NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

APOLLO 14

FLIGHT OPERATIONS PLAN

FOR SCIENCE SUPPORT

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PREPARED BY

FLIGHT CONTROL DIVISION

FLIGHT OPERATIONS DIRECTORATE

MANNED SPACECRAFT CENTER

HOUSTON, TEXAS

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PREFACE

This document is prepared as a supplement to the Apollo H Missions Flight Operations Plan. It is intended to expand and further define the specific plans for supporting the Apollo 14 science and experiment activities during the flight phase of the mission.

Any comments concerning the contents of this document should be directed to Gerald D. Griffith, Lunar/Earth Experiments Branch, HU3-4746.

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Approved by:

Sigurd A. Sjoberg
Director of Flight Operations

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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 (FOD) plans to execute the mission control functions for the experiments and integrally related operational objectives assigned to Apollo 14 in the Apollo 14 Mission Requirements Document. These activities are of paramount importance to a diverse group of scientists and support personnel. Consequently, it is important to prepare and publish an additional level of detail over the previously published Apollo H Missions Flight Operations Plan.

1.2 SCOPE

This document is addressed to the mission control plans for supporting the Apollo 14 scientific objectives. It principally identifies the functions, organization and interfaces of the flight control elements supporting these objectives.

1.3 PRECEDENCE

This document is intended as the detailed plan for the execution of mission control activities in support of scientific objectives. Because of the timeframe late in the mission development cycle in which it is prepared, it will be considered the primary authoritative document governing flight control functions, organization, and interface applicable to the scientific and integrally related operational objectives.

1.4 APPLICABILITY

This document applies to all members of flight control team elements directly supporting the specific referenced objectives and to their external interfacing elements.

SECTION 2

OPERATIONS PLAN OBJECTIVES

2.1 GENERAL OBJECTIVES

The principal goal of the flight control team in supporting the specific scientific objectives assigned to Apollo 14 is to maximize the value of the data acquired consistent with operational policy regarding crew risk exposure. Towards achievement of this goal, pre-mission emphasis is placed on an in-depth understanding of the individual detailed objectives, detailed mission planning to effectively integrate the tasks required to accomplish these objectives into the mission activities, and operations drills to analyze the plan and practice execution. During the mission phase, the operations approach will be to attempt to nullify the effects of events perturbing the mission plan and recover to the nominal mission plan execution conditions. Foreseeable conditions for which intentional departures from the nominal mission plan will be allowed will be addressed in the Flight Mission Rules.

Although the basic approach for perturbations is to recover to the nominal, it is recognized that some events and contingencies may render this approach impractical. For such cases which are identifiable pre-mission, alternate plans will be prepared.

Even when operating under these guidelines, there exists a possibility that unforeseeable events will occur which necessitate significant mission plan changes during the conduct of the mission. If these events occur, it is of paramount importance that all distractions and confusion factors be maintained at the lowest practical level. It is also important that the flight control team be allowed to concentrate on the activities at hand. Towards this end, the SPAN is designated as the focal point to control and filter the external inputs to the flight control team and to receive and insure proper action on requests from the flight control team for specific support.

This operations concept of objective awareness, detailed planning, comprehensive training and provision of organized specialized support groups will provide an effective mission control function for nominal or contingency mission execution as well as maximize the capability to move into alternate modes of operation when quick-look data review indicates unusual opportunities exist to maximize scientific objectives.

SECTION 3

FLIGHT CONTROL ELEMENTS

3.1 GENERAL

The personnel directly involved in the real-time science operations control activities will be working in several elements of the flight control team. These elements will be directly responsible to the Flight Director who has the primary responsibility for all flight activities. All members of the flight control team will be subject to flight controller certification policies and criteria established by the Flight Control Division. Minimum requirements will include participation in at least one simulation of the applicable mission phase in the Mission Control Center.

3.2 FLIGHT ACTIVITIES ELEMENT

The Flight Activities Element will be led by the Flight Activities Officer (FAO). In addition to the other mission support functions this element provides, it will also be responsible for:

- Contingency procedures/recommendations for hand-held, cabin-mounted cameras.
- Preparation of crew updates for orbital photography tasks.
- Time and motion specialty support on crew scientific tasks.

3.3 SURFACE EXPLORATION ELEMENT

The Surface Exploration Element will be led by the Experiments Officer (EO). The primary responsibilities assigned to this element are:

- Coordination of landing point determination.
- Traverse planning.
- Recommendations for action for contingencies occurring during EVAs except for ALSEP and life support systems related contingencies.
- Optimization of objective accomplishments during EVAs.

The composition and structure of this element and its major interfaces are depicted in figure 3-2.

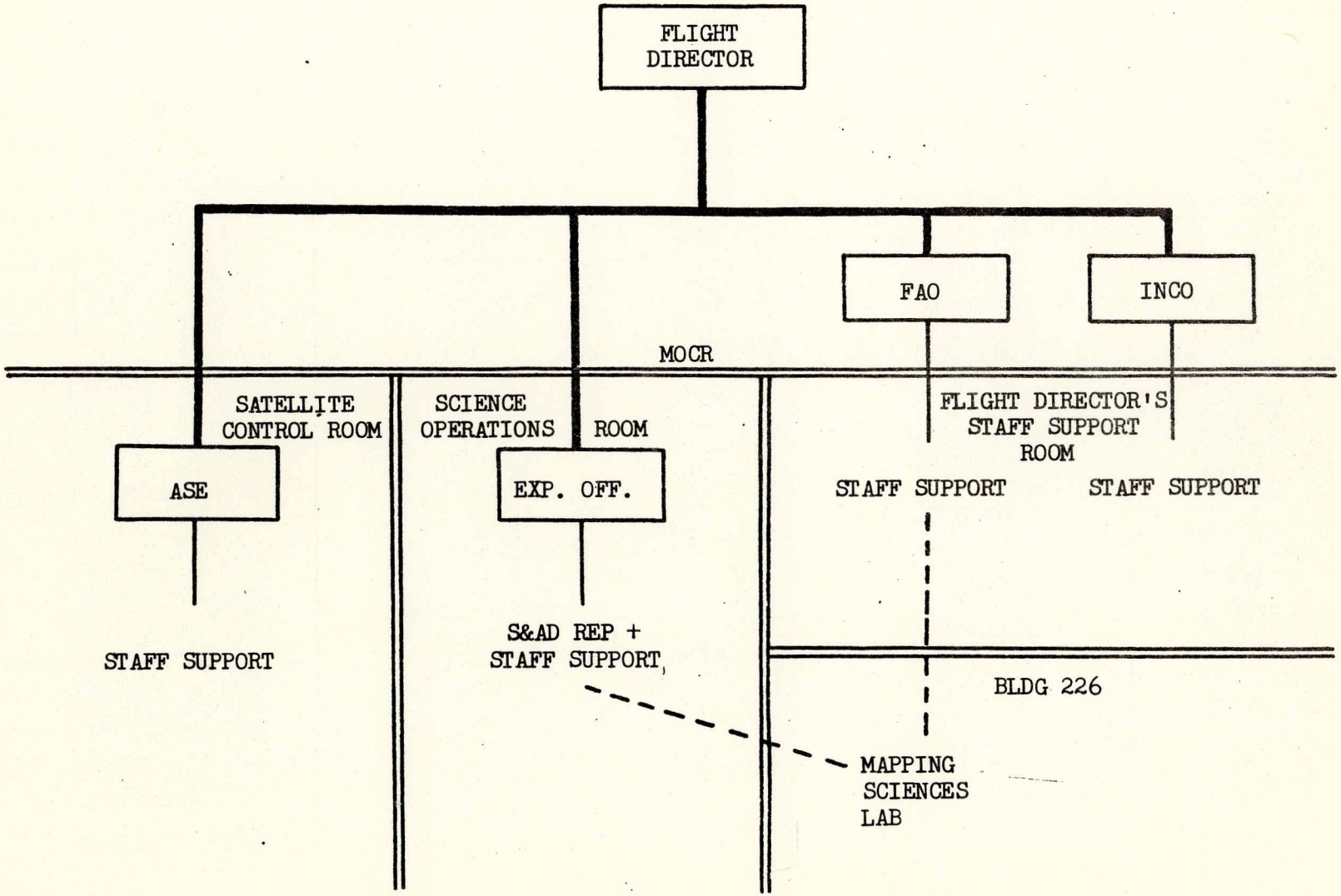

Figure 3-1. - SCIENCE OPERATIONS ELEMENTS OVERVIEW

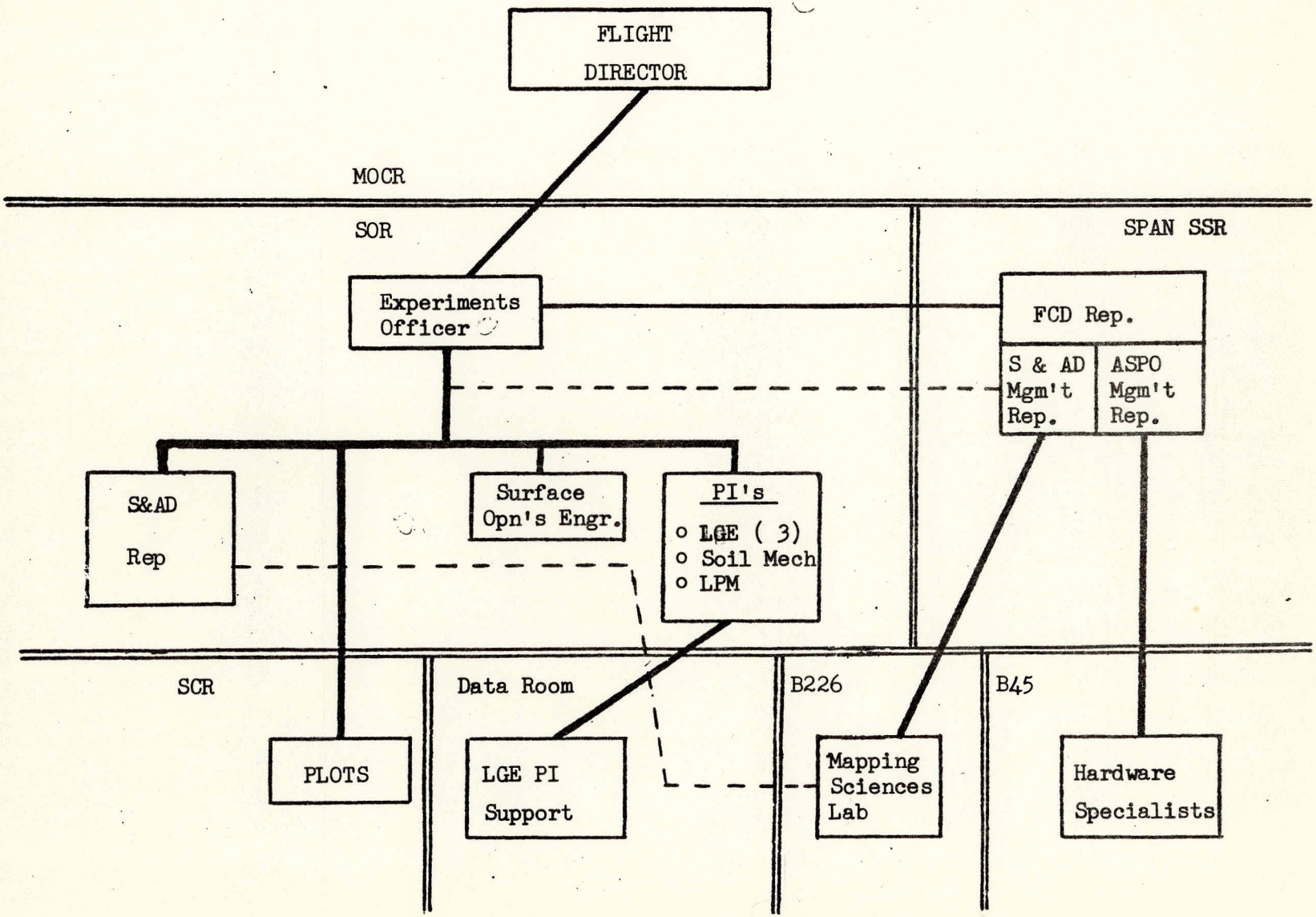

Figure 3-2. - SURFACE EXPLORATION ELEMENT AND INTERFACES (REAL TIME OPERATIONS)

3.4 ALSEP CONTROL ELEMENT

The ALSEP Control Element will be led by the ALSEP Senior Engineer (ASE). The responsibilities assigned to this element are:

- Coordination of ALSEP deployment and activation activities.
- Contingency procedures/recommendations for crew activities associated with the ALSEP.
- Exercising operational control over the ALSEP after activation.
- Optimization of the scientific data returned by the ALSEP during its useful life.

During the flight phase of the mission this element will be directly responsible to the Flight Director. Following flight termination it will be directly responsible to the Chief, Experiments Systems Branch, for support of ALSEP

The composition and structure of this element and its major interfaces are depicted in figure 3-3.

3.5 COMMUNICATIONS ELEMENT

The Communications Element of the flight control team is led by the Instrumentation and Communications Officer (INCO) and has responsibility for the two mission objectives which are within the communications field. These two objectives are:

- Downlink bistatic radar observations of the moon.
- EVA communication system performance.

The addition of the responsibilities for supporting these objectives over the normal duties of this element will require minimal added effort.

3.6 PRINCIPAL INVESTIGATORS

While the personnel from the operations directorates are prepared to execute mission control activities necessary to acquire the scientific information for the defined mission objectives, it is recognized that specific expertise is desirable to insure optimization of the value of this scientific information. To achieve this goal, Principal Investigators and/or their representatives for selected experiments are considered members of the specific flight control team elements. The basic selection considerations are:

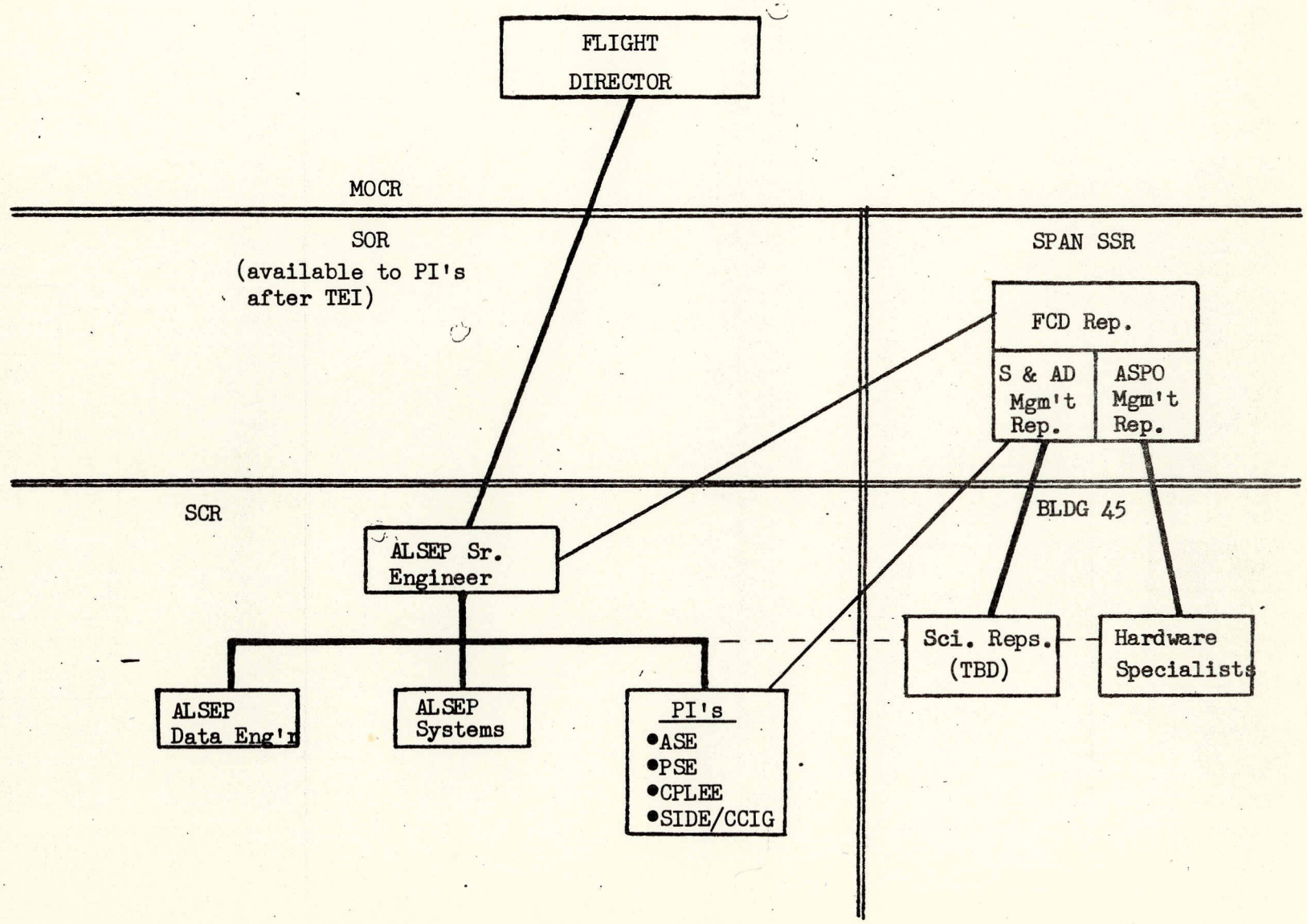

Figure 3-3. - ALSEP CONTROL ELEMENT AND INTERFACES

- Time criticality of requirement for specific inputs.
- Complexity of scientific objective.
- Tangibility of objectives and data.

The Principal Investigators and/or representatives for the following experiments have been identified as members of the flight control team:

- Lunar Field Geology (descent through EVA-2)
- Lunar Portable Magnetometer (EVA-2)
- Soil Mechanics (EVA-1 and EVA-2)
- Passive Seismic Experiment (PSE)
- Active Seismic Experiment (ASE)
- Charged Particle Lunar Environment Experiment (CPLEE)
- Suprathermal Ion Detector Experiment (SIDE)
- Cold-Cathode Gauge Experiment (CCGE)

The Principal Investigators identified above are assigned to specific elements of the flight control team as indicated in figures 3-2 and 3-3. Principal Investigators for other experiments should be accessible on a consultant basis to the flight control elements. The specifics of this point are addressed in the following section.

Specific badging arrangements will be defined to provide controlled access for the PIs and/or representatives to the flight control areas when they are required.

3.7 REPLANNING OF SCIENCE ACTIVITIES

The generalized flow of activities and responsibilities for adjusting the mission plan to incorporate science objectives tradeoffs or to take advantage of opportunities to increase the scientific return is depicted in figure 3-4. The S&AD Representative incorporated by dashed lines is included as an exception to the typical flow because of the need for a fast review-approval-implementation chain for the surface exploration activities. Normal time responsiveness of the SPAN chain is expected to be approximately one-half hour and will be used for changes out-of-scope of the Mission Rules and Mission Requirements Document not related to surface exploration science activities.

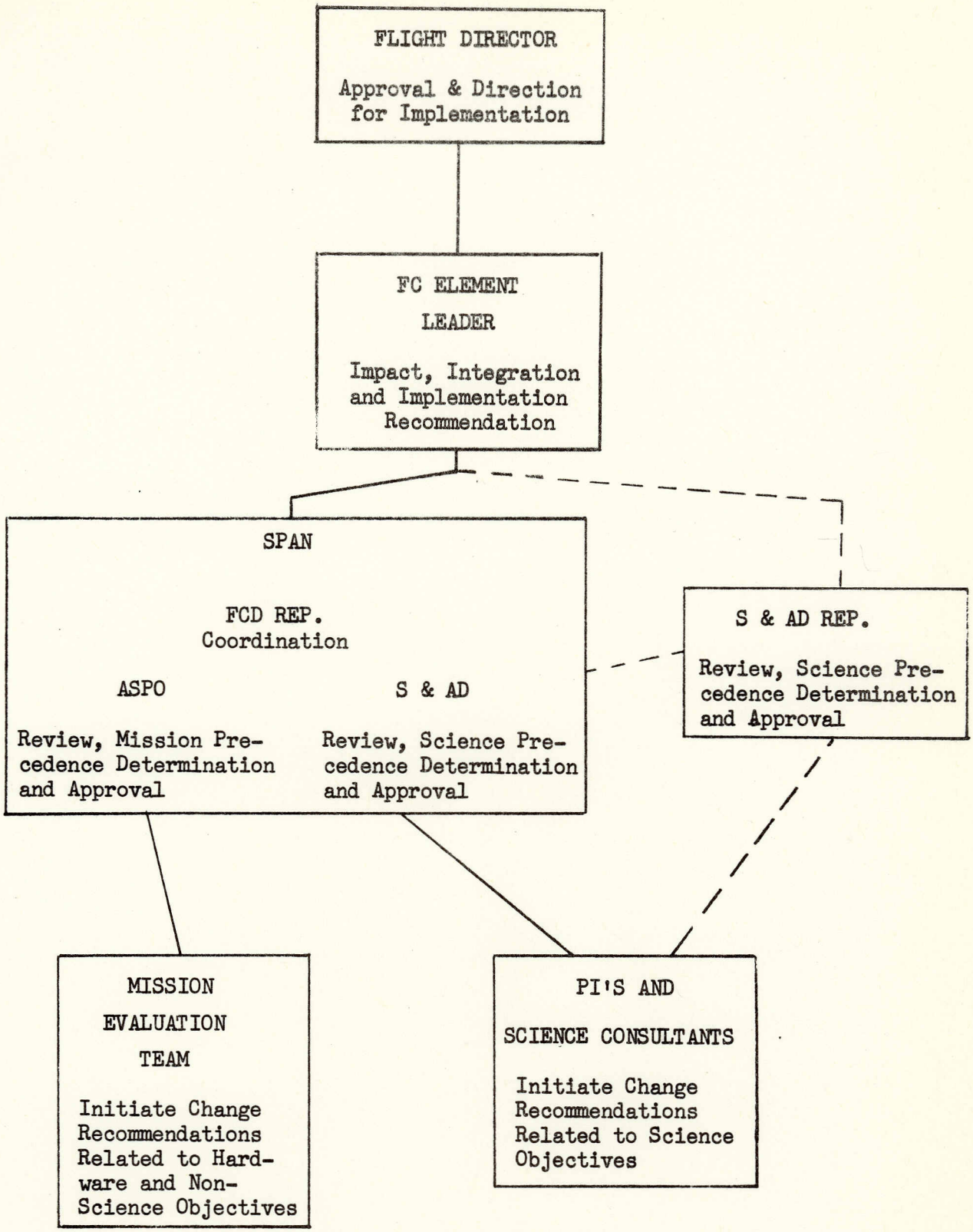

Figure 3-4. Change Flow Chart

SECTION 4

FLIGHT CONTROL TEAM SUPPORT ELEMENTS

4.1 GENERAL

Certain non-time-critical functions will be supported by external elements in support of the flight control team. These support elements serve primary goals of securing management concurrence on major departures from the mission plan, providing an in-depth analysis capability of systems anomalies, and provide a program management interface to the flight control team for resolution of mission priorities and objective tradeoffs required during the mission.

4.2 SPAN

The SPAN element will be the primary focal point for coordination of external inputs among affected organizations before forwarding to the flight control team. The SPAN element is being modified for Apollo 14 to include a Science and Applications Directorate management representative. This will enable the SPAN to be the single authoritative flight control team interface for programmatic decisions affecting science objectives. It will also provide a formalized focal point for scientists not directly involved in the real-time operations to provide scientific inputs for consideration during the flight phase.

4.3 MISSION EVALUATION TEAM

The Mission Evaluation Team (MET) element will include hardware design specialists with in-depth familiarity with hardware design, test history, etc. This element will assist in the in-depth analysis and performance assessment on a near-real-time basis and for contingencies when response time lags are acceptable. The specific hardware support and level of support will be coordinated with the Test Division of ASPO through the ASPO Team Leader in the SPAN room.

4.4 PRINCIPAL INVESTIGATORS

Certain Principal Investigators not of necessity involved in the direct real-time operations will be available for near-real-time consultation regarding experiment optimization and evaluation of scientific data acquired. The details as to the specific experimenters and their location will be coordinated with the Lunar Missions Office of S&AD.

4.5 MAPPING SCIENCES LAB

The Mapping Sciences Lab personnel will include members of the photo team as well as photo and mapping specialists. They will provide support on a near-real-time basis for bootstrap and orbital science photography. They will also assist the Surface Exploration Element of the flight control team in landing point determination.

SECTION 5

MCC FACILITIES

5.1 GENERAL

The MCC facilities dedicated primarily to the support of the Apollo 14 science objectives are room 314A, the Science Operations Room (SOR), and room 314B, the Satellite Control Room (SCR). The other mission control functions associated with scientific objectives are integrally conducted in the MOCR/SSR areas. Room 210A, the MCC Data Room will be available for limited use as a holding area and science support team working area during the EVA and EVA-preparation periods.

5.2 SCIENCE OPERATIONS ROOM

The Science Operations Room will be under the operational control of the Experiments Officer. It will be the principal operating area for the Surface Exploration Element of the flight control team. The Experiments Officer will be responsible for maintaining an effective operating environment within the SOR. The layout of the SOR and general operating position assignments are depicted in figure 5-1. Following LM rendezvous, this room will be used as an extension of the SCR to provide more space for review of ALSEP data.

5.3 SATELLITE CONTROL ROOM

The Satellite Control Room will be under the operational control of the ALSEP Senior Engineer. It is the operating area for the ALSEP control team. The layout of the SCR facility and operating positions are depicted in figure 5-2. The Plots position denoted in figure 5-2 is a member of the Surface Exploration Element and not directly involved in the ALSEP activities.

5.4 DATA ROOM

As described above, the Data Room will be available as a working area for the LGE Support Team during the lunar surface phase. The basic layout of the Data Room and the general LGE Support Team operating positions are identified in figure 5-3. The specific individuals supporting scientific activities requiring access to the Data Room during the lunar surface phase of the mission will be coordinated with the Lunar Missions Office of S&AD.

POSITIONS

1. Mission Scientist
2. S & AD Rep.
3. Experiments Officer
4. Surface Opns Eng'r
5. LGE PI Team
6. PI's
7. Hdq Monitor
8. S&AD Data Manager
9. Photo Coord
10. MSC Chief Scientist

COMMUNICATIONS

- Keyset
- Jack-box (T/M)
- Jack-box (M only)
- GOSS conf single loop
- GOSS conf single loop speaker with volume control
- Vu-Graph
- Telephone - Two line with crossover, ring, and dial
- Telephone - Hotline to building 226

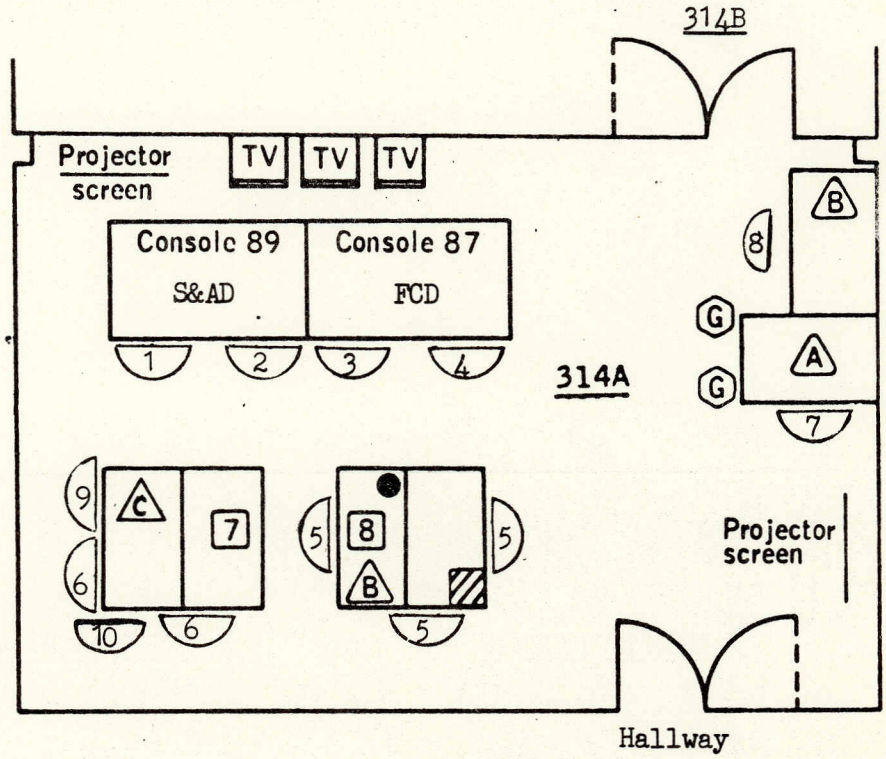

Figure 5-1. - Science Operations Room

POSITIONS

1. ALSEP Sr. Engineer
2. ALSEP Systems
3. ALSEP Data Engineer
4. ALSEP PI's
5. Plots

COMMUNICATIONS

- Keyset
- Jack-box (T/M)
- Jack-box (M only)
- (G) GOSS conf single loop
- (B) Telephone - Two line with crossover, ring, and dial

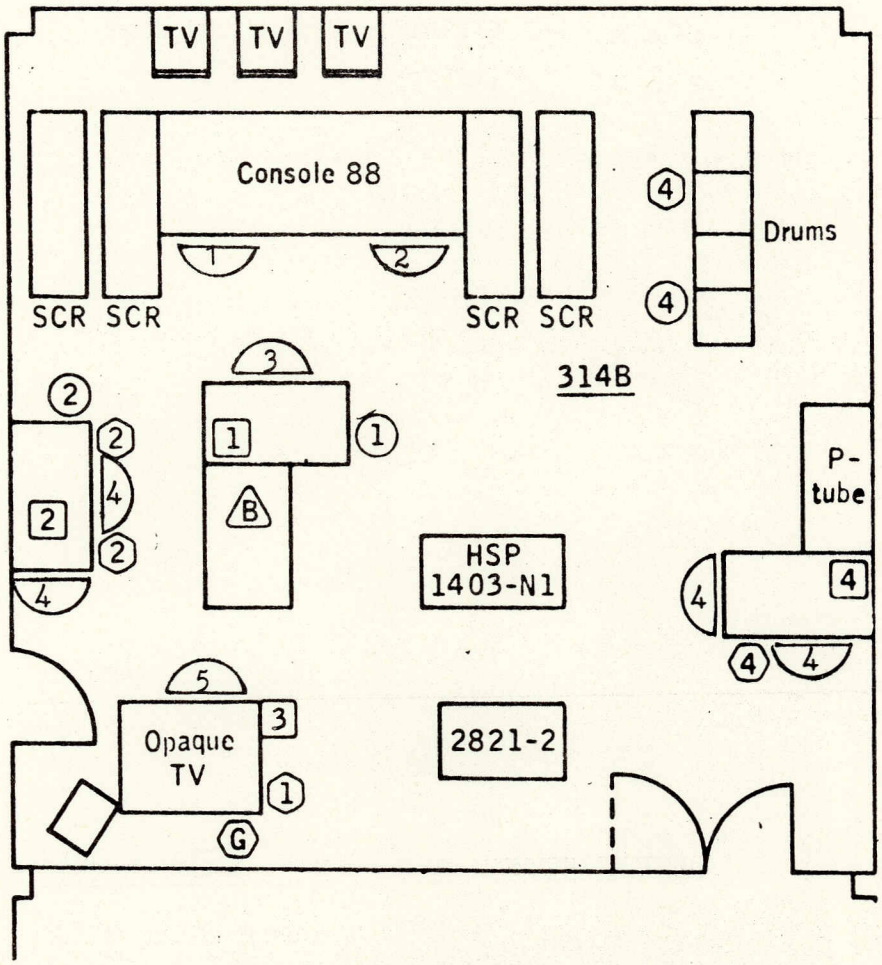

Figure 5-2. - SATELLITE CONTROL ROOM

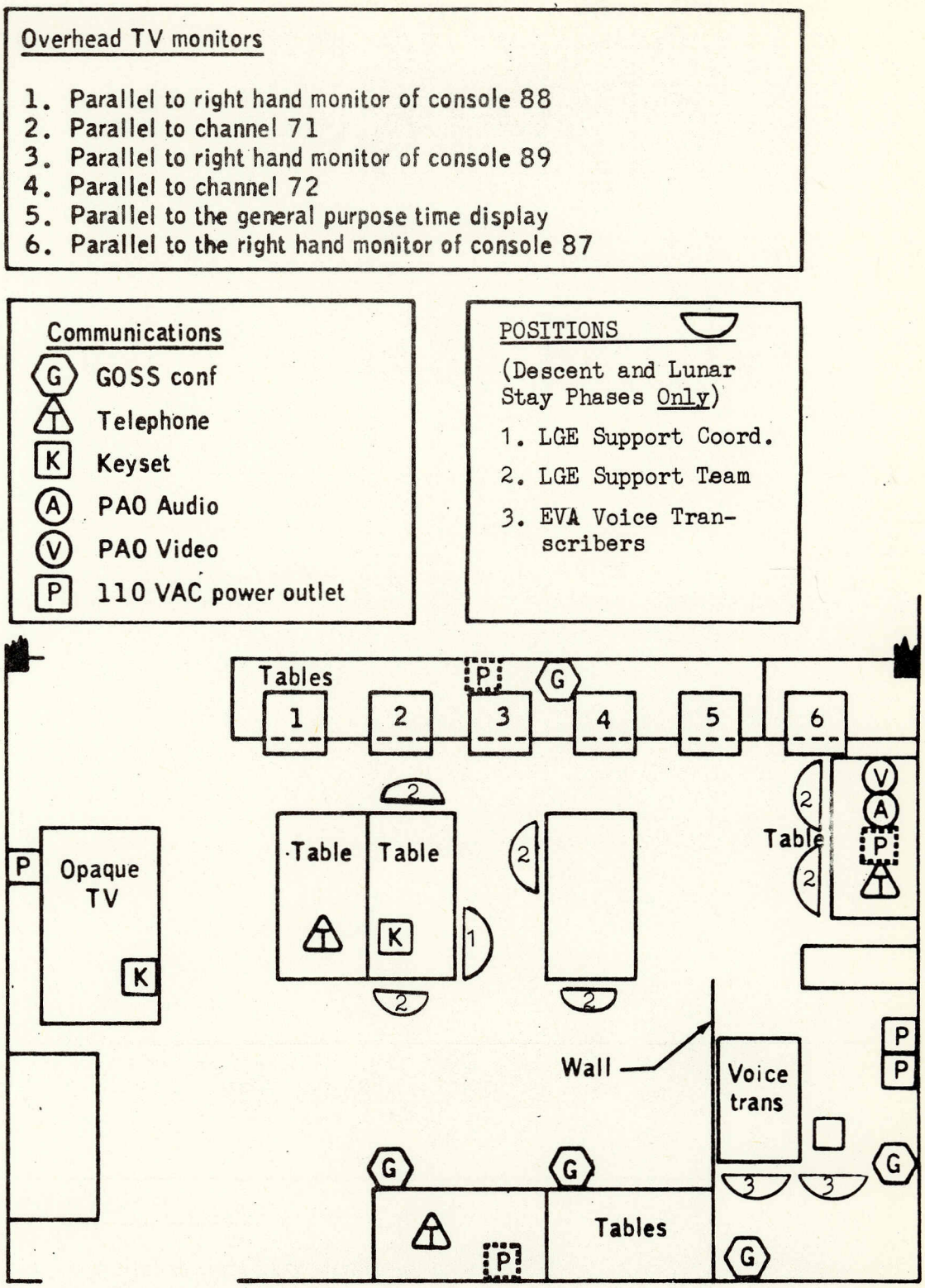

Figure 5-3. - Data Room 210A