N. CRANE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SCIENCE OPERATIONS SUPPORT PLAN

APOLLO 15

PREPARED BY

FLIGHT CONTROL DIVISION

MANNED SPACECRAFT CENTER

HOUSTON, TEXAS

PREFACE

This document defines the specific plans for supporting the Apollo 15 science and experiment activities during the flight phase of the mission.

It is requested that any organization having comments concerning the contents of this document contact Mr. Gerald D. Griffith, Lunar/Earth Experiments Branch, Building 30, Room 2087B, telephone 483-4746.

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Approved by:

Sigurd A. Sjoberg

Sigurd A. Sjoberg
Director of Flight Operations

Concurrence:

Anthony J. Calio

Anthony J. Calio
Director of Science and Applications

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SECTION 1

INTRODUCTION

1.1 PURPOSE

The purpose of this document is to describe the manner in which the Flight Operations Directorate plans to execute the mission control functions for the science and experiments related operational objectives assigned to Apollo 15 in the Mission Requirements document.

1.2 SCOPE

This document addresses the mission control plans for supporting the Apollo 15 science and experiments objectives. It identifies the functions, organization, and interfaces of the flight control elements supporting these objectives, and the recognized interfaces for other mission support activity elements.

1.3 APPLICABILITY

This document applies to all members of the flight control team elements directly supporting the science and experiment objectives, as well as the other mission support elements.

SECTION 2

OPERATIONS CONCEPT

2.1 GENERAL

The principal goal of the Flight Control Team in support of specific scientific objectives assigned to Apollo 15 is to maximize the value of the data acquired consistent with the operational policies regarding crew safety. To achieve this goal, a large amount of emphasis is directed toward premission preparation. During this time, the personnel that will actively support in real-time operations will also participate in the development of the Flight Plan, the Lunar Surface Procedures Document, and the Lunar Orbit Flight Activity Plan. These documents in reality are timelines developed from the Mission Requirements Document and related to specific tasks in crewman terms and activities. It is through this medium that planning for all primary and contingency operations is established. The same personnel will train, utilizing these and other mission-related documentation, during the simulation and training exercises in the Mission Control Center and in other training areas with the prime and backup flight crews. The Flight Operations Team consists of the same personnel that have accomplished the planning of the mission. The same management controls are available for concurrence, approval, et cetera, of all deviations to the preflight plan. The implementing organizations for the Mission Requirements Document, the Lunar Surface Procedures Document, and the Mission Flight Plan are the Flight Crew and the Flight Control Team. It is the function of the Flight Director and his team to satisfy the Mission Requirements Document while maintaining adequate crew safety.

The primary support element to the Flight Director and his team is the SPAN organization. The SPAN organization provides an interface between the operations team, the Program Office, the engineering and science organizations, and the prime hardware contractors. They

are available for providing their best engineering judgment on hardware anomalies and for participating in problem resolutions when the time allows. The SPAN organization also provides that management coordination loop for changes to mission requirements and priorities. This support organization has been in existence for the Mercury, Gemini, and Apollo programs, and has been a vital part in the success of these programs.

For science operations, there are three principal areas that require close attention. These include the flight hardware that is utilized, the scientific objectives and priorities that must be assessed and identified, and the operational planning and execution that must be accomplished. The Mission Control Center operational structure has been set up to provide for the separate yet integrated aspects of these three stated areas. They will be discussed in the following sections so that the functions of all elements of the Flight Control Team will be clearly understood.

2.2 GENERAL OPERATIONS REQUIREMENTS

The science operations aspects of the Apollo 15 mission will involve two types of functions - flight control and flight control support. A general description of the science operations function of these areas is discussed in this section with more specific details presented in ensuing sections.

A. Flight Control

The real-time science operations control activities associated with the flight are executed by the Flight Control Team under the direction of the Flight Director. This team is responsible for the control, direction, and execution of the real-time flight activities; for the development of alternate plans to respond to mission problems; and for insuring the adherence to management policy and decisions related to crew safety considerations, mission priorities, and flight mission rules. The Flight Director and his team provide the direct interface with the mission flight crew and provide them direct support in all areas.

B. Flight Control Support

Two areas of in-depth special support for science operations are planned. One of these areas is related to the specific hardware being flown. This support will primarily be provided through the SPAN/Mission Evaluation Team just as for the spacecraft, and will include problem resolution through detailed data evaluation to understand and analyze flight hardware anomalies.

The other area is best described as the science requirement area. Facilities are provided within the MCC for those scientists necessary for real-time mission operations in direct support of the Flight Control Team in this area.

SECTION 3

OPERATIONS PLAN

3.1 GENERAL

The mission operations organization has provided in its team structure science representatives at each level and at the primary decision-making points. Within the Flight Control Division, there are two scientific branches whose task it is to deal with the operational aspects of all Apollo and Skylab science. The Flight Control Team includes the three major Apollo science elements as part of the team. The Experiments Officer is responsible for surface science operations, the ALSEP Senior Engineer is responsible for ALSEP deployment and operations, and the Orbital Science Officer is responsible for the SIM bay experiments. These three unique positions also have support teams that provide for detailed systems and science support. The Flight Director and his team have the responsibility to implement the requirements that are listed in the Mission Requirements Document by the Apollo Spacecraft Program Office at MSC. The Mission Requirements Document is used as the basis to generate the Science Mission Rules, the Flight Plan, the Lunar Surface Procedures Document, and some portions of the Flight Control Console Handbooks. The Flight Director and his team are responsible to senior MSC management for the proper conduct of the space flight.

If all went according to the premission plans, there would be no further need for additional support. Throughout our experience in manned flight missions, several other levels of support are required. The other levels of support, however, fit into the above framework as a support function and not a directing function. One of the major organizations for the support of the Flight Director, as well as for the Apollo Spacecraft Program Manager, is the SPAN organization. This organization provides the interface between the operations organization and the engineering and support elements of the Center, as well as the contractors who design and manufacture the flight hardware.

All changes to the science or mission objective priorities must be approved through the SPAN Operations Manager for the Manager, Apollo Spacecraft Program.

The Experiments Officeris a key member of the Flight Director's MOCR team. The Experiments Officer, although he is located in room 314A, is a MOCR-level operator. He provides the necessary inputs on the surface science operations to the Flight Director. He is concerned with the three areas discussed above - hardware, science, and operations and planning. He will interface with other MOCR positions such as the communications systems officer, and provide inputs based on science requirements and objectives for the lunar surface TV camera. He will also discuss the science activities with the MOCR systems engineers that are responsible for the LM and EMU systems. These discussions and assessments with these and other MOCR engineers will assist the Experiments Officer in accomplishing his job of managing the surface science operations for the Flight Director. This plan will now discuss in detail how the Experiments Officer functions in three primary areas - science, hardware, and operations planning and execution. The ALSEP Senior Engineer and the Orbital Science Officer's functions and interfaces follow a similar pattern and will not be discussed in detail.

3.2 SCIENCE OPERATIONS

The Experiments Officer is responsible to the Flight Director for surface science operations and is located in room 314A of the Mission Control Center. To support the Experiments Officer, a Science Advisory Team provides a cross section of the scientific disciplines to be investigated. They are also located in room 314A. The majority of the requirements priorities, tradeoffs, questions, and new science desires will emanate from this room and, if consistent with the mission operations philosophy, mission constraints and real-time mission progress, will be transmitted from the Experiments Officer to the Flight Director. The Experiments Officer also has located within this room additional support personnel. They include the Lunar Rover systems engineers and a traverse plotting

specialist. The Science Advisory Team, as well as the Experiments Officer, has additional support and these personnel are located in room 210A.

Conflicts in science requirements which cannot be resolved by the Experiments Officer and the Science Advisory Team Leader will be referred to the SPAN Operations Manager, who is the representative of the Manager, Apollo Spacecraft Program. He will review the proposals made by the Experiments Officer and the Science Advisory Team Leader and approve/disapprove them. Upon resolution, this information is passed to the Flight Director for his concurrence and implementation.

3.3 HARDWARE SUPPORT

In instances where the flight hardware equipment does not function properly, the Flight Director and his MOCR team may request the SPAN organization for assistance. A written request is developed, concurred in, and transmitted to the Mission Evaluation Team in Building 45. This is identical to the process used for the LM and CSM.

3.4 OPERATIONS PLANNING

The third major area that the EO will direct is in operations planning and execution. This includes the flight activities scheduling and the traverse planning. Here again, if all went according to premission plans, there would be no requirement for additional support. The Experiments Officer is responsible to the Flight Director for replanning surface traverses based upon the requirements as specified in the Mission Requirements Document. He is also responsible for developing those questions of the crew to fully understand those activities that have been accomplished on the surface.

The Experiments Officer must integrate the use of the separate modes of crew mobility such as the Lunar Rover or crew walking, the flight equipment, and experimental packages. He is assisted in this integration task by the Science Advisory Team and the Lunar Rover systems

engineers. The EO and his team must assess what is occurring, what must occur, what might be planned for the next traverse. It is this same group of personnel who through the EO provide instructions to the Flight Director, who in turn passes them to the CapCom for transmission to the crew.

The SPAN Operations Manager reviews the upcoming traverse with the FOD, the MSFC Lunar Rover reps, and their consolidated requirements would be passed from the FOD rep to the Experiments Officer. In this manner, the EO and his team would have all inputs and requirements necessary to initiate the detailed traverse planning. Once this plan has been developed, the EO would discuss the plan with the Flight Director and provide the necessary briefings for program management for their concurrence. The SPAN organization would assist the EO in obtaining the program managment coordination. The EO and his team, located in room 314A, are assisted by other science support personnel located in room 210A.

Figure 1 provides an illustration of the MCC operational flow for science operations.

3.5 SURFACE SCIENCE OPERATIONS

The element of the Flight Control Team responsible for the surface science operations will be managed by the Experiments Officer, who reports directly to the Flight Director, similar to all other MOCR operators even though he is located in room 314A. This element will be staffed by personnel from the Flight Control Division, supplemented by scientists representing the lunar samples PI's, the soil mechanics PI, and the lunar geology investigation team. Communications call signs are indicated in parentheses following the position name.

A. Team Positions and Functions

- Experiments Officer. The Experiments Officer (EO) will be responsible for the overall direction of this element. He will insure adherence to mission rules, direct surface operations replanning activities as necessary, and insure mission plan deviations receive management concurrence via the SPAN as time constraints permit. He is also responsible for review, evaluation, and integration of operations changes related to surface science tasks and LRV operations. This position will be staffed by the Lunar/Earth Experiments Branch (LEEB) of the Flight Control Division.

- Surface Systems Engineer. The Surface Systems Engineer (Surface Systems) will report to the EO and will be responsible for overall cognizance of the Lunar Roving Vehicle (excluding navigation) and other electrical and mechanical systems used for surface exploration activities. He will be directly responsible for systems anomaly analysis and recommendations and maintaining the status, an evaluation of the equipment, and consumables and projected applications. This position will be staffed by LEEB personnel.

- The Chairman of the Traverse Planning Team will assist the EO as required in traverse planning.

- Surface Navigation Engineer. The Surface Navigation Engineer (Surface Nav) reports to the EO and is responsible for supporting the navigation aspects of the lunar surface exploration. This function includes determination of vehicle (LM and LRV) locations with respect to the surface features, determination of LRV navigation alignment desirability, provision of alignment data, assessment of LRV navigation systems performance, and assuring maintenance of adequate backup navigation techniques, as required. This position will be staffed by LEEB personnel.

- Surface Operations Engineer. The Surface Operations Engineer (Surface Ops) will report to the EO and will be responsible for the status of the science objectives accomplishments. He will also maintain the details of the EVA traverses and insure that these facts are input into the traverse replanning activities.

- Science Advisory Team. A Science Advisory Team will be selected and approved by the Director, Science and Applications Directorate, to provide the EO with in depth science support.

- Science Advisory Team Leader. The Science Advisory Team Leader will be responsible to the EO for the overall direction of the Science Advisory Team. It is his responsibility to provide to the EO a consensus science recommendation from the Science Advisory Team. He will provide this recommendation within the framework established by the Mission Rules, Mission Requirements Document, Flight Plan, and the Lunar Surface Procedures Document. In those instances where deviations are necessary during the mission operation, the Science Advisory Team Leader will discuss these deviations and receive approval from the SPAN Operations Manager. The Science Advisory Team Leader is also responsible for keeping the Director of Science and Applications advised of the science operations activities during all mission phases.

  The Science Advisory Team will be comprised of representatives of the Lunar Samples Principal Investigators as well as representatives from the Lunar Geology Experiment Principal Investigators.

- Figure 2 shows the operational flow for the lunar surface exploration operations.
- Figure 3 shows the room 314A layout for lunar surface operations support.
- Figure 4 shows the room 210A layout for lunar surface operations support.

3.6 ORBITAL SCIENCE OPERATIONS

The flight control functions associated with conducting the CSM SIM Bay orbital science activities will be the responsibility of the Orbital Science Officer. This element will be managed by the Orbital Science Officer who reports to the Flight Director. The CM-located cameras and associated detailed test objectives (DTO's) will continue to be the responsibility of the Flight Activities Officer and will be supported as they were for previous missions. This CM camera and related DTO support operation will not be addressed further in this document.

A. Team Positions and Functions

- Orbital Science Officer. The Orbital Science Officer (OSO) will be responsible for the overall direction of the element. He has the principal responsibility for management of scientific data acquisition by the SIM Bay experiments and cameras. This responsibility includes systems monitoring, data evaluation, anomaly resolution, corrective action determination and replanning as necessary to achieve optimum scientific objective accomplishments within the existing constraints. This position will be staffed by LEEB personnel.

- Optical Systems Engineer. The Optical Systems Engineer (Optics) serves in a staff support function reporting to OSO. He will be responsible for detailed systems performance monitoring and support of the SIM Bay cameras and the laser altimeter. This position will be staffed by LEEB personnel.

- Spectrometer Systems Engineer. The Spectrometer Systems Engineer (Spec) will also serve in a staff support function reporting to the OSO. He will be responsible for detailed systems performance monitoring and support of the SIM Bay spectrometer systems (x-ray, alpha, gamma, and mass spectrometers). This position will be staffed by LEEB personnel.

B. Flight Control Support

- Science and Photo Consultant Team. A group of scientists and photo specialists will be provided limited facilities in the MCC to serve as consultants to the OSO and his staff support. Their principal role will be to provide additional interpretation, as necessary, regarding the specific intents of the experiments, advise on how well the intent can be satisfied with proposed mission plan adjustments as necessary, and quick-look assessments of the data quality and of how well the acquired data is satisfying the scientific intent. These positions will be staffed by Photo Team and Experiment Investigation Team members as designated by the PI's. Figures 5 and 6 show the operational flow for Lunar Orbital Science Operations before and after Command Module recovery.

C. Orbital Science Team Leader

This position will be manned by a member of the Science and Applications Directorate. His function relative to orbital science will be similar to that of the Science Advisory Team Leader in room 314A. It will be his responsibility to provide to the OSO a consensus science recommendation from the Orbital Science and Photo Consultants. Conflicts which cannot be resolved will be referred to the SPAN Operations Manager, who is the representative of the Manager, Apollo Spacecraft Program, for resolution. The SPAN Manager will review the proposals with all parties, including the senior S&AD representative before making his decision

D. Facilities

The MCC facilities to be utilized by the Orbital Science Element include the booster systems consoles in the MOCR and in the Vehicle Systems SSR. Room 210B will be configured for the science support personnel required by the OSO. A layout of room 210B is included as Figure 7. A Science Advisor from the Science and Applications Directorate will be available to

resolve priority differences between PI's. This will be accomplished by approval of the SPAN Operations Manager.

3.7 ALSEP AND P AND FS OPERATIONS

The flight control functions associated with the ALSEP and P and FS experiment packages will be integrated and assigned to the ALSEP and the P and FS element of the Flight Control Team.

This element will be managed by the ALSEP Senior Engineer (ASE) who reports to the Flight Director during the manned phases of the flight. The ASE will be responsible for overall management of the ALSEP and P and FS control operations associated with ALSEP deployment, ALSEP and P and FS systems evaluation and maintenance, and acquisition of scientific data.

After mission termination and command module recovery, the ASE will report to a duty officer designated within the Flight Control Division. During this period, positions are manned as required by mission activities. Figure 6 summarizes the planned flight control support for the Particles and Fields subsatellite and the ALSEP and the manned completion of the mission.

All activities within the Satellite Control Room (room 314B) will be under the direction of the ASE.

A. Team Positions and Functions

- ALSEP Systems Engineer. The ALSEP Systems Engineer (ALSEP Systems) will serve in a staff support role to the ASE and provide detailed systems analysis support.
- ALSEP Data Engineer. The ALSEP Data Engineer (Data) will serve in a staff support role to the ASE and provide detailed data systems support and collect, sort, and plot systems information for real-time and later utilization.
- P and FS Senior Engineer. The P and FS Senior Engineer (SATCOM) is responsible to the ALSEP Senior Engineer for monitoring the detailed status and trends of the P and FS. He serves in a P and FS counterpart position to the ASE.
- Satellite Systems Engineer. The Satellite Systems Engineer (Satellite) is the P and FS counterpart to ALSEP systems with similar responsibilities.

B. Flight Control Support

- Science Consultants. Provisions have been made within the Satellite Control Room for a limited number of science consultants (PI's or their designees) to maintain cognizance of the operational status of their experiment and to advise the Flight Control Team of measures which can upgrade the value of the data being acquired. These personnel will be identified by the PI's. Figure 8 provides a sketch of the SCR facilities and position assignments (room 314B).

3.8 HARDWARE SUPPORT

In-depth engineering support to assist the Flight Control Team in anomaly resolution will be provided by the SPAN and the Mission Evaluation Team. The Mission Evaluation Team is comprised of subsystems managers, hardware contractors, personnel who have designed and tested the hardware, and other senior flight hardware personnel. The Flight Control Team will interface with this support group through the FCD personnel in the SPAN during the flight phase of the mission, and directly to the ASPO Test Division following mission termination and command module recovery. The ASPO SPAN Operations Plan identifies the procedures to be followed.

Normally, the following disciplines and types of support are available in the Mission Evaluation Room to assist the Flight Director and his team.

- CSM - Subsystems managers and prime contractors
- LM - Subsystems managers and prime contractors
- Data Book changes and control
- Test results
- Government-furnished equipment support (suits, crew equipment, etc.)
- Test facilities
- Lunar Rover systems support
- Et cetera

SECTION 4

TRAINING

4.1 TRAINING

Training for all operations team members is an integral part of the preparation of the mission operation. This training includes not only the Flight Control Team members, but all support personnel. Table I is a listing of those days that science training will be conducted. Due to the crew schedule, they are subject to change. The detailed schedule is published periodically by the FCD. All support personnel should be informed and call the Mission Simulation Requirements Branch, extension 5169, to verify the training dates. Required personnel should call MSRB in order to be placed on distribution for the training schedule (Activity Planning Guide) for each mission.

The following is the FOD training plan and requirements for science support personnel. This includes PI's, PI support, and the Science Advisory Team.

- Classroom training. This will be a 4-hour briefing on MCC systems and operations and will be provided by the Flight Control Division.
- Operations planning - 10 hours. This will include mission rules and mission requirements development and is accomplished through the normal mission preparation activity.
- Four hours - Detailed flight plan review.
- Six hours - General discussion of mission-oriented tasks that would include communications procedures, coordination procedures, etc. All of the operations planning briefings will be provided by the Flight Control Team to their specific group of principal investigators.
- Simulations. At least 24 hours of simulation support is required for all personnel that are listed on the FOD manning list. The Science Support Team member should attempt to obtain a cross section of simulation training, and will

participate in all mandatory training. This training is essential to establishing the detailed relationships for the mission, verifying the mission planning, and refining the decision loops.

- Cockpit trainer. The Flight Control Divsion has a command service module cockpit trainer which simulates the crew switch functions and procedures. The SIM Bay support team is required to participate in the CSM Familiarization run which lasts for 1 hour. Scheduling should be arranged via Mr. Harold Draughon, LEEB, extension 4426.

The Flight Control Division will maintain a training record of all personnel who are assigned on the manning list. Failure to complete the above training requirements will be cause to eliminate the recommended support personnel from the manning list.

TABLE I. - SCIENCE SIMULATION SUMMARY

Lunar Surface

May 27	EVA-KSC	8 hours
June 9	EVA-KSC	8 hours
June 21	EVA-MATH MODEL	8 hours
June 23	EVA-KSC	8 hours
June 25	EVA-Flagstaff (voice only)	8 hours
July 7	EVA-KSC	8 hours

SIM Bay

May 12	4 hours
May 26	10 hours
May 27	8 hours
June 8	8 hours
June 9	8 hours
June 23	8 hours
June 24	10 hours
July 7	8 hours

P and FS

May 28	8 or 12 hours
June 7	12 hours
June 8	6 hours
June 16	6 hours
June 22	6 hours
June 25	6 hours
June 28	6 hours
July 9	8 hours
July 12	6 hours
July 20	8 hours

ALSEP

May 26	8 hours
May 27	4 hours
June 9	4 hours
June 14	8 hours
June 23	4 hours
June 30	8 hours
July 9	8 hours
July 15	8 hours
July 20	8 hours

I

HARDWARE

- PROBLEM RESOLUTION
- EXTRA SUPPORT, DATA

NOTE: PRIMARY RESPONSIBILITY INITIATION AND CLOSEOUT OF PROBLEM RESOLUTION LIES WITH THE MOCR OPERATOR

II

SCIENCE

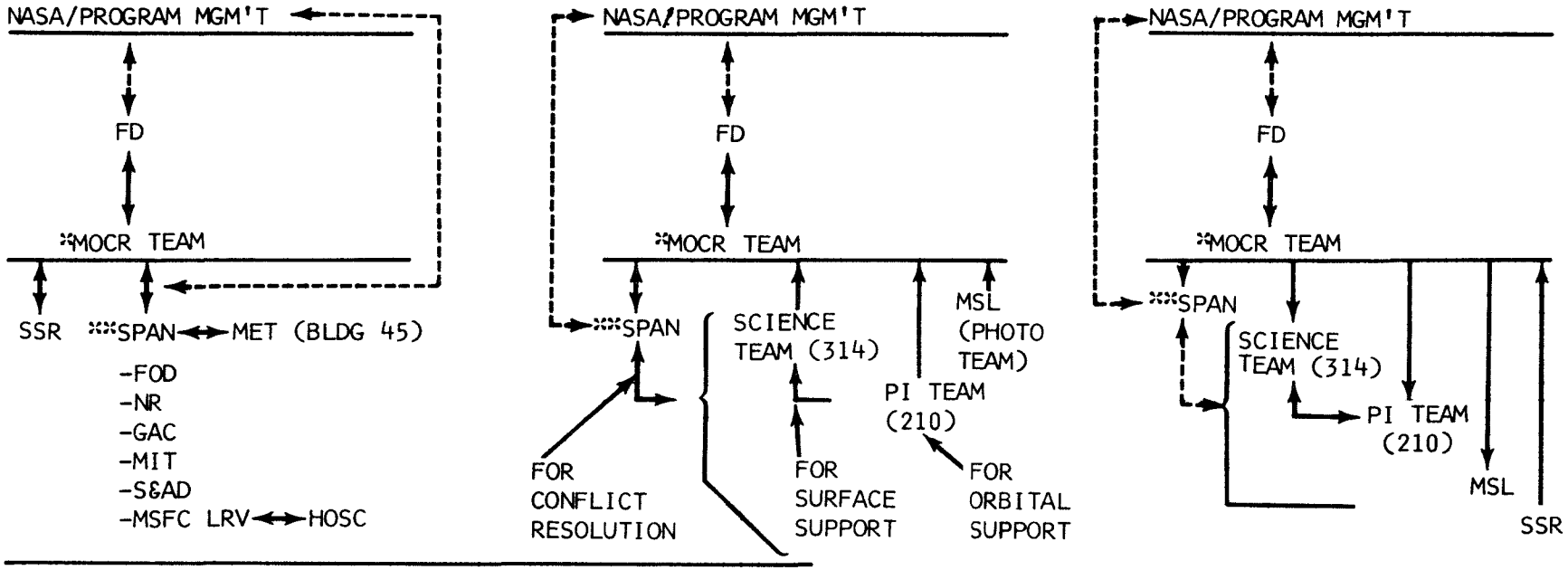
- RQMTS, OBJECTIVES
- PRIORITIES
- TRADEOFFS
- QUESTIONS

NOTE: PRIMARY RESPONSIBILITY FOR CHANGES TO THE MISSION OBJECTIVES LIES WITH THE PROGRAM MANGER.

III

OPS PLANNING AND EXECUTION

- FLIGHT ACTIVITIES SCHEDULE
- INTEGRATE USE OF VEHICLES, EQUIPMENTS, EXPERIMENTS
- VOICE INSTRUCTIONS TO CREW
- CMD FUNCTIONS



* MOCR TEAM INCLUDES EO (314), OSO, FAO, ASE, AND OTHERS

** SPACECRAFT ANALYSIS ROOM (SPAN) INCLUDES ORGANIZATIONAL REPRESENTATION AS SHOWN UNDER AREA I

------ DASHED LINE FOR PROGRAM MANGEMENT COORDINATION

FIGURE 1. - MCC OPERATIONAL FLOW FOR THREE FUNCTIONAL AREA OF HARDWARE, SCIENCE, AND OPS.

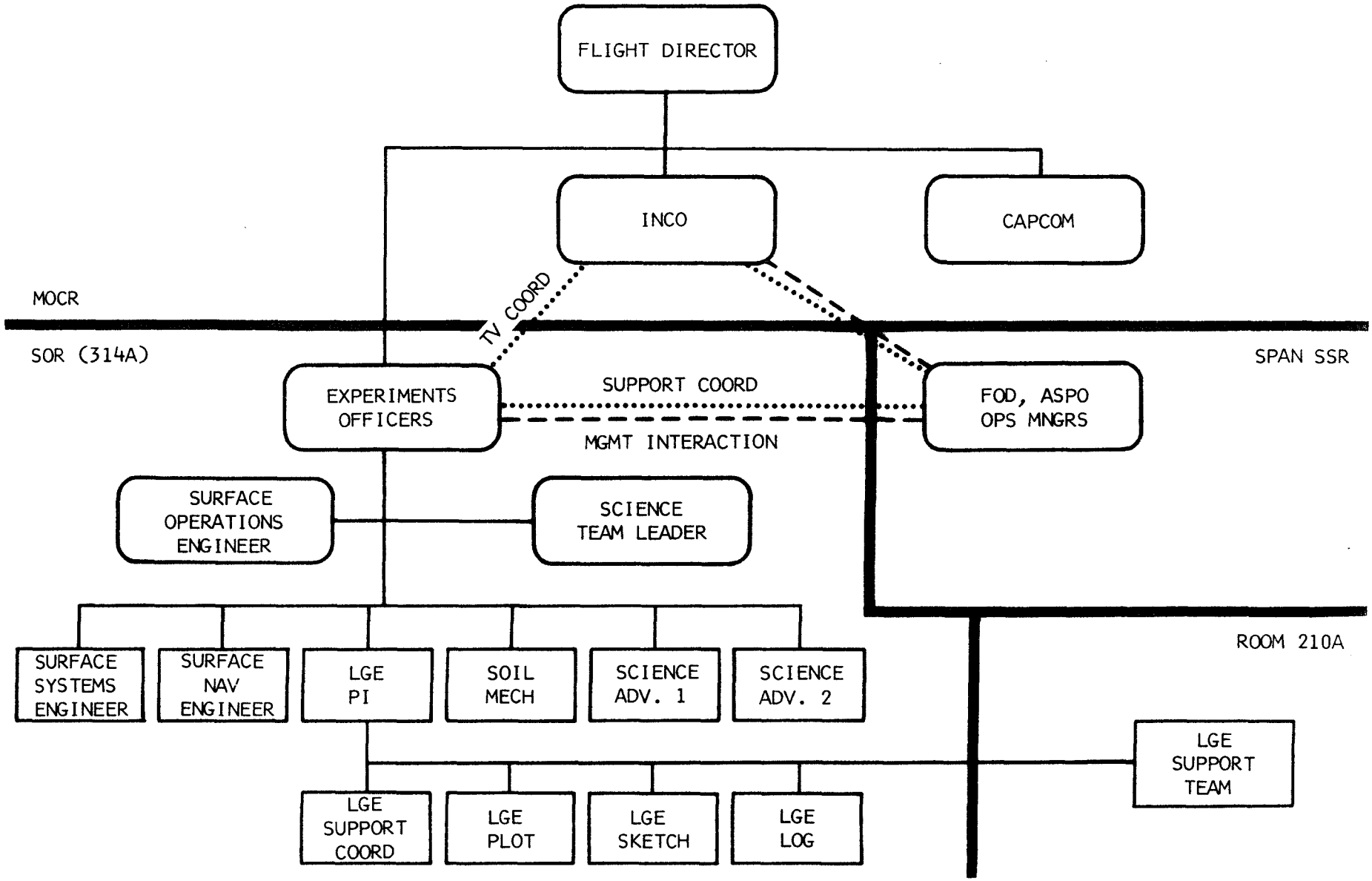


FIGURE 2. - SURFACE EXPLORATION OPERATIONS.

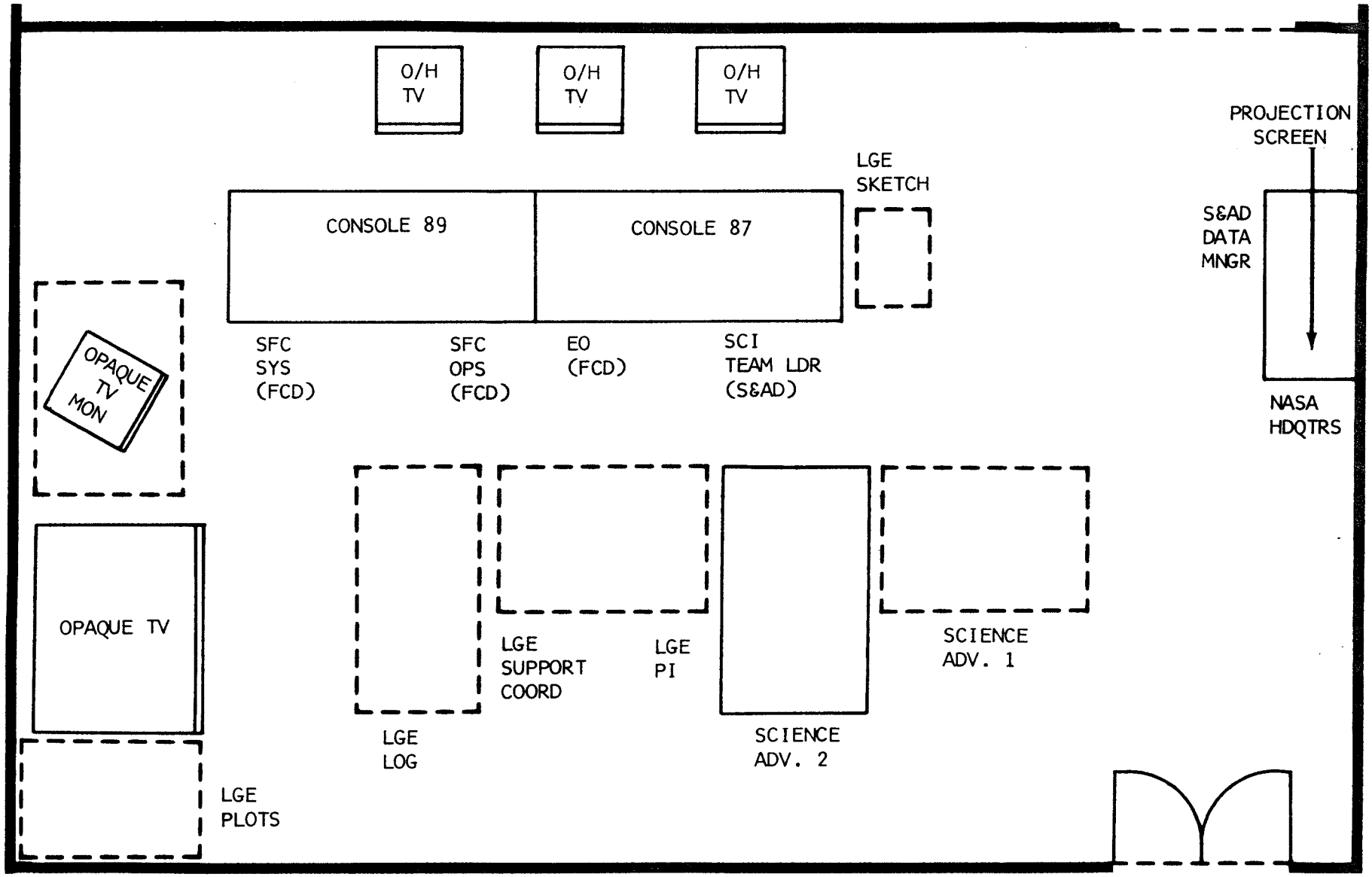


FIGURE 3. - SCIENCE OPERATIONS ROOM (314A).

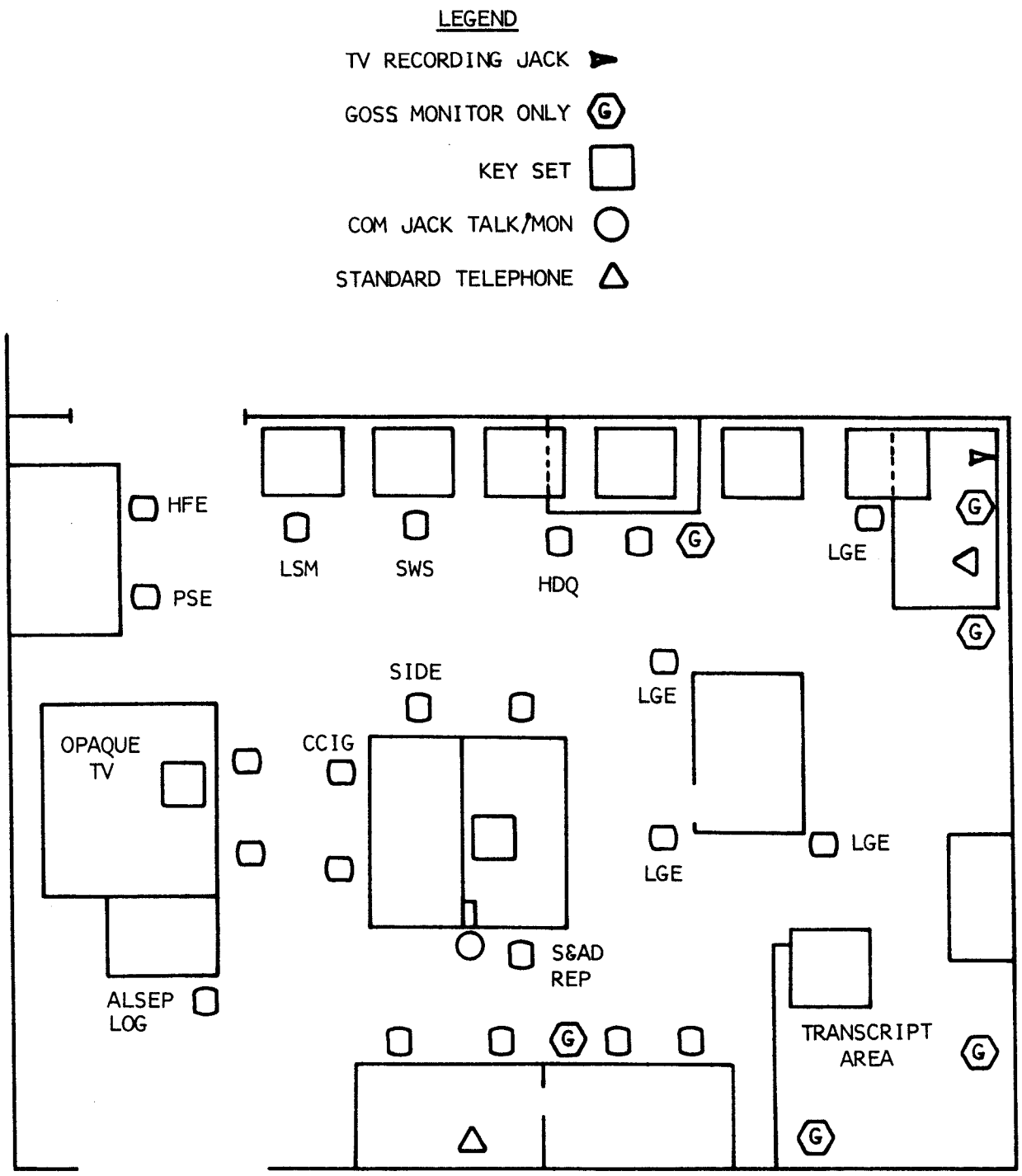


FIGURE 4. - ROOM 210A LAYOUT.

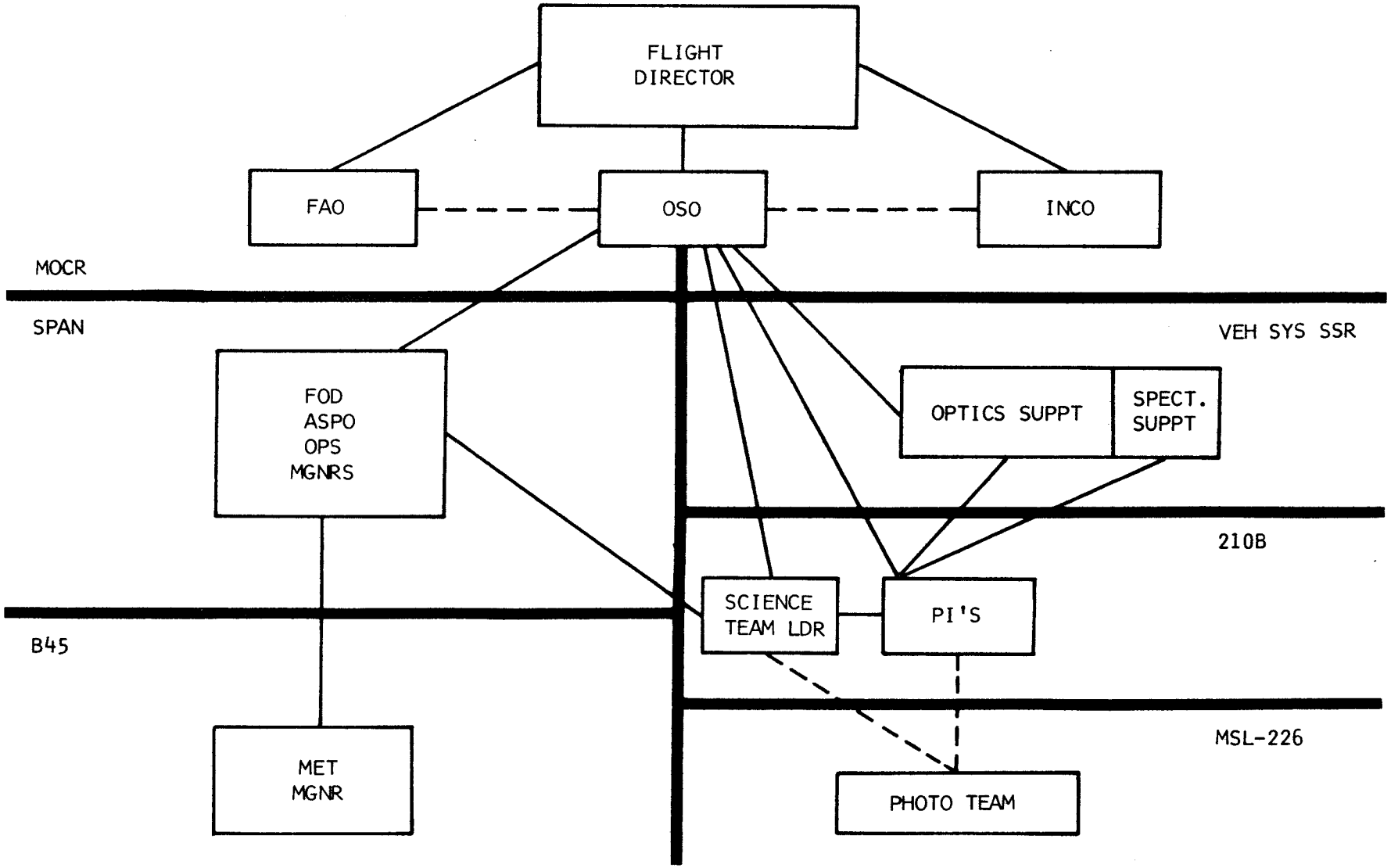


FIGURE 5. - ORBITAL SCIENCE SUPPORT PRIOR TO CM RECOVERY.

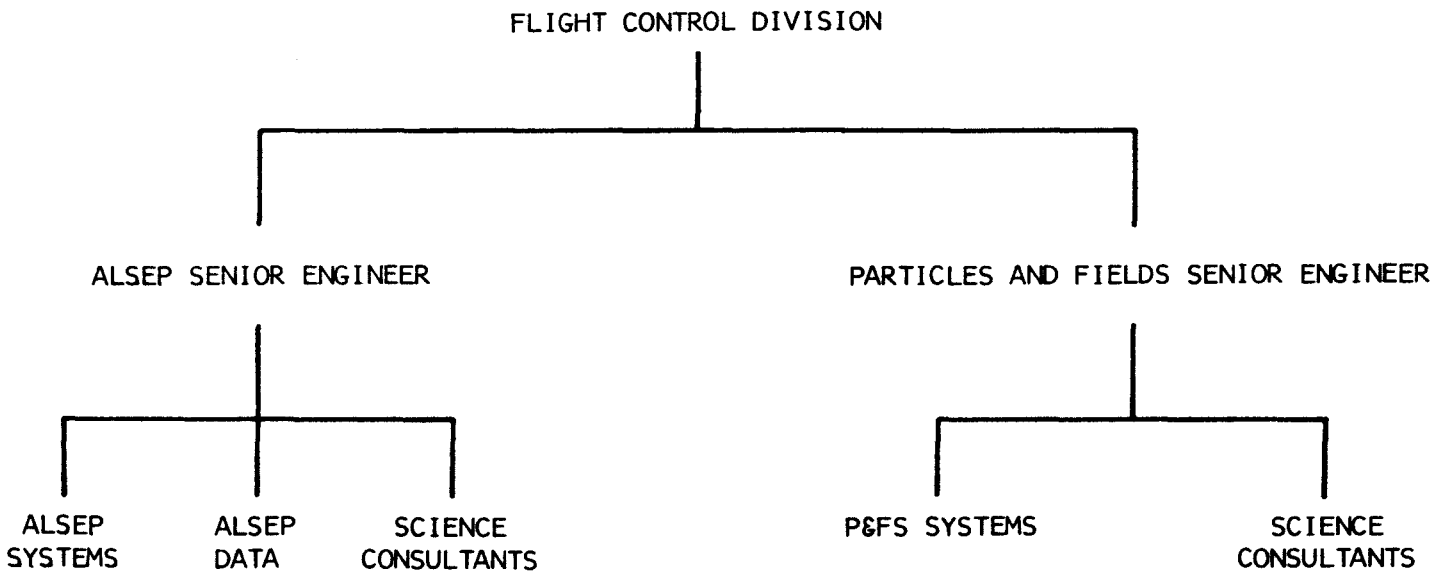


FIGURE 6. - SCIENCE SUPPORT SUBSEQUENT TO CM RECOVERY.

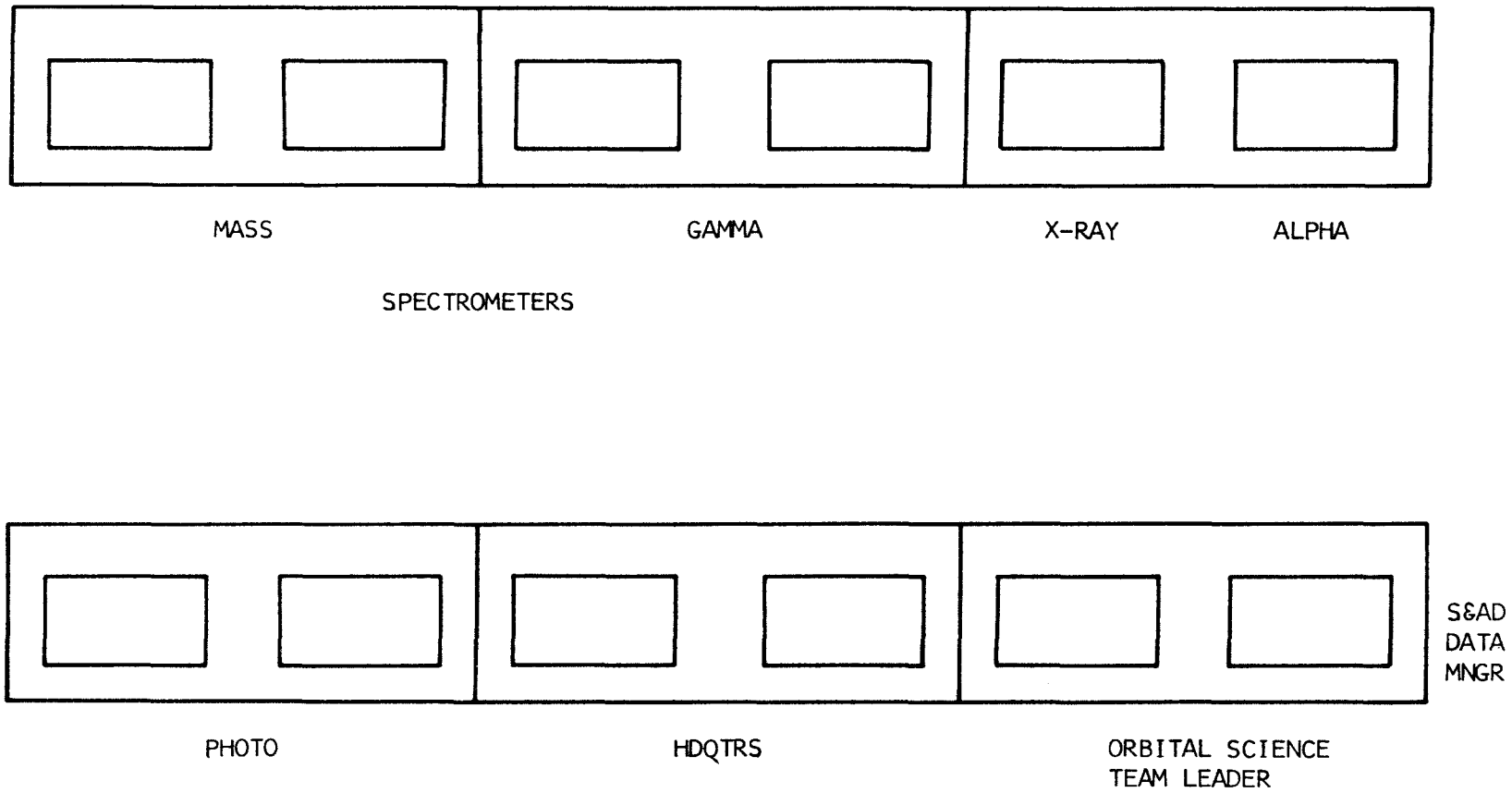


FIGURE 7. - ROOM 210B CONFIGURATION

POSITION

1. ALSEP SR. ENGINEER
2. ALSEP SYSTEMS
3. ALSEP DATA ENGINEER
4. ALSEP PI'S/P&FS PI'S
5. SATCOM (P&FS SR. ENGR)
6. SATELLITE (P&FS SYS ENGR)

COMMUNICATIONS

- KEYSET
- JACK-BOX (T/M)
- JACK-BOX (M ONLY)
- G GOSS CONF SINGLE LOOP
- B TELEPHONE - TWO LINE WITH CROSSOVER, RING, AND DIAL

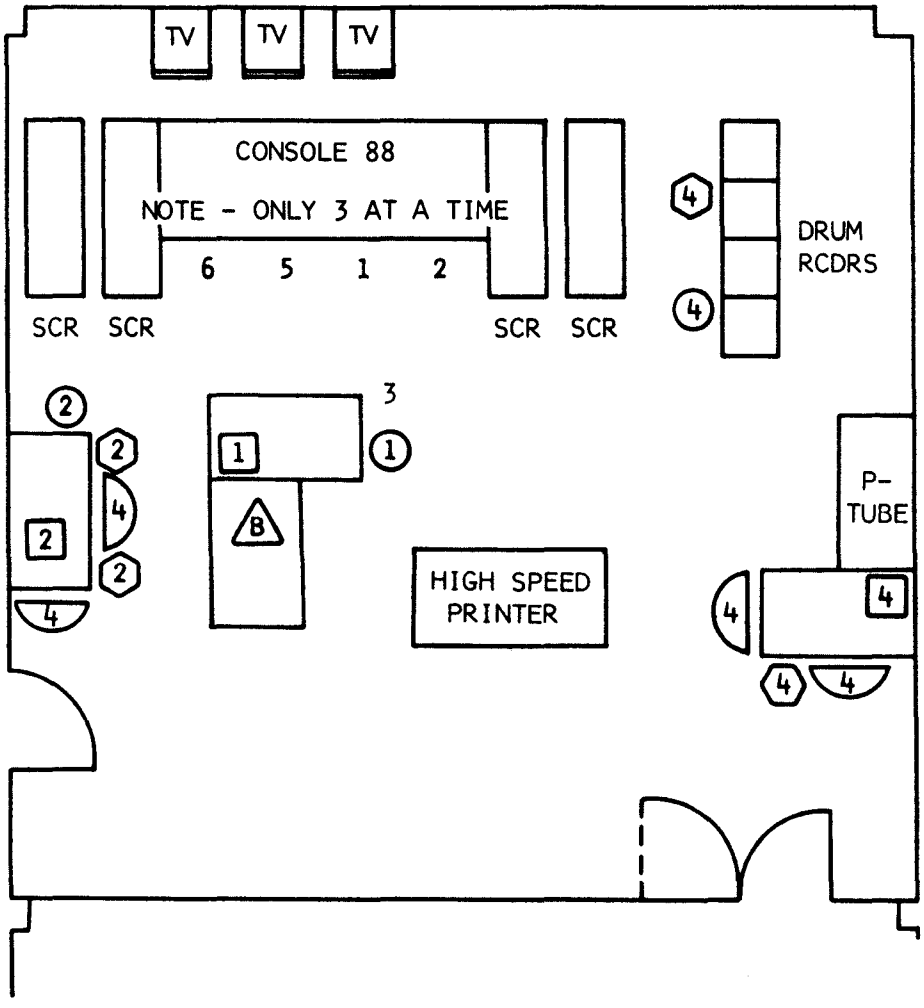


FIGURE 8. - ROOM 314B SATELLITE CONTROL ROOM.

NASA — MSC — Coml., Houston, Texas

AB/C. C Kraft, Jr.
AC/G. W. Abbey
AP3/M. Reim (10)
JL/J. R. Brinkman
CA/D. K. Slayton
CB/T. P. Stafford (8)
CG/J. W. Bilodeau
CG3/R. G. Zedekar (4)
CG5/S. H. Gardiner (4)
CG52/T. W. Holloway (5)
CD4/H. A. Keuhnel (5)
DA/C. A. Berry
EA/M. A. Faget
EF/E. M. Jones (3)
EH/D. G Wiseman (3)
FA/S. A. Sjoberg
H. W. Tindall
R. E. Ernull
R. G. Rose
L. C. Dunseith
E. L. Davis
FC/E. F. Kranz
M. F. Brooks
J. W. Roach
FC13/G. S. Lunney
M. P. Frank
G. D. Griffin
M. L. Windler
FC2/C. S. Harlan (4)
FC3/A. D. Aldrich
FC4/J. E. Hannigan (7)
FC5/J. C. Bostick
FC6/R. A. Hoover (6)
FC8/C. B. Shelley (4)
FC9/J. E. Saultz (50)
FM/J. P. Mayer (3)
FS/J. C. Stokes (3)
EW/R. L. Bond
PA/J. A. McDivitt
O. G. Morris
PD/R. W. Kubicki
PD4/J. Sevier
PD12/J. Peacock
S. Blackmer
PD9/J. Craig
PG/J. Goodman
PT/D. D. Arabian
PT3/E. P. Gammon
TA/A. J. Calio
J. A. Lovell
TF/F. W. Pearce, Jr.
TF5/J. Dietrich
TN4/W. D. Carrier
TD/J. Zarcaro (12)
TN/P. W. Gast (4)
SA/J. C. French
SF/D. D. Greenwell
DA/R. S. Johnston
TA/M. G. Simmons
PM-MO-F/R. S. Hamner (4)

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L. Reiffel, MA6
E. M. Davin, MAL
W. T. O'Bryant, MAL
J. K. Holcomb, MAO
G. Chandler, MAO
R. O. Aller, MAO
R. J. Allenby, MAS
J. W. Head/Bellcom, MAS

Center of Astrogeology
U. S. Geological Survey
601 East Cedar Avenue
Flagstaff, Arizona 86001
G. A. Swann (10)

Marshall Space Flight Center:
Dr. N. C. Costes, R-SSL-N
D. Strimling, PM-MO-I
O. Vaughn, S&E-AERO-YR

General Electric--Houston
J. E. Crane
R. Blevins

Philco-Ford--Houston
C. W. Abbitt, M/C D100B

Bendix Systems Division--Houston
Robert R. Miley
TDX, Bldg. 399

Leon T. Silver
Division of Geological Sciences
California Institute of Technology
Pasadena, California 91109

Bendix Aerospace Systems Div.
3300 Plymouth Road
Ann Arbor, Michigan 48107
R. Redick
B. Rusky

Dr. W. R. Muehlberger
Department of Geology
University of Texas
Austin, Texas 78712

Lamont-Doherty Geological Observatory
Columbia University
Palisades, New York 10964
Dr. G. V. Latham
Dr. M. E. Langseth

Dr. R. L. Kovach
Department of Geophysics
Stanford University
Stanford, California 44300

Dr. Palmer Dyal
Ames Research Center
Moffett Field, California 94035

Dr. J. E. Faller
Scott Laboratory
Wesleyan University
Middletown, Connecticut 06457

Dr. J. K. Mitchell
Department of Civil Engineering
440 Davis Hall
University of California
Berkeley, California 94720

Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California 91103
W. E. Sjogren
C. W. Snyder

Rice University
P. O. Box 1892
Houston, Texas 77001
D. Reasoner
J. W. Freeman

J. H. Hoffman
Southwest Center for Advanced Studies
University of Texas at Dallas
P. O. Box 30365
Dallas, Texas 75230

Goddard Space Flight Center
Greenbelt, Maryland 20771
Isidore Adler
O. E. Berg

J. R. Arnold
Department of Chemistry
University of California at San Diego
La Jolla, California 92037

Paul Gorenstein
American Science & Engineering, Inc.
11 Carleton Street
Cambridge, Massachusetts 02142

F. J. Doyle
Topographic Division
U. S. Geological Survey
1340 Old Chain Bridge Road
McLean, Virginia 22101

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

Joseph Weber
Department of Physics & Astronomy
University of Maryland
College Park, Maryland 20742

Kinsey A. Anderson
Space Science Laboratory
University of California
Berkeley, California 94720

W. E. Fastie
Johns Hopkins University
Baltimore, Maryland 21218

Robert O. Pepin
School of Physics & Astronomy
University of Minnesota
Minneapolis, Minnesota 55455

G. Carruthers
Code 7124.3
Naval Research Laboratory
Washington, D.C. 20390