volts.

The SWS equipment (Figure 2-26) consists of a sensor assembly, electronics assembly, thermal control assembly, and leg assembly. Seven Faraday cups (sensors) collect and detect the solar wind protons and electrons. These cups are provided with dust covers that are released and ejected by earth command after launch of the LM ascent stage. The SWS is electrically connected to the ALSEP central station by a 14-foot flat cable.

2.3.1.5 Suprathermal Ion Detector (S-036)/Cold Cathode Ion Gauge (S-058)

The purposes of the Suprathermal Ion Detector Experiment (SIDE) and Cold Cathode Ion Gauge (CCIG) Experiment are to determine the energy level and mass spectrum of the ionic environment of the moon resulting from ultraviolet ionization of the lunar atmosphere, free streaming solar wind ions and thermalized solar wind ions, and to determine the density of the lunar atmosphere. The suprathermal ion detector will measure the flux, number density, velocity, and energy per unit charge of positive ions in the vicinity of the lunar surface. The low energy detector will count ions in the velocity range from 4×10^4 to 9.35×10^6 centimeters/second and the energy range from 0.2 to 48.6 electron volts, which will enable determination of the distribution of ion masses up to 120 AMU. A separate detector will count higher energy ions (solar wind protons) in selected energy intervals between 10 and 3500 electron volts.

The Cold Cathode Ion Gauge (CCIG), a separate experiment integrated with the SIDE (Figure 2-27), determines the pressure (10^{-6} to 10^{-12} torr capability) of the ambient lunar atmosphere by measuring simultaneously the density of atmospheric neutral atoms and the gauge temperature. The CCIG also will measure the rate loss of contaminants left in the landing area by the crewmen and the LM.

The SIDE experiment (Figure 2-27) consists of a velocity filter, a low-energy curved plate analyzer ion detector, a high-energy curved plate analyzer ion detector, the CCIG which is classified as a separate experiment (S-058), a wire-mesh ground plane, and associated electronics. The detector and electronics are housed in an internal chassis that makes use of such devices as mirrors, coatings, thermal spacers, and heaters for thermal control. The base of the chassis is supported by two short and one long foldable legs. The long leg provides a SIDE tilt capability for off-equator site alignment. The CCIG housing, deployed separately from the SIDE on the pivoted SIDE ground screen storage tube*, is connected to the SIDE by a short cable. The ground plane is placed beneath the SIDE to provide an equipotential reference surface for control of local electric fields. A dust/moisture shield covering the CCIG aperture is removed by ground command after LM ascent stage lift-off. The SIDE is connected to the ALSEP central station with a flat cable.

*Deployment scheme is a recent design change instituted as a result of deployment difficulties encountered during the Apollo 14 mission.

2.3.1.6 Heat Flow Experiment (S-037)

The purpose of the Heat Flow Experiment (HFE) is to determine the rate of heat loss from the lunar interior. To perform this function, two holes are drilled in the lunar surface by a crewman to a depth of about 3 meters by means of the Apollo lunar surface drill (ALSD) for emplacement of heat flow instrumentation (probes). This experiment can detect lunar temperatures in the following ranges with corresponding accuracies noted in parentheses: high sensitivity measurements of ± 2°C (0.003°C) temperature difference; low sensitivity measurements of ± 20°C (0.03°C) temperature difference; probe ambient temperatures in the range from 200°K to 250°K (0.1°K); thermocouple reference temperature from -20°C to 60°C (0.1°C); and probe cable ambient temperatures from 90°K to 350°K (0.3°K).

The Heat Flow Experiment equipment (Figures 2-28 and 2-29) consists of two probes each about 1.2 meters in length for insertion into each of the drilled holes (the bore stem assembly used in drilling remains in the hole to provide a casing to prevent hole wall collapse during probe insertion), a special tool for probe insertion, and an electronics package that is cable-connected to the probes and the central station. The ALSD (Figures 2-30 and 2-31) is composed of the drill with core stem caps and retainers, core stems, open core bit, bore bit/drill adapter, bore stems with closed bit, treadle, and a bore stem/core stem wrench (wrench is mounted on the LRV aft pallet.)

Relative placement of the drilled holes with respect to the HFE electronics package, Central Station, and other ALSEP experiments is shown in Figure 4-5. It is highly desirable that the deep core sample (3 meters) obtained with the ALSD as part of the lunar geology activities be taken within 10 meters of the deployed HFE. This returned core sample will supply additional information for postmission HFE data interpretation by the PI.

2.3.1.7 Lunar Dust Detector Experiment (M-515)

The purpose of the Lunar Dust Detector Experiment (LDDE) is to separate and measure high-energy radiation damage to three solar cells, measure reduced solar cell output due to dust accumulation, and measure reflected infrared energy and temperatures for use in computing lunar surface temperature.

The dust detector (Figure 2-32) has two components: a sensor package mounted to the top of the central station sunshield and a printed circuit board located within the central station which interfaces with the power distribution unit of the ALSEP data subsystem.

2.3.2 OTHER SURFACE EXPERIMENTS AND DETAILED OBJECTIVES

2.3.2.1 Contingency Sample Collection

The purpose of the Contingency Sample Collection detailed objective is to collect a small sample of loose material (approximately 2 kilograms) in the immediate vicinity of the LM during the early part of the first EVA period. This will increase the probability of returning a lunar sample to earth in the event of early termination of the EVA period.

The only equipment used for this objective by the astronaut is the contingency sampler including the contingency sample collection container (Figure 2-33). Documentation photography is provided by the LM 16-mm DAC (10-mm lens) mounted in the LM window.

2.3.2.2 Lunar Geology Investigation (S-059)

The purposes of the Lunar Geology Investigation Experiment are to obtain a better understanding of the nature and development of the Apennine Mountain area and the processes which have modified the highland surface, through the study of documented lunar geological features and returned lunar samples. This experiment will be conducted by the Apollo lunar Geology Experiment Team (Experiment S-059) for J-1, in consultation with the MSC Science Working Panel representing the requirements of Principal Investigators for sample analyses.

The major equipment used for this experiment are: hammer; tongs; extension handle; adjustable sampling scoop; rake; gnomon/color patch; spring scale; core tubes*/caps; documented sample bags; sample collection bags; special environmental sample containers; and sample return containers (Figures 2-34 through 2-36). A deep (3-meter) core sample is obtained with the use of the ALSD core stems, bit, and caps.

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*Also called "drive" tubes

The hand tools (hammer, tongs, etc.) used for this experiment are the standard Apollo lunar hand tools (ALHT) and will be located on the Apollo Lunar Hand Tool Carrier (ALHTC) attached to the LRV aft pallet (Figure 2-37). Attachment of tools and collection bags to the PLSS of the Lunar Module Pilot (LMP) and Commander (CDR) for geological activities conducted from the LRV is shown in Figure 2-38.

Photography requirements for this experiment are satisfied with the use of the Hasselblad electric data camera (60-mm lens) and a Hasselblad electric data camera especially adapted for use with a 500-mm lens. This latter camera has been given the nomenclature of Long Focal Length Camera (LFLC). The GCTA controlled by ground commands provides real-time ground and science support for the geology activities.

The astronauts select sites (if not previously designated) of geologic interest, obtain and document the required geologic samples, and perform the required lunar geological photography and observations.

2.3.2.3 <u>Laser Ranging Retro-Reflector (S-078)</u>

The purpose of the Laser Ranging Retro-Reflector Experiment (LRRR) is to deploy the LRRR Experiment package on the lunar surface to provide a corner reflector for laser ranging from earth. These ranging data will provide information relative to lunar motion, lunar librations, and earth rotation.

The LRRR experiment (Figure 2-39) consists of a folded panel structure incorporating 300 individual fused silica optical corner reflectors, a simple alignment/leveling device, and an aim-handle mechanism. The LRRR becomes passive in nature after deployment. The LRV will be used to carry the LRRR to its specified deployment site.

Photography requirements for this experiment are met with the use of the Hasselblad electric data camera (60-mm lens).

The astronaut will deploy, align, aim, and level the LRRR.

2.3.2.4 Solar Wind Composition (S-080)

The purpose of the Solar Wind Composition (SWC) Experiment is to determine the elemental and isotopic composition of the noble gases and other selected elements in the solar wind by measurement of particle entrapment on an exposed aluminum foil sheet. These data will help provide resolution of competitive theories in the field of elemental synthesis, origin of the solar system, history of planetary atmospheres, and solar wind dynamics.

The SWC experiment (Figure 2-40) consists of an expanse of foil unrolled from a reel to face the sun vector and is mounted on a support structure emplaced on the lunar surface. The experiment is deployed and emplaced on the first EVA and the foil and reel are retrieved on the last EVA by the crewman.

Photography requirements for this experiment are met with the use of the Hasselblad electric data camera (60-mm lens).

2.3.2.5 Soil Mechanics (S-200)

The purpose of the Soil Mechanics Experiment is to obtain data on the characteristics and mechanical properties of the lunar soil at the surface and subsurface and their variations in a lateral direction.

The equipment (Figure 2-41) for the Soil Mechanics Experiment includes the use of the adjustable sampling scoop and self-recording penetrometer with interchangeable load plate and cone. Lunar samples are obtained from the Lunar Geology Investigation (S-059) activities from which further soil mechanics data are derived by testing in the LRL. These samples include the core tube samples and other geological specimens, especially the fine-grained soil samples.

Photography requirements for this experiment are met with the use of the battery-operated 16-mm data acquisition camera (10-mm lens) and the Hasselblad electric data camera (60-mm lens). The GCTA also is used in a real-time science support role.

The astronauts perform the required trenching activities, penetrometer load plate and cone tests, and soil behavior/characteristics observations such as the LRV wheel/lunar soil interaction and LM footpad/soil interaction. A crewman removes the head* from the penetrometer after all tests are complete for stowage and subsequent earth return.

*The penetrometer head contains the recording drum which indicates the results of all penetrometer tests.

Table 2-1. Lunar Orbit Science Equipment Summary

EXP. NO.	EXPERIMENT/OBJECTIVE	SPACECRAFT LOCATION	DEPLOYMENT	EQUIPMENT
---	CM Photographic Tasks	Command Module	None	• Electric Hasselblad Camera/ 80-mm Lens/250-mm Lens • Data Acquisition Camera/ 18-mm Lens • 35-mm Camera/55-mm Lens • Window Mounting Bracket • Sextant Optical Adapter
S-176	Apollo Window Meteoroid	Command Module	None	• CM Windows
S-177	UV Photography - Earth and Moon	Command Module	None	• Special CM RH window (high UV transmissivity) • Electric Hasselblad Camera/ 105-mm Lens (UV transmitting) • Mounting Bracket • 3 Filters - UV Spectrum • 1 Filter - Visible Spectrum • Filter Ring Slide
S-178	Gegenschein From Lunar Orbit	Command Module	None	• 35-mm Camera/55-mm Lens • CM Window Shades • Window Mounting Bracket

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

EXP. NO.	EXPERIMENT/OBJECTIVE	SPACECRAFT LOCATION	DEPLOYMENT	EQUIPMENT
---	SM Orbital Photographic Tasks	Service Module (SIM Bay)	None	• 24-Inch Panoramic Camera • Roll-Frame Assembly • Gimbal Assembly • Main Frame • GN_2 Pressure Vessel Assembly • Film Cassette • CM Crew-Operated Switches • CM Crew Display
			Rail-Type Mechanism	• 3-Inch Mapping Camera • Metric Camera • Stellar Camera • GN_2 Pressure Vessel Assembly • Film Cassette • CM Crew-Operated Switches • CM Crew Displays • Metric Camera Contamination Optics Shield (Shared with Laser Altimeter) • Stellar Camera Optics Shield
			Rail-Type Mechanism (Mounted to Mapping Camera)	• Laser Altimeter • CM Crew-Operated Switch • Contamination Optics Shield (Shared with Mapping Camera)

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

EXP. NO.	EXPERIMENT/OBJECTIVE	SPACECRAFT LOCATION	DEPLOYMENT	EQUIPMENT
S-160	Gamma-Ray Spectrometer	Service Module (SIM Bay)	Boom Mechanism	• Gamma-Ray Detector and Electronics • Thermal Protection Shield • Boom Deployment Assembly • CM Crew-Operated Switches • CM Crew Displays
S-161	X-Ray Fluorescence	• Fluorescence Sensor • Service Module (SIM Bay) • Solar Monitor • Service Module (Bay IV)	None	• X-Ray Fluorescence Sensing Assembly and Supporting Electronics (In same housing as Alpha Particle Experiment) • Solar Monitor • Contamination Sensor Shield (Shared with Alpha Particle Experiment) • CM Crew-Operated Switches • CM Display (Contamination Shield)

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

EXP. NO.	EXPERIMENT/OBJECTIVE	SPACECRAFT LOCATION	DEPLOYMENT	EQUIPMENT
S-162	Alpha Particle Spectrometer	Service Module (SIM Bay)	None	• Alpha Particle Sensing Assembly • Detector Array and Supporting Electronics (in same housing as X-Ray Fluorescence Sensing Assembly) • Contamination Sensor Shield (Shared with X-Ray Experiment) • CM Crew-Operated Switch • CM Display (Contamination Shield)
S-164	S-Band Transponder (CSM/LM)	• Command and Service Module • Lunar Module	None	• Equipment used is all operational (Spacecraft S-band Communications Subsystem)
S-165	Mass Spectrometer	Service Module (SIM Bay)	Boom Mechanism	• Mass Spectrometer Assembly • Mass Spectrometer • Electronics • Ion Source Heaters • Boom Deployment Mechanism • Contamination Shield • CM Crew-Operated Switches • CM Crew Displays • CM DAC/18-mm Lens
S-170	Bistatic Radar	Command and Service Module	None	• Spacecraft S-band and VHF Communications Subsystem

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

EXP. NO.	EXPERIMENT/OBJECTIVE	SPACECRAFT LOCATION	DEPLOYMENT	EQUIPMENT

---	Subsatellite	Stowed in Service Module (SIM Bay) Until Ejection	Ejected by spring mechanism after deployment from SIM on launch platform	• Launch Platform
				• Deployment Mechanism
				• Subsatellite
				  • Booms
				  • Charged Particle Detectors
				  • Magnetometer
				  • Data Storage Unit
				  • Solar Cell-Battery Power System
				  • S-Band Communications Subsystem
				• Contamination Shield Enclosure (SIM Bay)
				• CM Crew-Operated Switch
				• CM Crew Display
				• CM DAC/75-mm Lens
				  • Ring Sight

S-164	S-Band Transponder	Subsatellite	None	• Spacecraft S-band Communications Subsystem
S-173	Particle Shadows/Boundary Layer	Subsatellite	None	• Charged Particle Detectors • Subsatellite Support Subsystems

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

EXP. NO.	EXPERIMENT/OBJECTIVE	SPACECRAFT LOCATION	DEPLOYMENT	EQUIPMENT
S-174	Subsatellite Magnetometer	Subsatellite	5-Foot Subsatellite Boom	• Magnetometer • Subsatellite Support Subsystems • Deployment Boom

Table 2-2. Lunar Surface Science Equipment Summary

EXP. NO.	EXPERIMENT/OBJECTIVE	CENTRAL STATION INTERFACE	EQUIPMENT
---	Contingency Sample Collection	No	• Contingency Sampler Assembly • LM Data Acquisition Camera/ 18-mm Lens
---	ALSEP Central Station (Apollo 15 ALSEP)	--	• ALSEP Communications Subsystem (including antenna) • ALSEP Data Subsystem • Electronics Subsystem for ALSEP Seismic Experiment • Housing for Above Subsystems • Astronaut Switch Panel • Dust Detector • RTG Power Source and Power Conditioning Unit • Hasselblad Electric Data Camera/ 60-mm Lens
S-031	Passive Seismic Experiment (Apollo 15 ALSEP)	Yes	• Long Period and Short Period Seismic Sensing Assemblies • Support Structure and Thermal Shroud • Electronics Package (in Central Station) • 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-034	Lunar Surface Magnetometer (Apollo 15 ALSEP)	Yes	• Boom-Mounted, Flux Gate Magnetometers (3) • Electric Drive Motors • Electronics Package • Sunshield • Hasselblad Electric Data Camera/ 60-mm Lens
S-035	Solar Wind Spectrometer (Apollo 15 ALSEP)	Yes	• Sensor Assembly - Faraday Cups (7) • Electronic Assembly • Thermal Control Assembly • Leg Assembly • Hasselblad Electric Data Camera/ 60-mm Lens
S-036	Suprathermal Ion Detector (Apollo 15 ALSEP)	Yes	• Sensor Assembly - Ion Detectors (2) • Chassis with Foldable Legs • Electronics • Wire Mesh Ground Plane • Thermal Control Components • Cold Cathode Ion Gauge (see S-058) • 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-037	Heat Flow Experiment (Apollo 15 ALSEP)	Yes	• Apollo Lunar Surface Drill
			  • Drill
			  • Bore Stems (12)
			  • Bore Bit (2)
			  • Bore Stem Adapter
			  • Treadle
			  • Drill String Wrench (2)
			• Heat Probes (2)
			• Probe Emplacement Tool
			• Electronics Package
			• Hasselblad Electric Data Camera/ 60-mm Lens

S-058	Cold Cathode Ion Gauge (Apollo 15 ALSEP)	Yes (Through Interface with S-036)	• Deployed on SIDE ground screen tube • Ion Detector • Housing • Hasselblad Electric Data Camera/ 60-mm Lens
M-515	Lunar Dust Detector (Apollo 15 ALSEP)	Yes	• Sensor Package • Solar Cells (3) • Printed Circuit Board (Central Station PDU Interface) • 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	• Apollo Lunar Hand Tool Carrier and Tools
			  • Hammer
			  • Extension Handle
			  • 32-Inch Tongs (2)
			  • Lunar Surface Rake
			  • Adjustable Sampling Scoop
			  • Gnomon with Color Patch
			  • Spring Scale
			  • Core Tubes (9)
			  • Core Tube Cap Dispensers (3)
			  • Core Tube Follower Tool (2)
			  • Core Tube Stowage Bag (Contingency stowage only)
			  • PLSS Tool Carrier
			• Documented Sample Bag Dispenser (6)
			  • Two 20-Bag Documented Sample Bag Dispensers in ALSRC No. 1
			  • Four 20-Bag Documented Sample Bag Dispensers in ALSRC No. 2
			• Sample Collection Bag (2)
			  • One in each ALSRC
			• Extra Sample Collection Bag* (4)
			• Sample Containment Bag (6)
			• Apollo Lunar Sample Return Container (2)
			• Special Environmental Sample Container (3)
			• ALSD
			  • Core Stems (6)

*Extra Sample Collection bag is same configuration as sample collection bag with exception of no external pockets.

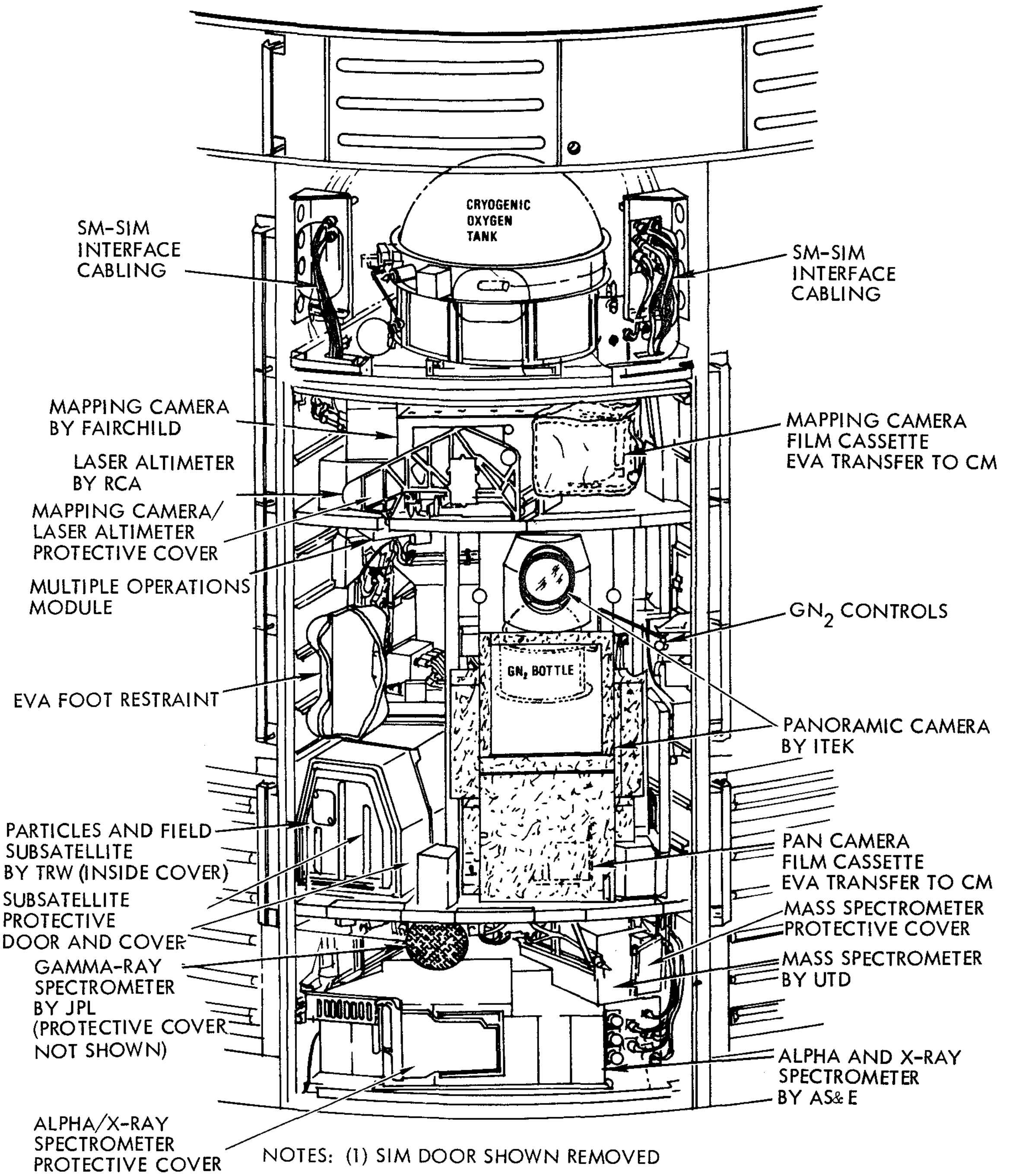
Table 2-2. Lunar Surface Science Equipment Summary (Continued)

EXP. NO.	EXPERIMENT/OBJECTIVE	CENTRAL STATION INTERFACE	EQUIPMENT
S-059 (Continued)			• Core Stem Caps and Retainer Dispenser (2) • Hasselblad Electric Data Camera/ 60-mm Lens • Long Focal Length Camera/500-mm Lens • Science Support • Lunar Surface 16-mm Data Acquisition Camera (Battery-Operated)/10-mm Lens • LRV • GCTA
S-078	Laser Ranging Retro-Reflector	No	• Retro-Reflector Assembly • Corner Reflectors (300) • Aim-Handle Mechanism • Hasselblad Electric Data Camera/ 60-mm Lens
S-080	Solar Wind Composition	No	• Foil/Reel Assembly • Lunar Surface Support/ Emplacement Structure • SWC Stowage Bag • 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-200	Soil Mechanics	No	• Self-Recording Penetrometer
			  • Recording Drum
			  • Cone
			  • Load Plate
			• S-059 Equipment
			• Hasselblad Electric Data Camera/ 60-mm Lens
			• Lunar Surface 16-mm Data Acquisition Camera (Battery - Operated)/10-mm Lens
			• Science Support
			  • GCTA

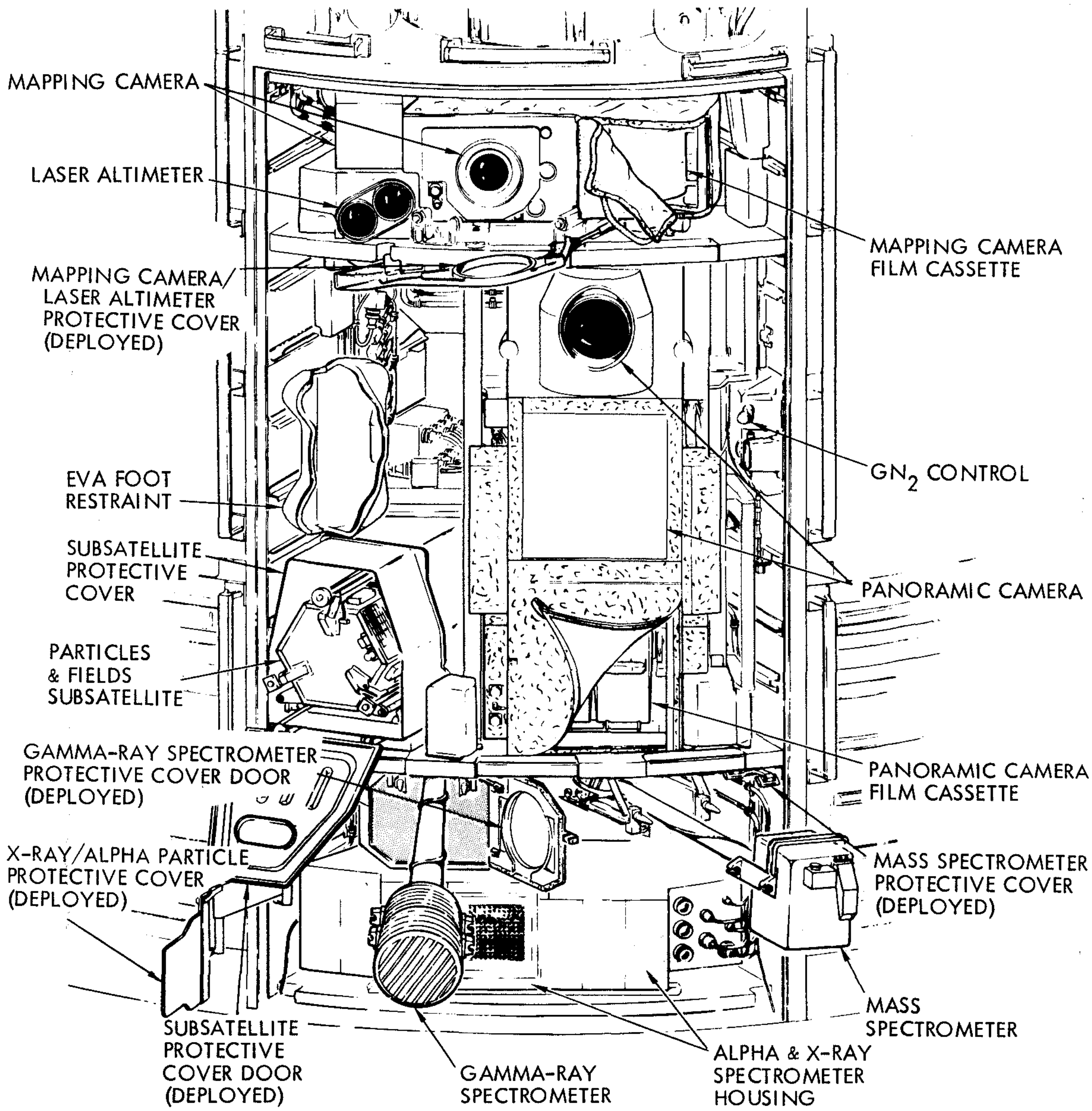


NOTES: (1) SIM DOOR SHOWN REMOVED

(2) PROTECTIVE COVERS FOR MAPPING CAMERA, LASER ALTIMETER, MASS SPECTROMETER, X-RAY/ALPHA PARTICLE SPECTROMETERS, AND SUBSATELLITE SHOWN IN CLOSED POSITIONS

(3) GAMMA-RAY AND MASS SPECTROMETERS AS WELL AS MAPPING CAMERA SHOWN IN RETRACTED POSITIONS

Figure 2-1. J-1 Mission SIM Bay Science Equipment Installation



NOTES: (1) MAPPING CAMERA/LASER ALTIMETER AND SUBSATELLITE SHOWN IN RETRACTED/LAUNCH POSITIONS, RESPECTIVELY
(2) GAMMA-RAY AND MASS SPECTROMETERS SHOWN PARTIALLY DEPLOYED

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

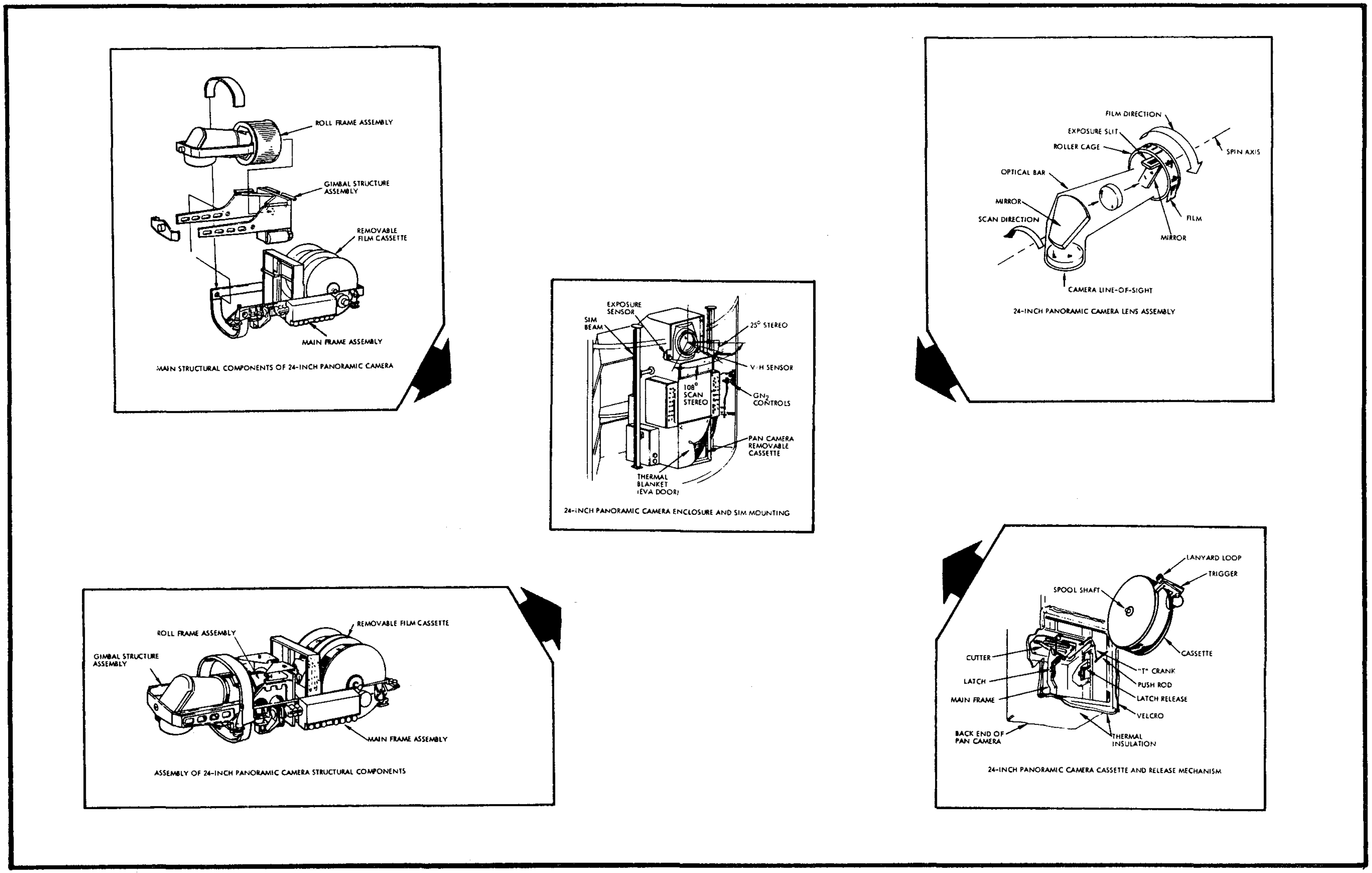


Figure 2-3. SIM Bay 24-Inch Panoramic Camera Assembly

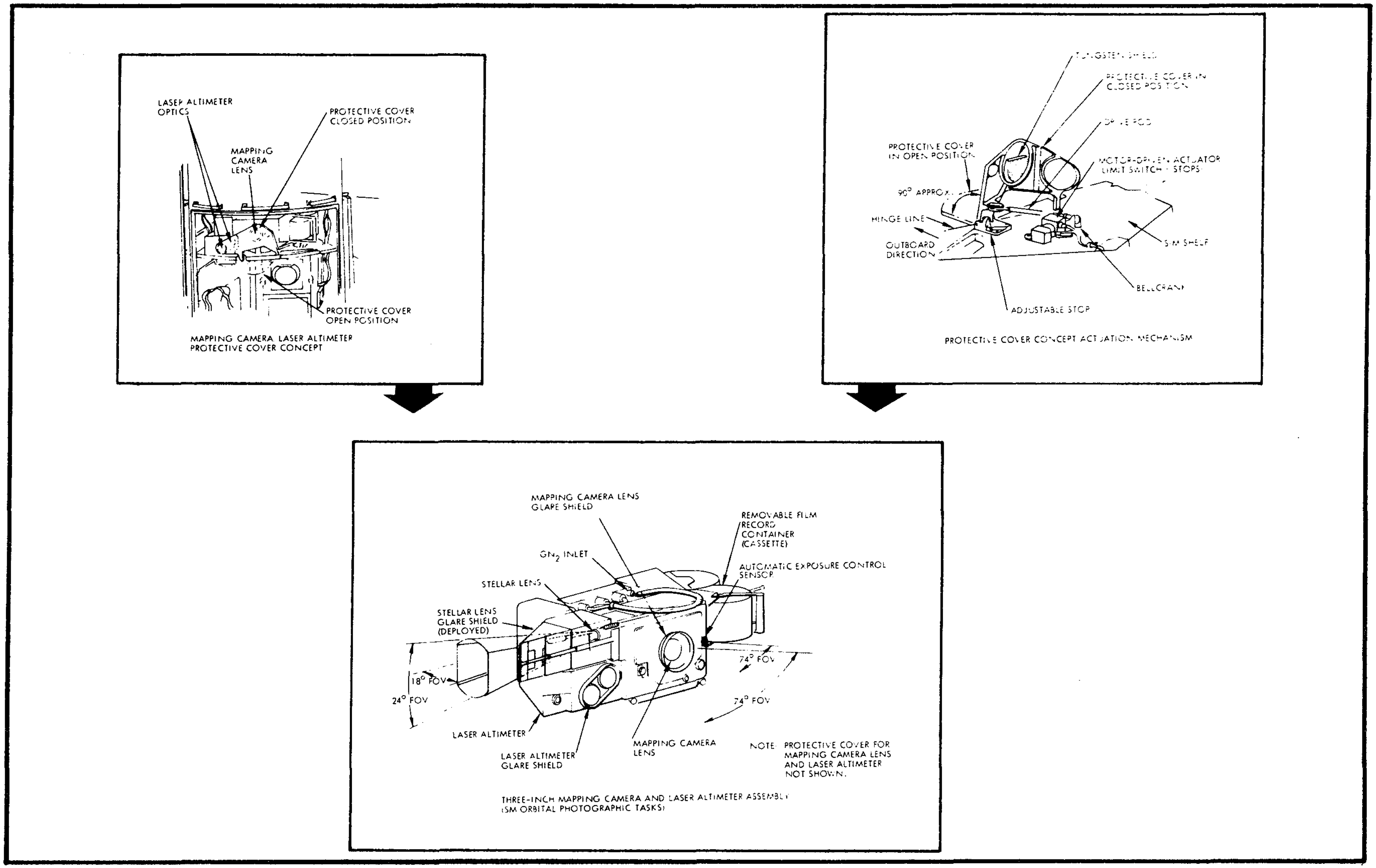


Figure 2-4. SIM Bay 3-Inch Mapping Camera Assembly

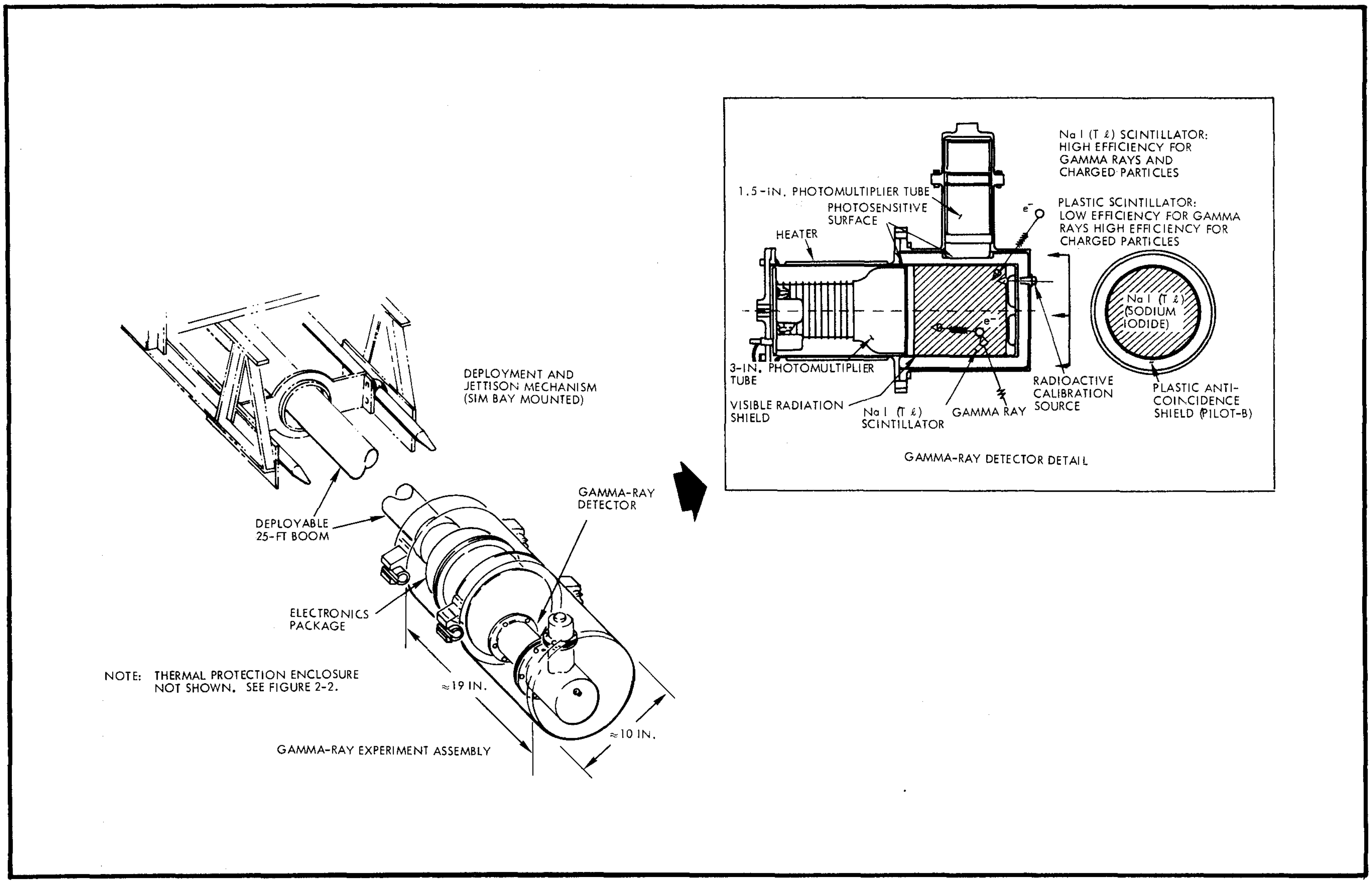


Figure 2-5. SIM Bay Gamma-Ray Spectrometer Assembly

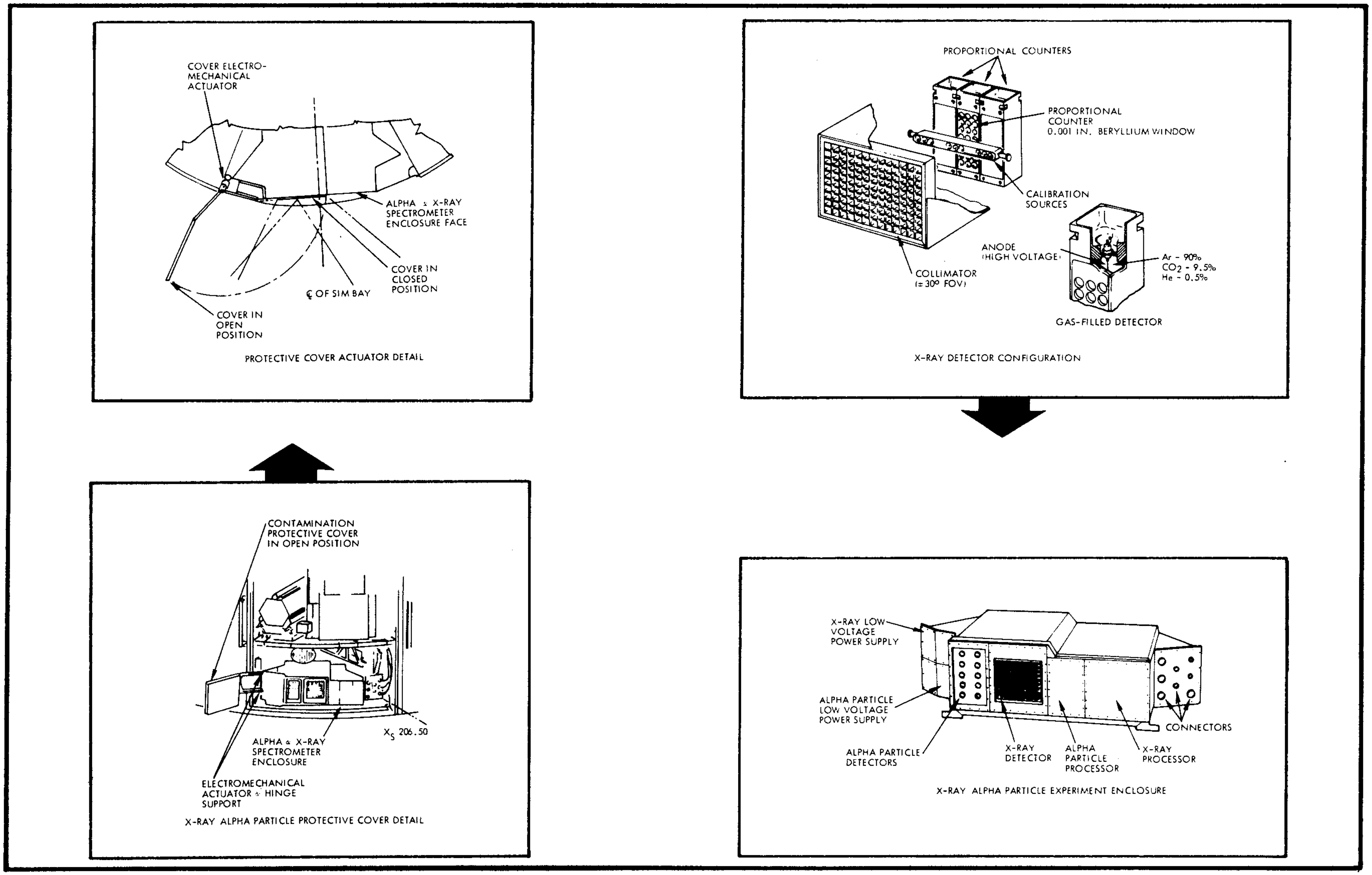


Figure 2-6. SIM Bay X-Ray/Alpha Particle Spectrometers Assembly

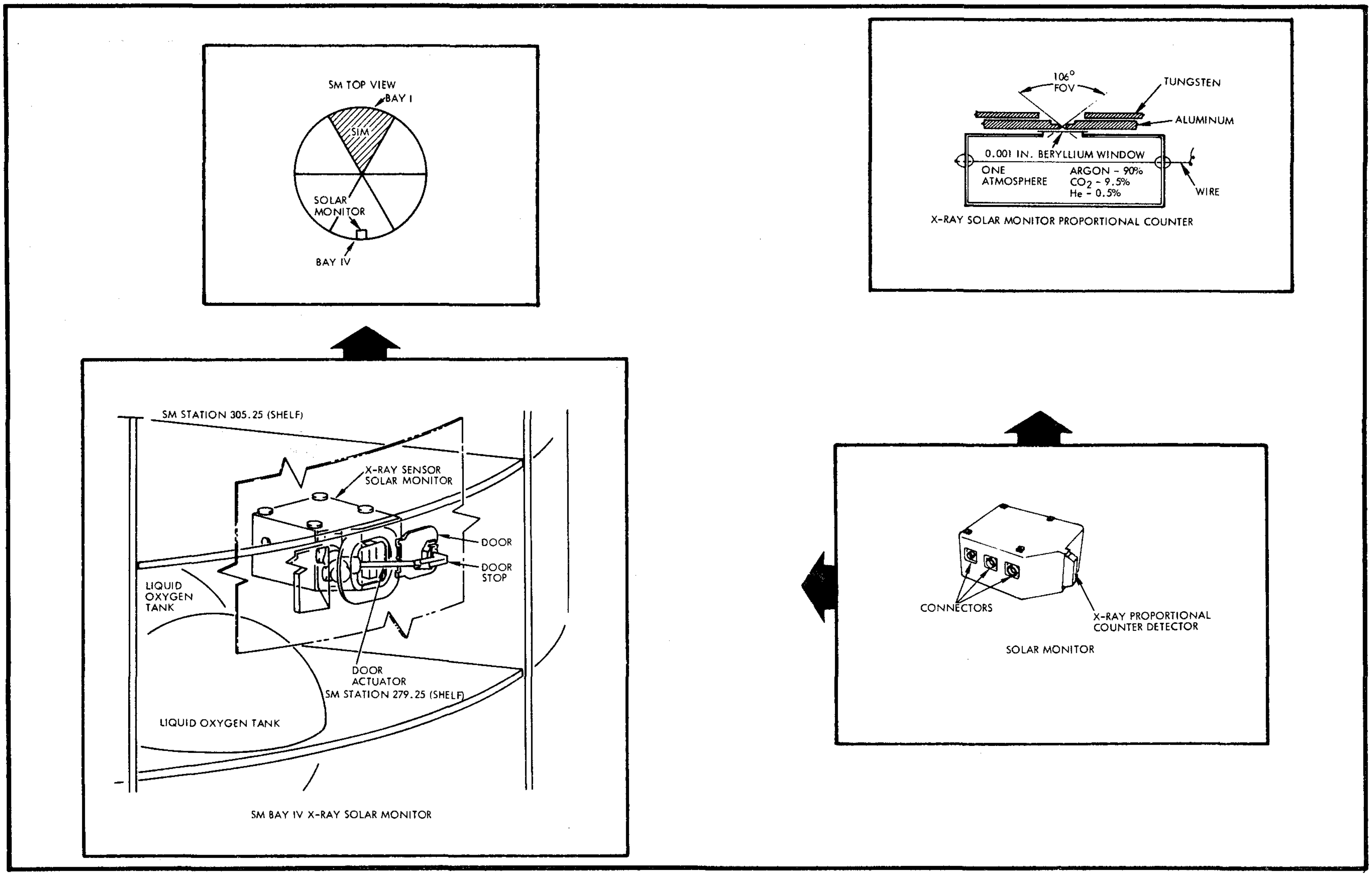


Figure 2-7. SM Bay X-Ray Solar Monitor Assembly

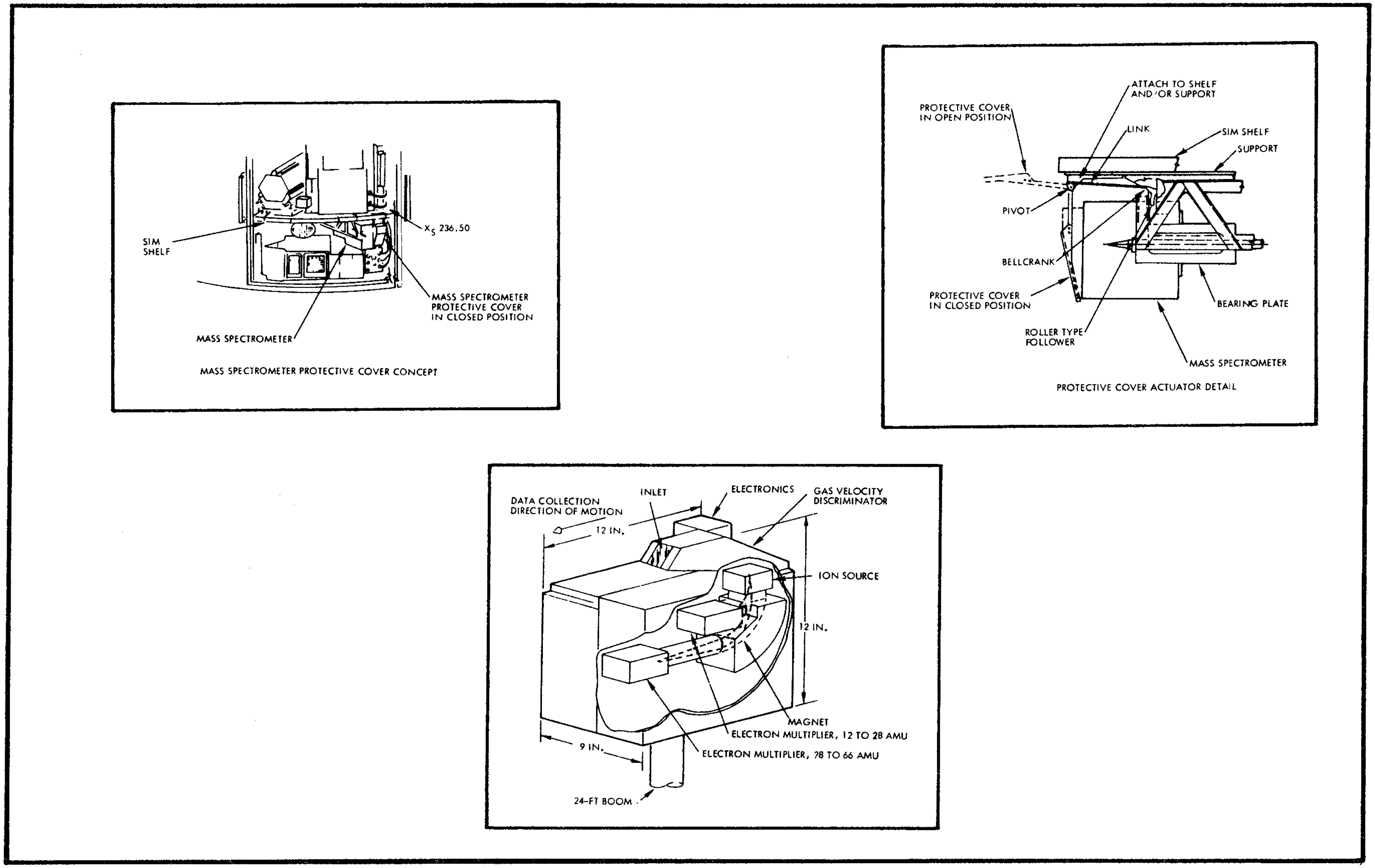


Figure 2-8. SIM Bay Mass Spectrometer Assembly

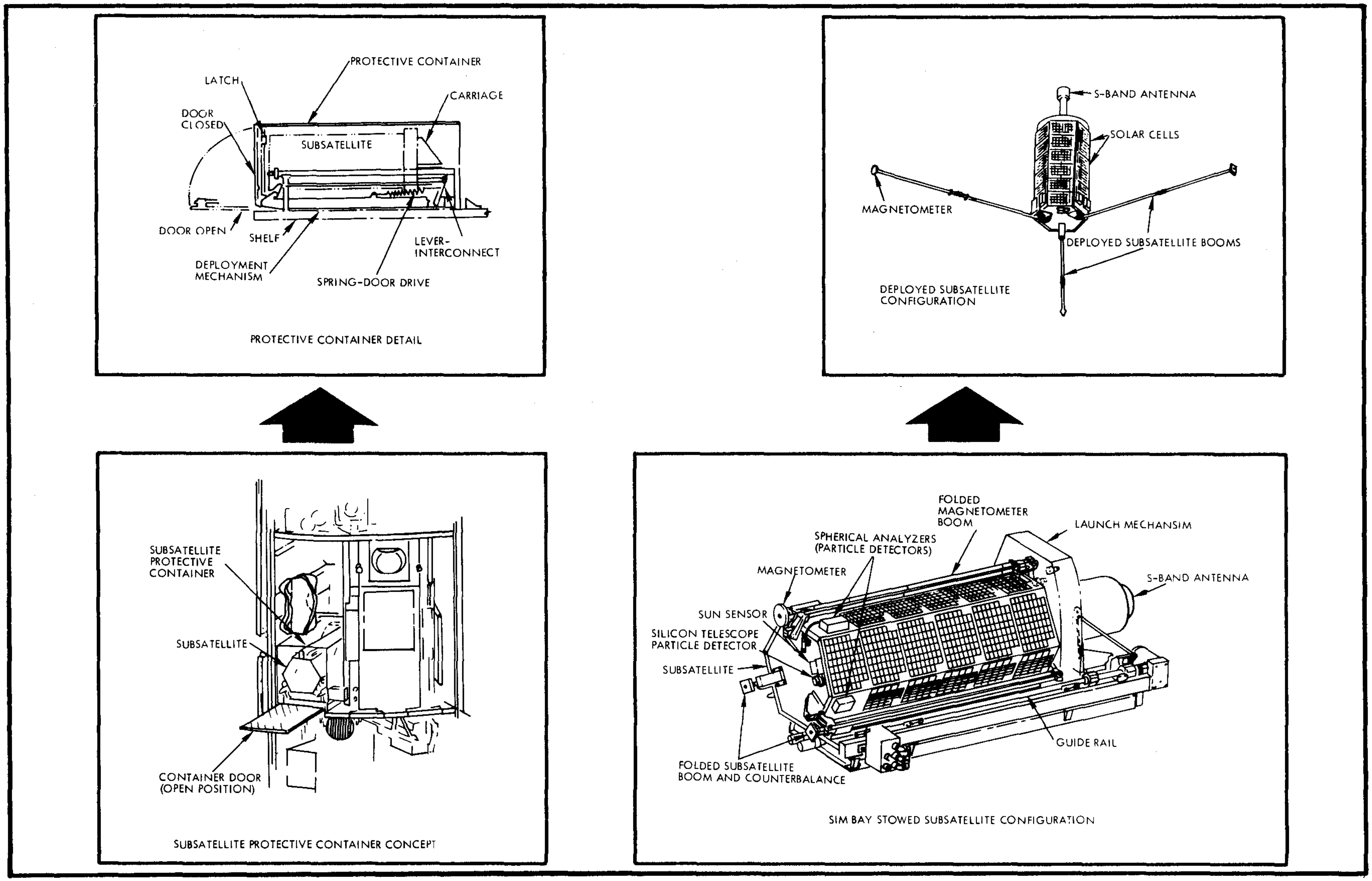


Figure 2-9. SIM Bay Subsatellite Assembly

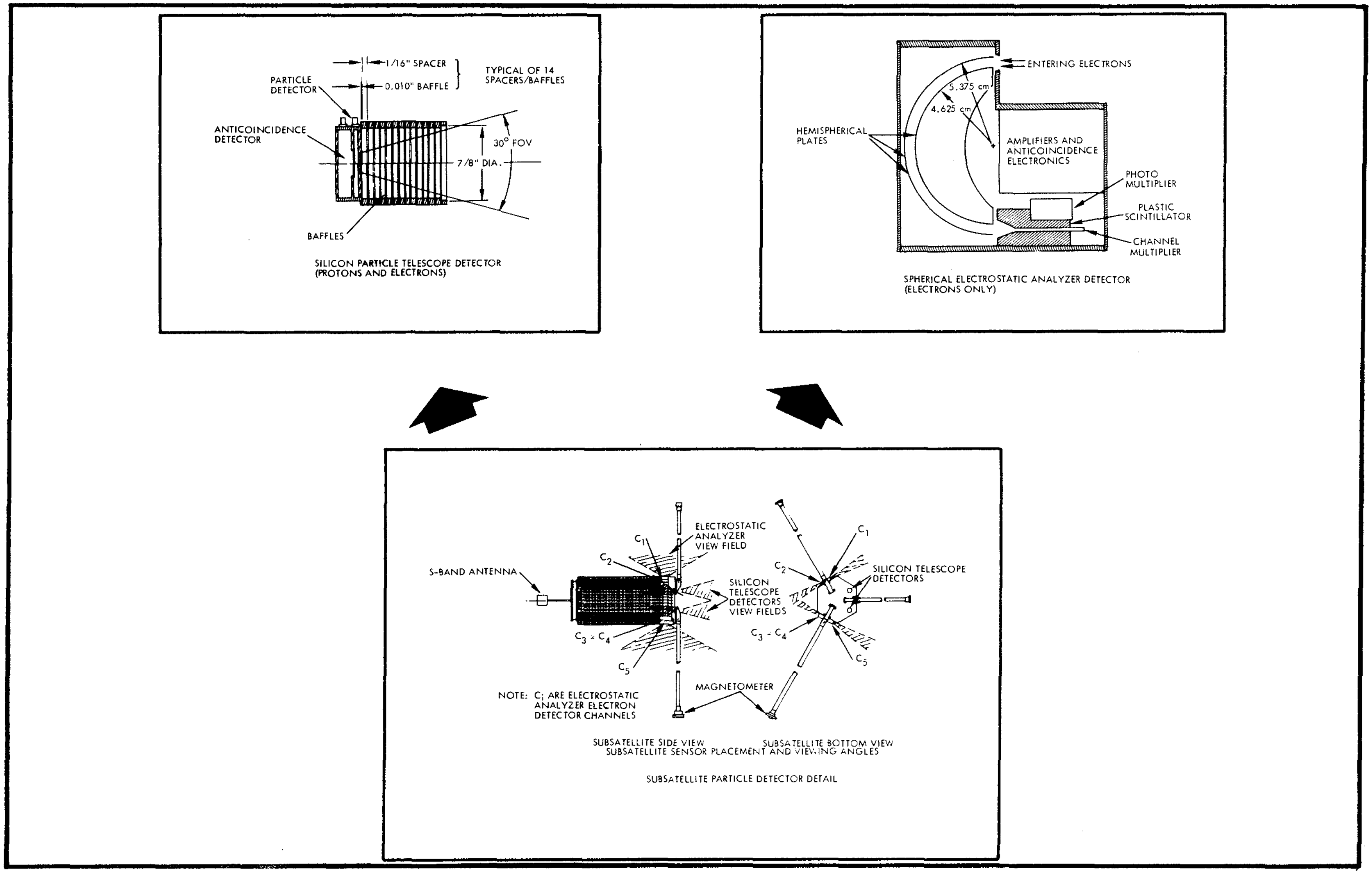


Figure 2-10. SIM Bay Subsatellite Particle Detectors

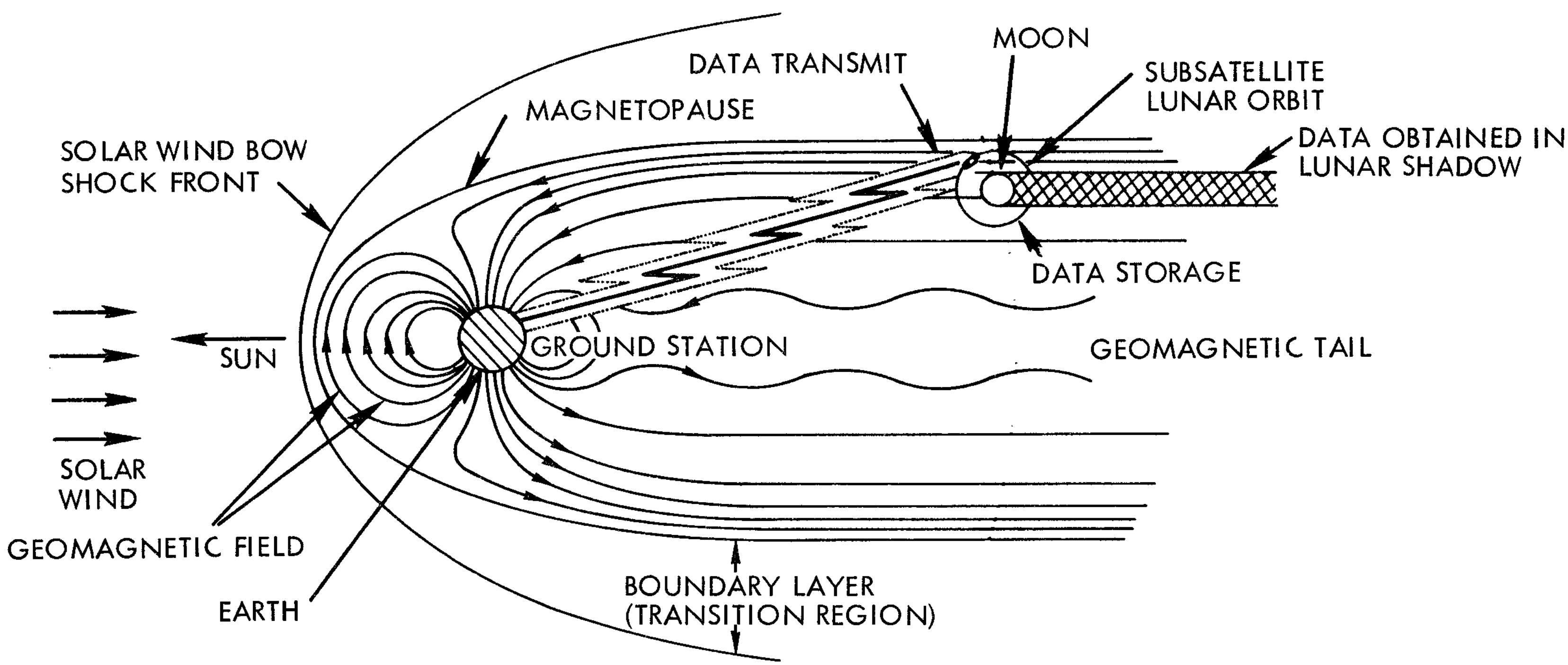


Figure 2-11. SIM Bay Subsatellite Experiments Concepts

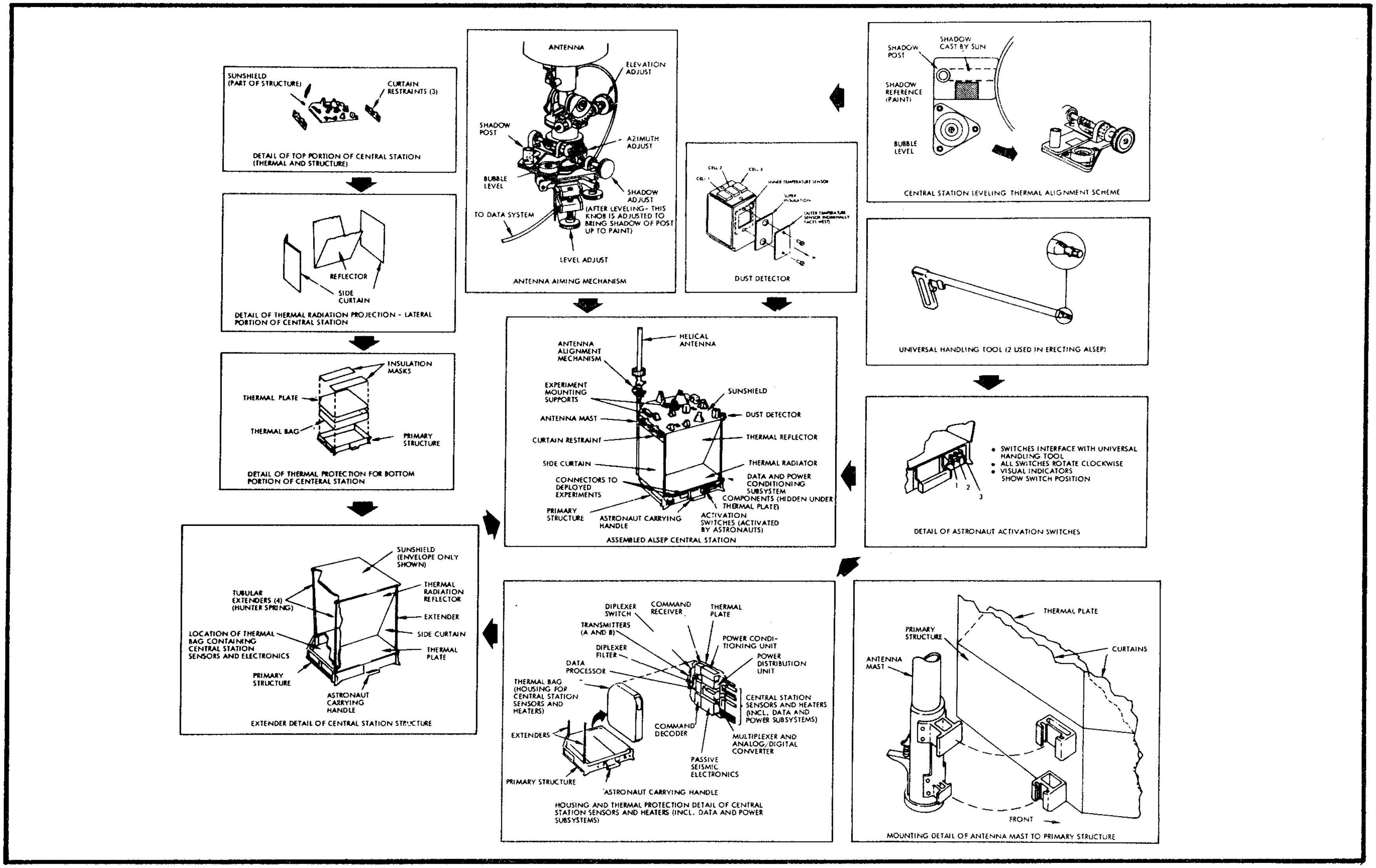


Figure 2-12. Apollo 15 ALSEP Central Station Assembly

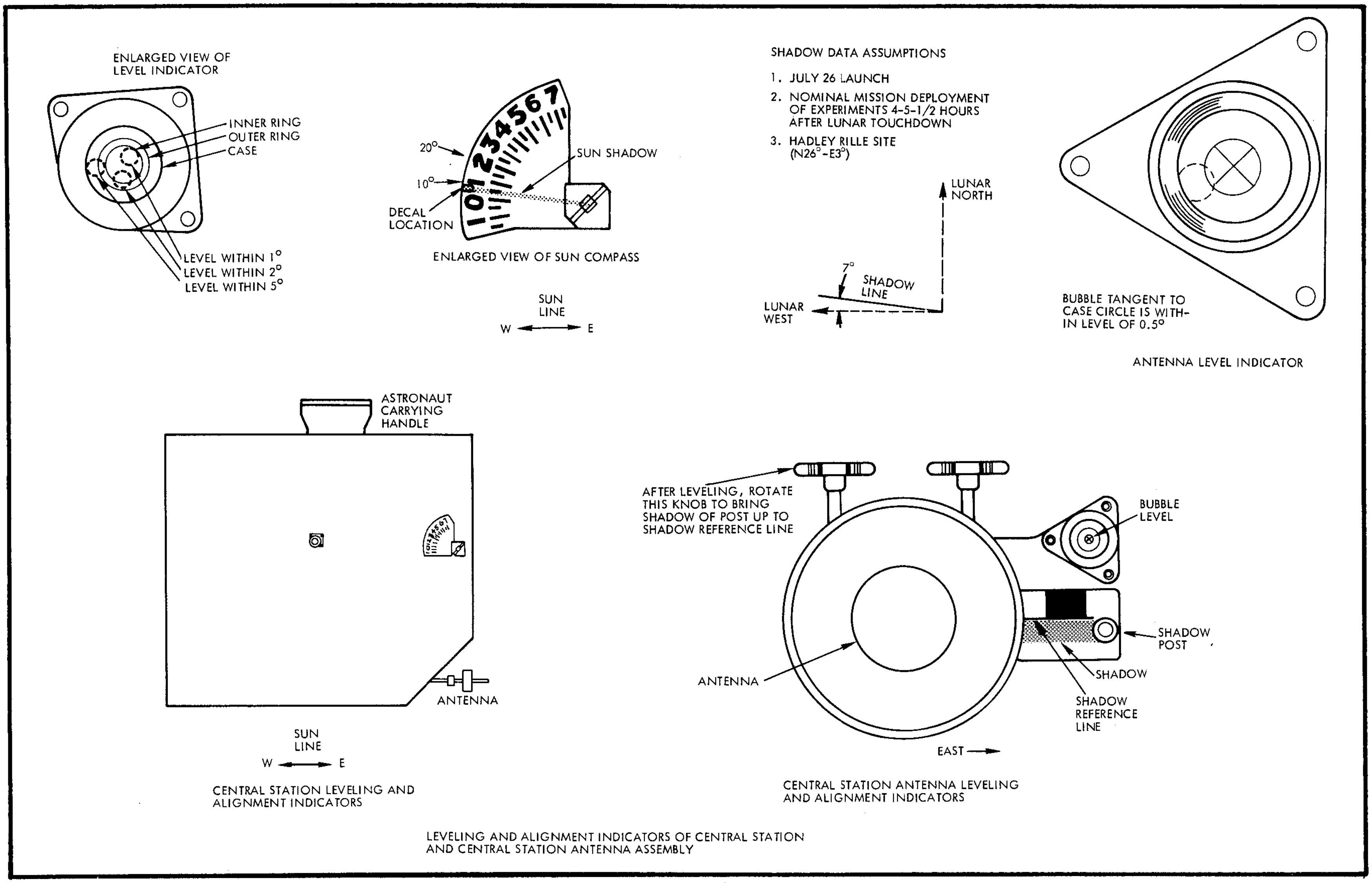


Figure 2-13. ALSEP Central Station Level/Alignment Indicators

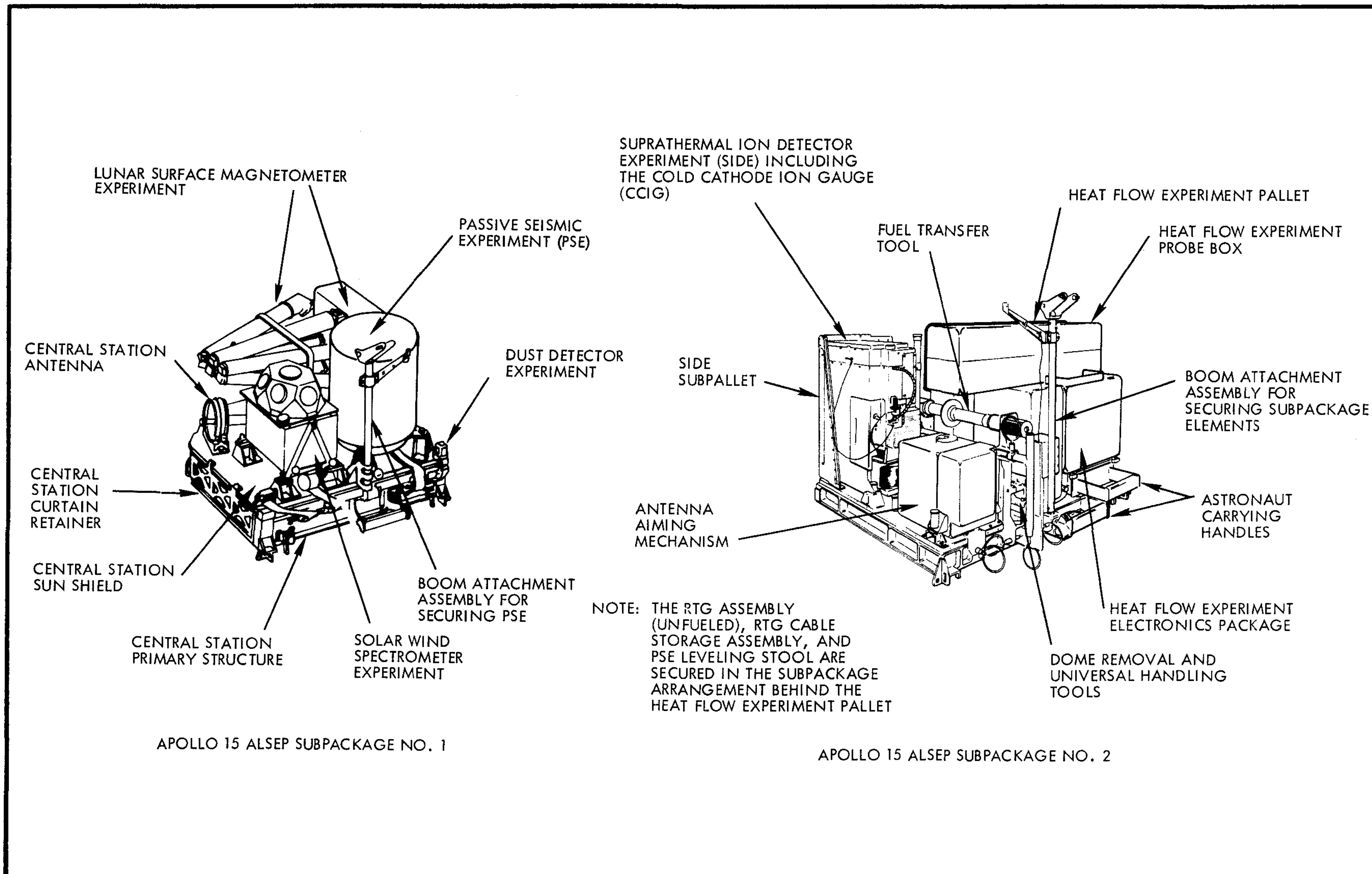


Figure 2-14. Apollo 15 ALSEP Experiment Subpackages

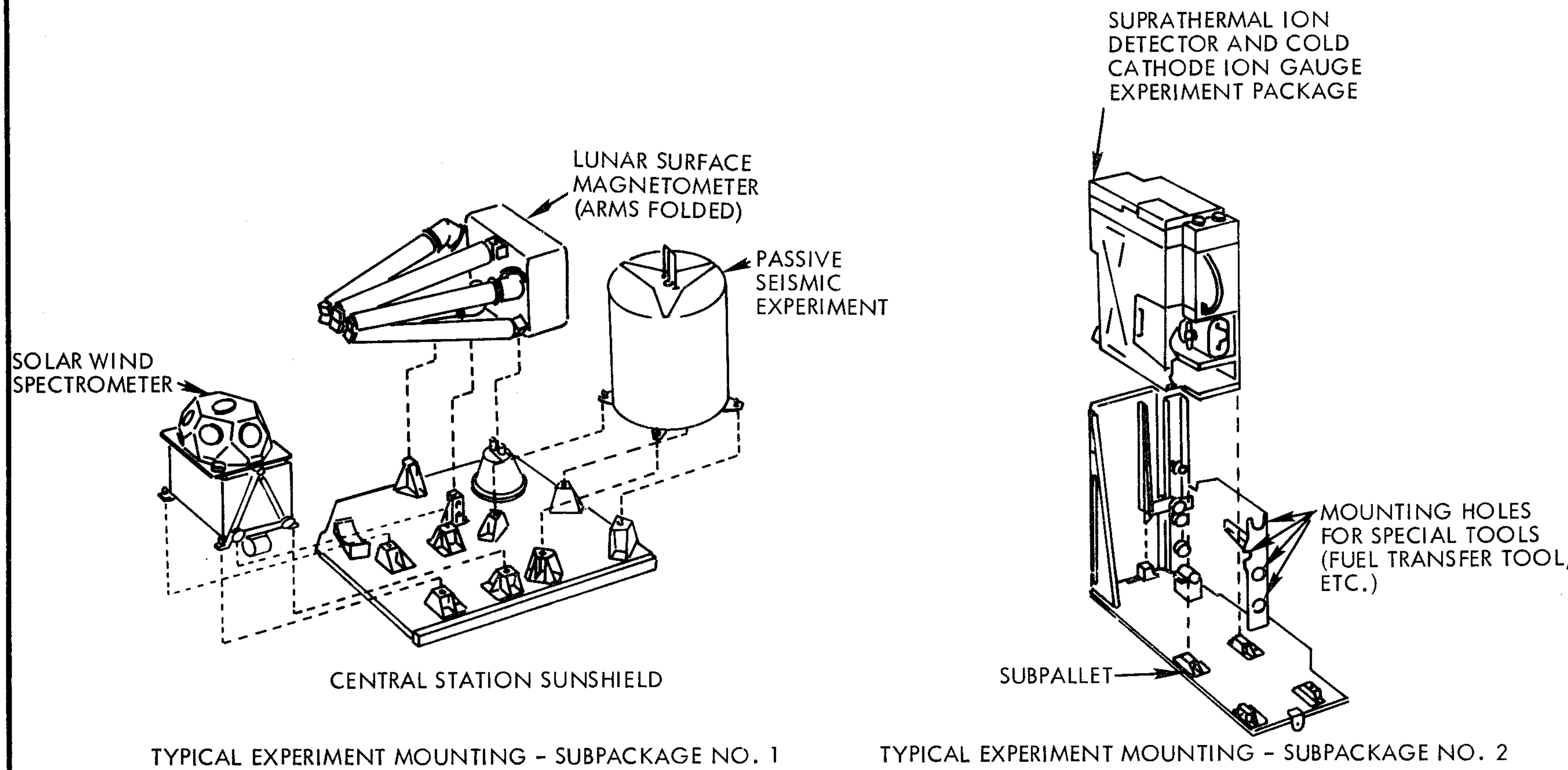
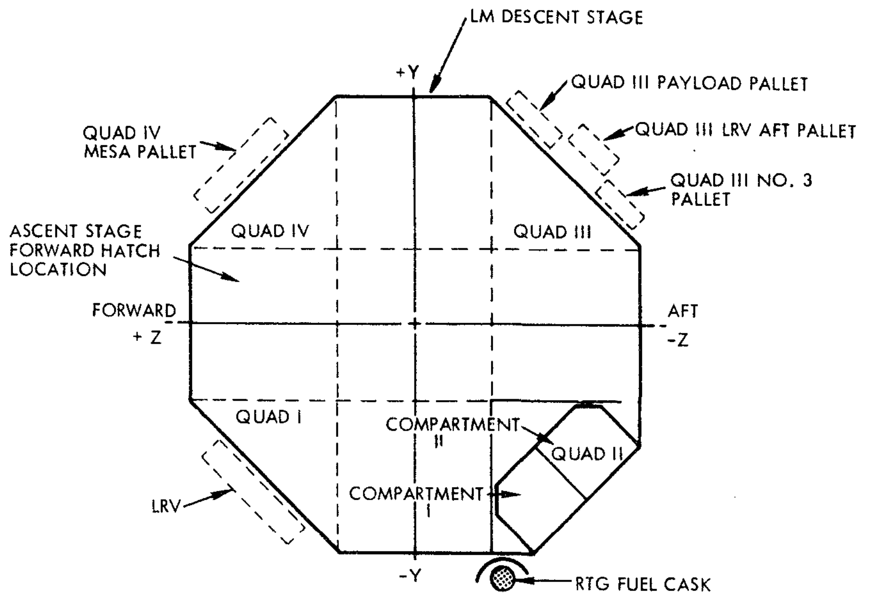


Figure 2-15. Typical ALSEP Experiment/Subpackage Mounting



QUAD I
- LUNAR ROVING VEHICLE

QUAD II SEQ BAY
- APOLLO 15 ALSEP
  - SUBPACKAGE NO. 1
  - SUBPACKAGE NO. 2

QUAD III PAYLOAD PALLET
- LASER RANGING RETRO-REFLECTOR

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)
- SOLAR WIND COMPOSITION
- LUNAR SURFACE RAKE

QUAD III LRV AFT PALLET
- ADJUSTABLE SAMPLING SCOOP
- APOLLO LUNAR HAND TOOL CARRIER
- GNOMON/COLOR PATCH
- SELF-RECORDING PENETROMETER
- HAMMER
- 32-INCH TONGS (2)
- TOOL EXTENSION HANDLE
- SAMPLE COLLECTION BAGS (2)
- EXTRA SAMPLE COLLECTION BAGS (4)

Figure 2-16. LM Descent Stage Stowage of Lunar Surface Science Equipment

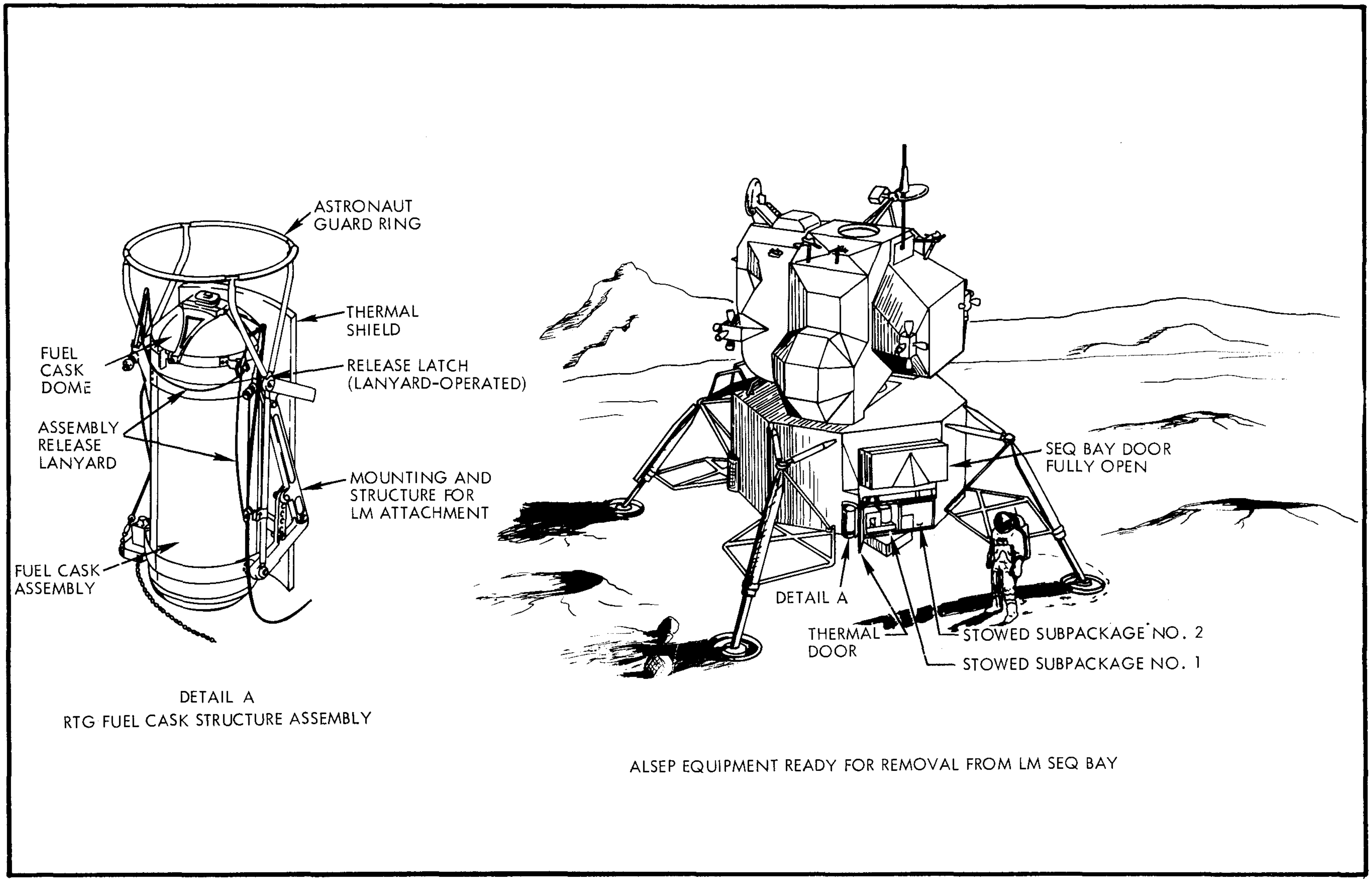


Figure 2-17. LM Mounting of ALSEP RTG Fuel Cask Structure

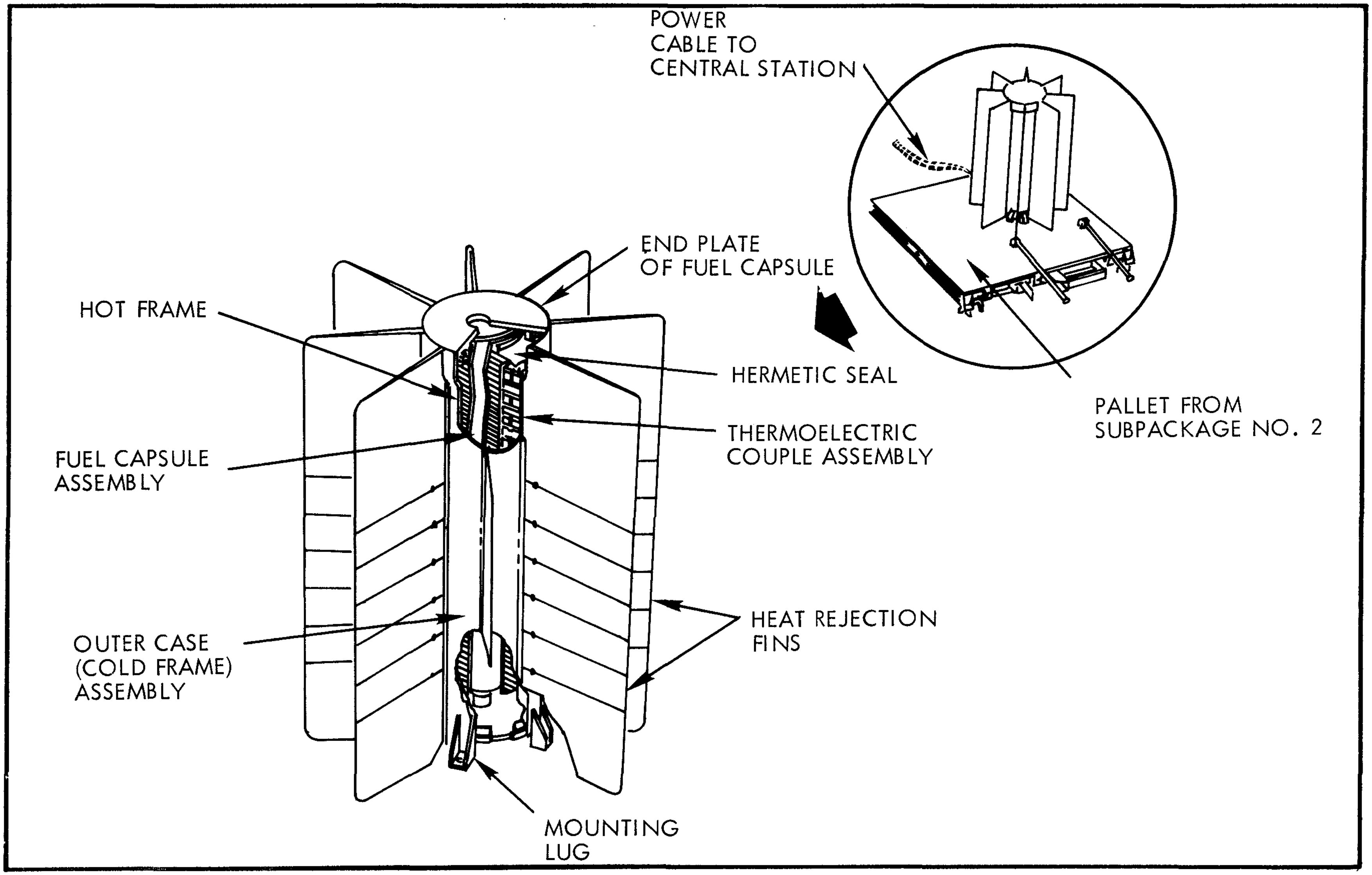


Figure 2-18. ALSEP RTG Assembly

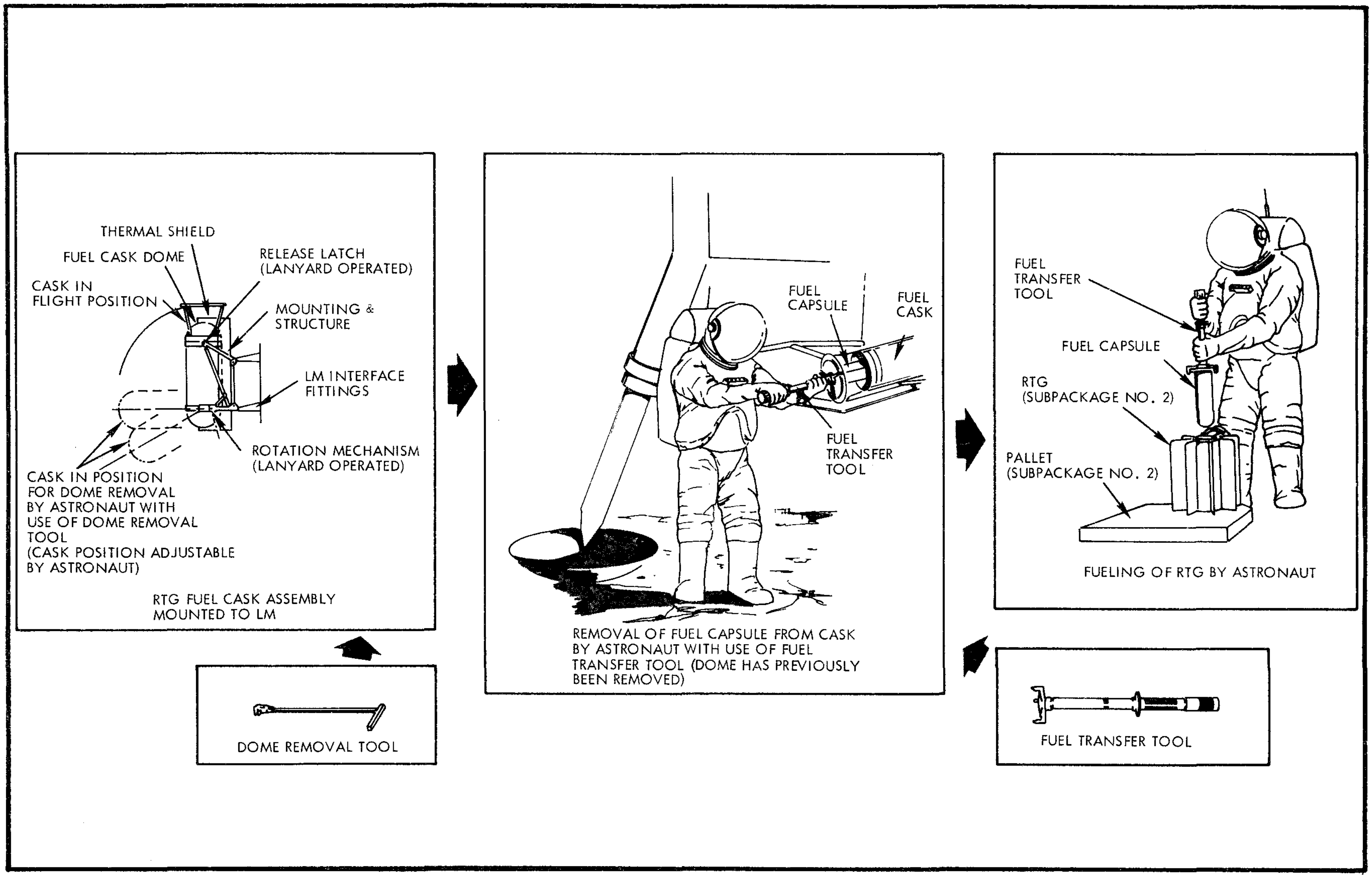


Figure 2-19. ALSEP RTG Fuel Transfer Activities

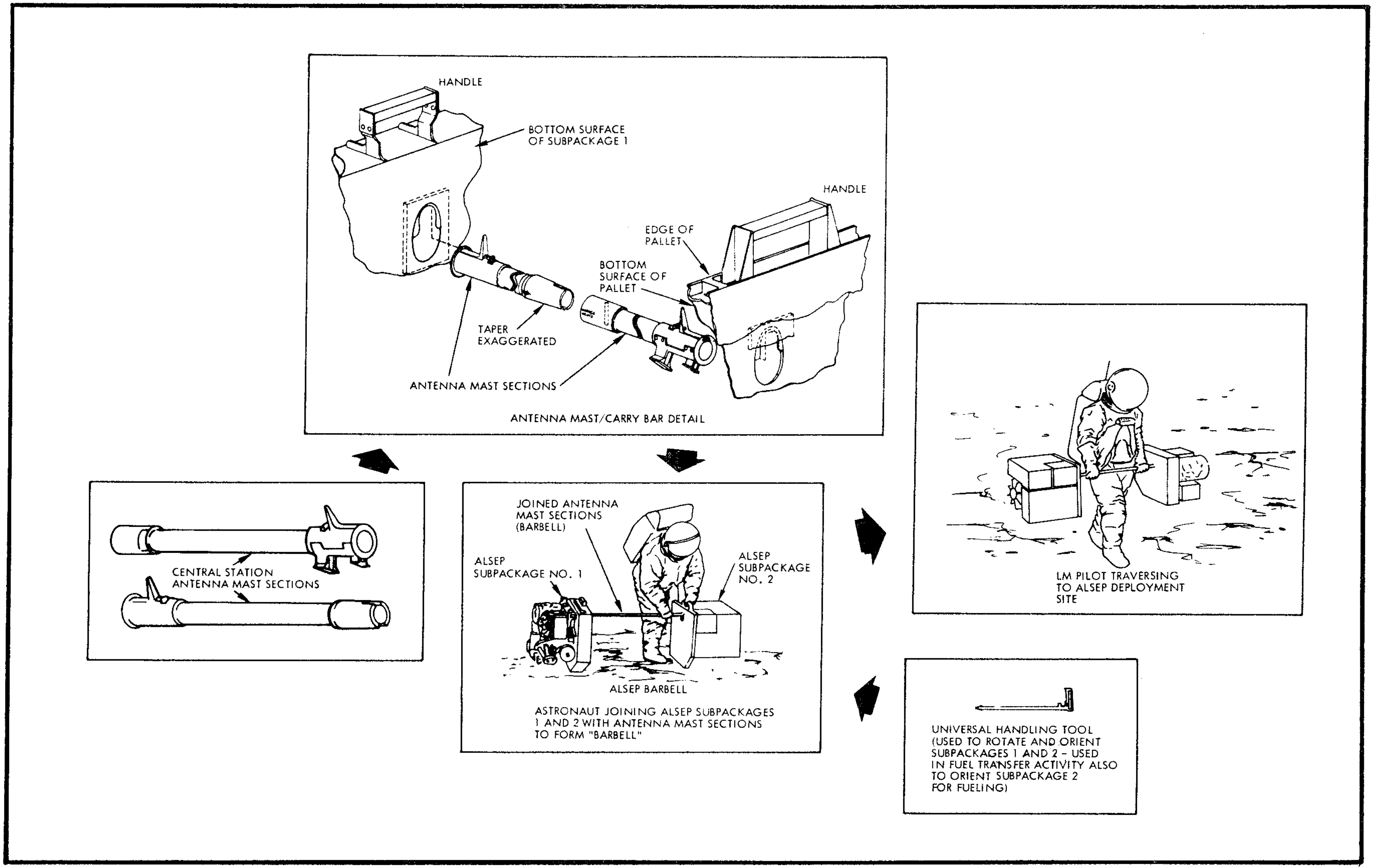


Figure 2-20. Traverse Preparation of ALSEP Subpackages

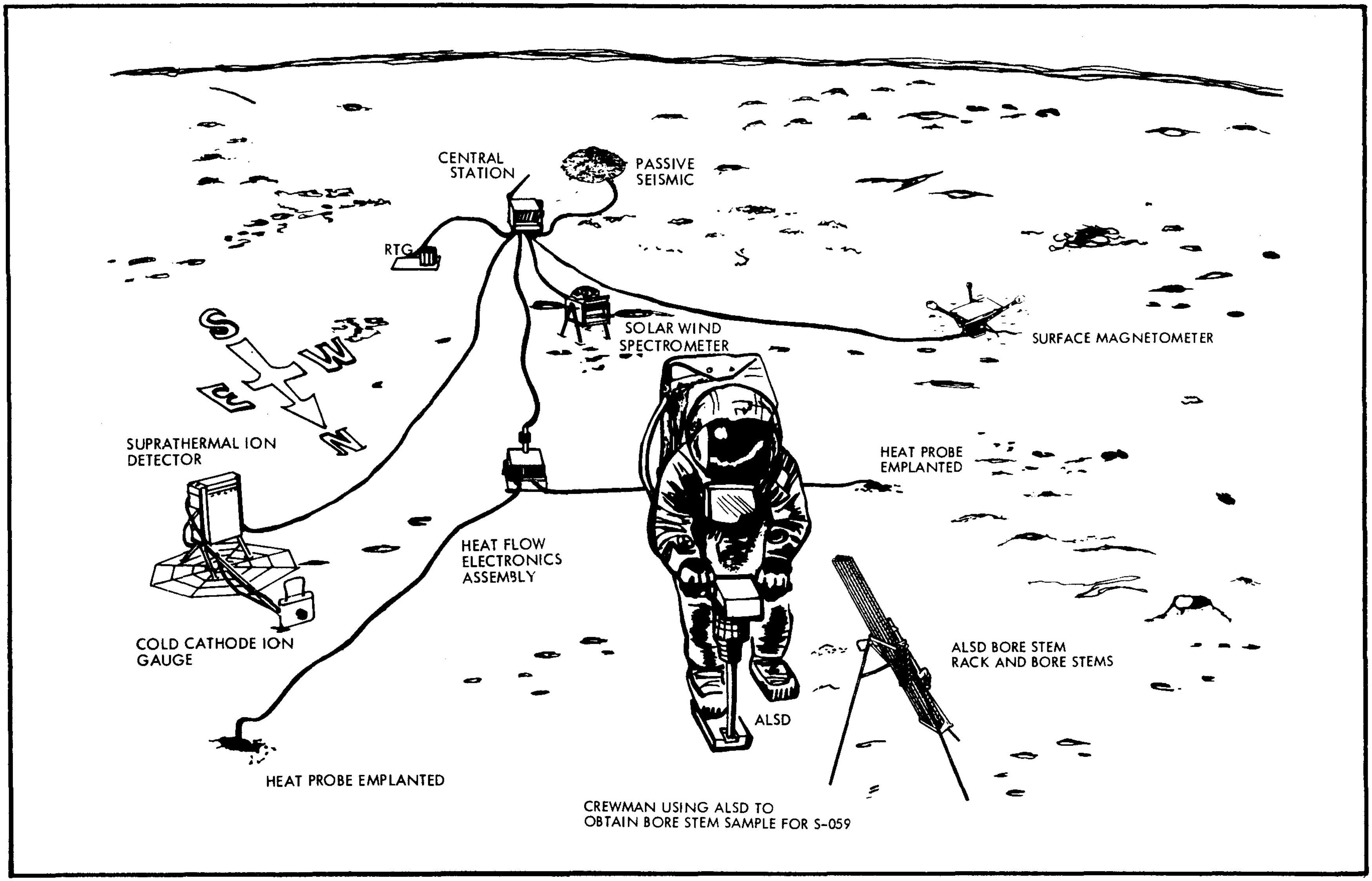


Figure 2-21. Apollo 15 ALSEP Experiment Deployment

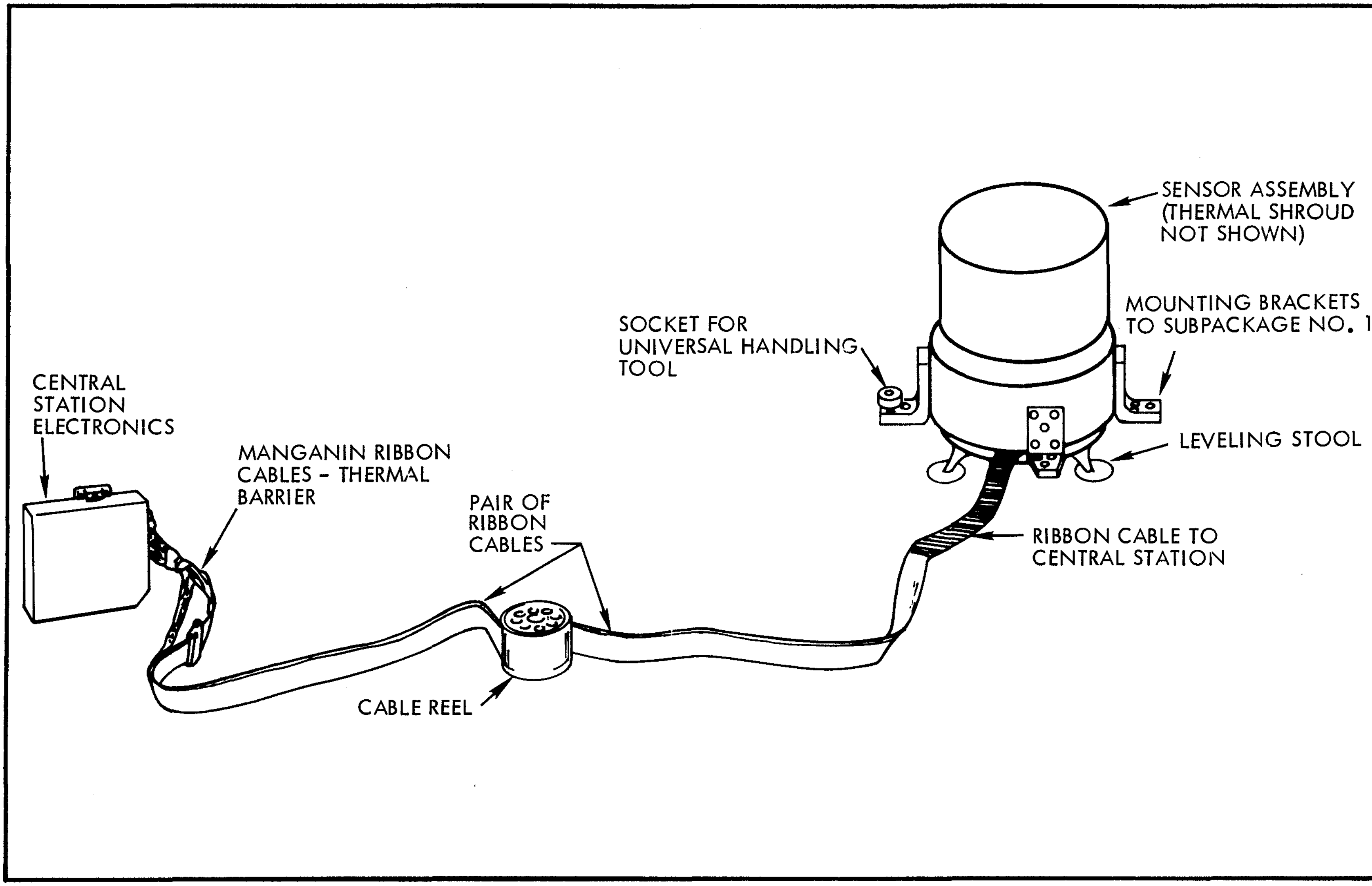


Figure 2-22. Interface of ALSEP Passive Seismic Equipment with the Central Station

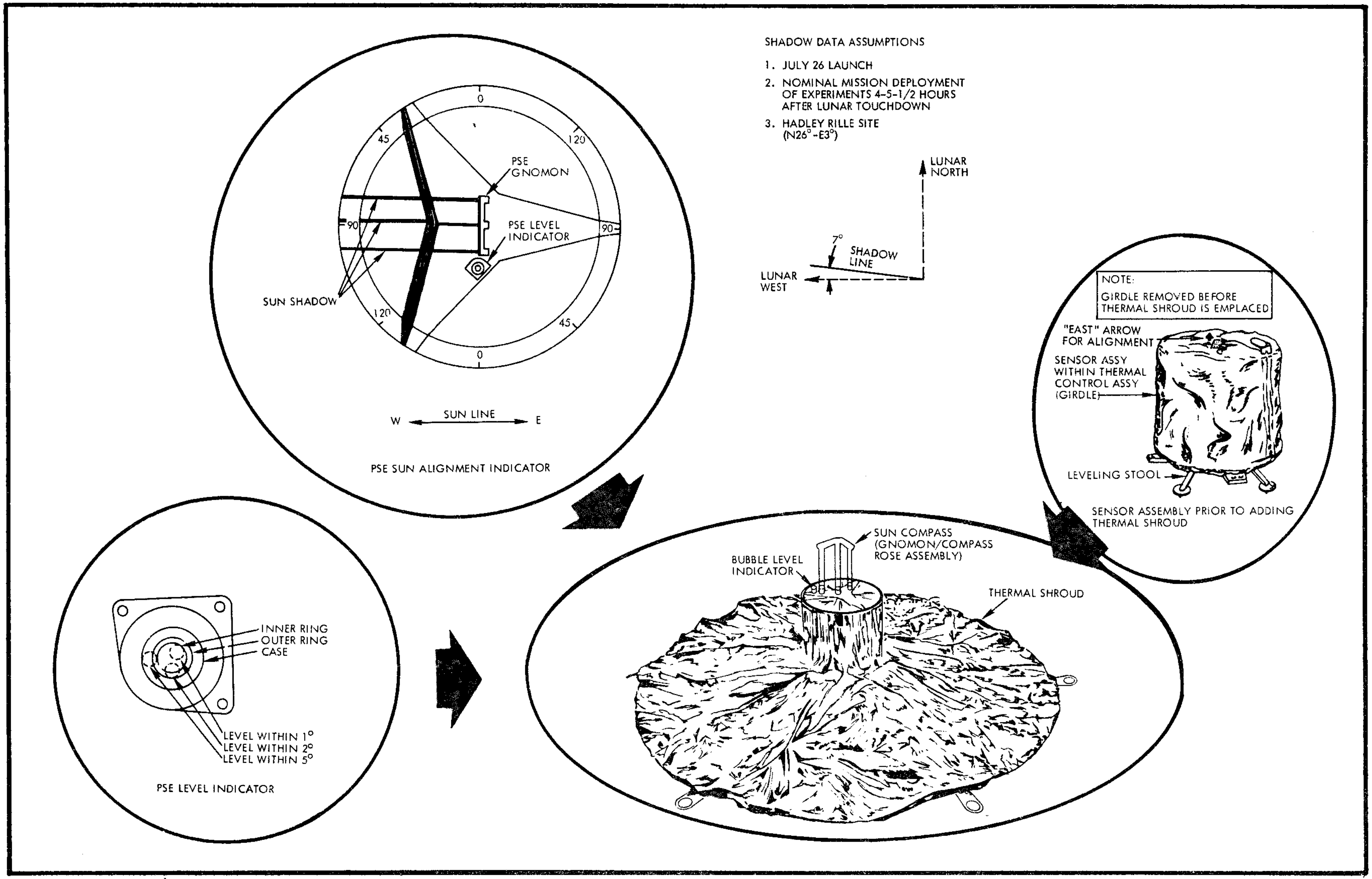


Figure 2-23. Deployed ALSEP Passive Seismic Experiment

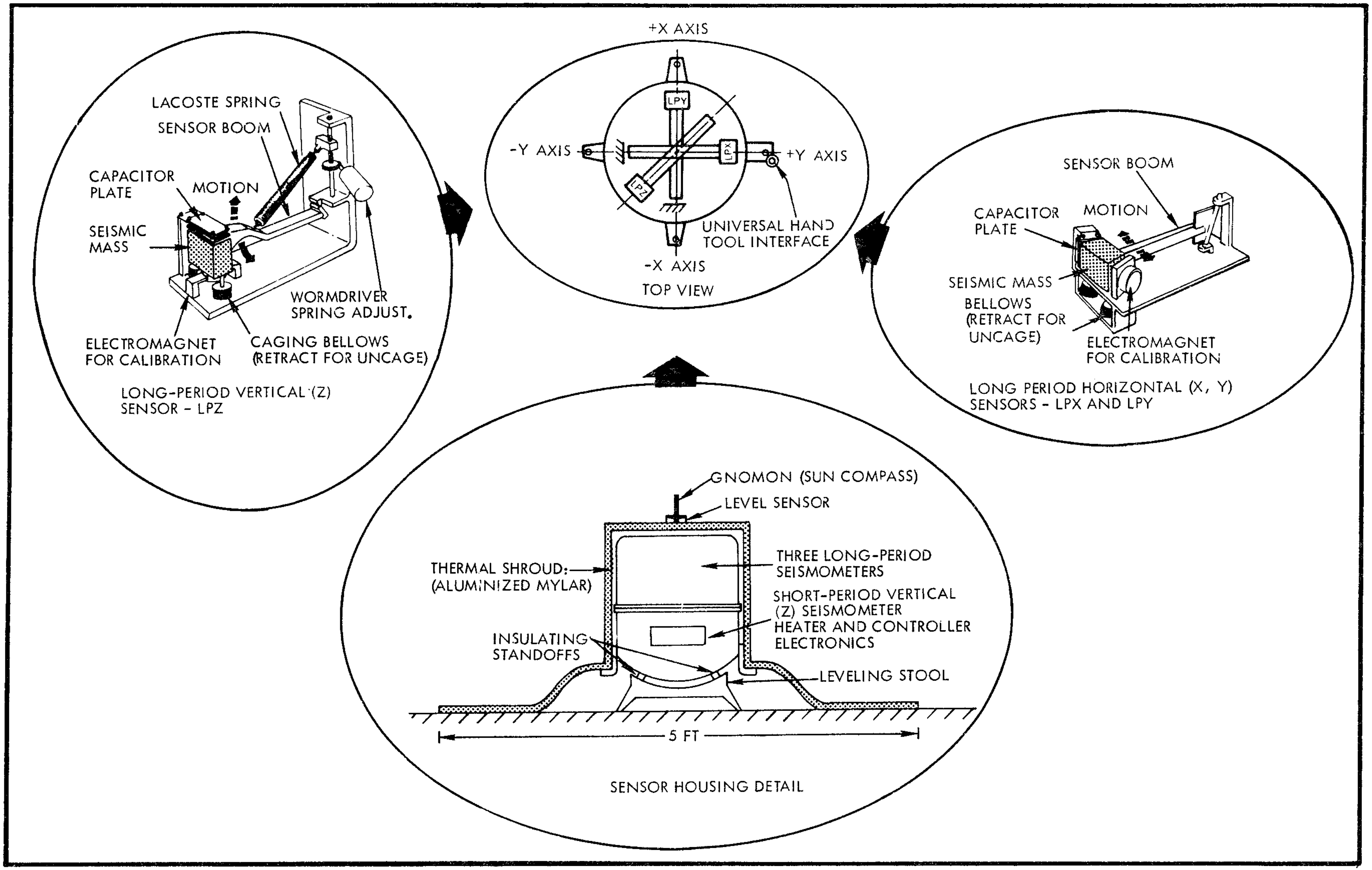


Figure 2-24. ALSEP Passive Seismic Experiment Sensors

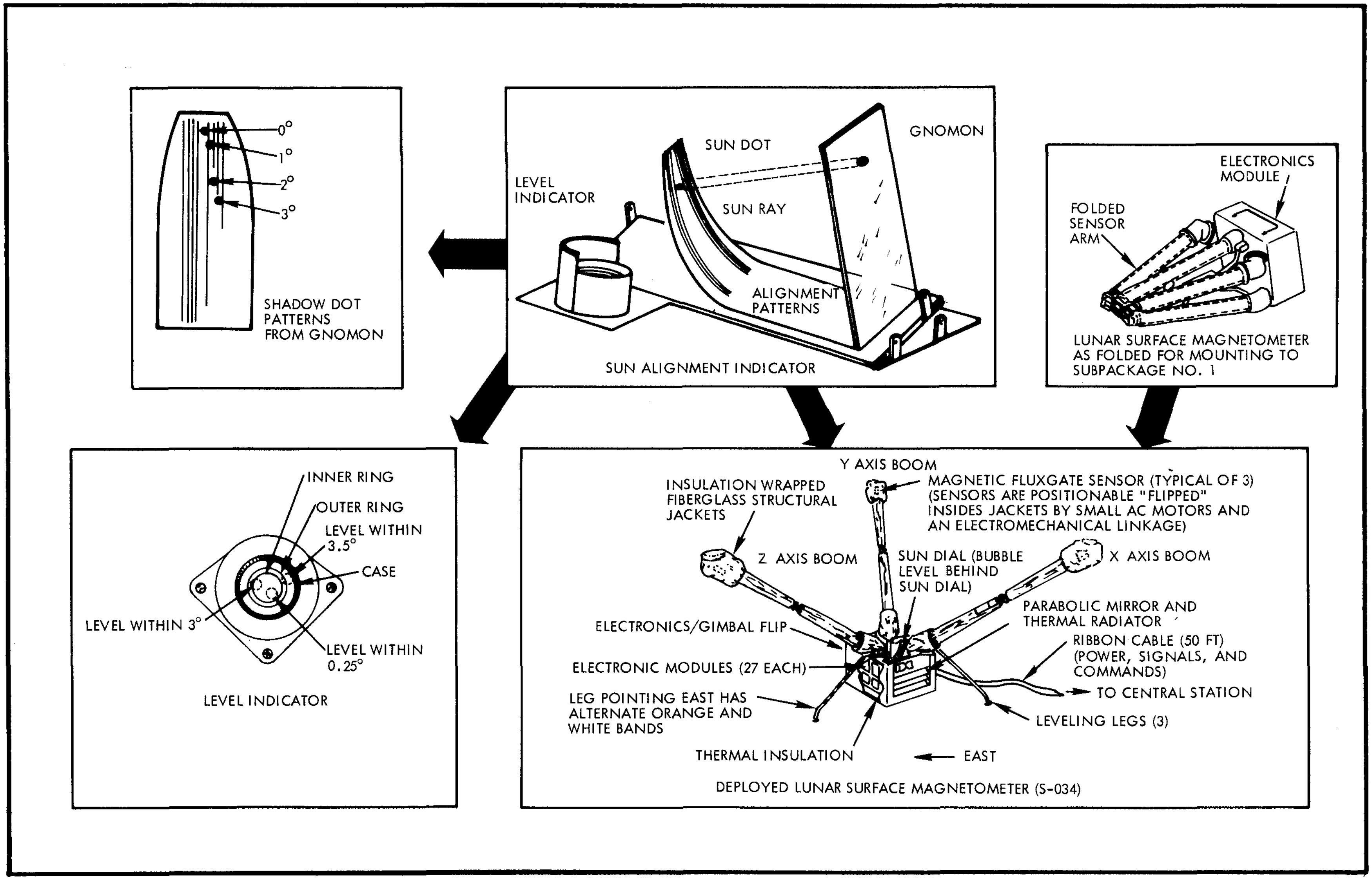


Figure 2-25. ALSEP Lunar Surface Magnetometer Experiment

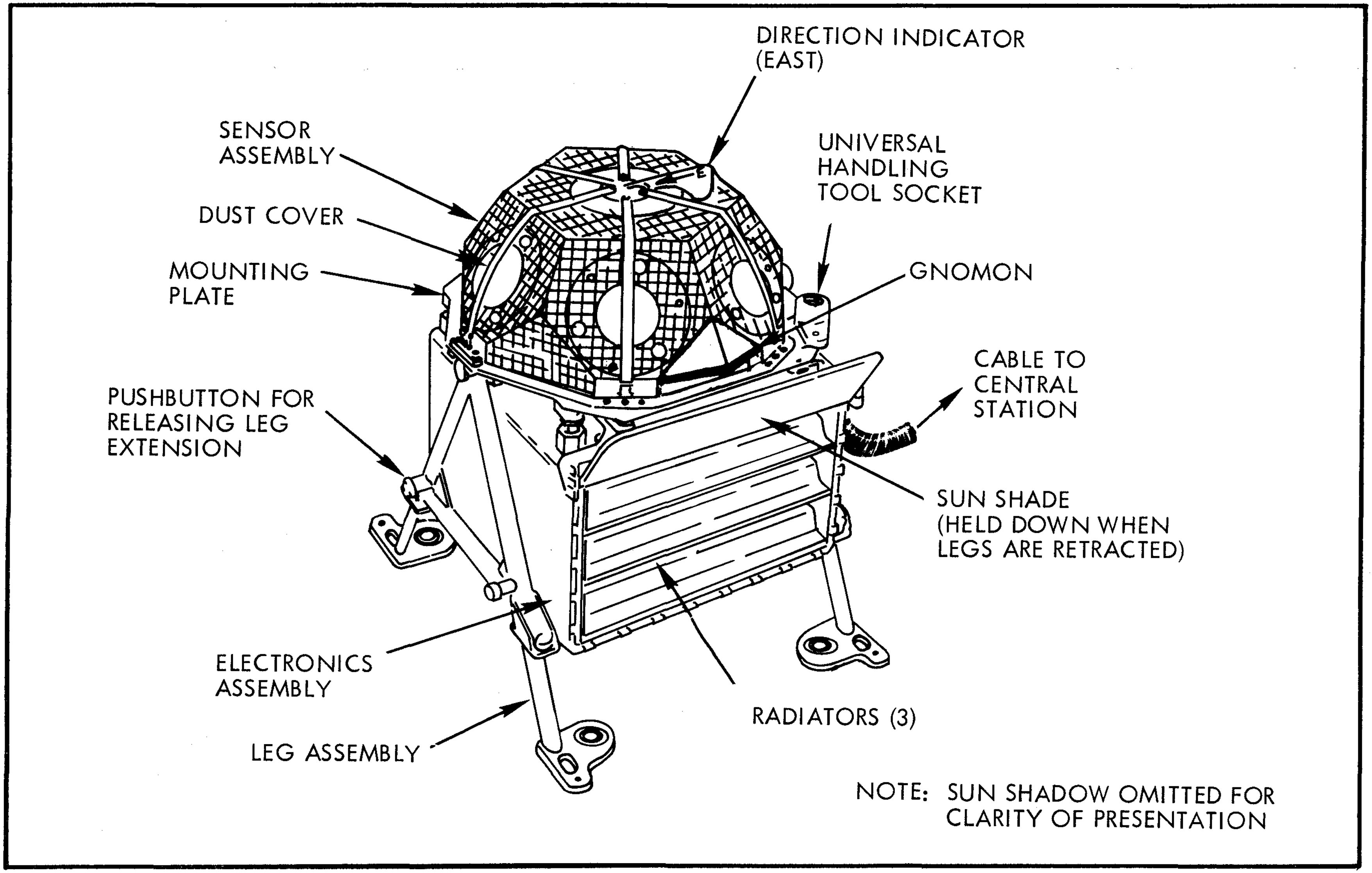


Figure 2-26. ALSEP Solar Wind Spectrometer Experiment

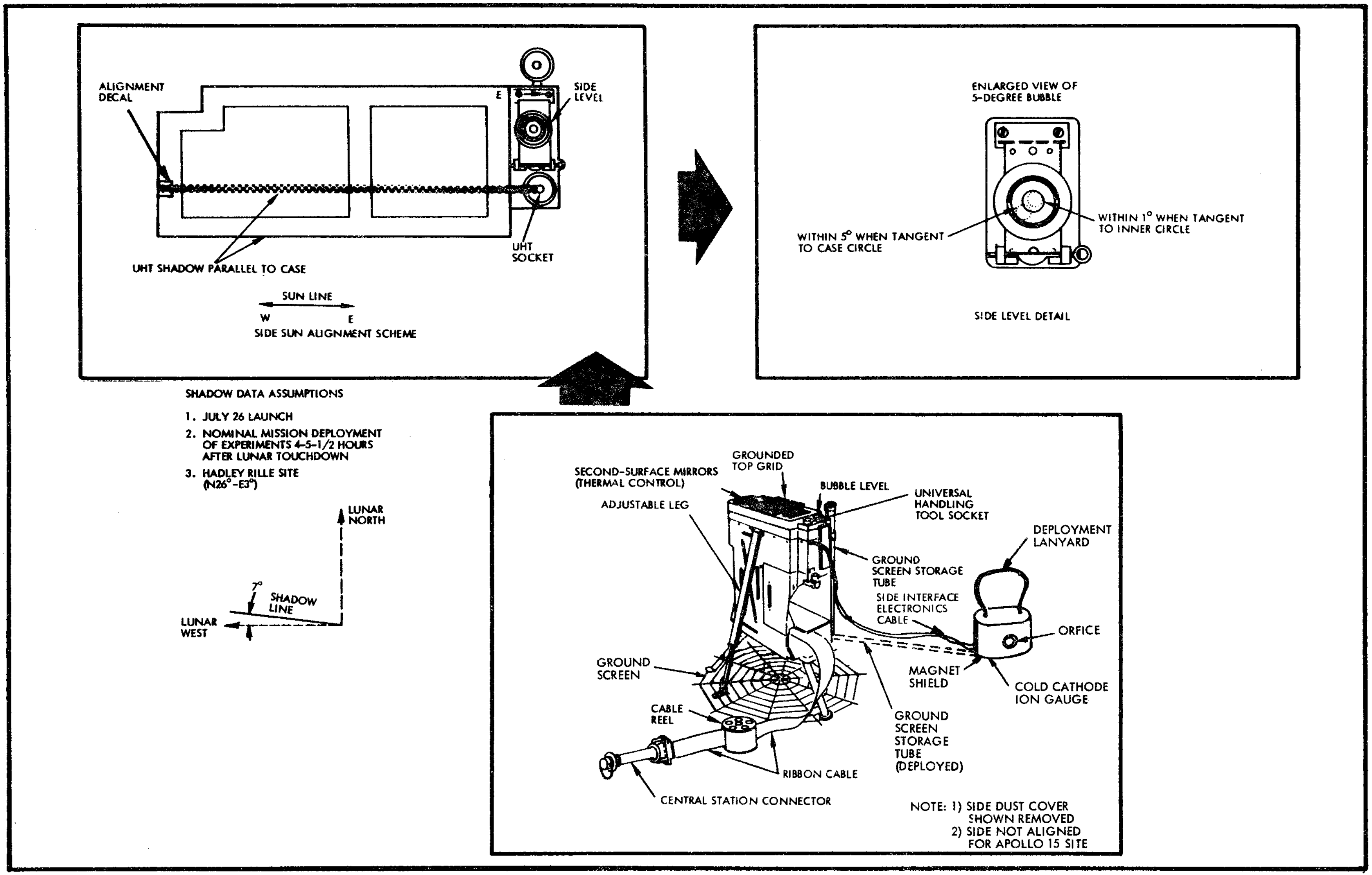


Figure 2-27. ALSEP Suprathermal Ion Detector/Cold Cathode Ion Gauge Experiments

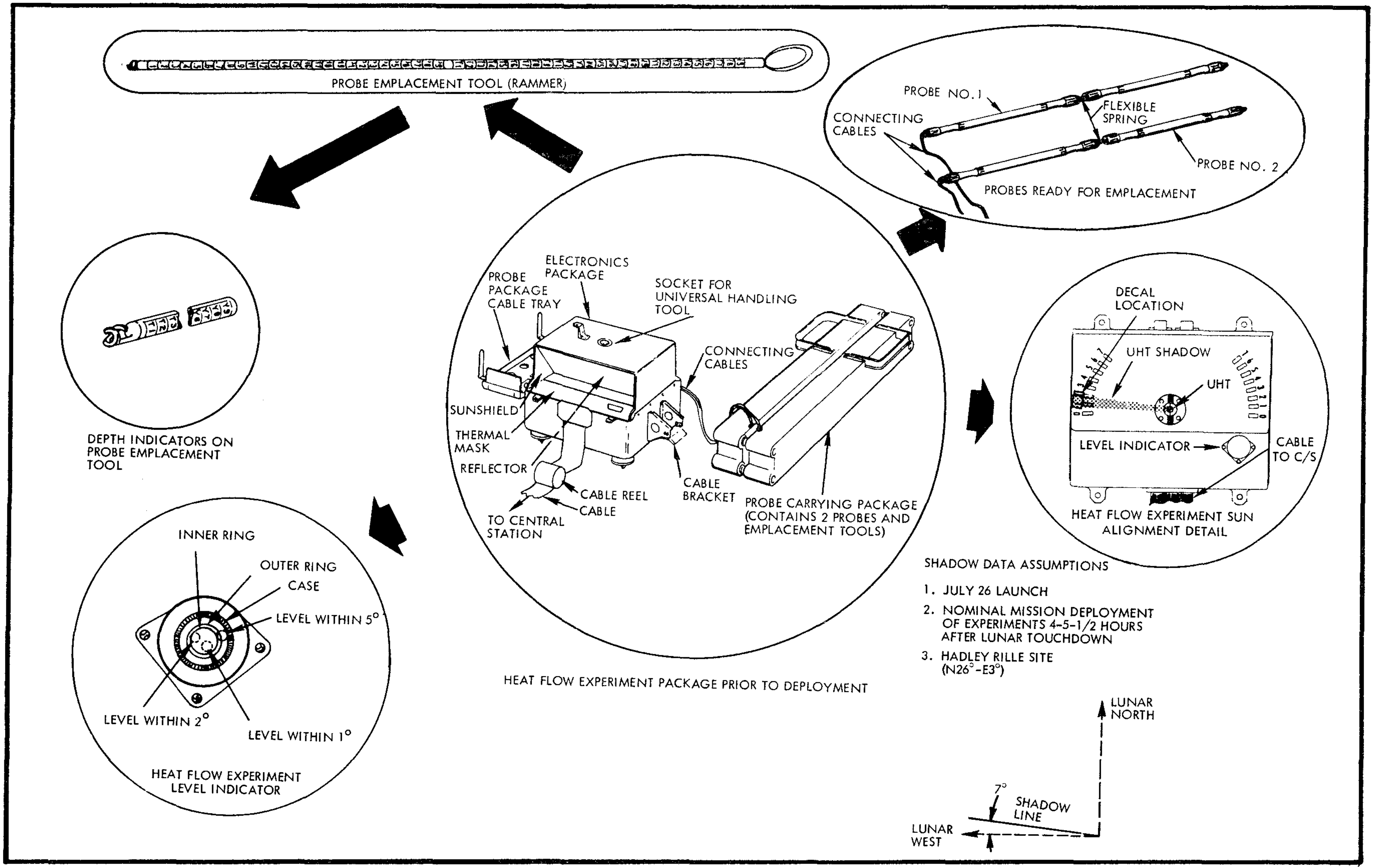


Figure 2-28. ALSEP Heat Flow Experiment

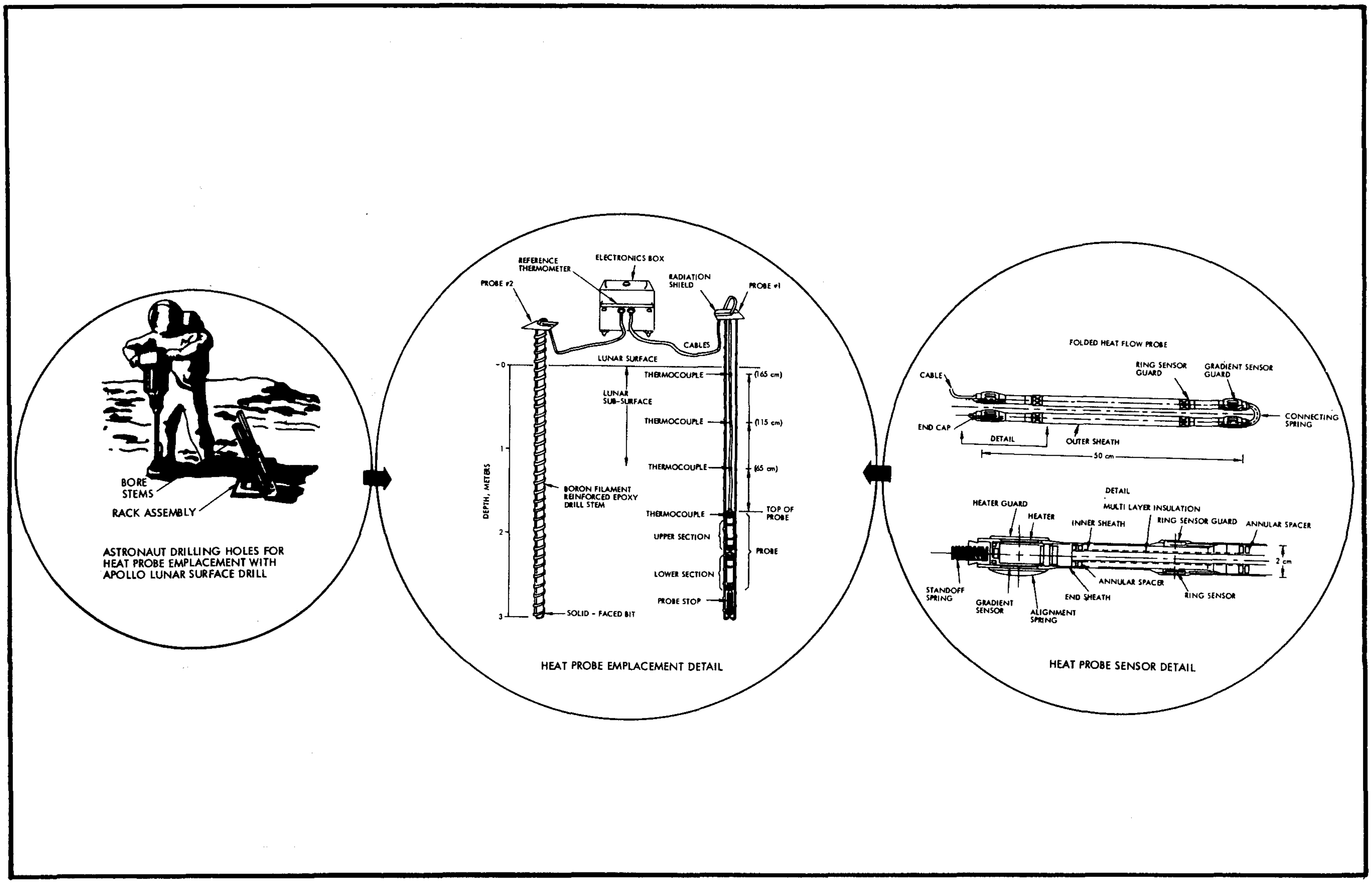


Figure 2-29. ALSEP Heat Flow Experiment Probe Emplacement and Sensors

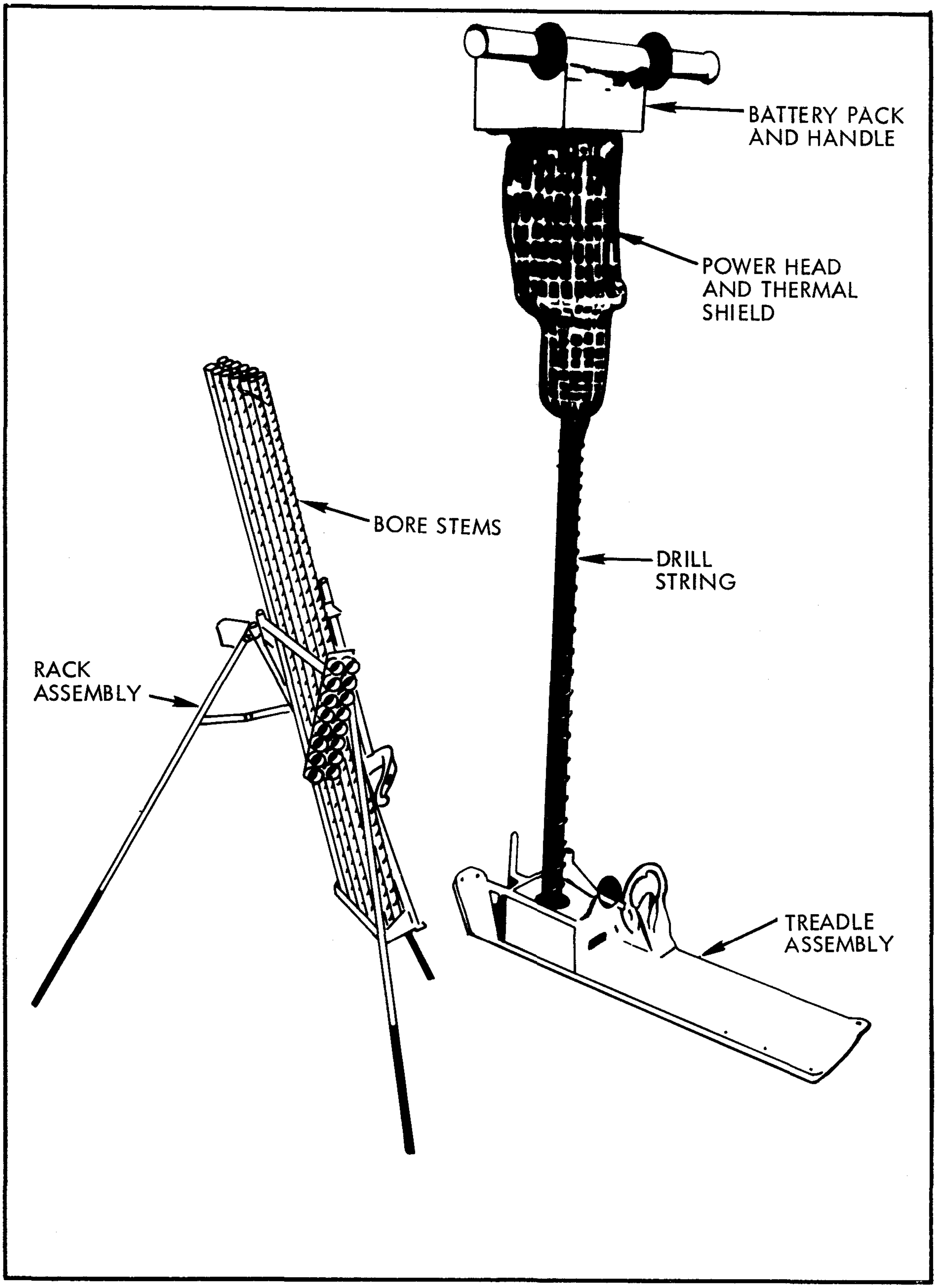


Figure 2-30. Apollo Lunar Surface Drill and Bore Stems

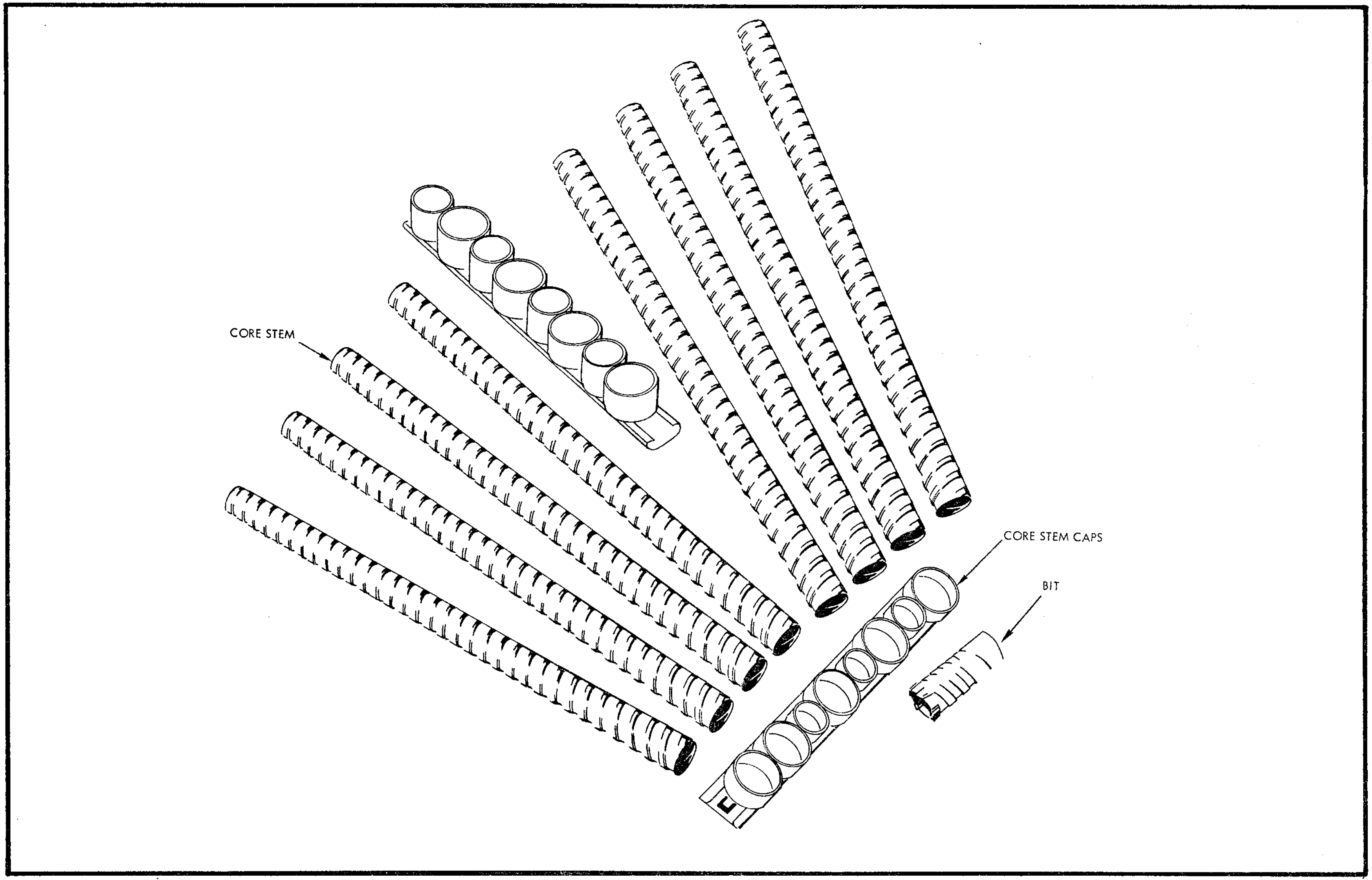
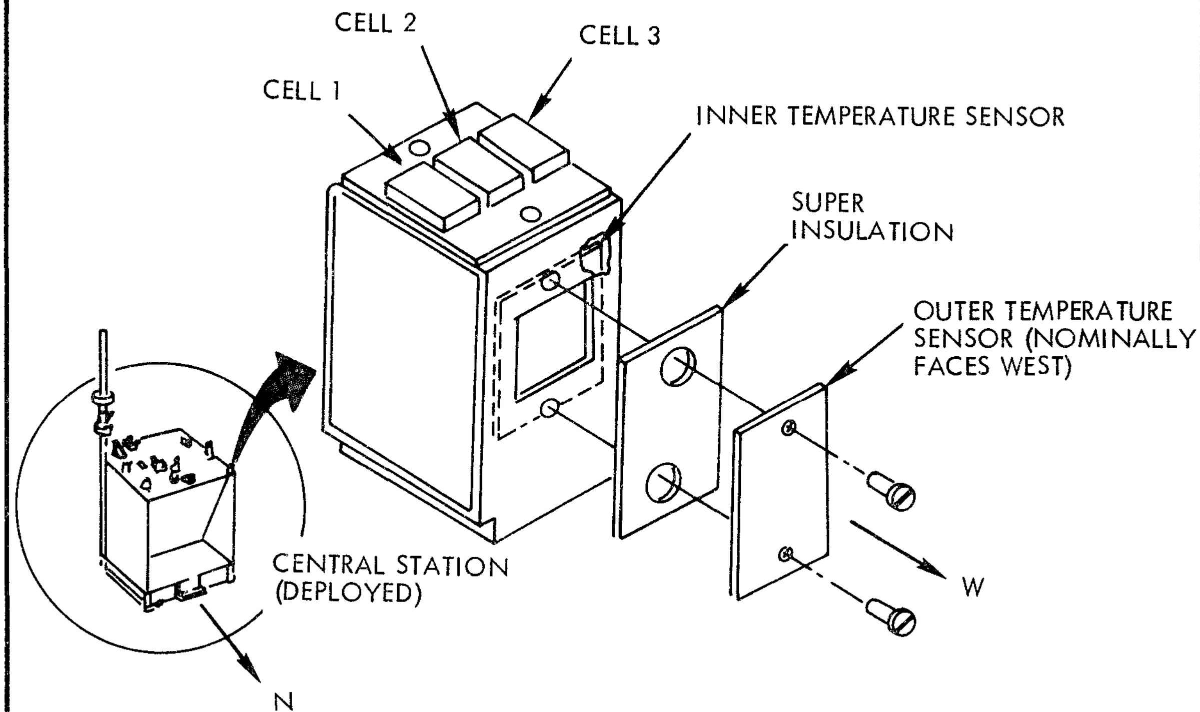


Figure 2-31. Apollo Lunar Surface Drill Core Stems



CELL 1 NO FILTER
CELL 2 IRRADIATED CELL, 6 MIL BLUE FILTER
CELL 3 6 MIL BLUE FILTER

Figure 2-32. ALSEP Lunar Dust Detector Experiment

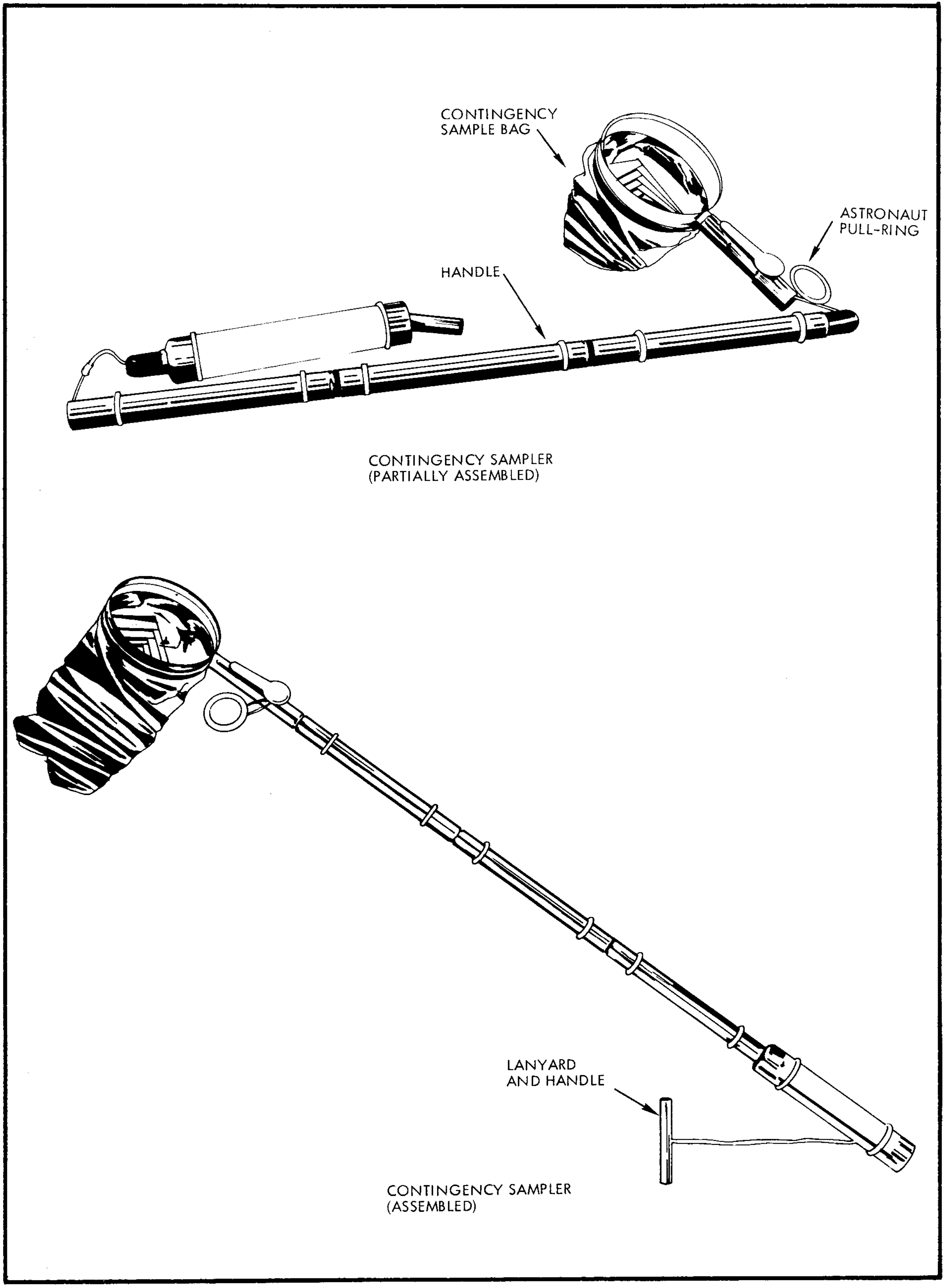


Figure 2-33. Contingency Sampler

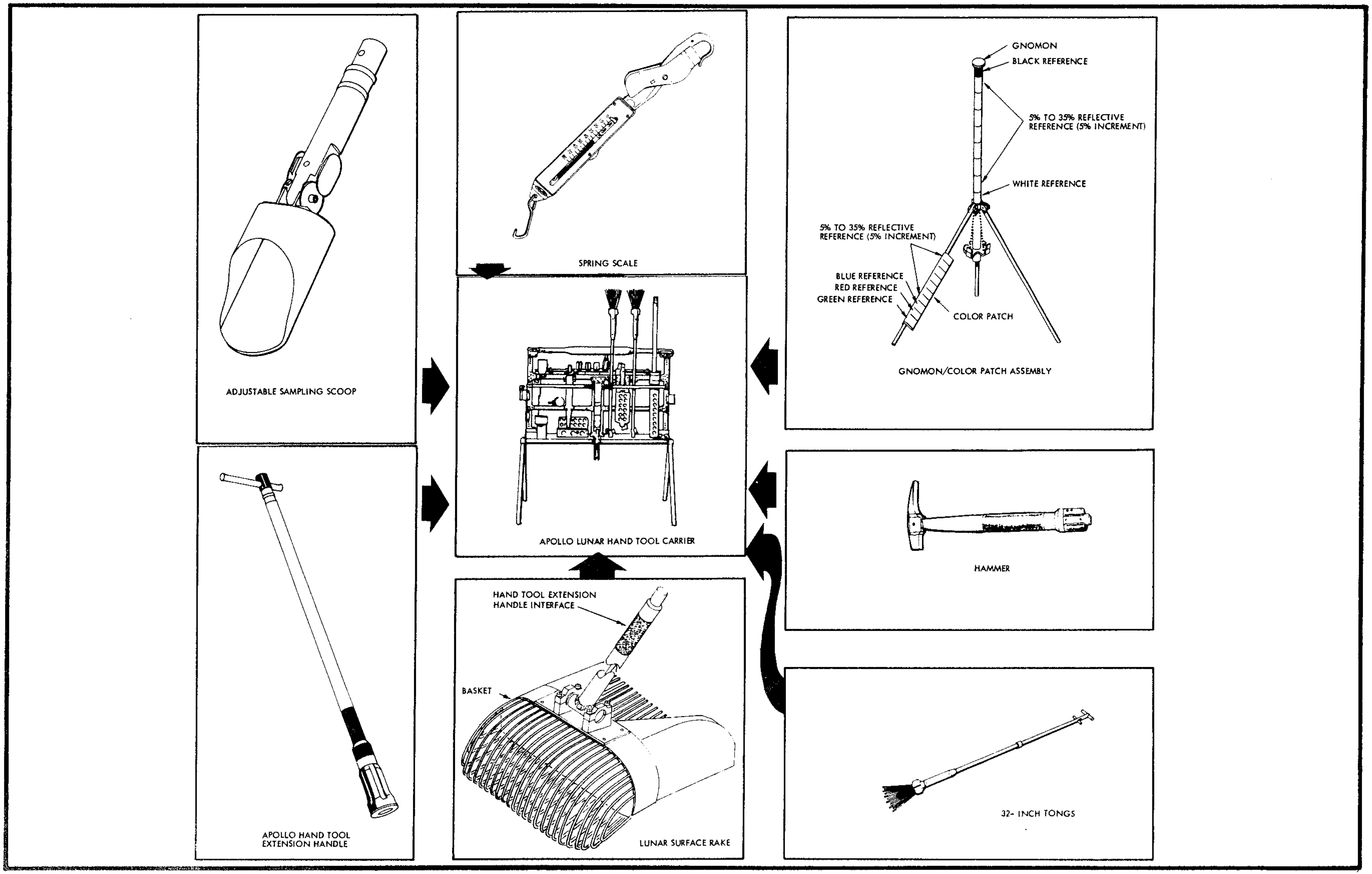


Figure 2-34. Lunar Geology Hand Tools

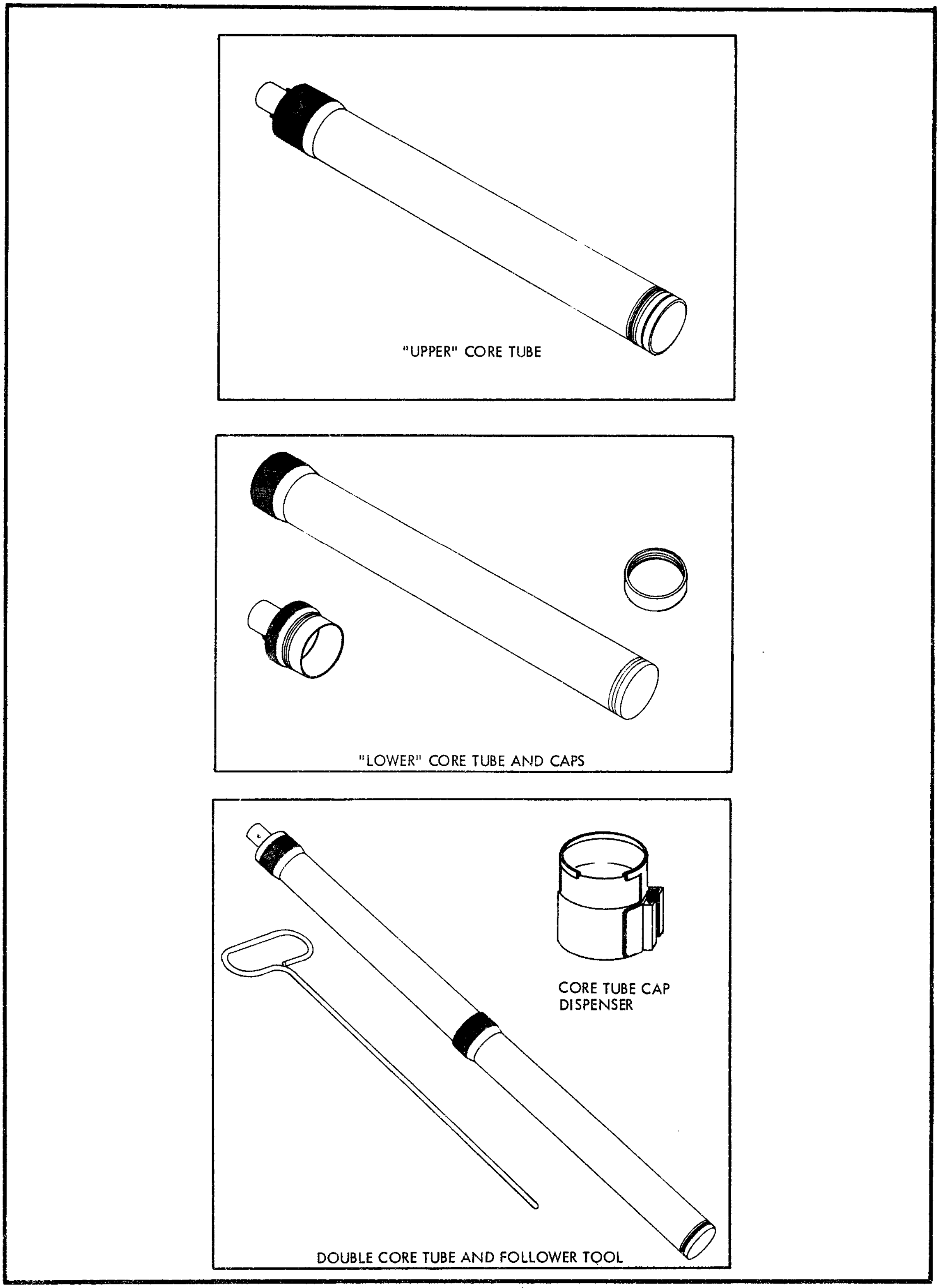


Figure 2-35. Lunar Geology Core Tubes

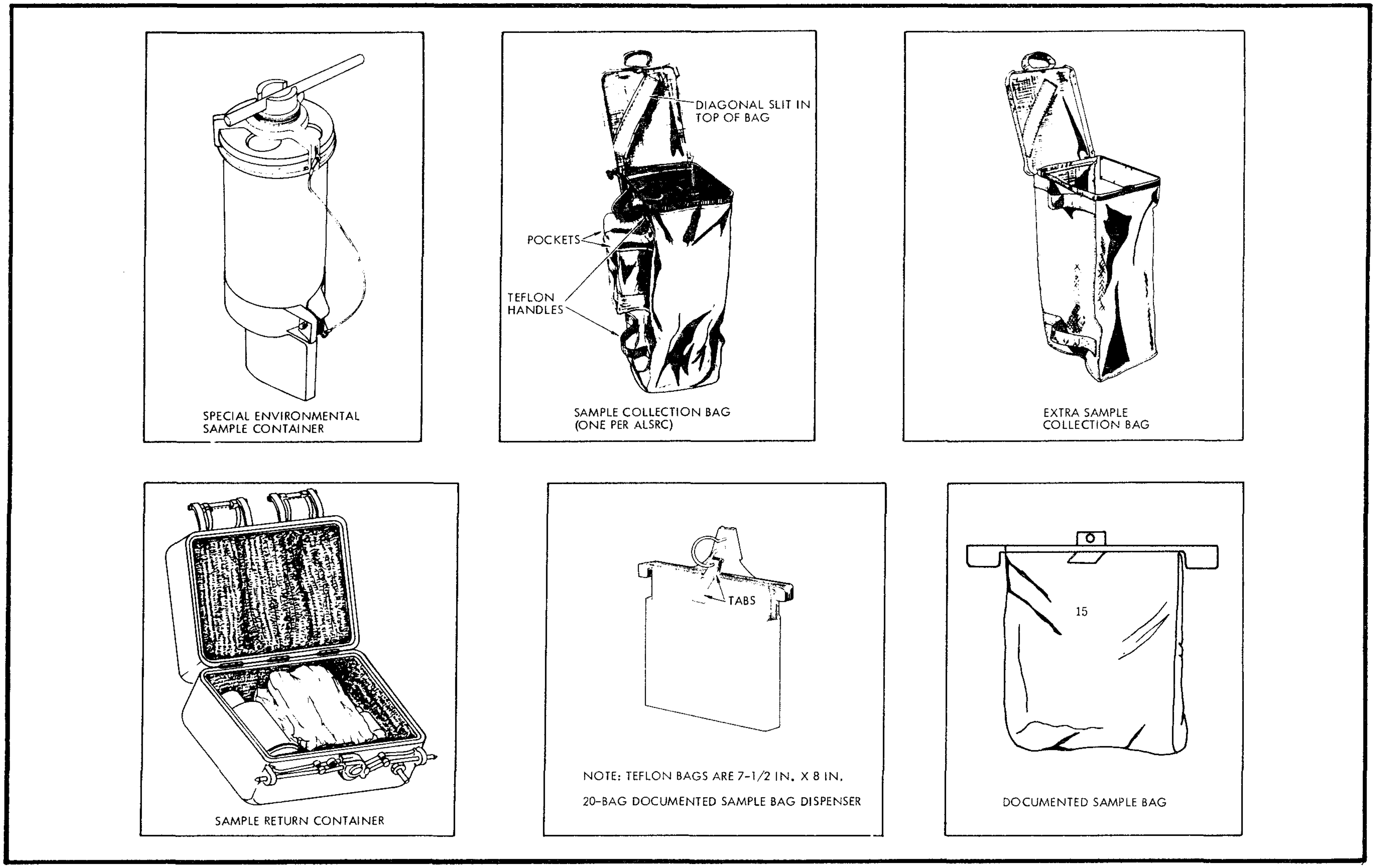


Figure 2-36. Lunar Geology Sample Containers

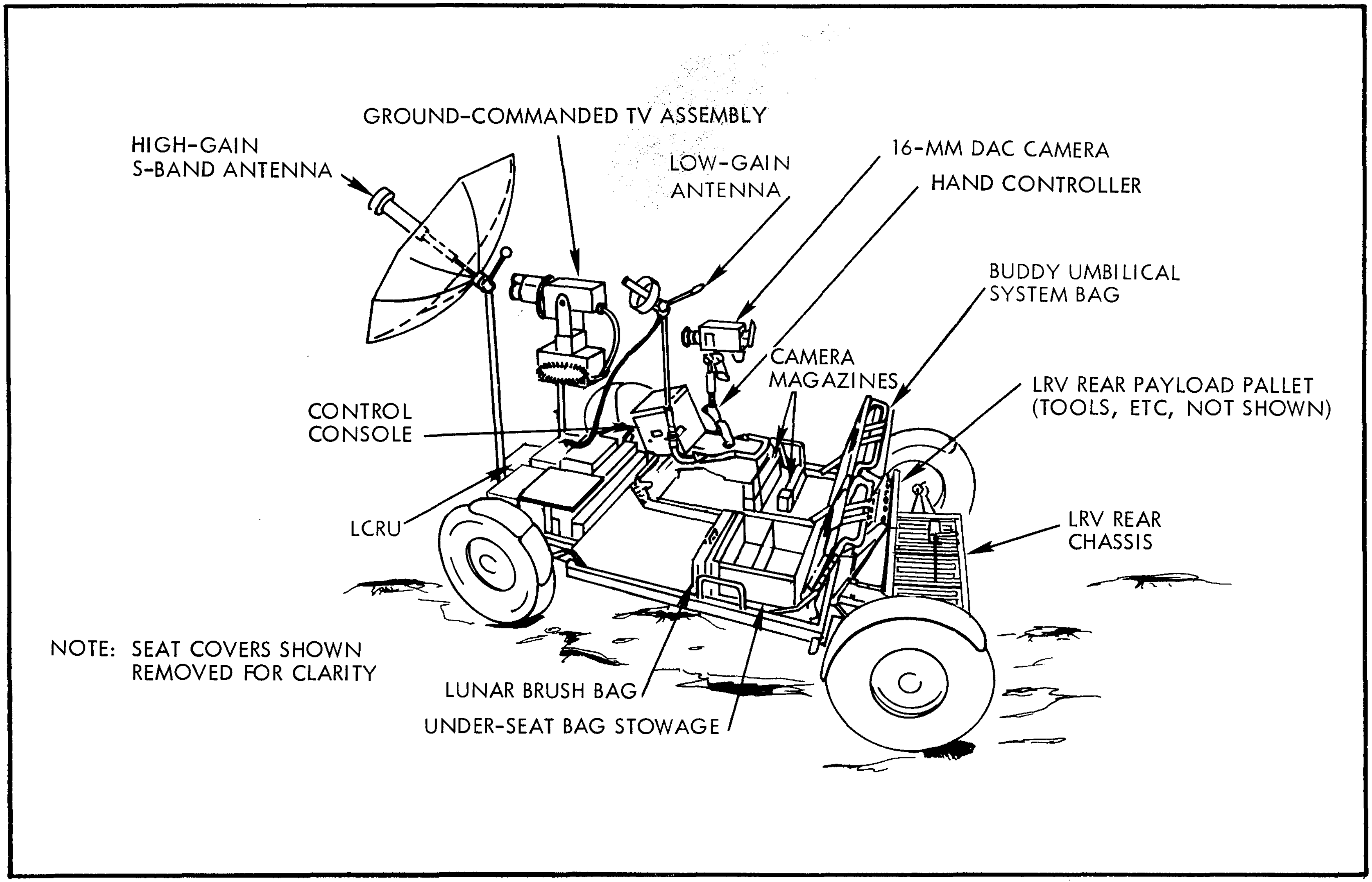
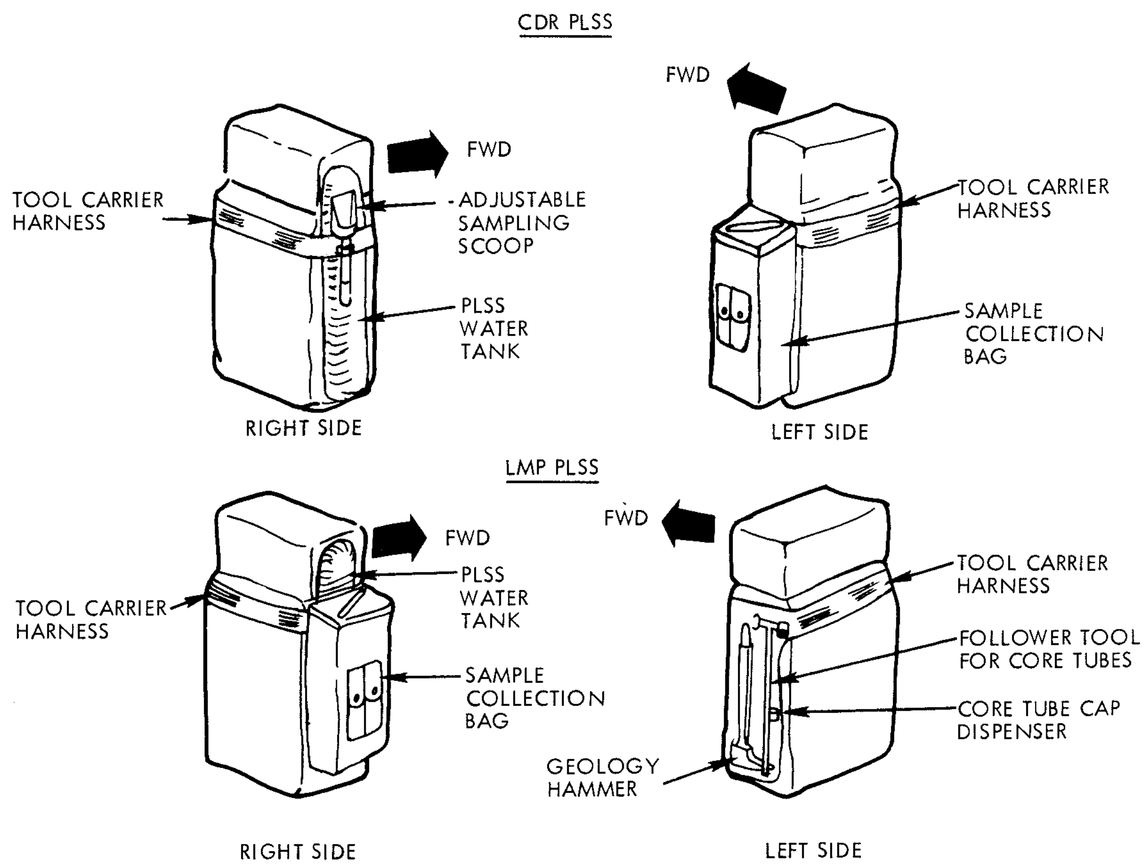


Figure 2-37. Lunar Roving Vehicle



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. FABRICATION AWAITING LEVEL 2 CCB APPROVAL.

Figure 2-38. PLSS Mounting of Lunar Geology Equipment

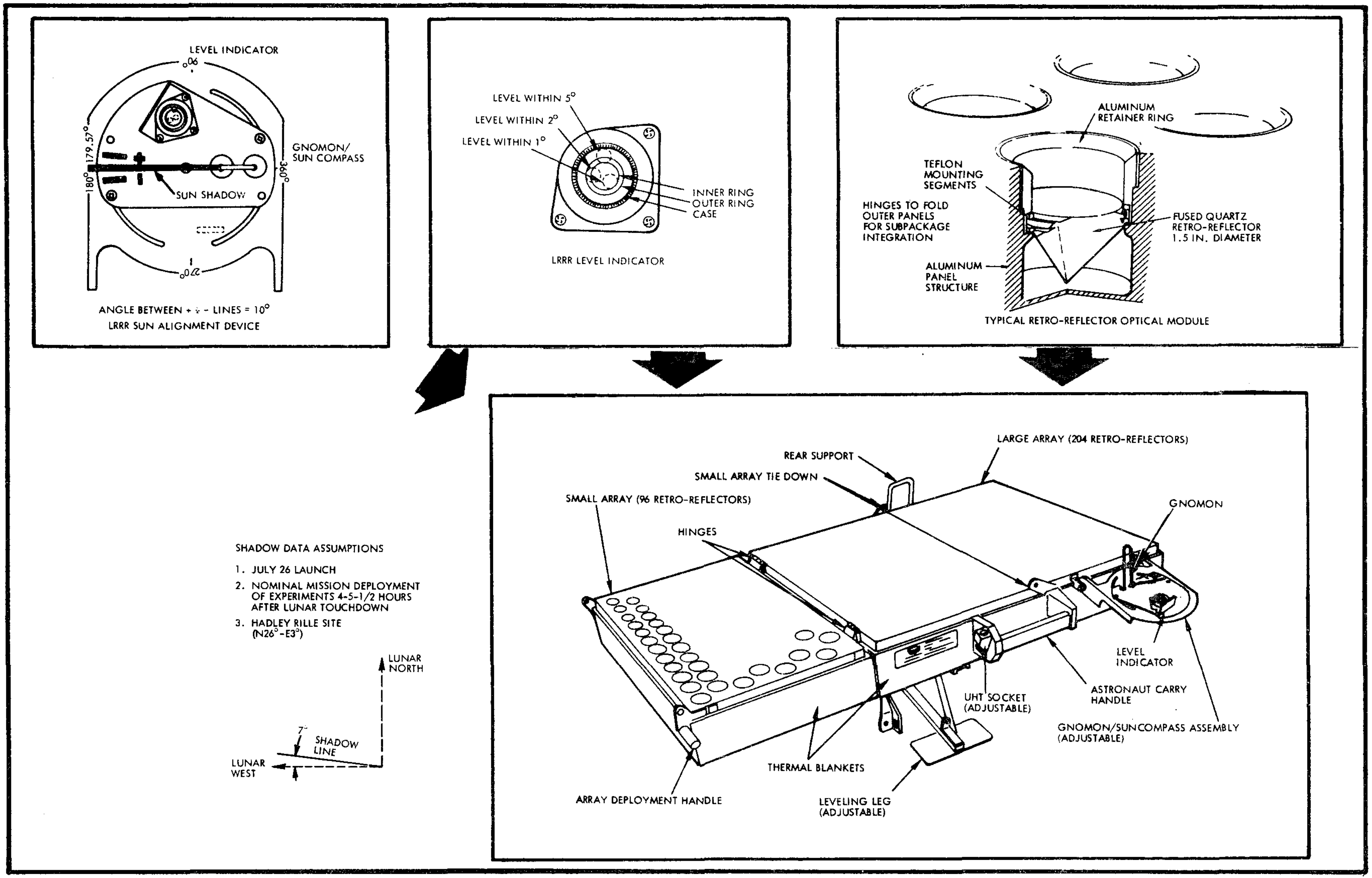


Figure 2-39. Laser Ranging Retro-Reflector Experiment

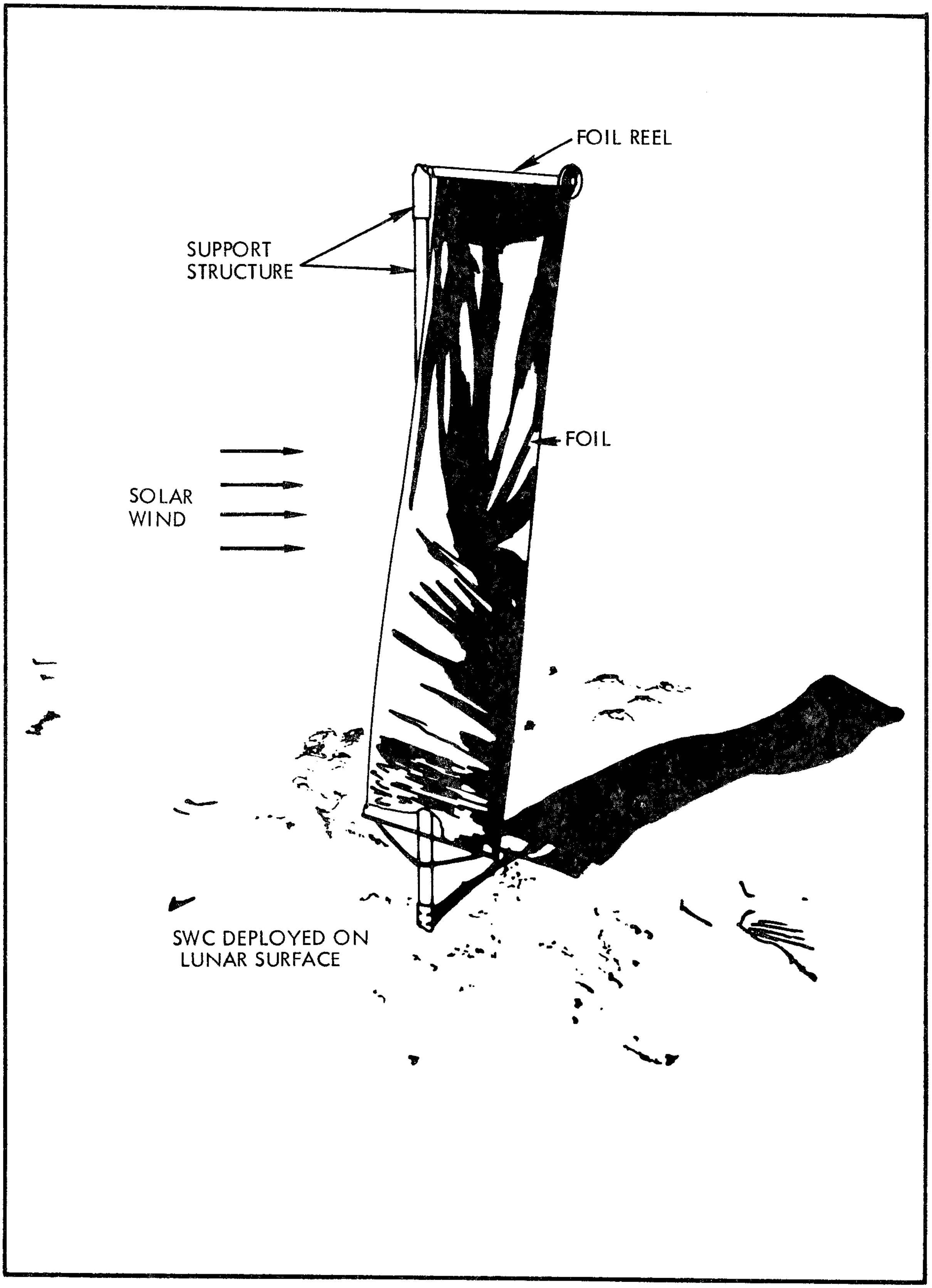


Figure 2-40. Solar Wind Composition Experiment

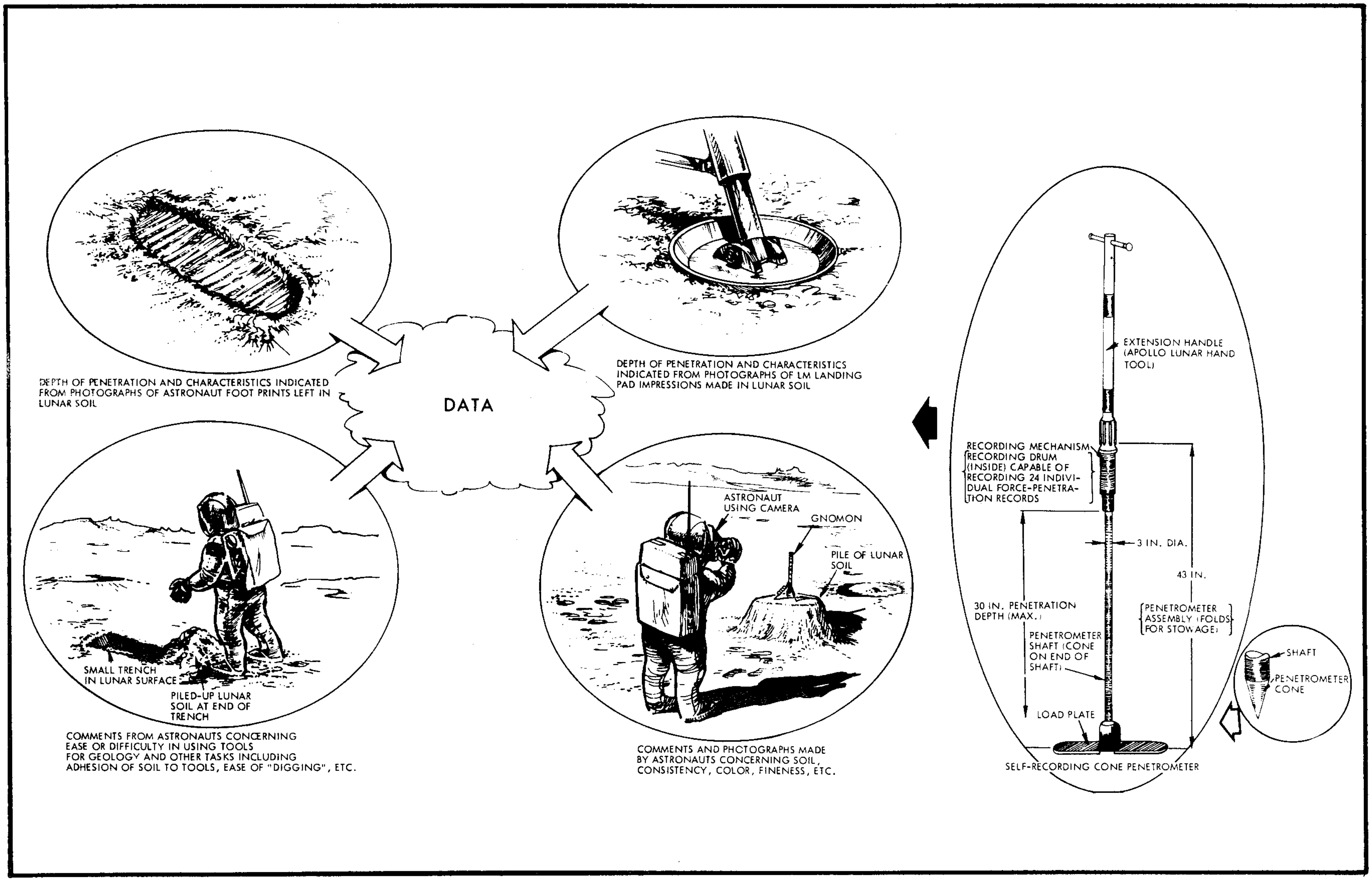


Figure 2-41. Soil Mechanics Equipment and Experiment Concept

SECTION III

PHOTOGRAPHIC PLAN

3.1 GENERAL

Data in this section were provided by the Science Requirements and Operations Branch/TD5, Mapping Science Branch/TF5, and Photographic Technology Division/BL. This section identifies and describes the types of photographic films which will be flown on Apollo Mission J-1 (Table 3-1), correlates photographic requirements to planned experiments and science-related detailed objectives (Tables 3-2 and 3-3), and specifies photographic film reproduction requirements (Table 3-4). 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 science requirements presented in the MSC-controlled J-1 Mission Requirements Document (Reference 1) until such data are published in other MSC-controlled documents. These documents include the Apollo 15 Flight Plan (Reference 2), Apollo 15 Lunar Surface Procedures (Reference 3), and the Apollo 15 Photographic and TV Procedures (Reference 4).

3.2 SUMMARY OF FILM TYPES

Table 3-1 lists the film types that will fly on Apollo Mission J-1, and a brief description of each. Detailed information on these and other films is given in Appendix E, including film characteristics, suggested exposure indexes, image-structure properties, emulsion characteristics, and typical density-log exposure curves. These data are the results of processing tests performed for the most part by the film supplier, and reflect averages based on many different batches of film. Thus, the data are accurate as to general film and emulsion characteristics, but should not be used for precise sensitometric comparison with any single batch of film. These detailed film descriptions should serve to indicate the 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 mission science photographic detailed objectives and experiments.

3.3 PHOTOGRAPHIC/SCIENCE REQUIREMENTS CORRELATION

Tables 3-2 and 3-3 present detailed photographic requirements for lunar orbital and lunar surface experiments, 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 specified by referring to the appropriate page of Appendix E.

The PTD performs sensitometric exposures of the flight films for each mission, for comparison with the manufacturer's sensitometric standards and establishment of film processing controls. The Film Sensitometric Calibration, Processing, Handling, and Equipment Capabilities Document (Reference 16) provides detailed information on sensitometric calibration, and describes a procedure for coordination of special photographic requirements with the PTD.

3.4 PHOTOGRAPHIC REPRODUCTION REQUIREMENTS

Table 3-4 presents the requirements for postmission reproduction of materials for lunar surface and lunar orbital photographic imagery.

Table 3-1. Apollo Mission J-1 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	Geological samples photography
3414*	Low-speed BW	Lunar surface photography from lunar orbit and transearth coast
SO-164	Medium-speed BW	Photography of Mass Spectrometer
SO-168 (ASA 160)	High-speed color exterior	Photography of Apollo Lunar Surface Experiments Package (ALSEP) deployment
SO-368	Medium-speed color exterior	Color photography on the lunar surface

*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 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, 3401, and SO-164)
LBW - Low-speed black and white (3414, formerly SO-349 and 3404)
VHBW - Very high-speed black and white (2485)
IIa-O- Ultraviolet (UV) spectroscopic

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-22).

Exposure parameters are preliminary based on previous mission photography. Final values are TBD by the Flight Crew Support Division (FCSD) and the Photographic Technology Division (PTD). The parameters are listed sequentially as aperture stop (including 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	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-22	Automatic Exposure Control Adjusted by MCC Commands
	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-14	Automatic Exposure Control
	Stellar photographs time-correlated with the metric photographs of the lunar surface	SC/3-Inch Lens	BW(3401)/E-18	f/2.8, 2 sec, ∞

*For photographic sequences see Section IV of the J-1 Mission Requirements Document.

**The 24-Inch panoramic camera has automatic V/h compensation from 45 to 80 NM. V/h compensation altitude range for the 3-Inch mapping camera is ±10 NM from 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
S-Band Transponder (CSM/LM) (S-164)	None			
Subsatellite (S-164, S-173, S-174)	30 seconds of sequence photography of the subsatellite after its launch, showing the condition of its external surface, confirming deployment of experiment booms, and indicating subsatellite orientation and spin rate	DAC/75-mm Lens/ Ring sight	CEX(SO-368)/ E-42	T/11, 1/125, 100, frame cycle rate of 12 frames per second
Mass Spectrometer (S-165)	Sequence photographs (terminator to terminator) of the fully extended Mass Spectrometer on 3 sunlit passes: one during an early operating period, one during an operating period midway in lunar orbit	DAC/18-mm Lens/ Window mounting bracket, RH side window	BW(SO-164)/E-14	f/8, 1/250, 20, 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
Mass Spectrometer (S-165) (Continued)	science period (HD), and one during a late operating period			
Apollo Window Meteoroid (S-176)	None			
UV Photography — Earth and Moon (S-177)	13 sets of 5 photographs as follows:			
	One photograph with each of three UV filters and one photograph with a visual range filter (a second photograph with each filter is desirable)	HEC/105-mm UV transmitting Lens/UV bandpass filters centered at 3750 Å, 3250 Å, and 2600 Å, visual range filter 4000-6000 Å/ring slide for filters and window mounting bracket	IIa-0 (Spectroscopic) /TBD	TBD, TBD, ∞
	One color photograph of approximately same scene as taken with UV filters (HD)	HEC/105-mm UV transmitting Lens/Visual range filter	CEX (SO-368)/ E-42	TBD, TBD, ∞

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
UV Photography (Continued)	<u>In earth parking orbit</u>: 1 set showing clouds 1 set showing land and water <u>During translunar coast</u>: 1 set of the earth disc from each of the approximate distances 60,000 NM, 120,000 NM, and 180,000 NM from the earth One set of the moon early in translunar coast for calibration of CM RH side window (HD) <u>In lunar orbit</u>: 2 sets of the earth 1 set of the earth and lunar horizon 1 set of lunar terra 1 set of lunar maria			

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
UV Photography (Continued)	<u>During transearth coast</u>: 1 set of the earth disc from each of the approximate distances 180,000 NM, 120,000 NM, and 60,000 NM from the earth One set of the moon late in transearth coast for calibration of the CM RH side window (HD)			
Gegenschein from Lunar Orbit (S-178)	6 photographs: 2 in the antisolar direction, 2 in the direction of the Moulton point, and 2 in the direction midway between the antisolar direction and the direction of the Moulton point. The photographs are to be taken while the spacecraft is in the	35/55-mm Lens (fixed)/window mounting bracket, light shield	VHBW (2485)/ E-7	f/1.2, (1 min, 3 min)*, ∞

*These two exposures in each direction

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
Gegenschein (Continued)	lunar double umbra			
	6 additional photographs the same as specified above (HD)	35/55-mm Lens (fixed) /window mounting bracket, light shield	VHBW (2485)/ E-7	f/1.2, (1 min, 3 min), ∞
	2 photographs in the direction midway between the antisolar direction and the direction of the Moulton point, photographs to be taken through the RH side window for calibration light intensity	35/55-mm Lens (fixed)/window mounting bracket, light shield	VHBW (2485)/ E-7	f/1.2, (1 min, 3 min), ∞
CM Photographic Tasks	Photographs of the lunar farside and eastern limb, taken at approximately the following times after TEI:			
	30 minutes, continuing to film depletion	MC/3-Inch Lens	BW(3400)/E-14	Automatic Exposure Control
	3 hours (5 frames)	HEC/250-mm Lens	LBW(3414, formerly SO-349 and 3404)/E-22	f/8, 1/250, ∞

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 (Continued)	3 series of solar corona photographs, one after CSM sunset and two prior to CSM sunrise*, each series to consist of: (a) Seven photographs taken at the following times:		HEC/80-mm Lens/ window mounting bracket	VHBW (2485)/ E-7	Aperture of f/2.8 and focus of ∞ for all photographs, shutter speeds variable with times of photographs, as follows (in sec):
	From CSM Sunset (Sec)	Prior to CSM Sun-rise (Sec)			
	10	-10			1/125
	20	-20			1/60
	30	-30			1/30
	40	-40			1/15
	50	-50			1/8
	60	-60			1/4
	70	-70			1.0

*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 (Continued)	(b) approximately 180 frames, during the following intervals:	DAC/18-mm Lens/ window mounting bracket	VHBW (2485)/ E-7	T/1.0 (f.95), (shutter speeds as given below), ∞, frame cycle rate of 1 frame per second
	Time from CSM Sunset (Sec) — Time Prior to CSM Sunrise (Sec)			
	0 to 80 — -80 to 0			1/500
	80 to 180 — -180 to -80			1/125
	180 — 0			OFF
	Three photographs of the moon through the CM RH rendezvous window, for calibration purposes	HEC/80-mm Lens/ window mounting bracket	VHBW (2485)/ E-7	f/2.8 (1/125, 1/60, 1/30), ∞
	Photographs of the moon during lunar eclipse by the earth, as follows:			

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 (Continued)	First Series: Time Relative to Moon Entering Earth's Umbra (Minutes)	HEC/80-mm Lens	CEX (SO-368)/ E-42	f/2.8, (as given below), ∞
	-15*			1
	-12*			2
	-9			1
	-6			2
	-3			10
	-1			120
	First Series: (Continued)	35/55-mm Lens (fixed)/window mounting bracket	VHBW (2485)/ E-7	f/1.2, (as given below), ∞
	-1			2
	0			4
	+1			8
	+2			15
	+3			30
	+4			60
	Second Series: Time Relative to Moon Leaving Earth's Umbra (Minutes)	HEC/80-mm Lens	CEX (SO-368)/ E-42	f/2.8, (as given below), ∞

*The 250-mm lens will be used at f/5.6.

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 (Continued)	+1 +3 +6 +9 +12* +15*			120 10 2 1 2 1
	Second Series (Continued)	35/55-mm Lens (fixed)/window mounting bracket	VHBW (2485)/ E-7	f/1.2, (as given below), ∞
	-4 -3 -2 -1 0 +1			60 30 15 8 4 2
	Three photographs of a comet, if one is in a favorable position	DAC/18-mm Lens/ optical adapter to the CM sextant	VHBW (2485)/ E-7	T/1.0 (f/.95), (60, 20, 5), ∞

*The 250-mm lens will be used at f/5.6.

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 (Continued)	Four photographs of a star field centered on RTCC catalog star No. 46 (Hamal), taken during TEC with the CM sextant optical axis at approximately 90 degrees to the S/C sun line	DAC/18-mm Lens/ optical adapter to the CM sextant	VHBW (2485)/ E-7	T/1.0 (f/.95), (60, 20, 5, 1), ∞
	Same 4 photographs with CM sextant optics shaded from the sun	DAC/18-mm Lens/ optical adapter to the CM sextant	VHBW (2485)/ E-7	T/1.0 (f/.95), (60, 20, 5, 1), ∞
	Two additional sets (8 photographs) as specified above, but taken during TLC (HD)	DAC/18-mm Lens/ optical adapter to the CM sextant	VHBW (2485)/ E-7	T/1.0 (f/.95), (60, 20, 5, 1), ∞

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 (Continued)	Four photographs of the L4 lunar libration region	35/55-mm Lens (fixed)/window mounting bracket	VHBW (2485)/ E-7	f/1.2, (60, 20, 20, 5), ∞
	23 photographs of zodiacal light, taken at the following times prior to CSM sunrise:* (Min:Sec) -25:00 -21:40 -18:20 -15:00 -11:40 - 8:20 - 5:00 - 1:00 - 0:45 - 0:30 - 0:15	35/55-mm Lens (fixed)/window bracket	VHBW (2485)/ E-7	Aperture f/1.2, focus at ∞ for all 23 photographs, shutter speeds for different times prior to sunrise as follows: 120, 30 120, 30 90, 30, 10 90, 30, 10 60, 20, 8 60, 20, 8 30, 10, 4 1/8 1/15 1/30 1/60
	Photographs of specific areas in low light levels near the terminator, at approximately 20-second	HEC/80-mm and 250-mm Lens	VHBW (2485)/ E-7	f/2.8, 1/125, ∞ with 80-mm Lens; f/5.6, 1/60, ∞ with 250-mm Lens

*For these photographs the CSM attitude rate will be matched to 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 (Continued)	intervals from 1 minute before terminator crossing (light side) to 40 seconds after terminator crossing (dark side)*			
	Photographs of the lunar surface in earthshine, at approximately 30-second intervals from 1 minute before to 8 minutes after crossing terminator	35/55-mm Lens (fixed)	VHBW (2485)/ E-7	f/1.2, (1/60 at start, to 1/15 1 minute after crossing terminator to 1/8 2 minutes later), ∞
	Photographs of specific** areas of the lunar surface, providing 60 percent forward overlap	HEC/250-mm Lens/ window mounting bracket (HD)	CEX (SO-368)/ E-50 and LBW(3414)/E-22	f/stop from spotmeter, 1/250, ∞
	Photographs of specific** areas of the lunar surface, providing 60 percent forward overlap	HEC/80-mm Lens/ window mounting bracket (HD)	CEX (SO-368)/ E-50	f/stop from spotmeter, 1/250, ∞

*Total with both lenses of up to 10 terminator crossings.
**For identification of photographic targets, refer to Section IV of the J-1 Mission Requirements Document.

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
Gamma-Ray Spectrometer (S-160)	*	PC/24-Inch Lens	LBW (3414, formerly SO-349 and 3404)/E-22	Automatic Exposure Control adjusted by MCC commands
X-Ray Fluorescence (S-161)	*	MC/3-Inch Lens	BW (3400)/ E-14	Automatic Exposure Control
Alpha Particle Spectrometer (S-162)	*	SC/3-Inch Lens	BW (3401)/ E-18	f/2.8, 2 sec, ∞
Bistatic Radar (S-170)	*			

*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

Film Nomenclature:

CEX - Color exterior (SO-368)
HCEX - High-speed color exterior (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-18).

Exposure parameters are based on previous mission photography. Final values are subject to change by the Flight Crew Support Division (FCSD) and the Photographic Technology Division (PTD). The parameters are listed sequentially as aperture stop (including 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.

*The film type for black and white surface photography 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
Standup EVA (SEVA)	2 sets of panoramic photographs, each set containing 15 or 20 overlapped photographs for 360-degree coverage, the two sets taken from slightly different heights	HEDC/60-mm Lens	BW (3401)/E-18	DECAL, 1/250, 74
	Distant photographs of interesting features on the horizon, at crew discretion	LFLC/500-mm Lens	BW (3401)/E-18	f/11 (down-sun) and f/8 (cross-sun or up-sun), 1/250, ∞*
ALSEP/Central** Station (C/S)	One photograph of the C/S taken from 7 feet behind the C/S looking north (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 7
	At least one photograph showing entire ALSEP deployed (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 11
	One photograph of the C/S taken from 11 feet looking south to show the positions of the switches (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 11

*The long focal length camera is permanently focused at ∞.
**Photographs desired but not listed as a science requirement in the J-1 Mission Requirements Document.

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
Radioisotope* Thermoelectric Generator (RTG) (ALSEP)	One photograph of the RTG on the subpallet, taken 7 feet from the RTG (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 7
Passive Seismic (S-031) (ALSEP)	PSE deployed - one photograph cross-sun from 3 feet, showing position of bubble and gnomon shadow on compass rose (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 3
	One photograph showing C/S in background, taken 7 feet from PSE (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 7
Lunar Surface Magnetometer (S-034) (ALSEP)	One photograph taken 3 feet from the LSM and focused on the shadowgraph, photograph to be taken prior to sunshade deployment	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 3
	One photograph taken 7 feet from the LSM, showing the LSM and, if possible, with the	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 7

*Photographs desired but not listed as a science requirement in the J-1 Mission Requirements Document.

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 Magnetometer (Continued)	C/S in the background			
Solar Wind Spectrometer (S-035) (ALSEP)	One photograph cross-sun taken 3 feet from SWS, looking north*	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 3
	One photograph cross-sun taken 3 feet from SWS, Looking south*	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 3
Suprathermal Ion Detector Experiment (SIDE) (S-036)/ Cold Cathode Ion Gauge (CCIG) (S-058) (ALSEP)	One photograph cross-sun, taken 7 feet from the SIDE and showing the CCIG aperture. (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 7
	One photograph showing SIDE and CCIG with C/S in background. (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 7
	One photograph of the SIDE bubble level from 3 feet, showing the deviation of the SIDE from the local vertical. (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 3

*It is desirable that the shadow cast on the top surface of the sensor mounting plate by the tetrahedral device be visible in at least one of the photographs.

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 hole, taken down-sun from 7 feet (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 7
	One photograph of HFE electronics package looking south from 7 feet (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 7
	One stereo pair of each bore hole with probe inserted, taken looking south from 11 feet (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 11
Lunar Dust Detector (M-515)	One photograph of the C/S taken from 7 feet showing the dust detector*	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 7

*No specific crew task required. A copy of any C/S photograph showing the LDD 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 Geology Investigation (S-059)	For each documented geological sample including the comprehensive sample and the 2-kilogram soil sample, the following 5 photographs:			
	Before Sampling:			
	One down-sun from 11 feet, including gnomon with color patch	HEDC/60-mm Lens	BW (3401)/E-18	f/11, 1/250, 11
	*One stereo pair cross-sun from 7 feet	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 7
	After Sampling:			
	One cross-sun from 7 feet	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 7
	*One location photograph cross-sun from 15 feet, including identifiable object or landmark, to be taken before or after sampling (HD)	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 74

*Sample documentation by a single crewman includes only these photographs.

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 radial sampling of a fresh crater: two stereoscopic partial panoramas covering the sampling area	HEDC/60-mm Lens	BW (3401)/E-18	DECAL, 1/250, 74
	Panoramic photographs, each set containing 15 to 20 overlapped photographs for 360-degree coverage, taken with horizon near top of the picture - sets to be taken from: a) Three positions approximately 20 feet from the LM and 120 degrees apart b) Geological features of interest along traverse c) High elevation points d) Points with items of crew interest	HEDC/60-mm Lens	BW (3401)/E-18	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 (Continued)	Distant photographs of Hadley Rille and the Apennine Front (number of photographs at crew discretion), as follows:	LFLC/500-mm Lens	BW (3401)/E-18	
	Across the rille			f/11, 1/250, 1 kilometer
	Along the rille			f/8, 1/250, 1 kilometer
	Along eastern rille wall and rille floor (shaded areas)			f/8, 1/125, 1 kilometer
	Apennine front down-sun			f/11, 1/250, 1 kilometer
	Apennine front cross-sun and up-sun			f/8, 1/250, 1 kilometer
	For near-field polarimetric measurement:			
	One photograph down-sun (10-degree phase angle), from 11 feet, taken of a rock sample area, including gnomon	HEDC/60-mm Lens	BW (3401)/E-18	f/11, 1/125, 11

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 (Continued)	Three photographs of area from 7 feet, one through each of three polarizing filters, at a phase angle of 90 degrees Same 3 photographs at phase angle of 110 degrees Same 3 photographs at phase angle of 130 degrees*	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/125, 7
	For distant polarimetric measurement:			
	Three photographs from at least 12 meters, approximately cross-sun, one each at the left, center, and right settings of the polarizing filter	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/125, 74
	Three photographs as above, but from about 20 degrees down-sun from first position	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/125, 74

*In addition to these 10 photographs, one location and one after-sample photograph as described for documented geological samples.

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 (Continued)	For each core tube sample: one stereo pair cross-sun of core tube in contact with surface, from 7 feet	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 7
	One location photograph of tube and horizon, from 15 feet after tube is emplaced	HEDC/60-mm Lens	BW (3401)/E-18	DECAL, 1/250, 74
	Prior to digging each small trench:			
	A stereo pair of trenching area cross-sun from 7 feet	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 7
	One photograph of trenching area down-sun from 11 feet	HEDC/60-mm Lens	BW (3401)/E-18	f/11, 1/250, 11
	After each small trench is dug:			
	A stereo pair of the illuminated trench wall, cross-sun from 7 feet	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 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 (Continued)	One photograph cross-sun from 7 feet after a soil sample is taken	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 7
	A location photograph approximately cross-sun from 15 feet, taken any time in the above trench procedure	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 74
	For each large rock sample: same as for documented geological samples			
	For the fillet sample: 4 photographs equally spaced around the rock, from 3 feet	HEDC/60-mm Lens	BW (3401)/E-18	DECAL, 1/250, 3
	One photograph before and after the exhaust contamination sample (HD)	HEDC/60-mm Lens	BW (3401)/E-18	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 (Continued)	For the lunar environment soil samples: soil mechanics photographs will suffice			
	For the lunar environment soil-rock sample: same as for documented geological samples			
Laser Ranging Retro-Reflector (S-078)	One photograph of the top of the LRRR from 3 feet, showing bubble level and shadow marker	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 3
	One photograph of the LRRR taken at a 45-degree angle between the front and side, from 11 feet and including the LM or other identifiable object	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	f/11, 1/250, 11

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
Solar Wind Composition (S-080)	One cross-sun stereo pair of the SWC showing the staff in the lunar surface, with the entire foil and staff filling the field of view.	HEDC/60-mm Lens	HCEX(SO-168)/ E-32	f11, 1/250, FOCUS
	Two photographs of the upper part of the deployed SWC from 7 feet, showing the red marking on the reel and the upper part of the foil and staff: one photograph taken immediately after deployment and one photograph taken just prior to retrieval of the foil and reel at the end of the foil exposure period.	HEDC/60-mm Lens	BW(3401)/E-18	f11, 1/250, 7

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

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Soil Mechanics (S-200)	Panoramic photographs taken in the vicinity of the LM (described under Lunar Geology Investigation) will be compared with pre-mission photographs of the LM strut assemblies	HEDC/60-mm Lens	BW (3401)/E-18	DECAL, 1/250, 74
	Photographs of the course traversed before and after traverses for ALSEP deployment (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	*
	Photographs of an astronaut's footprint during traverse for ALSEP deployment (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	

*Soil Mechanics photographs designated as HD, and with no exposure parameters indicated, require no specific crew tasks. Copies are to be provided only if such photographs are obtained 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 (Continued)	Before trench excavation:			
	a) One photograph of trench site down-sun from 11 feet, showing gnomon placed near site (down-sun)	HEDC/60-mm Lens	BW (3401)/E-18	f11, 1/250, 11
	b) A stereo pair of trench site cross-sun from 7 feet	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 7
	Sequence photographs down-sun during excavation*	LDAC/10-mm Lens	CEX (SO-368)/ E-42	f/8, 1/250, ∞, 24 frames per second
	The following photographs of the excavation trench:	HEDC/60-mm Lens	BW (3401)/E-18	
	a) A stereo pair of the trench interior up-sun from 7 feet			f/5.6, 1/250, 7

*Television coverage is an acceptable alternate.

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 (Continued)	b) Two stereo pairs, one cross-sun from each side of the trench, from 7 feet, showing excavated material			f/5.6, 1/250, 7
	c) A stereo pair of the trench, down-sun from 7 feet			f/11, 1/250, 7
	Photographs as listed under a), b), and c) above, to be taken of the LRV track section closest (approximately 10 feet) to the trench			
	One location photograph of trench site from 15 feet	HEDC/60-mm Lens	BW (3401)/E-18	DECAL, 1/250, 74
	Photograph of each penetrometer test site to show location and to show maximum depth to which astronaut was able to push penetrometer	HEDC/60-mm Lens	BW (3401)/E-18	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
Soil Mechanics (Continued)	For each plate load test:			
	a) A cross-sun stereo pair of the test surface after plate is removed, from 7 feet	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 7
	b) A location photograph taken from 15 feet	HEDC/60-mm Lens	BW (3401)/E-18	DECAL, 1/250, 74
	Photographs of the LM exterior showing any soil accumulation on the vertical surface, cross-sun (if possible) at a distance of 7 to 15 feet depending on the surface to be photographed (HD)	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 7 or 11
	Photographs of the lunar surface showing DPS exhaust impingement erosive craters, one photograph taken cross-sun at 11 feet	HEDC/60-mm Lens	BW (3401)/E-18	f/5.6, 1/250, 11

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 (Continued)	from the center of the LM			
	Photographs of each LM footpad and surrounding lunar soil exhibiting evidence of LM footpad-lunar soil interaction (HD)	HEDC/60-mm Lens	HCEX (SO-168)/ E-32	*
	Photographs of natural slopes, boulders, ridges, rills, crater walls, and embankments in the vicinity of the landing site (HD)	HEDC/60-mm Lens	BW (3401)/E-18	*
	Photographs of the lunar soil-LRV interactions (HD)	HEDC/60-mm Lens	BW (3401)/E-18	*
	Photographs of the LRV in motion (HD)	LDAC/10-mm Lens	CEX (SO-368)/ E-42	

*Soil Mechanics photographs designated as HD, and with no exposure parameters indicated, require no specific crew tasks. Copies are to be provided only if such photographs are obtained in support of other operational tasks.

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

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Contingency Sample Collection*	Sequence photographs from inside the LM showing the astronaut taking the sample	DAC/10-mm Lens	CEX (SO-368)/ E-32	T/2.8 (f/2.64), 1/500, ∞, 12 frames per second

*There is no firm science requirement for photographs in support of the Contingency Sample Collection. It is desirable to collect sample from a previously photographed location.

Table 3-4. Photographic Reproduction Requirements*

ITEM	LUNAR SURFACE ONLY	ORBITAL AND LUNAR SURFACE	ORBITAL ONLY	TOTAL
<u>70-mm Photography</u>				
Positive Transparencies (Rolls)	14	29	0	43
Masters (Rolls) - From Original Onboard Film	7	5	3	15
8 x 10 In. Prints - Color and BW (Set)	26	26	0	52
Proof Books (Set)	1	9	0	10
<u>16-mm Photography</u>				
16-mm - Optical Masters	0	0	3	3
16-mm Working Prints (Set)	16	14	0	30
<u>35-mm Orbital Photography</u>				
Positive Transparencies (Rolls)	0	0	31	31
Masters (Rolls) - From Original Onboard Film	0	0	9	9
8 x 10 In. Prints	0	0	24	24
Proof Books (Set)	0	0	10	10
<u>Television</u>				
Kinescope (16-mm)	0	0	0	0
Working Print (Set)	3	0	0	3
<u>24-In. Panoramic Camera</u>				
Positive Transparencies (Rolls)	0	0	5	5
Masters (Rolls) - From Original Onboard Film	0	0	5	5

Table 3-4. Photographic Reproduction Requirements* (Continued)

ITEM	LUNAR SURFACE ONLY	ORBITAL AND LUNAR SURFACE	ORBITAL ONLY	TOTAL
<u>3-In. Mapping Camera</u>				
Positive Transparencies (Rolls)	0	0	10	10
Masters (Rolls) - From Original Onboard Film	0	0	5	5
Contact Strip Prints	0	0	5	5
35-mm - Positive Transparencies (From 3-In. Camera)	0	0	5	5
35-mm - Masters (Rolls) From Original Onboard Film	0	0	5	5

* Quantities in this table refer to the number of copies (transparencies, masters, etc.) made from <u>all</u> film of the indicated type. For example: of the 43 recipients of 70-mm positive transparencies, 29 will receive positive transparencies of <u>all</u> 70-mm magazines to be exposed both in lunar orbit and on the lunar surface, and 14 will receive positive transparencies of <u>all</u> 70-mm magazines to be exposed on the lunar surface only.

SECTION IV

LUNAR SURFACE SCIENCE PLAN

4.1 GENERAL

Traverse data in this section were provided by the Systems Engineering Division/PD, USGS Center of Astrogeology, and J. W. Head/Bellcomm, Inc. This section defines the lunar surface activities planned for the Apollo Mission J-1. Included are a description of the landing site and rationale for its selection; lunar surface planning data [experiments identification, surface feature priorities, Lunar Roving Vehicle (LRV) traverse terrain profiles, traverse planning guidelines/constraints]; and lunar surface activities. These activities involve activities at the landing site and those related to preliminary LRV and walking traverses.

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-1 Mission Requirements Document (Reference 1) until such data are published in other MSC-controlled documents. These documents include the Apollo 15 Flight Plan (Reference 2), Apollo 15 Lunar Surface Procedures (Reference 3), Apollo 15 Photographic and TV Procedures (Reference 4), and Apollo 15 Flight Mission Rules (Reference 17).

4.2 LANDING SITE DESCRIPTION AND RATIONALE

4.2.1 GENERAL DESCRIPTIONS AND RATIONALE

Landing site data were derived from Reference 18. The lunar surface shown in Figure 4-1 is bounded by 18° and 36° N latitude and 5° W and 10° E longitude. The Hadley-Apennine area is labeled in the center of the figure. Hadley C Crater is the small circular formation within the bordered area. Hadley Rille, lying generally in a southwest/northwest direction, is the sinuous groove immediately to the right of Hadley C Crater.

Three very large craters (Aristillus, Autolycus, and Archemedes) are shown in the upper left. Secondary crater clusters, wide-spread in the Hadley-Apennine area (but not discernible on this photograph), are believed to have been formed by ejecta from Copernican age craters Aristillus and Autolycus. The Hadley-Apennine area is additionally identified in Figure 4-1 with respect to the Apennine and Caucasus Mountains.

The Hadley-Apennine area is shown in higher magnification in Figure 4-2. The landing site is marked with an "X". The most significant features labeled in the figure are as follows:

a) Apennine Ridge

b) Hadley C Crater

c) Apennine Front

d) Apennine Spur

e) Elongate depression

f) Hadley Rille

The Apennine Front is probably composed of materials that predate the excavation of the Imbrium Basin and may include pre-Imbrium rocks. This front offers opportunities to collect samples of ancient material from the lunar surface, deep lunar samples at the base of the highest scarp on the moon, and subsurface ejecta and surface rocks from the Mare Imbrium, which is a major ringed mare and mascon region.

Hadley Rille, about 1 kilometer wide and 300 meters deep, is a meandering channel much like river gorges on earth. The nature and origin of this rille is expected to provide information on important lunar surface processes and may yield data on the history of lunar volatiles.

4.2.2 LANDING AREA DESCRIPTION

The Hadley-Apennine area surrounding the landing site is shown in Figure 4-3. The two major features in the photograph are the Apennine Front and Hadley Rille. Another outstanding feature is the large crater of 2.2 kilometers in diameter on the Apennine Front, directly below the right-most bend in the rille. This crater may have excavated deep subsurface material.

The major geologic objective at the landing site is to perform selenological inspection, survey, and sampling of materials and surface features in the Hadley-Apennine area. This objective can be achieved at the selected landing site because:

a) The LRV traverses can reach and be used to sample the Apennine Front, Hadley Rille, the mare, a secondary crater cluster, and a probable constructional land form.

b) Should the LRV not be available for the mission or should it become inoperable after landing on the lunar surface, the Apennine Front and the Hadley Rille can be reached with walking traverses.

The areas of primary geologic interest are the bordered areas in the figure. The highest priority area is the base of the front area. Samples from the base of the front, where it meets the mare, are the most likely to include in-situ pre-Imbrium crustal materials, i.e., ancient rocks whose origin predates both the formation and the filling of the major mare basins.

The second highest priority is Hadley Rille. The bordered area is of particular interest because it includes a junction of the rille and front. Access to the rille may be possible near this point based on observable rille filling. Excellent photography in two directions down the rille can be achieved at a traverse station on the right rim of the rille in this vicinity. Blocks of front material excavated by the 2.2-kilometer crater directly below this area also may be accessible for sampling.

The mare area near the landing site is third in priority, and the bordered area toward the top (the north complex), along with the secondary crater cluster, is fourth in priority.

The north complex is an area of domes and domical hills. These features appear to be superimposed on the mare material and their structure suggests that they are constructional landforms. Investigation of this area may provide geochemical and age data on late stages of mare basin fill.

The craters in the secondary crater cluster are believed to have been caused by ejecta from Copernican age craters Autolycus and Aristillus (see Figure 4-1). Samples from and examination of this cluster could provide information about the age of Autolycus and Aristillus, and also provide samples from another part of the Imbrium basin.

4.3 LUNAR SURFACE PLANNING DATA

4.3.1 EXPERIMENTS IDENTIFICATION

Table 4-1 lists the assigned lunar surface experiments and science-related detailed objectives, and summarizes the information indicating to which scientific discipline each surface experiment contributes (Reference 23).

Table 4-2 lists detailed activities for implementing the lunar surface science requirements presented in Reference 1. These data are for use only until photographic activities and crew procedures/timeline are published in References 3 and 4.

a) Experiment (Number) and Activitiy (Priority)

Includes each activity and its priority. The priorities as assigned to each activity are based on the following definitions taken from the J-1 Mission Requirements Document (Reference 1):

1) Mandatory (M) - A mandatory item is essential for evaluation of the objective or experiment.

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 the essential parts of the objective or experiment.

b) Astronaut Activities

Lists activities required by the astronauts to support the experiment activity. The "Sample ID" in the column indicates that an astronaut voice comment is required to identify the prenumbered bag used, the serial number and order of the multiple core tubes used, and the type of sample (e.g., "small rocks showing erosion"). This information is for postmission correlation with samples and sample photography. A description of the hand tools and equipment available to accomplish these activities appears in Section II of this document.

c) Traverse/Station Number

Intended primarily to identify the particular station number on the traverse maps where activity will occur.

d) Photographs

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

e) Stowage

Indicates candidate container on the LRV in which the sample may be stowed. Actual containers will be identified in Reference 3.

f) 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 geologic features of the landing site for both LRV and walking traverses are discussed in Paragraph 4.2.2 These priorities are, in decreasing order, as follows:

a) Apennine Front

b) Hadley Rille

c) Mare

d) Constructional land form (north complex) and secondary crater cluster

4.3.3 LRV TRAVERSE ROUTE TERRAIN PROFILES

Figure 4-4 shows elevation cross sections of the lunar surface along the preliminary LRV traverses described in this section. These profiles were generated using mapping data which have an accurary of $\pm$20 meters. Marshall Space Flight Center (MSFC) is currently evaluating the trafficability of these traverses considering the latest known LRV capabilities.

4.3.4 TRAVERSE PLANNING GUIDELINES AND CONSTRAINTS

The guidelines and constraints listed below are taken from Lunar Surface EVA Planning Guidelines, Apollo J-Missions (Reference 20). These guidelines and constraints were used in the development of the traverses described in this section (based on a T+0 launch on July 26, 1971).

NOTE

Values specified are subject to change by MSC or MSFC based on Apollo 14 experience and data, additional knowledge gained about the Apollo 15 landing site and the LRV, and crew simulations.

a) Lunar Surface Stay-Time: 67.3 hours.

b) EVA Durations: Three extravehicular activities (EVA) of up to 7, 7, and 6 hours duration, respectively.

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

d) Walking Speed: 3.3 kilometers per hour, average.

e) BSLSS Ride-/Walk-Back Limit: If a Primary 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. With the LRV, an emergency return speed of 10 kilometers per hour is considered realistic. Hence, the maximum return distance to the lunar module (LM) on any LRV traverse is 9.5 kilometers. For a walking traverse, the distance limit is 3.8 kilometers, with an emergency walking speed of 4 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 (3.3 kilometers per hour at a metabolic rate of 1440 BTU per hour). The actual limits are a function of time.

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

h) <u>Overhead Times for Traverse Station Stops</u>:

LRV Traverses: Minor Stop (up to 15 minutes) - 3 minutes
Major Stop (15 minutes and longer) - 6 minutes

Walking Traverses: All stops - 3 minutes

i) <u>Map Correction Factor</u>: 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 ACTIVITIES

The Contingency Sample Collection, Apollo Lunar Surface Experiments Package (ALSEP), Laser Ranging Retro-Reflector (LRRR), and Solar Wind Composition (SWC) experiment are included separately here because they are normally accomplished or deployed in the vicinity of the LM during the first EVA, prior to beginning or after completing any traverse activities.

Figure 4-5 shows a typical Apollo 15 ALSEP deployment (Reference 21). The central station (C/S) must be deployed a minimum of 300 feet west of the LM, with the LRRR being deployed at least another 25 feet west of the C/S. These constraints are required to avoid dust and other contamination caused by the LM ascent stage during launch. The solid lines indicate interconnection cables; the dashed circles around the Heat Flow probes, the Passive Seismic Experiment (PSE), and the Radioisotope Thermoelectric Generator (RTG) indicate the circular areas which must be left clear of all equipment debris and relatively free of all astronaut-introduced surface disturbances. Debris and disturbances can cause errors in the probe data; the PSE can detect equipment thermal creeps which may introduce errors in the data; and the RTG thermal control can be degraded by extraneous material.

The dashed linear distances indicate similar constraints. The probes must be 30 feet apart, either in the primary locations or in the alternate locations. The primary locations are labeled "probe"; secondary locations lie along the dashed arcs labeled 30 feet. Each probe must be a minimum of 25 feet from the RTG to prevent the introduction of external thermal energy. The Lunar Surface Magnetometer (LSM) must be a minimum of 80 feet from the Suprathermal Ion Detector Experiment (SIDE)/Cold Cathode Ion Gauge (CCIG) because the CCIG contains a magnet of sufficient strength to disturb the LSM readings. The distance markings on the cables indicate the cable deployment lengths.

Figure 4-6 shows the impact points of the S-IVB and spent LM ascent stages for previous Apollo missions and the intended impact points for Apollo 15 (J-1). These impacts generate seismic signals which are measured by the PSE.

4.4.2 PRELIMINARY NOMINAL TRAVERSES

Both LRV and walking traverses are being planned for Apollo Mission J-1. The landing point shown on the map, which is subject to change prior to launch date, is at coordinates 26° 04' 54" N, 3° 39' 30" E (Source: 1:250,000 V-26.1 Photomap)*. The walking traverses are being planned in the event that the LRV is not operational for inclusion on Apollo 15 or that it cannot be deployed or becomes inoperable early during the surface activity phase of the mission.

In general, these traverses represent the current thinking of the Traverse Planning Subpanel of the Science Working Panel, but are subject to continual change and should be considered preliminary and representative for the Hadley-Apennine landing area (References 22 and 23). The Traverse Planning Subpanel will continue to study the landing site and will probably modify the traverses based on more current and complete knowledge about the landing site and experience gained on Apollo 14. The final traverses and detailed timelines will appear in the Apollo 15 Lunar Surface Procedures (Reference 3).

The priorities of the stations on both the preliminary LRV and walking traverses are shown in Table 4-3. The stations for each traverse are listed in decreasing order of priority. These priorities should be considered preliminary. Traverses presented have been developed within the guidelines and the constraints cited in Paragraph 4.3.4 of this section.

*The coordinates given are used for locating the landing point on a map product. The target point coordinates are 26° 04' 26" N, 3° 39' 14" E (Source: L.O. V 26.1 Control Data)

4.4.2.1 LRV Traverses

The LRV traverse routes are shown in Figure 4-7. Table 4-4 contains supplementary data described below for use with the traverse map. These data should be considered preliminary at this planning cycle stage.

a) Station or Travel: Indicates the appropriate station number (letter) or that the crew is traveling, as appropriate.

b) Distance: Shows the actual traverse distance between the two stations and the cumulative total of these distances. The actual distance is obtained by multiplying the map distance by the map correction factor of 1.1.

c) Station Stop or Travel Time: Indicates the travel times between individual stations and the cumulative travel time, or the individual station stop times and the cumulative station stop time, as appropriate. (Overhead times for LRV traverses are 3 minutes for stops up to 15 minutes, and 6 minutes for stops of 15 minutes or longer.)

d) Station Science Time: Indicates the time at each station devoted to scientific activities, i.e., station stop time minus station stop overhead. The cumulative total is also shown.

e) EVA Time After Event: Shows the time, since beginning the EVA, at the end of each station stop or travel sequence, as appropriate.

f) Geological Features/Observations and Activities: Describes the surface feature at the station or along the traveled route, as appropriate. Lists crew observations and scientific activities considered appropriate for the station or traveled route.

The LRV traverses are summarized in Table 4-6.

4.4.2.2 Walking Traverses

The walking traverse routes are shown in Figure 4-8. Table 4-5 provides for these traverses the supplementary data which were described above for the LRV traverses. (Overhead times for walking traverse stops are 3 minutes). Table 4-6 contains the walking traverse summaries. The walking traverses should be considered preliminary at this early planning stage.

Table 4-1. Background Scientific Information on the Lunar Surface Experiments

EXPERIMENT \ SCIENTIFIC DISCIPLINE	GEOLOGY	GEOPHYSICS	GEOCHEMISTRY	BIOSCIENCES	LUNAR ATMOSPHERE	PARTICLES AND FIELDS	ASTRONOMY
CONTINGENCY SAMPLE COLLECTION	AID IN DETERMINING LUNAR HISTORY BY AGING OF LUNAR SAMPLES		DETERMINE COMPOSITION OF LUNAR SURFACE BY CHEMICAL ANALYSIS OF LUNAR SAMPLES	AID IN DETERMINING POSSIBILITY OF BIOLOGICAL FORMS ON LUNAR SURFACE			
ALSEP PASSIVE SEISMIC (S-031)	AID IN DETERMINING INTERIOR STRUCTURE, TECTONISM AND VOLCANISM	AID IN DETERMINING FREE OSCILLATIONS, TIDES, SECULAR STRAINS, TILT, VELOCITY, ATTENUATION AND DIRECTION OF SEISMIC WAVES					MEASURE METEOROID IMPACTS
HEAT FLOW (S-037)	AID IN DETERMINING LUNAR EVOLUTION	MEASURE VERTICAL TEMPERATURE GRADIENTS, ABSOLUTE TEMPERATURE OF THE SURFACE TO ESTABLISH VERTICAL THERMAL CONDUCTIVITY	BULK COMPOSITION AND CHEMICAL SORTING MAY BE INFERRED FROM DATA				DETERMINE THERMAL ENVIRONMENT
LUNAR SURFACE MAGNETOMETER (S-034)	AID IN DETERMINING MAGNETIC ANOMALIES, SUBSURFACE FEATURES AND LUNAR HISTORY	AID IN DETERMINING THERMAL STATE OF THE LUNAR INTERIOR				ESTABLISH GROSS ELECTRICAL DIFFUSIVITY; MEASURE MAGNETIC FIELD OF THE MOON	DETERMINE LUNAR RESPONSE TO FLUCTUATIONS IN THE INTERPLANETARY MAGNETIC FIELD
SOLAR WIND SPECTROMETER (S-035)		MONITOR FLUX, ENERGY STREAMING DIRECTION, AND TEMPORAL VARIATIONS IN THE SOLAR WIND PLASMA			DETERMINE PRESENCE OF ATMOSPHERE	ESTABLISH GROSS ELECTRICAL CONDUCTIVITY	
SUPRATHERMAL ION DETECTOR (S-036)		MEASURE FLUX, NUMBER DENSITY, VELOCITY AND ENERGY PER UNIT CHARGE OF POSITIVE IONS			DETERMINE IONOSPHERE/ ATMOSPHERE CHARACTERISTICS	DETERMINE AMBIENT ELECTRIC FIELD EFFECTS	
COLD CATHODE ION GAUGE (S-058)					DETERMINE DENSITY OF THE LUNAR ATMOSPHERE INCLUDING TEMPORAL VARIATIONS	PROVIDE INFORMATION ON RATE OF LOSS ON CONTAMINANTS LEFT BY ASTRONAUTS	
LUNAR DUST DETECTOR (M-515)		AID IN DETERMINING SURFACE MATERIAL TRANSPORT. PROVIDE INFORMATION ON HIGH ENERGY RADIATION, DUST ACCUMULATION AND LUNAR SURFACE TEMPERATURES			PROVIDE INFORMATION ON DUST ACCUMULATION		
LASER RANGING RETRO-REFLECTOR (S-078)		DETERMINE FACTORS ABOUT LUNAR MOTION, LUNAR LIBRATION, AND EARTH GEOPHYSICAL DATA					PROVIDE INCREASED ACCURACY IN LUNAR ORBITAL DATA PARAMETERS
LUNAR GEOLOGY INVESTIGATION (S-059)	AID IN DETERMINING LUNAR GEOLOGICAL STRUCTURE AND HISTORY		DETERMINE CHEMICAL COMPOSITION OF LUNAR SAMPLES	LUNAR SAMPLES MAY BE TESTED FOR ABILITY TO SUPPORT LIFE FORMS USED TO DETERMINE POSSIBILITY OF BIOLOGICAL LIFE FORMS ON THE LUNAR SURFACE			
SOIL MECHANICS (S-200)	AID IN DETERMINING LUNAR HISTORY. ENABLE DETERMINATION OF COMPOSITIONAL TEXTURAL, AND MECHANICAL PROPERTIES OF LUNAR SOIL		ENABLE DETERMINATION OF COMPOSITION OF LUNAR SOIL				
SOLAR WIND COMPOSITION (S-080)			DETERMINE COMPOSITION OF SOLAR WIND PLASMA		AID IN DETERMINING HISTORY OF PLANETARY ATMOSPHERE	PROVIDE INFORMATION ON THE ELEMENTAL AND ISOTOPIC COMPOSITION OF NOBLE GASES AND OTHER ELEMENTS IN THE SOLAR WIND	

Table 4-2. Experiment Activities

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
<u>Lunar Geology Investigation (S-059)</u>					
Documented samples (M)	Collect samples at each major geological site on traverses. Where rocks are too large, chips will be obtained. Sample ID.		For each sample, the following Documented Sample Photography.* 5 photographs: 3 before sampling (1 plus a stereo pair) 1 location (before or after sampling) 1 after sampling	In prenumbered bags in an SRC. If too large, store in collection bag.	Different types showing variations in color, texture, shape, degree of rounding and mineral composition.
Documented samples (M)	Collect samples from around blocky-rimmed craters. Sample ID.		Documented Sample Photography	In prenumbered bags in an SRC. If too large, store in collection bag.	
3 comprehensive samples (M)	Collect all rocks larger than 3/8 in. diameter within sample area. Sample ID. Highly desirable that at least 1 kg of rocks with diameters from 3/8 in. to 1-1/2 in. be collected. Collect 1-kg soil sample. Sample ID.	One comprehensive sample to be taken in an area representative of the mare surface in the general vicinity of the Soil Mechanics trench near a double core tube and a lunar environmental soil sample.	Documented Sample Photography	Segregated in separate bags. Soil sample in separate bag.	Size and nature of area dependent on astronaut's assessment of the task.

*If only one crew member is collecting and photographically documenting a single sample and the gnomon leg with color patch is pointed toward the sample to be collected, only the cross-sun stereo pair prior to sampling and the location photograph are mandatory.

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
3 comprehensive samples (M) (Continued)		Second one in vicinity of Apennine Front near a small trench, a double core tube and a lunar environmental soil sample. Third one in vicinity of Hadley Rille near a small trench and a single core tube.			
Soil samples from each documented sample area (M)	Collect samples of 50 to 100 grams each. Sample ID.		None	In prenumbered bags or with a rock sample from the same site.	
Additional samples to maximize amount of material returned (M)	Collect samples of particular interest in order of priority: a) small rocks b) soil. Sample ID.		Documented Sample Photography	Loose in an SRC or collection bag.	Collect near end of available sampling time on each EVA. a) size of documented samples
Radial sampling of a fresh crater (M)	Collect 3 soil plus rock samples: 1 one crater diameter outward on ejector field; 1 one-half crater diameter outward from rim; 1 on crater rim. Perform diametric sampling time permitting: a) crater center; b) diametrically opposite crater rim; c) one-half crater diameter outward from this crater rim; d) one crater diameter from this center rim.		1 partial stereoscopic panorama	Loose in an SRC or collection bag.	Crater 5 to 10 m in diameter in relatively flat area.

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
Lunar surface features and field relationships (M)	Examine and describe following type 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 the range of size, freshness and degradation; d) rock-soil contacts such as fillets banked against rocks on all sides of one block on a slope and another on a fresh crater; e) disturbed and undisturbed surface material; f) rille wall; g) boundary zone between hillside and relatively level ground at its base.		Features and field relationships will be photographed at crew discretion.		
Additional panoramic photographic sequences (M)	Take photographs.	At least one at each major station on traverses	15 to 20 photographs to provide 360 degree overlapped coverage.	N/A	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.
Long focal length photography	Take photographs of distant features including: a) near and far rille wall; b) deposits on rille floor; c) outcrops and large boulders at Apennine Front.		Photographs of rille area mandatory.	N/A	

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
Near-field polarimetric measurement photographs (M)	Take photographs in an area of several rocks. If sampling photographs are taken between near- and far-field polarimetric measurements, filter may be left on.		10 photographs	N/A	In area where at least 4 rock samples will be collected.
At least 4 rock samples (M)	Collect samples.		2 photographs: 1 location 1 after sampling	In documented prenumbered bags in an SRC.	In area where near-field polarimetric measurement taken.
Far-field polarimetric measurement photographs (M)	Take photographs in an area such as a rocky area or an inner crater wall.		6 photographs	N/A	Crater diameter > 12 m.
3 panoramic photograph sequences at LM (M)	Take photographs.	At LM	15 to 20 photographs to provide 360 degree overlapped coverage.	N/A	20 ft from LM at three positions approximately 120 degrees apart.
1 double or triple core tube sample (M)	Obtain core tube sample. Sample ID.	In vicinity of S-200 trench.	3 photographs: 1 stereo pair 1 location	In an SRC or a collection bag.	
1 double core tube sample (M)	Obtain core tube sample; separate and store. Sample ID.	In comprehensive sample areas.	3 photographs: 1 stereo pair 1 location	In an SRC or a collection bag.	
1 single or double core tube sample (M)	Obtain core tube sample in one comprehensive sample area. Sample ID.	In a comprehensive sample area.	3 photographs: 1 stereo pair 1 location	In an SRC or a collection bag.	
Single or double core tube samples (M)	Obtain core tube samples. Sample ID.	Targets of opportunity	3 photographs: 1 stereo pair 1 location	In an SRC or a collection bag.	Examples are a mound, fillet, patterned ground, places representing different occurrences of layering in the lunar surface.

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
3 soil/small rock samples (M)	Collect samples from a trench; from bottom, side, and top and/ or from all discernible layers. Samples should include both soil and small rocks. Sample ID.	May be from S-200 trench.	Photographs taken in support of S-200 will suffice	In prenumbered bags in an SRC	At least 300 ft from LM; each sample to be 200 to 500 grams.
1 three-meter drill core (M)	Obtain sample using Apollo lunar surface drill.	In vicinity of ALSEP deployment site.	1 panorama consisting of 15 to 20 photographs	Store 6 drill stems in SRC No. 1	
1 panoramic photograph sequence during SEVA	Take photographs	At LM	15 to 20 photographs to provide 36 degree overlapped coverage.	N/A	
Small exploratory trenches (M)	Dig small exploratory trenches using available hand tools. The following sites will be considered for trenching: a) near rim in ejecta from a small fresh crater in a mare area; b) near edge of Hadley Rille; c) at break of slope near Apennine Front; d) from at least 2 locations on steeper slope of the Apennine Front; e) on south side of secondary crater cluster at base of Apennine Front; f) in a mound; g) in an area where there is change in surface characteristics such as color surface patterns, or mechanical properties; h) in a distinct crater	One trench will be dug in each of two comprehensive sample areas, preferably diametrically opposite core tube sample location.	3 photographs: 1 stereo pair (after trenching) 1 location (before or after sampling)	In prenumbered bag in an SRC.	Trenches will be dug 10 degrees off sun line to a depth of 3 to 8 inches. Photographs will be taken at crew's discretion if interesting features are observed.

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
Small exploratory trenches (M) (Continued)	Soil and rock samples will be taken at crew's discretion, except that 200 to 500 grams of soil will be taken from bottom of trenches in comprehensive sample areas.				
At least one buried rock sample, if encountered (HD)	Take sample.		None	In prenumbered bag.	
1 large, equidimensional rock (M)	Collect rock, 6 to 8 inches on a side, from relatively flat area.		Documented Sample Photography	In collection bag.	Rock preferably showing erosion.
Approximately 5 smaller equidimensional rocks (M)	Collect rocks 3 to 6 in. in diameter.		Documented Sample Photography	Placed individually in prenumbered bags in an SRC.	Should include examples of the most angular and most rounded rocks on the surface; representatives of each type, if distinguishable.
2 fillet samples (M and HD)	Sample fillet along with one large or smaller rock. Before collecting rock fillet sample will be taken. A nearby typical soil sample will also be taken. Sample ID.		Documented Sample Photography	Rock, fillet material and nearby soil will be placed in separate prenumbered bags.	In a relatively flat area, with fillet surrounding the entire rock. Highly desirable that fillet be from within a fresh crater. Collect only fillet material, not deeper soil under fillet.
2 lunar environment soil samples (M)	Collect samples from the bottom of trenches at least 3 in. deep. S-200 trench may be used provided sample is taken before any other tests at bottom of trench. Previously described small exploratory trenches will suffice if sample is taken before other samples. Sample ID.	Near comprehensive sample areas in vicinity of Apennine Front and in area representative of mare surface.	S-200 and small exploratory trench photographs will suffice, depending on which trench is used.	Special environmental sample container in an SRC.	Trenches must be at least 300 ft from LM, not under LM flight path.

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
1 exhaust-contaminated sample (M)	Collect soil sample from erosion crater caused by DPS exhaust impingement.		2 photographs: 1 before sampling 1 after sampling	Special environmental sample container in an SRC.	
3 organic control samples (M)	Seal the organic control sample at the beginning of each EVA.	N/A	N/A	In each SRC.	
Soil Mechanics (S-200)					
Trench (M)	Excavate a narrow trench immediately adjacent to a penetrometer test location; sunlit wall should be vertical and smooth. Comment on any layers (or strata) detected while excavating the trench. Describe excavation, estimate depth, time required to complete, and natural slope of excavated material.	Near comprehensive sample area in area representative of mare surface.	12 photographs: 3 of site before trenching (1 plus a stereo pair); 4 stereo pairs of trench (1 of each side, 1 up sun, 1 down sun; 1 must include excavated material); 1 location. Stereo pairs of trench should include LRV tracks. Sequence photographs or television coverage of trench operation.		
1 penetrometer test (M)	Perform test at trench site prior to excavation of trench using 0.5 in.^{2} cone.	Trench excavation site.	Each penetrometer test will be documented by 1 photograph for location and to show maximum penetration depth.	N/A	On each test, astronaut should apply a smooth, even force when using the penetrometer and should comment on penetration number as read from self-recording penetrometer indexing system on smoothness of application of pressure upon the penetrometer and any abrupt changes in

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
1 penetrometer test (M) (Continued)					force applied, and on abrupt changes in resistance to penetration of the cone penetrometer as would indicate the presence of hard subsurface layers, rock fragments, very soft substrata or cavities.
2 plate load tests (M)	Perform tests: a) at trench bottom using 1 in. x 5 in. plate b) at top of sunlit, smooth wall with 1 in. x 5 in. plate to induce wall failure. Delete if wall failure occurs during excavation.	Trench excavation site	Each plate load test will be documented by 3 photographs (1 plus a stereo pair)	N/A	5 in. side of plate should be parallel to and one-third trench depth from the smooth vertical wall.
3 penetrometer and 1 plate load tests (M)	Perform tests at one core tube site using 0.5 $in.^2$ cone, 1 $in.^2$ cone, 0.2 $in.^2$ cone and 1 in. x 5 in. plate			N/A	
2 penetrometer tests (M)	Perform tests in and adjacent to LRV track (soft soil) using 0.5 $in.^2$ cone.			N/A	
2 penetrometer tests (M)	Perform tests in and adjacent to LRV track (firm soil) using 0.5 $in.^2$ cone.			N/A	
3 penetrometer tests (M)	Perform tests at a small crater using 0.5 $in.^2$ cone at a) bottom crater b) side c) rim			N/A	
4 penetrometer tests (M)	Perform tests at four core tube sites using 0.5 $in.^2$ cone.			N/A	

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
1 penetrometer test (M)	Perform test at trench bottom using 0.5 $in.^2$ cone.			N/A	
Photographs of LM lunar surface, etc. (M and HD)	Take photographs.	———		N/A	See Photographic Plan, Section III, Table 3-3, for details.
Contingency Sample Collection (M)	Collect sample of about 2 kg in an area already photographed through LM window.	Immediate vicinity of LM	1 of sample area through LM window before taking sample.	Contingency sample return container.	As early as practical during initial EVA.
Laser Ranging Retro-Reflector (LRRR) (M)	Deploy LRRR; emplace, level and orient it.		2 photographs: 1 of array top 1 between front and side of array	N/A	Deploy a minimum of 300 ft from LM such that ascent plume does not impinge on array face.
Solar Wind Composition (S-080) (M)	Remove experiment from LM MESA and deploy it on the lunar surface. Retrieve the reel and foil, place in teflon bag, store in LM. Comment on location of experiment with respect to LM, attitude of foil with respect to sun, and total time foil was deployed.	At LM	2 photographs: 1 close-up of experiment showing staff 1 with LM in field of view	Teflon bag in LM	Deployed during the first EVA. Retrieval should be as late as possible during last EVA.

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
Apollo 15 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	$\geq$ 300 ft 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. The transmitter is turned ON by the astronaut if it was in the ON condition at launch; if not, the ground will command transmitter ON. 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.
Passive Seismic (S-031) (M)	Deploy, coarse level and rough align the sensor assembly. Deploy the thermal shroud. Perform a fine leveling and report azimuth readings to MCC.		2 photographs: 1 showing bubble level and gnomon shadow on compass rose; 1 with C/S in background.	N/A	Part of Apollo 15 ALSEP.

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
Heat Flow (S-037) (M)	Deploy, level, and align the electronics package. Drill 2 holes 10 ft deep and 30 ft 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 bore stem.	N/A	Part of Apollo 15 ALSEP
Lunar Surface Magnetometer S-034) (M)	Deploy, level and align the sensor assembly. Report shadowgraph readings to MCC.		2 photographs: 1 of shadowgraph 1 of sensor heads with C/S in background.	N/A	Part of Apollo 15 ALSEP
Solar Wind Spectrometer (S-035) (M)	Deploy on a relatively smooth, flat surface; orient and report on orientation.		2 photographs: 1 looking North 1 looking South	N/A	Part of Apollo 15 ALSEP
Suprathermal Ion Detector (SIDE) (S-036) (M) and Cold Cathode Ion Gauge (CCIG (S-058) (M)	Select a relatively smooth surface; the CCIG is removed from the SIDE housing and both experiments are deployed, leveled and aligned.		3 photographs: 1 of SIDE showing CCIG aperture; 1 of SIDE and CCIG with C/S in background; 1 of SIDE bubble level to show deviation from local vertical.	N/A	Part of Apollo 15 ALSEP CCIG and SIDE are physically attached.

Table 4-2. Experiment Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS	STOWAGE	REMARKS
Lunar Dust Detector (LDDE) (M-515) (M)	Deployed with C/S; located on top of C/S.	On top of C/S	None (C/S photographs will suffice)	N/A	Part of Apollo 15 ALSEP

Table 4-3. Traverse Station Priorities

Traverse Number	Decreasing Priority	Traverse Station Numbers	
		LRV	Walking
I	Highest	2	a
		3	b
	Lowest	1	
II	Highest	5	d
		6	e
		7	c
		8	f
	Lowest	4	
III	Highest	9	g
		11	h
		10	i
		13	j
		12	
	Lowest	14	

Table 4-4(a). LRV Traverse Data - Traverse I

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
LM	-	-	85	85	0	0	1:25	Smooth mare: Take contingency sample. EVA/Traverse preparation.
Travel	2.20	2.20	17	17	-	-	1:42	Typical smooth mare fill: Observe and describe traverse over smooth mare fill material. Describe surface features and block distribution.
1	-	-	14	99	11	11	1:56	On rim of Hadley opposite meander (the Elbow) near bright crater: Describe east-west trending ridge on western side of rille. Describe rille wall. Sample fresh bright crater. 500-mm lens camera photography. Panorama.
Travel	1.55	3.75	11	28	-	-	2:07	Around Elbow Crater to base of Apennine Front north of St. George Crater: Observe low ridge around Elbow Crater. Observe any differences between rille rim material and mare material. Compare Apennine Front material to other material. Look for changes in lithology or ground texture as indications of base of Front.
2	-	-	52	151	46	57	2:59	(Mandatory Sampling Area.) At base of Apennine Front between Elbow and St. George Craters: Radial sampling of Elbow Crater. Radial sampling of St. George Crater. Comprehensive sample in area at Front.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(a). LRV Traverse Date - Traverse I (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
2 (cont'd)								Double core tube. 500-mm lens camera photography of blocks on rim of St. George and of rille. Rille description. Stereo panorama. Penetrometer. Lunar environmental soil sample. Exploratory trench.
Travel	1.20	4.95	9	37	-	-	3:08	Across base of Apennine Front to edge of possible debris flow: Observe debris and relation to mare surface. Note distribution of blocks from St. George Crater.
3	-	-	14	165	11	68	3:22	(Mandatory Sampling Area.) At base of Apennine Front adjacent to possible debris flow: Examine flow and compare to mare and Front. Documented samples of Apennine Front and flow material. Observe and describe vertical and lateral changes in Apennine Front; compare to previous stop. Panoramic photography. Observe characteristics of EVA II route.
Travel	3.75	8.70	28	65	-	-	3:50	From base of Apennine Front across mare to LM: Observe characteristics and extent of possible debris flow. Observe area to be traversed on EVA II. Compare mare material to Apennine Front and rille rim. Observe possible ray material.
LM	-	-	190	355	150	218	7:00	Smooth mare: Deploy ALSEP, LRRR, and SWC. Exhaust contaminated sample.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(a). LRV Traverse Data - Traverse I (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULA-TIVE	INDIVID-UAL	CUMULA-TIVE	INDIVID-UAL	CUMULA-TIVE		
LM (cont'd)								Store samples and records. EVA/Traverse closeout.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(b). LRV Traverse Data - Traverse II

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULA-TIVE	INDIVID-UAL	CUMULA-TIVE	INDIVID-UAL	CUMULA-TIVE		
LM	-	-	49	49	0	0	0:49	Smooth mare: EVA/Traverse preparation.
Travel	1.45	1.45	11	11	-	-	1:00	South along smooth mare toward secondary crater cluster: Observe smooth mare characteristics. Observe secondary crater cluster characteristics. Photography as appropriate.
Check Point	-	-	2	51	0	0	1:02	Smooth mare: Observe terrain for purposes of selecting traverse path, navigation, potential sampling. Photography as appropriate.
Travel	2.00	3.45	15	26	-	-	1:17	South along smooth mare on west side of secondary crater cluster to station 4: Same as previous "travel" entry.
4	-	-	20	71	14	14	1:37	Secondary crater cluster: South of 400m crater: Documented sampling. Soil sample. Sample typical and atypical rock types. Compare secondary crater material to other terrain geologic units. Exploratory trench. Panoramic photography. Possible core tube. Observe crater interior and ejecta. Possible 500-mm lens camera photography of Apennine Front.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(b). LRV Traverse Data - Traverse II (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
Travel	1.30	4.75	10	36	-	-	1:47	South along smooth mare, southwest at secondary crater cluster to base of Apennine Front, then east along Front: Observe smooth mare characteristics. Observe secondary crater cluster characteristics. Traverse along Apennine Front; determine position of base of Front and search for optimum sampling areas for stops on return leg of traverse. Photography as appropriate.
Check Point	-	-	4	75	0	14	1:51	At base of Apennine Front: Same as previous "check point" entry.
Travel	1.30	6.05	10	46	-	-	2:01	East along Apennine Front: Same as previous "travel" entry.
Check Point	-	-	4	79	0	14	2:05	At base of Apennine Front: Same as previous "check point" entry.
Travel	0.70	6.75	5	51	-	-	2:10	East along Apennine Front: Same as previous "travel" entry.
Check Point	-	-	4	83	0	14	2:14	At base of Apennine Front: Same as previous "check point" entry.
Travel	1.55	8.30	12	63	-	-	2:26	East along Apennine Front to Station 5: Same as previous "travel" entry.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(b). LRV Traverse Data - Traverse II (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
5	-	-	53	136	47	61	3:19	(Mandatory Sampling Area.) At base of Apennine Front near rim of Front Crater: Documented samples of mare material and Apennine Front material around crater rim. Stereo panorama. Documented sample up slope from crater. Exploratory trench up slope from crater.
Travel	2:00	10:30	15	78	-	-	3:34	Along base of Apennine Front to vicinity of Station 6: Observe lateral variations in material and surface textures. Search for blocky areas along Apennine Front which are suitable for sampling (craters, etc). Photography as appropriate.
6	-	-	47	183	41	102	4:21	(Mandatory Sampling Area.) Along base of Apennine Front on slope in intercrater areas or on crater rims; chosen at crew's discretion based on previous observations. Stops should include the following activities which should be modified according to the local geology: Documented samples of Apennine Front material. Panoramic photography. Exploratory trench. Description of Apennine Front in sampling area and location. Comparison of Apennine Front and material to other surface units. Other activities might include: 500-mm lens camera photography. Core tube. Fillet sample.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(b). LRV Traverse Data - Traverse II (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
Travel	1.10	11.40	8	86	-	-	4:29	Along base of Apennine Front to vicinity of Station 7: Same as previous "travel" entry.
7	-	-	47	230	41	143	5:16	(Mandatory Sampling Area.) Same as Station 6 entry. At the last Apennine Front stop; based on previous observations along Front, crew uses discretion to complete sampling.
Travel	2.90	14.30	22	108	-	-	5:38	From base of Apennine Front along southwestern edge of secondary crater cluster. Observe secondary crater deposits and relation to other terrain. Observe eastern edge of possible debris flow from Apennine Front. Photography as appropriate.
8	-	-	29	259	23	166	6:07	In mare material near crater: Comprehensive sample area. Double core tube. Lunar environmental soil sample. Soil Mechanics trench. Panoramic photography. Documented sampling of large mare center.
Travel	1.65	15.95	13	121	-	-	6:20	Across smooth mare: Compare mare material with other terrain.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(b). LRV Traverse Data - Traverse II (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
LM	-	-	40	299	0	166	7:00	Smooth mare: Store samples and records. EVA/Traverse closeout.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(c). LRV Traverse Data - Traverse III

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
LM	-	-	42	42	0	0	0:42	Smooth mare: EVA/Traverse preparation.
Travel	2.40	2.40	18	18	-	-	1:00	Across smooth mare to rille rim turning northwest at rille rim to the Terrace: Compare smooth mare material to rille rim material.
9	-	-	50	92	44	44	1:50	(Mandatory Sample Area.) At rim of Hadley Rille at southern end of the Terrace: Observe and describe rille and far wall. 500-mm lens camera photography. Comprehensive sample area. Core tube. Exploratory trench. Penetrometer. Documented sampling of crater at edge of rille. Compare rille rim material to other terrain. Panoramic photography.
Travel	0.40	2.80	3	21	-	-	1:53	Along rille rim at the Terrace: Continued description of rille and rim material. Photography as appropriate.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(c). LRV Traverse Data - Traverse III (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
10	-	-	10	102	7	51	2:03	(Mandatory Sampling Area.) Along rille rim at the Terrace: 500-mm lens camera panoramic photography. Documented sample.
Travel	0.80	3.60	6	27	-	-	2:09	Along rille rim to north end of the Terrace: Continued description of rille and rille rim material. Photography as appropriate.
11	-	-	19	121	13	64	2:28	(Mandatory Sampling Area.) At rim of Hadley Rille at northwest end of the Terrace: Observe and describe rille and far rille wall; compare to previous observations. 500-mm lens camera photography. Documented samples of rille rim and crater at edge of rille. Panoramic photography. Compare rille rim material to other terrain.
Travel	0.60	4.20	5	32	-	-	2:33	Leave rille rim and traverse across mare toward Chain Crater in North Complex: Observe changes in material between rille rim, mare, and North Complex.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(c). LRV Traverse Data - Traverse III (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
Check Point	-	-	2	123	0	64	2:35	Smooth mare: Observe terrain for purposes of selecting traverse path, navigation, and potential sampling. Photography as appropriate.
Travel	1.80	6.00	14	46	-	-	2:49	Traverse across mare to Chain Crater: Observe changes in material between rille rim, mare, and North Complex. Observe characteristics of crater chain originating in Chain Crater. Observe possible secondary craters.
12	-	-	25	148	19	83	3:14	(Mandatory Sampling Area.) Southeastern rim of Chain Crater in North Complex at junction of elongate depression: Documented sample of crater ejecta. Panorama. Describe wall of crater and relation to elongate depression. Documented sample of North Complex material. Attempt to determine if crater if endogenetic or impact; search for exotics.
Travel	1.10	7.10	8	54	-	-	3:22	In North Complex between large craters: Observe intercrater area in North Complex and compare ejecta between craters. Continue to compare North Complex to other terrain types.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(c). LRV Traverse Data - Traverse III (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
13	-	-	60	208	54	137	4:22	(Mandatory Sampling Area.) Multiple objective stop at end of North Complex scarp between large craters: 750-m crater: Observe and describe crater interior and rim. Documented sample. Attempt to determine if crater is endogenetic or impact; search for exotics. Photography. Edge of scarp: Note any layering or changes in vertical scarp and sample. Photograph scarp. Note relation of scarp to rest of complex. 380-m crater: Observe and describe crater interior and rim. Photograph and describe extremely large boulder in southwestern part of crater and assess possibility of sampling. Documented samples. The following tasks should be completed in the North Complex area; location at discretion of crew based on their observations: Soil sample in typical North Complex. Single core tube. Exploratory trench. Stereo panorama. Penetrometer.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-4(c). LRV Traverse Data - Traverse III (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
Travel	2.55	9.65	19	73	-	-	4:41	From North Complex into mare fill region with possible secondaries: Observe and describe differences in material and surface textures between North Complex and mare. Note amount of secondary cratering. Photography as appropriate.
14	-	-	19	227	13	150	5:00	Fresh blocky crater south of North Complex in mare: Compare blocks and mare material with North Complex. Documented sample of mare material. Panorama.
Travel	1.9	11.55	15	88	-	-	5:15	Mare fill in region between North Complex and LM: Describe differences between this area and other mare areas. Note distribution of possible secondaries.
LM	-	-	45	272	0	150	6:00	Smooth mare: Store samples and records. EVA/Traverse closeout.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-5(a). Walking Traverse Data - Traverse I

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
LM	—	—	210	210	165	165	3:30	Smooth mare. EVA/Traverse preparation. Take Contingency Sample and deploy ALSEP, LRRR and SWC in LM vicinity.** Soil mechanics trench in mare in general vicinity of ALSEP. Do 2 penetrometer and 2 plate load tests: 1) Penetrometer with 0.5 $in.^2$ cone. a) Adjacent to trench b) At trench bottom 2) Plate load with 1 in. x 5 in. plate a) Top of vertical cut of trench b) At trench bottom In mare at small, nonblocky crater near LM, perform 3 penetrometer tests with 0.5 $in.^2$ cone. 1) At bottom center of crater 2) At side of crater 3) In rim of crater
Travel	2.4	2.4	44	44	—	—	4:14	Across typical smooth mare fill to rille rim. Compare rille rim material to mare material.
a	—	—	37	247	34	199	4:51	Rim of Hadley Rille. Traverse as near rim as possible. Radial sample of 50 m crater on rille rim.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

**A priority change may result in the interchange of Traverses I and II.

Table 4-5(a). Walking Traverse Data - Traverse I (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULA-TIVE	INDIVID-UAL	CUMULA-TIVE	INDIVID-UAL	CUMULA-TIVE		
a (Cont'd)								Observation and photography of far rille wall. Stereo panorama. Double core tube. Documented sample of rille rim. Penetrometer test with 0.5 in.^{2} cone. Long focal length photography.
Travel	1.2	3.6	22	66	—	—	5:13	Rim of Hadley Rille. Note differences in rille rim materials and lateral changes in surface characteristics. Observe lateral and vertical changes in rille wall. Photography as appropriate.
b	—	—	24	271	21	220	5:37	Rim of Hadley Rille. Observations and photography of far rille wall. Examination and sampling of crater penetrating rille rim. Stereo panorama. Sample coarse fines and rock chips on rille rim. Long focal length photography.
Travel	1.5	5.1	28	94	—	—	6:05	From rille rim across mare fill. Compare rille rim material to mare material.
LM	—	—	42	313	0	220	6:47	Smooth mare fill. Store samples and records. EVA/Traverse close-out.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-5(b). Walking Traverse Data - Traverse II

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
LM	—	—	38	38	0	0	0:38	Smooth mare. EVA/Traverse preparation.
Travel	3.1	3.1	56	56	—	—	1:34	Across mare to rim of Hadley Rille. Compare rille rim material to mare material.
c	—	—	30	68	27	27	2:04	Rim of 355 m crater on rille rim. Describe stratigraphy in far rille wall. Stereo panorama of rille. Documented samples from crater penetrating rille rim. Double core tube. Penetrometer with 0.5 in.^{2} cone. Long focal length photography.
Travel	0.7	3.8	13	69	—	—	2:17	Along rille rim to base of 2.2 km crater on Apennine Front. Describe changes in material and surface textures toward crater.
d	—	—	70	138	67	94	3:27	At base of Apennine Front near 2.2 km crater. Describe changes in surface materials and sample. Stereo panorama. Sample coarse fines and rock chips (comprehensive sample). Documented sample of variety of Apennine Front material. Long focal length photography.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-5(b). Walking Traverse Data - Traverse II (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
Travel	1.0	4.8	18	87	—	—	3:45	Base of Apennine Front slope. Note lateral changes in material and surface textures. Observe relation of debris slope and relation to mare surface.
e	—	—	30	168	27	121	4:15	At base of Apennine Front on south rim of approximately 50 m crater. Documented samples. Double core tube. Panorama. Observe and describe lateral and vertical changes in lithologies of surface blocks; compare to mare material. Penetrometer with 0.5 in.^{2} cone. Long focal length photography.
Travel	2.7	7.5	49	136	—	—	5:04	Mare fill material. Observe lateral differences in material and surface textures.
f	—	—	10	177	7	128	5:14	Mare material. Documented sample. Single core tube. Do 3 penetrometer and 1 plate load test: 1) Penetrometer with 0.2 in.^{2} cone. 2) Penetrometer with 0.5 in.^{2} cone. 3) Penetrometer with 1 in.^{2} cone. 4) Plate load with 1 in. x 5 in. plate

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-5(b). Walking Traverse Data - Traverse II (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
Travel	0.45	7.95	9	145	—	—	5:23	Mare material. Observe lateral differences in material and surface characteristics.
LM	—	—	45	223	0	128	6:08	Mare material. Store samples and records. EVA/Traverse close-out.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-5(c). Walking Traverse Data - Traverse III

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
LM	—	—	38	38	0	0	0:38	Mare material. EVA/Traverse preparation.
Travel	3.6	3.6	65	65	—	—	1:43	Across mare material. Observe lateral differences in materials and surface characteristics. Observe debris slope and relation to mare surface. Describe lateral and vertical variations in Apennine Front.
g	—	—	30	68	27	27	2:13	Base of Apennine Front slope. Documented samples. Panorama. Sample of coarse fines and rock chips (comprehensive sample). Observe and describe lateral and vertical changes in lithologies of surface blocks. Long focal length photography.
Travel	1.0	4.6	18	83	—	—	2:31	Along base of Apennine Front slope. Observe lateral variations in materials and surface textures. Photography as appropriate.
h	—	—	19	87	16	43	2:50	Base of Apennine Front slope. Documented samples. Panorama. Observe and describe lateral and vertical changes in lithologies of surface blocks.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-5(c). Walking Traverse Data - Traverse III (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
h (Cont'd)								Long focal length photography.
Travel	0.7	5.3	13	96	—	—	3:03	Off of Apennine Front slope to bright crater near group of secondary craters. Observe and describe relation of front slope and secondary crater cluster.
i	—	—	20	107	17	60	3:23	Bright crater in margin of secondary crater cluster. Observe crater interior and ejecta. Documented representative sample and exotics. Estimate amount of blanketing by secondary material. Double core tube. Penetrometer with 0.5 in.^{2} cone. Long focal length photography.
Travel	1.0	6.3	18	114	—	—	3:41	Across smooth part of secondary crater cluster. Observe secondary crater deposits and compare to other terrain. Photography as appropriate.
j	—	—	20	127	17	77	4:01	Secondary crater cluster; southwest corner of 400 m crater. Compare mare material and secondary crater material. Observe crater interior and ejecta. Documented representative sample and exotics. Sample coarse fines and rock chips (comprehensive sample). Panorama. Trench.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-5(c). Walking Traverse Data - Traverse III (Continued)

STATION OR TRAVEL	DISTANCE (km)		STATION STOP OR TRAVEL TIME (min)		STATION SCIENCE TIME (min)*		EVA TIME AFTER EVENT (hr:min)	GEOLOGICAL FEATURES/OBSERVATIONS AND ACTIVITIES
	TO STATION	CUMULATIVE	INDIVIDUAL	CUMULATIVE	INDIVIDUAL	CUMULATIVE		
Travel	3.2	9.5	58	172	—	—	4:59	From secondary crater cluster across mare material and broad ridge. Note number of secondaries to northwest of 400 m crater. Compare mare materials and surface structures to front and cluster. Photograph as appropriate.
LM	—	—	45	172	0	77	5:44	Smooth mare. Store samples and records. EVA/Traverse close-out.

*Station Science Time equals Station Stop Time minus Station Stop Overhead.

Table 4-6. LRV and Walking Traverse Summaries

TRAVERSE	ACTUAL TRAVERSE DISTANCE (km)	TRAVEL (min)	TRAVERSE STATION STOP OVERHEAD (min)	STATION SCIENCE (min)	EVA PREPARATION/ CLOSEOUT (min)	TOTAL EVA TIME (min)
LRV Traverse I	8.7	65	12	218	125	420
LRV Traverse II	15.95	121	44	166	89	420
LRV Traverse III	11.55	88	35	150	87	360
Walking Traverse I	5.1	94	6	220	87	407
Walking Traverse II	7.95	145	12	128	83	368
Walking Traverse III	9.5	172	12	77	83	344

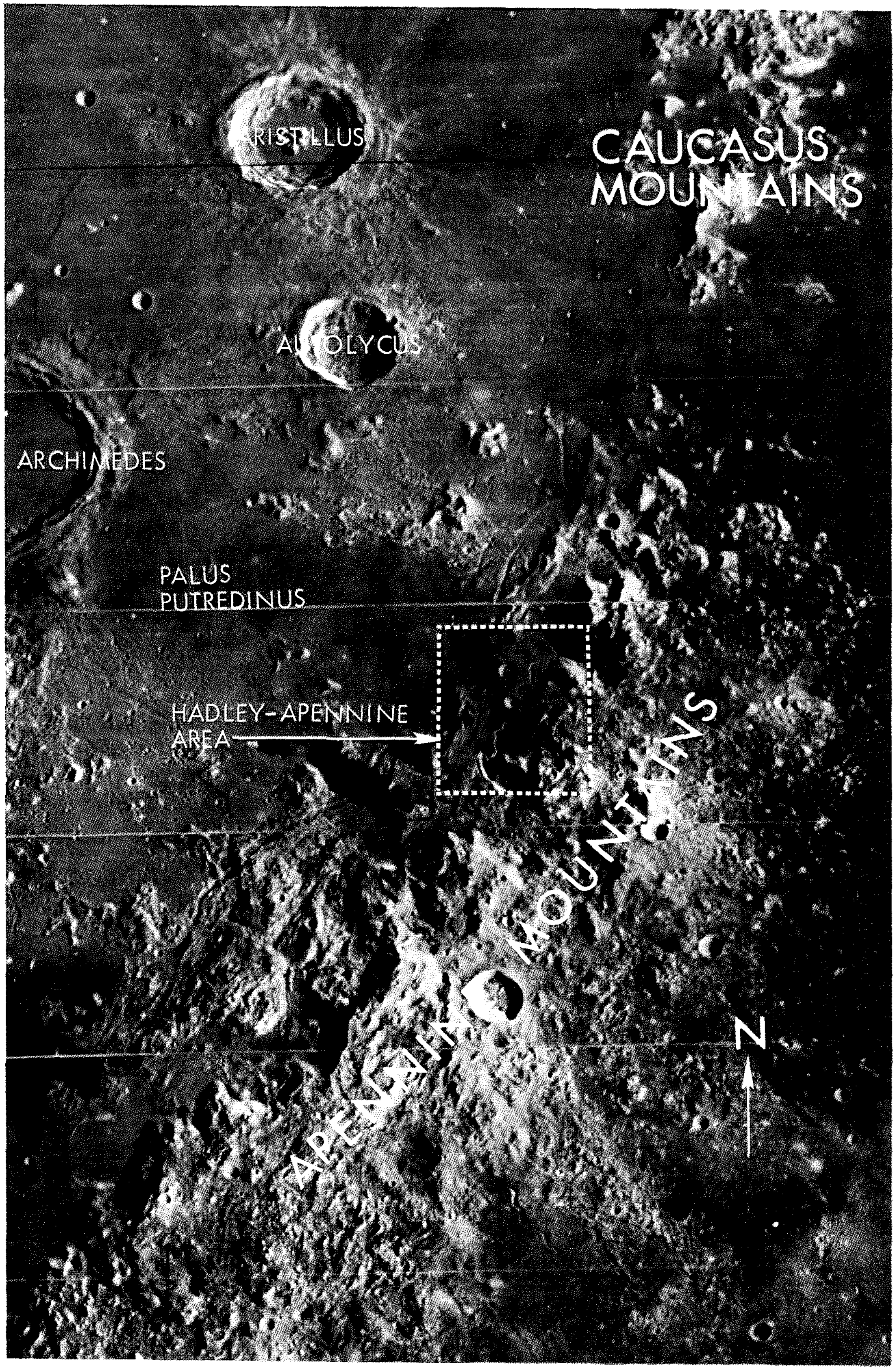


Figure 4-1. Hadley-Apennine Area

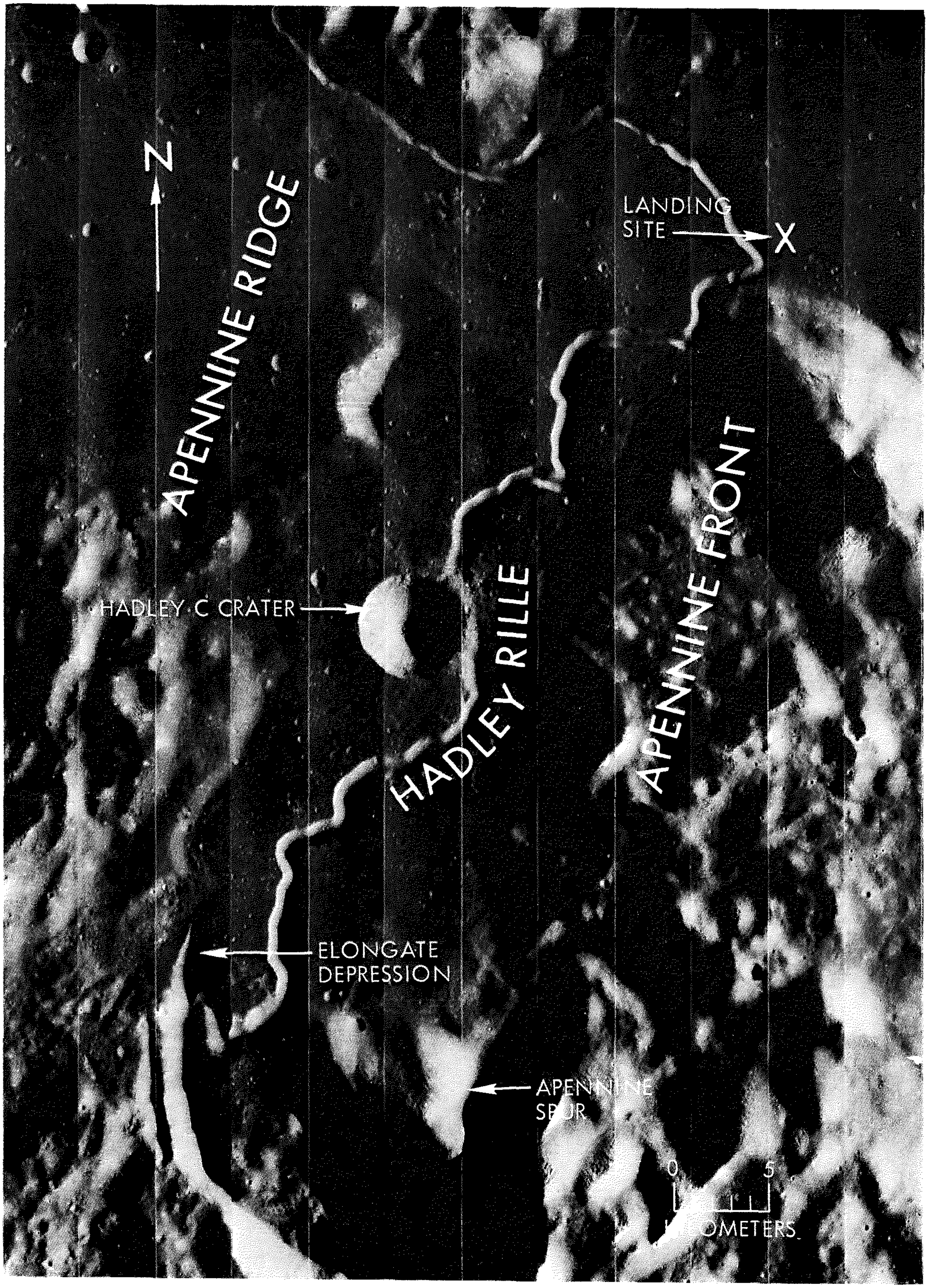


Figure 4-2. Hadley-Apennine Area, Magnified View

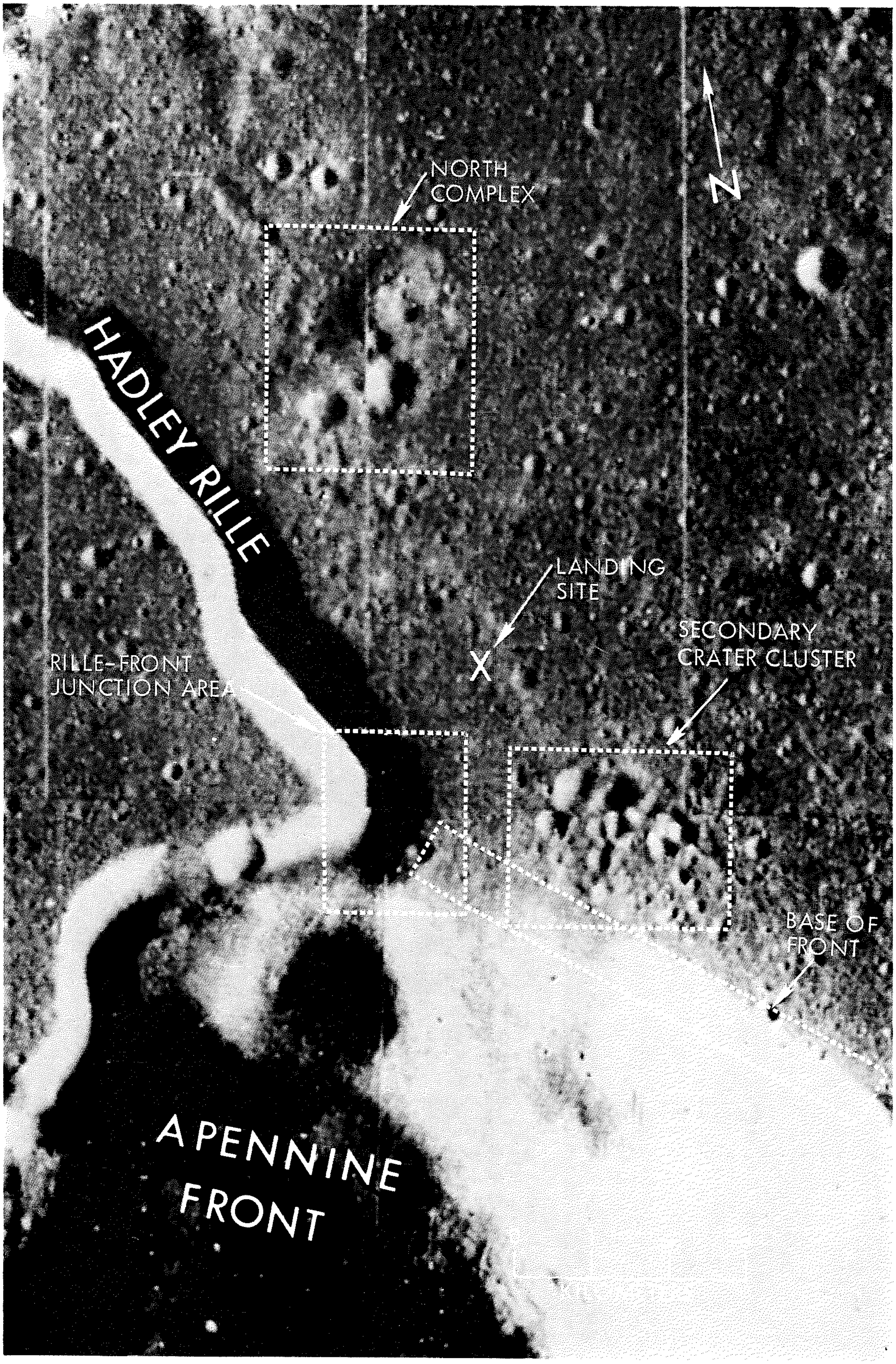


Figure 4-3. Hadley-Apennine Landing Area

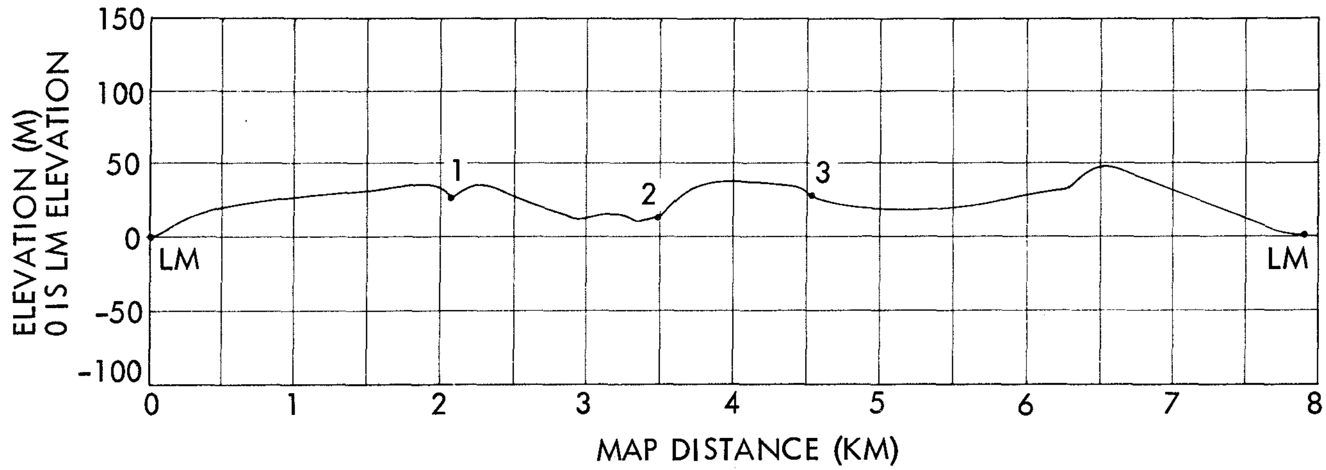


Figure 4-4(a). LRV Traverse Elevation Cross Sections - Traverse I

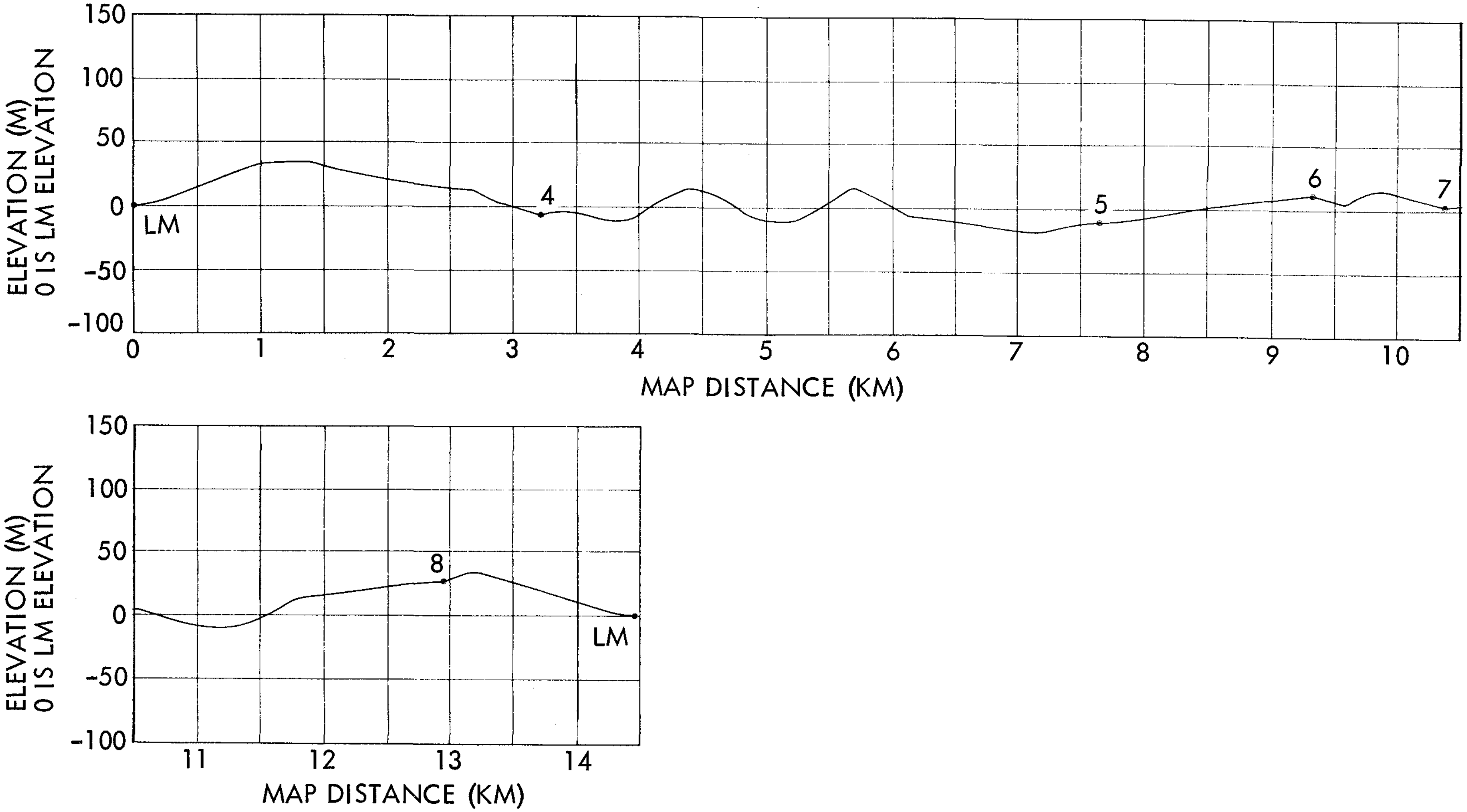


Figure 4-4(b). LRV Traverse Elevation Cross Sections - Traverse II

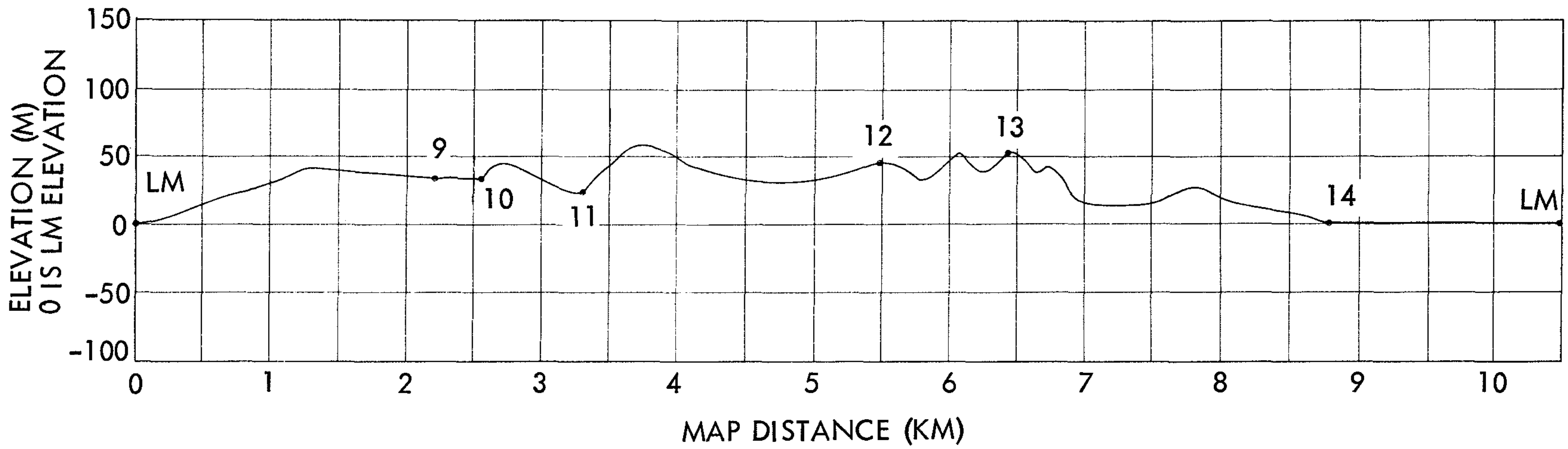


Figure 4-4(c). LRV Traverse Elevation Cross Sections - Traverse III

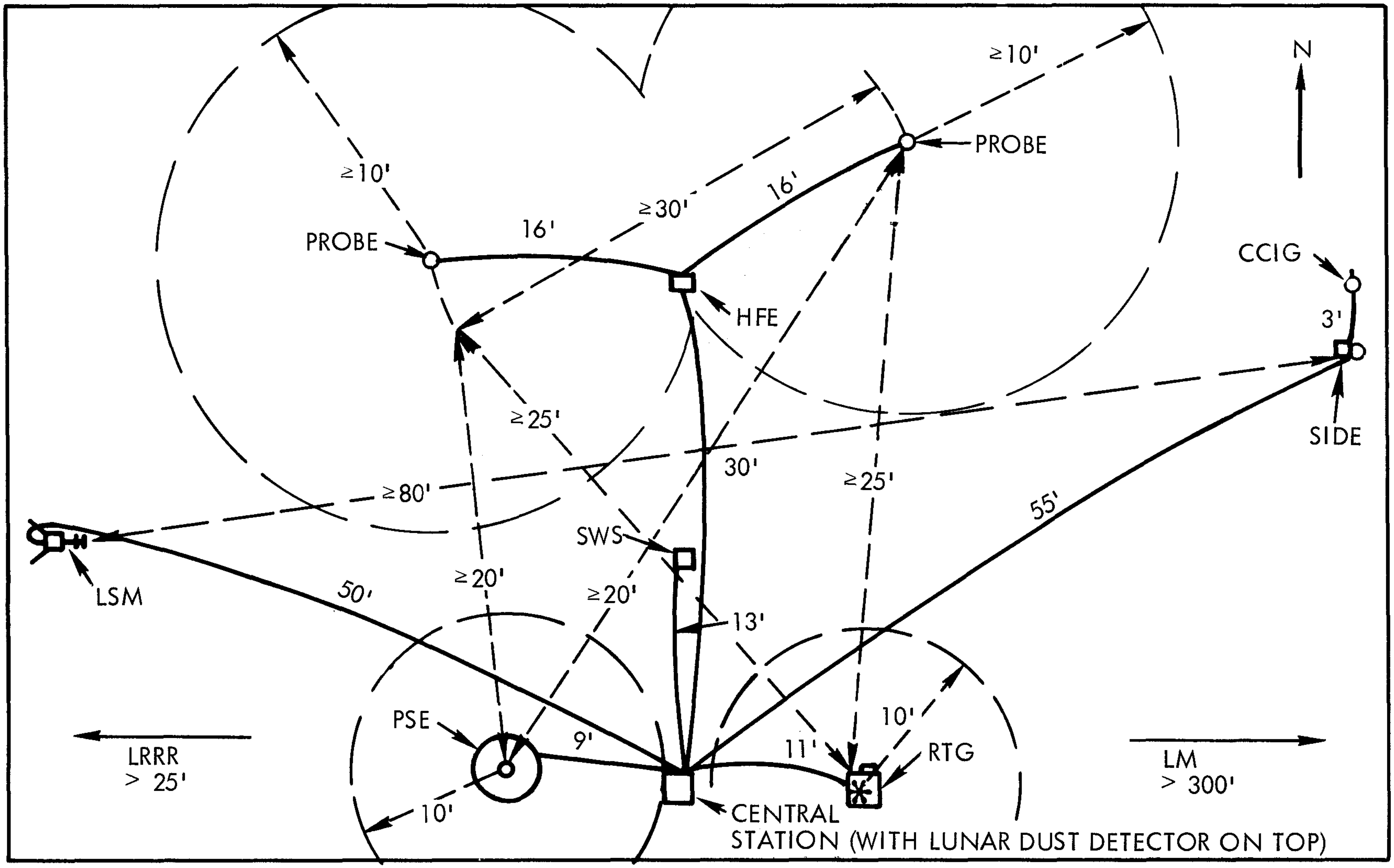


Figure 4-5. Apollo 15 ALSEP Deployment Diagram

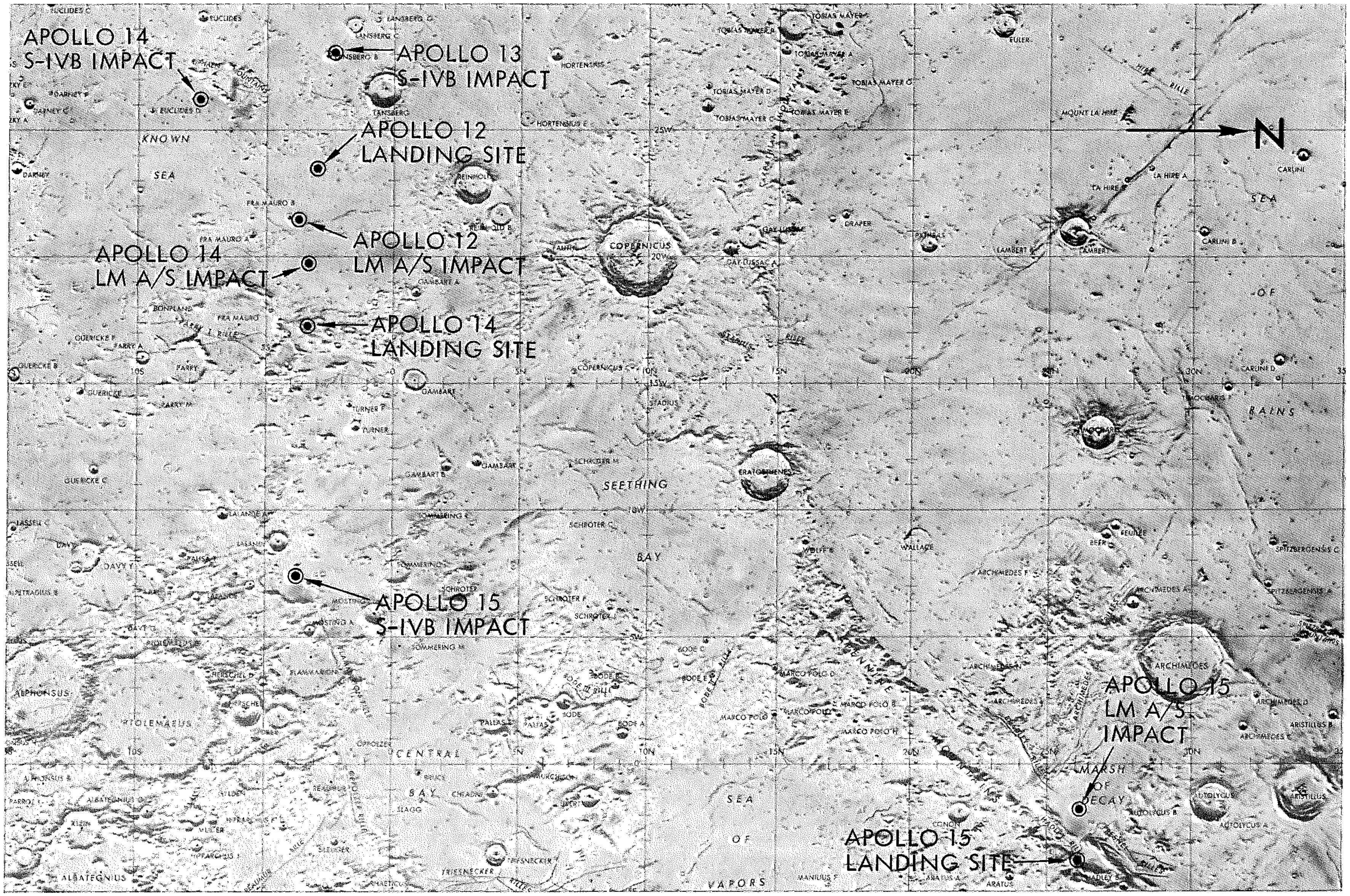


Figure 4-6. S-IVB and LM Ascent Stage Impact Points

Figure 4-7. LRV Traverse Routes

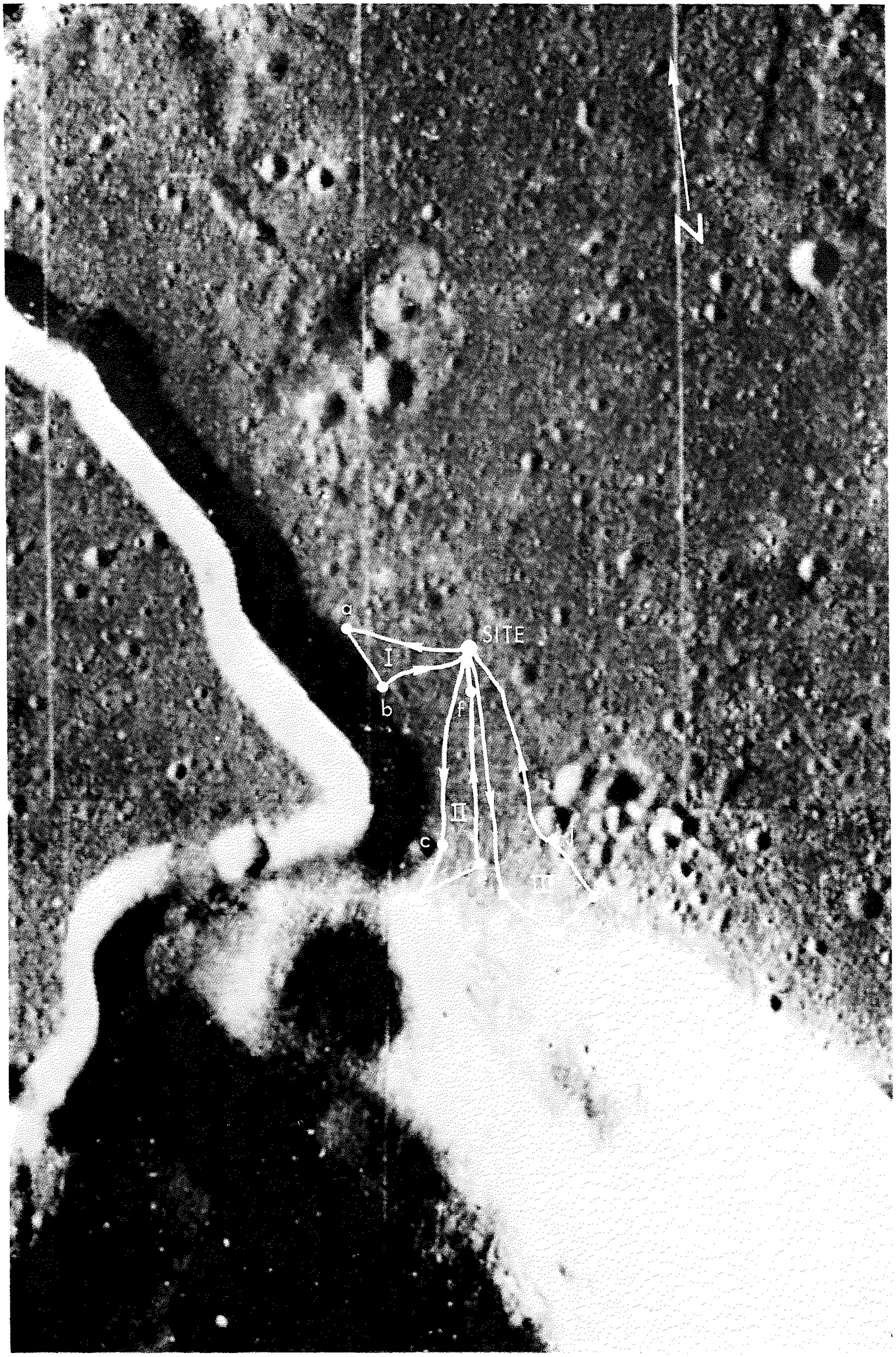


Figure 4-8. Walking Traverse Routes

SECTION V

SCIENCE ACTIVITIES RATIONALE

5.1 GENERAL

This section contains the rationale for experiments and science-related detailed objectives (DO) assigned to Apollo Mission J-1. These rationale give the reasons for each unique science activity (such as collecting a particular lunar surface sample) and thus serve as a basis for selection of alternate activities if deviation from the nominal time-line becomes necessary.

Data presented in this section are intended for use by experiment Principal Investigators, members of the scientific community, and personnel involved in planning and implementing mission science activities. For details pertaining to activities covered in this section, reference should be made to other sections in this document, to the Science Operations Support Plan, Mission J-1/Apollo 15 (Reference 24), and to MSC-controlled documents which include the J-1 Mission Requirements Document (Reference 1), Apollo 15 Flight Plan (Reference 2), Apollo 15 Lunar Surface Procedures (Reference 3), and Apollo 15 Photographic and TV Procedures (Reference 4).

5.2 RATIONALE

Rationale for lunar orbit experiments and DO's are presented in Tables 5-1 and 5-2; those for lunar surface experiments and DO's are presented in Table 5-3.

Table 5-1. Rationale for Lunar Orbit Experiments and Science Detailed Objectives

EXPERIMENT/DETAILED OBJECTIVE		OPERATING TIME REQUIRED	MEASUREMENT AND CONSIDERATIONS	RATIONALE
TITLE	NO.			
Gamma-Ray Spectrometer	S-160	Lunar Orbit 10 hrs. minimum, >60 hrs. desirable. Transearth Coast 30 hrs. minimum, 4 hrs. partial boom extension.	Gamma-ray radiation flux in the 0.1 to 10 MeV range. This is a mapping-type experiment. Therefore, the scientific gain is proportional to the surface seen by the spectrometer. In addition, extended operation is almost imperative due mainly to the high background-to-data ratio. The improvement in resolution of the data is proportional to the square root of operating time.	Obtain evidence on the origin and evolution of the moon by determining the degree of chemical differentiation the moon has undergone during its development and in conjunction with the other geochemical experiments (X-Ray Fluorescence and Alpha Particle) to determine the composition of the lunar surface. Chemical differentiation is the result of melting within the moon at any time in the past or present, and is indicated at the surface of the moon by concentrations of various elements which are distinctive from the mean values measured in the solar atmosphere and meteorites. The gamma-ray spectrometer measures the radiation flux from the surface of the moon while in orbit around the moon. This flux has two components. One is the decay of natural radioactivity mixed in lunar surface material, the principal contributors to which are isotopes of potassium, uranium, and thorium plus radioactive daughters of the latter two. The intensity of these contributors is a sensitive function of the degree of differentiation. Gamma radiation is also produced by the interaction of cosmic-ray particles with the nuclei of chemical elements making up the lunar surface. The observation of characteristic gamma-ray lines of decay and nuclear interaction is correlated with abundance. Secondary objective is to measure radiation flux in cislunar space and to obtain a spectrum of cosmological gamma-ray flux.

Table 5-1. Rationale for Lunar Orbit Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		OPERATING TIME REQUIRED	MEASUREMENT AND CONSIDERATIONS	RATIONALE
TITLE	NO.			
X-Ray Fluorescence	S-161	Lunar Orbit 10 hrs. minimum, more is desirable. Transearth Coast 15 hrs. minimum, 30 hrs. desirable. Data from selected galactic objects.	The K-line radiation yield of Na, Mg, Al, Si, K, Ca, and Fe, from the lunar surface is measured during the quiet, active, and flare periods of the sun as occurs during the experiment operation period. Similarly, the instantaneous solar X-ray spectrum is measured for background information and to determine the excitation conditions. The measured energy range is from 1 to 6 KeV. This experiment is a mapping-type experiment like the Gamma-Ray Spectrometer and has the same operating times and relationships with the surface overflown. Constant operation is desirable to obtain data from as much of the lunar surface as possible. Measurements will also be made on three galactic objects while in transearth coast.	Perform a compositional survey of the lunar surface. Solar X-rays should interact with the lunar surface to produce characteristic fluorescent X-rays. The measurement of these X-rays should yield the following information about the lunar surface: a) Data about the nature of surface material. b) A measure of the homogeneity of the surface as one sweeps around the moon. c) By comparison with the gamma-ray results, some idea of the extent of gardening and whether the composition of the surface is like that of the subsurface. Conduct an X-ray flux survey of three galactic sources.

Table 5-1. Rationale for Lunar Orbit Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		OPERATING TIME REQUIRED	MEASUREMENT AND CONSIDERATIONS	RATIONALE
TITLE	NO.			
Alpha Particle Spectrometer	S-162	Lunar Orbit 10 hrs. minimum, more is desirable. Transearth Coast Operation is concurrent with X-Ray Fluorescence.	Alpha particles in the energy range from 3.5 to 7.5 MeV. This experiment is also a mapping-type with the same relationships to surface overflown and operation time. The search for localized sources of radon makes constant operation desirable. The transearth coast data is used for background and engineering evaluation of the Alpha Particle and X-Ray Spectrometers.	The primary objectives are the determination of lunar surface radon evolution which assists the other geochemical experiments (Gamma-Ray Spectrometer and X-Ray Fluorescence) in determining lunar surface composition and identifying localized sources of enhanced radon emission. There are several reasons for a study of radon evolution from the moon. Perhaps the most important is that the concentrations of uranium and thorium in different lunar regions can be directly compared when the alpha particle and gamma-ray results are correlated. With information from a gamma sensor, the concentration of uranium can be determined so that it is possible to determine the diffusion characteristics of the soil. In turn, the diffusion properties are related to the porosity and quantity of absorbed gases in the lunar soil. If there is significant diffusion of radon to the surface, then the active deposit from the radon decay will increase the gamma activity of the surface (for terrestrial rates of radon evolution, the gamma emission would be increased by a factor of three, thus making the surface appear considerably more granitic). Hence, the alpha measurement is needed in order to subtract the effect of surface deposits. The location of regions with enhanced radon emission is an indication of one or more of the following interesting features: the occurrence of crevices or fissures on the lunar surface; areas which release volatiles generally; or possibly regions with unusual concentrations of thorium.

Table 5-1. Rationale for Lunar Orbit Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		OPERATING TIME REQUIRED	MEASUREMENT AND CONSIDERATIONS	RATIONALE
TITLE	NO.			
S-Band Transponder • CSM/LM	S-164	Front side passes, in order of science priority: CSM/LM 60 x 8 NM; LM descent; LM ascent stage to impact; CSM 60 x 60 NM; CSM/LM 60 x 170 NM. (Unpowered flight)	Doppler tracking data of CSM, LM, and Subsatellite. Tracking data below 16 NM altitude is most useful.	The objective of this experiment is to track the CSM, LM, and/or a subsatellite in lunar orbit by means of S-band doppler measurements during periods when the spacecraft is unperturbed by maneuvers, attitude control, or astronaut activity, and then to reduce these data for an enhanced gravity field determination. Accurate measurement of a spacecraft's natural lunar orbit position over meaningful periods of time allows definition of a lunar mass model. Such a model, when correlated with lunar shape information, will enhance and support future lunar activities by permitting greater surface landing accuracy, backside landings, and more accurate or alternate orbit determinations, and will give the scientific community a basic model for such considerations as lunar origin and subsurface structure.
• Subsatellite		Minimum requirements: Data for all frontside passes in order of science priority: when Subsatellite is below 16 NM for two frontside passes, each for two equivalent groundtracks with Subsatellite at two altitudes separated at least 10 NM and two-station tracking 4 times per month. Data for all Subsatellite passes below 30 NM are desired. Data for at least one frontside pass with Subsatellite between 45-and 60-NM altitudes, and for another pass with Subsatellite passing over groundtrack complementary to first.		The subsatellite, with its projected one year orbit of the moon and freedom from nongravitational forces will provide the greatest opportunity to gather precise tracking information. If low-altitude tracking is obtained, gravity anomalies over craters such as Copernicus and Alphonsus can be analyzed.

Table 5-1. Rationale for Lunar Orbit Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		OPERATING TIME REQUIRED	MEASUREMENT AND CONSIDERATIONS	RATIONALE
TITLE	NO.			
Mass Spectrometer	S-165	Three 2-rev periods minimum. 5 revs per period are desirable Data collected in the 60 x 8 and 60 NM circular lunar orbits and during Transearth Coast. 1 rev. for background data collection (with CSM +X axis pointed in the direction of velocity vector).	Measure the abundance of particles in the 12 to 66 AMU range. The sunrise and sunset terminators are the primary regions of interest as certain gases are predicted to be concentrated in these regions. Data collection over a complete orbit will provide data on the distribution of the gases. Experiment operation spread over the total lunar orbit period will provide maximum data coverage. The main objective of the Transearth Coast operation is obtaining data on contamination in the region of the CSM.	Obtain data on composition of lunar ambient atmosphere as an aid in understanding mechanisms of release of gases from the surface, as a tool to locate areas of volcanism, and for determining distribution of gases in lunar atmosphere. Study of the composition and distribution of gases in the lunar atmosphere is important to two current investigations. First is the understanding of the origin of the lunar atmosphere. Light gases, such as hydrogen, helium, and neon probably originate from neutralization of solar wind ions at the surface of the moon, while Ar^{40} is most likely due to radioactive decay of K^{40}, and Ar^{36} and Ar^{38} may be expected as spallation products of cosmic ray interactions with surface materials. Molecular gases, such as carbon dioxide, carbon monoxide, hydrogen sulfide, ammonia, sulphur dioxide, and water vapor may be produced by lunar volcanism. The second investigation is related to transport processes in planetary exospheres. The exosphere of the earth, and that of almost any other planet, is bounded by a dense atmosphere in which hydrodynamic wind systems complicate the problem of specifying appropriate boundary conditions for exospheric transport. This contrasts sharply with the situation in the lunar atmosphere, which is entirely a classical exosphere, with its base the surface of the moon. The lunar exosphere should be amenable to accurate, analytical study, and experimental determination of the global distributions of lunar gases can provide a reasonable check on theory, giving confidence to the application of theoretical techniques to transport problems in the terrestrial exosphere.

Table 5-1. Rationale for Lunar Orbit Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		OPERATING TIME REQUIRED	MEASUREMENT AND CONSIDERATIONS	RATIONALE
TITLE	NO.			
Bistatic Radar	S-170	Minimum: 1/2 frontside pass in S-band 1/2 frontside pass in VHF; 1/2 frontside pass in both VHF and S-band. More frontside passes are desirable.	Measure the CSM signals, VHF and S-Band, reflected from the lunar surface. The MARS dish antenna is the selected receiving station for the S-Band data. The 150-foot Stanford antenna system is the selected receiving station for the VHF data.	This experiment will provide fundamental scientific information on the upper few meters of the lunar crust by determining the surface roughness and the dialectic constant (by the Brewster angle method) at wavelengths of approximately 13 centimeters and 1 meter. The experiment will also provide information on subsurface layering to the depth of approximately 20 meters and will provide engineering data necessary for optimizing the design of future bistatic experiments from low lunar orbits (60 NM altitude). In addition, the results will provide lunar S-band bistatic radar calibrations which will have considerable utility in the interpretation of similar experiments conducted in the future on the planets. Bistatic radar data also provide information on surface shape through the spectrum of the reflected signal.
Magnetometer (Subsatellite)	S-174	Real-time mode data while in magnetotail and S-173 providing valid data. Real-time mode data once per day for 4 lunations. Real-time mode data twice a week after 4 lunations. All data (MRO mode) outside real-time mode support periods. Real-time mode data while in magnetosheath after 4 months.	Local magnetic field up to 200 gamma. Due to unpredictable variations of the interplanetary medium, as much data as possible must be collected to minimize the statistical uncertainty of experiment conclusions and to improve the resolution of the data. High bit rate data must be collected to obtain the maximum resolution of electrical conductivity and thermal distribution information derived from Subsatellite and ALSEP magnetometer data.	Measurements of magnetic fields in the transient and steady state boundary layers should provide indirect information on the lunar ionosphere and transient lunar atmosphere. It is estimated that the altitude of the top of the boundary layer at the surface, or the skin depth of the lunar perturbation in the solar wind plasma, will vary from 5 to 500 km. The dynamical processes, e.g., wave-particle and field-particle interactions, are probably very important in this region. Magnetic field measurements at the high data rate should provide exploratory data on such phenomena. In the cavity directly behind the moon, the properties of the plasma and magnetic field are very different from those of the solar wind flowing in the adjacent regions. At the boundary between this downstream cavity and the solar wind, there are strong gradients in the density and velocity of the plasma. The 60 NM lunar orbit will traverse this layer in two places. Thus, one of the main purposes of this experiment would be to obtain data on the microscopic behavior in this region.

Table 5-1. Rationale for Lunar Orbit Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		OPERATING TIME REQUIRED	MEASUREMENT AND CONSIDERATIONS	RATIONALE
TITLE	NO.			
Particle Shadows/Boundary Layer (Subsatellite)	S-173	Real-time mode data while in magnetotail. Real-time mode data once per day for 4 lunations. Real-time mode data twice a week after 4 lunations. All data (MRO mode) outside real-time support periods.	Electrons in the energy range from 20 to 320 KeV and protons from 50 KeV to 2.3 MeV. Electrons in selected bands from 0.58 to 15 KeV. The unpredictability of the occurrence of solar flares and propagation of solar flare electrons requires that as much data be acquired as possible. Data passes should be evenly spaced in time to assure sampling of most solar flares. To maximize the scientific return from possible widely varying conditions, it is essential that the subsatellite be monitored and controlled continuously in the magnetotail. The polar sounding rocket program may be conducted concurrently with the subsatellite experiment.	The objectives of this experiment are the study of the formation and dynamics of the earth's magnetosphere, the physics of solar flares, and the interaction of plasmas with the moon. The study of the interaction region will yield information on the external plasma, the interior of the moon, the surface, and the lunar ionosphere. The empirical study of the boundary layers and discontinuities in naturally occurring plasmas is complicated by the motion of the layers. This problem has arisen, for example, in the studies of the bow shock and magnetopause at the earth. On the basis of present evidence, the interaction of the solar wind with the moon occurs very close to the lunar surface. The boundary layer for this interaction extends from the lunar surface outward to some distance which is as yet unknown, but which is estimated to be of the order of 100 kilometers. We have, then, a boundary layer that is fixed in space, since the inner boundary is the lunar surface, and variable in thickness. Thus, in this particular boundary layer, complications due to the motion do not exist. The goal of this part of the experiment is to obtain data on the physics of this interaction region or boundary layer. The characteristics of the boundary layer are determined by the properties of the plasma as well as those of the moon. Recently a new method (particle shadows) complementary to using magnetometers has been described. This method is used to determine the large scale topology of field lines under certain conditions. It is essentially a particle tracing technique which determines where particles have been and where they go on the particular field lines under study. The tracer particles are supplied by the sun. The method also requires the presence of a large absorber such as the moon. As a spacecraft orbits the moon, a pattern of varying solar electron intensity is experienced. The characteristics of the field lines are then deduced from the symmetry properties of these patterns.

Table 5-2. Rationale for Lunar Orbit Photography Experiments and Science Detailed Objectives

EXPERIMENT/DETAILED OBJECTIVE		PHOTOGRAPHIC SUBJECT AND CONSIDERATIONS	RATIONALE
TITLE	NO.		
24-Inch Panoramic Camera (Part of SM Orbital Photographic Tasks)		Lunar surface. Concurrent operation of 3-Inch Mapping Camera is required.	Obtain 1- to 2-meter resolution photography of potential Apollo Mission J-3 landing sites and exploration areas and provide selective detailed information to support selenodetic/cartographic activity using the 3-Inch Mapping Camera. Lunar landing-site analysis and selection well in advance of the mission can significantly improve the efficiency of activities on the lunar surface. The same is even more true for manned or automated surface traverse missions. Only a thorough analysis of high resolution photography (the resolution must be three to five times better than the sizes of potential topographic hazards for the system under consideration) can provide high confidence in the operational suitability of landing sites or exploration areas. Identification and photogrammetric studies of features of high scientific interest in the vicinity of candidate landing sites can reduce the time needed for scientific activities during the lunar missions and also provide important inputs to the site selection process. It has been proposed to survey an area of several hundred square kilometers several times with 1- to 2-meter resolution orbital photography at 1- to 3-year intervals to extend meteoroid flux measurements to larger masses.

Table 5-2. Rationale for Lunar Orbit Photography Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		PHOTOGRAPHIC SUBJECT AND CONSIDERATIONS	RATIONALE
TITLE	NO.		
3-Inch Mapping Camera (Part of SM Orbital Photographic Tasks)		Lunar surface with time-correlated stellar photography. Operation is essential whenever panoramic camera operates.	The mapping camera photographs provide a means for establishing a lunar geodetic network. This network will provide positional reference on the moon. It also forms the basis for subsequent photogrammetric determination of the gravitational field through re-section of camera position with respect to the control network. The mapping camera photographs also form the basis of specialized cartographic maps ranging from small-scale flight charts, used for lunar orbit operations, to medium-scale topographic charts 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 terrain profile information required to plan subsequent lunar exploration missions.
Laser Altimeter (Part of SM Orbital Photographic Tasks)		Range from CSM to lunar surface with 1-meter resolution. To be supported by Stellar camera as film budget permits. Minimum of 1 complete orbit of operation every 2nd orbit exclusive of sleep periods, continuous operation in lunar orbit desired.	Provide precise time-correlated altitude information for use in conjunction with tracking data and pictures taken by the mapping and panoramic cameras. The determination of the moon's gravitational field from analysis of lunar orbiter perturbations, of which the main result is the mass concentrations, is of great importance to the study of the moon's structure and evolution. However, the lack of accurate topographic elevations makes it difficult to draw inferences as to internal structure because the contribution to the gravitational field of the visible topography cannot be subtracted out accurately. Also the spectrum of the long wave variations in topography is of significance to lunar structure itself. This experiment should yield data to help resolve these problems. The laser altitudes are used with DSIF tracking from the earth to determine improved orbits. The variations in topographic variations are then determined by subtracting the laser altitudes from the orbital radial coordinates. This procedure should give the topographic variations with an accuracy approaching that of the instrument.

Table 5-2. Rationale for Lunar Orbit Photography Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		PHOTOGRAPHIC SUBJECT AND CONSIDERATIONS	RATIONALE
TITLE	NO.		
UV Photography - Earth and Moon	S-177	Earth and moon during earth parking orbit, at different points during translunar and transearth coast, and in lunar orbit.	This experiment is an investigation of the terrestrial atmosphere by means of photographs of the earth obtained in ultraviolet light in order to aid in the interpretation of similar photographs of Mars and Venus. By photographing the earth in the same manner that is employed for planetary studies, one can use the detailed knowledge about the properties of the terrestrial atmosphere to interpret such planetary observations. Photographs of the moon at 2600 Å will be used to extend the wavelength coverage of ground-based colorimetric work and to search for possible fluorescence. Color differences on the moon that can be correlated with topographic features have been known for some time. By extending the wavelength range, it should be possible to improve the definition of features already recorded as well as to detect new colorimetric boundaries.
Gegenschein from Lunar Orbit	S-178	Photographs in the antisolar direction, in the direction of the Moulton point, and in the direction midway between the Moulton point direction and the antisolar direction, taken while the CSM is in lunar double umbra (lunar umbra <u>and</u> no earthshine).	The objective is to attempt to confirm the possible accumulation of matter at the Moulton point, which is the L1 libration point of the rotating sun-earth system. The photographs are intended to show differences in the distribution of reflected light from the vicinity of the Moulton point, and to help assess the contribution to the Gegenschein of light reflected from the region of the Moulton point.
Transearth Lunar Photography (Part of CM Photographic Tasks)		Wide-angle photographs of the lunar surface following TEI.	The objective is to extend 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 photographed during landmark tracking. 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.

Table 5-2. Rationale for Lunar Orbit Photography Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		PHOTOGRAPHIC SUBJECT AND CONSIDERATIONS	RATIONALE
TITLE	NO.		
Dim Light Photography			
a) Lunar libration region		Photographs of the region about the L4 libration point in the earth-moon system, taken in lunar double umbra.	a) b) The objectives are to 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 lunar double umbra can also take advantage of the increased parallax along the earth-moon baseline. Analysis of these photographs will have application to the study of the distribution 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.
b) Zodiacal light		Photographs of the Zodiacal light as the CSM approaches sunrise in lunar orbit.	
c) Solar corona		Photographs of the solar corona taken in lunar orbit after CM sunset and before CM sunrise.	The objective is to study the pattern of energy outflow from the sun, by photographing its outermost region while the solar disc is occulted by the moon.
d) Lunar eclipse		Photographs of the moon as it enters the earth's umbra and as it emerges from the earth's umbra during trans-earth coast.	The objective is to study terrestrial atmospheric effects. Photographs of the moon as it enters and exits the earth's umbra will show color changes due to selective transmission of light through the earth's atmosphere.
e) Sextant star field photographic test		Photographs of a star field centered at RTCC Catalog star number 46 (Hamal) taken through the CM sextant during transearth coast, with sextant optics both within and without the shadow of the CM (sextant internal lighting off).	The objective is to determine the sources of stray light which over exposed the earth's dark side photographs attempted on Apollo 14. The photographs will constitute a test of the 16-mm data acquisition camera in conjunction with the CM sextant optics, to assess the effectiveness of this combination for photography of low-brightness astronomical subjects.
a) through e) are part of CM Photographic Tasks			

Table 5-2. Rationale for Lunar Orbit Photography Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		PHOTOGRAPHIC SUBJECT AND CONSIDERATIONS	RATIONALE
TITLE	NO.		
Lunar Surface Photography: a) In low light levels near the terminator b) In earthshine c) Of targets of scientific interest a), b), and c) are part of CM Photographic Tasks		Photographs of areas on the lunar surface taken from the CM in lunar orbit. Specific targets will appear in the J-1 Mission Requirements Document.	This photography will complement SIM bay photography by photographing specific targets at altitudes and sun incidence angles which are not feasible for the SIM cameras due to their own altitude and attitude constraints. Photographs of selected targets at different sun incidence angles, i.e., different illumination levels, will also provide information on the reflective properties of the lunar surface.

Table 5-3. Rationale for Lunar Surface Experiments and Science Detailed Objectives

EXPERIMENT/DETAILED OBJECTIVE		RATIONALE
TITLE	NO.	
Contingency Sample Collection	--	This detailed objective will enable early collection of approximately 2 kg of lunar surface samples to increase the probability of returning a lunar sample to earth in the event of early termination of the EVA period.
Apollo Lunar Surface Experiment Package (ALSEP):		This collection of seven, lunar surface, telemetered experiments is designed to measure lunar seismic, thermal, magnetic, and particle environment data over an extended period of time (from a full lunar day to one earth year or more). These data will be the bases of fundamental lunar geophysical, geochemical, plasma physics, and other investigations which will greatly contribute to our knowledge and understanding of the moon, the earth, and the solar environment. Data from ALSEP's at different locations on the moon are necessary to enable determination of directional, spatial, and temporal distributions of the measured phenomena. Therefore, it is planned to deploy an ALSEP during every lunar landing mission. ALSEP's were deployed and successfully operated during Apollo 11, 12, and 14. Individual ALSEP experiments are described below:
• Passive Seismic Experiment (PSE)	S-031	This experiment will determine the number, origin, and character of lunar seismic events, and obtain knowledge on the physical properties and general structure of the moon. The PSE was deployed on Apollo 11, 12, and 14. Those deployed on Apollo 12 and 14 are presently operative.

Table 5-3. Rationale for Lunar Surface Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		RATIONALE
TITLE	NO.	
• Lunar Surface Magnetometer (LSM)	S-034	This experiment will measure the magnitude and temporal variations of the lunar surface magnetic field vector. Data from this experiment will also be used to derive information on the electrical properties and thermal state of the deep interior of the moon and on the interplanetary magnetic field that diffuses through the moon. The LSM was deployed on Apollo 12 and 14.
• Solar Wind Spectrometer (SWS)	S-035	This experiment will monitor the flux, energy, streaming direction, and temporal variations of the solar wind plasma. These data will contribute knowledge about the properties and characteristics of the solar wind flux and solar wind/lunar surface interactions. The SWS was deployed on Apollo 12.
• Suprathermal Ion Detector Experiment (SIDE)	S-036	This experiment will detect ions resulting from ultraviolet ionization of the lunar atmosphere and the solar wind flow/lunar surface interaction. The SIDE was deployed on Apollo 12 and 14.
• Heat Flow Experiment (HFE)	S-037	This experiment will provide data on lunar soil thermal conductivity, contribute to the resolution of issues concerning the internal heating processes, and establish constraints on the interior temperature and composition of the moon. The HFE has not been deployed on previous Apollo missions.
• Cold Cathode Ion Gauge (CCIG)	S-058	This experiment will measure density of the ambient lunar atmosphere and variations in density which result from outgassing of the lunar interior and other sources. The CCIG was deployed on Apollo 12 and 14.

Table 5-3. Rationale for Lunar Surface Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		RATIONALE
TITLE	NO.	
• Lunar Dust Detector Experiment (LDDE)	M-515	This experiment will provide data on dust accretion on ALSEP, thermal degradation of thermal surfaces, and lunar surface temperature. The LDDE was deployed on Apollo 12 and 14.
Lunar Geology Investigation:	S-059	The collection of geological samples and photography of geological features are planned to provide data for lunar geological studies that will increase our knowledge of the physical makeup of the moon, its history, the nature and history of the solar system, and the history of earth. The activities that comprise this experiment are described below:
• Documented sample with documented sample photography		The objective is to obtain samples peculiar to the Hadley-Apennine area, especially samples from the Apennine Mountain front; from rim of Hadley Rille; from the lunar mare; from probable secondary crater clusters; and from probable constructional land forms. The photography will show sample orientation, buried depth, relationship to other geologic features, location with respect to LM or other recognizable feature; with gnomon, to show orientation with respect to sun and lunar local vertical; stereo pairs for precise photogrammetric measurements of features.
• Comprehensive sample including 1-kg sample		The comprehensive sample will increase the probability of returning deep or shocked Imbrium rocks. Statistical significance of the sample may be increased by returning the maximum numbers of rocks.

Table 5-3. Rationale for Lunar Surface Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		RATIONALE
TITLE	NO.	
		The 1-kg sample is to characterize the regolith in the vicinity where the rocks are collected (e.g., at Apennine Front, to characterize regolith in talus slope at base of scarp).
• Radial sampling of a fresh crater, including photography		The aim is to determine the stratigraphic history of the area. The deepest material should be exposed at the crater rim; the material origin should get progressively shallower moving out from the crater, i.e., materials farthest away should have the shallowest origin in the crater. Photographs of the crater will record its size, type, and freshness (freshness is suggested by radiating patterns of high albedo material or by large abundance of angular blocks).
• Panoramic photography		These photographs, when joined as mosaics, provide accurate map control data.
• Polarimetric photography and samples		Comparison of polarimetric signatures with those of known materials will allow classification and correlation of lunar material even though textures are not resolvable.
• Long focal length camera photography		The 5 to 10 cm resolution at 1 to 2 km distance will allow pictures to be taken of the cliff exposure on the far wall of Hadley Rille. The contact of the regolith layer with the lava flows of the mare basin fill should be visible as well as possible fragmental debris layers between lava flows. The resolutions should be sufficient to show layering within the flows and distribution patterns of vesicles (gas

Table 5-3. Rationale for Lunar Surface Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE TITLE	NO.	RATIONALE
Long focal length camera photography (Continued)		bubble holes). The distribution patterns of vesicles in bedrock units may allow an interpretation of the mode of emplacement of the lava flows. This may be the only place on the Moon that will be visited by Apollo where such an interpretation can be made. The high degree of resolution will make it possible to analyze the shape and size distribution of material on the floor of the rille, hopefully leading to an understanding of the processes of rille formation and of the types of transportation that occur along the resulting channel. It will be possible to photograph outcrops and large blocks surrounding small impact craters on the slopes of the Apennine Front. It may not be possible to travel far enough up these slopes to actually visit these rock exposures. Photographs with the 5 to 10 cm resolution will allow the texture and structures in these rocks that are the prime objective of the mission to be recorded.
• Double core tube sample and photographs (can be replaced by triple core tube, approximately 3 feet long)		This objective provides a sample for determining stratigraphy and soil type distribution to depths of approximately 2 feet in the lunar surface at selected locations (expected multiple layer areas). The photographs will record the surface characteristics and location of the sample area.
• Single core tube sample and photographs		This objective provides a sample for determining soil type distribution to depths of approximately 15 inches in the lunar surface at

Table 5-3. Rationale for Lunar Surface Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE TITLE	NO.	RATIONALE
Single core tube sample and photographs (Continued)		selected locations (comprehensive sample area and targets of opportunity such as mounds, fillets, and the mare/Appenine Front interface). The photographs will record the surface characteristics and location of the sample area.
• Drill Core		This objective provides the only certain deep sample of regolith; a secondary objective is to determine stratigraphy in the sample area.
• Small exploratory trench sample with photographs		The objective is to determine the character of regolith down to 3 to 8 in. and small scale stratigraphy in terms of petrologic characteristics and particle size. The photographs will record the surface characteristics and location of the trench sample area and other characteristics.
• Large equidimensional rock (6 to 8 inches diameter) with photographs		The objective 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.
• Smaller equidimensional rock (3 to 6 inches diameter) with photographs		Similar to above. Several small rocks may be more valuable than one large rock because of higher statistical significance of more samples.
• Fillet sample		Debris (soil) piled up against rock is called a fillet; the volume of the fillet may be directly proportional to the time the rock has been in position and to the rock size.

Table 5-3. Rationale for Lunar Surface Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		RATIONALE
TITLE	NO.	
• Lunar environment soil/ rock sample		These samples will be the only truly virgin vacuum samples from the moon; biologically pure samples for organic analysis, for gas analysis, and for chemical and microphysical analysis.
Laser Ranging Retro-Reflector (LRRR)	S-078	This experiment will permit precise short-term and long-term measurement of the earth/moon distance and provide data for • More accurate lunar orbital parameters • An improved lunar libration model • Analysis of earth rotation variations • Determining the magnitude of continental drift on earth LRRR's were deployed during Apollo 11 and 14. A third LRRR to be deployed during Apollo Mission J-1 will provide accurate directional data as well as range data.
Solar Wind Composition (SWC)	S-080	This experiment will determine the elemental and isotopic composition of the noble gasses and other selected elements in the solar wind by measuring particle entrapment on an exposed aluminum foil sheet. The SWC was deployed on Apollo 11, 12, and 14.
Soil Mechanics: • Trench with trench photography	S-200	The objectives are: To photograph the soil layers that will be exposed on the side of a trench dug as deep and as long as possible. The achievable depth prior to wall failure indicates soil mechanical properties. The experiment will furnish qualitative information for design of lunar

Table 5-3. Rationale for Lunar Surface Experiments and Science Detailed Objectives (Continued)

EXPERIMENT/DETAILED OBJECTIVE		RATIONALE
TITLE	NO.	
Trench with trench photography (Continued)		shelters using lunar soil as thermal, radiation shield.
• Penetrometer and plate load tests with photographs		The objective is to obtain stress versus penetration data that reflect nonhomogeneities in soil profile; the data will be correlated with penetrometer and plate penetration data for simulated lunar soil to determine lateral and vertical particle size distribution of lunar soil.

SECTION VI

SCIENCE RECOVERY PLAN

6.1 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 6.2.1 and 6.2.2. Transportation priorities are specified in Table 6-1.

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-1 Mission Requirements Document (Reference 1) until such data are published in other MSC-controlled documents. These documents include the Apollo 15 Flight Mission Rules (Reference 17) and Recovery Requirements-Apollo 15 (Reference 25).

6.2 PREPARATION AND TRANSPORTATION REQUIREMENTS

6.2.1 PREPARATION OF DATA AND EQUIPMENT FOR RETURN TO MSC

6.2.1.1 Decontamination

Because of the recent 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 missions. The precautions and requirements associated with the processing of returned lunar samples, however, are still in effect.

6.2.1.2 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.

6.2.2 TRANSPORTATION REQUIREMENTS

6.2.2.1 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 if an aircraft is lost.

6.2.2.2 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 6-1. J-1 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 1013	1	Flight No. 1	The SRC's are not to be opened prior to delivery to the LRL. The Organic Control Sample installed in each SRC prior to flight will remain in the container throughout the mission. Serial numbers of the SESC's identified may change because of changes that may result during SRC preflight packing activities.
• Sample Collection Bag No. 1	1		
• Deep Core Stems	6 (max.)		
• Documented Sample Bags (Geological Samples from EVA No. 1)	40 (max.)		
• Environmental Soil Sample (SESC No. 1012)	1		
• Organic Control Sample	1		

Table 6-1. J-1 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• SRC No. 2, S/N 1012	1	Flight No. 2	The SRC's are not to be opened prior to delivery to the LRL. The Organic Control Sample installed in each SRC prior to flight will remain in the container throughout the mission. The DSEA is hermetically sealed. The complete unit must be removed from the LM. At recovery, the unit must be placed in a magnetic shielded container for shipment to the LRL.
• Sample Collection Bag No. 5	1		
• Documented Sample Bags (Geological samples from EVA No. 2)	40 (max.)		
• Environmental Soil Sample (SESC No. 1015)	1		
• Core Tubes (From EVA No. 2)	3 (max.)		
• Organic Control Sample	1		
• DSEA Tape From LM	1		

Table 6-1. J-1 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Sample Collection Bag No. 7	1	Flight No. 1 or No. 2	Flight assignment of collection bags and other samples will largely be determined by the science value attached to the actual samples acquired. Collection bags to be placed in special return containers similar to those used for the SRC's.
• Environmental Soil Sample (SESC No. 1018)	1		
• Core Tubes (From EVA No. 3)	3 (max.)		
• Documented Sample Bags (Geological Samples from EVA No. 3)	40 (max.)		
• Sample Collection Bag No. 4	1		
• Core Tubes (From EVA No. 1)	3 (max.)		
• Other Geological Samples from EVA No. 1	EVA Dependent		

Table 6-1. J-1 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Magazines/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) • 70-mm Hasselblad Electric Camera	13* Magazines 7** Magazines 20 Magazines (Total)		
• 35-mm Camera	4 Magazines		

*Includes 1 magazine of lunar surface Long Focal Length Photography
**Includes 1 magazine of CM UV Photography

Table 6-1. J-1 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Magazines/Cassettes from following camera systems: (continued)			Remarks from the previous page apply except for shipping priority.
• 3-Inch Mapping Camera	1* Cassette	Determined at time of CM recovery.	
• 24-Inch Panoramic Camera	1 Cassette		
• Sample Collection Bag No. 2 (Contains geological sample overflow from EVA No. 2)	1	Flight No. 1 or No. 2	Flight assignment of collection bags and other samples will largely be determined by the science value attached to the actual samples acquired. Collection bags to be placed in special return containers similar to those used for the SRC's. Collection bags containing large rocks and sample overflow are to be divided equally between the two flights.
• Sample Collection Bag No. 3 (Contains large rocks from EVA No. 1)	1		
• Sample Collection Bag No. 6 (Contains large rocks from EVA No. 2)	1		
• Sample Collection Bag No. 8 (Contains geological sample overflow from EVA No. 3)	1		

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

Table 6-1. J-1 Mission Scientific Data and Equipment Recovery Requirements Matrix (Continued)

DATA/EQUIPMENT TO BE RETURNED TO LRL	QUANTITY	SHIPPING PRIORITY FROM RECOVERY AREA	REMARKS
• Solar Wind Composition Foil and Reel	1	Flight No. 1 or No. 2	Stowed in SWC stowage bag.
• Soil Mechanics Penetrometer Drum (in penetrometer head)	1		Stowed in geological documented sample bag.
• Astronaut Flight Logs	-	Flight No. 1 with the astronauts.	Flight logs contain information vital to the interpretation and analysis of lunar surface activities. Transcripts of the flight logs should be made available as quickly as possible after return to MSC.
• CM DSE Tape	1	Remove from CM upon receipt at LRL.	The DSE tape is the only record of telemetry transmissions during CM reentry.
• Contingency Soil Sample	1	Flight No. 1 or No. 2	If the SRC's are not available for return to the LRL, the contingency sample will be treated as a high priority time-critical item. It will be placed in the Contingency Sample Return Container and shipped by aircraft to EAFB.

SECTION VII

LUNAR RECEIVING LABORATORY PLAN

7.1 GENERAL

This section was provided by the Lunar Receiving Laboratory (LRL)/TL. It defines requirements of the LRL as they relate to the lunar samples returned from Apollo Mission J-1. Requirements specified in this section pertain to the performance of sample operations, the identification of the types of samples to be processed, and the constraints to be observed during sample processing. Also included are descriptions of special experiments to be performed, documentation procedures to be followed, and Curator inventory control measures to be used in sample cataloging. Anticipated lunar samples for Apollo J-1 Mission are listed in Table 7-1.

Requirements presented in this section are provided for experiment Principal Investigators, 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 26) and an array of LRL procedural documents.

7.2 SCOPE

This document defines those requirements which the LRL must meet for the conduct of a successful preliminary sample examination. It addresses only those laboratory objectives pertaining to the physical characterization of the lunar sample, 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.

7.3 SAMPLE PRELIMINARY EXAMINATION

The purpose of the preliminary examination conducted by LSPET is to determine the nature of the lunar samples; their surface features, mass, density, mineralogy, petrography, and position on the lunar surface; their soil mechanics properties; the nature of fossils, if present; their noble gas abundances; the abundances of major, minor, and trace elements; and the abundances of gamma-emitting nuclides and organic molecules.

The examination shall provide data for the following:

a) Sample allocation decisions

b) A comprehensive catalog describing the returned samples, their surface location and orientation

c) A publishable paper summarizing the significant findings of the preliminary examination

7.4 SAMPLE PROCESSING

7.4.1 DEFINITIONS

Rocks - Fragments retained on a 1-cm sieve

Fines - Fragments passing a 1-cm sieve

Fine Fines - Material passing a 1-mm sieve

Coarse Fines - Fines retained on a 1-mm sieve

Source Item - A bag or container from which multiple samples are developed

Chips - Fragments produced by the intentional fracturing of a rock

7.4.2 PROCESSING STEPS

All returned samples will be numbered, weighed, described, and photographed. Portions of various samples will be used for further detailed analyses.

All returned material from each source (bag, container, etc.) with the exception of material contained in the Special Environmental Sample Container (SESC) and core samples will be sieved on a 1-centimeter sieve.

Fines samples will be further separated into fractions of

<1 mm
1 to 2 mm
2 to 4 mm
4 to 10 mm

Each such fraction will constitute a unique sample.

Initial packaging of all material <1 millimeter will be in magnetic monopole cans as long as they are available.

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 inside the can.

Collections of fines having volumes greater than about 250 cubic centimeters will be divided 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 completed. Chipping will be carried out in such a way that fragments will not be scattered and lose their geneology.

Residual fragments from chipping will be packaged in aliquots of approximately 100, 250 and 500 milligrams.

Models will be made of all rocks with a mass greater than 50 grams.

Each core tube will be considered a separate sample. X-rays will be obtained of each core prior to opening (if required, samples for biotest and organic analysis may be taken from the ends of a core without the tube being considered opened).

Each SESC will be separately numbered and canned. One SESC will be used for analysis of trapped gas and subsequently retained at high vacuum as a special fines sample.

Rocks should be handled with great care to minimize surface abrasion. Dust should be removed by blowing or vacuuming, not by brushing. If several fines fractions are to be split from the same source sample, the coarse fractions will be split before the fine fractions.

7.5 SAMPLE ANALYSES AND DESCRIPTIONS

7.5.1 INORGANIC GAS ANALYSIS

A rare gas survey will be performed on a typical sample of each rock type and on samples designated by the LSPET as "special." Sufficient analyses should be performed to measure the distribution of cosmic ray exposure ages.

7.5.2 TOTAL CARBON ANALYSIS

The total abundance of carbon in the lunar sample will be determined on the same representative types of samples that are tested for organic compounds.

7.5.3 PRIMORDIAL AND COSMIC RAY INDUCED NUCLIDE ANALYSIS

Determinations of the abundance of K, Th and U will be made for approximately 15 rocks and at least one sample of fines. Major cosmogenic nuclides will be determined and, as time permits, other cosmogenic nuclides will be identified.

7.5.4 ORIENTATION DETERMINATION

Tests may be performed on samples to confirm presumed surface orientation. This will be ascertained by the surface distribution of solar proton-induced radionuclides on up to five rocks.

7.5.5 CHEMICAL ANALYSIS

A determination of major, minor, and trace elements will be made with particular attention to typical samples of each major rock type and samples designated by the LSPET as "special."

7.5.6 MINERALOGICAL-PETROLOGICAL DESCRIPTION

A detailed description of the mineralogy and petrography features of each sample will be obtained. Emphasis will be placed on the use of thin sections and the consistency of description.

7.5.7 ORIENTATION DETERMINATION FROM SURFACE PHOTOGRAPHS

The orientation of rocks while on the lunar surface will be determined by the field geology members of the LSPET in as many cases as possible by examination of rocks using simulated light conditions of actual surface photographs. For confirmation, the LSPET may recommend the use of gamma spectroscopy (Paragraph 7.5.4).

7.6 OPERATING CONDITIONS

7.6.1 GENERAL

All possible efforts 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 such as by-products of sterilization will be removed where possible and characterized where removal is not possible.

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.

7.6.2 ORGANIC CONTAMINATION

The level of organic contamination will be determined by measuring the amount of organic material absorbed on clean Ottawa sand. The target level for such contamination should not exceed 0.1 parts per million during a 24-hour exposure. This type of monitoring will cease just prior to opening the sample return container (SRC).

Known sources of organic contamination such as sterilants will be analyzed.

7.6.3 PROCESSING ENVIRONMENT

The environment in which samples are handled shall be monitored for gas composition. In the case of samples handled under nitrogen the following gases are of interest:

O_2, H_2O, CO, CO_2, H_2, CH_4, and Ar

The target level of contamination by these gases during sample operations is as follows:

Gas	Inlet (ppm)	Outlet SNAP (ppm)	Outlet PCTL* (ppm)
O_2	10	50	200
H_2O	10	30	100
CO	10	10	50
CO_2	10	10	50
CH_4	1	1	10
H_2	10	10	50
Ar	200	200	200

The Sterile Nitrogen Atmosphere Processing (SNAP) line should not be operated until moisture levels are below 30 parts per million.

A permanent record will be obtained on the level of contaminants in each processing area.

7.6.4 PARTICULATE CONTAMINATION (SNAP LINE)

Prior to sterilization of the cabinet the following target levels of contamination for inactive cabinets as determined by a particle counter shall apply:

Particle Size	Count (counts/min/SCF**)
0.5μ to 5μ	2000
1.5μ to 3.0μ	500
>3μ	0

*PCTL - Physical/Chemical Test Laboratory
**SCF - Standard Cubic Foot

Prior to SRC entry the following target levels of contamination for inactive cabinets as determined by catch plate techniques shall apply:

Particle Size	Count (counts/hr/cm^2 over background)
5μ to 25μ	200
25μ to 50μ	20
50μ to 100μ	10
100μ to 175μ	5
>175μ	1

The most common sources of particulate contamination will be identified and cataloged.

Catch plates will be exposed up to the time of SRC opening to provide a permanent record of particulate contaminants.

7.6.5 EQUIPMENT AND MATERIAL CONSTRAINTS

Clean sieves and splitters will be used for each distinct original sample.

No chemicals, such as index of refraction oils, are to be introduced into any sample processing area.

7.7 DATA

7.7.1 GENERAL

A fully redundant record of sample identity and location will be maintained. Documentation will be sufficient to unequivocally identify samples.

7.7.2 INVENTORY AND NUMBERING

Rocks of a size such as to be retained on a 1-centimeter sieve will be assigned a unique sample number.

Each separated size fraction of fines from each source (bag, container, etc.) will be given a unique sample number.

Each interior container (SESC, core, etc.) will be given a unique sample number.

An inventory will be made of all samples and an inventory photograph taken as a permanent part of the Curator's record.

Source items, such as documented bags which yield several samples, will be described for inventory purposes and the unique samples derived from each bag will be listed in the description.

Following the preliminary examination, all samples (except those under vacuum) will be subject to a final physical inventory and transferred to the control of the Curator. Material stored under vacuum will be inventoried and under the control of the Curator. Other samples may remain in processing and examination areas in accordance with continuing sample processing requirements and Principal Investigator (PI) allocations.

7.7.3 PHOTOGRAPHY AND SKETCHES

Rock chipping will be documented to clearly show the orientation and location of the chip with respect to the main rock.

Complete photographic records will be obtained on each rock (mass >50 grams) before and after chipping. This will include stereo and color views.

Prior to sawing for distribution, high resolution, one-to-one full surface closeup photographs with 60 percent overlap will be taken.

An abbreviated photographic record will be obtained on smaller rock fragments (mass <50 grams but size >1 centimeter), and on all groups of coarse fines.

Photomicrography will be performed on all thin sections.

7.8 SPECIAL EXPERIMENTS

Sealed sample return containers and the SESC designated for gas analysis will be provided. The nature of the gas trapped in the SRC will be determined.

Determinations will be made of the abundances of H^3, Ar^{37}, and Ar^{39} in selected lunar samples.

A search will be conducted for magnetic monopoles on all available lunar material after preliminary examination operations are completed.

Table 7-1. Anticipated J-1 Mission Lunar Samples

SAMPLE	IMMEDIATE CONTAINER	RETURN CONTAINER
Contingency Sample	Contingency Sample Return Container	Contingency Sample Return Container
Selected Documented Geological Samples, Including Rocks and Fines	Prenumbered Teflon Documented Sample Bags (120 max.)/Sample Collection Bags No. 1, No. 5, and No. 7	SRC No. 1 - S/N 1013 SRC No. 2 - S/N 1012 Sample Collection Bag No. 7 in Sample Containment Bag (See Note 1)
Other Documented Geological Samples, Including Large Rocks and Sample Overflow from the SRC's	Sample Collection Bags No. 2, No. 3, No. 4 and No. 6	Sample Containment Bags
Deep Core Sample taken with ALSD	Core Stems (6)/Sample Collection Bag No. 1	SRC No. 1 - S/N 1013
Core Tube Samples (May be Single or Double Core Tube Samples) (See Note 2)	Sample Collection Bag No. 4 (3 Core Tubes from EVA No. 1)	Sample Containment Bag
	SRC No. 2 (3 Core Tubes from EVA No. 2)	SRC No. 2 - S/N 1012
	Sample Collection Bag No. 7 (3 Core Tubes from EVA No. 3)	Sample Containment Bag
Special Environmental Samples	Special Environmental Sample Containers:	
• One Exhaust/Contaminated Soil Sample (Taken from Crater created by DPS Erosion)	SESC No. 1012 (Taken on EVA No. 1) (See Note 3)	SRC No. 1 - S/N 1013
• Two Environmental Soil Samples (Taken from Bottom of Trenches)	SESC No. 1015 (Taken on EVA No. 2)	SRC No. 2 - S/N 1012
	SESC No. 1013 (Taken on EVA No. 3)	Sample Collection Bag No. 7

Table 7-1. Anticipated J-1 Mission Lunar Samples (Continued)

SAMPLE	IMMEDIATE CONTAINER	RETURN CONTAINER
Soil Mechanics Penetrometer Drum (Contains record of penetrometer test results)	Penetrometer Head	Geology Documented Sample Bag
Solar Wind Composition Foil and Reel	SWC Stowage Bag	SWC Stowage Bag
Organic Control Samples	SRC No. 1 - S/N 1013 SRC No. 2 - S/N 1012	SRC No. 1 - S/N 1013 SRC No. 2 - S/N 1012

NOTES:

(1) SRC No. 1, SRC No. 2, and Sample Collection Bag No. 7 to contain documented geological samples obtained on EVA No. 1, EVA No. 2, and EVA No. 3, respectively. Extra sample collection bags are also provided for each EVA to take care of sample overflow and large rock samples.

(2) The exact type of core tube sample obtained (single or double) is dependent upon the type of geological conditions encountered and exact activity performed on each EVA.

(3) Serial numbers of the SESC's identified may change because of changes that may result during SRC preflight packing activities.

SECTION VIII

SCIENCE CONTINGENCY DATA

8.1 GENERAL

This section was provided by the Science Requirements and Operations Branch/TD5. General information is contained in this section for use in real-time replanning and rescheduling of Apollo Mission J-1 experiments and science activities if a contingency or off-nominal condition exists during the mission.

Data contained in this section are provided for experiment Principal Investigators, members of the scientific community, and personnel responsible for science contingency planning. These data are intended for use in implementing the lunar orbital and surface science requirements presented in the MSC-controlled J-1 Mission Requirements Document (Reference 1) until such data are published in other MSC-controlled documents. These documents include the Apollo 15 Flight Plan (Reference 2), Apollo 15 Lunar Surface Procedures (Reference 3), Apollo 15 Photographic and TV Procedures (Reference 4), Apollo 15 Flight Mission Rules (Reference 17), and Scientific Experiments Contingency and Planning Procedures, Mission J-1/Apollo 15 (Reference 27). Reference 27 contains detailed contingency data and procedures for all lunar orbit and lunar surface experiments and science-related detailed objectives.

8.2 CONTINGENCY PLANNING DATA

Table 8-1 lists the lunar orbit experiments and science-related detailed objectives assigned to the mission, and indicates the following for each: effects of a scrubbed mission in terms of recycling requirements, and whether science data can be obtained on various alternate missions. These alternate missions are

a) Earth orbit (EO)
b) Lunar flyby (LF)
c) Lunar orbit/no surface extravehicular activity (LO/NSE)
d) No transearth coast EVA (NTE)

Table 8-2 lists alternate lunar surface science activities which can be conducted in the event of the following contingencies:

a) Crew unable to locate touchdown point in the landing ellipse

b) Not enough time for EVA

c) Time available for brief EVA (1 or 2 men)

d) Time available for EVA 1 only (2 men)

e) Time available for one-man EVA 1 only (No EVA 2 or EVA 3)

f) One-man EVA 1 (EVA 2 planned, no EVA 3)

g) One-man EVA 2 or EVA 3

Detailed contingency data and procedures for science equipment and activities are provided in the Scientific Experiments Contingency Planning and Procedures, Mission J-1/Apollo 15 (Reference 27).

NOTE: Experiments should be activated during any alternate mission to verify hardware operation and to evaluate procedures.

Table 8-1. Lunar Orbit Experiments/Objectives - Science Data Return Matrix for Alternate Missions

EXPERIMENT	SL	ALTERNATE MISSION EO	LF	LO/NSE	NTE
SM Orbital Photographic Tasks:					
• 24-Inch Panoramic Camera	G^3	G^1	N	G	N
• 3-Inch Mapping Camera	G^3	G^1	N	G	N
• Laser Altimeter*	G^3	N	N	G	G
CM Photographic Tasks	G	G^1	G^4	G	G
UV Photography - Earth and Moon	G	G^4	G^4	G	G
Gegenschein from Lunar Orbit	G	N	N	G	G
Gamma-Ray Spectrometer	G^5	N	G^4	G	G
Alpha Particle Spectrometer*	G^5	N	G^4	G	G
X-Ray Fluorescence	G^5	G^1	G^4	G	G
Mass Spectrometer	G^5	N	G^4	G	G
S-Band Transponder (CSM/LM)	G	N	N	G	G
Subsatellite:					
• Magnetometer*	N^2	N	G^4	G	G
• Particle Shadows/Boundary Layer	N^2	G^1	G^4	G	G
• S-Band Transponder	N^2	N	N	G	G
Bistatic Radar	N/A	N/A	N/A	G	G

*No useful science data in earth orbit

LEGEND:

SL - Scrubbed launch: can be recycled without experiment effect
EO - Earth Orbit
LF - Lunar Flyby
LO/NSE - Lunar Orbit/No Surface EVA
NTE - No TEC EVA Period
A - Alternate
G - Go
N - No/Go
N/A - Not Applicable

Superscripts:

1 - Objectives may be changed if operated during alternate mission
2 - Batteries may have to be charged
3 - Film may require reloading
4 - Possibly partial or degraded data
5 - Dependent on time period (calibration sources may require renewal)

Table 8-2. Surface Experiments/Objectives - EVA Decisions

EVENT NO.	CONTINGENCY	RESPONSIBLE AGENT	ACTION	REMARKS
1	Crew unable to locate touchdown point in the landing ellipse.	Crew	Make visual observations and describe features around the LM.	
		MCC	1. Compare television images and the astronaut's description of features to the overall features in the map package.	
		MCC Crew	2. Revise ALSEP deployment and traverse plans as required.	
2	Not enough time for EVA.	Crew	Make careful observations and descriptions of surface through LM windows. Numerous still camera photos should be taken with both black and white and color films from both windows. Photos with polarizing filter in three different positions should be made.	
		MCC	Study landing area on maps and submit pertinent questions relating to surface smoothness or roughness, the contours of surface, size of rocks, and craters in area.	

Table 8-2. Surface Experiments/Objectives - EVA Decisions (Continued)

EVENT NO.	CONTINGENCY	RESPONSIBLE AGENT	ACTION	REMARKS
3	Time for brief EVA. (1 or 2 men)	Crew	1. Repeat activity in preceding Event No. 2.	
		Crew	2. Collect contingency sample.	
		Crew	3. If possible, take a panorama of area and photographs of surface nearby. Take photographs of surface under LM descent engine and around footpads.	
4	Time for EVA 1 only. (2 men)	Crew	1. Collect contingency sample.	
		Crew	2. Collect documented samples at the Apennine Front.	Photograph and describe geological features as well as collect samples; cut down number of stations and distance attempted.
		Crew	3. Deploy ALSEP as normal but in direction toward the nearest available and recognizable Hadley Rille material.	

Table 8-2. Surface Experiments/Objectives - EVA Decisions (Continued)

EVENT NO.	CONTINGENCY	RESPONSIBLE AGENT	ACTION	REMARKS
		Crew	4. Deploy LRRR.	
		Crew	5. Collect documented samples while returning from the ALSEP site.	
5	Time for one-man EVA 1 only. (No EVA 2 or EVA 3)	Crew	1. Collect contingency sample.	
		Crew	2. Deploy ALSEP as normal but in direction toward the nearest available and recognizable Hadley Rille material.	
		Crew	3. Deploy LRRR.	
		Crew	4. Collect documented samples during return traverse from ALSEP site.	Cut down the number of stations and distance attempted.
6	One-man EVA 1. (EVA 2 planned, no EVA 3)	Crew	Same action as for Event No. 5.	
7	One-man EVA 2 or EVA 3.	Crew	1. If LRV is available. a) Perform geology sample collection and documentation. b) Take panorama shots of traverse area.	

Table 8-2. Surface Experiments/Objectives - EVA Decisions (Continued)

EVENT NO.	CONTINGENCY	RESPONSIBLE AGENT	ACTION	REMARKS
		Crew	2. If LRV is not available. a) Perform geology sample collection and documentation. b) Take panorama shots of traverse area.	Crew must carry ALHTC.

APPENDIX A

ACRONYMS AND ABBREVIATIONS

Å	Angstrom Unit (1×10^{-10} m)
AEC	Automatic Exposure Control
AFMA	Apollo Flight Mission Assignments
Al	Aluminum
ALSD	Apollo Lunar Surface Drill
ALSEP	Apollo Lunar Surface Experiments Package
ALHT	Apollo Lunar Hand Tools
ALHTC	Apollo Lunar Hand Tool Carrier
ALSRC	Apollo Lunar Sample Return Container
AMU	Atomic Mass Unit
APO	Apollo Program Office
Ar	Argon
Ar^{36}	Isotope of Argon
Ar^{37}	Isotope of Argon
Ar^{39}	Isotope of Argon
Ar^{40}	Isotope of Argon
ASA	American Standards Association
AS&E	American Science and Engineering, Incorporated
ASPO	Apollo Spacecraft Program Office
ASSY	Assembly
BSLSS	Buddy Secondary Life Support System
BW	Black and White
C	Centigrade

ACRYNOMS AND ABBREVIATIONS (Continued)

Ca	Calcium
CCBD	Configuration Control Board Directive
CCIG	Cold Cathode Ion Gauge
CDR	Commander
CEX	Color Exterior
CH_4	Methane
℄	Center Line
CM	Command Module
cm	Centimeter
CO	Carbon Monoxide
CO_2	Carbon Dioxide
C/S	ALSEP Central Station
CSM	Command and Service Module
DAC	Data Acquisition Camera
Decl.	Declination (measured in celestial coordinates)
DIA.	Diameter
DO	Detailed Objective
DOI	Descent Orbit Insertion
DPS	Descent Propulsion System
DSE	Data Storage Equipment
DSEA	Data Storage Electronics Assembly
DSIF	Deep Space Instrumentation Facility
E	East
EAFB	Ellington Air Force Base

EPO	Earth Parking Orbit
EVA	Extravehicular Activity
Ex	Example
f	Camera Aperture Opening Reference
FCSD	Flight Crew Support Division
Fe	Iron
FMC	Forward Motion Compensation
FOV	Field-of-View
ft	Feet
FWD	Forward
GCTA	Ground-Commanded Television Assembly
GET	Ground Elapsed Time
gm	Gram
GN_2	Gaseous Nitrogen
H_2	Hydrogen
H_2O	Water
H^3	Triatomic Hydrogen
HBW	High-Speed Black and White
HCEX	High-Speed Color Exterior
HD	Highly Desirable
He	Helium
HEC	Hasselblad Electric Camera
HEDC	Hasselblad Electric Data Camera

ACRONYMS AND ABBREVIATIONS (Continued)

HFE	Heat Flow Experiment
HFE	Heat Flow Electronics
hr	Hour
ID	Identification
IMC	Image Motion Compensation
in	Inch
IU	Instrument Unit
JPL	Jet Propulsion Laboratory
K	Kelvin
K	Potassium
K^{40}	Isotope of Potassium
keV	One Thousand Electron Volts
kg	Kilogram
kHz	Kilohertz
km	Kilometer
LBW	Low-Speed Black and White
LCRU	Lunar Communications Relay Unit
LDAC	Lunar Surface 16-mm Data Acquisition Camera
LDDE	Lunar Dust Detector Experiment
LFLC	Long Focal Length Camera
LM	Lunar Module
LMP	Lunar Module Pilot
LO	Lunar Orbit

LOI	Lunar Orbit Injection
LP	Long-Period
LPX	Long-Period Seismic Sensor (horizontal X-direction)
LPY	Long-Period Seismic Sensor (horizontal Y-direction)
LPZ	Long-Period Seismic Sensor (vertical Z-direction)
LRL	Lunar Receiving Laboratory
LRRR	Laser Ranging Retro-Reflector
LR^3	Laser Ranging Retro-Reflector
LRV	Lunar Roving Vehicle
LSAPT	Lunar Samples Analysis and Planning Team
LSM	Lunar Surface Magnetometer
LSPET	Lunar Sample Preliminary Examination Team
m	Meter, Milli
M	Mandatory
MAX	Maximum
MC	Mapping Camera
MCC	Mission Control Center
MESA	Modularized Equipment Stowage Assembly
meV	One Million Electron Volts
Mg	Magnesium
min	Minute
MIP	Mission Implementation Plan
mm	Millimeter
MRD	Mission Requirements Document
MRO	Memory Read-Out

MSC	Manned Spacecraft Center
MSFC	Marshall Space Flight Center
MSFEB	Manned Space Flight Experiments Board
MSPD	Mission Science Planning Document
N	North
n	Newton
Na	Sodium
N/A	Not Applicable
NaI	Sodium Iodide
NASA	National Aeronautics and Space Administration
Ne	Neon
NM	Nautical Mile
No.	Number
O_2	Oxygen
OMSF	Office of Manned Space Flight
OSSA	Office of Space Sciences and Application
PC	Panoramic Camera
PCTL	Physical/Chemical Test Laboratory
PDU	Power Distribution Unit
PI	Principal Investigator
PKG	Package
PLSS	Portable Life Support System
ppm	Parts Per Million
PSE	Passive Seismic Experiment

PTD	Photographic Technology Division
R. Asc.	Right Ascension (measured in celestial coordinates)
RCA	Radio Corporation of America
RCS	Reaction Control System
REV	Revolution
RH	Right Hand
Rn	Radon
RTCC	Real Time Computing Complex
RTG	Radioisotope Thermoelectric Generator
S	South
S	Sulphur
SA	Saturn Apollo
S&AD	Science and Applications Directorate
SC	Stellar Camera
S/C	Spacecraft
SCF	Standard Cubic Foot
sec	Second
SESC	Special Environmental Sample Container
SEQ	Scientific Equipment Bay
SEVA	Standup Extravehicular Activity
Si	Silicon
SIDE	Suprathermal Ion Detector Experiment
SIM	Scientific Instrument Module
SM	Service Module

ACRONYMS AND ABBREVIATIONS (Continued)

SNAP	System for Nuclear Auxiliary Power
SNAP	Sterile Nitrogen Atmosphere Processing
SO	Special Order
SP	Short-Period
SPS	Service Propulsion System
SPZ	Short-Period Seismic Sensor (vertical Z-direction)
SRC	Sample Return Container (also known as ALSRC)
SWC	Solar Wind Composition
SWS	Solar Wind Spectrometer
TBD	To Be Determined
TEC	Transearth Coast
TEI	Transearth Injection
Th	Thorium
Tl	Thallium
TLI	Translunar Injection
TRW	Thompson Ramo Wooldridge, Incorporated
torr	Unit of Pressure (1/760 of a standard atmosphere or 0.757×10^{-2} n/m^2)
TV	Television
U	Uranium
UHT	Universal Handling Tool
UTD	University of Texas at Dallas
UV	Ultraviolet
V/h	Velocity-to-height

VHBW	Very High-Speed Black and White
VHF	Very High Frequency
W	West
Z	Atomic Number
h	Hour (Superscript)
m	Minute (Superscript)
°	Degrees
35	35-mm Camera
∞	"Infinite" focus distance
γ	Gamma
μ	Micron

APPENDIX B

GLOSSARY

ALBEDO	The amount of electromagnetic radiation reflected by a body expressed as a percentage of the radiation incident on the body.
ALIGUOTS	Small amounts of equal parts.
ALPHA PARTICLE	A nuclear particle of atomic mass 4 made up of 2 protons and 2 neutrons.
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.
BASALTIC	A type of dark gray rock formed by solidification of molten material.
BISTATIC	The characteristic of a reflector which reflects energy along a line or lines different from, or in addition to, that of the incident ray. The reflectors in this case are the lunar surface and subsurface, and the sources of radiation energy are from the CSM S-band and VHF transmitters.
BOUNDARY LAYER	Interaction layer between the surface of the moon and the undisturbed portion of the solar wind. Also the interaction layer between the solar wind bow shock and the magnetopause.
BOW SHOCK	The shock wave produced by the interaction of the solar wind with the earth's magnetosphere.
CARTOGRAPHIC	Related to the production of accurately scaled maps as of the moon's surface.
CASSETTE	Container of photographic film for the 24-Inch Panoramic Camera or 3-Inch Mapping Camera.

CISLUNAR	Pertaining to the space between the earth and moon or the moon's orbit.
COLLIMATOR	A device for producing beams of parallel rays of light or other electromagnetic radiation.
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 separate photographic exposure stations to a single photographic subject, whereby the merging of the separate photographs results in stereoscopic imagery of the subject.
COSMIC RAYS	Streams of very high energy nuclear particles, commonly protons, that bombard the earth from all directions.
COSMOLOGICAL	Related to the investigation of the character and origin of the universe.
CROSS-SUN	A direction approximately 90 degrees to the solar vector and related to lunar surface photography.
CROSS-TRACK	In a plane perpendicular to the instantaneous direction of a spacecraft's ground track.
DIELECTRIC	A material with few conduction electrons, i.e., an electrical insulator.
DIFFUSE DENSITY	The degree of darkening of a photographic film approximately proportional to the mass of metallic silver per unit area.
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 direction of the solar vector and related to lunar surface photography.
EARTHSHINE	Illumination of the moon's surface by sunlight reflected from the earth.
ECLIPTIC PLANE	The plane defined by the earth's orbit about the sun.
EFFLUENT	Any liquid substance discharged from a spacecraft such as waste water, urine, fuel cell purge products, etc.
EJECTA	Lunar material thrown out (as resulting from meteoroid impact or volcanic action).

ELECTRON	The extranuclear constituent of all atoms carrying a negative charge and a mass of 1/1836 that of a proton.
EXOSPHERE	The outermost portion of the earth's or moon's atmosphere from which gases can escape into outer space.
EXPOSURE	The product of illumination (luminous flux per unit area) and the time interval during which a photographic film is subjected to the illumination.
FIELD	A spatial region in which each point has a definite value of a scalar or vector quantity such as a magnetic field.
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; the volume of the fillet may be directly proportional to the time the rock has been in position and to the rock size.
FLUORESCENCE	Emission of radiant energy in response to the absorption of radiant energy at a different wavelength.
FLUX	The time rate of flow (per unit area, as well, for some applications) of some quantity such as the flux of cosmic rays or the flux of plasma particles in the solar wind.
FRONT	The more or less linear outer slope of a mountain range that rises above a plane or plateau.
GALACTIC	Pertaining to a galaxy in the universe such as the Milky Way.
GAMMA	A measure of magnetic field strength equal to 1×10^{-5} gauss.
GAMMA	The average slope of the diffuse density versus the relative $\log_{10}$ exposure curve (see Appendix E) and is used in specifying photographic film processing requirements.

GAMMA-RAY	A quantum of electromagnetic radiation emitted by an atomic nucleus as a result of a quantum transition between two energy levels of the nucleus.
GARDENING	Reference to the overturning, reworking, and changing of the lunar surface due to such overall processes as meteoroid impact, possible volcanic action, aging, and the like.
GEGENSCHEIN	A faint light covering a 20-degree field-of-view projected on the celestial sphere about the sun-earth vector (as viewed from the dark side of the earth).
GEOCHEMICAL GROUP	A group of three experiments especially designed to study the chemical differentiation and constituents of the lunar surface remotely from lunar orbit, viz, S-160, S-161, and S-162.
GEODESY	The science which deals mathematically with the size and shape of the earth, and the earth's external gravity field, and with surveys of such precision that overall size and shape of the earth must be taken into consideration.
GEOPHYSICAL	Pertaining to the physics of the earth, or moon and the surrounding environment.
GNOMON	A rod pivoted about a free bearing that is used for lunar surface photography to indicate the local vertical, to give sun position, and to serve as a distance scale. Color and reflectance scales are provided on the rod and an indicator mounted on one leg of the gnomon for colorimetric references.
GRADIENT	The space rate of change of a function. For example, the change in local lunar surface magnetic field strength with distance (as from the LM).
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.
ION	An atom or group of atoms that carries a positive or negative electric charge as a result of having lost or gained one or more electrons.

IONOSPHERE	The part of the earth's atmosphere beginning at an altitude of about 25 miles and extending outward 250 miles or more, containing free electrically charged particles, and consisting of several regions within which occur one or more layers that vary in height and ionization with time of day, season, and the solar cycle.
J-1 MISSION	The first of a class of Apollo missions in the Apollo Lunar Exploration 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	Apparent motion of the geometric center of the moon due primarily to the ellipticity of the lunar orbit coupled with the fact that its rotation and orbital frequencies are equal.
LIBRATION POINT	One of five theoretical locations in space of the rotating earth-moon system where the gravitational attraction forces of the earth and moon are equal. It is believed that interplanetary dust and other forms of particulate matter collect at these points and that sunlight will be reflected from these particles which can be used to locate their presence either by direct observation or from photographic exposures.
LIMB	The outer edge of the apparent disk 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 phases.
MAGMATIC	Pertaining to molten material or mass from which igneous rock results by cooling and crystallization.
MAGNETOPAUSE	The boundary between the solar wind bow shock/magnetosphere interaction boundary layer and the magnetosphere.
MAGNETOSHEATH	The region between the bow shock and the magnetotail region of the earth's magnetosphere, also called the boundary layer of the magnetosphere.

MAGNETOSPHERE	The region of the earth's atmosphere where ionized gases contribute to the determination of the dynamics of the atmosphere and where the forces of the earth's magnetic field are predominant.
MAGNETOTAIL	The tube-like elongated region of the earth's magnetosphere of undetermined length in the anti-solar direction.
MANTLE	An intermediate layer of the moon between the lithosphere (outer layer) and the central core.
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. They are believed to contain large bodies or masses that have impacted the lunar surface from outer space.
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 events by means of photography, together with an appropriate network of coordinates, to form the basis of accurate measurements and reference points for precise photo mapping.
MICROSCOPIC	Of such a size as to be observed, if at all, only under optical magnification.
MINERALOGY	The science of minerals that deals with the study of their crystallography and their general physical and chemical properties.
MONOENERGETIC SOURCE	A source of electromagnetic radiation, confined to a very narrow frequency range used, for example, as a calibration source for spectrometers.
MONOPOLE	The flux element of a magnetic field whose lines of force are not closed and flow in only one direction. The existence of monopoles in the universe has not yet been established and is a subject of study in theoretical physics.

MORPHOLOGY	The external structure of rocks in relation to the development of erosional forms or topographic features.
MOULTON POINT	A theoretical point along the sun-earth line located 940,000 statute miles behind the earth at which the sum of all gravitational forces is zero (in a rotating coordinate system).
NADIR	That point on the earth (or moon) vertically below the observer.
NEUTRON	An uncharged elementary particle that has a mass nearly equal to that of a proton and is present in all known nuclei except the hydrogen nucleus.
NUCLEON	A constituent particle of an atomic nucleus. For example, a proton or a neutron which falls in terms of mass between a meson and a hyperon.
NUCLIDES	Particular nuclear species characterized by specific values of atomic number and atomic mass.
OCCULATION	The disappearance of a body behind another body of larger apparent size. For example, the occulation of the sun by the moon as viewed by an earth observer to create a solar eclipse.
P-10	A gas mixture consisting of 90 percent argon, 9.5 percent carbon dioxide, and 0.5 percent helium used to fill the X-ray experiment detectors.
PANORAMA	Lunar surface photographs taken from a point to cover 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, on returned specimens, and on thin microscopic sections.
PLASMA	An electrically conductive gas comprised of neutral particles, ionized particles and free electrons but which, when taken as a whole, is electrically neutral.

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.

PRIMORDIAL — Pertaining to the earliest or original lunar rocks that were created during the time period between the initial and final formation stages of the moon.

PROTON — The positively charged constituent of atomic nuclei. For example, the entire nucleus of a hydrogen atom having a mass of 1.67252×10^{-27} kilograms.

RADON — A radioactive gaseous element with atomic number 86 and atomic mass of 220 and 222 formed by the radioactive decay of radium.

REGOLITH — The unconsolidated residual material that resides on the solid surface of the moon (or earth).

RESEAU — A system of lines forming small squares of standard size that is photographed by a separate exposure on the same film with data images, to facilitate measurement of distances.

RETROGRADE — Lunar orbital motion opposite the direction of lunar rotation.

RILLE/RILL — A long, narrow valley on the moon's surface.

S-BAND — A frequency band used in radar and communications extending from 1.55 to 5.2 kilomegahertz.

SCARP — A line of cliffs produced by faulting or erosion.

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 one aerial photographic strip with another 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.
SOLAR WIND	Streams of plasma emanating from and flowing approximately radially outward from the sun.
SPALLATION	A nuclear reaction in which light particles are ejected as the result of bombardment (as by high energy protons).
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.
SPUR	A ridge of lesser elevation that extends laterally from a mountain or mountain range.
STELLAR	Of or pertaining to stars. The stellar camera composing a part of the 3-Inch Mapping Camera is used to photograph star fields.
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.
SUPRATHERMAL	Having energies greater than thermal energy.
SUBSATELLITE	A small unmanned satellite, deployed from the spacecraft while it is in orbit, designed to obtain various types of solar wind particle, lunar magnetic field, and S-band tracking data over an extended period of time.

TALKBACK DISPLAY	A CM crew cue display associated typically with an event or operation activity which exhibits a striped ("barber pole") color scheme format during the execution of the event or activity and a grey color when the event or activity has been satisfactorily completed.
TALUS	A slope formed by an accumulation of rock debris at the base of a cliff.
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.
THORIUM	A heavy metallic element with an atomic number of 90 and an atomic mass of 232.
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 earth's gravitational attraction. Similar in nature to the tidal movements of the earth's ocean.
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.
TOPOLOGY OF THE MAGNETOTAIL	Pertaining to the study of the composition, structure, and time-tracing of solar wind particles appearing in the magnetotail.
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 and related to lunar surface photography.
URANIUM	A heavy metallic element of atomic number 92 and principal atomic weight of 238.
VECTOR	A physical quantity requiring both magnitude and direction for its specification, as magnetic force field and gravitational acceleration vectors.
WAVELENGTH	The distance between maxima (or minima) of a periodic phenomenon such as an electromagnetic wave.
X-RAY	An electromagnetic radiation of non-nuclear origin within the wavelength interval of 0.1 to 100 angstroms (between gamma-ray and ultra-violet radiation).
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).

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APPENDIX E

FILM CHARACTERISTICS AND PROCESSING TEST DATA

CONTENTS

NOTES:

*Film types not used on Apollo Mission J-1, but flown on previous Apollo missions.

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

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

KODAK PAN FILM TYPE 2484
(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 which is very useful for photo-recording under weak illumination or when extremely short exposure times are encountered.

USE

Photographic applications of this film include CRT photography, high-speed photography, missile tracking and re-entry phenomena and spark-chamber photography.

BASE

This film has a 4.0-mil ESTAR-AH polyester base with fast-drying PX backing. The 0.10 density of this base reduced 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; D-19 chemicals for 4 minutes development at 68°F

Characteristic	Value	Classification
Resolving Power		
Test-object contrast 1000:1	70 lines/mm	Medium
Test-object contrast 1.6:1	22 lines/mm	--
RMS Granularity (at net density of 1.0)	37	Moderately 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.

MECHANIZED PROCESSING

This film can be processed in the Kodak Versamat Film Processor, Model 11, 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	No. of Racks	Path Length (feet)	Temperature
Develop	1	4	85°F ± ½°F
Stop	1	4	85°F
Fix*	2	8	85°F, nominal
Wash	2	8	80°F
Dry			130°F**

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

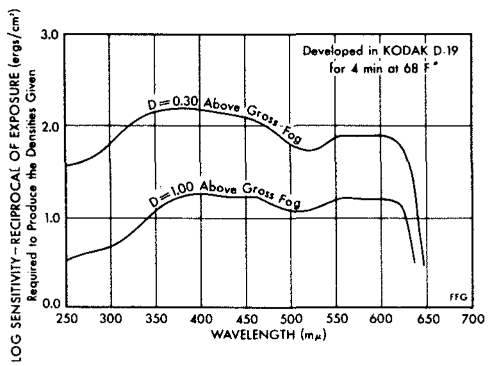
** The temperature of the dryer may require adjustment, depending upon the ambient temperature conditions in the processing area. Set temperature approximately five degrees above temperature required to dry clear film.

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

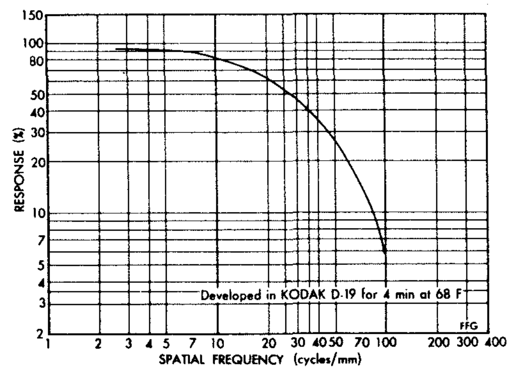
Machine Speed (feet per minute)	No. of Developer Racks	Average Gamma	Average Exposure Index
3	1	.89	2760

KODAK PAN FILM TYPE 2484
(ESTAR-AH Base)

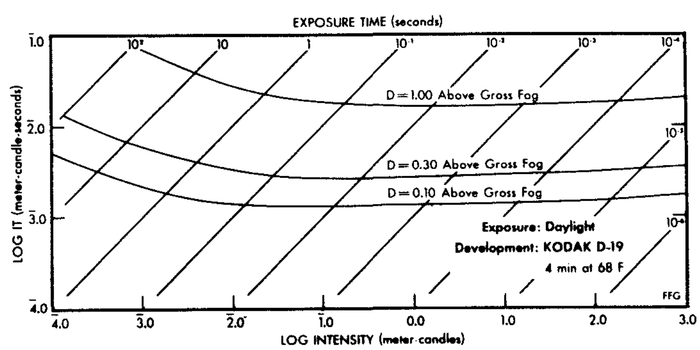
Spectral Sensitivity Curve



Modulation Transfer Function Curve

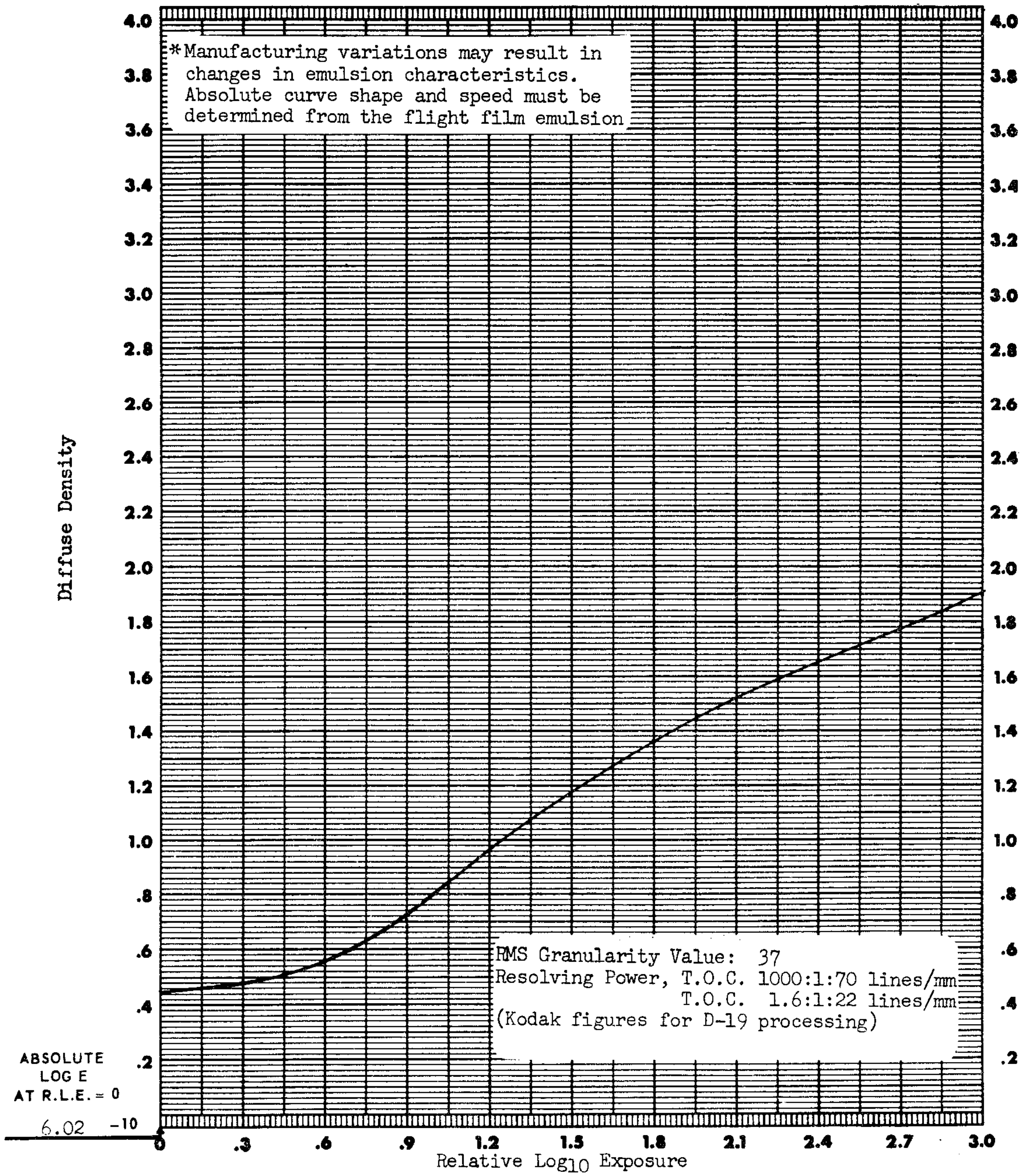


Reciprocity Curve



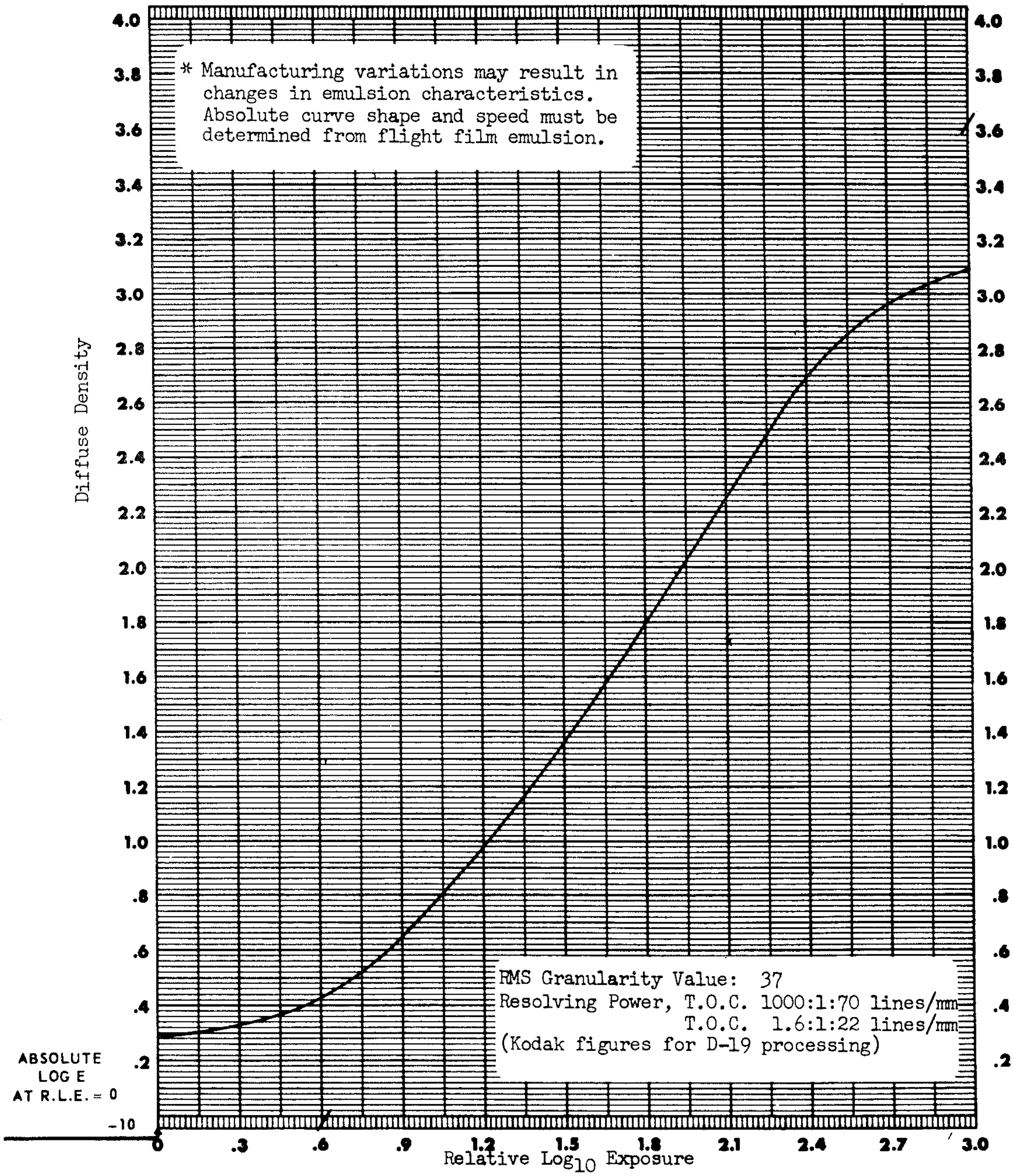
FILM 2484 EMULSION # 59-4 * MFG Kodak DATE: 8/1/70

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
Sensitometer I-B	PROCESSOR VMt 11-CM	INSTRUMENT TD-217 DR	
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE Macbeth	
1/100 SEC.	SPEED: 1 TANKS 3 FPM	APERTURE SIZE 2 MM	GAMMA 0.82*
Filter 5500K + 1.0ND	Temp. 90°F TIME ------	FILTER Status A, Vis	BASE + FOG 0.45*



FILM 2484 EMULSION # 092-07* MFG Kodak DATE: 8/1/70

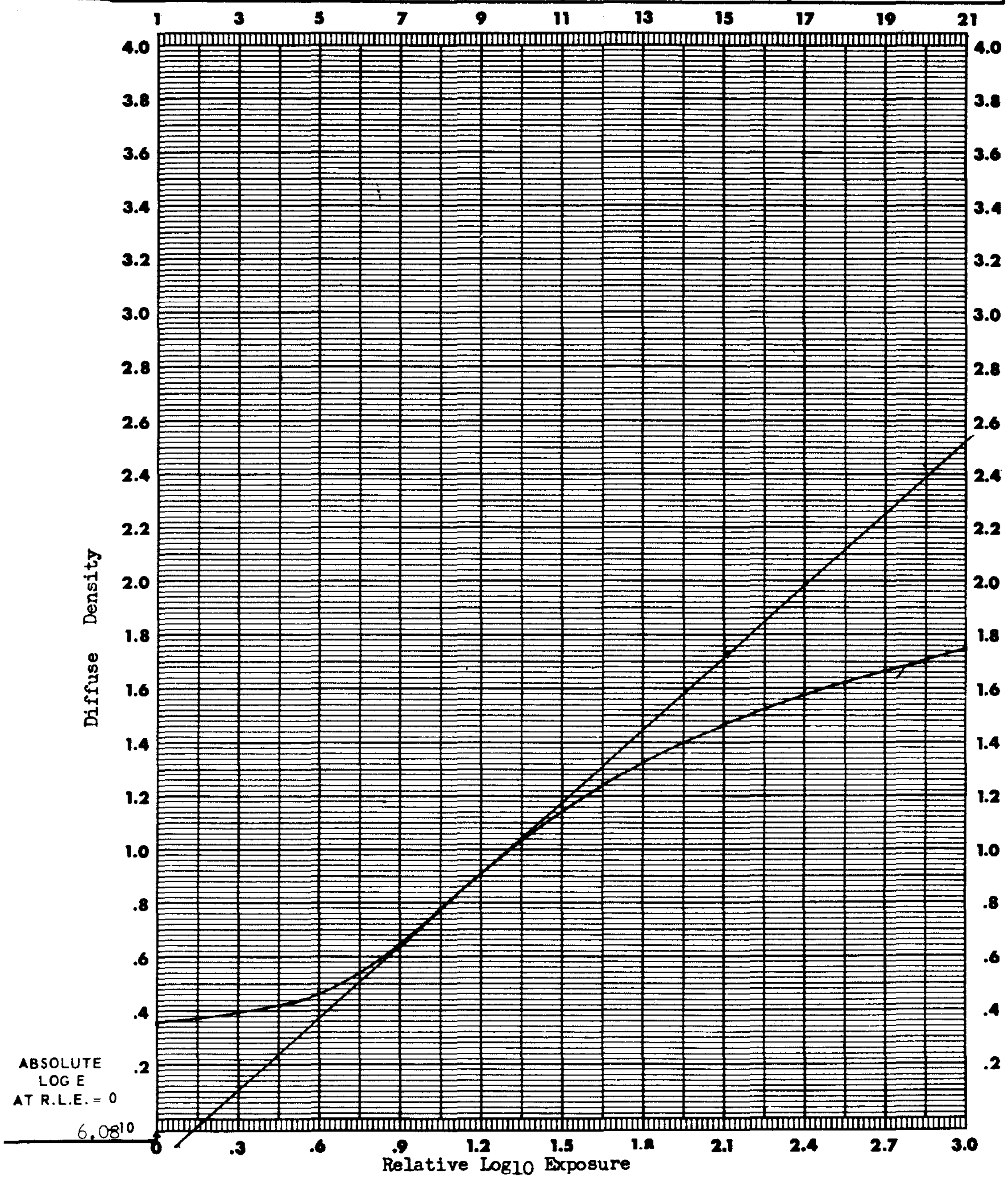
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
Sensitometer I-B	PROCESSOR Houston M-P	INSTRUMENT TD217-DR	
ILLUMINANT 2850 °K	CHEMISTRY D-19	TYPE Macbeth	D-MAX 3.10*
1/100 SEC.	SPEED N/A TANKS N/A FPM	APERTURE SIZE 2 MM	GAMMA 1.42*
Filter 5500K + 1.0 ND	Temp. 75°F TIME 5½ min	FILTER Status A vis.	BASE + FOG 0.29*



DATE 14 July 70

FILM 2484 EMULSION # ______ MFG E.K. Co.

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
I-B	PROCESSOR Versamat #1	INSTRUMENT TD-403	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD	D-MAX
1/100 SEC.	SPEED 1 TANKS 3 FPM	APERTURE SIZE 4 MM	GAMMA .89
5500 K +1.00	85°F TIME	FILTER 106	BASE + FOG



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.

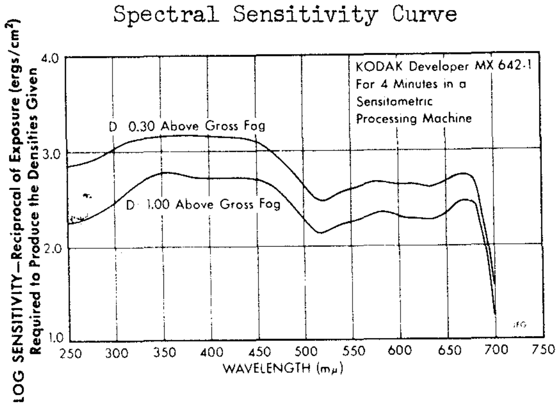
** The temperature of the dryer may require adjustment, depending upon the ambient temperature conditions in the processing area. Set temperature approximately 5 degrees above temperature required to dry clear film.

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

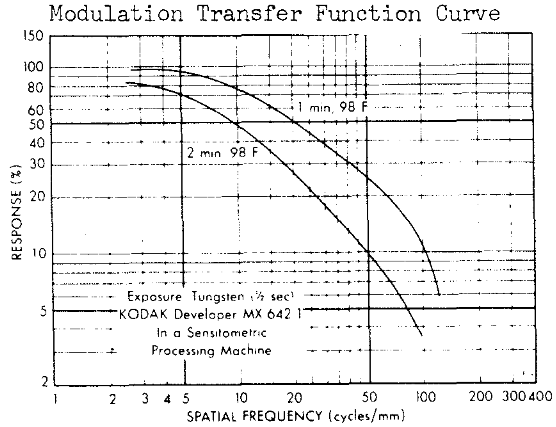
Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Exposure Index
3	2	1.45	2350 (ASA)
4.5	2	1.05	—
6	2	0.66	—

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

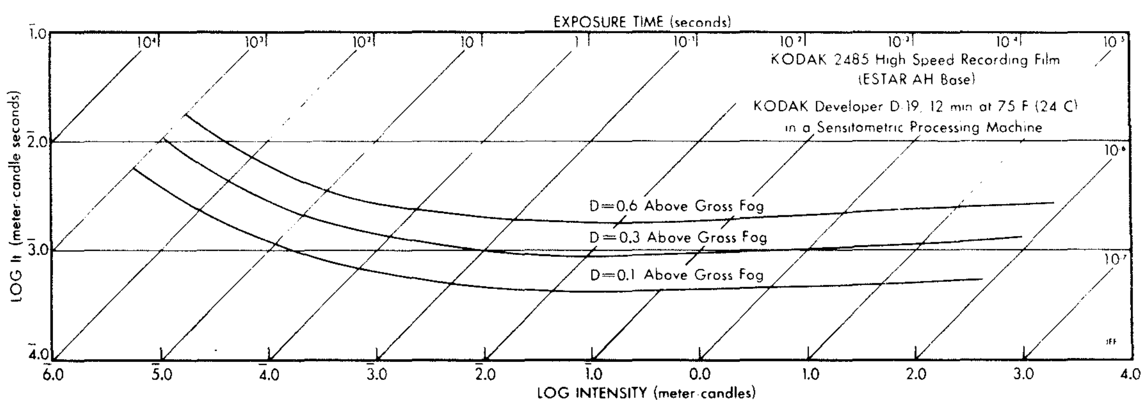
Spectral Sensitivity Curve



Modulation Transfer Function Curve



Reciprocity Curve



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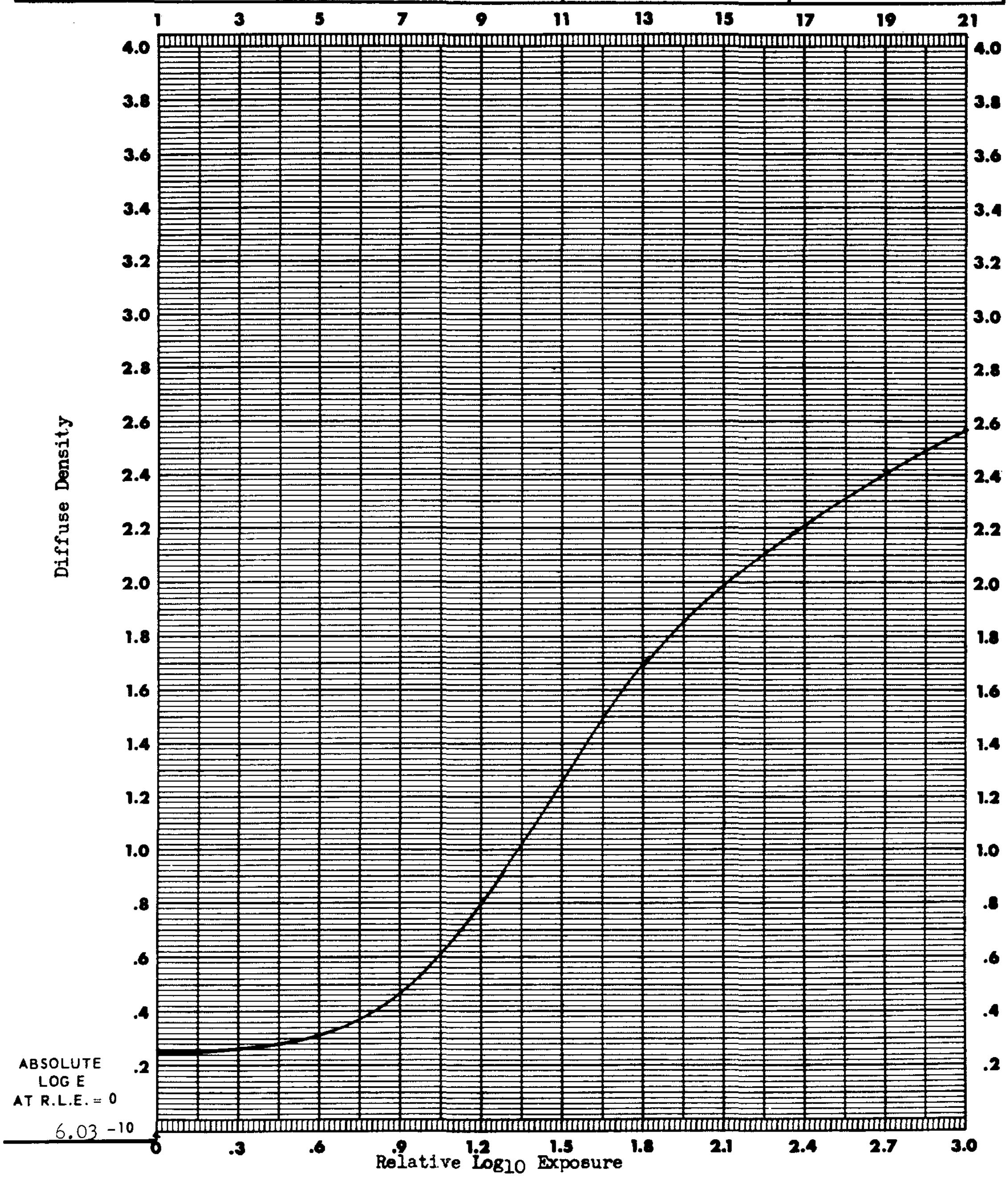
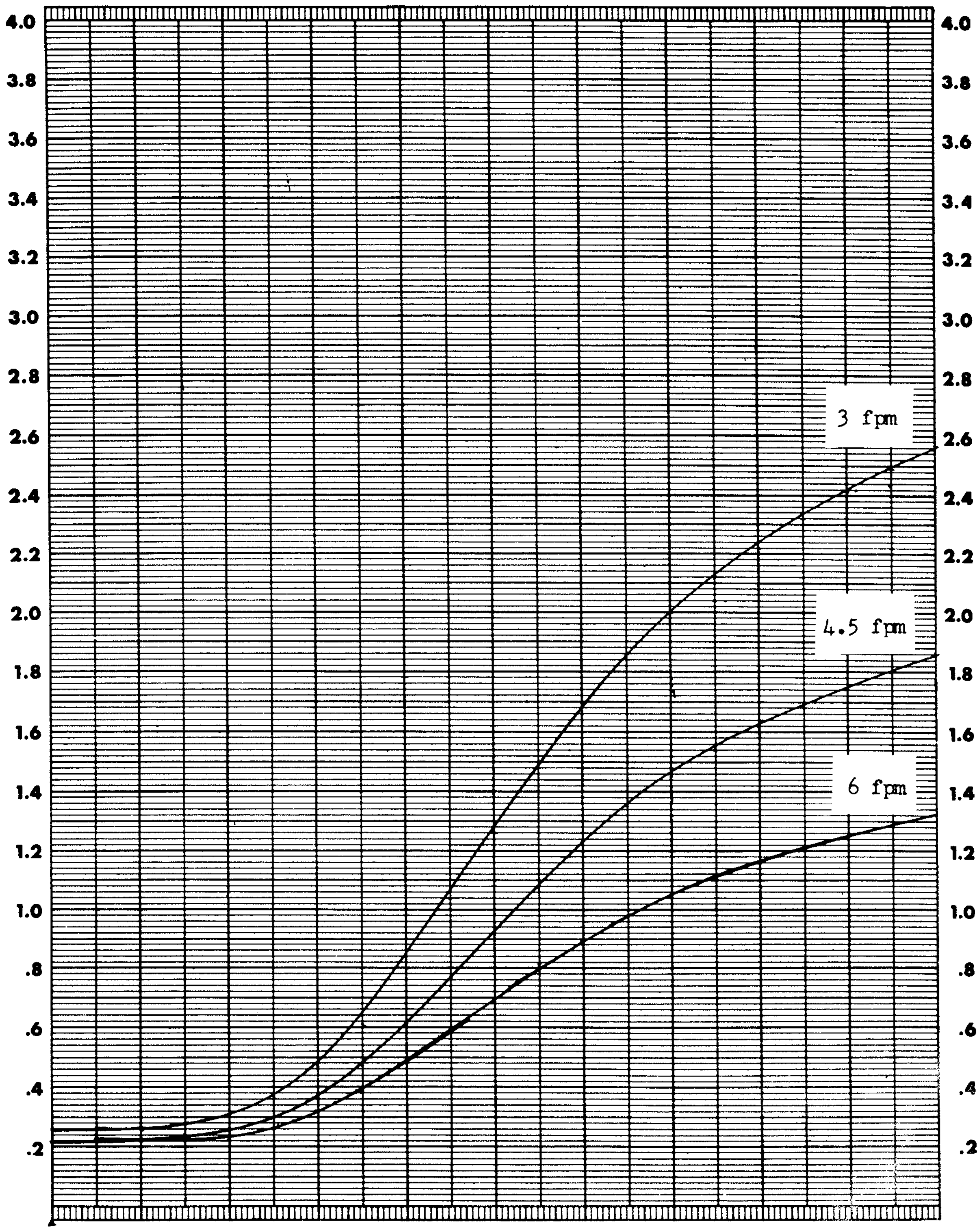
FILM 2485 EMULSION # 26-1 MFG E.K. Co.

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
I-B	PROCESSOR Versamat 11C-M	INSTRUMENT Macbeth	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE TD-217 DR	D-MAX
1/100 SEC.	SPEED 2 TANKS 3 FPM	APERTURE SIZE 2 MM	GAMMA 1.45
C-5900 + 1.0 ND	85°F TIME	FILTER V-106	BASE + FOG 0.26

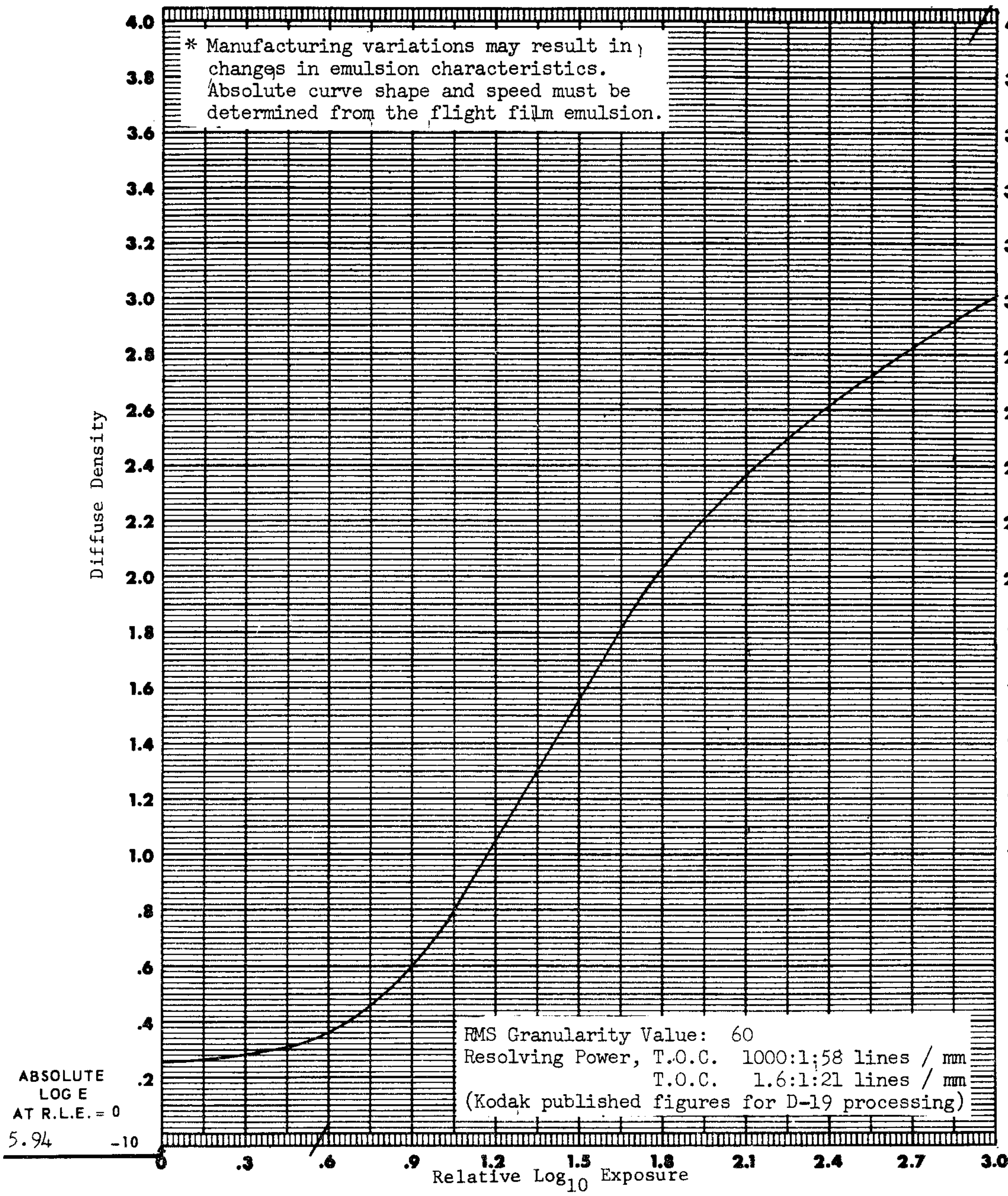




Effect of Processor Speed, MX-641 Developer @ 85°F

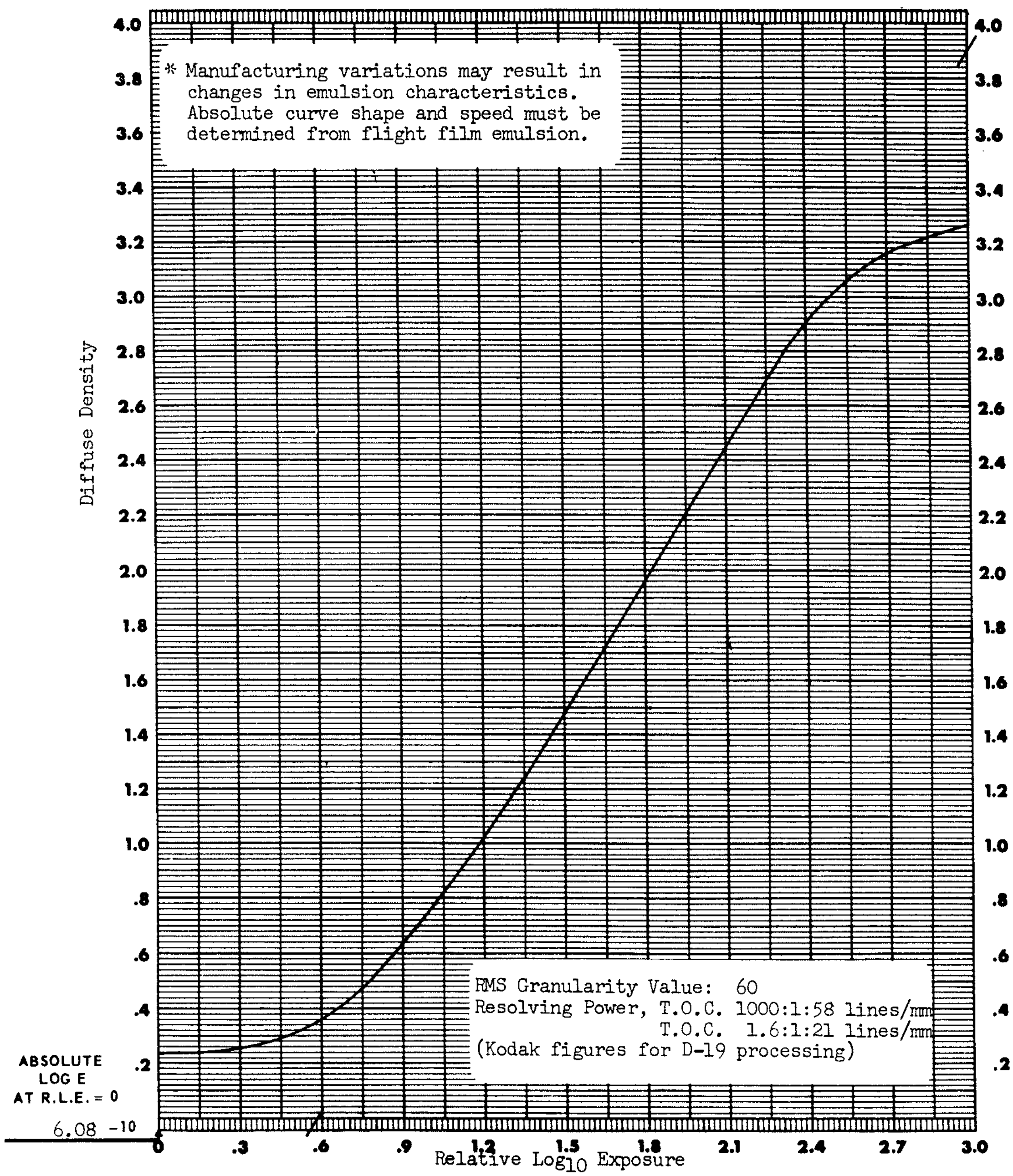
FILM 2485 EMULSION # * MFG Kodak DATE: 8/1/70

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
Sensitometer 1-B	PROCESSOR VMt 11 C-M	INSTRUMENT TD-403	SPEED (*) ± 10%
ILLUMINANT 2850 °K	CHEMISTRY Mx 641	TYPE DD	
1/100 SEC.	SPEED 2 TANKS 3 FPM	APERTURE SIZE 4 MM	GAMMA 1.70 + 0.05
Filter C5900 + SCW + 1.0	Temp 85°F TIME - - -	FILTER 106	BASE + FOG .26 ± 0.02



FILM 2485 EMULSION # 026001* MFG Kodak DATE: 8/1/70

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
Sensitometer I-B	PROCESSOR Houston M-P	INSTRUMENT TD-217-DR	
ILLUMINANT 2850 °K	CHEMISTRY D-19	TYPE Macbeth	D-MAX 3.26*
1/100 SEC.	SPEED N/A TANKS N/A FPM	APERTURE SIZE 2 MM	GAMMA 1.58*
Filter 5500K + 1.0 ND	Temp 81°F TIME 5½ min.	FILTER Status A vis.	BASE + FOG 0.24*



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:

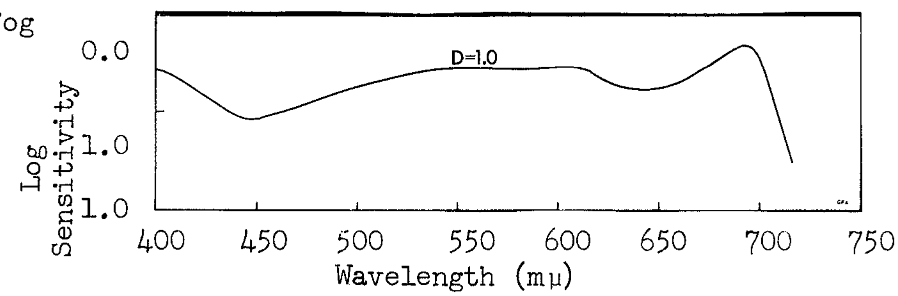
Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Aerial Exposure Index
5	1	2.80	16
	2	2.90	20
10	1	2.30	10
	2	2.60	12
15*	1	1.90	6.4
	2	2.30	10
20*	1	1.60	6.4
	2	2.20	8

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

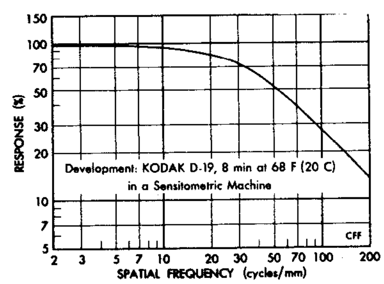
KODAK PANATOMIC-X AERIAL FILM 3400
(ESTAR Thin Base)

Spectral Sensitivity Curve

D-19
D = 1.0 above
gross fog

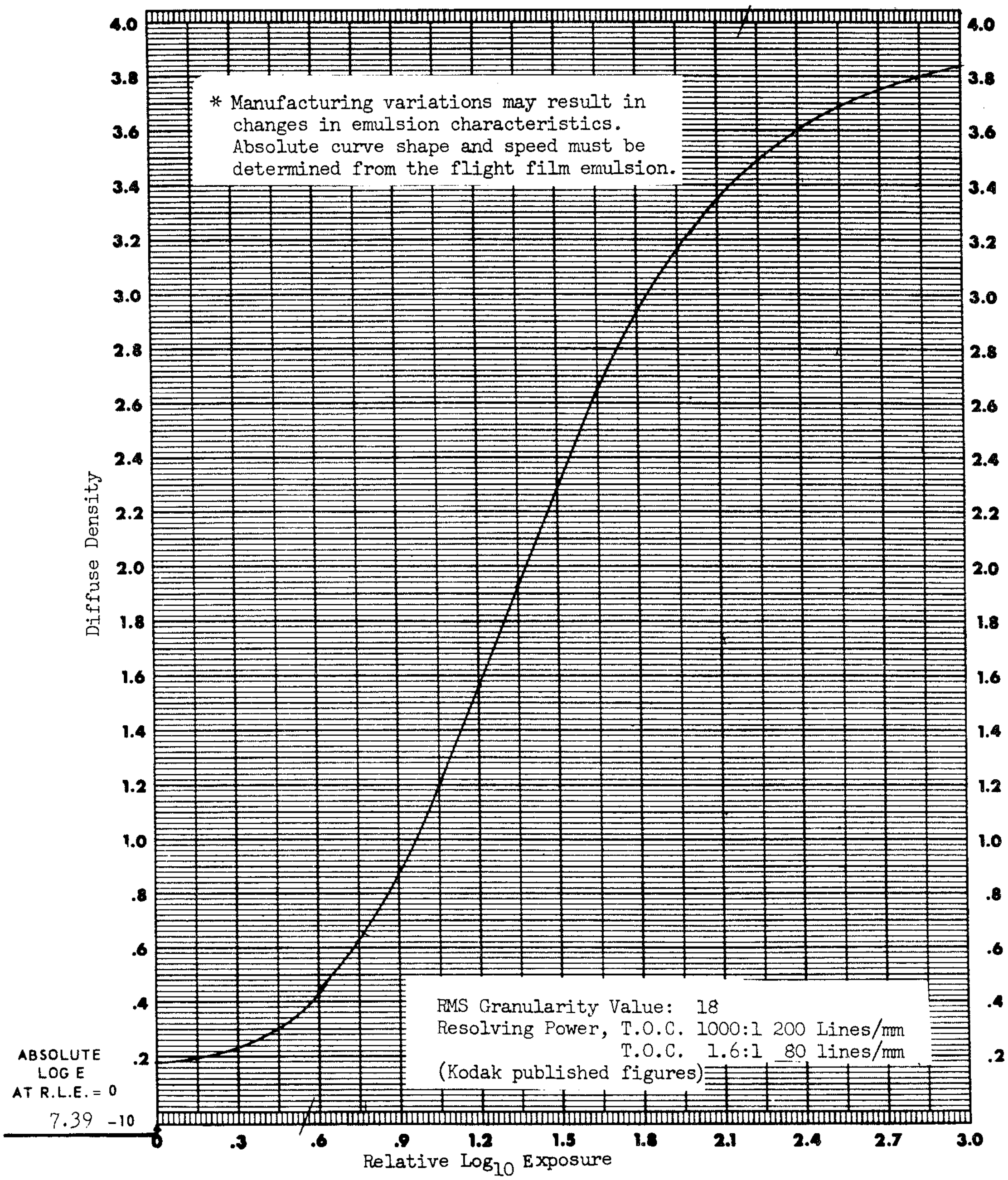


Modulation Transfer Function Curve



FILM 3400 EMULSION # * MFG Kodak DATE: 8/1/70

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
Sensitometer I-B	PROCESSOR Versamat 11C-M	INSTRUMENT Macbeth	SPEED (AEI) 35*
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE TD-403	D-MAX 3.84*
1/50 SEC.	SPEED 2 TANKS 5 FPM	APERTURE SIZE 4 MM	GAMMA 2.44*
Filter C-5900	Temp. 85 °F TIME ----	FILTER V-106	BASE + FOG 0.18*



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°F ± ½°F
Fix*	3	12	85°F, nominal
Wash	2	8	80°F to 82°F
Dry			120°F 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.

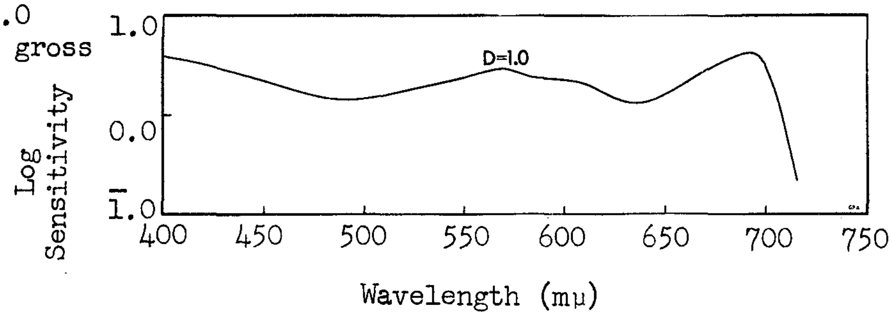
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK VERSAMAT 641 CHEMICALS AT 85°F PROCESSING TEMPERATURE

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

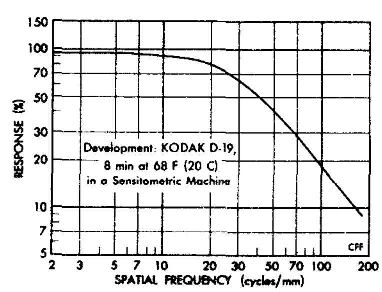
KODAK PLUS-X AERIAL FILM 3401
(ESTAR Thin Base)

Spectral Sensitivity Curve

D-19
D = 1.0
above gross fog

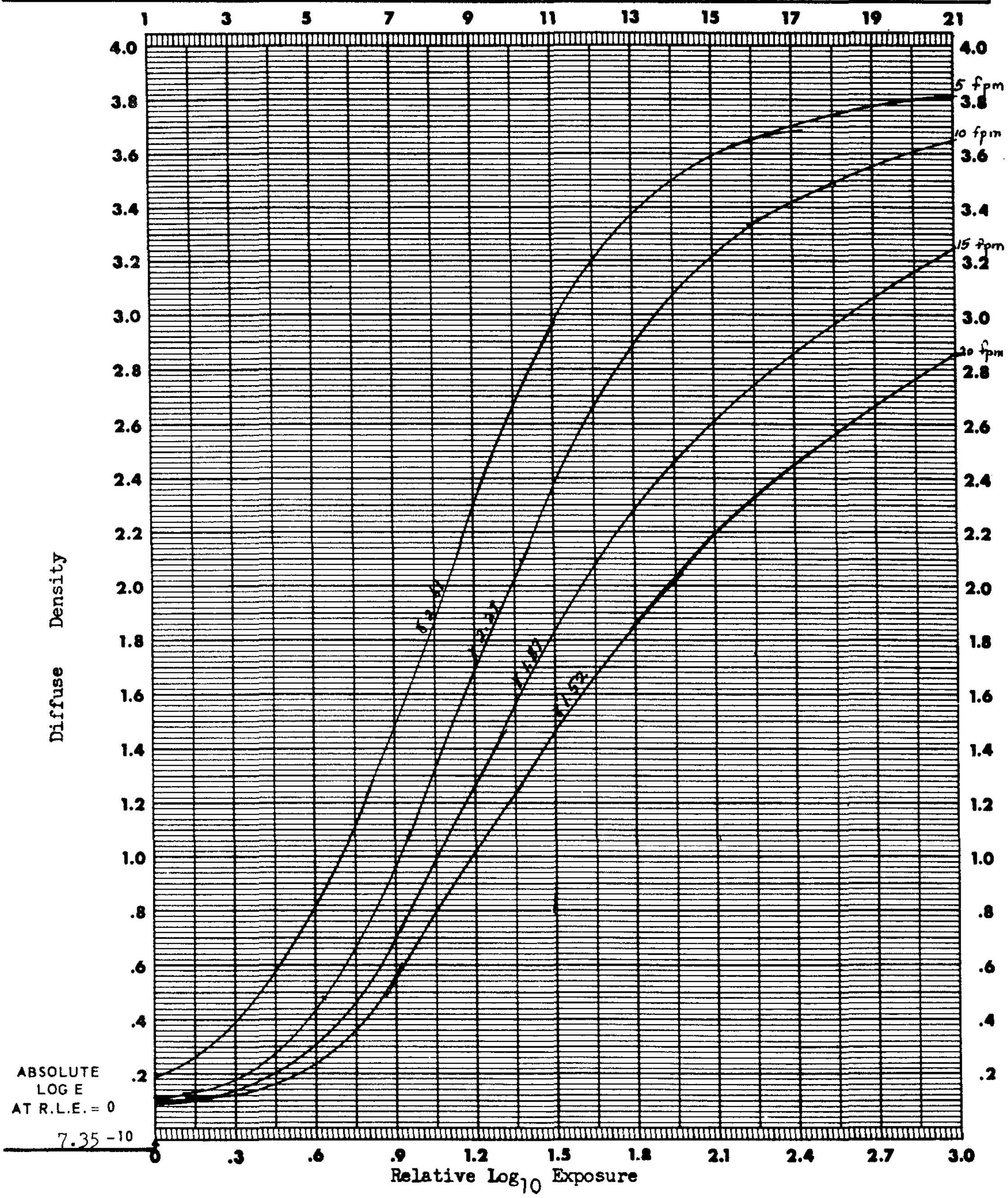


Modulation Transfer Function Curve



FILM 3401 EMULSION # 294-6 MFG E.K. Co.

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
I-B	PROCESSOR Versamat 11C-M	INSTRUMENT TD-403	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD	D-MAX
1/50 SEC.	SPEED 2 TANKS FPM	APERTURE SIZE 4 MM	GAMMA
C5900	85°F TIME	FILTER Wr 106	BASE + FOG



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.

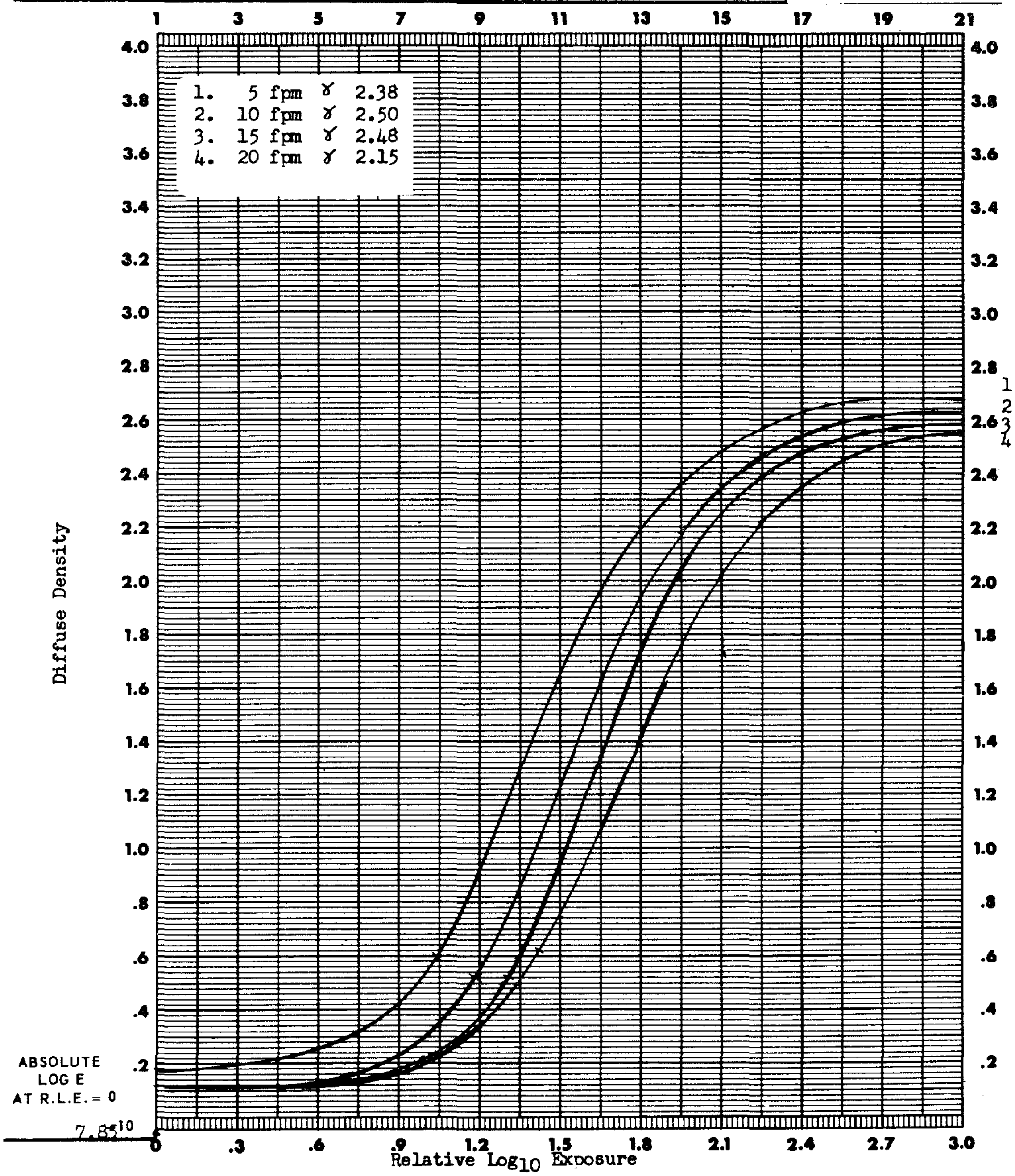
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK VERSAMAT 641 CHEMICALS AT $95^{\circ}F$ PROCESSING TEMPERATURE:

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 14 Jan 70

FILM SO-349

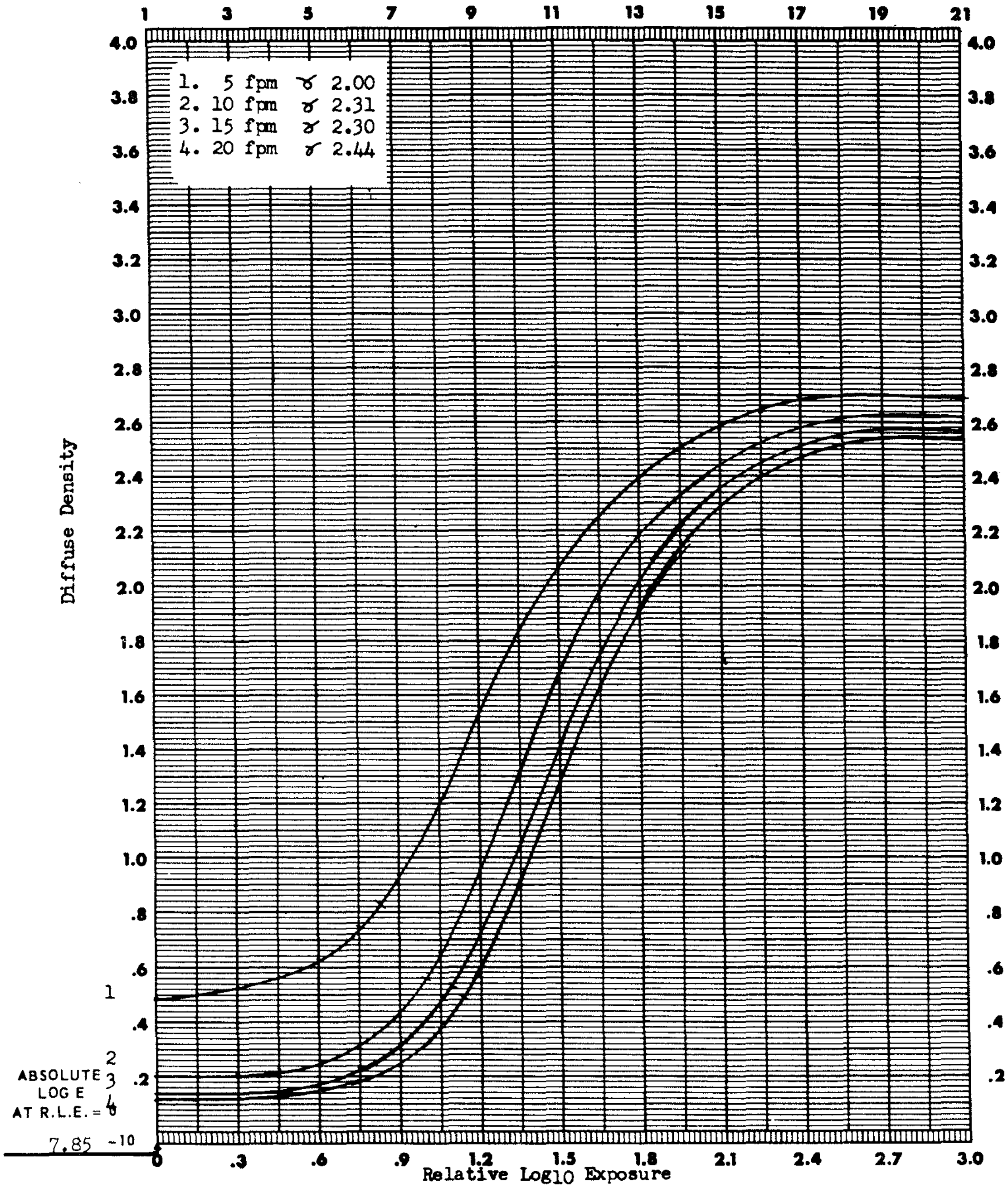
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
I-B	PROCESSOR Versamat 11C-M	INSTRUMENT TD-217
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD
1/10 SEC.	SPEED 1 TANKS Various FPM	APERTURE SIZE 2 MM
C-5900 + SCW	95°F TIME	FILTER Status A



DATE 14 Jan 70

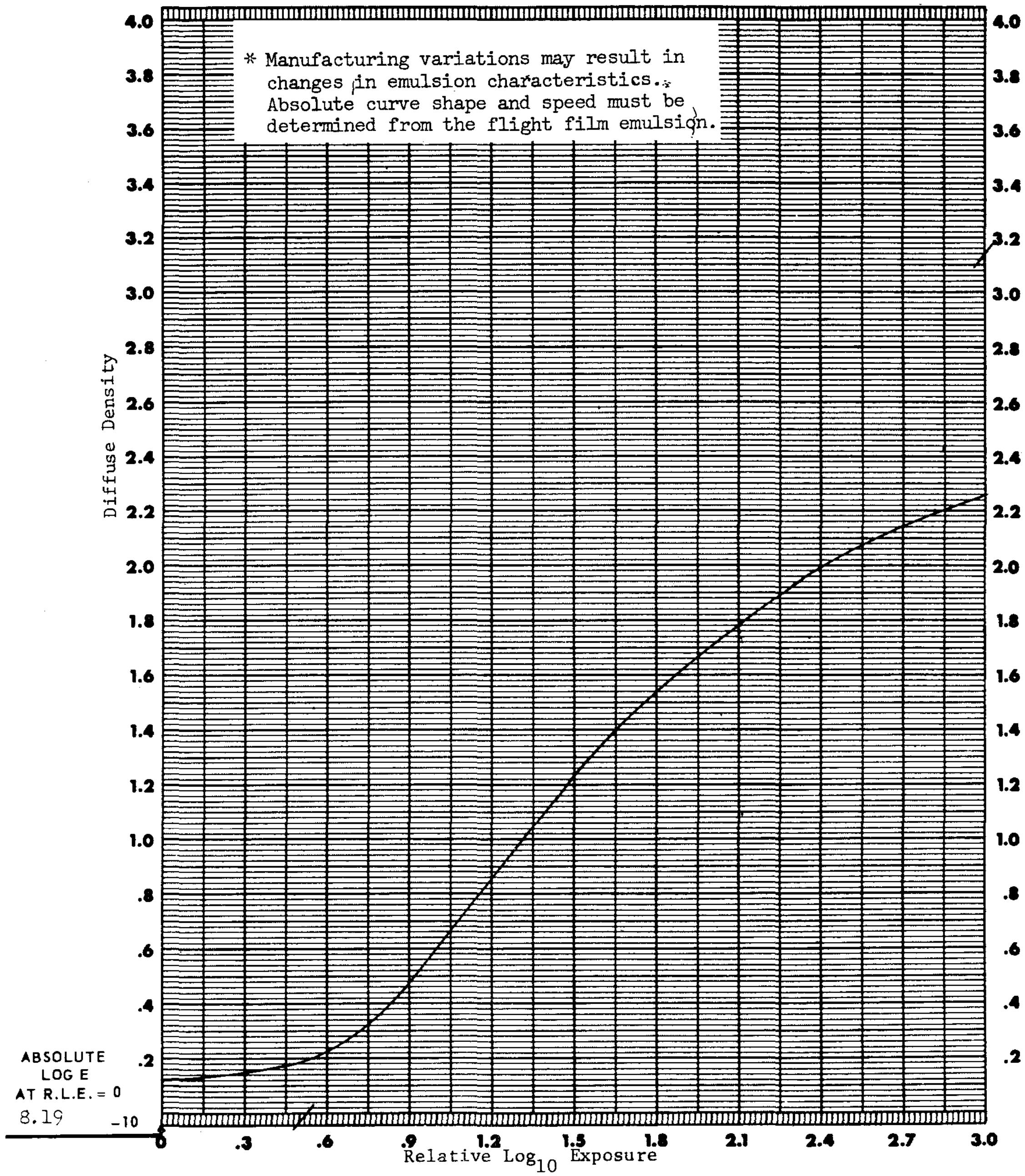
FILM SO-349

EXPOSURE DATA	PROCESSING DATA	DENSIT
I-B	PROCESSOR Versamat 11C-M	INSTRUMENT TD-217
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD
1/10 SEC.	SPEED 2 TANKS Various FPM	APERTURE SIZE 2 MM
C-5900 + SCW	95°F TIME	FILTER Status A



FILM SO-349 EMULSION # * MFG Kodak DATE: 8/1/70

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
Sensitometer 1-B	PROCESSOR VMt 11 C-M	INSTRUMENT TD-403	SPEED (*) ± 10%
ILLUMINANT 2850 °K	CHEMISTRY G4-L	TYPE DD	
1/5 SEC.	SPEED 2 TANKS 9 FPM	APERTURE SIZE 4 MM	GAMMA 1.27 ± 0.05
Filter LC5900 + SCW	Temp 80°F TIME - - -	FILTER V-106	BASE + FOG .12 ± 0.02



KODAK AEROCHROME INFRARED FILM TYPE 3443
(ESTAR Thin Base)

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

FILM CHARACTERISTICS*
This film type is a standard film replacement for special order film type SO-180, which was coated on a 2.5-mil Estar base with clear gel backing. It is a false color-reversal film used for camouflage detection, forest survey, medical and industrial research, and pictorial photography.

BASE
This film has a 2.5-mil Estar thin base with a clear gel backing. Total nominal thickness of this film is 3.65 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; EA-4 chemicals with 2 developer racks at 3.2 fpm

Characteristic	Value	Classification
Resolving Power		
Test-object contrast 1000:1	63 lines/mm	Moderately Low
Test-object contrast 1.6:1	32 lines/mm	Low
RMS Granularity (at net density of 1.0)	17	

MECHANIZED PROCESSING
This film should be processed in the Kodak Ektachrome RT Processor, Model 1411, using Kodak Process EA-4 chemicals.

* 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:

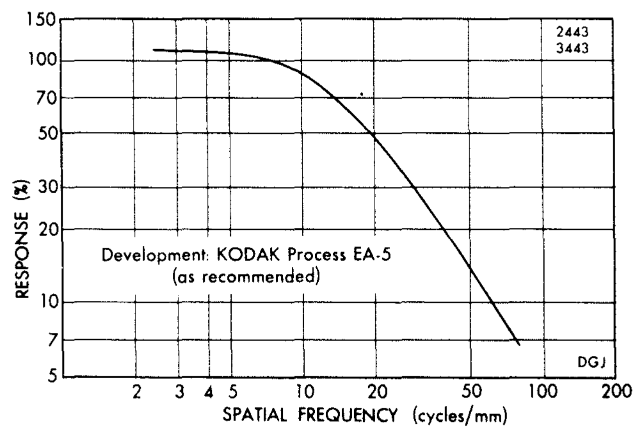
Processing Step	No. of Racks	Time	Temperature
Prehardener	1 & 2	2'30"	95° $\pm$ 1°F
Neutralizer	3	1'15"	97° $\pm$ 3°F
First Developer	4 & 5	2'30"	100° $\pm$ $\frac{1}{2}$°F
First Stop	6	1'15"	100° $\pm$ 1°F
Wash	7	1'15"	88° to 95°F
Color Developer	8 & 9	2'30"	110° $\pm$ 1°F
Second Stop	10	1'15"	110° $\pm$ 1°F
Wash	11	1'15"	88° to 95°F
Bleach	12	1'15"	110° $\pm$ 1°F
Fix	13	1'15"	110° $\pm$ 1°F
Wash	14	1'15"	88° to 95°F
Dryer		2'30"	125° $\pm$ 5°F

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

Machine Speed (feet per minute)	No. of Developer Racks	Average Gamma	Average Exposure Index
3.2	2	2.41	93 (ASA)

Kodak Aerochrome Infrared Film 3443
(ESTAR Thin Base)

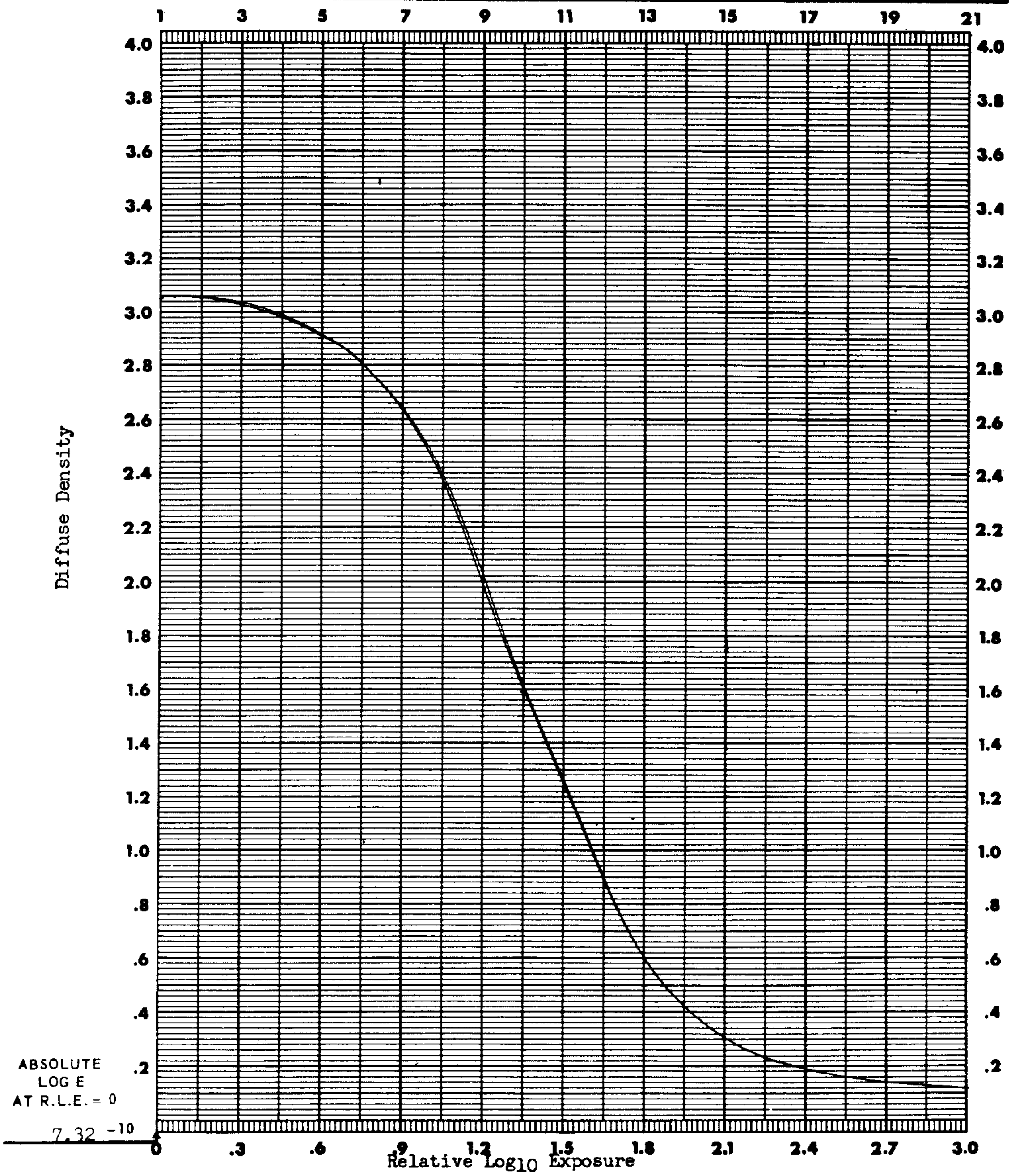
Modulation Transfer Function Curve



DATE 20 May 70

FILM 3443 EMULSION # 70mm MFG E.K. Co.

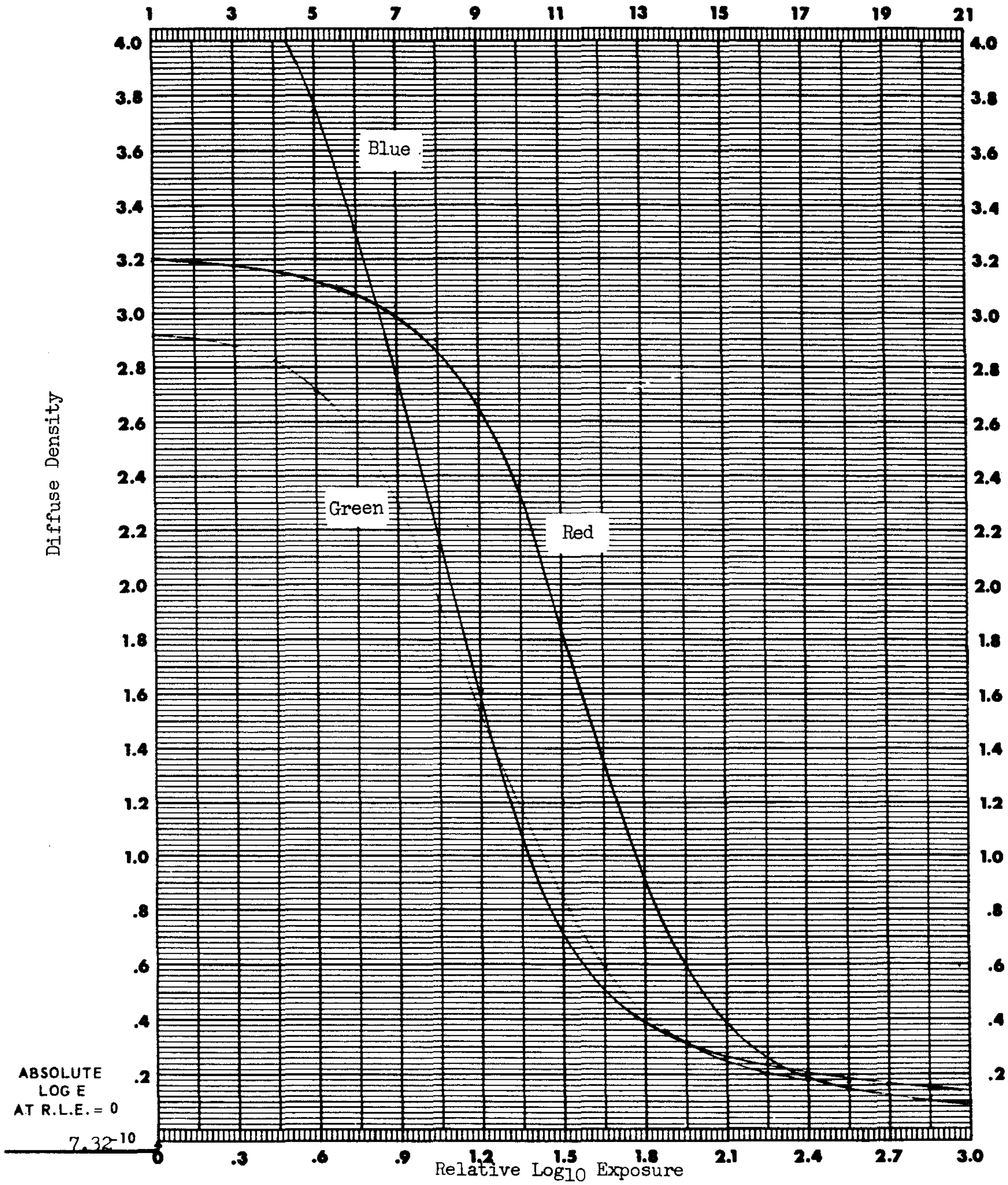
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
I-B	PROCESSOR 1811 M	INSTRUMENT TD-403	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY EA-5	TYPE DD	D-MAX 3.09
1/50 SEC.	SPEED — TANKS 9 FPM	APERTURE SIZE 4 MM	GAMMA
C-5900 + 2043 + Wr12	113.5°F TIME 9 min.	FILTER Visual	BASE + FOG



DATE 20 May 1970 TASK 468

FILM 3443 70mm MFG Kodak

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
I-B	PROCESSOR 1811 M	INSTRUMENT TD-403
ILLUMINANT 2850 °K	CHEMISTRY EA-5	TYPE DD
1/50 SEC.	SPEED All TANKS 5 FPM	APERTURE SIZE 4 MM
C5900 + 2043 + Wr. 12	113.5 TIME 9 min	FILTER Status A



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:

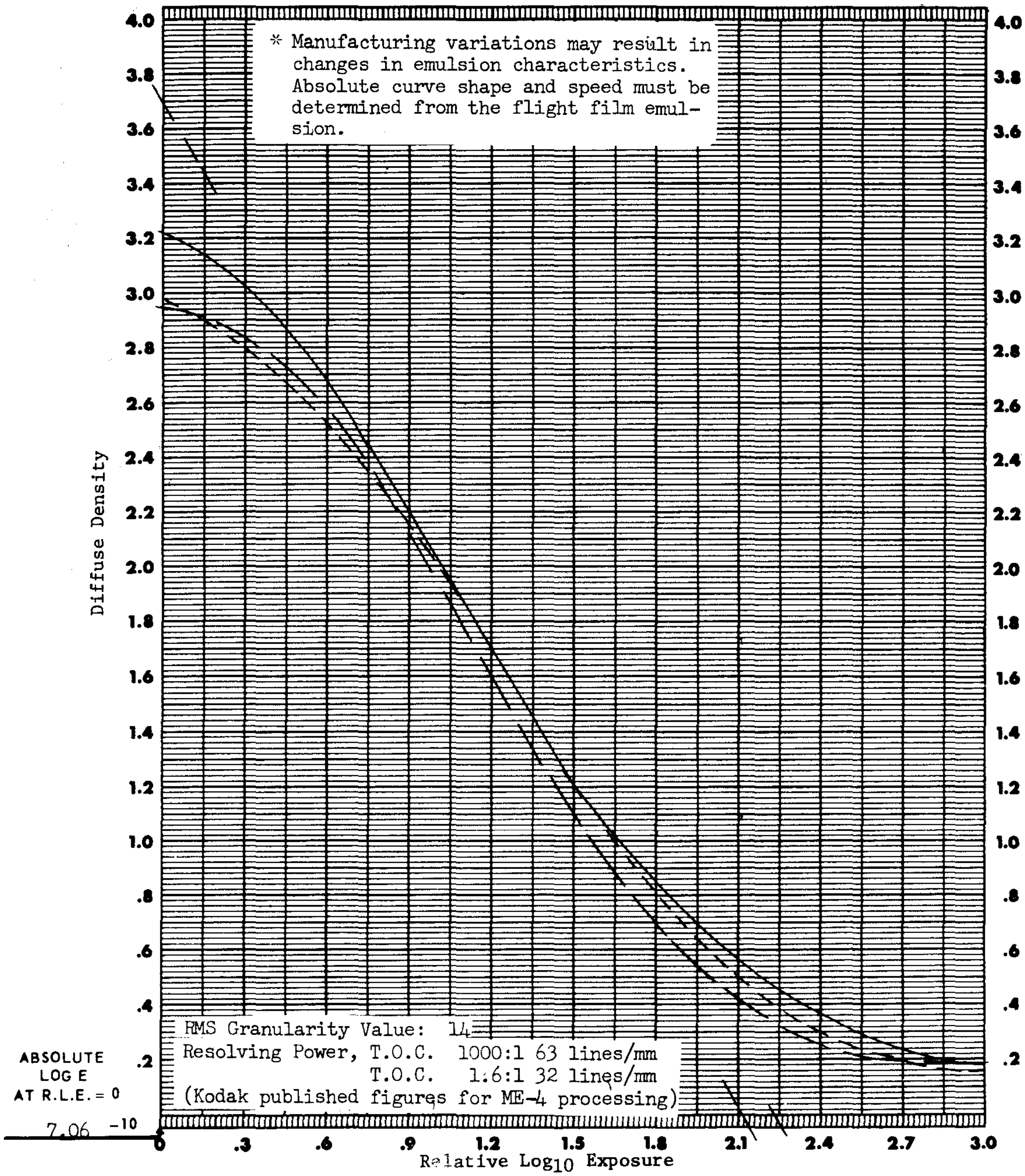
Processing Step	Number of Racks	Time	Temperature
Prehardener	1 & 2	2'30"	95° ± 1°F
Neutralizer	3	1'15"	97° ± 3°F
First Developer	4 & 5	2'30"	100° ± ½°F
First Stop	6	1'15"	100° ± 1°F
Wash	7	1'15"	88° to 95°F
Color Developer	8 & 9	2'30"	110° ± 1°F
Second Stop	10	1'15"	110° ± 1°F
Wash	11	1'15"	88° to 95°F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

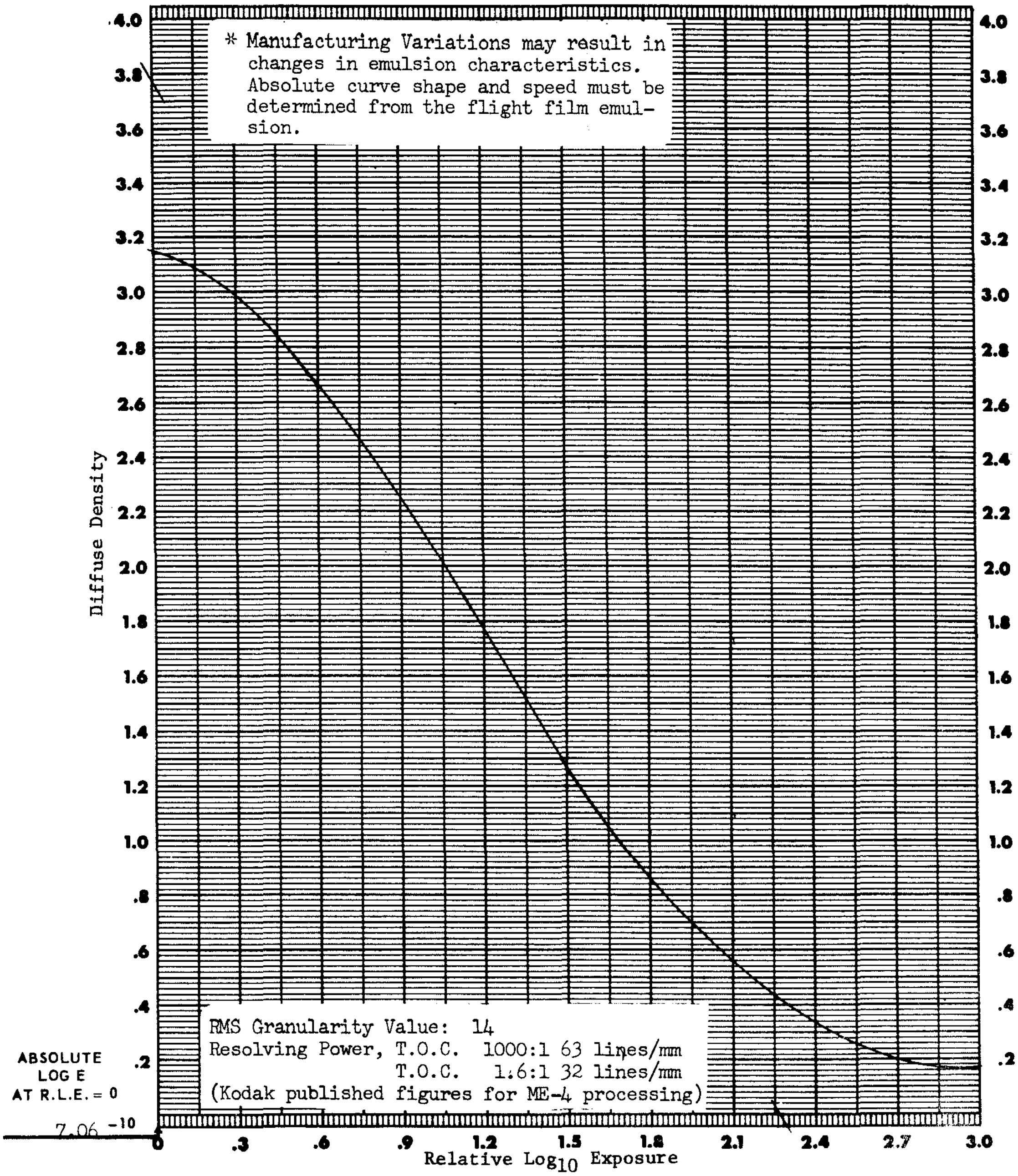
FILM SO-168 EMULSION # * MFG Kodak DATE: 8/1/70

EXPOSURE DATA		PROCESSING DATA		DENSITOMETRY	
Sensitometer	1B	PROCESSOR	1411-M	INSTRUMENT	Macbeth
ILLUMINANT	2850 °K	CHEMISTRY	EA-4	TYPE	TD-403
	1/100 SEC.	SPEED --	TANKS 3.2 FPM	APERTURE SIZE	4 MM
Filter	C-5900	---	TIME ---	FILTER	Status A



FILM SO-168 **EMULSION #** * **MFG** Kodak DATE: 8/1/70

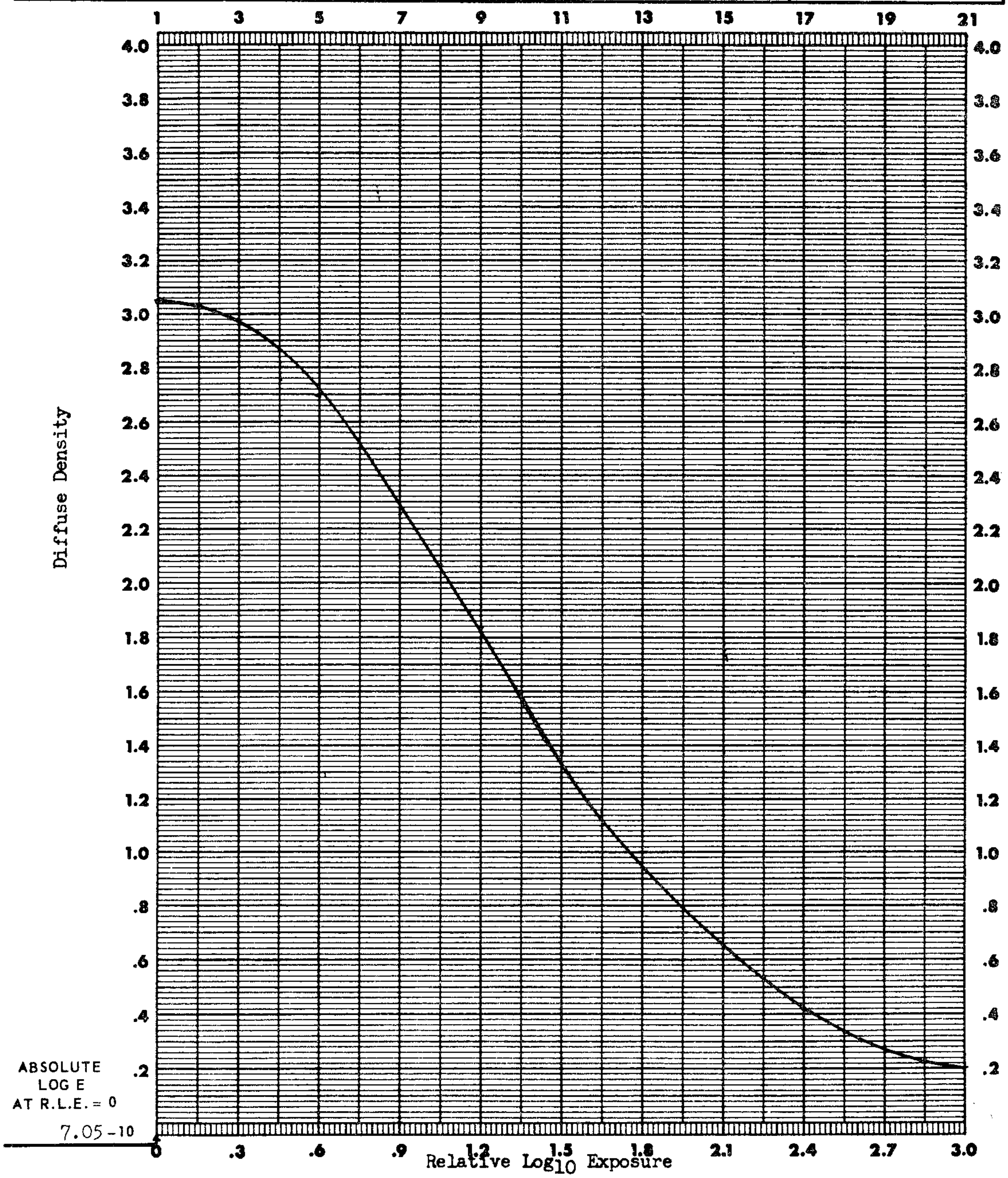
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
Sensitometer 1-B	PROCESSOR 1411-M	INSTRUMENT Macbeth
ILLUMINANT 2850 °K	CHEMISTRY EA-4	TYPE TD-403
1/100 SEC.	SPEED --- TANKS 3.2 FPM	APERTURE SIZE 4 MM
Filter C-5900	--- TIME ---	FILTER Visual-106



DATE 29 Oct 69

FILM SO-168 EMULSION # 2-1 MFG E.K. Co.

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
I-B	PROCESSOR Ektachrome 1411M	INSTRUMENT TD-403	SPEED (ASA) 148
ILLUMINANT 2850 °K	CHEMISTRY EA-4	TYPE DD	D-MAX 3.05
1/100 SEC.	SPEED 2 TANKS 3.2 FPM	APERTURE SIZE 4 MM	GAMMA 1.51
LC5900	93.8°F TIME	FILTER Status A	BASE + FOG .20



KODAK DOUBLE-X AEROGRAPHIC FILM TYPE SO-174 (Formerly SO-267)
(ESTAR 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 sensitivity, high acutance, good contrast and wide exposing latitude. Its extended red sensitivity permits greater speed through haze-cutting filters. This film is on a 4.0-mil Estar base which provides very high resistance to tearing and extremely good dimensional stability, and its exposure, image-structure characteristics, and machine processing are the same as Type 2405 film. This film is suitable for high-temperature, rapid processing in the Kodak Versamat Film Processor.

BASE
This film has a 4.0-mil Estar polyester base with fast drying (PX) backing.

EXPOSURE
Suggested aerial exposure indexes are designed for use with 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 8 fpm

Characteristic	Value	Classification
Resolving Power		
Test-object contrast 1000:1	85 lines/mm	Medium
Test-object contrast 1.6:1	38 lines/mm	Low
RMS Granularity (at net density of 1.0)	36	

MECHANIZED PROCESSING
This film should be processed in equipment made especially for this purpose, such as the Kodak Versamat Film Processor, Model 11, using Kodak Versamat 641 chemicals.

* 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 CHEMICALS:

Kodak Versamat 641 Developer and 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.

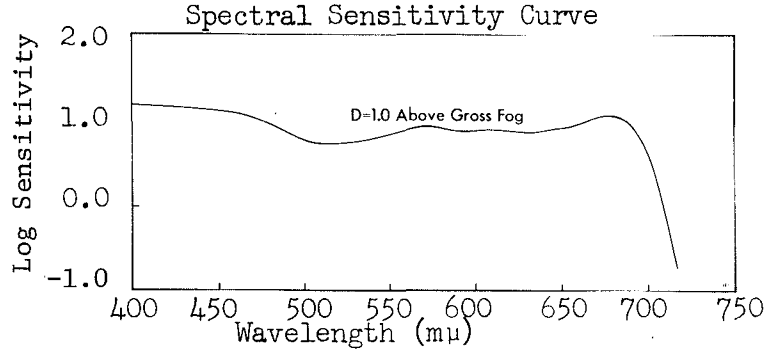
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK VERSAMAT CHEMICALS AT 80°F PROCESSING TEMPERATURE:

Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Exposure Index
8	2	1.12	690 (ASA)

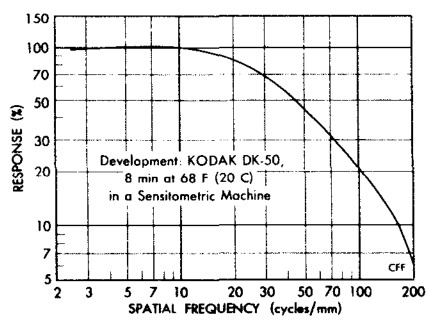
KODAK DOUBLE-X AEROGRAPHIC FILM SO-174
(ESTAR Base)

Spectral Sensitivity Curve

DK-50
D = 1.0 above gross fog

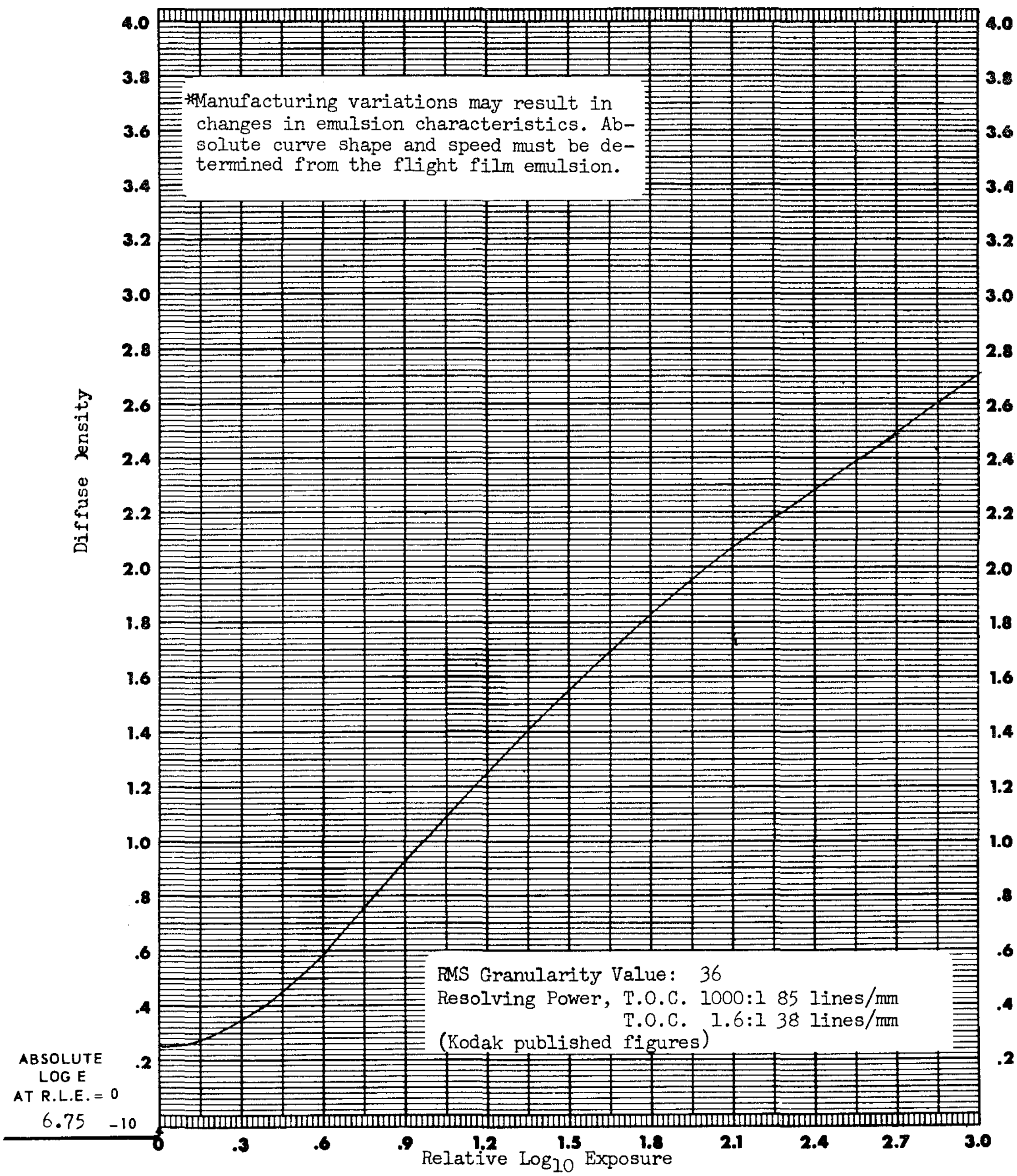


Modulation Transfer Function Curve



FILM SO-267 EMULSION # 1-1* MFG E. K. Co. DATE: 8/1/70

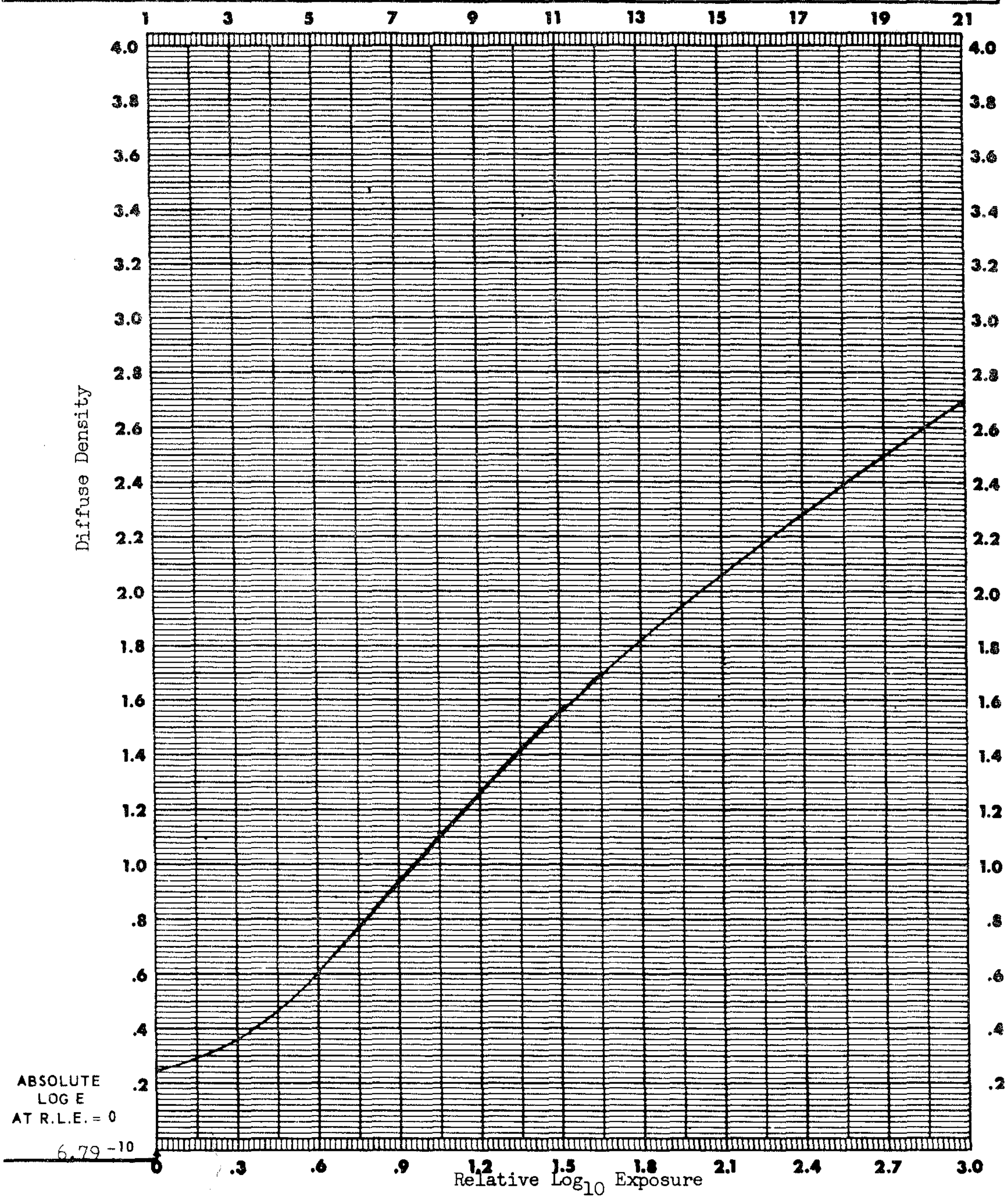
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
Sensitometer I-B	PROCESSOR 11C-M	INSTRUMENT TD-403	SPEED (ASA) 690
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD	D-MAX -
1/50 SEC.	SPEED 2 TANKS 8 FPM	APERTURE SIZE 4 MM	GAMMA 1.12
Filter C5900 + .60ND	Temp. 80°F TIME - - - -	FILTER Visual	BASE + FOG -



DATE 12 Mar 70 CONTROL # Apollo 13

FILM SO-267 EMULSION # 1-1 MFG E. K. Co.

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
I-B	PROCESSOR Versamat 11C-M	INSTRUMENT TD-403	SPEED (ASA) 690
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD	D-MAX -
1/50 SEC.	SPEED 2 TANKS 8 FPM	APERTURE SIZE 4 MM	GAMMA 1.12
C-5900 + .60ND	80°F TIME	FILTER Visual	BASE + FOG -



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:

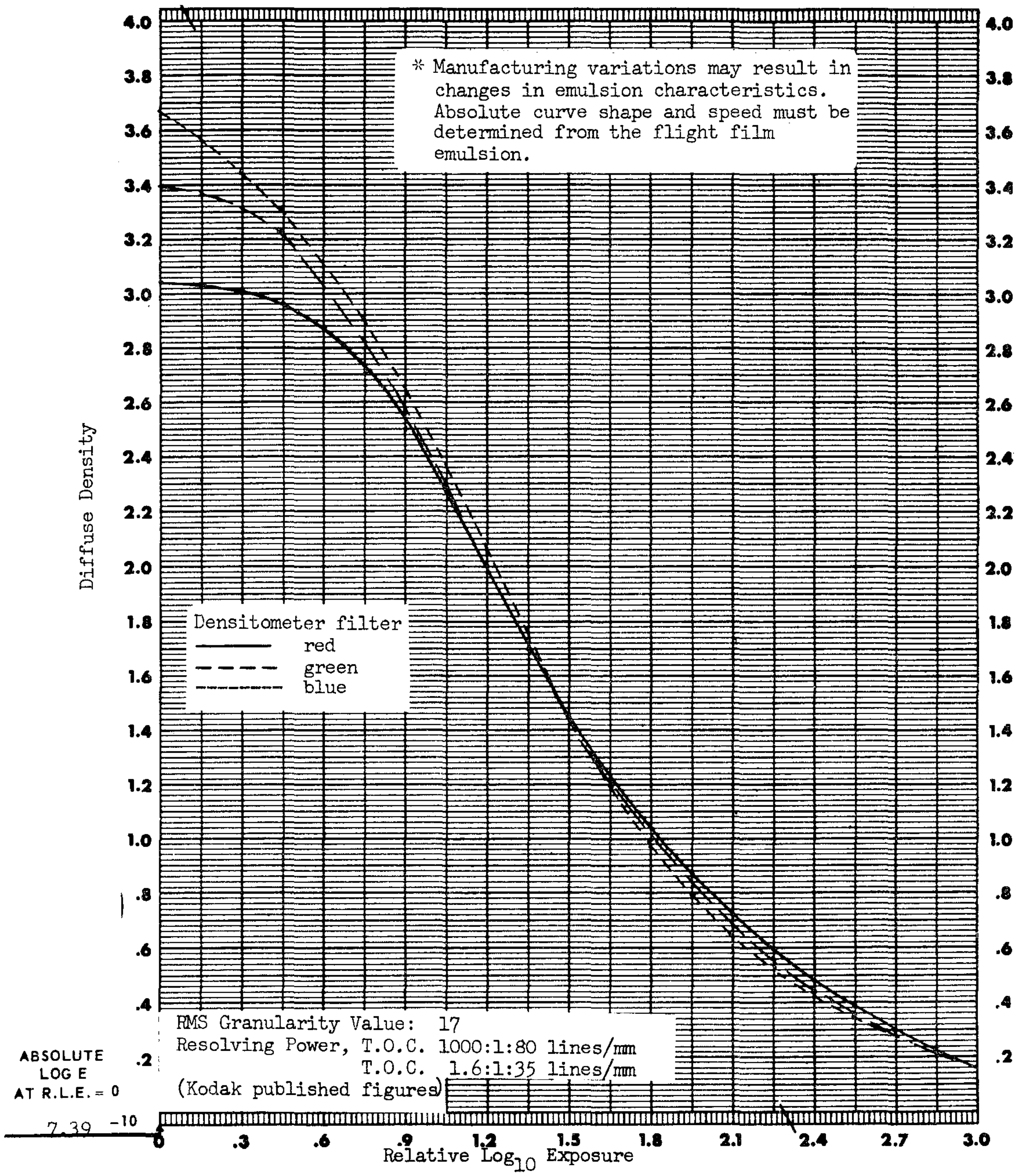
Processing Step	Number of Racks	Time	Temperature
Prehardener	1 & 2	2'30"	95° ± 1°F
Neutralizer	3	1'15"	97° ± 3°F
First Developer	4 & 5	2'30"	100° ± ½°F
First Stop	6	1'15"	100° ± 1°F
Wash	7	1'15"	88° to 95°F
Color Developer	8 & 9	2'30"	110° ± 1°F
Second Stop	10	1'15"	110° ± 1°F
Wash	11	1'15"	88° to 95°F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

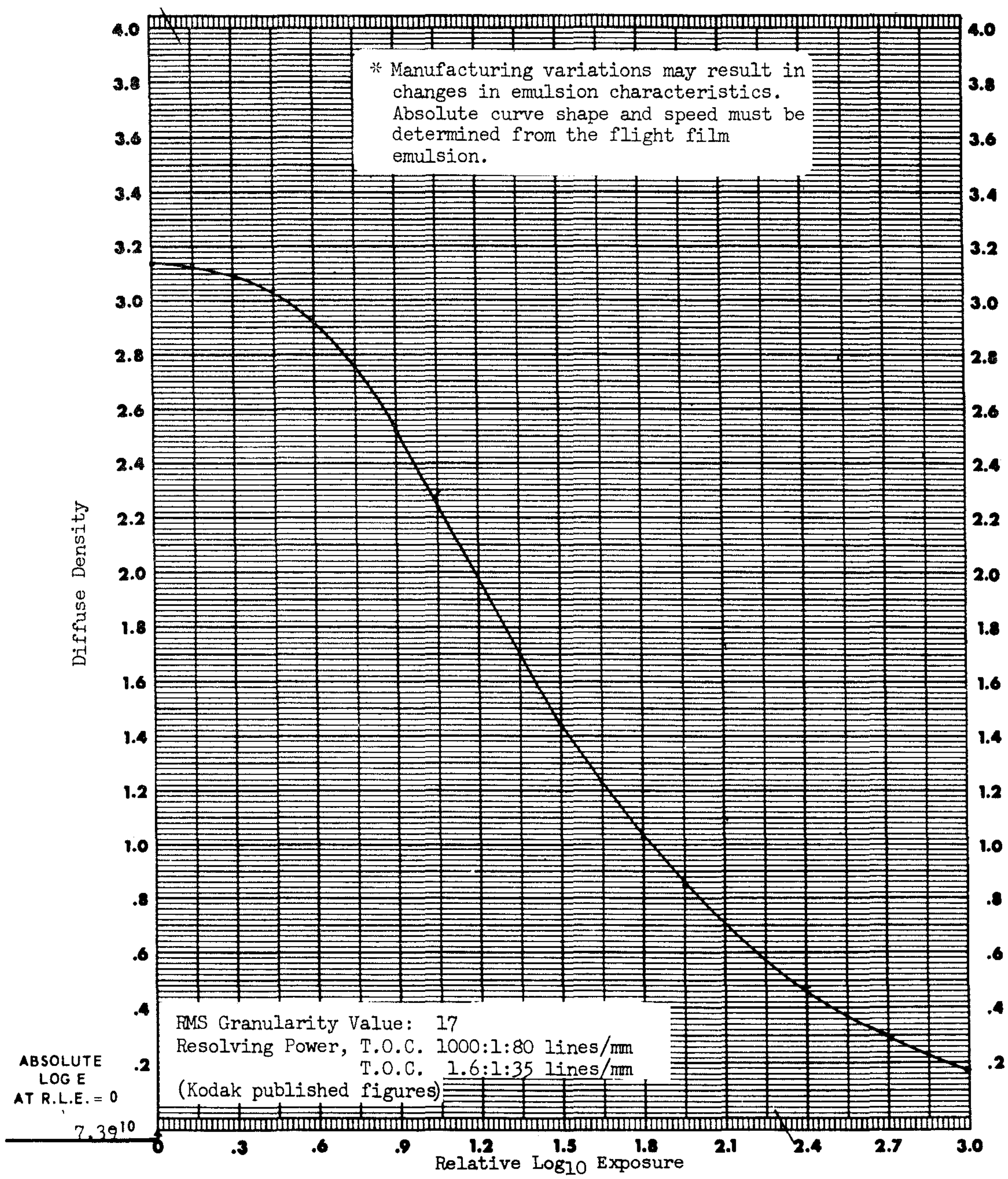
FILM SO-368 EMULSION # 15* MFG Kodak DATE: 8/1/70

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
Sensitometer I-B	PROCESSOR Hi-Speed	INSTRUMENT Macbeth
ILLUMINANT 2850 °K	CHEMISTRY ME-2A	TYPE TD-203
1/50 SEC.	SPEED --- TANKS --- FPM	APERTURE SIZE 4 MM
Filter C-5900	Temp 74.75°F TIME 8'50"	FILTER Status A



FILM SO-368 EMULSION # * MFG Kodak DATE: 8/1/70

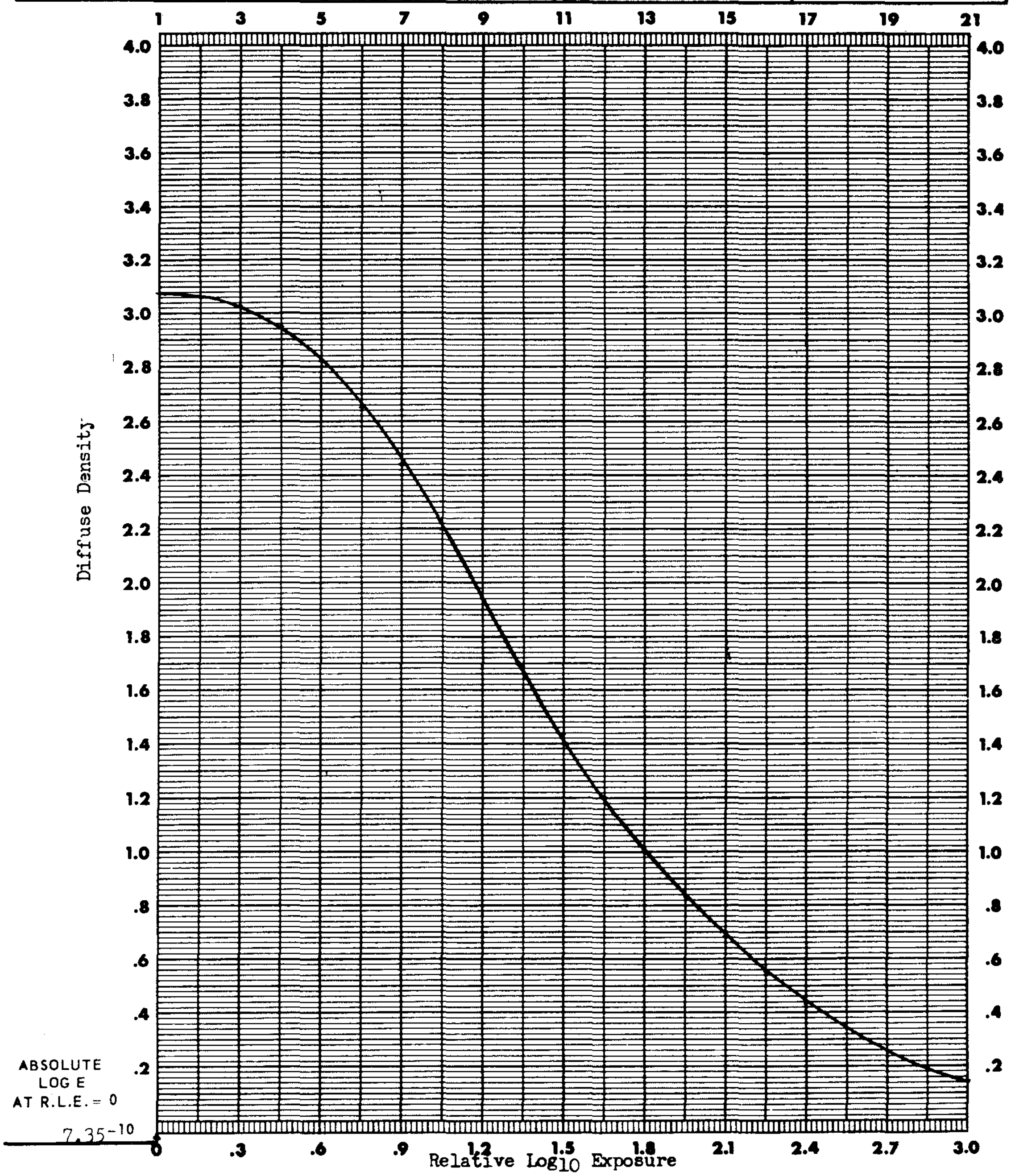
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
Sensitometer I-B	PROCESSOR Hi-Speed	INSTRUMENT Macbeth	SPEED (ANSI) 46*
ILLUMINANT 2850 °K	CHEMISTRY ME-2A	TYPE TD-203	D-MAX 3.13*
1/50 SEC.	SPEED --- TANKS --- FPM	APERTURE SIZE 4 MM	GAMMA 1.80*
Filter C-5900	Temp 74.75°F TIME 8'50"	FILTER Visual 106	BASE + FOG 0.14



DATE 21 Oct 69

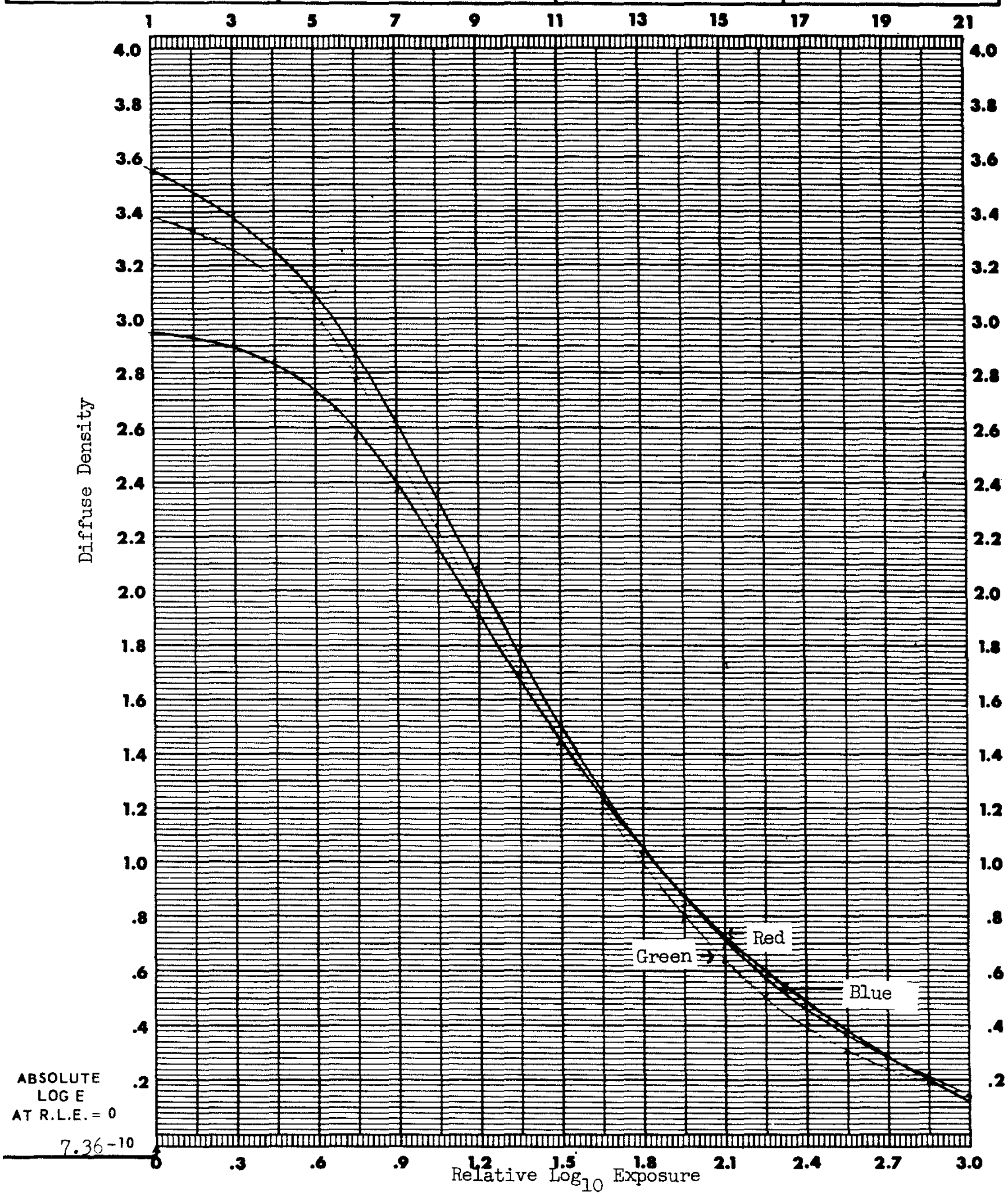
FILM SO-368 EMULSION # 1-4

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
I-B	PROCESSOR Hi-Speed	INSTRUMENT TD-203	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY ME-2A	TYPE DD	D-MAX
1/50 SEC.	SPEED TANKS 3.4 FPM	APERTURE SIZE 4 MM	GAMMA 1.79
5500°K	72°F TIME 8'50"	FILTER Status A	BASE + FOG



FILM SO-368 EMULSION # 1-4 MFG E.K. Co.

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
I-B	PROCESSOR Hi-Speed	INSTRUMENT TD 203	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY ME-2A	TYPE Macbeth	D-MAX
1/50 SEC.	SPEED TANKS 3.4 FPM	APERTURE SIZE 4 MM	GAMMA
5500 K	TIME	FILTER Status A	BASE + FOG



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