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APOLLO MISSION J-1

(APOLLO 15)

MISSION SCIENCE REQUIREMENTS

PRELIMINARY

OCTOBER 30, 1970

C2253

LUNAR MISSIONS OFFICE
SCIENCE AND APPLICATIONS DIRECTORATE
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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J-1 TYPE MISSION (APOLLO 15)

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October 30, 1970

Prepared by TRW Systems

for

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SCIENCE AND APPLICATIONS DIRECTORATE
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

Contract NAS 9-8166

MISSION SCIENCE REQUIREMENTS

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SUBMITTED BY:

Richard R. Baldwin, TM1
Science Mission Manager

CONCURRED BY:

James H. Sasser, Chief
Mapping Sciences Laboratory

R. Bryan Erb, Manager
Lunar Receiving Laboratory

APPROVED BY:

John G. Zarcaro, Manager
Lunar Missions Office

for Anthony J. Calio, Director
Science and Applications

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- Section VII, Lunar Receiving Laboratory Plan: Lunar Receiving Laboratory/TL.
- Section VIII, Contingency Plan: Data Management and Operations Office/TM5, supported by General Electric Company.
- Appendix E, Film Characteristics and Processing Test Data: Photographic Technology Laboratory/BL.

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INTRODUCTION

The Mission Science Requirements Document (MSRD) has been produced by TRW Systems under the direction of the Lunar Missions Office, Science and Applications Directorate (LMO/S&AD). It is intended for use by the Manned Spacecraft Center (MSC) and off-site organizations in program and mission planning and in the integration and implementation of mission science requirements. Detailed data included in this document are provided as source material for other MSC documents such as the Flight Plan, Lunar Surface Procedures, Photographic and Television Procedures, Voice Data Plan, Launch Mission Rules, and Flight Mission Rules.

The MSRD is divided into the following eight sections: Section I, General Mission Science Planning; Section II, Experiment and Equipment Description; Section III, Photographic Plan; Section IV, Lunar Traverse Plan; Section V, Science Operations Support Plan; Section VI, Science Recovery Plan; Section VII, Lunar Receiving Laboratory Plan; and Section VIII, Contingency Plan. These sections include detailed data which supplement science requirements for the J-1 Mission experiments defined in Detailed Experiment write-ups incorporated in the Mission Requirements Document.

Publication dates for the MSRD have been scheduled to optimize the availability and use of science data for preparation of other MSC documents. These publication dates for the J-1 Mission MSRD are: L - 9 months for the preliminary MSRD, L - 5 months for the final MSRD, and L - 2 1/2 months for the MSRD revision.

All proposed changes to and requests for additional copies of the MSRD should be submitted in writing to the following representatives of the Lunar Missions Office, Manned Spacecraft Center, Houston, Texas: Mr. Richard R. Baldwin/TM1, Science Mission Manager, J-1 Mission, and Mr. Bruce H. Walton/TM1, Technical Assistant.

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GENERAL MISSION SCIENCE PLANNING

1.1 GENERAL

This section summarizes the science objectives and experiments for Apollo Mission J-1 (Apollo 15). Included are a general description of the J-1 Mission, a listing of the general science objectives to be accomplished, a brief general description of the lunar landing site, and a listing of the individual science experiment and science-oriented objectives that have been assigned to accomplish these general science objectives. This section also identifies the cognizant MSC Point-of-Contact for science requirements and the Principal Investigator responsible for data analysis and reporting for each of these experiments/objectives. A more detailed description of the J-1 landing site and its desirable science characteristics are presented in Section IV, Lunar Traverse Plan.

1.2 MISSION DESCRIPTION

Apollo Mission J-1 is the first of three missions that will terminate the Apollo Space Flight Program. These missions will incorporate spacecraft hardware modification and additional science equipment to provide increased capabilities for greater mission science return than was possible on previous Apollo missions. These increased capabilities, referenced to the highly successful Apollo 12 Mission, will provide for:

a) An extended total mission duration from 11 days to 16 days.

b) An extended lunar surface staytime from 32 hours to 66 hours.

c) An increased lunar injected payload from 101,000 pounds to 107,000 pounds.

d) An increased lunar orbital science payload from 25 pounds to 900 pounds.

e) An increased lunar surface-landed payload from 345 pounds to 1000 pounds.

f) An increased lunar surface ascent science payload from 100 pounds to 175 pounds.

g) An extended total lunar surface EVA operation time from 8 hours to 18 hours.

h) An increased lunar surface mobility and exploration capability--new pressure suit, modified portable life support system (PLSS), lunar surface color TV, and Lunar Roving Vehicle.

i) Conducting of scientific experiments and mapping operations from lunar orbit (SIM bay experiments and deployment of subsatellite).

j) Deployment of a greater variety of lunar surface experiments and the conducting of more and varied lunar surface geological activities.

Nominally, the launch date for Apollo 15 (J-1 Mission) will be July 27, 1971, with a planned lunar landing at the Apennine Front/Hadley Rille landing site. A hybrid translunar trajectory will be required because of the increased gross weight of the spacecraft. Multiburn LOI maneuvers may be required to reach this relatively high-latitude (25°N) site.

The LM can remain on the lunar surface up to 65 hours. During this time it is planned to accomplish three 2-man EVA's, each having a duration of a little over 6 hours for lunar surface exploration and surface science experiments deployment. As currently planned the first EVA will be performed on the day of landing, the second on the following day, and the third on ascent day. The maximum radius of operation from the LM has been extended over that characterized by "foot" traverses through use of the upgraded PLSS and the Lunar Roving Vehicle. Nominally, the Lunar Roving Vehicle will not be more than about 8 km from the LM at any time. The total traverse distance per EVA is expected to be approximately 15-20 km (about 10 km for the first EVA) although the total traverse capability is much greater.

A 72-hour lunar orbital experiment period has been provided between CSM/LM rendezvous and TEI for subsatellite deployment, remote sensing of the lunar surface with the SIM bay sensors, and SIM bay high-resolution photography activities. These science activities will be performed after pyrotechnic jettisoning of the SIM door which will be accomplished after CSM/LM docking. Orbital science activities will be conducted in a nominal 60 NM circular orbit. Investigations are currently underway to accomplish the lunar orbital and lunar surface science activities simultaneously, but this concept has not yet supplanted the original concept. Command Module science activities - principally photography - can be conducted during the LM surface stay period, during the regular orbital science period, and for selected periods during transearth coast and translunar coast.

Some SIM bay experiments will be operated during transearth coast to obtain galactic and spacecraft background data. This data gathering period will be interrupted by an EVA lasting approximately 44 minutes to retrieve the film cassettes from the SIM bay cameras. Splashdown will nominally occur on August 10, 1971 (15-day mission).

1.3 MISSION SCIENCE OBJECTIVES

Science objectives are derived from the official mission objectives, assigned by the Office of Manned Space Flight (OMSF), that are listed in the Apollo Flight Mission Assignments Directive (AFMAD). The AFMAD document has not yet been updated to reflect the recent science payload changes and landing site selection for the J-1 Mission. Thus, the precise official science objectives in terms of delineation and verbiage cannot be presented in this document issue. However, the science objectives to evolve are expected to be similar to those presented in the following list:

a) Investigate, survey, and sample the floor of a sinuous rille.

b) Investigate, photograph, and document the major materials and structures of a sinuous rille.

c) Investigate, photograph, and document Apennian materials in the mare landing area that may be impact ejecta from the formation of the Imbrium Basin.

d) Emplace and activate science experiments for the purpose of examining local, regional, and subsurface structures and environmental characteristics.

e) Investigate, survey, and measure the lunar surface and the near-moon environment from lunar orbit.

These primary science objectives have, in turn, been subdivided into individual science experiments and detailed science objectives intended to acquire the information necessary to fulfill these primary objectives. Science experiments are those scientific investigations which have been recommended and assigned a number (e.g., S-059) by the Manned Space Flight Experiments Board (MSFEB), and assigned to the Apollo Program by the Associate Administrator for Manned Space Flight. Detailed scientific objectives represent science investigations that provide data and experience useful for the development of science hardware and/or procedures for application to other Apollo missions, or which contain activities largely of an experimental nature (e.g., SM Orbital Photographic Tasks).

Detailed objectives and experiments also encompass engineering, medical, and similar disciplines. Only those 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 the Principal Investigators for the lunar surface experiments. Detailed objectives, experiments, operational objectives, and engineering tests for all disciplines including science to be performed on the J-1 mission are contained in the J-1 Mission Requirements Document (MRD) published by the Systems Engineering Division, Apollo Spacecraft Program Office. Changes in mission assignments of experiments, detailed objectives, and operational tests are governed by Configuration Control Board Directives approved by the Apollo Program Director.

1.4 LANDING SITE DESCRIPTION

The J-1 mission landing site, termed Hadley-Apennines, is located in the north-central part of the moon (latitude of 24.5°N, longitude of 2.5°E) at the foot of the Apennine Mountains. These mountains rise up to 2km above the lunar surface and ring the eastern end 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 rille Rima Hadley that winds down from the mountains and meanders across the Palus Putredinis ("swamp of decay").

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, apparently volcanic in nature, and generally has a width of about 1 km and a depth of about 200 m until it merges with a second rille approximately 100 km to the north. Fresh exposures, possibly of stratified mare beds, occur along the top of the rille walls down which numerous blocks 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. The determination of the nature and origin of this sinuous rille and its associated elongated depression and deposits will provide information of an important lunar surface process and may yield data on the history of lunar volatiles.

The Apennine Mountains that rise from the area of Rima Hadley contain ancient material exposed during the excavation of the Imbrium Basin. Sampling of Apennine material should provide very ancient rocks whose origin predates the foundation and filling of the major mare basins.

An additional surface feature of interest in this landing area is a small (5.5 km in diameter) but conspicuously sharp and round crater which appears to have partially covered the rille. This crater, termed Hadley C, is characterized by a raised rim and ejecta blanket which covers the mare craters and other features in the surrounding area. The origin of this crater is a subject of interest and speculation among lunar scientists.

1.5 MISSION SCIENCE EXPERIMENTS AND OBJECTIVES

The science experiments and objectives assigned to this mission have been divided into three groupings: those to be performed from the Command Module in lunar orbit; those to be performed from the Service Module in lunar orbit; and those to be performed on the lunar surface. Command Module lunar orbital experiments and objectives are listed in Table 1-1, Service Module lunar orbital 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 MSC/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 Mission Requirements Document.

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. Problems that arise regarding integration of these experiments and objectives into mission and program planning should be referred to the S&AD Science Mission Manager for the J-1 Mission, Mr. Richard R. Baldwin/TM1 of the Lunar Missions Office.

1.6 PRIORITY OF SCIENCE EXPERIMENTS AND OBJECTIVES

Science priorities are subject to the approval of the Associate Administrator for the Office of Space Sciences and Application (OSSA) and concurrence of the Apollo Program Director. Recommendations for this approval are submitted to OSSA by the Apollo Lunar Exploration Office (MAL). The priorities for the J-1 Mission experiments/objectives are the MSC ASPO/S&AD recommendations presented to MAL.

Science experiments and objectives 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 the science value of the experiment and the science benefits expected; the results obtained from previous missions; changes made in the science payload since previous missions; the science "opportunity" for the mission such as a particular landing site; "first time to fly" hardware; and the role of the experiment or objective in integrated science planning for future flights and programs.

This prioritization is of significance only when any of the experiments or objectives cannot be accomplished as planned because some contingency or abnormal situation occurs during the mission with a resulting impact on such major mission considerations as consumables availability, crew participation in the science activities, or 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 Lunar Orbit 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 Data Camera • Hasselblad Electric Camera • Maurer Data Acquisition Camera	CSM Orbital Science Photographic Team Mr. Frederick J. Doyle, Chairman Topographic Division U. S. Geological Survey 1340 Old Chainbridge Road McLean, Virginia 22101 (202) 343-9445	Mr. Samuel N. Hardee, Jr./TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621
S-176	Apollo Window Meteoroid	TBD	TBD
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./TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621
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./TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621

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

LUNAR ORBIT EXPERIMENT/OBJECTIVE NO.	TITLE	PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
-	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 Chainbridge Road McLean, Virginia 22101 (202) 343-9445 Laser Altimeter Data Analysis Dr. William M. Kaula Institute of Geophysics and Planetary Physics University of California at Los Angeles Los Angeles, California 90024 (203) 825-4363	Mr. Samuel N. Hardee, Jr./TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621
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/TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621
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/TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621

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

LUNAR ORBIT EXPERIMENT/OBJECTIVE		PRINCIPAL INVESTIGATOR	S&AD POINT-OF-CONTACT
NO.	TITLE		
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/TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621
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 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621
S-165	Mass Spectrometer	Dr. John H. Hoffman Atmospheric & Space Sciences University of Texas at Dallas P. O. Box 30365 Dallas, Texas 75230 (214) 231-1471 Ext. 322	Mr. Vernon M. Dauphin/TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621
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/TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621

Table 1-2. J-1 Lunar Orbit 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/TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621
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/TM2 Lunar Orbital Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-4621

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 Dr. Robert O. Pepin, Chairman School of Physics and Astronomy University of Minnesota Minneapolis, Minnesota 55455 (612) 373-7874	Mr. Martin L. Miller/TM3 Lunar Surface Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
-	Selected Sample Collection	MSC Science Working Panel Subgroup Dr. Robert O. Pepin, Chairman School of Physics and Astronomy University of Minnesota Minneapolis, Minnesota 55455 (612) 373-7874	Mr. Martin L. Miller/TM3 Lunar Surface Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-031	Passive Seismic (ALSEP Array A-2 Experiment)	Dr. Gary V. Latham Lamont-Doherty Geological Observ. Columbia University Palisades, New York 10964 (914) 359-2900	Mr. Wilbert F. Eichelman/TM3 Lunar Surface Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-034	Lunar Surface Magnetometer (ALSEP Array A-2 Experiment)	Dr. Palmer Dyal, Code N204-4 Space Science Division/Electro-dynamics Branch NASA Ames Research Center Moffett Field, California 94034 (415) 961-1111 Ext. 2706	Mr. Timothy T. White/TM3 Lunar Surface Experiments Office Lunar Missions Office 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-035	Solar Wind Spectrometer (ALSEP Array A-2 Experiment)	Dr. C. W. Snyder Jet Propulsion Laboratory 4800 Oak Grove Drive Pasadena, California 91103 (213) 354-3744 Ext. 2302	Mr. Martin L. Miller/TM3 Lunar Surface Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-036	Suprathermal Ion Detector (ALSEP Array A-2 Experiment)	Dr. J. W. Freeman Department of Space Science Rice University Houston, Texas 77001 (713) 528-4141 Ext. 1297	Mr. Martin L. Miller/TM3 Lunar Surface Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-037	Heat Flow (ALSEP Array A-2 Experiment)	Dr. Marcus E. Langseth Lamont-Doherty Geological Observatory Columbia University Palisades, New York 10964 (914) 359-2900	Mr. Wilbert F. Eichelman/TM3 Lunar Surface Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
S-058	Cold Cathode Ion Gauge (ALSEP Array A-2 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/TM3 Lunar Surface Experiments Office Lunar Missions Office 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-059	Lunar Field Geology	Dr. Gordon A. Swann Center of Astrogeology U. S. Geological Survey 601 E. Cedar Avenue Flagstaff, Arizona 86001 (602) 774-1406	Mr. Martin L. Miller/TM3 Lunar Surface Experiments Office Lunar Missions Office 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/TM3 Lunar Surface Experiments Office Lunar Missions Office 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/TM3 Lunar Surface Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666
M-515	Lunar Dust Detector (ALSEP Array A-2 Experiment)	Dr. Stanley C. Freden, Code 650 Laboratory for Meteorology and Earth Sciences NASA Goddard Space Flight Center Greenbelt, Maryland 20771 (301) 982-5249	Mr. Martin L. Miller/TM3 Lunar Surface Experiments Office Lunar Missions Office NASA Manned Spacecraft Center Houston, Texas 77058 (713) 483-2666

Table 1-4. J-1 Mission Lunar Science Experiment/Objective Priority

EXPERIMENT/OBJECTIVE	PRIORITY
Contingency Sample Collection	1
ALSEP Array A-2/Heat Flow	2
• Passive Seismic (S-031)	2.1
• Heat Flow (S-037)	2.2
• Lunar Surface Magnetometer (S-034)	2.3
• Solar Wind Spectrometer (S-035)	2.4
• Suprathermal Ion Detector (S-036)	2.5
• Cold Cathode Ion Gauge (S-058)	2.6
• Lunar Dust Detector (M-515)	2.7
Selected Sample Collection	3
Lunar Field Geology (S-059)	4
Laser Ranging Retro-Reflector	5
Gamma-Ray Spectrometer (S-160)	6
X-Ray Fluorescence (S-161)	7
Alpha Particle Spectrometer (S-162)	8
SM Orbital Photographic Tasks	9
• 24-Inch Panoramic Camera	9.1
• 3-Inch Mapping Camera	9.2
• Laser Altimeter	9.3
Subsatellite	10
• Particle Shadows/Boundary Layer (S-173)	10.1
• Magnetometer (S-174)	10.2
• S-Band Transponder (S-164)	10.3
Mass Spectrometer (S-165)	11
Soil Mechanics (S-200)	12
Bistatic Radar (S-170)	13
UV Photography-Earth and Moon (S-177)	14
CM Photographic Tasks	15
• Hasselblad Electric Data Camera	15.1
• Hasselblad Electric Camera	15.2
• Maurer Data Acquisition Camera	15.3
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SECTION II

EXPERIMENT AND EQUIPMENT DESCRIPTION

2.1 GENERAL

This section contains a brief description of the physical characteristics of the science hardware systems to be used for the scientific investigations and identifies any supporting hardware involved. These descriptions are intended only to aid in the understanding of the operational and deployment aspects of the experiments, to indicate the manner in which the experiment operates, and to show the relationship which the experiment has to the spacecraft and other experiments or equipment.

Equipment of an operational nature, such as the CM cameras used for the CM Photographic Tasks objective, are not described although such equipment is identified. Science equipment for lunar orbit activities is summarized in Table 2-1, and for lunar surface activities in Table 2.2. More detailed experiment descriptions may be found in such documents as CSM/LM Spacecraft Operational Data Book/Volume VI, CSM Experiments Data Book for J-Series Missions; Photo Equipment for Manned Space Flight Handbook; or the Apollo Lunar Surface Experiments Package (ALSEP), Flight Systems Familiarization Manual.

2.2 LUNAR ORBIT SCIENCE EXPERIMENTS AND OBJECTIVES

2.2.1 COMMAND MODULE SCIENCE EXPERIMENTS AND OBJECTIVES

2.2.1.1 CM Photographic Tasks

The purpose of the CM Photographic Tasks objective is to obtain photographs of the following:

a) Lunar surface areas of prime scientific interest (specifically using the opportunities afforded prior to SIM door jettison).

b) Specific segments of the lunar surface in earthshine and in low light near the terminator.

c) Diffuse galactic light of four specified celestial subjects.

d) Zodiacal light as the CSM approaches sunrise.

e) The solar corona after CSM sunset and prior to CSM sunrise.

f) A TBD lunar libration region.

g) The earth's darkside with use of the CM sextant.

h) The earth limb during solar eclipse by the earth.

i) Comets, if the opportunity arises.

These tasks involve the use of the following operational CM cameras: Hasselblad electric camera with a 250-mm lens; Hasselblad electric data camera with an 80-mm lens; and the 16-mm data acquisition camera with an 18-mm lens. The crew is required to operate the cameras and to record such items as GET, frame number, magazine number, and exposure time.

2.2.1.2 Apollo Window Meteoroid (S-176)

The function of this experiment is to obtain data pertaining to the meteoroid cratering flux for masses of 10^{-12} gm and larger, i.e., those particles responsible for the degradation of surfaces exposed to the space environment.

This experiment is passive in nature and makes use only of the CM windows, composed of fused silica, as meteoroid detectors. High magnification 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 function of this experiment is to obtain photographs in the UV spectrum 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. The photographs required are taken from the right-hand window of the CM while in earth orbit, lunar orbit, translunar coast, and transearth coast.

Photography is performed with the use of the operational Hasselblad electric camera that is mounted in a special window bracket. The CM window consists of a special quartz pane that transmits a large fraction of the incident UV radiation. The camera is to be provided a 105-mm UV transmitting lens and a ring slide containing four filters: three that admit wavelengths in different regions of the UV spectrum, and one that admits wavelengths in the visible spectrum. The crew is required to install the special bracket, mount and operate the camera, change filters, and to record the beginning and ending times of each photographic set.

2.2.1.4 Gegenschein from Lunar Orbit (S-178)

The function of this experiment is to make photographic observations of specified directions referenced to the gegenschein and Moulton point from lunar orbit. From these photographs a determination will be made of the extent of the contribution to the gegenschein of dust particles that may have collected to the Moulton point.

Photography is performed with the use of the 16-mm data acquisition camera using an 18-mm lens and an aperture setting of T1.0. The use of special window shades will also be required to minimize the effect of stray spacecraft light. The crew is required to maneuver the spacecraft to the proper photography attitude and to record the start and stop times of each of the required nine photographic exposures.

2.2.2 SERVICE MODULE SCIENCE EXPERIMENTS AND OBJECTIVES

2.2.2.1 SM Orbital Photographic Tasks

a. 24-Inch Panoramic Camera

The function of the 24-Inch Panoramic Camera (Figures 2-1 through 2-5) is to obtain high-resolution photography incorporating stereo coverage of the lunar surface from lunar orbit. The panoramic camera also provides support photography data for the other cameras and for experiment objectives performed in lunar orbit. The camera will provide 1-meter resolution photography at an orbital altitude of 60 NM.

The panoramic camera is composed of four main components: a roll frame assembly that rotates continuously in the cross track scan direction during camera operation; a gimbal assembly which tilts fore and aft to provide stereo coverage and forward motion compensation (FMC); the main frame; and a GN_2 pressure vessel assembly (provides GN_2 for certain film roller gas bearings). The GN_2 pressure vessel assembly is used also by the 3-Inch Mapping Camera. Film for the panoramic camera is stored in a cassette which must be retrieved by a crewman EVA during the transearth portion of the mission. The panoramic camera is mounted on structural beams 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.

CM crew camera controls are provided to activate/deactivate camera heaters; supply/remove primary camera power; select operate/standby camera operation modes; supply film roller torque to prevent film slack during launch, TLI, and other SPS-powered flight phases; and activate the five-film-frame advance cycle required daily to prevent film "set" after film loading. One CM crew display of the "GO/NO-GO" talkback type is provided to verify camera operational status.

b. <u>3-Inch Mapping Camera</u>

The function of the 3-Inch Mapping Camera (Figure 2-6) is to obtain high-quality metric photographs of the lunar surface and time-correlated stellar photographs. The mapping camera also provides supporting photography for the other cameras and for experiment objectives performed in lunar orbit. The stellar camera provides star field photography for precision spacecraft experiment postflight pointing knowledge, especially for the mapping camera and for those experiments acquiring data on the lunar dark side such as the laser altimeter. The mapping camera will provide 20-meter resolution photography at an orbital altitude of 60 NM.

The mapping camera subsystem is composed of two camera systems: the terrain mapping camera and stellar camera integrated into a single unit that has the optical axis relationship necessary to satisfy the precision mapping camera attitude-determination requirement; and the laser altimeter that is hard-mounted to the mapping camera in the required optical axis relationship. This subsystem also uses a GN_2 pressure vessel assembly (shared with the panoramic camera) to supply GN_2 which provides an inert and pressurized atmosphere within the cameras to help prevent unwanted film exposure. Film for the mapping and stellar cameras is stored in a common film cassette unit which must be retrieved by a crewman EVA during the transearth portion of the mission. The inclusion of a deployment mechanism completes the mapping camera subsystem.

The mapping camera subsystem is mounted on the second (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 (star field clear of both the lunar horizon and the SM mold line) for the stellar camera.

CM crew camera controls are provided to activate/deactivate camera heaters and the photography sequence, to activate/deactivate the FMC control switch and to change FMC control settings, and to extend/retract the mapping camera subsystem on deployment rails. Two CM crew displays of the talkback type are provided to verify camera operational status and to indicate whether the mapping camera subsystem is fully extended or fully retracted.

c. Laser Altimeter

The function of the Laser Altimeter (Figure 2-6) is to measure spacecraft altitude in lunar orbit with high precision. Specifically, it is to support mapping camera photography, to provide precision altitude data for other lunar orbital experiments, and to relate lunar topographical features for better definition of lunar shape. The altimeter is capable of supplying precise altitude ranging data to an accuracy of 1 meter.

The laser altimeter is hard-mounted and aligned to the mapping camera subsystem that is mounted on the top shelf in the CSM SIM bay. It is deployed on a rail-type mechanism when photography data are being acquired. The altimeter can operate in one of two modes. When the mapping camera is operating, it automatically emits a laser pulse to correspond to a mid-frame ranging measurement for each frame taken with the mapping camera. It is also capable of operating in a decoupled mode (from the mapping camera) which allows independent ranging measurements when the mapping camera is not operating.

CM crew controls are provided to activate/deactivate the altimeter. No CM crew displays are furnished specifically for the laser altimeter although they are available for the mapping camera subsystem.

2.2.2.2 Gamma-Ray Spectrometer (S-160)

The function of the Gamma-Ray Spectrometer Experiment assembly (Figures 2-7 and 2-8) is to measure from lunar orbit the gamma radiation flux emanating from the lunar surface. A galactic gamma radiation mapping exercise as well as a spacecraft gamma radiation environment determination will also be performed during transearth coast. The energy level of gamma radiation to be detected ranges from 0.2 MeV to 10 MeV.

The experiment sensing assembly is composed of a gamma-ray detector and its associated electronics. When gathering prime data, it is deployed from the CSM SIM bay on a boom by a boom deployment mechanism to remove the detector from the influence of the CSM radiation environment. The fully deployed distance is 25 feet past the SM mold line when the detector is in its primary operational mode. Boom extension to various intermediate distances will be done during transearth coast when the gamma radiation gradient as contributed by the CSM/SIM is to be measured. The experiment assembly (including the deployment mechanism) is suspended from the bottom of the first SIM shelf above the bottom of the SIM bay.

CM crew controls are provided to extend, to retract, and to jettison the boom. Any intermediate boom position may also be selected by timing the boom extension/retraction rate which is 3 ±1 inches per second. CM crew experiment controls are also provided to activate/deactivate the experiment, to change the experiment sensitivity gain, and to select one of two detector counting modes. Two CM crew displays are associated with boom status. They indicate the state of boom deployment (fully extended or retracted) and jettison (jettison complete or not).

2.2.2.3 X-Ray Fluorescence (S-161)

The function of the X-Ray Experiment assembly (Figure 2-9) is to measure from lunar orbit the characteristic fluorescent X-rays in the 1 KeV to 6 KeV range that are emitted as a result of the interaction of solar radiation with the lunar surface. A separate assembly (Figure 2-10), termed the solar monitor, is provided to measure the solar X-ray flux which is the excitation source for the lunar surface fluorescence produced. A data gathering period for instrument calibration is also to be performed during transearth coast.

The X-ray fluorescence sensing assembly consists of gas-filled proportional counters, passive filters, and supporting electronics which are housed in an integral package which also contains the alpha particle experiment. This combined package is mounted on the shelf forming the bottom of the CSM SIM bay. The solar monitor is mounted in the bay of the SM (Bay IV) opposite from that of the SIM to provide a view direction 180 degrees from that of the X-ray fluorescence sensor. The solar monitor has a door shielding its sensor until it is opened in lunar orbit.

The X-Ray Fluorescence Experiment is designed to acquire data in its SIM-installed position. No deployment mechanisms are required for experiment operation. CM crew-operated controls are provided for experiment activation/deactivation and deployment of the solar monitor door. There are no CM crew displays for this experiment.

2.2.2.4 Alpha Particle Spectrometer (S-162)

The function of the Alpha Particle Experiment assembly (Figure 2-9) is to measure from lunar orbit mono-energetic alpha particles emitted from the lunar surface crust by the emission of radon gas isotopes (Rn^{220} and Rn^{222}). The energy level of alpha particles to be detected ranges from 3.5 MeV to 7.5 MeV.

The alpha particle sensing assembly is composed of an array of detectors and supporting electronics housed in the same integral enclosure as the X-ray fluorescence sensor.

The Alpha Particle Spectrometer Experiment is designed to acquire data in its SIM-installed position. No deployment mechanisms are required for experiment operation. CM crew-operated controls are provided for experiment activation and deactivation. There are no CM crew displays for this experiment.

2.2.2.5 Mass Spectrometer (S-165)

The function of the Mass Spectrometer (Figures 2-7 and 2-11) is to obtain data from lunar orbit relative to identifying the constituents of the lunar atmosphere, and to aid in the identification and understanding of transport processes that take place in a planetary exosphere. The spectrometer has the capability of identifying species with atomic mass units (AMU's) ranging from 12-28 AMU with its No. 1 ion counter and from 28-66 AMU with its No. 2 ion counter.

The spectrometer assembly consists of the mass spectrometer and its associated electronic components. When gathering prime data, the spectrometer assembly is deployed from the CSM SIM bay on a boom by a boom deployment mechanism to remove the spectrometer from the influence of CSM contaminant sources. The fully deployed distance is 24 feet past the SM mold line when the spectrometer is in its primary operational mode. The spectrometer also acquires data at various intermediate positions during transearth coast to determine the CSM contamination "gradient". The spectrometer assembly's inlet plenum is designed such that atmospheric species enter it when the spacecraft is orbiting with its "-X" axis facing in the direction of the spacecraft orbital velocity vector. The experiment assembly (including the deployment mechanism) is suspended from the bottom of the first SIM shelf above the bottom of the SIM bay. The gamma-ray and mass spectrometers are separated by about 15 feet when both are in the fully deployed position.

CM crew controls are provided to extend, to retract, and to jettison the boom. Any intermediate boom position may also be selected by timing the boom extension/retraction rate which is 3 ±1 inches per second. CM control capability is also provided to activate/deactivate the experiment, to increase or decrease the spectrometer sensitivity (two methods provided), and to activate/deactivate the experiment ion source heaters. There are two CM crew displays 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 (Figure 2-12), 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. The experiments to be carried by the subsatellite 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 consist of the subsatellite itself, a launch platform, and a deployment mechanism to deploy the subsatellite and launch platform from the CSM SIM bay. The deployment mechanism provides for a subsatellite launch position that is about 30 inches clear of the SM mold line. The deployment mechanism is retracted after launch. The launch platform imparts to the subsatellite a spin rate of about 140 rpm for attitude stabilization and a launch velocity of about 4 fps to effect the desired launch clearance from the CSM. The subsatellite has three booms each of which automatically deploys at launch to 5 feet. The subsatellite magnetometer is mounted at the end of one boom, whereas the other two booms are provided to achieve the desired balanced spin stabilization characteristics of the subsatellite.

The subsatellite itself consists of charged particle detectors, a magnetometer, a data storage unit, a solar cell battery power system, and an S-band communications subsystem. CM crew controls are provided to deploy and to launch the subsatellite as well as to retract the deployment mechanism into the SIM bay. One multipurpose CM crew display is provided to verify launch of the subsatellite and full retraction of the deployment mechanism.

a. S-Band Transponder (S-164)

The function of the subsatellite S-Band Transponder Experiment is to obtain long-term Doppler tracking data of the unperturbed subsatellite in lunar orbit to describe the lunar gravitational field. This experiment requires no hardware or supporting equipment other than the transponder that is a part of the subsatellite S-band communications subsystem.

b. Particle Shadows/Boundary Layer (S-173)

The function of the Particle Shadows/Boundary Layer Experiment (Figure 2-13) is to obtain data on wave particle interactions occurring within the solar wind boundary layer as the solar wind flows over the moon. These data will, in turn, yield information relative to plasma flow and electric fields associated with the solar wind and the earth's magnetotail. Solar flare electron events are also to be monitored.

The subsatellite charged particle detectors and corresponding subsatellite support subsystems are used for this experiment. The detectors are capable of detecting protons in the energy range of 0.3-6.0 MeV and electrons in the energy range of 0.5-1.0 KeV, 2.0-3.0 KeV, 6.5-8.5 KeV, and 13.5-16.5 KeV.

c. Subsatellite Magnetometer (S-174)

The function of the Subsatellite Magnetometer Experiment (Figure 2-13) is to obtain data on the lunar magnetic field and the earth's magnetosphere.

The subsatellite magnetometer, boom-deployed to remove itself from the magnetic environment of the subsatellite, and corresponding subsatellite support subsystems are used for this experiment. The magnetometer that acquires the prime data for this experiment is of the biaxial fluxgate type. This magnetometer is capable of measuring 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 provides the third vector component. The dynamic range of each component can be measured up to 200 γ.

2.2.2.7 S-Band Transponder (S-164)

The S-Band Transponder Experiment uses the CSM and LM S-band transponders in much the same manner as does the S-Band Transponder Experiment conducted on the subsatellite. The S-Band Transponder Experiment acquires unperturbed (if possible) Doppler tracking data of the LM during the unpowered portions of its descent to the lunar surface impact after CSM rendezvous. These tracking data are used to better define the lunar gravitational field. The low-altitude Doppler data obtained from the LM are especially valuable. This experiment requires no hardware or supporting equipment other than the use of the spacecraft transponder that composes a part of the spacecraft S-band communications subsystem.

2.2.2.8 Bistatic Radar (S-170)

The function of the Bistatic Radar Experiment is to obtain S-band and VHF bistatic radar data on the lunar crust. These data can then be used to indicate lunar surface roughness, surface shape, and the surface material Brewster angle (a measure of the dielectric constant of the surface material). This experiment requires no hardware or supporting equipment other than the CSM S-band and VHF communications subsystems. The crew is required to maintain a specific spacecraft attitude during the time period that measurements are being obtained.

2.3 LUNAR SURFACE SCIENCE EXPERIMENTS AND OBJECTIVES

2.3.1 ALSEP EXPERIMENTS

2.3.1.1 ALSEP Central Station

The ALSEP Central Station (Figure 2-14), though not an experiment, is important functionally to the array of surface experiments (ALSEP) with which it interfaces, in that it provides all the subsystems necessary to support these experiments. The experiments which it supports include 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 MCC/MSFN ground commands. Electrical power (dc) for the data and experiment subsystems is provided by a 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 2-15 through 2-17) are stored in the LM SEQ bay; the RTG fuel capsule is attached to the outside of the LM descent stage (Figure 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.

Photography requirements of the deployed central station and ALSEP experiments (Figures 2-21 and 2-22) are accomplished with the Hasselblad electric data camera and its 60-mm lens.

2.3.1.2 Passive Seismic Experiment (S-031)

The function of the Passive Seismic Experiment (PSE) is to monitor lunar seismic activity and to detect meteoroid impacts and free oscillations of the moon should they occur. Lunar surface crust (tidal) deformations can also conceivably be detected.

The Passive Seismic Experiment (Figures 2-23 and 2-24) consists of two seismic assemblies: a long-period seisometer (tri-axial, orthogonal) with a seismic frequency response of 0.004 to 3 Hertz (80 dB dynamic range); and a short-period seisometer (uniaxial, vertical motion) with a seismic frequency response of 0.05 to 20 Hertz (80 dB dynamic range). The minimum detectable signals of the PSE are 10 mμ for the SP and all LP seismic signals; 0.4 arc-sec for the LP horizontal tidal output signal; and 320 μgal for the LP vertical tidal output signal. These seisometers are housed in a drum-shaped enclosure rounded on one end. This enclosure rests on a support structure covered by a thermal shroud after deployment. The PSE electronics package located in the central station is cable-connected to the seisometers (Figure 2-25).

2.3.1.3 Lunar Surface Magnetometer (S-034)

The function of the Lunar Surface Magnetometer (LSM) is to measure the magnitude and time variations of the lunar surface magnetic field vector.

The LSM equipment (Figure 2-26) 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 ranges of $\pm 100\ \gamma$, $\pm 200\ \gamma$, or $\pm 400\ \gamma$ (earth-commanded) with a resolution and accuracy of 0.2% and 0.5% full scale, respectively. The boom-mounted sensors can be rotated by small, automatically programmed electric motors. The electronics package is cable-connected to the central station.

2.3.1.4 Solar Wind Spectrometer (S-035)

The function of the Solar Wind Spectrometer (SWS) is to measure the energies, densities, incidence angles, and temporal variations of the electron and proton components of the solar wind plasma that strikes 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 if it can be detected; and the properties of the earth's magnetospheric tail. Electrons can be detected in the energy range of 6.2 to 817 eV and 10.5 to 1376 eV. Protons are detected in the range of 45 to 5700 eV and 75 to 9600 eV.

The SWS equipment (Figure 2-27) consists of a sensor assembly, electronic 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 take-off 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 function of the Suprathermal Ion Detector Experiment (SIDE), composed of the suprathermal ion detector and the cold cathode ion gauge (CCIG), is to measure the ionic environment of the moon by detecting the ions resulting from the UV ionization of the lunar atmosphere and the solar wind flow/lunar surface interaction. 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 of 4×10^4 cm/sec to 9.35×10^6 cm/sec and the energy range of 0.2 eV to 48.6 eV, which will enable the 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 eV and 3500 eV. The CCIG determines the pressure of the ambient lunar atmosphere (10^{-6} to 10^{-12} torr capability) by measuring the density of neutral atoms and gauge temperature at the time of measurement. 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 2-28) 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, and thermal spacers in addition to heaters for thermal control. The base of the chassis is supported by three foldable legs. The CCIG housing deployed separately from the SIDE is connected to it by a short cable. The ground plane is placed beneath the experiments to provide an equi-potential reference surface for control of local electric fields. The SIDE is connected to the ALSEP central station with a flat cable.

2.3.1.6 Heat Flow Experiment (S-037)

The function of the Heat Flow Experiment is to measure the net outward flux of heat from the moon's 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 (gradient) measurements of ±2°C (0.003°C) temperature difference; low sensitivity (gradient) measurements of ±20°C (0.03°C) temperature difference; probe ambient temperatures in the range of 200 to 250°K (0.1°C); thermocouple reference temperature of -20°C to 60°C (0.1°C); and probe cable ambient temperatures of 90° to 350°K (0.3°C).

The Heat Flow Experiment equipment (Figures 2-29 and 2-30) consists of two probes each about 45 inches in length for insertion into each of the drilled holes, a special tool for probe insertion, and an electronics package that is cable-connected to the probes and the central station. The ALSD (Figure 2-31) is composed of the drill with core stem caps and retainers, core stems, a core bit, a treadle, and a drill string wrench.

2.3.1.7 Lunar Dust Detector Experiment (M-515)

The function of the Lunar Dust Detector Experiment 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 temperatures.

The dust detector (Figure 2-32) has two components: a sensor package mounted to the top of the central station sun-shield 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 OBJECTIVES

2.3.2.1 Contingency Sample Collection

The function of the Contingency Sample Collection Objective is to obtain a small sample (about 2 pounds) of loose lunar soil material in the immediate vicinity of the LM during the early part of the first lunar surface EVA period. This will provide at least a minimum soil sample for later earth analysis should the EVA and the lunar stay be terminated early.

The equipment used for this objective are the contingency sampler, the contingency sample collection container, and sample return container No. 1 (Figures 2-33 and 2-34). The Hasselblad electric data camera (60-mm lens) is used to satisfy photographic requirements.

2.3.2.2 Selected Sample Collection

The function of the Selected Sample Collection Objective is to obtain geologically interesting lunar material during the first lunar surface EVA period. This will provide a greater variety of lunar soil samples for later earth analysis should the EVA and the lunar stay be terminated early.

The equipment used for this objective are the Apollo Lunar Hand Tools, documented sample bags, weigh bag, and sample return container No. 1 (Figures 2-34 and 2-35). The Hasselblad electric data camera (60-mm lens) is used to satisfy photographic requirements.

2.3.2.3 Lunar Field Geology (S-059)

The function of the Lunar Field Geology Experiment is to obtain a collection of documented lunar material samples and photographs/observations of lunar topographic features. These data will increase the knowledge and understanding of the nature and origin of the moon and the processes which have modified it.

The major equipment used for this experiment are: hammer; tongs; extension handle; small scoop; large scoop; brush/scribe/lens tool; gnomon; color patch; spring scale; core tubes; cap and bracket assembly (for "driving" the core tubes); sample bags; weigh bags; collection bags; and sample return containers (Figures 2-34 and 2-35). Geology core samples are also obtained with the use of the ALSD. The hand tools (hammer, tongs, etc.) used for this experiment are the standard Apollo lunar hand tools (ALHT) and will be located on the hand-tool carrier attached to the LRV (Figure 2-36).

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

2.3.2.4 Laser Ranging Retro-Reflector (S-078)

The function of the Laser Ranging Retro-Reflector (LRRR) is to provide a corner reflector for laser energy beamed from one or more earth-based stations. These ranging data will provide information relative to lunar motion, lunar librations, and earth rotation.

The LRRR experiment (Figure 2-37) consists of a folded panel structure incorporating 300 individual fused, silica optical corner reflectors and a simple aim-handle mechanism. The LRRR becomes passive in nature after deployment. The LRV is to be used for deployment. 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 function of the Soil Mechanics Experiment is to obtain data pertaining to the characteristics and mechanical behavior of the lunar soil at the surface and subsurface and the variation of these properties in a lateral direction.

The equipment (Figure 2-38) for the Soil Mechanics Experiment includes the use of the trenching tool, core tube samples, and other physical data obtained from the lunar field geology activities. Additional equipment being considered are the use of a self-recording penetrometer (interfaces with the ALHT extension handle) and load plate interchangeable with a common staff-type handle.

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).

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/250-mm lens • Hasselblad Electric Data Camera/80-mm lens • Data Acquisition Camera/ 18-mm lens
S-176	Apollo Window Meteoroid	Command Module	None	• CM Windows
S-177	UV Photography - Earth and Moon	Command Module	None	• Special CM RH quartz window (high UV transmissivity) • Electric Hasselblad Camera/105-mm lens (UV transmitting) • Mounting Bracket • 3 Filters - UV Spectrum • 1 Filter - Visible Spectrum
S-178	Gegenschein From Lunar Orbit	Command Module	None	• Data Acquisition Camera/ 18-mm lens • CM Window Shades

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
			
			Rail-Type Mechanism
			
			Rail-Type Mechanism (hard-mounted to Mapping Camera)
				• 24-Inch Panoramic Camera
				  • Roll-Frame Assembly
				  • Gimbal Assembly
				  • Main Frame
				  • GN_2 Pressure Vessel Assembly
				  • Film Cassette
				  • CM Crew-Operated Switches (3)
				  • CM Crew Display (1)
				• 3-Inch Mapping Camera
				  • Terrain Camera
				  • Stellar Camera
				  • GN_2 Pressure Vessel Assembly
				  • Film Cassette
				  • CM Crew-Operated Switches (3)
				  • CM Crew Displays (2)
				• Laser Altimeter
				  • CM Crew-Operated Switches (1)

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 • Boom Deployment Assembly • CM Crew-Operated Switches (4) • CM Crew Displays (2)
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 • CM Crew-Operated Switches (2)
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) • CM Crew-Operated Switches (1)

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

EXP. NO.	EXPERIMENT/OBJECTIVE	SPACECRAFT LOCATION	DEPLOYMENT	EQUIPMENT
S-164	S-Band Transponder (CSM/LM)	• 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 • Electronics • Boom Deployment Mechanism • CM Crew-Operated Switches (6) • CM Crew Displays (2)
---	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 • CM Crew-Operated Switches (1) • CM Crew Displays (1)

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

EXP. NO.	EXPERIMENT/OBJECTIVE	SPACECRAFT LOCATION	DEPLOYMENT	EQUIPMENT
S-173	Particle Shadows/Boundary Layer	Subsatellite	None	• Charged Particle Detectors • Subsatellite Support Subsystems
S-174	Subsatellite Magnetometer	Subsatellite	5-Foot Subsatellite Boom	• Magnetometer • Subsatellite Support Subsystems • Deployment Boom
S-164	S-Band Transponder	Subsatellite	None	• Spacecraft S-band Communications Subsystem
S-170	Bistatic Radar	Service Module	None	• Spacecraft S-band and VHF Communications Subsystems

Table 2-2. Lunar Surface Science Equipment Summary

EXP. NO.	EXPERIMENT/OBJECTIVE	CENTRAL STATION INTERFACE	EQUIPMENT
---	Contingency Sample Collection	No	• Contingency Sampler Assembly • Sample Return Container No. 1 • Hasselblad Electric Data Camera/ 60-mm lens
---	Selected Sample Collection	No	• Apollo Lunar Hand Tools • Documented Sample Bags • Collection Bag • Weigh Bag • Sample Return Container No. 1 • Hasselblad Electric Data Camera/ 60-mm lens
---	ALSEP Central Station (ALSEP Array A-2/Heat Flow)	--	• ALSEP Communications Subsystem (including antenna) • ALSEP Data Subsystem • Electronics Subsystem for ALSEP Seismic Experiment • Housing for Above Subsystems • Astronaut Switch Panel • RTG Power Source and Power Conditioning Unit • 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-031	Passive Seismic Experiment (ALSEP Array A-2/Heat Flow)	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
S-034	Lunar Surface Magnetometer (ALSEP Array A-2/Heat Flow)	Yes	• Boom-Mounted, Fluxgate Magnetometers (3) • Electric Drive Motors • Electronics Package • Hasselblad Electric Data Camera/ 60-mm lens
S-035	Solar Wind Spectrometer (ALSEP Array A-2/Heat Flow)	Yes	• Sensor Assembly - Faraday Cups (7) • Electronic Assembly • Thermal Control Assembly • Leg Assembly
S-036	Suprathermal Ion Detector (ALSEP Array A-2/Heat Flow)	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)

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

EXP. NO.	EXPERIMENT/OBJECTIVE	CENTRAL STATION INTERFACE	EQUIPMENT

S-037	Heat Flow Experiment (ALSEP Array A-2/Heat Flow)	Yes	• Apollo Lunar Surface Drill
			  • Drill
			  • Core Stem Caps and Retainers (2 Pkgs.)
			  • Core Stems (6)
			  • Core Bit
			  • 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 (ALSEP Array A-2/Heat Flow)	Yes (Through Interface with S-036)	• Ion Detector • Housing
M-515	Lunar Dust Detector (ALSEP Array A-2/Heat Flow)	Yes	• Sensor Package • Solar Cells (3) • Printed Circuit Board (Central Station PDU Interface)

S-059	Lunar Field Geology	No	• Apollo Lunar Hand Tools Carrier and Tools
			  • Hammer
			  • Extension Handle
			  • Tongs (2)

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

EXP. NO.	EXPERIMENT/OBJECTIVE	CENTRAL STATION INTERFACE	EQUIPMENT

S-059 (Cont'd)	Lunar Field Geology	No	• Large Scoop
			  • Small Scoop
			  • Gnomon
			  • Scribe/Brush/Lens, Etc.
			  • Core Tubes (9)
			  • Cap and Bracket Assemblies (3)
			• Documented Sample Bag Dispenser (3)
			  • 35 Sample Bags per Dispenser
			• Ring-Type Bag Dispenser (1)
			  • 15 Documented Sample Bags
			• Collection Bag (3)
			• Weigh Bag (6)
			• Apollo Lunar Sample Return Container (3)
			• Hasselblad Electric Data Camera/ 60-mm lens
			• Science Support
			  • Lunar Surface Color TV Camera
			  • 16-mm Data Acquisition Camera
			  • LRV
			  • ALSD

S-078	Laser Ranging Retro-Reflector	No	• Retro-Reflector Assembly
			  • Corner Reflectors (300)
			  • Aim-Handle Mechanism
			• Hasselblad Electric Data Camera/ 60-mm lens
			• LRV (for deployment)

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

EXP. NO.	EXPERIMENT/OBJECTIVE	CENTRAL STATION INTERFACE	EQUIPMENT
S-200	Soil Mechanics	No	• Trenching Tool • Self-Recording Penetrometer • Hasselblad Electric Data Camera/ 60-mm lens • Battery Operated Data Acquisition Camera/10-mm lens • S-059 Equipment

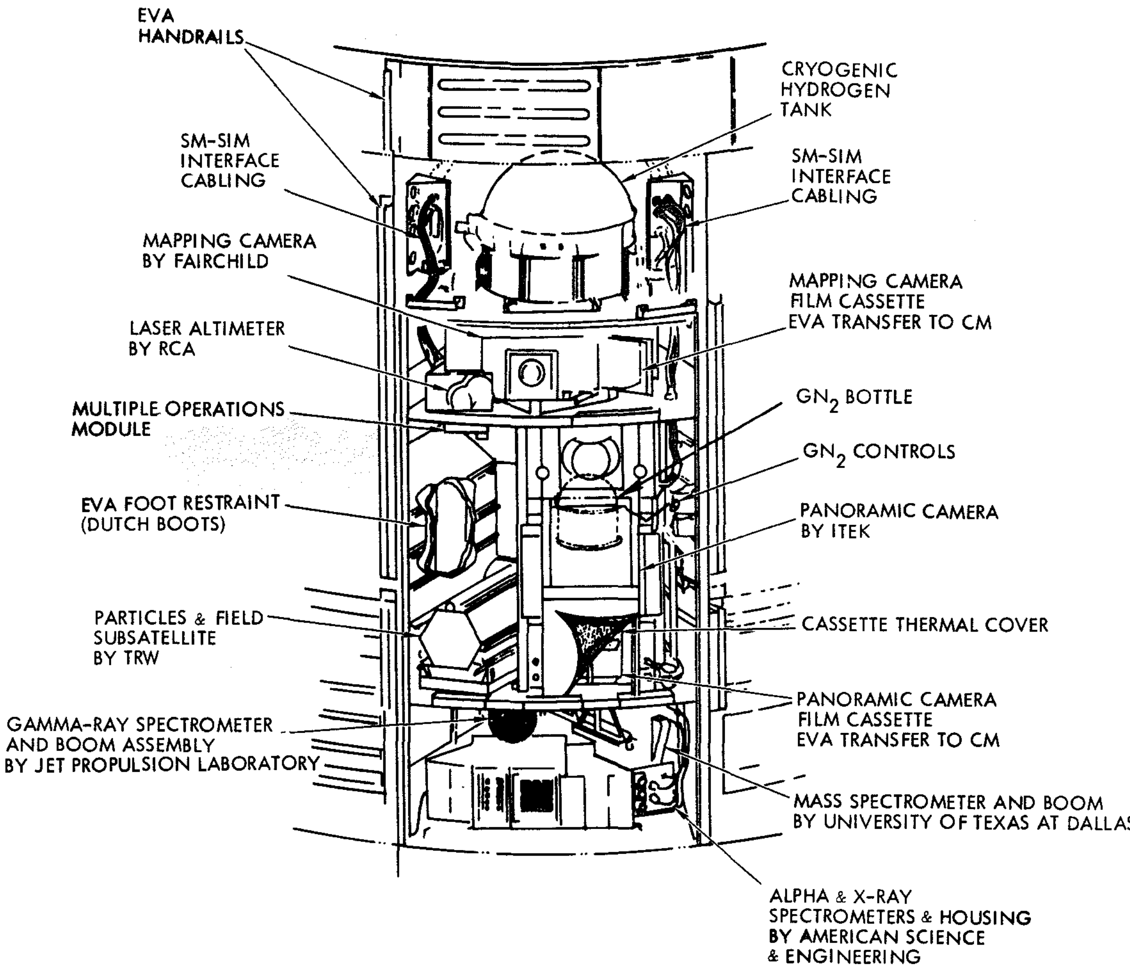


Figure 2-1. J-1 Mission SIM Bay Orbit Experiments Installation

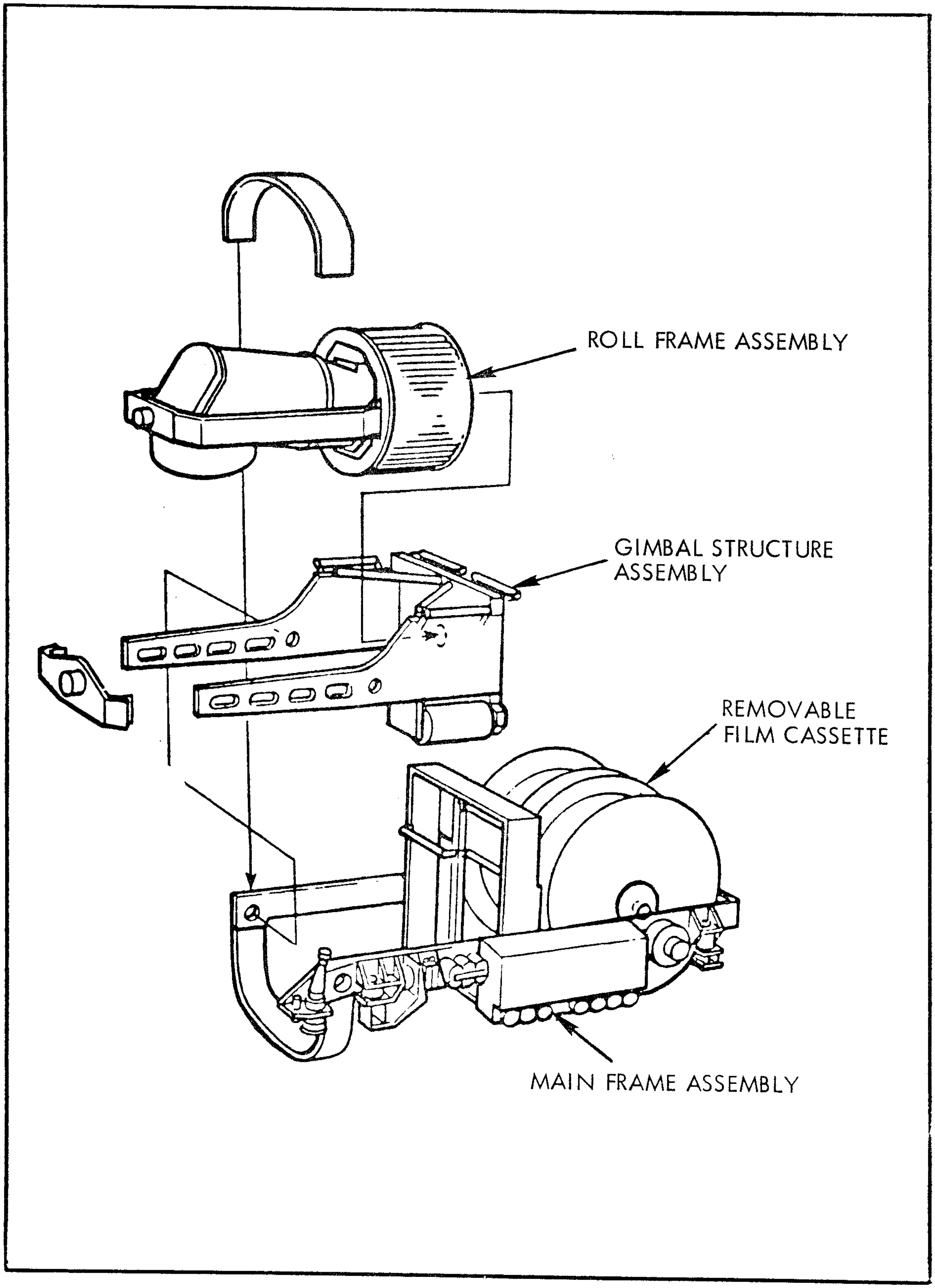


Figure 2-2. Major 24-Inch Panoramic Camera Subassemblies

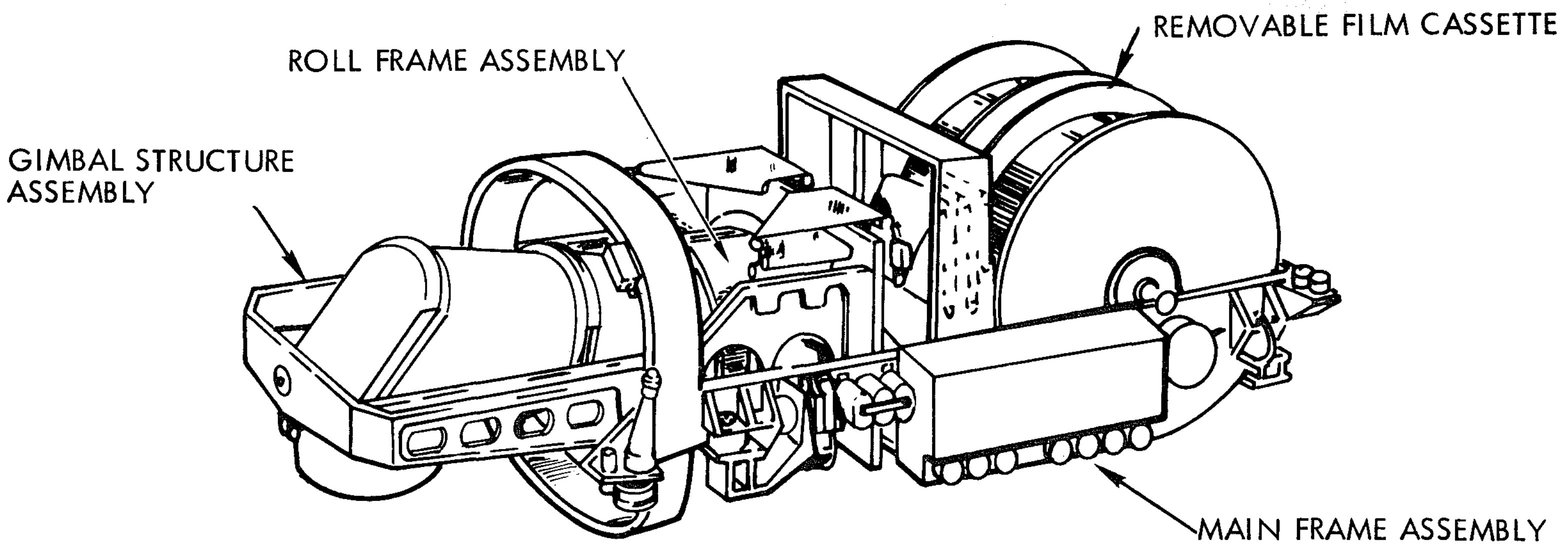


Figure 2-3. 24-Inch Panoramic Camera

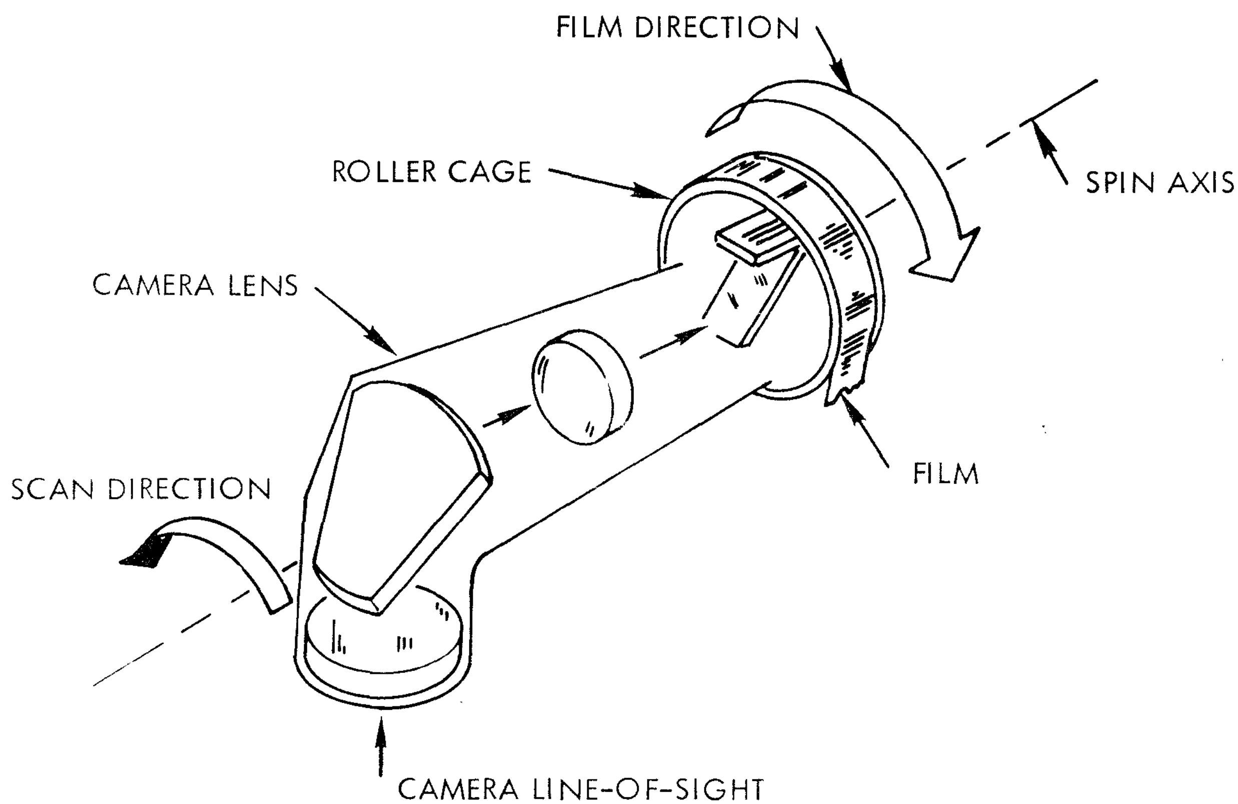
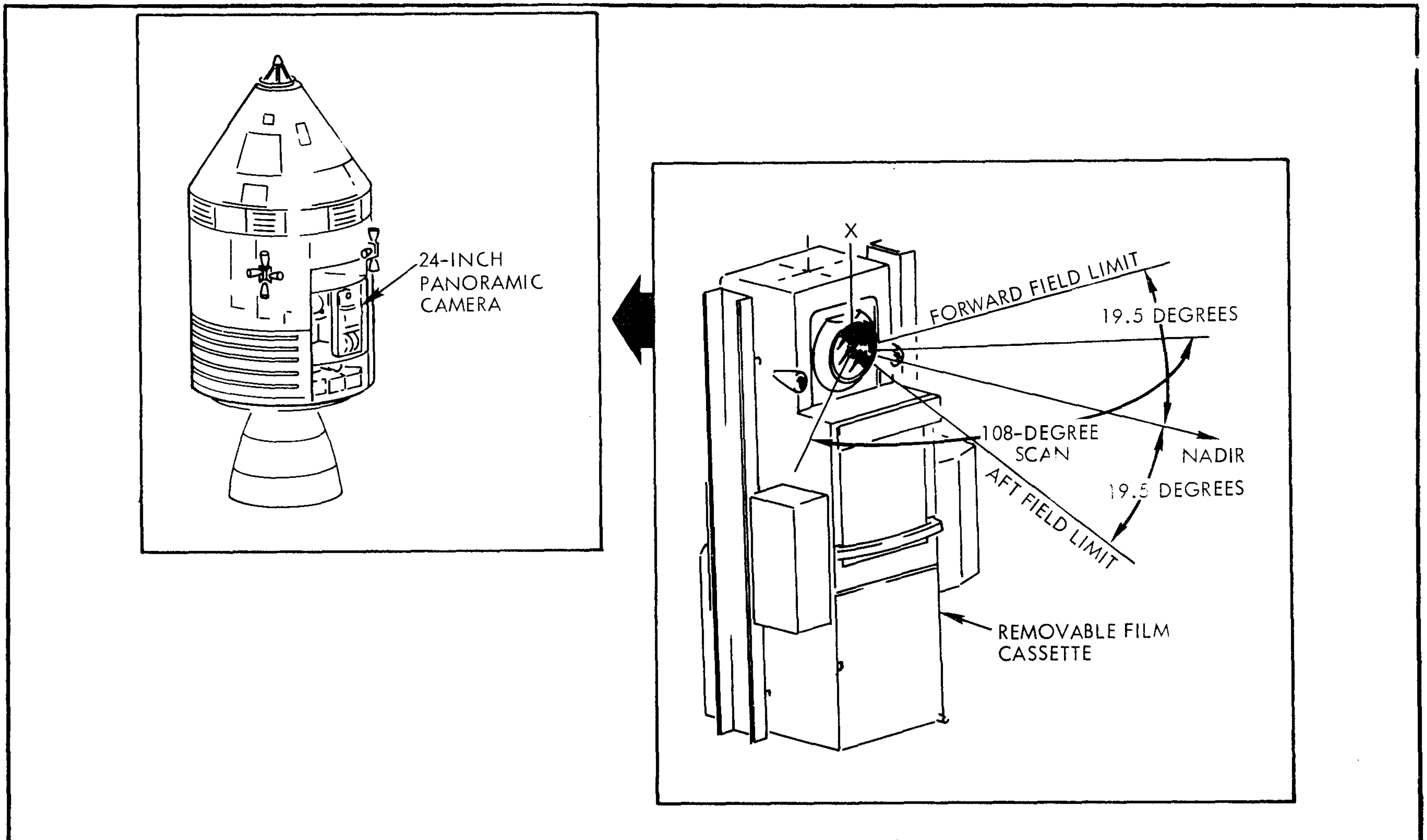
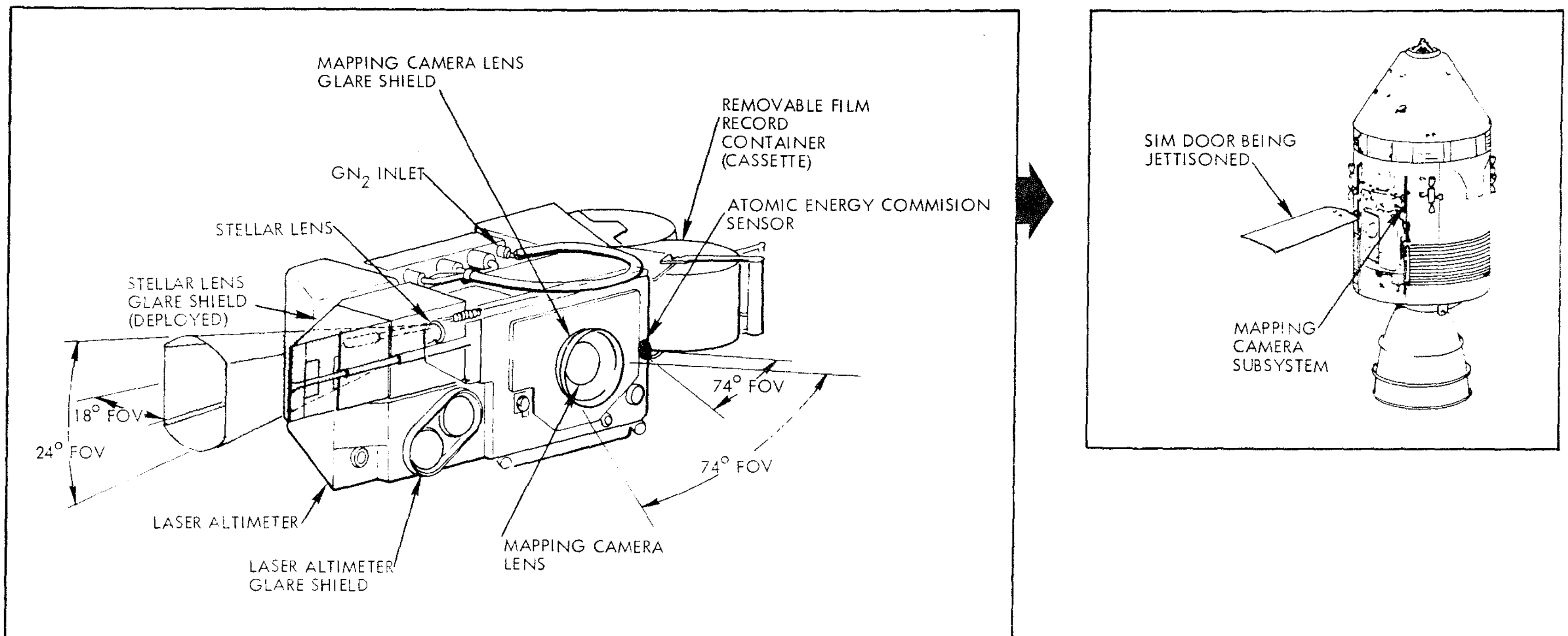


Figure 2-4. 24-Inch Panoramic Camera Optics Detail



24-INCH PANORAMIC CAMERA ASSEMBLY
(SM ORBITAL PHOTOGRAPHIC TASKS)

Figure 2-5. Field-of-View Detail of 24-Inch Panoramic Camera Assembly



THREE-INCH MAPPING CAMERA AND LASER ALTIMETER ASSEMBLY
(SM ORBITAL PHOTOGRAPHIC TASKS)

Figure 2-6. 3-Inch Mapping Camera and Laser Altimeter Assembly

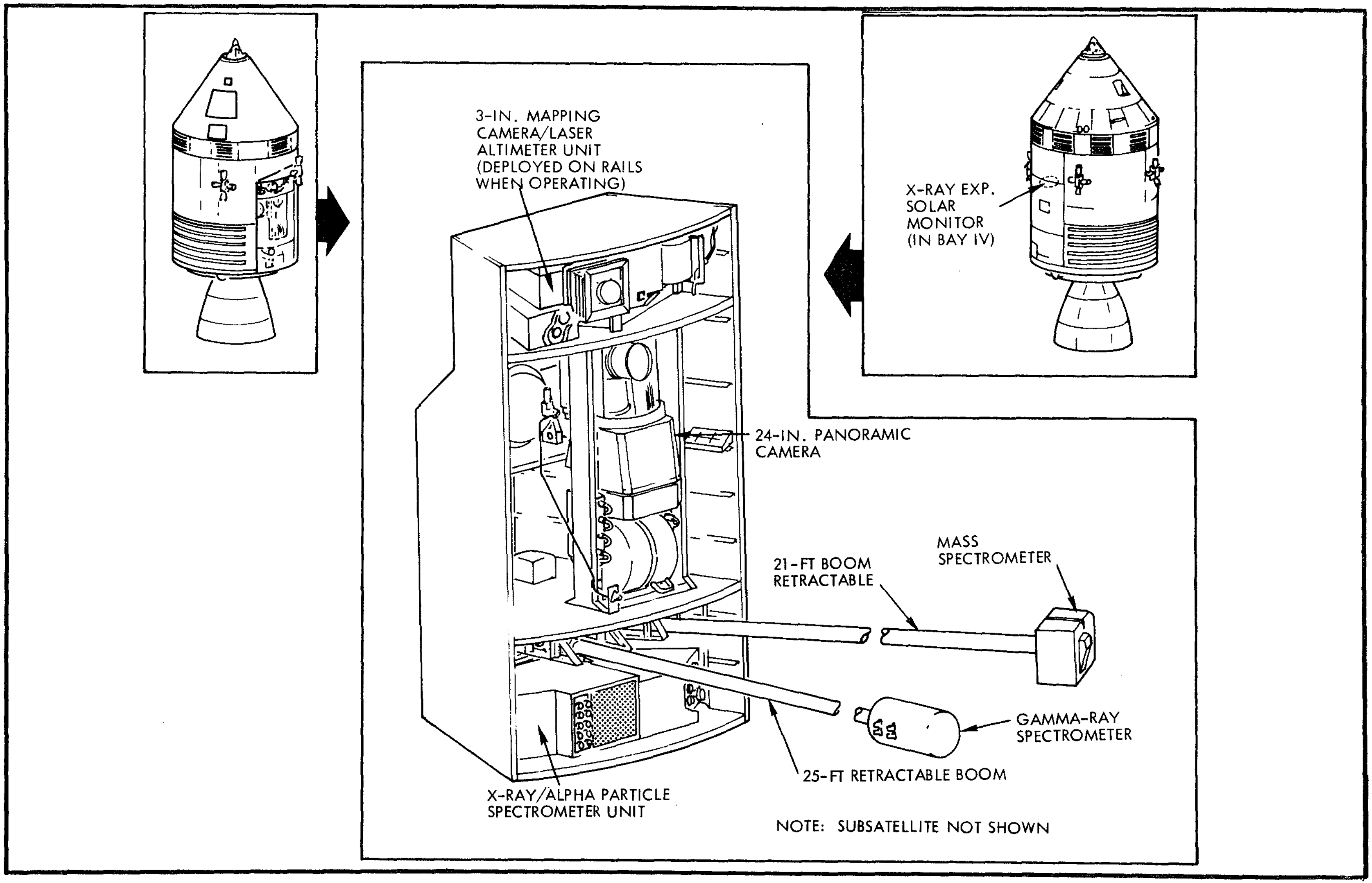


Figure 2-7. SIM Bay Boom-Mounted Experiment Deployment

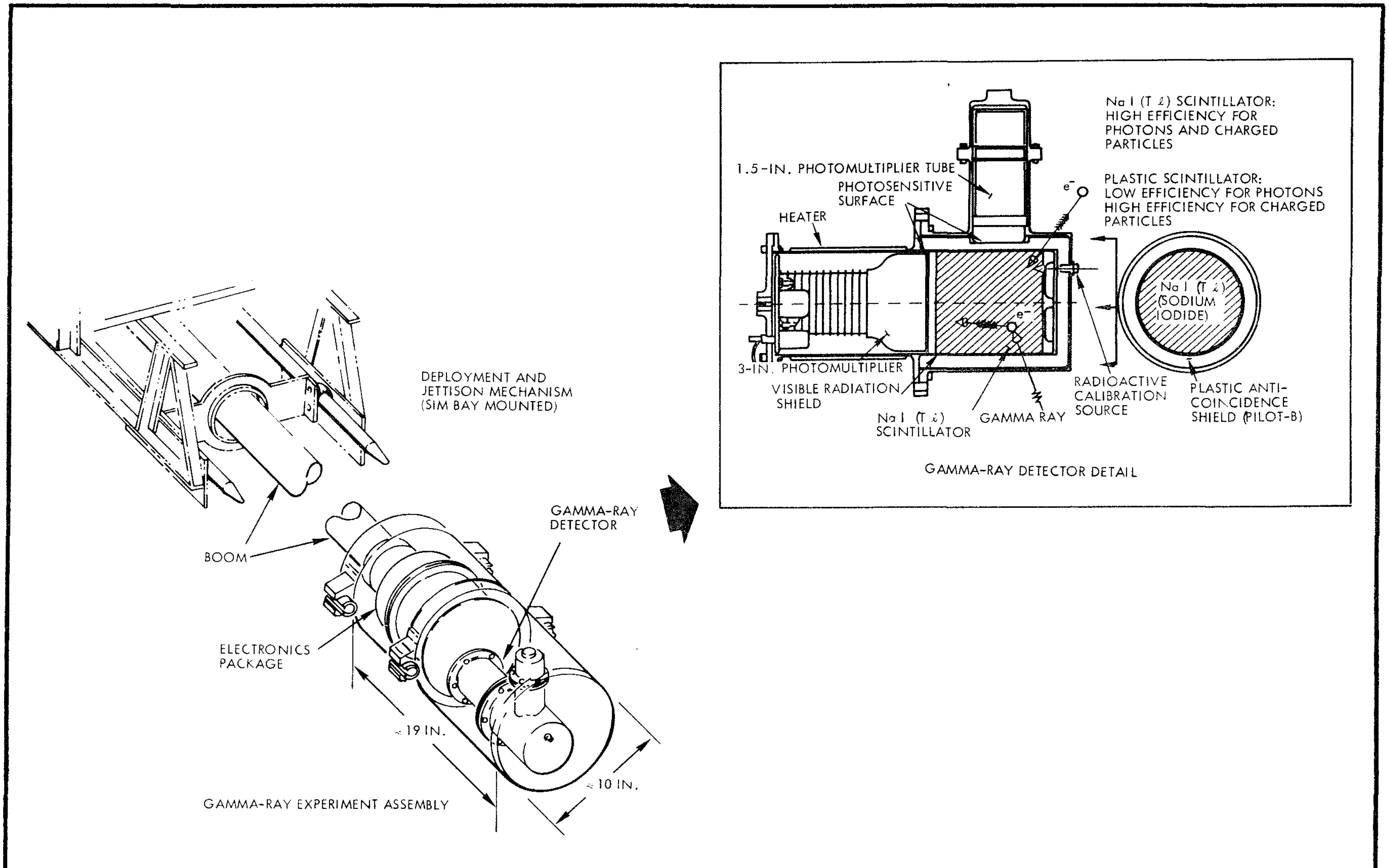


Figure 2-8. SIM Bay Gamma-Ray Spectrometer Experiment Assembly

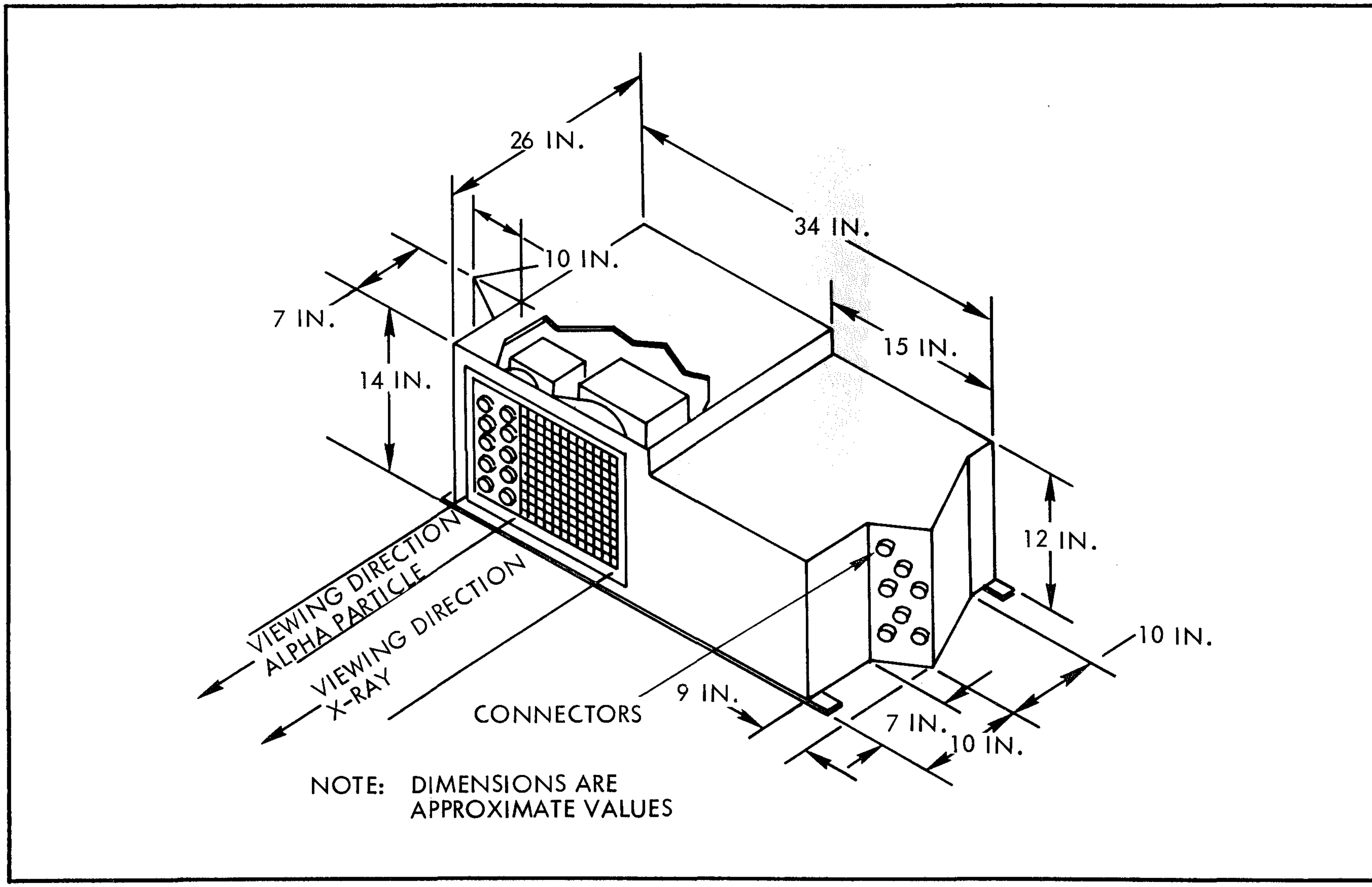


Figure 2-9. SIM Bay Housing of Alpha Particle/X-Ray Fluorescence Sensors and Electronics

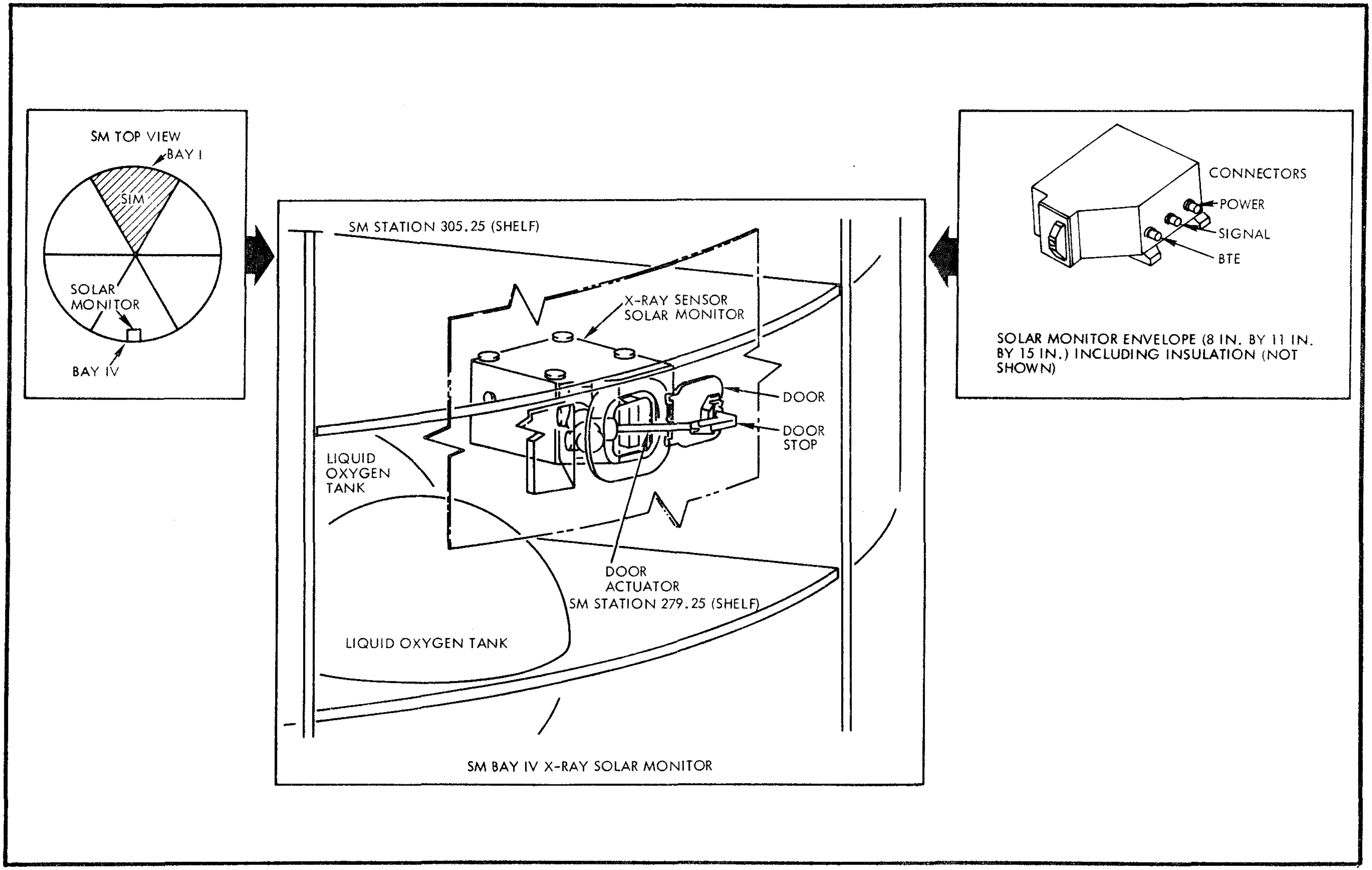


Figure 2-10. SM Mounting of X-Ray Fluorescence Solar Monitor

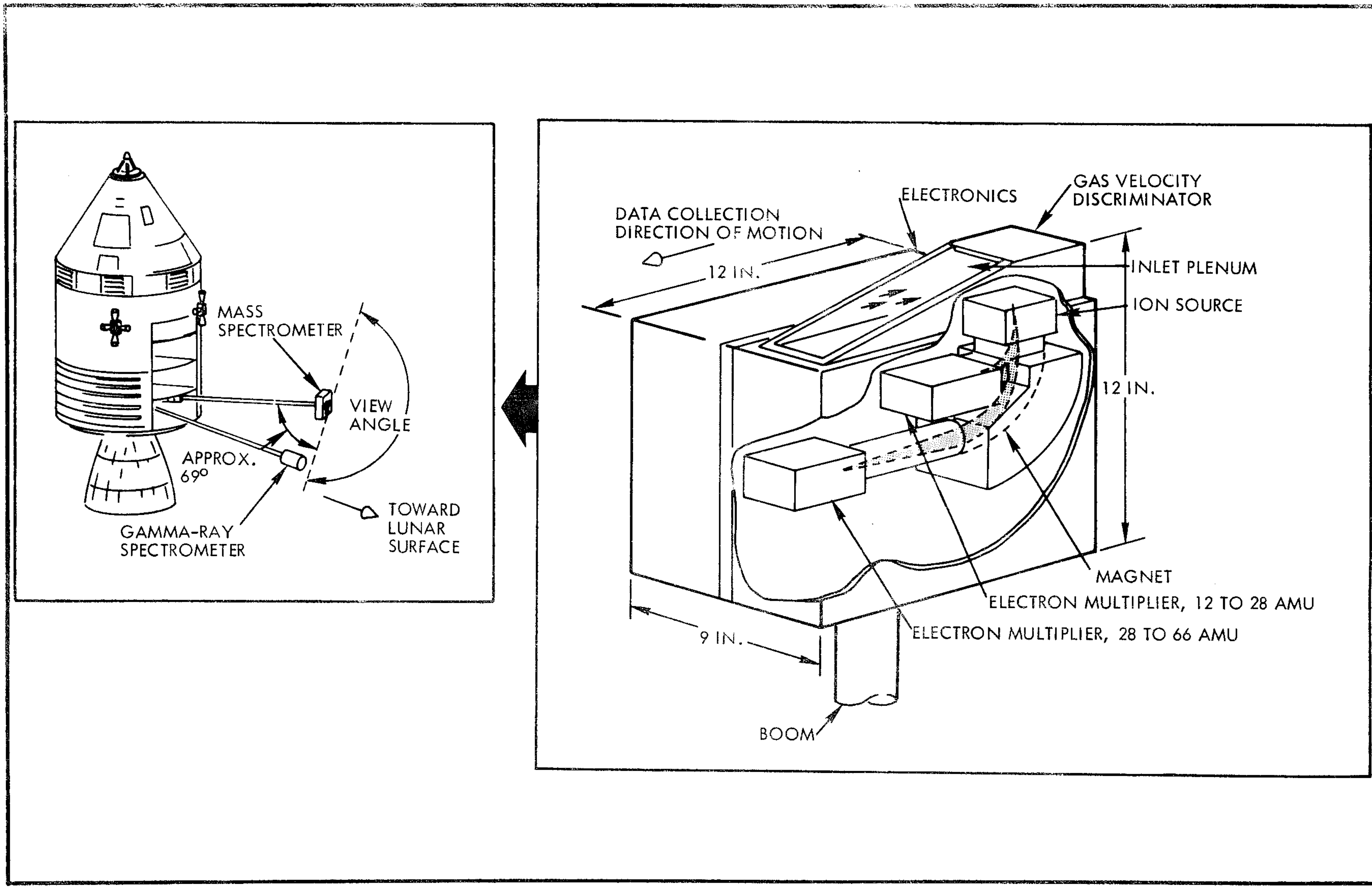


Figure 2-11. Mass Spectrometer Experiment Assembly

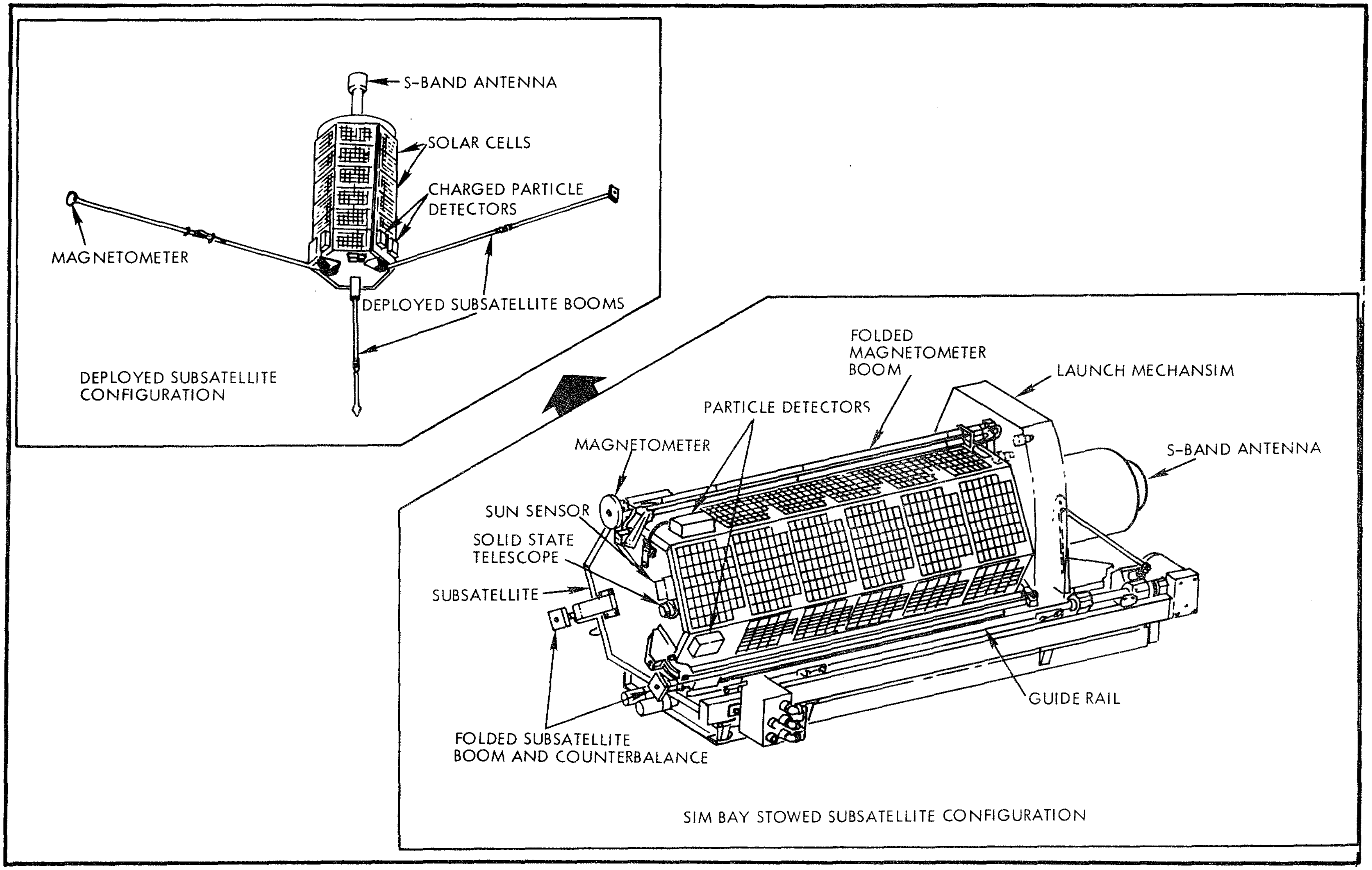


Figure 2-12. SIM Bay Subsatellite

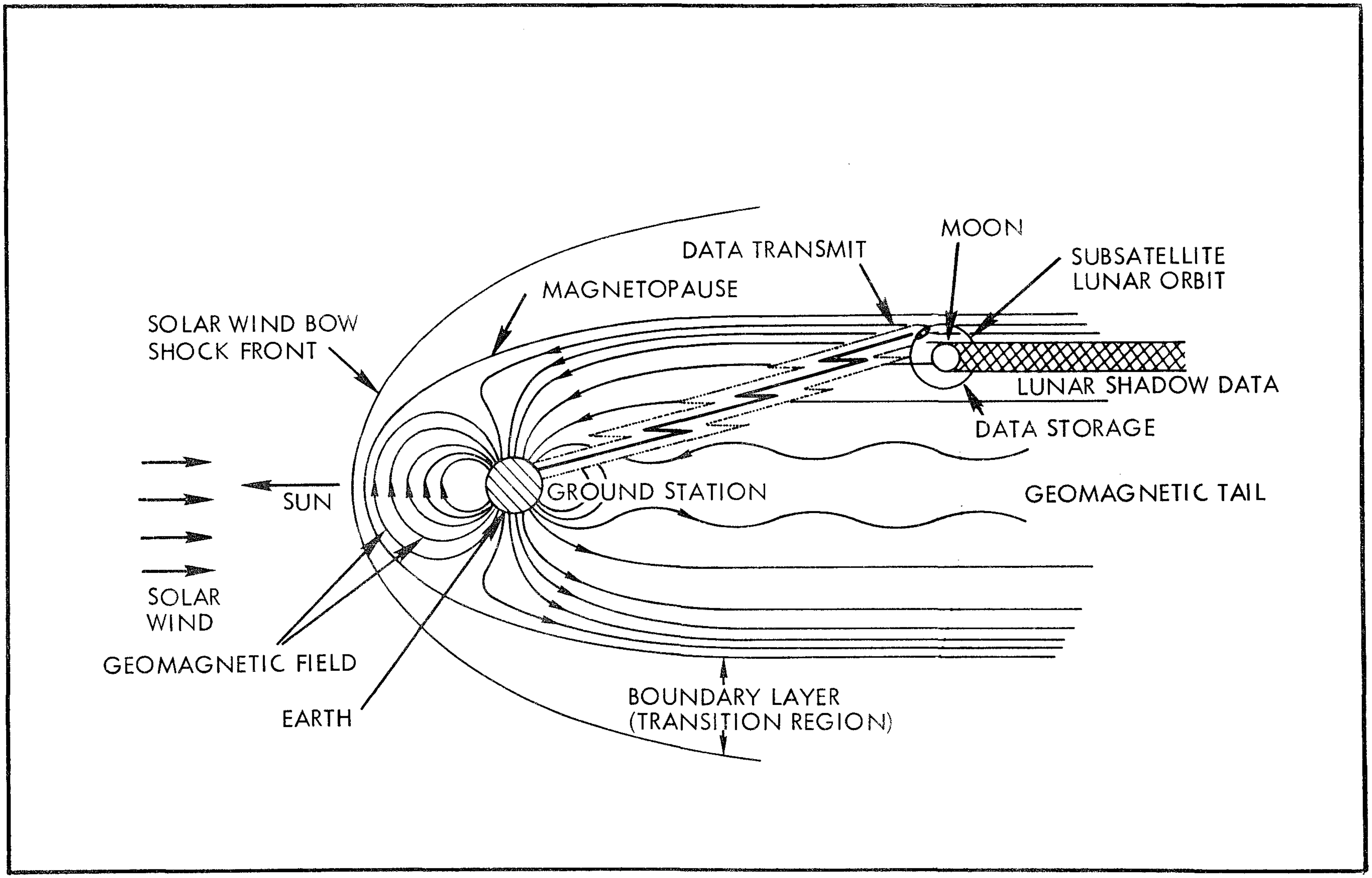


Figure 2-13. Subsatellite Experiment Concept (Particle Shadows/Boundary Layer and Magnetometer)

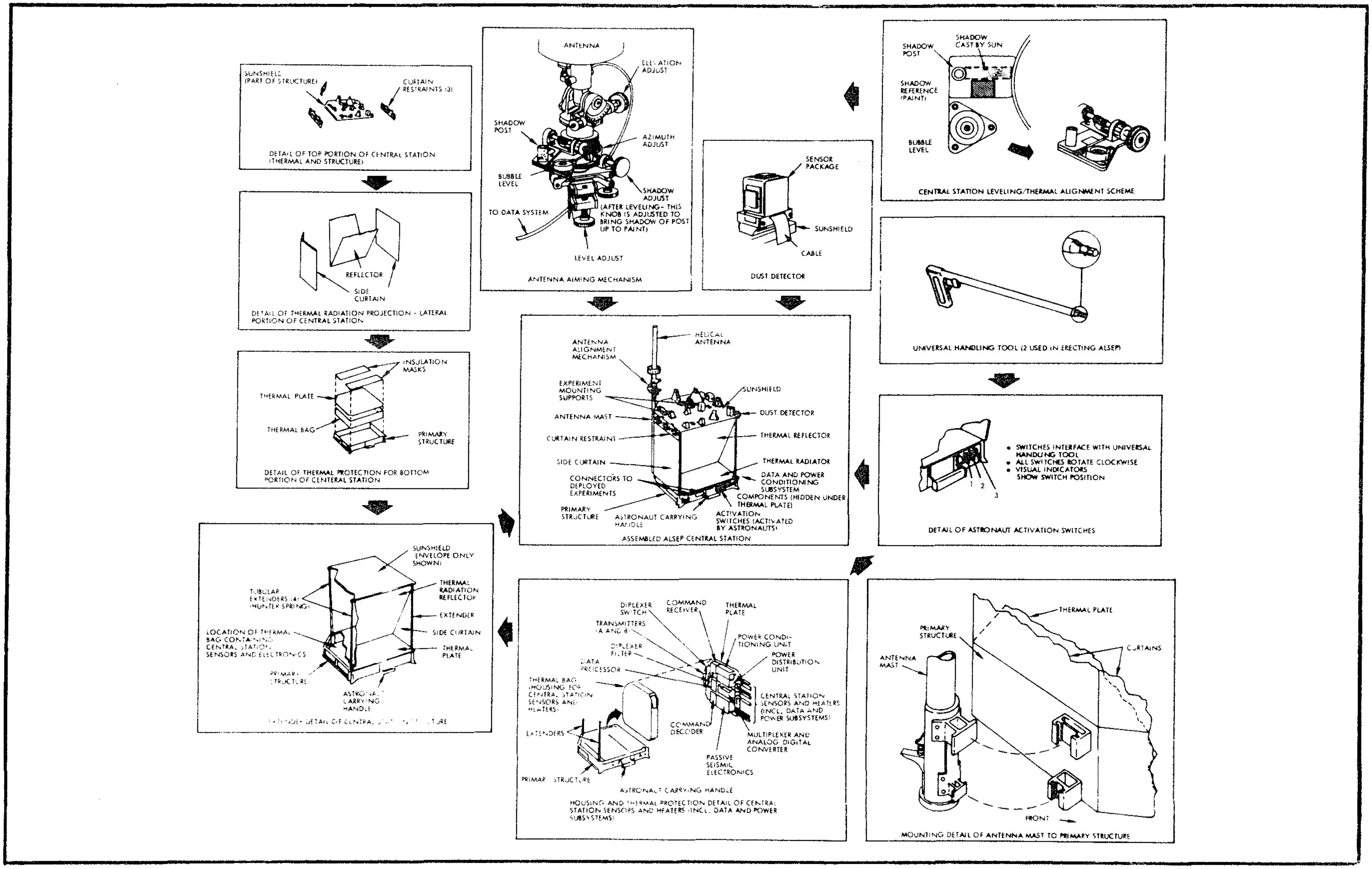


Figure 2-14. ALSEP Central Station Assembly Details

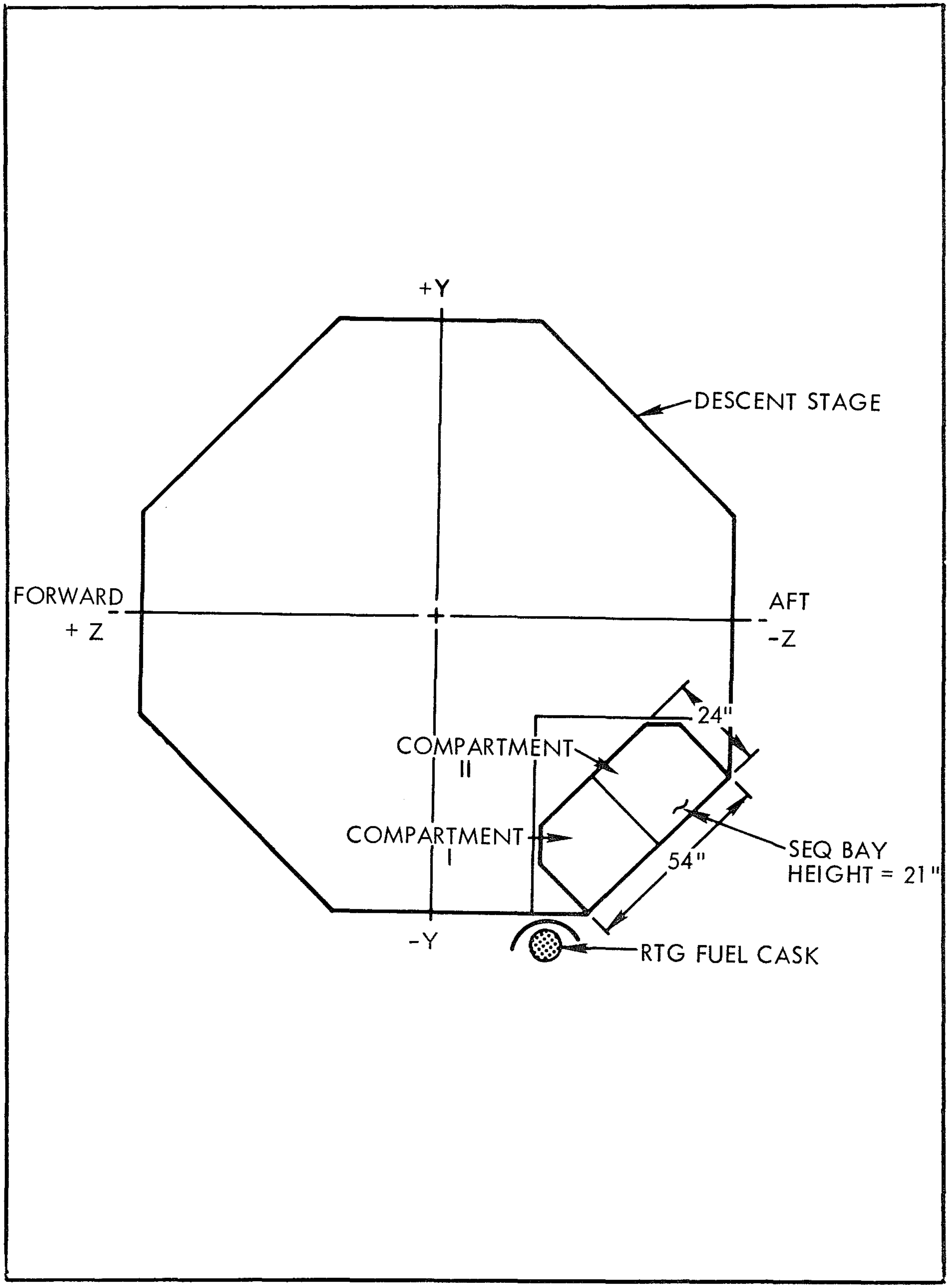


Figure 2-15. LM SEQ Bay Stowage of ALSEP Subpackages

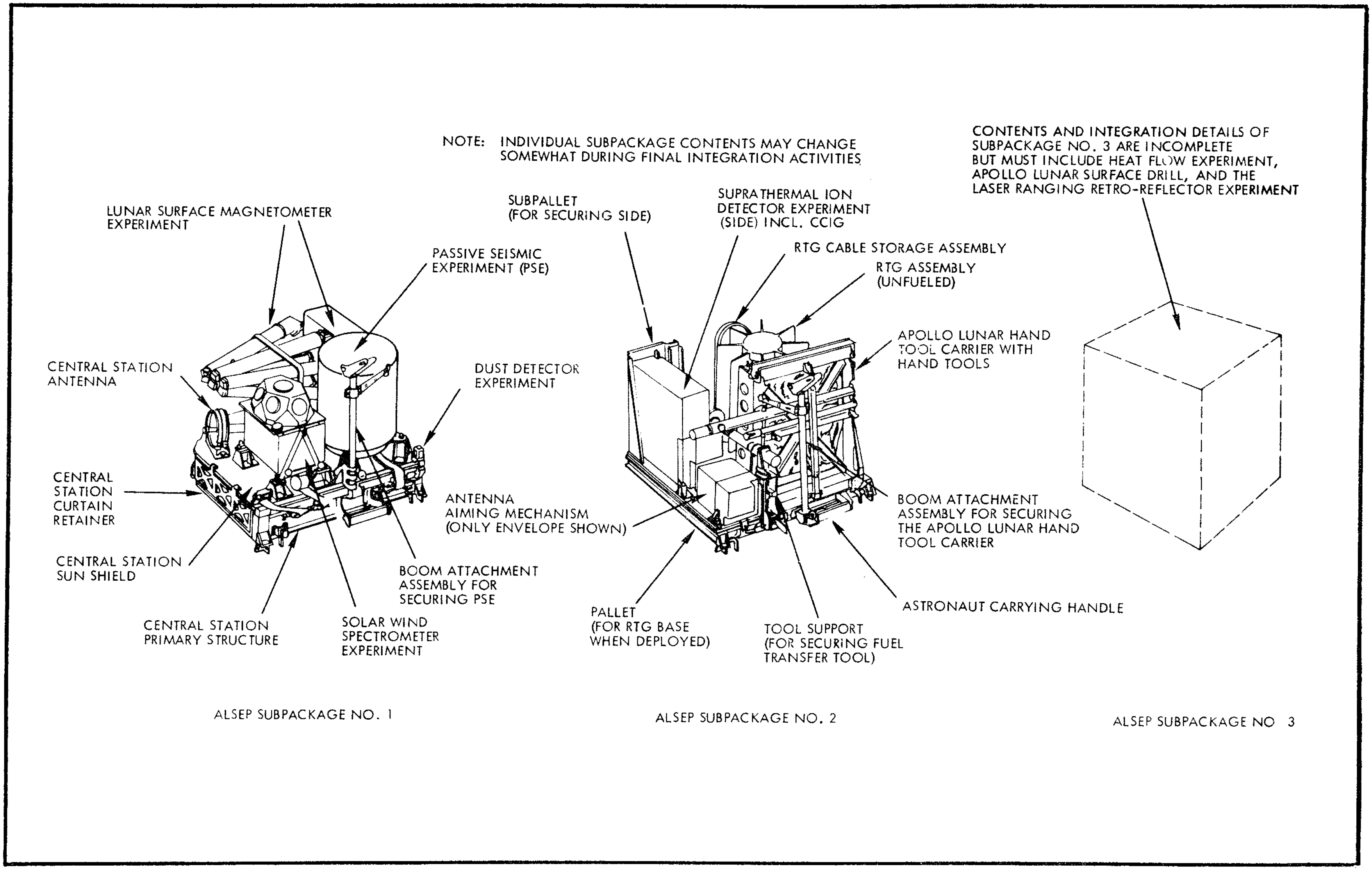
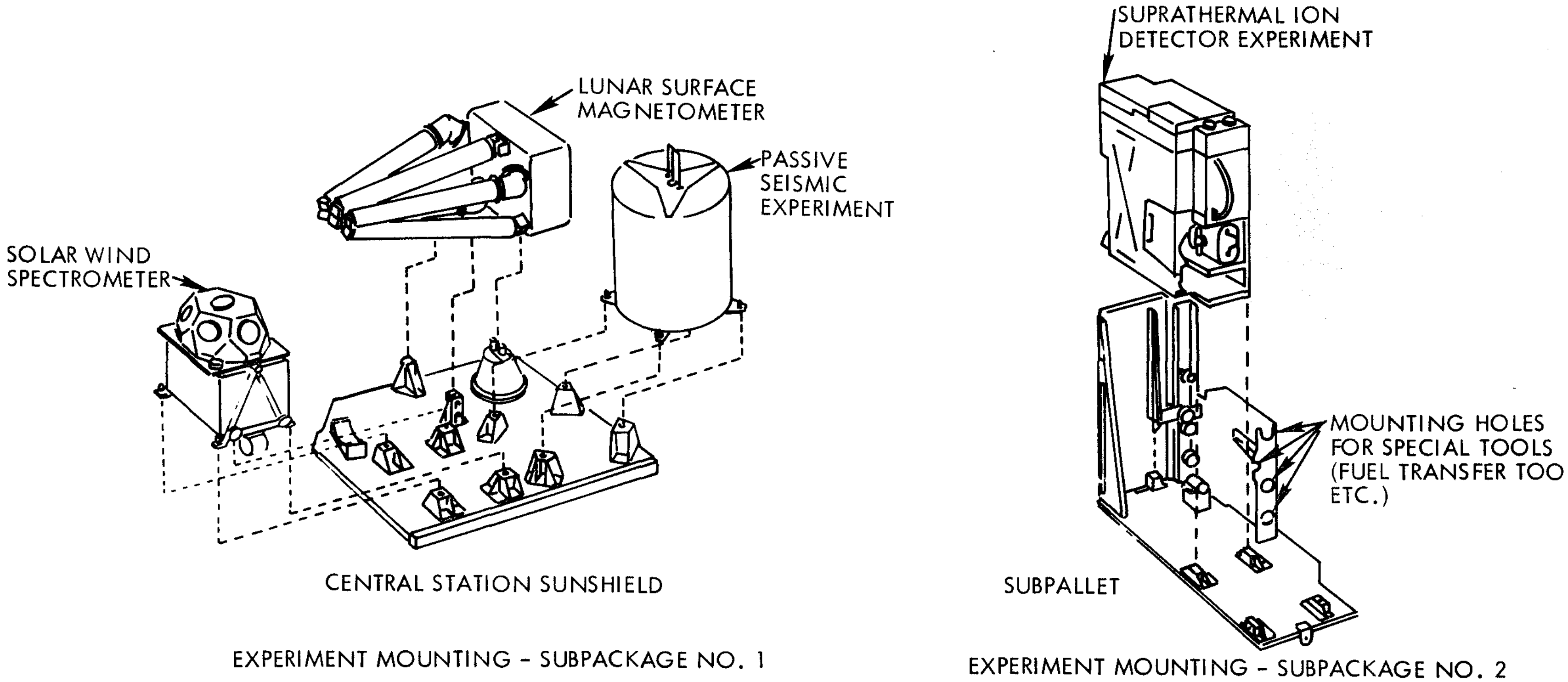
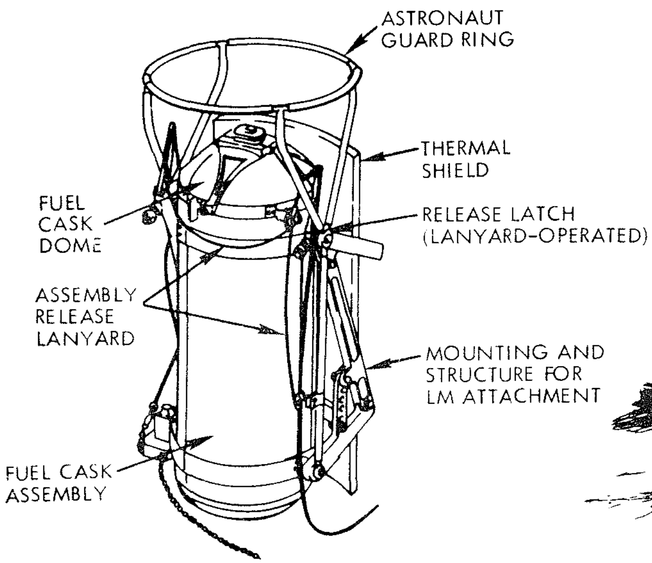


Figure 2-16. LM SEQ Bay Subpackages Configurations - ALSEP A-2/Heat Flow Array

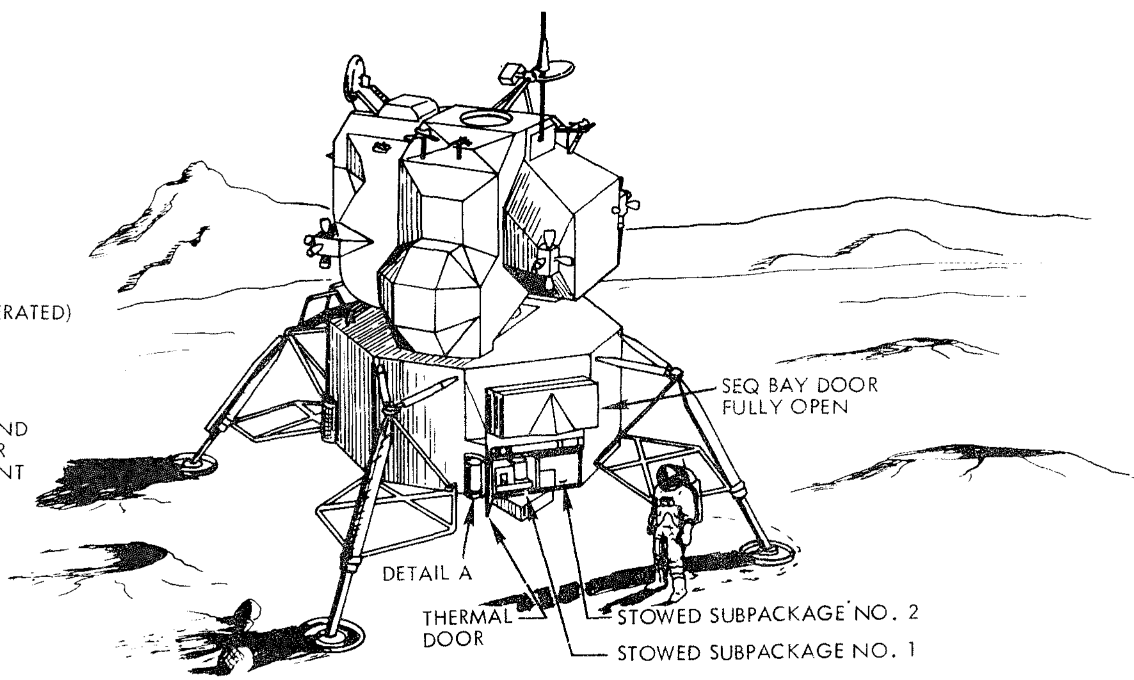


NOTE: MOUNTING DETAILS OF HEAT FLOW EXPERIMENT, LUNAR SURFACE DRILL, AND LASER RANGING RETRO-REFLECTOR ARE NOT FINALIZED

Figure 2-17. Typical ALSEP Subpackages Experiment Mounting Details



DETAIL A
RTG FUEL CASK STRUCTURE ASSEMBLY



ALSEP EQUIPMENT READY FOR REMOVAL FROM LM SEQ BAY

Figure 2-18. RTG Fuel Cask Structure/LM Interface Detail

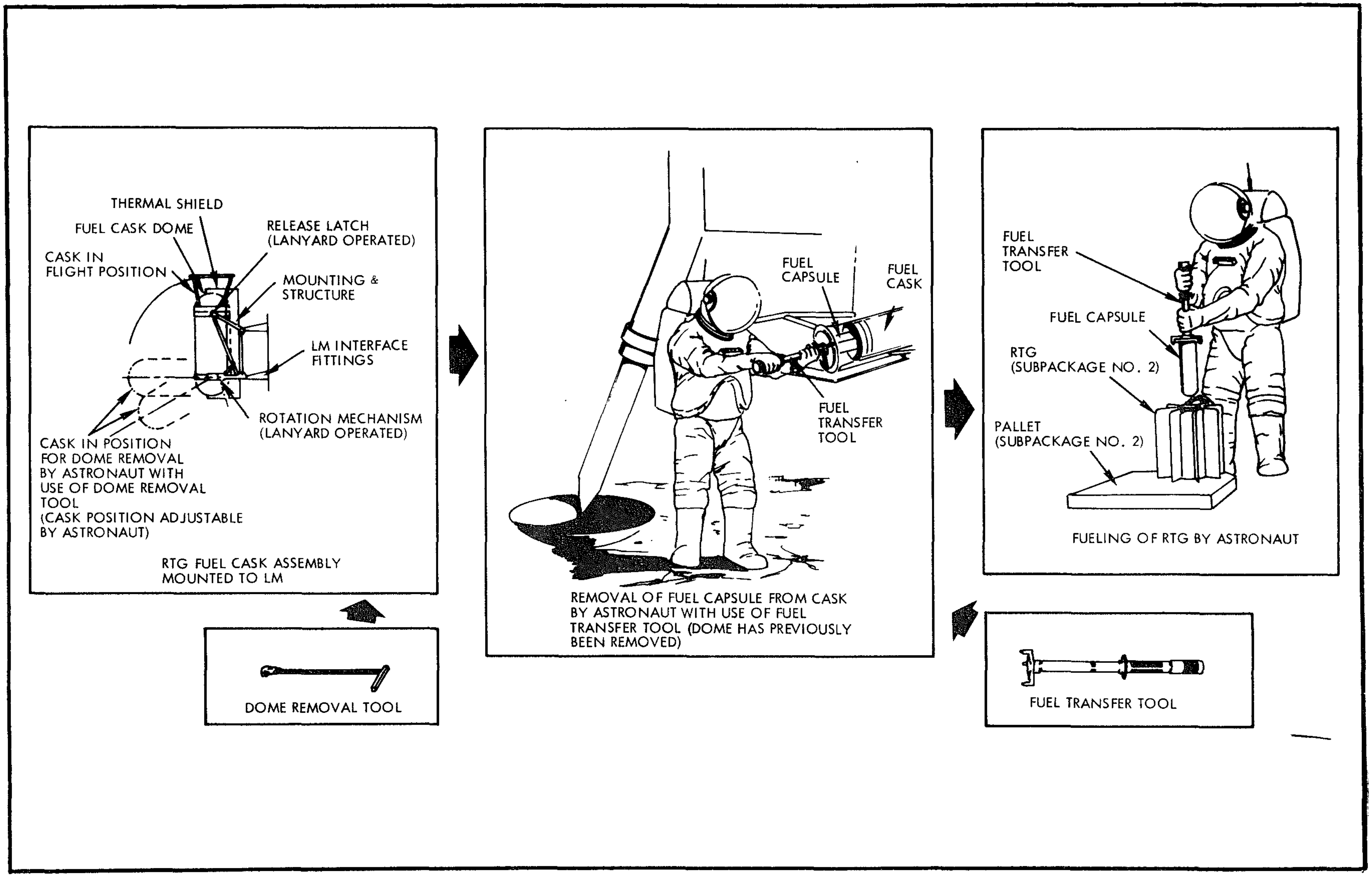


Figure 2-19. RTG Fuel Transfer Activities

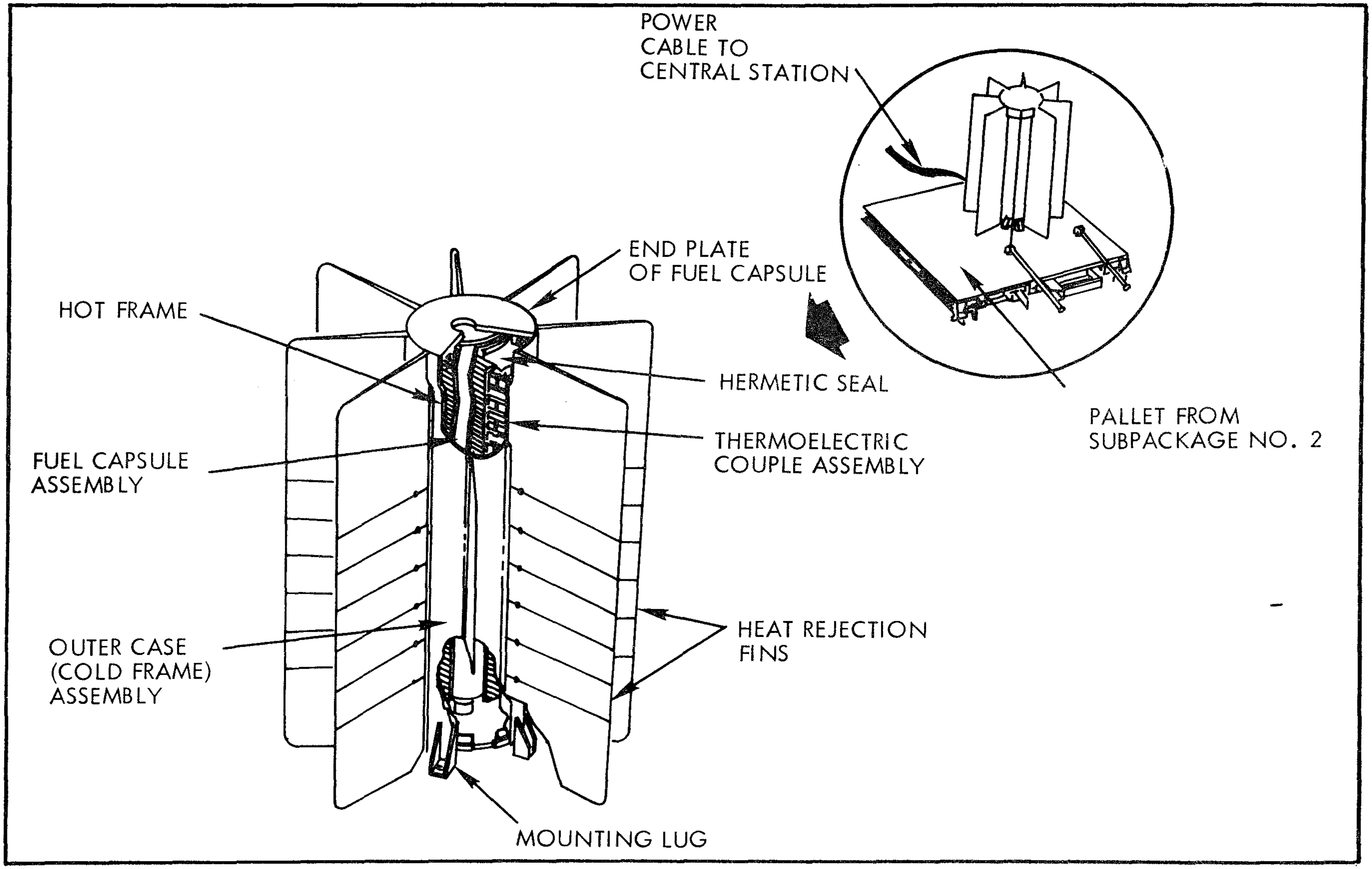


Figure 2-20. ALSEP RTG Assembly

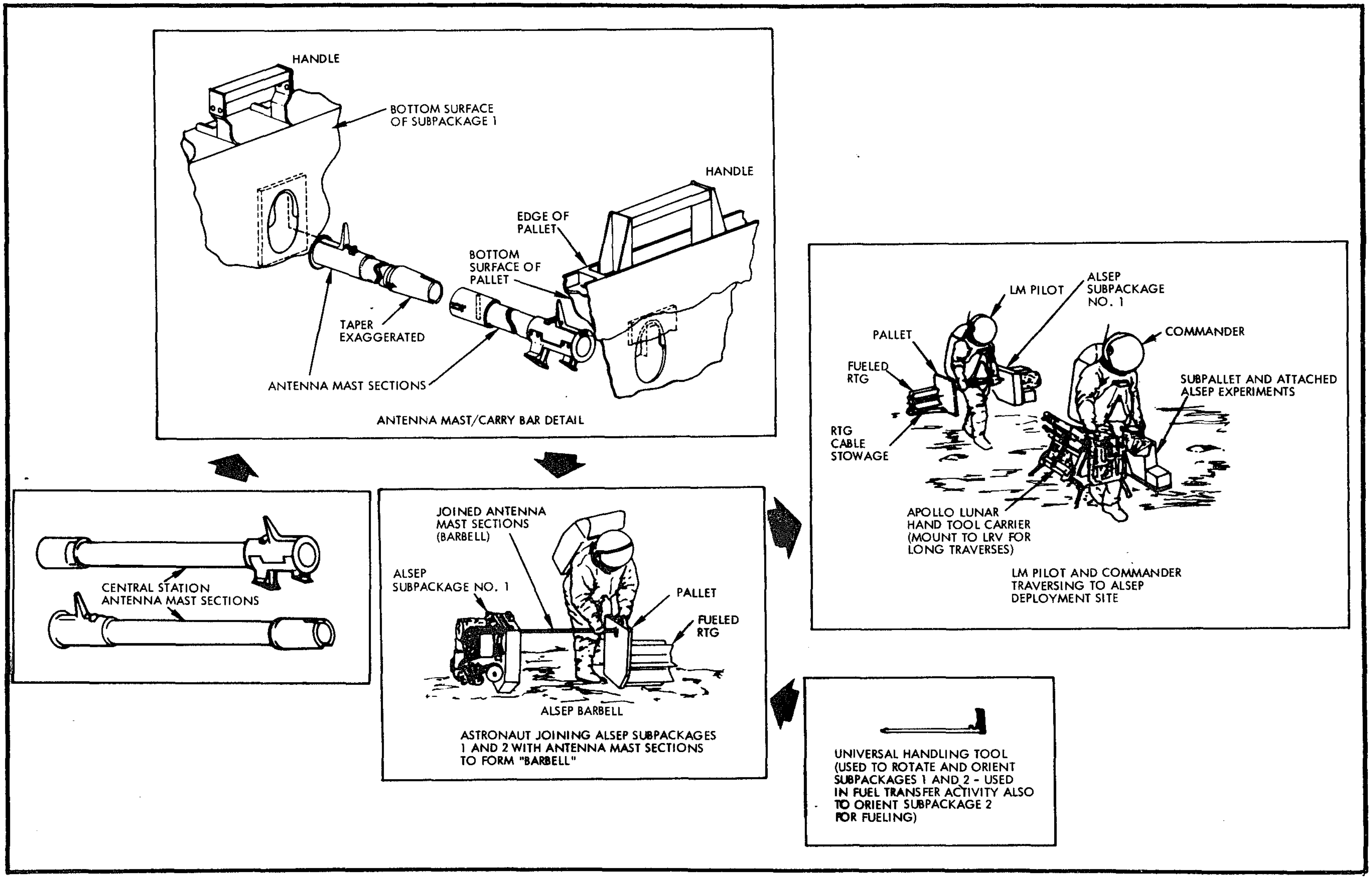


Figure 2-21. Preparation of ALSEP Subpackages for Traverse to Deployment Site

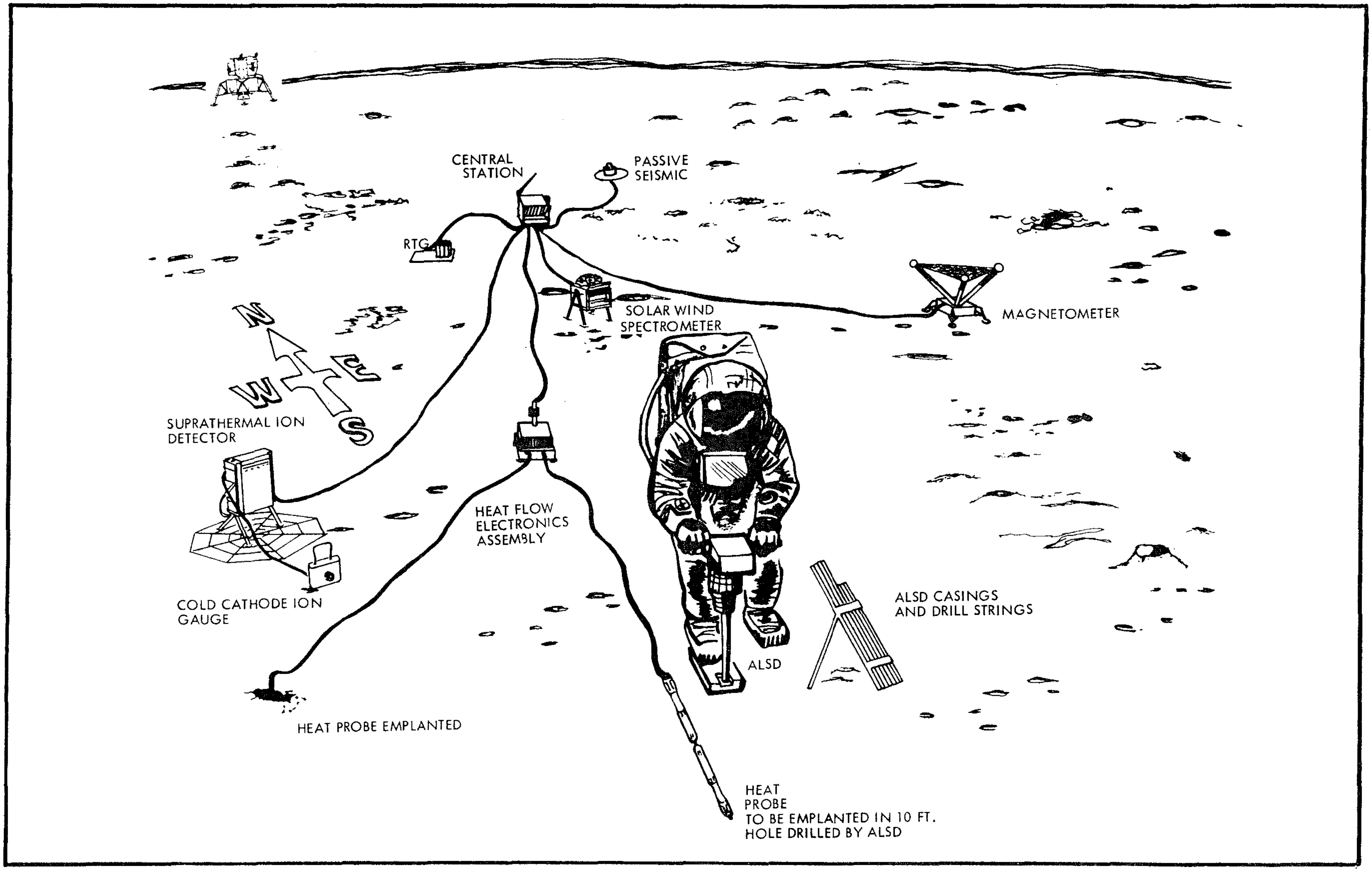


Figure 2-22. Perspective Representation of ALSEP Array A-2/Heat Flow Deployed Positions

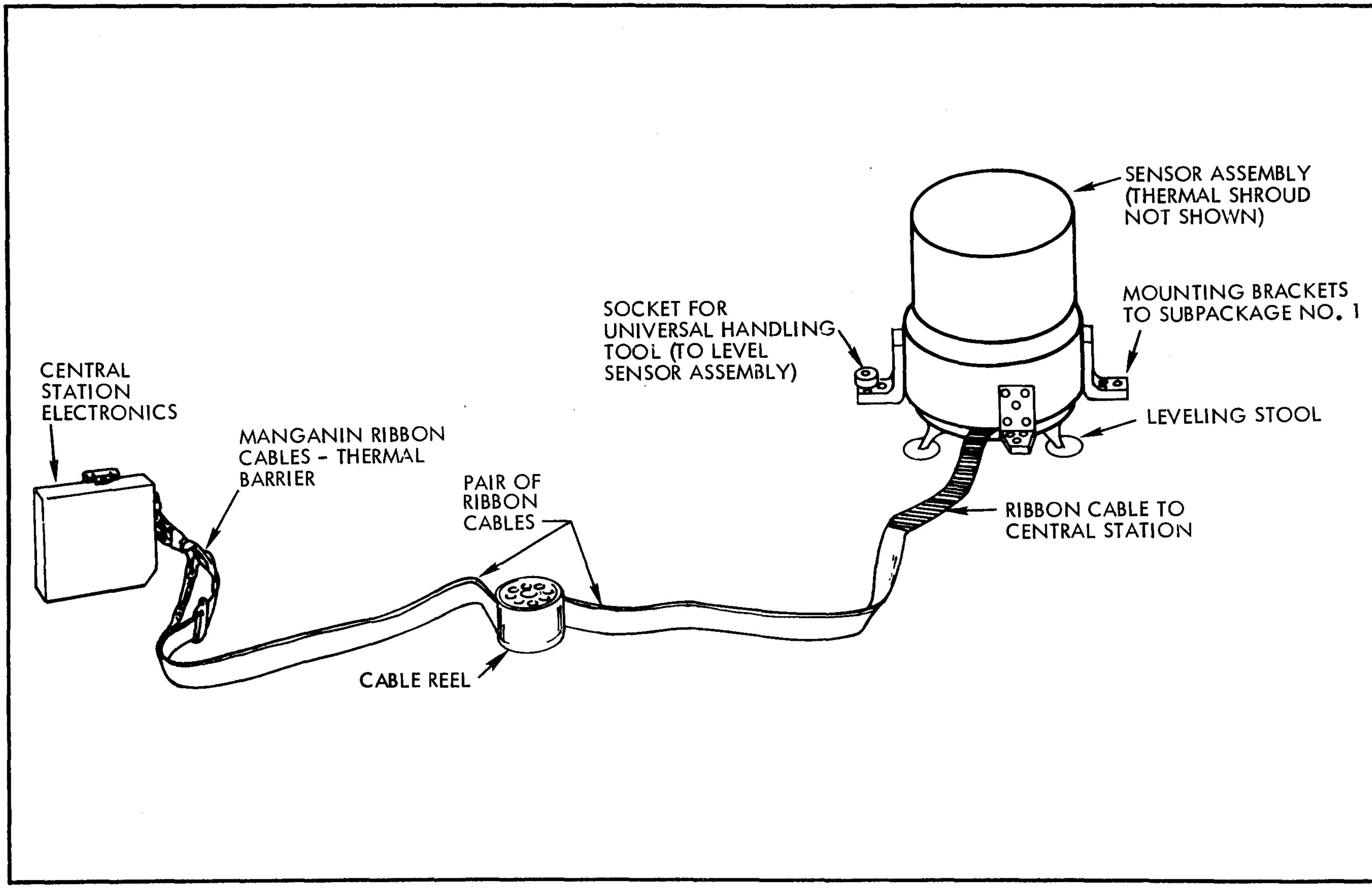


Figure 2-23. Passive Seismic Experiment (S-031)

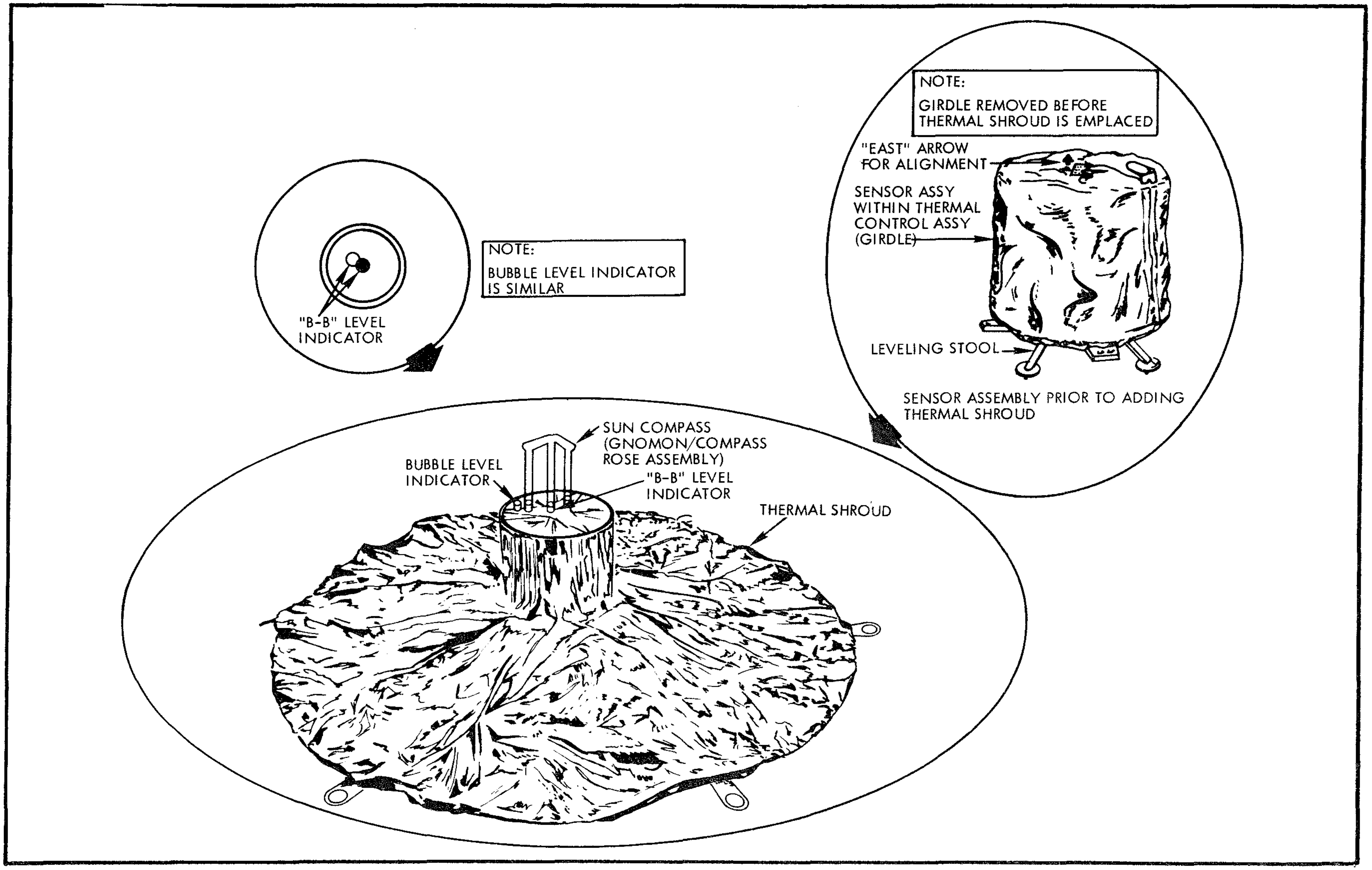


Figure 2-24. Deployed Passive Seismic Experiment (S-031)

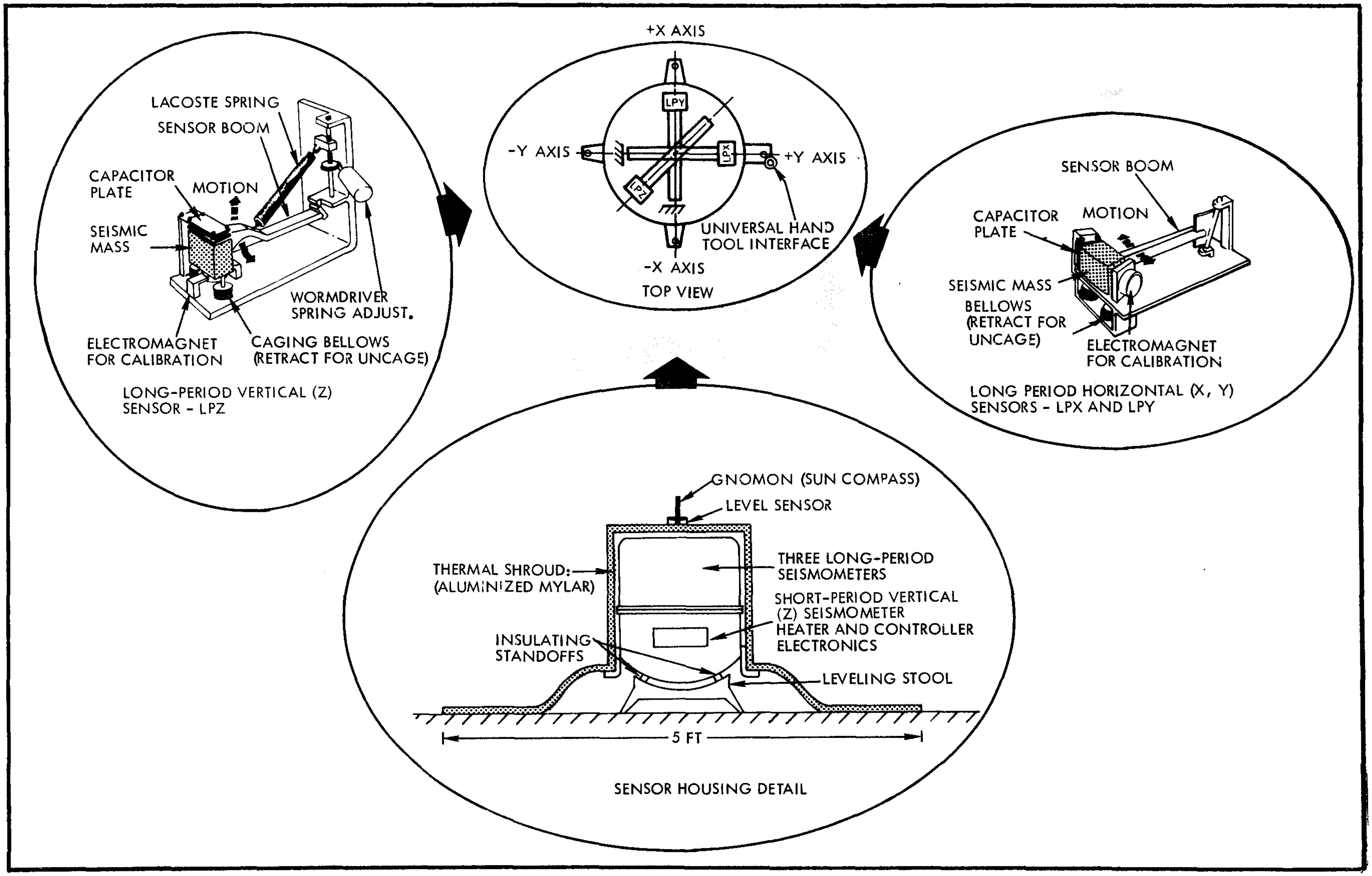


Figure 2-25. Passive Seismic Experiment Sensors

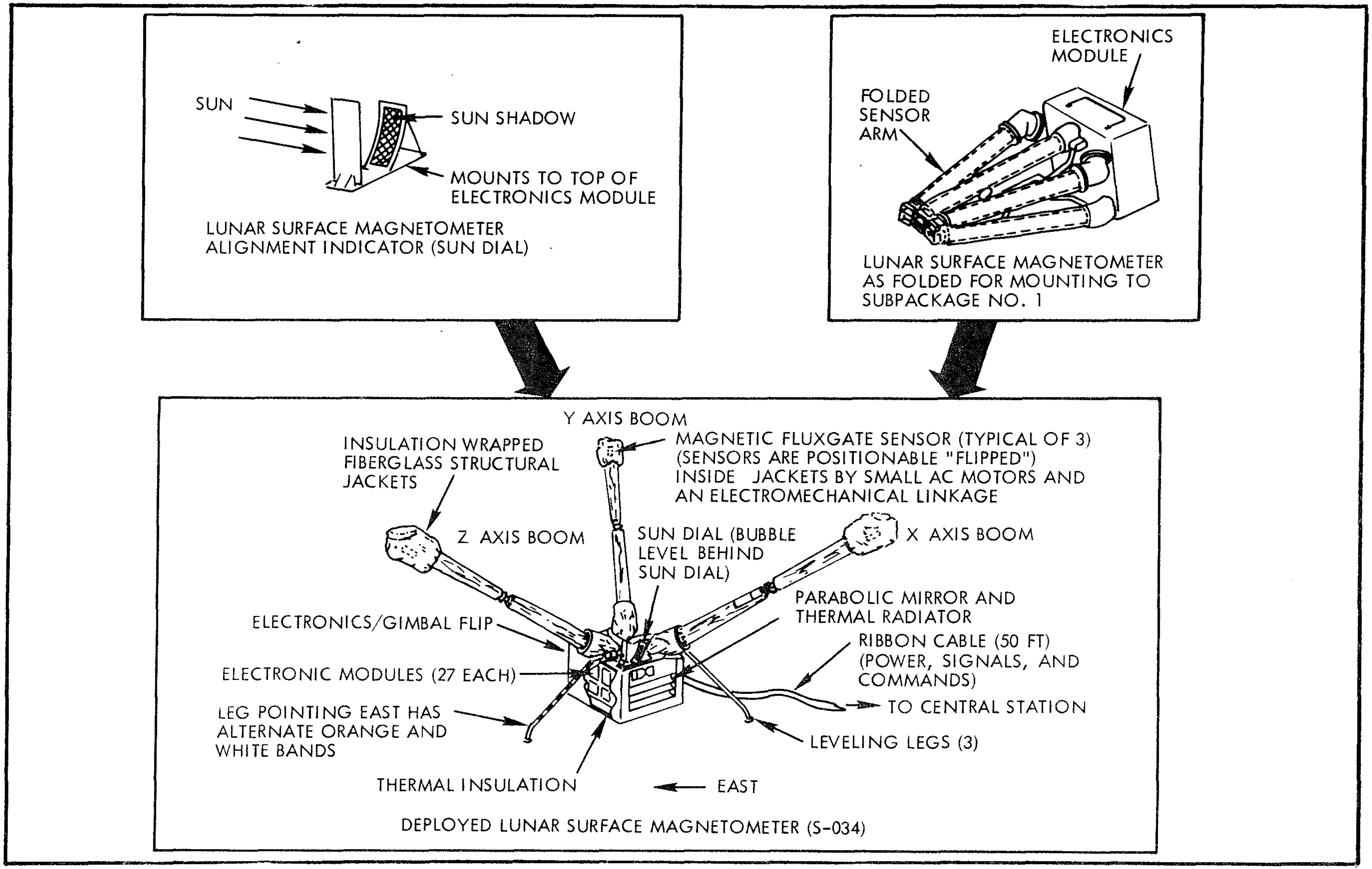


Figure 2-26. Lunar Surface Magnetometer Experiment (S-034)

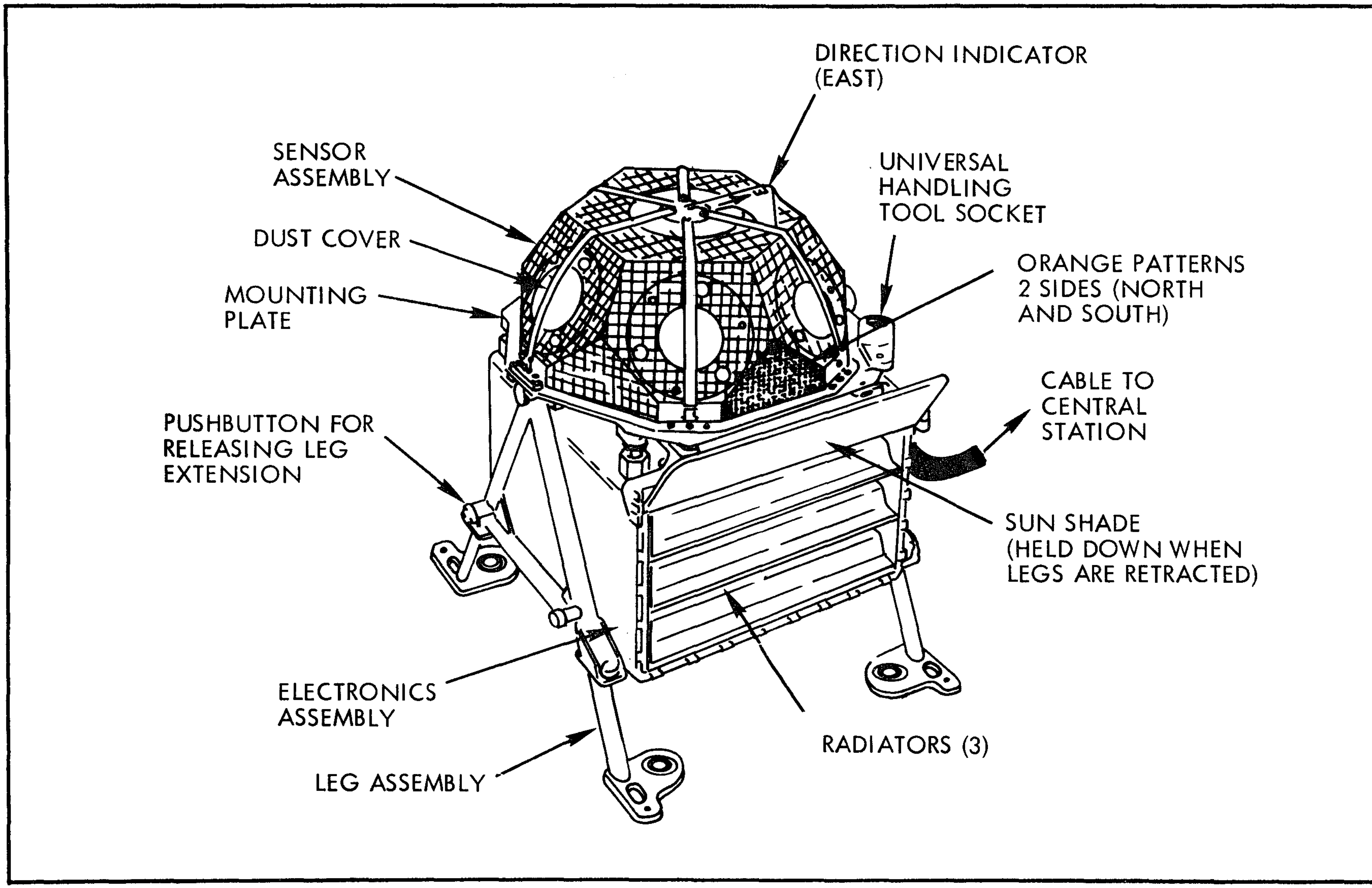


Figure 2-27. Solar Wind Spectrometer Experiment (S-035)

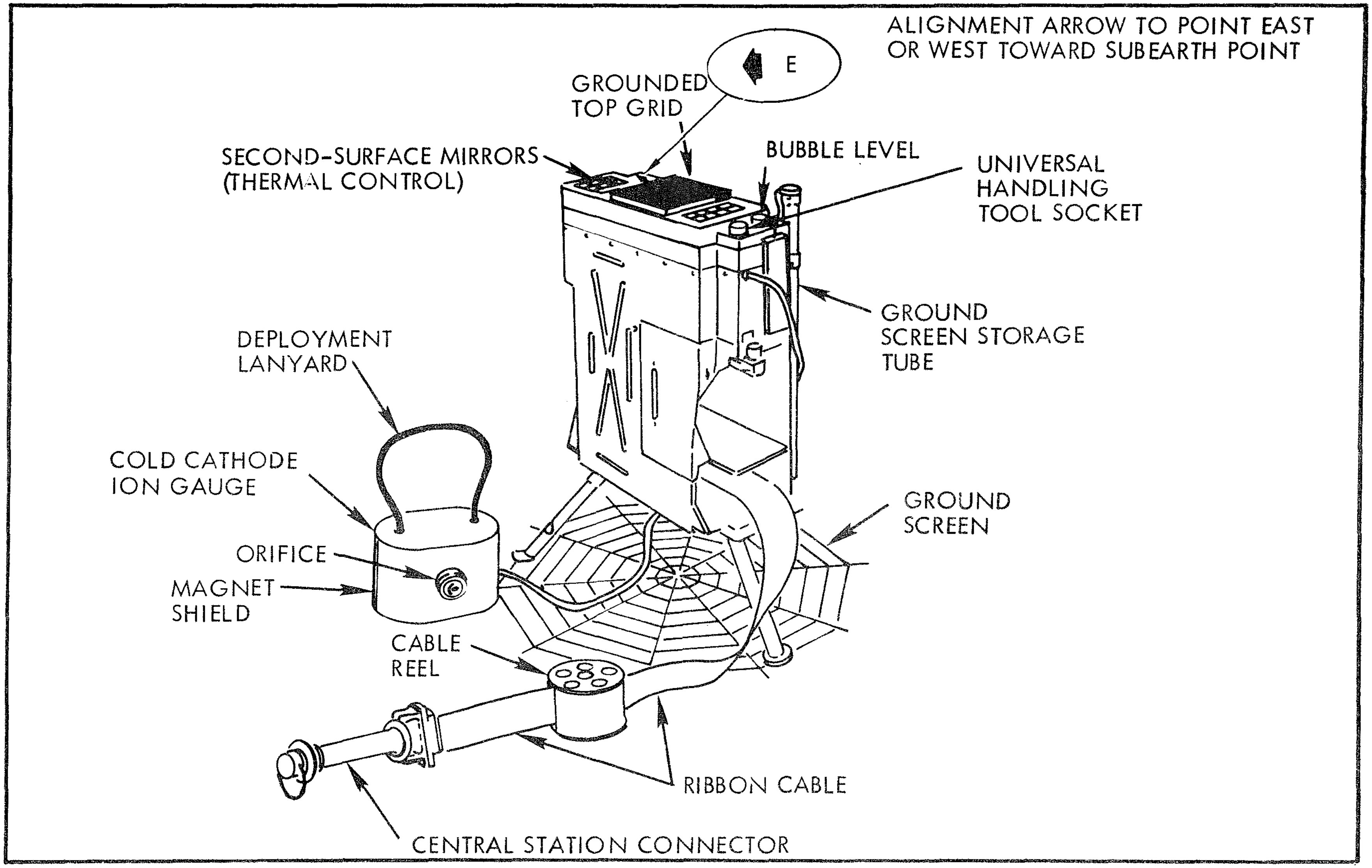


Figure 2-28. Deployed Suprathermal Ion Detector (S-036) and Cold Cathode Ion Gauge (S-058) Experiments

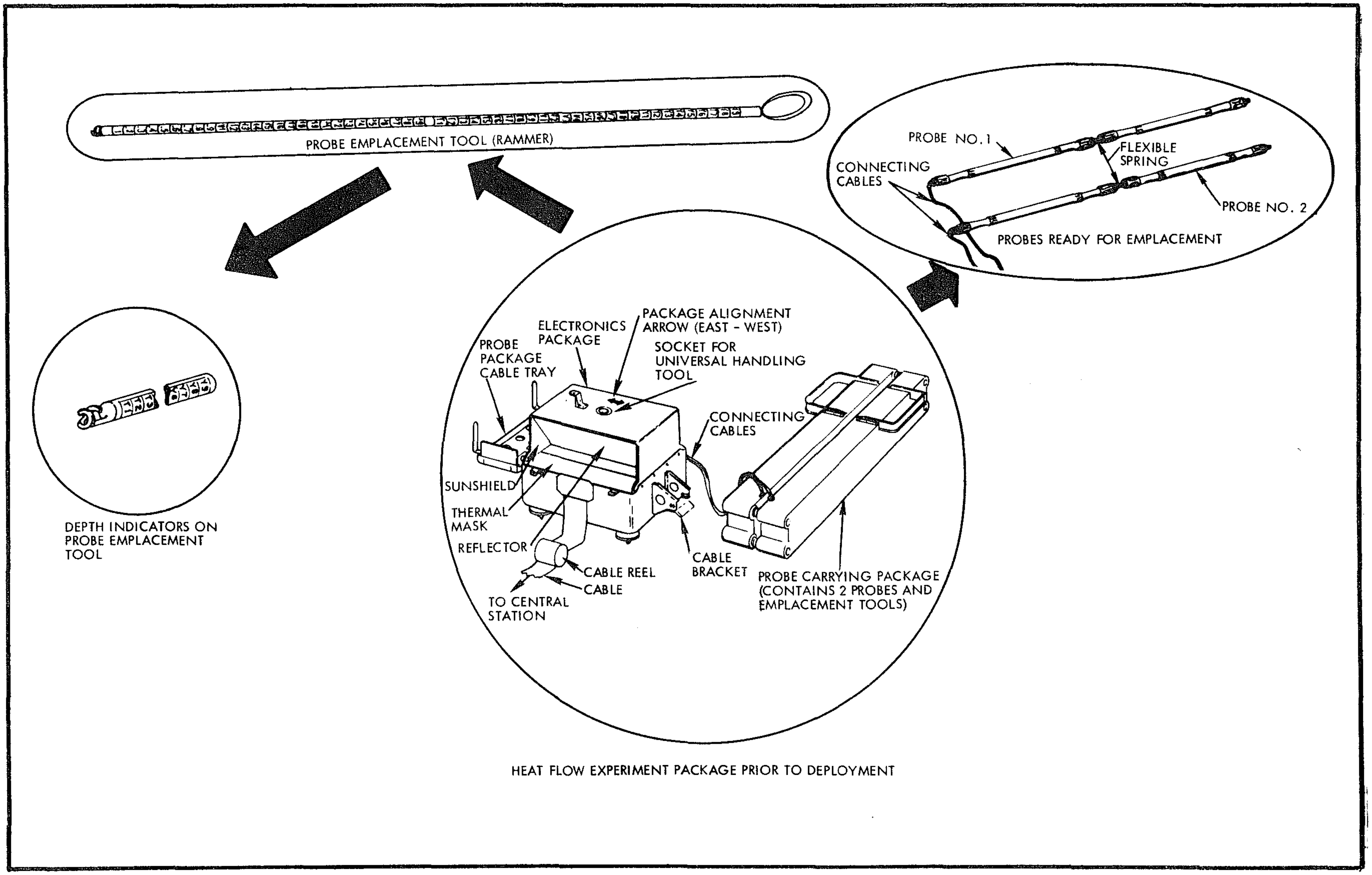


Figure 2-29. Heat Flow Experiment (S-027) Equipment

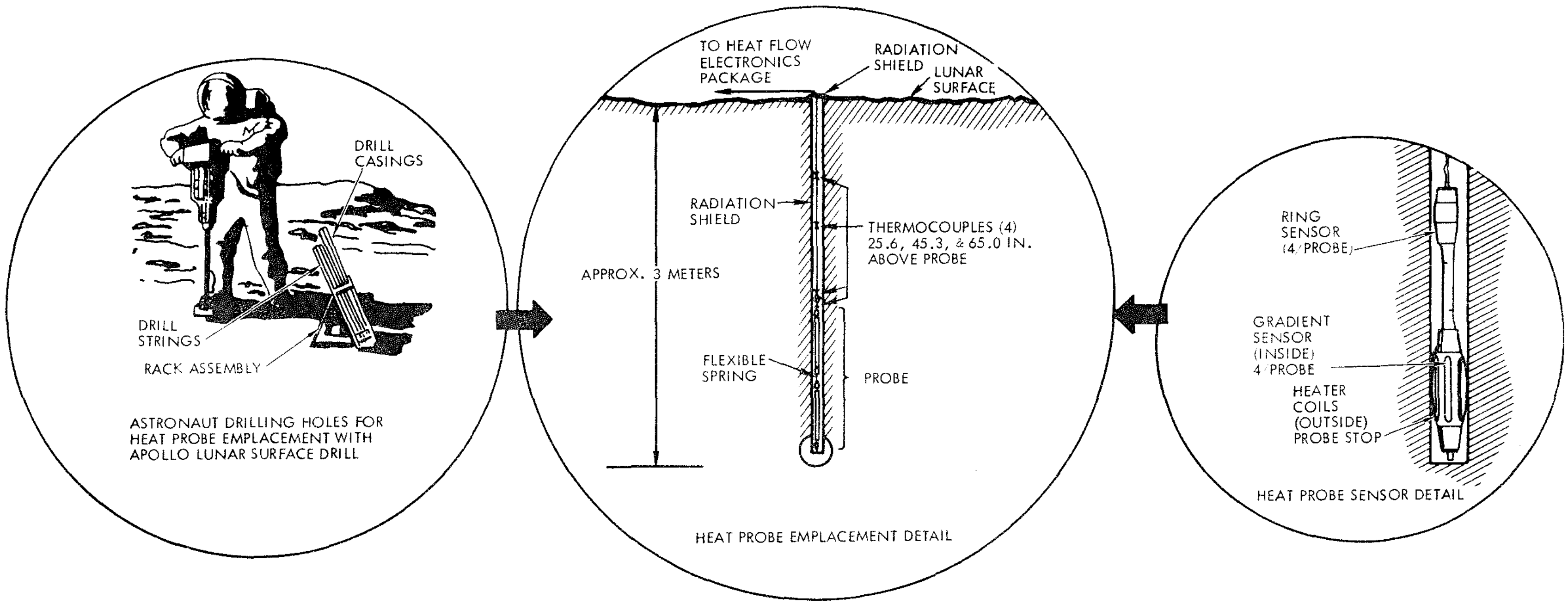


Figure 2-30. Heat Flow Experiment Probe Emplacement Detail

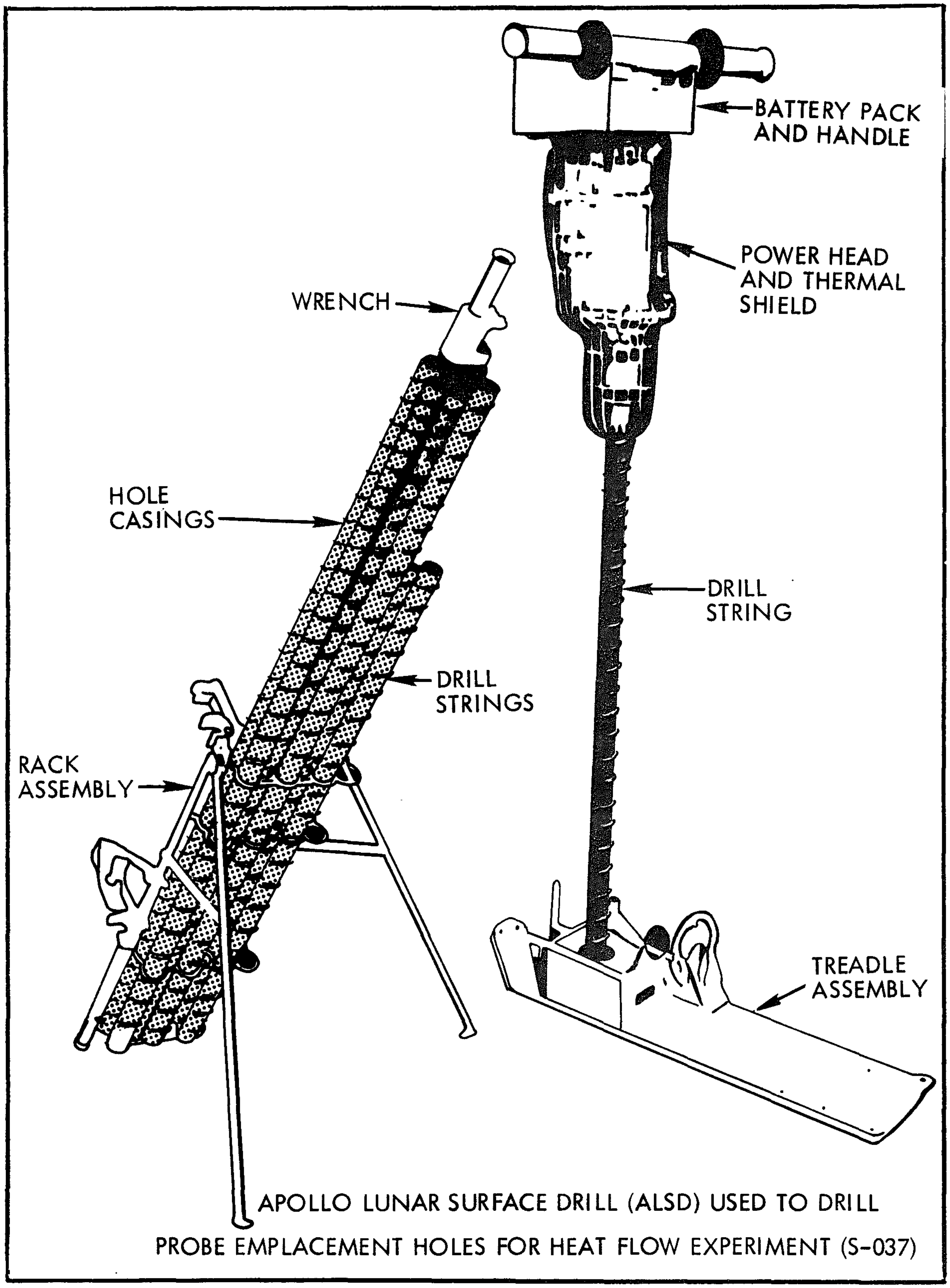


Figure 2-31. Apollo Lunar Surface Drill (ALSD)

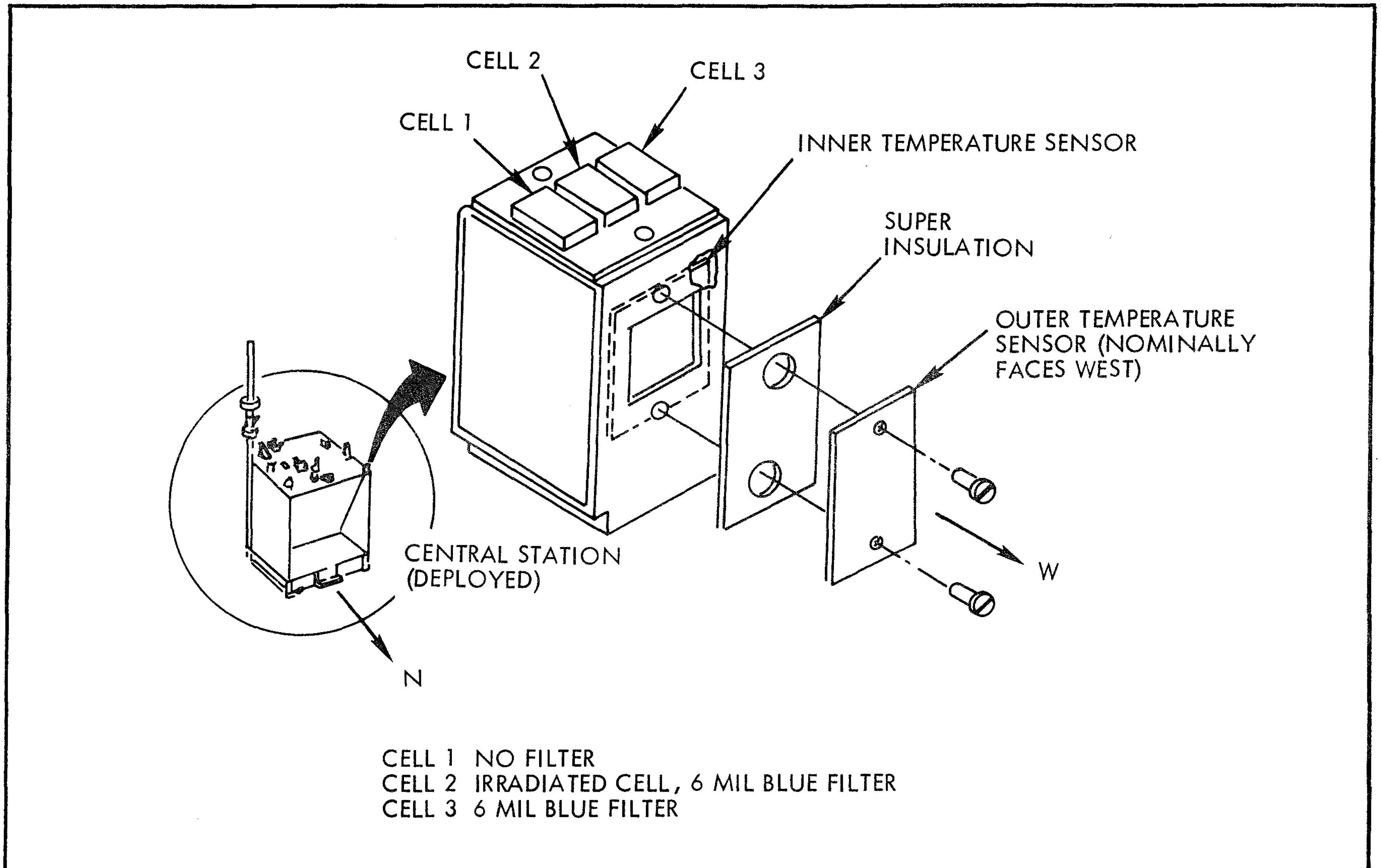


Figure 2-32. Lunar Dust Detector Experiment (M-515)

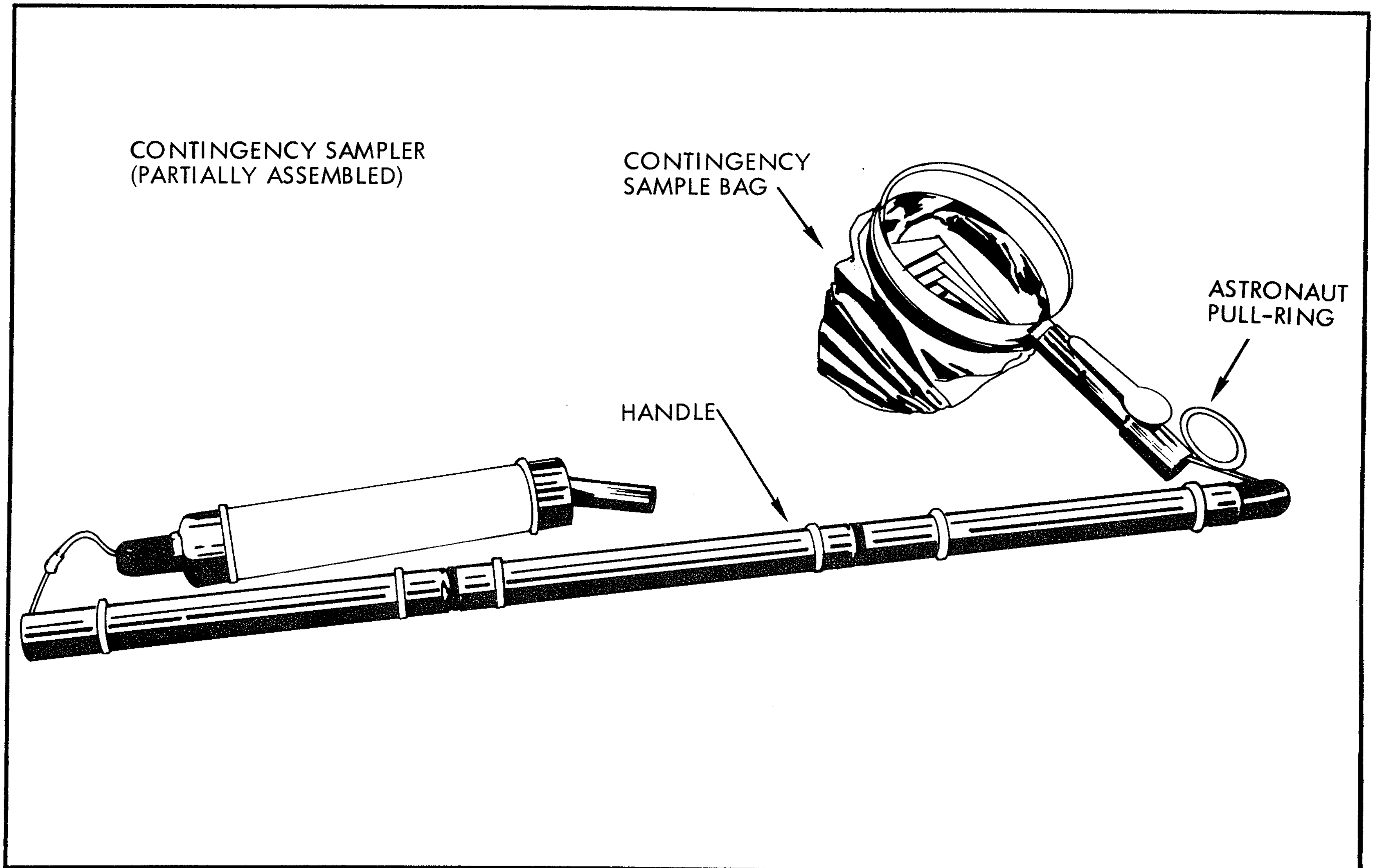


Figure 2-33. Contingency Sampler (Contingency Sample Objective)

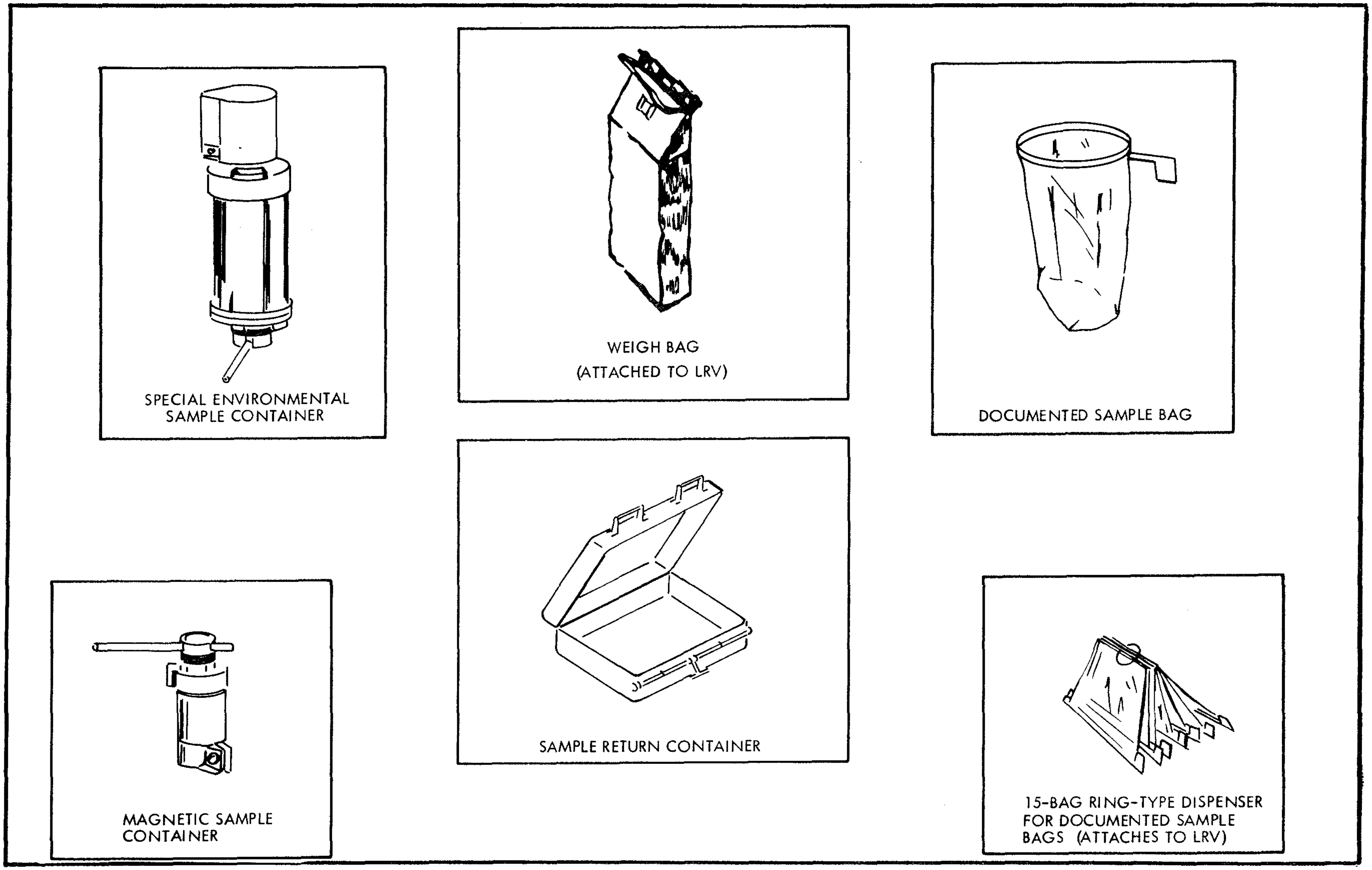


Figure 2-34. Lunar Geology Sample Containers

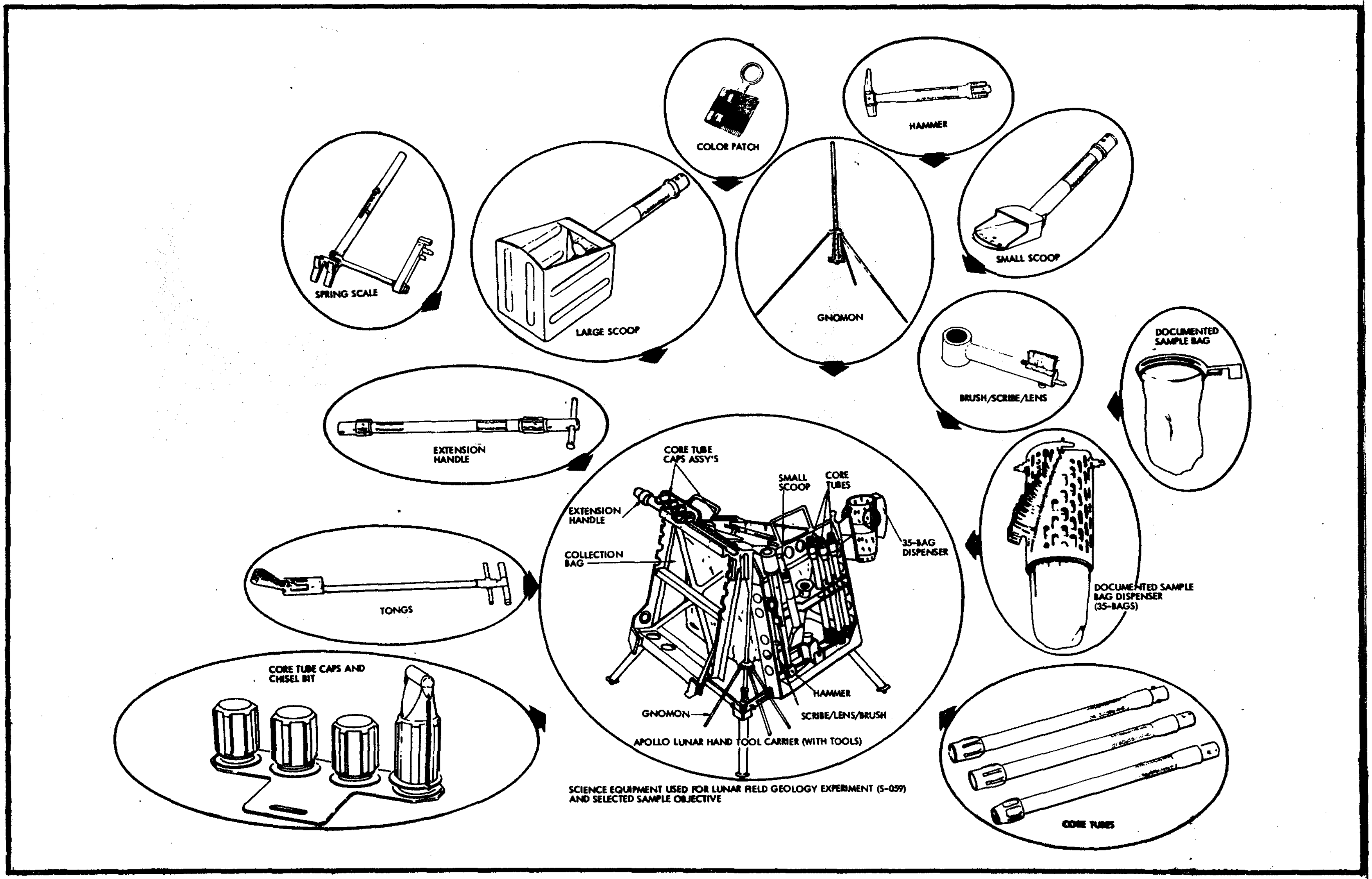
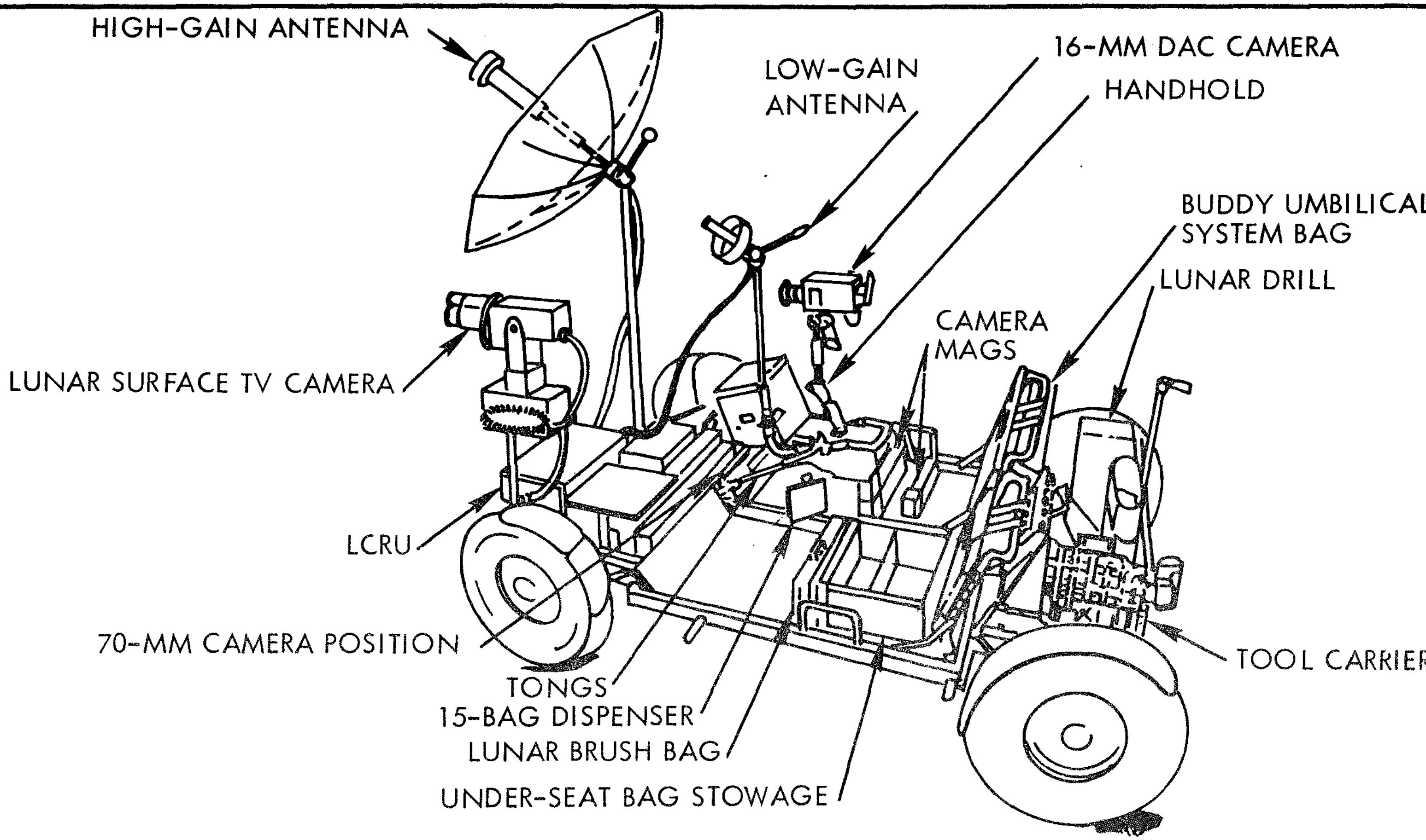


Figure 2-35. Lunar Field Geology Experiment (S-059) Equipment



LUNAR ROVING VEHICLE WITH LUNAR SURFACE TV CAMERA AND 16-MM CAMERA (DAC)
(PROVIDES GREATLY ENHANCED CAPABILITIES FOR LUNAR SURFACE EXPLORATION
AND CORRESPONDING SCIENTIFIC ACTIVITIES)

Figure 2-36. Lunar Roving Vehicle

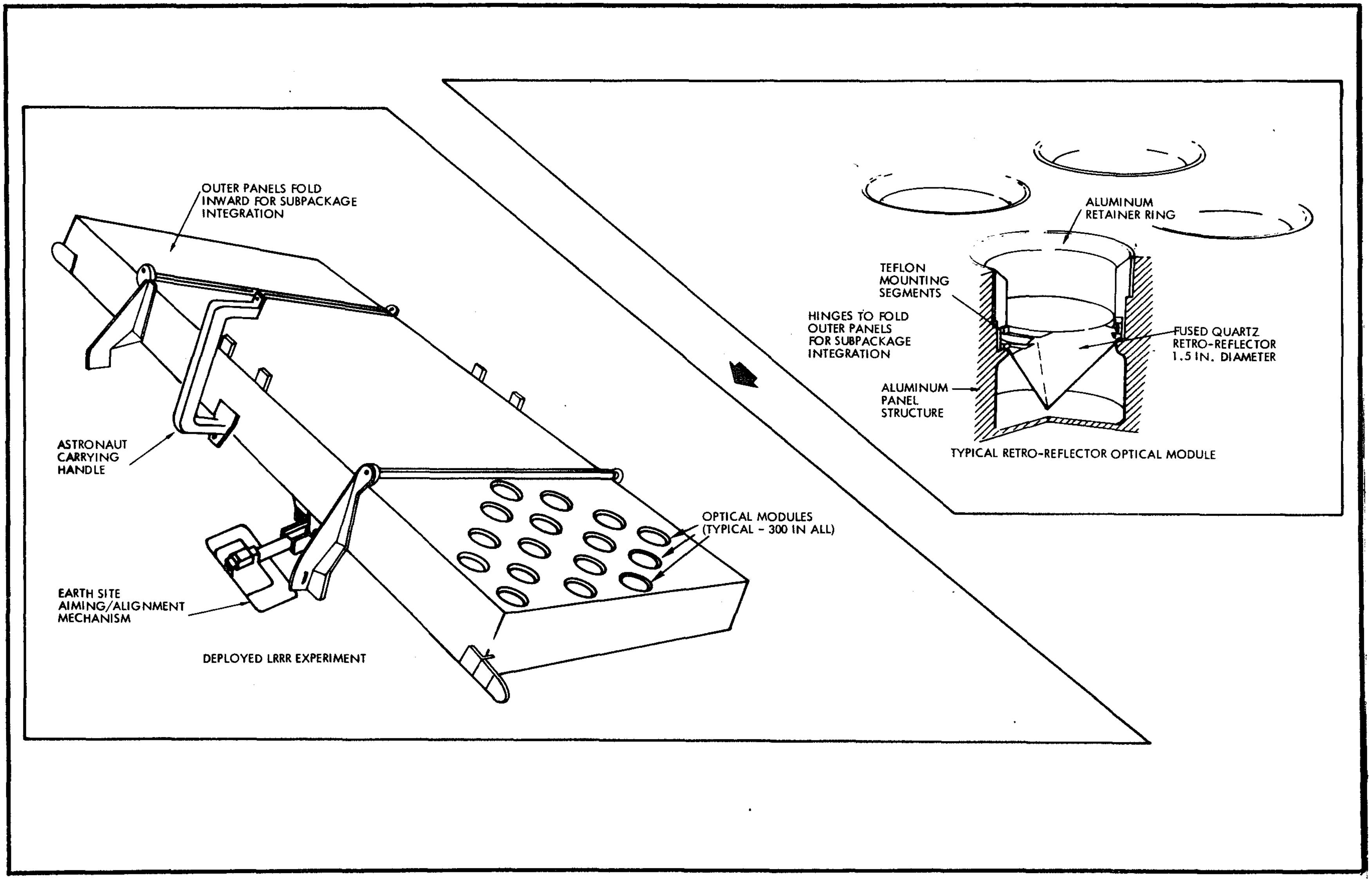


Figure 2-37. Laser Ranging Retro-Reflector Experiment (S-078)

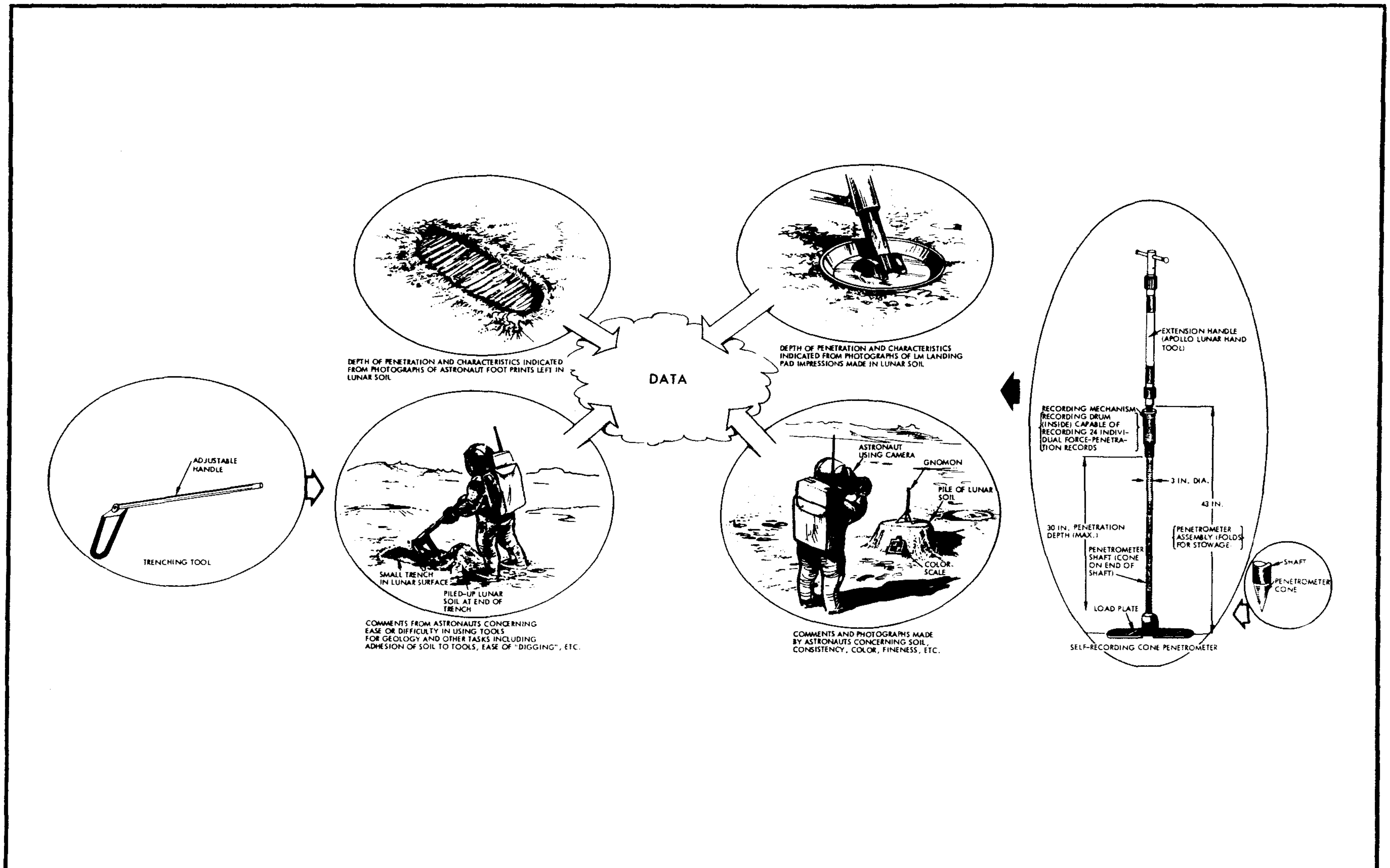


Figure 2-38. Soil Mechanics Experiment (S-200)

SECTION III

PHOTOGRAPHIC PLAN

3.1 GENERAL

The purpose of this section is to focus attention on the science photographic requirements of the mission, to provide a central source of complete photographic planning information, and to correlate photographic requirements with individual science experiments and objectives. This section contains a list of films flown on previous Apollo missions, with a brief description of each. Detailed descriptions of these films appear in Appendix E which also contains general film properties and processing test data. Detailed photographic requirements are the major constituents of this section and are listed separately for lunar orbit and lunar surface experiments/objectives.

3.2 SUMMARY OF FILM TYPES

Table 3-1 lists the film types that have flown on previous Apollo missions, with a brief description of each. Detailed information on these films is given in Appendix E, including general 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 each 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 Laboratory (PTL) at MSC, and aid in the selection of film types and processing techniques for mission science photographic 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. Where photographic equipment and film codes are used they are identical to those used in the Mission Requirements Document. A listing of these 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 reference to the appropriate page of Appendix E.

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

3.4 PHOTOGRAPHIC REPRODUCTION REQUIREMENTS

Table 3-4 presents the requirements for postmission photographic reproduction materials, which are listed separately for lunar surface photography and lunar orbital photography.

Table 3-1. Previous Apollo Flight Films

NUMBER	CHARACTERISTIC	TYPICAL FLIGHT APPLICATION
2485	Very high-speed BW	Low-light-level astronomy
3400	Intermediate-speed aerial BW	Candidate sites photography
3401	Medium-speed, fine grain aerial BW	Stellar photography
SO-121	High-resolution aerial color	Photography of earth's surface from EPO
SO-168 (ASA 160)	High-speed color exterior	Photography of ALSEP deployment
3443*	False color reversal aerial, infrared sensitive	Multi-spectral photography from EPO
SO-246	BW and infrared sensitive, high-contrast aerial	Multi-spectral photography of earth and moon
2405**	High-speed BW	Lunar surface samples documentation photography
SO-349***	Medium-speed BW	Transearth lunar photography
SO-368	Medium-speed color exterior	Soil mechanics photography using the closeup stereo camera
Drugstore type	Kodacolor color negative	Experimental use
2484	Very high-speed BW	Tested for radiation effects on film

*replaces SO-180

**formerly SO-267

***SO-349 and 3404 have been redesignated as 3414

Table 3-2. Lunar Orbit Science Photographic Requirements

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING*	EXPOSURE PARAMETERS**
Bistatic Radar (S-170)	***	—	—	—
Gamma-Ray Spectrometer (S-160)	***	—	—	—
X-Ray Fluorescence (S-161)	***	—	—	—
Alpha Particle Spectrometer (S-162)	***	—	—	—

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)
HEC - 70-mm Hasselblad electric camera
LTC - Lunar topographic camera
MC - 3-Inch mapping camera
PC - 24-Inch panoramic camera

Film Nomenclature:

CEX - Color exterior (SO-368)
HCEX - High-speed color exterior (SO-168) (ASA 160)
CIN - Color interior (SO-168) (ASA 1000)
BW - Black and white (3400)
BW - Black and white (3401)
HBW - High-speed black and white (2405, formerly SO-267)
MBW - Medium-speed black and white (SO-349)
VHBW - Very high-speed black and white (2485)

*Film processing is specified by reference to the page in Appendix E which contains the appropriate processing information.

**Exposure parameters are preliminary based on previous mission photography-final values are TBD by FCSD and PTL.

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

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 stero coverage (25-degree convergence angle) of potential landing sites (TBD) and exploration areas on the moon (TBD)	PC/24-Inch Lens	MBW(3414, formerly 3404)/TBD	Automatic Exposure Control
	High-quality metric photographs of the lunar surface, based on 78 percent forward overlap on each photographic revolution and 55 percent sidelap between consecutive photographic revolutions	MC(terrain)/3-Inch Lens	BW(3400)/TBD	Automatic Exposure Control
	Stellar photographs time-correlated with the metric photographs of the lunar surface	MC(stellar)/85-mm Lens	BW(3401)/TBD	f/1.8, 2, ∞
S-Band Transponder (CSM/LM) (S-164)	None			
Subsatellite (S-164, S-173, S-174)	Photographs of the subsatellite after its launch, showing the condition of its external	TBD	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
Subsatellite (S-164, S-173, S-174) (Continued)	surface, confirming proper deployment of experiment booms, and determining subsatellite orientation			
Mass Spectrometer (S-165)	1 photograph of boom at sunrise, noon, and sunset on each revolution of mandatory experiment operation; 1 lightside pass of terrain photography coincident with "+X" operation of the experiment	MC	BW(3400)/TBD	Automatic Exposure Control
Apollo Window Meteoroid (S-176)	None			
UV Photography - Earth and Moon	13 sets of 5 photographs as follows: One photograph with each of three UV filters and one photograph with a visual range filter	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, ∞

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)	One photograph of approximately same scene as taken with filters In earth parking orbit: 1 set showing clouds 1 set showing land and water During translunar coast: 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 In lunar orbit: 2 sets of the earth 1 set of the earth and lunar horizon 1 set of lunar terra 1 set of lunar maria During transearth coast: 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	HEC/80-mm Lens	CEX (SO-368)/ TBD	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
Gegenschein from Lunar Orbit (S-178)	9 photographs, 3 each in the antisolar direction, in the direction of the Moulton point, and 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 shadow of the moon.	DAC/18-mm Lens/ window mounting bracket, light shield	VHBW (2485)/ E-15	T1.0, approximately 60, ∞
CM Photographic Tasks*	Photographs of TBD areas of the lunar surface, providing 60 percent forward overlap	HEC/250-mm Lens	TBD	TBD
	Photography of TBD areas of the lunar surface, providing 60 percent forward overlap	HEDC/80-mm Lens/ window mounting bracket		
	Photographs of TBD areas in low light levels in earthshine and near the terminator	DAC/18-mm Lens	TBD	TBD

*This entry contains an extensive list of dim light photography objectives which may be modified as a result of Apollo Mission H-3 or because of operational impact on other higher-priority orbital experiments.

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 (Cont'd)	Photographs of TBD areas in low light levels in earthshine and near the terminator, providing stereo strips with 60 percent forward overlap	HEDC/80-mm Lens/ window mounting bracket	TBD	T1.0 (F.95), TBD, TBD, frame cycle rate of 1 frame per second
	12 photographs, 3 taken of each of 4 points on the celestial sphere: Subject (R. Asc. Decl.) North Galactic Pole (12^h 50^m, +27.3°) North Ecliptic Pole (18^h 0^m, +66.5°) North Celestial Pole (- , +90.0°) Northernmost Milky Way (0^h 40^m, +60.0°)	DAC/18-mm Lens/ window mounting bracket	VHBW (2485)/ E-15	T1.0, (20, 20, 5)*,∞

*Exposure times for the three photographs are 20 seconds, 20 seconds, and 5 seconds, respectively.

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 (Cont'd)	25 photographs of zodiacal light, taken at the following times prior to CSM sunrise:*	DAC/18-mm Lens/ mounting bracket	VHBW (2485)/ E-15	Aperture T1.0, focus at ∞ for all 25 photographs, shutter speeds as shown below for different times prior to sunrise:
	(Min:Sec)			
	-25:00			20, 10, 5
	-21:40			20, 10, 5
	-18:20			16, 8, 4
	-15:00			16, 8, 4
	-11:40			8, 4, 2
	- 8:20			8, 4, 2
	- 5:00			4, 2, 1
	- 1:00			1/60
	- 0:45			1/125
	- 0:30			1/250
	- 0:15			1/500
	2 series of solar corona photographs, one after CSM sunset and one 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-15	Aperture of f2.8 and focus of ∞ for all photographs, shutter speeds variable with times of photographs, as follows:

*For these photographs the CSM attitude will be matched to the lunar orbital rate, holding the +X axis aligned near the forward-looking local horizontal such that approximately one-eighth 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 (Cont'd)	From CSM Sunset (Sec) — Prior to CSM Sunrise (Sec)			
	0 — 0			–
	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
	(b) approximately 180 frames, during the following intervals:	DAC/18-mm Lens/ window mounting bracket	VHBW (2485)/ E-15	T1.0, (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
	Four photographs of a lunar libration region	DAC/18-mm Lens/ window mounting bracket	VHBW (2485)/ E-15	T1.0, (60, 20, 20, 5), ∞

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

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
CM Photographic Tasks (Cont'd)	Six photographs of the earth darkside, two series of 3 photographs, as follows:			
	3 photographs of the earth's darkside, taken near the translunar mid-distance point when PTC is not scheduled	DAC/18-mm Lens/ optical adapter to the CSM sextant	VHBW (2485)/ E-15	T1.0, (60, 20, 5), ∞
	3 photographs of the earth's darkside, taken near the transearth mid-distance point when PTC is not scheduled	DAC/18-mm Lens/ optical adapter to the CSM sextant	VHBW (2485)/ E-15	T1.0, (60, 20, 5), ∞
	Two series of photographs of the earth's limb during solar eclipse by the earth, each series to consist of the following:			
	Beginning when the sun appears to set:			
	7 photographs of the earth's limb	HEC/80-mm Lens/ window mounting bracket	VHBW (2485)/ E-15	f2.8, 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
CM Photographic Tasks (Cont'd)	Approximately 180 frames of the earth's limb Beginning 3 minutes prior to computed sunrise: same as above	DAC/18-mm Lens/ window mounting bracket	VHBW (2485)/ E-15	T1.0, TBD, ∞, frame cycle rate of 1 frame per second
	Three photographs of a comet, if one is in a favorable position	DAC/18-mm Lens/ optical adapter to the CSM sextant	VHBW (2485)/ E-15	T1.0 (60, 20, 5), ∞

Table 3-3. Lunar Surface Science Photographic Requirements

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING*	EXPOSURE PARAMETERS**
Passive Seismic (S-031) (ALSEP)	PSE deployed - one photograph cross-sun from 3 feet, showing position of bubble and gnomon shadow on compass rose	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 3
	One photograph showing C/S in background, taken 7 feet from PSE	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 5

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)
HEC - 70-mm Hasselblad electric camera
LTC - Lunar topographic camera
MC - 3-Inch mapping camera
PC - 24-Inch panoramic camera

Film Nomenclature:

CEX - Color exterior (SO-368)
HCEX - High-speed color exterior (SO-168) (ASA 160)
CIN - Color interior (SO-168) (ASA 1000)
BW - Black and white (3400)
BW - Black and white (3401)
HBW - High-speed black and white (2405, formerly SO-267)
MBW - Medium-speed black and white (3414, formerly SO-349 and 3404)
VHBW - Very high-speed black and white (2485)

*Film processing is specified by reference to the page in Appendix E which contains the appropriate processing information.

**Exposure parameters are preliminary based on previous mission photography - final values are TBD by FCSD and PTL.

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 (S-034) (ALSEP)	One photograph taken 3 feet from the LSM and focused on shadowgraph	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 3
	One photograph cross-sun showing the three LSM sensor heads	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, TBD
	One photograph taken 7 feet from the LSM, showing the LSM with the C/S in the background	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 5
Heat Flow (S-037) (ALSEP)	One photograph of each bore hole, cross-sun looking toward the C/S - view to show a 10-foot diameter about each hole	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 10
	One photograph cross-sun of HFE electronics package from 7 feet to include C/S in the background	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 7
	One photograph of each bore stem, taken from 7 feet, showing the maximum deviation from the vertical of the stem	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 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
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-40, E-41	TBD
	One photograph cross-sun taken 3 feet from SWS, looking south	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	
ALSEP/Central Station	One photograph of the C/S taken from 7 feet behind the C/S looking north	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 7
	At least one photograph showing entire ALSEP deployed	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, TBD
	One photograph of the C/S taken from 3 feet looking south to show the positions of the switches	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, TBD
Radioisotope Thermoelectric Generator (RTG) (ALSEP)	One photograph of the RTG on the subpackage, taken 7 feet from the RTG	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 3

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
Suprathermal Ion Detector Experiment (SIDE) (S-036)/Cold Cathode Ion Gauge (CCIG) (S-058) (ALSEP)	One photograph cross-sun 7 feet from the SIDE looking south	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	TBD
	One photograph cross-sun 7 feet from the SIDE looking north, showing the aperture of the CCIG	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	TBD
	One photograph showing SIDE and CCIG with C/S in background	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	TBD
	One photograph of the SIDE bubble level from 3 feet, showing the deviation of the SIDE from the local vertical	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	TBD
Laser Ranging Retro-Reflector (S-078)	One photograph of the top of the LR^3 from 3 feet, showing bubble level and shadow marker	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 3
	One photograph of the LR^3 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-40, E-41	f11, 1/250, 10

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

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Soil Mechanics (S-200)	One photograph of each of the eight LM secondary strut assemblies; line-of-sight approximately perpendicular to plane of strut assembly; field-of-view as small as possible but including all of secondary strut and all of primary strut below the attachment of the secondary strut. These photographs must also be taken prior to the mission	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD
	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	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD
	Photographs of the lunar surface showing DPS exhaust impingement erosion crater, one photograph to be taken cross-sun from 11 feet	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD

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

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Soil Mechanics (cont'd)	Eight photographs, two of each LM footpad and surrounding lunar soil exhibiting evidence of LM footpad-lunar soil interaction			
	-Y pad, cross-sun -Z pad, up-sun -Y pad, cross-sun -Z pad, down-sun	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f8, 1/250, 5
	Photographs of the course traversed before and after traverses for ALSEP deployment	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	TBD
	Photographs of an astronaut's footprint during traverse for ALSEP deployment, cross-sun from 11 feet	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	TBD
	Before trench excavation (a) One photograph of trench site up-sun from 10 feet, showing gnomon placed near trench site (up-sun)	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD

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

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Soil Mechanics (Cont'd)	(b) A stereo pair of trench site cross-sun from 7 feet			
	Sequence photographs down-sun during excavation	LDAC/10-mm Lens	CEX (SO-368)/ E-34, E-35	f8, 1/250, ∞, 24 frames per second
	The following photographs of the excavated trench: (a) A stereo pair of the trench interior up-sun from 7 feet (b) Two stereo pairs, one cross-sun from each side of the trench, from 7 feet (c) A stereo pair of the trench, down-sun from 7 feet	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD

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

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Soil Mechanics (Cont'd)	The following photographs of the excavated material: (a) A stereo pair cross-sun from 7 feet (b) A stereo pair from 7 feet after an astronaut has stepped on the pile of excavated material	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD
	Photographs of soil surface adjacent to penetrometer and plate load tests, both before and after the tests are performed, cross-sun from 7 feet	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD
	Photograph at each penetrometer test site showing depth to any impenetrable stratum or the maximum depth to which the astronaut was able to push penetrometer, cross-sun from 7 feet	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD

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

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Soil Mechanics (Cont'd)	Photographs of the area where each penetrometer/ plate load test was conducted, showing location relative to LM or a prominent terrain feature	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD
	Photographs of natural slopes, boulders, ridges, rills, crater walls and embankments in the vicinity of the landing site	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD
	A stereo pair of the lunar soil-LRV interaction at each of four locations cross-sun from 7 feet	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/ E-25	TBD
	Photographs of the LRV in motion	LDAC/10-mm Lens	CEX (SO-368)/ E-34, E-35	f8, 1/250, ∞, 24*

*frames per second

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
Contingency Sample Collection	One photograph cross-sun of the sample while it is on the lunar surface and one photograph cross sun of the sample area after the sample is taken	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f8, 1/250, 5
Selected Sample* Collection	One stereo pair, showing sample and gnomon, cross sun from 7 feet	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 7
	One photograph down-sun from 11 feet, including gnomon	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 11
	One photograph cross-sun of sampled areas, from 7 feet	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 7
	One photograph approximately cross-sun, including an identifiable object, from 15 feet	HEDC/60-mm Lens	HCEX (SO-168)/ E-40, E-41	f11, 1/250, 74
Lunar Field Geology (S-059)	For each documented geological sample, the following 5 photographs:			

*Photographic requirements for the Selected Sample are preliminary.

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 Field Geology (Cont'd)	Before Sampling:			
	One down-sun from 11 feet, including gnomon	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	TBD, 1/250, 11
	One stereo pair cross-sun from 7 feet	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	TBD, 1/250, 7
	After Sampling:			
	One cross-sun from 7 feet	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	TBD, 1/250, 7
	One approximately cross-sun from 15 feet, including an identifiable object or landmark	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	TBD, 1/250, 74
	For diametric sampling of a fresh crater: two partial panoramas, one before and one after sampling	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	TBD
	For each large rock sample: same as for documented geological samples			
	One photograph before and after the exhaust contamination sample	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	TBD

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

EXPERIMENT OR OBJECTIVE	PHOTOGRAPHIC SUBJECT/ DESIRED VIEWS	CAMERA/LENS/FILTER AUXILIARY EQUIPMENT	FILM TYPE/ PROCESSING	EXPOSURE PARAMETERS
Lunar Field Geology (Cont'd)	For the fillet sample: 4 photographs equally spaced around the rock, from 3 feet	HEDC/60-mm Lens	HBW*(2405, formerly SO-267)/E-25	TBD, 1/250, 3
	For each core tube sample: One stereo pair cross-sun of core tube in contact with surface, from 7 feet	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	TBD, 1/250, 74
	One photograph of tube and horizon, from 15 feet	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	TBD, 1/250, 74
	For the 4-kilogram soil sample: same as for documented geological samples			
	For the trench sample: same as for the soil mechanics trench or, if soil mechanics trench is used, photographs in support of soil mechanics will suffice			
	For the lunar environment soil sample: same as above			

*On one of the latter two EVA's, the film will be HCEX(SO-168)/E-40, E-41.

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 Field Geology (Cont'd)	For the gas analysis sample and the residual magnetic rock sample: same as for the documented geological samples For large examples of lunar surface features and field relationships: same as for documented geological samples but with extended stereo photography Up to 12 sets of panoramic photographs, each set containing 12 overlapped photographs for 360-degree coverage, taken with horizon near top of picture - sets to be taken from: a) 20 feet from LM quad 2 b) 20 feet from LM quad 3 c) 20 feet from LM +Z strut d) geological features of interest along traverse	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	TBD, TBD, 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 Field Geology (Cont'd)	e) high elevation points f) points with items of crew interest			
	For near field polarimetric measurement:			
	One photograph down-sun (10-degree phase angle), from 10 feet, taken of a rock sample area, including gnomon	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	f11, 1/250, 11
	Three photographs of area from 7 feet, one through each of three polarizing filters, at a phase angle of 90 degrees	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	f5.6, 1/125, 7
	Same 3 photographs at phase angle of 110 degrees			
	Same 3 photographs at phase angle of 130 degrees			
	One photograph down-sun from 10 feet after sample collection	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	f11, 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
Lunar Field Geology (Cont'd)	For distant polarimetric measurement:			
	Three photographs from at least 12 feet, approximately cross-sun, one each at the left, center, and right settings of the polarizing filter	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	f5.6, 1/125, 74
	Three photographs as above, but from about 20 degrees down-sun from first position	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	f5.6, 1/125, 74
	For each near-field colorimetric survey:			
	Four photographs down-sun from 7 feet, showing rock with color chart (chart facing up-sun) and gnomon	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	f18, f11, f8 and f5.6, respectively <u>TBD</u>, 7
	One photograph from 7 feet, at a phase angle of 45 degrees, showing same scene	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	f11, <u>TBD</u>, 7
	One photograph down-sun from 7 feet, of same scene <u>after</u> sampling	HEDC/60-mm Lens	HBW (2405, formerly SO-267)/E-25	f11, <u>TBD</u>, 7

Table 3-4. Photographic Reproduction Requirements

ITEM	LUNAR SURFACE ONLY	ORBITAL AND LUNAR SURFACE	ORBITAL ONLY	TOTAL
70-mm Photography				
Positive Transparencies (Rolls)	13	28	0	41
Masters (Rolls) - From Original O/B Film***	5	5	0	10
8 X 10 In. Prints - Color And BW (Set)	21	25	0	46
Proof Books (Set)	2	8	0	10
16-mm Photography				
16-mm - Optical Masters - B-Wind (Set)	0	2	2*	4
16-mm - Working Prints (Set)	13	15	0	28
35-mm Photography				
Positive Transparencies (Rolls)	8	0	0	8
Masters (Rolls) - From Original O/B Film	2	0	0	2
Slides (Set)	27	0	0	27
8 X 10 In. Prints (Set)	12	0	0	12
Proof Books (Set)	1	0	0	1
Television				
Kinescope (16-mm)	0	0	0	0
Working Print (Set)	3	0	0	3
Lunar Topographic Camera (Hycon)				
Positive Transparencies (Rolls)	0	0	30	30
Strip Prints 4-1/2 X 4-1/2 In. (Set)	0	0	22	22
8 X 10 In. Prints (Set)	0	0	9	9
Masters (Rolls) - From Original O/B Film	0	0	5	5

Table 3-4. Photographic Reproduction Requirements (Continued)

ITEM	LUNAR SURFACE ONLY	ORBITAL AND LUNAR SURFACE	ORBITAL ONLY	TOTAL
24-In. Panoramic Camera**				
Positive Transparencies (Rolls)	0	0	3	3
Masters (Rolls) - From Original O/B Film	0	0	5	5
3-In. Mapping Camera**				
Positive Transparencies (Rolls)	0	0	10	10
Masters (Rolls) - From Original O/B Film	0	0	5	5
35-mm - Positive Transparencies (From 3-Inch Camera)	0	0	10	10
35-mm - Masters (Rolls) From Original O/B Film	0	0	5	5

* Dim Light Photography only - Gegenschein Experiment S-178

**Printing and distribution of material from the 3-Inch and 24-Inch camera systems, the method of reproduction, and the facility to be used are TBD.

***O/B Film - Onboard Film

SECTION IV

LUNAR TRAVERSE PLAN

4.1 GENERAL

This section is intended to provide information for use in the planning of lunar traverses for Apollo Mission J-1. Included are a brief geological description of the landing site and a listing of the detailed activities required for the science experiments scheduled to be performed on the lunar surface. These activities have not been correlated to traverses for the three planned EVA's because the landing site was not identified until recently and traverse data have not been available. However, detailed traverses and the activities for each will be provided in the next issue of this document scheduled for publication at L-5 months.

4.2 GEOLOGICAL DESCRIPTION

The two major features of the Hadley-Apennines landing site are the Apennine Mountains and Hadley Rille (Figure 4-1). The Apennine Mountains, rising up to 2 km above the lunar surface, are the most imposing of the lunar mountain ranges and form the southeastern boundary of Mare Imbrium. The front of these mountains is probably composed of materials that predate the excavation of the Imbrium and may include pre-Imbrium rocks. These mountains offer 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 both a major ringed mare and mascon region.

Hadley Rille is a meandering channel much like river gorges on earth. About 1 km wide and 200 m deep, this rille runs parallel to the Apennine Mountains in a northeasterly direction. The nature and origin of Hadley Rille and its associated elongate depression and deposits are expected to provide information on important lunar surface processes and may yield data on the history of lunar volatiles.

Significant features in the Hadley-Apennines area, shown in Figure 4-1 with letter designations corresponding to those below, are as follows:

a) Apennine Ridge

b) Hadley C Crater

c) Apennine Front

d) Apennine Spur

e) Elongate Depression

4.3 EXPERIMENT ACTIVITIES

The ALSEP Array A-2/Heat Flow is a family of experiments assigned to the mission. A typical deployment arrangement is shown in Figure 4-2. Required activities associated with these and other assigned experiments are listed in Table 4-1. Data listed under each column heading are described below. Detailed procedures and the timeline for these activities are defined in the Lunar Surface Procedures, those for photographic activities are defined in the Photographic and Television Procedures.

a) Experiment (Number) and Activity (Priority). Includes each activity and its priority.

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 No. Identifies the particular station number on the traverse map where activity will occur. An entry in the column will indicate whether the activity is left to the astronaut's discretion.

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

e) Sample Stowage. Indicates appropriate container on the LRV in which the sample is to be stowed.

f) Remarks. Provides additional information pertinent to the development of detailed timelines and procedures.

4.4 TRAVERSES

Experiment activities for each of the three planned traverses will be provided in the next issue of this document. Traverses will be plotted on maps. Supplementary traverse data will be provided in a format similar to that shown by Table 4-2. Data to be listed under each column heading are described below.

a) Station, From and To. The route and activities can be followed by reading the station designations and referring to the traverse map (Figure 4-3).

b) Distance. Shows the computed map distance between the two stations in kilometers.

c) Geologic Feature. Describes the major geological feature at the "To Station." Data in parentheses indicates whether the station stop is a "long" or "short" stop.

d) Activities. Indicates the "enroute" phase as well as the science activity for the particular station.

e) Duration. Indicates the time in minutes for both the enroute phase and the station science activities. The latter time includes both science time and the required overhead time.

f) Cumulative Distance and Time. Indicates the estimated cumulative totals of both distance (kilometers) and time (hours:minutes) as the traverse progresses from station to station. The sum of the science time, overhead time, and enroute time is the total traverse duration. Time and distance are only estimates and are preliminary. Official timelines will be provided in the Lunar Surface Procedures.

4.5 GROUND RULES AND CONSTRAINTS

Data in this paragraph are TBD.

Table 4-1. Experiments Activities

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT* ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS**	STOWAGE	REMARKS
<u>Lunar Geology/Sample Collection (S-059)</u>					
1 large fresh crater (HD)	Collect samples of different types of rocks and soil; sample ID.	<u>TBD</u>	5 photographs: 3 before sampling 2 after sampling	In prenumbered bags in SRC No. <u>TBD</u>. If too large, store in SRC or collection bag.	Different types showing variation in color, texture, shape and degree of rounding. When rocks are too large, chips should be taken.
1 small fresh blocky crater (HD)	Collect samples of bedrock; sample ID.	<u>TBD</u>	Same as above.	Same as above.	Same as above.
1 subdued crater (HD)	Collect samples of different types of rocks and soil; sample ID.	<u>TBD</u>	Same as above.	Same as above.	Same as above.
Each major geological site (M)	Collect samples of different types of rocks and soil; sample ID.	<u>TBD</u>	Same as above.	Same as above.	Same as above.
Comprehensive sample (M)	Collect all rocks within this sampling site larger than 1/2 in. diameter; sample ID.	Astronaut discretion	Same as above.	Same as above.	Flat region of up to 100 square feet desirable.
Radial sampling of a fresh crater (HD)	Collect soil plus rock samples: 1 on crater rim, 1 one-half crater diameter outward on ejector field, 1 one crater diameter outward on ejector field. 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 outward from this crater rim.	<u>TBD</u>	2 partial panoramas, before and after sampling.	Loose in an SRC or a collection bag.	

Table 4-1. Experiments Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT* ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS**	STOWAGE	REMARKS
Additional samples (HD)	Collect samples in order of priority: a) small rocks, b) rock chips, c) soil.	Astronaut discretion	For each sample, 5 photographs: 3 before sampling 2 after sampling.	Loose in an SRC or in a collection bag.	a) Size of documented samples b) ≤ 1 in. diameter
Lunar surface features and field relationships (M)	Examine and describe following type field relationships: a) surface patterns of small grooves or linear features, b) rock surfaces that show textures and structures too large to return, c) craters that show the range of size, freshness and degradation, d) rock-soil junctions such as fillets banked against rocks, e) disturbed and undisturbed surface material.	Astronaut discretion	Small features: 3 photographs Large features: Extend stereo photographs.	N/A	
3 panoramic photograph sequences at LM (M)	Take photographs	At LM	12 photographs to provide 360 degree coverage.	N/A	20 ft. from Q_2, Q_3 and +Z struts.
Up to 9 panoramic photographic sequences (HD)	Take photographs	TBD	12 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 clear interest.
Near-field polarimetric measurement photographs (M)	Take photographs in an area of several rocks.	Astronaut discretion	10 photographs	N/A	In area where at least 4 rock samples will be collected.
4 rock samples (M)	Collect samples.	Astronaut discretion (from area where near-field polarimetric measurement taken).	1 of area after samples collected.	In prenumbered bags in an SRC.	

Table 4-1. Experiments Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT* ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS**	STOWAGE	REMARKS
Far-field polarimetric measurement photographs (M)	Take photographs in a rocky area or an inner crater wall.	TBD	6 photographs	N/A	Crater diameter >12 m.
Near-field colorimetric survey photographs (M)	Take photographs of a rocky area with different color materials.	Astronaut discretion	2 photographs	N/A	In area where 4 rock samples will be collected.
4 rock samples (M)	Collect samples	Astronaut discretion (from area where near-field colorimetric survey photographs taken).	1 of area after samples collected	In prenumbered bags in an SRC.	
1 triple core tube sample (M)	Obtain core tube sample; sample ID.	TBD (In vicinity of S-200 trench).	3 photographs: 1 stereo pair 1 localization	Core tubes will be stored in SRC No. TBD. Bit will be individually bagged and stored in SRC No. TBD.	Between craters at distant point on traverse.
1 double core tube sample (M)	Obtain core tube sample; sample ID.	TBD	Same as above.	Core tubes will be stored in SRC No. TBD.	From multiple layer area, e.g., bottom of a subdued crater.
Single core tube samples (M)	Obtain core tube samples; sample ID.	Astronaut discretion	Same as above.	Core tubes will be stored in an SRC.	Targets of opportunity.

Table 4-1. Experiments Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT* ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS**	STOWAGE	REMARKS
4 kg soil sample (M)	Collect sample.	Astronaut discretion (from within comprehensive sample area).	5 photographs: 3 before sampling 2 after sampling	Single collection bag.	
3 soil/small rock samples (M)	Collect samples from trench; sample ID: a) from bottom, b) from side, c) from top.	TBD (may be from S-200 trench.)	Sample area to be documented photographically same as S-200 trench.	In prenumbered bags in SRC No. TBD.	Location far away from LM.
1 three-meter drill core (M)	Collect sample using Apollo lunar surface drill.	TBD (In vicinity of ALSEP deployment site).	TBD	Store six drill items in SRC No. 1	
2 large rocks (M)	Collect rocks, preferably showing evidence of erosion, from flat area.	Astronaut discretion	5 photographs: 3 before sampling 2 after sampling	Collection bag.	Equidimensional, 6 to 8 in. on a side; crystalline if distinguishable.
Several small rocks (about 5 in number) (M)	Collect samples, representing various stages of erosion.	Astronaut discretion	Same as above.	In prenumbered bags in an SRC.	Equidimensional, should include most angular and most rounded; crystalline if distinguishable.
1 fillet sample (M)	Sample fillet along with one large rock or one small rock; sample ID.	Astronaut discretion (with rock).	4 photographs: 1 from each quadrant of fillet.	In prenumbered bag in an SRC.	Sample just fillet material, not deeper soil under fillet.
1 exhaust contaminated sample (M)	Collect sample; sample ID.	From under LM.	2 photographs: 1 before sampling 1 after sampling	Special environmental sample container; SRC No. TBD.	Collect only top layer; if material too hard to scoop, delete sample.

Table 4-1. Experiments Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT* ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS**	STOWAGE	REMARKS
1 gas analysis rock sample (M)	Collect sample of spherules, glass-splattered rocks, or combinations of different rocks; sample ID.	Astronaut discretion	5 photographs: 3 before sampling 2 after sampling	Special environmental sample container; SRC No. TBD.	≥300 ft from LM; sample should be free of soil; SESC should be filled.
1 lunar environmental soil sample (M)	Collect from bottom of S-200 trench; sample ID.	TBD	Sample area to be documented photographically same as S-200 trench.	Special environmental sample container; SRC No. TBD.	≥300 ft from LM.
1 micro-breccia rock (M)	Collect sample; sample ID.	Astronaut discretion	5 photographs: 3 before sampling 2 after sampling	Magnetic sample container; SRC No. 2.	≥300 ft from LM.
1 crystalline rock (M)	Collect sample; sample ID.	Astronaut	Same as above.	Magnetic sample container; SRC No. 2.	≥300 ft from LM.
Soil Mechanics (S-200)					
Trench (M)	Excavate a narrow trench; pile excavated material to determine its natural slope.	TBD	15 photographs: 3 of site before trenching; 4 stereo-pairs of trench; 2 stereo-pairs of excavated material. Sequence photographs of trenching operation.	N/A	Aligned 10 degrees off sun-line; 6 to 8 in. deep; adjacent to penetrometer and plate load test.
1 penetrometer and plate load test (M)	Perform test.	Trench excavation site (TBD).	4 photographs of each penetrometer and plate load test: 1 to show	N/A	Prior to excavation of trench.

Table 4-1. Experiments Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT* ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS**	STOWAGE	REMARKS
			depth of penetration; 1 localization; 1 of soil surface adjacent to test, both before and after test.		
2 penetrometer and plate load tests (M)	Perform tests: 1 at trench bottom; 1 adjacent to trench to cause wall failure.	Trench excavation site (TBD).	Same as above.	N/A	If wall failure occurs during trench excavation, second test is not done.
TBD penetrometer and plate load tests (M)	Perform tests.	One at each core tube sample station under S-059 (TBD).	Same as above.	N/A	A total of at least 15 tests will be made.
4 penetrometer and plate load tests (M)	Perform tests.	Astronaut discretion	Same as above.	N/A	At locations where LRV performance data are available.
Photographs of LM, lunar surface, etc. (M)	Take photographs	**	**	N/A	See Photographic Plan for specifics.
Comments on the following (M): ability to dig in lunar soil and estimates of depths of any layers detected;	Make comments.	At trench site (TBD)	N/A	N/A	
estimate of the excavated depth, description of excavation, and time required to complete excavation;		At trench site (TBD)	N/A	N/A	
on effort required to push the penetrometer and bearing plate into surface and depth and firmness of any subsurface obstructions.		At penetrometer and plate load test sites (TBD).	N/A	N/A	

Table 4-1. Experiments Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT* ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS**	STOWAGE	REMARKS
Contingency Sample Collection (M)	Collect sample of about 2 lb.	Immediate vicinity of LM	2 photographs: 1 of sample on surface; 1 of sample area after sample is taken.	Contingency sample return container.	As early as practical during initial EVA.
Selected Sample Collection (M)	Collect samples: a) 3/4 of quantity, rocks of varied texture and mineralogy, b) 1/4 of quantity, fine-grained fragmented material, c) 1 large rock of TBD size.	Astronaut discretion	5 photographs: 3 before sampling 2 after sampling	SRC No. 1	During first EVA.
Laser Ranging Retro-Reflector (S-078) (M)	Deploy LR^3; emplace, level and orient it.	TBD	2 photographs: 1 of top of array 1 between front and side of array.	N/A	Deploy: ≥300 ft. from LM such that ascent plume does not impinge on array face.
ALSEP Array A-2/Heat Flow					
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; subpackage 3, the heat flow experiment and lunar surface drill will be be transported on the LRV;	TBD	4 photographs: 2 of the c/s 1 of the RTG 1 of the entire deployed ALSEP	N/A	≥300 ft. from LM; as early as possible in first EVA. 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.

Table 4-1. Experiments Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT* ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS**	STOWAGE	REMARKS
	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.				
Passive Seismic (S-031) (M)	Deploy, coarse level and rough align the sensor assembly. Deploy the thermal shroud. Perform a fine alignment and report readings to MCC.	TBD	2 photographs: 1 showing bubble level and gnomon shadow on compass rose; 1 with C/S in background.	N/A	Part of ALSEP A-2/Heat Flow Array.
Heat Flow (S-037) (M)	Deploy, level, and align the electronics package. Drill 2 holes 3 meters deep in surface with the lunar surface drill; insert 1 sensor probe into each hole and report the appropriate marking to determine the probe depth.	TBD	5 photographs: 1 of each drilled hole with probes inserted; 1 of the electronics package; 1 of each bore stem.	N/A	Part of ALSEP A-2/Heat Flow Array.
Lunar Surface Magnetometer (S-034) (M)	Deploy, level and align the sensor assembly. Report shadowgraph readings to MCC.	TBD	3 photographs: 1 of shadowgraph 1 of sensor heads 1 with C/S in background.	N/A	Part of ALSEP A-2/Heat Flow Array.
Solar Wind Spectrometer (S-035) (M)	Deploy on a relatively smooth, flat surface; level and align and report on leveling and alignment.	TBD	2 photographs: 1 looking North 1 looking South	N/A	Part of ALSEP A-2/Heat Flow Array.

Table 4-1. Experiments Activities (Continued)

EXPERIMENT (NUMBER) ACTIVITY (PRIORITY)	ASTRONAUT* ACTIVITIES	TRAVERSE/ STATION NO.	PHOTOGRAPHS**	STOWAGE	REMARKS
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.	TBD	4 photographs: 1 of SIDE looking North; 1 of SIDE looking South; (one of above to show 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 ALSEP A-2/Heat Flow Array. CCIG and SIDE are pysically attached.
Lunar Dust Detector (LDDE) (M-515) (M)	Deployed with C/S; located on top of C/S.	On top of C/S	None	N/A	Part of ALSEP A-2/Heat Flow Array.

*A description of hand tools and equipment available to accomplish these activities can be found in Section II of this document.

**Detailed photographic requirements can be found in Section III of this document.

Table 4-2. Traverse Data for Hadley-Apennines

Station		Distance (km)	Geologic Feature	Activities	Duration (min)	Cumulative	
From	To					Distance (hr)	Time (hr:min)
				(To Be Provided)			

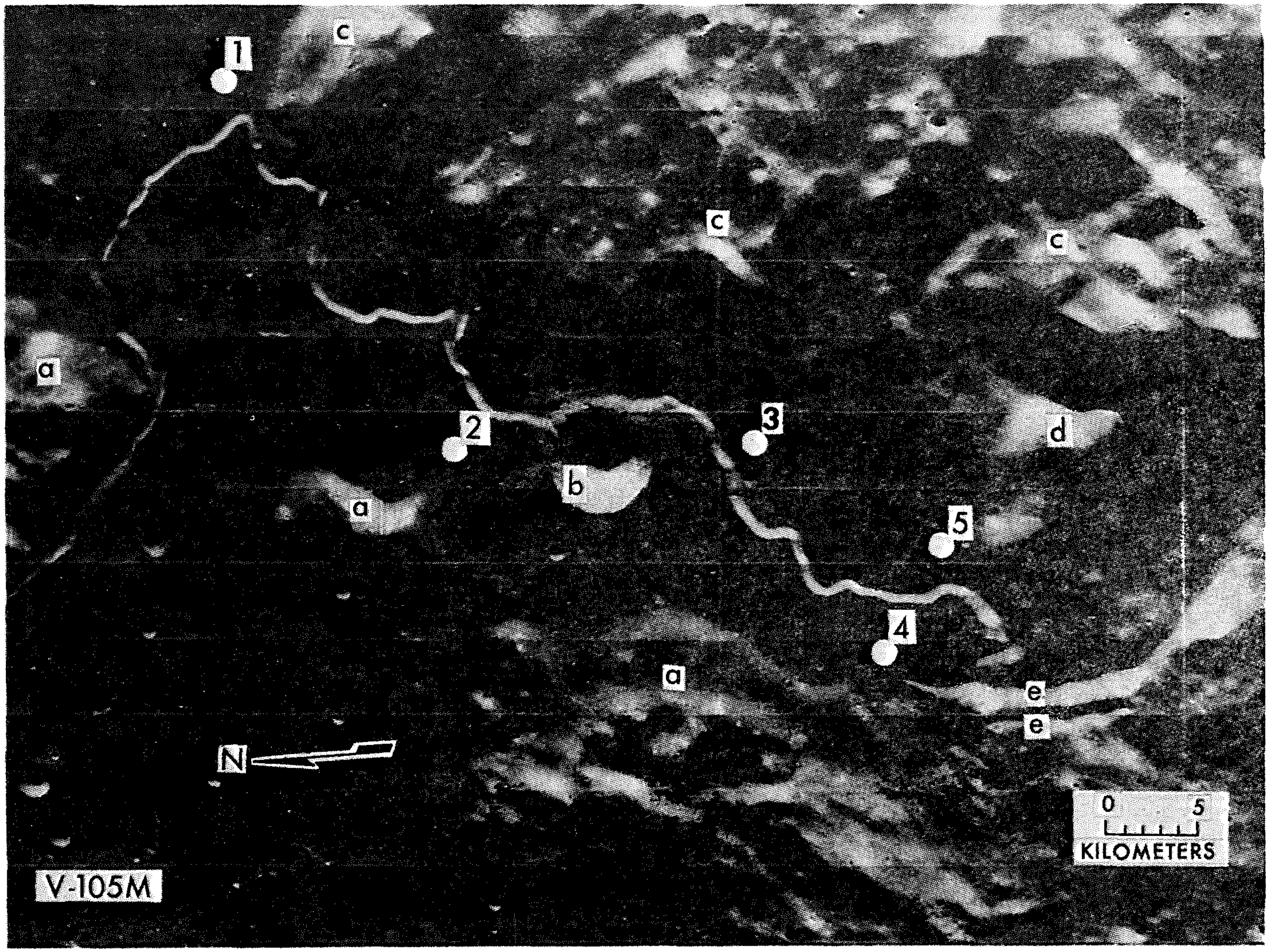


Figure 4-1. Landing Site

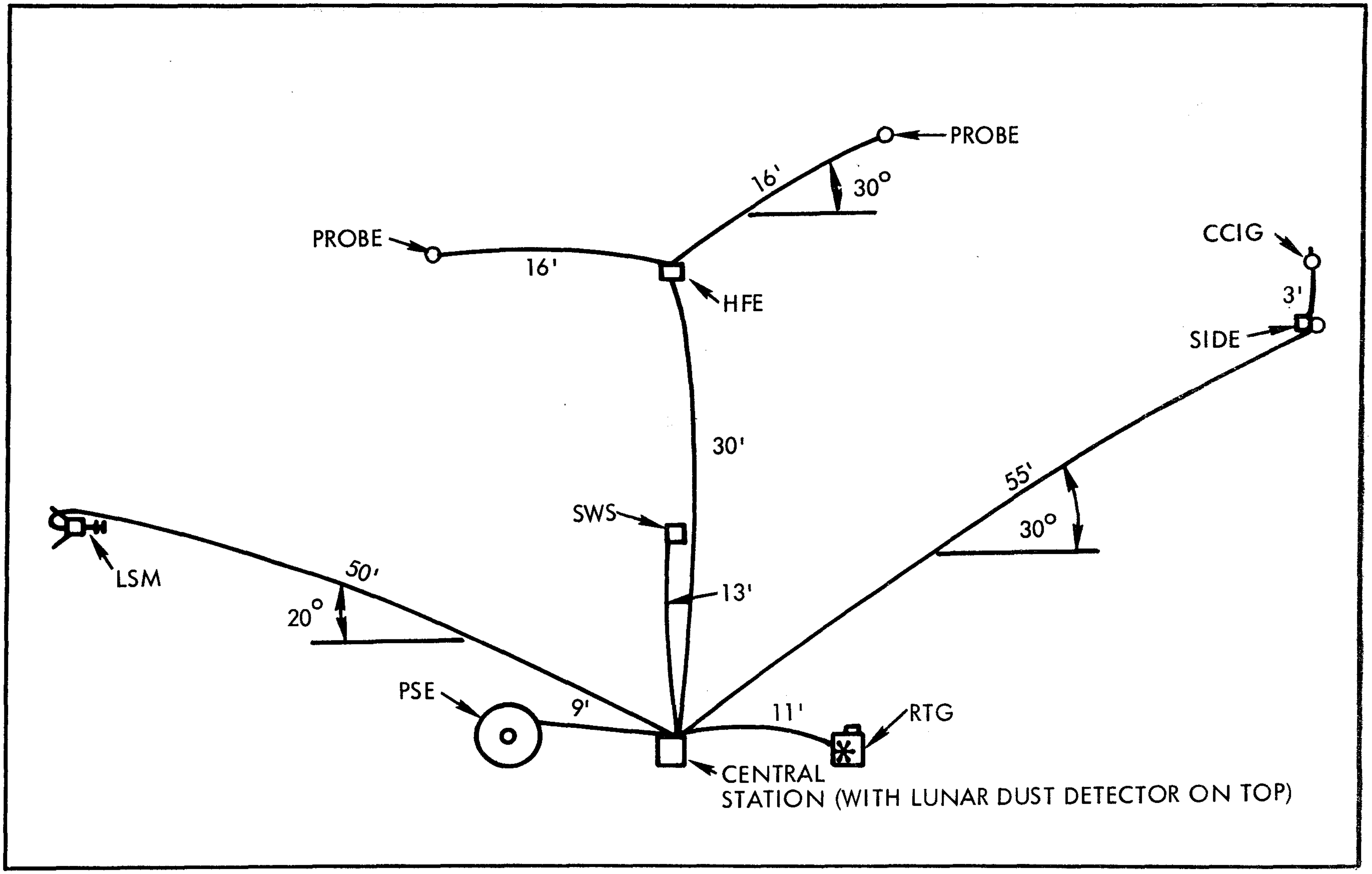


Figure 4-2. ALSEP Array A-2/Heat Flow Layout

TBD

Figure 4-3. Hadpey-Apennines Traverse Route

SECTION V

SCIENCE OPERATIONS SUPPORT PLAN

5.1 GENERAL

This section defines the science operational procedures as set forth by the Principal Investigators and the Science and Applications Directorate. These procedures are for use by mission planners and controllers in satisfying the experiment requirements contained in the Mission Requirements Document, SA-511/CSM-112/LM-10, J-1 Type Mission.

Included in this section are pertinent data resulting from the Principal Investigator's Operational Interface Meetings. These data define the scientific experiments operations, the lunar geology traverse, and the crew activities during the lunar surface operation phases. Reference should be made as necessary to these other sections in this document: Section II, which identifies and describes science experiments and equipment; Section III, which details the photographic requirements for both lunar orbit and lunar surface experiments; and Section IV, which presents the requirements for science lunar traverse activities.

Reference should also be made as applicable to other MSC documents which provide necessary procedures in a chronological sequence (timeline) for all science activities. These documents include the Flight Plan, Lunar Surface Procedures, Photographic and Television Procedures, and CSM Solo Book. Detailed operational data not included in this section or other sections of this document may be found in the CSM/LM Spacecraft Operational Data Book, Volumes V (ALSEP Data Book) and VI (CSM Experiments Data Book for J-Missions).

5.2 MISSION PHASES

The mission operational timeline consists of five phases as defined in the following paragraphs. Specific events for each of the phases are identified in Figure 5-1.

5.2.1 PHASE I (LUNAR SURFACE EVA PHASE)

Phase I is outlined in Table 5-1, and covers the period during which the astronauts are available for specific deployment activities, backup operations, and lunar geology investigations. Refer to Figures 5-2, 5-3, and 5-4 for supplemental information.

5.2.2 PHASE II (LUNAR SURFACE OPERATION CHECKOUT PHASE)

Phase II is outlined in Table 5-2, and covers the period from LM ascent through the checkout of all subsystems.

5.2.3 PHASE III (FORTY-FIVE DAY PHASE)

Phase III is outlined in Table 5-3, and covers the period from power turn-on and experiment checkout through the first 45 calendar days of ALSEP operation.

5.2.4 PHASE IV (ONE-YEAR PHASE)

Phase IV is outlined in Table 5-4, and covers the period from day 45 through the first year of ALSEP operation.

5.2.5 PHASE V (LUNAR ORBIT PHASE)

Phase V is outlined in Table 5-5, and covers all scientific activities after earth orbit except those related to experiments performed on the lunar surface.

Table 5-1. Phase I (Lunar Surface EVA Phase)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Contingency Sample Collection	Collect a contingency sample.			Sample should be taken as soon as possible after egress and placed in the Contingency Sample Return Container.
2. Selected Sample Collection	Collect samples of lunar material.			Typical Selected Samples are documented as follows: a. Photograph area before collecting sample. b. Collect sample and place in prenumbered collection bag. c. Photograph area after collecting sample. d. Store samples in the Sample Return Containers. NOTE: For more detailed procedures reference the Mission Requirements Document, SA-511/CSM-112/LM-10.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
3. Central Station Deployment	a. Deploy the Central Station 300 to 1000 feet due West or East of LM.			This distance is required to keep ALSEP out of the LM ascent blast area and the astronaut within the time/distance limitations for the PLSS. Easterly site acceptable only if Western site is unaccessible.
	b. Level Central Station to within 5° as indicated by the bubble level with the sun shield in the stowed position.			
	c. Align Central Station to within $\pm 5^{\circ}$ of East-West, using partial compass rose.			Central Station, as with most ALSEP subsystems, requires clear field-of-view for thermal control. Central Station must not be shaded from the sun on the lunar surface prior to deployment. ALSEP design allows deployment when sun angle is between sunup and 45 degrees.
	d. Level Central Station antenna to within 0.5° as indicated by bubble level.			The bubble at the edge of the indicators means 0.7° off level.
	e. Align Central Station antenna to within $\pm 0.5^{\circ}$ of East-West line, with reference to sun line.			Astronaut should use sun dial to align.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
4. Radioisotope Thermoelectric Generator Deployment	a. Deploy the RTG 9 to 12 feet from Central Station.			Limited by 13-foot cable. Hot RTG should be away from Central Station to maximize heat radiation to free space.
	b. Orient RTG to within ± 20° East-West of Central Station.			Orient as visually determined by astronaut to minimize thermal load on Central Station. Astronaut should orient RTG so as to favor RTG cable exit toward Central Station.
	c. Level RTG Pallet to within ± 10° of horizontal.			Level as visually determined by astronaut. Astronaut will avoid craters and slopes which impede dissipation of heat from RTG.
				NOTE: Astronaut should read ammeter on shorting switch box and connect RTG cable to Central Station after completion of RTG deployment.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
5. Passive Seismic Experiment Deployment	a. Deploy PSE 8 to 9 feet West of Central Station.			Limited by 10-foot cable, 8 feet minimum separation from RTG. Separation is necessary to avoid heat input from RTG. Must be out of field-of-view of Central Station radiator.
	b. Coarse level the PSE to within 5° of vertical utilizing the bubble level.			PSE should be placed in an approximately level spot, free from loose material. Five degrees is the limit of the automatic leveling gimbal system.
	c. Rough align the PSE to within ± 20° of lunar East, before opening PSE shroud, by pointing arrow on the sensor girdle away from the sun.			
	d. Fine align the PSE after removing girdle and spreading the thermal shroud.			Astronaut should read and report, to the nearest degree, the intersection of the shadow of the gnomon on the compass rose. Final azimuth alignment must be known within ± 5° accuracy with reference to sun line utilizing shadow graph.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
6. Suprathermal Ion Detector Experiment/ Cold Cathode *Gauge Experiment Deployment	a. Deploy the SIDE/CCGE 50 to 60 feet from Central Station.			Limited by 60-foot cable.
	b. Level SIDE to within 5° of vertical.			Astronaut will utilize bubble level during emplacement.
	c. Align SIDE to within ± 5° of sun line.			Align with respect to sun line to satisfy SIDE thermal and scientific data-gathering requirements. Astronaut should align unit utilizing direction marking indicating which end of the experiment must face the sub-earth point. The large side areas of the experiment must face in a N-S direction for proper thermal control. Final alignment by astronaut utilizing shadows on long sides of SIDE.
	d. Deploy CCGE*3.5 to 4 feet from SIDE.			Limited by length of cable. CCGE must be off the SIDE ground screen.
	e. Level CCGE to within ± 20° of vertical as visually determined by astronaut.			Shadow of UHT covers "E".
	f. Align CCGE orifice within ± 20° of Lunar North so that it has a clear field-of-view.			The CCGE gauge aperture must point away from the LM and ALSEP.

*The terms Cold Cathode Gauge Experiment (CCGE) and Cold Cathode Ion Gauge Experiment (CCIG) are used interchangeably in Section V, Tables 5-1 through 5-5.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
7. Solar Wind Spectrometer Deployment	a. Deploy SWS 12 to 15 feet from Central Station.			Limited by 15-foot cable.
	b. Orient SWS approximately due North or South of Central Station as visually determined by astronaut.			
	c. Level the SWS to within $\pm 5^{\circ}$ of vertical about E-W hinge axis. (eyeball)			SWS should be placed in an approximately horizontal spot to avoid thermal perturbations. Due to A-frame construction, there is a pendulum effect about E-W axis; SWS should swing freely. No leveling about N-S axis is necessary since N-S orientation is determined from sun sensor TM data. Astronaut can estimate level of instrument by observing shadows cast by triangular surfaces on the sensor mounting plate.
	d. Rough align the SWS to within $\pm 5^{\circ}$ of East-West by making arrow point East or West with respect to sun line.			

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
7. Solar Wind Spectrometer Deployment (Cont'd)	e. Fine align the SWS by setting N-S orange triangular faces equally in shade.			Louvered side (radiator) should be away from RTG and Central Station due to thermal control requirements.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Lunar Surface Magnetometer Deployment	a. Deploy LSM to 45 to 53 feet from Central Station.			Limited by 55-foot cable. Separation required to minimize EMI effects on LSM sensors.
	b. Orient LSM on opposite side of Central Station from LM within $\pm 20^{\circ}$ as visually determined by astronaut.			Required to minimize magnetic and EMI influence on LSM.
	c. Level the LSM to within $\pm 3^{\circ}$ of vertical.			LSM should be placed in an approximately level spot, free from loose material.
	d. Align the LSM to within $\pm 3^{\circ}$ of East-West sun line.			Astronaut should read the shadowgraph within $\pm 1^{\circ}$. Alignment is critical because thermal control is critical and exact alignment is required to interpret LSM scientific data.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. Heat Flow Experiment Deployment	a. Deploy the HFE Electronics Package 25 to 30 feet from Central Station.			Limited by 30-foot cable.
	b. Level the HFE Electronics Package to within ± 12° of vertical for maximum utilization of the thermal sunshield.			HFE Electronics Package should be placed in an approximately level area, removed from any surface irregularities or rocks that might reflect sunlight directly onto the sunshield reflector of the electronics package.
	c. Align the HFE Electronics Package to within ± 5° of the plane of the ecliptic or lunar equator.			
	d. Deploy the Probe 16 to 20 feet from the Electronics Package.			Limited by length of cable.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. Heat Flow Experiment Deployment (Cont'd)	e. Align the HFE Probe to within ± 15° of vertical.			The HFE Probes should be placed at least 200 feet from fresh craters with surrounding strewn fields of stones. The HFE Probes should be at least 5 diameters from large isolated blocks (boulders) exposed at the surface. Try to avoid topographic features greater than a meter in diameter such as craters or hummocks that have an aspect ratio greater than 1 to 10, (slopes of 10°). On the scale of 10's of meters topographic highs should be avoided and depressions preferred to assure thickest possible regolith.
	f. HFE Probe-to-Probe separation should be approximately 34 to 36 feet.			The HFE should be at least 10 feet from all other experiments and at least 20 feet from the PSE. Reference Figure 5-3 for typical HFE deployment arrangement.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
10. ALSEP Turn-On		a. Start Data Recorders.		
	a. Astronaut will notify MCC of readiness status via voice link and actuate Switches S-1 and S-5.	b. Acknowledge readiness message via voice link.		If ALSEP does not respond, initiate command octal 013, "Transmitter On".
		c. Verify reception of RF signal from ALSEP.		If ALSEP still does not respond, astronaut will actuate Switches SW-2 and SW-3.
		d. Verify transmission of 1060 bps telemetry.		Verify all data are within operational limits (Word 33).
	b. Acknowledge MCC receipt of RF signal and useful data via voice link.	e. Advise astronaut via voice links that ALSEP transmitter is functioning.		

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
11. Passive Seismic Experiment Turn-On		a. Check experiment status telemetry AB-04, AB-05 and CS-02 for correct indication and Shunt Reg #1 current status telemetry AE-05 for indication lower than octal 267.		
		b. Initiate command octal 036, PSE Operational Power ON.		If telemetry data are interrupted for more than 5 minutes, command PSE to Standby (Octal 037)
		c. Check experiment status telemetry, AB-04, AB-05 and CS-02 for correct indication.		
		d. PSE Housekeeping Data Check (Word 33)		
		(1) Long period gain X and Y AL-01.	3.0 volts	Preset condition: - 30 db
		(2) Long period Z amplifier gain AL-02.	3.0 volts	Preset condition: - 30 db
		(3) Level direction and speed AL-03.	0 volts	Preset condition: + low
		(4) Short period amplifier gain Z, AL-04.	3.0 volts	Preset condition: - 30 db
		(5) Leveling mode and coarse sensor mode AL-05.	0 volts	Auto, Coarse Sensor Out
		(6) Thermal control status AL-06.	0 volts	Auto, On

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
11. Passive Seismic Experiment Turn-On (Cont'd)		(7) Calibration status (L.P. and S.P.) AL-07.	3.0 volts	All Off
		(8) Uncage status AL-08.		Caged
		e. Uncage Passive Seismometer.		
		(1) Initiate command - octal 073, Uncage Arm/Fire.		
		(2) Verify change in uncage status AL-08.		Uncage/Arm.
		(3) Reinitiate command octal 073.		Wait 30 seconds between reinitiation of command octal 073.
		(4) Verify change in uncage status AL-09.		Uncage/Fire.
		(5) Observe short period scientific data on drum recorder for evidence of physical uncaging.		Consult PI before adjusting any gains. Adjust gain to visible signal.
		f. Level Passive Seismometer.		
		(1) Verify that feedback filter is switched OUT (present position) by comparing LP Seismic and LP Tidal data on recorders.		During initial leveling or when all LP components are off level, verify feedback position during Step f(7). If filter is IN, execute command octal 101, feedback filter IN/OUT, and note response.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
11. Passive Seismic Experiment Turn-On (Cont'd)		f. Level Passive Seismometer (Cont'd)		
		(2) Initiate command octal 102, COARSE LEVEL SENSOR IN/OUT		
		(3) Check telemetry AL-05 for change in status of COARSE LEVEL SENSOR and verification of AUTO Leveling mode.		Switch as required to obtain COARSE LEVEL SENSOR and AUTO status by commands octal 102 and octal 103.
		(4) Initiate command octal 070 LEVELING POWER X MOTOR ON.		
		(5) Observe recording of long period, tidal X-axis data as leveling proceeds.		During initial leveling, verify that feedback filter is switched out. This can be done by verifying the time lag between tidal and seismic data. If filter is in, execute command octal 101 and note response.
		(6) Observe S.P. Z Seismic data on recorder.		Observe S.P. Z channel for mortar activity and coarse sensor operations.
		(7) When X tidal output reaches a value of ± 5 micro radians or less, initiate command octal 070 LEVELING POWER X MOTOR OFF.		If tidal outputs are not within ± 5 micro radians, repeat steps f(1) to f(7) deleting step f(2).

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
11. Passive Seismic Experiment Turn-On (Cont'd)		f. Level Passive Seismometer (Cont'd)		
		(8) Repeat Event 13, steps f(4) thru (7) for Y-axis, initiating and verifying command octal 071 LEVELING POWER Y MOTOR while monitoring appropriate recorder.		
		(9) Initiate and verify command octal 102 COARSE LEVEL SENSOR.		
		(10) Check AL-05 for change of status.		Auto, Coarse Sensor OUT.
		(11) Verify that X and Y tidal outputs are within ± 5 micro radians.		
		(12) Initiate and verify command octal 072 LEVELING POWER Z MOTOR ON.		Leveling of Z axis requires: Level mode: Manual (103) Leveling speed: High (075) Leveling direction: Positive (074)
		(13) When a zero crossing is observed on Z tidal output, initiate command octal 103, leveling mode AUTO.		

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
11. Passive Seismic Experiment Turn-On (Cont'd)		f. Level Passive Seismometer (Cont'd) (14) When Z tidal output reaches a value of ± 0.5 milli gals, initiate and verify command octal 072 LEVELING POWER Z MOTOR OFF. (15) Verify that X and Y tidal outputs are within ± 5 micro radians and Z tidal output is within ± 0.5 milli gals. (16) Initiate and verify command PSE FILTER IN octal 101. (17) Verify that filter has been switched IN by comparison of LP Seismic and LP Tidal data on recorders. (18) Execute command octal 076 THERMAL CONTROL MODE SELECT as required to keep within limits.		

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
11. Passive Seismic Experiment Turn-On (Cont'd)		g. Passive Seismometer Calibration		
		(1) Initiate and verify command octal 066 CALIBRATION LP ON/OFF		
		(2) Check for status change in AL-07.		LP On. SP Off.
		(3) Initiate and verify command octal 066 CALIBRATION LP ON/OFF.		Approximately 60 seconds after step (2).
		(4) Check for status change in AL-07.		All Off.
		(5) Initiate and verify command octal 065 CALIBRATION SP ON/OFF.		
		(6) Check for status change in AL-07.		LP Off. SP On.
		(7) Initiate and verify command octal 065 CALIBRATION SP ON/OFF.		
		(8) Check for status change in AL-07.		All Off.
		h. Thermal Stabilization of Passive Seismometer.		
		(1) Monitor sensor unit temperature and verify that trend is toward 126°F, determine gradient.	$126 \pm 1^{\circ}$	Relevel as required.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
11. Passive Seismic Experiment Turn-On (Cont'd)		i. Collection of Baseline Passive Seismic Data. (1) Record data without further transmission of command for determination of background noise level, frequency and magnitude of detectable seismic events. (2) Fix gains at levels determined from Step i(1) above.		

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
12. Suprathermal Ion/Detector Experiment/ Cold Cathode Gauge Experiment Turn-On		a. Turn-On Checks (1) Check experiment status telemetry AB-04, AB-05 and CS-02 for correct indication. (2) Initiate and verify command octal 045 SIDE/CCGE OPERATIONAL POWER ON. (3) Check experiment status telemetry AB-04, AB-05 and CS-02 for correct indication. b. Telemetry Checks (1) Examine telemetry data and insure that SIDE frame counter (SIDE Word 1) cycles from 0-127.		Consult PI before initiating commands. SIDE/CCGE average thermal temperature must be below 25°C for initial operation. Do not initiate any commands to the channeltron high voltage supply or the gauge high voltage supply.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
12. Suprathermal Ion Detector Experiment/ Cold Cathode Gauge Experiment Turn-On (Cont'd)		b. Telemetry Checks (Cont'd)		
		(2) Check the reference and calibration voltages in SIDE Word 2.		DI-21, DI-22, DI-23, DI-25, DI-26, DI-27, DI-28, DI-30
		(3) Check the power supply output and performance parameters in SIDE Word 2.		DI-2, DI-13, DI-14, DI-15, DI-16, DI-17, DI-18, DI-20, DI-29
		(4) Check the experiment temperatures in SIDE Word 2.		DI-4, DI-5, DI-6, DI-9, DI-10, DI-19
		(5) Check the status parameters on SIDE Word 2.		DI-12, DI-24, DF-29
		(6) Check for appropriate cycling of the Ground Plane Voltage in SIDE Word 2.		DI-11
		(7) Check for appropriate cycling of High Energy Curved Plate Analyzer Filter Voltage, SIDE Word 3.		DI-40 thru DI-60
		(8) Check the status parameters in SIDE Word 6.		DI-63, DI-64, DI-65, DI-66, DI-68, DI-69, DI-70 and DI-71
		(9) Check for appropriate cycling of Velocity Filter Voltage in SIDE Word 7.		DI-72 thru DI-99 and DJ-00 thru DJ-97

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
12. Suprathermal Ion Detector Experiment/ Cold Cathode Gauge Experiment Turn-On (Cont'd)		b. Telemetry Checks (Cont'd)		
		(10) Check for appropriate cycling of Low Energy Curved Plate Analysis Filter Voltage in SIDE Word 8.		DJ-98, DJ-99 and DF-00 thru DF-04
		(11) Check High Energy data in SIDE Words 4 and 5 for baseline level with Dust Cover On.		DI-61 and DI-62.
		(12) Check Low Energy data in SIDE Words 9 and 10 for baseline level.		DF-05 and DF-06
		(13) Check Central Station housekeeping parameters (AI-01 and AI-02) for baseline levels of Low Energy and High Energy Detector Count Rates, respectively.		AI-01 and AI-02
		(14) Check telemetry associated with CCGE performance in SIDE Word 2.		DI-03, DI-08 and DI-67

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
12. Suprathermal Ion Detector Experiment/ Cold Cathode Gauge Experiment Turn-On (Cont'd)		b. Telemetry Checks (Cont'd) (15) Transmit and verify command octal 046, SIDE Standby Power.		SIDE should be in this condition during lunar ascent burn. The 4.5 KV and 3.5 KV source should be OFF.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
13. Lunar Surface Magnetometer Turn-On		a. Initiate Command octal 042 , LSM Operational Power SELECT.		
		b. Check telemetry word 46 for verification of command reception and parity check.		
		c. Check for appropriate change in reserve power.		
		d. Check experiment status telemetry, AB-4 for correct indication.		
		e. LSM Range Determination		
		(1) Observe baseline scientific data for X, Y and Z axis on analog recorder.		Consult PI for proper range setting.
		(2) Initiate and verify Command (octal 123) RANGE SELECT.		Check parity bit 1, ALSEP Word 46 for command verification.
		(3) Check for response in science data on analog recorders.		Should indicate a range change from 400 to 100 gammas.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
13. Lunar Surface Magnetometer Turn-On (Cont'd)		e. LSM Range Determination (Cont'd)		
		(4) Check for status change in ALSEP Word 5, LSM Frame 7, bits 9 and 10.		
		(5) If required, repeat event 14, steps e(2), e(3), and e(4).		Step e(3) should indicate a range change from 100 to 200 gammas.
		(6) Set range to optimum by repetition, as required of command octal 123 RANGE SELECT.		
		(7) Confirm proper setting by examination of data on analog recorders.		
		f. LSM Flip Calibrate No. 1		LSM Flip Calibrate No. 1 to be initiated one hour before LM ascent.
		(1) Check status of Bulova timer for automatic 12 hour FLIP/CAL Command (from running log)		
		(2) Initiate and verify Command octal 127 FLIP/CAL INHIBIT.		Check PSE scientific data during flip period for crosstalk and detection of motion.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
13. Lunar Surface Magnetometer Turn-On (Cont'd)		f. LSM Flip Calibrate No. 1 (Cont'd)		
		(3) Check telemetry for status of calibration inhibit gate, LSM Frame 15, bit 10.		
		(4) Check for availability of reserve power, AE-05 (shunt regulator current). Adjust PDR's if necessary. Monitor during this sequence.		
		(5) Check status of Delayed Command Sequencer to preclude initiation of conflicting commands.		
		(6) Initiate and verify Command octal 131 FLIP/CAL INITIATE.		Consult PI before initiating this command. This command to be initiated 1 hour before LM ascent. Record in running log.
		(7) Observe calibration rasters on analog recorder.		Record as FLIP/CAL No. 1 in Flight Controller's log.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
13. Lunar Surface Magnetometer Turn-On (Cont'd)		f. LSM Flip Calibrate No. 1 (Cont'd)		
		(8) Verify that sensor Flip Positions have changed, ALSEP Word 5, LSM frames 1-3, bits 9-10, and that X, Y and Z offsets have reversed.		
		(9) Verify that mode state telemetry, Frame 13, bit 10, has changed.		
		(10) Monitor mode state telemetry for return to original status in approximately 7 minutes.		
		(11) Initiate and verify Command octal 127 FLIP/ CAL INHIBIT.		
		(12) From LSM data, print out 5 minutes prior to, during, and 5 minutes subsequent to the FLIP/ CAL sequence.		Use either real-time data or tape recorder data for this requirement.
		(13) Verify change in status on LSM frame 15, bit 10.		

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
14. Heat Flow Experiment Turn-On		a. Check Heat Flow reserve power status.		Reserve Power CS-02 > 8 watts.
		b. Initiate Command 055 HFE Operational Power On.		
		c. Check experiment status for correct indications AB-04, AB-05, CS-02.		
		d. Check HFE data channels as shown below:		
		(1) +5V supply AH-01	+5V	
		(2) -5V supply AH-02	-5V	
		(3) +15V supply AH-03	+15V	
		(4) -15V supply AH-04	-15V	
		(5) Low Conductivity Heater AH-06	ON/OFF	
		(6) High Conductivity Heater AH-07	ON/OFF	

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
14. Heat Flow Experiment Turn-On (Cont'd)		f. Thermal check of HFE:		Should turn-on in Mode 1.
		(1) Check telemetry data word 21 for subsystem mode indications (bit 3, 4, 5, of frames 3 and 11).	100 mode 1 010 mode 2 001 mode 3	Gradient Mode Low Conductivity Mode High Conductivity Mode
		(2) If system is not in mode 1, initiate and verify Command octal 135, HFE mode/Select.		Refer to HFE command description.
		(3) Initiate and verify commands HF-8 and HF-9 in that order.		This sequence of commands selects an operating subsequence which includes ambient temperatures at both probes and at the electronic package.
		(4) Check telemetry indication of HFE thermocouple reference and probe cable temperature (word 21 subcommutated).		
		(5) Continue to monitor until stabilization of temperatures has been confirmed.		

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
15. Dust Detector Turn-On		a. If necessary, initiate and verify reception of command octal 027 Dust Detector - ON. b. Verify Dust Detector status by observing data in AX-04, AX-05 and AX-06 (cell voltages). c. Check temperature of Dust Detector cells in parameters AX-01, AX-02 and AX-03.		May be in "ON" condition from SIT. The Dust Detector remains in the "ON" condition throughout the life of ALSEP and is monitored as part of the Central Station format, Word 33.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
16. Experiments Turn-On Verification	Acknowledge report.	a. Advise crewmen that the PSE, SIDE/CCGE, LSM and HFE experiments have been turned ON.		PSE Power ON SIDE/CCGE Standby ON LSM Power ON HFE Power ON, Mode 1 If experiments cannot be turned on by ground command, astronaut will actuvate ALSEP backup switch #3.
		b. Monitor PSE data.		
		c. Monitor LSM data.		
		d. Monitor HFE data.		

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
17. Laser Ranging Retro-Reflector Experiment Deployment	a. Deploy the LR^3 300 to 1000 feet Southwest of LM. b. Level LR^3 to within $\pm 2.5^{\circ}$ as indicated by bubble level. c. Align the LR^3 to within $\pm 2.5^{\circ}$, using the partial compass rose.			Deployment distance required to keep LR^3 out of the LM ascent blast area. Craters and slopes which would degrade thermal control should be avoided.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
18.				

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Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
18.				

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Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
18.				

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Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
19. Field Geology Investigation		The MSC activity consists of managing the incoming geologic information in various ways. a. Encode data for input into computer. b. Make real-time notes and sketches of descriptions to transmit over closed circuit TV. c. Make hard copy of Apollo TV images. d. Annotate large scale versions of the astronaut data package maps. e. Keep track of photos taken as a check on photo coverage. f. Prepare specific questions to ask if and when appropriate.		
	a. Sample and describe the morphological features of small but predominant craters in the near area of the landing site.			Photograph sample site in stereo.
	b. Take scoop samples at scattered points along traverse.			Describe texture and composition; compare to other areas; photograph each sample site in stereo.

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
19. Field Geology Investigation (Cont'd)	c. Dig several trenches parallel to sun's rays at different points along traverse.			Photograph trench in stereo and show details of wall texture such as: Color Change Chemical Alterations Textural Changes Compositional Changes Fragment Type and Concentration
	d. Collect fragments of rocky material which appears to be representative types.			Try to move the large objects or pry beneath them after photographing their original positions.
	e. Take core tube samples, preferably where layering is known to exist.			Check for layering with chisel end of hammer along traverse. Take one photograph of surface before driving tube, then stereo photographs with tube and extension handle in place. Give brief statement of impressions on: Origin of Material How Emplaced How Distributed or Affected Since Emplacement Mechanical Properties

Table 5-1. Phase I (Lunar Surface EVA Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
19. Field Geology Investigation (Cont'd)	f. Observe Morphologic type craters on horizon (sharp-rimmed to subdued, pan-craters, funnel-shaped, dimple craters, chain and loop craters, secondary craters, etc.)			Briefly identify Morphologic type, then photograph general shape in stereo with baselines approximately 1/3 to 1/2 distance to points of interests, such as far wall. Give impressions or origin and mechanism of the craters' formation (impact, volcanic, other); relative age of crater. Activities a through f will be performed consistent with the Apollo 15 Flight Plan. These activities are not necessarily listed in order or priorities.

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. LM Ascent	Monitor all scientific and engineering telemetry during and after launch noting any changes attributable to LM activity.		Note significant trends. SIDE/CCGE, should be in Standby Power.

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. Power Supply Check	a. Check the following parameters:		When telemetry indicates the need for adjustment of the DC load, the necessary control can be accomplished by switching power dumps in or out through use of the following commands:
	(1) 0.25 Vdc Calibration AE-01	0.24 volts	PDR Load #1 ON — Octal 017 PDR Load #1 OFF — Octal 021 PDR Load #2 ON — Octal 022 PDR Load #2 OFF — Octal 023
	(2) 4.75 Vdc Calibration AE-02	4.78 volts	
	(3) Converter Input Voltage AE-03	15.94 volts	
	(4) Converter Input Current AE-04	4.62 amps	
	b. Verify that system is operating on PCU #1.		Optimize Central Station thermal environment by dumping reserve power into the external power dissipation resistors. Initiate commands in accordance with the following table:
	(1) Shunt Regular #1 current AE-05.		<u>If AE-5 Shunt Current is:</u> — <u>Command PDR</u> 0.6 to 1.1 Amps — Octal 017 PDR #1 ON 1.1 to 1.5 Amps — Octal 022 PDR #2 ON 1.5 Amps — Octal 017 and 022 Both PDR #1 & #2 ON 0.6 Amps — Octal 021 and 023 Both PDR #1 & #2 OFF
	(2) Power Oscillator #1 AT-36	84°F	
	(3) Regulator #1 AT-38	125°F	

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. Power Supply Check (Cont'd)	b. Verify that system is operating on PCU #1. (Cont'd)		
	(4) Output Voltage		If either the temperatures or the parameters of Event 2, Step b, are out of limits, switch to PCU #2 by transmission of octal command 062 PCU #2 Select.
	+29V AE-07	+28.72 Volts	
	+15V AE-08	+15.22 Volts	
	+12V AE-09	+12.12 Volts	
	+ 5V AE-10	+ 5.11 Volts	
	-12V AE-11	-12.08 Volts	
	- 6V AE-12	- 5.95 Volts	
	c. Check RTG temperatures as follows:		
	(1) Hot Frame #1 AR-01	1146°F	
	(2) Hot Frame #2 AR-02	1146°F	
	(3) Hot Frame #3 AR-03	1146°F	
	(4) Cold Frame #1 AR-04	455°F	
	(5) Cold Frame #2 AR-05	455°F	
	(6) Cold Frame #3 AR-06	455°F	

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY		NOMINAL VALUE	REMARKS
3. Temperature Check and Thermal Control	a. Check telemetry parameters as indicated below for pertinent temperature measurements:			
	Location			
	(1) Sunshield	AT-01,02	38°F	If necessary turn Central Station Back-up Heater (DSS-3) On and Off by initiation and verification of following commands: DSS HTR 3 ON Octal 024; DSS HTR 3 OFF Octal 025
	(2) Thermal Plate	AT-03,04, 05	61°F	
	(3) Structure Sides	AT-08,09	163°F, 35°F	
	(4) Structure Bottom and Back	AT-10,11	109°F, 216°F	
	(5) Inner Multilayer Insulation	AT-12	62°F	
	(6) Outer Multilayer Insulation	AT-13	126°F	
	(7) Analog Data Processor Base	AT-27	60°F	
	(8) Analog Data Processor Internal	AT-28	76°F	
	(9) Digital Data Processor Base	AT-29	57°F	
	(10) Digital Data Processor Internal	AT-30	70°F	
	(11) Command Decoder Base	AT-31	56°F	
	(12) Command Decoder Internal	AT-32	57°F	
	(13) Command Demodulation VCO	AT-33	62°F	
	(14) Power Distribution Unit Base	AT-34	69°F	
	(15) Power Distribution Unit Internal	AT-35	93°F	

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
4. Transmitter Checks	a. Monitor the following transmitter parameters:		
	(1) Transmitter A Crystal Temperature AT-23	65°F	
	(2) Transmitter A Heat Temperature Sink AT-24	67°F	
	(3) Transmitter A AGC Voltage AE-15	.90V @ +67°F	
	(4) Transmitter A Power Doubler Current AE-17	153 ma @ 67°F	

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
5. Receiver Check	a. Check Local Oscillator Crystal A Temperature AT-21	+144°F	
	b. Check Local Oscillator Level AE-14	6.4 dbm	
	c. Check Receiver Prelimiting Level AE-13	-70 dbm	
	d. Check Command Demodulation, 1 kHz Present AB-01		No modulation 0 to 76 pcm Modulation 77 to 127 pcm No carrier 128 to 255 pcm

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
6. Passive Seismic Experiment Checkout	Monitor all science data measurements on a continuous basis. Level as required.		Note significant trends, especially during the turn-on period for the other experiments. During LM ascent, PSE Scientific Data must be monitored continuously so as to measure any seismic disturbance due to ascent engine blast.

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
7. Suprathermal Ion Detector Experiment/ Cold Cathode Gauge Experiment	a. Check experiment status telemetry AB-04, AB-05 and CS-02 for correct indications.		SIDE/CCGE Standby ON.
	b. Initiate command octal 045, SIDE Operational Power ON.		NOTE: SIDE/CCGE must remain in the standby mode until the end of the first lunar day or until the average internal experiment temperature is 25°C or less.
	c. Check experiment status telemetry AB-04, AB-05 and CS-02 for correct indications.		SIDE/CCGE Power ON.
	d. Initiate the following commands in sequence:		Consult PI before sending this command sequence.
	(1) CCGE High Voltage OFF Octals 104, 106, 107 and 110		NOTE: CCGE Seal and SIDE Dust Cover removal have been blown.
	(2) Channeltron High Voltage OFF - Octals 105, 106, 107 and 110.		
	e. Check science data for configuration of Dust Cover removal.		
	f. Monitor engineering data measurements on a continuous basis.		

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Solar Wind Spectrometer Turn-On	a. Turn-On Checks		
	(1) Check for adequate reserve power, AE-05 (shunt regulator current) and adjust PDR's if necessary.	1.1 amps	
	(2) Initiate and verify command octal 045 SWS OPERATIONAL POWER SELECT.		
	(3) Check AB-05 for change in status of SWS.		
	(4) Check level of experiment supply voltage, AE-7	29.0 Volts	
	(5) Check AE-05 for appropriate decrease.	1.1 amps	
	b. Telemetry Check		
	(1) Examine telemetry data and ensure that decommutation is being properly executed and sequence is identified (SWE words 184 & 185).		

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Solar Wind Spectrometer Turn-On (Cont'd)	b. Telemetry Check (Cont'd) (2) Check A/D Converter Calibrations, sequence ID: LSB = 0.		
	ID — Level — Words		
	DW-3 — 9 millivolts — 112, 117	9 millivolts	
	DW-4 — 90 millivolts — 113	90 millivolts	
	DW-5 — 900 millivolts — 114, 118	900 millivolts	
	DW-6 — 3 millivolts — 115	3000 millivolts	
	DW-7 — 9 millivolts — 116, 119	9000 millivolts	
	(3) Check Eletrometer calibration, SWS words 120-127. (a) 0 amp., DW-19 to DW-26, sequence ID: LSB = 0 (b) 5.76×10^{-12} amp. calibration sequence ID: LSB = 01 DW-27 (sum) DW-28 to DW-34 (Cups 1-7)		

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Solar Wind Spectrometer Turn-On (Cont'd)	b. Telemetry Check (Cont'd)		
	(c) 5.76×10^{-11} amp. calibration, sequence ID: LSB = 10 DW-35 (sum) DW-36 to DW-42 (Cups 1-7)		
	(d) 5.76×10^{-9} amp. calibration, sequence ID: LSB = 11 DW-43 (sum) DW-44 to DW-50 (Cups 1-7)		
	(4) Check temperature and performance, monitor telemetry, SWS words 112-119, sequence ID: LSB = 1 (DW-11 to DW-13 Temperature Sensors)	25°C	
	DW-14 (Temp. Sensor) Cups Assy.	25°C	
	DW-15 (Sun Angle Sensor)	0 Volts	
	DW-16 (Programmer Voltage)	4.95 Volts	
	DW-17 (Step Generator Voltage)	0.88 Volts	
	DW-18 (Modulator Monitor)	1.2 Volts	

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Solar Wind Spectrometer Turn-On (Cont'd)	b. Telemetry Check (Cont'd) (5) Check DC High Voltage Calibrations sequence ID: LSB = 1110		

Symbol	Level	SWS Word
DW-51	1	0
DW-52	2	8
DW-53	3	16
DW-54	4	24
DW-55	5	32
DW-56	6	40
DW-57	7	48
DW-58	8	56
DW-59	9	64
DW-60	10	72
DW-61	11	80
DW-62	12	88
DW-63	13	96
DW-64	14	104
DW-65	15	128
DW-66	16	136
DW-67	17	144
DW-68	18	152
DW-69	19	160
DW-70	20	168
DW-71	21	176

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Solar Wind Spectrometer Turn-On (Cont'd)	b. Telemetry Check (Cont'd) (6) Check AC High Voltage calibrations, sequence LD: LSB = 1111		

Symbol	Level	SWS Word
DW-72	1	0
DW-73	2	8
DW-74	3	16
DW-75	4	24
DW-76	5	32
DW-77	6	40
DW-78	7	48
DW-79	8	56
DW-80	9	64
DW-81	10	72
DW-82	11	80
DW-83	12	88
DW-84	13	96
DW-85	14	104
DW-86	15	128
DW-87	16	136
DW-88	17	144
DW-89	18	152
DW-90	19	160
DW-91	20	168
DW-92	21	176

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Solar Wind Spectrometer Turn-On (Cont'd)	c. Dust Cover Removal		
	(1) Check for the availability of adequate reserve power, (adjust PDR's, if necessary).	1.1 amp	
	(2) Initiate and verify Command octal 122 DUST COVER REMOVAL.		Do not initiate Command 122 without approval of PI.
	(3) Check housekeeping channels for confirmation of no change of experiment status.		
	(4) Check science data for periods before and after dust cover removal to confirm that cover has properly cleared sensor.		

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Solar Wind Spectrometer Turn-On (Cont'd)	d. Collection of Baseline SWS Data Record data without further transmission of commands to establish background noise level and frequency and magnitude of plasma current peaks.		
	e. High Voltage Gain Change		
	(1) Initiate and verify Command octal 122 HIGH VOLTAGE GAIN CHANGE.		This command is decoded in the SWS from a reception of octal 122 three times within ten seconds. Each of the three transmissions returns an ALSEP Command Verification Word.
	(2) Check DC and AC High Voltage Calibrations per Event 8, Steps b(5) and b (6) to confirm execution of the command.		The gain change command will probably not be authorized by the PI until data have been collected for several days and analyzed.
	f. Collection of Baseline SWS Data in High Gain Record data without further transmission of commands to establish background noise level and frequency and magnitude of plasma current peaks.		

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. Lunar Surface Magnetometer Checkout	a. Housekeeping Data Check		
	Check the following data parameters in the indicated subcommutation of ALSEP word 5, bits 2-8 on print-out:		
	(1) X Sensor Temperature. DM-1	+40°C	
	(2) Y Sensor Temperature. DM-2	+40°C	
	(3) X Sensor Temperature. DM-3	+40°C	
	(4) Gimbal Flip Unit Base Temperature. DM-4	+20°C	
	(5) Internal Electronics Temperature. DM-5	+20°C	
	(6) Level Sensor #1. DM-6	0 degrees	
	(7) Level Sensor #2. DM-7	0 degrees	
	(8) DC Supply Voltage.DM-8	+5 volts	
	b. Initial Status Check		
	Check the status of the following parameters in ALSEP word 5, subcommutation as indicated:		
	(1) X-axis Flip Position Frame 1, bits 9-10. DM-9	0° Position	

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. Lunar Surface Magnetometer Checkout (Cont'd)	b. Initial Status Check (Cont'd)		
	(2) Y-axis Flip Position Frame 2, bits 9-10. DM-10	0° Position	
	(3) Z-axis Flip Position DM-11 Frame 3, bits 9-10.	0° Position	
	(4) X-axis Gimbal Position Frame 4, bit 9. DM-12		Pre-site-survey position
	(5) Y-axis Gimbal Position Frame 4, bit 10. DM-13		Pre-site-survey position
	(6) Z-axis Gimbal Position Frame 5, bit 9. DM-14		Pre-site-survey position
	(7) Temperature Control State Frame 5, bit 10. DM-15		X-axis
	(8) Heater power status Frame 6, bit 10. DM-28		On or Off
	(9) Measurement Range Frame 7, bits 9-10. DM-16		400 gammas
	(10) X-axis Field Offset. Frame 9, bits 9-10 and Frame 10, bit 9. DM-17		0%
	(11) Y-axis Field Offset. Frame 10, bit 10 and Frame 11, bits 9-10. DM-18		0%
	(12) Z-axis Field Offset. Frame 12, bits 9-10 and Frame 13, bit 9. DM-19		0%

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. Lunar Surface Magnetometer Checkout (Cont'd)	b. Initial Status Check (Cont'd)		
	(13) Calibration Mode State Frame 13, bit 10. DM-20		Scientific
	(14) Offset Address State. Frame 14, bits 9-10. DM-21		Neutral
	(15) Filter Status Frame 15, bit 9. DM-22		IN
	(16) Calibration Inhibit status Frame 15, bit 10. DM-23		Inhibited
	c. Field Offset Determination		
	(1) Initiate and verify Command octal 125 OFFSET ADDRESS		Consult PI before initiating command.
	(2) Check telemetry for indication of OFFSET ADDRESS, ALSEP word 5, LSM Frame 14, bit 9 and 10. DM-21		X-axis
	(3) Initiate and verify Command octal 124 FIELD OFFSET		
	(4) Verify that X-axis offset has changed, (Frame 9, bits 9 & 10 and Frame 10, bit 9).		

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. Lunar Surface Magnetometer Checkout (Cont'd)	c. Field Offset Determination (Cont'd)		
	(5) Observe change in X-axis data on analog recorder.		
	(6) Repeat Event 9, Step c(3) as necessary to bring X-axis output to suitable value. Observe the shift in X-axis offset per analog recorder and Frame 9 and 10 telemetry.		Consult PI before repeating this step.
	(7) Confirm optimum range and offset setting by observation of analog recorder.		
	(8) Initiate and verify Command octal 125 OFFSET ADDRESS.		
	(9) Check telemetry of offset address, Frame 14, bits 9-10. DM-21		
	(10) If required, repeat Event 9, Step c(3)		
	(11) Confirm that Y-axis offset has changed.		

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. Lunar Surface Magnetometer Checkout (Cont'd)	c. Field Offset Determination (Cont'd)		
	(12) Repeat Event 9, Step c(3) as necessary observing change in Y-axis offset.		Consult PI before repeating this step.
	(13) Initiate and verify Command octal 125 OFFSET ADDRESS.		
	(14) Check telemetry of offset address Frame 14, bits 9-10. DM-21		Z-axis
	(15) Repeat Event 9, Step c(3).		
	(16) Confirm that Z-axis offset has changed.		
	(17) Repeat Event 9, Step c(3) as necessary observing change in Z-axis offset.		Consult PI before repeating this step.
	(18) Initiate and verify Command octal 125 OFFSET ADDRESS		

Table 5-2. Phase II (Lunar Surface Operation Checkout Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
10. Heat Flow Experiment Checkout	a. Check HFE data on a continuous basis.		Note significant trends, especially during the turn-on period for the other experiments.
	b. Monitor the experiment supply voltage, AE-07.	29.0 volts	Note significant trends.
	c. Check need for leveling of the HFE electronics package.		
	d. Initiate and verify octal command 152 twice.		To insure command link is operating properly.
	e. Monitor HFE engineering channels as shown below:		Note significant trends.
	Telemetry word 33		
	(1) +5 v supply	+ 5.0 volts	
	(2) -5 v supply	- 5.0 volts	
	(3) +15 v supply	+15.0 volts	
	(4) -15 v supply	-15.0 volts	
	(5) Low conductivity heater	0	Should be zero except during the conductivity experiment.
	(6) High conductivity heater	0	

Table 5-3. Phase III (Forty-Five Day Phase)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Central Station	a. Monitor and record all engineering telemetry and utilize reserve power to optimize Central Station thermal environment.		Note any out-of-limit readings and significant trends toward limits.
	<u>Lunar Cycle</u> — <u>Commands</u>		
	Day/Night — Octal 017 PDR #1 ON		
	Day/Night — Octal 021 PDR #1 OFF		
	Day/Night — Octal 022 PDR #2 ON		
	Day/Night — Octal 023 PDR #2 OFF		
	Night — Octal 055 DSS Htr #1 ON		
	Night — Octal 056 DSS Htr #2 ON		
	Night — Octal 024 DSS Htr #3 ON		
	b. Confirm an appropriate change for each command executed.		
	c. Check downlink signal strengths at each "hand-over" from one MSFN station to the next. Log results and note any significant trend.		

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. Passive Seismic Experiment	a. Monitor and record all science and engineering data continuously. b. Relevel in Auto Mode as required. Octal 070 - X-Motor ON/OFF Octal 071 - Y-Motor ON/OFF Octal 072 - Z-Motor ON/OFF c. Check for evidence of automatic calibration of short period sensor at 12-hour intervals. d. Once per day, calibrate long period circuitry as in Phase I, Event 13, Steps g(1) through g(4).		

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
3. Suprathermal Ion Detector Experiment/ Cold Cathode Gauge Experiment	a. Monitor SIDE/CCGE average temperature.		Near the first lunar sunset, the SIDE/CCGE average temperature will approach 25°C.
	b. Initiate and verify the following sequence of commands: (1) CCGE high voltage ON, octals 104, 106, 107 and 110. (2) Channeltron high voltage ON, octals 105, 106, 107 and 110.		NOTE: SIDE/CCGE average internal experiment temperature must be less than 25°C before executing any commands.
	c. Monitor and record all SIDE/ CCGE Engineering and Scientific data continuously.		Note any significant trends.
	d. At discretion of the PI, utilize SIDE/CCGE voltage step commands.		

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
4. Solar Wind Spectrometer	a. Monitor science data on a continuous basis and advise SWS PI of significant measurement developments.		Note any out-of-limit conditions and significant trends toward limits.
	b. Once per day, log and note significant trends of the following:		

Temp. Meas.	Description	SWS Word	LSB
DW-11	Temp. Mod 100	112	1
DW-12	Temp. Mod 200	113	1
DW-13	Temp. Mod 300	114	1
DW-14	Temp. Sensor Cup Assembly	115	1
DW-15	Sun Angle Sensor	116	1
DW-16	Programmer Voltage	117	1
DW-17	Step Generator Voltage and Supply Voltage, HK-20	118	1
DW-18	Modulation Monitor	119	1

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
	c. Monitor all engineering data on a continuous basis and advise PI of significant measurement developments.		Note any out-of-limit conditions and significant trends toward limits.

Table 5-3. Phase III (Forty-Five Day Phase) (Conti

EVENT	MCC ACTIVITY	NOMINAL VALUE	
5. Lunar Surface Magnetometer	a. Monitor science data measurement, DM-25 through DM-27, on a continuous basis.		During non-active periods of LSM activity, print out 5 minutes of data per hour on the high speed printer.
	b. Once per day, record housekeeping data as in Phase II, Event 9, Step a.		Note significant trends.
	c. Once per day, record experiment supply voltage, AE-07.	29.0 Volts	
	d. Flip Calibrate No. 2		
	(1) Check science data for evidence of automatic flip/calibration.		Turn on high speed printer and brush recorder for continuous recording.
	(2) Repeat Phase I, Event 9, Step f, FLIP/CAL INITIATE octal 131.		Consult PI before initiating command. Record as FLIP CAL No. 2 in Flight Controller's log.
	e. Housekeeping Data Check		
	Repeat check of Phase II, Event 9, Step a and compare with original data.		
	f. Flip Calibrate No. 3		
	Repeat Phase I, Event 14, Step f.		Consult PI before initiating command. Record as FLIP/CAL No. 3 in the Flight Controller's log.

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
5. Lunar Surface Magnetometer (Cont'd)	g. Flip Calibrate No. 4		
	Repeat Phase I, Event 14, Step f.		Consult PI before initiating command. Record as FLIP/CAL No. 4 in the Flight Controller's log.
	h. After the fourth Flip/Cal cycle, perform site survey as follows:		Consult PI before sending command for site survey.
	(1) Check for adequate reserve power, AE-05.		
	(2) Initiate and verify Command octal 133 SITE SURVEY		NOTE: First Transmission of this command initiates X-axis survey.
	(3) From LSM data, print out 5 minutes prior to, during, and 5 minutes subsequent to the Flip/Cal sequence.		Use either real-time data or tape recorder data for this requirement.
	(4) Verify appropriate change in science data as survey progresses.		PI requires 3 hours for data analysis prior to initiation of next step.
	i. Repeat Step h(1) through h(4) above, twice to perform Y-axis and Z-axis site surveys.		
	j. At least 6 days after completion of site survey, initiate Command octal 132 FILTER BYPASS. Verify as per Frame 15, bit 9.		Filter Out

Table 5-3. Phase III (Forty-Five Day Phase) (Cor

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMA
5. Lunar Surface Magnetometer (Cont'd)	k. Record data for 6 hours.		
	l. Initiate Command octal 132 FILTER BYPASS. Verify as per Frame 15, bit 9.		Filter In
	m. Ground Command FLIP/CAL during Lunar Sunrise: Initiate FLIP/CAL command every 6 hours commencing 18 hours prior to lunar sunrise and continuing for a period of 18 hours after the event. Procedure will follow Phase I, Event 14, Step f.		
	n. Ascertain from scientific data that the 12 hour automatic Flip/Cal sequence is in effect at all times other than Step m above.		
	o. Auxiliary Commands These commands will be initiated at the request of the PI due to special scientific requirements.		Log all timer (delayed command sequence) FLIP/CAL commands.
	(1) Command octal 123, Range Select		
	(2) Command octal 124, Steady Field Offset		

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
5. Lunar Surface Magnetometer (Cont'd)	(3) Command octal 125, Steady Field Offset Address		
	(4) Command octal 127, FLIP/CAL Inhibit In/Out		
	(5) Command octal 131, FLIP/CAL		
	(6) Command octal 132, Filter Failure Bypass In/Out		
	(7) Command octal 134 Temperature Control		

Table 5-3. Phase III (Forty-Five Day Phase) (Continue

EVENT	MCC ACTIVITY	NOMINAL VALUE	[illegible]
6. Heat Flow Experiment	A. Monitor the HFE Engineering and Scientific Data.		Monitor temperature trends at each sensor. Monitor mode, heater, and programmer states and note abnormal readings.
	B. Heat Flow Conductivity Experiment		Consult PI prior to performing conductivity experiment. During the conductivity experiment consult the PI before making any mode changes or data interruptions. The time interval for hard copy printouts will be a real-time decision by the PI.
	1. Check HFE data telemetry word 21, bits 3, 4, 5, 6 of HF word 5 for correct heater state.	0000	
	2. If bits 3, 4, 5, 6 of HF word 5 are not 0000, send octal command 152 (Heater Advance) until the bits are in the proper state. Reference HF heater sequence - Page 6-11.		Octal command 152 advances the heater switch one state for each command sent. The heater sequence is equivalent to that of a rotary switch, except in order to go from heater 12 OFF to heater 11 OFF, four heater advance commands must be sent. The next state after Heater 23 ON is Heater 12 OFF.

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
6. Heat Flow Experiment (Continued)			Heat Flow Cond. Experiment	Heater Energized
			1	H12
			2	H14
			3	H22
			4	H24
			5	H11
			6	H13
			7	H21
			8	H23
7. Heat Flow Conductivity Experiment 1 Mode 2 Operation H12	Command Sequence (Initiate and verify)		Bridge Measurement	Heater State
A) Initation	Monitor for 2 hours		DTH 11	0000
B) Heating Phase (a) PI will determine, after 1 hour, to continue in Mode 2 or switch to Mode 3 operation	152, 136		DTH 11	0001
			If PI elects to stay in Mode 2 the heating phase will be from 15 to 36 hours.	
			(a) The heater advance Command 152, in Mode 2 operation, can be sent during the 2 hour initiation period.	

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
			Bridge Measurement	Heater State
8. Heat Flow Conductivity Experiment 1 Mode 3 Operation	Command Sequence (Initiate and Verify)			
A) Heating Phase 10 hrs. Terminate on approval of PI.	140, 144		DTR 11, TR 11	0001
B) Monitor lower section ring bridge for 15 minutes.	152		DTR 12, TR 12	0010
C) Monitor upper section ring bridge for 15 minutes. (a)	135, 152, 152, 140, 144		DTR 11, TR 11	0100
D) Monitor Probe 1 gradient bridge for 15 minutes. (b)	135, 142, 152 (14 times)		DTH (11, 12) T (11, 12)	0010
E) Monitor Lower section ring bridge for 15 minutes.	140, 144		DTR 12, TR 12	0010

(a) For ring bridge, Mode 3 measurements, the 15 minute period starts when the last command has been initiated and verified.

(b) For gradient bridge measurements, the 15 minute period starts when command 135 has been initiated and verified.

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
8. (Continued)				
F) Return to Step 3 and repeat steps (C-E) for a minimum of 6 hours.				
G) Return to Mode 1 operation, full sequence.	135, 141			
9. Heat Flow Conductivity Experiment 2 Mode 2 Operation H 14			Bridge Measurement	Heater State
A) Initiation	Monitor for 2 hours		DTH 12	0010
B) Heating Phase	152, 136		DTH 12	0011
PI will determine, after 1 hour to continue in Mode 2 or switch to Mode 3 operation.				

Table 5-3. Phase III (Forty-Five Day Phase) (Conti

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
			Bridge Measurement	Heater State
10. Heat Flow Conductivity Experiment 2 Mode 3 Operation	Command Sequence (Initiate and Verify)			
A) Heating Phase 10 hours Terminate on approval of PI.	140, 144		DTR 12, TR 12	0011
B) Monitor lower section ring bridge for 15 minutes.	135, 152, 152, 152, 140, 144		DTR 12, TR 12	0110
C) Monitor Probe 1 gradient bridge for 15 minutes	135, 142		DTH (11, 12) T (11, 12)	0110
D) Monitor lower section ring bridge for 15 minutes.				
E) Return to Step C and repeat steps (C and D) for a minimum of 6 hrs.				
F) Return to Mode 1 operation, full sequence	135, 141			

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
			Bridge Measurement	Heater State
11. Heat Flow Conductivity Experiment 3 Mode 2 Operation H 22	Command Sequence (Initiate and verify)			
A) Initiation	Monitor for 2 hours		DTH 21	0110
B) Heating Phase	152, 152, 152, 136		DTH 21	1001
PI will determine after one hour, to continue in Mode 2 or switch to Mode 3 operation.				

Table 5-3. Phase III (Forty-Five Day Phase) (Conti

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS: Bridge Measurement	REMARKS: Heater State
12. Heat Flow Conductivity Experiment 3 Mode 3 operation	Command Sequence (Initiate and Verify)			
A) Heating Phase 10 hr. Terminate on approval of PI.	140, 144		DTR 21, TR 21	1001
B) Monitor lower section ring bridge for 15 minutes	152		DTR 22, TR 22	1010
C) Monitor upper section ring bridge for 15 minutes	135, 152, 152, 140, 144		DTR 21, TR 21	1100
D) Monitor Probe 2 gradient bridge for 15 minutes	135, 143, 152 (14 times)		DTH (21, 22) T (21, 22)	1010
E) Monitor lower section ring bridge for 15 minutes.	140, 144		DTR 22, TR 22	1010
F) Return to Step C and repeat steps (C-E) for a minimum of 6 hours.				

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
12. (Continued)				
G) Return to Mode 1 operation, full sequence	135, 141			
13. Heat Flow Conductivity Experiment 4 Mode 2 Operation H 24	Command Sequence (Initiate and Verify)		Bridge Measurement	Heater State
A) Initiation	Monitor for 2 hours		DTH 22	1010
B) Heating Phase	152, 136		DTH 22	1011
PI will determine, after 1 hour to continue in Mode 2 or switch to Mode 3 operation.				
14. Heat Flow Conductivity Experiment 4 Mode 3 operation	Command Sequence (Initiate and Verify)		Bridge Measurement	Heater State
A) Heating Phase 10 hours Terminate on approval of PI	140, 144		DTR 22, TR 22	1011
B) Monitor lower section ring bridge for 15 minutes	135, 152, 152, 152, 140, 144		DTR 22, TR 22	1110

Table 5-3. Phase III (Forty-Five Day Phase) (Conti

EVENT	MCC ACTIVITY	NOMINAL VALUE	[illegible]	
14. (Continued)				
C) Monitor Probe 2 gradient bridge for 15 minutes.	135, 143		DTH (21, 22) T (21, 22)	1110
D) Monitor lower section ring bridge for 15 minutes.	140, 144		DTR 22, TR 22	1110
E) Return to Step C and repeat steps (C thru D) for a minimum of 6 hrs.				
F) Return to Mode 1 operation, full sequence.				
15. Heat Flow Conductivity Experiment 5 Mode 2 operation H 11	Command Sequence (Initiate and Verify)		Bridge Measurement	Heater State
A) Initiation	Monitor for 2 hours		DTH 11	1110
B) Heating Phase	152 (7 times), 136		DTH 11	0101
PI will determine after 1 hour, to continue in Mode 2 or switch to Mode 3 operation.				

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
			Bridge Measurement	Heater State
16. Heat Flow Conductivity Experiment 5 Mode 3 Operation	Command Sequence (Initiate and Verify)			
A) Heating Phase - 10 hrs. Terminate on approval of PI.	140, 144		DTR 11, TR 11	0101
B) Monitor upper section ring bridge for 15 minutes.	135, 152 (11 times) 140, 144		DTH 11, TR 11	0000
C) Monitor Probe 1 gradient bridge for 15 minutes.	135, 142		DTH (11, 12) T (11, 12)	0000
D) Monitor upper section ring bridge for 15 minutes.	140, 144		DTR 11, TR 11	0000
E) Return to Step 3 and repeat steps (C-D) for a minimum of 6 hours.				
F) Return to Mode 1 operation full sequence	135, 141			

Table 5-3. Phase III (Forty-Five Day Phase) (Conti

EVENT	MCC ACTIVITY	NOMINAL VALUE	Bridge Measurement	Heater State
17. Heat Flow Conductivity Experiment 6 Mode 2 Operation H 13	Command Sequence (Initiate and Verify)			
A) Initiation	Monitor for 2 hours		DTH 12	0000
B) Heating Phase	152 (7 times), 136		DTH 12	0111
PI will determine after 1 hour, to continue in Mode 2 or switch to Mode 3 operation.				
18. Heat Flow Conductivity Experiment 6 Mode 3 Operation	Command Sequence (Initiate and Verify)		Bridge Measurement	Heater State
A) Heating Phase 10 hrs. Terminate on approval of PI.	140, 144		DTR 12, TR 12	0111
B) Monitor upper section ring bridge for 15 minutes.	135, 152 (9 times), 140, 144		DTR 11, TR 11	0000
C) Monitor lower section ring bridge for 15 minutes.	135, 152, 152, 140, 144		DTR 12, TR 12	0010

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
18. (Continued)				
D) Monitor Probe 1 gradient bridge for 15 minutes	135, 142, 152 (14 times)		DTH (11, 12) T (11, 12)	0000
E) Monitor upper section ring bridge for 15 minutes.	140, 144		DTR 11, TR 11	0000
F) Return to Step C and repeat steps (C thru E) for a minimum of 6 hrs.				
G) Return to Mode 1 operation, full sequence.	135, 141			
19 Heat Flow Conductivity Experiment 7 Mode 2 operation H 21	Command Sequence (Initiate and Verify)		Bridge Measurement	Heater State
A) Initiation	Monitor for 2 hours		DTH 21	0000
B) Heating Phase	152 (13 times), 136		DTH 21	1101
PI will determine after 1 hour, to continue in Mode 2 or switch to Mode 3 operation.				

Table 5-3. Phase III (Forty-Five Day Phase) (Contin

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
20. Heat Flow Conductivity Experiment 7 Mode 3 operation	Command Sequence (Initiate and Verify)		Bridge Measurement	Heater State
A) Heating Phase - 10 hrs. Terminate on approval of P.I.	140, 144		DTR 21, TR 21	1101
B) Monitor upper section ring bridge for 15 minutes.	135, 152 (11 times), 140, 144		DTR 21, TR 21	1000
C) Monitor Probe 2 gradient bridge for 15 minutes.	135, 143		DTH (21, 22) T (21, 22)	1000
D) Monitor upper section ring bridge for 15 minutes.	140, 144		DTR 21, TR 21	1000
E) Return to Step C and repeat steps (C thru D) for a minimum of 6 hr.				
F) Return to Mode 1 operation, full sequence	135, 141			

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
			Bridge Measurement	Heater State
21. Heat Flow Conductivity Experiment 8 Mode 2 operation H 23	Command Sequence (Initiate and Verify)			
A) Initiation	Monitor for 2 hours		DTH 22	1000
B) Heating Phase	152 (7 times), 136		DTH 22	1111
PI will determine after 1 hour, to continue in Mode 2 or switch to Mode 3 operation.				
			Bridge Measurement	Heater State
22. Heat Flow Conductivity Experiment 8 Mode 3 operation	Command Sequence (Initiate and Verify)			
A) Heating Phase 10 hrs.	140, 144		DTR 22, TR 22	1111
Terminate on approval of PI.				
B) Monitor upper section ring bridge for 15 minutes.	135, 152 (9 times), 140, 144		DTR 21, TR 21	1000
C) Monitor lower section ring bridge for 15 minutes.	135, 152, 152, 140, 144		DTR 22, TR 22	1010

Table 5-3. Phase III (Forty-Five Day Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
22. (Continued)			
D) Monitor Probe 2 gradient bridge for 15 minutes.	135, 143, 152 (14 times)		DTH (21, 22) T (21, 22) 1000
E) Monitor upper section ring bridge for 15 minutes.	140, 144		DTR 21, TR 21 1000
F) Return to Step C and repeat Steps (C thru E) for a minimum of 6 hours.			
G) Return to Mode 1 operation, full sequence	135, 141		

Table 5-4. Phase IV (One-Year Phase)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Central Station	a. Check Central Station engineering telemetry as in Phase III, Event 1, Step a, and initiate any contingency action indicated. b. Optimize the Central Station thermal environment for the next 24-hour period as in Phase III, Event 1, Step a.		Check temperatures early in each access period, and every day during continuous coverage.

Table 5-4. Phase IV (One-Year Phase) (Continue

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. Passive Seismic Experiment	a. Early in the access period and every day during continuous coverage, check sensor temperature, DL-07, and initiate contingency action if out-of-limits.		Log temperatures and note trends.
	b. Early in the access period and again near end of access, check Tidal X, Y and Z data, DL-04, DL-05 and DL-06, respectively, for excessive drift of sensor and relevel as required.		X MTR ON/OFF Octal 070 Y MTR ON/OFF Octal 071 Z MTR ON/OFF Octal 072
	c. During each continuous coverage access period, check for evidence of automatic calibration in short period data, DL-08 and initiate contingency action if necessary. Adjust gain, if necessary, per Phase I, Event 13, Step d.		
	d. During each access period, calibrate long period circuitry as in Phase I, Event 13, Step g.		
	e. Monitor science data for evidence of unusual developments.		

Table 5-4. Phase IV (One-Year Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
3. Suprathermal Ion Detector Experiment/ Cold Cathode Gauge Experiment	a. Early in each access period and daily during continuous coverage, check instrument temperatures as in Phase I, Event 14, Step b(4), and initiate contingency action if required. b. Early in each access period and daily during continuous coverage, check power supply performance as in Phase I, Event 14, Step b(3) and initiate contingency action, if required. c. Monitor SIDE/CCGE science data and adjust operating mode at the discretion of the PI to optimize data.		Log temperatures and note trends.

Table 5-4. **Phase IV (One-Year Phase) (Continue**

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
4. Solar Wind Spectrometer	a. Early in each access period and every day during continuous coverage, check telemetry as in Phase II, Event 8, Step b, and initiate contingency action, if required. b. Near the end of each access period, examine science data for evidence of unusual developments.		Log data and note significant trends.

Table 5-4. Phase IV (One-Year Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS
5. Lunar Surface Magnetometer	a. Early in each access period and every day during continuous coverage, check engineering data as in Phase II, Event 9, Step a(1) through a(8) and initiate contingency action if required.		Log analog engineering value and note significant trends.
	b. During each continuous coverage access period, check science data for evidence of automatic FLIP/CAL at 12-hour intervals.		Initiate following contingency action if required because of time failure: Initiate command octal 131, LSM FLIP/CAL initiate, once every day during intermittent support and every six hours during continuous support.
	c. During periods of continuous coverage, perform additional FLIP/CAL cycles as required, per Phase I Event14, Step f. Readjust gain and offset per Phase I, Event 14, Step e if required.		
	d. Near the end of each access period, examine LSM scientific data for evidence of unusual developments.		

Table 5-4. Phase IV (One-Year Phase) (Continued)

EVENT	MCC ACTIVITY	NOMINAL VALUE	REMARKS	
6. Heat Flow Experiment	Command Sequence:		Bridge Measurement:	Heater State:
A. Check HFE data for 2 hr. periods	(Initiate and Verify)		Monitor temperature trends at each sensor. Monitor mode, heater, and programmer states and note abnormal readings.	
1. Initiation			Ensure heater state is 0000. If not, send command 152 until state 000 is reached.	
2. M 3 operation - 15 min.	140, 144		DTR11	0000
3. M 1 operation - 15 min.	135, 152, 152		Full Sequence	0010
4. M 3 operation - 15 min.	140, 144		DTR12	0010
5. M 1 operation - 15 min.	135, 152 (6 times)		Full Sequence	1000
6. M 3 operation - 15 min.	140, 144		DTR21	1000
7. M 1 operation - 15 min.	135, 152, 152		Full Sequence	1010
8. M 3 operation - 15 min.	140, 144		DTR22	1010
9. M 3 operation - 15 min.	135, 152 (6 times)		Full Sequence	0000
			The PI will perform a second set of conductivity experiments during the final two months of the lunar year.	

Table 5-5. Phase V (Lunar Orbit Phase)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
1. Orbital Experiment				Most experiments require a field-of-view along the local vertical when mounted in the SIM. However, for calibration purposes, some experiments require CSM orientation to other attitudes for various time periods. In the case when the SIM is not pointing along the local vertical, some experiments should be turned to Standby or OFF. This decision will be made in Real-Time by the PI. Lunar Orbit experiments must be scheduled relative to time-critical operations such as LM descent and ascent, rendezvous and transearth injection and without interference with essential mission profile operations.

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. SM Orbital Photographic Tasks				
2.1 24-Inch Panoramic Camera		TBD		

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. SM Orbital Photographic Tasks (Cont'd) 2.2 3-Inch Mapping Camera		TBD		

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
2. SM Orbital Photographic Tasks (Cont'd) 2.3 Laser Altimeter		TBD		

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
3. Gamma-Ray Spectrometer (S-160)		TBD		

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
4. X-Ray Fluorescence (S-161)		TBD		

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
5. S-Band Transponder (CM/LM) (S-164)	a. Orbit attitudes between 10-100 nm are desired. b. Each frontside ground track should be covered at least twice with approximately 80 minutes allowed for each measurement. c. Orbital location during measurement should be during a complete frontside orbital pass.			

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
6. Particle Shadows/ Boundary Layer (S-173)		TBD		

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
7. Subsatellite Magnetometer (S-174)		TBD		

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
8. Alpha Particle Spectrometer (S-162)				

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
9. Mass Spectrometer (S-165)				

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
10. UV Photography Earth and Moon (S-177)				

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
11. CM Orbital Photographic Tasks				
11.1 Hasselblad Electric Data Camera		TBD		

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
11. CM Orbital Photographic Tasks (Cont'd)				
11.2 Hasselblad Electric Camera		TBD		

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
11. CM Orbital Photographic Tasks (Cont'd)				
11.3 Maurer Data Acquisition Camera				

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
12.				

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Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
13. Gegenschein from Lunar Orbit (S-178)	Nine photographs should be taken in three different directions as follows: a. Three photographs with camera pointed in the anti-solar direction. b. Three photographs with camera pointed toward the Moulton point. c. Three photographs with camera pointed midway between the anti-solar and the Moulton point directions.			Astronaut should log the time, IMU gimbal angles, the CSM attitude and position when the photographs are taken. The photographs should be taken while the CSM is in total darkness in lunar orbit and all exterior lights turned off and window shades deployed. Lunar orbit photographs of the Gegenschein and Moulton point regions should be obtained from the CSM while in an undocked configuration. Following the attitude maneuver for each of the three camera pointing angles, the CSM attitude will be maintained within minimum deadband limits of $\pm 0.5^{\circ}$ and the firing of SM RCS jets should be inhibited during film exposure.

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
14. Downlink Bi-Static Radar (S-170)	a. An orientation maneuver required for the Brewster angle determination of the lunar surface.			In the event that the spacecraft omni-antenna is inadequate for measurements, astronaut participation would be required to direct the hi-gain antenna systems toward the lunar surface.
	b. Only one measurement is required during any orbit and should be conducted when the spacecraft-earth-moon-angle is 100° to 130° - 140°.			The measurement duration will be 30° - 40° of the orbital arc.
	c. The spacecraft pointing accuracy should be within ± 5°.			
	d. An attitude hold of ± 0.5° is required for 30° - 40° of the orbital arc during the measurement period.			
	e. Allowable spacecraft rate should be within ± 0.05°/sec - all axes.			

Table 5-5. Phase V (Lunar Orbit Phase) (Continued)

EVENT	ASTRONAUT ACTIVITY	MCC ACTIVITY	NOMINAL VALUE	REMARKS
15. Apollo Window Meteroid (S-176)				The Apollo windows must be scanned at 20X magnification and any surface imperfections mapped before flight. The Apollo windows must be recovered and delivered to MSC for post flight analysis.

LUNAR SURFACE EVA PHASE

Collect Contingency Sample and Selected Sample	Deploy, orient and align Central Station, Experiments Instruments and Antenna	Confirm Xmtr and Experiment Turn-On Deploy LRRR	Field Geology Investigation

LUNAR SURFACE OPERATION CHECKOUT PHASE

Checkout Central Station	Monitor PSE, SIDE/CCGE, HFE and LSM	Turn-On SWS

FORTY-FIVE DAY PHASE

Perform HFE Conductivity Experiment	CCGE Seal Break	Measure Baseline Science Data

ONE-YEAR PHASE

Operate all Experiments Continuously	Monitor Solar Flares, Eclipses	Monitor Seismic and Tidal Activity

LUNAR ORBIT PHASE

Perform SIM Science Experiments	Launch Subsatellite Experiments

Figure 5-1. Lunar Operation Phases, Events Identification

(TBS -- Refer to Section II
for interim information)

Figure 5-2. Lunar Surface Equipment Use Chart

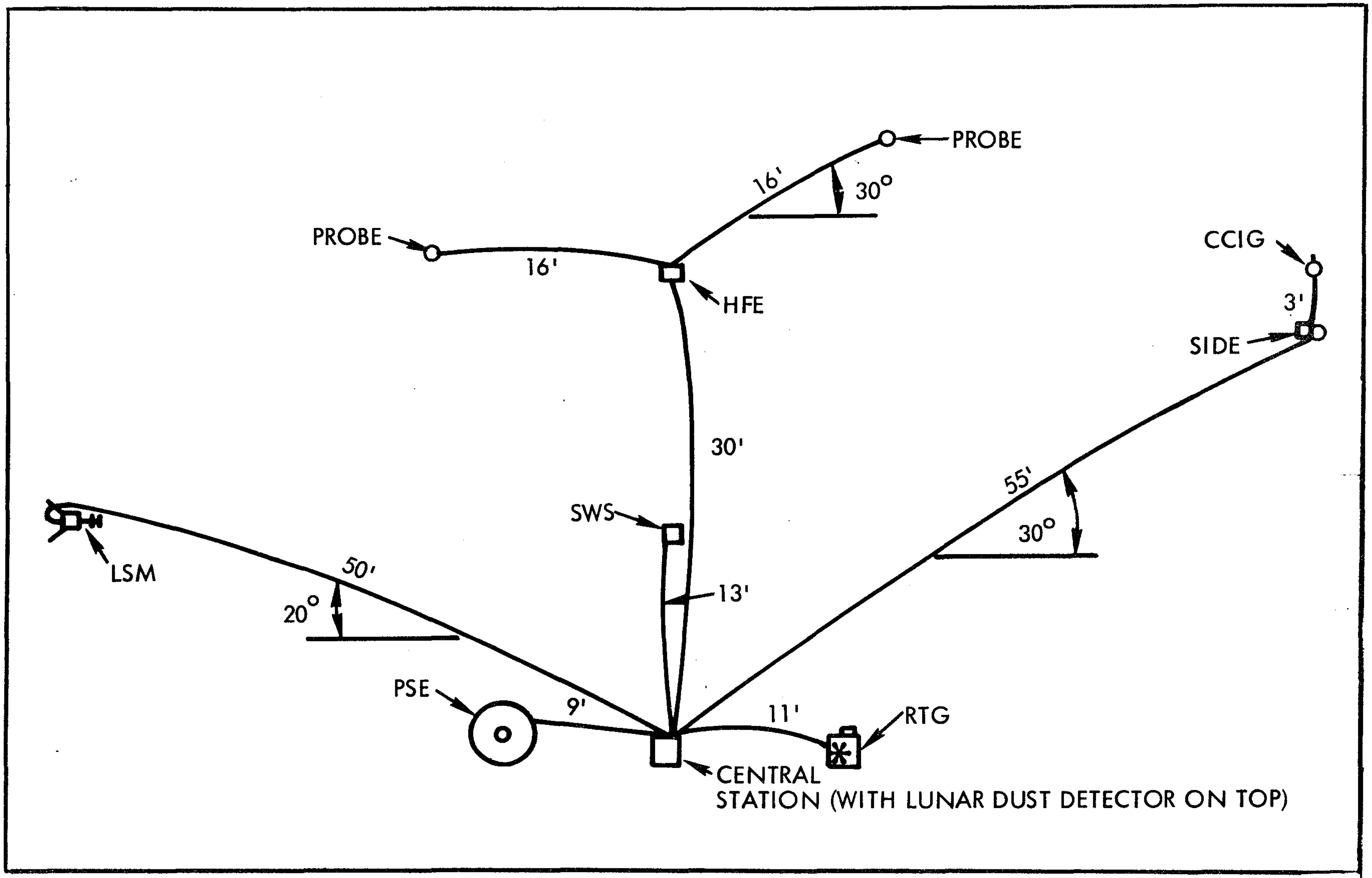

Figure 5-3. ALSEP Array A-2/Heat Flow Deployment Diagram (Typical)

Event (Geologic features to be studied)	Astronaut Activity			MSC Activity
	SAMPLING	PHOTOGRAPHY	DESCRIPTION	MONITORING
1. OUTCROP 2. Blocky Rimmed Crater 3. Blocks 4. Bright Halo Crater 5. Regolith 6. Sharp Rimmed Crater 7. Elongate Crater 8. Crater Chain 9. Mare Ridge 10. Scarp 11. Crater Cluster 12. Dimple Crater 13. Lineament 14. Subdued Crater	of • Outcrop • Blocks • Regolith using • hammer • tongs • scoop • core tubes	of • Outcrop • Blocks • regolith • geologic features • topographic features using • monoscopic • stereoscopic • panoramic with • Hasselblad • Apollo TV • Time-Sequence	of • Rock Material and Geologic features with respect to • Color, texture, composition, structure weathering or alteration • variations-horizontal and vertical • relationships to adjacent features • comparisons with similar features • integrations of: - origins of features - sources of materials - processes	of • Sample No's. • Photo No's. • Descriptions and • encoding data • annotating maps and photos • prepare questions • answer questions • advise astronauts

The astronaut activity will consist of observation, photography, description, and sampling of certain geologic features conducted along the traverse. At the same time MSC will be monitoring and documenting the astronaut activity.

Figure 5-4. Lunar Geology General Planning Chart

State	H4	H3	H2	H1	Heater	Function	Bridge Energized
1	0	0	0	0	12	OFF	DTR 11
2	0	0	0	1	12	ON	DTR 11
3	0	0	1	0	14	OFF	DTR 12
4	0	0	1	1	14	ON	DTR 12
5	0	1	0	0	11	OFF	DTR 11
6	0	1	0	1	11	ON	DTR 11
7	0	1	1	0	13	OFF	DTR 12
8	0	1	1	1	13	ON	DTR 12
9	1	0	0	0	22	OFF	DTR 21
10	1	0	0	1	22	ON	DTR 21
11	1	0	1	0	24	OFF	DTR 22
12	1	0	1	1	24	ON	DTR 22
13	1	1	0	0	21	OFF	DTR 21
14	1	1	0	1	21	ON	DTR 21
15	1	1	1	0	23	OFF	DTR 22
16	1	1	1	1	23	ON	DTR 22

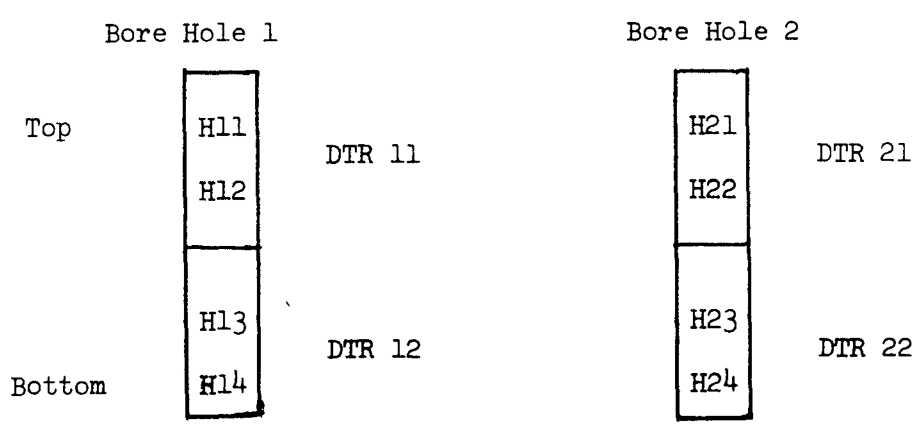

Figure 5-5. Heat Flow Experiment, Heater Sequence

SECTION VI

SCIENCE RECOVERY PLAN

6.1 GENERAL

This section defines the Science and Applications Directorate requirements for the return of time-critical scientific data and equipment from the recovery zone to the Lunar Receiving Laboratory (LRL), Manned Spacecraft Center, Houston. Guidelines for the preparation and transporting of the data are specified in paragraphs 6.2.1 and 6.2.2. Transportation priorities are specified in Table 6-1.

6.2 PREPARATION AND TRANSPORTATION REQUIREMENTS

6.2.1 PREPARATION OF DATA AND EQUIPMENT FOR RETURN TO MSC

6.2.1.1 Decontamination

During the quarantine period, each item removed from the Mobile Quarantine Facility (MQF) will be placed in a plastic Biological Isolation Container (BIC), the internal pressure of the BIC reduced by a vacuum pump and the BIC heat-sealed. After sealing, the external surface of the BIC must be completely bathed in decontaminant (sodium hypochlorite solution). Safe passage of an item from the MQF is through a transfer portal provided for this purpose.

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 and the Mobile Quarantine Facility (MQF) from EAFB to the Lunar Receiving Laboratory (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
• ALSRC No. 1, S/N 1013	1	Flight No. 1	The contents of each ALSRC are exempt from the decontamination procedures specified in 6.2.1.1. The ALSRC's are not to be opened prior to delivery to the LRL. The Organic Control Sample installed in each ALSRC prior to flight will remain in the container throughout the mission. The minimum (min) core tubes specified for each ALSRC is the quantity actually assigned to each container. If the tubes are not used on their respective EVA, they will be carried over to the next EVA. When used, the tubes will be stored in the ALSRC assigned to that particular EVA which will yield the maximum (max) number.
• Sample Collection Bag No. 1	1		
• Drill Stems	6		
• Core Tubes/Caps	3 (max)		
• Environmental Soil Sample (SESC No. TBD)	1 (max)		
• Selected Geological Samples	(TBD)		

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
• ALSRC No. 2, S/N 1012	1	Flight No. 1 or 2 (TBD)	
• Sample Collection Bag No. 2 or No. 3	1		
• Core Tubes/Caps	3 (min) 6 (max)		
• Environmental Soil Sample (SESC No. TBD)	1 (2 max)		
• Selected Geological Samples	(TBD)		

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
• ALSRC No. 3, S/N 1009	1	Flight No. 1 or 2 (TBD)	
• Sample Collection Bag No. 2 or No. 3	1		
• Core Tubes/Caps	3 (min) 9 (max)		
• Environmental Soil Sample (SESC No. TBD)	1 (2 max)		
• Selected Geological Samples	(TBD)		
• Contingency Soil Sample	1	Mobile Quarantine Facility (MQF)	If the ALSRC's are not available for return to the LRL, the contingency sample will be treated as a high priority time-critical item, prepared in accordance with paragraph 6.2.1.1, placed in a Contingency Sample Return Container and shipped by aircraft to Ellington Air Force Base, Houston.

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
• Magnetic Soil Sample (MSSC No. TBD)	1	MQF	
• Special Sample Return Bag (EVA No. 3 only)	1	MQF	
• Extra Collection Bags	3 (max)	MQF	Soil samples and rocks - overflow from ALSRC's.
• Data Storage Electronics Assembly (DSEA) from LM	1	Flight No. 2	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.
• Data Storage Equipment (DSE) - Tape from CM	1	With CM. Remove when CM is returned to LRL.	The DSE tape is the only source of telemetry available during the period of CM reentry.

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
• Astronaut Flight Logs	-	MQF with Astronauts	Flight logs contain information vital to the interpretation and analysis of lunar surface activity. Transcripts of the flight logs should be made available as quickly as possible after return to MSC.
• Magazines/Cassettes from following camera systems:			The film magazines will be placed in specially constructed containers at the recovery site and returned to Ellington Air Force Base with film data divided between the two aircraft. Film will remain in the custody of the Photographic Technology Laboratory (PTL) couriers until it arrives at MSC. The film will then be processed through the LRL before being released to the PTD for development.
• Maurer 16-mm DAC	(TBD)	1/2 of total magazines on each flight	
• Hasselblad 70-mm DC (Reseau)	(TBD)	1/2 of total magazines on each flight	
• Hasselblad 70-mm EC	(TBD)	1/2 of total magazines on each flight	
• 24-Inch Panoramic	1	TBD	
• 3-Inch Mapping	1	TBD	

SECTION VII

LUNAR RECEIVING LABORATORY PLAN

Data for this section will be included in the next issue of the J-1 MSRD, scheduled for publication at L minus 5 months. These data are not required as source material for any MSC document or for use by any MSC organization before that time.

SECTION VIII

CONTINGENCY PLAN

8.1 GENERAL

This section provides data for use in real-time replanning and rescheduling of mission science activities in the event that a contingency or off-nominal condition occurs during the mission. Included are the assumptions upon which planning data are based and the constraints which will impact real-time decisions. Planning data are provided for the following major contingencies: no launch (mission scrubbed), no translunar injection (earth orbital mission only), lunar flyby (no lunar orbital or lunar surface activities), lunar orbital mission (no lunar surface landing), no lunar surface EVA, and no lunar orbital EVA.

8.2 ASSUMPTIONS

a) Launch delays of more than a few days may require replacement or adjustment of some experiment hardware.

b) For the earth orbit mission case, the altitude and inclination will both be increased within operational limitations.

c) An experiment may be operated for engineering tests only, if orbit will not allow for science data collection.

d) A lunar flyby mission will not allow for proper attitude and operating time for SM experiment operations.

e) If the mission is off-nominal so that it appears that there will be no more than one surface EVA, the ALSEP should be deployed in a direction toward the nearest available and recognizable Hadley-Apennine material to increase the possibility of collecting selected sample materials.

8.3 TIME CONSTRAINT

For any malfunction on a scientific task, spend a maximum of 10 minutes on malfunction procedures and then abandon. Additional time may be allocated on certain malfunctions before resulting in total experiments abandonment. This additional time will be a real-time decision based on consumables and timeline constraints.

8.4 HOLD POINTS

The sequence of the experiment deployment or operation may be stopped after the completion of any one of the following hold points. It will be continued at some time later by going to the next series of tasks:

a) Remove ALSEP Subpackages No. 1 and No. 2; close SEQ bay door; emplace ALSEP Subpackages with experiments in and facing the sun.

b) Tilt fuel cask; dome not removed.

c) Tilt fuel cask; remove dome, do not defuel.

d) Fuel RTG; carry ALSEP to deployment site; remove subpallet from Subpackage No. 2; carry Subpackage No. 1 to emplacement site (do not deploy); interconnect RTG cable (do not actuate switch).

e) Deploy ALSEP Subpackage No. 1 as well as ALSEP Subpackage No. 2; release and remove experiments; raise sunshield; mount and aim antenna; deploy PSE.

f) Deploy ALSEP experiments and complete tasks. A hold point exists after each experiment is deployed.

g) Geology hold points (TBD).

h) Orbital hold points (TBD).

8.5 EXPERIMENT RESCHEDULING

In the event of a major contingency (no lunar landing, etc.), deployment and operation of lunar orbital and/or lunar surface experiments will be affected and must be rescheduled. Table 8-1 indicates which of the lunar orbital experiments may be accomplished for each major contingency.

Preliminary contingency planning data for the lunar surface experiment activities are presented in Table 8-2. Detailed contingency procedures for the lunar surface experiments and related activities will be provided in the next issue of the MSRD.

Table 8-1. Experiment Use for Contingency Missions

EXPERIMENT	MISSION TYPE					
	S	A	B	C	D	E
SM Orbital Photographic Tasks:						
• 24-Inch Panoramic Camera	X	G	N	G	G	N
• 3-Inch Mapping Camera	X	G	N	G	G	N
• Laser Altimeter*	X	N	N	G	G	G
CM Photographic Tasks	G	X	F	G	G	G
UV Photography - Earth and Moon	G	G	G	G	G	G
Gegenschein from Lunar Orbit	G	X	N	G	G	G
Gamma-Ray Spectrometer	X	G	N	G	G	G
Alpha Particle Spectrometer*	X	N	N	G	G	G
X-Ray Fluorescence	X	G	N	G	G	G
Mass Spectrometer	X	G	N	G	G	G
S-Band Transponder (CM/LM)	G	X	N	G	G	G
Subsatellite:						
• Magnetometer*	N	N	G	G	G	G
• Particle Shadows/Boundary Layer	N	G	G	G	G	G
• S-Band Transponder	N	G	G	G	G	G
Bistatic Radar	N/A	N/A	N/A	G	G	G

*No useful science data in earth orbit

LEGEND:

S-Scrubbed launch; can be recycled without experiment effect.
A-Earth Orbit
B-Lunar Flyby
C-Lunar Orbit
D-No Surface EVA
E-No Orbital EVA
F-Alternate
G-Go
N-No/Go
N/A-Not Applicable
X-TBD

Table 8-2. EVA Decisions

EVENT NO.	CONTINGENCY	RESPONSIBLE AGENT	ACTION	REMARKS
1	Crew unable to locate touch-down point in the landing ellipse.	Crew	Make visual observations and describe features around the LM.	
		MCC	1. Compare television images and the astronauts' description of features to the overall features in the map package. 2. After locating the touchdown point advise crewmen of which map sheet to use for plotting their traverse routes.	
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. 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 2. 2. Collect contingency sample. 3. If possible, take a panorama of area and shots of surface nearby. Take shots of surface under LM descent engine and around footpads.	

Table 8-2. EVA Decisions (Continued)

EVENT NO.	CONTINGENCY	RESPONSIBLE AGENT	ACTION	REMARKS
4	Time for EVA 1 only. (2 men)	Crew	1. Collect contingency sample. 2. Deploy ALSEP as normal but in direction toward the nearest available and recognizable Hadley-Apennines material. 3. Deploy LR^3. 4. Collect documented samples during traverse to the ALSEP site and while returning. 5. Photograph and describe geological features as well as collect samples. 6. Cut down the number of stations and distance attempted rather than reduce quality of sample collections and documentation.	
		MCC	Study landing area on maps and make decision on ALSEP deployment site.	

Table 8-2. EVA Decisions (Continued)

EVENT NO.	CONTINGENCY	RESPONSIBLE AGENT	ACTION	REMARKS
5	Time for one-man EVA 1 only. (Not enough time for EVA 2)	Crew	1. Collect contingency sample. 2. Deploy ALSEP as normal but in direction toward the nearest available and recognizable Hadley-Apennines material. 3. Deploy LR^3. 4. Collect documented samples during return traverse from ALSEP site. 5. Cut down the number of stations and distance attempted rather than reduce quality of sample collections and documentation.	
6	One man EVA 1. (EVA 2 possible)	Crew	1. Collect contingency sample. 2. Deploy ALSEP as normal but in direction toward the nearest available and recognizable Hadley-Apennines material. 3. Deploy LR^3. 4. Collect documented samples during return traverse from ALSEP site.	

Table 8-2. EVA Decisions (Continued)

EVENT NO.	CONTINGENCY	RESPONSIBLE AGENT	ACTION	REMARKS
7	One man EVA 2.	Crew	1. If LRV is available. a. Perform geology sample collection and documentation. b. Take panorama shots of traverse area. 2. If LRV is not available. a. Perform geology sample collection and documentation. b. Take panorama shots of traverse area.	a. May abbreviate documentation requirements for samples if MCC concurs.

APPENDIX A

ACRONYMS AND ABBREVIATIONS

A	Ampere(s)
Å	Angstrom Unit (One Ten-Billionth of a Meter)
ac	Alternating Current
A/D	Analog-to-Digital
AGC	Automatic Gain Control
AFMAD	Apollo Flight Mission Assignments Directive
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
amp	Ampere(s)
AMU	Atomic Mass Unit
ASA	American Standards Association
ASPO	Apollo Spacecraft Program Office
Auto	Automatic
BIC	Biological Isolation Container
BPS	Bits Per Second
BTE	Bench Test Equipment
C	Centigrade
CAL	Calibrate
CCB	Configuration Control Board
CCIG	Cold Cathode Ion Gauge

CM	Command Module
cm	Centimeter
C/S	Central Station
CSM	Command and Service Module
dB	Decibel
dBm	Decibel Below 1 Milliwatt
dc	Direct Current
Decl.	Declination (measured in celestial coordinates)
DPS	Descent Propulsion System
DSE	Data Storage Equipment
DSEA	Data Storage Electronics Assembly
DSS	Data Subsystem
E	East
EAFB	Ellington Air Force Base
EMI	Electromagnetic Interference
EPO	Earth Parking Orbit
eV	Electron Volt
EVA	Extravehicular Activity
F	Fahrenheit
FCSD	Flight Crew Support Division
FMC	Forward Motion Compensation
FOV	Field-Of-View
fps	Feet per Second

gal	cm/sec^2
GET	Ground Elapsed Time
gm	Gram
GN_2	Gaseous Nitrogen
HD	Highly Desirable
HFE	Heat Flow Experiment
Hq.	Headquarters
ID	Identification
IMU	Inertial Measurement Unit
JPL	Jet Propulsion Laboratory
K	Kelvin
keV	One Thousand Electron Volts
kg	Kilogram
kHz	Kilohertz
km	Kilometer
kV	Kilovolt
LASER	Light Amplification through Stimulated Emission of Radiation
LCRU	Lunar Communications Relay Unit
LDDE	Lunar Dust Detector Experiment
LM	Lunar Module
LMO	Lunar Missions Office
LOI	Lunar Orbit Injection
LP	Long-Period

LRL	Lunar Receiving Laboratory
LRRR	Laser Ranging Retro-Reflector
LR^3	Laser Ranging Retro-Reflector
LRV	Lunar Roving Vehicle
LSB	Least Significant Bit
LSM	Lunar Surface Magnetometer
m	Meter, Milli
M	Mandatory
MAL	NASA Headquarters Apollo Lunar Exploration Office Symbol
MCC	Mission Control Center
MESA	Modularized Equipment Stowage Assembly
Mev	One Million Electron Volts
MHz	Megahertz
mm	Millimeter
MQF	Mobile Quarantine Facility
MRD	Mission Requirements Document
MSC	Manned Spacecraft Center
MSFEB	Manned Space Flight Experiments Board
MSFN	Manned Space Flight Network
MSRD	Mission Science Requirements Document
MSSC	Magnetic Soil Sample Container
mV	Millivolt
N	North
n	Newton

N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NM	Nautical Mile
No.	Number
O_3	Ozone (Triatomic Oxygen)
OMSF	Office of Manned Space Flight
OSSA	Office of Space Sciences and Application
PCM	Pulse Code Modulation
PCU	Power Conditioning Unit
PDR	Power Dissipation Resistor
PDU	Power Distribution Unit
PI	Principal Investigator
PLSS	Portable Life Support System
PSE	Passive Seismic Experiment
PTC	Passive Thermal Control
PTL	Photographic Technology Laboratory
R. Asc.	Right Ascension (measured in celestial coordinates)
RCS	Reaction Control Subsystem
RF	Radio Frequency
rpm	Revolutions per Minute
RTG	Radioisotope Thermoelectric Generator
S	South
SA	Saturn Apollo

ACRONYMS AND ABBREVIATIONS (Continued)

S&AD	Science and Applications Directorate
sec	Second
SESC	Special Environmental Sample Container
SEQ	Scientific Equipment Bay
SIDE	Suprathermal Ion Detector Experiment
SIM	Scientific Instrument Module
SM	Service Module
SNAP	Space Nuclear Auxiliary Power
SO	Special Order
SP	Short-Period
SPS	Service Propulsion System
SRC	Sample Return Container (also known as ALSRC)
SWE	Solar Wind Experiment
SWS	Solar Wind Spectrometer (Same as SWE)
TBD	To Be Determined
TBS	To Be Supplied
TEI	Transearth Injection
Temp	Temperature
TLI	Translunar Injection
TM	Telemetry
torr	Unit of Pressure (1/760 of an atmosphere or 0.757×10^{-2} n/m^2)
TV	Television
UHT	Universal Handling Tool
UV	Ultraviolet

V	Volt
VCO	Voltage Controlled Oscillator
Vdc	Volts of Direct Current
VHF	Very High Frequency
W	West
X	Magnification Factor
Xmtr	Transmitter
h	Hour (Superscript)
m	Minute (Superscript)
°	Degrees
'	Feet
"	Inches
γ	Gamma
μ	Micron

APPENDIX B

GLOSSARY

AEROSOL	A suspension of fine solid or liquid particles such as smoke or fog in the earth's atmosphere.
ALBEDO	The amount of electromagnetic radiation reflected by a body expressed as a percentage of the radiation incident on the body.
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	The opening of a camera through which light rays pass when the film shutter is open.
AREAL	Pertaining to coverage of area as maximum areal coverage of a lunar traverse.
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 (previously found on the lunar surface).
BIT	Binary digit of telemetered information.
BOUNDARY LAYER	Interaction layer between the surface of the moon and the undisturbed portion of the solar wind.
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.
COLORIMETRIC	Pertaining to the measurement of the intensities of different colors as of lunar surface materials.

COSMIC RAYS	Very high energy nuclear particles, commonly protons, that bombard the earth from all directions.
COSMOLOGICAL	Concerned with the investigation of the character and origin of the universe.
CROSSTRACK	In a plane perpendicular to the instantaneous direction of a spacecraft's ground track.
DEADBAND	The limits of an allowable spacecraft attitude excursion in a particular attitude-hold mode.
DIELECTRIC	A material with few conduction electrons, i.e., an electrical insulator.
DIURNAL	Recurring daily.
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.
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 substance discharged from a spacecraft such as waste water, urine, fuel cell purge products, etc.
EJECTA	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.
EPHEMERIS	A tabulation of the predicted positions of a celestial body - such as the moon - at regular intervals.
EPICENTER	The lunar surface point directly above the source of a seismic disturbance.
EXOSPHERE	The outermost portion of the earth's or moon's atmosphere from which gases can escape into outer space.

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 area from which light is admitted into an optical instrument, usually expressed in terms of angles.
FINE-GRAINED	Broad description of lunar geological material to be gathered that is characterized by a structural composition of fine-grained matrices evident upon microscopic examination.
FLUORESCENCE	Emission of radiant energy in response to the absorption of radiant energy at a different wavelength.
FLUX	The 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.
FRAGMENTAL	Broad description of lunar geological material to be gathered representing fragmented material such as small rock chips.
GAL	A measure of gravitational acceleration equal to 1 cm/sec^2.
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} oersteds.
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.
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.

GEOPHYSICAL	Pertaining to the physics of the earth, or moon, and the surrounding environment.
GNOMON	A rod pivoted about a free bearing used on the lunar surface to indicate the local vertical, to give sun position, and to serve as a distance scale.
GRADIENT	The space rate of change of a function. For example, the local lunar surface magnetic field.
GRANITIC	Pertaining to very hard igneous rock.
GROUND TRUTH	Lunar surface data used as a calibration or check on data taken from lunar orbit.
HERTZ	A unit of frequency used to describe electromagnetic radiation and equal to 1 cycle per second.
HUMMOCK	A rounded knoll or hill.
INERTIAL COORDINATE SYSTEM	A system in which the (vector) momentum of a particle is conserved in the absence of external forces and whose axes are not undergoing acceleration or rotation.
IGNEOUS ROCK	Rock formed by solidification of molten material.
IN SITU	"In its original position." For example, taking photographs of a lunar surface rock sample "in situ" (as it lays on the surface).
J-1 TYPE 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).
K LINES	Band spectra lines characteristic of the innermost atom electron shell containing 2 electrons; this shell is called the K-shell.
L - "X" MONTHS	The number of months before launch, e.g., L-5 months.
L LINES	Band spectra lines characteristic of the next to innermost atom electron shell containing electrons; this shell is called the L-shell.

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.
LITHIFIED	Evidence of having been changed into stone.
MACROSCOPIC	Large enough to be seen with naked eye or under low magnification.
MAGNETOPAUSE	The transition region between the earth's magnetosphere and the solar wind bow shock.
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.
MICRO-BRECCIA	A rock consisting of sharp fragments embedded in a fine-grained matrix.

MICROSCOPIC	Of such a size as to be viewable, if at all, only under optical magnification.
MIE	Name associated with the theory of scattering of electromagnetic radiation from spherical particles without regard to comparative size of radiation wavelength and particle diameter.
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.
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.
NOCTILUCENT	Shining at night. For example, noctilucent clouds or collections of high-altitude aerosols which scatter light.
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.
OCCULTATION	The disappearance of a body behind another body of larger apparent size. For example, the occultation of the sun by the moon as viewed by an earth observer to create a solar eclipse.
OZONE	Triatomic oxygen (O_3) found in significant quantities in the earth's upper atmosphere.
PENUMBRAL	Referring to the part of a shadow in which the light (or other ray-type material such as the solar wind) is only partially masked in contrast to the umbra in which light is completely masked by the intervening object.

PHOTON	The electromagnetic quantum, regarded as a zero rest mass particle with no electric charge and possessing an energy of $H\nu$ where H is Planck's constant and ν is the radiation frequency.
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.
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 222 formed by the radioactive decay of radium.
RAYLEIGH	Name associated with atmospheric scattering of electromagnetic radiation from spherical particles of radii smaller than about one-tenth the wavelength of the radiation.
REGOLITH	The unconsolidated residual material that resides on the solid surface of the moon (or earth).
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 vibrations within the surface of the earth or moon resulting from, for example, impact of projectiles on the surface.
SELENOCENTRIC	Referring to an inertial coordinate system whose origin is referenced at the center of the moon.
SELENODETIC	Relating to the accurate determination of positions of points on the moon, measurement of areas on the lunar surface, and the determination of lunar gravitational variations.

SENSITOMETRIC	Pertaining to the measurement of the light response characteristics of photographic film under controlled conditions of exposure and development.
SIDELAP	Overlap of one aerial photographic strip with another in a direction perpendicular to the length of the strips.
SLAVED	The condition of a controlled device or mechanism which operates whenever another device is operating, usually in synchronization.
SOLAR WIND	Streams of plasma emanating from and flowing approximately radially outward from the sun.
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.
SPHERULES	Pertaining to the small, spherical crystalline bodies found in vitreous volcanic rocks.
SPUR	A ridge or lesser elevation that extends laterally from a mountain or mountain range.
STANDBY	An operating mode of certain scientific equipment and sensors in the SIM Bay indicating that thermal control heaters are "ON" or that the electronics are in the process of being "warmed-up" in readiness for the operational period to follow.
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.

SUBSATELLITE	A small unmanned satellite, deployed from the spacecraft while it is in orbit, designed to obtain various types of solar wind and lunar magnetic data over an extended period of time.
TEKTITES	Small glassy bodies containing no crystals, composed of at least 65 percent silicon dioxide, bearing no relation to the geological formation in which they occur, and believed to be of extra-lunar origin.
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 90 and an atomic mass of 232.
THREE-WAY MODE	A Doppler radar method involving a primary station which both sends and receives signals, a transponder on the spacecraft, and a secondary station which receives signals only.
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 oceans.
TIMELINE	A detailed schedule of astronaut or mission activities indicating the activity and time at which it is to occur within the mission.
TOPOGRAPHIC	Pertaining to the accurate graphical description, usually on maps or charts, of the physical features of an area on the earth or moon.
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.
TWO-WAY MODE	The Doppler radar tracking method which employs a single sending and receiving station and the spacecraft transponder.
URANIUM	A heavy metallic element of atomic number 92 and principal atomic weight 238.
VECTOR	A physical quantity requiring both magnitude and direction for its specification, as magnetic force field and gravitational acceleration vectors.
VITREOUS	Resembling glass as in color, composition, etc.
WAVELENGTH	The distance between maxima (or minima) of a periodic phenomenum 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 ultraviolet 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 entir zodiac but showing most prominently in the neighborhood of the sun. (It may be seen in the West after twilight and in the East before dawn as a diffuse glow. The glow may be sunlight reflected from a great number of particles of meteoritic size in or near the ecliptic in the planetoid belt).

APPENDIX C

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APPENDIX D

DISTRIBUTION

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1 CF24/P. C. Kramer
1 CF25/L. G. Richard
1 CF25/D. C. Schultz
1 CF32/H. A. Kuehnel
1 CF32/J. W. McKee
1 CF32/R. H. Nute
1 CF32/J. A. Taylor
1 CF32/W. N. Teague
1 CF32/J. J. Van Bockel
1 CF32/R. G. Zedekar
1 CF33/S. Faber
1 CF34/T. W. Holloway
1 CF34/J. W. O'Neill
1 CF131/D. F. Grimm
1 CF131/G. C. Franklin
1 CF131/C. D. Perner
1 DA/C. A. Berry, M.D.
1 DA/H. R. Hair
1 DC5/W. R. Carpentier, M.D.
1 DC52/H. O. Wheeler, M.D.
1 DC52/B. C. Wooley, M.D.
1 DD/W. R. Hawkins, M.D.
1 EA/M. A. Faget
1 EA2/R. A. Gardiner
1 EA8/P. M. Deans
1 EA8/J. B. Lee
1 EB/H. C. Kyle
1 EB2/R. W. Moorehead
1 EB3/M. R. Franklin
1 EB5/G. D. Marlow
1 EC/R. E. Smylie
1 EC/P. F. Hurt
1 EC3/R. J. Gillen
1 EC3/F. H. Samonski
1 EC3/E. M. Tucker
1 EC6/L. E. Bell
1 EC9/J. L. Gibson
1 EC9/C. C. Lutz
1 EC9/R. L. Spann
1 ED/E. H. Brock
1 ED3/M. T. Cunningham
1 ED5/F. Fulton
1 ED5/D. E. Iloff
1 EE/R. S. Sawyer
1 EE2/H. J. Wood
1 EE3/E. L. Chicoine
3 EE12/M. G. Kingsley
5 EF/E. M. Jones
1 EG2/D. C. Cheatham
1 EG23/K. J. Cox
1 EG27/D. W. Gilbert
1 EG42/G. T. Rice
1 EG43/R. E. Wilson
1 EG412/J. F. Hanaway
1 EH/D. G. Wiseman
1 EL/J. C. McLane
1 EM3/A. Travis
1 EP/R. B. Ferguson
2 EP2/C. W. Yodzis
2 EP4/H. O. Pohl
1 EP5/W. E. Rice
1 EP12/R. K. McSheehy
1 ES/R. E. Vale
1 ES2/G. E. Griffith
1 ES3/J. W. Kiker
1 ES5/D. H. Greenshields
1 ES12/W. G. McMullen
1 ES16/J. A. Smith

1 EW/C. C. Johnson
1 EW31/G. C. Miller
1 EX/M. A. Silveira
1 FA/S. A. Sjoberg
1 FC/E. F. Kranz
1 FC/J. W. Roach
3 FC2/C. S. Harlan
3 FC3/A. D. Aldrich
2 FC4/J. E. Hannigan
1 FC5/J. C. Bostick
1 FC6/C. B. Shelley
1 FC7/R. A. Hoover
2 FC9/J. E. Saultz
1 FC13/G. S. Lunney
1 FC14/H. G. Miller
1 FL/J. B. Hammack
1 FL2/D. E. Stulken
1 FM/C. R. Huss
1 FM/J. P. Mayer
1 FM2/F. V. Bennett
1 FM3/C. C. Allen
3 FM4/J. C. McPherson
3 FM5/R. L. Berry
3 FM6/E. C. Lineberry
1 FM7/M. D. Cassetti
1 FM7/D. A. Nelson
2 FM13/R. P. Parten
1 FS/L. C. Dunseith
2 FS2/J. M. Satterfield
4 FS4/J. A. Frere
1 FS5/J. C. Stokes
2 FS63/J. A. Miller
1 HD/A. J. Mayer, Jr.
1 HE/J. P. Loftus
1 NA/W. M. Bland
1 NB/J. H. Levine
1 PA/R. S. Johnston
1 PA/J. A. McDivitt
1 PA/S. H. Simpkinson
1 PB/A. Hoboken
3 PB7/L. R. Fisher
1 PC/W. H. Gray
1 PC2/R. Frazer
1 PC2/F. L. Miller
1 PD/R. L. Kubicki
1 PD4/C. H. Glancy
1 PD4/C. C. Guild
1 PD4/J. R. Sevier
1 PD7/S. M. Blackmer
1 PD7/R. H. Kohrs
1 PD7/J. M. Peacock
1 PD7/D. R. Segna
1 PD9/J. W. Craig
1 PE/H. P. Davis
1 PE/O. G. Morris
1 PF/A. Cohen
1 PF/D. R. Broome
1 PP/J. G. McClintock
1 PP3/G. H. Jordan
1 PP3/H. L. Tash
1 PP5/R. C. Hood
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1 PP7/W. R. Kelly
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1 PT3/J. F. DeMoss
1 PT3/G. B. Foster
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1 PT13/D. M. Goldenbaum
1 SA/M. L. Raines
1 TA/A. J. Calio
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1 TA/G. Simmons
1 TG2/B. C. Cour-Palais
1 TG4/R. P. Kovar
1 TJ/J. L. Dragg
1 TJ/A. W. Patteson
1 TJ/J. H. Sasser
1 TJ/L. C. Wade
1 TL/R. B. Erb
1 TL/H. Huber
1 TM/J. G. Zarcaro
5 TM1/R. R. Baldwin
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1 TM1/B. H. Walton
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1 TM2/V. M. Dauphin
1 TM2/S. N. Hardee
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2 TM4/Crew Training Office

8 TM5/W. K. Stephenson
5 TN/P. Gast
1 TN4/W. D. Carrier
1 TN4/D. Strangway

NASA AMES RESEARCH CENTER

1 Dr. Palmer Dyal, Code N204-4
Electrodynamics Branch/Space
Sciences Division
Moffett Field, California 94034

NASA GODDARD SPACE FLIGHT CENTER

2 Dr. Isidore Adler, Code 641
Theoretical Studies Branch
Greenbelt, Maryland 20771

1 Dr. Stanley C. Freden, Code 650
Laboratory for Meterology and
Earth Sciences
Greenbelt, Maryland 20771

1 Lawrence Dunkelmen, Code 613.3
Planetary Optics Section
Greenbelt, Maryland 20771

NASA KENNEDY SPACE FLIGHT CENTER

5 CKF/R. D. McCafferty
1 LO-PLN/R. E. Moser
1 LO-RRO/E. P. Bertram
1 LS-ENG-7/R. B. Gaskins
1 LS-ENG-8/C. B. Mars
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3 MAL/W. T. O'Bryant
1 MAO/E. W. Land
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AMERICAN SCIENCE & ENGINEERING, INC.

1 Dr. Paul Gorenstein
11 Carleton Street
Cambridge, Massachusetts 02142

BELLCOMM

1 MAS/V. Hamza
1 MAS/V. Mummert
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1 HA69/R. Zeiger
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GENERAL ELECTRIC

3 Dr. Robert L. Fleischer
General Physics Laboratory
General Electric R&D Center
Schenectady, New York 12305

GRUMMAN AIRCRAFT CORPORATION

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1 NR/AB46/B. C. Johnson

TRW SYSTEMS

3 TRW (Houston Office)/G. L. Christen
20 TRW (Houston Office)/G. E. Teveldahl
1 T. H. Pederson/Bldg. M2/Rm 1179
One Space Park
Redondo Beach, California 90278

JET PROPULSION LABORATORY

1 Dr. Albert Metzger
Mail Code T-1173
4800 Oak Grove Drive
Pasadena, California 91103

1 W. L. Sjogren, Mail Code 156-251
4800 Oak Grove Drive
Pasadena, California 91103

1 Dr. C. W. Snyder, Mail Code 169-236
4800 Oak Grove Drive
Pasadena, California 91103

UNITED STATES GEOLOGICAL SURVEY

3 Dr. G. A. Swann
Center of Astrogeology
601 East Cedar Avenue
Flagstaff, Arizona 86001

5 F. J. Doyle
Topographic Division
1340 Old Chainbridge Rd.
McLean, Virginia 22101

CALIFORNIA INSTITUTE OF TECHNOLOGY

1 R. F. Scott
Room 111/Thomas Laboratory
Pasadena, California 91109

UNIVERSITY OF CALIFORNIA AT BERKELEY

1 Dr. Kinsey A. Anderson
Space Sciences Laboratory
Berkeley, California 94726

1 Dr. James K. Mitchell
Department of Civil Engr.
440 Davis Hall
Berkeley, California 94726

UNIVERSITY OF CALIFORNIA AT DAVIS

1 Dr. Ian McGregor
Department of Geology
Davis, California 95616

UNIVERSITY OF CALIFORNIA AT LOS ANGELES

1 Dr. Paul J. Coleman, Jr.
Department of Planetary & Space Science
Los Angeles, California 90024

1 Dr. William M. Kaula
Institute of Geophysics & Planetary Physics
Los Angeles, California 90024

UNIVERSITY OF CALIFORNIA AT SAN DIEGO

1 Dr. J. R. Arnold
Chemistry Department
La Jolla, California 92037

COLUMBIA UNIVERSITY

1 Dr. Marcus E. Langseth
Lamont-Doherty Geological Observatory
Palisades, New York 10964

1 Dr. Gary V. Latham
Lamont-Doherty Geological Observatory
Palisades, New York 10964

UNIVERSITY OF MINNESOTA

1 Dr. Robert O. Pepin
School of Physics and Astronomy
Minneapolis, Minnesota 55455

THE STATE UNIVERSITY OF NEW YORK

1 Dr. Tobias C. Owen
Department of Earth and
Space Sciences
Stoney Brook, New York 11790

RICE UNIVERSITY

1 Dr. J. W. Freeman
Department of Space Science
Houston, Texas 77001

1 Dr. David Reasoner
Department of Space Science
Houston, Texas 77001

STANFORD UNIVERSITY

1 Dr. Robert L. Kovach
Department of Geophysics
Stanford, California 94035

2 H. Taylor Howard
Stanford Electronics Lab.
Stanford, California 94035

UNIVERSITY OF TEXAS AT AUSTIN

1 Dr. William R. Muehlberger
Geology Department
Austin, Texas 78712

UNIVERSITY OF TEXAS AT DALLAS

1 Dr. John H. Hoffman
Atmospheric & Space Sciences
P.O. Box 30365
Dallas, Texas 75230

1 Dr. F. S. Johnson
Atmospheric & Space Sciences
P.O. Box 30365
Dallas, Texas 75230

T J / Patterson

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

OCT 30 1970

PLY TO
TN OF: TM1

MEMORANDUM TO: Distribution in Appendix D of enclosure

FROM : TM/Manager, Lunar Missions Office

SUBJECT : Preliminary J-1 Mission Science Requirements Document (MSRD)

The MSRD enclosure is the first of three versions scheduled for Apollo Mission J-1 (Apollo 15). This preliminary document is scheduled for publication at launch (L) - 9 months, the final MSRD at L - 5 months, and a revised final MSRD at L - 2.5 months. MSRD's will also be prepared for Apollo Mission J-2 (Apollo 16) and J-3 (Apollo 17).

The recent selection of the Hadley-Apennines landing site delayed the availability of some related detailed data. These data will be included in the final MSRD scheduled for L - 5 months.

Your aid is solicited in improving the usefulness of the MSRD for mission planners and other users. Recommendations or requests for changes to the document or its distribution should be submitted to the J-1 Science Mission Manager, Mr. Richard R. Baldwin, TM1, extension 2840.

John G. Zarcaro

Enclosure

TM1:RRBaldwin:cr

APPENDIX E

FILM CHARACTERISTICS AND PROCESSING TEST DATA

CONTENTS

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 $\pm \frac{1}{2}$°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:

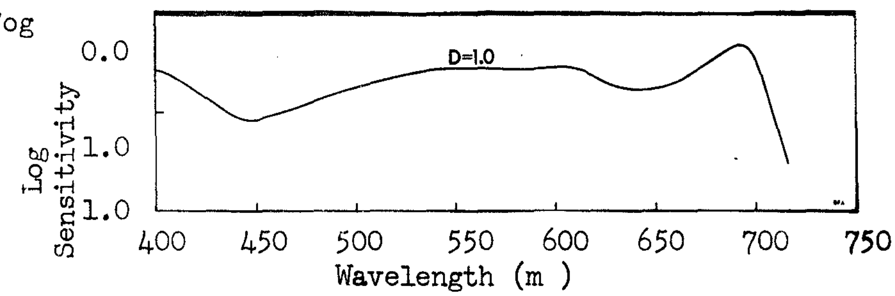
Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Aerial Exposure Index
5	1	2.80	16
	2	2.90	20
10	1	2.30	10
	2	2.60	12
15*	1	1.90	6.4
	2	2.30	10
20*	1	1.60	6.4
	2	2.20	8

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

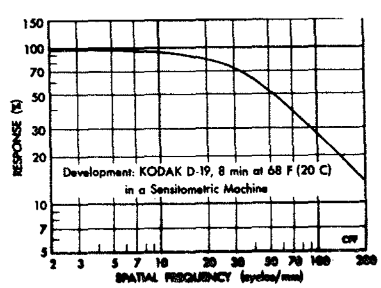
KODAK PANATOMIC-X AERIAL FILM 3400
(ESTAR Thin Base)

Spectral Sensitivity Curve

D-19
D = 1.0 above
gross fog

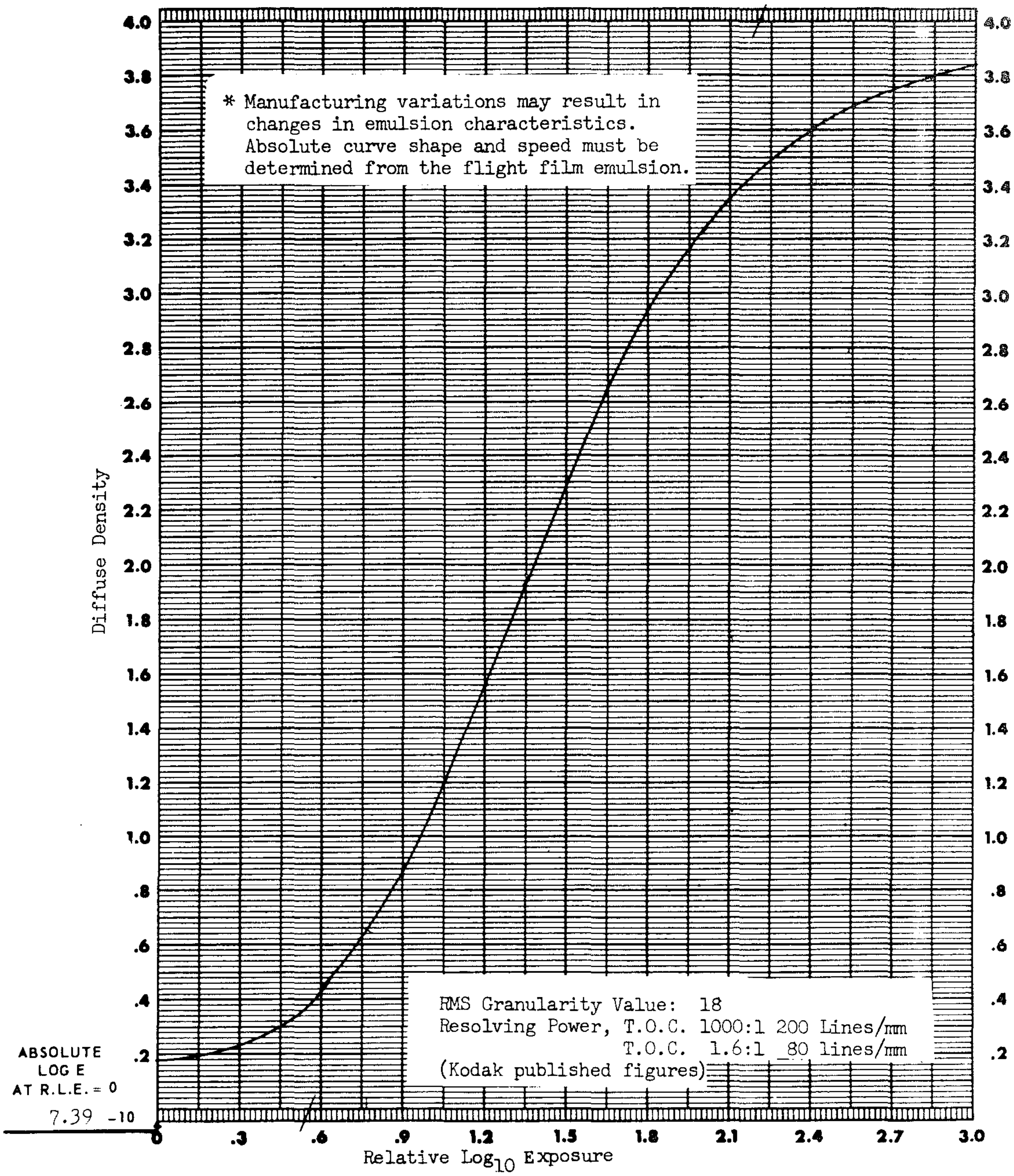


Modulation Transfer Function Curve



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) [illegible]
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

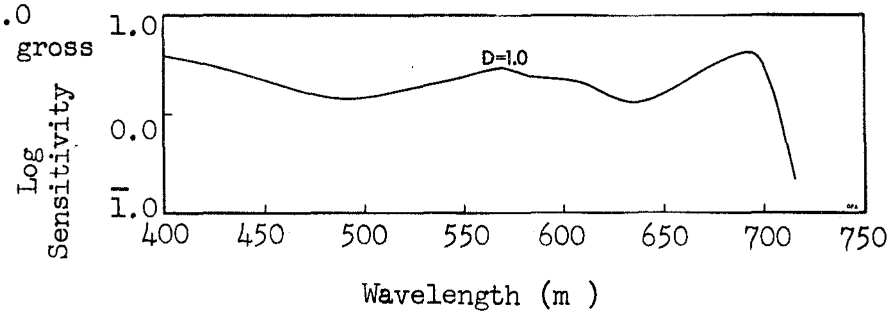
** The temperature of the dryer may require adjustment, depending upon the ambient temperature conditions in the processing area. Set temperature approximately 5 degrees above temperature required to dry clear film.

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

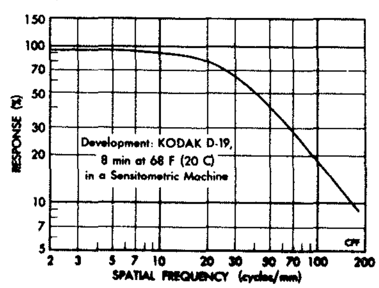
Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Aerial Exposure Index
5	2	2.61	64
10	2	2.27	50
15	2	1.87	40
20	2	1.52	32

Spectral Sensitivity Curve

D-19
D = 1.0
above gross
fog

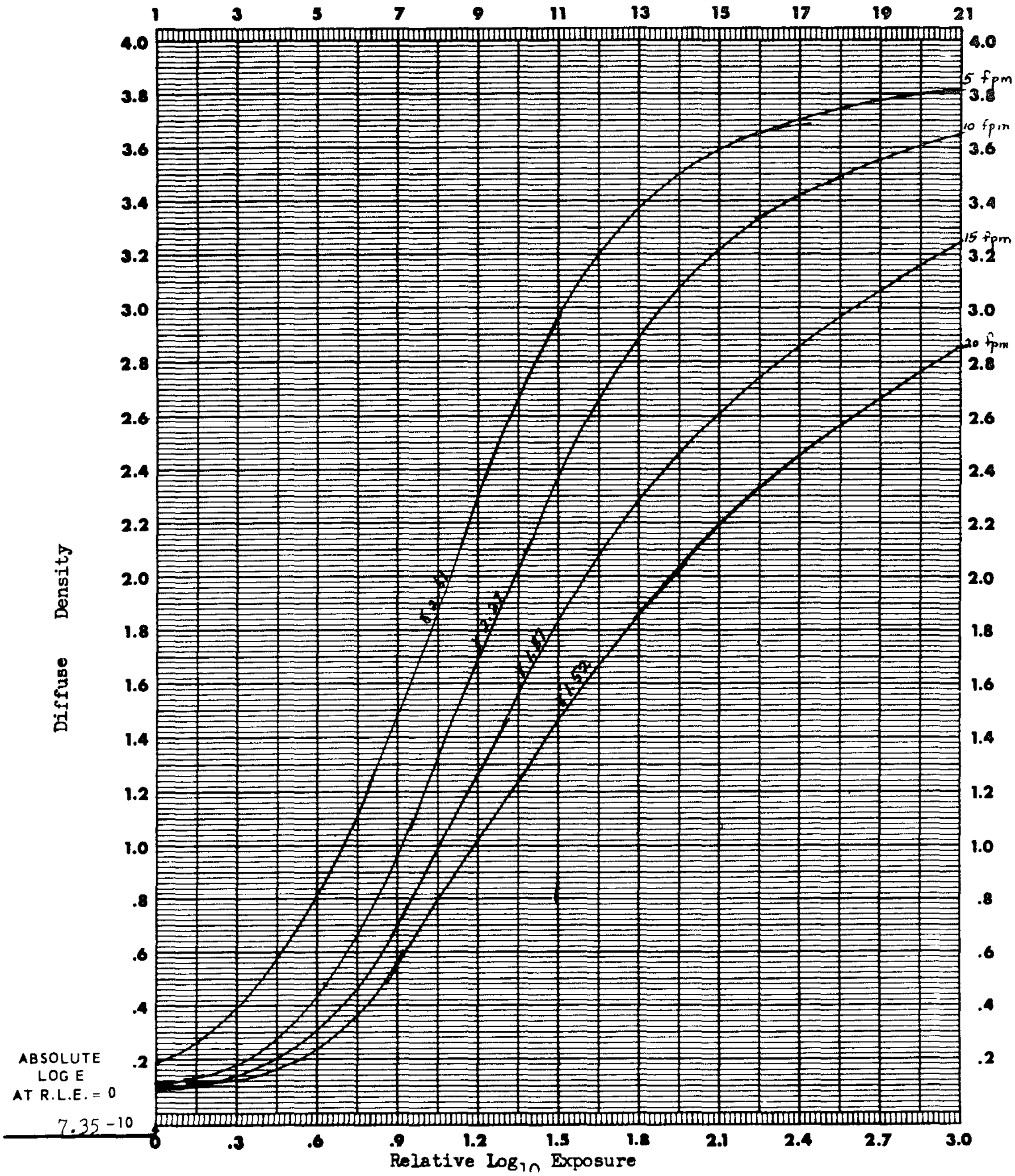


Modulation Transfer Function Curve



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 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 PTL 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 $\pm \frac{1}{2}$°F
Fix*	3	12	85°F, nominal
Wash	2	8	80° to 82°F
Dry			120° to 145°F

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

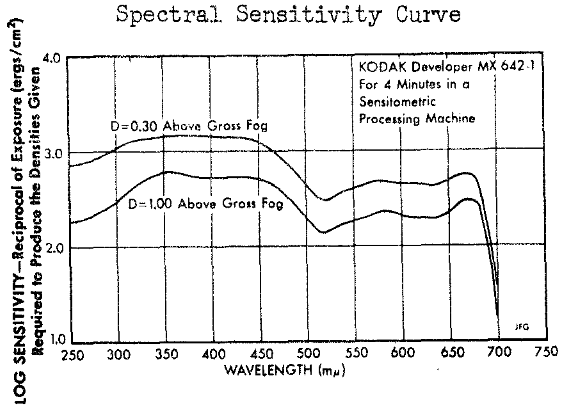
** The temperature of the dryer may require adjustment, depending upon the ambient temperature conditions in the processing area. Set temperature approximately 5 degrees above temperature required to dry clear film.

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

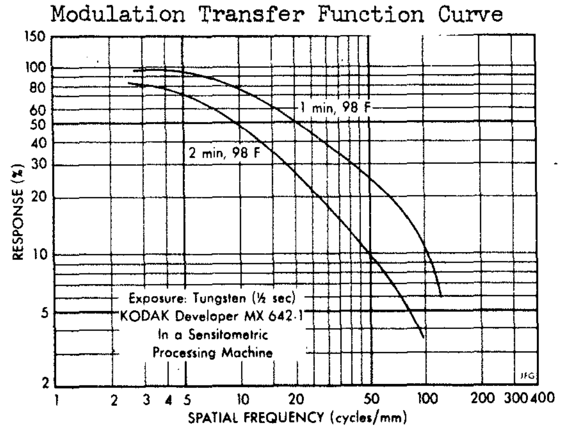
Machine Speed (feet per minute)	Number of Developer Racks	Average Gamma	Average Exposure Index
3	2	1.45	2350 (ASA)
4.5	2	1.05	---
6	2	0.66	---

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

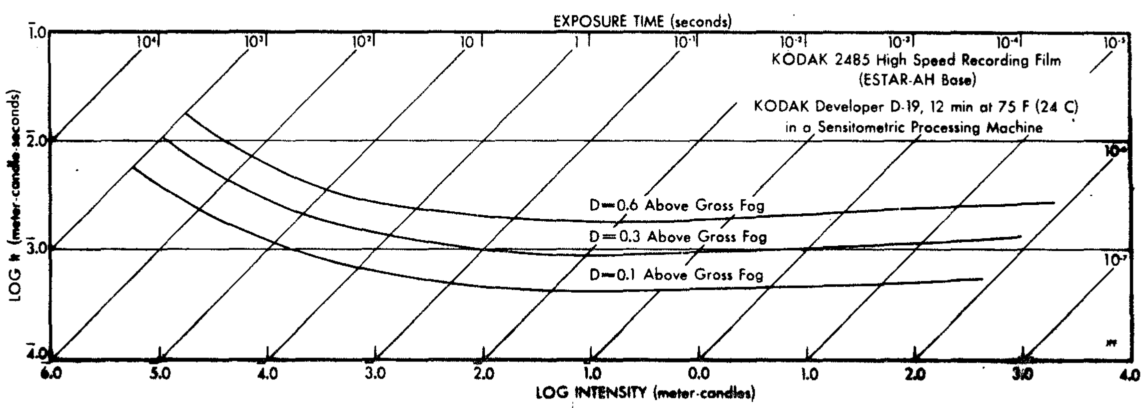
Spectral Sensitivity Curve



Modulation Transfer Function Curve



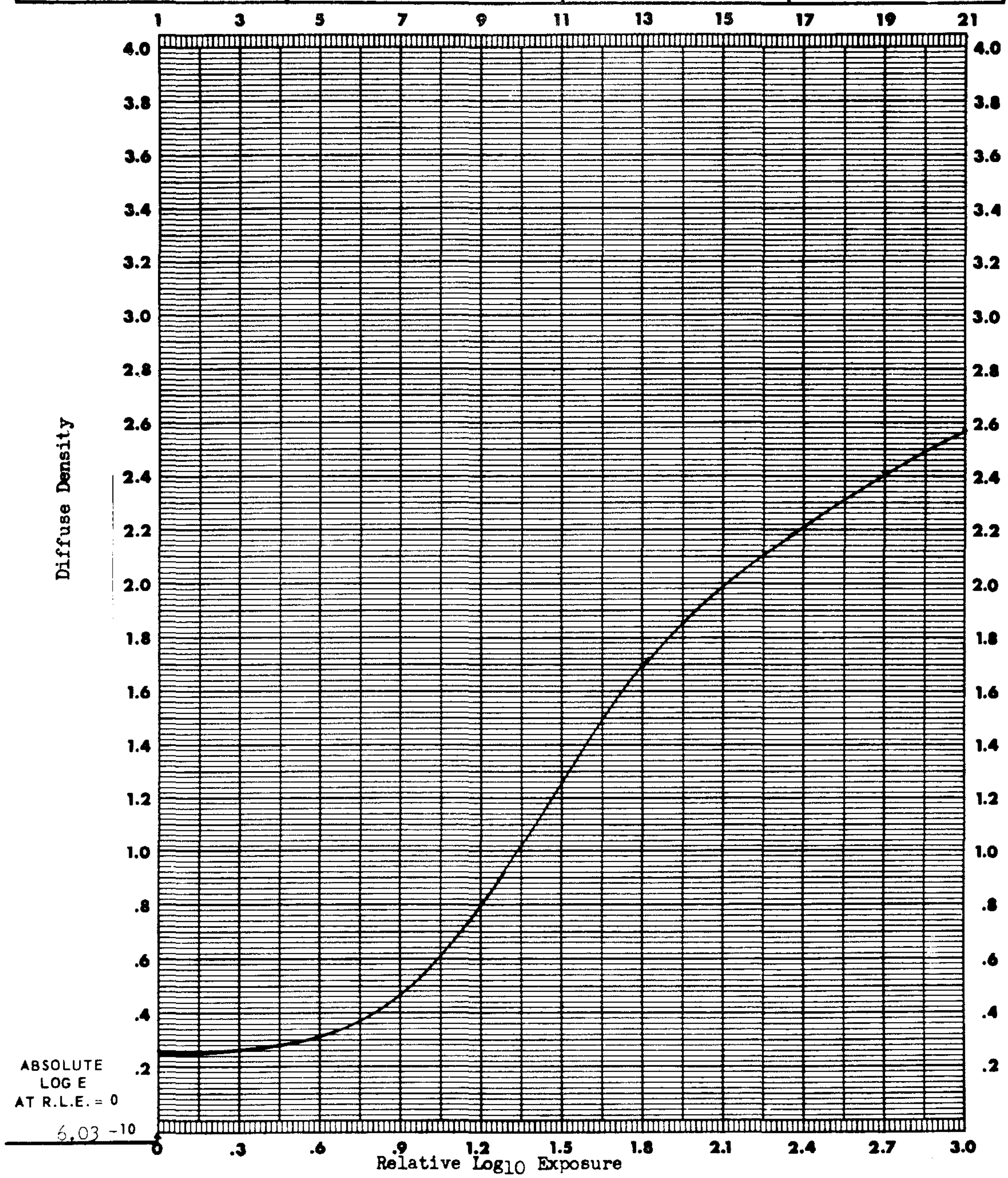
Reciprocity Curve

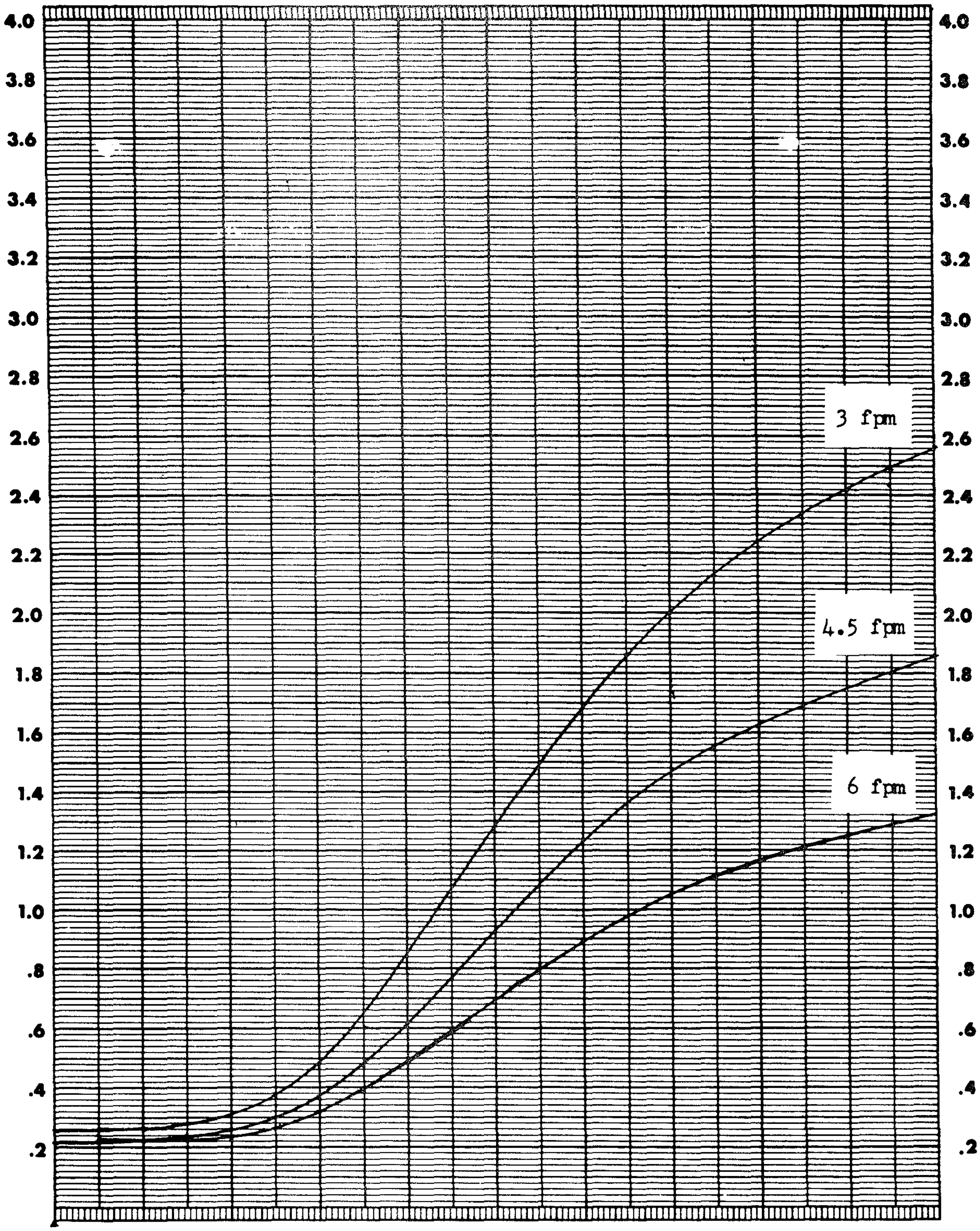


DATE 9 Mar 70

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

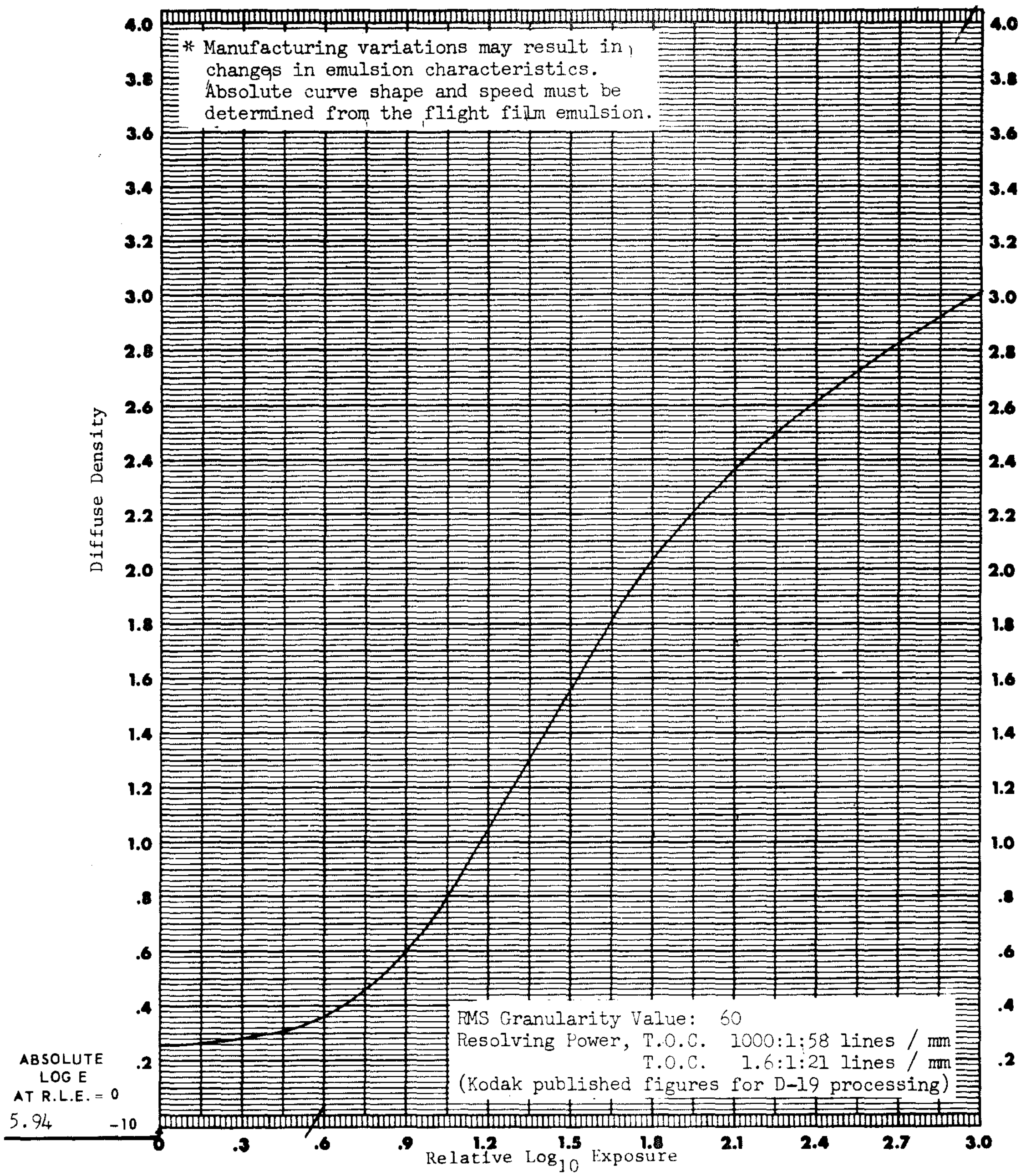




Effect of Processor Speed, MX-641 Developer @ 85°F

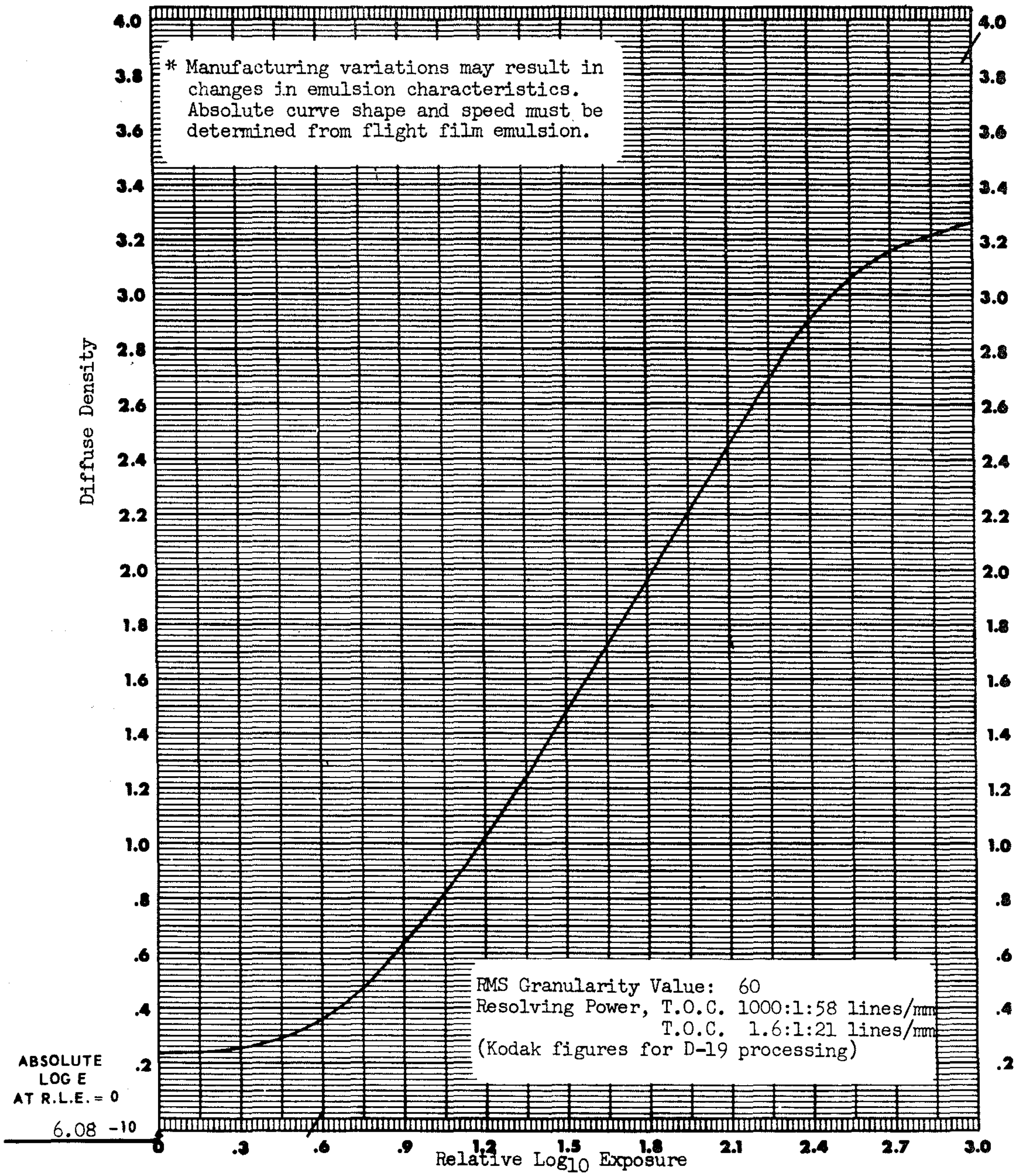
FILM 2485 EMULSION # * MFG Kodak DATE: 8/1/70

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 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.

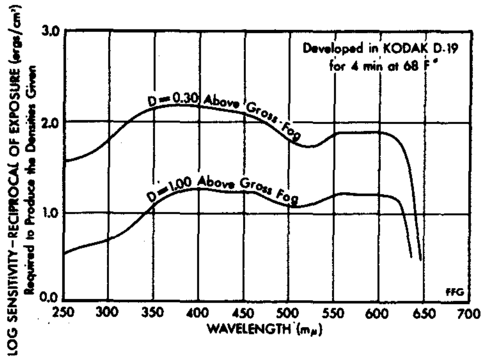
** The temperature of the dryer may require adjustment, depending upon the ambient temperature conditions in the processing area. Set temperature approximately five degrees above temperature required to dry clear film.

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

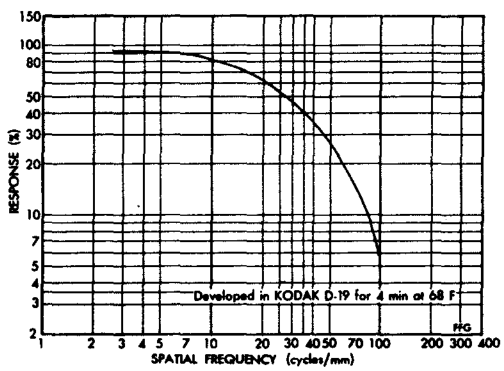
Machine Speed (feet per minute)	No. of Developer Racks	Average Gamma	Average Exposure Index
3	1	.89	2760

KODAK PAN FILM TYPE 2484
(ESTAR-AH Base)

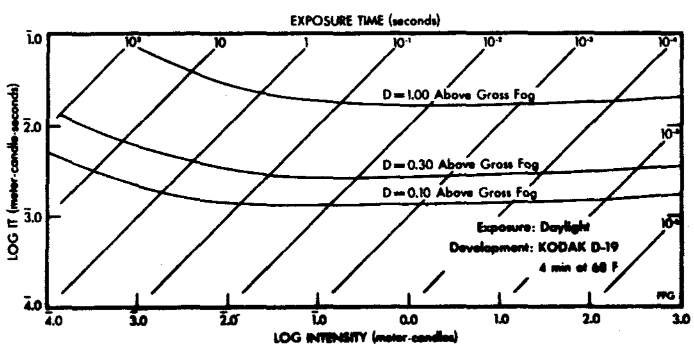
Spectral Sensitivity Curve



Modulation Transfer Function Curve

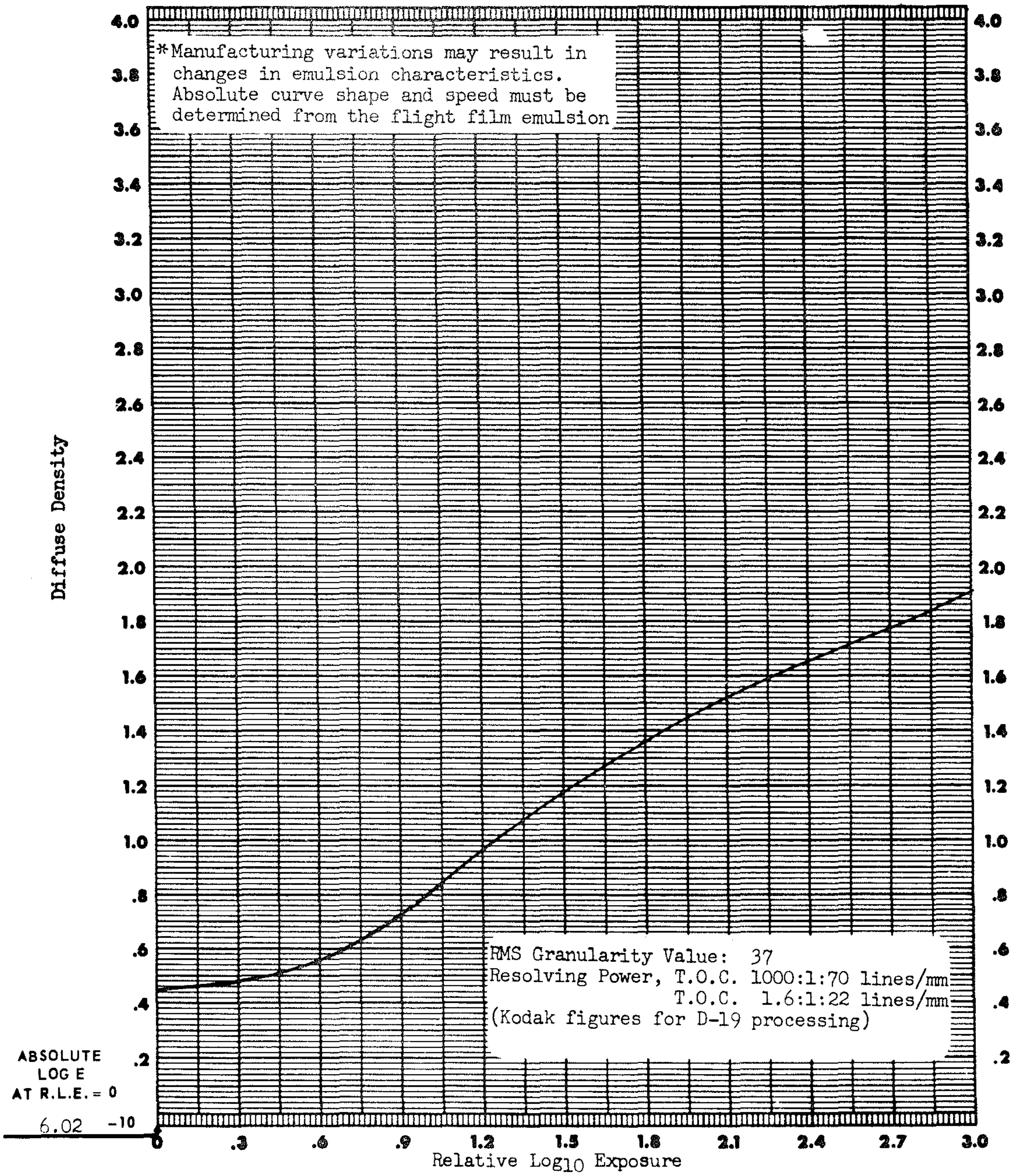


Reciprocity Curve



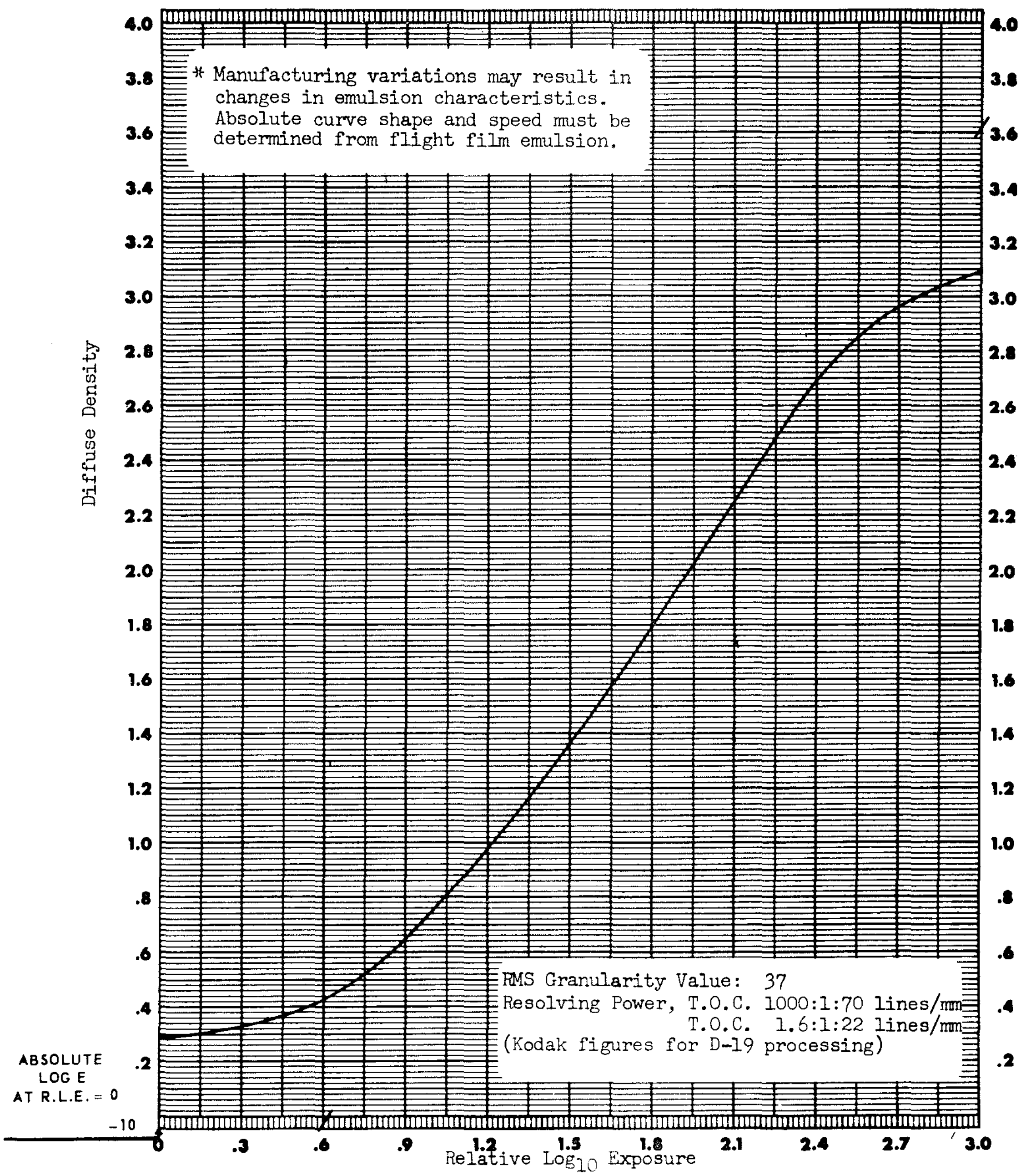
FILM 2484 EMULSION # 59-4* MFG Kodak DATE: 8/1/70

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

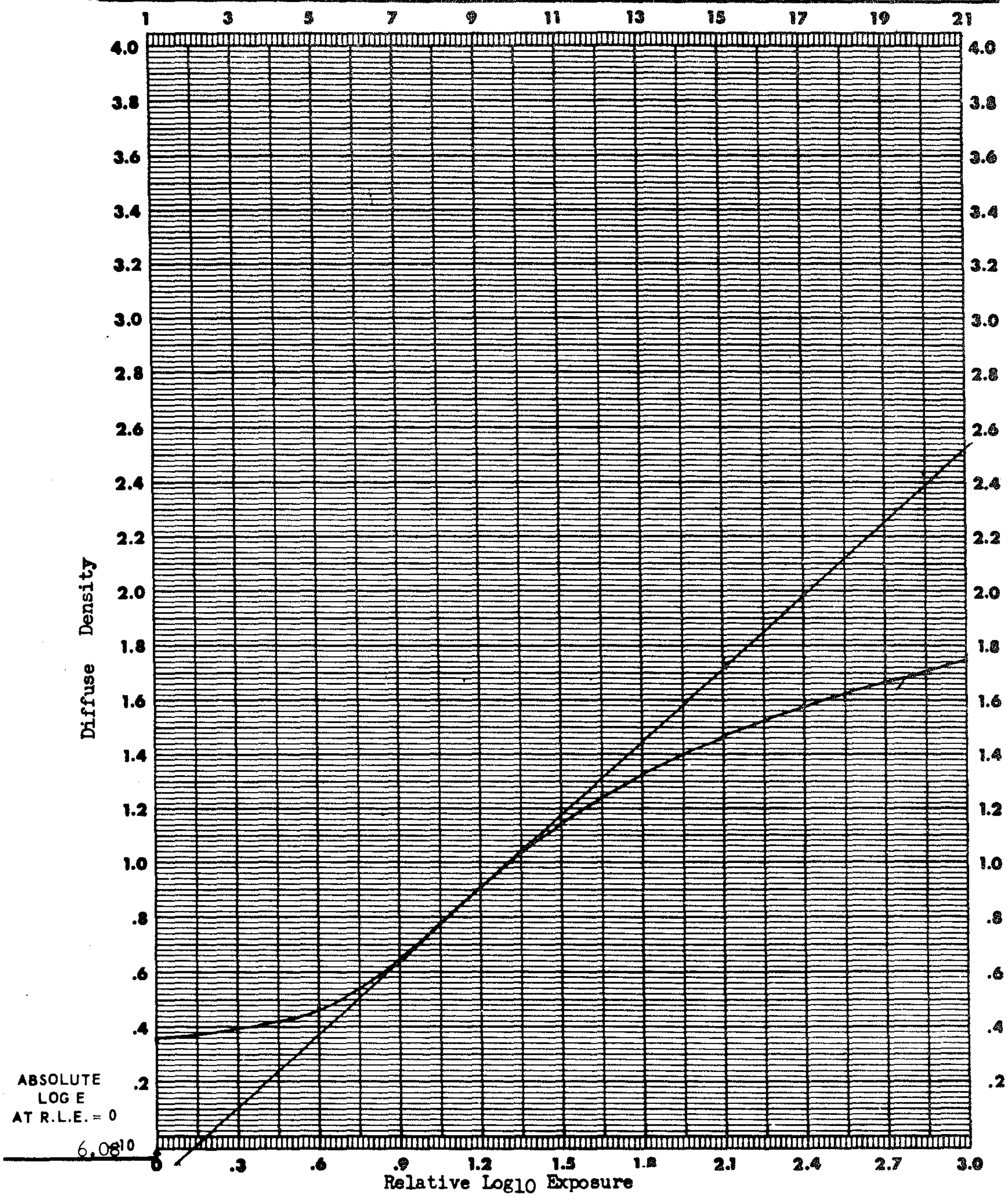
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
Sensitometer I-B	PROCESSOR Houston M-P	INSTRUMENT TD217-DR	
ILLUMINANT 2850 °K	CHEMISTRY D-19	TYPE Macbeth	D-MAX 3.10*
1/100 SEC.	SPEED N/A TANKS N/A FPM	APERTURE SIZE 2 MM	GAMMA 1.42*
Filter 5500K + 1.0 ND	Temp. 75°F TIME 5½ min	FILTER Status A vis.	BASE + 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	MMA .89
5500 K +1.00	85°F TIME	FILTER 106	BASE + FOG



KODAK DOUBLE-X AEROGRAPHIC FILM TYPE 2405 (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.

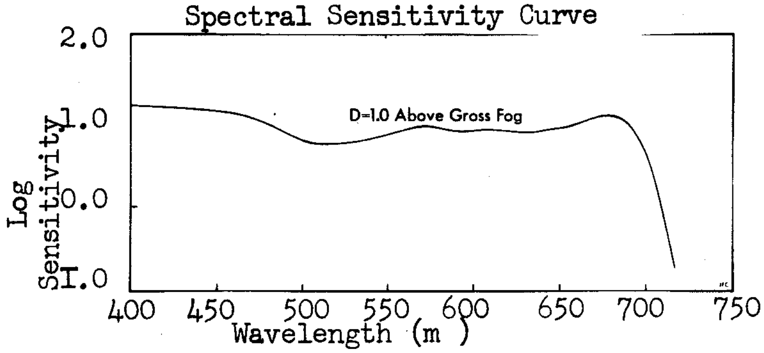
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK VERSAMAT CHEMICALS AT 80°F PROCESSING TEMPERATURE:

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

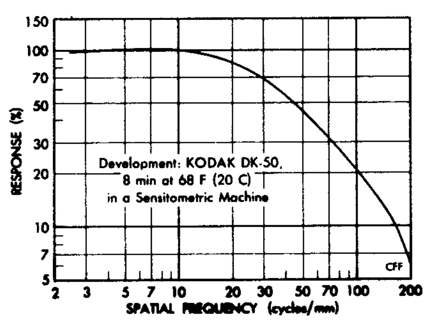
KODAK DOUBLE-X AEROGRAPHIC FILM 2405 (SO-267)
(ESTAR Base)

DK-50
D = 1.0 above
gross fog

Spectral Sensitivity Curve



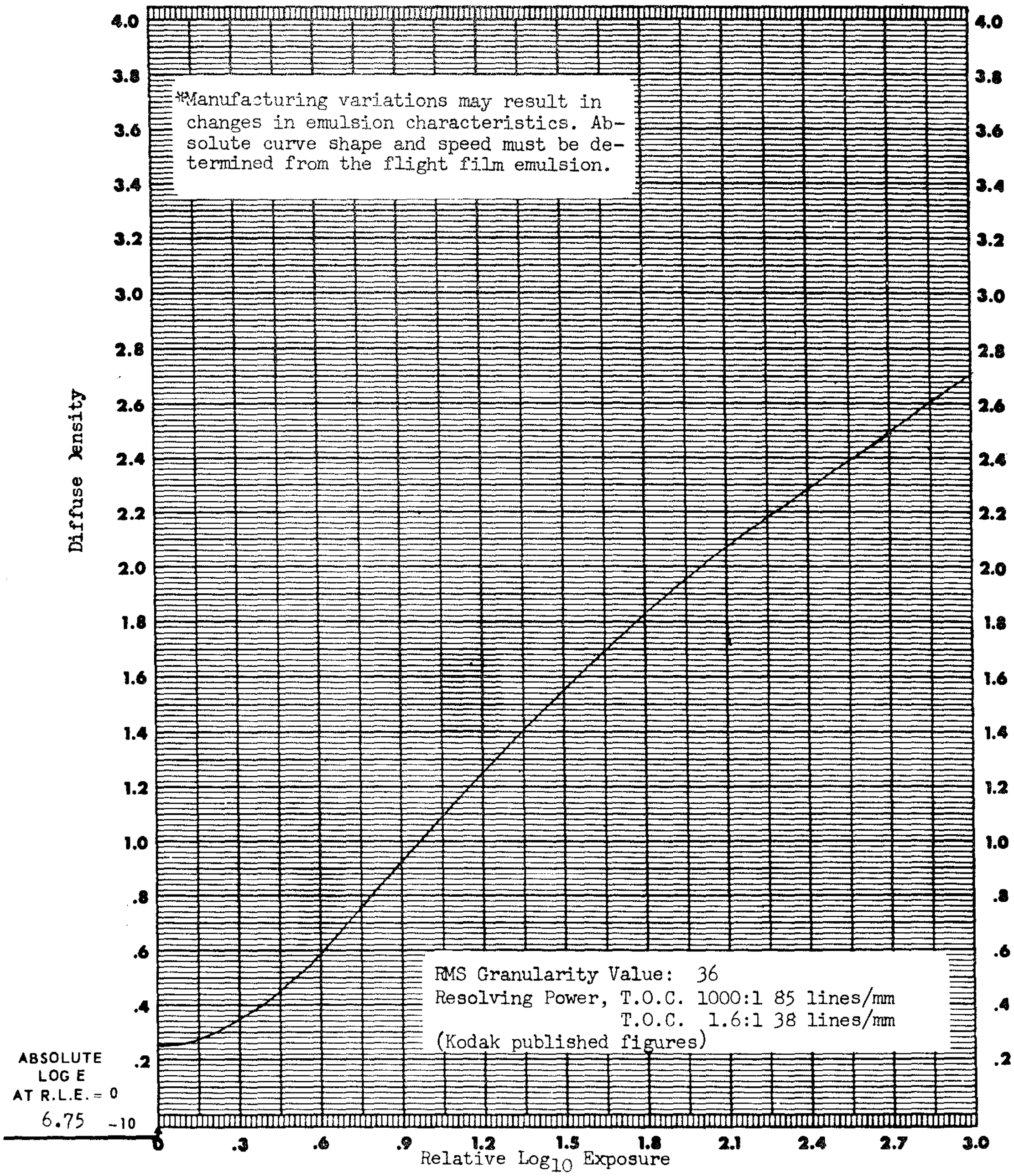
Modulation Transfer Function Curve



(SO-267)

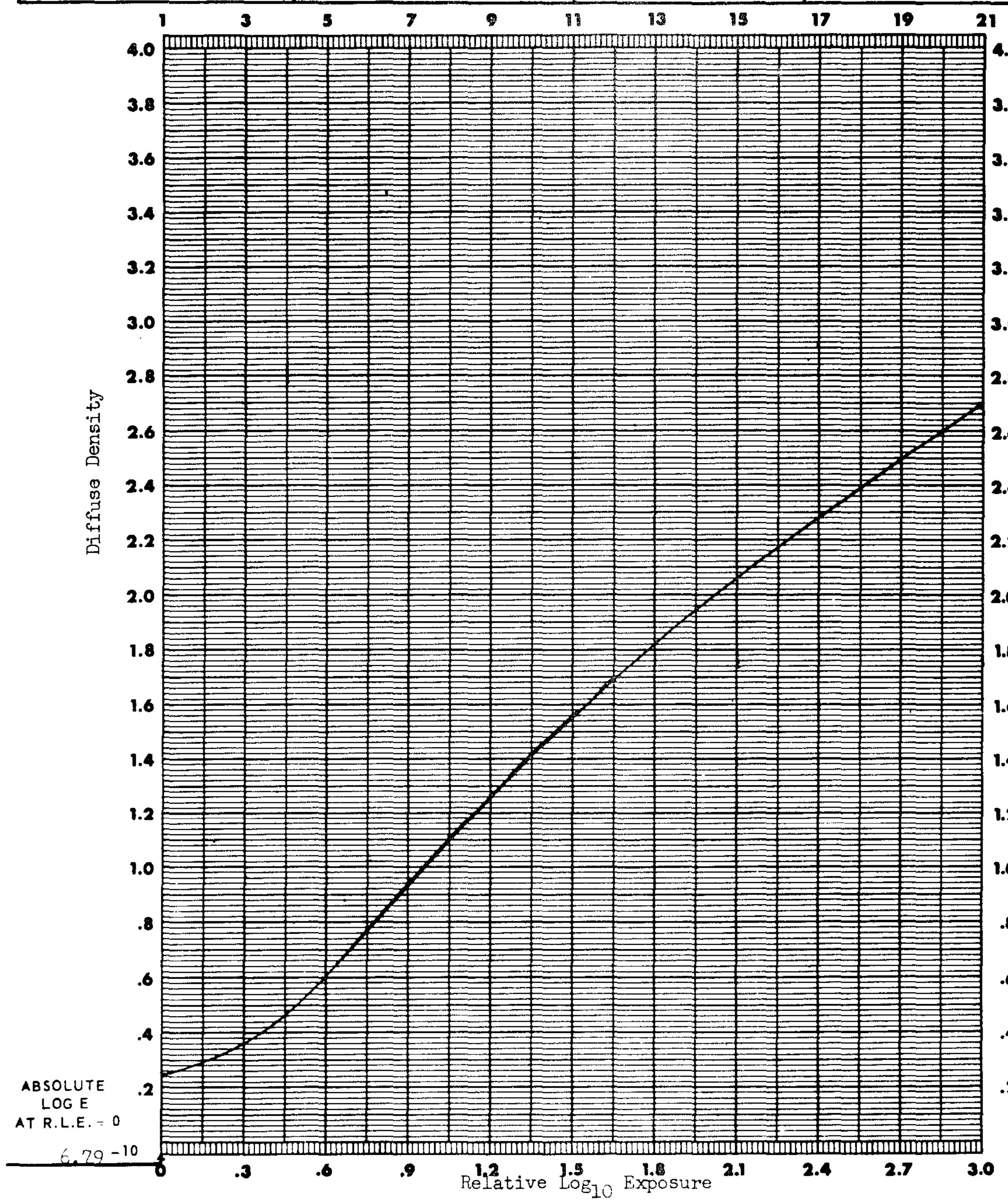
FILM 2405 EMULSION # L-1* MFG E. K. Co. DATE: 8/1/70

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
(SO-267)
FILM 2405 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 HIGH DEFINITION AERIAL FILM TYPE SO-349
(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 equivalane 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°F
Fixer*	2	8	95°F
Wash	2	8	90° to 92°F
Dry**		8	120° to 145°F

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

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

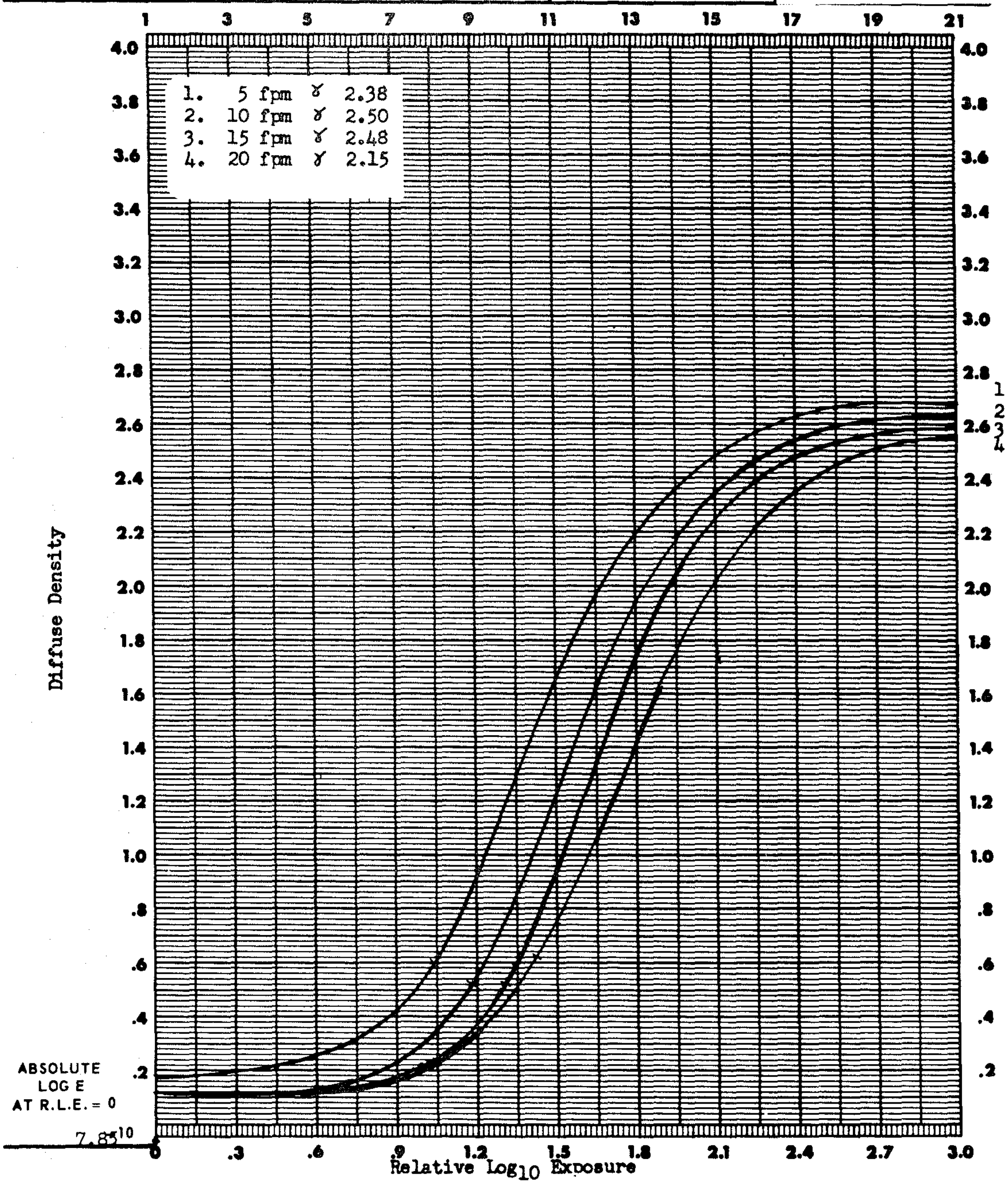
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK VERSAMAT 641 CHEMICALS AT 95°F PROCESSING TEMPERATURE:

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

DATE 14 Jan 70

FILM SO-349

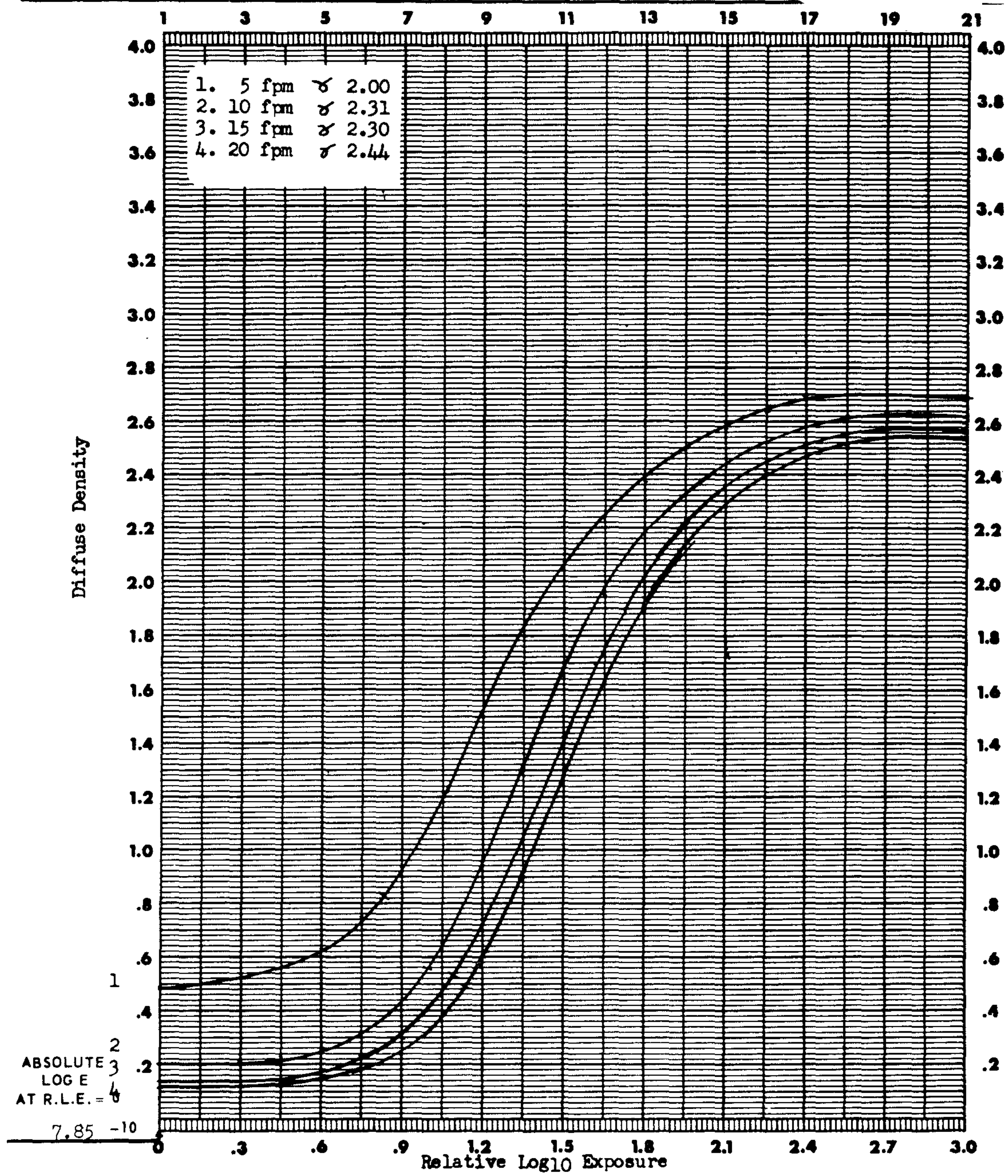
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
I-B	PROCESSOR Versamat 11C-M	INSTRUMENT TD-217
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD
1/10 SEC.	SPEED 1 TANKS Various FPM	APERTURE SIZE 2 MM
C-5900 + SCW	95°F TIME	FILTER Status A



DATE 14 Jan 70

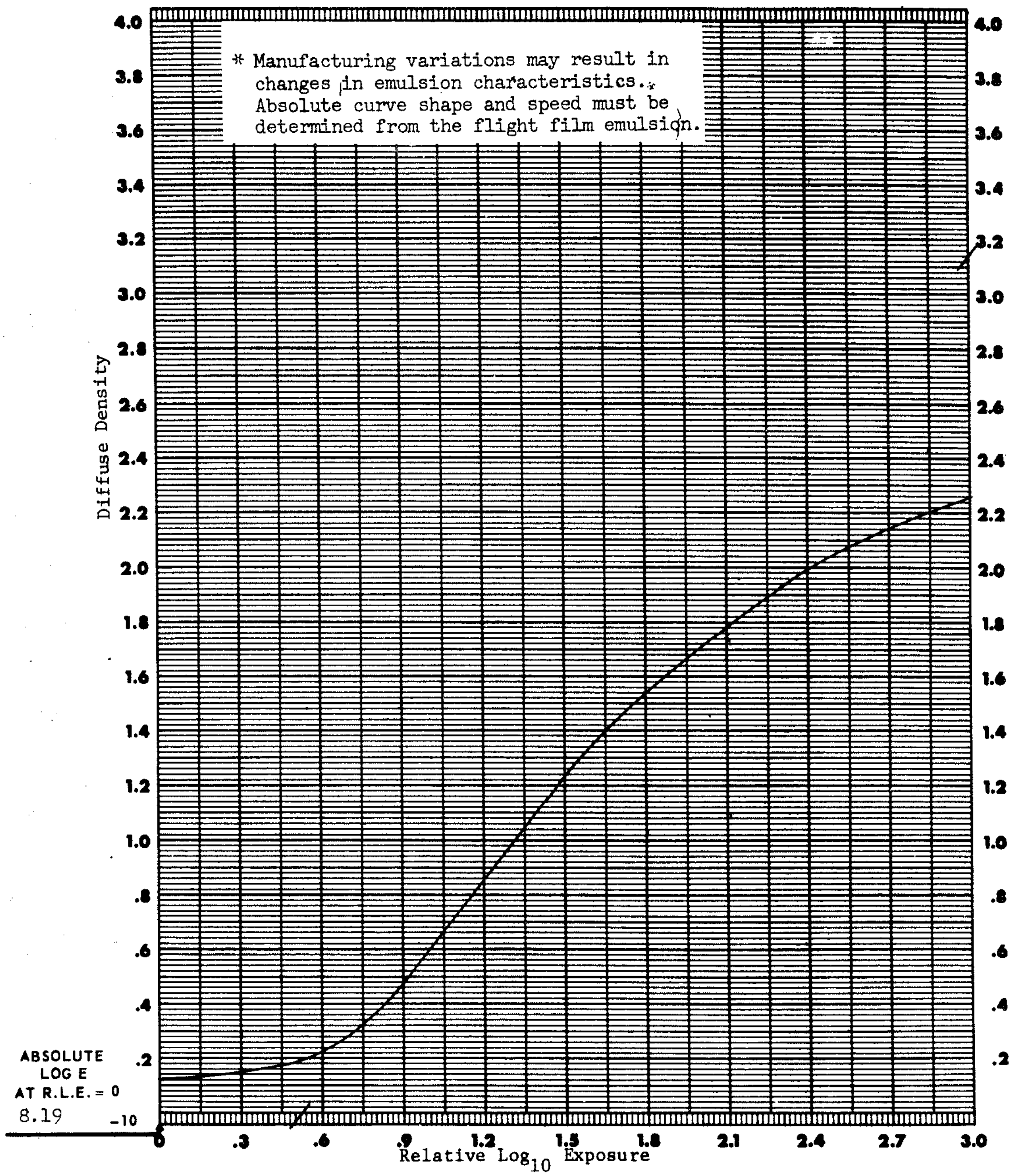
FILM SO-349

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 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:

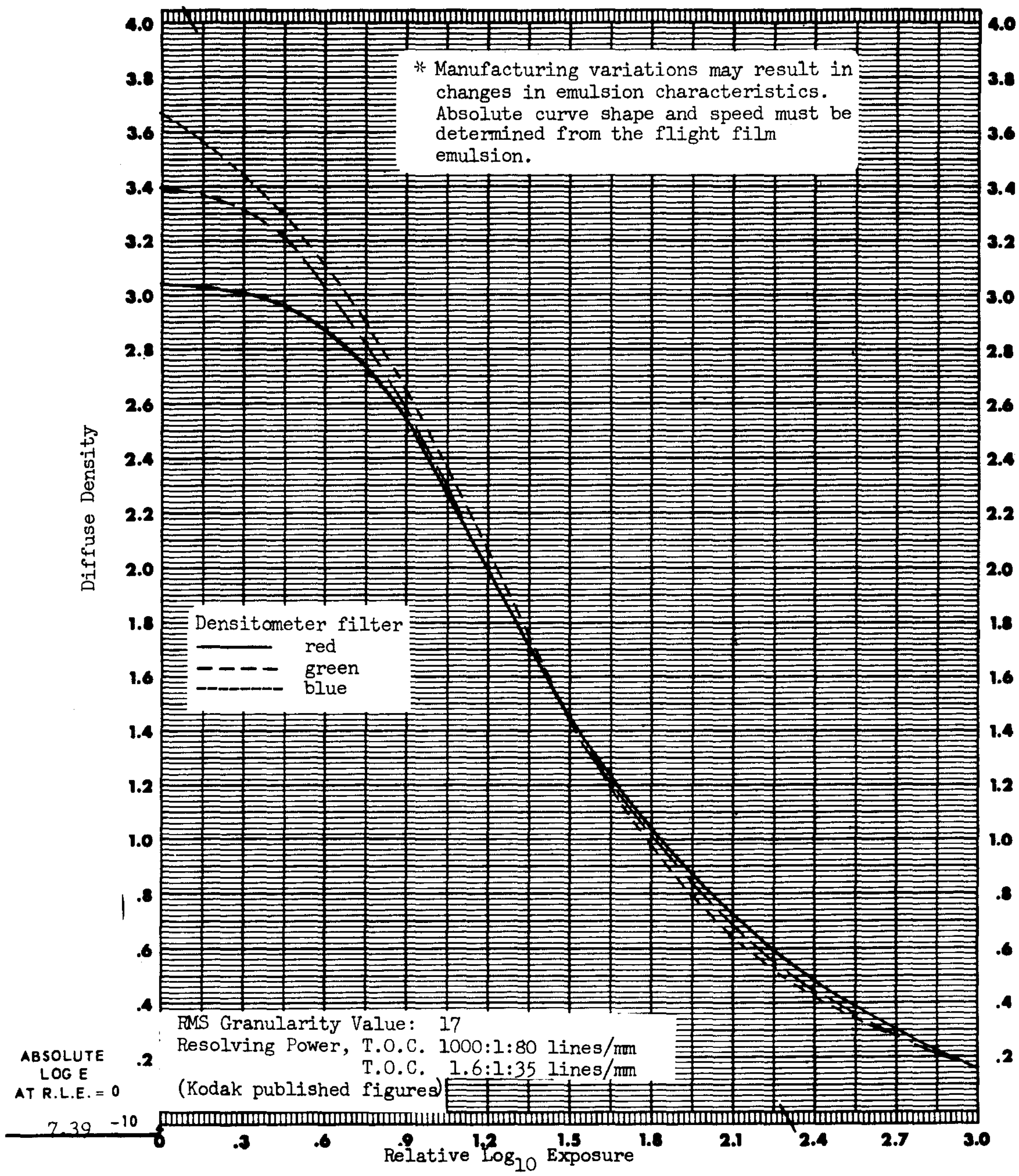
Processing Step	Number of Racks	Time	Temperature
Prehardener	1 & 2	2'30"	95° ± 1°F
Neutralizer	3	1'15"	97° ± 3°F
First Developer	4 & 5	2'30"	100° ± ½°F
First Stop	6	1'15"	100° ± 1°F
Wash	7	1'15"	88° to 95°F
Color Developer	8 & 9	2'30"	110° ± 1°F
Second Stop	10	1'15"	110° ± 1°F
Wash	11	1'15"	88° to 95°F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

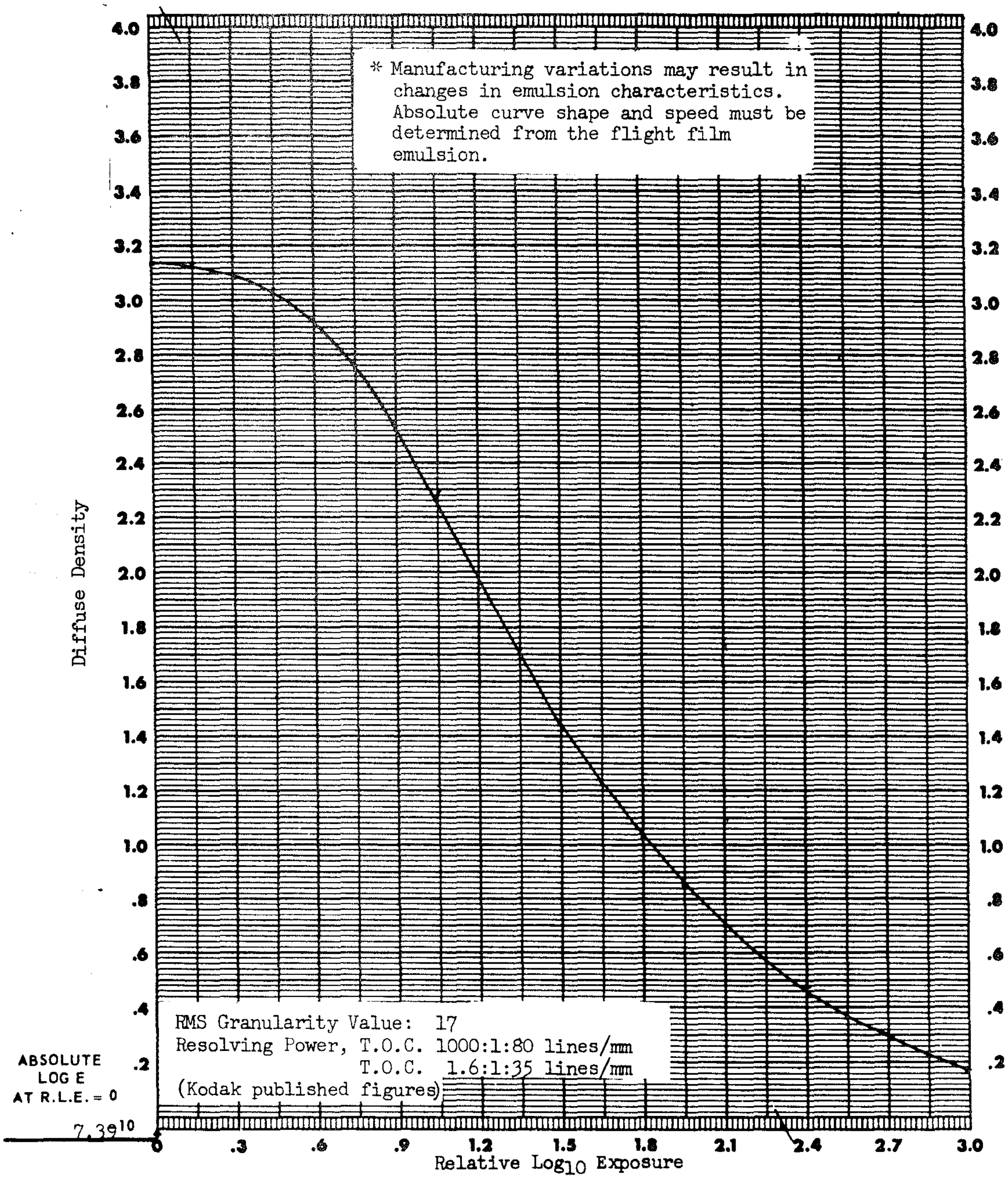
FILM SO-368 EMULSION # 15* MFG Kodak DATE: 8/1/70

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

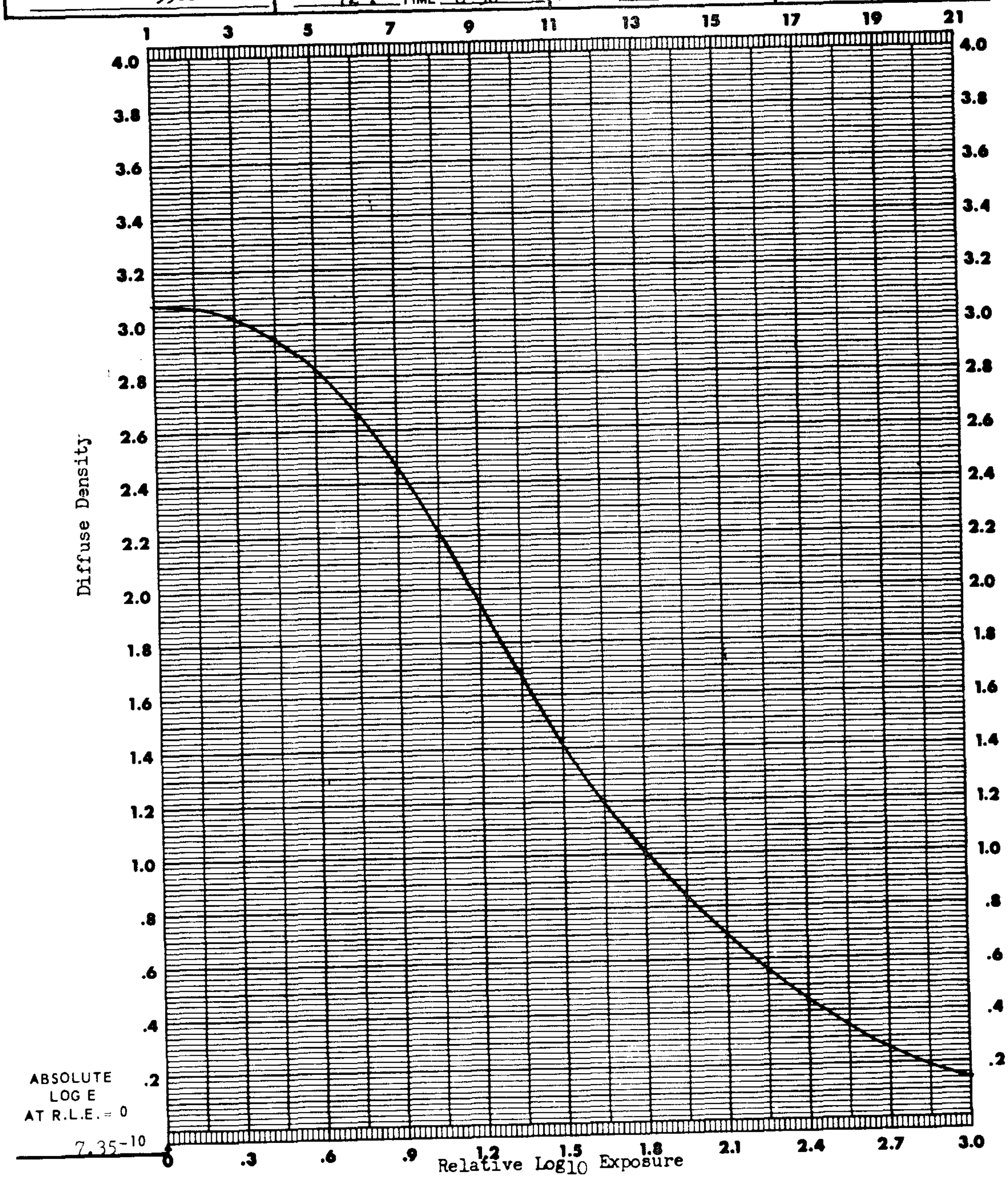
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
Sensitometer I-B	PROCESSOR Hi-Speed	INSTRUMENT Macbeth	SPEED (ANSI) 46*
ILLUMINANT 2850 °K	CHEMISTRY ME-2A	TYPE TD-203	D-MAX 3.13*
1/50 SEC.	SPEED --- TANKS --- FPM	APERTURE SIZE 4 MM	GAMMA 1.80*
Filter C-5900	Temp 74.75°F TIME 8'50"	FILTER Visual 106	BASE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



DATE 21 Oct 69

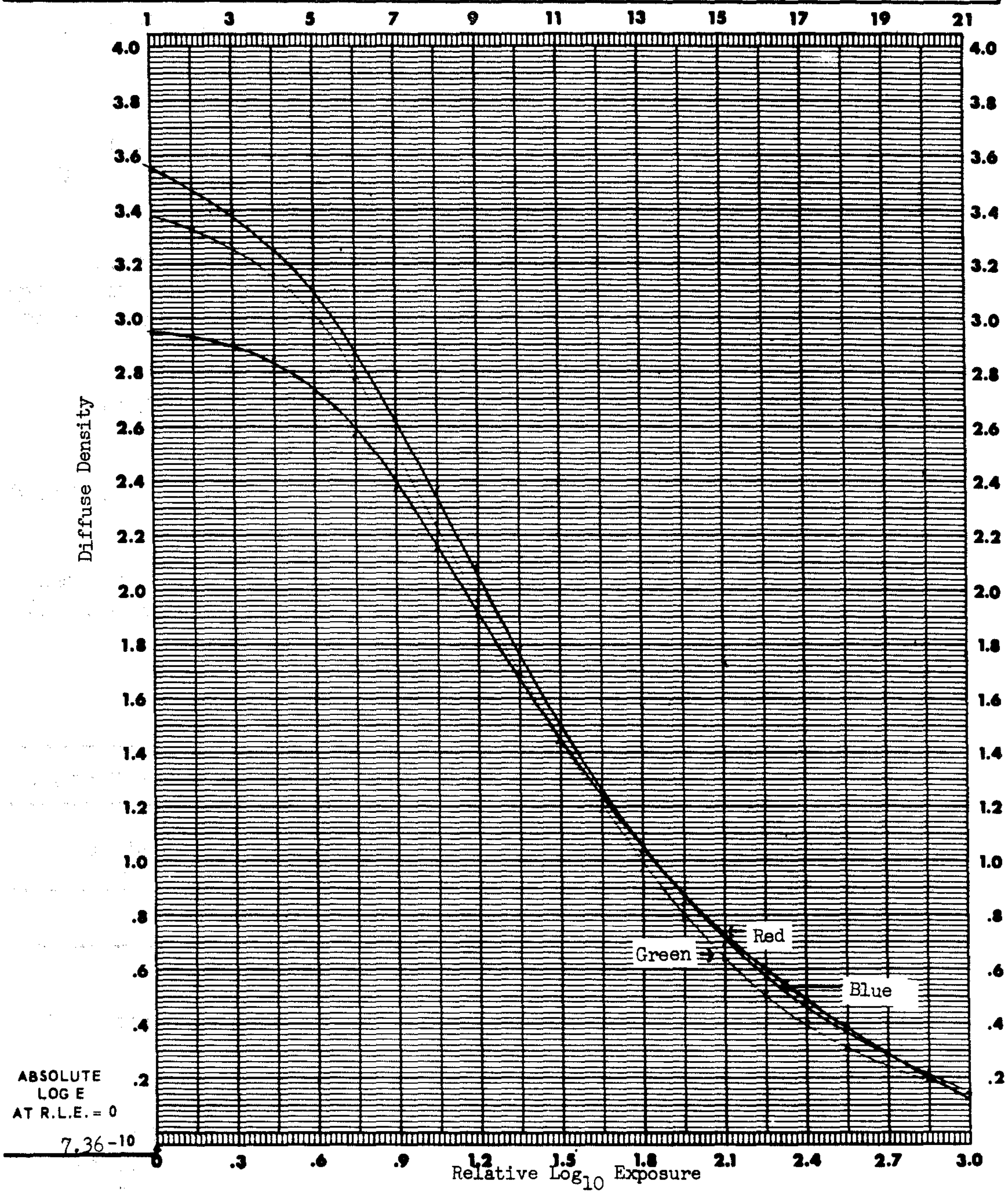
FILM SO-368 EMULSION # 1-4

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



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.

* 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:

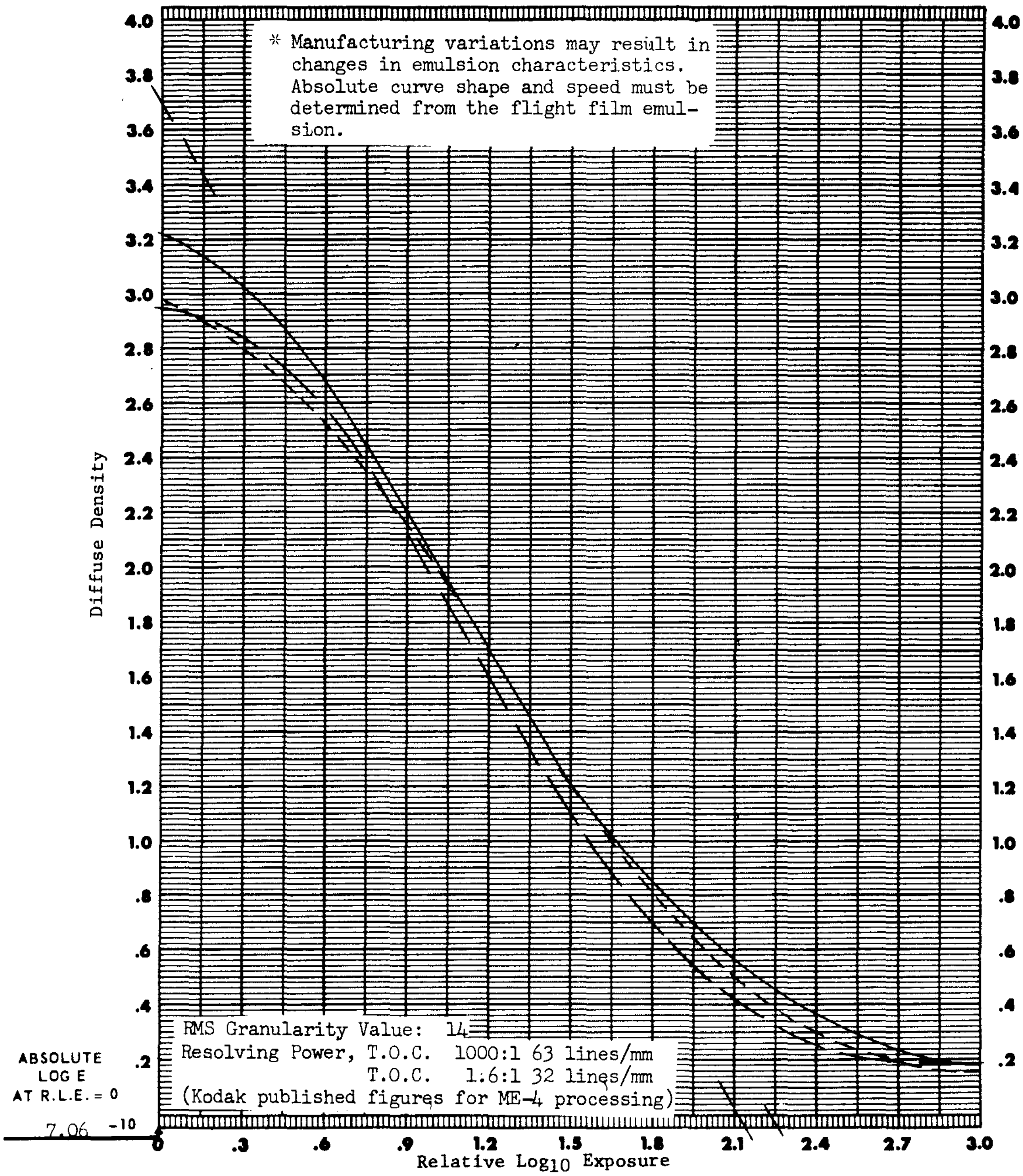
Processing Step	Number of Racks	Time	Temperature
Prehardener	1 & 2	2'30"	95° ± 1°F
Neutralizer	3	1'15"	97° ± 3°F
First Developer	4 & 5	2'30"	100° ± ½°F
First Stop	6	1'15"	100° ± 1°F
Wash	7	1'15"	88° to 95°F
Color Developer	8 & 9	2'30"	110° ± 1°F
Second Stop	10	1'15"	110° ± 1°F
Wash	11	1'15"	88° to 95°F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

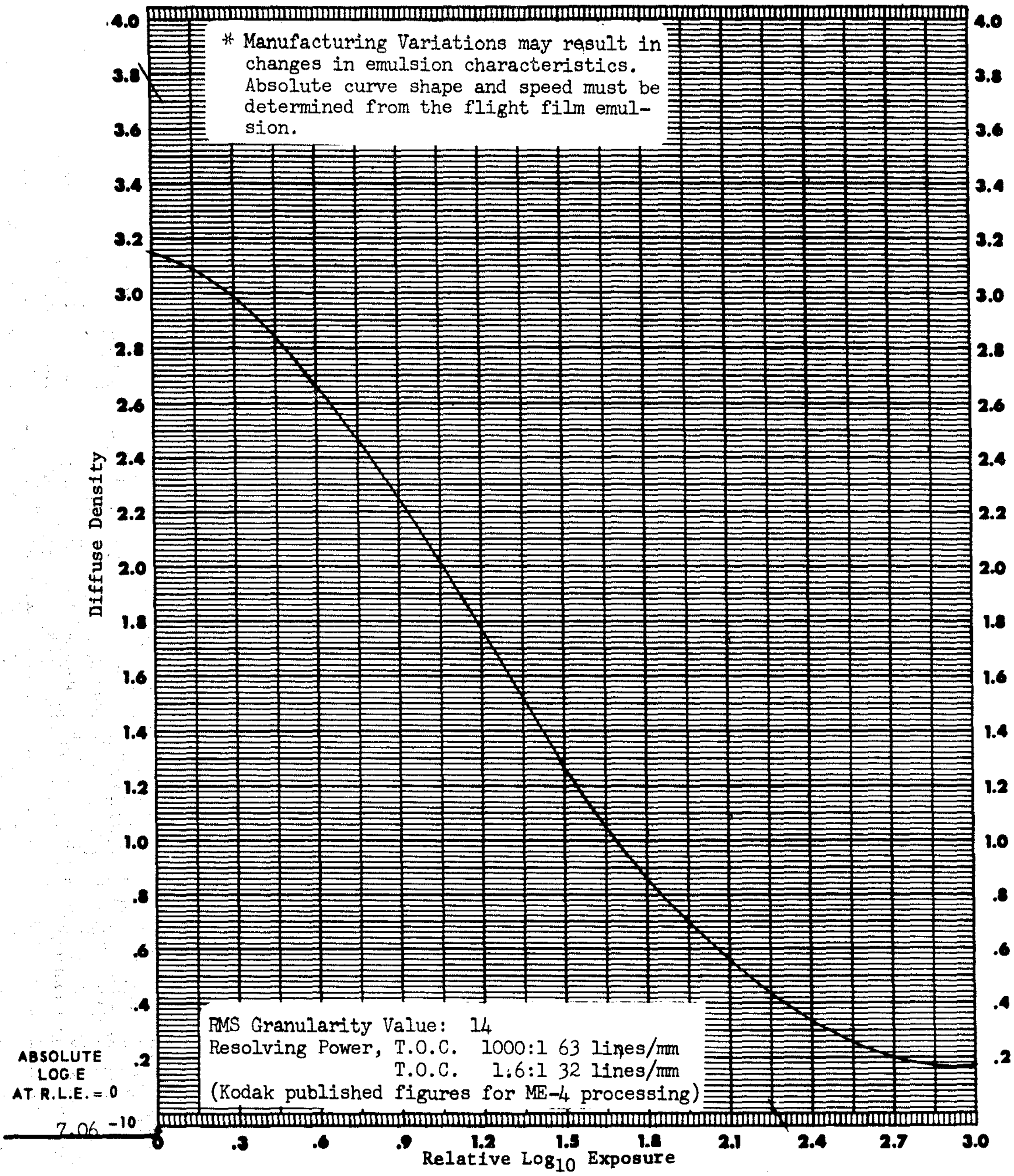
FILM SO-168 EMULSION # * MFG Kodak DATE: 8/1/70

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

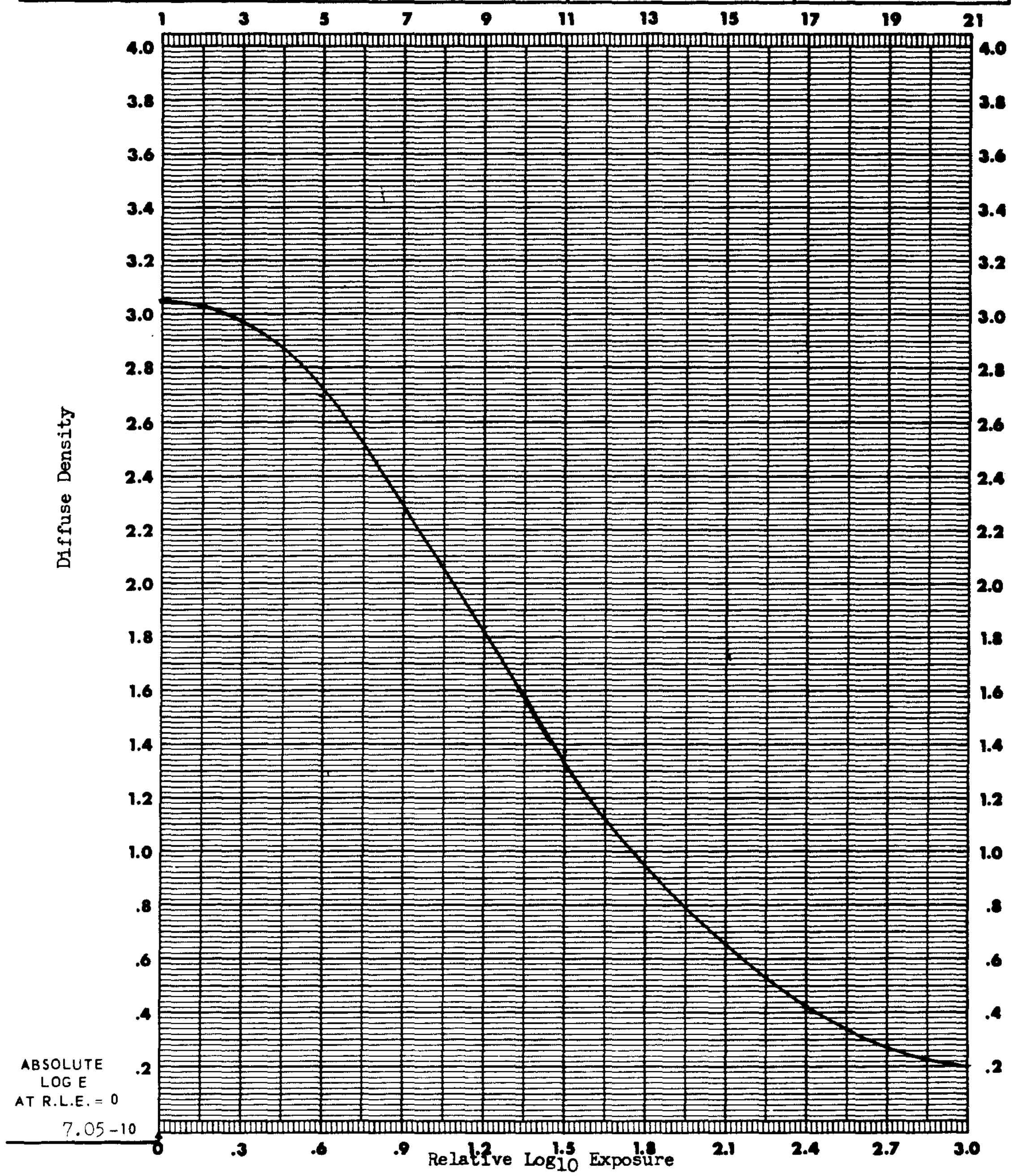
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
Sensitometer 1-B	PROCESSOR 1411-M	INSTRUMENT Macbeth
ILLUMINANT 2850 °K	CHEMISTRY EA-4	TYPE TD-403
1/100 SEC.	SPEED --- TANKS 3.2 FPM	APERTURE SIZE 4 MM
Filter C-5900	--- TIME ---	FILTER Visual-106



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 INFRARED AEROGRAPHIC FILM TYPE SO-246
(Acetate Gray Base)

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

FILM CHARACTERISTICS*
A negative material which is sensitive to infrared radiation as well as the blue light of the visible spectrum. It has exceptional sensitivity and is capable of giving high contrast. These qualities make this film especially suitable for the reduction of haze effects, camouflage detection, and oblique long-distance photography. The physical characteristics, exposure, image-structure characteristics, and mechanized processing of this film are the same as those for Kodak Infrared Aerographic Film Type 5424.

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 this film.

BASE
This film has a 5.2-mil cellulose acetate butyrate Gray Base with no 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; D-19 chemicals for 8 minutes at 68 F

Characteristic	Value	Classification
Resolving Power		
Test-object contrast 1000:1	89 lines/mm	Medium
Test-object contrast 1.6:1	28 lines/mm	Low
RMS Granularity (at net density of 1.0)	39	

* 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 only in equipment made especially for this purpose, such as Kodak Versamat Film Processor, Model 11, 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.

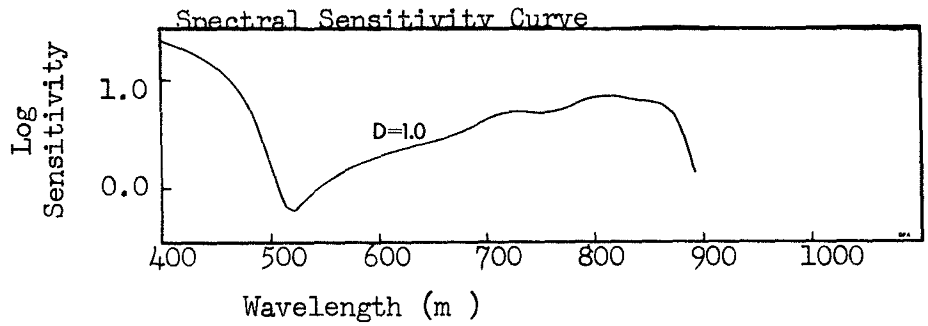
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK VERSAMAT 641 CHEMICALS AT 85°F PROCESSING TEMPERATURE:*

Machine Speed (feet per minute)	No. of Developer Racks	Average Gamma	Average Aerial Exposure Index
8.5	2	1.41	38
10.5	2	1.84	

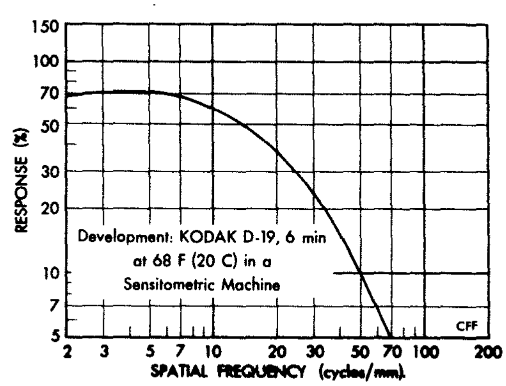
* PTL data from film processed 13 January 1970

KODAK INFRARED AEROGRAPHIC FILM SO-246
(Acetate Gray Base)

D-19
D = 1.0 above
gross fog



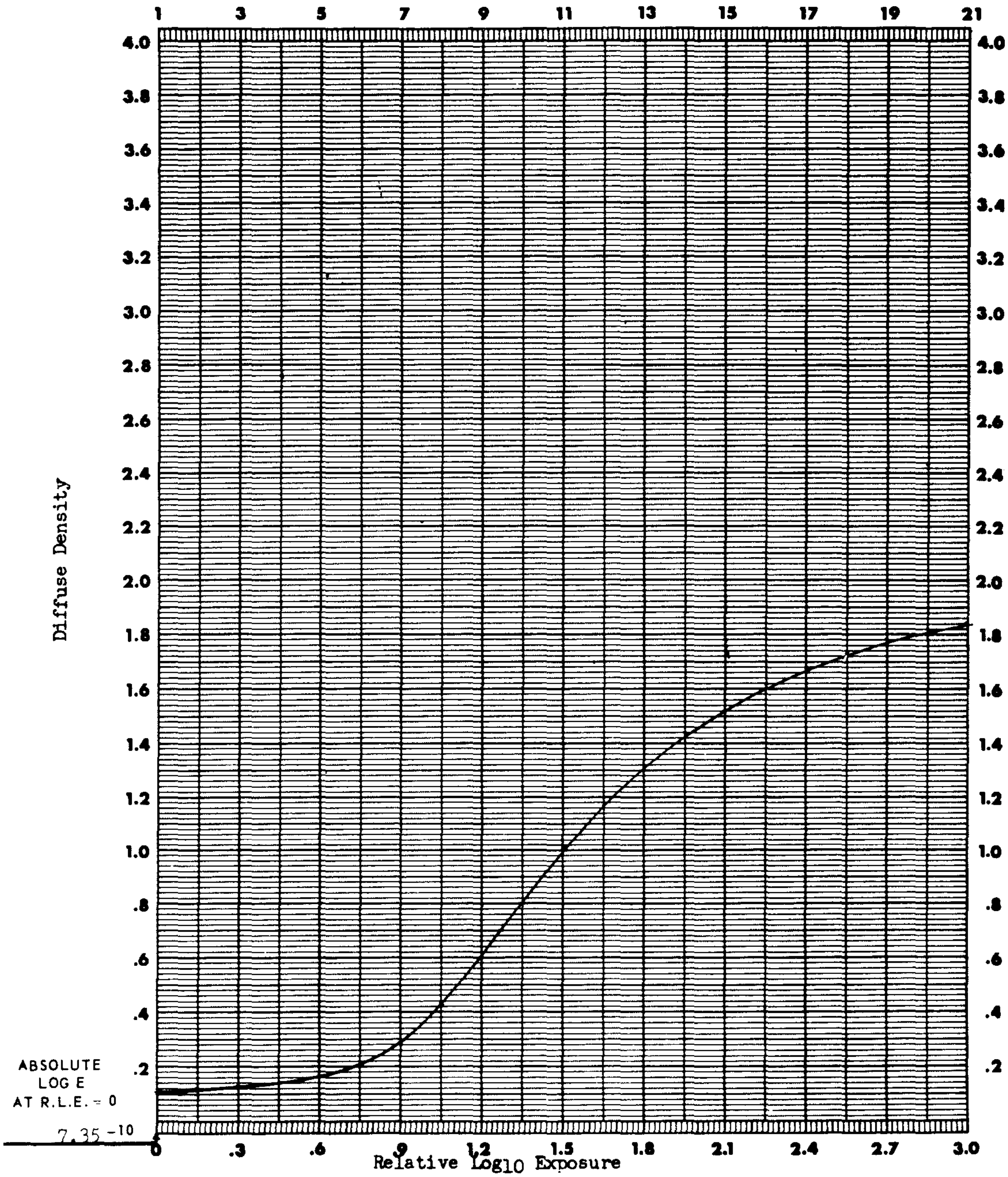
Modulation Transfer Function Curve



DATE 7 Jan 70

FILM SO-246 EMULSION # MFG E.K.Co.

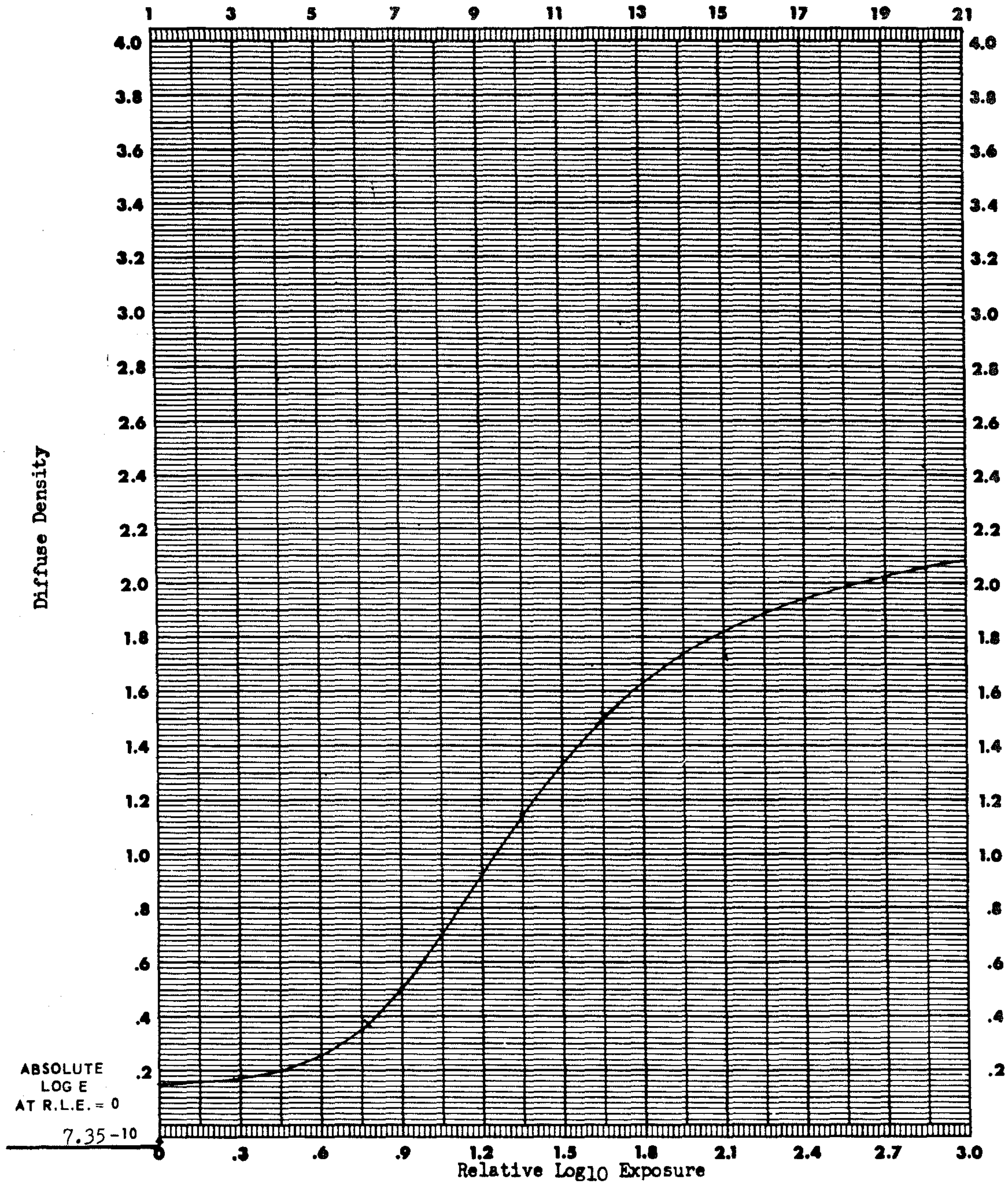
EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
I-B	PROCESSOR Versamat 11C-M	INSTRUMENT TD-403	SPEED (.60+BF) 1.27
ILLUMINANT 2850 °K	CHEMISTRY MX-641	TYPE DD	D-MAX 1.84
1/50 SEC.	SPEED 2 TANKS 10.5 FPM	APERTURE SIZE 4 MM	GAMMA 1.27
C-5900 + 2043 + 89B	85°F TIME	FILTER 106	BASE + FOG .11



DATE 28 Jan 70

FILM SO-246 EMULSION # ______ 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 2.08
1/50 SEC.	SPEED 2 TANKS 8.5 FPM	APERTURE SIZE 4 MM	GAMMA 1.41
C-5900 + 2043 + 89B	85°F TIME	FILTER 106	BASE + FOG .15



KODAK AERIAL COLOR FILM, TYPE SO-121
(ESTAR Thin Base)

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

FILM CHARACTERISTICS*
A high-resolution color reversal film designed specifically for high-altitude aerial reconnaissance. Because of its intended use, this film has extremely fine grain and very high definition.

BASE
This film has a 2.5-mil Estar base with an antihalation undercoat and clear 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; EA-4 chemicals with 2 developer racks at 3.2 fpm

Characteristic	Value	Classification
Resolving Power		
Test-object contrast 1000:1	160 lines/mm	Very High
Test-object contrast 1.6:1	80 lines/mm	Medium
RMS Granularity		
(at net density of 1.0)	15	

MECHANIZED PROCESSING
The Kodak Ektachrome RT Processor, Model 1411-M, can be used to process this film using Kodak Ektachrome 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 CHEMICALS:

Kodak Ektachrome Process EA-4 Chemistry

PROCESSING SEQUENCES WITH KODAK EKTACHROME CHEMICALS:

Processing Step	No. 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

* Process at 106° ± ½°F for double camera speed. Film force-processed for double camera speed will shift somewhat in color balance and contrast, and will have lower maximum densities.

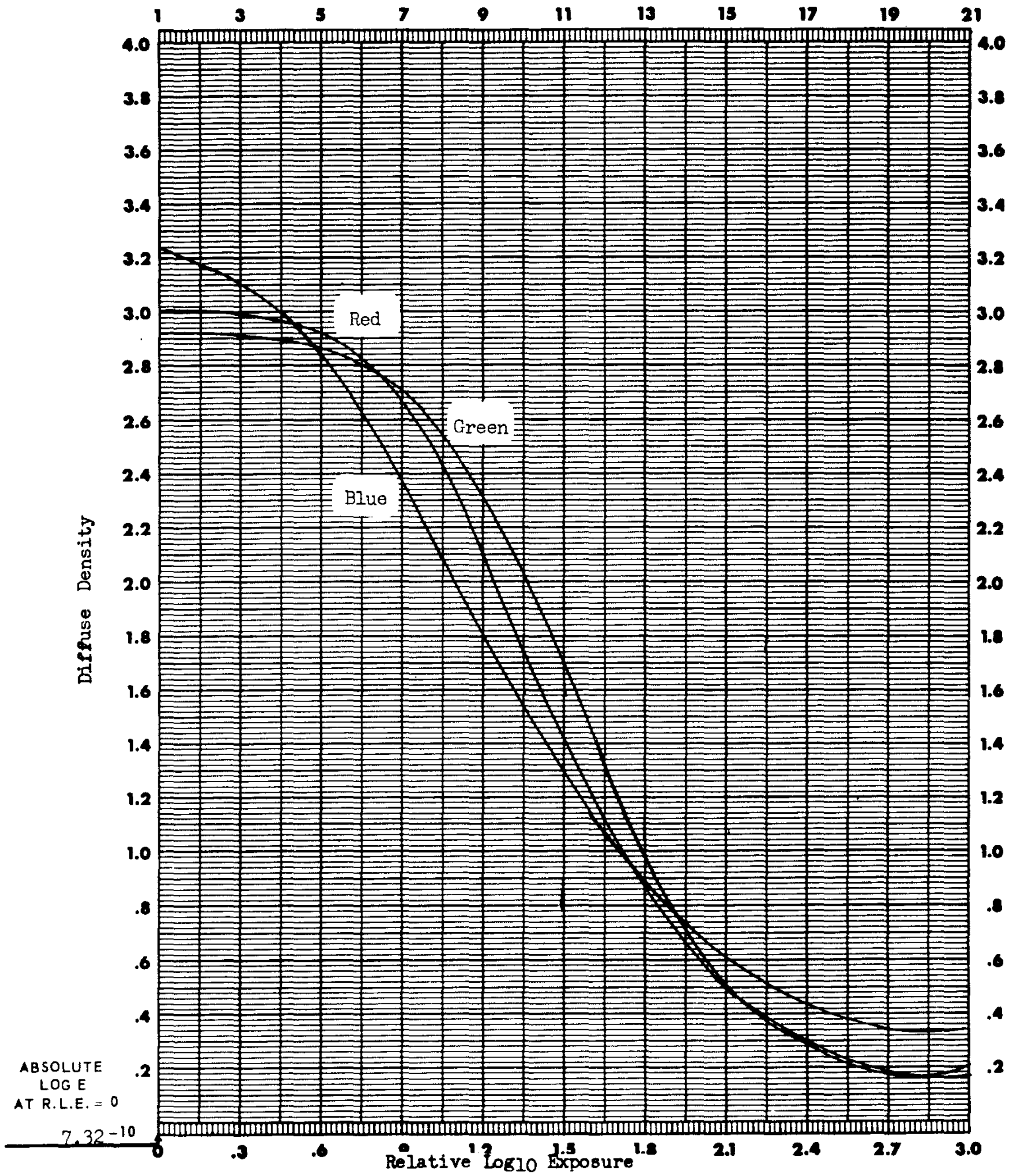
SUGGESTED AERIAL EXPOSURE INDEXES, GAMMAS, AND MACHINE SPEEDS WITH KODAK EKTACHROME EA-4 CHEMICALS AT 100°F PROCESSING TEMPERATURE:

Machine Speed (feet per minute)	No. of Developer Racks	Average Gamma	Average Aerial Exposure Index
3.2	2	2.09	6

DATE 8 Jul 70

FILM SO-121 EMULSION # ________ MFG E.K. Co.

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
I-B	PROCESSOR Versamat 1411M	INSTRUMENT TD-403	SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY EA-4	TYPE DD	D-MAX
1/50 SEC.	SPEED 2 TANKS 3.2 FPM	APERTURE SIZE 4 MM	GAMMA
C5900	100°F TIME	FILTER M-58	BASE + FOG



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:

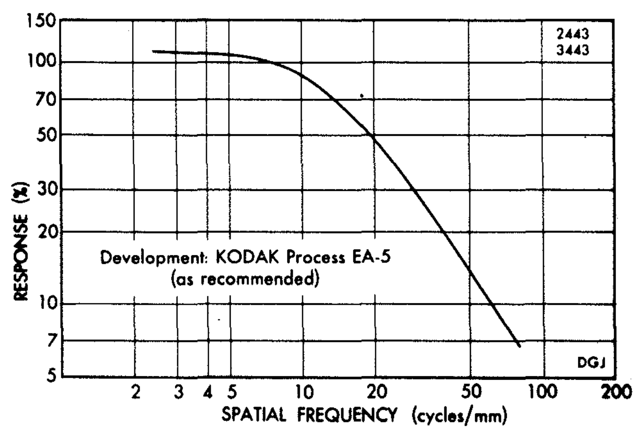
Processing Step	No. of Racks	Time	Temperature
Prehardener	1 & 2	2'30"	95° ± 1°F
Neutralizer	3	1'15"	97° ± 3°F
First Developer	4 & 5	2'30"	100° ± ½°F
First Stop	6	1'15"	100° ± 1°F
Wash	7	1'15"	88° to 95°F
Color Developer	8 & 9	2'30"	110° ± 1°F
Second Stop	10	1'15"	110° ± 1°F
Wash	11	1'15"	88° to 95°F
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:

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)

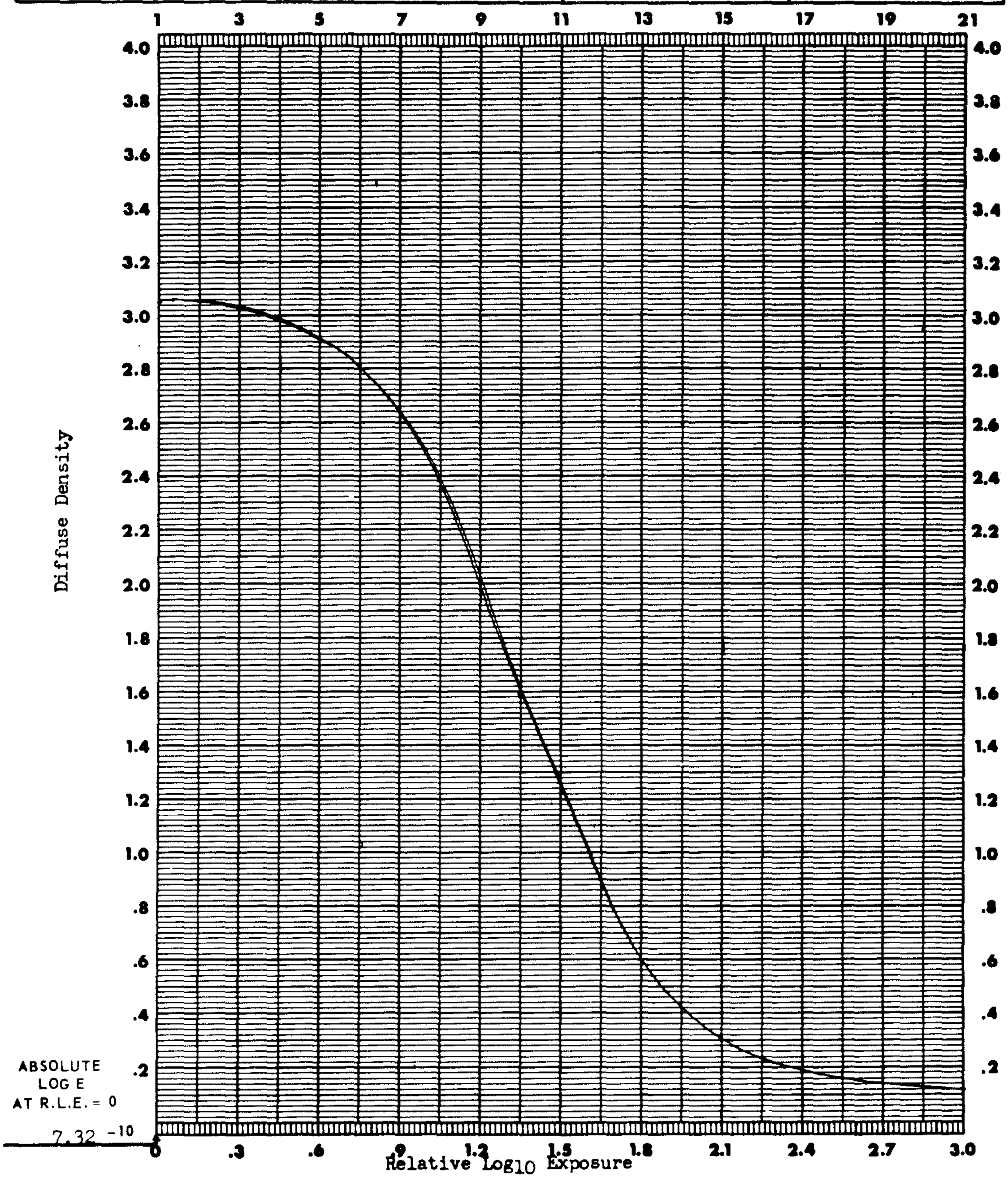
Modulation Transfer Function Curve



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 113.5°F TANKS 9 FPM	APERTURE SIZE 4 MM	GAMMA
C-5900 + 2043 + Wr12	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 + 2042 + Wr. 12	113.5 TIME 9 min	FILTER Status A