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MSC/Apollo Program Management

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MANNED SPACECRAFT CENTER

HOUSTON, TEXAS

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FOREWARD

The purpose of this document is to describe how the Manned Spacecraft Center is managing its responsibilities in the Apollo Program. The organization, procedures, and management philosophy described herein, represent the accumulated knowledge gained from our experience with the Mercury, Gemini, and Apollo Programs. It should be remembered, however, that managing a research and development program of Apollo's size and complexity, is an experimental "R&D" process in itself.

Within program management, there is no best way to manage; there are always better ways, and areas needing review and improvement. As we gain additional experience with the Apollo and later programs, we will continue to re-examine our management organizations and procedures in light of the current conditions and requirements. We will undoubtedly find better management methods and they will be incorporated into our management philosophy.

Robert R. Gilruth
Director, Manned Spacecraft Center

INTRODUCTION

The management of the Manned Spacecraft Center in the execution of its Apollo Program responsibilities is an extremely complicated task. The progression from the Mercury Program to the Gemini Program and now to the Apollo Program has involved enormous leaps, not only in the technology involved, but also in the size and complexity of the task and, consequently, in the managerial job to be done. The Apollo Program is complex, but the management principles have evolved from the techniques used successfully on the Mercury and Gemini Programs.

The Apollo Program required advancing the state-of-the-art in many of the technological disciplines involved while simultaneously building the organizations and personnel to bring the Apollo Program through the ground test phase in preparation for the flight tests. In each of the major areas of its responsibilities--spacecraft development, crew training, and flight control, MSC has virtually had to "write the textbook," defining both what has to be done and how to go about it. Because of the interrelatedness of the three elements--spacecraft, crew, and mission, this effort has been one in which all MSC organizations have had to participate jointly from the beginning.

At the same time that this definition of requirements and specifications was taking place, MSC was increasing its staff from the 800 required for the Mercury Program to the 4500 Civil Service and 9,000 support contractor employees necessary for the Apollo Program. Unquestionably, an expansion of this degree would present serious management difficulties even in a routine commercial enterprise. Coming simultaneously with the need to define the job to be done, the challenge was enormous.

In response to these challenges, MSC leadership has evolved the management philosophy, practices, and tools presented in the following pages. Since there is no definitive textbook on the management of multi-billion dollar spacecraft developments, these ideas had to evolve over the life of the program, and may continue to evolve over the remainder of the program.

The purpose of this document is to describe the Apollo Spacecraft Management System. This Manned Spacecraft Center document describes the structure of the spacecraft management system, explains why it is structured as it is, describes and explains the organizational interrelationships involved in the system, and demonstrates how the system operates in practice. It outlines the mission, organization, and resources of the Manned Spacecraft Center. It details the functions, responsibilities, and authorities assigned to the Apollo Spacecraft Program Office (ASPO) and the functional relationships ASPO has with other MSC elements, other NASA Centers, NASA Headquarters, and other government agencies. The heart of the document is a discussion of MSC's management philosophy and a description of the program management processes employed. Various examples of program management are discussed to more fully illuminate the management philosophy and process. The document concludes with a discussion of future management plans.

SECTION I

CENTER FUNCTION AND SCOPE OF ACTIVITY

MISSION OF MSC

The MSC is a field installation of the National Aeronautics and Space Administration (NASA) and is under the direct cognizance of the Office of Manned Space Flight (OMSF).

The overall mission for MSC is to manage the development of spacecraft and related equipment, flight crews, and space flight techniques. In order to accomplish this mission, MSC has been assigned specific functions, as follows:

1. Providing overall planning and direction of all assigned aspects of major projects, including establishment of spacecraft design criteria, and coordinating the efforts of other NASA installations or Government agencies assigned related development responsibilities.

2. Conducting studies and development necessary for the advancement of manned spacecraft technology and performance capabilities.

3. Performing, in the accomplishment of flight tests and missions in execution of the Center's space vehicle development projects, the following:

   a. Directing the design and implementation of control system elements,

   b. Generating requirements for remote network elements, and

   c. Integrating overall ground operational support system.

4. Procuring spacecraft flight, control, recovery, and related systems according to assigned responsibilities; monitoring and directing contractor efforts; conducting acceptance tests at contractor plants, approving all deviations, waivers, and specification changes resulting from prelaunch test and checkout requirements; and conducting liaison with DOD units during design and installation of DOD operated systems.

5. Conducting flight crew selection and training program; designing and procuring simulation and training equipment.

6. Establishing requirements for flight tests and missions, developing test plans, test and mission directives, test procedures, and specific flight plans.

7. Planning and executing mission operational aspects of assigned manned and unmanned space flight projects under the direction of the Mission Operations Director, including the providing and training of flight control, tracking, data acquisition, communications, computations, and recovery crews.

8. Providing engineering support to spacecraft, assembly, checkout and launch, and other space program activities at NASA centers or DOD operating locations.

9. Reporting on the status of approved projects and recommending changes or modifications to meet goals and schedules, and interpreting and reporting results of assigned programs.

10. Conducting a medical research program to advance science's knowledge concerning the physiological and psychological capabilities of man in space, and conducting the medical operations program during manned tests and manned space flights.

11. Conducting lunar and earth science investigations in the areas of radiation and fields, solar physics, astronomy, atmospheric physics, optical experiments, and meteoroid sciences.

12. Developing, qualification and operational support of extra-vehicular life support systems which includes space suits and other systems.

13. Conducting earth science and applications programs such as the manned meteorology program and the earth resources survey program.

14. Providing administrative and management support as required for carrying out assigned functions and projects.

CENTER RESOURCES

CIVIL SERVICE PERSONNEL

At the close of FY 67 the Manned Spacecraft Center had an authorized strength of 4765. Included were 4634 permanent employees, 119 Cooperative Education student-trainees, and 12 Youth Opportunity Campaign students. These employees are distributed organizationally as shown in Figure I-1.

Figure I-2 shows the Center permanent manpower by profession. A very high percentage, 57%, of the Center's employees are trained and working in the areas of science, engineering, and medicine. This 57% is significantly higher than the overall NASA average of 38%. It is also higher than most government agencies involved in research and development.

FACILITIES

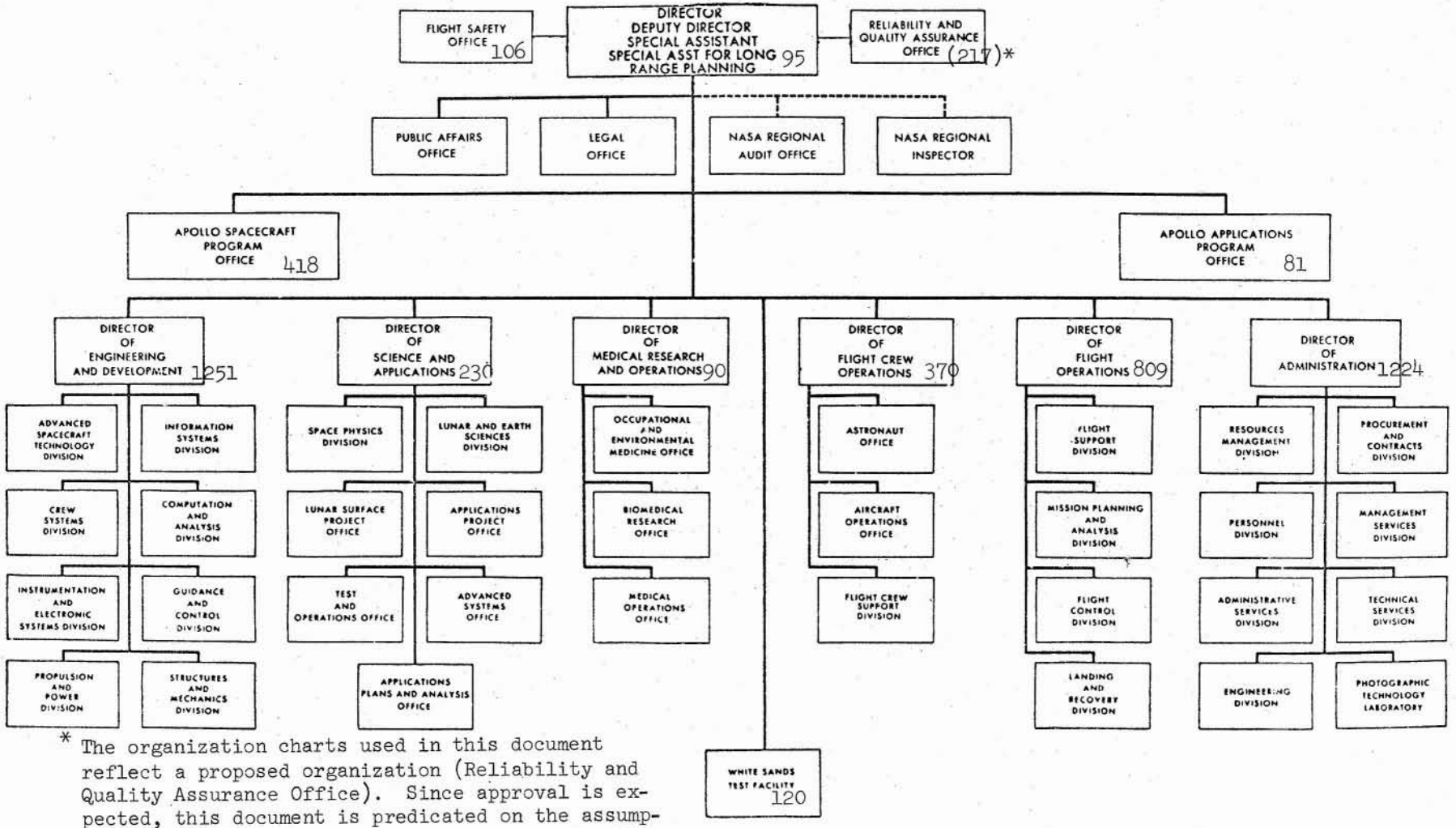
The facilities and equipment of the MSC are valued at more than $600,000,000. More than 60% of the floor space of the buildings is either general purpose laboratories or specialized test facilities.

FIGURE I-1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

HOUSTON TEXAS



* The organization charts used in this document reflect a proposed organization (Reliability and Quality Assurance Office). Since approval is expected, this document is predicated on the assumption that the organization will be approved. The R&QA will be staffed to the level shown by transfers within the existing Center authorization.

CIVIL SERVICE MANPOWER PROFILE

(By Profession)

PROFESSIONAL SCIENTIFIC, ENGINEERING AND MEDICAL	57%
PROFESSIONAL ADMINISTRATIVE	12%
SUPPORTING TECHNICIAN	8%
CLERICAL	19%
WAGE BOARD	4%
	100%

FIGURE I-2

Figure I-3 is a listing of the major facilities at MSC showing those facilities directly involved in research, development, test and evaluation of the spacecraft and other facilities directly involved in support of the Apollo, or any other spacecraft program.

MSC has a complete spacecraft test capability. The major spacecraft test facilities are:

Systems Evaluation Laboratory. Used for the detailed investigation of materials, spacecraft structural components, and complete structural assemblies under environmental conditions.

Anechoic Chamber Test Facility. Used for development and testing of antenna and communications in anechoic environment.

Instrumentation and Electronic Systems. Used for development and testing of electronic systems and subsystems of the spacecraft.

Flight Acceleration Facility. Consists of a centrifuge used to provide an environmentally controlled dynamic simulator.

Space Environment Simulation Laboratory. Has facilities for testing spacecraft under environmental conditions.

Ultra-high Vacuum. Laboratory for evaluation of spacecraft components under extreme vacuum conditions, heat transfer evaluations, gas leakage, and material phenomena.

Crew Systems Laboratory. Consists of altitude chambers, life support and space suit laboratories, materials development laboratories, and other support laboratories.

Antenna Range. Used for making full scale antenna pattern measurements for the Apollo vehicles.

MAJOR MSC FACILITIES

Administrative Support Office

*Anechoic Chamber Test Facility

*Antenna Test Range

Auditorium

Central Cafeteria

Central Data Office

Crew Systems Laboratory

*Electronic Systems Compatibility Facility

*Flight Acceleration Facility

Flight Operations Office

Garage

*Guidance and Navigation Office and Laboratory

*Instrumentation and Electronic Systems Laboratory

*Life Systems Laboratory

Logistics Support Warehouse

Lunar Mission and Space Exploration Facility

**Mission Control Center

Mission Simulation and Training Facilities

Printing and Reproduction Facility

Project Engineering Facility

Project Management

Propulsion and Guidance Offices

*Radar Boresight Range

**Radiation and Fields Acceleration Laboratory

SESL Contractor Support Facility

**Solar Telescope Facility

*Space Environment Simulation Laboratory

*Structures and Mechanics Office and Laboratory

Support Shop and Warehouse

**Technical and Engineering Services

Technical Services Shop

*Thermochemical Test Area

Translation and Docking Simulation Facility

*Ultra High Vacuum Facility

*Vibration and Acoustic Test Facility

*White Sands Test Facility

*Apollo RDT&E Support
**Other Direct Apollo Support

FIGURE I-3

Radar Boresight Range. Used for checking and correcting pointing accuracy on LM Rendezvous and Landing Radars caused by antenna orientation relative to the spacecraft.

Vibration and Acoustic Facility. Used for testing of spacecraft under simulated launch environments of noise and vibration.

Thermochemical Test Area. Used for development and testing of propellants and small scale explosive devices.

Radiological Laboratory. Used for evaluating the effects of gamma and neutron radiation on electronic systems and components.

A large percentage of the MSC resources at Houston are devoted to the Apollo Spacecraft Program. All of the laboratory, test, and office facilities at White Sands Test Facility (WSTF) are in direct support of, or house people whose major effort directly supports, the Apollo Program.

SUPPORT CONTRACTORS

In addition to the civil service personnel, over 9,000 contractor personnel directly support the spacecraft program activities at Houston. These contractors (Apollo prime contractors are not included) may be categorized as either mission support contractors or center support, laboratory operation, contractors. In addition, WSTF has one contractor providing both mission and laboratory operations support.

The major laboratory operation support contractors are: Lockheed Electronics Corporation, Brown and Root/Northrop, LTV Aerospace Corporation (Range Safety Division), General Precision (Link Group).

These support contracts are managed by a cognizant MSC functional organization and provide support to the functional organizations requiring support.

Lockheed Electronics Corporation provides laboratory operations support for the areas of guidance and control, instrumentation and electronic systems, information systems, and space science which includes radiation and fields, lunar surface technology, and meteoroid technology and optics. In addition, Lockheed provides computer programming, computer operations, and data reduction support for the Center.

Brown and Root/Northrop provides operational support for various laboratories and test facilities including the Lunar Receiving Laboratory, Space Environment Simulation Laboratory, Thermochemical Test Area, Life Systems Laboratory, Arc Jet Facility, and all the other major test and/or development facilities at the Center. This contract also calls for preventive maintenance and repair of most of these facilities.

LTV Aerospace Corporation (Range Systems Division) provides a facilities support program including control and operations of all utilities systems and plants; operate, maintain, repair, alter, and perform minor construction for certain facilities, roads and grounds; furnish rigging and test equipment and assembly support; and provide equipment maintenance and modification.

General Precision provides support to the Flight Crew Operations Directorate in the Simulator Complex at MSC and KSC. Maintenance, repair, modifications, and operations are included within the scope of the contract.

At WSTF, the LTV contract provides mission support for special laboratory equipment in the following laboratories: Data Processing Center, Materials and Processes, Physical Measurements and standards, Electrical Measurements and standards, and Systems and Material Evaluation.

The five major mission support contractors are: IBM, Philco, TRW, Boeing, and General Electric. These contractors provide support to both functional organizations and the program office.

The IBM contract provides support for the Real-Time Computer Complex (RTCC) of the Mission Control Center (MCC). The contract calls for IBM to design, develop, implement, program, maintain, and operate the RTCC. The Philco contract provides support to the MCC. The contract includes the design, development, implementation, maintenance, and operation of almost all of the equipment and facilities within the MCC. The General Electric contract provides for the design, development, implementation, maintenance, and operation of the Apollo Spacecraft Automatic Checkout Equipment. A second General Electric contract provides for support in the areas of spacecraft integration, checkout, and quality and reliability. The TRW contract provides engineering support for system analysis. The Boeing contract provides engineering and technical support for the integration and compatibility of the complete Apollo system, including launch facilities, boosters, spacecraft and lunar module, and supporting facilities and equipment. In addition, the Boeing contract provides for support of safety activities at MSC. Specifically, the contractor will develop a Systems Safety Plan including implementing guidelines and safety directives.

They will support the Flight Safety Office in identifying hazards, conducting hazard analyses and helping to prepare safety survey criteria for evaluating contractor's safety effort.

MAJOR APOLLO SPACECRAFT CONTRACTORS

Accomplishing the objectives of the Apollo Spacecraft Program involves three major contractors for the spacecraft:

North American Rockwell Corporation, Space Division, Los Angeles, California, for the Command and Service Module.

Grumman Aircraft and Engineering Co., Bethpage, New York, for the Lunar Module.

AC Electronics, Division of General Motors, Milwaukee, Wisconsin, for the Navigation and Guidance System - working in conjunction with Massachusetts Institute of Technology who designed the system.
Figure I-4 shows additional contractors and their geographical location.

INTERAGENCY SUPPORT

The Space Act of 1958, Section 102(c)(3), directed NASA to make effective and efficient utilization of scientific and engineering resources and provide for close cooperation with all interested agencies to avoid the duplication of effort, facilities, and equipment. NASA Policy Directive 1050.1 sets forth the guidelines for the formulation of interagency agreements.

DEPARTMENT OF DEFENSE SUPPORT

MSC derives most of its interagency support from various elements of the DOD.

NASA-S-66-8932

APOLLO SPACECRAFT CONTRACTORS

CONTRACTS AND SUBCONTRACTS $5,000,000 AND OVER

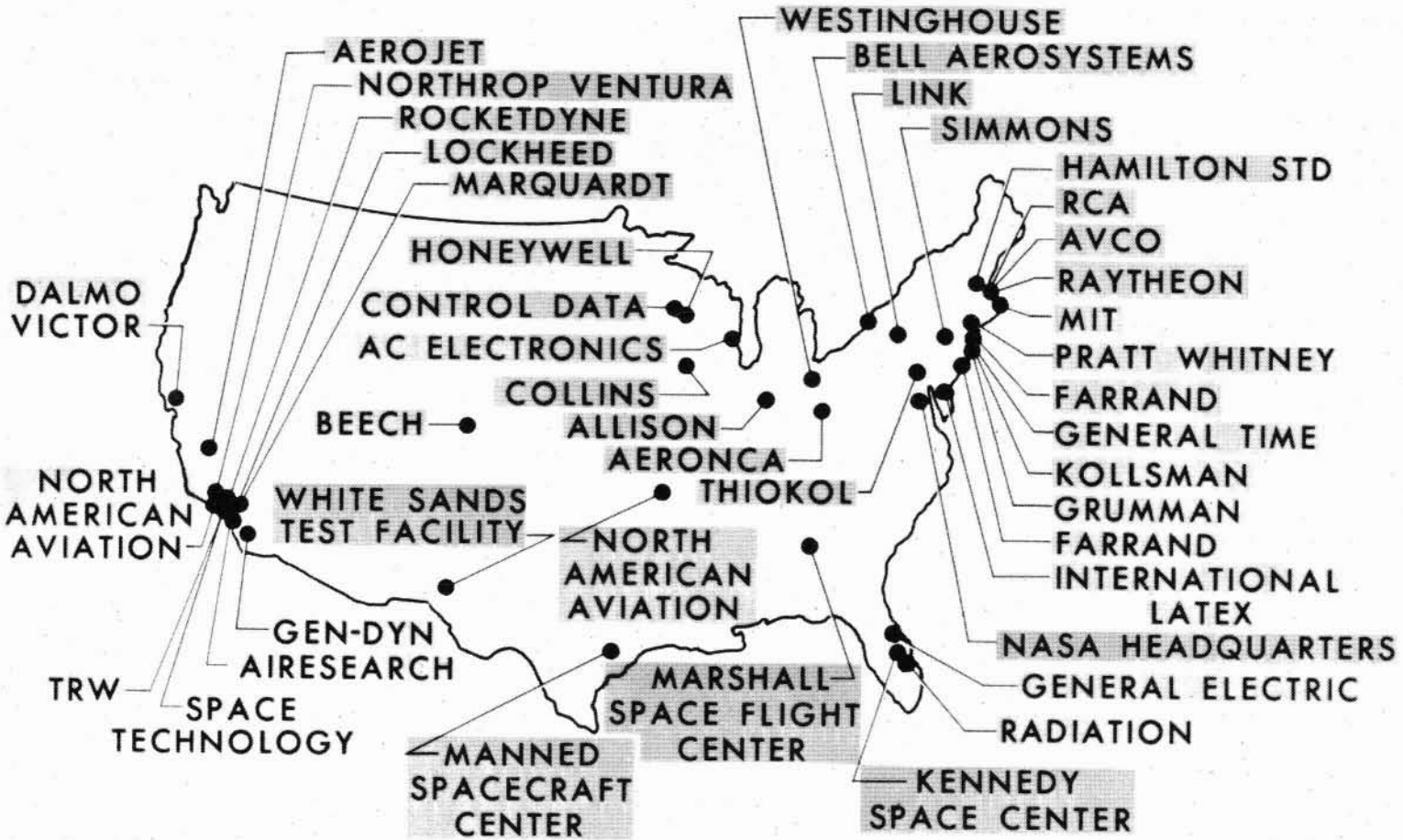


FIGURE I-4

PRIME CONTRACTOR
SUBCONTRACTOR
CENTER

In fact, there are over 65 interagency agreements in effect at the present time with the Department of Defense. These agreements provide for a wide spectrum of support ranging from contract administration services to spacecraft recovery operations.

In 1960, NASA and DOD established an Aeronautics and Astronautics Coordinating Board to assure a full exchange of information, technology, and provide for the most efficient utilization of available resources. As a result, each military service provides research and development support within various areas of the Apollo Program as well as a substantial amount of logistic support. In addition, the Corps of Engineers has provided site construction support since the MSC site was activated.

At White Sands Missile Range, the DOD has provided support in terms of services, personnel, equipment and facilities for some of the phases of the testing work performed by NASA-MSC personnel located at WSMR. This support was provided primarily during the flight qualification of the launch escape system for the Apollo Spacecraft Program.

Additional agreements provide for testing of various spacecraft systems including the lunar landing system, lunar module, and service module engines, earth landing systems, plus testing of various system components. Biomedical research and operations support is provided by the USAF Aerospace Medical Division and the USN Aerospace Medical Research Institute. The Air Force also supports MSC in such areas as lunar and extraterrestrial mapping and survey systems. The Defense Supply Agency provides procurement and contract field services on many of the Apollo spacecraft contracts.

Personnel of the Navy and Air Force located at certain contractor facilities provide contract administration field service functions in connection with several NASA prime contracts. These services include contract administration, engineering property administration, contract auditing, inspection, test and acceptance of the spacecraft, systems, or components, plus other services. It can be seen that the support the DOD provides is extensive and vital to the accomplishment of the mission of the Apollo program. However, the best known and perhaps most vital services provided by the DOD deal with the launch and recovery phases of the Apollo program.

Particular mention, at this point, ought to be made about recovery support provided by the DOD. Recovery operations and procedures are planned to cover all conceivable earth landing situations. The level of the support required is commensurate with the probability of landings occurring. The primary concern is the safe recovery and return of the spacecraft crew with the recovery, preservation, and return of scientific data and spacecraft as important secondary considerations. The recovery force is under the cognizance of the DOD recovery force commander.

Aircraft are used to support all landing areas. They work as a team, with ships, to provide capability for tracking and locating the spacecraft, on-scene assistance, and retrieval. To meet all contingency requirements, ships and aircraft are deployed on a world-wide basis. Typically, this means that ships are constantly on station in all planned recovery zones, and aircraft are predeployed to advance staging bases in all parts of the world. The anticipated reaction time to locating the spacecraft to support preferred target points is one-half hour while the time-to-support contingency areas or alternate target points is two hours.

In addition to locating and recovering the spacecraft crew, the DoD provides preliminary medical assistance, if required.

CIVILIAN AGENCY SUPPORT

Among the civilian agencies providing support are the Department of Commerce and U.S.G.S. The Department of Commerce provided prelaunch, flight, and recovery weather information, while U.S.G.S. provides support for lunar surface mapping and flight crew geological training. The U.S. Public Health Service has detailed employees to MSC for work in biomedical research and has also performed biomedical research for MSC in their laboratories.

Another group of agencies providing support to the Apollo program comprise the Interagency Committee on Back Contamination. These agencies are the Departments of Agriculture and Interior, the Public Health Service, and the National Academy of Sciences. The purpose of the Committee is to provide to NASA the specialized knowledge and experience of the agencies in order to protect the public's health, agriculture, and other living resources against the possibility of contamination resulting from the manned lunar landing and to preserve the integrity of the lunar samples. The Committee has provided support to MSC in the design and construction phases of the Lunar Receiving Laboratory (LRL) and will continue to support the program until a determination is made that there is no danger to the earth's resources from lunar contamination.

SECTION II

MANAGEMENT PHILOSOPHY

GENERAL DISCUSSION

The organization and management of the Apollo Program are based upon several early decisions which, in effect, constitute the basic philosophy of NASA. Primary among these decisions was that NASA would be an agency which performed technical management of a government-contractor team rather than design and manufacture its own hardware in NASA facilities. It was also decided that the Ground Test Program would be conducted by the contractors utilizing specialized NASA-owned facilities such as the Thermal Vacuum Chamber at MSC and the static test stands at the Mississippi Test Facility. The Flight Test Program would be conducted by NASA with contractor support as required. Spacecraft design was to be no more complex than necessary to assure successful mission performance, and manned flights would proceed only after all hardware had been thoroughly tested on the ground and in flight for performance and reliability and man has been proven ready to safely perform the mission. Based upon these decisions, a philisophy for management was developed, organizations were formed, and facilities were planned.

Among the first things to be decided was the matter of the division of responsibilities and functions between NASA and the contractor-members of the team. In view of the fact that NASA could not hand the contractors detailed specifications for the desired product and that the contractors were not experienced spacecraft manufacturers, it was inevitable that the job would be a team-effort. Both NASA and contractor personnel would have to work together to plan the program, ascertain requirements, develop specifications, and design the hardware.

In spite of the lack of a clear-cut separation of the customer and producer roles, MSC has tried to keep its role defined and to work within that definition. This has been done, first, because MSC does not have the manpower to do the contractor's job, but also in order to not dampen the contractor's incentive and initiative with excessive government direction and control. MSC has defined its role as follows:

a. It is the NASA/MSC responsibility to define the spacecraft requirements. Stating in definite terms the environmental conditions to which the spacecraft will be subjected, requirements evolve as information is gained through simulated ground testing and unmanned data gathering missions.

b. The contractor develops an approach to satisfying the requirement based on broad guidelines provided by NASA/MSC. At selected points in this development NASA/MSC reviews, makes recommendations, and/or approves the approach.

c. Development articles are selected for testing in simulated environments to demonstrate that the design has met the prescribed design requirements and is ready for release for production. Production hardware is subjected to qualification testing and is certified to be within operating limits prescribed in the requirements. All electronic, electrical, and electro-mechanical equipment which do not have proven/demonstrated reliability will be subjected to qualification testing during the early phases of development.

d. NASA/MSC provides interfacing and supporting equipment (GFE) that has been procured separately. The basic requirement for development and qualification testing and piece part certification is identical to that required for CFE as outlined in paragraph c. above.

e. NASA/MSC must manage the program. That is, the government must make the decisions on major redirections of the program and monitor the efforts of the contractor to ensure adherence to specifications, quality of the product, proper responsiveness to schedules, and appropriate attention to costs.

f. NASA/MSC Administrators, Managers, Scientists, Engineers, and Technicians have a responsibility to transfer knowledge gained in spacecraft development to the next generation of spacecraft. This is accomplished primarily in the retention of knowledgeable personnel. Information is stored in established data banks and microfilm drawing files. However, the information is made useful and dynamic only when knowledgeable people transpose the information into applicable systems. The Center captures the spacecraft heritage for the next generation to build upon. The Apollo Program Data Management System provides NASA-wide guidelines for the kind of documentation required to document this spacecraft heritage. The Center and Apollo Data Managers, Technology Utilization Office and the Technical Library are the key MSC officials and organizations for implementing the Data Management System.

Contract awards for major spacecraft programs are made only to those contractors who thoroughly understand and comprehend the magnitude of the task. In its negotiating procedures and exchange of information, the NASA takes every precaution to insure that the contractor thoroughly understands what is expected of him.

The contractor then proceeds with the procurement of facilities (if required) machinery, material, and manpower usually in that order. The contractor provides evidence periodically to the effect that he is meeting key milestone dates included in the contract.

MSC ORGANIZATIONAL CONCEPTS

The two organizational concepts used at MSC are the functional, or line, organization and the program organization. The functional organization is the conventional organization structure consisting at MSC of directorates responsible for engineering and development, flight operations, crew operations, medical research and operations, space science and applications, administration, plus certain staff offices. Each of these operate in a fairly autonomous manner and participate as necessary to achieve over-all Center objectives.

FUNCTIONAL MANAGEMENT

Functional management was formally established as an operating concept within NASA following the reorganization of 1961. Within MSC, functional management means the provision of centralized professional leadership and continuous monitoring, evaluation, and reporting to senior Center officials on Centerwide policies, procedures, and operational practices in a given functional area.

Generally, a functional area is a specific professional or managerial discipline such as Medicine, Space Science, Mission Operations, or Flight Crew Operations. However, a functional area may also be an important external relationship or pattern of activities which, in total, represent a significant area of specialization.

Within his assigned functional area, each functional manager is responsible for: a. Recommending to the Director and Deputy Director over-all Centerwide operating concepts and policies. b. Implementing policy decisions through promulgation of operating practices and procedures.

c. Reviewing and evaluating the continuing effectiveness of policy and practice and recommending changes or corrective actions to the appropriate authority. d. Providing the Director and Deputy Director with regular appraisals of overall Center performance and quality of effort; including timely notification of significant problems, events, and accomplishments. e. Providing maximum assistance and support to institutional and program line management in Headquarters and in other field Centers. f. Incorporating advanced techniques and practices to improve performance. g. Integrating the concepts and operations of his functional efforts with those of other functional areas and institutional and program line activities.

APOLLO PROGRAM MANAGEMENT

The program organization is one established for, and tailored to, a specific program such as Apollo, as a general management activity responsible for the planning, control, supervision, engineering, and manufacturing activities involved in producing the hardware end item. It is similar to the functional organization in that it is basically getting work done through people. It differs however, in ways which have far-reaching effect. The program organization has very specific objectives which, when achieved, mean the end of the organization. The program manager has no line authority over the functional specialists who are so important to the program's objectives.

Each of these organizational concepts has obvious advantages and disadvantages and, in almost every case, the advantage of one coincides with a disadvantage of the other. For example, a program organization provides full-time attention of its personnel to accomplishing the program's objectives; a functional organization does not. A functional organization provides a reservoir of personnel skilled in a particular functional area;

a program organization does not. A program organization provides program visibility and a focal point for all program matters; a functional organization does not. A functional organization provides freer interchange of ideas and problem solutions in a given functional area; a program organization does not.

It has been said that program organization has something in common with weaving: it involves the interlacing of the traditional vertical "stands" of organization, with the horizontal "fibers" of program organization into a fabric-like matrix. Thus, two complementary management organizations exists: the vertical functional organization, and the horizontal program organization with a resulting matrix structure extending across such functions as engineering, budgeting, contract management, and procurement. A series, or hierarchy, of matrices evolve because program management at MSC involves intracenter and intercenter functions and often one or more other government agencies.

Since the beginning of the Apollo Program, MSC has operated with this joint program/functional organizational matrix which capitalizes on the advantages of each concept and minimizes the disadvantages. It is believed that an organization of this type, with proper balance of responsibility and authority between the program and functional organizations, is the optimum one for the Apollo Spacecraft Program. A detailed analysis of the ASPO philosophy is a separate chapter of this document.

INTER-CENTER PANELS CONCEPT

Inter-Center Coordination Panels, acting under Co-chairmen from the Centers involved, define and solve the technical interface problems between the

Spacecraft launch vehicles, facilities, and associated equipment. Basically, these panels are engineering and operational working groups responsible to a Panel Review Board (PRB) chaired by the Apollo Program Director. Eight panels and 24 sub-panels make available the technical competence of OMSF, MSFC, MSC, KSC, and their contractors for the solution of interface problems. The panels and sub-panels function within specific assigned areas to: (1) initiate actions regarding design, analysis, study, test, and operations, (2) identify and generate Interface Control Documents (ICD's) within established Program requirements, and (3) recommend solutions of problems outside their assigned responsibility to the PRB for action by the proper panel and organization. A detailed discussion of the Inter-Center Panels is contained in the Headquarters Volume.

FORMAL DIRECTION CONCEPT

The MSC Issuance System is used to publish management issuance of general Center-wide interest which prescribe, establish, or define policy, organization, methods, procedures, or guidelines, or that contain authority or information that must be promulgated formally. Issuances do not reflect internal operations of an element, nor do they reflect operational agreements between elements unless the inclusion of such material in the system is clearly necessary to inform other elements that have a need to know. They are brief, direct, and to the point, and do not duplicate material adequately covered in NASA Issuance System. There are three types of issuances in the MSC Management Issurance System:

(1) MSC Management Instruction

Used for policy-type material; general procedures that briefly describe who does what, where, and when; and for other information of a continuing nature. (See Example under Implementation of Apollo Program Directives in Appendix A).

(2) MSC Announcement

Used when there is a need to issue a large amount of highly specialized subject matter.

(3) MSC Complementary Manual

Used when there is a need to issue a large amount of highly specialized subject matter.

(a) Safety Manual

(b) Personnel

(c) Security

SECTION III

ORGANIZATION AND RELATIONSHIPS

GENERAL DISCUSSION

The organizational structure, as shown in Figure III-1, is designed to implement the MSC management philosophy of attaining the maximum utilization of the available resources at MSC in furthering the Apollo Spacecraft Program. The overall mission of the MSC has already been discussed. An examination of each major supporting element will follow, in order that the interrelationships may be better understood. Figure III-2 presents a summary of the Apollo support provided by MSC elements.

ORGANIZATION AND RELATIONSHIPS

The Director and Deputy Director are responsible for the implementation of all policy, programs, and directives affecting MSC, established and issued by NASA Headquarters. Implementation action is usually delegated to the cognizant program manager, or functional manager within MSC. Therefore, it is the responsibility of all MSC senior officials to insure that all such direction from NASA Headquarters be routed to the Director and Deputy so that action can be assigned to the appropriate official. Similarly, when Headquarters direction requires a reply by MSC, it is prepared for the approval and signature of the Director or Deputy.

The MSC Deputy Director is involved in the total spectrum of Center activities, including the Apollo Spacecraft Program. The Deputy is delegated authority to take final actions effecting all phases of the MSC program, bringing to the Director's attention only those matters where basic policy or program matters require his personal attention.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

HOUSTON TEXAS

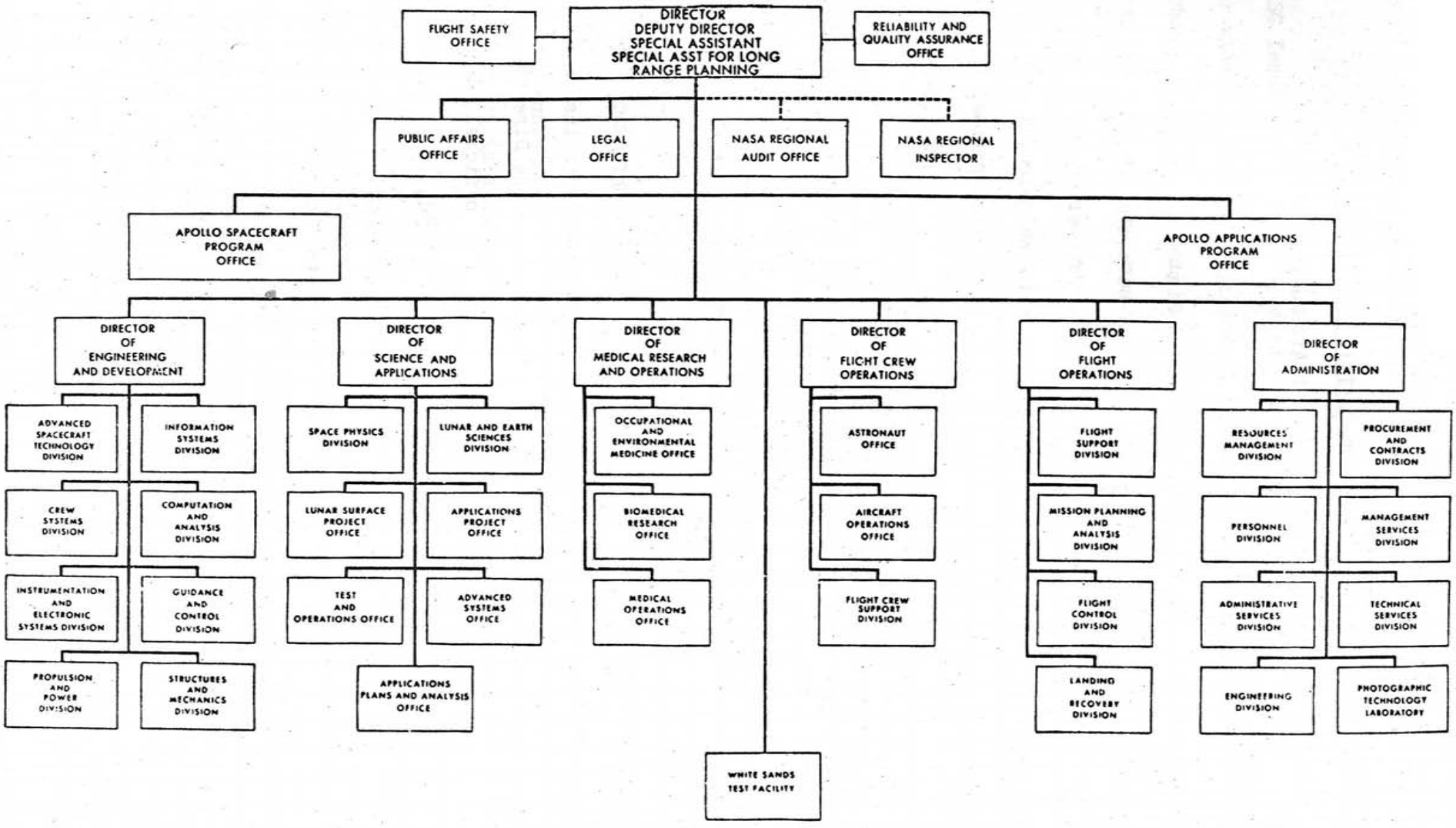


FIGURE III-1

MSC SUPPORT ELEMENTS TEAM

ENGINEERING AND DEVELOPMENT DIRECTORATE	FLIGHT CREW OPERATIONS DIRECTORATE	FLIGHT OPERATIONS DIRECTORATE	ADMINISTRATION DIRECTORATE	MEDICAL RESEARCH AND OPERATIONS DIRECTORATE	SCIENCE AND APPLICATIONS DIRECTORATE
· SUBSYSTEM MANAGEMENT	· CREW SYSTEM EVALUATION	· GSE SUPPORT	· FACILITIES	· IN-FLIGHT MEDICAL EXPERIMENTS	· IN-FLIGHT EXPERIMENTS
· TEST AND TEST SUPPORT	· CREW TRAINING HARDWARE SUPPORT	· TRAJECTORY ANALYSIS	· TECHNICAL SERVICES	· TEST OPERATIONS SUPPORT	· LUNAR EXPERIMENTS
· INSTRUMENTATION		· PREFLIGHT, FLIGHT AND POSTFLIGHT SUPPORT	· ADMINISTRATIVE AND MANAGEMENT SUPPORT	· FLIGHT OPERATIONS SUPPORT	· LUNAR RECEIVING LABORATORY
· COMPUTATION SUPPORT					

WHITE SANDS TEST FACILITY

· DEVELOPMENTAL TESTING

· OPERATIONAL TESTING

FIGURE III-2

In carrying out their responsibilities, the Director and Deputy rely heavily on the Special Assistant and the Director of Administration. The Special Assistant serves as a focal point for the technical activities of the Center. All of the decisions and information coming to the Director or Deputy flow through the Special Assistant who: reviews all staff work to assure that completed staff work has been done; to assure that the material submitted has been properly coordinated and that related problems have been identified and resolved; and to assure that meetings and presentations are handled in a similar expeditious manner.

The Special Assistant assists the senior officials in resolving intra- and inter-organizational problems that can be resolved by closer coordination and improved communication within, and between, the organizations.

Thus, the role of the Special Assistant is not to supervise, but to coordinate the actions of the senior officials who report to the Director and Deputy. his job is to help these officials define problems and identify solutions, when possible, which allows the Director and Deputy to utilize their time and efforts most effectively and productively.

The Director of Administration is responsible for the effective control of the total integrated management of MSC and its programs. He is responsible for relieving the Director and Deputy of as much as possible of the recurring management of MSC's nontechnical affairs. In the areas of budget, procurement, manpower, and supporting services, he is authorized to act on behalf of the Director and Deputy on all matters except those specifically reserved to the Director.

Those specific areas in which the Director of Administration is authorized to act for the Director and Deputy include the following: (1) Conducting program reviews with functional Directors and developing the final Center budgetary position; resolving major issues and policy questions with the Director; and recommending necessary reprogramming actions to NASA Headquarters as required. (2) Determining most suitable method of procurement to be utilized for major MSC contracts; reviewing and approving procurement plans; serving as the source selection official or advising the Director or Deputy when they are the selecting official; and serving as Chairman of the Center Award and Incentive Fee Boards. (3) Approving MSC manpower management plans to reflect the Center's total resources capability, including civil service and contractor; validating the Center's manpower planning through the use of various manpower utilization and validation techniques; and allocating manpower to major Center elements. (4) Providing overall guidance to MSC elements on the management aspects of their functions.

Flight Safety Office

The Flight Safety Office is responsible for establishing the safety policies, standards, criteria and procedures for the MSC and for maintaining a high management level safety awareness and visibility into all aspects of the development and test programs of the Center. The FSO jurisdiction includes hardware, software and mission operations related to manned ground and flight tests. FSO has the following specific functions:

Developing safety policies, standards, and procedures and application to MSC and its contractor.

Reviewing and evaluating the effectiveness of MSC and contractor in carrying out safety program requirements.

Providing management and administrative staff for man-rated test facility review boards.

Participating as the senior advisor to the MSC Director and Deputy, in major design reviews and spacecraft acceptance and test readiness reviews.

Participating on accident investigation boards related to manned test activities.

Reviewing mission and program plans and performing the following:

In-depth safety analysis of critical systems and subsystems.

Safety evaluation of critical systems and subsystems.

Safety reviews of spacecraft software.

While only about 25 civil service personnel are directly assigned to the FSO, about six to nine percent of the center personnel complement have safety related responsibilities ... manufacturing, construction, testing, mission planning, etc. In fact, safety is an inherent part of the job of everyone who has an input to the design, manufacturing, construction, mission planning and mission operations involved in the Apollo program. Figure IV-3 depicts the MSC/FSO Functional Relationships.

The Flight Safety Office is comprised of three groups -- Flight Safety Operations, Flight Safety Analysts, and Manned Test Operations. The Flight Safety Operations Office (Cape) is located at KSC. This office has the following functions and responsibilities:

Supports pre-operational safety reviews of operational checkout procedures.

MSC/FSO FUNCTIONAL RELATIONSHIPS

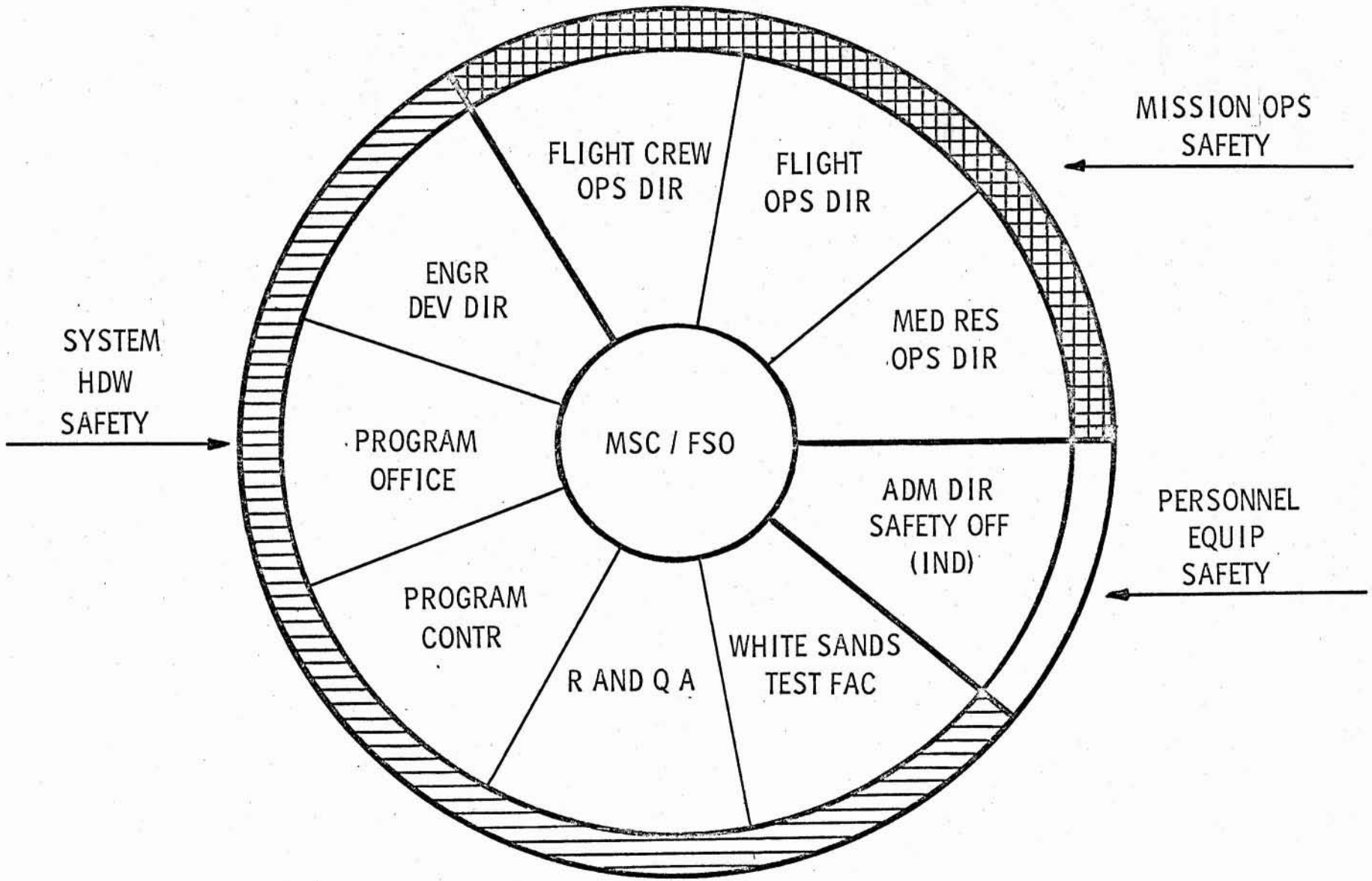


FIGURE III-3

Review test and checkout requirement documents.

Point of contact on flight safety problems for KSC-based MSC offices of APO, medical, and flight crew.

Point of contact for local S/C contractor operations offices and after offices involving safety problems of: Abort, Recovery, Rescue, Range Safety.

Maintains MSC coordination and management liaison on flight safety problems.

The Flight Safety Analysis Office has the following functions and responsibilities:

Identifies potential accidents and recommends resolutions.

Systems hardware safety evaluation and analysis.

Missions operations (including crew procedures) safety evaluation and analysis.

Operation and system analysis integration.

Monitors, evaluates and supports center and contractor safety activities.

Participates in reviews.

Provides technical support on special boards and accident investigation teams.

Provides interface with MSC directorates, program offices, Headquarters, and other NASA Centers.

The Manned Test Operations office has the following functions and responsibilities:

Reviews and evaluates effectiveness of manned testing safety policy, standards, and procedures.

Manages and administers man-rated test facility review board.

Verifies implementation of board recommendations.

Reviews facility test plans.

Establishes accident investigation procedures.

Participates as advisor on accident review board.

In addition to the civil service personnel of the FSO, the Boeing contract provides support to the flight safety activities of MSC. Most of the Boeing personnel are systems safety specialists. The civil service and contractor personnel involved in the flight safety programs provides the capability to make a complete and independent examination of systems and missions characteristics from the safety viewpoint.

Reliability and Quality Assurance Office

The Reliability and Quality Assurance Office (RQAO) is responsible for the overall planning, coordination and direction of the Manned Spacecraft Center (MSC) reliability and quality effort. This responsibility includes the development and management of Center, contractor and government agency reliability and quality programs to insure that the flight and ground equipments procured under MSC contract, or fabricated on site, comply with reliability and quality standards established by the RQAO for the Center's programs. The functions and responsibilities of the RQAO include:

Establishing reliability, quality and inspection requirements and criteria for spacecraft, subsystems and supporting equipment.

Insuring implementation of R&QA requirements and criteria at contractors' plants and MSC sites.

Implementing the development, review and approval of MSC engineering design standards and criteria.

Establishing Certification Test Criteria, approving Certification Test Plans and Reports.

Establishing and assuring implementation of policies to provide parts and materials identification, usage and qualification information for critical spacecraft hardware and GSE.

Participating in a program of exchange of R&QA information with other NASA elements, other government agencies and industry.

Serving as advisor to director for R&QA aspects of design, manufacturing, checkout, acceptance and flight readiness reviews.

Reviewing and evaluating programs for R&QA training of inspection personnel.

The R&QA Office is structured organizationally according to clear cut functional disciplines of Reliability and Certification, Quality Engineering, Quality Control, and Quality Assurance. The Quality Assurance organizations located at the contractors' plants in resident offices, are hardlined to the MSC R&QA Office and take technical direction and supervision from this office; however, the day-to-day work activities are directed by the local R&QA manager in accordance with the requirements of the Resident Apollo Manager. The same operational rationale applies to the R&QA operation at White Sands Test Facility.

Within the R&QA Office there is a special support staff office which handles data management and arrangement for spacecraft major review activities that the R&QA Office is involved with. This staff office is also involved in many of the administrative and interface activities with General Electric, the supporting contractor for R&QA activities. Another staff office

implements support to the R&QA and FS Offices for the development, review and issuance of the various kinds of documentation required.

In addition to the MSC civil service personnel assigned to R&QA functions, there are a large number of DOD personnel supporting the spacecraft R&QA program. These personnel, representing the Defense Contract Administration Service (DCAS), Navy, and Air Force, are located at contractors' plants and at White Sands Test Facility. There are over 1,000 people involved on a full-time basis in the total MSC R&QA program.

The prime spacecraft contractors also have extensive R&QA organizations. The functions and responsibilities of the contractors include:

Implementing a system and preparing plans for MSC approval to control the R&QA programs in accordance with MSC requirements.

Assuring that design specifications are capable of meeting R&QA requirements.

Preparing failure mode and effects analysis by subsystem and end-item.

Preparing operational readiness estimates by launch complex and flight end-item to assure launch window capability.

Providing for vehicle assessments at various R&QA milestone reviews including CARR's and FRR's, and furnishing in-process, final assembly and checkout inspections.

Maintaining a closed-loop discrepancy and failure reporting, analysis and corrective action system.

Providing control of electronic, electrical, electro-mechanical parts utilized in flight vehicles.

Maintaining a certification system to assure that all applicable qualification and higher level requirements and testing are accomplished prior to FRR's.

Providing surveillance of supplier quality operations and receiving inspection.

Providing material review, process control, and inspection planning.

Engineering and Development Directorate

The Engineering and Development Directorate is responsible for the technical support in depth for the Apollo and Apollo Applications Programs through the direction of assigned system and subsystem work of the respective program contractors, and through extensive in-house test and evaluation programs which are a part of the program development milestones. The Directorate also provides Center long-range technical planning, directs the Center's supporting research technology programs, and conducts advanced studies for future programs. For mission support, E&D administers the following areas:

1. Analyzing spacecraft-to-ground communications and tracking systems electronic compatibility and performance.

2. Establishing systems analysis in the field of guidance and control.

3. Developing new applications and techniques of digital computation and data reduction for support and providing the capability for furnishing these services.

4. Developing, testing, and evaluating life support systems for use in the Apollo missions and conducting medical research programs which culminate in medical flight experiments.

5. Post flight analysis of the performance of spacecraft systems and subsystems.

Flight Operations Directorate

The Flight Operations Directorate is responsible for operational mission planning and the overall direction and management of flight control and recovery activities associated with real-time mission progress accessment, and ground-based decision-making functions for all MSC space flight missions. In addition, this Directorate is responsible for implementation of MSC's Manned Space Flight Network instrumentation requirements, configuration and operation of the Mission Control Center, Houston (MCC-H), and for operational evaluation and testing of landing and post-landing systems. Flight Operations will be dealt with in depth in a subsequent chapter of this document.

Flight Crew Operations Directorate

The Flight Crew Operations Directorate is responsible for flight crew selection, training, and mission performance. In addition, it is responsible for technological and engineering contributions to the development of flight hardware and scientific space experiments.

Science and Applications Directorate

The Science and Applications Directorate is responsible for the planning and implementation of MSC programs in the areas of space and earth science and their application to the space program and knowledge generally. It establishes flight test objectives and requirements and manages experiment support systems. It also acts as the focal point for coordination and control of the MSC elements involved in these programs, and as the point of contact with the scientific community.

Medical Research and Operations Directorate

The Medical Research and Operations Directorate is responsible for implementing and evaluating MSC's medical effort and serving as medical spokesman for MSC to the medical community. Specific responsibilities include biomedical research, management of medical in-flight experiments, the MSC occupational medical program, and for providing mission support for manned space flights.

The Medical Research and Operations Directorate conducts required training and medical briefings of flight crews and of appropriate ground support personnel prior to missions, and for coordinating needs with the Department of Defense for medical support. This Directorate furnishes medical consultation to assist in identifying and making provision for medical requirements during mission planning and flight. In addition, this organization conducts extensive post-flight medical examinations, debriefing of the crew and medical monitors and reduction of biomedical recording date.

Administrative Directorate

The Administrative Directorate has the responsibility of providing contract management, procurement functions, other technical and administrative support for the Center and serves as the principal advisor to Center officials on administrative and management problems. It provides direct mission support for facilities maintenance, security, and other housekeeping functions.

White Sands Test Facility

The White Sands Test Facility conducts or directs developmental and operational tests with emphasis on propulsion testing and provides common purpose laboratories, facilities, instrumentation, and other engineering and support services for conducting these tests. Test projects are conducted within the scope of test directives originated by MSC program offices or technical divisions.

Apollo Applications Program Office

The Apollo Applications Program Office is responsible for the over-all planning, coordination, and direction of the Apollo Applications Program (AAP) elements assigned to the Manned Spacecraft Center through the supervision of industrial contractors and by the planning and control of resources and schedules; and acts as the Center focal point for all MSC and other NASA elements involved in this program.

APOLLO SPACECRAFT PROGRAM OFFICE

The management of the Apollo Spacecraft Program is assigned to the Apollo Spacecraft Program Office (ASPO). The MSC Apollo Program Manager directs the activities of this office and reports organizationally to the MSC Director and Deputy. He is responsive to program direction from the Apollo Program Director under the overall direction of the Program Management Council. The Apollo Program Manager is delegated the authority for the overall coordination, planning, and direction of aspects of the Apollo Project that are assigned to the Center; he is the primary and official interface between NASA and the contractors participating in his assigned project. The ASPO organization is shown in Figure III-4.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
APOLLO SPACECRAFT PROGRAM OFFICE

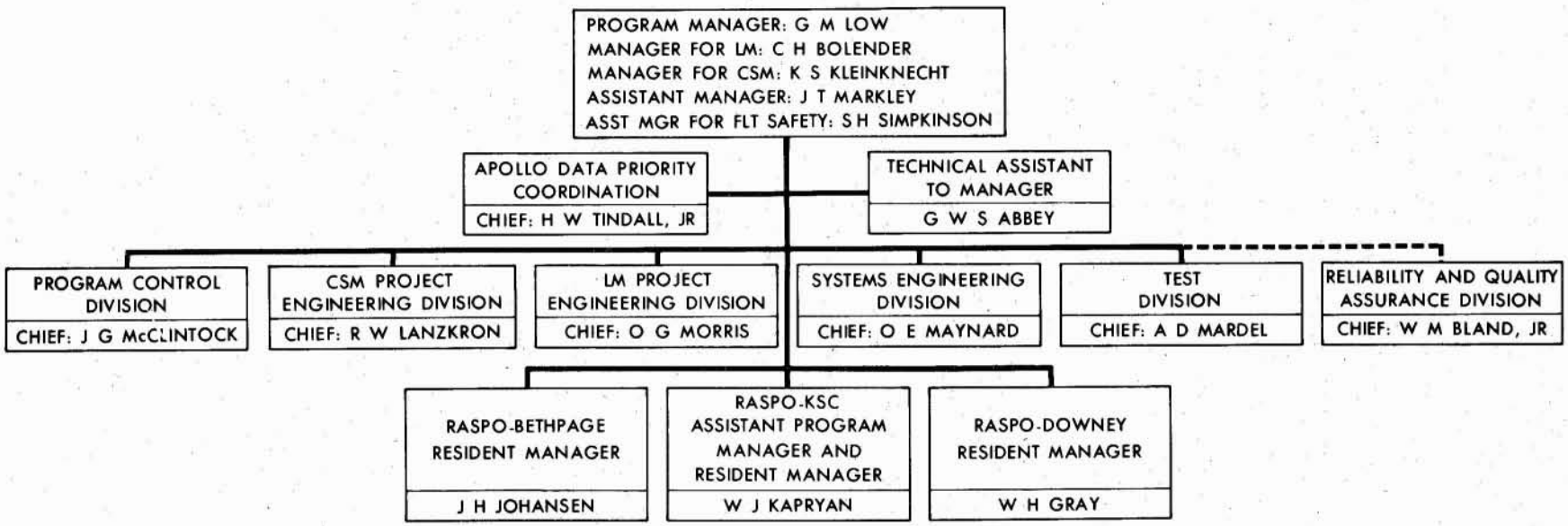

FIGURE III-4

The ASPO, under the direction of the Apollo Program Manager, is responsible for the planning, coordination, and direction of all aspects of the Apollo Spacecraft Program. This includes the supervision of industrial contractors within the scope of the contract and the direction and coordination with other elements of MSC or NASA Headquarters which are assigned parts of the program. Specific responsibilities include:

a. Development of the Apollo Spacecraft Program resources and scheduling plans, their integration and development into an overall program development plan and the control of the implementation of this plan.

b. Serving as the primary point of coordination and control of systems design, specification, and development for the Apollo Spacecraft Program.

c. Development or approval of spacecraft subsystems design requirements, the performance of trade-off studies, the definition and control of all interfaces between spacecraft subsystems and the spacecraft, interfaces between other related program elements, and the development and maintenance of all crew safety requirements.

d. Management of the detailed planning, implementation, and reporting of results for each major flight and integrated systems ground test.

e. Coordination and development of the test program plan, the development of the mission directive documents, the determination of instrumentation and measurement lists and requirements, the determination of engineering data acquisition and reduction requirements, the establishment of detailed schedules, and the determination of the adequacy of checkout procedures for each major flight and integrated systems ground test.

f. Development of the basic design of the Lunar Landing Mission and the development of criteria for the training of the spacecraft crew for the Lunar Landing Mission.

Manager, Command and Service Module and Lunar Module

The Managers, Command and Service Modules and LM, are responsible respectively to the Manager, Apollo Spacecraft Program, for all matters pertaining solely to or affecting the Command and Service Module and LM. They are responsible for keeping the Manager fully informed on the status of the work and for referring to him those matters requiring either approval of the Director, or coordination with OMSF or other NASA Centers, and matters involving other aspects of the Program. As Chairman of the C&SM Configuration Change Panel, the Manager, CSM, approves or disapproves all changes not included in the categories in the Memorandum of June 17, 1967. (See Appendix D)

Each of these managers is also responsible for all noncontractual direction given to the prime contractor but has the authority to delegate as he chooses.

Specific responsibilities, as defined in MSC Announcement No. 67-33 and 67-34, February 20, 1967, are:

a. Directing the design, development, and fabrication program contracted by NASA with the prime contractors for the CSM and LM.

b. Directing and planning detailed systems engineering and systems integration functions for the project, including review of engineering design work and systems engineering studies conducted by the contractor.

c. The development of the program of ground and flight tests conducted at White Sands, MSC Houston, and the Kennedy Space Center.

d. Monitoring contractors' operations to assure adherence to specifications, to identify and solve problems which might impede development of systems or subsystems.

e. Directing subordinate functional chiefs on all vehicle problems associated with the project, and resolving or securing resolution of major technical, flight and program problem areas.

f. Chairing the Configuration Control Panel for Command and Service Module and LM.

Assistant Program Manager for Flight Safety

The Assistant Program Manager for Flight Safety assists the Apollo Spacecraft Program Manager and the Managers for the Command and Service Modules and the Lunar Module in the attainment of the necessary product assurance for the Apollo Spacecraft. His duties involve the interrelationship of the Manned Spacecraft Center with the Kennedy Space Center, North American Rockwell and Grumman Aircraft Engineering Corporation, as well as other supporting industrial concerns.

He assures that the policies and procedures of the Manned Spacecraft Center's Flight Safety Office are carried out and implemented throughout the Apollo Spacecraft Program and performs his functions in coordination with this office. Furthermore, he conducts special studies and reviews and solves specific problems in the general areas of safety of operations during test, checkout, and flight of the Apollo spacecraft; reliability and quality of spacecraft and ground support equipment; and ground test programs, preparations for flight, and flight tests.

Assistant Program Manager, KSC

The Assistant Program Manager, KSC, is physically located at KSC for the purpose of exercising on-the-spot authority within the limits established

by the Manager and providing direct liaison with KSC officials with responsibilities for execution of the Apollo program.

The Assistant Manager, KSC, has the following responsibilities:

a. Maintaining close contact with the Spacecraft Operations Director, KSC, on all problems relating to spacecraft preparation or checkout, including the status of and problems arising during the course of checkout.

b. Submitting MSC Test and Checkout Requirements and Specifications to KSC; approving KSC Test and Checkout Procedures, and approving those procedures affecting flight crews (as delegated by the Directors of Flight Operations and Flight Crew Operations); approving KSC Test Start Conditions when MSC approval is required (as delegated by the Directors of Flight Operations and Flight Crew Operations); and approving KSC Test and Checkout Requirement Waivers and Deviations, and any changes in spacecraft configuration at KSC subject to RQAO and FSO concurrence. (These authorities are spelled out in greater detail in MSC Management Instruction 8050.1, June 8, 1967. See Appendix A.)

c. Maintaining contact with other KSC officials as appropriate and representing the Apollo Spacecraft Program Office on all matters relating to the Apollo Program, including maintaining contact with the Launch Operations Director and other KSC officials on such matters as schedule changes, changes in operation which require modifications in facilities, etc.

d. Securing the approval of the MSC Apollo Spacecraft Program Manager on all problems associated with the Apollo Program which require the personal approval of the Program Manager, including problems which

have a serious impact on launch dates, preparation of the spacecraft for flight, etc.

Division Chiefs

The chiefs of the functional divisions are responsible for the management of their respective organizations and for the technical quality in their respective engineering disciplines and activities.

Project Officers, C&SM and LM

Project Officers are those individuals designated for specified contracts who are responsible to the Chief, Program Control Division, for:

a. "Signing-off" for ASPO all direction to the contractors within the scope of the contracts.

b. Placing requirements on MSC functional organizations for review or action on contractor-generated correspondence or documents.

c. Assuring proper coordination on all proposals, directions, and correspondence to the contractor.

d. Advising appropriate elements of ASPO management on all proposed directives or contractor generated correspondence warranting their attention.

e. Reviewing all proposed directives and contractor generated information in relation to the contract, and initiating action with the Contracting Officer or other functional organizations when required.

f. Maintaining visitor and information control on matters relating to the contract and subcontracts.

g. Arranging and coordinating all regular meetings involving senior NASA and contractor personnel.

h. Coordinating closely with the Resident Manager, insuring that the Resident Manager is kept cognizant of all significant activities involving the contract.

Vehicle Managers and Project Engineers

Each individual spacecraft is managed by a representative of the Apollo Spacecraft Program Manager. These Vehicle Managers are organizationally assigned to the C&SM and LM Project Engineering Divisions. Direct supervision of their activities is provided by the Chief, CSM or LM Project Engineering Division. This direction is broad and within lines of established program policy. Each Vehicle Manager has assigned to him project engineers to assist him in the performance of his duties.

FLIGHT OPERATIONS MANAGEMENT

During the time the launch vehicle and spacecraft are undergoing design, fabrication and testing, the personnel of the Flight Operations Directorate are preparing earth-orbital and lunar-landing flight support requirements for Apollo missions. The Director of Flight Operations at the Manned Spacecraft Center represents the Director of MSC in all operational areas, including flight operations and the flight operational aspects of flight crew and medical operations. In this capacity he acts as MSC's single point of contact with the OMSF Mission and Mission Operations Directors both during non-mission and during mission periods. In general, the Director of Flight Operations works through the normal organizational channels of MSC in accomplishing the operational functions. Figure III-5 shows the Apollo Mission operations organization and identifies the MSC organizational elements directly responsive to the Director of Flight Operations.

APOLLO MISSION OPERATIONS ORGANIZATION

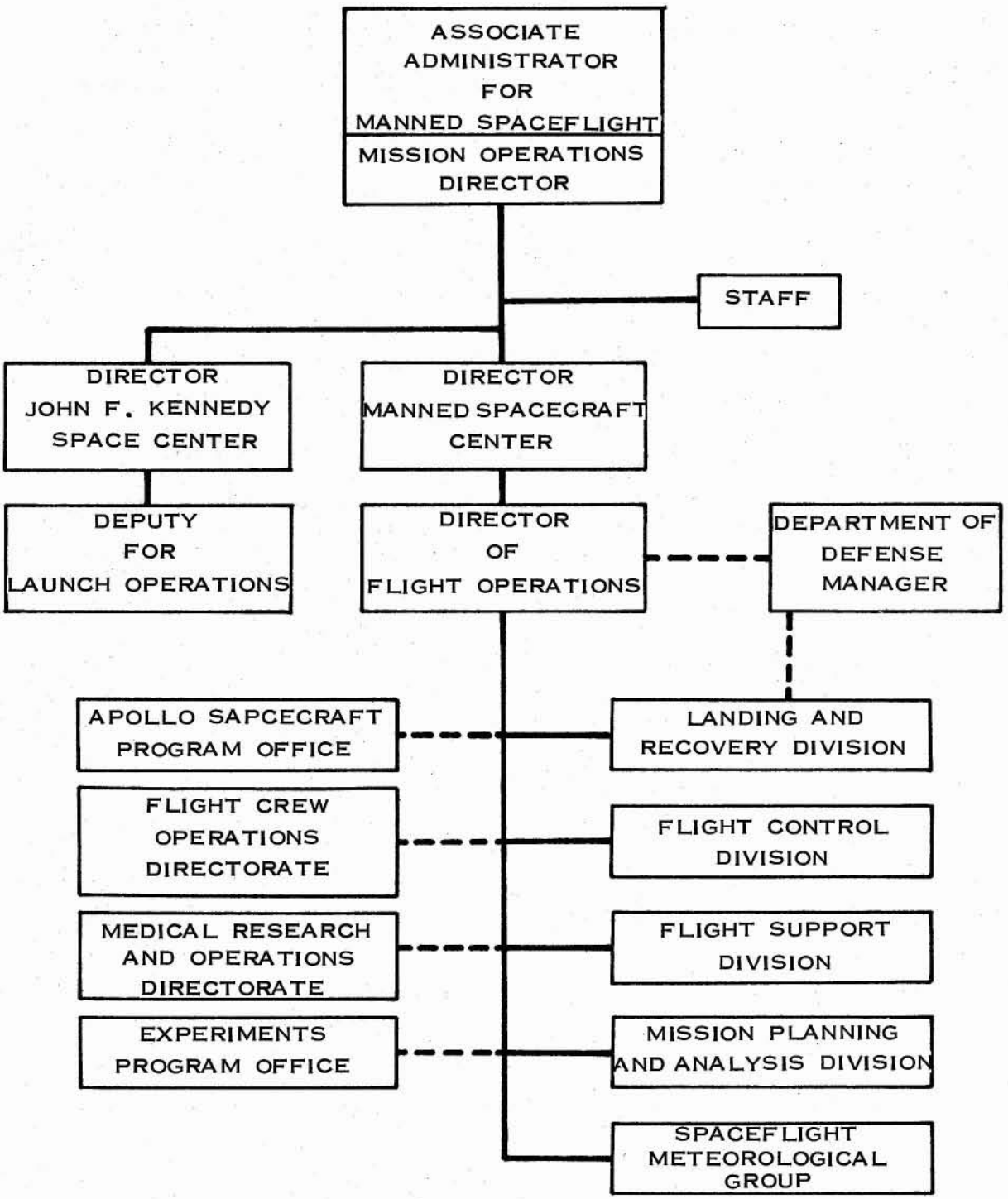

FIGURE III-5

The Flight Operations Directorate is responsible for developing the requirements for flight control operations and facilities, mission planning, control center implementation and operations. In addition, this directorate coordinates and conducts spacecraft landing and recovery planning. Specifically, this organization is responsible for:

a. Providing the MSC channel through which all flight operations support requirements are officially submitted, consolidated and coordinated.

b. Developing the Apollo flight mission rules and detailed flight control plans.

c. Providing trained flight control and flight monitoring personnel for Control Center and Remote Site support of the Apollo missions.

d. Establishing the operational requirements in support of the landing and recovery phase of each mission, and coordinating these requirements with the Department of Defense recovery forces.

e. Designing and optimizing the operational trajectory in consonance with MSFC responsibilities.

f. Developing the real-time computer programs.

g. Establishing the instrumentation and operational requirements for the Mission Control systems, including the Mission Control Center-Houston, the Manned Space Flight Network, and the necessary communications interfaces.

h. Configuring and operating the Mission Control Center-Houston.

In meeting the above flight operations requirements, other elements within MSC support Flight Operations Directorate with specialized technological support. Later portions of this section will discuss, in detail, the sources and nature of this type of support.

MSC INTERNAL RELATIONSHIPS

The Center Director and Deputy have the responsibility for implementing all programs, policies, and directives received from NASA Headquarters. Similarly, MSC replies to Headquarters directions are signed by the Director or Deputy. Thus, they are involved in those actions affecting the policy, mission, and direction of the manned space flight program. They also sign all communications which leave the Center addressed to the OMSF Associate Administrator dealing with the following program matters: a. MSC interrelated Apollo Spacecraft Program operation problems; b. Statements of needs; c. Operational status request for direction and response to direction. They also sign communications addressed to other NASA Centers' Directors (other than KSC) which involve management agreements requiring interfacing and supporting resources to accomplish stated tasks. The Director also signs all KSC communications dealing with KSC/MSC agreements and relationships outlined in APD #26 requiring interfacing support and resources. The Director and Deputy have the Center approval authority for flight plans and mission rules and Level I changes, which are then transmitted to NASA Headquarters for final approval. The Director or Deputy also is chairman of the third phase of the Customer Acceptance Readiness Review (CARR) Board for acceptance of the end item from the contractor, participates in the Design Certification Review (DCR) Board conducted by the Management Council, and is chairman of the Flight Readiness Review (FRR), the last MSC review prior to launch.

Thur, the Director and Deputy are involved to the extent necessary to provide maximum visibility into the program. All channels of information and

communication flow, decision-making and actions-implementations are designed to provide maximum visibility for the key management officials.

Management responsibility for the execution of major programs is focused on the Program Managers. They obtain the approval of the Center Director or Deputy on all initial plans of a significant nature and all changes to previously approved plans. On matters involving the functional specialties of the Directorates, the Program Managers seek the concurrences or coordination of the effected Directors.

It is virtually impossible to spell out in detail all of those instances requiring the approval of the Director or Deputy and the concurrences or coordination of the functional Directors. Certainly, factors involving mission success and crew safety are coordinated in order that the Program Manager may be assured that he has taken every step feasible to assure success. The functional Directors, however, also share part of the Program Manager's responsibility for meeting schedule and cost targets and, therefore, should be responsive to him.

Since the functional Directors are responsible for the technical quality of their part of the total mission, it is their prerogative to refer matters to the Director or Deputy when they believe that decisions have been made that adversely affect their performance.

The Apollo Spacecraft Program Manager is responsible for the implementation of those aspects of the Apollo Program mission assigned to the Manned Spacecraft Center. In this capacity, he is an agent of the Director, MSC, in assuring that the Center carries out in full all assigned missions that

are part of the Apollo Program. He is also responsible for keeping the Director and Deputy fully informed on all significant aspects of the program.

He has a secondary responsibility to the Apollo Program Director, OMSF, for the implementation of directives from that office. However, directives from the Program Director follow line organization channels and flow through the Center Director and Deputy, who have basic responsibility for execution, to the Manager. A free flow and exchange of information between the Apollo Program Director and the Apollo Spacecraft Program Manager is both desirable and encouraged, however, in order that working relationships may be as close as possible between counterparts.

In the execution of his duties, the Manager obtains the approval of the Director or Deputy and seeks the concurrence or coordination of the effected functional Directors on all significant program decisions or changes in matters previously agreed upon. Since, however, mission success and crew safety can be impaired by assumed insignificant details, it is expected that approval, concurrence, or coordination will be sought on a wide range of matters involving the design, manufacture, checkout and test of the flight hardware.

The principal means of coordinating technical changes is the Configuration Management procedure as described in the following documents: NPC 500-1, MSC Supplement No. 1; Apollo Spacecraft Program Office Configuration Management Plan (Revision B, March 15, 1966); and Memorandum from the Manager, Apollo Spacecraft Program, Subject: Apollo Configuration Board, dated June 17, 1967. (See Appendix D)

The Configuration Management Process, as defined in these documents, provides all of the functional directors an opportunity to voice their opinions on all decisions that are a matter of contractual direction to the contractor. Configuration Management is composed of four levels which are based on the necessary authority to approve configuration changes. Level IV changes are those configuration changes made by the contractor and do not require NASA approval but must be recorded and the appropriate documents revised to reflect the changes on the effected systems. Level III configuration changes may not exceed $300,000 in cost, cause no schedule slip or weight increase and be approved by the appropriate MSC Configuration Control Panel (CCP). Level II changes require approval of the Spacecraft Program Manager, acting for the Configuration Control Board (CCB) and generally relate to changes effecting overall spacecraft and ground support systems. Level I changes require interface with other Center/agency responsibilities or have a cost impact limited by procurement regulations, and are forwarded by the Director or Deputy, acting on behalf of the CCB, to the Apollo Program Director for final approval.

On matters that impact the interface between the LM and CSM, the Spacecraft Managers refer the problem to the Program Manager for resolution. If the problem involves interfaces with ground systems or launch vehicles, the Spacecraft Managers may deal through Interface Control Documents (ICD's) with other Centers. If the problem places a new requirement upon another Center, the matter must be referred through the Manager to the Director for transmittal.

All direction to KSC is issued through the Assistant Program Manager, KSC. He is fully responsive to the requests of the CSM and LM Managers and the Assistant Manager. He does, however, have the prerogative of consulting

the Manager before executing requests which he believes may be prejudicial to the success of KSC operations.

The ASPO Division Chiefs are fully responsive to the CSM and LM Managers. The Chiefs of the C&SM and LM Project Engineering and Checkout Divisions normally communicate through the CSM and LM Managers respectively. The Chiefs of the divisions supporting both spacecraft, Program Control, Systems Engineering, and Test, are responsive to these Managers but report directly to the ASPO Manager for their total effort. Since Division Chiefs are responsible for the technical quality of their functional specialties, they have the alternative of recourse to the ASPO Manager in situations where they believe that decisions have been made that adversely affect their performance.

In the conduct of daily affairs, the C&SM and LM Managers work through an informal organization. The elements of this organization include the RASPO, Project Engineering Division and its Vehicle Managers, the single-points-of-contact in the Systems Engineering Division, the Project Officer and the Contracting Officer. The specific working arrangments between these elements is defined periodically as required in memoranda such as that of July 7, 1967, subject: "Discussion of CSM Factory Acceptance Test and Checkout Responsibilities," published by the Chief, Test Division.

The Vehicle Manager is authorized to take, and be responsible for, any action deemed necessary to accomplish his duties, except that official contract direction is reserved to the Project Officer or Contracting Officer. Where normal responsibility is assigned to another MSC organizational element, the Vehicle Manager attempts to contact the responsible elements

prior to taking action. When this is not feasible, the Vehicle Manager's action is supported by the normally responsible element and shall be reserved only by the Program Manager or Contracting Officer.

The Vehicle Manager is specifically authorized to:

Have direct contact with any element of MSC to resolve problems relating to his assigned spacecraft. This contact includes signature on correspondence that may be signed by the Chief, Project Engineering Division.

Have direct contact with the Site Activation Manager of the several sites which support the assigned spacecraft.

Stop any action on the part of the contract which, in his judgment, is prejudicial to the vehicle configuration, safety, or schedule. His stop order must be followed up by an immediate referral of the problem to the RASPO Manager, Project Officer, or Contracting Officer, as appropriate, for final resolution.

Contact any person within the contractor organization necessary to understand and resolve problems by discussion and agreement. Official direction to the contractor emanates from either the Project Officer or Contracting Officer.

Have direct contact with the stage manager and other persons at MSFC and KSC directly relating to his assigned spacecraft.

Change the spacecraft end-item specification, Test Requirements Document operational Checkout Procedures (OCP), mission plan, or certification test requirements, if necessary after prior coordination with responsible ASPO organizational elements.

RESEARCH, DEVELOPMENT, TEST, EVALUATION AND SAFETY

The Apollo subsystem management plan is the management tool used to involve engineers and scientists of the functional directorates in the management of the Apollo spacecraft program. There are approximately 46 subsystem managers, the majority of whom are in the Engineering and Development Directorate. The subsystem manager is responsible through normal supervisory lines to the Manager, ASPO for the development of his subsystem to given or developed specifications within the cost and schedule constraints of the program.

The subsystem manager has responsibility for technical and administrative aspects of the management of his subsystem, short of official authority to direct. ASPO has designated a project office to conduct the official relationship with the contractor within the scope of the contract and to provide the official ASPO sign-off to the contracting officer with respect to contract changes. Thus, the subsystem manager and the project officer work as a team in monitoring and managing the contractor effort on the subsystem.

SYSTEM MANAGEMENT FOR GOVERNMENT FURNISHED ITEMS

For reasons of economy and standardization of spacecraft checkout systems and methods at the spacecraft contractor facilities and at MSC, MSC manages one contract with General Electric for the design, fabrication, operation and maintenance of the Apollo Spacecraft Acceptance Checkout Equipments (ACE-S/C) at these locations. MSC also provides ACE-S/C equipment to KSC and retains configuration control over this equipment although KSC has full responsibility for operating these systems at the KSC location under separate contracting authority with GE. The ASPO has assigned program management responsibility for ACE-S/C to an E&D functional division.

SOFTWARE SYSTEMS MANAGERS

In specific cases ASPO has assigned system analysis and performance evaluation responsibilities to functional divisions of MSC. For example a Software System Manager is assigned in an E&D functional division to be responsible for overall Spacecraft-Ground communications compatibility and performance. This job is required to coordinate spacecraft and ground systems design and interfaces to assure radio frequency signal compatibility and overall systems performance compatible with operational requirements. Coordination with NASA Headquarters elements, other centers, especially Goddard Space Flight Center, and the spacecraft communications subsystem managers is a major task. The division has set up a major compatibility test program to verify the system performance.

The management function is called "software" because the task has no direct hardware contractor control function. The Software Manager must work through the spacecraft hardware subsystem managers and ASPO for necessary spacecraft hardware design changes and through NASA Headquarters and Goddard Space Flight Center for MSFN ground station interface design changes. Other software managers are assigned for spacecraft thermal control, flight test data reduction, aerodynamics and flight dynamics, engineering simulations, and similar functions.

Within MSC, the interfaces of the Flight Safety Office may be categorized into three basic areas: spacecraft system safety, mission safety, and personnel and test equipment safety. These interfaces involve all of the major organizational elements of MSC and point out the broad scope of the flight safety program. The Center Systems Safety Plan is the controlling document.

MSC/HEADQUARTERS RELATIONSHIPS

In addition to receiving mission support from various elements within MSC, flight operations requirements also involve inter-center relationships with MSFC, KSC, GSFC and NASA Headquarters. Within the OMSF, the Apollo Program Director is responsible for coordinating the various elements within NASA in support of the design and development of the Apollo spacecraft. Also, within OMSF the Director of Mission Operations directs and integrates the development of total operational capability necessary for conducting manned space flight. Goddard Space Flight Center provides the Mission Control Center at MSC with a worldwide tracking and communications network while KSC is responsible for the launching of the spacecraft. MSFC provides flight operations planning and development for the Saturn launch vehicles. The DOD supports flight operations with trajectory tracking and flight crew recovery responsibilities.

Other NASA Headquarters' elements provide additional coordinating support. The Operational Support Requirements Office (OSRO) at NASA Headquarters provides coordination, consolidation, and levying of all MSC mission support requirements. The Flight Support Division of FOD is designated as the MSC point of contact with OSRO. The Chief Flight Support Division participates in the development of operational requirements and ensures that they are properly integrated into the total support requirements documents. The Chief, Landing and Recovery Division, FOD is the MSC Technical Control Officer to the Weather Bureau Space Flight Meteorology Group and receives technical requirements for research services and real-time operational meteorological support. The FOD also represents MSC in the Network Control Group and Liaison with GSFC. The Network Control Group

establishes network configuration for supporting mission activities and schedules for Manned Space Flight Network. Although formal submission of MSC operational requirements is through OSRO, as previously mentioned, the FOD continuously participates at the working level in technical discussions with GSFC personnel to strive for refined and practical network support requirements.

The MSC/Flight Safety Office has major interfaces with NASA Headquarters and the DOD.

The interface with NASA Headquarters is based on the fact that they issue the safety program directives and policies that establish the baselines for MSC's safety program.

The interface with DOD involves range safety operations and coordination of requirements for recovery operations.

INTER-CENTER RELATIONSHIPS

Day-to-day management of the Apollo Spacecraft Program from design through manufacturing, factory checkout, Cape checkout, and launch requires close coordination and cooperation between the three Manned Space Flight Field Centers. In order to assure that this type of full and complete cooperation occurs, inter-center agreements are used to detail the relationships and interfaces involved. Appendix E contains an extensive discussion of the interfaces and responsibilities of each of the three Field Centers.

In general, relations with other NASA Centers are conducted by the Center Director, particularly when the matter involves placing a requirement upon another Center. All matters effecting the management relationships between the Centers are also handled by the Director and Deputy. The Program Manager

may act in those situations that result in minor changes to commitments previously agreed upon by the Center Directors. Lower-level officials may deal with other Centers when only an exchange of information is involved.

The Inter-Center Coordination Panels were originally established between MSFC and MSC in October 1961. However, by August 1963, OMSF and KSC were also made permanent members. The primary objective of these panels is to recommend solutions to technical interface problems involving the launch vehicle, the spacecraft, facilities, and related equipment. There are now eight panels and twenty-four sub-panels involving 340 people on a limited, part-time basis.

All panels are under the cognizance of the Panel Review Board (PRB) which consists of representatives of OMSF, and the three participating Centers. The PRB is responsible for being informed on major technical problems, resolving interface problems between Centers, prescribing general guidelines for panel, procedures and membership, and the general supervision of the activities of the Inter-Center Panels. A PRB decision, unless challenged by a Center Director or by the Associate Administrator for OMSF, is binding on all participating elements. Membership is at the Deputy Director or equivalent technical level.

Figure III-6 reflects the organization of the PRB. Each panel, within its defined area of authority, is responsible for resolving interface problems and for initiating actions to implement decisions. In addition, the panels are responsible for recommending solutions on interface problems outside of their scope of authority to the PRB or to the other panels. Panel members must be of such a stature that they may commit their organizations in

PANEL REVIEW BOARD - ORGANIZATION

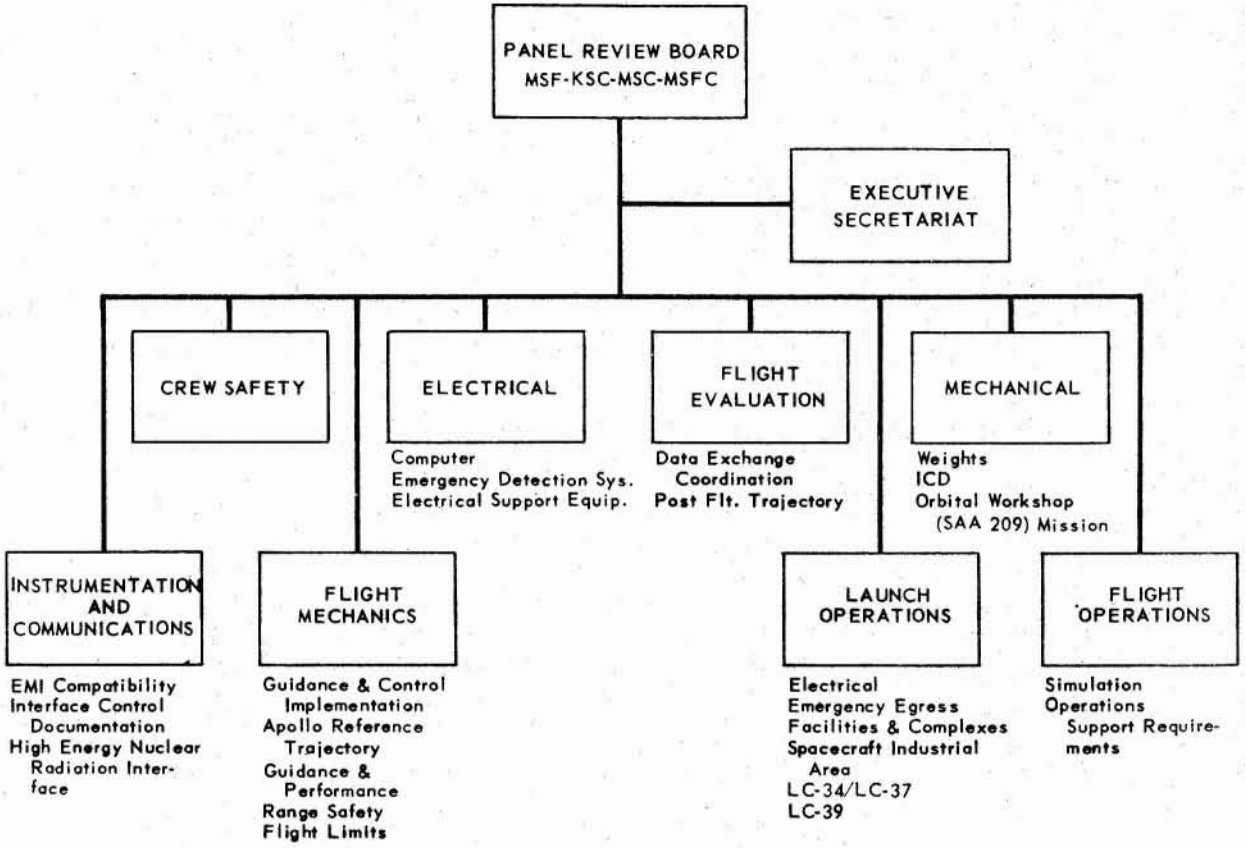

FIGURE III-6

implementing decisions. Detailed information on the duties of each of the eight panels is contained in the NASA Headquarters Volume.

SECTION IV

APOLLO SPACECRAFT PROGRAM MANAGEMENT ELEMENTS

Since the cost in lives and dollars prohibits a management philosophy of evaluating the contractor only by his results, MSC has developed a system that provides for continual monitoring of the contractors technical achievement, cost expenditures, and schedule status as the program progresses. The system is designed to provide MSC management the visibility into the program required to enable MSC to insure that "the loop has been closed" in all situations where problems have been identified and corrective action has been directed.

Essentially, the steps in this "closed-loop" management system include the definition of requirements, the implementation of these requirements through specifications on contractors or on other MSC elements, reporting and reviews of progress, assessment and decision making by MSC management, and follow-up to insure the implementation and effectiveness of corrective action. The management system control cycle is depicted in Figure IV-1.

REQUIREMENTS (HEADQUARTERS)

The basic requirements placed upon the Centers are contained in a set of documents that are summarized in the NASA Headquarter Volume.

REQUIREMENTS IMPLEMENTATION

MSC Amplification of Headquarters requirements is contained in the following documents:

1. The Apollo Spacecraft Program Development Plan was issued at MSC to implement the spacecraft portion of the Apollo Program Development Plan.

NASA/CONTRACTOR MANAGEMENT SYSTEM CONTROL CYCLE

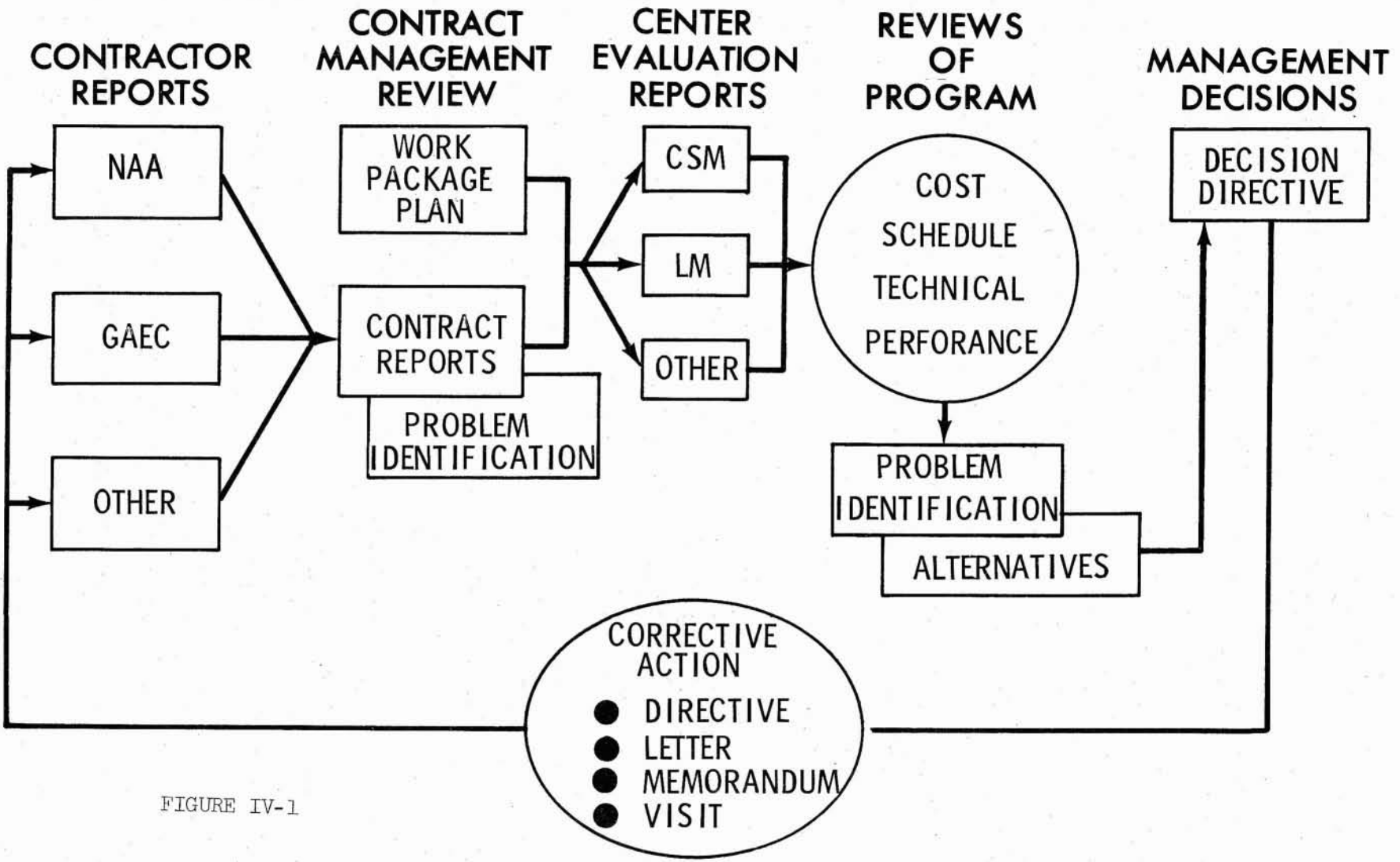

FIGURE IV-1

2. The Apollo Spacecraft Specifications were generated from the Apollo Specifications into the major component specification CSM, LM, and others represented graphically in the specification tree.

3. Apollo Spacecraft Program Office Configuration Management Plan implements NPC 500-1 internal to MSC whereas MSC Supplement #1 to NPC 500-1 is the implementing guide to contractor configuration control requirements.

4. Apollo Spacecraft Test and Checkout Instructions (MSC Instruction #8050.1) implements the requirements of NPC 500-10. (See Appendix A)

5. Apollo Spacecraft Flight Mission Assignment implements the requirement of Apollo Flight Mission assignment.

6. Apollo Spacecraft Management Guide or MSC Management Instructions implement the requirements of Apollo Program Directives.

The ASPO Management Guide was developed to provide a ready reference to policy, procedure, instructions and agreements used to manage the Apollo Spacecraft Program. The ASPO Program Control Division is responsible for maintaining the guide with issuances of changes and additions as they occur. Offices and individuals having primary responsibility for promulgating Apollo spacecraft procedures, instructions, and agreements are to use the guide as the mechanism for publishing new items and for making changes to those already published. The management guide is used for immediate implementation within the Apollo Spacecraft Program Office. If the application should expand to other organizations in MSC, the procedure is incorporated into MSC Management Instructions.

An example of publications issued through the Management Guide in Chapter 23, "Certification Test Program".

7. MSC Manual 1700, MSC Safety Manual incorporates and amplifies the requirements of the Apollo Safety Plan.

8. Quality Assurance Manual (#) and ASPO-RQTD-D67-1 "Apollo Spacecraft Reliability and Test Requirement for Government Furnished Equipment (GFE)" incorporates and amplifies the requirements of the Apollo Reliability and Quality Assurance Program Plan for work on GFE.

9. Apollo Spacecraft Documentation, Chapter 10, ASPO Management Guide reflects the implementation of Documentation requirements. Documentation requirements placed on contractors are reflected in the Documentation Exhibit of the respective contracts.

In support of FOD during mission phases, ASPO prepares the following documents:

1. Mission Requirements Document.
2. Apollo Ground Operations Requirements Plan.
3. Manned Spacecraft Center Flight Status Report.

The Mission Requirements Document describes the individual flight profile, the overall spacecraft mission requirements and related instrumentation requirements, the spacecraft assigned to the mission, and the alternate mission and above guidelines. The Ground Operations Requirements Plan describes requirements and procedures necessary to conduct comprehensive ground tests and operations. The requirements presented are for test, checkout, transport, and handling operations to be performed on the spacecraft from manufacture through test, countdown, recovery and post-recovery testing.

The Apollo Flight Mission Rules is updated and published before each mission. Flight Mission rules related to the launch vehicle are prepared by the MSFC Flight Control Office (located at MSC) and coordinated with the Flight Operations Directorate, MSC, and the MSFC Mission Operations Office. Launch vehicle mission rules which pretain to Flight Operations are incorporated in the Apollo Mission Rules by joint agreement between MSC and MSFC.

The MSC Flight Status Report is issued 48 hours following a flight and includes an overall appraisal of instrumentation and communication performance, range operations, and equipment status during the flight. In addition ASPO provides post-flight data analysis, data for data processing and range requirements, and reliability predictions and assessments.

The Flight Crew Operations Directorate provides trained flight crews, both primary and backup, to man specific Apollo missions. FCOD prepares the Apollo Operations Handbooks and the Mission Flight Plan. The purpose of the Handbooks is to provide the flight crew, simulator personnel and flight planners of systems information and flight crew operational procedures on the CSM, LM and guidance and navigation. The Mission Flight Plan identifies a time reference for crew activities for accomplishing mission objectives. It contains the necessary check lists, procedures, spacecraft systems data, and information related to tests and experiments to be performed during the mission.

The Public Affairs Office is responsible for planning and implementing MSC mission information systems. This includes the preparation of the Public Information Operations Plan. This plan covers documentary photography,

public information assignments, news media liaison, and protocol arrangements.

As a result of receiving the various plans for operational support, FOD is able to prepare the following documents reflecting these various interfaces. The Flight Operations Plan describes the manner in which FOD proposes to support the mission. It includes such elements as test objectives, mission profile, description of launch vehicle and spacecraft, NSFN facilities, personnel requirements training and flight plan. The Operational Spacecraft Flight Trajectory presents all trajectory work to be performed in support of the mission and final mission trajectory date. The Spacecraft Operational Alternate Mission and Abort Trajectory Plan contains alternate trajectories in the event an alternate mission or an abort is required at any point in the mission.

MSC AMPLIFICATION OF OPERATIONS REQUIREMENTS

The Flight Operations Directorate (FOD) prepares the Program Support Requirements Document and updates it periodically prior to each mission. The data processed in the PSRD consists of information identifying all items required to support the performance of flight control, recovery, postflight analysis, etc., and includes all data applicable to the individual missions within a program. Included are the detailed operations requirements which relate to acquisition of spacecraft and launch vehicle data at land sites and by ships and aircraft and for the transmission of this data to MCC-H. All direct Saturn flight control support requirements are coordinated with MSC by the MSFC Flight Control Office and are included in the MSC document submitted by joint agreement.

The Apollo Flight Mission Rules is updated and published before each mission. Flight Mission rules related to the launch vehicle are prepared by the MSFC Flight Control Office (located at MSC) and coordinated with the Flight Operations Directorate, MSC, and the MSFC Mission Operations Office. Launch vehicle mission rules which pretain to Flight Operations are incorporated in the Apollo Mission Rules by joint agreement between MSC and MSFC.

The prime objective of the mission rules is to identify equipment configuration to mission support and formulate a series of basic ground rules based upon systems analysis and mission planning consideration. Application of these rules will provide for the safety of the flight crew, optimize chances for mission success, and expedite the decision process in the event of deviations from the applicable mission plan.

The purpose of Mission Recovery Requirements is to identify NASA's recovery requirements to the Department of Defense and to serve as a basis for the development of the DOD recovery support for the specified mission.

The Mission Control Center - Houston Operational Configuration is updated prior to each scheduled mission. This document is a single source for flight control data display requirements and the configuration of systems necessary to implement the required data flow. It defines what each flight controller can expect to see at, or from, his operating position. In addition, it provides information pertinent to patching, programming, and setup of support equipment.

The Overall Operations Count, MCC-H is to provide Mission Control Center - Houston operations personnel with a detailed chronological list of activities that require their participation or that are of significant interest. These activities include countdowns and required action on the spacecraft, launch vehicle, the MCC-H, the flight crew, and network.

The Apollo Simulations Operation Plan provides the simulation control teams with a basis for the preparation of the simulation for each flight. It is also intended to be used by supporting organizations for planning purposes. It contains the manuscripts and procedures used in the simulation exercises.

REQUIREMENTS IMPLEMENTATION

The philosopy of contracting by NASA was discussed earlier. The implementation of the philosophy, and of the Headquarter and MSC requirements, is accomplished through the contracting process and is epitomized in the formal contract document with its boilerplate statements. The contract, in addition to the technical direction it contains, spells out the administrative, or indirect, requirements which the government requires. Included are the government controls exercised, contract reports agreements, direction and response relationships, etc. MSC does not require contractors to standardize their organizations and internal systems to conform with MSC's. Rather, the emphasis is on obtaining data and results from one contractor that are compatible with those obtained from other contractors and in-house efforts.

It is the NASA/MSC (and other government agencies) policy to pay the contractor incrementally where the contract covers a wide span of time.

Private corporations are not financially able to undertake long range development programs because the expense is beyond their capability and the financial return is questionable. The spacecraft program must be incrementally funded due to its magnitude and time span from start to completion. The government takes the following factors into consideration when making a contract award:

Cost to date (manpower, and materials)

Outstanding Orders (materials)

Subcontractor cost and outstanding orders

The technical management portion of the contract contains the Work Packages. Work packages are descriptions of the end-items to be provided by the contractors. Work packages contain five basic elements - Specifications, Schedules, Delivery, Processes, and Quantity. The Work Packages will be in various levels of detail depending on the nature of the end-items and other variables.

a. Specifications:

Specifications which describe what the end-item must do, form the technical performance baseline. Some refinement is found in the Technical specifications, Master end-item specifications and the individual or Contract End Item (CEI) Specification.

b. Schedules

In order for the contractor to plan his work he must know what the schedule is. The basic element of resource planning allows the contractor to arrange the elements of development in building block sequence of design, manufacture, assemble and test in gross terms.

These are refined within this framework as development progresses.

This frame work also allows the contractor to procure engineers, tool designers, toolmakers, machinest, electrical and electronic technicians in a logical sequence. The Master Delivery Schedule (MDS) and Schedule Analysis Reporting Procedure (SARP) are used as reference points.

c. Delivery

The contractor agrees to provide an end item of specified configuration to a specific location and, as indicated above, at a specific time. This may be to a government site or another contractor. If it is to be delivered to another contractor it then becomes Government Furnished Equipment (GFE) to the receiving contractor.

d. Processes

The contractor is responsible for his own manufacturing process. However, the processes are evaluated to insure sufficient controls are inserted in the manufacturing process to insure nonvariance, and may provide advice and guidance in the technical aspects of the process.

e. Quantity

Hardware procurements are oriented to spacecraft missions in order to minimize costs. Assembly or component failures which occur during test are replaced from a central spare parts inventory or from a later vehicle. This philosophy required extra components in the manufacturing line, but precludes large warehousing and storage at the launch area. Under this policy the contractor and NASA share responsibility to insure that sufficient parts are always available to accomplish missions on schedule.

WORK PACKAGE MANAGEMENT SYSTEM

In the management of its contractors, the MSC Apollo Program Office has developed what is termed a "Work Package Management System." This system constitutes an adaptation of the hardware - oriented work breakdown structure of the PERT and Companion Cost concept to the realities of functionally managed aerospace companies. Consequently, the Work Packages are tied to specific organizational entities where one man is actually responsible and can be held accountable for the status of the work contained therein.

Specifically, the Work Package Management System provides for a detailed breakdown of the total job into manageable elements, provides clear definition of tasks and responsibilities, identifies responsibility for the package with a single individual, and it provides a common base for management between MSC and the contractor. Although the system is designed primarily as an internal management system for the contractor, it provides increased visibility for MSC. The Work Packages are negotiated between the respective Work Package Managers for the Contractor and MSC, and tasks, schedules and budgets are defined. The negotiated positions then serve as the baselines for all subsequent status reporting.

Figure IV-2 presents the breakdown of Work Packages for the Command and Service Modules contract with the North American Rockwell Corporation, Space Division (NAR). The Engineering Work Packages are, for the most part, the responsibility of the subsystem managers from other MSC elements. It should be pointed out that in addition to the subsystem management responsibility for the Engineering Work Packages, the subsystem managers are also responsible for the technical status and performance of their subsystem throughout the program.

APOLLO CSM WORK BREAKDOWN STRUCTURE

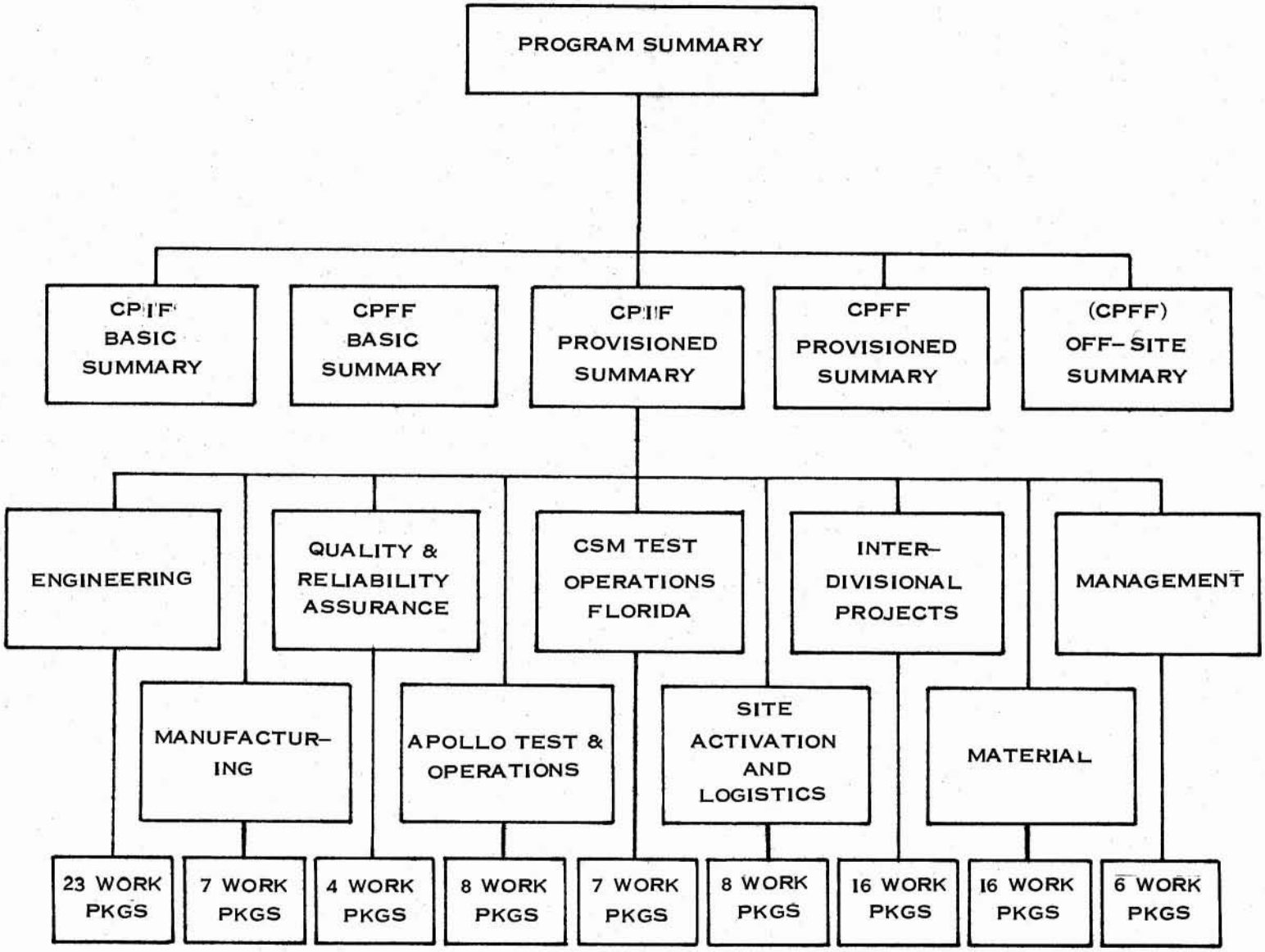

FIGURE IV-2

In the day-to-day execution of the contract and the implementation of the Work Package concept, relations between MSC, the prime contractor and the sub-contractor are conducted as depicted in Figure IV-3. In this relationship the official channel for all contact is between the Apollo Spacecraft Program Office and the prime contractors. All technical direction from MSC and all progress reporting and other responses from the contractor flow through this channel.

Likewise, the official channel for all communication with the sub-contractor is through the prime contractor. The process provides for coordination between the MSC Work Package/Subsystem Manager and his counterpart at the prime contractor and for liaison with the sub-contractor. It should be noted, however, that the MSC Work Package/Subsystem Manager makes his technical evaluations and recommended contract changes to the ASPO rather than directly to either prime or sub-contractor. This process serves to keep the ASPO Manager in control as well as to preserve the nature of the prime - sub relationship.

FLIGHT OPERATIONS REQUIREMENTS IMPLEMENTATION

In order to maintain effective monitoring of mission rules, Apollo flights are controlled, after launch, from the Mission Control Center - Houston, (MCC-H) at MSC. A centralized group of flight controllers maintain contact with the spacecraft from launch through recovery and exercise technical management in the areas of vehicle systems, flight dynamics, life systems, flight crew activities and physiological condition, recovery support, and ground system operations. In addition, flight controllers are deployed to various remote stations to aid in maintaining contact with the

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CONTRACTOR - NASA MANAGEMENT RELATIONSHIPS

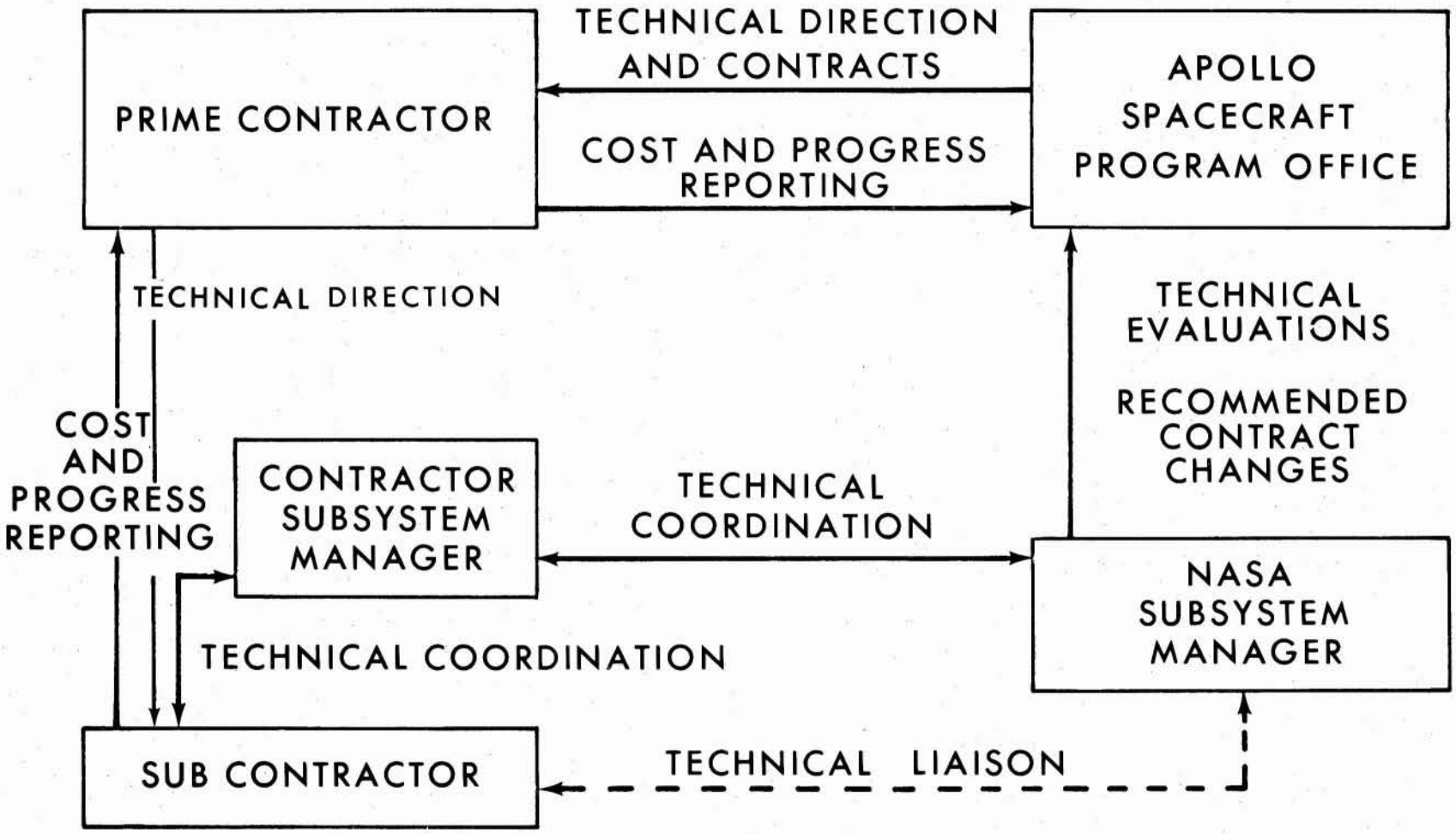


FIGURE IV-3

spacecraft and to analyze spacecraft flight data. These sites consist of fixed stations, ships and aircraft located to provide timely mission support. The MCC-H has dual facilities and equipment, providing the capability of supporting various combinations of real-time missions, simulation exercises, or systems checkout.

The MCC-H is comprised of five basic systems of which the FOD is the cognizant element:

a. Display/Control System

b. Real-Time Computer Complex (RTCC)

c. Communications System

d. Command System

e. Simulation, Checkout and Training System (SCATS)

These systems are designed to provide the flight operations team with the necessary real-time data and associated reference data for rapid assessment of mission progress, and for rapid decisions in the event of abnormal or emergency situations. The reference data are the result of an effort spent prior to each mission, in analyzing every possible contingency situation and contain predicted trand data, mission rules, and operational procedures for regulating the mission. A description of each of the five systems in the MCC-H is to follow.

The display/control system provides mission control personnel with information concerning booster and vehicle systems, flight dynamics, life systems, the MSFN, and recovery. Variable combinations of data are provided by computer driven display generation equipment controlled by flight control personnel. A video switching matrix provides flight

controllers a vast selection of reference information, as well as real-time data, to be displayed on T.V. monitors in a variety of formats. This information is necessary to assure that the decisions made for mission success are made as rapidly as possible, using the most appropriate information.

The real-time computer complex (RTCC) provides the computation facilities for flight dynamic analysis, telemetry processing, acquisition predictions, and flight controller display generation with call-up capability. The primary function of this complex is to process incoming tracking and telemetry data for evaluation of overall mission conditions. Computers predetermine the location of the spacecraft at any time throughout the flight. The computers are also used for monitoring and evaluating telemetry information received from the spacecraft to determine if both equipment and personnel are performing satisfactorily within predetermined environmental and operational parameters.

The Communications System processes and distributes all signals, except television, entering or leaving the MCC. There are facilities for teletype and facsimilie traffic, voice communications to the spacecraft, and internal communications within the MCC and to remote sites.

The master digital command system (MDCS) is the prime command point during missions and provides a capability for updating and controlling functions in the spacecraft from the ground. In order to perform this function, the command system must have the ability to receive, store, verify and route digital commands to real-time sites. It also relays prepass information to digital command system units at remote sites.

The Simulation, Checkout and Training System (SCATS) provides realistic simulation of manned space flight missions for training both flight control personnel and the flight crew. The system includes simulated remote sites and has the capability of integrating the simulation systems with flight crew trainers located at both KSC and MSC. The simulation system also provides the capability of pretesting a mission, procedures, and flight controllers and the flight crew by purposely introducing "faults" into the information data streams. By this technique, potential weak points are detected and corrected. Simulation training gives the astronauts and flight controllers an opportunity to work together and build mutual confidence and respect in their ability to successfully handle any contingency before the mission is actually flown.

The Mission Operations Control Room (MOCR) is the principal command and decision area in the MCC. Critical information relating to spacecraft, launch vehicle and ground systems, and aeromedical parameters, from world-wide stations, ships and aircraft is processed by the five systems previously described and supplied to the flight controllers in the MOCR. Based on analysis of this continuous flow of information, flight controllers assess the spacecraft flight status and progress, and in critical periods, determine the continuation, alternation or termination of the space flight.

A DOD representative is located in the MOCR for overall control of DOD recovery forces supporting the mission. This responsibility includes the deployment of recovery forces, operation of recovery communications network, and the search, location and retrieval of the crew and spacecraft.

CREW SELECTION AND TRAINING

The initial selection of astronauts and the selection and training of specific flight crews is a responsibility of MSC. Astronauts must meet certain basic requirements such as age, height, education and experience, and other physical, scientific aptitude and personality traits.

There are two basic purposes taken into consideration in the flight crew training program. First, and most important, is to provide crew members prepared to operate the spacecraft in the best possible manner - both in normal pursuit of particular flight objectives as well as in emergency and contingency situations. Second, to provide competent observers in the appropriate non-operational disciplines in order to successfully accomplish the scientific objectives on the flight.

In order to achieve the desired proficiency, the training program is broken down into a number of areas according to activity. The amount of time spent on each of these phases is dependent upon a number of factors. All astronauts participate in specific formal training areas which apply to the Apollo program. These areas are science and technology summary courses, operation familiarization, environmental and contingency training, spacecraft and launch vehicle design and development, and an aircraft flight program.

The majority of the science and technology courses are basic in nature, but some of them deal directly with spacecraft systems such as the Apollo guidance and navigation system. The basic material of the inertial guidance systems is covered in conjunction with the Apollo guidance and navigation instruction.

Other courses include geosciences (geology, geophysics, geochemistry) - including terrestrial and simulated lunar training - flight mechanics, rocket propulsion systems, aerondynamics, astronomy, communications, physics of the upper atmosphere and space, medical aspects of flight, and meteorology.

The bioscience training program for Apollo mission crews provides rudimentary facts about microbial life forms and insight into their importance in the Apollo program generally, and specifically in the lunar missions. It also provides both didactic and participative training in the collection of lunar samples and in the various aspects of the guarantine program

MANAGEMENT INFORMATION SYSTEMS AND COMMUNICATION (CENTER)

It is the policy of MSC to encourage and facilitate the flow of information between Center elements, both vertically and horizontally, throughout the organization. Similarly, information flow from MSC to other Centers and to functional or programmatic counterparts in Headquarters is free and open.

There are several special reporting procedures established to keep the Director and Deputy informed of significant activities and decisions at lower levels, problem areas, recommended policy changes, and other significant items. Weekly Activity Reports are submitted to the Director and Deputy each Monday morning by the program office managers, functional directors, and staff office chiefs. This report is a narrative description of activities or problems of major significance. In addition to his

weekly report, the ASPO Manager submits a report almost daily on significant problems and actions taken by the program office. The Special Assistant also briefs the Director and Deputy on a daily basis regarding actions, problems, solutions, and other significant activities brought to his attention.

Two other types of reports are submitted to the Director and Deputy on an as-required basis. They are Action Staff Papers, and Information Staff Papers. An Action Staff Paper is a report forwarded to the Director's office for action which has the effect of establishing Center policy, sufficiently broad and pervasive in its application to warrant action by the Director or Deputy. An Information Staff Paper is a report which informs the Director and Deputy of significant actions taken by an MSC element pursuant to its delegated authority or by virtue of its functional responsibilities and of other significant action items. Either type of staff paper is reviewed by the Special Assistant or the Director of Administration, depending on the nature of its contents.

Therefore, significant decisions involving new programs or missions, new capabilities, or that either impact several MSC organizational elements; commit MSC dollar, personnel, or facility resources; or change approved programs or practices are submitted through a channel that provides for the concurrence of the affected managers/directors and for decision by the Director or Deputy.

MANAGEMENT INFORMATION SYSTEMS AND COMMUNICATIONS (APOLLO)

In order to provide management visibility into the numerous aspects of the Apollo Spacecraft Program, a comprehensive system of reporting has been developed. The system relies upon many tried and tested methods as well as the newly developed, automated techniques, such as Program Evaluation

and Review Technique (PERT). The system includes formal and informal methods, written and verbal, details and summaries. The intention has been to provide management with timely, useful data that accurately reflects status and identifies potential problems.

Although reporting varies according to the requirements of individual contracts, certain formal requirements are almost standard. In general, prime contractors have submitted monthly reports on technical progress, schedule status and forecasts, cost status and forecasts. In view of the fact that the development and ground test phases of the program are over and the emphasis is now on the delivery of flight articles, the pace has quickened. Most primes now report technical and schedule progress daily by telegram and submit PERT reports on a bi-weekly basis.

To consider only formal reports, however, would be to neglect much of the information flow to NASA management. Since the pace has been relatively fast since the initiation of the program, informal means of communication have always been heavily relied upon.

1. Formal Status Reporting Systems

Apollo Program Contractors provide the following formal reports to the Program Office:

a. Monthly cost report submitted on NASA Form 533, Financial Management Report.

b. Schedule status reports in the form of bi-weekly or monthly PERT reports supplemented with daily reports on hardware in the final stages of manufacture and factory checkout.

c. Technical progress reports on a monthly basis that identify all significant technical problems and the corrective action being taken.

The information from these reports is received and analyzed by the ASPO Program Control Division. From this data, reports are generated for Apollo Program, MSC, and NASA Headquarters management levels.

The formal reports produced by ASPO for these purposes are as follows:

Bi-weekly status reports for ASPO and MSC management. The reports contain significant developments pertaining to technical progress and schedule status.

Monthly Schedule Analysis and Report Procedure (SARP) submissions to Headquarters detailing technical problems, schedule status, and cost status. Detailed review of these data is performed by Apollo Program and MSC management prior to submission to Headquarters. The SARP report is scheduled to arrive at Headquarters immediately prior to the monthly Management Council meetings in order that the reports can be analyzed, and significant problems can be discussed at the meeting.

Quarterly Program Operating Plan (POP). The POP is a financial document that includes the following data: Cost history to date of submission, monthly cost projections for the remainder of the current fiscal year, and annual estimates of the years to program completion.

This report summarizes the data presented in the monthly SARP reports and provides a tool for analysis of program cost trends. The document also serves as a basis for the development of NASA's annual budget submission to Congress.

Preparation of the POP by ASPO requires an extensive, integrated analysis of the technical, schedule and cost status of the program by management in order that adequate funding may be assured.

2. Informal Status Reporting

a. Day-to-day assessment

(1) Design is assessed by Program Office Engineering Division and at the subsystems level by MSC subsystem managers visiting plants having design and manufacturing responsibilities. Though design control is not maintained at the drawing level, the MSC engineers study the drawings and may make recommendations and suggestions to the contractor as his experience justifies. Constant communication with the contractor at the design department level of operations gives him an awareness of design progress and problems. This awareness by the MSC Engineer is conveyed to his supervisor and in the weekly activity report.

(2) Manufacturing, like design, is monitored/assessed by the engineers by "walking-the-line" in either the prime contractor or sub-contractor plant. He maintains an awareness of where components for the respective spacecraft are and where they should be with respect to the work package plan.

(3) Sub-assembly review is conducted to provide insight into the progress between manufacture start and testing. This involves the assessment of component mating and compatibility prior to assembly of major systems. This assessment of systems such as G&N is intended to minimize the requirement for removal and replacement of the sub-assemblies.

b. Informal Communications Techniques

(1) Fast Communication - MSC/Apollo is taking advantage of all the fast communication media available to keep informed and retain an acute awareness of program development. This involves commercial and government communication networks, electrical and electronic system, in fact, NASA becomes the prospective customer for any new communication system available. However, only those systems that have been proven are procured. The NASA management systems of the future will be a subject of the last part of this report but the potential improvement lies in the informal, fast electronic systems, evolving in the electrical/electronic industry.

(a) Telephone is the most acceptable informal, fast communication system presently employed. All levels of management are encouraged to maintain close contact, visits when possible, telephone when visits are not possible. Subsystem managers/engineers are close enough to the system to know what their contractor counterpart is talking about on the subject of cost, schedule, and item performance when communicating by telephone.

(b) Datafax system supplements the telephone on fast, informal transmission of information. This system is recognized to be an expediant in the transmission and "fills the gap" until hard official copies can be transmitted. Figure IV-4 shows the Telegraphic service available to MSC.

(c) Teletype systems transmit messages between/among responsible managers to communicate information and/or direction.

(d) Digital data transmits coded bits of information similar to the teletype. The receiving apparatus may be a part of a computer or electrical/electronic accounting machine system.

TELEGRAPHIC SERVICE - MSC

SEPTEMBER 1, 1967

- 1 COMMERCIAL TWX (BELL SYSTEM) (UNSECURE)
- 1 COMMERCIAL TELEX (WESTERN UNION) (UNSECURE)
- NASA NET MSC-MSFC (SECURE)
- NASA NET MSC-WONASA (SECURE)
- MSC NET MSC-WSTF (UNSECURE)
- MSC NET MSC-KSC (UNSECURE)
- DOD-AUTODIN-MSC-TINKLER AFB (SECURE)
- MSC NET MSC-LTV DALLAS (UNSECURE)
- MSC LOCAL BLDG 2 COM CENTER-BLDG 30 MOCR

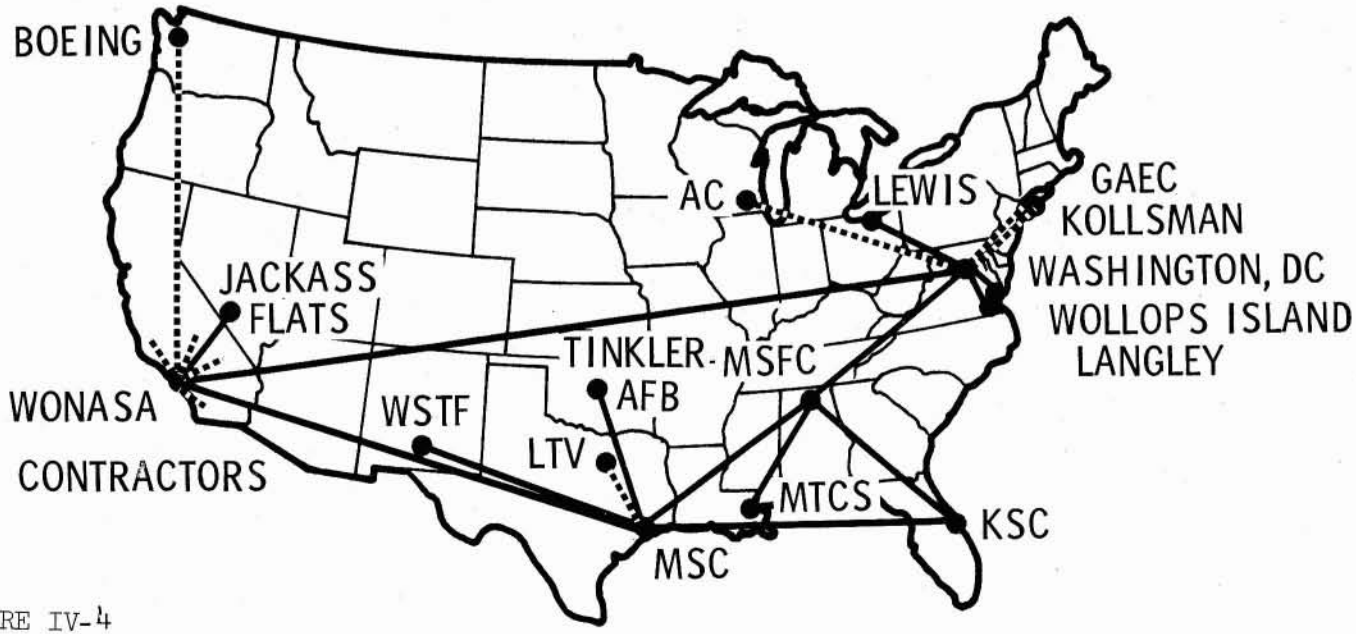


FIGURE IV-4

(2) Meetings form a significant part of the informal management system.

This aspect of information reporting to management is where more comprehensive understanding and exchange of thoughts bring out logical solutions to problems. It is in the "pooling" of experience that a firm understanding of the problem evolves and that resolution to the problem begins. The MSC subsystem managers have a liberal travel budget and are encouraged to meet with their contractor counterparts at their facility where problems are couched in the real, rather than simulated and described, environment. If several optional alternatives are open to the subsystem manager, he may draw upon the counsel of his associates and superiors. If the problem is critical, enough he may find it to his advantage to have his superiors visit and meet with those experiencing the problem. The responsibility for solution and ultimate decision may reach the top levels of management. This will become a matter of detailed discussion under change control. Decisions to bring in higher level management usually come in meetings that are initially very informal.

(3) Written Reports are required by ASPO management and may fall in one of several categories covered under "documentation". Type I documentation requires NASA approval before the contractor may proceed. Type II documentation requires NASA be given an opportunity to review and concur or non-concur within a specified time. Type III does not require NASA approval and may be forwarded to NASA only on request of NASA. The types take many forms and shapes. Again, some appreciation for the type reports can be realized by review of the contractor documentation exhibit.

The informal reporting revolves around plans reflected in the documentation requirements and hardware being developed. Most subsystem managers and engineers prepare a trip report documenting the trip taken and results of the meeting(s) they attend. In any event, the results are recorded in the weekly activity report forwarded to the manager.

Flash Reports are used to identify activities, conditions, or events that jeopardize or have the potential of adversely affecting program objectives, schedules, or cost. Examples of situations calling for flash reports include test failures, accidents, and labor relations problems. The responsible MSC organization originates the flash report and submits it to the OMSF Program Director.

3. Formal Progress Reviews

Together, the formal and informal reporting methods provide management a great depth of visability into the status of the program. The vast size of the program obviously requires that the volume of data presented be reduced at each successive step of the management ladder. Consequently, there is careful selection by the contractor and the field center in the reporting process. The daily contact, in person or by phone, between contractor, field center, and Headquarters management provides flexibility in order that corrective action to problems does not have to wait upon formal channels as a vehicle for decision making.

In addition to status reporting, there are several other noteworthy activities that provide MSC not only status information, but also the opportunity to evaluate the contractor's work and monitor his effectiveness.

These activities include Quality Control, Failure Reporting, and Certification (or Qualification) Testing.

Government inspectors are on hand at contractor plants during the manufacturing phase to insure that all specifications and requirements are being met. Although each contractor has his own Quality Control personnel to make these inspections, NASA and supporting DOD inspectors also provide a backup service to assure the adequacy of performance. These inspections range from analysis of materials to X-rays to welds and bonds to observance of adherence to test specifications and environments.

The Failure Reporting, Analysis, and Corrective Action System (FRACAS) is MSC's means of insuring that corrective action is successfully completed on all anomalies encountered by the contractors.

The system is based on the following policies:

No flight shall be accomplished with unresolved failures or problems.

All failures have a cause which must be determined in order to apply corrective action.

The closeout criteria must include a documented correction applied to either the hardware or software, i.e., specifications, procedures, processes, etc.

The system defines all squawks, unsatisfactory conditions, or failures that must be reported to MSC. Figure IV-5 reflects the cycle that the reports are processed through, resulting finally in either a fix for a particular mission or for the entire program. Periodic audits are made

CLOSED-LOOP MANAGEMENT
HARDWARE AND PAPER FLOW

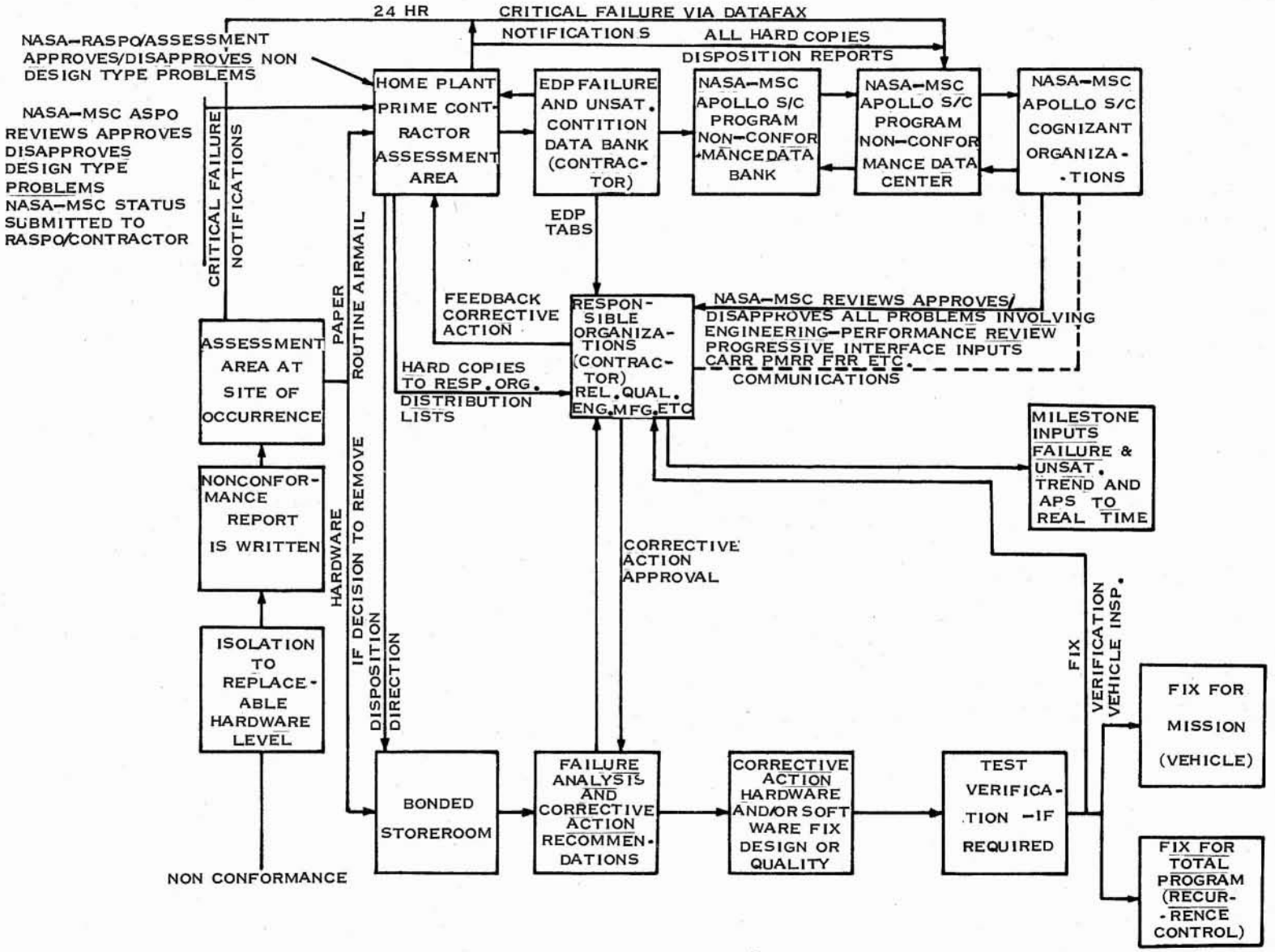


FIGURE IV - 5

of contractor performance in the area of recurrenance control, and the record is reviewed again as part of the technical reviews, such as Customer Acceptance Readiness Review (CARR), Premate Readiness Review PMR), or Flight Readiness Review (FRR). These reviews will be discussed later in this document in detail; however, it is pertinent at this point to state that areas of concern highlighted through FRACAS are brought to the attention of the review chairman for consideration.

The Certification Test Network (Figure IV-6) is another process by which MSC gains visability into the program and evaluates the contractors products. Certification Testing is conducted at the subsystem level for the purpose of qualifying the hardware for manned flight. The requirements and specifications for the tests are approved by the ASPO and MSC engineers who monitor the tests. The results are submitted to ASPO for analysis and certification as being qualified for flight.

EVALUATION AND DECISION-MAKING

Final authority on all administrative matters lies with the Center Director. However, it is intended by the Center Director that as many of these matters as possible be resolved between the Directors/Program Managers, with the Deputy Director serving as the agent for the Center Director in providing policy guidance and solutions of conflicting demands. Those matters that cannot be satisfactorily resolved at this level, however, will be referred to the Center Director for decision.

The decision-making process varies with the magnitude of the decision and, of course, its impact on parts of the program under the management of other centers. For the most part, MSC utilizes an informal decision-making

CLOSED-LOOP MANAGEMENT
HARDWARE AND PAPER FLOW

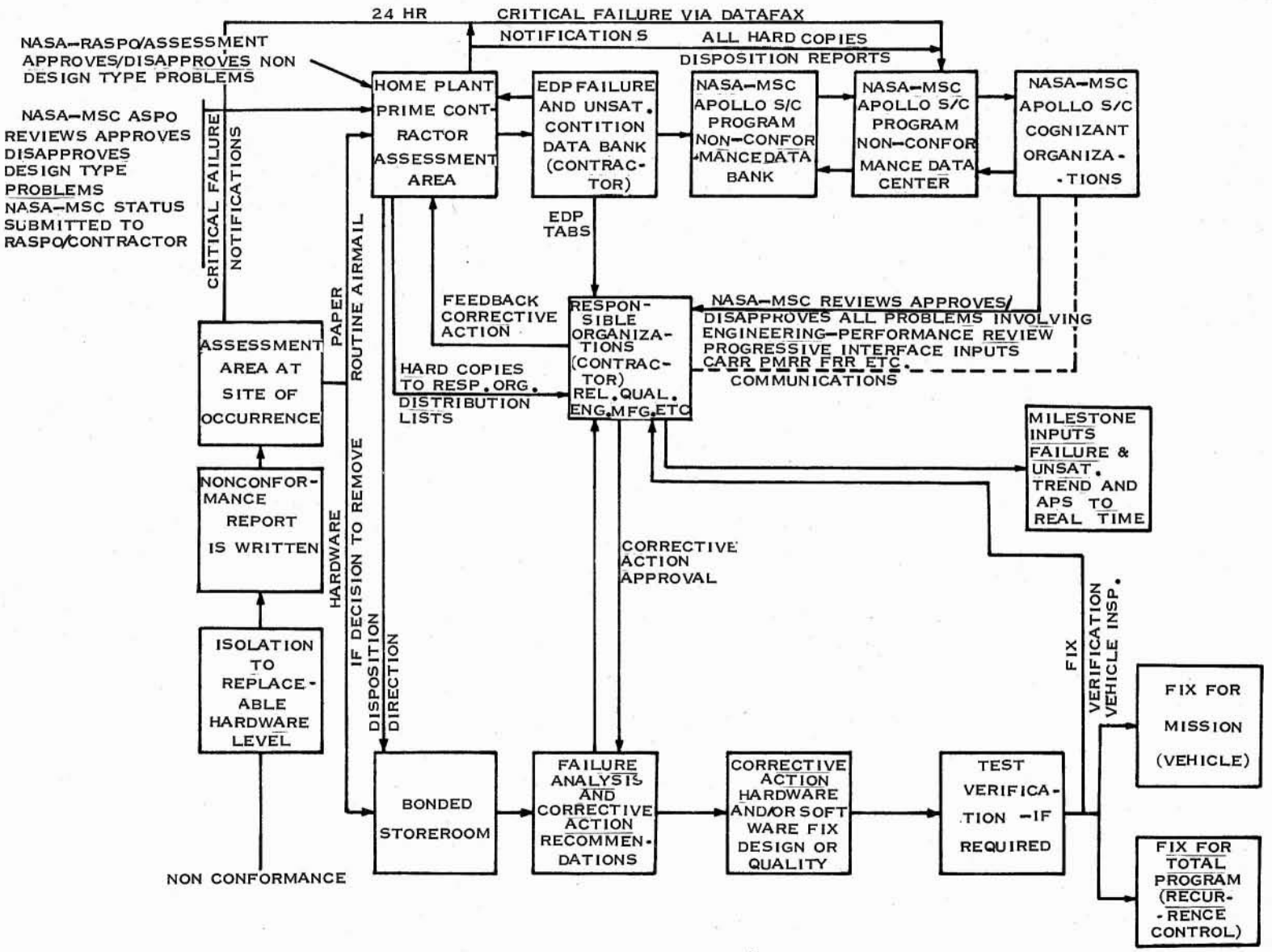
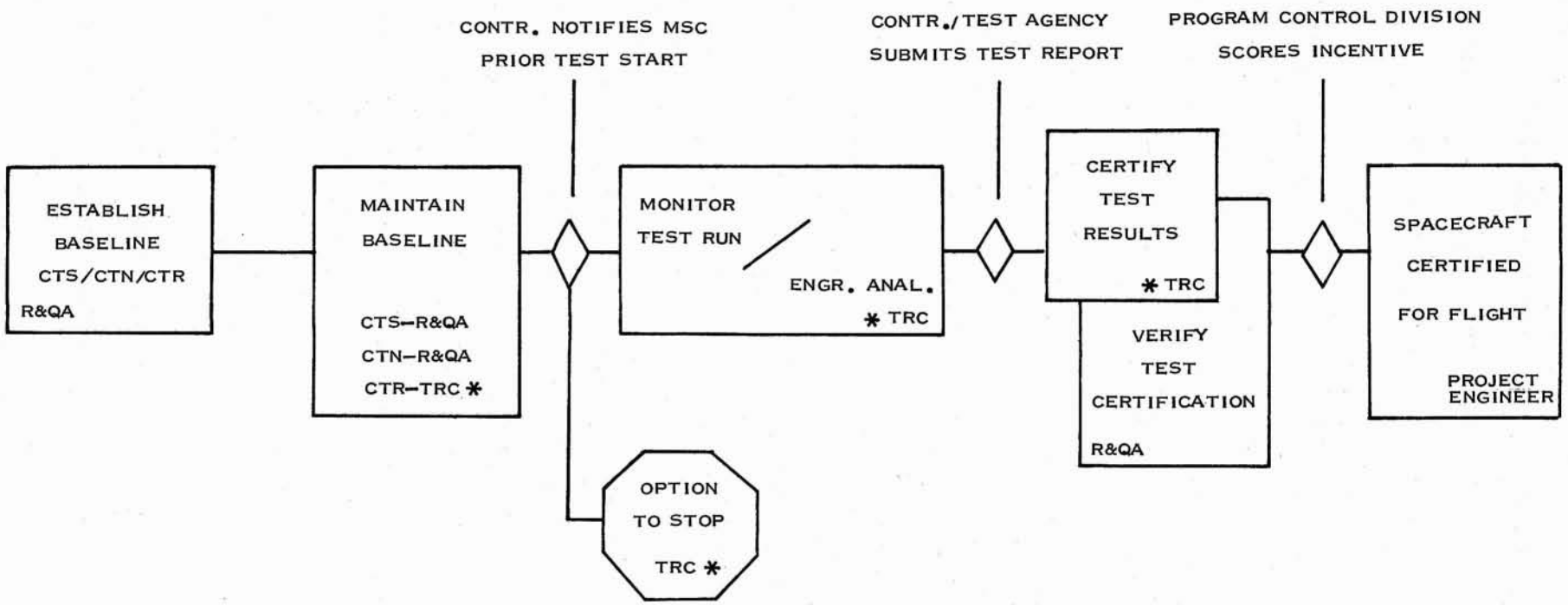


FIGURE IV – 5

CERTIFICATION TEST PROGRAM



* TRC-TECHNICAL REVIEW COORDINATOR

FIGURE IV–6

process in order that meetings, presentations, analyses, and recommendations can be scheduled to meet the needs of the moment. Formalized procedures are used, however, for the two most important decision-making activities of MSC Apollo management: Configuration Changes and Review of the Contractors' products. The Configuration Management procedure has already been described in some depth and will be treated only briefly in this part of the document. Because of their paramount importance, the technical reviews will be treated in considerable depth.

Changes in spacecraft design are recommended by either MSC elements or contractors and fall into the four levels previously described. (See Appendix D) changes fall within the jurisdiction of MSC, approval or disapproval of proposed changes represents one of the key formal decision-making activities of the MSC. The decision to send Level I changes to Headquarters for final approval also represents a significant activity. On these occasions, elements of the MSC/industry team present their cases. Their proposals may result from either new or redefined requirements, or as fixes to problems encountered in the development program. In any event, there are usually as many reasons for not making the change as for making it. The full impact of the change must be carefully assessed to determine how it may effect such things as weight, thermal balance, center of gravity, power loading, crew performance, cost, delivery date, and many other things. ASPO Systems Engineering has the basic responsibility for the analysis of all factors affecting compatibility, and for the integration of subsystems into any single, functioning spacecraft system.

As pointed out in the Configuration Management description, the Configuration Control Board is composed of the directors of each of the functional

organizations in order to insure that each element will have its change to support changes affecting the execution of its responsibilities. Approval or disapproval, however, for Level II changes, rests with the Apollo Spacecraft Program Manager who is charged with the overall responsibility for the accomplishment of the program objectives.

The major activity of periodically evaluating the contractors' products is performed by the conduct of intensive reviews following the completion of design, the completion of manufacturing and factory checkout, and following the completion of specified tests during checkout at KSC.

The basis for effective configuration management is the establishment and definition of baselines to serve as departure points for configuration control and adequacy of flight or operational readiness. During the development of an end item, three baselines are used, a Program Requirements Baseline, Design Requirements Baseline, and Product Configuration Baseline. The latter two are established to meet the Apollo Program Specification through the contractural documentation provided by the contractor, while the first is established by the approval of the Apollo Program Specification. Once the Design Requirements and Product Configuration baselines are established, all changes must be formally approved to insure consideration of cost, schedule, incentives, and mission compatibility impact.

The nature of the Apollo Program is such that definite periods cannot be accurately pre-established to provide the required baselines since they are dependent on the status of the end item development and the requirements of the program. A number of reviews and inspections are scheduled

to satisfy incremental phasing as shown in Appendix F, Figure 1, and to validate the accuracy and adequacy of the baselines being utilized. The purpose of this section is to show the accomplishment of these reviews and inspections that provide NASA with the ability to establish, control, and maintain baselines and Apollo Spacecraft Program end items, assuring their readiness for flight.

The scope of configuration control covers the period from design requirements through the period just prior to launch operations as shown in Appendix F, Figure 2. This system is tailored to spacecraft development and is progressive in nature, each review building on the previous activities. The configuration of an end item at a date following the establishment of its baseline is identified by the original baseline configuration plus all of the ensuing approved changes incorporated since that time, and must be known and thoroughly documented at any given point in time.

PRELIMINARY DESIGN REVIEW

The following paragraphs discuss the nature of each formal review and inspection beginning with the initial review concerned with design. The Preliminary Design Review (PDR) is held to formally review the design approach of the Contract End Item prior to the detail design phase and to review and approve Part I of the Detailed Contract End Item Specification. Requirements of the PDR are specifically to:

1. Establish the compatibility of the selected design approach for the Contract End Item with Part I of the Detailed Contract End Item Specification.

2. Review pre-design drawings, schematic diagrams, layouts, sketches,

envelope drawings and any other available design documentation to establish system compatibility of the design approach.

3. Review and analyze all available breadboard models, mockups, circuit logic diagrams, packaging techniques, off-the-shelf equipment, etc., to establish the integrity and safety of the design approach.

4. Determine those portions of the design approach which must be subjected to further detailed engineering analysis.

5. Review requirements for special tools, fixtures and facilities to establish the producibility of the selected design approach.

6. Identify interfaces which must be established with other contractor and government agencies.

Placement of Part I of the End Item Specification into the contract signifies the completion of the PDR and establishes the Design Requirements Baseline. Any changes to the Part I Specification must subsequently be accomplished through the Configuration Control Panel/Configuration Control Board action.

The Systems Engineering Division of MSC/ASPO has the primary responsibility for organizing and conducting the PDR. This Division is responsible for identifying to the contractor those end items or blocks of end items that will be subjected to Preliminary Design Reviews, and the following Critical Design Reviews. Two weeks prior to the scheduled review data, the contractor, RASPO, and ASPO convene for a review of the agenda, the status of the design effort, the contractor's data, and the arrangements made for administrative support. The Apollo Spacecraft Program Office Manager or his designated representative serves as chairman of the PDR. The review is normally conducted by a review team or teams. The team composition and

functional responsibilities are designated by ASPO. The contractor has available counterparts for the various NASA team members and for the NASA team captains. During the Review, comments made by the NASA members of the review teams are reviewed with their contractor counterparts to insure the validity of the comment. The comments are then written up and submitted to the NASA team captain and his contractor counterpart for additional review. The NASA Review Team Captain and his contractor counterpart make their recommendations for disposition of the comments. In addition, they are responsible for determining if the comments duplicate previously submitted comments or should be combined with other comments. If it is determined that the comment is not a proper submission, a duplication of previous comments, or should be combined with other comments, the author is notified by the team captain. If the author agrees, the comment may then be withdrawn or combined with other comments. Each NASA team captain submits a written report to the review chairman, incorporating the appropriate review comments. The chairman determines the final disposition of all comments and the minutes record their disposition.

The following areas are to be reviewed, as appropriate, and as they relate to the end item or block of similar end items being reviewed for the PFR:

1. General Functional Aspects

   a. Compliance of the end item with specific design criteria and other applicable direction.

   b. Compatibility with formalized technical requirements.

   c. Development schedule for end item.

   d. Development and qualification test schedules and test plans.

   e. Environmental criteria (induced and natural aspects).

   f. Maintainability.

g. Handling restrictions and ground support equipment requirements.

h. Reliability considerations.

i. Crew and personnel safety considerations.

j. Human factor considerations.

k. Manufacturability considerations including cost, special tools, and facility requirements.

l. The end item specification and other documentation which must be developed is parallel with the end item.

m. Mission constraints and requirements.

n. Range safety considerations.

o. Physical apportionments (duty cycles, weight, volume, reach, etc.).

p. Identification of interfaces, ICD's and ICD schedules for completion.

2. Electrical - Electronic Aspects

a. Circuit and logic diagrams.

b. Electrical characteristics, including power input, output, and tolerance.

c. Packaging techniques.

d. Installation and interface consideration.

3. Mechanical Aspects

a. Preliminary stress analysis.

b. Preliminary dynamic loads analysis.

c. Installation and interface consideration.

The following items reflect the data that must be submitted by the contractor for the PDR evaluation.

a. Proposed Part I of the end item specification or block of end item and any other related specifications.

b. Proposed development and qualification test plans for the end item.

c. Any applicable design criteria and requirements.

d. Process specifications for components where the processing is critical or which presents a departure from standard manufacturing processes.

e. A listing of interface control documents and the schedule for completion.

f. Any preliminary analyses related to the design approach for the end item or block of end items.

g. Any drawings, functional diagrams, or schematics, and any preliminary circuit and logic diagrams.

Upon the completion of the review, the ASPO manager analyzes the PDR minutes and authorizes Part I of the Master End Item and/or Contract End Item Detail Specificature to be inserted into the contract along with any necessary design modifications.

CRITICAL DESIGN REVIEW

The Critical Design Review (CDR) is held to formally review the design of a selected Contract End Item or series of end items representing a Master End Item Specification and its individual diviation specifications. The CDR is normally conducted at the 90-95% design release point. The review may, in itself, be a progressive review held in several phases:

(1) Design Review; (2) Mission Compatibility Review; and (3) Ground Support Equipment (GSE) Design Review. Objectives of the CDR are specifically to:

1. Establish the compatibility of the Contract End Item or items, as designed, with the Master End Item and End Item Specifications; relate the design to the design approach established at PDR and updated to the point of CDR.

2. Establish the system compatibility of the design by reference to Interface Control Documents (ICD's), schematic block diagrams, functional block diagrams, and all other available system engineering documentation to support the ICD's. ICD's should be essentially complete at the point in time of CDR.

3. Review analytical and test data and reliability apportionment and analysis available at this point in time to establish the integrity of the design.

4. Review and approve all drawings released or ready for release to manufacturing.

The personnel composition and conduct of the CDR are much the same as those of the PDR. Completion of the CDR signifies establishment of the drawing baseline. Delta CDR's may be held on future specific contract end items to formally review any significant differences between it and the contract end item which has completed CDR, and are conducted using the same requirements as the CDR.

The following list delineates that data the contractor is required to submit to NASA for the CDR:

1. Up-to-date specifications including all approved Specification Change Notifications (SCN).

2. All Interface Control Documents (ICD's) related to the end item or block of end items.

3. Detailed drawings of critical areas or components as directed.

4. Detailed analyses that support the design approach and detailed design.

5. Test data as necessary to verify the adequacy of the design.

6. Process specifications for components where the processing is critical or which represent a departure from standard manufacturing processes.

7. Integrated functional schematics.

The following areas will be reviewed as appropriate and as they relate to the end item or block of end items being reviewed:

1. General Functional Aspects

   a. Compliance of the end item with the requirements of the applicable specifications.

   b. Status of the related development and qualification test programs.

   c. Maintainability including accessibility, assembly, disassembly.

   d. Handling restrictions with emphasis on specific planning related to any unusual handling criteria.

   e. General environmental restrictions.

   f. Human factor and safety considerations.

g. Manufacturability considerations with emphasis on imposed tolerance, special tooling requirements, and facility requirements.

h. Review status of all documentation requirements with emphasis on technical adequacy and proper scheduling.

i. Process specifications with emphasis in areas which represent unusual or state-of-the-art advances.

j. Interface considerations and status of all ICD's.

2. Electrical - Electronic Aspects

a. Circuit logic analysis using block diagrams.

b. Electrical input and output characteristics.

c. Functional interface requirements.

d. Characteristics related to thermal environment vibration-shock and IMI.

e. Packaging.

f. Test support equipment requirements and self-test capability.

g. Measurements provisions.

h. Parts selection, standards and deviations.

3. Mechanical Aspects

a. Detailed stress analysis.

b. Detailed dynamic loads analysis.

c. Detailed static loads analysis.

d. Shock and vibration environment to be generated or to which CEI is to be subjected.

e. Installation and interface considerations.

f. Detailed weight and center of gravity analysis.

During the review, the contractor is required to identify the specific items to be reviewed. The documentation on each end item is identified to be in one of the following categories:

1. Presented for design approval.
2. Presented for design review prior to release to manufacturing.
3. Presented for information only. Not representative or beyond the scope of the review.
4. Presented for information only. Previously reviewed and approved.

Since the intent of this design review is to determine the acceptability by NASA of the end item or block of end items being developed, it will not be necessary to originate contractural action to require the contractor to correct deficiencies noted at the time of the review. When it is necessary to revise any NASA imposed requirements, the contractor will be requested by the Design Review Chairman to submit an Engineering Change Proposal (ECP). The CDR will not be considered to be complete until all such action items have been satisfactorily completed and there is agreement between all affected contractors on the related ICD's. When design changes are required or any items are disapproved, a date for further review of the item will be included in the minutes. In certain instances, limited approval may be given contingent upon submittal of additional documentation or analyses to substantiate the detailed design presented for review.

Following the completion of the design reviews, the approved end item enters the manufacturing process. Each Command and Service Modules (CSM) and Lunar Module (LM) goes through two processing and manufacturing phase

and contractor checkout operations; and is subject to a Customer Acceptance Readiness Review (CARR) at the contractor's facilities prior to shipment to the launch site. This review precedes and supports the formal acceptance of the space vehicle by NASA.

CUSTOMER ACCEPTANCE READINESS REVIEW

The CARR is a phased review to formally analyze the manufacturing accomplishments and evaluate systems performance as obtained during the contractors checkout operations. In addition, verification is made that all mission constraints are valid and that the module is capable of specified performance and ready for delivery. It should be noted that the overall CARR is conducted in three phases: The Phase I CARR prior to entry into subsystem testing; the Phase II CARR prior to integrated or Final Engineering Acceptance Test (FEAT); and the Phase III CARR prior to delivery to KSC.

The Systems Engineering Division is responsible for preparing the CARR requirements. The LM or CSM Project Engineering Division, and more specifically, the assigned Vehicle Manager, is responsible for the coordination and implementation of the CARR requirements for the particular vehicle of concern. The vehicle contractor is required to assign a review Coordinator, responsible for the coordination and implementation of the review requirements for the contractor. In addition, the contractor is required to provide complete logistic and administrative support for all CARR activities.

The basic objective of the overall CARR is to evaluate the readiness of the module for delivery to Kennedy Space Center for launch preparation or to the field site for test operations. Specific, objectives are to:

1. Evaluate all work accomplished prior to each particular CARR phase.

2. Determine the status of the hardware with respect to all waivers, deviations, discrepancies, shortages, unresolved checkout problems, generic and end-item failures, limited-life components, irregular parts, and open work.

3. Determine the configuration of the total as built and modified spacecraft including non-flight items.

4. Determine qualification and/or certification status of hardware, including evaluation of test versus flight hardware differences.

5. Determine the readiness for shipment and the degree of engineering confidence in the reliability of the hardware at the point in time of the review.

6. Specify action to be accomplished as a result of the review.

7. Release the hardware for final shipment preparations.

8. Approve the material content for each CARR phase.

9. Assess the readiness of the Ground Support Equipment (GSE) to support the next phase of checkout.

For several working days preceding each phase, CARR Board working sessions at the contractor's facility are conducted for a thorough review of spacecraft and GSE status. The length of these work sessions varies, dependent on the module, review phase, and depth of review required. This working session commences with a Reliability and Quality Review Team reviewing all necessary data and documentation required to establish the reliability and quality status, providing this evaluation as an input into the Subsystem Working Team reviews. This team also conducts the hardware walk-around inspection, if required, for each phase of the CARR and reports their

findings at the NASA Pre-CARR Board meeting. The Chairman of this team is a member of the Reliability and Quality Assurance Office, MSC, with participating members from the MSC Safety Office, Resident ASPO (RASPO), (the contractor facility), RASPO-KSC, and the Quality Surveillance Division, KSC.

Team evaluation of documentation includes an assessment of spacecraft safety with emphasis on pressure vessels, wiring deficiencies, corona effects, plumbing, fluid leaks and spills, corrosion, contamination, combustible materials, incompatible materials, toxicity, unique tests to identify hazards, special safety precautions, and existence and adequacy of a list of non-flight items, in addition to the failure, certification, general quality items and hardware inspection. The walk-around module hardware inspection consists of an inspection of spacecraft materials, connectors and component installation in addition to a random check of the "as-build" to "as-designed" configuration of the spacecraft. Items identified as discrepant are entered on Request for Action (RFA) forms and tagged for identification. As an additional portion of the pre-CARR review, subsystem working teams are designated, as required, to review all data and documentation necessary to verify the spacecraft configuration, failure analysis and corrective action, hardware certification, previous and planned tests, checkout plans, and to review the status of previous action items. The checkout operations and CARR Reports are evaluated in detail for complete accuracy. The determiniation that technical information requirements have been satisfied are made by the NASA-MSC subsystem managers chairing the NASA working team meetings. The NASA-MSC subsystem managers work with the contractor to insure that the

group findings are documented as specified on the special forms (RFS's). The information on these forms is used in the preparation of the minutes. Any disagreement among members of these working groups is noted for final resolution at the Phase Pre-CARR Board Meeting.

Specifically, these subsystem working team reviews are expected to determine the following for the applicable phase:

1. Status of action items from previous reviews.

2. Acceptability of waivers and deviations to the Contract Specifications, and approved checkout requirements.

3. Hardware certification status (in conjunction with Reliability and Quality Review Team).

4. Status of accomplishments and open work with regard to checkout, rework and modifications.

5. Status of failure analysis and corrective action, including anomalies, and resolution of quality items for program recurrence control (in conjunction with Reliability and Quality Review Team).

6. Status of spacecraft hardware as related to:

   a. Have all failures been resolved?

   b. Have all quality items been corrected?

   c. Removed and replaced hardware (whether any rework was required or not). Rework accomplishment, retest before and after installation, and open work remaining must be identified.

   d. Shelf life and time and cycle limitations.

7. Establishment of baseline configuration (Phase I). For Phases II and III, have all configuration changes resulting from failures, Engineering Orders, or any other source been accomplished.

8. Non-flight items listing and status.

9. Material acceptability (including Material Review Board actions on non-conforming material, if any). (In conjunction with Reliability and Quality Review Team).

10. Status of all Operational Checkout Procedures (OCP's) to be run adequacy of test results from completed OCP's.

11. Status of spares availability.

12. Shortage items and their status.

13. Appropriateness of all refurbished, repaired or previously flown hardware.

The subsystem working teams are organized to parallel the subsystem organization breakdown. Special working teams may be established to review facilities readiness (including GSE and ACE) and the items of special consideration. Any problems identified or suspected by the various working teams involving an area for which one of the special teams has been organized are submitted to the special working team for their consideration and evaluation.

Request for Action forms (RFA's) are prepared in a clear-concise manner with the action request stated together with the recommended constraint. A proposed solution to the problem may also be stated in the form of some positive action to be taken. A proposed solution should not be in the form of a design review. It is re-emphasized that the CARR is not a design review. The contractor is required to provide an answer in writing to all RFA's at the CARR Phase Pre-Board Meeting.

Each working team prepares and submits a certificate of readiness for subsystem test, integrated test, or acceptance specifically identifying all items which may affect test readiness or acceptance for which it is responsible. The format for the readiness statements includes all exceptions or constraints to test acceptance readiness. This includes all elements which are considered to be safety hazards.

For each phase, NASA participants conduct a Summary Review Meeting on the day preceding the formal Phase CARR Board Meeting. The NASA Team Chairmen present their team findings for review and subsystem consolidation. The Chief, Applicable Module Project Engineering Division, MSC, chairs this Pre-CARR Board Meeting for Phase I and II, and the Program Manager, Applicable Module, Apollo Spacecraft Program, MSC, will chair the Phase III Pre-CARR Board Meeting. The Pre-CARR Board Review is responsible for:

1. Providing the Pre-CARR Board members an opportunity to understand and assess all problems identified in preparation for the CARR Board activities.
2. Determining the appropriateness of each Request for Action (RFS).
3. Determining the acceptability of the contractor response.
4. Establishing which RFA's will become agenda items for the CARR Board.

Valid RFA's with acceptable contractor responses are not submitted to the CARR Board for action but will be included in the CARR Board Minutes with the Board's understanding that agreements have been reached between the NASA and the contractor and are therefore binding as action items.

Upon the completion of the Pre-CARR Review Board Meeting, the formal CARR Board phase is instituted. Figure 3, 4, and 5 of Appendix F compare the

elements reviewed in each CARR phase. Figure 6 of Appendix F reflects the membership of the CARR board for each phase.

In general, the formal CARR Board Meeting for each phase consists of a presentation by the contractor subsystem representatives of the results of each of the subsystem working team reviews. The presentation will include an assessment of the readiness of the module to proceed with the next text phase or customer acceptance. Each presentation includes all significant checkout problems and resolutions, waivers and deviations, hardware certification status, configuration variances, etc. All disagreements between NASA and the contractor are discussed and, where no problem or disagreement exists, it is so stated.

The NASA Team Chairman specifically indicates his agreement or disagreement with the contents of the Contractor CARR Report. The NASA Team Chairman then presents his team's RFA's individually for the Board's consideration and action. The CARR Board also directs its attention to the evaluation and resolution of items which remain open from previous reviews or have not been satisfactorily closed out by the action item responses.

The review is limited to major or significant items of interest to the CARR Board. In general, there is no detailed technical discussion unless requested by a CARR Board member or contractor management. If the CARR Board requires any additional information which cannot readily be made available, action items are assigned for future resolution and review.

Data utilized by the contractor to certify special areas of consideration for the particular vehicle under review are made available at the contractor's facility for the applicable CARR phase. These special program considerations will be identified prior to the review so that the contractor can make appropriate preparations. Examples of special consideration areas are: tanks, wiring, plumbing, and materials. This special data also includes a detailed statement of any safety precautions implemented since the previous CARR phase.

The Phase I CARR Board defines the acceptability of the end-item to enter subsystem testing while the Phase II CARR Board defines the acceptability of the end-item to enter integrated testing. The Phase III CARR Board defines the acceptability of the end-item for delivery with waivers and deviations which the Board determines are acceptable for flight operations, and with equipment or parts shortages which the Board determines can be installed by the contractor at the launch site without adversely affecting the launch date. However, the Board reserves the right to have all deviations corrected and equipment installed prior to acceptance if the Phase III CARR Board determines this is in the best interests of NASA in accordance with the contract.

If the NASA Phase III CARR Board, based on the information presented, declares the spacecraft acceptable for shipment, with the exception of the Evnironmental Control Subsystem (ECS), preparations for shipment may be completed. (The acceptance of the ECS will be deferred until the data from the chamber run at KSC have been evaluated.) This decision is documented by sign-off of the Acceptability Statement and the Endorsement No. 1 of the Certificate of Flight Worthiness (COFW) by the Phase III CARR

Board Chairman or his designated representative. Any problem areas of concern to the Phase III CARR Board are considered constraints to shipment of the spacecraft until resolved.

The NASA CARR Board Secretary records the Board Action Items and makes them available for information purposes to the Board Chairman immediately following meeting adjournment. Those action items considered to be constraints to further testing or to delivery are identified. The Module acceptability statement is to be prepared by the Secretary for the signatures of the Phase III CARR Board Chairman and appended to the minutes.

The Phase III CARR Board Minutes, in addition to the regular meeting activities, includes the following:

1. A narrative summary of the spacecraft checkout operations from the cut-off date for the Volume III report to the Phase III CARR Board.
2. Efforts between CARR Board Phase III and shipment.
3. Efforts transferred to the field (open work, E.O., etc.).
4. Contractor Quality Assurance Statement.
5. NASA Quality Assurance Statement.
6. Spacecraft Acceptability Statement.
7. Contractor Safety Summary.

It is the responsibility of the Manager, Applicable Module, Apollo Spacecarft Program, MSC, to determine when proper action has been implemented to resolve the action items resulting from the CARR Board Meeting. Constraints to further testing or to delivery as defined by the CARR Board are considered removed only by this determination of action item resolution. The Test Preparation Sheet (TPS) which authorizes further

testing or shipment requires the approval of the Manager, Applicable Module, MSC. Until such time as all action items and constraints are closed, the contractor supplies NASA with a weekly status of these items. NASA/MSC may confirm or reject all contractor proposals for close-out of action items. The data and documentation required for CARR includes a three volume CARR Report. The contractor is required to prepare the CARR Reports, Volume I through III. Volume I is the Basic CARR Report for Phase I CARR, with Volume II being an update of Volume I for Phase II CARR, and Volume III an update of Volume II for Phase III CARR. This report includes historical information covering all spacecraft activities from initial manufacturing to the time of the CARR as well as other information concerning hardware failures, configuration, and certification, as well as quality control problems (unsatisfactory conditions).

The NASA subsystem contractors (ACED/MIT/GE) prepare that portion of the report for which they are responsible and submit their inputs through the RASPO Test and Engineering Branch to the contractor for integration into the CARR Report. NASA/MSC is responsible for preparation of the report material involving all other GFE.

As previously indicated, the products of the Phase III CARR are the NASA delivery acceptance statement, DD-250, Material Inspection and Receiving Report, sign-off, and execution of Endorsement No. 1 of the Certificate of Flight Worthiness (COFW). The delivery acceptance statements includes a KSC statement on acceptance of open work.

RASPO executes the DD-250 upon completion of the Acceptance Data Package review and review of the DD-250. Any items not in conformance with the Phase III CARR Meeting and/or Program requirements are specifically stated in the DD-250. Prior to signing the DD-250, the RASPO Resident Manager briefs the Phase III CARR Board Vice-Chairman on the status of the vehicle, the Acceptance Data Package, and DD-250 contents.

The Certification of Flight Worthiness is part of the overall program of reviews and assessments as shown in Appendix F, Figure 7. This procedure is used by the Program Manager and the respective hardware contractors to certify hardware configuration and completeness, availability and disposition of required documentation, and the readiness of the module and its associated GSE from the manufacturing phase through integration and checkout at the launch site. The COFW is not a review requirement, but rather a certification that the review requirements have been met.

There are four COFW endorsements made for each individual module and its associated GSE of the space vehicle as each passes the particular milestone, and one final endorsement for the assembled spacecraft.

Endorsement one, Configuration Definition, Manufacturing and Checkout, as shown in Appendix F, Figure 7, is completed for each module and its associated GSE, when manufacturing, test and checkout have been satisfactorily completed in accordance with the contractual requirements as verified by the CARR. This endorsement certifies that the contents of the Acceptance Data Package (ADP) and the DD-250 are in order and that the items listed in Appendix F, Figure 8 have been identified. The ADP

is negotiated by the contractor and the RASPO Manager and will be assigned to depict, in detail, the entire history of the design, manufacturing, and testing of the specific module in question.

Endorsement two, Launch Site Receiving Inspection, as shown in Appendix F, Figure 9, is endorsed to coincide with the completion of receiving and inspection of the module and its associated GSE, upon arrival at the launch site. The equipment must satisfactorily pass a visual receiving inspection, and be accompanied by the necessary hardware and documentation.

Endorsement three, Pre-Launch Vehicle Mating and Checkout, as shown in Appendix F, Figure 10 is made after all checkout requirements, modifications, and all other necessary work prior to mating with the launch vehicle have been satisfactorily accomplished.

Proof of accomplishment of all Pre-Mate Checkout activities, including Astronaut-Spacesuit compatibility is supplied in writing to the Program Manager by the pertinent Test Director and verified by the MSC Quality Representative. This verification provides the means by which the article will be certified and be permitted to move to the Vehicle Assembly Building (VAB) for Saturn V missions or to the launch pad for Saturn I-B missions.

Endorsement four, and the final endorsement, takes place following the Design Certification Review (DCR) and the Flight Readiness Review (FRR) and will be described following the discussion of these five deliveries.

DESIGN CERTIFICATION REVIEW

The Design Certification Review (DCR) is a three-phased formal review to examine the design of the total mission complex for proof of design and

development maturity. Specific objectives of the DCR include the assessment and certification of the design of the Space Vehicle for flight worthiness and manned safety, assessment and certification of manned Apollo missions, and of the design of the Launch Complex, Mission Control Center, Manned Space Flight Network and Launch Instrumentation.

The overall DCR is a lengthy review with Phase I commencing approximately 26 weeks prior to launch and concluding approximately 8 weeks prior to launch.

The basic responsibility for conducting the DCR rests with the Office of Manned Space Flight (OMSF) Management Council consisting of the Associate Administrator of MSF, as Chairman, and the Directors of each of the three Manned Space Flight Centers. A Mission Design Certification Document, executed by the MSF Management Council serves as the approval authority for proceeding with specific flight missions designated for manned flight.

The spacecraft DCR development cycle, as summarized in Appendix F, Figure 11, is divided into five progressive and distinct phases:

Pre-Phase I	-	Orientation and Previews
Phase I	-	DCR Manager's Review and Critique
Phase II	-	Apollo Spacecraft Program Manager and MSC Review and Assessment Boards Critique
Phase III	-	Apollo DCR
Post Phase III	-	Closure of Open Items

Because of the incremental nature of the DCR, each phase will be discussed in order with concentration on the make-up, operation, and objectives of that phase.

Figure 12 of Appendix F, list the participants and their responsibilities throughout the various DCR phases.

Pre-Phase I, Phase I and Phase II are primarily concerned with preparation of presentations to be made for Phase III. In the course of preparation, various reviews are conducted by NASA to insure that the DCR report to be submitted to the DCR Board has eliminated all question of technical adequacy and accuracy. During the Pre-Phase I, the spacecraft DCR Manager, his staff, and representatives of individual project offices meet with the contractor to discuss procedure and implementation of the following phases.

Phase I begins shortly afterwards with the principle objective of a technical critique by MSC management of the DCR material to be presented at later reviews. The DCR Manager, together with Spacecraft Review Teams consisting of ASPO and E&D Personnel, provide the contractor with extensive comments concerning technical accuracy, adequacy of presentation during Phase II. The critiques by the DCR Manager and MSC Review Teams are used as a guide by the contractors as they update their written reports and oral presentations just prior to Phase II.

Approximately 19 weeks prior to launch, Apollo Spacecraft Program Manager and MSC Review and Assessment Board convene to critique the final coordinated report prior to presentation to the DCR Board. This phase of the review allows the Program Manager and the MSC Review and Assessment Board to perform a technical critique of all materials and methods of presentation used, thereby assuring that the Apollo Program Director and the Apollo Design Certification Board will have technical visibility on which to base their decisions. All changes to the DCR presentation material

are coordinated with the DCR Manager prior to final presentation by prior to final presentation by contractor and MSC personnel at Phase III.

The Apollo Design Certification Review, Phase III of the DCR, is the formal and official presentation of the complete Apollo Space Vehicle and Mission Support elements and is held during the period of 13 to 8 weeks prior to launch. It is organized and directed by the Apollo Program Director and conducted by the Apollo Design Certification Board.

The mission support presentations are coordinated by the Mission Operations Director.

The Apollo DCR objectives are to:

1. Examine the design and development maturity of the:
    a. Space Vehicle.
    b. Launch complex.
    c. Mission Control Center.
    d. Manned Space Flight Network.
    e. Launch instrumentation.
2. Certify the design of the space vehicle for flight worthiness and manned safety.
3. Certify the design of Mission Support for capability to support an Apollo manned mission.
4. Review and certify Flight Crew Operations.

The members of the DCR expect to receive answers to detailed, penetrating and technical questions from any participating officials concerning all aspects of design development, maturity, and configuration of hardware.

Particular emphasis beyond the scope of the presentation is expected in the area of manned safety. The scope of this review includes a systematic examination of spacecraft module, subsystems, GSE, and GFE.

Up to this point, only the development and presentation of the module and GFE portion of the DCR has been discussed. Other portions of the review are as follows:

1. Mission Control Center Summary, by the Director of Flight Operations.
2. Flight Crew Operations Summary, by the Director of Flight Crew Operations.
3. Spacecraft System Engineering Summary, by the Chief of Systems Engineering Division and E&D Personnel.
4. Module and GFE Assessments, by CSM LM Managers.
5. Spacecraft Reliability Summary, by Chief Reliability and Test Division.
6. Spacecraft Manned Safety Summary, by Manager, Flight Safety Office.
7. Spacecraft Design Certification Summary, by DCR Manager.
8. Spacecraft Design Assessment and Certification, by the Apollo Spacecraft Program Manager.

In assessing their module and GFE, CSM and LM Managers must consider design maturity, flight worthiness, manned safety, and the capability of their systems to meet or exceed Apollo requirements in support of the specific mission. The presentations on reliability and safety analyses predict reliabilities on the modules, GFE and GSE and provide a single reliability number for the entire spacecraft in support of the mission. The DCR Manager summarizes all of the modules, GFE and GSE certifications,

noting any contingencies, exceptions or open items.

Having been assured of the flight worthiness and safety of the spacecraft, the Apollo Design Certification Board executes a Mission Design Certification Document, identifying any actions upon which certification is contingent.

The Post Phase III of the DCR is a period of time allotted for the closing of open action items which are to be accomplished by the responsible MSC and contractor personnel. All such action items are reviewed by the DCR Manager and must be completed in sufficient time to allow for review and closure by the DCR Board prior to the final formal review.

FLIGHT READINESS REVIEW

The final formal review is a two-part Flight Readiness Review conducted by the Office of Manned Space Flight. Part I of the FRR is conducted to determine if the space vehicle hardware and launch complex are ready to commence the mission period and is conducted by the Apollo Program Director. The purpose of Part II is to determine the readiness of the operational elements and is conducted by the Mission Director. Both parts are conducted on the basis of oral summary presentations approved by the responsible program managers. The FRR is usually held approximately two weeks prior to launch.

Approximately three days prior to the Part I, MSC and KSC representatives meet with the respective CSM, LM, and subsystem contractors to conduct a Pre-Flight Readiness Review (Pre-FRR). The purpose of the Pre-FRR is to provide an initial spacecraft readiness review to determine the adequacy of the preparation of the FRR report and review the disposition of any outstanding action items.

The Program Manager orally reports at the Part I FRR and is responsible for providing both a written and oral update of the spacecraft checkout, failure analysis and qualification status and implementation of the Pre-FRR actions. The final COFW is presented and discussed.

The overall objective of the Parts I and II is the evaluation and readiness of the spacecraft, GSE and ACE hardware to achieve the specified mission. Specifically, the FRR objectives are to:

1. Evaluate all work accomplished subsequent to the delivery of the spacecraft to KSC.
2. Determine the status of the hardware with respect to all waivers, deviations, discrepancies, shortages, unresolved checkout problems, generic and end-item failures, limited life components, configuration changes, uncontrolled parts, and open work.
3. Determine qualification/certification status of spacecraft hardware, including the evaluation of test versus flight hardware differences.
4. Determine the flight readiness and degree of engineering confidence in the reliability of the hardware up to that point of the review.
5. Specify action to be accomplished as a result of the review.
6. Release the hardware for the final launch preparations.
7. Approve the material content to be submitted for the FRR.

The FRR Board has the responsibility of the supervision and conduct of the review, the approval or disapproval of the material content of the review and of recommendations made in the course of the review, and the establishment of tasks, as deemed appropriate, to implement the Board's decisions. The personnel assigned to the board are shown in Appendix E, Figure 13.

The Chairmen exercise the final authority for all decisions and have the prerogative of determing the extent of the Board's advice and consultation.

Preparing the report for each phase of the FRR is the responsibility of the spacecraft contractor. To meet the objectives of the FRR, this report integrates reports written by the CSM and LM contractors, subsystem contractors, various agencies and the spacecraft contractor. Representatives of KSC and MSC are assigned to assist the contractor's preparation of the report in the areas of spacecraft checkout summary and hardware summary, respectively. Each Center is required to approve these areas of the report assigned to it, prior to presentation. The presentation summarizes the Pre-FRR Reports and treats only significant non-nominal performance discussed in the written report.

The Chairman of the Part I FRR is responsible for executing Endorsement Four, Pre-Launch Space Vehicle Checkout, shown in Appendix F, Figure 14. This endorsement is made after all the checkout and work required on the spacecraft has been successfully integrated into the launch vehicle and the contractor's FRR report accepted and approved. This endorsement further reflects the satisfactory completion of the FRR, permitting certification of the spacecraft as acceptable for launch. If any of the previous three endorsements have been executed with exceptions, the Program Manager obtains assurances that all exceptions and provisions have been satisfied.

Upon the completion of Endorsement Four, the Program Manager again reviews and evaluates all endorsements and endorsement exceptions. All waivers and deviations are fully coordinated and approved for launch.

When the Program Manager is confident that all stated COFW requirements have been completed, he certifies the spacecraft flight worthiness by executing the final certification as shown in Appendix F, Figure 15.

DELTA REVIEWS

A discussion of the formal review system would not be complete without including delta reviews. The purpose of the delta review is to formally review all contract end items that are produced after the initial end item was accepted. In this way, NASA maintains continuing visibility on all contract end items assuring that each meets or exceeds contract specifications. The procedures for the delta review are identical with the review that granted initial approval for the original end item.

OPERATIONAL READINESS INSPECTION

The basic tool used to effect safety in the MSC manned ground testing operations is the Operational Readiness Inspection (ORI). The ORI was developed in 1963 and is used in the activation of new test facilities involved in testing for the manned spaceflight program. It is also used for the re-review of an existing facility after each major change in test programs and/or changes in a test facility. The purpose of the ORI is to provide an independent verification of the adequacy of safety measures, management and functional approaches, operating procedures, etc., of major test facilities prior to authorization to commence operations. The ORI committee is appointed by the Director, MSC and includes a chairman, executive secretary, and at least six division or branch chief level members. Compliance with ORI mandatory recommendations is to prerequisite to initiation of test activities.

The process by which an ORI is conducted is as follows:

ORI Committee conducts inspections which include:

Planned briefings by facility operations and testing staff

Physical inspection of facility

Informal discussion and working group sessions

Review of documentation

ORI Committee reports findings and recommendations

Facility staff implements recommendations

ORI Committee conducts reinspections

Permissions to initiate testing activities granted upon completion of mandatory recommendations.

There are ten areas that are dealt with in an ORI. They include looking in depth into the facility design and construction, organization and stopping for operation, level of training of operating personnel, plans and procedures for normal and emergency operations, and configuration control procedures and documentation.

The Apollo prime contractors are required to have a safety program plan to define the safety organization, authority and responsibility for safety matters, relationships to other contractor organizations, safety tasks to be accomplished, and the major safety milestones. Contractors are required to develop safety procedures to minimize hazards, assure safety review and approval of design criteria, standards and safety factors, assure safety participation in reviews and tests, conduct safety analyses, and identify and correct hazards. The prime contractor

safety organizations are required to audit their subcontractors safety programs and provide safety reports to the MSC-FSO.

OPERATIONS REVIEWS

In order to insure the operational readiness required, Flight Operations Directorate holds formal assessments of key operational resources. A DOD Pre-Mission Review is held with the Department of Defense to review in detail the plans and readiness of DOD recovery forces, network, and launch areas for mission support. A Flight Controller briefing is conducted by the mission Flight Director prior to the deployment of flight control personnel to remote sites and ships. This briefing serves as the final review of the mission profile, network configuration, and spacecraft systems updating. A final Readiness Assessment by the Director of Flight Operations is held to evaluate the mission readiness of the Mission Control Center - Houston, the network, recovery plans and coordination, and flight control personnel and the flight crew. This assessment is a final examination of the results of MSC preparation activities involving flight crew training, flight controller training, network and control center test operations, and confidence testing, and all preceding operations briefings. The results of various types of simulation exercises serve as valuable inputs to this Readiness Assessment.

Following the completion of a mission, FOD is responsible for the preparation of the Post-Flight Trajectory Analysis, to evaluate and document trajectory performance of the mission and a debriefing of the flight controllers.

FOLLOW-UP OR "CLOSING THE LOOP"

The previous discussion has explained in detail the various means used by MSC management to provide visability, identify problems, and take corrective action. The process is not complete, however, until there is assurance that the corrective action has been taken and actually corrected the problem. Therefore, the management cycle places great emphasis upon follow-up, or "closing the loop".

FAILURE REPORTING

Figure IV-7, "Spacecraft Readiness", depicts the relationship between the techniques previously described to illustrate how this follow-up is achieved. Through the failure reporting system, continuous effort is applied to the solution of problems that arise. At the subsystem level, all of these failures will be corrected prior to Certification of the subsystem. Failures occuring during factory or KSC checkout of certified subsystems will be evaluated at one of the periodic technical reviews, CARR, CDR, or FRR. As previously described each of these reviews picks up with the previous review, considers all subsequent configuration changes, test results, and other pertinent data. Even though all of this data has been previously reviewed and analyzed, a final check in depth is made to insure that corrective action has been successful and that all open items are closed out prior to approval for launch.

POST-FLIGHT EVALUATION

Following the mission an extensive post-flight evaluation is made for the purpose of identifying all deviations from required performance in order that fixes, either design or procedural change, can be prescribed.

NASA-S-65-10040

SPACECRAFT READINESS

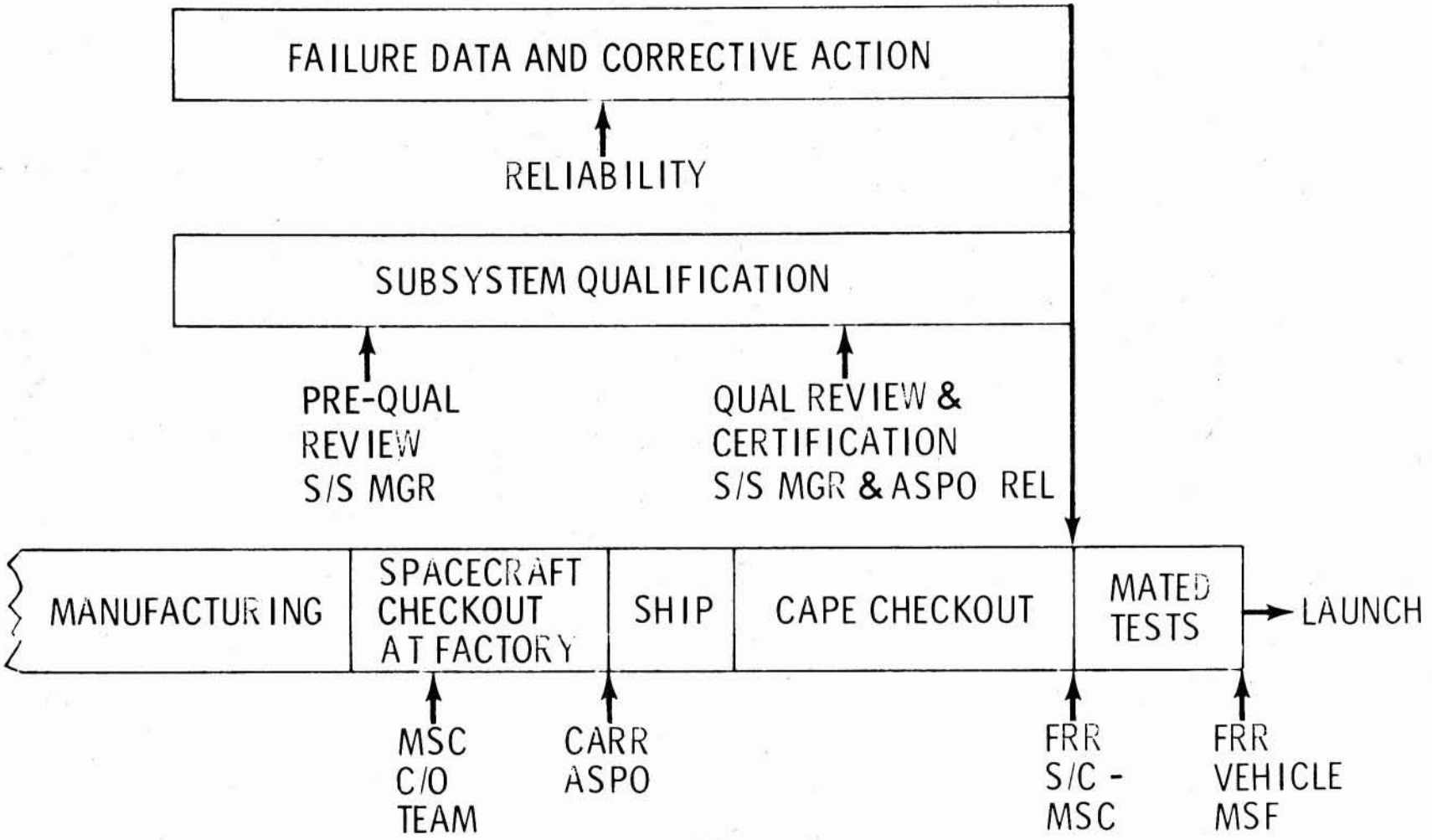


FIGURE IV-7

Each Apollo mission is required to be individually analyzed with respect to system and subsystem performance meeting assigned objectives.

The Apollo mission evaluation procedure is a management tool providing continuing visability on technical aspects of the Apollo spacecraft. The planning, implementation, management and publication of the mission reports is the responsibility of ASPO. To accomplish this objective, ASPO requires the support and assistance of personnel from other MSC directorates and various contractor personnel.

An evaluation team for each mission is established at MSC. Each team is responsible for analyzing and evaluating systems performance during and after the mission, providing technical information during the mission through analysis of pertinent data, identifying and resolving problems and anomalies, establishing requirements for control of post-flight testing, and preparing the required mission reports. In addition, all flight hardware comes under the direct control of the evaluation team following recovery operations.

The mission evaluation teams receive mission data in the following areas:

a. Trajectory
b. Mission support
c. Experiments
d. Crew station
e. Biomedical
f. Radiation environment
g. Voice tapes
h. Subsystem performance

Various MSC elements, as shown in Figure IV-8, are required to provide technically qualified personnel to prepare the analysis of the results of the mission within their assigned areas and provide their evaluation to the team manager. Contractor personnel are responsible for identifying problems and anomalies within their respective systems, and determine causes and resolutions for inclusion in the Mission Report. In addition, the contractor, with the concurrence of the appropriate Analysis Manager, prepares an integrated list of all pertinent mission events, which constitutes the official mission sequence of events.

The results of each Apollo mission are reported in a series of seven documents:

a. Twenty-Four Hour Flash Report
b. MSC Daily Report
c. MSC Three-Day Report
d. MSC Ten-Day Report
e. Anomaly Report
f. Thirty-Day Anomaly Listing Report
g. Mission Report

The Twenty-Four Hour Flash Report is issued by the Mission Director listing such data as launch and recovery time, statement of success based on general purpose, and the listing of any observed significant events or anomalies. The balance of the reports will be issued by the evaluation team.

The MSC Daily Report summarizes major mission activities during the reporting period, emphasizing significant accomplishments, anomalies

EVALUATION TEAM ORGANIZATION

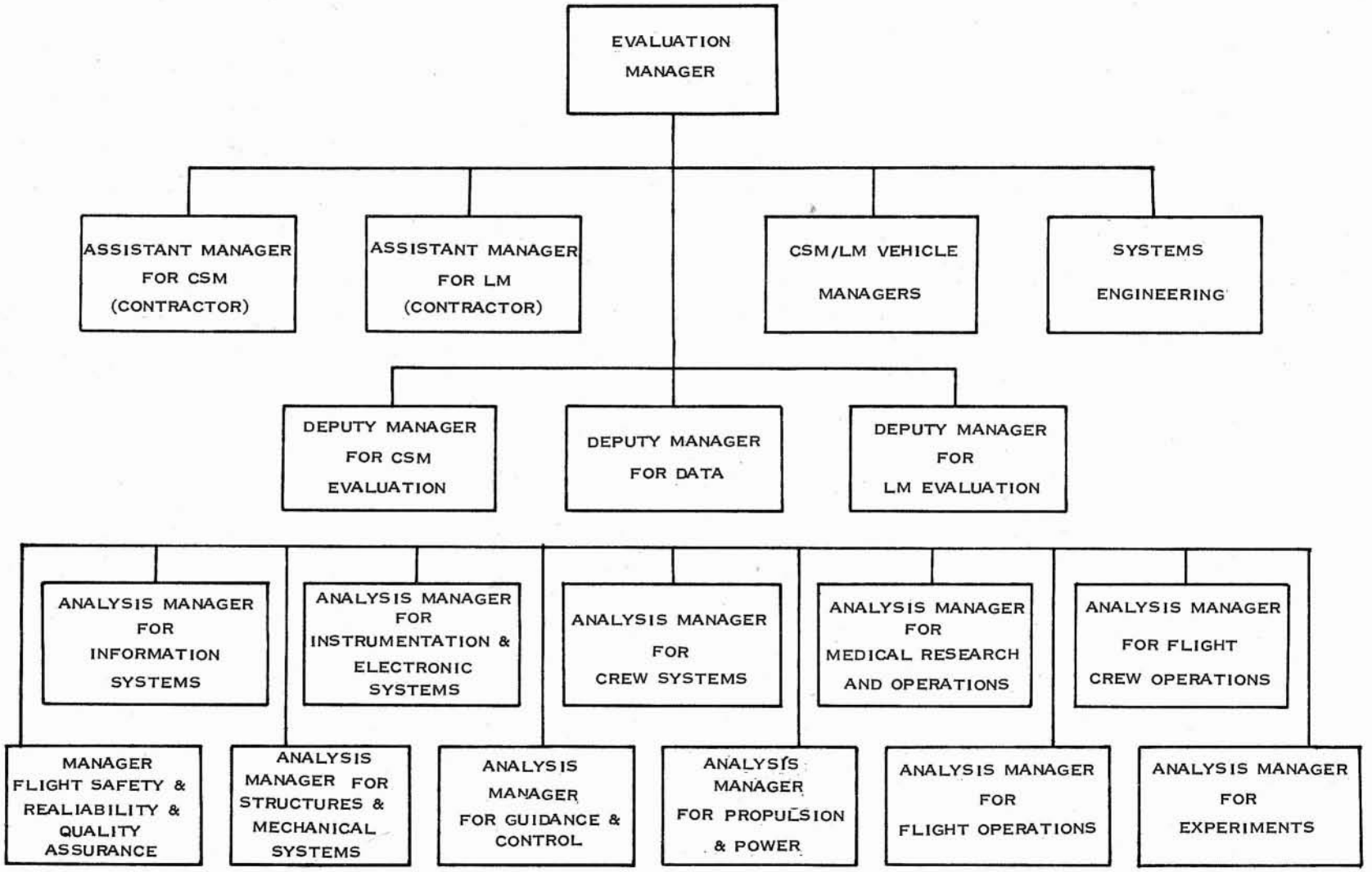


FIGURE IV-8

problem areas, and remaining quantity of consumables. The MSC Three-Day Report is issued within three days after mission termination and summarizies significant mission events. It also includes an indication of the degree to which each of the spacecraft objectives are satisfied, identification of trajectory results, anomalies and indication of systems performance. The MSC Ten-Day Report is issued ten days after the completion of the mission and provides additional data analysis.

An Anomaly Report, for internal use, is prepared for each anomaly and provides a brief description and analysis of the anomaly as well as an intended solution. A Thirty-Day Anomaly Listing Report is issued 30 days after completion of the mission and provides the Apollo Program Director a complete listing of significant spacecraft anomalies, including criticality and impact on the mission objectives, the history of ground qualification and proposed corrective action.

The Mission Report is issued 45 days after mission completion. It describes configurations of vehicles and mission accomplishments. Sufficient data and figures are included to verify that mission objectives were satisfied. System performance states whether or not the system functioned normally, and detailed analysis is provided only where required. This Mission Report also included a condensation of Thirty-Day Anomaly Listing Report and all Anomaly Reports.

An additional part of the mission evaluation process is the coordination of the interfaces between MSC, KSC, MSFC, and GSFC for the evaluation of the performance of the launch vehicle and the spacecraft.

This portion of the evaluation is conducted by the Flight Evaluation Panel. This panel is responsible for resolving the causes of flight malfunctions and deviations that are not confined to either the launch vehicle or to the spacecraft. The panel facilitates the appropriate exchange of data for analysis and evaluates all mutual problems of flight instrumentation as they effect flight evaluation.

Figures IV-9 and IV-10 summarize the elements of Apollo Program Management at the Manned Spacecraft Center and Figure IV-11 shows the spacecraft and launch vehicle development and mission operations milestones related to the factor of time. Appendix G summarizes the entire Apollo Program Management Process in a series of one page figures and charts.

APOLLO MANAGEMENT CYCLE

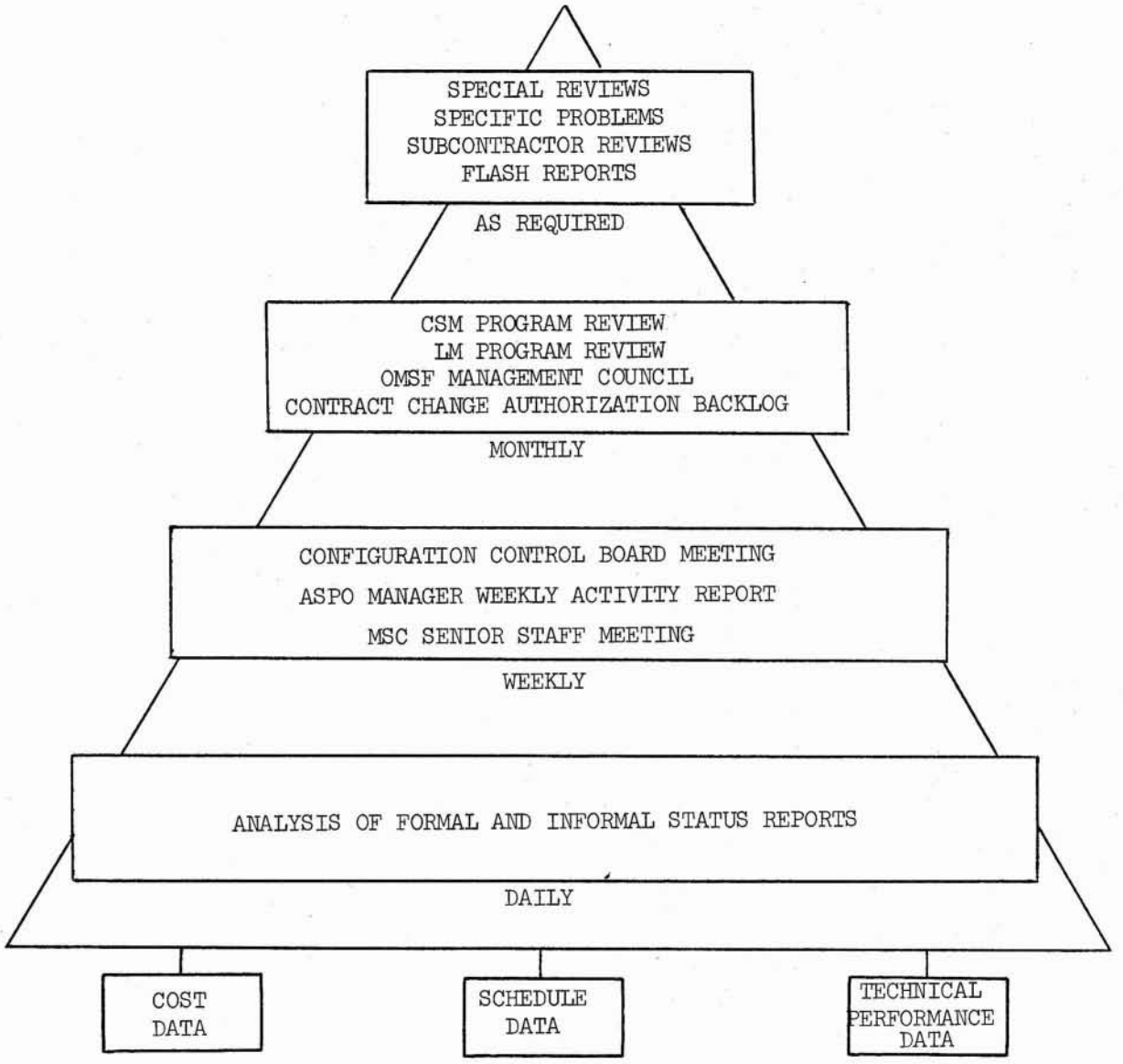


FIGURE IV-9

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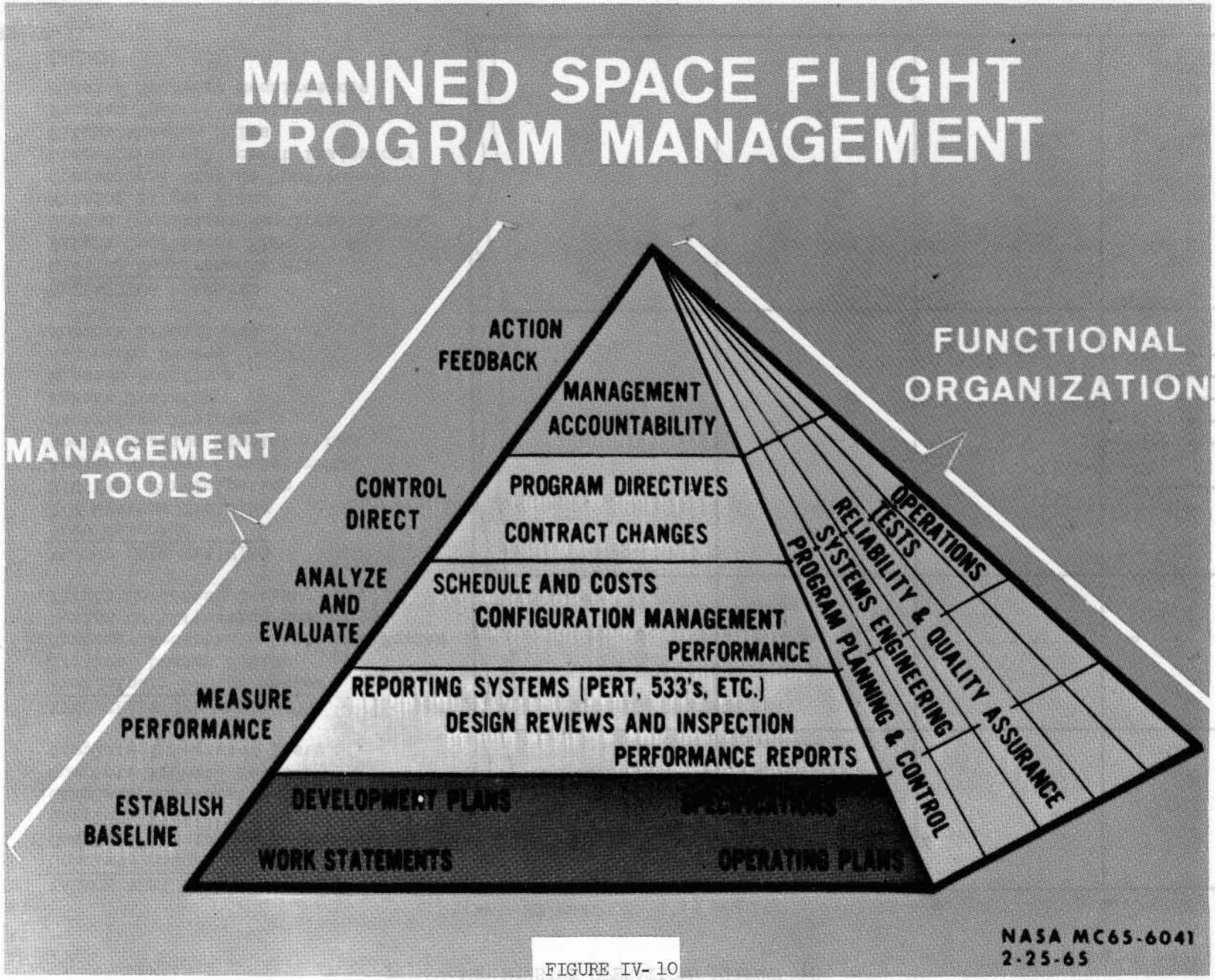
MANNED SPACE FLIGHT
PROGRAM MANAGEMENT
ACTION
FEEDBACK
MANAGEMENT
TOOLS
FUNCTIONAL
ORGANIZATION
MANAGEMENT
ACCOUNTABILITY
CONTROL
DIRECT
PROGRAM DIRECTIVES
CONTRACT CHANGES
ANALYZE
AND
EVALUATE
SCHEDULE AND COSTS
CONFIGURATION MANAGEMENT
PERFORMANCE
MEASURE
PERFORMANCE
REPORTING SYSTEMS (PERT, 533's, ETC.)
DESIGN REVIEWS AND INSPECTION
PERFORMANCE REPORTS
ESTABLISH
BASELINE
DEVELOPMENT PLANS
WORK STATEMENTS
OPERATING PLANS
PROGRAM PLANNING & CONTROL
SYSTEMS ENGINEERING
RELIABILITY & QUALITY ASSURANCE
TESTS
OPERATIONS
NASA MC65-6041
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FIGURE IV- 10

SPACECRAFT AND LAUNCH VEHICLE DEVELOPMENT
AND MISSION OPERATIONS MILESTONES

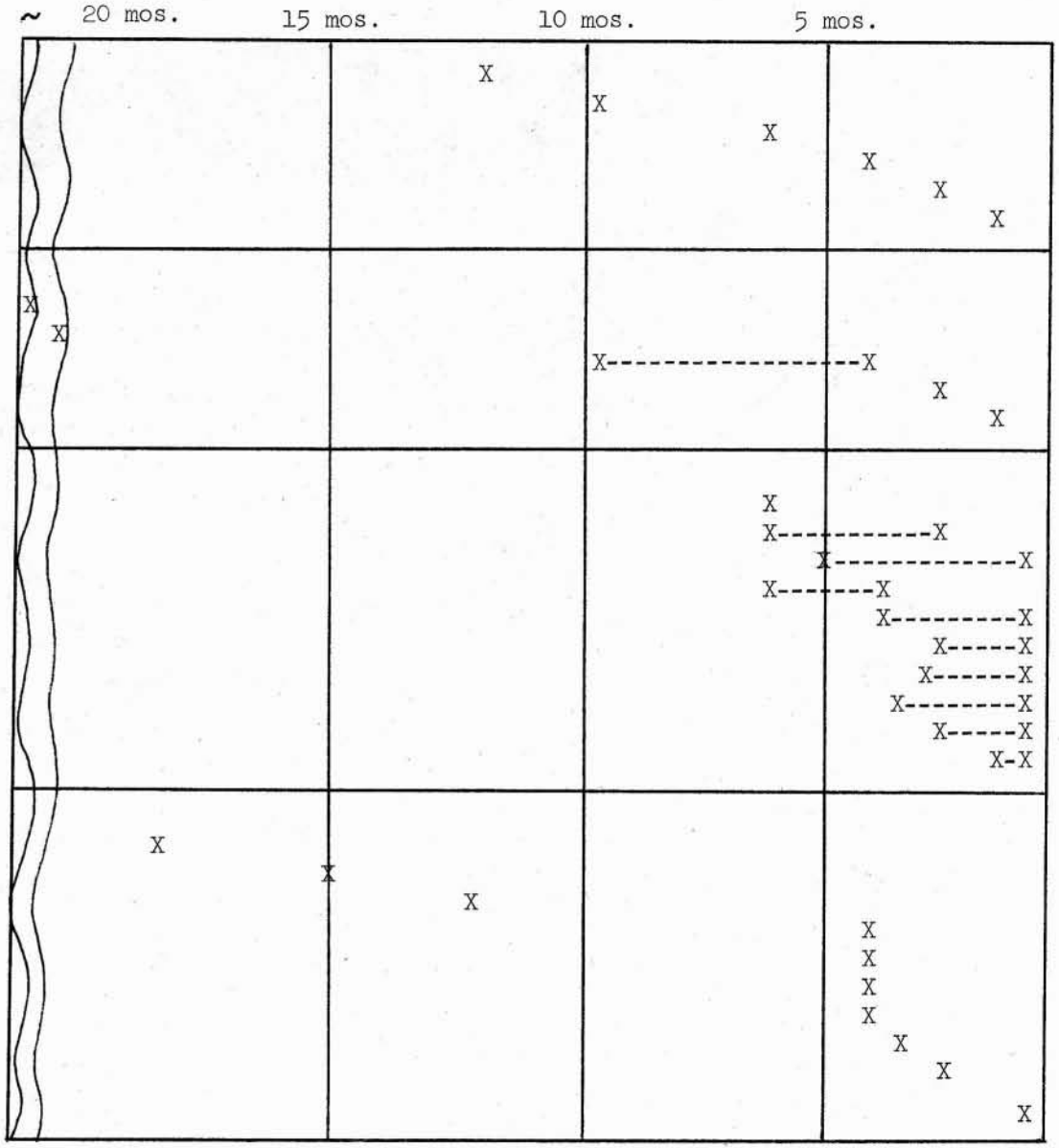


FIGURE IV-11

SECTION V

CURRENT MANAGEMENT SYSTEM IMPROVEMENTS

The NASA Headquarters volume has spoken of the NASA-wide need for continually improving the quality and timeliness of the basic information on which critical decisions are based. That volume has also described a number of management system improvements which are currently being investigated. Because these system improvements will have OMSF-wide applicability, and because they are representative of the kinds of systems and improvements being considered at MSC, no further discussion of them is necessary for this volume.

There are, however, several system improvements which are being implemented at the current time. Several of these improvements are directed toward the subsystem manager plan. This plan, which was discussed earlier in this document, is one of the prime methods whereby the program office receives support from the functional organizations of MSC. Basically, the support plan being implemented allows the functional organizations to have a more uniform and controllable approach to the utilization of resources, particularly manpower.

A number of areas are currently being studied in an attempt to make meaningful improvements. For example, there is a need for better long-range budget estimates and studies are being conducted to find better ways to generate and analyze data for budget estimates. Other study groups are assessing the effects of configuration changes on schedule and cost so that management will have better information to use in decision-making.

An area of Center-wide concern is data management. A study team is currently reviewing the entire data management problem in an attempt to determine what reports and data are needed; what can be eliminated that is of little or no value or duplicates other data that is available; how the date management function should be organized and staffed; and where it should report organizationally. This study should result in improvements throughout the Center in data management.

The brevity of this Section is indicative of what has been said elsewhere--once the program requirements are established and implemented, program management becomes primarily an assessment, decision, action and feedback process. It is a truism that there is no best way in program management; there are always better ways, always improvements to be made. Thus, improving the management system is a continuing, evolutionary process that does not result in large changes, but in steady and constant progress.

APPENDIX A

MSCI 8050.1, APOLLO SPACECRAFT
TEST AND CHECKOUT INSTRUCTIONS

MSCI 8050.1

June 8, 1967
effective date

MANNED SPACECRAFT CENTER

MANAGEMENT INSTRUCTION

APOLLO SPACECRAFT TEST AND CHECKOUT INSTRUCTIONS

1. PURPOSE

To implement the requirements of Apollo Program Directive No. 26, subject, "Preparation of Test and Checkout Plans and Procedures at KSC," dated April 18, 1967, and to insure that all MSC elements involved take necessary action to implement this directive.

2. SCOPE

This Instruction applies to test and checkout of all Apollo spacecraft. The intent of Apollo Program Directive No. 26 will apply to spacecrafts used in AS-501, -502, and -204 and LM-1 through existing MSC test and checkout documents.

3. REFERENCES

a. Apollo Program Directive No. 26, dated April 18, 1967, subject, "Preparation of Test and Checkout Plans and Procedures at KSC."

b. MSCM 1700, "MSC Safety Manual," part 7, subpart 1, "Minimum Safety Requirements for Facilities and Equipments Involving Personnel in a Vacuum or Oxygen-Rich Environment."

c. MSCI 8825.2, "Operational Readiness Inspections of Facilities and Equipments Involving Man in a Vacuum or Oxygen-Rich Environment."

4. DESCRIPTION OF DOCUMENTS

The following documents will satisfy the requirements of Apollo Program Directive No. 26:

a. Types.

(1) Test and Checkout Requirements Document.

(2) Safety Criteria Documents.

(3) Specification Requirements for Test and Checkout Document.

(4) Factory Operational Checkout Procedures.

(5) Apollo Operations Handbook.

(6) Launch Mission Rules.

b. Descriptions.

(1) Test and Checkout Requirements Document. The Test and Checkout Requirements Document will identify what testing processes must be carried out and what prerequisites to initiating the various phases of testing exist between the time an accepted spacecraft is delivered at KSC and the time it is launched. The retest prerequisites, in the event of a failure or malfunction during the test processes, also will be identified. This document will be prepared in three parts:

(a) LM for Saturn IB.

(b) CSM for Saturn IB.

(c) LM and CSM for Saturn V.

The document will delineate the requirements in phases related to the test prerequisites. The test requirements will relate strictly to the acquisition of data required to complete the steps between acceptance and launch. These will be associated solely with:

(a) Validation of systems operation in the vacuum environment.

(b) Validation of the spacecraft interfaces.

(c) Verification of expendable quantity gaging.

(d) Verification of spacecraft launch readiness.

(e) System requirements relating to life and operation cycle restrictions.

(f) Operation limitations.

Constraints currently imposed on the testing sequence by the current GSE (ground support equipment) configuration are identified as requirements for that particular sequence of testing. The mode of presentation of the material will include a block diagram identifying the interrelationships constituting the test prerequisites accompanied by text delineating the requirements for each. This document will define data report contents. This document will be prepared, published, and distributed by the contractor under the direction of MSC.

(2) Safety Criteria Documents. References 3b and c describe the requirements for an ORI (operational readiness inspection) and supporting documentation. The ORI reviews the following:

(a) Adequacy of design and construction.

(b) Proper organization and staffing for operation.

(c) Definition of responsibility interfaces.

(d) Proper level of training of operating personnel.

(e) Adequacy of preoperational inspection and quality control.

(f) Plans and procedures for normal and emergency operation.

(g) Documentation.

(h) Availability of supporting safety services and facilities.

(i) Adequacy of configuration control procedures and documentation.

(j) Any other factors bearing on safe operation.

(3) Specification Requirements for Test and Checkout Document.

(a) The document will have a format and contents analogous to sections 3 and 4 of the Part II Specification defined in NPC 500-1. One portion will identify the values and tolerances of measurements that must be made, and the other will define the method required for making the measurements.

(b) The document will comprise an abbreviation of the Part II Specification identifying only those parameters that must be examined between acceptance and launch. The test specification and criteria will contain items in addition to those from the Part II Specification which are unique to the processes between acceptance and launch, including altitude testing and servicing.

(c) In consonance with the MSC responsibility for the spacecraft GSE configuration control, the method of measurement specified will be constrained to the capability of the current GSE configuration.

(4) Factory Operational Checkout Procedures.

(a) Factory Operational Checkout Procedures are those operating procedures covering checkout of equipment prior to shipment from the factory.

(b) The checkout of the equipment will be patterned like that used to check out the totally integrated system prior to and during flight. Interfaces between modules will be simulated where the actual interfacing article is not available. This test and checkout determines the integrity of the system and should minimize removing, replacing, and reworking articles after shipment.

(c) Test and checkout of the equipment will be conducted at selected points in assembly. Test duration will be minimized to be in consonance with operation life of the equipment.

(d) Test results will be recorded and made a part of the information in the data package.

(e) The results of the factory test and checkout will be available for the final integrated test and checkout to determine that the system is retained at the high performance level found at the factory.

(5) Apollo Operations Handbook. The Apollo Operations Handbook is prepared in two volumes. Volume I is a description of the Block II spacecraft and its systems with differences between flight vehicles noted. Volume II, "Operating Procedures," contains the flight crew's normal, backup, malfunction, and emergency procedures necessary for the safe and efficient operation throughout a scheduled mission. It is issued and updated for each individual spacecraft.

(6) Launch Mission Rules (Inputs). These shall cover:

(a) Mandatory and highly desirable onboard instrumentation required to collect data for flight control purposes or for post-flight evaluation.

(b) Mandatory and highly desirable onboard instrumentation required to verify that the space vehicle is ready for launch.

(c) Red line values defining upper and lower limits of pressure, temperature, voltage, current, operating time, etc., for any system/subsystem essential to mission success.

(d) Mandatory and highly desirable range and instrumentation support required to prepare and launch the space vehicle and for post-flight analysis of launch.

(e) Range safety requirements and instrumentation established by the Eastern Test Range.

(f) Wind and weather restrictions for launch.

(g) Long-range camera coverage required for launch.

(h) Launch window definition and launch window rules pertaining to launch operations, such as fueling.

(i) Space vehicle functional sequence.

(j) Time span before launch during which manual cut-off will not be attempted.

(k) Other information as appropriate.

5. PREPARATION, COORDINATION, AND APPROVAL OF DOCUMENTS

Responsibility for preparation, coordination, and approval of documents listed in paragraph 4 is reflected on Attachment 2. This attachment also prescribes concurrences which must be obtained.

6. TRANSMISSION TO KSC AND REQUIRED DATES

a. KSC Coordination Cycle. KSC will review and comment on the MSC Test and Checkout Requirements Documents and the Factory Operational Checkout Procedures since these are the pacing documents and will influence KSC in preparing the plan and procedures documents. Coordination with KSC will be continuous and will permit as much leadtime as possible.

b. Requirements Dates.

(1) The MSC Test and Checkout Requirements Document will be submitted to KSC 4 months prior to delivery of the end item.

(2) Safety criteria were released on May 15, 1967, and will be updated as required. The Operational Readiness Inspection will be completed prior to manned operations.

(3) Specification Requirements for Test and Checkout will be submitted to KSC as they are prepared, but not later than 2 months prior to shipment of the end item.

(4) Factory Operational Checkout Procedures will be submitted to KSC as prepared, but not later than 1 month prior to spacecraft delivery.

(5) Apollo Operations Handbook will be submitted to KSC as issued in increments of 9 months, 6 months, $3\frac{1}{2}$ months, and 2 months prior to mission and at other intervals as required.

(6) Final Launch Mission Rules will be submitted to KSC 2 months prior to mission. Preliminary rules will be submitted 4 months prior to mission.

7. KSC DOCUMENT PREPARATION AND TESTS

KSC will prepare the Test and Checkout Plan and Procedures based on MSC requirements.

8. MSC REVIEW AND APPROVAL OF KSC DOCUMENTS

a. KSC Test and Checkout Plan. This plan will be directed to ASPO for internal MSC coordination through the Assistant Apollo Spacecraft Program Manager located at KSC. The MSC position will be expressed in approval of these documents signed by the Assistant Apollo Spacecraft Program Manager located at KSC. All changes to these documents, waivers, and deviations that affect the requirement will be approved by the Assistant Apollo Spacecraft Program Manager located at KSC.

b. KSC Test and Checkout Procedures. These procedures will be directed to ASPO for internal MSC coordination through the Assistant Apollo Spacecraft Program Manager located at KSC. All KSC Test and Checkout Operating Procedures involving flight crew will be approved by the MSC Flight Crew Operations Director. Delegation can be made by letter to the Assistant Apollo Spacecraft Program Manager located at KSC. All other MSC positions will be expressed in comments on these documents signed by the Assistant Apollo Spacecraft Program Manager located at KSC.

c. KSC Test Start Conditions. KSC will secure the approval of MSC where the flight crew and MSC Launch Mission Rules are involved. MSC Flight Crew Operations and Flight Operations Directorates can delegate by letter to the Assistant Apollo Spacecraft Program Manager located at KSC that authority considered appropriate. All other MSC positions will be expressed by the Assistant Apollo Spacecraft Program Manager located at KSC.

d. KSC Test and Checkout Requirements Waiver and Deviation. The MSC position will be expressed in the approval of these documents signed by the Assistant Apollo Spacecraft Program Manager located at KSC.

9. SUMMARY FLOW CHART

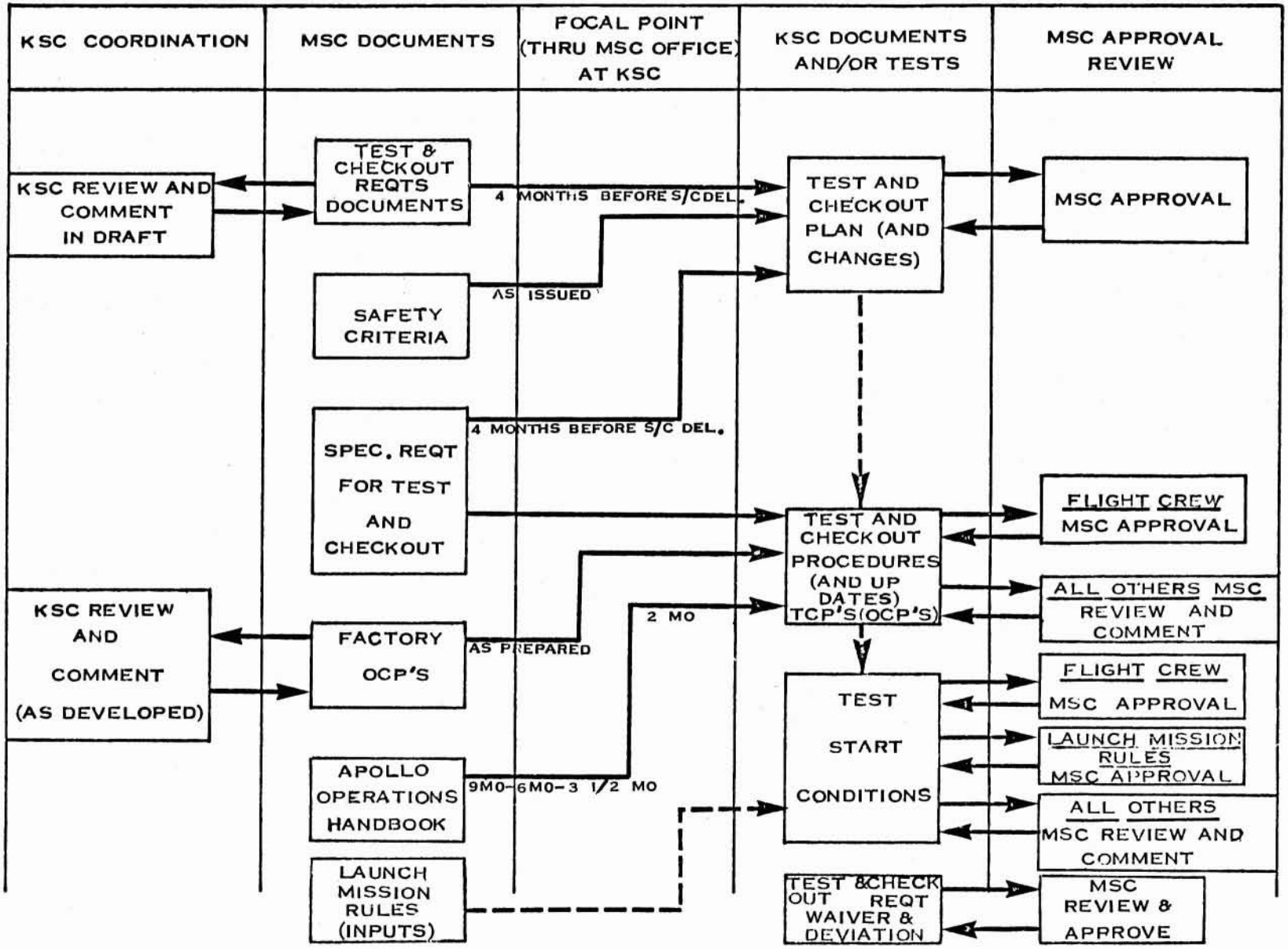
A summary of documentation flow is shown on Attachment 1.

Robert R. Gilruth
Director

Enclosures 2

DISTRIBUTION:
1 Plus PP3 (25)

MSC / KSC TEST AND CHECKOUT DOCUMENTATION DEVELOPMENT AND COORDINATION



PREPARATION, COORDINATION, AND APPROVAL OF DOCUMENTS

Document Title	Prepares	Coordinates	Concurs	Approves
Test and Checkout Requirements Document	Apollo Spacecraft Program Office and Contractors	All Directorates	Flight Safety Office	Apollo Spacecraft Program Manager
Safety Criteria Documents	Flight Safety Office	All Directorates	Director of Medical Research and Operations; Director of Flight Crew Operations	MSC Director
Specification Requirements for Test and Checkout Document	Apollo Spacecraft Program Office and Contractors	Subsystem Managers	None	Apollo Spacecraft Program Manager
Factory Operational Checkout Procedures	Contractors	Apollo Spacecraft Program Manager	None	Resident Manager at Contractor Plants
Apollo Operations Handbook	Flight Crew Operations Directorate	All Directorates	Flight Safety Office	Director of Flight Crew Operations; Apollo Spacecraft Program Manager
Launch Mission Rules (inputs)	Flight Operations Directorate	Director of Flight Crew Operations; Director of Medical Research and Operations	Apollo Spacecraft Program Manager	Director of Flight Operations

APPENDIX B

MEDICAL SUPPORT FOR TEST AND MISSION OPERATIONS

MEDICAL SUPPORT FOR TEST AND MISSION OPERATIONS

The Medical Research and Operations Directorate is responsible for planning, implementing, and continually evaluating the Center's medical effort. The Directorate supports the Apollo Spacecraft Program in three major areas: in-flight medical experiments (discussed in Appendix C), test operations, and flight operations.

TEST OPERATIONS

The Directorate provides medical support to testing activities by:

Reviewing and making recommendations based on medical considerations on plans for the construction or modification of testing facilities utilizing human subjects.

Establishing the physiological limits to which man will be subjected during tests.

Reviewing and approving detailed testing plans for manned testing programs.

Providing on-site medical support during operational periods with human subjects.

Providing required physiological training for human subjects and test monitors involved in manned testing programs, and conducting medical examinations of human subjects.

Providing medical support during the environmental development, testing and qualification of recovery systems.

MISSION OPERATIONS

The Directorate provides medical support to mission operations by:

Establishing overall medical standards and providing medical care for flight crews.

Reviewing the nominations for flight crew assignments to specific missions and making recommendations concerning assignments based on medical considerations.

Establishing and integrating medical requirements for preflight, in-flight, and postflight activities in order to meet medical support and medical research objectives.

Participating in mission planning activities and providing the medical input for mission operation documents such as mission rules, flight control standard operating procedures, recovery requirements, and milestone schedules.

Establishing the medical support requirements which are consistent with the overall mission planning and providing or obtaining the world-wide medical support capabilities for manned missions including equipment and trained personnel.

Providing, during mission periods at the Mission Control Center, Houston, the flight surgeon and staff support room manning.

Providing medical operations requirements for use in development of crew support systems hardware.

APPENDIX D

CONFIGURATION MANAGEMENT PLAN

CONFIGURATION MANAGEMENT PLAN

All design changes to Apollo Systems are controlled through a management plan which permits a systematic evaluation, coordination, and approval or disapproval of proposed changes. This process is designated Apollo Program Configuration Management and its method of operation is described in NPC 500-1, Apollo Configuration Management Manual. In the forward of that document, General Samuel C. Phillips stated the concept of configuration management as follows:

> "Configuration Management is directly related to Program Management in that the definition of hardware in terms of specifications is the basis for establishing realistic schedules and program budgeting. Additionally, specifications are the basis for effective contract negotiations. As changes evolve to the technical description of the contract end items during the development cycle, they are formally recognized, documented, contractually covered, and the impact on forecasted schedules and budget determined."

The basis for initiation of configuration control is the establishment of a baseline or a statement of firm design requirements based on NASA approval of design specifications provided by the contractor. Upon such approval, the design specifications are "frozen" and the end item baseline is established. Within each block of spacecraft produced, one is chosen to be the most representative and to reflect the baseline of the Master End Item Specification. The balance of the spacecraft in the block have separate and unique end item specifications and all changes in their individual baselines are subject to configuration control.

The administrative machinery for conducting configuration control rests with the Configuration Control Board (CCB) and its subsidiary

Configuration Control Panels (CCP) as shown on page D-4. The CCB is a functional body of ASPO under the chairmanship of the ASPO Manager. Other members of the CCB include: Director of E&D, Director of Flight Operations, Director of Flight Crew Operations, C&SM Program Manager, LM Program Manager, Assistant ASPO Manager, Director, MR&O, Director, Science and Applications, Manager, Flight Safety Office, and Manager, R&QA Office. The CCB chairman has the sole decision-making capability and receives advice from the various CCB members within their specific areas of responsibility.

There are four levels of configuration management based on the program impact of the Engineering Change Proposal (ECP).

Level IV - Configuration changes which are made by the contractor that do not require NASA/MSC approval but must be recorded in the system where revision to documents on effected systems will be accomplished.

Level III - Configuration changes which must be approved by the appropriate NASA/MSC CCP. The panels are chaired by the various system managers (LM, C&SM, G&N, ACE, etc.). These panels are authorized to approve changes that have no interface with another panel, do not exceed $300,000 in cost, cause no schedule slip, and no weight increase.

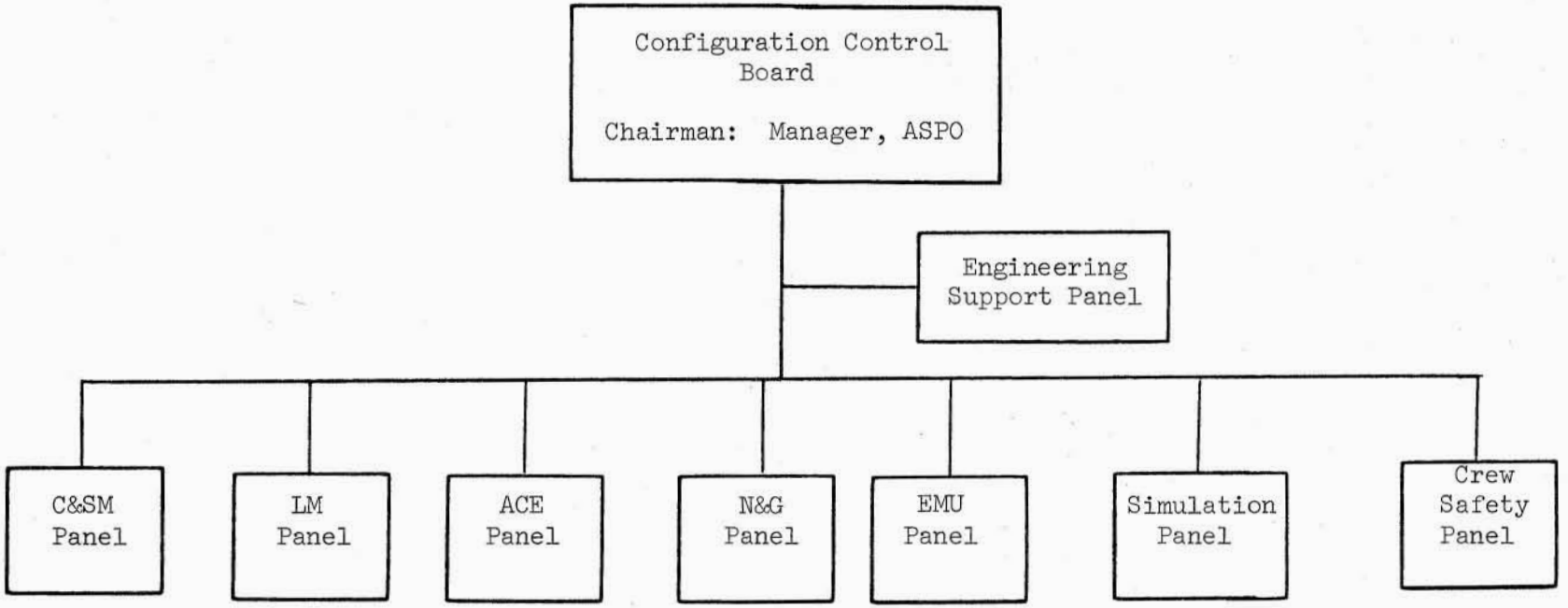
Level II - Configuration changes in the overall spacecraft and ground support system which require the approval of the NASA/MSC CCB.

Level I - Configuration changes interfacing with the booster or other Center/agency responsibilities, and changes having a cost impact limited by

NPC 400 (Procurement Regulations) are directed to the NASA CCB chaired by the Apollo Program Manager, NASA Headquarters.

In operation, the configuration management plan requires that configuration changes in levels I, II, and III be submitted to the appropriate CCP in the form of an Engineering Change Proposal (ECP) or a request for an ECP. The submittal must state the justification for change, the impact of the change on other systems, costs and schedules, and the proposed method of implementing the ECP. If the ECP requires level I or II approval, it is forwarded to the CCB with comments by the CCP chairman. The ECP is then subject to Board review and decision by the board chairman. The decision of the CCB is recorded by means of a CCB directive, upon which the contracting officer will issue the contractual authority for the contractor to effect the change.

APOLLO SPACECRAFT CONFIGURATION CONTROL BOARD



APPENDIX E

INTER-CENTER RELATIONSHIPS

OFFICE OF MANNED SPACE FLIGHT PROGRAM DIRECTIVE	M-D MA 1400.074 (Project)	DATE NOV 8 1967

APOLLO PROGRAM DIRECTIVE NO. 33

MA 009-033-1A

TO: DISTRIBUTION

FROM: APOLLO PROGRAM DIRECTOR

SUBJECT: Center Responsibilities in the Apollo Program

I. PURPOSE:

The purpose of this Directive is to assign responsibility and functions and define inter Center relationships for the conduct of the Apollo Program.

II. SCOPE

This Directive assigns responsibilities and functions to MSF Centers for accomplishment of the Apollo Program in amplification of and in consonance with NMI 1142.1 Functions and Authority - Manned Spacecraft Center, NMI 1142.3 Functions and Authority - George C. Marshall Space Flight Center, and NMI 1142.2 Functions and Authority - John F. Kennedy Space Center.

III. RESPONSIBILITY

A. The Director of the Manned Spacecraft Center is responsible for design, development, fabrication, qualification, acceptance test and delivery of Apollo spacecraft, associated ground support equipment and assigned experiments; for the planning of all Apollo Missions; for the control of the flight phase of Apollo Missions including the development of ground equipment necessary for mission control and not provided by other centers in the execution of their missions; for the selection, training and assignment of flight crews; for the development of software as needed for spacecraft guidance, checkout, and mission control; for establishing prelaunch requirements for test, checkout and inspection of Apollo spacecraft; and for the planning and implementation of a lunar science program to support the Apollo Program.

B. The Director of the George C. Marshall Space Flight Center is responsible for the design, development, fabrication, qualification, acceptance test and delivery of the Saturn launch vehicles including engines, associated ground support equipment and assigned experiments; providing mission planning data from the standpoint of overall vehicle performance; providing launch vehicle data and software for launch vehicle guidance and checkout; for establishing prelaunch requirements for test, checkout and inspection of Saturn launch vehicles; and supporting launch and flight operations as requested by KSC and MSC.

C. The Director of the John F. Kennedy Space Center is responsible for development and operation of launch and industrial facilities and associated ground support equipment required to support the Apollo Program and the assembly, test, inspection, checkout and launch of Apollo-Saturn space vehicles at KSC.

D. Center Directors will retain ultimate responsibility for Apollo Program functions delegated within the Center, and will supervise their performance. Significant changes in delegation of functions will be discussed with the Apollo Program Director prior to implementation.

IV. FUNCTIONS

A. Manned Spacecraft Center

The Manned Spacecraft Center is assigned the following functions for the Apollo Program:

1. Hardware

a. Providing for the detailed specifications, design, manufacture, checkout, test, reliability and quality, qualification, and acceptance of MSC developed hardware. This does not include the test and checkout functions accomplished at the launch site by KSC.

b. Developing and delivering to KSC spacecraft which has been qualified for flight along with associated software, data and support equipment.

c. Providing for the detailed specifications, design, development, fabrication, qualification, acceptance test and delivery of experiments flight hardware and associated specialized ground equipment for those experiments approved by the Manned Space Flight Experiments Board and assigned by the Apollo Program Director.

d. Providing logistic support planning and implementation at factory, test and launch sites for MSC developed hardware.

e. Controlling receipt and stowage of flight crew personal equipment at KSC which is scheduled for flight and providing to KSC a list of equipment which is considered flight crew personal equipment.

2. Configuration Control

a. Establishing and controlling configuration of spacecraft hardware, associated software and support equipment (designed or provided by MSC) at each stage of preparation or test in the factory, test or launch site, including approval of changes at KSC.

b. Providing and maintaining a list of acceptable items and materials that may enter the spacecraft for checkout and for flight.

3. Test and Checkout

a. Establishing and maintaining test and checkout requirements and test and checkout specifications and criteria for factory or test site acceptance and launch site preparation of MSC developed hardware (including Ground Support Equipment and software).

b. Providing test and checkout requirements and test and checkout specifications and criteria for launch site preparation of MSC developed hardware, software and Ground Support Equipment.

c. Reviewing factory, test site and launch site test requirements and test and checkout plans and procedures as necessary to assure that adequate testing is being accomplished without unnecessary overlap and duplication between testing conducted at different locations.

d. Providing written approval of KSC test and checkout plans in consonance with paragraphs IV.A.3b and IV.A.3c.

e. Providing Center approved factory or test site test and checkout procedures to KSC for use as a baseline in the development of similar procedures required at the launch site.

f. Reviewing at the option of MSC, the adequacy of KSC test procedures at the launch site.

g. Providing requirements and criteria to KSC for assuring flight readiness of experiments flight hardware, unless KSC and MSC on the basis of written agreement for a specific experiment make other arrangements for flight readiness determination.

h. Determining functional performance and flight readiness of flight hardware closed out at the factory or test site and not accessible for inspection or not included in test and checkout requirements for evaluation of functional performance at KSC.

i. Providing such technical assistance or data as may be required by KSC in preparation of hardware for flight.

j. Assuring that MSC personnel participating in KSC tests are responsive to KSC direction during conduct of the tests and attend pre-test briefings and participate in training exercises as required by KSC in accordance with responsibilities outlined herein.

k. Providing an assessment of flight readiness of the spacecraft and associated software at the Flight Readiness Review in accordance with Apollo Program Directives.

4. Reliability and Quality Assurance

   a. Providing quality control requirements and inspection criteria for MSC developed hardware for use at the factory, test site and launch site.

   b. Conducting audits to evaluate contractor factory and test site performance in accordance with MSC quality control requirements and inspection criteria for MSC developed hardware, and participating at the option of MSC in audits conducted by KSC at the launch site.

   c. Determining corrective action and disposition of MSC developed hardware which fails, malfunctions or performs outside the performance limits contained in test and checkout specifications and criteria during checkout at KSC. This responsibility does not include routine trouble-shooting or maintenance of MSC developed ground support equipment operated by KSC.

5. Systems Engineering

   Providing MSC technical representation on design and operations inter-Center panels or working groups as established by Apollo Program Directives.

6. Operations

   a. Developing flight techniques for mission control and hardware and software for the Mission Control Center.

   b. Developing mission objectives, plans and rules to support Apollo mission assignments.

   c. Conducting flight operations.

   d. Obtaining from KSC the operational requirements pertaining to checkout and launch which need to be incorporated into MSC designed hardware.

   e. Planning jointly with the Department of Defense the provision of recovery support.

   f. Providing input to and comment on KSC launch rules.

   g. Identifying MSC operational support requirements according to approved procedures and evaluating support implementation of said requirements.

7. Flight Crew

a. Providing trained flight crews and personal equipment for manned missions.

b. Directing all astronaut activities except during the time they are participating in KSC flight hardware tests.

c. Developing and operating flight crew simulators and training equipment at MSC and KSC.

8. Science

a. Planning and implementation of a lunar science program to support Apollo, including site selection, lunar science operations, the Lunar Receiving Laboratory operation and lunar sample analysis.

9. Management

This section contains general management responsibilities for the conduct of the Apollo program at MSC as well as some specific management requirements which need to be highlighted.

General

a. Assuring that Apollo program requirements for manpower or for institutional support from other elements of MSC are properly conveyed to those elements and that Apollo program institutional support requirements are reflected in Center resource requirements plans, schedules, and budgets.

b. Assuring that Apollo program requirements for institutional support are met on an effective and timely basis.

c. Developing and operating Center facilities required for the Apollo Program.

d. Developing and implementing adequate security procedures.

e. Establishing detailed schedules (Levels 2, 3 and 4) for MSC hardware, software and associated equipment and operations activities consistent with the basic schedules (Level 1) approved by the Director, Apollo Program, and the Director, Mission Operations.

f. Providing contract authority for KSC control of spacecraft contractor's test and checkout activities at KSC through a supplemental contract under KSC administration.

Medical

Medical support for the Apollo program will be provided in accordance with NMI 8900.1. In addition, the following specific requirements will be met on the Apollo program.

a. Providing for the medical surveillance and support of the astronauts during all phases of the Apollo Program at any location including test and checkout operations.

b. Providing for the evaluation of medical data obtained during manned tests, to insure that the interpretation of such data regarding the acceptability of equipment performance is properly reflected in post flight mission reports.

c. Providing for the development and implementation of medical disaster plans associated with the test of Apollo hardware at MSC.

Safety

Safety activities in the Apollo program will be conducted in accordance with instructions provided by the Apollo Program Director and directives issued by the Manned Space Flight and NASA Safety Directors. In addition the following specific requirements will be met on the Apollo program.

a. Providing written approval of KSC criteria for determining hazardous operations at the launch site.

b. Reviewing and approving any KSC test and checkout procedure in which the flight crew participates.

B. George C. Marshall Space Flight Center

The George C. Marshall Space Flight Center is assigned the following functions for the Apollo Program.

1. Hardware

   a. Providing for the detailed specifications, design, manufacture, checkout, test, reliability and quality, qualification and acceptance of MSFC developed hardware. This does not include the test and checkout functions accomplished at the launch site by KSC.

   b. Developing and delivering to KSC launch vehicles which have been qualified for flight along with associated software, data and support equipment.

   c. Providing for the detailed specifications, design, development, fabrication, qualification, acceptance test and delivery of experiments flight hardware and associated specialized ground equipment for those experiments approved by the Manned Space Flight Experiments Board and assigned by the Apollo Program Director.

   d. Providing logistic support planning and implementation at factory, test and launch sites for MSFC controlled hardware.

2. Configuration Control

   a. Establishing and controlling configuration of launch vehicle hardware, associated software and support equipment (designed or provided by MSFC) at each stage of preparation or test in the factory, test or launch site, including approval of changes at KSC.

   b. Providing criteria to KSC for controlling tools, equipment and materials that enter and leave the launch vehicle stages and instrument unit during operations at KSC.

3. Test and Checkout

   a. Establishing and maintaining test and checkout requirements and test and checkout specifications and criteria for factory or test site acceptance and launch site preparation of MSFC developed hardware (including Ground Support Equipment and software).

   b. Providing test and checkout requirements and test and checkout specifications and criteria for launch site preparation of MSFC developed hardware, software and Ground Support Equipment.

   c. Reviewing factory, test site and launch site test requirements and test and checkout plans and procedures as necessary to assure that adequate testing is being accomplished.

   d. Providing written approval of KSC test and checkout plans in consonance with paragraphs IV.B.3b and IV.B.3c.

   e. Providing Center approved factory or test site test and checkout procedures to KSC for use as a baseline in the development of similar procedures required at the launch site.

f. Reviewing at the option of MSFC, the adequacy of KSC test procedures at the launch site.

g. Providing requirements and criteria to KSC for assuring flight readiness of experiments flight hardware, unless KSC and MSFC on the basis of written agreement for a specific experiment make other arrangements for flight readiness determination.

h. Determining functional performance and flight readiness of flight hardware closed out at the factory or test site and not accessible for inspection or not included in test and checkout requirements for evaluation of functional performance at KSC.

i. Providing such technical assistance or data as may be required by KSC in preparation of hardware for flight.

j. Assuring that MSFC personnel participating in KSC tests are responsive to KSC direction during conduct of the tests and attend pre-test briefings and participate in training exercises as required by KSC in accordance with responsibilities outlined herein.

k. Providing an assessment of flight readiness of the launch vehicle and associated software at the Flight Readiness Review in accordance with Apollo Program Directives.

4. Reliability and Quality Assurance

a. Providing quality control requirements and inspection criteria for MSFC developed hardware for use at the factory, test site and launch site.

b. Conducting audits to evaluate contractor factory and test site performance in accordance with MSFC quality control requirements and inspection criteria for MSFC developed hardware, and participating at the option of MSFC in audits conducted by KSC at the launch site.

c. Determining corrective action and disposition of MSFC developed hardware which fails, malfunctions, or performs outside the performance limits contained in test and checkout specifications and criteria during checkout at KSC. This responsibility does not include routine trouble-shooting or maintenance of MSFC-developed ground support equipment operated by KSC.

5. Systems Engineering

a. Providing MSFC technical representation on design and operations inter-Center panels or working groups as established by Apollo Program Directives.

b. Providing the overall integrated space vehicle systems analysis and criteria for operational requirements and limitations for handling, checkout, launch and flight as required by MSFC, MSC and KSC.

c. Operating the Manned Space Flight Interface Documentation Repository.

6. Operations

a. Developing mission objectives and plans to support Apollo mission assignments.

b. Providing real time mission support as requested by MSC and KSC both on site and at Huntsville.

c. Providing input to and comment on KSC launch and MSC flight mission rules.

d. Obtaining from KSC the operational requirements pertaining to checkout and launch which need to be incorporated into MSFC designed hardware.

e. Identifying MSFC operational support requirements according to approved procedures and evaluating support implementation of said requirements.

7. Flight Crew

Providing instructions and material for training and familiarization of flight crews with the Saturn vehicle.

8. Science

None

9. Management

This section contains general management responsibilities for the conduct of the Apollo program at MSFC as well as some specific management requirements which need to be highlighted.

General

a. Assuring that Apollo program requirements for manpower or for institutional support from other elements of MSFC are properly conveyed to those elements and that Apollo program institutional support requirements are reflected in Center resource requirements plans, schedules, and budgets.

b. Assuring that Apollo program requirements for institutional support are met on an effective and timely basis.

c. Developing and operating Center facilities required for the Apollo Program.

d. Developing and implementing adequate security procedures.

e. Establishing detailed schedules (Levels 2, 3 and 4) for MSFC hardware, software, and associated equipment consistent with the basic schedules (Level 1) approved by the Apollo Program Director.

f. Providing liquid hydrogen management for MSFC and KSC.

g. Providing contract authority for KSC control of launch vehicle contractor's test and checkout activities at KSC through a supplemental contract under KSC administration.

Medical

Medical support for the Apollo program will be provided in accordance with NMI 8900.1. In addition, the following specific requirement will be met on the Apollo program.

a. Providing for the development and implementation of medical disaster plans associated with the test of Saturn hardware at MSFC.

Safety

Safety activities in the Apollo program will be conducted in accordance with instruction provided by the Apollo Program Director and directives issued by the Manned Space Flight and NASA Safety Directors. In addition the following specific requirement will be met on the Apollo program.

a. Providing written approval on KSC criteria for determining hazardous operations at the launch site.

C. John F. Kennedy Space Center

The John F. Kennedy Space Center is assigned the following functions for the Apollo Program.

1. Hardware

a. Providing for detailed specifications, design, manufacture, checkout, test, reliability and quality, qualification and acceptance of KSC developed hardware.

b. Developing and delivering qualified ground support equipment associated with launch facilities and not provided by MSC or MSFC.

c. Developing and operating ground communications, computation, and instrumentation systems and equipment for the conduct of launch operations.

d. Taking measures to protect flight hardware and associated Ground Support Equipment from contamination, corrosion or damage which may result from environment, housekeeping, procedure or human error and reporting incidents to MSC and MSFC as appropriate.

e. Providing logistics support planning and implementation at the factory test or at KSC for KSC developed hardware.

2. Configuration Control

a. Establishing and controlling configuration of KSC developed launch facilities and ground support equipment at each stage of preparation or test at the factory, test site or at KSC.

b. Maintaining configuration control of MSC and MSFC developed hardware and software after delivery to KSC in accordance with the configuration requirements established by MSC and MSFC. Assuring that prior approval is secured from MSC and MSFC before any changes in configuration are made in spacecraft, launch vehicle, or associated GSE furnished by MSC or MSFC.

c. Securing, after the flight readiness test, the prior approval of MSC or MSFC for the replacement of failed parts.

d. Controlling everything that enters and leaves the spacecraft during checkout at KSC in accordance with the MSC list of acceptable items and materials that may be taken into the spacecraft for checkout and for flight.

e. Controlling tools, equipment and materials that enter and leave the launch vehicle stages and instrument unit during operations at KSC in accordance with criteria provided by MSFC.

3. Test and Checkout

a. Conducting the assembly, checkout, and launch of flight hardware for Apollo missions and assembly, checkout and operation of required ground support equipment.

b. Providing control of all personnel participating in test and checkout activities, including representatives from MSC and MSFC, and assuring that personnel attend pre-test briefings and participate in training exercises as necessary to assure personnel safety and proper conduct of the tests.

c. Providing requirements, specifications and criteria, and procedures for test and checkout of KSC developed support equipment whose performance must be verified for each launch.

d. Providing test and checkout plans in accordance with MSC and MSFC test and checkout requirements plus any additional KSC test requirements necessary to verify launch facility, Manned Space Flight Network and launch crew readiness or to satisfy range and safety requirements.

e. Securing MSC and MSFC written approval on test and checkout plans and changes thereto before the plans are approved or implemented.

f. Developing and providing to MSC or MSFC test and checkout procedures adapted to the KSC environment using as a baseline the development center approved factory test and checkout procedures.

g. Making final determination that test and checkout procedures are adequate, safe and in accordance with MSC and MSFC test and checkout requirements and test and checkout specifications and criteria.

h. Obtaining approval on deviations and waivers from MSC and MSFC concerning test and checkout requirements, test and checkout specifications and criteria and inspection criteria when unable to meet requirements.

i. Determining functional performance and flight readiness of flight hardware and software in accordance with tests and checkout requirements and test and checkout specifications and criteria provided by MSC and MSFC except for that which is closed out at the factory and not accessible for inspection or not included in test and checkout requirements for evaluation of functional performance at KSC.

j. Determing flight readiness of equipment associated with inflight experiments in accordance with MSC or MSFC (as appropriate) specifications and criteria unless specifically excluded by written agreement with MSC or MSFC.

k. Controlling receipt and storage, and assuring flight readiness of all Government Furnished Equipment, other than flight crew personal equipment, which is scheduled for flight and which is not processed to KSC through a contractor responsible to KSC.

l. Providing routine trouble shooting and maintenance for MSC and MSFC developed equipment in accordance with MSC and MSFC requirements, specifications and criteria.

m. Providing an assessment of the flight readiness of the launch complex, flight hardware and software at the Flight Readiness Review in accordance with Apollo Program Directives.

Reliability and Quality Assurance

a. Providing quality control requirements and inspection criteria for KSC developed hardware for use at the factory, test site and KSC.

b. Conducting audits to evaluate contractor factory and test site performance in accordance with KSC quality control requirements and inspection criteria for KSC developed hardware.

c. Determining corrective action and disposition of KSC developed hardware which fails, malfunctions, or performs outside the performance limits contained in test and checkout specifications and criteria during checkout at KSC.

d. Generating quality control plans in accordance with MSC and MSFC quality control requirements plus any additional KSC requirements necessary to verify launch facility and space vehicle readiness or satisfy range and safety requirements.

e. Securing MSC and MSFC written approval of quality control plans insofar as development center responsibilities are concerned before the plans are approved or implemented.

f. Conducting quality control inspections and audits of contractor activities at KSC and inviting MSC and MSFC participation as applicable.

g. Obtaining approval from the appropriate development center (MSC or MSFC) to disassemble or open any flight hardware closed out at a factory or test site.

h. Advising MSC or MSFC of any problem arising during prelaunch preparation concerning flight worthiness of flight hardware.

i. Conducting failure analysis as required by MSC and MSFC.

j. Participating in MSC and MSFC flight hardware acceptance reviews and providing recommendations to MSC or MSFC and the Apollo Program Director, concerning the acceptance of the hardware for shipment to KSC.

5. Systems Engineering

Providing KSC representation on design and operations inter-Center panels or working groups as established by Apollo Program Directives.

6. Operations

a. Identifying KSC operational support requirements according to approved procedures and evaluating implementation of support planning.

b. Providing data to MSC and MSFC in accordance with approved Program Support Requirements Documents.

c. Conducting launch operations.

d. Developing launch plans and rules.

7. Flight Crew

Coordinating and directing astronaut activities during the time they are actively participating in KSC tests of flight hardware except that the flight crew may take any action necessary for their safety.

8. Science

None

9. Management

This section contains general management responsibilities for the conduct of the Apollo program at KSC as well as some specific management requirements which need to be highlighted.

General

a. Assuring that Apollo program requirements for manpower or for institutional support from other elements of KSC are properly conveyed to those elements and that Apollo program institutional support requirements are reflected in Center resource requirements plans, schedules, and budgets.

b. Assuring that Apollo program requirements for institutional support are met on an effective and timely basis.

c. Providing control of all activities of Apollo contractors at KSC other than those directly associated with astronaut training.

d. Developing and operating Center facilities required for the Apollo Program.

e. Developing and implementing adequate security procedures.

f. Establishing detailed schedules (Levels 2, 3 and 4) for KSC hardware, software and associated equipment consistent with the basic schedules (Level 1) approved by the Director, Apollo Program and the Director, Mission Operations.

Medical

Medical support for the Apollo program will be provided in accordance with NMI 8900.1. In addition, the following specific requirement will be met on the Apollo program.

a. Providing for the development and implementation of medical disaster plans associated with the assembly, checkout and prelaunch operations of Apollo flight hardware at KSC.

Safety

Safety activities in the Apollo program will be conducted in accordance with instructions provided by the Apollo Program Director and directives issued by the Manned Space Flight and NASA Safety Directors. In addition the following specific requirements will be met on the Apollo program.

a. Performing as the NASA single point of responsibility for safety in the Merritt Island and Cape Kennedy area and for NASA range safety inputs to the Eastern Test Range.

b. Developing criteria for determining hazardous operations at the launch site and securing written approval of MSC and MSFC.

V. PRECEDENCE

This Directive takes precedence over any inter-Center agreements on Apollo program responsibilities.

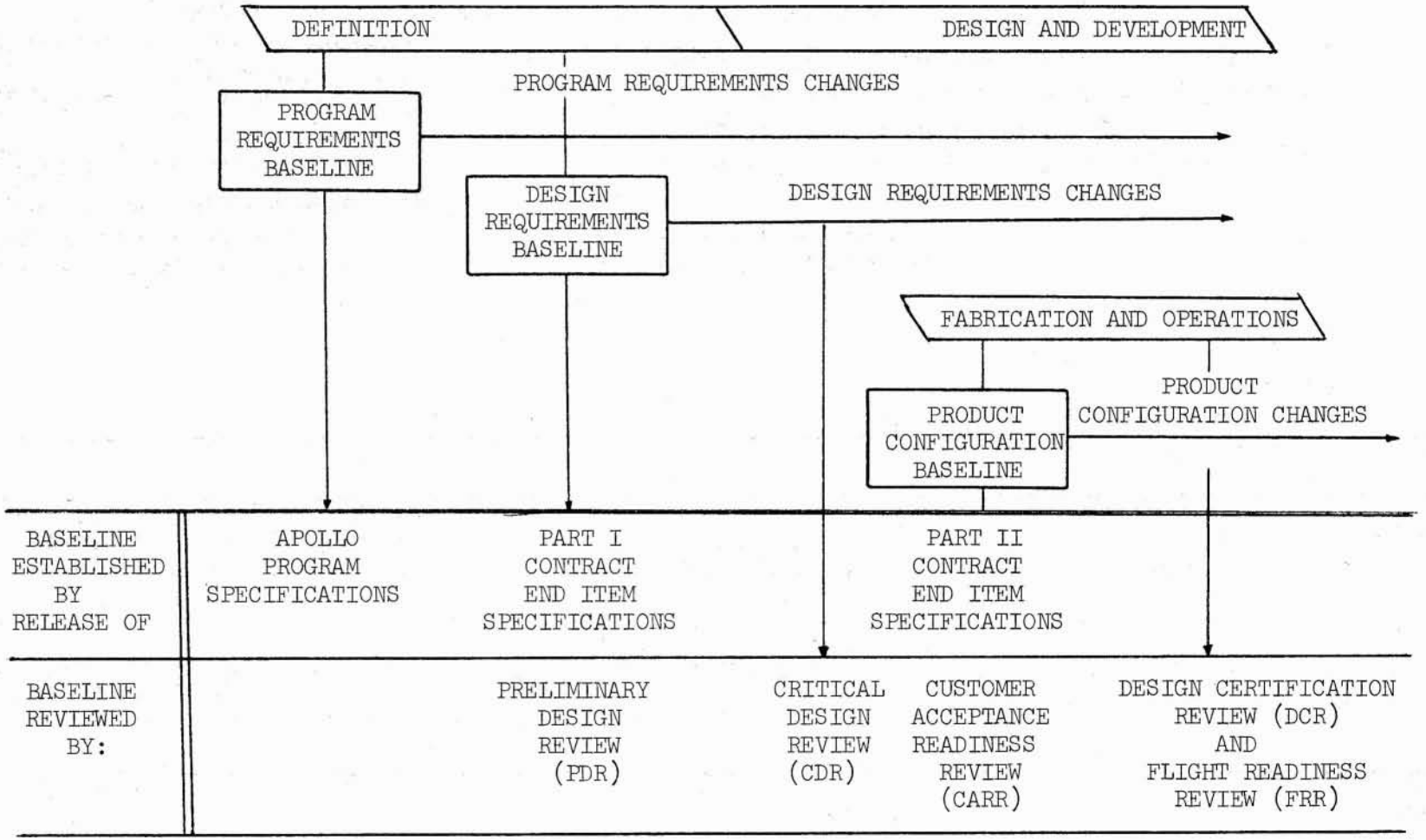
VI. CONCURRENCE

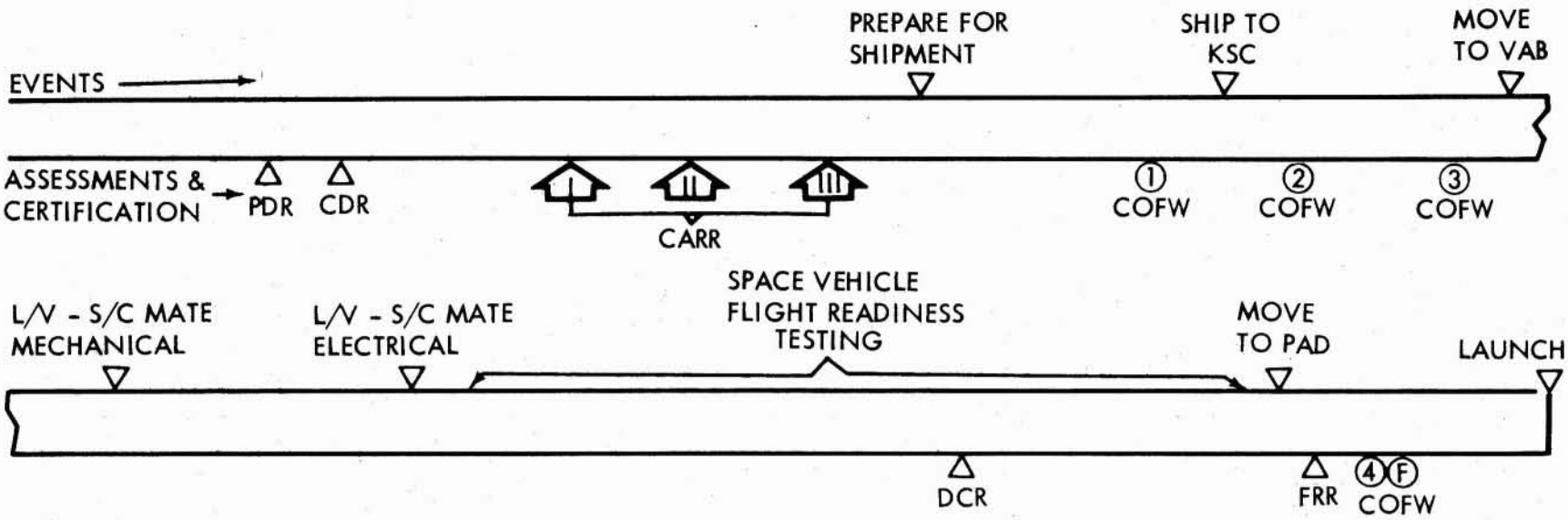
This Program Directive has been reviewed and concurred in by the Associate Administrator for Manned Space Flight and the Associate Administrator for Organization and Management. Any proposed substantive changes in the responsibilities defined in this document will be submitted for review and concurrence in the same manner.

APPENDIX F

SPACECRAFT REVIEWS

FIGURE 1 APOLLO CONFIGURATION MANAGEMENT SYSTEM





PDR - Preliminary Design Review
CDR - Critical Design Review
CARR - Customer Acceptance Readiness Review
I Phase I = Article Configuration Inspection
II Phase II = Subsystem Test & Configuration Review
III Phase III = Integrated System Test, Configuration & Acceptance Review

DCR - Design Certification Review
FRR - Flight Readiness Review
COFW - Certification of Flight Worthiness
① - Endorsement One = Configuration Definition, Mfg. Checkout
② - Endorsement Two = Launch Site Receiving Inspection
③ - Endorsement Three = Pre-Launch Vehicle Mating Checkout
④ - Endorsement Four = Pre-Launch Space Vehicle Checkout
Ⓕ - Final Certification of Flight Worthiness

PROJECT APOLLO SPACECRAFT ASSESSMENT FLOW PLAN

FIGURE 3
CUSTOMER ACCEPTANCE READINESS REVIEW
PHASE I

Phase Review Consists of:

a. The baseline configuration and acceptance test requirements identification in Part II of the Contract End Item Detail Specification for the subject module. The hardware will be made available for inspection as required;

b. The Reliability and Quality summary and analysis, including open generic and end-item failures, and single point failures, and quality unsatisfactory conditions, and program failures of spacecraft-related hardware;

c. Review status of contract Specification Change Notices (SCN's) and waivers;

d. Previous Flight Anomalies;

e. The Operational Checkout Procedure (OCP) status and correlation to the Part II Specification and the Test and Checkout Requirements Document;

f. The certification status of the modules hardware; including a schedule for uncompleted items;

g. The status of Government Furnished Equipment (GFE);

h. The status of Ground Support Equipment (GSE);

i. The open work items and their schedule for completion;

j. Hardware shortages;

k. The spares support availability status;

l. Listing and justification for installation and use of non-flight items;

m. The vehicle hardware through a walk-around hardware inspection;

n. Irregular Parts Summary;

o. Readiness for the module to enter into individual subsystem testing.

FIGURE 4

CUSTOMER ACCEPTANCE READINESS REVIEW

PHASE II

Phase Review Consists of:

a. Changes to the module configuration since the Phase I CARR (E.O. status) and the status of the contract specifications, SCN's and waivers;

b. The updated reliability summary and analysis and program failures of spacecraft-related hardware;

c. The status and dispositions of the action items resulting from the Phase I CARR;

d. The update of Previous Flight Anomalies;

e. The status of integrated test OCP's;

f. The updated certification status;

g. The updated status of GFE;

h. The updated status of GSE;

i. The updated open work summary and schedule to complete;

j. Hardware shortages;

k. The updated spares support availability status;

l. The updated non-flight hardware status;

m. The vehicle hardware through a walk-around hardware inspection as required;

n. The update of Irregular Parts Summary;

o. The summary of subsystem test results, and assessment of test data;

p. Readiness for the module to enter into integrated systems testing.

FIGURE 5

CUSTOMER ACCEPTANCE READINESS REVIEW

PHASE III

Phase Review Consists of:

a. The updated configuration (E.O., SCN, etc., status);

b. The updated reliability summary and analysis and program failures of spacecraft-related hardware;

c. The status and disposition of the action items resulting from the CARR Phase I and II;

d. The update of Previous Flight Anomalies;

e. The OCP status for KSC operation;

f. The updated certification status;

g. The updated status of GFE;

h. The updated status of GSE;

i. The updated open work summary, constraints to work-off, and schedule to complete;

j. Hardware shortages;

k. The updated spares support availability status;

l. The updated non-flight hardware status;

m. The Acceptance Data Package (ADP);

n. The update of Irregular Parts Summary;

o. The integrated systems test results;

p. Readiness of the module for shipping preparation and delivery.

FIGURE 6

NASA STAFFING OF APOLLO PROJECT

CUSTOMER ACCEPTANCE READINESS REVIEW

PHASE I & PHASE II	PHASE III
Chairman: Manager, Applicable Module Apollo Spacecraft Program, MSC	Chairman: Director, Manned Spacecraft Center
Vice-Chairman: Chief, Project Engineering Division MSC	Vice-Chairman: Manager, Apollo Spacecraft Program, MSC
Members: Chief, Systems Engineering Division, MSC Chief, Reliability & Quality Assurance Office, MSC Engineering and Development, MSC, Representative Chief, Flight Safety Office, MSC RASPO/KSC Chief, Test Division, MSC Flight Operations, MSC, Representative Medical Research and Operations, MSC, Representative Flight Crew Operations Representative RASPO/Contractor Facility Spacecraft Operations, KSC, Representative Apollo Program, NASA Headquarters, Representative Applicable Project Officer, MSC, Representative Applicable Contracts Branch, MSC, Representative	Members: Manager, Applicable Module, Apollo Spacecraft Program, MSC Chief, Reliability and Quality Assurance Office, MSC Director, Engineering and Development, MSC Chief, Flight Safety Office, MSC Director, Flight Crew Operations, MSC Director, Flight Operations, MSC Director, Medical Research and Operations, MSC Resident Manager, RASPO/Contractor Facility Deputy Director, Apollo Program, Headquarters Director, Launch Operations, KSC Director, Spacecraft Operations, KSC Resident Manager, RASPO/KSC Assistant Manager, Apollo Spacecraft Program, KSC Chief, Guidance and Control Division, MSC (G&C Manager) Chief, Applicable Contracts Branch, MSC
Secretary: Project Engineering Division, MSC, Representative	Secretary: Project Engineering Division, MSC, Representative

FIGURE 7

CERTIFICATE OF FLIGHT WORTHINESS

MODULE: _____

ENDORSEMENT ONE: CONFIGURATION DEFINITION, MANUFACTURING & CHECKOUT

THIS IS TO CERTIFY THAT THE FOLLOWING ITEMS HAVE BEEN ACCOMPLISHED ON THE MODULE AND ITS ASSOCIATED GSE EXCEPT AS NOTED ON THE ATTACHED LOG OF EXCEPTIONS

	EXCEPTIONS	
	Contractor	MSC
a. The configuration of the module and its associated GSE is in accordance with the requirements stipulated in _____ Module Contract End Item Detail Specifications.		
b. Each departure from module specifications & drawings has been approved by the Material Review Board or Contractual Waiver.		
c. A DD-250 has been executed for interim acceptance and documents the relationship of the module and its associated GSE as described by the module specifications and drawings to the module as manufactured and assembled and the shortages as stated in the contents of the DD-250.		
d. The module and its associated GSE has been manufactured, inspected and tested in accordance with the approved quality control program of NPC-200-2.		
e. Acceptance tests through manufacturing & certification tests have been successfully completed in accordance with contractual requirements as verified by successful completion of Module CARR.		
f. The module and its associated GSE has successfully completed manufacturing checkout.		
g. All retesting, resulting from discrepancies discovered during manufacturing checkout, has been completed.		
h. Failures of Flight & Flight Type Hardware have been analyzed and corrective action implemented.		
i. All discrepancies have been resolved.		
j. All data required by the Acceptance Data Package is complete, compatible, available and accompanies the module.		
k. The shipping requirements shown in the Contract End Item Specification have been satisfied.		

THE UNDERSIGNED CONSIDERS THAT THE EXCEPTIONS LISTED AT THIS MILESTONE CAN BE SATISFACTORILY RESOLVED AT THE PLACE AND TIME STIPULATED IN THE LOG OF EXCEPTIONS WITHOUT DEGRADATION TO REQUIRED MODULE FLIGHT PERFORMANCE. THE MODULE AND ITS ASSOCIATED GSE IS CONSIDERED ACCEPTABLE TO PASS THIS MILESTONE.

_____	_____	_____
CONTRACTOR Authorized Representative	MSC Quality Representative	MSC Program Manager's Designee
DATE: _____	DATE: _____	DATE: _____

FIGURE 8

ENDORSEMENT ONE CHECKLIST

Identification of these items, as a minimum, shall be implemented prior to completion of Endorsement One to the COFW.

1.0 The baseline configuration and acceptance test requirements for the specific module and its associated GSE have been identified in Part I and Part II of the Contract End Item Detail Specification.

2.0 The as-built configuration of the specific module and its associated GSE is in agreement with the final engineering drawings and releases.

3.0 The results of acceptance tests and certification tests have been reviewed and approved.

4.0 The final updated reliability summary & analyses including numerical, failure mode & effect, and failure analyses, and review of single point failures have been reviewed and are acceptable.

5.0 The integrated subsystems and systems test results have been accepted.

6.0 The updated hardware certification test status has been established.

7.0 The Operational Checkout Procedure (OCP) status and correlation to the Part II Specification and Test and Checkout Requirements Document has been verified.

8.0 A finalized updated open work summary, constraints to work-off, and schedule to complete has been tabulated, reviewed and approved.

9.0 An updated hardware shortages review has been made.

10.0 An updated non-flight hardware status review has been made.

11.0 An updated status of support spares and availability is defined.

12.0 The Acceptance Data Package (ADP) is adequate, compatible, and available to accompany the hardware.

13.0 The module and its associated GSE and all documentation are in readiness for shipment and delivery.

FIGURE 9

CERTIFICATE OF FLIGHT WORTHINESS

MODULE: _____

ENDORSEMENT TWO: LAUNCH SITE RECEIVING AND INSPECTION

THIS IS TO CERTIFY THAT THE FOLLOWING ITEMS HAVE BEEN ACCOMPLISHED EXCEPT AS NOTED ON THE ATTACHED LOG OF EXCEPTIONS:

a. A visual inspection of the module, accompanying hardware and associated GSE was completed and the Receiving Inspection Report has been reviewed and accepted.

b. All exceptions taken during the previous endorsement have been identified.

c. The data package is complete.

d. The module is in the configuration as identified in Endorsement One.

EXCEPTIONS	
Contractor	MSC/ KSC

THE UNDERSIGNED CONSIDER THAT THE MODULE AND ITS ASSOCIATED GSE HAS BEEN INSPECTED AND CONSIDERED SATISFACTORY FOR PRE-LAUNCH VEHICLE MATING CHECKOUT.

KSC or MSC Representative	MSC Quality Representative	MSC Program Manager's Designee
DATE: _____	DATE: _____	DATE: _____

FIGURE 10

CERTIFICATE OF FLIGHT WORTHINESS

MODULE: _____

ENDORSEMENT THREE: PRE-LAUNCH VEHICLE MATING CHECKOUT

THIS IS TO CERTIFY THAT THE FOLLOWING ITEMS HAVE BEEN ACCOMPLISHED EXCEPT AS NOTED ON THE ATTACHED LOG OF EXCEPTIONS:

a. All discrepancies have been resolved.

b. All checkout operations required prior to mating with the launch vehicle or other modules have been successfully accomplished.

c. All necessary work including mandatory E.O.'s required prior to mating with the launch vehicle or other modules has been satisfactorily accomplished.

d. All required retesting has been completed.

e. Written proof by the Test Director of accomplishment of all pre-mate checkout activities including verification of Spacesuit - Astronaut Compatibility has been provided.

f. The data package has been updated and is complete.

EXCEPTIONS	
Contractor	MSC/ KSC

THE UNDERSIGNED CONSIDERS THAT THE MODULE HAS BEEN SATISFACTORILY CHECKED OUT AND IS ACCEPTABLE FOR MATING WITH THE LAUNCH VEHICLE AND OTHER SPACECRAFT MODULES.

_____	_____	_____
KSC or MSC Representative	MSC Quality Representative	MSC Program Manager's Designee
DATE: _____	DATE: _____	DATE: _____

FIGURE 11

APOLLO SPACECRAFT DCR PROGRAM SUMMARY

POINTS \ STEPS	PRE-PHASE I	PHASE I	PHASE II	PHASE III	POST-PHASE III
WHAT IS IT?	· DCR MANAGER & PROJECT REPRESENTATIVES ASSIST CONTRACTORS	· INITIAL COORDINATING DRY RUNS OF CSM/LM GFE SUBSYSTEM INPUTS TO DCR ARE REVIEWED AND CRITIQUED BY MSC TEAMS.	· DRESS REHEARSAL OF THE MSC PORTION OF THE APOLLO DCR (FINAL COORDINATING DRY RUN).	· A THOROUGH AND FORMAL REVIEW OF THE DEVELOPMENT AND QUALIFICATION OF ALL STAGES AND MODULES AND THEIR INSTALLED SUBSYSTEMS TO CERTIFY THE DESIGN OF THE APOLLO TOTAL MISSION COMPLEX FOR FLIGHT WORTHINESS AND MANNED SAFETY.	· FORMAL CLOSURE OF OPEN ITEMS ASSIGNED BY DESIGN CERTIFICATION BOARD AT PHASE III DCR.
WHY IS IT NEEDED?	· TO ENSURE CONSISTENT INTERPRETATION AND IMPLEMENTATION OF DCR PROCEDURE.	· TO ENSURE AN INTEGRATED PRESENTATION BY DIVERSE AND WIDELY SEPARATED CONTRACTORS AT THE DRESS REHEARSAL PHASE II DCR. · TO PERMIT TIMELY AND PROPER DEVELOPMENT OF THE PRESENTATION	· TO ASSESS AND CERTIFY THE DESIGN MATURITY OF THE SPACECRAFT AND MISSION CONTROL CENTER.	· TO ASSURE TOP NASA MANAGEMENT THAT THE SPACECRAFT & MISSION CONTROL CENTER HAS BEEN ASSESSED AND CERTIFIED AS PROOF OF DESIGN DEVELOPMENT MATURITY AND MANNED SAFETY.	· TO ACCOMPLISH AND REPORT OPEN ITEMS FROM PHASE III DCR.

STEPS / POINTS	PRE-PHASE I	PHASE I	PHASE II	PHASE III	POST-PHASE III
WHERE WILL IT BE HELD?	· AT INDIVIDUAL FACILITIES OF PRIME CONTRACTORS, AND AT MSC AS REQUIRED	· AT INDIVIDUAL FACILITIES OF PRIME CONTRACTORS, OTHER CONTRACTORS, OR MSC AS REQUIRED.	· AT HOUSTON SPACECRAFT CENTER.	· AT MSF IN WASHINGTON. (DCR REPORT SUBMITTED TO DESIGN CERTIFICATION BOARD MEMBERS SIX WEEKS IN ADVANCE OF PHASE III DCR.)	·AT CONTRACTOR'S FACILITIES, MSC AND AT OTHER CENTERS AS REQUIRED TO WORK OPEN ITEMS.
WHO WILL PARTICIPATE?	· DCR MANAGER/ REPRESENTATIVES · THE CSM/LM, GFE PROJECT MANAGERS OR REPRESENTATIVES, AND PRIME CONTRACTORS.	· MSC SPACECRAFT REVIEW TEAMS (PROJECT MANAGERS OR REPRESENTATIVES SUPPORTED BY E&DD AND DCR MANAGER'S REPRESENTATIVES) · DCR MANAGER (CHAIRMAN) · CSM/LM AND GFE CONTRACTORS.	· MSC REVIEW AND ASSESSMENT BOARD. · SPACECRAFT PROGRAM MANAGER (CHAIRMAN). · DCR MANAGER/ REPRESENTATIVES. · ASPO AND APPROPRIATE CONTRACTOR PERSONNEL.	· THE APOLLO MANAGEMENT COUNCIL ACTING AS THE DESIGN CERTIFICATION BOARD. · THE SPACECRAFT PORTION WILL BE GIVEN BY MSC/ CONTRACTOR PERSONNEL WHO PARTICIPATED IN THE PHASE II DRY RUN	·SPACECRAFT PROGRAM MANAGER/ DCR MANAGER. ·RESPONSIBLE MSC ELEMENTS AND/OR THEIR CONTRACTORS
HOW WILL IT BE CONDUCTED?	· INFORMAL MEETINGS WITH QUESTION AND ANSWER PERIODS.	· ORAL AND WRITTEN REPORTS BY CONTRACTORS. · REVIEW AND CRITIQUE BY MSC REVIEW TEAMS.	· ORAL SUMMARY PRESENTATIONS. · WRITTEN REPORTS.	· ORAL SUMMARY PRESENTATIONS. · WRITTEN REPORTS.	·SPACECRAFT PROGRAM MANAGER'S REPORT. ·SPECIFIC OPEN ITEM REPORTS.

FIGURE 12

DESIGN CERTIFICATION REVIEWS

The responsibilities of NASA and contractor organizational elements for organizing, planning, and implementing the Apollo Design Certification Reviews.

OFFICE OF MANNED SPACE FLIGHT

Apollo Program Director

- Issue Apollo Program Directive No. 7 establishing Apollo DCR Program and assigning action responsibilities to Centers.
- Organize the DCR.
- Issue a final agenda approximately one month prior to the scheduled DCR.
- Present oral summary of Mission Objectives and Performance requirements and provide supporting documentation covering Mission Description and Performance Requirements.

Apollo Design Certification Board (Apollo Management Council, acting)

- Schedule and conduct the DCR's.
- Review close-out of action items from DCR.
- Execute a Mission Design Certification Document, identifying any actions upon which certification is contingent.

Manned Spacecraft Center:

Spacecraft Program Manager

Responsibilities:

- Organize requirements for the Design Certification Review of the Spacecraft and related GSE.
- Issue Spacecraft Procedure for DCR Implementation.
- Conduct Phase II DCR.
- Assess jointly with MSC Review and Assessment Board, proof of the Spacecraft design and development maturity and manned safety.
- Represent Spacecraft Program at Apollo DCR.
- Assess and certify Spacecraft design for flight worthiness and manned flight safety at Apollo DCR.
- Report accomplishment of MSC action items identified by the Apollo Design Certification Board.
- Sign Statement of Certification for CSM, LM, Mission Control Center, Flight Crew, and GFE.

MSC Review and Assessment Board

- Assist the Spacecraft Program Manager during the Phase II DCR by:
- Assess proof of design and development maturity and manned safety of the spacecraft.
- Establish MSC position for the Apollo DCR.

DCR Manager

- Manage DCR for Apollo Spacecraft Program Manager.

Plan, develop, implement and update DCR procedures.

Coordinate DCR requirements with appropriate MSC/contractor elements through their designated project points of commitment.

- Furnish status of DCR implementation progress to Spacecraft Program Manager.
- Conduct Phase I Dry Runs at the Contractors' facilities.
- Assist Spacecraft Program Manager in conducting Phase II DCR.
- Ensure that all inputs to DCR written reports and oral summary presentations meet the minimum requirements established in this procedure.
- Integrate inputs to Systems Engineering Summary written reports and oral summary presentations, during each phase of DCR preparation, into a summary assessment to support certification of the spacecraft design by the Spacecraft Program Manager at the Apollo DCR.
- Develop written reports and oral presentations summarizing all open items upon which spacecraft design certifications are contingent.
- Present Spacecraft Design Certification Summary at Phase II and Phase III DCR's.
- Track open and action items identified at DCR's.
- Prepare Spacecraft and Related GSE Briefing Book for Design Certification Board.
- Assure that all subsystems presented are adequately supported by design certifications.
- Review and critique Phase I DCR oral presentations and written reports.
- Ensure preparation and updating of program DCR documentation.
- Ensure preparation of LSM/LM written reports and oral summary presentations for Phase II and Phase III DCR's.
- Present CSM/LM oral summaries at Phase II and Phase III DCR's.

Provide written and oral presentation material, including design certifications for GFE forming a part of this project, but not covered in the contractor's subsystem presentations.

Sign Statement of Certification for: CSM and LM.

Director of Flight Operations

- Implement DCR Procedures for Mission Control Center Summary.
- Review and critique Phase II Dry Runs.
- Ensure preparation and updating of Mission Control Center Summary DCR documentation.
- Present Mission Control Center Summary at Phase II and Phase III DCR's.
- Sign Statement of Certification for Mission Control Center.

Director of Flight Crew Operations

- Implement DCR Procedures for Flight Crew Operations Summary.
- Review and critique Phase II Dry Runs.
- Ensure preparation and updating of Flight Crew Operations Summary.
- Sign Statement of Certification for Flight Crew Operations.
- Present Flight Crew Operations Summary at Phase II and Phase III DCR's.

Director of Engineering and Development

- Implement DCR Procedures for Crew Equipment.
- Review and critique Phase II Dry Runs.
- Ensure preparation and updating of Crew Equipment Summary DCR documentation.

- Present Crew Equipment Summary at Phase II and Phase III DCR.
- Sign Statement of Certification for: CSM and LM Subsystems, G&N, PGA and crew equipment.

Director of Science and Applications

- Implement DCR Procedures for Scientific Experiments Summary.
- Review and critique Phase II Dry Runs.
- Ensure preparation and updating of Scientific Experiments Summary DCR documentation.
- Present Scientific Experiments Summary at Phase II and Phase III DCR.
- Sign Statement of Certification for Scientific Experiments.

Flight Safety Office

- Ensure preparation and updating of Manned Safety Summary.
- Present Manned Safety Summary at Phase II and Phase III DCR's.

CSM and LM Program

- Direct implementation of DCR Procedures for their projects.
- Implement contractual coverage for their contractors' participation in the Spacecraft DCR Program.

Systems Engineering Division

- Implement DCR Procedure for the Systems Engineering Summary.
- Ensure preparation and updating of Systems Engineering DCR documentation.
- Present Systems Engineering Summary at the Phase II and Phase III DCR's.

· Sign Statement of Certification for CSM, LM.

Reliability and Quality Assurance Office

· Implement DCR Procedures for the Spacecraft Reliability Summary.

· Review and critique Phase I Dry Runs.

· Ensure preparation and updating of Reliability Summary DCR documentation.

· Present Reliability Summary at the Phase II and Phase III DCR's.

Engineering and Development Subsystem Managers

· Provide, through written certification, by subsystem, proof of design and development maturity and manned safety of the Spacecraft.

· Review and critique subsystem, CSM, LM, and GFE written reports and oral presentations.

· Provide technical inputs to the Systems Engineering Summary for the DCR.

· Present (as required) portions of Systems Engineering Summary during Phase II and Phase III DCR's.

· Implement requirements defined in the DCR Procedures, as applicable.

· Sign Statement of Certification for CSM/LM Subsystems.

CONTRACTORS

Chief Engineers

· Implement DCR Procedures for CSM, LM, G&N, and PGA.

· Review and critique Phase I Dry Runs.

- Ensure preparation and updating written reports and oral summary reports.

- Sign Statement of Certification for CSM, LM, CSM/LM Subsystems, G&N, and PGA.

CSM and LM Program Managers

- Review and critique Phase I Dry Runs.

- Develop and update written and oral presentations for CSM and LM programs.

- Make oral summary presentations at Phase I, II, and III DCR on CSM and LM Introduction and Assessment.

- Sign Statement of Certification for CSM and LM.

Subsystem Managers

- Develop and update written and oral reports meeting DCR requirements, for assessment and certification of CSM and LM Subsystems, G&N and PGA design and development maturity.

- Make oral summary presentations at Phase I, II, and III DCR's on CSM and LM Subsystems, G&N and PGA.

- Sign Statement of Certification for CSM subsystems, LM subsystems, G&N and PGA.

FIGURE 13

PERSONNEL ASSIGNED TO FLIGHT READINESS REVIEW BOARD

Chairman:

Part I FRR, Apollo Program Director
Part II FRR, Apollo Mission Director

Members:

Representative from the Flight Operations Directorate, MSC.

Representative from the Medical Research and Operations Directorate, MSC.

Representative from the Flight Crew Operations Directorate, MSC.

Representative from the Flight Safety Office, MSC.

Representative from the Reliability and Quality Assurance Office, MSC.

Saturn (IB or V) Program Manager, MSFC.

Apollo Spacecraft Program Manager, MSC.

Representative from the Office of the Director, Plans, Programs and Resources, KSC.

Representative from the Office of Director for Launch Operations, KSC.

Participation of subsystem managers, stage managers, and experiment managers involved is at the discretion of the Program Director.

FIGURE 14

CERTIFICATE OF FLIGHT WORTHINESS

SPACECRAFT: _____ LES _____ CSM _____ LM _____

SLA _____ SPACESUIT _____

ENDORSEMENT FOUR: PRE-LAUNCH SPACE VEHICLE CHECKOUT

THIS IS TO CERTIFY THAT THE FOLLOWING ITEMS HAVE BEEN ACCOMPLISHED EXCEPT AS NOTED ON THE ATTACHED LOG OF EXCEPTIONS:

a. All discrepancies have been resolved.

b. All mandatory engineering changes approved by MSC have been incorporated into the spacecraft.

c. All required retesting has been accomplished.

d. The spacecraft has been checkout out and has successfully met the requirements, specifications and criteria provided by MSC in accordance with MSC-KSC agreements.

e. The data package has been updated and is complete.

THE UNDERSIGNED CONSIDERS THAT THE SPACECRAFT HAS BEEN SATISFACTORILY CHECKED OUT, HAS BEEN SUCCESSFULLY INTEGRATED INTO THE LAUNCH VEHICLE, AND IS ACCEPTABLE FOR LAUNCH.

EXCEPTIONS	
Contractor	MSC/ KSC

_____ KSC or MSC Representative DATE: _____

_____ MSC Program Manager's Designee DATE: _____

_____ DATE: _____

FIGURE 15

CERTIFICATE OF FLIGHT WORTHINESS

SPACECRAFT: _____

CERTIFICATION OF FLIGHT WORTHINESS

It is certified by the undersigned that the requirements of each of the COFW endorsement milestones listed below have been satisfactorily fulfilled with approved exceptions as noted on the attached Log of Exceptions:

a. Configuration Definition, Manufacturing and Checkout

b. Launch Site Receiving and Inspection

c. Pre-Launch Vehicle Mating and Checkout

d. Pre-Launch Space Vehicle Checkout

The undersigned further certifies that the spacecraft is flightworthy.

SIGNATURE: _____ DATE: _____

PROGRAM MANAGER
APOLLO SPACECRAFT PROGRAM OFFICE

APPENDIX G

APOLLO PROGRAM MANAGEMENT PROCESS SUMMARY

SPECIFIC APOLLO OBJECTIVES

UNMANNED QUALIFICATION-APOLLO SPACECRAFT/SATURN IB

MANNED ORBITAL FLIGHTS

a. LONG DURATION MISSION

b. RENDEZVOUS AND DOCKING

UNMANNED QUALIFICATION - APOLLO SPACECRAFT/SATURN V

MANNED LUNAR FLIGHT

a. ORBITAL LUNAR MISSION SIMULATION

b. LUNAR MISSIONS

G-1

NASA M64-794
REV 1/26/65

NASA-S-66-10496

MANAGEMENT PHILOSOPHY

- INDUSTRY-NASA TEAM APPROACH
  - INFORMAL DAY-TO-DAY WORKING RELATIONSHIP
  - JOINT REVIEWS OF PROGRESS AND COSTS
  - TECHNICAL ASSISTANCE ON PROBLEMS FROM ALL POSSIBLE SOURCES
- WORK PACKAGES FOR EFFICIENT MANPOWER AND COST CONTROL
- DESIGN NO MORE COMPLEX THAN NECESSARY TO ASSURE SUCCESSFUL MISSION PERFORMANCE
- HARDWARE THOROUGHLY GROUND AND FLIGHT TESTED FOR PERFORMANCE AND RELIABILITY PRIOR TO MANNED FLIGHTS

NASA-S-66-8931

SCOPE OF APOLLO SPACECRAFT MANAGEMENT

- THIRTY-SIX COMPANIES WITH CONTRACTS > $5.M
- 100,000 PERSONS EMPLOYED ON SPACECRAFT
- BUDGET IN EXCESS OF $6.7 B
- CURRENT SPENDING RATE > $4.7M PER DAY
- TEN TEST SITES AROUND COUNTRY
- 70,000 PERT ACTIVITIES (STATUS EVERY TWO WEEKS)
- 1,200 LINE ITEM REPORTS ON COST AND MANPOWER
- CORRESPONDENCE EXCHANGE RATE 2630/ MONTH
  - LETTERS & TWX'S - 2426/MONTH
  - CCA'S - CCP'S - 71/MONTH
  - RECP'S - 133/MONTH

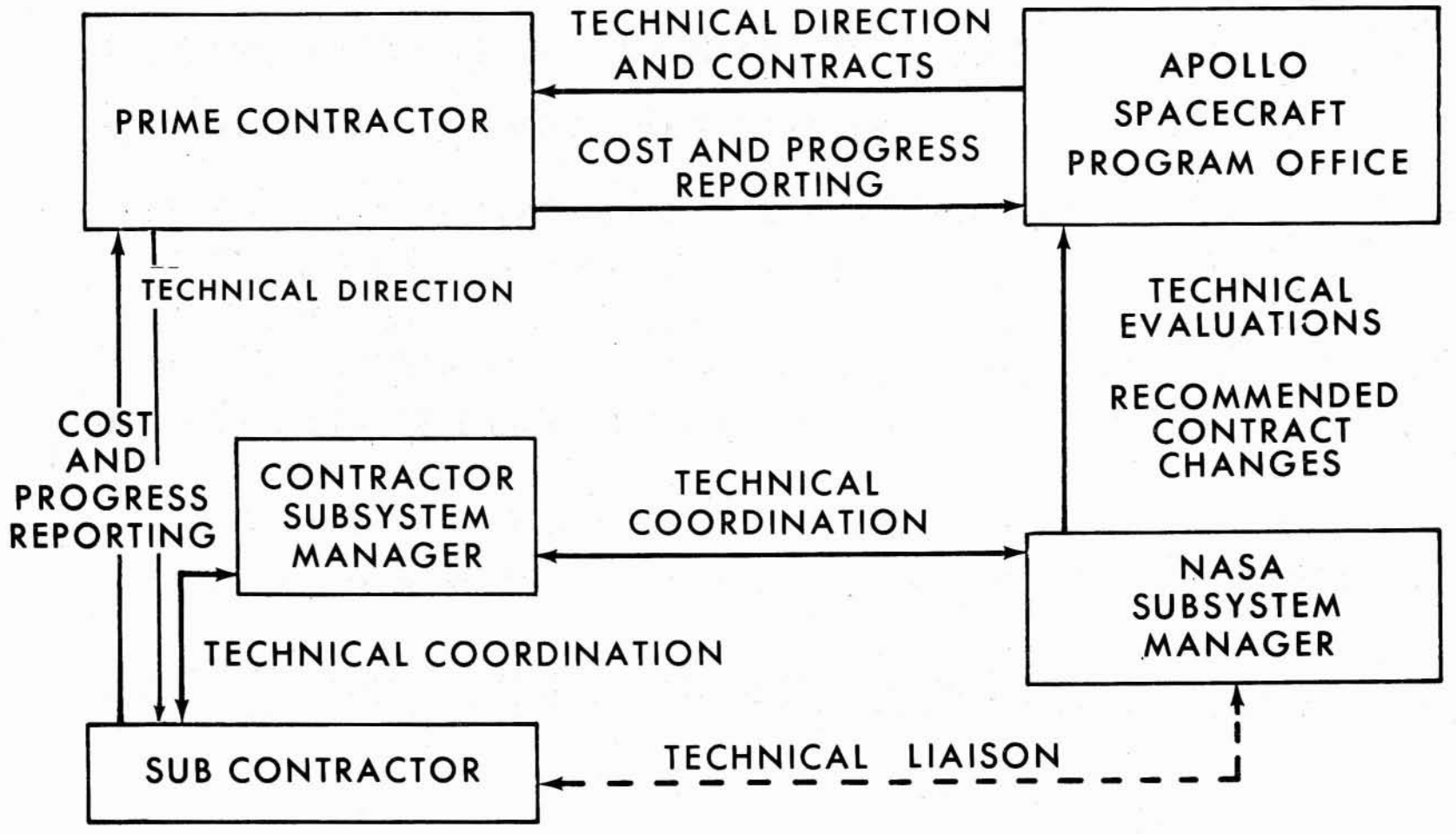
NASA-S-66-1620 FEB 14

TOOLS USED

- ORGANIZATION
- BASELINE
- REPORTING
- SYSTEMS
  - SCHEDULE/PERT
  - SPECIFICATIONS
  - COST
  - CONFIGURATION MANAGEMENT
  - INTEGRATION WITH S/C-LEM
- CONTROL ROOM
- MEETINGS
- CONTRACT
  - PROGRAM BASELINE REVIEW
  - INCENTIVES

NASA-S-66-12802

CONTRACTOR - NASA MANAGEMENT RELATIONSHIPS



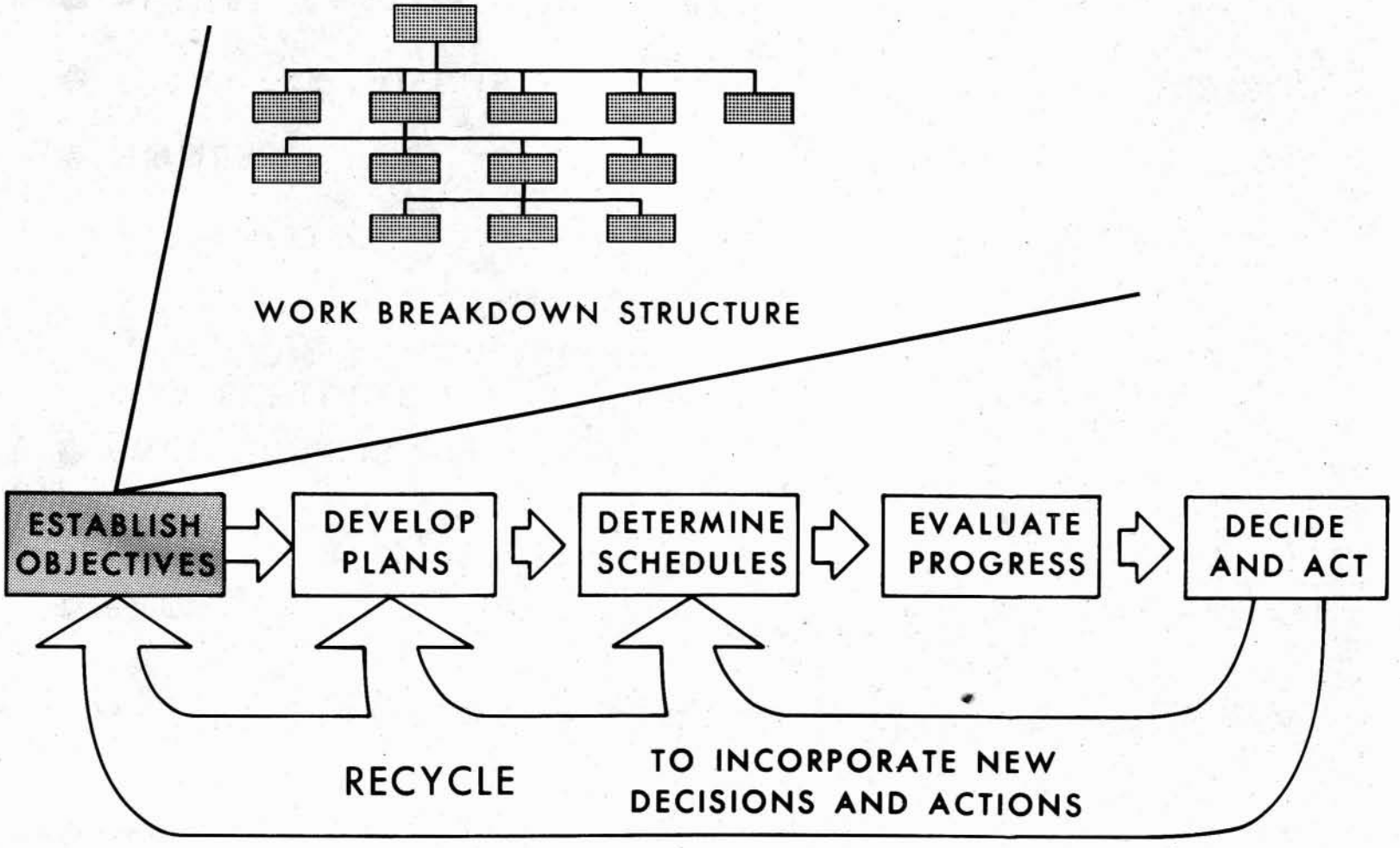
NASA-S-66-9519

WORK PACKAGE MANAGEMENT SYSTEM

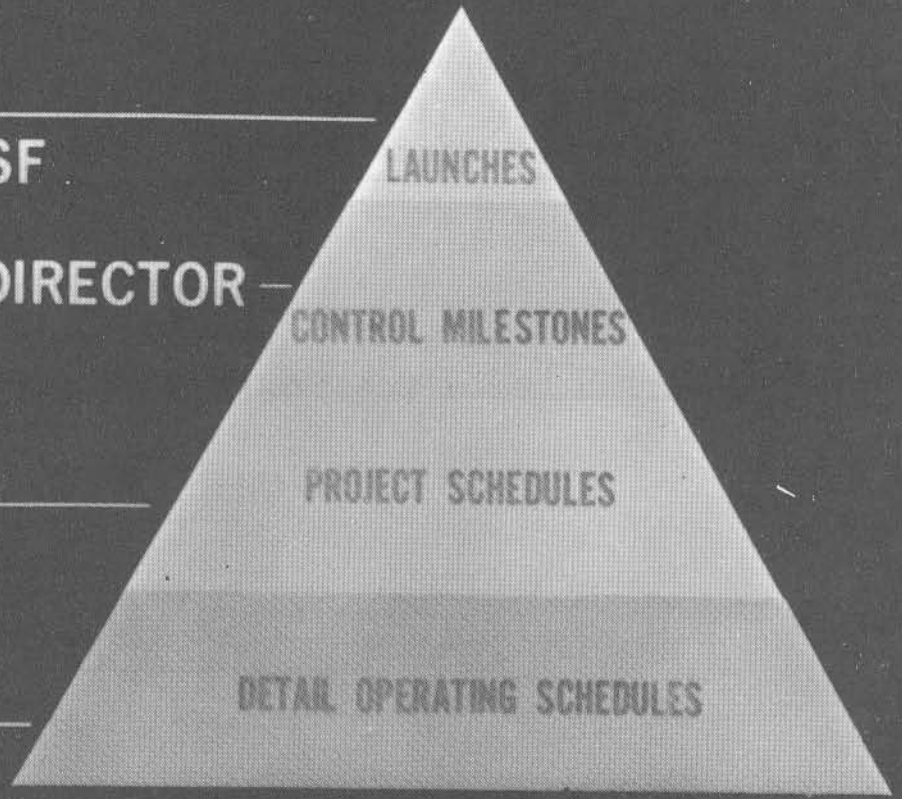
- EACH MAJOR ACTIVITY IS DEFINED IN DETAIL AND BROKEN DOWN INTO TASKS
- EACH TASK IS DEFINED IN DETAIL
  - A SCHEDULE IS ESTABLISHED WITH INTERMEDIATE CONTROL MILESTONES
  - COST BUDGETS ARE ESTABLISHED
  - MANPOWER LEVELS DEVELOPED AND JUSTIFIED
- NONESSENTIAL TASKS ARE DELETED
- TOTAL PACKAGE IS ASSIGNED TO A SPECFIC SUPERVISOR
- ACTUAL MANPOWER USED AND MILESTONES ACCOMPLISHED ARE REPORTED ON A PERIODIC BASIS AND VARIATIONS EXPLAINED

NASA-S-67-2563

IDENTIFICATION AND ORGANIZATION OF OBJECTIVES

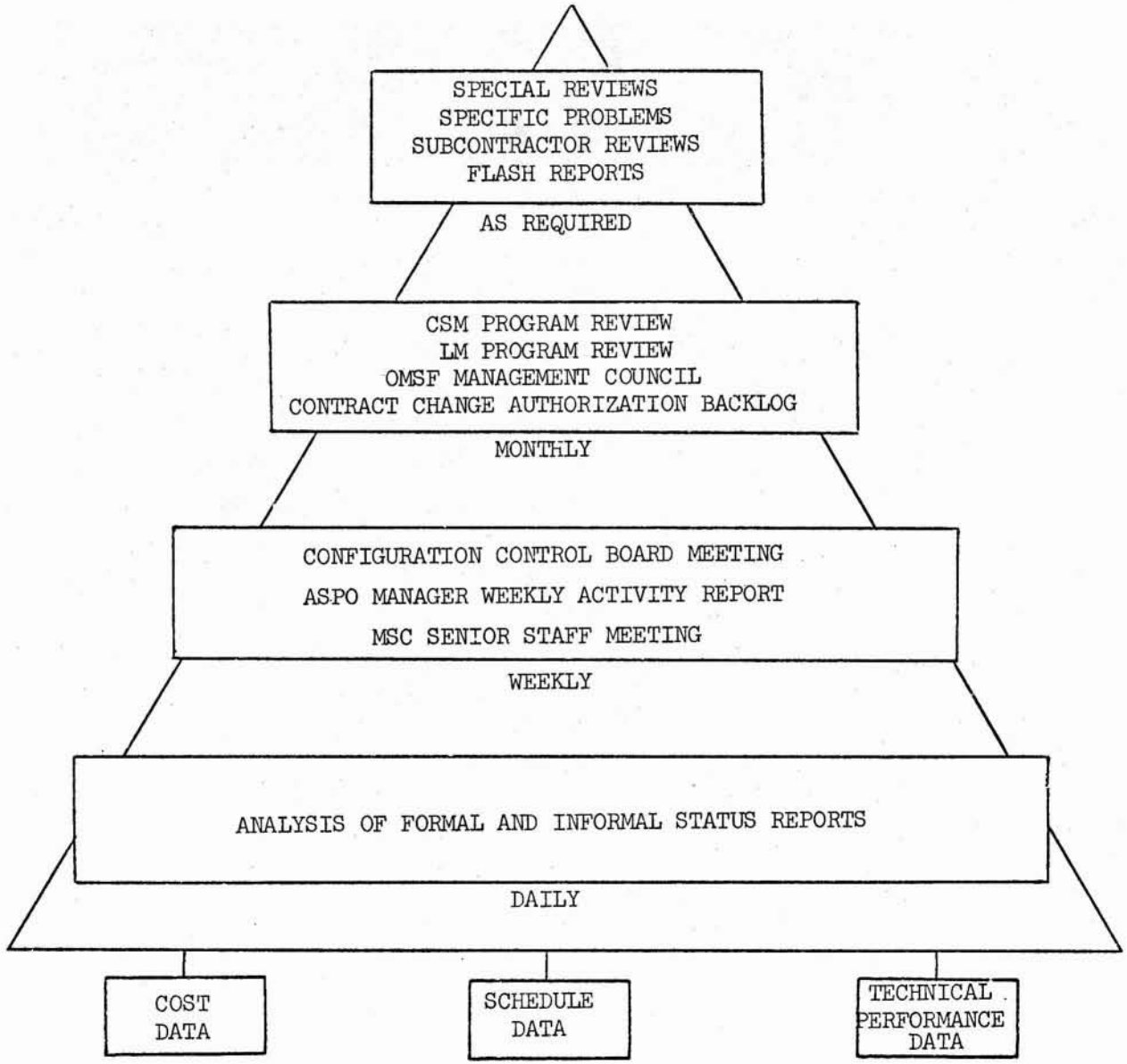


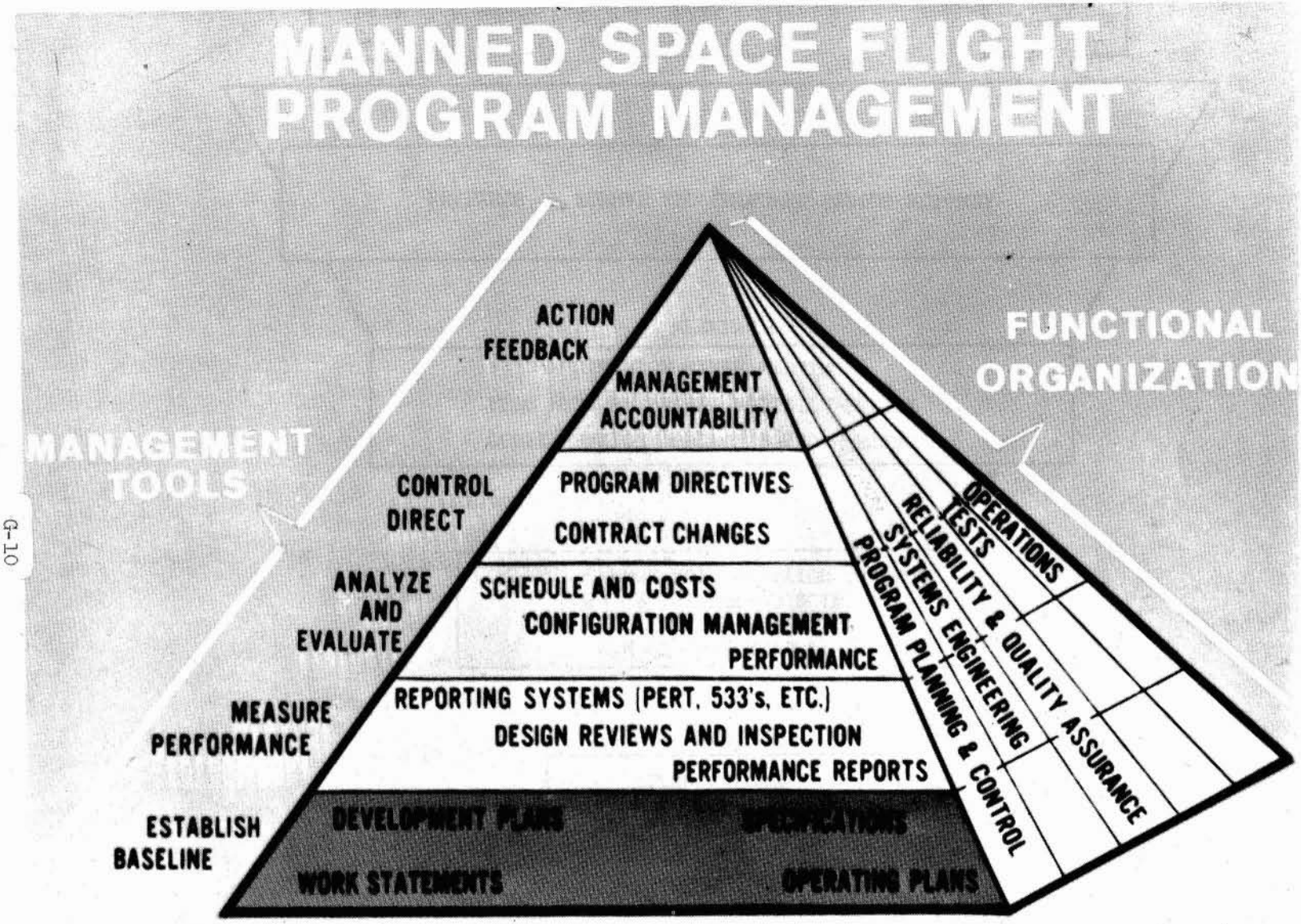
CONTROL LEVELS



NASA MA65-11,701
1-21-66

APOLLO MANAGEMENT CYCLE





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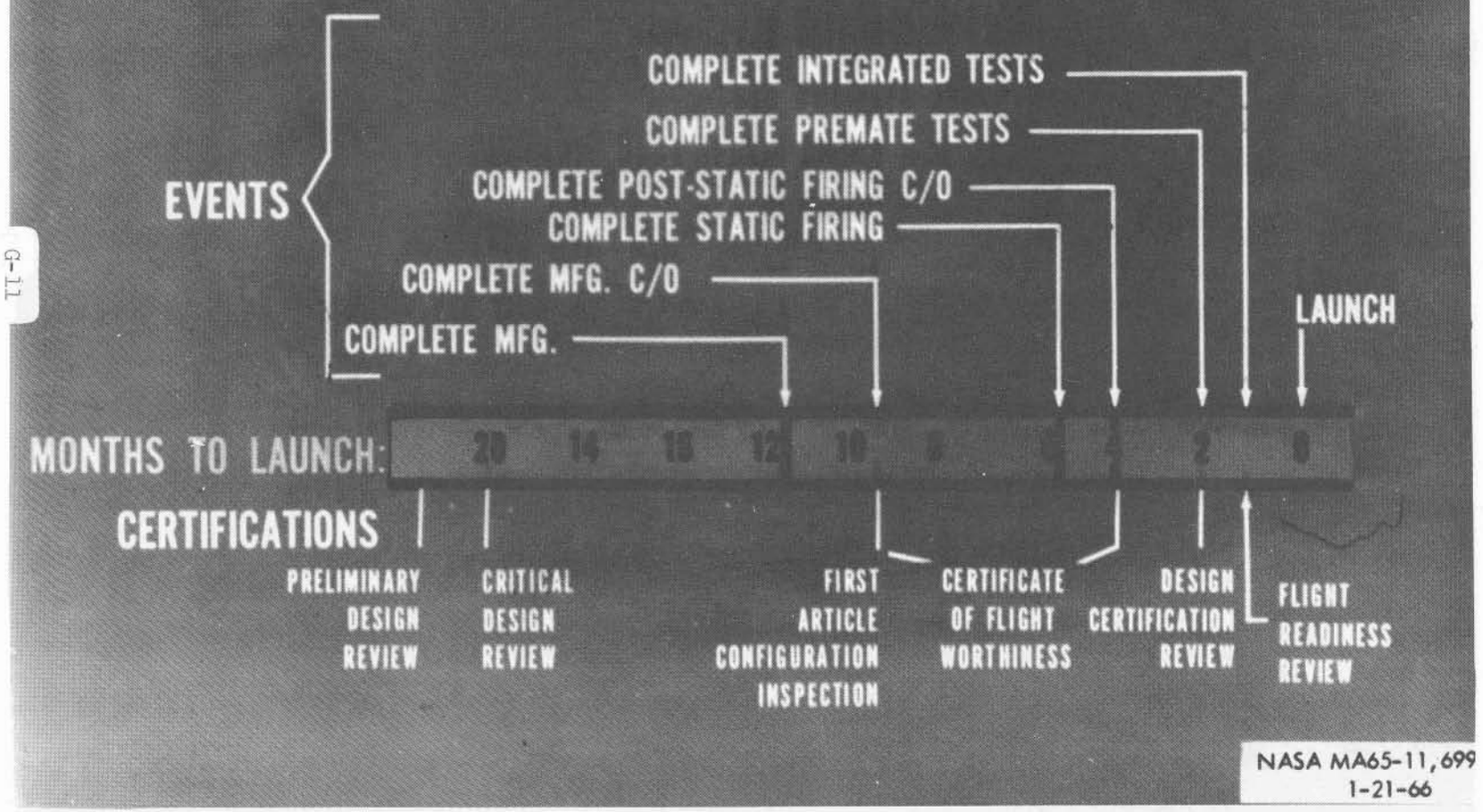
2-25-65

LAUNCH VEHICLE & SPACECRAFT SUPPORTING CERTIFICATION REVIEW PHASING



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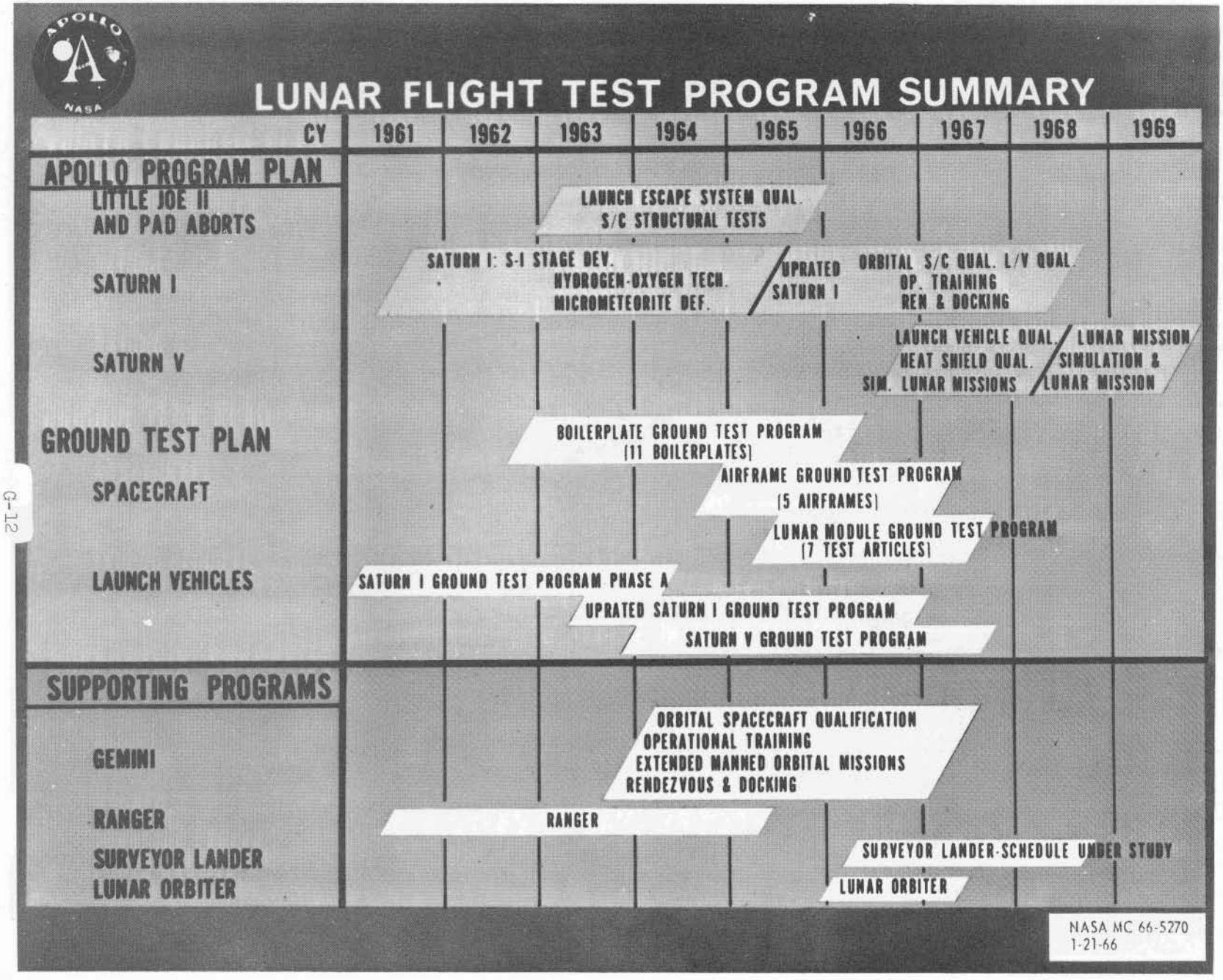
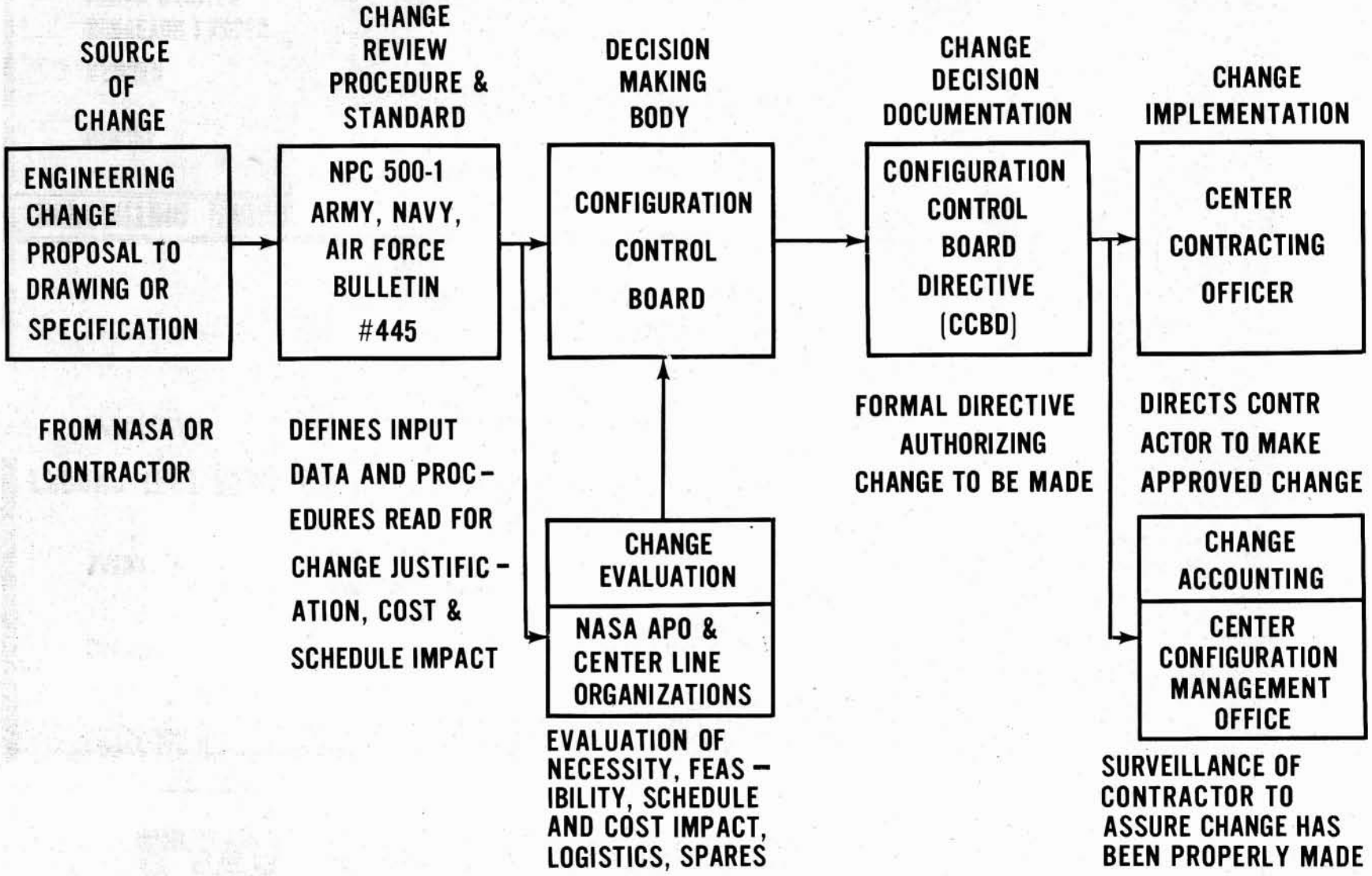
1-21-66


LUNAR FLIGHT TEST PROGRAM SUMMARY
CY
1961
1962
1963
1964
1965
1966
1967
1968
1969
APOLLO PROGRAM PLAN
LITTLE JOE II AND PAD ABORTS
LAUNCH ESCAPE SYSTEM QUAL.
S/C STRUCTURAL TESTS
SATURN I
SATURN I: S-I STAGE DEV.
HYDROGEN-OXYGEN TECH.
MICROMETEORITE DEF.
UPRATED SATURN I
ORBITAL S/C QUAL. L/V QUAL.
OP. TRAINING
REN & DOCKING
SATURN V
LAUNCH VEHICLE QUAL.
HEAT SHIELD QUAL.
SIM. LUNAR MISSIONS
LUNAR MISSION SIMULATION & LUNAR MISSION
GROUND TEST PLAN
BOILERPLATE GROUND TEST PROGRAM (11 BOILERPLATES)
SPACECRAFT
AIRFRAME GROUND TEST PROGRAM (5 AIRFRAMES)
LUNAR MODULE GROUND TEST PROGRAM (7 TEST ARTICLES)
LAUNCH VEHICLES
SATURN I GROUND TEST PROGRAM PHASE A
UPRATED SATURN I GROUND TEST PROGRAM
SATURN V GROUND TEST PROGRAM
SUPPORTING PROGRAMS
GEMINI
ORBITAL SPACECRAFT QUALIFICATION
OPERATIONAL TRAINING
EXTENDED MANNED ORBITAL MISSIONS
RENDEZVOUS & DOCKING
RANGER
RANGER
SURVEYOR LANDER
SURVEYOR LANDER-SCHEDULE UNDER STUDY
LUNAR ORBITER
LUNAR ORBITER
NASA MC 66-5270
1-21-66

CHANGE CONTROL SYSTEM DESCRIPTION



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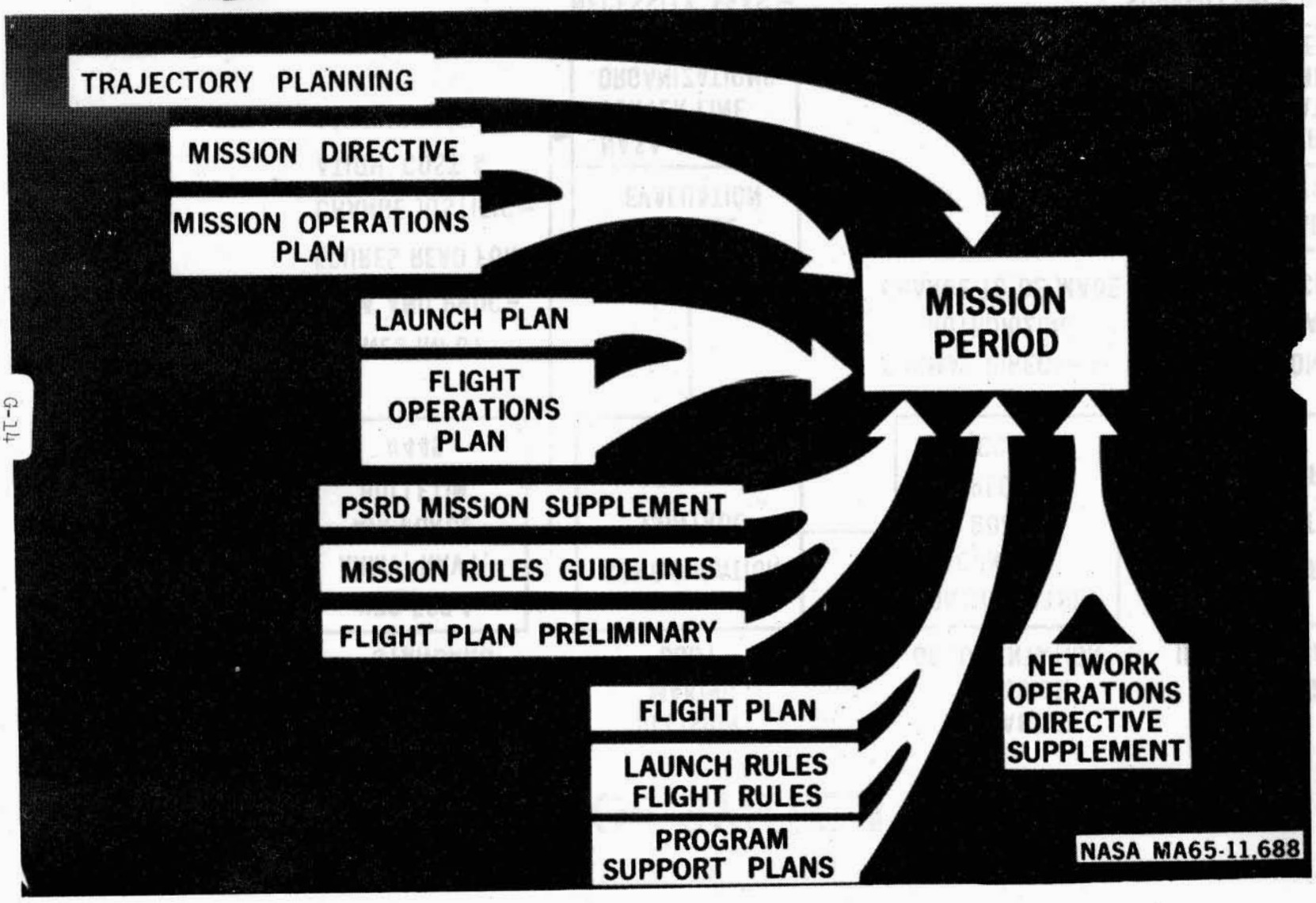
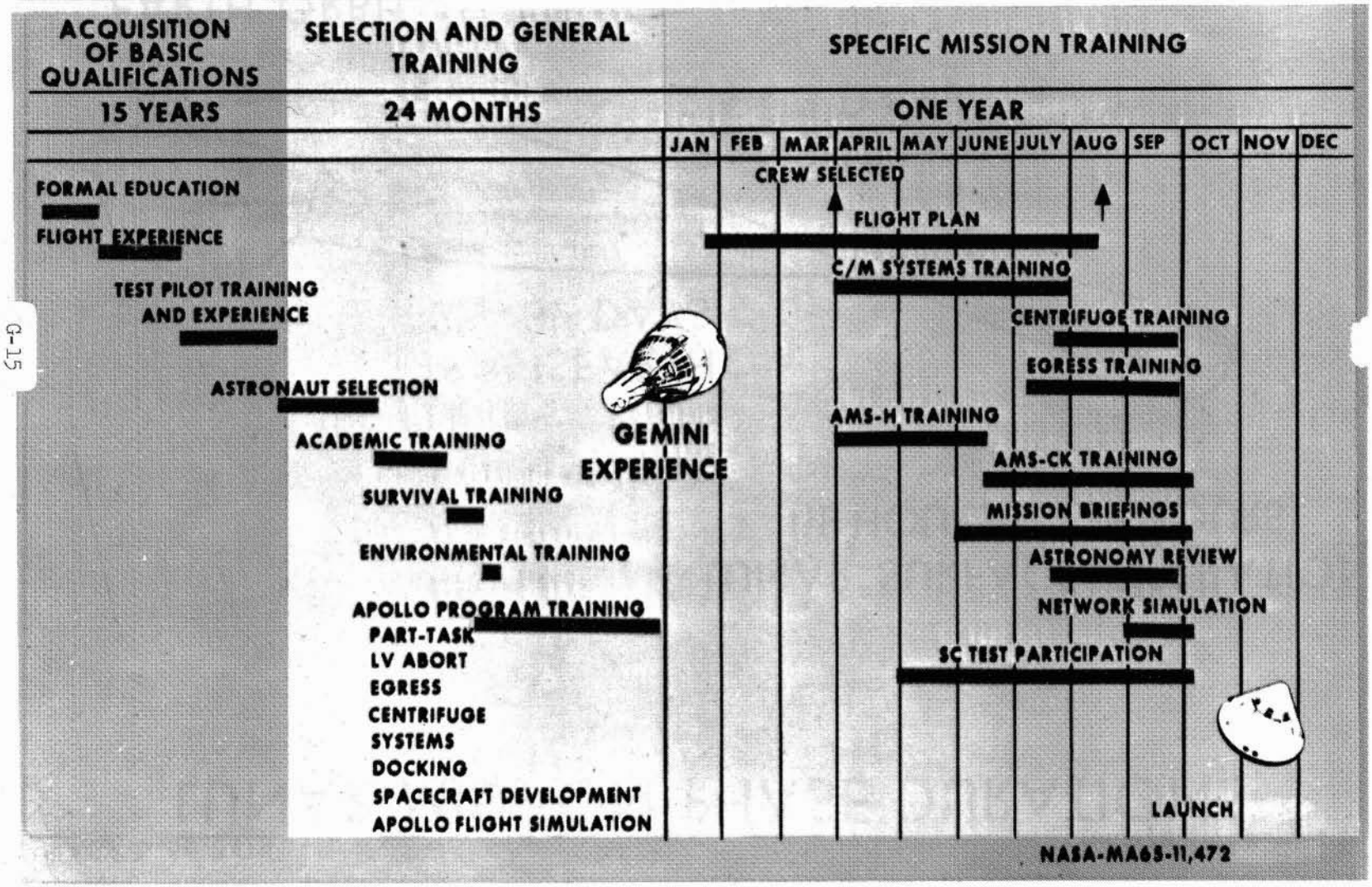
1-21-66

OPERATIONS PLANNING



APOLLO FLIGHT CREW TRAINING



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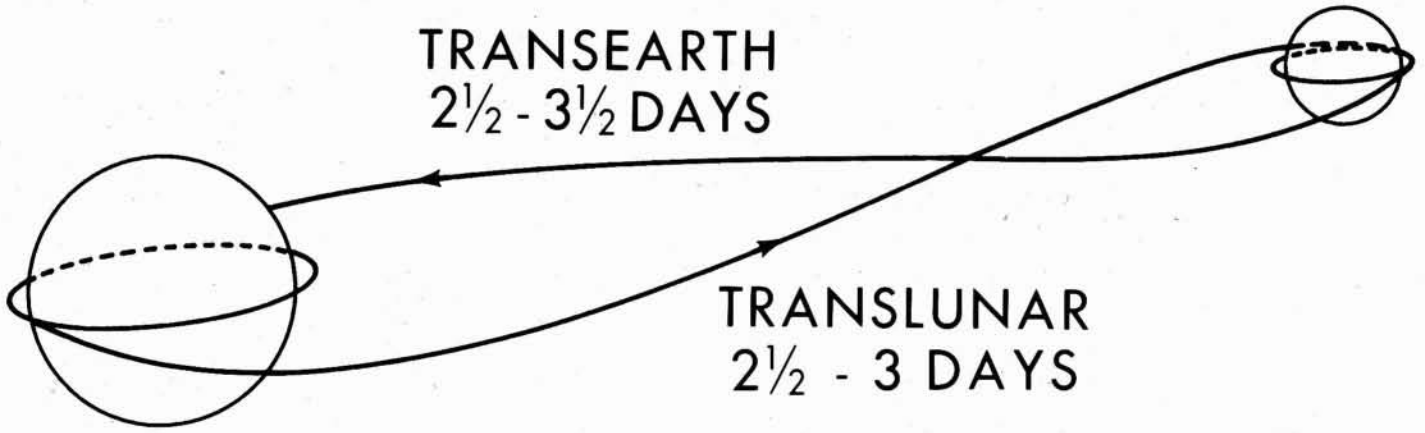
LUNAR MISSION PHASE DURATIONS

LUNAR SURFACE OPERATIONS
(18 HOURS TO 35 HOURS)



MINIMUM DURATION 8 DAYS
MAXIMUM DURATION 14 DAYS


QUALITY
NASA
COST
ACHIEVE
THE BEST
FOR LESS