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GE C. MARSHALL SPACE FLIGHT CENTER

MSFC

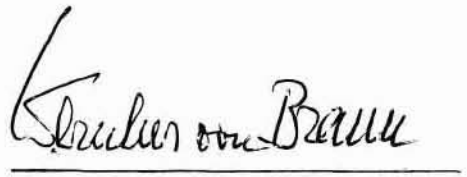
APOLLO PROGRAM MANAGEMENT
VOLUME 3

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA

PREFACE

The need for documentation of our management systems has considerable merit. However, systems do not operate alone and without change. The continual stimulus of management direction is the impulse which provides the effectiveness of any systemized activity. In fact, many of the management practices and process used and documented in the Apollo Program have evolved as the technical development has progressed and as the situation has demanded.



Wernher von Braun
Director, MSFC

INTRODUCTION

The purpose of this document is to describe in summary the MSFC segment of the total Apollo Management process and to describe the methodologies and techniques currently being implemented. Details of management systems employed are described in the Headquarters document (Volume 1) and repeated in this document only in summary fashion as they are applied to the MSFC organization. The MSFC document reflects the complexities inherent in a research and development environment as well as the magnitude of the management effort which has crystallized the many agencies, government and contractor, into a technical and management team with unified spirit and a common purpose.

The intricacies of management practice in general have made it necessary to limit the subject matter of this document to but one field of management, that, of course, being Program Management. However, information is included, either in summary or by appendix, which encompasses all of the basic activities which complete the management network at the George C. Marshall Space Flight Center.

The Program Management process, as it is now being practiced, is presented in a sequence of five broad categories.

- Function and Scope of Activity
- Program Management Concept
- Organization and Relationships
- Management System Elements
- Current Management Systems Improvements

The first category (Function and Scope of Activity) summarizes the evolution of MSFC in general, emphasizes the increasing importance of its role in the Space Program and illustrates less widely publicized benefits to society in general. The second category (Program Management Concept) essentially reveals the ideological approach which has produced the existing decentralized structure within the MSFC.

The third category (Organization and Relationships) discusses this structure in terms of broad functional responsibilities and the inter-relationships of the various offices which practice Program Management. The fourth category (Management System Elements) describes the essential ingredients of a successful management system. In brief, these are defintion, implementation, communcation, decision-making, and reviewing the effectiveness of the entire management process. The final category (Current Management Systems Improvements) discusses management research activities and plans for improving management at the Center. Three appendices are included which provide more detailed information on general management and list those key documents from which most of the information contained in this document was gathered.

For the most part, the current management systems reflected by this document were not fully developed at the inception of the Apollo Program, but gradually evolved as the complexities of the Program became more apparent. Since management systems are ever changing due to the increasing complexities of space technology and the need for more sophisticated techniques, this document will undoubtedly require periodic updating. However, it is believed that the total series of volumes of which this document forms a part will provide a valuable source of reference for those who would understand the basic techniques required to perform Program Management.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Concluded)

SECTION 1

FUNCTION AND SCOPE OF ACTIVITY

HISTORICAL SUMMARY

The George C. Marshall Space Flight Center was formally established in 1960. Under the direction of Dr. Wernher von Braun, its energy and resources were assembled to assure the achievement of the national goal of landing men on the moon and returning them safely to earth within this decade.

At that time, the basic organizational structure consisted of Research and Development Laboratories with highly specialized scientific and engineering capabilities. This structure incorporated a nucleus of demonstrated in-depth knowledge encompassing the disciplines so vital to the success of the Apollo program and all other related activities including research in the fields of ballistic missiles and general rocketry. Superimposed on this laboratory system were project offices whose function it was to perform conventional staff and administrative services such as budgets, schedules, and reporting. The status of the program during this period required that a major portion of the total effort be accomplished within the laboratories. This system of management was supported by contractors who were called upon as suppliers and in providing technical assistance in sub-system development. Authority for managing the contractor effort was delegated to the laboratories. The simplicity of this structure permitted overall program management to be conducted by the Center Director.

As the Apollo program progressed, the launch vehicle projects evolved from the two stage Saturn I to a three vehicle family consisting of the Saturn I, IB, and V, (see Figs. 1-1, 1-2, 1-3, respectively). It became apparent by late 1962, that the

manpower and facility requirements of the program far exceeded the capacity of the laboratories. To meet these increasing demands, the George C. Marshall Space Flight Center adjusted its management system to provide for an increased reliance on private industry. This adjustment resulted in the approach still being followed. Major segments of the launch vehicle such as a stage or related system are developed and produced by a major aerospace firm. (Fig. 1-4 illustrates the contractors' role in the Saturn/Apollo Program.) This shift in management emphasis from a Laboratory environment to one of managing and integrating large contracts for developing and producing increasingly complex launch vehicles necessitated a center-wide reorganization in 1963. This reorganization established Industrial Operations as the MSFC element responsible for multi-program management with Research and Development Operations providing technical support and management of in-house technical projects. Thus, the technical expertise continues to provide an important source of knowledge and experience in support of program management.

In order to provide the reader with closer insight into the complexities of single program management it is necessary to describe briefly the many objectives and responsibilities of MSFC in conducting not only multi-program management but also in the critical areas of technical research in support of both current and future programs.

MSFC MISSION

During FY 67-8 the many and varied activities of the Marshall Space Flight Center required the services of some 7000 civil service personnel in close cooperation with prime contractors personnel and single support contractor personnel representing a large percentage of the Center's total annual budget (Fig. 1-5). In addition to the prime mission of obtaining large launch vehicles and related equipment systems in support

SATURN I LAUNCH SUMMARY

RESEARCH AND DEVELOPMENT FLIGHTS

SA-1	1. LAUNCHED-OCT. 27, 1961 2. S-I STAGE PROPULSION SYSTEM SATISFACTORY
SA-2	1. LAUNCHED-APR. 25, 1962 2. PROJECT HIGHWATER RELEASED 22,900 GAL. H_2O INTO IONOSPHERE
SA-3	1. LAUNCHED-NOV. 16, 1962 2. 2ND PHASE PROJ HIGHWATER 3. FULL PROPELLANT LOADING
SA-4	1. LAUNCHED-MAR. 28, 1963 2. ENGINE OUT CAPABILITY DEMONSTRATED
SA-5	1. FIRST BLOCK II LAUNCHED-JAN. 29, 1964 2. FIRST LIVE S-IV STAGE AND INSTRUMENT UNIT
SA-6	1. LAUNCHED-MAY 28, 1964 2. FIRST ACTIVE GUIDANCE FLIGHT 3. FIRST FLIGHT APOLLO BOILERPLATE AND LES 4. ENGINE OUT (UNPLANNED)

OPERATIONAL FLIGHTS

SA-7	1. LAUNCHED-SEPT. 18, 1964 2. COMPLETELY ACTIVE ST-124 GUIDANCE
SA-9	1. LAUNCHED-FEB. 16, 1965 2. FIRST PEGASUS (METEOROID TECHNOLOGY SATELLITE) ORBITED 3. FIRST UNPRESSURIZED INSTRUMENT UNIT
SA-8	1. LAUNCHED-MAY 25, 1965 2. ORBITED SECOND PEGASUS SATELLITE
SA-10	1. LAUNCHED-JULY 30,1965 2. ORBITED THIRD PEGASUS SATELLITE 3. COMPLETED SATURN I PROGRAM

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FIGURE 1-1. SATURN I LAUNCH SUMMARY

FIGURE 1-2. UPRATED SATURN I LAUNCH SUMMARY

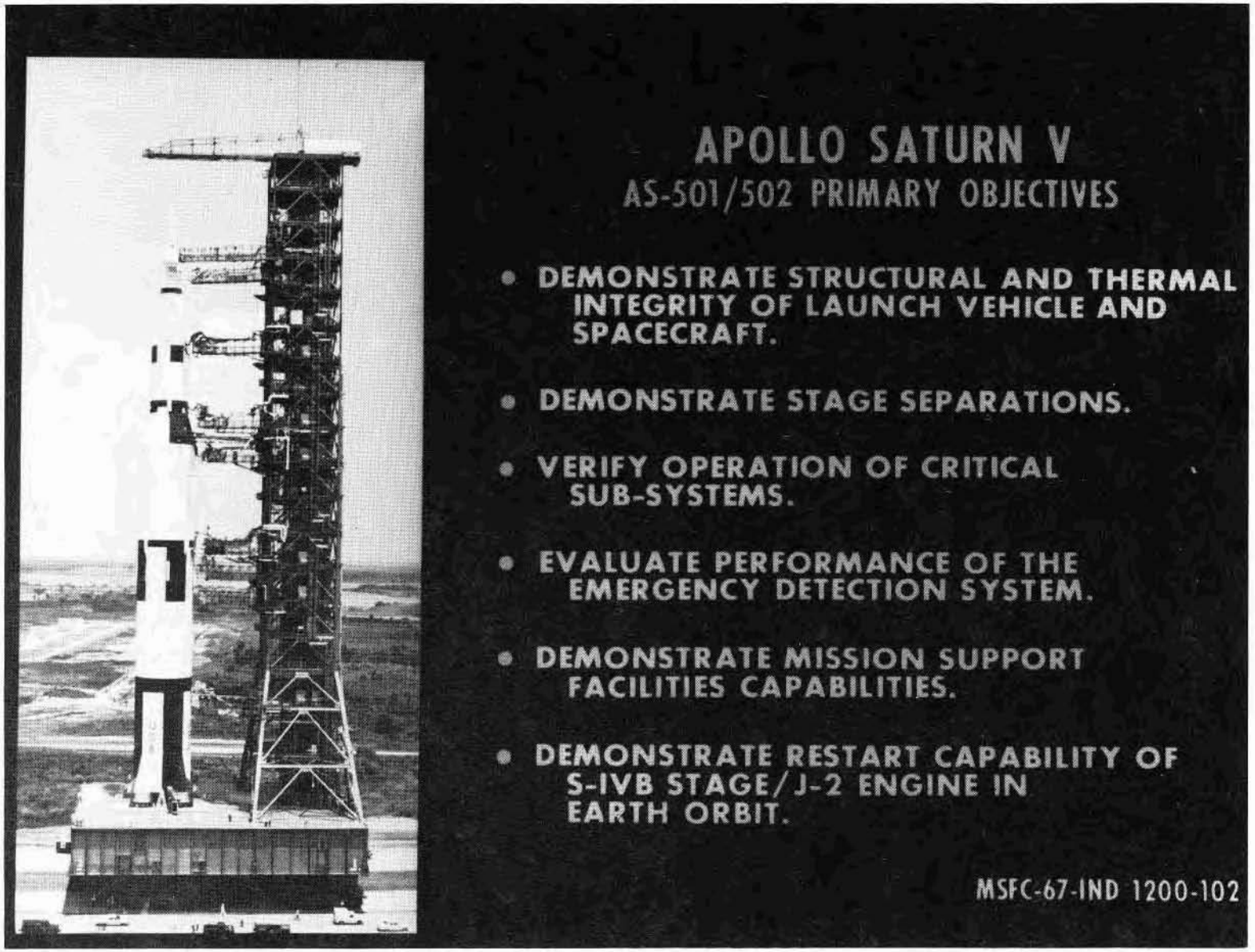

FIGURE 1-3. SATURN V PRIMARY OBJECTIVES

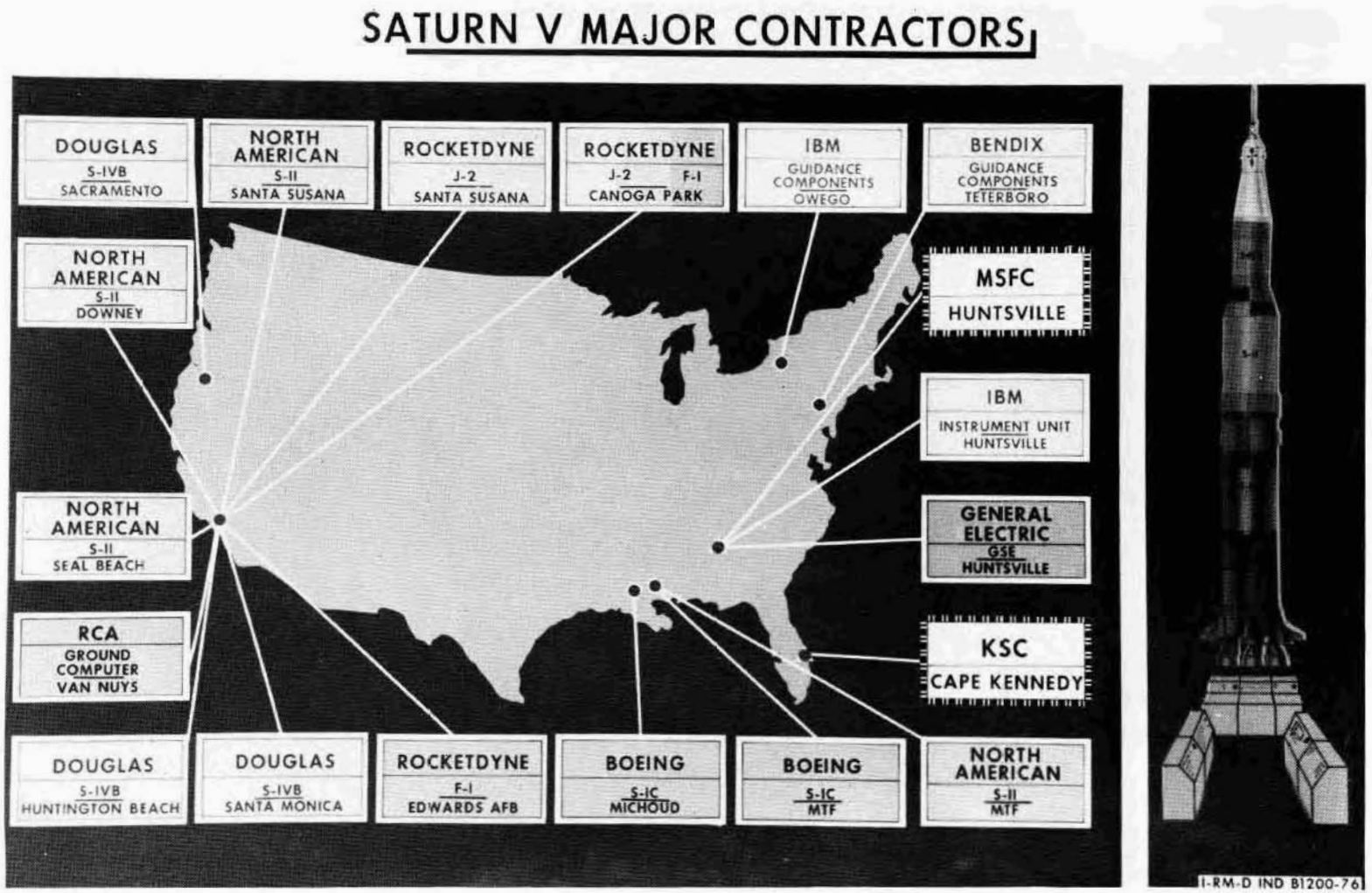

FIGURE 1-4. SATURN V MAJOR CONTRACTORS

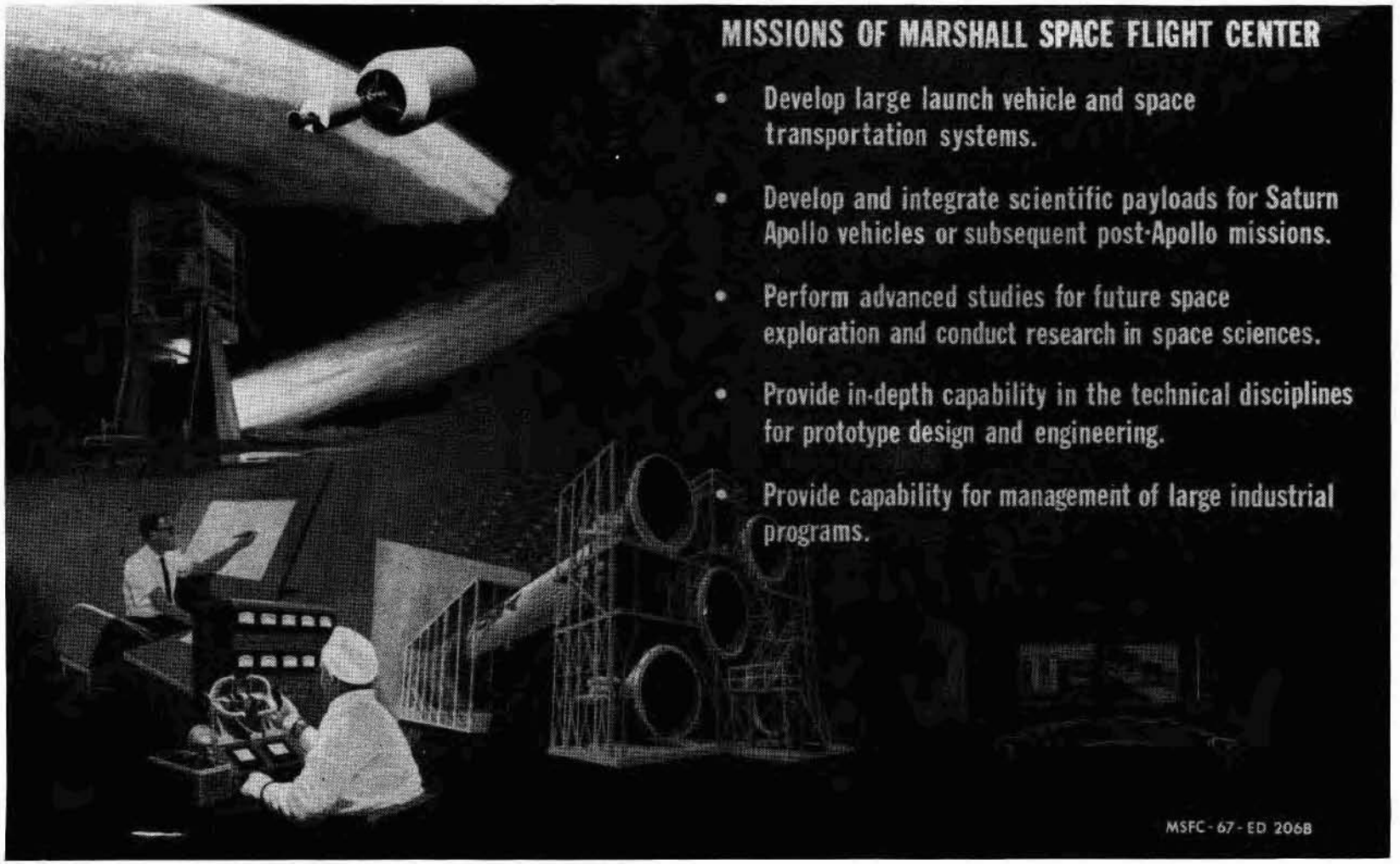

FIGURE 1-5. MISSIONS OF MSFC

of Apollo, MSFC Research and Development Operations performs extensive scientific research and manages those contracts awarded to universities and private industry for the advancement of the state-of-the-art in such fields as thermophysics, astrophysics, aeronomy, astronomy, geophysics, optics, selenology and nuclear physics. MSFC scientists and engineers support this activity by serving as Center representatives in furthering scientific relationships with NASA Headquarters, other Federal Agencies, and private industry. These efforts have demonstrated their value to society in yielding important scientific advances such as:

SIGHT-SWITCH

This innovation was developed by a contractor employee and explained in a MSFC "spin off" report or technical brief (see Fig. 1-6). The brief describes how a simple infra-red sensing unit attached to regular eye glass rims could be used to open and close electrical circuits and operate a variety of mechanical devices. It represents a significant breakthrough for the physically handicapped in that the device can enable them to independently operate such things as wheelchairs, typewriters, radios, television sets, page turners, and self-feeding devices. Through NASA Technology Utilization Program information on the device was furnished not only to the Veterans Administration, Rehabilitation Center, and Research Institute, but also to more than 90 individual victims of crippling accidents or diseases.

MICRO-EYE CAMERA

Under a contract to MSFC, a tiny camera was developed weighing less than 24 ounces and having dimensional parameter about the size of an average palm. The camera can be fitted to a surgeon's cap during an operation to permit television viewing by an unlimited number of medical students (see Fig. 1-7).

FIGURE 1-6. SIGHT SWITCH

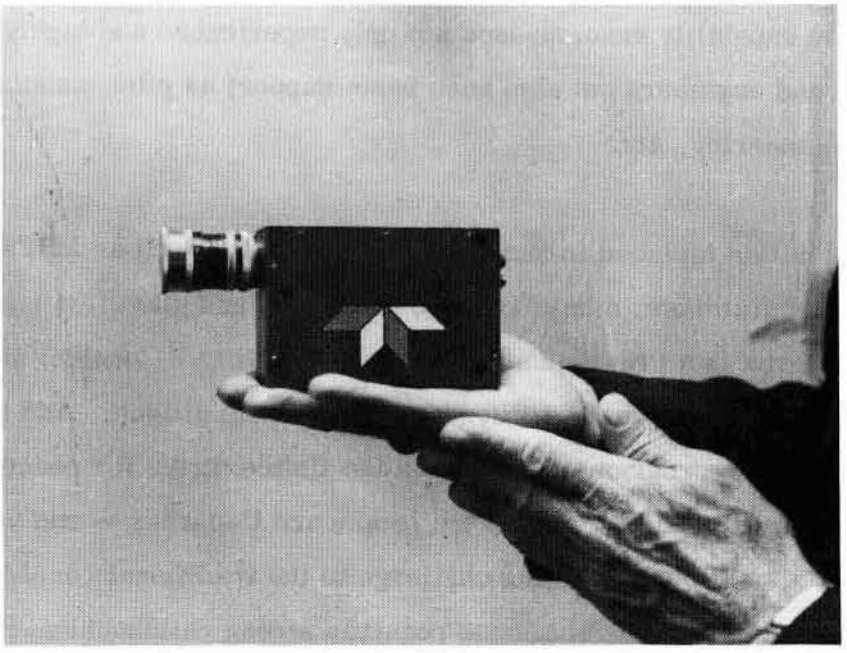

FIGURE 1-7. MICRO-EYE CAMERA

MAGNETIC HAMMER

A "magnetic hammer" was developed by Marshall's Manufacturing Engineering Laboratory. The hammer, a compact device that uses the force of an electric field to form metal uniformly, is expected to save NASA more than 6 million dollars in fabrications of Saturn V bulkhead segments. Five of the hammers are being evaluated by industrial firms in non-space related areas (see Fig. 1-8).

These devices are only three of the more than 2500 such technical briefs which have been prepared by and for MSFC since 1962.

SUMMARY

To conduct extensive research to provide technical support to Program Management by providing solutions to complex problems which penetrate, at times, many technical disciplines simultaneously requires the maintenance of a unique capability. This unique capability encompasses not only experienced and highly competent scientists and engineers but also such basic support as pilot manufacturing, tooling, product engineering, etc.

The complexities included in sustaining an institution such as MSFC with its important laboratories, administrative buildings, and giant test stands, covering over 1800 acres is a great management responsibility. Consider its impact on the local economy as well as its influence on the private citizen. Add to those things, the largest single program conducted by the United States for peaceful purposes — Apollo, carried out in full view of the people and Congress — and you will begin to imagine an almost overwhelming challenge to the traditional concepts of management. To successfully meet this challenge requires strong philosophical foundations which take advantage of proven techniques while retaining the necessary flexibility to meet the challenge of the future.

FIGURE 1-8. MAGNETIC HAMMER

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SECTION 2

PROGRAM MANAGEMENT CONCEPT

The management philosophy of MSFC is essentially one of providing a continuing in-depth capability to accomplish the complete management and technical job for all assigned projects.

The Director with the Deputies for Administration and Technical provide the overview and policy guidance which gives the Center flexibility in applying as much of the total resources as are necessary at any point in time to accomplish each assigned program objective.

The scope of active major projects is so great that each requires an individual program management office capable of doing a complete management job, responsive to the requirement of the Apollo Program Office, and able to call on all of the in-depth technical capability of the R&DO laboratories under the policy guidance of Center Director.

In maintenance of the established capability, the "keeping hands dirty" philosophy is practiced and means that the divisions assure the maintenance of a high level of technical competence within the organization and actively perform work on projects selected specifically to update this knowledge and increase its competence.

The responsibility for management of projects including more than one discipline is vested in the project offices (see Fig. 2-1). The project management aspect includes directing, coordinating, programming, and budgeting all effort that relates to individual projects. This total effort includes all that which is expended by the technical

divisions as well as that performed by contractors. But the task of the project office is not to do any part of the technical job in the various disciplines but rather to assure that all effort required by the project has been planned for, budgeted for, and is actually being accomplished in a coordinated, effective, and efficient manner.

Because project management involves a multitude of complex technical considerations and decisions, technical support in-depth is required by the Project Office. This technical support is not established in the Project Office but rather in the technical divisions. The technical divisions, through instruments such as working groups, technical committees, or task assignments, directly assist the director of the project office to make the technical decisions required for effective project management.

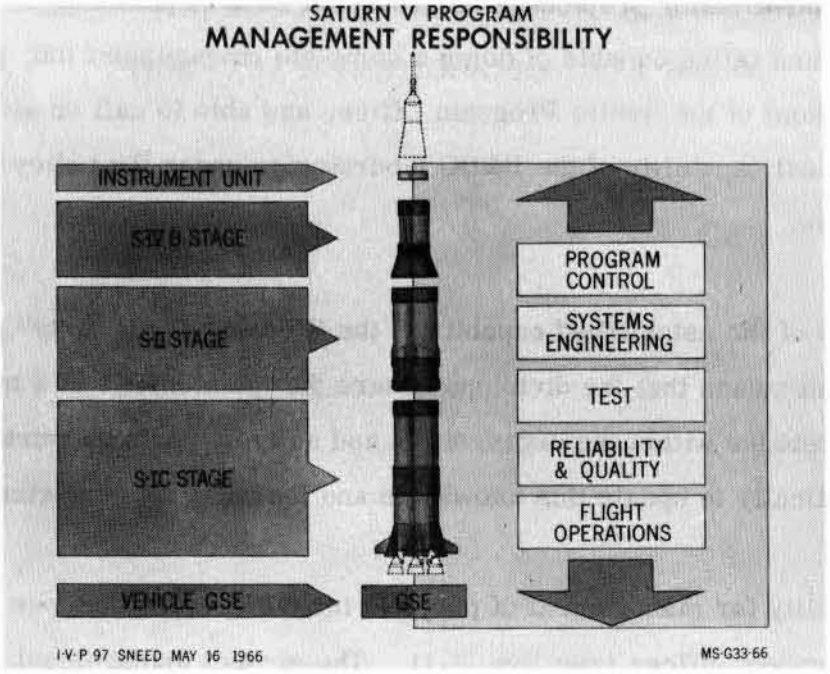

FIGURE 2-1. PROGRAM MANAGEMENT STRUCTURE

Institutional matters such as financing, procurement, personnel, technical and management services which impact the project and technical assignments are directly coordinated and resolved through the respective functional manager for these areas.

Continuous overview by Center Management through Board and Staff meetings and periodic technical and management reviews helps to keep these principles in focus and assures an economical and integrated application of the Center's management, and technical resources to the accomplishment of assigned missions.

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SECTION 3

MSFC ORGANIZATION AND RELATIONSHIPS

The management challenge as viewed by MSFC is one of utilizing to the maximum existing manpower resources without creating an environment which requires continuous readjustment on the part of the individual involved, thereby, jeopardizing the compatible relationship between managers and employees. The organizational structure at MSFC has demonstrated a high degree of efficiency and with only minor changes will most likely continue in light of management system concepts now under development (see Section 5 - Current Management System Improvements).

On the following pages the vertical alignment of the MSFC organization is described in summary followed by a description of the horizontal relationships between line organizations. A detailed description of each organization at MSFC in terms of specific functions and responsibilities is included as Appendix A.

MSFC ORGANIZATION

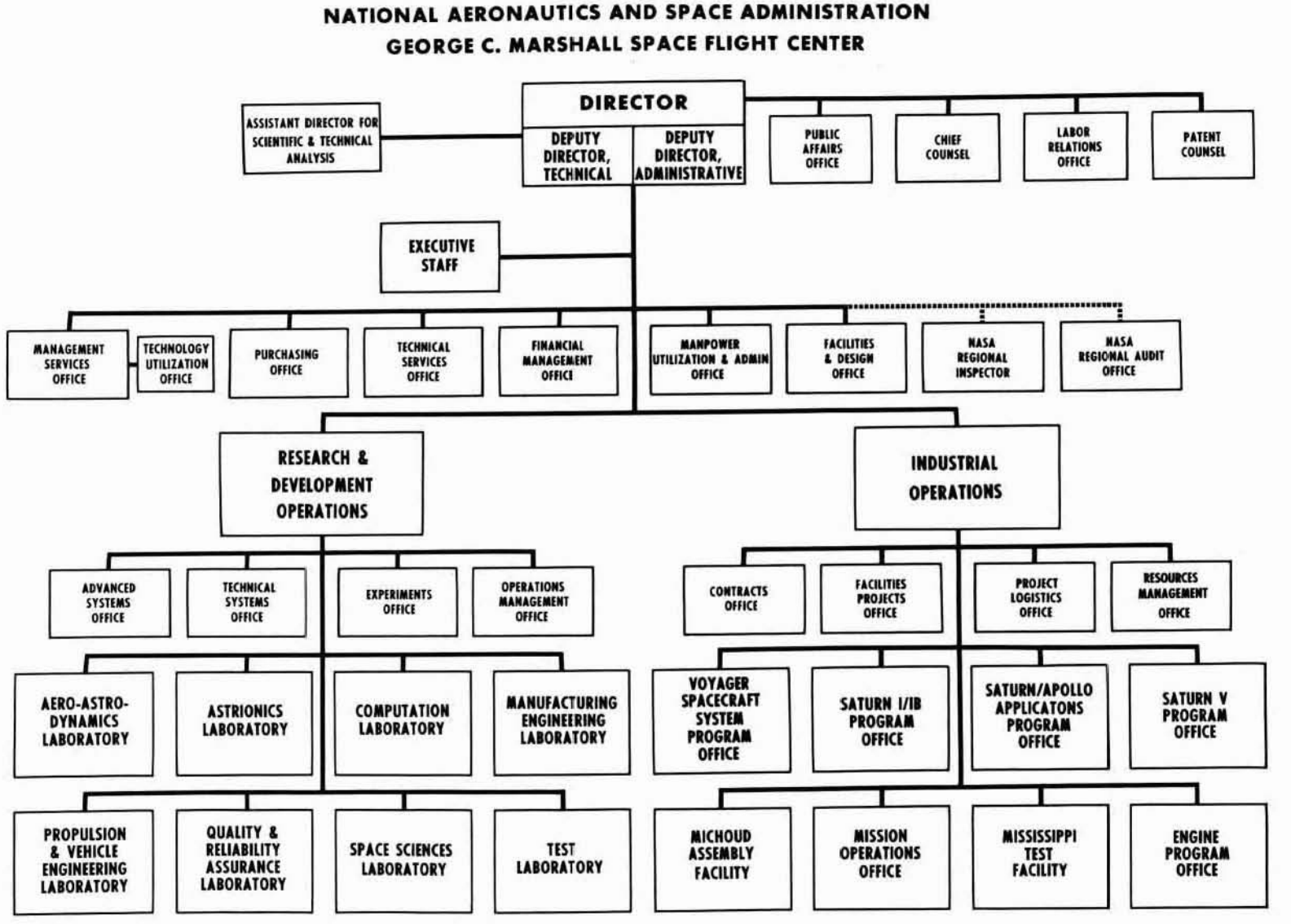
There are three major organizational elements under the cognizance of the MSFC Director. They are:

- Staff and/or Administration Services
- Industrial Operations
- Research and Development Operations

This basic organization with its supporting elements is illustrated in Figure 3-1.

STAFF AND/OR ADMINISTRATIVE SERVICES

The general term "staff" at the MSFC includes both staff and administrative services organizations. These elements provide needed services, which their names imply,



APPROVED Original Signed By
DATE — James E. Webb

FIGURE 3-1. MSFC ORGANIZATION

to both Center Management and line organizations. The elements in this general category are all functions of an institutional nature, servicing the two operating elements and center management. Approximately 20 percent of center manpower is allocated to these functions.

INDUSTRIAL OPERATIONS

Industrial Operations performs multi-program management. Under the guidance of the Director of Industrial Operations responsibility and authority for management of specific programs is delegated to particular organizational elements within Industrial Operations. The Director of Industrial Operations is supported by four basic staff and services organizations which provide management assistance to him and to Program Managers. Industrial Operations is basically a management organization which relys on scientific and engineering expertise provided by Research and Development Operations. Included in this operation are the management functions for the Michoud Assembly Facility, Mississippi Test Facility and Resident Offices at prime contractor plants. Some 17 percent of center manpower is assigned to Industrial Operations.

RESEARCH AND DEVELOPMENT OPERATIONS

This unique organization makes up the majority of the MSFC work force. It supports major projects by performing technical research and development and testing. In addition to supporting specific programs, Research and Development Operations performs studies on future space exploration and maintains a scientific research program for advancing the state-of-the-art in space technology. For example, the Aero-Astrodynamics Laboratory conducts research and development in such fields as aerodynamics, astrodynamics, guidance and control theory and related sciences for the purposes of establishing optimum design for launch and space vehicles,

spacecraft and other assigned projects. An example of a task in support of Program Management would be the establishment and maintenance of the natural environment criteria for launch vehicle design.

MSFC ORGANIZATIONAL RELATIONSHIPS

The horizontal relationships as opposed to the vertical organizational alignment discussed in the early part of this chapter, are exemplified in the "team concept" as it is applied here at Marshall. The concluding part of this chapter will discuss only internal relationships. Other vital relationships such as Center to Center, Center to Headquarters, Center to Contractor, etc., will be discussed at the Program Management level as it exists on the Apollo Program and more particularly on the Saturn V. (See Section 4 - Management System Elements.)

PROGRAM SUPPORT AGREEMENT

The importance of the Apollo Program demands a fully concerted effort by MSFC which requires a close working relationship between Industrial Operations and Research and Development Operations. In order to more clearly define this relationship a Program Support Agreement was reached between Directors of both organizations. The agreement was published to explain the scope of work to be accomplished, the general procedures to be followed, and prescribed certain responsibilities for specific work packages or manageable segments. (See Fig. 3-2.)

WORKING GROUPS

Related to the original Program Support Agreement, eight working groups were established with the assigned tasks of resolving technical interfaces and discipline oriented problems which impacted the launch vehicle systems. These working

groups proved to be of immeasurable value in obtaining solutions to critical technical problems . (See Section 4 - Management System Elements.)

PROGRAM MANAGEMENT INTERFACE RELATIONSHIPS

The importance of a close working relationship between Program Managers was emphasized by the publication of Directive I-1230.1. This document clearly defined specific lines of authority and requirements for open lines of communications between programs. Each Program Manager is charged with the responsibility for providing impacted Program Managers with status information. The most effective means of accomplishing these tasks has been through regularly scheduled meetings. This, of course, is not to say that informal communications are not sanctioned. The reverse is true. Aside from the free exchange of information which flows between Program Managers, there are two reviews which are held on a month-to-month basis. They are:

- Program Internal Review
- MSFC Programs Status Review

PROGRAM INTERNAL REVIEW

This review is conducted by a Program Manager for the purpose of determining the current status of the total program. Other Program Managers are invited to attend each review.

MSFC PROGRAMS STATUS REVIEW

This review is conducted by the Director of Industrial Operations for the purpose of determining the current status of all MSFC Programs. Each Program Manager is responsible for providing a comprehensive report which is presented during this review. All Program Managers or their designated representatives are required to attend.

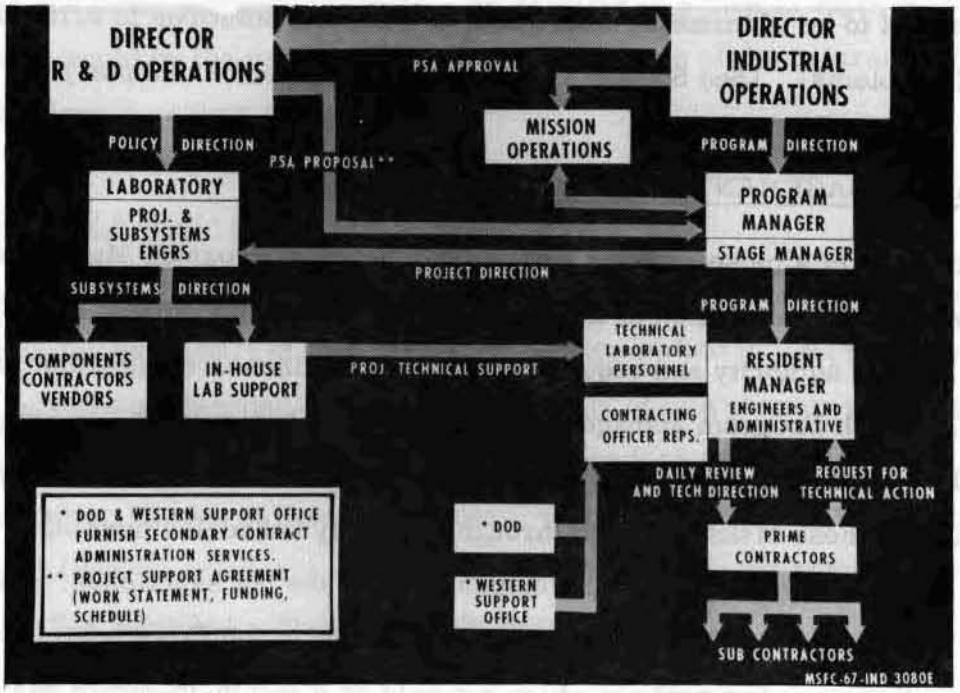


FIGURE 3-2. MSFC MANAGEMENT AND TECHNICAL RELATIONSHIPS

PROGRAM MANAGEMENT ORGANIZATION AND RELATIONSHIPS

A Program Manager within Industrial Operations is supported by Stage or Project Managers who are delegated responsibility for segments of the total program. The Stage Managers actually support, in certain cases, more than one Program Manager. For example, there is a Stage Manager or Project Manager assigned to the S-IVB Stage. Since this stage is manufactured by one contractor and yet is part of two entirely different launch vehicles, one MSFC Stage Manager is held responsible for the execution of the prime contract, thus, supporting both the uprated Saturn I and the Saturn V Program Managers. These Stage Managers are given total managerial authority which is constrained only by certain performance, cost, and schedule limitations imposed by the Program Managers. Each Program Manager is also supported by five functional elements which also provide services to the Stage

Managers. These functional elements are a "mirror image" to those which exist at Apollo Headquarters and are identified as: (See Fig. 3-3.)

- Program Control
- Systems Engineering
- Quality and Reliability
- Test
- Flight Operations

This, then, represents the basic Program Management Organization which exists at MSFC on each program for which they are responsible. Their functional responsibilities are presented in detail in Appendix A. The Program Management interface relations and managerial communication at all levels within NASA is discussed as a part of "Management Information and Communications."

It is established that this organization is reponsible for establishing Program or Project requirements at the Center level and responds to the Apollo Program Manager as he communicates (Fig. 3-4) directly to this organization the broad parameters of the total program which can be termed Level I Program Requirements.

MISSION OPERATIONS

The MSFC Mission Operations Office manages all program activities involved with accomplishing MSFC's mission operations including both launch and flight operations for manned and unmanned missions. This office manages the program operations planning for the Center, and is the focal point for Operations Support Requirements and mission operations plans and documentation. The office comprises mission engineering and management functions including operations engineering, support requirements, and flight control elements.

An HOSC, Huntsville Operations Support Center, support organization is determi for the mission periods of each launch vehicle launch to support the vehicle countc and flight operations. This organization consists of representatives from the R&D Laboratories, Program Offices, Mission Operations Office and technical working groups.

In providing launch and flight operations support to KSC and MSC, respectively, this office manages the assignment of MSFC support engineers for each mission, the MSFC vehicle flight controllers at MSC, and all MSFC contractor mission support engineers deployment to remote network monitoring stations. The office assigns flight controllers to the MSC Flight Director for conducting vehicle flight control functions. MSFC supports the Launch Director for configuration control and engineering design aspects of vehicle hardware provided for the mission. Due to the critical time element during the final phases of launch operations, countdown, and during flight and orbital operations, the MSFC technical resources are made available to KSC and MSC through the Launch Information Exchange Facility (LIEF) at the Huntsville Operations Support Center. The technical engineering support through LIEF is provided to KSC in pre-launch checkout and launch operations, to MSC in flight and orbital operations and for MSFC postflight engineering data evaluation.

SUMMARY

This section has presented MSFC management practices by describing the functions of the vertical organization. Emphasis was placed on the horizontal relationships to illustrate the cohesiveness of the total MSFC organizational structure. The following section discusses the methods by which baselines are established by Program Management, information is generated and communicated, decisions provided and management evaluated.

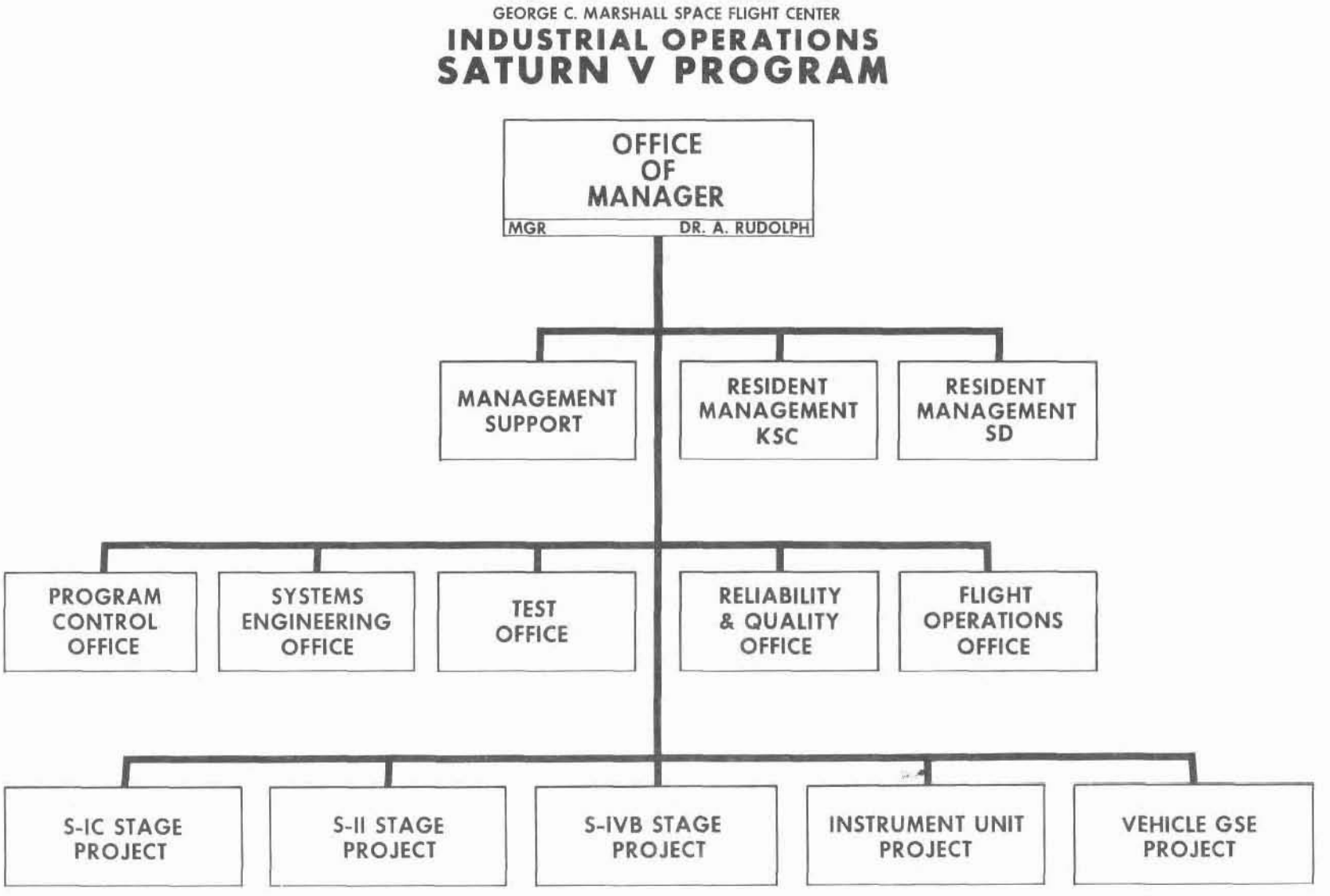


FIGURE 3-3. SATURN V ORGANIZATION

APOLLO/SATURN PROGRAM MANAGEMENT RELATIONSHIPS WITH MSF

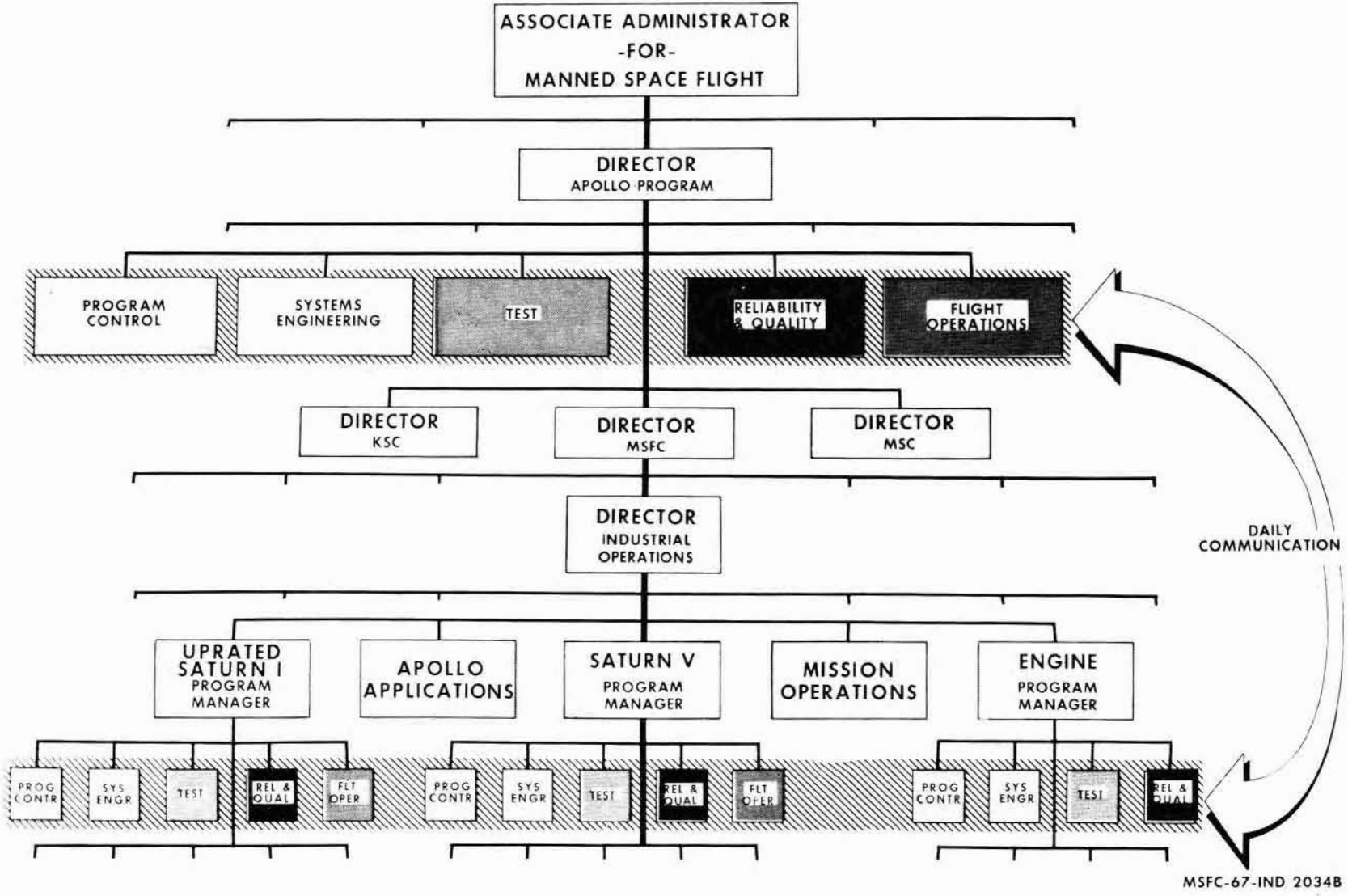


FIGURE 3-4. PROGRAM MANAGEMENT RELATIONSHIPS

SECTION 4

MANAGEMENT SYSTEM ELEMENTS

The George C. Marshall Space Flight Center, being guided by experience gained from earlier programs, has recognized the increasing need for a more formalized system of defining and controlling program cost, schedule, and performance. The respective Program Managers at MSFC are the focal points for developing and implementing the latest available techniques which make up an effective management system beginning with Program Requirements Definition.

PROGRAM REQUIREMENTS DEFINITION

Definition of Program Requirements has been interpreted by many to mean several different actions. Basically, it requires answers to four questions:

1. Who is responsible? (Organization - See Section 3.)
2. What are the objectives? (Technical requirements)
3. When must it be accomplished? (Schedules)
4. What is the estimated cost? (Cost analysis)

This segment of the document will discuss Program Requirements Definition in this sequence beginning with description of technical management requirements.

TECHNICAL MANAGEMENT REQUIREMENTS

On a program such as the Saturn V Launch Vehicle, the technical requirements of the total series of vehicles are contained in a uniform set of specifications. This set of specifications and the supporting data is structured after the pattern established by the publication of NPC 500-1, "Apollo Configuration Management," in March of 1964.

Prior to the issuance of this document, the technical requirements of the launch vehicle were defined in more traditional ways such as model specifications and contracts work statements. This new requirement was subjected to management analysis in terms of its impact on the existing contracts, internal procedures, and its economic feasibility. The intent of the document was achieved without detrimental effect to the program by "tailoring" the basic procedure and establishing the minimum requirements of the Configuration Management System to be met by Program Project Management as well as Prime Contractors. Implementation of the new system essentially required three significant steps:

- Baselining of all interface areas
- New specifications at the Stage Managers level
- New work statements for Prime Contractors

In order to achieve more positive control of critical interfaces within the launch vehicle and between related systems such as launch vehicle to GSE and launch vehicle to spacecraft, etc., a system was developed at the program level which required progressive definition and documentation of all interface areas in which more than one agency was functioning. As these areas were identified, documented, and agreed to by all parties they became formal technical requirements and were subsequently controlled via the Configuration Management System. That is, any changes to these "baselined" requirements must be bilateral and approved through established channels. This system essentially assumes the role of an integrating system at the Program/Project level.

NEW CONTRACT SPECIFICATIONS

It was also determined that more effective control of individual contractors and products could be attained by clearer definition of the known configuration. This

configuration existed as a model specification plus all recorded changes and served as a foundation for the preparation of Contract End Item Specifications with the format supplied by NPC 500-1. These new specifications were prepared jointly by MSFC and the prime contractors to expedite the next step of formal baselining at the contractor level.

BASELINING TECHNICAL REQUIREMENTS

To more fully grasp the meaning of "baselining" at the Project/Contractor level it is suggested that the reader refer to Figure 1-4 for an illustration of the contractors involved and to Figure 1-8 for an illustration of the Project/Stage Managers. Each of these Stage or Project Managers is responsible for a series of hardware products in support of several planned launches. It was necessary, therefore, to prepare individual specifications in sequence to provide positive identification of the agreed to configuration and to permit full coordination of all interface areas. As these specifications were completed they also were subjected to formal control procedures.

COMPLETE TECHNICAL DESCRIPTION

The technical description of a given launch vehicle system is completed through incremental release of engineering drawings, component specifications, process specifications, and manufacturing, test, and quality control records. All of these data, of course, being subordinate to and controlled by the top level documents previously mentioned (see Fig. 4-1). Through a uniform numbering system under MSFC control, total traceability is maintained down to the critical component level which will, should the need arise, prove to be of immeasurable value in fault isolation or failure detection. The complete technical description contained in all these data is preserved through normal Configuration Accounting procedures at both contractor and Center level.

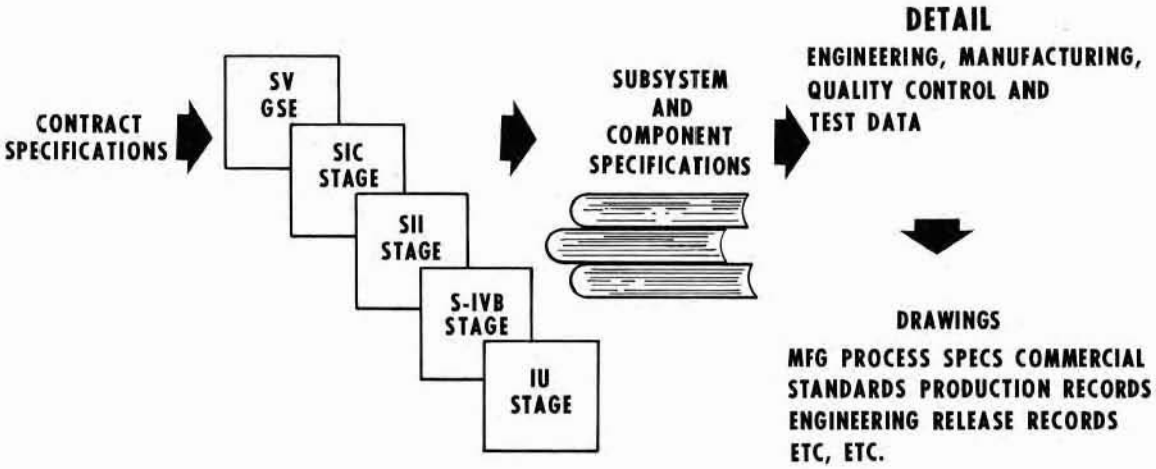


FIGURE 4-1. COMPLETE TECHNICAL DESCRIPTION

SYSTEMS ENGINEERING MANAGEMENT

The Program Requirements definition process relies heavily on an effective Systems Engineering process for the development of achievable technical concepts. In concert with the objectives of the Apollo Program, and the Saturn V Project in particular, as expressed in their respective Program Development Plans, the objective of the Saturn V Systems Engineering Management Program is to prescribe structure, and actively implement a process which will:

- Identify, organize, and establish all necessary systems engineering requirements to define and control the total Saturn V Launch Vehicle
- Identify and establish technical documentation requirements for the total Saturn V Launch Vehicle

- Establish an effective everyday management control process which assures that the total requirements are imposed, communication is effective and correct, and timely response is obtained.
- Continuously execute the Systems Engineering Integration function in an organized and effective manner.

The Systems Engineering process provides the Program Manager with documentation in the following technical areas:

Analysis

- Expected Performance
- Problems/Recommended Solutions
- Mission Planning (effects)
- Operations Analysis
- Cost Effectiveness Studies
- Logistics Analysis
- Maintenance Analysis
- Potential Systems Analysis (Performance and Operations)

Requirements and Integration Constraints

- Mission
- Performance
- Manufacturing
- Test Data Evaluation Results
- Structural Constraints
- Assembly Checkout and Launch
- Range Safety and Test Agency Support

Launch Vehicle Systems Hardware Status

- Technical status on specific problems in:
  - Structures
  - Propulsion
  - Ground Support Equipment
  - Flight Control (Guidance and Navigation)
  - Instrumentation and Communication

SUMMARY

The technical and management processes discussed thus far represent a vital segment of Program Requirements Definition at MSFC. The process would not, however, be complete without accurate definition of other management constraints, namely, budget and schedules. It is these other constraints to which we shall now address ourselves.

SCHEDULES AND COST, MANAGEMENT REQUIREMENTS

Volume I of this series of documents describes the management process which establishes the initial schedules pertaining to delivery of hardware to the launch site and actual launch dates. It suffices to say here that these critical milestones are communicated to the Center (MSFC) via a Program Directive approved by the Administrator, OMSF, and signed by the Program Director. On the Apollo Program these schedules were outlined in Apollo Program Directive No. 4. All schedules are maintained and controlled through the procedures of a Schedule Control System which are discussed as part of the "Management Decision Process." It should be mentioned that while schedules, budget, and manpower are herein separated for clarity, in actua practice these elements are an integral part of one entity. That is, each impacts

the other in the final decision cycle. For example, development, production, and delivery of a rocket engine within an 18-month period presents no particular problem when other constraints such as manpower and money are absent. Therefore, all of these considerations must be planned, allocated, scheduled, and controlled as one manageable segment.

Development Planning

Just as a development plan evolves at the Headquarters level so must a similar plan be developed at the field Center with the Program Offices. The plan is summarized in a Project Development Plan and supported by a PERT network or, as the circumstances dictate, master schedules and planning charts. Development and delivery schedules, manpower and cost data are established and reported down through the subsystem level, including tests and facilities.

MSFC Summary Network Diagrams

Summary Network Diagrams are maintained in the Program Offices which currently reflect the latest available information with respect to critical event completion, logic changes, and addition or deletion of activities. Copies are transmitted to OMSF on a quarterly basis or as major changes occur. The diagrams are constructed on the basis of available contractor or in-house PERT networks, or master schedules and planning charts.

Funding Schedules

In addition to the Project Development Plan, master schedules, and planning charts, a funding schedule is also prepared. The schedule by graphic illustration documents the total R&D obligations and is accompanied by a breakdown of system elements which compares planned obligations with actual for the current fiscal year. Funding

authorization is described in Volume I under "Program Operating Plan" and "Project Approval Document." Further details on the overall OMSF Program Scheduling and Review procedures are documented in NASA Handbook 2330.1.

Summary of Program Requirements Definitions

In the preceding paragraphs it has been shown that definition of Program Requirements is, in summary, a management process which establishes total requirements in terms of Performance (Technical requirements), Cost, and Schedule (Management requirements). It must also be stated that this total Program Planning process brings together all the necessary resources of a Program/Project team (Headquarters, Center, Contractors) in a descriptive summary to provide the visibility so important to the management decision process. In conclusion, it can be said that for management purposes technical requirements and management requirements are defined by summary data.

PROGRAM REQUIREMENTS IMPLEMENTATION

Program Requirements, once defined and translated into manageable segments, must be communicated downward to those organizational elements responsible for their implementation. Management at the working level must be directed to take the actions which implement the Program Requirements. In consonance with the basic steps taken at the Headquarters level through such media as Program Directives, Management Issuances, Program Development Plan, and Program Operating Plan as well as the Project Approval Document, the Program Offices as well as overall Center Management take similar actions at the project level. Therefore, requirements are implemented through the system of communication which produces such data as:

- Management Instructions (MSFC Issuance System)
- Program Directives

- Operating Procedures
- Contracts (Work Statements and Change Orders)
- Working Group Action Items

MSFC ISSUANCE SYSTEM

The MSFC counterpart to the NASA Policy Directive 1410.1 is MSFC Management Instruction 1410-1. This document establishes and explains the MSFC Issuance System. The system is generally compatible with the NASA Issuance System and includes requirements for Management Instructions, Program Directives, Operational Procedures, etc., which contain sufficient information to permit use by line organizations without extensive reinterpretation. This Issuance System itself is an example of a Management Instruction and needs no further explanation.

PROGRAM DIRECTIVES

This medium is used to announce and implement policies and decisions which emanate from within a particular program such as Saturn V. An example of how this particular data is used is taken from Saturn V Program Directive No. 9 (see Fig. 4-2) which not only directed certain elements to take action in implementing Program Requirements but also caused the preparation and implementation of organizational operating procedures. This directive, entitled "Program Control System," actually defined specific data to be accumulated in support of Program Requirements. The data which was generated complemented the Saturn V Project Development Plan by expanding by functional categories the procedures to be followed in implementing the Program Requirements. The directive introduced the current concept of Program Control by describing the activities to be accomplished as five separate elements.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GEORGE C. MARSHALL SPACE FLIGHT CENTER

SATURN V PROGRAM DIRECTIVE

SATURN V PROGRAM DIRECTIVE NUMBER: 9 **DATE:** April 1, 1965

SUBJECT: SATURN V PROGRAM CONTROL SYSTEM

I. PURPOSE

This Program Directive:

1. Authorizes implementation of the Program Control System.
2. Describes actions required for implementation of the Program Control System.
3. Assigns responsibilities and authorities for implementation and execution of the Program Control System.

Enclosed is the Program Control System Plan which describes the system and its operation.

II. SCOPE

The Saturn V Program Control System consists of several parts:

1. Baseline Definition
2. Performance Measurement and Analysis
3. Problem Resolution System
4. Management Reporting System
5. Program Control Center

each of which can be described in terms of specific objectives, policies, and requirements.

PAGE 1 OF 9

I-V-FORM NO. 53 - 64 DECEMBER 1964 OT

FIGURE 4-2. PROGRAM DIRECTIVE

1. Baseline Definition
2. Performance Measurement and Analysis
3. Problem Resolution System
4. Management Reporting System
5. Program Control Center

In summary, the directive specified the job to be done, who was to do it, and when it was to be completed. It provided the line organizations a medium for demonstrating their understanding of the overall management requirements and caused the preparation of key documents which became, in some instances, internal operating procedures. The following list represents the type of management data which resulted.

- Program Management Plan
- Schedule Control System Plan
- Procurement/Contracts Plan
- Documentation Plan
- Configuration Management Plan
- Logistics Support Plan
- Facilities Plan
- Manning Requirements Plan
- Finance Plan
- Technical Requirements and Definition
- Reliability and Quality Assurance Plan
- Testing Plan
- Launch and Mission Operations Plan

The content of some of these documents was adequate for use as operating procedures, such as the Schedule Control System Plan. Others, however, required extensive

amplification, such as the discipline of Configuration Management. In response to Headquarters requirements the Saturn V Program Office prepared and issued the "Saturn Configuration Management Manual," a counterpart to the issuance of NPC 500-1, "Apollo Configuration Management."

In the following paragraphs, it will be seen that these documents are also effectively used in requirements implementation at the contractor level.

CONTRACTOR WORK STATEMENTS

Contractor work statements prior to actual signing of the contract are a part of Program Requirements definition. However, once the contract is signed, it then becomes the authoritative document which directs the contractor to take action in implementing his portion of the program. These work statements are directly related to the overall Work Breakdown Structure which is described in the NASA Agency Wide Coding Structure. In implementing Program Requirements at the contractor level, two things must be discussed. These are:

- Contracts Administration
- Technical Direction

Contract Administration

Contract administration and management activities involve assistance to the Program and Project Offices in preparing procurements requests, requests for proposals, and in source selections, pre-negotiations reviews, approval and award of contracts, and communicating modification approvals. This assistance to the Program/Project Offices is provided by the Contracts Office within Industrial Operations. This activity generally follows the guidelines of NASA Procurement Regulations and MSFC Administrative Regulation 18-9.

Technical Direction

Technical direction which authorizes a contractor to take action at the beginning of a program is provided in a definitive work statement which clearly defines not only technical requirements in the form of performance specifications but also specific management requirements to be met, such as Configuration Management, Data Management, and Reliability and Quality Assurance Requirements. These requirements are levied on a contractor by including basic procedures to be followed in the work statement, usually by referencing such manuals as NPC 500-1, "Apollo Configuration Management," and NPC 500-6, "Documentation Administration Instruction." The work statement also includes an instruction as to schedule and cost data, which is part of the Schedule and Reporting Procedure (SARP).

After a Program is underway, technical direction on contract modification may be given by the Technical Director of the contract through formal letters or, in the case of technical changes, through Contract Change Notices resulting from change requests (ECP's) from the contractor. The methods for managing and accounting for technical changes are discussed under "Management Decision Process - Configuration Management."

WORKING GROUPS AND ACTION ITEMS

Working groups are established at MSFC to provide technical expertise in solving problems of an unusual nature. They are comprised of selected technically competent representatives from the respective laboratories and provide vital assistance to the Program Managers as well as Center Management. An example of the technical capabilities inherent in such a group was evidenced by the recent solution proposed and implemented by our Systems Engineering Working Group. Through working group concepts, the three major centers were brought together to agree on a new,

safe, sound, and simple design of new protective covers of sensors in EDS for astronaut safety both prior to and during launch. This design was based on these criteria:

- Safety of crew
- Technical adequacy
- Non-interference with other systems
- Reliability
- Economy

ACTION ITEMS

Action items are assigned to responsible individuals who act as chairmen of either temporary or permanent working groups to solve particular problems. These action items are normally the result of periodic Program Reviews, Contractor Reviews, Center Reviews, or Management Council Meetings. By assigning specific responsibility for problem resolution and requiring management feedback in a given time frame maximum effort can be focused on critical problem areas throughout the life cycle of a program. These working groups, who respond to action items, play a major part in overall Management Information and Communications.

SUMMARY OF PROGRAM REQUIREMENTS IMPLEMENTATION

In summary, it was established that Program Requirements are implemented through a "top down-feedback" system of communication which directs certain elements to take action and also requires periodic status reports on the progress of the implementation procedures. Several means are available including data such as Program Directives, Management Instructions, Action Item Memo, Contract Work Statements, and Change Orders. These media are the accepted means of communicating formal

direction but the personal contact between program personnel and management in general cannot be discounted. Such media as telephone calls, TWX, memos, etc., complete the "real life" management environment which has contributed greatly to the current status of the Apollo Program.

MANAGEMENT INFORMATION AND COMMUNICATIONS

Throughout this volume there are practical examples of selected management systems being applied at the Marshall Space Flight Center. A more detailed description of those systems which significantly contribute to management visibility of total Program Status in terms of Performance, Cost, and Schedule, as well as those systems which control data inputs, are presented in this segment of the document. These systems include:

- Program Control Center (Information Display)
- Documentation Control (Program Data Management)
- Schedule Control System

PROGRAM CONTROL CENTER

The Program Control Center (see Figs. 4-3 and 4-4) provides management with an integrated, in-depth display of cost, schedules, technical performance baseline data, and program status as compared to baseline requirements. It is the focal point of all activities which make up the Program Control System described in Program Directive No. 9. More specifically, it provides management visibility through:

- Presentation of current program data
- Problem display and follow-up data on action items
- Correlation of data to verify consistency with program objectives

FIGURE 4-3. PROGRAM CONTROL CENTER

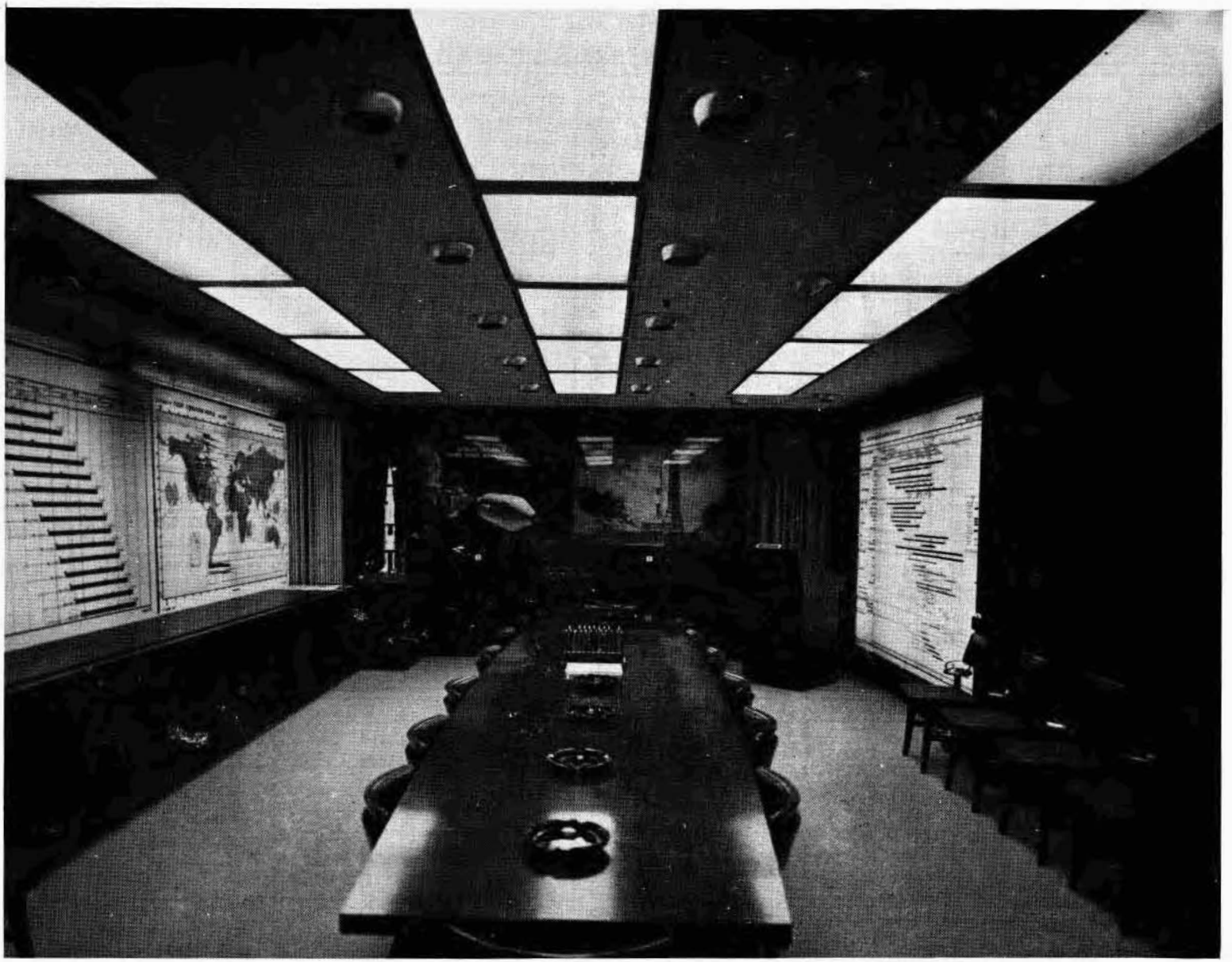


FIGURE 4-4. PROGRAM CONTROL CENTER

COST DATA

The cost information is displayed as:

- Specific cost comparison - authorized project cost versus the actual expenditures of MSFC elements and contractors.
- Manpower Data - Authorized versus actual manpower figures for both MSFC and contractors. This data includes information relative to actual and authorized overtime expenditures (see Fig. 4-5).
- Funding - both fiscal and long range funding is displayed. The data is identified with the organizational recipients of the funds.

Schedule Data

Schedule information is displayed and maintained in the Program Control Center at three levels of detail. The first, or top level, is the Saturn V Development and Delivery Flow Plan (see Fig. 4-6) and the SA-502 Flow Plan (see Fig. 4-7). The second level includes schedules as they relate to specific projects (see Fig. 4-8) such as:

S-IC Project
S-II Project
S-IVB Project
Instrument Unit Project
Spacecraft
Ground Support Equipment Project
Dynamic Test Vehicle Test Program
MTO Facility Activation
KSC Facility Activation
Saturn Vehicle Assembly

SCHEDULE RESPONSIBILITY: Dr. Arthur Rudolph

STATUS RESPONSIBILITY: M. Urlaub

MANNED SPACE FLIGHT SCHEDULE
OBLIGATIONS, COST, AND MANPOWER

S-IC STAGE

3 LEVEL

CONTRACTOR: BOEING (NAS8-5608) (2577) PROJECT: SATURN V SCHED. NO:

ORIGINAL SCHED APPROVAL 4/30/65 (Date)

LAST SCHED CHANGE 6/30/67 (Date) (No.) (Initials)

STATUS AS OF 8/31/67 (Date) (Initials)

FISCAL YEAR 1968		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
OBLIGATIONS	POP 67-7	11.6	24.0	38.0	77.0	77.0	77.0	110.0	110.0	110.0	120.0	120.0	120.0
	ACTUAL	11.6	24.5										
	OUTLOOK			38.5									
COST	POP 67-2	8.9	18.3	33.1	42.3	53.2	63.7	71.8	83.0	94.2	102.8	113.5	123.6
	ACTUAL	7.3	18.7*										
	OUTLOOK			33.5									
COST RATE	POP 67-2	8.9	9.4	14.8**	9.2	10.9**	10.5	8.1	11.2**	11.2	8.6	10.7**	10.1
	ACTUAL	7.3	11.4*										
	OUTLOOK			14.8									
WORK DAYS		19	20	24	20	19	23	18	20	25	20	20	24
DIRECT MANPOWER	POP 67-2	4,300	4,250	4,200	4,150	4,090	4,030	3,970	3,910	3,840	3,770	3,700	3,620
	ACTUAL	4,413	4,250*										
	OUTLOOK												

FISCAL YEAR 1969		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
OBLIGATIONS	POP 67-2			63.0			63.0			85.0			94.0
	OUTLOOK												
COST (QUARTERLY AVERAGE)	POP 67-2			27.0			51.0			72.0			91.0
	OUTLOOK												
COST RATE	POP 67-2			9.0			8.0			7.0			6.3
	OUTLOOK												
WORK DAYS				24			24			25			24
DIRECT MANPOWER	POP 67-2			3,400			2,900			2,400			1,900
	OUTLOOK												

ALL FISCAL YEARS		PRIOR	1967	1968	1969	1970	1971	TO COMPL	TOTAL
UNCOSTED		N/A	11.8	10.7	7.1	10.1	4.6	0	N/A
OBLIGATIONS	POP 67-2	638.5	142.7	120.0	94.0	26.1	3.0	0	1024.3
	TOT AVAIL	638.5	154.5	130.7	101.1	36.2	7.6	0	N/A
COST	POP 67-2	626.7	143.8	123.6	91.0	31.6	7.6	0	1024.3
	533 REPORT								
YEAR END	UNFILL. ORD.	11.8	10.7	7.1	10.1	4.6	0	0	N/A
	ADV. FUNDG								
	COST RATE	15.0	14.0	10.1	7.2	2.8	0	0	N/A
DIRECT MANYEARS	POP 67-2		5,110	3,986	2,900	1,000	240	0	N/A

REMARKS

*INDICATES ESTIMATE

**INCLUDES BONUS FEE FOR STAGE DELIVERIES: SEP. 3.7M, NOV. 2.2M, FEB. 2.2M, MAY 2.2M

III-3-28a

FIGURE 4-5. COST DATA

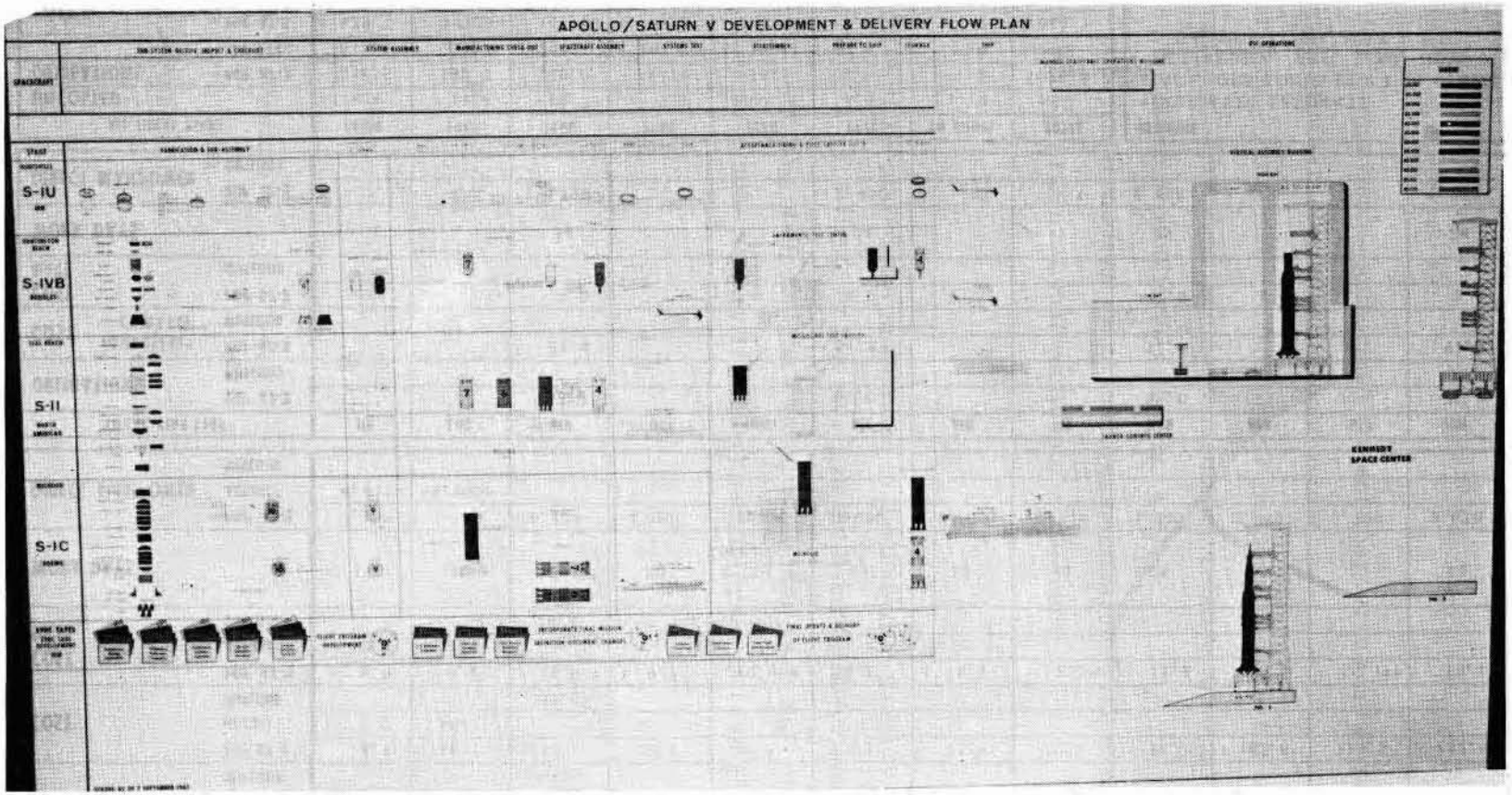


FIGURE 4-6. DEVELOPMENT AND DELIVERY FLOW PLAN

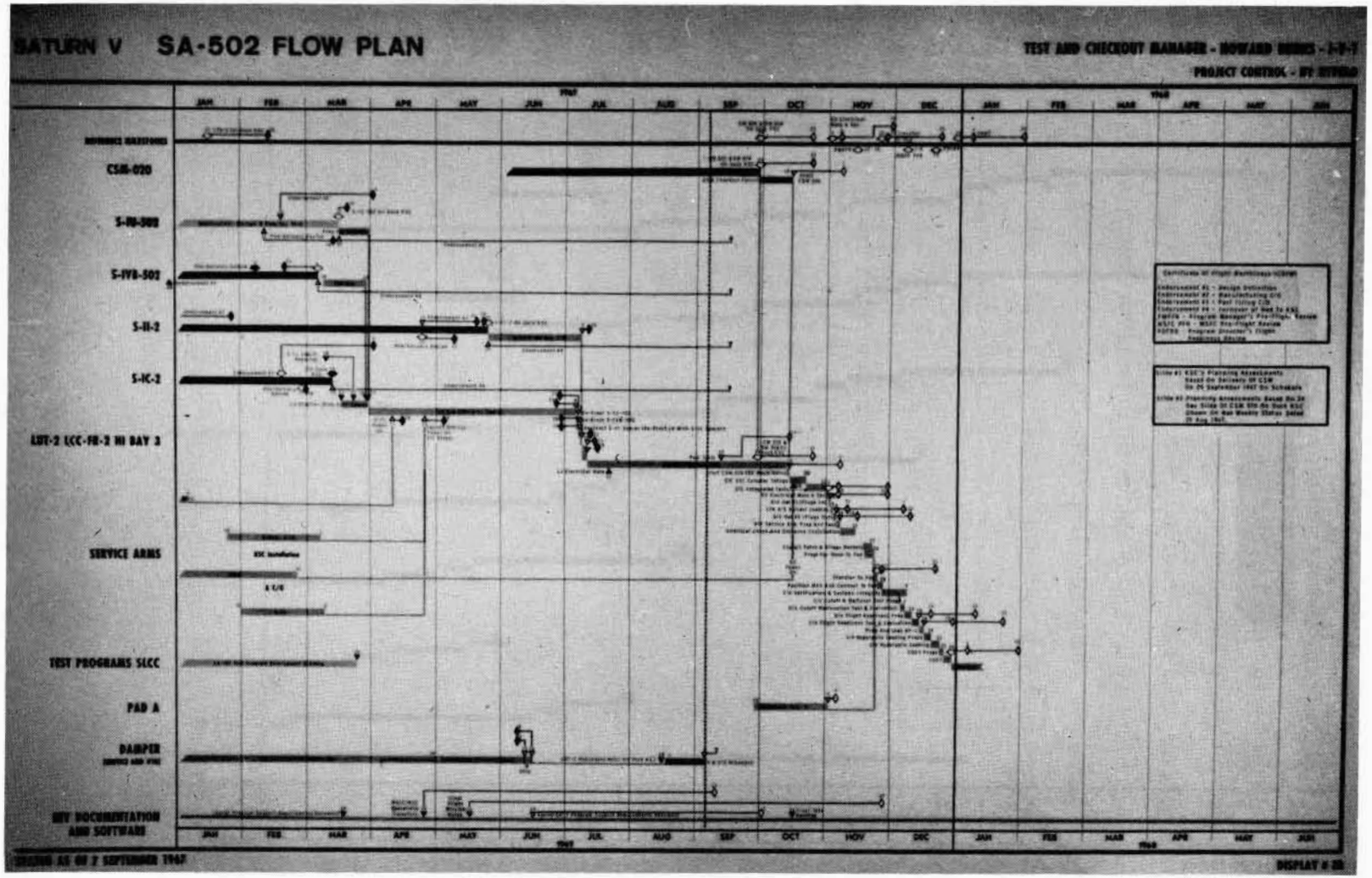


FIGURE 4-7. SA-502 FLOW PLAN

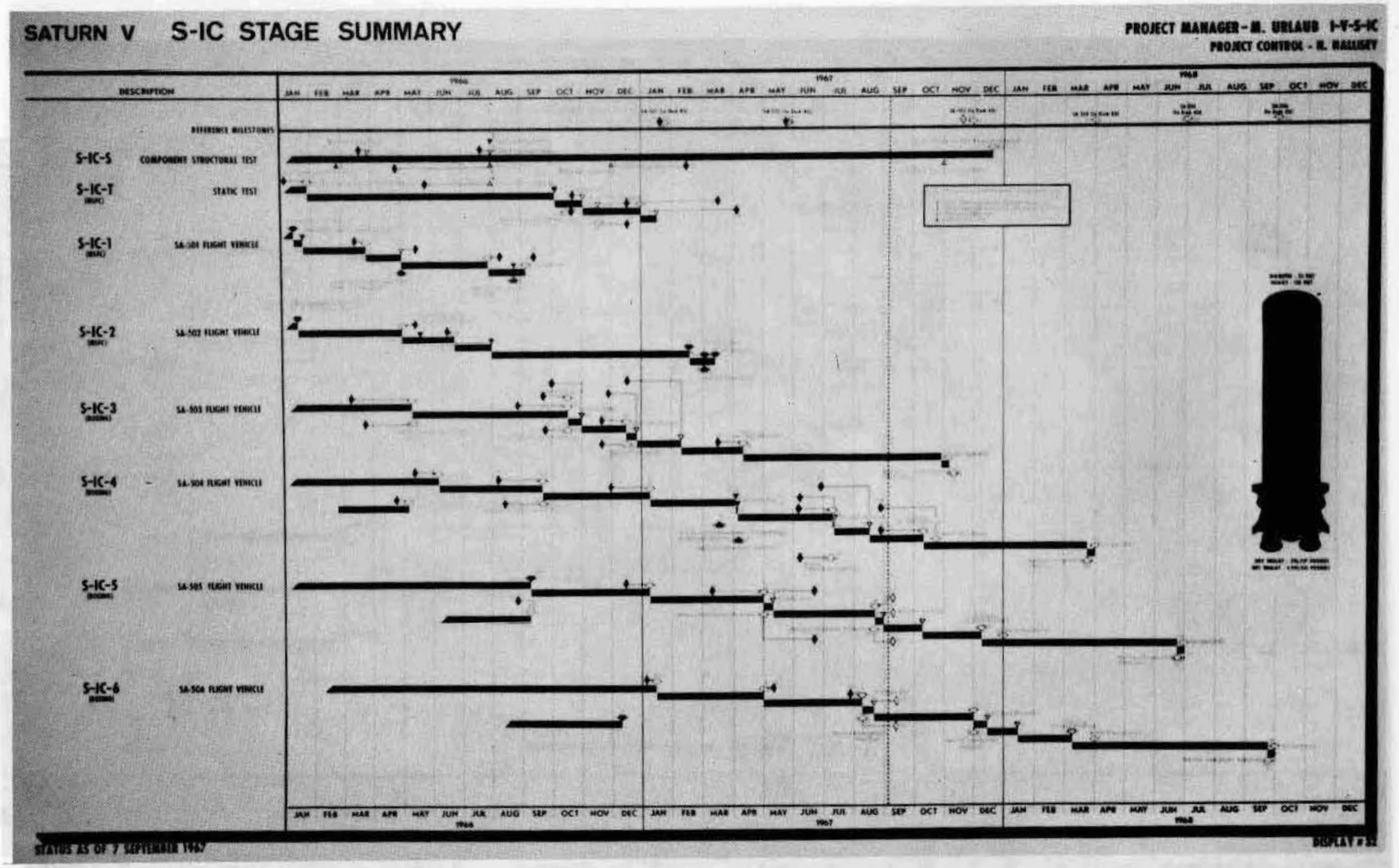


FIGURE 4-8. S-IC STAGE SUMMARY

The third level includes those controlled events which support the completion of Project Phasing Schedules. These three levels of schedule display major events, phasing of functions, and detailed events relative to a program. The Program Evaluation and Review Technique (PERT) has been employed to support each schedule level. For example, a PERT summary network has been displayed in the Program Control Center which illustrated all events listed in the Stage Contractors/ Government Agencies PERT computer printouts and schedules. All event numbers, nomenclature, and schedule dates are related to the major milestones displayed on the schedule charts.

Technical Performance Data

Information concerning technical performance requirements and status is displayed and includes:

- Weight data
- Performance data
- Reliability data
- Configuration data
- Interface data
- Engineering change data
- Logistics support data
- Test data
- Documentation data
- Value Engineering data
- Other technical items as appropriate

Each of these displays provides Program Management with capability to assess program status in each major technical area (see Figs. 4-9 and 4-10).

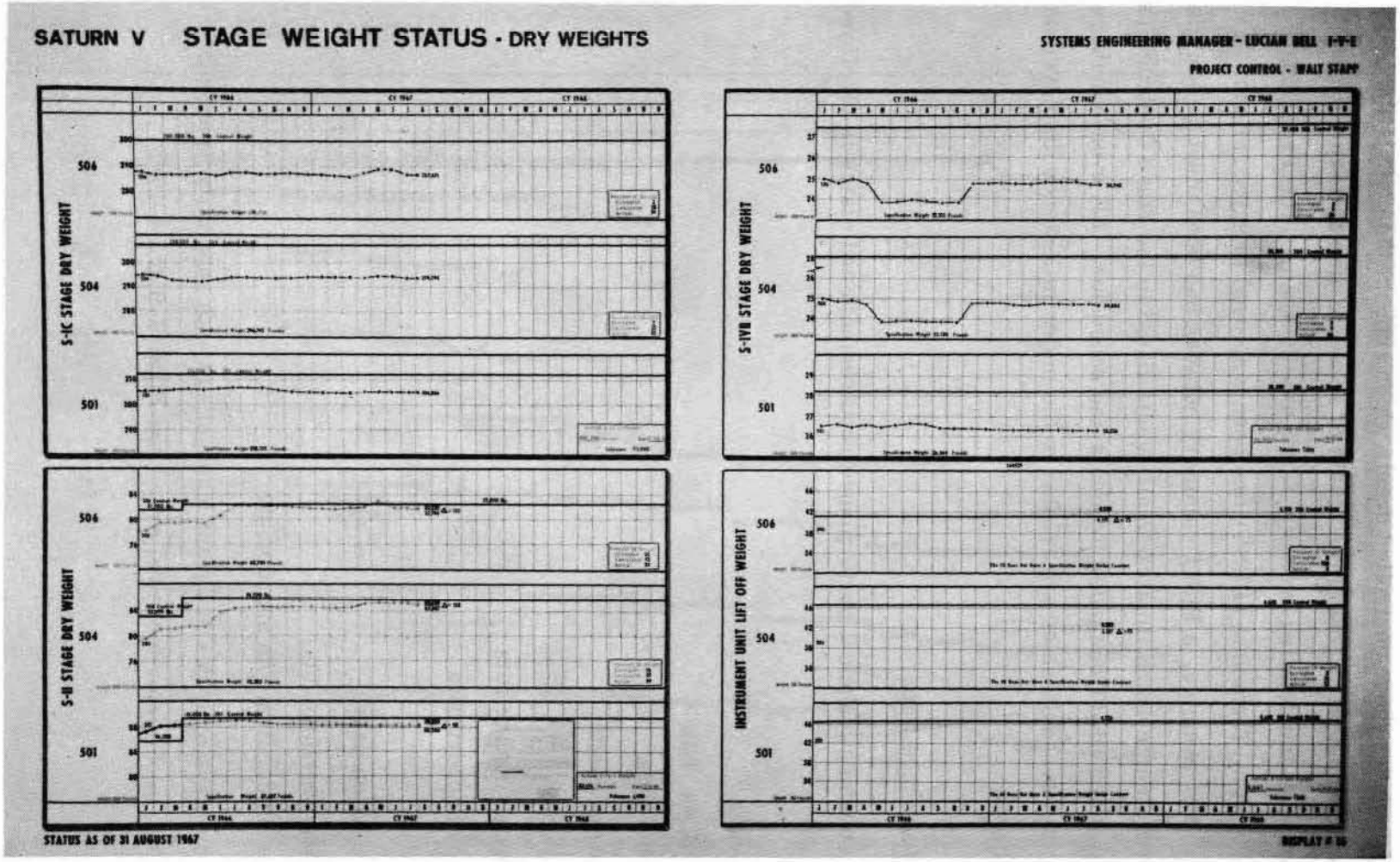


FIGURE 4-9. STAGE WEIGHT STATUS

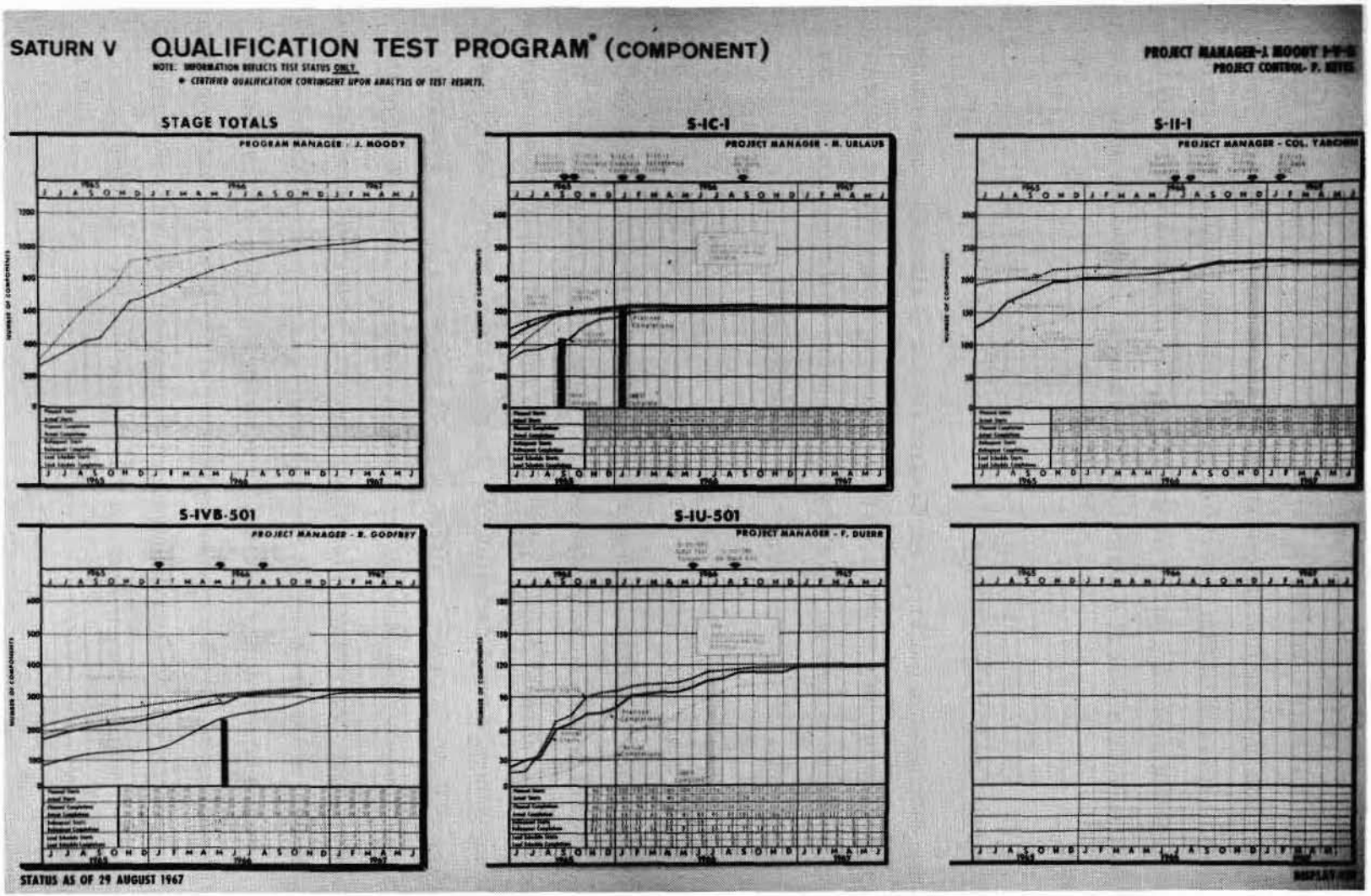


FIGURE 4-10. QUALIFICATION TEST PROGRAM

Action Item Data

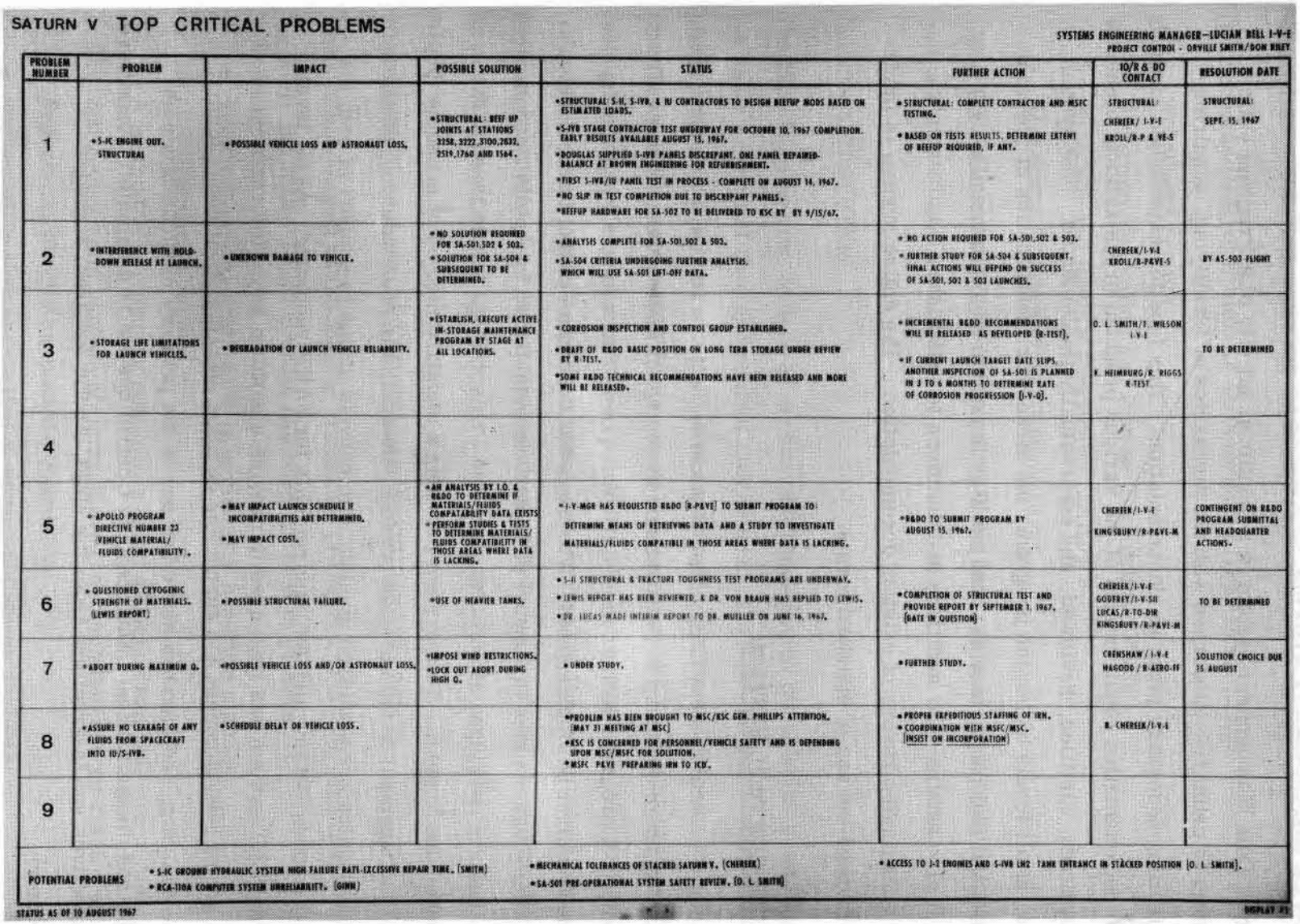
A problem resolution chart (see Fig. 4-11) is displayed which graphically depicts progress being made on all action items processed as part of the Problem Resolution System. There is also a situation report log book containing detailed reports on progress in resolving problems on the program. As the problems are resolved and closed out, they become a part of a historical file which is maintained in the Program Control Center.

Access to Program Control Center Data

All information displayed in the Program Control Center is classified as sensitive and as such is accessible only to those agencies demonstrating a direct "need to know." Government personnel only are permitted access to the data and any contractor exceptions must be approved by the Program Manager.

DATA UTILIZATION

The mass of data which is accumulated and displayed in the Program Control Center is disseminated to both the Program Manager and higher level management. It keeps the Program Manager abreast of each problem area related to discrete work packages for which he has schedule responsibility. At the same time, it provides a "real time" summary of the total program status which is presented during Program Reviews, Center Reviews, and Management Council meetings as the needs of the program dictate. Such requirements for data, however, create the need for a Data Management System at the program level which would assure that only necessary documentation would be created, especially in actually acquiring data by contract agreement from industry. Such a system is in being at MSFC and is basically compatible with the overall Apollo Data Management System. A summary description is available in NPC-500-6, "Documentation Administration," or the MSFC Data Management Manual.



SATURN V TOP CRITICAL PROBLEMS

SYSTEMS ENGINEERING MANAGER--LUCIAN BELL I-V-E
PROJECT CONTROL - ORVILLE SMITH/BOB RILEY

PROBLEM NUMBER	PROBLEM	IMPACT	POSSIBLE SOLUTION	STATUS	FURTHER ACTION	IO/R & DO CONTACT	RESOLUTION DATE
1	• S-IC ENGINE OUT. STRUCTURAL	• POSSIBLE VEHICLE LOSS AND ASTRONAUT LOSS.	• STRUCTURAL: BEEF UP JOINTS AT STATIONS 3258, 3222, 3100, 2832, 2519, 1760 AND 1584.	• STRUCTURAL: S-II, S-IVB, & IU CONTRACTORS TO DESIGN BEEFUP MODS BASED ON ESTIMATED LOADS. • S-IVB STAGE CONTRACTOR TEST UNDERWAY FOR OCTOBER 10, 1967 COMPLETION. EARLY RESULTS AVAILABLE AUGUST 15, 1967. • DOUGLAS SUPPLIED S-IVB PANELS DISCREPANT. ONE PANEL REPAIRED-BALANCE AT BROWN ENGINEERING FOR REFURBISHMENT. • FIRST S-IVB/IU PANEL TEST IN PROCESS - COMPLETE ON AUGUST 14, 1967. • NO SLIP IN TEST COMPLETION DUE TO DISCREPANT PANELS. • BEEFUP HARDWARE FOR SA-502 TO BE DELIVERED TO KSC BY BY 9/15/67.	• STRUCTURAL: COMPLETE CONTRACTOR AND MSFC TESTING. • BASED ON TESTS RESULTS, DETERMINE EXTENT OF BEEFUP REQUIRED, IF ANY.	STRUCTURAL: CHERIER/ I-V-E KROLL/R-P & VE-S	STRUCTURAL: SEPT. 15, 1967
2	• INTERFERENCE WITH HOLD-DOWN RELEASE AT LAUNCH.	• UNKNOWN DAMAGE TO VEHICLE.	• NO SOLUTION REQUIRED FOR SA-501,502 & 503. • SOLUTION FOR SA-504 & SUBSEQUENT TO BE DETERMINED.	• ANALYSIS COMPLETE FOR SA-501,502 & 503. • SA-504 CRITERIA UNDERGOING FURTHER ANALYSIS. WHICH WILL USE SA-501 LIFT-OFF DATA.	• NO ACTION REQUIRED FOR SA-501,502 & 503. • FURTHER STUDY FOR SA-504 & SUBSEQUENT. FINAL ACTIONS WILL DEPEND ON SUCCESS OF SA-501, 502 & 503 LAUNCHES.	CHEREEK/I-V-E KROLL/R-P&VE-S	BY AS-503 FLIGHT
3	• STORAGE LIFE LIMITATIONS FOR LAUNCH VEHICLES.	• DEGRADATION OF LAUNCH VEHICLE RELIABILITY.	• ESTABLISH, EXECUTE ACTIVE IN-STORAGE MAINTENANCE PROGRAM BY STAGE AT ALL LOCATIONS.	• CORROSION INSPECTION AND CONTROL GROUP ESTABLISHED. • DRAFT OF R&DO BASIC POSITION ON LONG TERM STORAGE UNDER REVIEW BY R-TEST. • SOME R&DO TECHNICAL RECOMMENDATIONS HAVE BEEN RELEASED AND MORE WILL BE RELEASED.	• INCREMENTAL R&DO RECOMMENDATIONS WILL BE RELEASED AS DEVELOPED (R-TEST). • IF CURRENT LAUNCH TARGET DATE SLIPS, ANOTHER INSPECTION OF SA-501 IS PLANNED IN 3 TO 6 MONTHS TO DETERMINE RATE OF CORROSION PROGRESSION (I-V-O).	O. L. SMITH/T. WILSON I-V-E K. HEIMBURG/R. RIGGS R-TEST	TO BE DETERMINED
4							
5	• APOLLO PROGRAM DIRECTIVE NUMBER 23 VEHICLE MATERIAL/ FLUIDS COMPATIBILITY.	• MAY IMPACT LAUNCH SCHEDULE IF INCOMPATIBILITIES ARE DETERMINED. • MAY IMPACT COST.	• AN ANALYSIS BY I.O. & R&DO TO DETERMINE IF MATERIALS/FLUIDS COMPATABILITY DATA EXISTS • PERFORM STUDIES & TESTS TO DETERMINE MATERIALS/ FLUIDS COMPATIBILITY IN THOSE AREAS WHERE DATA IS LACKING.	• I-V-MGR HAS REQUESTED R&DO (R-P&VE) TO SUBMIT PROGRAM TO: DETERMINE MEANS OF RETRIEVING DATA AND A STUDY TO INVESTIGATE MATERIALS/FLUIDS COMPATIBLE IN THOSE AREAS WHERE DATA IS LACKING.	• R&DO TO SUBMIT PROGRAM BY AUGUST 15, 1967.	CHERIER/I-V-E KINGSBURY/R-P&VE-M	CONTINGENT ON R&DO PROGRAM SUBMITTAL AND HEADQUARTER ACTIONS.
6	• QUESTIONED CRYOGENIC STRENGTH OF MATERIALS. (LEWIS REPORT)	• POSSIBLE STRUCTURAL FAILURE.	• USE OF HEAVIER TANKS.	• S-II STRUCTURAL & FRACTURE TOUGHNESS TEST PROGRAMS ARE UNDERWAY. • LEWIS REPORT HAS BEEN REVIEWED & DR. VON BRAUN HAS REPLIED TO LEWIS. • DR. LUCAS MADE INTERIM REPORT TO DR. MUELLER ON JUNE 16, 1967.	• COMPLETION OF STRUCTURAL TEST AND PROVIDE REPORT BY SEPTEMBER 1, 1967. (DATE IN QUESTION)	CHERIER/I-V-E GODFREY/I-V-SII LUCAS/R-TO-DIR KINGSBURY/R-P&VE-M	TO BE DETERMINED
7	• ABORT DURING MAXIMUM Q.	• POSSIBLE VEHICLE LOSS AND/OR ASTRONAUT LOSS.	• IMPOSE WIND RESTRICTIONS. • LOCK OUT ABORT DURING HIGH Q.	• UNDER STUDY.	• FURTHER STUDY.	CRENSHAW / I-V-E HAGOOD / R-AERO-FF	SOLUTION CHOICE DUE 15 AUGUST
8	• ASSURE NO LEAKAGE OF ANY FLUIDS FROM SPACECRAFT INTO IO/S-IVB.	• SCHEDULE DELAY OR VEHICLE LOSS.		• PROBLEM HAS BEEN BROUGHT TO MSC/KSC GEN. PHILLIPS ATTENTION. (MAY 31 MEETING AT MSC) • KSC IS CONCERNED FOR PERSONNEL/VEHICLE SAFETY AND IS DEPENDING UPON MSC/MSFC FOR SOLUTION. • MSFC P&VE PREPARING IRN TO ICD.	• PROPER EXPEDITIOUS STAFFING OF IRN. • COORDINATION WITH MSFC/MSC. INSIST ON INCORPORATION	R. CHERSEK/I-V-E	
9							

POTENTIAL PROBLEMS
- S-IC GROUND HYDRAULIC SYSTEM HIGH FAILURE RATE-EXCESSIVE REPAIR TIME. (SMITH)
- RCA-110A COMPUTER SYSTEM UNRELIABILITY. (GINN)
- MECHANICAL TOLERANCES OF STACKED SATURN V. (CHERSEK)
- SA-501 PRE-OPERATIONAL SYSTEM SAFETY REVIEW. (O. L. SMITH)
- ACCESS TO J-2 ENGINES AND S-IVB LH2 TANK ENTRANCE IN STACKED POSITION (O. L. SMITH).

STATUS AS OF 10 AUGUST 1967

DISPLAY #1

FIGURE 4-11. TOP CRITICAL PROBLEMS

MSFC DATA MANAGEMENT SYSTEM

A Program Data Management System is a functional activity of a Program Office. The system is primarily concerned with the mechanics of identifying, acquiring, and controlling necessary program documentation. This function establishes methods by which documentation requirements of the various program organizational elements are determined, justified, reviewed, and contractually implemented. The system provides, at all levels within the program, the means for identification of the minimum essential data requirements, and justification of the need for specific data items. It also provides for additions and deletions to established requirements through a continuing review of existing documentation. The entire system is implemented through the use of standard forms.

SCHEDULE CONTROL SYSTEM

The Schedule Control System is designed to provide the tools for the accomplishment of scheduling and monitoring of performance by the specific Program Offices. The complexity of a program such as the Saturn V requires that a single integrated system of schedule control be implemented. The basis for Schedule Control is the development of time-phased plans in support of objectives established by Apollo Headquarters. These plans are developed at both Program and Project/Stage levels through the use of the Schedules System. This system provides a standard method of schedule display to assist management in monitoring progress, determining and evaluating program status. Schedules are published monthly with current status in support of both the Monthly Program Review and the requirements for SARP reporting. At all levels, the NASA PERT system has been used to provide a uniform basis for verification of initial planning, development and supporting detailed planning, continuous logic sequence analysis, and also has served as one of the primary methods of status collection and dissemination. The Schedule Control System is completely responsive to all directives and instructions from the MSFC Apollo Program Manager (IO Director).

SCHEDULE CONTROL SYSTEM DESCRIPTION

The Schedule Control System is structured into four basic parts:

1. Schedules System
2. Program Evaluation and Review Techniques (PERT)
3. Schedule and Review Procedure (SARP)
4. Quarterly Progress Reporting

A general description follows for each of these four parts of the Schedule Control System.

SCHEDULES SYSTEM

The Schedules System is used to develop the time-phased plans which establish the basic sequential flow and control milestones. Through the application of such techniques as milestone listings, Gantt bar charts, matrices, graphs, etc., it provides a single integrated display system using standard format and symbols to assist Program Management in the evaluation, analysis, and monitoring of program progress. Major products of the system are the Master Program Schedules, Master Project Schedules, and Detail Project Support Schedules, all of which are displayed in the Program Control Center.

PROGRAM EVALUATION AND REVIEW TECHNIQUES (PERT)

Upon establishment of the Master Schedules (Program, Project, and Detail Project Support) the NASA PERT System has been utilized to provide:

- Verification and assistance in revision of schedule planning
- More detailed planning
- A method of performing continuous logic sequence analysis and a systematic and regular comparison of planned event accomplishment as related to the probability of meeting planned objectives
- Collection and dissemination of status and status analysis

The basic parts required for use in implementing this system were logic networks, a mechanized data processing program, and reports, which are utilized at both Program and Project levels. Data products of this technique include the Program Integrated Summary Network, Master Project Summary Network, and Detailed Support Summary Networks.

SCHEDULE AND REVIEW PROCEDURE (SARP)

MSF Instruction M-IM#9330 establishes SARP reporting as the official method of documenting Manned Space Flight Program status as a basis for review and evaluation of total program effort. In support of this requirement, SARP reporting is performed by Center Program Offices to provide OMSF with visibility on particular programs. Project/Stage Offices submit monthly SARP reports to the Program Control Office. Information used in the preparation of these reports includes data obtained through the PERT and Schedules System as well as funding, costs, and manpower data. The Program Control Office prepares a consolidated Program SARP Report from these inputs for submittal to OMSF.

QUARTERLY PROGRESS REPORTING

The Quarterly Progress Report is used to summarize Program schedule accomplishment in comparison with technical performance accomplishments over a three month period. It provides narrative coverage to pertinent schedule information. Political, economic, and technical backup information is included to accentuate items of special interest. Through this report, a capsule review of all elements of a program (i.e., progress, research and development, and major achievements) is documented and retained for historical purposes.

SUMMARY

The existence of massive amounts of data and corresponding requirements of periodic reports are absolutely essential to the success of any program. However, the information owes its existence to the decision-making process which requires timely and accurate program facts upon which decisions are based. This decision-making process is described on the following pages.

MANAGEMENT DECISION PROCESS

In Section Two, "Program Management Concept," it was stated that the success of management largely depends on the information which flows both from within and without the decision-making organization. On the preceding pages the information which flows to and from this function was described in terms of implementing data and status data. The decision-making process itself can only be described in terms of existing procedures which serve to expedite this decision-making process. It goes without saying that once a program is well defined and documented and organizations are directed to take action that management attention should be concentrated on specific problem areas which cause redirection in performance, cost, and schedule areas. This focusing of management concentration is accomplished through the establishment of particular levels of authority from the contractor to Center to Program to NASA Administration. Through a series of reviews and committee meetings critical problems of major impact are forced to the very top of the Manned Space Flight Program Structure.

This process is described first by a discussion of the Configuration Management System and the levels of authority for approving technical changes and second by a discussion of the levels of responsibility for Program Schedules and Status.

CONFIGURATION MANAGEMENT

The preparation and use of performance specifications and the supporting data which constitute the complete technical description of hardware segments has been previously discussed as a product of the Systems Engineering process. For clarity, only the decision-making function of this system is herein described.

Change Control

Configuration Control Boards are established at each management level. The processing of technical changes as related to the various levels of Configuration Control Boards is illustrated in Figure 4-12, ECP Flow. Within the Program, each CCB Chairman is delegated complete authority and responsibility for approval or disapproval of all changes within his level. He must, however, obtain concurrence from other on-line CCB chairmen which are affected by the change. Changes which are not mutually resolvable are referred to a higher level CCB. Changes which would result in schedule slippage or un-programmed increases in funding are outside the purvue of Configuration Management. These decisions must be made by higher management such as a Center Director who retains schedule responsibility for a launch vehicle system in toto and Center commitments to the Apollo Program Director for hardware delivery to the launch site.

MANAGEMENT REVIEW PROCEDURE

As part of the Management Decision Process and also in Measuring Management Effectiveness a series of reviews is regularly conducted at all levels of management. These reviews are:

- Program Managers Internal Review
- MSFC/Industrial Operations Review
- Management Council Meetings

A summary description follows each of these three reviews.

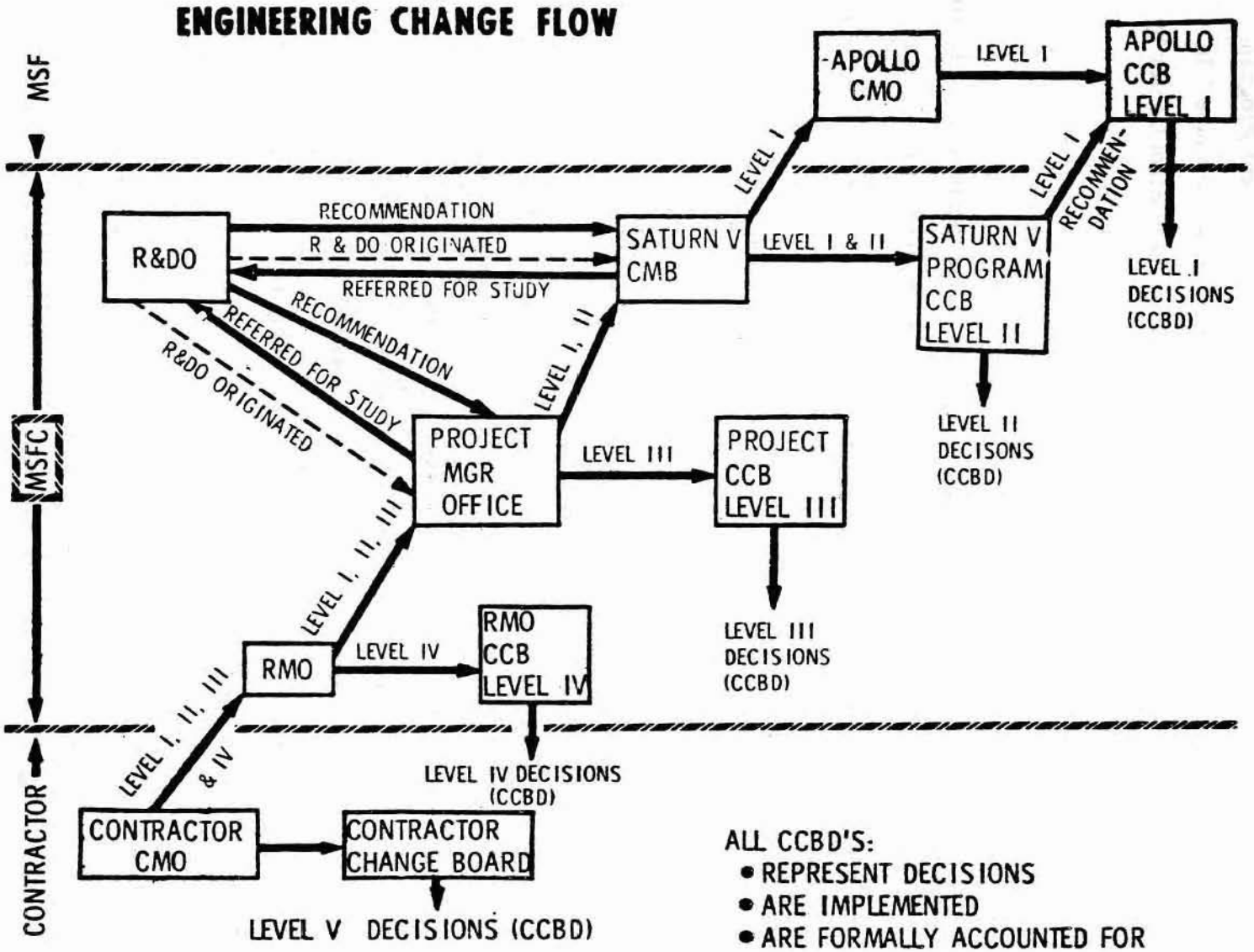


FIGURE 4-12. ECP FLOW

Program Managers Internal Review

The Program Control Center provides a continuous display of current Program Status information which is available to the Program Manager at all times. In addition, monthly SARP reports are submitted to the Program Control Center by each Project and Stage Office by program.

MSFC/Industrial Operations Review

Monthly MSFC/IO Reviews are held to report program status including identification of problem areas to be channeled to proper decision-making levels for corrective action. Special topics and action items are also discussed. Each Program Manager is required to make monthly presentations which are addressed to:

- Significant programmatic information to be presented at the Management Council Meetings. As a rule, non-controversial charts are not shown but are available as back-up information.
- Significant information of interest to MSFC is presented by Program Manager on odd-numbered months.
- Critical internal problems which require the attention of Center Management prior to the MSF Management Council Meeting. Only those items jointly approved by the Center Director and the Director of Industrial Operations are presented at the Management Council Meeting.
- Action items and special topics previously assigned.

An example of a typical agenda for the MSFC/IO monthly review is included as Figure 4-13.

Management Council Meetings

The purpose, function, and results of MSF Management Council Meetings is explained in Volume I of this series. It suffices to say that MSFC is represented at these

MSFC/IO REVIEW

Thursday Prior to MSF MCM, 1:30 - 5:00 p.m.
Tenth Floor Conference Room, Building 4200

- PRESENTATION AGENDA -*

Time:**	Subject:	Reporting Responsibility
1:30 - 1:45	Introduction	I-DIR
1:45 - 1:50	MCM Information	I-RM
1:50 - 2:00	Resources Summary	I-RM-P
	Apollo Program: (Status, Action Items, and Intelligence)	
2:00 - 2:15	Saturn I/IB	I-I/IB-MGR
2:15 - 2:35	Saturn V	I-V-MGR
2:35 - 2:55	Engines	I-E-MGR
2:55 - 3:10	Apollo Applications	I-S/AA-MGR
3:10 - 3:20	Mission Operations (Status)	I-MO-MGR
3:20 - 3:35	R&DO Topics (Apollo/SAA Related)	R-DIR
3:35 - 4:35	Special Topics:***	E-DIR
	Programmatic	As Assigned
	Administrative	As Assigned
	Executive Session	As Assigned
4:35 - 5:00	Discussion, if any	I-RM

*The agenda will consist of presentations covering the program being reviewed by the program manager (I-I/IB, I-V, I-E, and I-S/AA); response to action items; discussion of special and Executive Session topics; and also, any intelligence on what MSF plans to present that is of MSFC interest.

**Times are flexible and should be used only as a guide. An agenda will be published each month with the specific time allocations.

***Proposed agenda items will be submitted no later than 3 days prior to the MSFC/IO Review. Programmatic items should be directed to I-RM (876-6757) and other than programmatic items to E-R (876-0049).

FIGURE 4-13. MSFC/IO REVIEW

meetings and is responsible for providing status information and technical back-up for specific problem areas related to performance, cost, and schedules.

MEASURING MANAGEMENT EFFECTIVENESS

The effectiveness of the decision-making process is determined by monitoring and assessing the status of performance, cost, and schedules within the constraints of total program requirements. This is accomplished through the conduct of properly planned and previously scheduled Management Reviews. In addition to the status reviews previously described, such as Program Quarterly and Monthly Reviews, and Management Council meetings, there are both technical and management reviews which are conducted both at the contractor's facilities and at the launch site. They are described in two categories:

- Technical Reviews
- Contractor Performance Reviews

Technical Reviews

Prior to actual delivery of hardware to the launch site, a series of technical reviews is conducted at each hardware contractor's facility. They may be conducted incrementally or concurrently depending on the preplanned schedules and status of the hardware. These reviews are:

- Preliminary Design Review
- Critical Design Review
- First Article Configuration Inspection

Preliminary Design Review

This review takes place when the first segment of a general requirement specification is complete. It is a review of the contractor's understanding of the requirements and results in government approval of the basic design approach to be developed.

Critical Design Review

This review takes place when the design is developed to the degree that it is ready for manufacturing. It establishes interface compatibility with other hardware segments and results in approval of hardware design and the commitment of the design to manufacturing.

First Article Configuration Inspection

This review or inspection occurs when all engineering data are complete, including the final segment of the general performance specification, and at least one hardware segment is awaiting government acceptance. It results in formal approval of all hardware descriptive data and the demonstrated hardware configuration.

A final review is scheduled as part of the preparation for the Program Managers Pre-Flight Review.

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SECTION 5

CURRENT MANAGEMENT SYSTEM IMPROVEMENTS

The MSFC plans for management improvement include research in increased use of automated techniques and management systems development. These improvements are described in four categories:

- Information Retrieval and Reporting Systems
- PERT and Cost Correlation Technique (PACCT)
- Third Generation Computer System
- On-Line Data System

INFORMATION RETRIEVAL AND REPORTING SYSTEMS

NASA management over the past few years has developed and implemented several cost, time and performance reporting systems to meet the demands for timely and reliable information needed in planning, measuring and evaluating results to effect decisions required to control the NASA programs. The systems were developed to satisfy the needs of different levels of management with varying problems, and in many cases overlapping systems have evolved which have placed undue demands on lower levels of management. The fact that some of the reporting systems were automated did not alleviate the need to avoid duplications in reporting.

Our objective is to develop and extend the knowledge and capability of on-line information retrieval and reporting systems which could economically and practically fulfill the information needs of the Center and fully utilize the Third Generation computer system capabilities.

Three systems currently under study are the Apollo Management Information Retrieval System (AMIRS) the Information Management Retrieval and Dissemination System (IMRADS) and Boeing's Schedule, Control, Planning and Evaluation (SCOPE) System. AMIRS is being developed by the General Electric Company (Apollo Support Department, Daytona Beach, Florida) for the Office of Manned Space Flight (Apollo Program Control Office). The primary objective of AMIRS is to establish an on-line information retrieval capability which will provide Program Management with pertinent data required to make timely and effective decisions. The implementation of AMIRS would establish an on-line, data flow system between and within NASA Apollo organizations and provide remote access to specified data banks, enabling the selection of specific information for early identification of problem areas. AMIRS is a general purpose system and is not restricted to a unique data base. It is able to extract information from available files (such as POP, PERT, CMCTS, CMI, etc.) and does not require restructuring of the basic data files.

IMRADS has been under active development by the Information Systems Group at UNIVAC since 1964. IMRADS is being designed basically as a generalized on-line real time information retrieval system. It would respond to the data required, the resources available for obtaining the data, the processing that is required to put it in the proper context and format, and the actual routing of the resultant information to the person who requested it.

The objectives of the SCOPE System stress use of a common baseline no redundancy and "quick look" evaluation methods. The accepted essential planning elements are used; e.g., work breakdown structure, task matrix (W.B.S. - organization) work package - cost account assignment, etc. The system includes a schedule/cost correlation technique and an estimated projection based on current status. The

information reported is processed and stored in a computer center. Customer(s) monitoring (at remote locations) is possible through use of a TELPAK LINE and compatible equipment at the customer's location. Such equipment includes teletype, cathode ray tube displays and a process for reproducing the data displayed on the CRT.

Study and review in these areas will provide, in addition to knowledge of Headquarters developments and trends, a basis for development of a Center position on implementation of a general retrieval system.

PERT AND COST CORRELATION TECHNIQUE (PACCT)

The PERT and Cost Correlation Technique (PACCT) is a system designed to assist program management in using existing time and cost information more effectively to evaluate contractor performance. The technique offers a systematic, practical method for correlating and analyzing the enormous amount of time and cost data that is presently available to the project manager. Correlation is attained at a high level where the data are available without requiring additional contractor reporting. Correlation at this gross level, although broad in scope, allows the calculation of trends of contractor effectiveness in fulfilling the cost and schedule requirements of a contract. In addition, it provides the basis for predicting shifts in program funding requirements from the original plan, funding for a set time interval, e.g., a fiscal year and for predicting the total run-out cost of the program according to the PERT expected date for program completion and the contractor performance to date.

The unique feature of PACCT is the computerized method used for assigning the planned cost of a program to the individual activities of the program summary PERT network. Once this initial assignment is made and each activity is costed, the

PERT/time network is updated to reflect changes to the baseline plan. A new cost allocation and phasing is calculated for each update based on the network changes. Adjustments to the original planned costs are made according to two considerations: (1) For a given change in the elapsed time required for completing an activity, a proportional change is made in the dollars required for the activity. (2) Future cost projections based on the latest PERT plan are adjusted by an index of contractor performance to date.

THIRD GENERATION COMPUTER SYSTEM

The Marshall Space Flight Center has undertaken the implementation of Third Generation Computer System to supply the increasing demand for computer resources, and at the same time to provide a more advanced state-of-the-art computer system within budget requirements. The planning required to accomplish this task originated within the Computation Laboratory in 1964 and had as general objectives (a) to define future computational requirement (b) to research available computer resources (c) to recommend methods for satisfying future computation needs, and (d) to establish a time interval for these computation needs and requirements.

Emerging from this planning were recommendations to acquire a single type computing system to perform scientific, commercial, and data reduction computations. These recommendations were geared to MSFC's requirement for mission support while adhering to the latest regulatory controls. Later developed hardware and software specifications established the MSFC Third Generation Computer Concept.

The concept is a centrally located, multiple process computer which can be operated by users located at a remote terminal. This on-line capability, which allows direct communications to a high-speed facility with a large computer memory, has three central processors accessible to any remote station. The ratio of business oriented

to scientific oriented computer processing at Marshall (approximately 60/40) allows efficient use of the computer's capability. The computer system's executive control permits simultaneous operation of programs, giving large amounts of central processor time to scientific oriented programs while providing sufficient input/output control for the business oriented programs. Advanced peripheral equipment such as drum files, drum memory, magnetic tape and card readers fulfill the system's requirements to extend memory for a large number of users. This concept gives the users the computer resources unequal to any present procedure using computers at various locations. Operating procedures of the Third Generation Computer were designed to provide the user with rapid access to a computer that has a range of capability to satisfy present and future requirements. The executive system scans the remote stations (42 commercial and 28 scientific) every few seconds, and allows concurrent operations of many programs with real-time application. The user can store, retrieve, file and protect large amounts of data at the central site while operating from a station containing card readers, card punches, teletype, plotters, and graphic displays.

At the scientific remote stations, for example, the operator communicates through a Data Central Terminal which provides access to the central processors, memory banks, drum and tape storage, card readers, and printers. An access control register permits access to stored data, assigns priority and establishes the communications line from the remote station. The operator can then proceed in a conversational or batch processing mode using the basic FORTRAN language. The graphic display allows immediate changes in the real-time operation.

The commercial programs which are written in the COBOL language have a large input/output capability at the central site. Most stations serve as communications terminals which control operation and manipulation of the data.

The Third Generation Computer Concept provides a flexible computer system which can grow and change along with the Center's requirements for computer support. Future Center requirements for program management and reporting will be augmented with this capability.

ON-LINE DATA SYSTEM

The advent of third generation computing systems has greatly accelerated the trend to on-line management information and reporting systems. The desirability of such systems has long been recognized but until recently the hardware capability has been a limiting factor. This no longer being the case, the challenge now is designing systems which will take full advantage of the hardware.

As a first step toward an on-line management information and reporting system, MSFC has established an MSF/MSFC On-line Data System. This system is run on the IBM 7010/7740 Teleprocessing System with IBM 1050 remote terminals at Executive Staff, MSFC and Apollo Program Control, MSF, using information from PACCT as the data base. With this system, a query can be entered at the remote terminal stating the desired information. This message is transmitted over the data link to the central computing system, the specified information is extracted from the data file, transmitted back over the data link and typed out on the remote terminal. Thus, a question can be asked and an answer received within a matter of seconds. This phase of the system development is intended to demonstrate the capability of a Marshall/Headquarters data link and to highlight problem areas.

Marshall is presently converting to the UNIVAC 1108 Third Generation Computing System, and the capability for on-line information storage and retrieval will be greatly enhanced by this advanced equipment. The multiprocessing/multiprogramming features, expanded data storage and remote terminal improvements are major contributors to making on-line systems feasible and economical.

More sophisticated software is being developed to fully utilize the hardware capability and provide the flexibility and adaptability desired of the on-line systems. Two major areas of software development are the executive or operating programs for the computers and general retrieval programs capable of handling many different data files and performing varied functions with the data such as retrieval, sorting, computing and report formating.

These advances in hardware and software are expected to allow the development of an on-line information retrieval and reporting system which will provide in an economical and practical manner the information needs of NASA Managers. The data will be up-to-date through automatic updating of the files as changes and new information become available. Through a remote terminal located in his immediate vicinity, the manager can retrieve the specific data desired through video display or printed output. He can operate on the data by calculating, comparing with other data, re-sorting, etc., display the results, and then receive hard-copy output as desired.

This system will allow managers a greater flexibility in evaluating the existing information before making decisions and taking action.

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APPENDIX A

MSFC ORGANIZATIONAL FUNCTIONS

The Marshall organization continues the theme of decentralization fostered by NASA Headquarters. This is accomplished by delegating authority necessary to accomplish assigned responsibilities to lower levels of management.

The George C. Marshall Space Flight Center is assigned the following functions:

a. Performing as assigned the research and development associated with large launch vehicle or space transportation systems and selected payloads, together with the related support equipment and facilities.

b. Procuring launch vehicle systems and subsystems, including related electrical and ground support equipment, according to assigned responsibilities; monitoring and directing contractor efforts; conducting acceptance tests; and approving all deviations and changes from contract specifications.

c. Providing or performing overall systems engineering, systems integration and production engineering for the launch vehicle or space transportation systems assigned.

d. Performing advanced studies, research, and planning in the general field of astronautics, including advanced space navigation techniques.

e. Developing and/or procuring engines for assigned support propulsion systems as well as those required to support launch vehicle and space transportation systems.

f. Providing flight ready launch vehicle systems, insuring proper in-flight functioning within the approved mission profile, and providing post-flight evaluation and analysis.

g. Providing support, according to assigned responsibilities, for the space program activities of other NASA Installations, Department of Defense elements or other Government agencies.

h. Performing in-house support research and management of research contracts with industry and universities for the advancement of the state-of-the-art in technologies associated with assigned programs.

i. Conducting operations in support of the Technology Utilization Program, including a continuing search for and reporting of new technology, including innovations in techniques, processes, materials, and devices evolved in the course of performing the functions outlined in this Instruction.

j. Providing a NASA in-house capability for pilot manufacturing, tooling, engineering and related technical disciplines; and investigating, in considerable depth, technical problems in all the above areas when requested.

k. Reporting on the status of projects and recommending changes or modifications to meet goals and schedules.

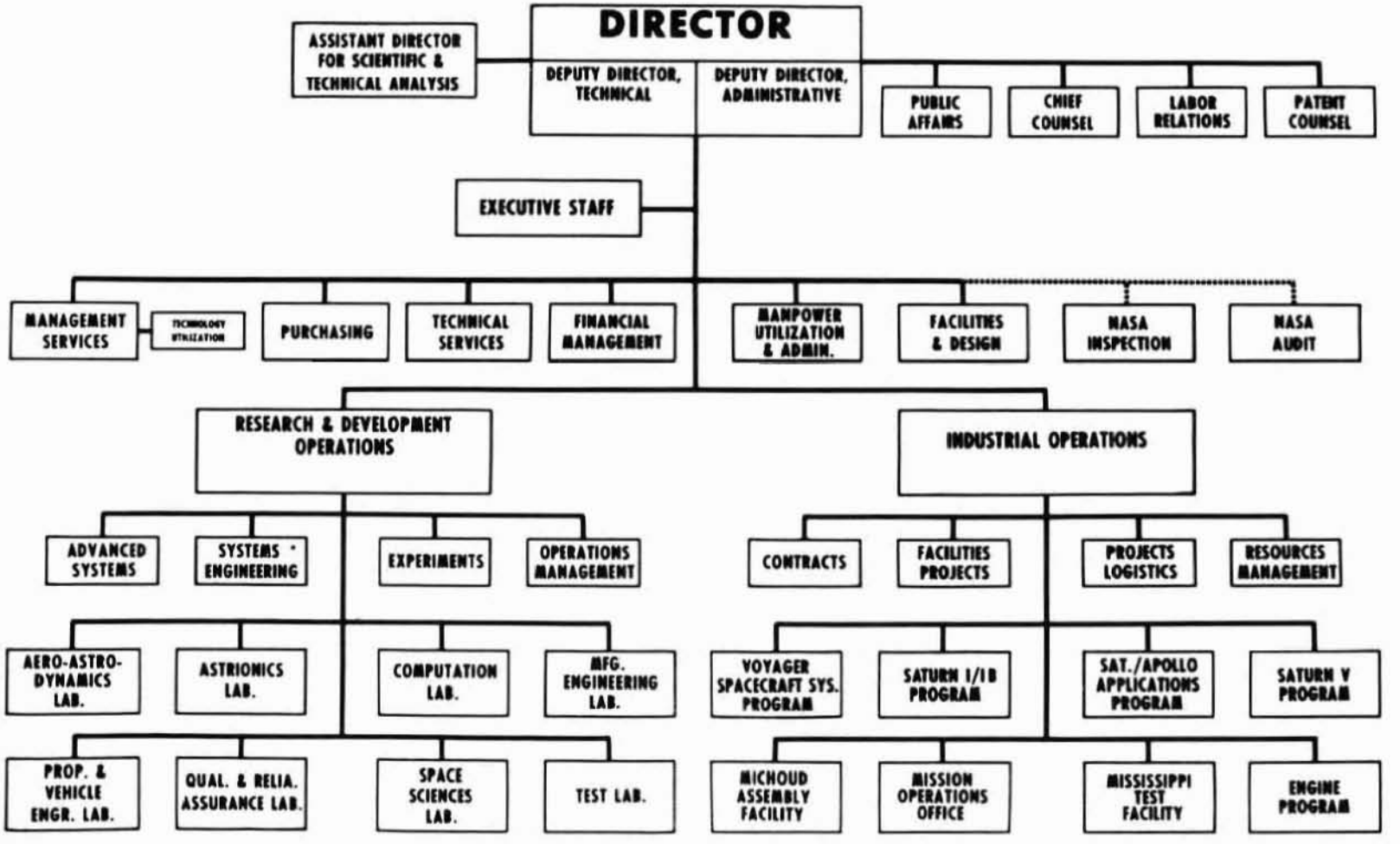
l. Exercising management responsibility of component installations, including Michoud Assembly Facility and Mississippi Test Facility.

m. Providing administrative and management support as required for carrying out assigned functions and programs.

There are generally three organizational "elements" below the MSFC director: Research and Development Operations, Industrial Operations and the Staff. Each of these "elements" is discussed on the following pages by a summary discussion of the responsibilities and activities of subordinate organizations.

The basic organization of the George C. Marshall Space Flight Center is outlined in the organizational chart set forth on the next page. Modifications or changes to the basic organization are subject to the approval of the Administrator, NASA.

GEORGE C. MARSHALL SPACE FLIGHT CENTER



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RESEARCH AND DEVELOPMENT OPERATIONS

The responsibility for establishing, managing and maintaining the scientific and engineering capabilities of the Center's eight laboratories, compatible with MSFC's immediate and long range technical objectives and goals, rests with Research and Development Operations (R&DO). This unique activity which comprises a majority of the Center's work force provides in depth technical assessment for Industrial Operations' prime contracts. It carries out the in-house research, development, and testing which is primarily in support of MSFC's major projects. In addition, R&DO performs studies on future space exploration and a program of scientific research and advanced technology to maintain the Center's technical proficiency in depth. The major functions of R&DO in support of the Industrial Operations and the Apollo Program are:

a. To perform overall systems engineering for the Saturn Launch Vehicle Programs and to provide scientific, engineering, manufacturing, test, quality assurance and managerial support to assure the successful performance and technical adequacy of the programs.
b. To perform complete engineering, development, manufacturing, test and program management for assigned subsystems.
c. To perform a continuing research and development program to provide engineering trade solutions, increased reliability, performance and usefulness of the Saturn Launch Vehicles.
d. To perform scientific and engineering studies on Apollo follow-on programs, additional flight missions, and modifications to uprate the payload capabilities of the Saturn Vehicles.

Management of the Center's scientific and engineering capabilities for space launch vehicles, payloads, projects, and supporting research and technology is vested in

the Research and Development Operations. This organization is composed of eight major laboratories and four staff offices. These staff elements perform such activities as overall resources management, systems engineering, total program planning, advanced systems planning and direction, and overall management of research and technology. The eight laboratories contain the disciplinary functions to provide in-depth technical capability on any major system, subsystem, or component required for a development project. The laboratory personnel maintain a high level of technical and scientific capability through research and technology activities in a given speciality. This range of activity enables the laboratory personnel to provide expert requirements definition, development design, technical problems solving, and technical assessment of detailed parts, overall systems, subsystem, project plans and technical changes; these constitute the basic elements of the technical assistance and contractor technical management and assessment provided in support of Apollo program management.

Aero-Astrodynamics Laboratory

The Aero-Astrodynamics Lab conducts research and development in the fields of aerodynamics, astrodynamics, guidance and control theory, and related sciences for the purpose of establishing optimum design for launch and space vehicles, spacecraft and assigned projects. This laboratory evaluates overall launch vehicle mission capability in terms of payload, total weight and configuration. Complete systems analyses are performed to establish mission concepts for new vehicle systems. The natural environment criteria for vehicle design is established and maintained by this laboratory.

Astrionics Laboratory

Astrionics Laboratory conducts research and development, including prototype development, in the areas of guidance, control, electrical networks, vehicle-borne

tracking, measuring, telemetering and range safety devices for launch and space systems. This includes the design and fabrication of electrical ground support equipment for testing, launching and operation of the vehicles and payloads.

Computation Laboratory

This laboratory plans, establishes and conducts the application of high-speed computers and automation devices to the launch vehicle research, development, test, as well as to the areas of management and project direction. The function of the laboratory also includes data transmission, handling and reduction.

Manufacturing Engineering Laboratory

The Manufacturing Engineering Laboratory conducts basic and applied manufacturing research and development, evaluates new technology, conducts feasibility studies for porposed designs of space flight hardware and operates shops for all manufacturing-type activities. These include engineering models, prototype and experimental hardware. The laboratory also assesses all facets for manufacturing activities at contractor plants in support of program management.

Propulsion and Vehicle Engineering Laboratory

The primary function of the Propulsion and Vehicle Engineering Laboratory is to direct and conduct research, development engineering, and technical management in areas of propulsion, structures, materials, vehicle systems, systems integration, and mechanical support systems. It also performs studies in advanced system design of future launch vehicle and space systems within the primary disciplines of the laboratory.

Quality and Reliability Assurance Laboratory

This laboratory establishes, supervises, and maintains a comprehensive quality and reliability assurance program for launch vehicle systems, related support equipment and material during all phases of activity both at MSFC and in industry to assure that material accepted meets established requirements and standards. It performs analysis, tests, and checkout of launch vehicle support systems, subsystems, components, and related support equipment. It develops and applies techniques in quality engineering, reliability engineering and checkout of launch vehicles and payloads.

Space Sciences Laboratory

This laboratory develops and supports scientific flight experiments, including analysis and evaluation of scientific data. It assists in the development of scientific objectives and payload technology for assigned flight missions. It also initiates and executes original and supporting research in selected areas.

Test Laboratory

The Test Laboratory performs experimental and developmental testing of launch vehicle systems, components, and support equipment, providing an independent evaluation of test results and recommendations on design criteria. It conducts research and development in testing methods and techniques and provides design criteria for test facilities. It also assesses the contractor test facilities development and operations and conducts research and development in transportation systems for large launch vehicles.

Advanced Systems Office

The Advanced Systems Office provides for the planning and execution of future space flight programs. It fosters and supports laboratory system development studies and integrates these into overall advanced vehicle systems and proposals.

Experiment Office

This office provides formulation implementation, review, and coordination of the consolidated Research and Technology Program and the Supporting Development Program conducted in the laboratories. The office provides for the identification, definition and development of the flight experiments accomplished by the laboratories.

Operations Management Office

The Operation Management Office coordinates and integrates all facets of Research and Development Operations planning and resources management, including funding, manpower, facilities, equipment, materials and contracts. It provides coordinated management of projects and technical support of the laboratories to the program management activities. The office develops and coordinates management control systems and provides long-range planning and management support for R&DO.

Systems Engineering Office*

The Systems Engineering Office performs overall vehicle-level systems engineering for approved programs, serving as the technical focal point for planning, leadership and management of systems engineering for the Center. It provides program-oriented technical management of the R&DO systems engineering and control of technical systems interface through direction of R&DO participation in intercenter panels.

MANAGEMENT OF RESEARCH AND DEVELOPMENT OPERATIONS

R&DO operates on a decentralized basis with each laboratory being responsible for and operating with an assigned functional area. Each laboratory is structured with

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* Name change pending NASA Headquarters Approval

line operating divisions and specialized staff project offices and systems engineering offices. These staff offices provide the internal and external interface and commitment points while the line divisions fulfill the laboratory's responsibilities in the assigned engineering and scientific disciplines. The R&DO staff offices serve as the focal for overall administrative and technical coordination with the eight laboratories, Industrial Operations and the Center Staff.

Management Relationship in Prime Contractor Activities

The laboratories are MSFC's source of in-depth technical capability. Each laboratory is automatically responsible for support of Industrial Operations (IO) in the technical management of prime contractors within the laboratory's assigned functional area. In addition, the laboratories are responsible for providing requested technical support to IO. These responsibilities are performed through a continuing program of detailed assessments and evaluation of design, manufacturing, test, and quality activities at contractor's facilities, and by evaluation of project changes. These assessments are performed both at MSFC and on-site at the contractor's facility by on-site technical representatives who provide technical support to the IO Resident Manager and through whom the laboratory's technical competence can be brought to bear on any program technical problem confronting that contractor's facility.

Single Support Contractor

Each R&DO laboratory is provided a non-personal services contractor to furnish the additional technical capability necessary for the laboratory to carry out fully its assigned functions. This provides the laboratory a necessary flexibility in providing rapid responses to automatic responsibilities and emergency requests for support.

IO and R&DO Relationship

R&DO personnel provide the in-depth technical support to the IO projects. Daily communication and support on subsystems and components are handled automatically by designated personnel within the laboratory line organization and the IO subsystem managers. In general, R&DO personnel are responsive to the requirements of the IO program and project managers although formal commitment channels to the IO project are identified in the laboratory project office. Other more formalized communication and working relationships, involving interfaces of many subsystems and organizational elements, are the Working Groups, the Lead Laboratory, and the Inter-Center Panels.

Working Groups

Working Groups, with members from the laboratories, Industrial Operations, and the prime contractors have been established to work interface problems of the Saturn/Apollo Spacecraft, launch vehicle, facilities and associated equipment, and to recommend solutions to these problems. These technical solutions are incorporated into the Saturn/Apollo Program through the line organization of appropriate R&DO Laboratory and/or office and the IO project office. These groups are co-chaired by R&DO and the Prime Contractor.

Lead Laboratory

The Director of R&DO makes lead laboratory assignments to R&DO Laboratory Directors on designated major payloads, major experiments, or similar large scale tasks involving more than one laboratory. The Lead Laboratory Director manages the R&DO activities pertaining to the assigned task and, in doing so, acts for the Director, R&DO. The other laboratories involved in the task actively support the

lead laboratory in the establishment of the overall development plan and the commitment and application of the necessary personnel and other resources required to carry out their portion of the plan.

a. Organizational relationship

The Lead Laboratory Director designates an Engineering Manager who is responsible for translating task or program objectives into an overall development plan for accomplishment within R&DO. The Engineering Manager implements and manages the overall development plan within limitations of approved resources plans for fiscal authority as may be appropriate. He also provides support to and coordinates with the IO Program Office for those tasks where IO is assigned the program management responsibility.

b. Project engineer functions

Each involved laboratory director designates a project engineer for the assigned task who has responsibility in support of the engineering manager for the coordination of the laboratory commitments and is the primary point of contact for the laboratory on the designated task. The laboratory director delegates full authority to the project engineer to represent the laboratory in support of the assigned task and to provide the necessary support and coordination for which his laboratory has responsibility.

Inter-Center Panels

Inter-Center panels, with membership from MSF, MSC, MSFC, and KSC, have been established to consider technical interface problems of the Saturn/Apollo Spacecraft, launch vehicle, facilities, and associated equipment; and to recommend solutions to these problems. These technical solutions are incorporated into the Saturn/Apollo Program through the line organization of appropriate MSF Centers.

INDUSTRIAL OPERATIONS

The overall responsibility for the conduct and management of the Saturn Launch Vehicle Systems Programs, which include the complete launch vehicles (Saturn I, IB and V), MSFC assigned payloads, related ground support equipment and software, and all support, handling and logistics requirements, rests with Industrial Operations (IO). This activity, which has the smallest amount of the Center's workforce (approximately 17.5 percent), takes all actions necessary to ensure that the entire series of Saturn launch vehicle systems is successfully developed, produced, tested, delivered and launched to carry out the specified missions on the officially scheduled dates and at the most reasonable cost to the government within allotted funds. The major functions of Industrial Operations in support of the Apollo Program are:

a. To assure the technical adequacy of the overall launch vehicle system and the successful integration of vehicle stages, engines, ground support equipment, associated equipment and MSFC assigned payloads — and to assure that courses of action and final decisions are reached by mutual agreement between program and project managers, including Research and Development Operations senior responsible personnel involved.

b. To be the final authority on all program matters assigned, including the launch vehicle and ground support equipment configuration, related software, test programs, and quality and reliability programs — and to insure all program participants conform to established systems specifications and program requirements.

c. To direct all government contracting activities for launch vehicle stages, program related facilities, program logistics and MSFC assigned Saturn payloads, except those subsystems and other Saturn related elements which are assigned to Research and Development Operations.

d. To manage the off-site field operations of MSFC, including the Mississippi Test Facility, Michoud Operations Facility, Resident Management Offices and attached elements.

e. To manage MSFC program logistics activities, including spare parts, propellants and pressurants, transportation equipment and facilities, and field operations.

f. To direct a facilities program to provide and maintain facilities and equipment required for the Saturn program.

Organization

Management of the Centers' Saturn Launch Vehicle Systems Programs, including related GSE and MSFC assigned Saturn payloads is vested in Industrial Operations. This organization is composed of four staff offices and five program offices, including two government-owned facilities, Michoud Assembly Facility and Mississippi Test Facility.

Staff Offices

The four staff offices are Contracts, Facilities, Logistics and Resources Management. However, of these four, only Resources Management is a true staff office, while Contracts, Facilities and Logistics are in reality line or operating level organizations.

a. Contracts Office

The Contracts Office plans and administers a complete range of contracting operations encompassing proposals, negotiations, awards, administration and contract management of stage and large systems contracting and procurement at the Center, associated contractor plants and other Center locations, as designated.

b. Facilities Office

The Facilities Office establishes Industrial Operations policies concerning facilities management and appropriate relationships between MSFC industrial sites of operation, related MSFC offices, NASA Headquarters and other NASA centers to insure development and maintenance of mutually compatible facilities management systems. They also consolidate and coordinate information from Program Managers into the Facilities Program Control and documentation requirements of MSFC and NASA.

c. Logistics Office

The Logistics Office performs the overall planning and coordination of logistic support operations for launch vehicle and engine programs within approved budgets, schedules and guidelines. It provides guidelines, definitions of requirements, review, coordination, and monitoring of performance to insure adequate, economical, and timely support of the logistics programs. In addition, this office monitors all logistic changes to assure that the changes are within Apollo specifications or required changes are requested.

d. Resources Management Office

The Resources Management Office serves as the focal point for collection, integration and consolidation of management information. It also establishes and maintains appropriate systems and mechanisms as a basis for overall appraisal of performance and progress of assigned tasks, and implements standard information and reporting processes for application by all industrial organization elements and appropriate external industrial activities. It directs the preparation of, consolidates and provides information and reports required by NASA Headquarters. This office is also responsible for Schedule and Review System, Budget, Finance and Manpower, the establishment and maintenance of

a Project Management Control Room and serves as the focal point for development and administration of an effective data management system which identifies, selects, acquires, controls and minimizes essential MSFC documents within the Saturn/Apollo Program. In addition, this office manages the MSFC configuration management system, establishes policies and develops general operating plans. It continually reviews the implementation of the configuration management system by the Program Offices and performs internal administrative activities.

Program Offices

The five program offices are: Saturn I/IB, Saturn V, Engines, Apollo Applications and Mission Operations. However, of the five, Mission Operations is not considered a true Program Office.

a. Saturn I/IB Program Office

This office plans and directs the execution of its program responsibilities within established technical, schedule and resources limitations. It also manages the composite MSFC/Industry performance through the phases of program planning, coordination, and contractor managerial and technical direction in the design, engineering, integration, development, control, production, testing, delivery and pre-launch checkout of the assigned vehicle and associated equipment. In addition, this office is responsible for the technical adequacy of the overall vehicle system and the successful integration of the vehicle stages and associated equipment within established mission objectives.

The Saturn I/IB Program Office is organized into three major elements reporting to the Program Manager. These are a staff patterned after the Apollo Program

Office to provide functional support to the Program Manager and Stage Managers; Resident Management Offices which provide on-site supervision and management of the respective contractor facility and at Kennedy Space Center; and project offices which manage the following projects: S-IB Stage, S-IVB Stage, Instrument Unit and Vehicle GSE.

b. Saturn V Program Office

This office plans and directs the execution of their program responsibilities within established, technical, schedule and resources limitations. It manages the composite MSFC/Industry performance through the phases of program planning, coordination, and contractor managerial and technical direction in the design, engineering, integration, development, control, production, testing, delivery and pre-launch checkout of the assigned vehicle and associated equipment. In addition, this office also assures the technical adequacy of the overall vehicle system and the successful integration of vehicle stages and associated equipment within established mission objectives.

The Saturn V Program Office is supported by a staff structure modeled after that of the Apollo Program Office and provides program-oriented functions. The five project offices, each authorized to take the actions necessary to accomplish its assigned responsibilities are: S-IC Stage, S-II Stage, S-IVB Stage, Instrument Unit and Vehicle GSE. In addition, there are two resident offices which have elements to provide on-site representation and direction located at KSC and NAA/Space Division.

c. Engine Program Office

This office plans and directs the execution of its project responsibilities within established technical, schedule and resources limitations. It also

manages the composite MSFC/Industry performance through the phases of program planning, coordination, and contractor managerial and technical direction in the design, engineering, integration, development, control, production, checkout, testing and delivery of assigned engine projects and associated equipment. In addition, this office assures the technical adequacy and successful integration of assigned engine projects and associated equipment within established mission objectives.

The Engine Program Office staff structure is patterned after that of the Apollo Program Office with similar areas of responsibility. The three engine project offices, each authorized to take the actions necessary to accomplish its assigned responsibilities are: H-1, J-2 and F-1. These project offices are supported by on-site resident managers and representatives at MSFC facilities and NASA field centers (MAF and KSC). Resident managers are also located at contractor facilities at Canoga Park, Calif.; Neosho, Mo.; and Edwards AFB.

d. Saturn/Apollo Applications Program Office

This office plans and directs the execution of its program responsibilities within established technical, schedule, and resources limitations. It manages the composite MSFC/Industry performance through the phases of mission and program planning, coordination, and contractor managerial and technical direction in the mission planning, integration, development, design, engineering, control, production, testing, delivery, and pre-launch checkout relative to experiments, payloads, systems, and related equipment involved in the assigned program. In addition, this office is responsible for the technical adequacy of experiments, payloads, related systems and interfaces and successful integration thereof, and related equipment within established mission objectives.

The Apollo Applications Program Office has been assigned three payload-type projects. They are the Orbital Workshop, the Apollo Telescope Mount, and the Multiple Docking Adapter.

e. Mission Operations Office

This office plans, coordinates and directs, from one single centralized point, all activities involved with accomplishing the Center's mission operations role pertaining to manned and unmanned launch vehicles during space flight missions, flight tests or similar operations.

The Mission Operations Office acts as interface between other NASA Field Centers and MSFC in the development of launch and flight mission plans, coordinates launch vehicle systems under the flight director and manages the MSFC Launch Information Exchange Facility.

f. Michoud Assembly Facility

This activity manages the administrative and industrial activities of the government-owned, contractor-operated plant, including contractor programs, documentation, facilities, finance, support and computation services, quality control, and on-site supervision of contractor launch vehicle development, design, manufacture and assembly.

The manager of this facility reports to the Director, Industrial Operations and functions both as the institutional manager of the installation and as resident manager for the contractor activities at the facility. Common support services are provided by Mason-Rust and the Computer Operations Office, which services both MAF and MTF, and is operated by Ling-Temco-Vaught.

This facility oversees the engineering, fabrication and assembly of the Saturn IB, S-IB Stage by Chrysler employees and the Saturn V, S-IC Stage by Boeing employees.

g. Mississippi Test Facility

This activity manages the administrative, industrial, and development activities of the government-owned, contractor-operated plant, including contracts, programs, finance, safety, quality engineering, and on-site supervision of stage and support contractors' performance of assigned developmental and acceptance testing, checkout, refurbishment, and service support programs. It also assures the flight worthy quality of launch vehicle stages prior to delivery for launch missions. In addition, this facility represents NASA/MSFC in matters relating to state and local affairs.

The manager, who reports to the Director, Industrial Operations, fills a dual role as resident manager for the contractor activities at the facility and also serves as the institutional manager of the installation. The General Electric Company Missile and Space Division is the plant and technical support contractor.

This facility oversees the static testing of the Saturn V, S-IC stage by Boeing Company employees and the Saturn V, S-II Stage by NAA/Space Division employees.

STAFF

The general term "Staff" at MSFC includes both staff and services (support) organizations. The purely staff elements perform functions which their names imply.

Public Affairs Office

The Public Affairs Office promotes a program which will reflect the Center's contribution to NASA's provision "for the widest practical and appropriate dissemination of information concerning its activities and results thereof."

Chief Counsel

The Chief Counsel provides legal counsel to assure that Center activities conform to applicable legal and policy requirements; prepares and coordinates MSFC legislative proposals.

Labor Relations

Labor Relations promotes and maintains for MSFC and NASA the best possible relations with industry, with organized labor, and with employee groups.

Patent Counsel

The Patent Counsel provides legal counsel throughout the center on matters involving patents, trademarks, copyrights, trade secrets and other proprietary data.

Executive Staff

The Executive Staff functions in support of the Center director, normally fulfills a role of planning actions to be taken, defines how and by whom the work will be accomplished and reviews and analyzes to assure adequacy of performance and desired end results. This includes placing requirements on and directing various functional activities as required to execute assigned responsibilities.

The service organizations provide general and administrative type support to all Center elements. In specific cases designated individuals within these elements

serve in advisory capacity in relation to specific functions to the different levels of management.

Management Services Office

The Management Services Office develops, implements, and administers a comprehensive program in support of the Center encompassing the areas of:

Technology Utilization

Technology Utilization ensures exchange of technology utilization information between MSFC and Center contractors, NASA Headquarters, other NASA centers, other government agencies, educational institutions and industry.

Electronic Communications

Electronic Communications assures development and implementation of requirements for all types of telecommunications services.

Security Administration

Security Administration establishes and maintains programs for safeguarding classified material, personnel security and security education.

Safety

Safety assures development and implementation of a comprehensive industrial safety program; consults and advises on installation of safety features in space vehicle systems.

Administrative Services

Administrative Services assures provision of adequate services in such areas as food concessions, records administration, mail handling, reports control, printing control, forms control, janitorial, refuse collection and laundry services.

Documentation Management

Documentation Management obtains, prepares, disseminates, microfilms, and stores technical scientific and other documents essential for the knowledge and management of MSFC programs.

Purchasing

The role of Purchasing is that of planning and administering a complete range of purchasing and contracting operations encompassing proposal, negotiation, award, and administration of contracts in support of the R&DO Laboratories and supply offices. Procurement direction and policy are received from the Assistant Director for Procurement, MSFC. Functional responsibilities can be described in four categories:

1. Negotiate and administer all methods and types of contracts such as cost reimbursement, cost-plus-fixed fee time and material, labor hours, etc., necessary to provide research design, development, fabrication, architect and/or engineering services, major and minor construction and other services relative to space vehicles and plant support.

2. Perform contract management on all types of contracts and delegate contract administration services including audit, inspection, plant security, quality and reliability, property, etc., to the Defense Contract Administration Services Regions, DCAA, and other supporting agencies.

3. Maintain necessary liaison with Department of Defense components, other Government Agencies, and other NASA Centers supporting the contracting effort at MSFC.

4. Procure all standard stock items of equipment and materials through GSA, Federal Supply Schedules, local charge accounts, and other industrial firms and vendors necessary for program and plant support.

Procurement requests ranging from standard commercial items to complex space vehicle equipment are reviewed for adequacy in terms of nomenclature, specifications, drawings, scope of work, and justification for the request. In FY 1967, procurement awards approximated 235 million dollars.

Technical Services Office

The Technical Services Office develops, implements, and administers a comprehensive program of technical services encompassing operation, maintenance, modification and repair of plant, facilities and equipment; receipt, storage and issue of supplies and equipment, photographic services (photographic instrumentation, motion picture film production and still photography) and transportation services (worldwide movement of people and freight).

Financial Management

Financial Management is a part of the Central Staff, reporting to the Director, MSFC. As a staff advisor, guidance and assistance is provided to the Program/Project Offices in all phases of the Budgetary cycle. Financial Management is the designated Program Manager for Administrative Operations appropriations and in this capacity conducts quarterly program reviews. In other appropriations, Financial Management has review and concurrence responsibilities.

Financial Management is the central point for receipt and control of funds and program authorizations. Resources Authority is received from the Headquarters program directors through the cognizant institutional director. Summary distributions are made to FIN-A (Accounting Branch), Michoud Assembly Facility, and Mississippi Test Facility. Detailed distributions are made to MSFC laboratories and offices by means of a Program Authorization Release (MSFC Form 200 - Work Order). Fund

authority is received from Headquarters, Office of Organization and Management. Distributions of funds within MSFC are made for control purposes only to assure compliance with Section 3679 of the Revised Statutes (Anti-Deficiency Act). Accounting control is maintained over all of the Center's funds, assets, and liabilities and Financial Management certifies to the availability and propriety of program authority and funds for all financial transactions. Systematic reviews of financial activities of the Center are conducted to evaluate compliance with regulations, procedures, and directives.

Facilities and Design Office

Facilities and Design Office serves in a staff capacity to the Office of the Director, MSFC, and exercises direct functional authority over the acquisition of facility resources required for the support of MSFC assigned programs. Functional authority for technical adequacy and direction of MSFC facility program is applied across the board on all facilities regardless of location within MSFC area cognizance. Managerial responsibility is exercised for only those projects located in Huntsville. Staff responsibilities such as technical expertise, planning, budgeting, adherence to authority delegations and real property accountability are also applied across the board to all locations.

The activities normally associated with a facility program and with which the Facilities and Design Office is engaged are categorized as: planning, budgeting, design, construction and project management.

Planning

Activation of a facility project funded under the Construction of Facilities Program is normally completed two years after identification in a preliminary budget submittal.

Projects accomplished under the Minor Construction or Repair and Alteration Programs are normally operational some 13 months after the requirement is made known to Facilities and Design Office. The consequence of this lead time can only be compensated for through firm planning.

Budgeting

Budgeting for Construction of Facilities Program is initiated at the laboratory or program office level based upon guidelines prepared by NASA Headquarters and distributed by Executive Staff with additional guidelines and interpretations furnished by Facilities and Design Office. The proposed budget is presented to the Center Director and staff by the requesting elements in a general meeting attended by affected MSFC organizations. Project Managers that have been assigned to the projects as they were identified in the budget generation are called upon to develop, in conjunction with the using element, the additional information required by NASA Headquarters, BOB and Congress during their reviews. The responsiveness and accuracy are critical factors in obtaining favorable action on the budget items.

Design and Construction

The design and construction phase of the facility cycle are areas where Facilities and Design Office technical direction is emphasized. F&D is responsible for the technical adequacy of all facilities under MSFC cognizance regardless of location. This responsibility is exercised with in-house Civil Service personnel, support contractor or architect-engineer firms. Design of Facilities at Mississippi Test Facility and various locations is accomplished under the direct surveillance of on-site personnel under the overall guidance of Facilities and Design Office. Construction is accomplished under the same managerial philosophy.

Management

The project manager concept was adopted as a means of integrating and coordinating all the activities that are involved in obtaining facility resources. Each project manager is assigned to several specific laboratories or staff offices located here in Huntsville. A project manager generally follows a project from its inception during the planning cycle or budget cycle through to activation. Generally F&D is not engaged in activating a facility after acceptance from the constructing agent unless otherwise requested by the user.

Manpower Utilization and Administration Office

As the Apollo program emerges from the design and early prototype development phases into production of hardware, the role of Marshall's work force, including support contractors, is subject to constant change. The MU&A Office provides the Center with a viable and dynamic capability to meet these changing conditions. The MU&A Office serves as the focal point for the Center's programs in the field of personnel management and manpower planning, including all facets of the planning, utilization and control of the Center's human resources. These activities include:

a. Administration of the Federal Civil Service personnel programs.

b. Conducting a program to actively recruit "hard to get" scientists and technicians.

c. Providing career development training to sustain the technical competence of the work force and to assure the availability of the skills necessary to meet changing roles and missions.

d. Working with civic leaders to assure that the commuting communities offer every reasonable enticement for the acquisition and retention of outstanding individuals in the professional and technical fields.

e. Directing and sustaining those federally-recognized programs established to assure equal employment opportunities.

f. Conducting a system of wage and salary administration which is designed to provide equity, and stability in the wages paid both Civil Service and contractor employees.

g. Developing and administering plans and programs to enhance the capability for survival of the assigned personnel and their families during civil defense or other emergency conditions.

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APPENDIX B

MSFC CONTRACTOR RESPONSIBILITIES

Industrial Operations currently has 103 active contracts valued at approximately 6.400 billion dollars. Approximately 5.380 billion dollars of the total contract value is with the eight following contractors: Chrysler, McDonnell-Douglas, IBM, General Electric, North American, Boeing Company, Bendix, and RCA.

A brief summary of the broad areas of contribution of each of the major contractors is presented as follows:

CHRYSLER CORPORATION

Chrysler is the contractor responsible for the design, development, and fabrication of the S-IB stage and associated mechanical ground support equipment of the uprated Saturn I, qualification and reliability testing of related ground support equipment and stage components, and facilities support at Michoud.

McDONNELL-DOUGLAS CORPORATION

McDonnell-Douglas is contractor for the S-IVB stage and is responsible for engineering, research, development, fabrication, and services for this stage of the uprated Saturn I and Saturn V launch vehicles. McDonnell-Douglas is also responsible for the design and manufacture of ground support equipment in support of the S-IVB stage assembly and checkout operations.

INTERNATIONAL BUSINESS MACHINES CORPORATION (IBM)

IBM is responsible for design, development, manufacture, and checkout of the Instrument Unit for the uprated Saturn I and Saturn V vehicles, as well as design,

development, and manufacture of the Saturn guidance computer processor and the guidance computer and data adapters for the Instrument Unit.

GENERAL ELECTRIC COMPANY, APOLLO SYSTEMS DEPARTMENT

General Electric is responsible for design, development, and manufacture of Electric Support Equipment (ESE) for the uprated Saturn I and Saturn V launch vehicles and related engineering field support. G. E. also provides services for facilities activation and operation for the Mississippi Test Facility; Data Management, and Management Information Systems support for Program control; and reliability and quality assessments and related investigations for Program R&QA.

NORTH AMERICAN AVIATION, INC. (NAA)

The Space and Information Systems Division of NAA, Downey and Seal Beach, California, is responsible for the design, fabrication, assembly, and test of the S-II test and flight stages and associated ground support equipment for the Saturn V launch vehicle.

Rocketdyne Division of NAA is the contractor for development and production of the H-1, F-1, and J-2 engines. Eight 200 000-pound thrust engines of the H-1 are used in the first stage of the uprated Saturn I. Five 1 500 000-pound thrust F-1 engines are used in the first stage of the Saturn V. One 200 000-pound thrust J-2 engine is used in the S-IVB stage as the second stage of the uprated Saturn I and third stage of the Saturn V. Five J-2 engines are used in the second stage of the Saturn V.

THE BOEING COMPANY, SPACE DIVISION

The Space Division of the Boeing Company is the contractor for the Saturn V first stage (S-IC) and its ground support equipment. Components are fabricated at

Wichita and assembled at Michoud Assembly Facility at New Orleans, Louisiana. Operations at Michoud and Mississippi Test Facility (MTF) include fabrication and assembly, and qualification and reliability testing for all flight stages. Boeing also provides Saturn V systems engineering and integration support at Huntsville, Alabama, and launch operations support at Cape Kennedy, Florida.

BENDIX CORPORATION

Bendix is responsible for the design, manufacture, and delivery of the ST-124 stabilized platform used in the guidance package of the uprated Saturn I and the Saturn V.

RADIO CORPORATION OF AMERICA (RCA)

RCA is the contractor responsible for the design, manufacture, and checkout of the 110 computers used in the Saturn V flight vehicles and in the automatic checkout systems for ground test.

OTHER CONTRACTORS

Some of the many other contractors who either provide components or direct support to the Apollo Program activities at MSFC are:

Mason-Rust	New Orleans, La.
Brown Engineering	Huntsville, Ala.
Greer Hydraulics	Los Angeles, Calif.
AETRON	Covina, Calif.
General Dynamics	Fort Worth, Texas
Northrop	Norwood, Mass.
Martin Marietta	Orlando, Fla.

Hayes International	Birmingham, Ala.
Hamilton Standard	Windsor Locks, Conn.
Sanders Assoc.	Nashua, N. H.
Motorola, Inc.	Scottsdale, Ariz.
Aero Spacelines	Van Nuys, Calif.

APPENDIX C

MSFC CAPITAL PLANT

For the Apollo Program, MSFC has been responsible for the design and construction of extensive facilities for engineering and administration, manufacturing, and testing of launch vehicles and associated equipment at Huntsville, Alabama; Michoud Assembly Facility, New Orleans, Louisiana, Mississippi Test Facility; and several major installations and facilities in various locations on the West Coast and central United States.

The MSFC is located on U.S. Army property at Redstone Arsenal, Huntsville, Alabama, occupying approximately 1800 acres of land. The estimated value of facilities is 330 million dollars. Marshall Space Flight Center complex is generally divided into five main categories: headquarters area, general support area manufacturing and quality area, engineering and laboratory area, and test area.

a. Headquarters area — consists mainly of Buildings 4200, 4201, and 4202; these new office buildings are located on Rideout Road near the northern boundary of MSFC (Fig. C-1).

b. General support area — located south of the headquarters area east of Rideout Road. It contains such activities as Communications, Security Patrol headquarters, Training Division, Photo Laboratory, Technical Services headquarters building, Financial Management Office, Space Museum, and others.

c. Manufacturing and quality area — located west of Rideout Road opposite the services and support area. It contains the shops, assembly facilities, and checkout facilities for production of the stages manufactured at MSFC (see Fig. C-2).

FIGURE C-1. HEADQUARTERS AREA

FIGURE C-2. MANUFACTURING AND QUALITY AREA

d. The engineering and laboratory area — located generally along Martin Road east of Rideout Road. Contains Astrionics and Propulsion & Vehicle Engineering offices and laboratories (see Fig. C-3).

e. Test area — located in the southern portion of MSFC south of Martin Road. Contains the test stands, control centers, fuel transmission facilities, test headquarters, and other testing facilities (see Fig. C-4).

The Michoud Assembly Facility is composed of two complexes — a main facility of approximately 900 acres at Michoud, Louisiana, which is approximately 15 miles east of downtown New Orleans (see Fig. C-5) and a smaller facility, the MAF Central Computer Facility, which is a site of 14 acres located at Slidell, Louisiana, approximately 22 miles northeast of Michoud (see Fig. C-6)

The Mississippi Test Facility (MTF) consists of an operational fee area of 13 428 acres surrounded by an additional 125 442 acre buffer zone. MTF consists of three major areas or complexes:

a. Test area — contains one dual S-IC stage static test stand with control center and two S-II stage static test stands and control center (Fig. C-7).

b. Administrative and laboratory area — contains headquarters and communications buildings, data handling facilities and electronics, instrumentation, Materials and Acoustics laboratories (Fig. C-8).

c. Service area — contains maintenance, emergency service, and storage buildings, utilities centers and docking and water transportation facilities.

Other NASA industrial facilities supporting MSFC and the Apollo Program are located at Downey, California; Seal Beach, California; Tulsa, Oklahoma; Santa Susana, California; Santa Monica, Huntington Beach and Sacramento, California; Edwards Rocket Test Site - Canoga Park, California; and Neosho, Missouri.

FIGURE C-3. THE ENGINEERING AND LABORATORY AREA

FIGURE C-4. TEST AREA

FIGURE C-5. MICHOUD ASSEMBLY FACILITY

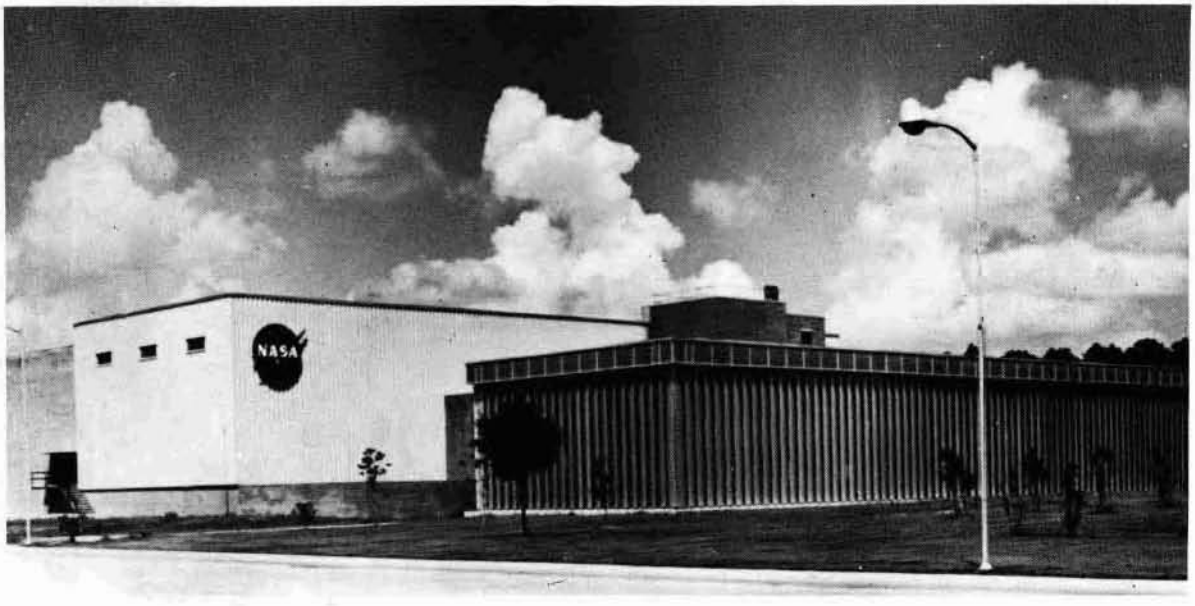

FIGURE C-6. COMPUTER OPERATIONS OFFICE - SLIDELL

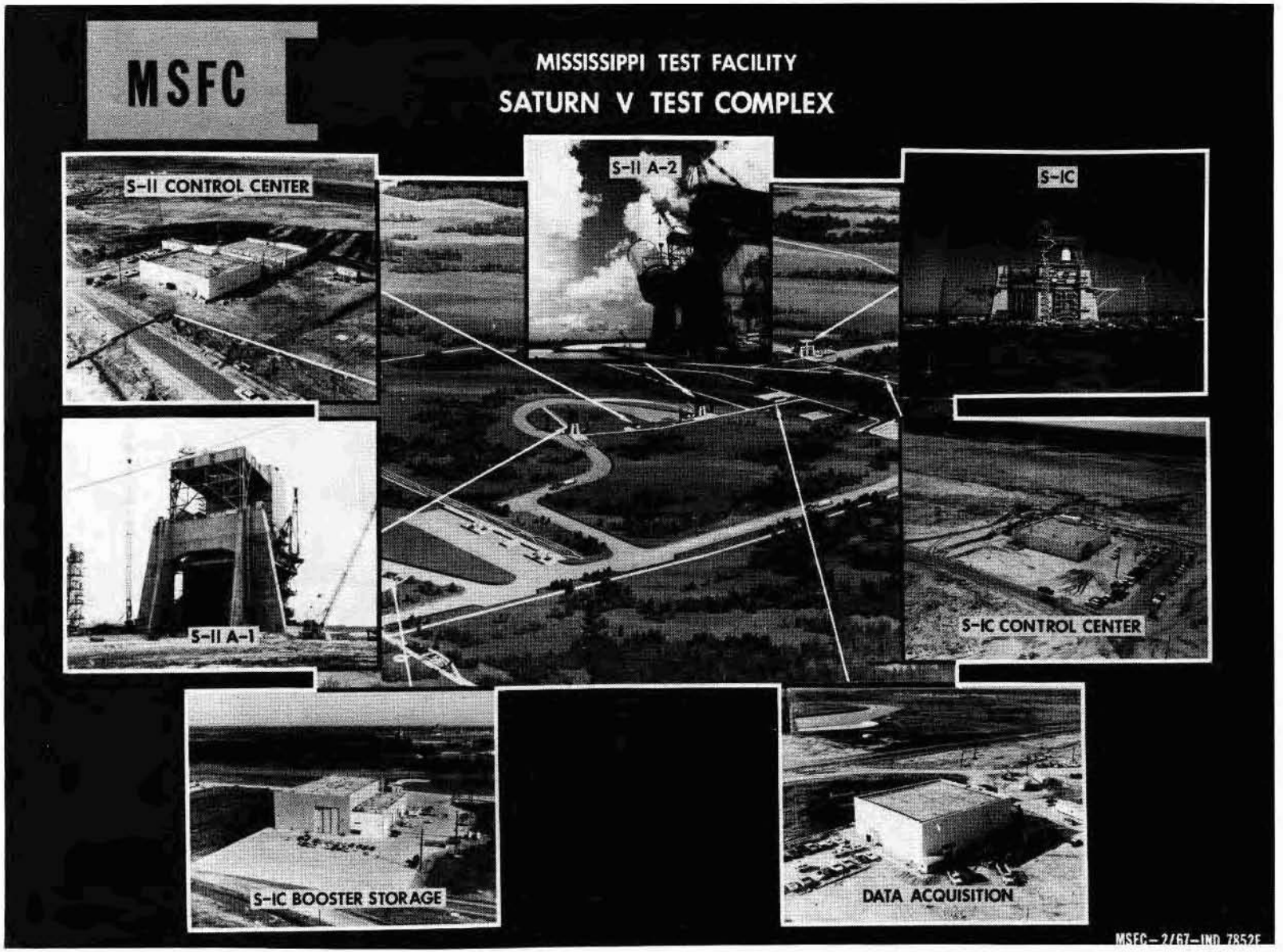

FIGURE C-7. MISSISSIPPI TEST FACILITY SATURN V TEST COMPLEX

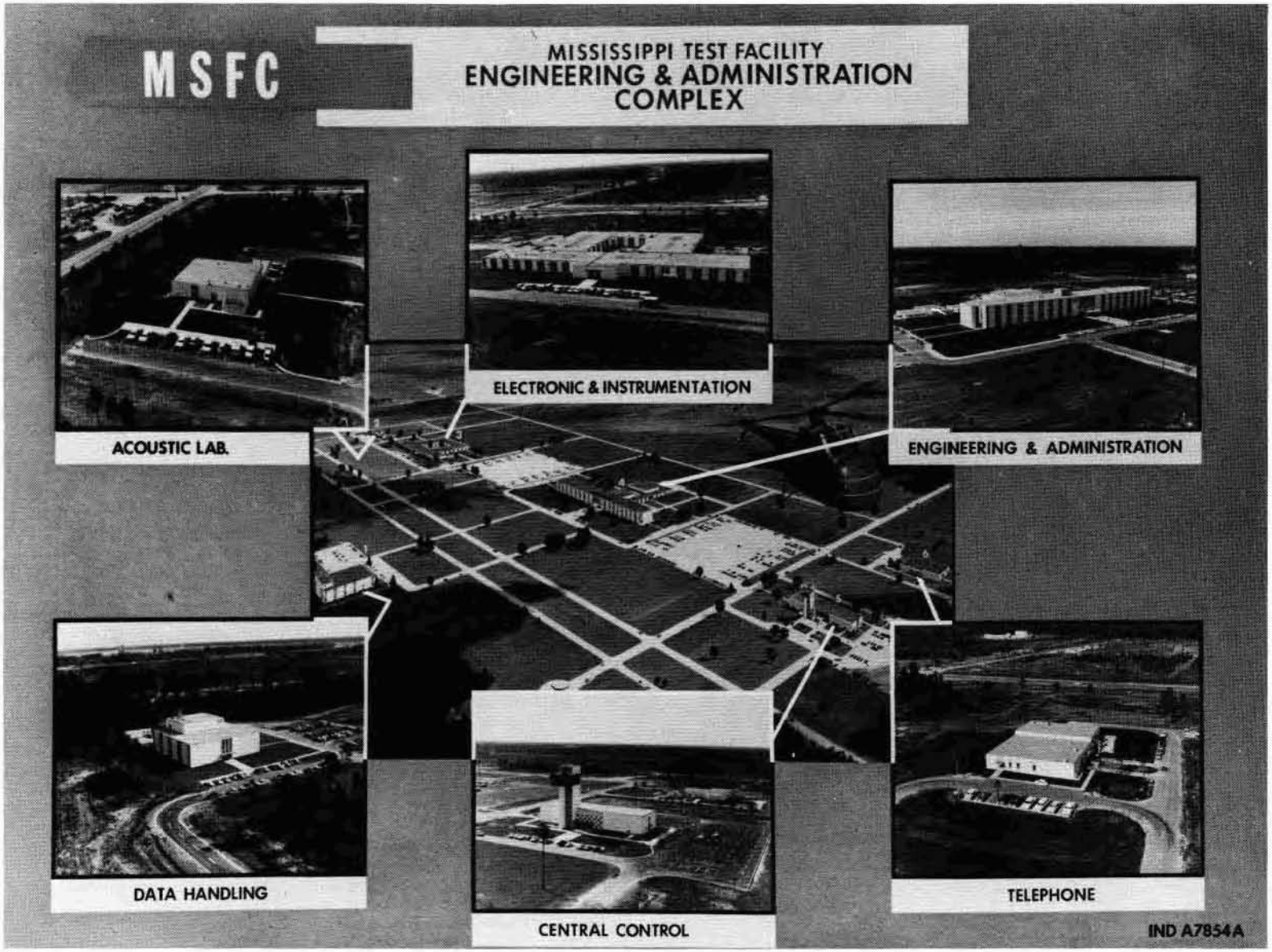

FIGURE C-8. MISSISSIPPI TEST FACILITY ENGINEERING & ADMINISTRATION COMPLEX