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APOLLO  
MAINTENANCE PLAN

NAS 9-150

Review Copy



Prepared By

Apollo Logistics

NORTH AMERICAN AVIATION, INC.  
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## FOREWORD

The Apollo Maintenance Plan is presented in accordance with Exhibit I, Paragraph 3.5 of the Apollo NAS 9-150 Contract. This issue constitutes the fourth revision of the original document which was first published as SID 62-202 on May 1, 1962. The Maintenance Concept, SID 62-702, has been incorporated as an integral part of this plan.

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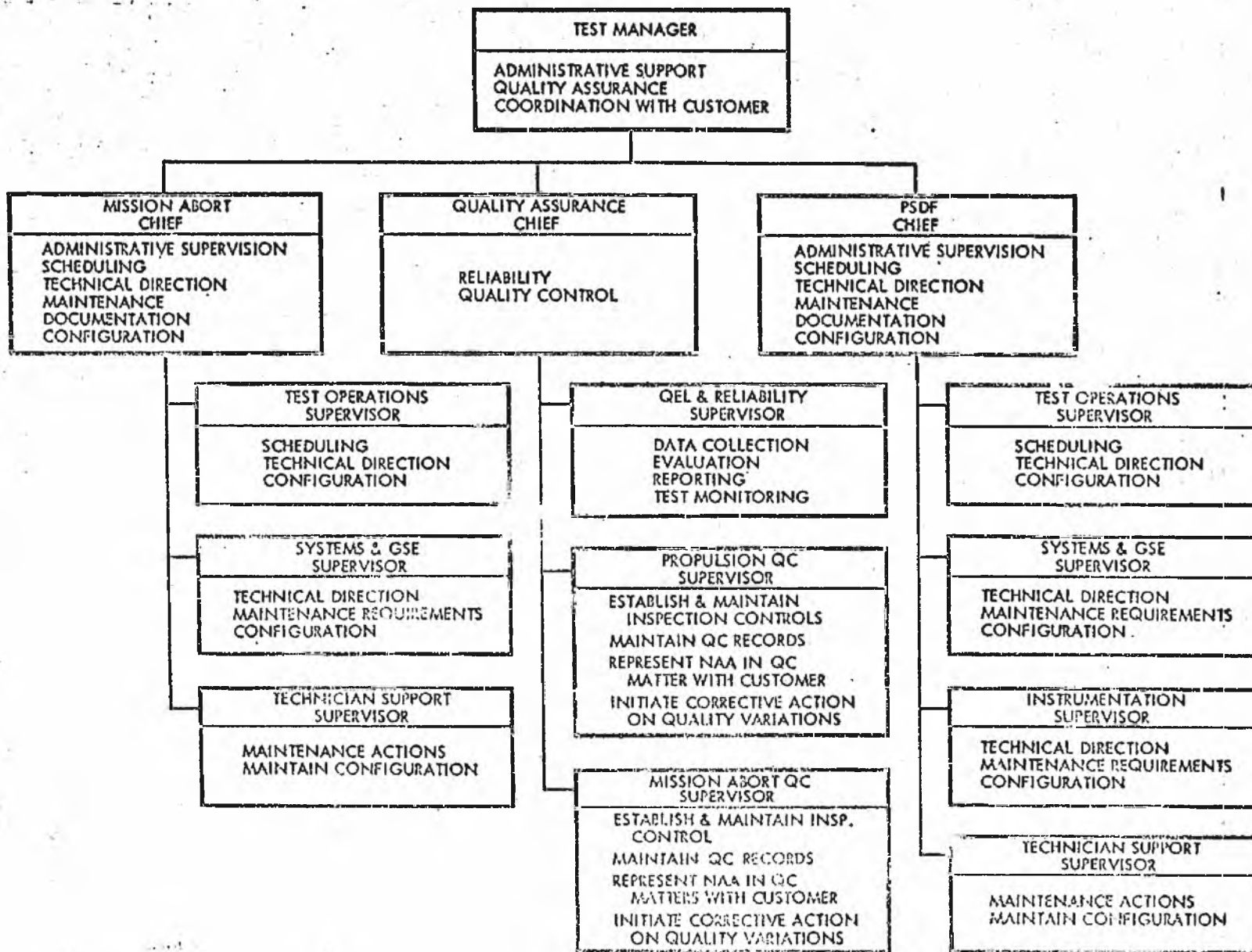


Figure 2-5. Apollo Program Organization, White Sands Missile Range



## INTRODUCTION

In accordance with the recent NASA request, this document combines both the Apollo Maintenance Concept and the Apollo Maintenance Plan. Section I comprises the conceptual presentation. The intent of the Concept is to summarize those basic elements and considerations that are essential in formulating an effective maintenance support activity. Section II contains the plan. The purpose of the Plan is to describe what maintenance is, what its restraints are, where it will be performed, and who is responsible for its management and conduct. A Glossary of Terms is included at the end of the document. This revision reflects the views of Division management pertinent to maintenance planning, requirements, responsibilities, and activities that are within the contractor's scope of authority.

## I. MAINTENANCE CONCEPT

### 1.1 SCOPE

This section presents the contractor's philosophy and approach regarding the development of effective maintenance support for Apollo test and mission objectives. It is the basic intent of the Concept to establish the principles upon which a maintenance activity will be structured, as well as to outline the parameters within which it will operate. Fundamental considerations such as objective, requirements, and planning, are dealt with in the body of the text, and corollary factors such as maintenance levels, maintenance areas, and maintenance functions are also covered.

#### 1.1.1 General

The philosophy expressed in this Concept is principally based on the contractual requirement that NAA/S&ID will perform and/or control all maintenance associated with Apollo Spacecraft, ground support equipment, and spares (end items and materiel) provided by the contractor. Within the context of this document, maintenance is defined as those functions which are required to retain materiel in, or restore it to, a serviceable condition.

The Concept, in substance, results from a detailed study of the Apollo Program Plan, the General Test Plan, the Facilities Plan, the Quality Control Plan, the Reliability Plan, and the Master Development Schedule. It is equally the result of a thorough examination of Apollo test and mission objectives, and a critical analysis of what will be required from a maintenance standpoint to support them.

## 1.2 MAINTENANCE OBJECTIVES

First among the considerations to be resolved before a maintenance activity is established are the objectives to be achieved. The Apollo maintenance objectives are: To maintain system reliability, to ensure operational capability, and to provide optimum maintenance support for Apollo Test and Operations in order that tests may be carried out as scheduled.

## 1.3 MAINTENANCE REQUIREMENTS

The determination of requirements that are essential to the performance of maintenance is next in importance after maintenance objectives have been established. These requirements are of a manifold nature and have to do with such considerations as site location, programmed capability, provisioning support, test and operational schedules, and the economy of maintenance operations. Considerations that pertain expressly to maintenance activities are defined and described in succeeding paragraphs:

### 1.3.1 Maintenance Categories

For the purposes of effective planning, scheduling and provisioning, maintenance is aligned under two distinct categories. These categories are scheduled maintenance and unscheduled maintenance. Scheduled maintenance is preventive in nature and can be predicted with reasonable accuracy. Unscheduled maintenance is corrective in nature, cannot be predicted, results from a deficiency or discrepancy, and usually arises during a test, operation, or scheduled maintenance activity. The various functions that are performed as a consequence of scheduled and unscheduled maintenance requirements are described below.

### 1.3.2 Maintenance Functions

Maintenance comprises many functions, each of which is essential to the successful accomplishment of the maintenance objectives. These functions

include inspection, servicing, adjustment, calibration, modification, repair and overhaul. The depth at which these functions may be performed is directly influenced by the maintenance capability programmed for the individual test site.

#### 1.4 MAINTENANCE PLANNING

In order to achieve the maintenance objectives previously expressed, extensive analysis and planning are required. Considerable attention must be given as to where maintenance will take place, what depth of maintenance is possible at each test site, and who is organizationally responsible for maintenance management at various locations. Consideration must also be given to the economy of operation, and to the corollary need for avoiding a duplication of facilities or equipment. A studied analysis of projected Apollo Program tests and operations has been instrumental in determining the maintenance requirements at various areas, and has indicated the need to establish varying levels of maintenance to support test and operations in these areas.

##### 1.4.1 Maintenance Levels

The contractor has determined that maintenance objectives can best be achieved by establishing three distinct levels of maintenance capability. These levels will hereafter be referred to as A, B, and C. This division of maintenance lends itself to programming facilities, equipment and personnel in an economical manner to meet the requirements of test and operations. It also avoids the provisioning of costly facilities and equipment at each area, and still provides an optimum capability that will be responsive to requirements. Levels of maintenance relating to electronic systems, mechanical systems, and ground support equipment are exemplified in Figure 1-1.

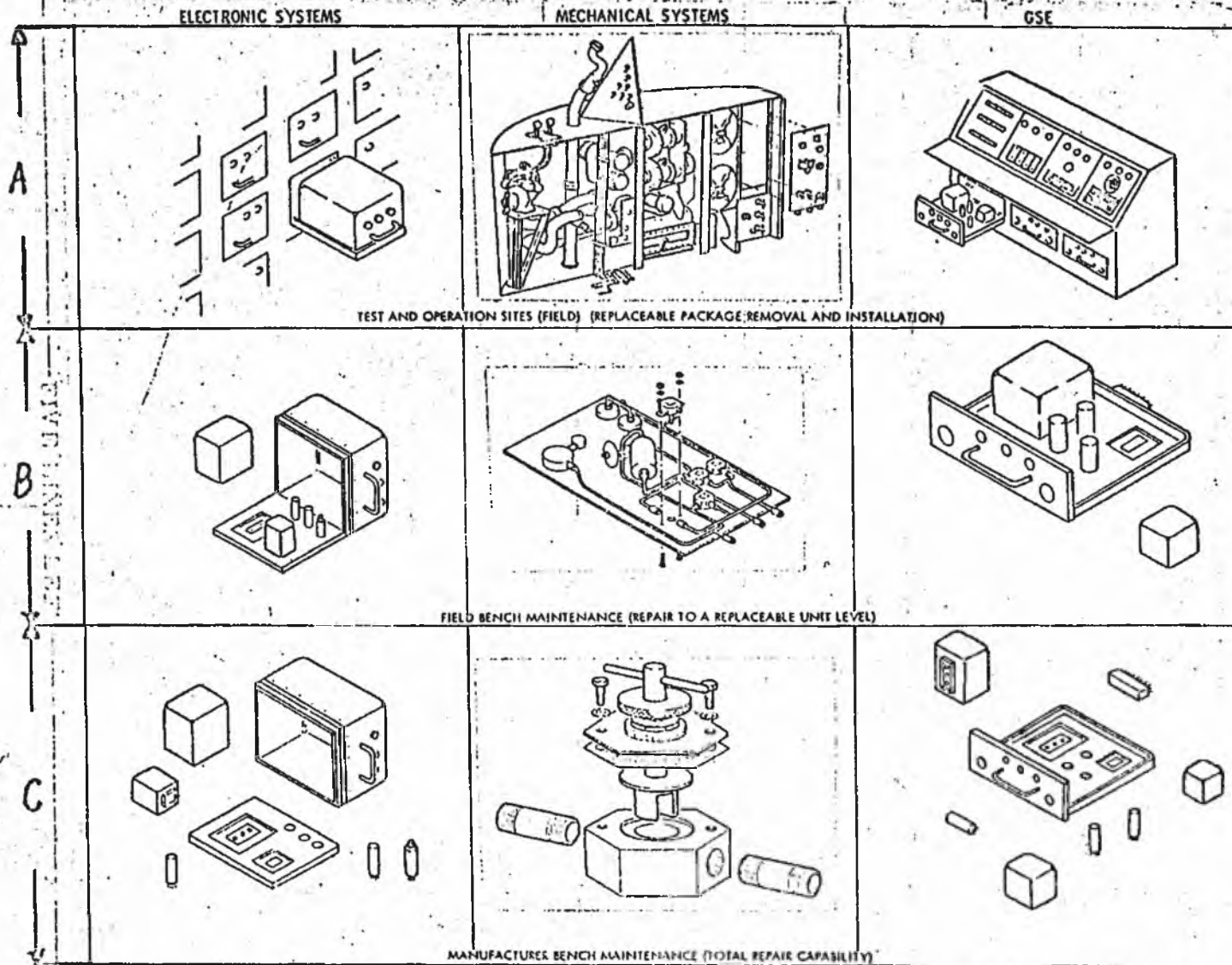


Figure 1-1. Maintenance Levels



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- 1.4.1.1 A-Level Maintenance. Maintenance accomplished at this level is generally limited to inspection, test, removal and installation of replaceable packages or components such as drawers and panel assemblies, and system verification.
- 1.4.1.2 B-Level Maintenance. This level of maintenance provides a greater capability and depth of penetration than that assigned to A-Level. For example, a replaceable package or component may be repaired through replacement down to a replaceable serialized unit, i.e., an amplifier or valve assembly. B-Level maintenance is generally available at each test site.
- 1.4.1.3 C-Level Maintenance. This level of maintenance provides a total maintenance capability. Maintenance actions performed at this level include extensive modification, repair, and overhaul. The contractor's and subcontractors' factory facilities are utilized to support C-Level maintenance as required.

1.4.2 Maintenance Areas

Review of the Apollo Program Plan indicates that tests and operations will be performed at S&ID-Downey, Florida Facility, White Sands Missile Range, and Manned Spacecraft Center. Various levels of maintenance will be performed at these areas in support of test and operations. Test and operations are also programmed at Marshall Space Flight Center and at El Centro, but no contractor maintenance effort has been programmed by the contractor.

1.4.3 Maintenance Organization

The nature of the Apollo Program does not lend itself to an organizational separation of maintenance from test and operations at the Test Sites. The

contractor organization at individual Test Sites is set up to perform both test and operations and maintenance. The contractor and its subcontractors are organized to provide extensive maintenance at factory facilities. The contractor's maintenance management organization, depicting functional responsibilities and subcontractor and customer interfaces, is presented in Figure 1.2.

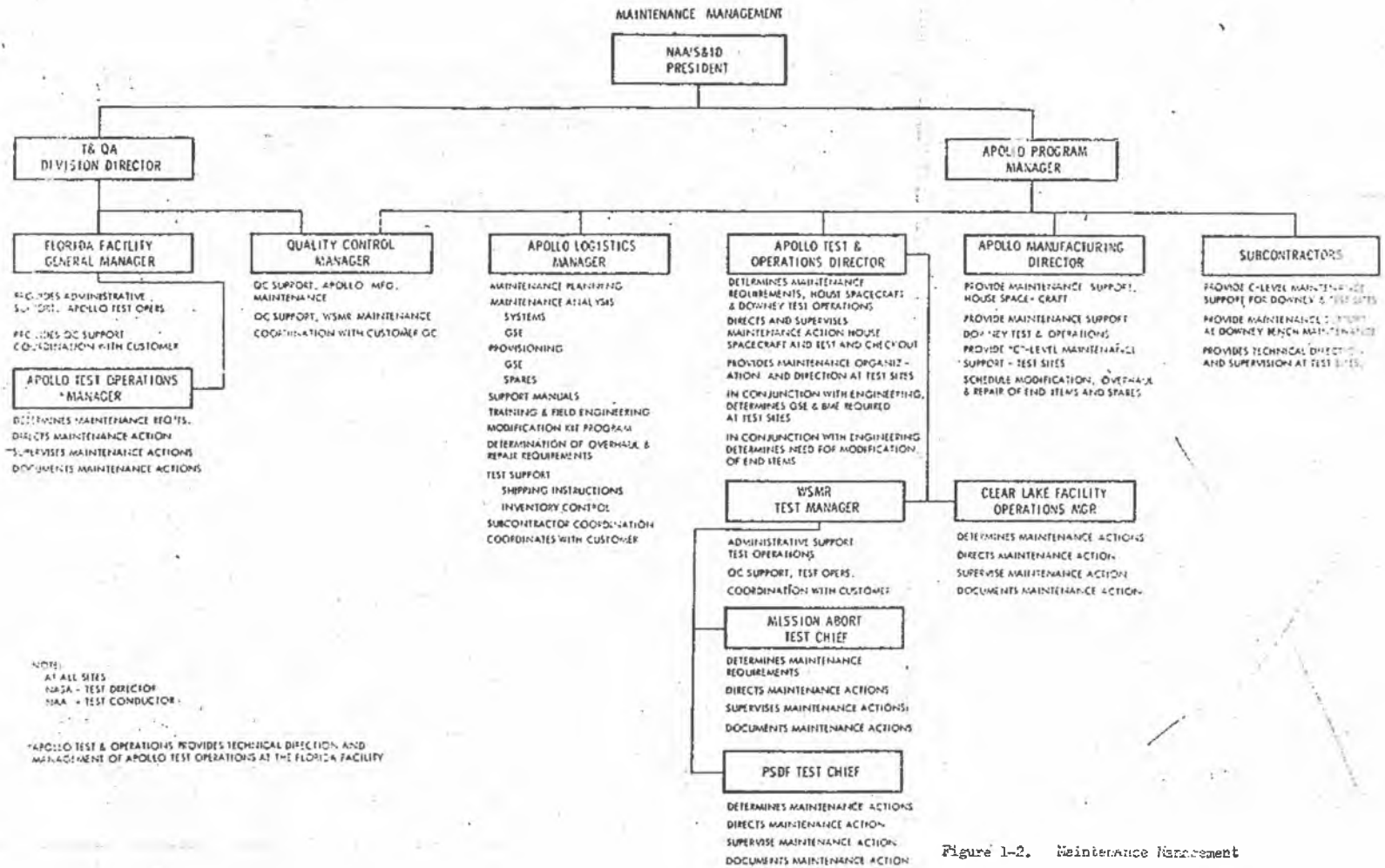


Figure 1-2. Maintenance Management



## II. MAINTENANCE PLAN

### 2.1 SCOPE

This section defines and describes what maintenance is, what its constraints are, where it is performed, and who is responsible for its accomplishment. Illustrations that depict maintenance flow, maintenance organization, and maintenance documentation are also included.

#### 2.1.1 General

This plan was developed to deal expressly with pure maintenance activity requirements, responsibilities, and functions. The organization, system and methods described in the succeeding text resulted from a review of other Apollo planning documentation, a thorough evaluation of program requirements, and the performance of detailed support analyses. Though not covered in this document, certain essential factors such as facilities, quality control, training, and other support functions or services have been considered. Information on these subjects is provided in the publications listed in the Bibliography appended to this document.

As used herein, maintenance applies to end items and materiel that have completed the manufacturing cycle, and have been transferred to the customer by a properly executed Form DD-250.

## 2.2

### MAINTENANCE ANALYSIS

Maintenance analyses shall be performed on all Apollo spacecraft, ground support equipment and trainers provided by the contractor and its sub-contractors. The objective of these analyses is to determine the maintenance capability and maintenance support required for each end item of equipment that is within the scope of contractor responsibility. Principal elements of the maintenance analysis are the spares summary, the special tools and equipment summary, and the task and equipment analysis. The Apollo Support Plan, SID 62-702-1, describes the system and procedures used to develop these analyses from basic input material and information sources.

## 2.3

### MAINTENANCE CATEGORIES

Two categories of maintenance are involved in keeping Apollo end items operable and support materiel serviceable. These categories are identified as scheduled maintenance and unscheduled maintenance. Scheduled maintenance consists of predictable tasks that must be performed at periodic intervals in order to assure the reliability and availability of a system. The Apollo Master Repair Schedule (MRS) SID 63-903, provides a forecast of predictable maintenance requirements. This document is defined and described in detail in the Apollo Support Plan, SID 62-702-1. Unscheduled maintenance consists of tasks performed at unpredictable intervals due to discrepancies or deficiencies within a system.

### 2.3.1

#### Scheduled Maintenance

Scheduled maintenance will be performed on spacecraft, ground support equipment and associated spares at periodic intervals throughout their service life. This category of maintenance is preventive in nature and is intended to retain equipment and materiel in a serviceable condition. Inspection and servicing are two examples of scheduled maintenance functions.

### 2.3.2 Unscheduled Maintenance

Unscheduled maintenance will be performed on spacecraft, ground support equipment and spares as a result of discrepancies and deficiencies found during test operations or during scheduled inspections. This category of maintenance is corrective in nature and is intended to restore equipment to a serviceable condition. Fault isolation and repair are two examples of unscheduled maintenance functions.

## 2.4 MAINTENANCE LEVELS AND FUNCTIONS

Three levels of maintenance (A, B, and C) have been established to provide realistic and economical support through all stages of the Apollo Program. These levels are commensurate with equipment configuration and location, and therefore determine the scope of maintenance functions which may be performed, i.e., fault isolation, verification, repair, servicing, calibration, adjustment, inspection, modification, and overhaul. A- and B-Level maintenance flow is illustrated in Figure 2-1, and C-Level maintenance flow is illustrated in Figure 2-2.

### 2.4.1 A-Level Maintenance

This level of maintenance relates to functions and tasks that are performed on an installed system of flight hardware or GSE. It is maintenance at the system level. A-Level repair of a system is accomplished by the removal of a faulty replaceable package, repair of the package or replacement with a qualified spare, and verification of the system. These activities will include in-place servicing and adjusting that can be performed through external access points.

All A-Level maintenance performed must be within the verification capability of available ground support equipment that is common to systems and inte-

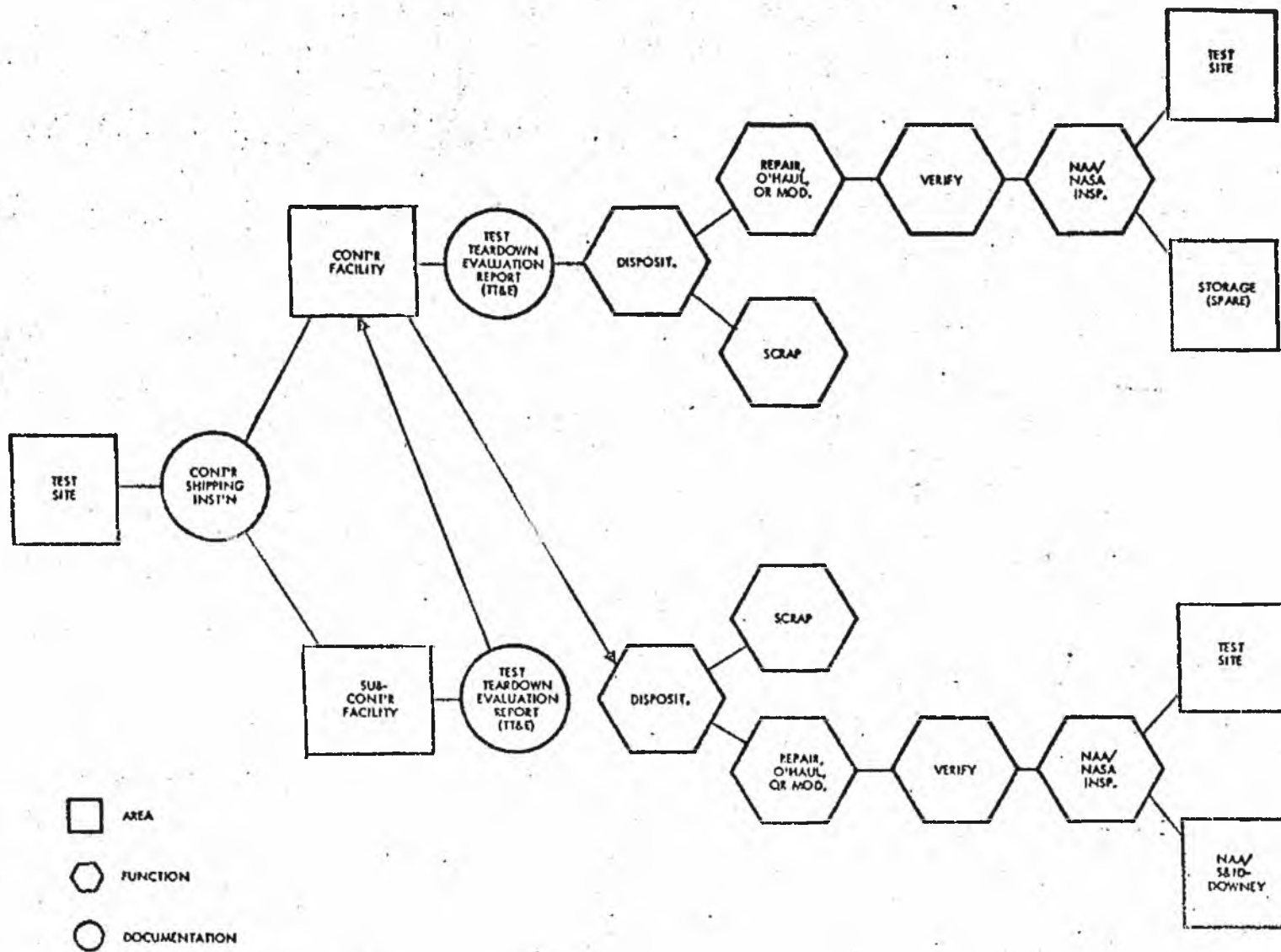


Figure 2-2. C-Level Maintenance Flow

grated systems checkout. This level of maintenance is intended to return a system to an operational condition in the minimum amount of time.

- 2.4.1.1 Testing - System Malfunction. When a system malfunction occurs in an Apollo end item, a test will be conducted with available GSE to isolate the fault to a replaceable package in its installed configuration. At this level of maintenance, test points will be confined to those that are externally located. The GSE used to detect and isolate a fault must also be capable of system verification after repair has been accomplished.
- 2.4.1.2 Repair. The repair of Apollo equipment at this level of maintenance consists of the removal of replaceable packages suspected or determined to be faulty, and the installation of serviceable packages. It also includes the removal and installation of externally accessible items such as bulbs or indicator lens, as well as limited structural repair not requiring disassembly, structural reverification, or special tools and test equipment. No repair will be attempted at this level of maintenance that cannot be performed with available certified equipment, spares, facilities, and trained personnel.
- 2.4.1.3 Servicing. The elements of servicing at this level of maintenance include cleaning, lubricating, charging, flushing, purging, and the replacement of filters and desiccators. All elements of this maintenance function are confined to servicing at externally accessible service points. There will be no requirement to remove replaceable packages at this level of maintenance.
- 2.4.1.4 Calibration and Adjustment. Certain ground support equipment and all test measurement equipment are subject to periodic calibration and adjustment. At this level of maintenance, calibration and adjustment of an assembled

system consists of that which can be accomplished at externally available test and adjustment points. The performance of these tasks will be constrained by the verification capability of available equipment provided for system operational checkout.

2.4.1.5 Inspection. This level of inspection involves the verification of the physical and functional integrity of a system or group of systems while in the operational configuration. It also includes inspections that are associated with the verification of all A-Level maintenance tasks.

Within the maintenance aspect, inspection will occur as a result of a completed maintenance action (conformance verification). An inspection that reveals a discrepancy can also result in a requirement to perform unscheduled maintenance (discrepancy identification). The removal of equipment access doors and inspection plates also constitutes a maintenance action (accessibility requirements).

2.4.1.6 Modification. This level of modification pertains to limited structural changes on spacecraft and ground support equipment that will not require reverification of structural integrity. Modification at an A-Level of maintenance also includes the exchange of a replaceable package for a new configuration or a modified package. It further includes authorized modifications which are possible while the system is in an operational configuration.

2.4.1.7 Overhaul. This activity does not apply to A-Level maintenance.

#### 2.4.2 B-Level Maintenance

This level of maintenance pertains to functions and tasks that are performed on a replaceable package. It is maintenance at the package level. B-Level

repair of a package is accomplished by the removal of a faulty item, and replacement down to the serialized unit level with a qualified spare.

Repair at this level can only be accomplished with the package removed from the end item system of which it is a portion, and will take place in the Bench Maintenance Area where isolation of the failure as well as verification of the repair can be accommodated.

B-Level maintenance will include all tasks that can be performed on a replaceable package in the bench maintenance area, except the disassembly of replaceable serialized units or components that make up the replaceable package.

Internal access points can be serviced, or adjusted and tested as needed to return a replaceable package to an operable condition. On electronic equipment, a replaceable serialized unit will be of the type that does not require soldering for removal or installation...it may be a plug-in or threaded fastener type.

2.4.2.1 Testing - Replaceable Package. The testing of a malfunctioned replaceable package that has been removed from an end item will be performed at the site Bench Maintenance Area. At this level of maintenance, available equipment (BME) will be capable of isolating the fault in a replaceable package to a replaceable serialized unit or units, and will verify the serviceability of the package after repair has been made.

2.4.2.2 Repair. Apollo equipment repair at this level of maintenance applies particularly to the restoration of replaceable packages to a serviceable condition after malfunction and removal from a system. After the malfunction is isolated to a replaceable serialized unit, repair will consist of removing the faulty unit and installing a serviceable spare.

Repairs that are more complex and require a deeper penetration than that involved in the exchange of a replaceable serialized unit will be considered C-Level maintenance which is covered under the overhaul phase. Under certain conditions at a Test Site, an exception might be made to allow the exchange of a faulty part in a replaceable unit with a provisioned spare (C-Level maintenance).

- 2.4.2.3 Servicing. The elements of servicing at this level of maintenance are essentially the same as those described under A-Level, but at a greater depth. Consequently, the performance of this function is extended to include the removal of replaceable packages or units in order to permit servicing at internally located access points.
- 2.4.2.4 Calibration and Adjustment. At this level of maintenance, access to a replaceable package is required in order to accomplish calibration and adjustment. These functions shall only be performed on a replaceable package or one of its replaceable units in a Bench Maintenance environment. The calibration or adjustment of equipment that cannot be verified with available BME or standard certified test equipment will be avoided.
- 2.4.2.5 Inspection. The performance of inspection at this level of maintenance applies particularly to the verification of integrity of equipment assigned to the Bench Maintenance Area for maintenance. It also includes the verification and acknowledgement of all maintenance tasks performed at the E-Level.
- 2.4.2.6 Modification. End item modification at this level of maintenance generally comprises the exchange of a replaceable unit in a replaceable package with a modified unit. However, it may also include any end item component modification that has been approved, and that can be performed within the parameters of B-Level maintenance.



2.4.2.7 Overhaul. This activity does not apply to B-Level maintenance.

2.4.3 C-Level Maintenance

This level of maintenance provides the most comprehensive capability of the three levels established. It encompasses all maintenance that lies beyond the scope of levels previously described. C-Level maintenance will be performed at the contractor's facility or a subcontractor's facility, where all of the provisions for modification, repair, or overhaul that can be accomplished are available. The maximum depth of penetration is possible in C-Level maintenance, since fault isolation can be carried to the lowest replaceable part or group of parts with factory equipment. This equipment will provide a verification capability sufficient to accomplish the certification of all items repaired.

To prevent the costly duplication of test equipment, the contractor and its subcontractors will perform modification, repair and overhaul with the same facilities as used in manufacturing.

2.4.3.1 Modification, Repair and Overhaul. The modification, repair and overhaul of Apollo end items at a C-Level of maintenance accommodates the performance of these functions to the level required, e.g., complete modification, repair or overhaul to the lowest part level...such as a resistor, diode, seal or bracket. The fault isolation and repair verification capability of available ground support equipment will permit the accomplishment of all maintenance required.

2.5 MAINTENANCE AREAS

Maintenance of Apollo end items and materiel will be performed at the contractor's facility, at subcontractors' facilities, and at the Test Sites. The contractor's and subcontractors' facilities will be programmed to accommodate C-Level maintenance, and the test sites will be programmed to support B-Level maintenance.

## 2.5.1 S&ID-Downey

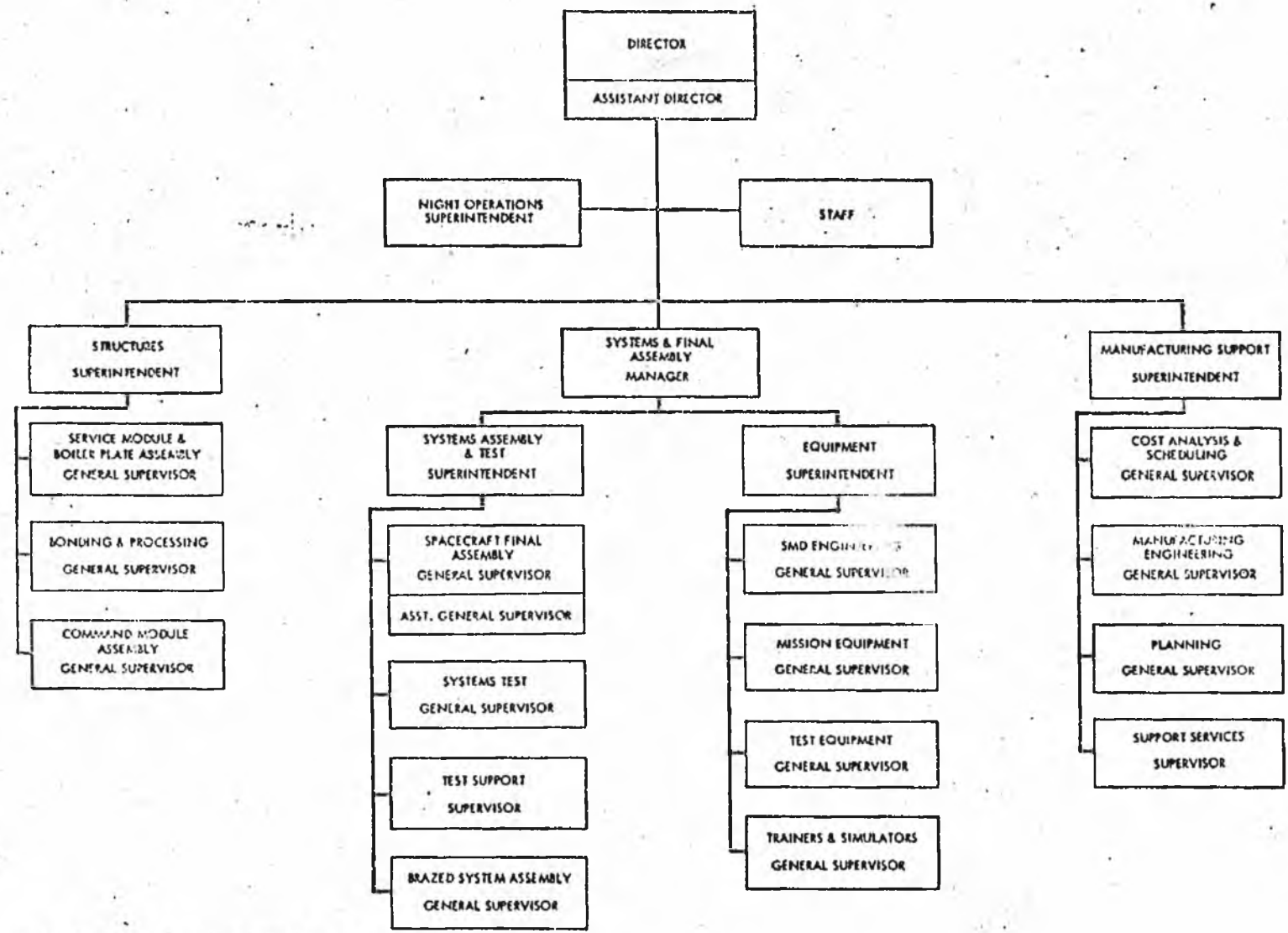
All levels of maintenance support for end items and materiel are provided by the contractor at S&ID-Downey. Manufacturing provides the organization (see Figure 2-5) and facilities to support Downey Test Operations as well as Test Site requirements. Manufacturing Bench Maintenance is organized and oriented to support Downey Test Operations, as well as to support C-Level maintenance requirements originating at the Test Sites.

2.5.1.1 Bench Maintenance Area. The Bench Maintenance Area at S&ID-Downey is located in Building 290. This area is equipped to permit A, B, and some C-Level modification, repair and overhaul of Apollo end items and materiel. Subcontractor maintenance equipment and personnel are also situated in the area to provide specialized testing, repair, and certification of subcontractor furnished items. To preclude the compromise of hardware reliability during maintenance, this area is equipped to provide a high degree of environmental control, i.e., cleanliness, humidity, and temperature control.

2.5.1.2 Manufacturing Production Area. NAA/S&ID manufacturing production facilities are located within the Downey complex. This complex provides back-up support for C-Level maintenance requirements that are generated at Downey and the Test Sites. The same organization, facilities, equipment, and personnel which were utilized for the initial fabrication of Apollo hardware will be used to perform modification, repair and overhaul of end items and materiel.

## 2.5.2 Florida Facility

The contractor maintains an activity at the Florida Facility to provide maintenance support for Apollo Test Operations at that site. Apollo Test and Operations, (see Figure 2-4) at the Florida Facility, is organized



\*ABOVE FUNCTIONAL DEPARTMENTS PROVIDE MAINTENANCE SUPPORT TO DOWNEY AND TEST SITE OPERATIONS

Figure 2-3. Apollo Manufacturing Organization, S&ID-Downey

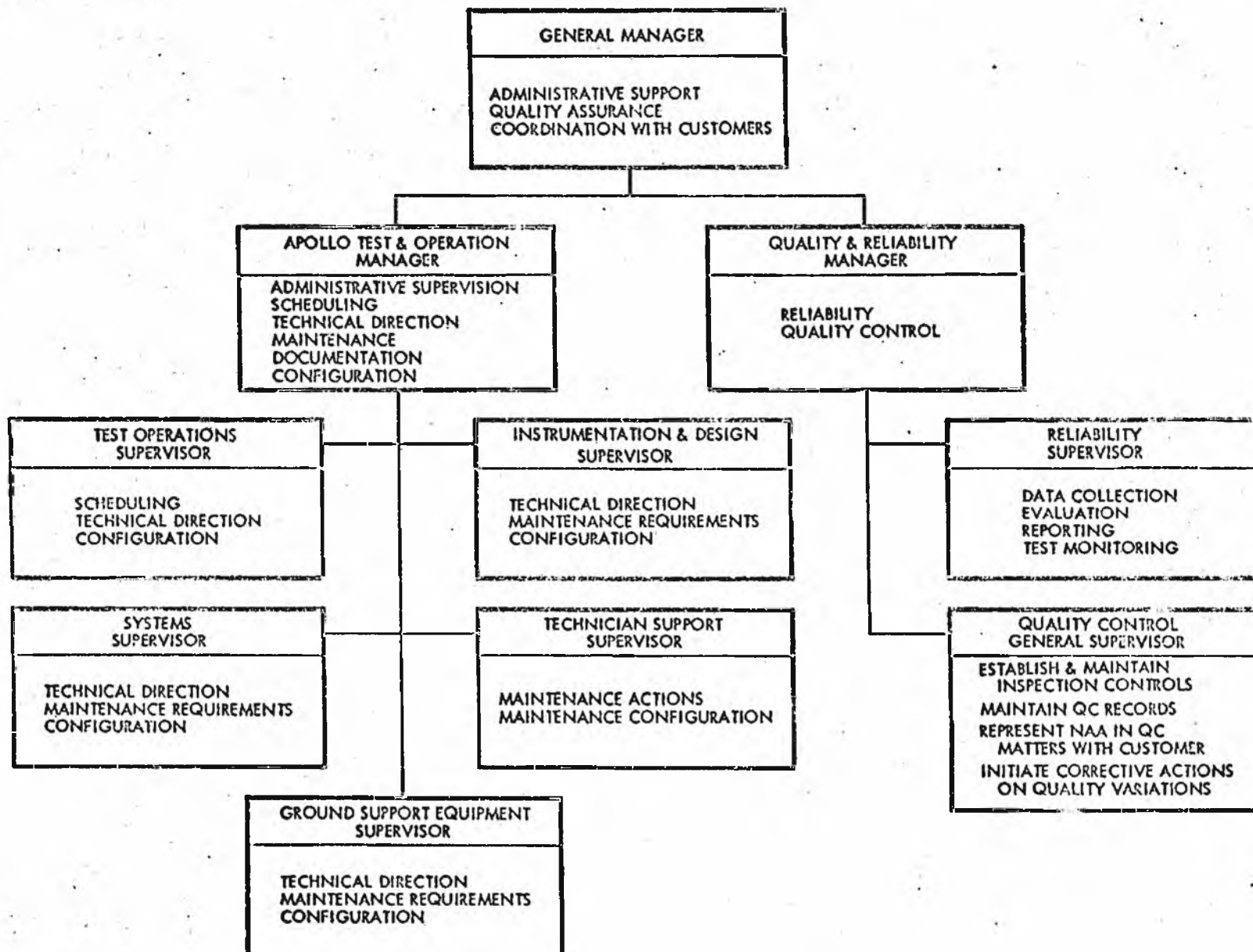


Figure 2-4. S&ID Apollo Program Organization, Florida Facility

to provide A- and B-Level maintenance support. There are three principal areas at this site where maintenance will be performed. These are the Operations and Checkout Area, the Launch Area, and the Bench Maintenance Area.

- 2.5.2.1 Operations and Checkout Area. Maintenance tasks performed in this area support the receiving and checkout of spacecraft, systems, subsystems, and related ground support equipment prior to transfer to the launch area. Maintenance support in this area is generally limited to A-Level and involves the inspection, test, adjustment, calibration, removal, installation, and verification of replaceable packages. Modification that is within the capability of programmed equipment and personnel may also be performed in this area. All B-Level maintenance requirements that originate in the Operations and Checkout Area are supported by the Bench Maintenance Area.
- 2.5.2.2 Launch Area. Maintenance tasks performed in this area involve the mating of launch vehicle and spacecraft, with subsequent servicing and preflight checkout. Maintenance requirements occurring in this area are predominantly of an unscheduled nature. Launch Area maintenance tasks will generally be limited to the A-Level. B-Level maintenance requirements originating in this area will be supported by the Bench Maintenance Area.
- 2.5.2.3 Remote Areas. In addition to the three principal areas cited above, certain maintenance tasks will be performed in the Static Firing Facility, Cryogenic Facility, Radar Bore Sight Facility, Parachute Facility, Hypergolic Facility, Ordnance Facility, and Environmental Control Facility. Maintenance tasks performed in these areas are generally limited to A-Level

and consist of such functions as inspection, servicing, calibration, and minor modification. The site Bench Maintenance Area will provide B-Level support for the Remote Areas.

2.5.2.4 Bench Maintenance Area. This area has been programmed to provide B-Level Maintenance support for the Operations and Checkout Area, the Launch Area, and the Remote Areas, and will have repair and recertification capabilities to a replaceable package level. Maintenance tasks performed in the Bench Maintenance Area will consist primarily of fault isolation in replaceable packages to the lowest replaceable unit, and recertification of the package when repair is completed. Certain modification tasks will also be performed in the Bench Maintenance Area. These will include the installation of modified replaceable units in replaceable packages, as well as other specifically authorized changes that are within the verification capability of available GSE. Maintenance requirements originating at the site that are beyond the B-Level capability will be referred to the contractor or subcontractor as appropriate. These items are routed in accordance with the Source Maintenance Recoverability (SMR) code which designates the repair location. The SMR code is defined and described in the Apollo Support Plan, SID 62-702-1.

2.5.3 White Sands Missile Range

Maintenance support requirements exist at WSMR in two widely separated locations, and for two entirely different test operations. These locations are the Mission Abort Area and the Propulsion Systems Development Facility (PSDF). Maintenance activities at Mission Abort and PSDF are under the immediate direction of their respective Chief of Test Operations and these, organizationally, are subordinate to the overall direction of the WSMR Test Manager (see Figure 2-5).

Maintenance requirements originating at Mission Abort or PSDF which are beyond the programmed capability of these areas will be referred to the contractor or subcontractor. The SMR code assigned to reparable items designates where they will be repaired. This information is contained in the Site Support List.

2.5.3.1 Mission Abort Area. The Mission Abort Area contains a Vertical Assembly Building (VAB) and a Launch Facility. Receiving inspection and checkout of systems and ground support equipment takes place in the VAB. Scheduled and unscheduled maintenance tasks performed in this building are all confined to the A-Level. Stacking and integrated system checkout are conducted at the Launch Facility, utilizing the launch pad and service tower. Maintenance tasks performed in this area are generally of an unscheduled nature, and are also confined to the A-Level. Modifications of a minor nature that fall within an A-Level capability will be performed at both the VAB and the Launch Facility.

A Meter Room, situated in the VAB, is equipped with sufficient bench maintenance equipment (BME) to provide B-Level maintenance support for mission abort test operations.

The Technical Area of the WSMR complex contains laboratory and test facilities far more extensive than those located at the Apollo test areas. Arrangements will be made through NASA to obtain support from these facilities when the maintenance capability at the Mission Abort Area proves inadequate.

2.5.3.2 Propulsion Systems Development Facility. Maintenance is performed in two locations at the PSDF. These locations are the Test Fixture Area and the Meter Room. Maintenance tasks performed in the Test Fixture Area generally fall within the A-Level and involve receiving inspection, servicing, cali-

bration, minor modification, etc. The Meter Room contains EME that provides B-Level maintenance support to the Test Fixture Area.

As with the Mission Abort Area, arrangements will be made to obtain support from the Technical Area of the WSMR complex when the maintenance capability at PSDP proves inadequate.

#### 2.5.4 Manned Spacecraft Center

Spacecraft environmental test programs encompassing all of the multiple system environmental chamber (thermal-vacuum) tests will be conducted in the Environmental Proof Simulator Facility at the Manned Spacecraft Center (MSC). Maintenance performed in support of these tests will occur in the Assembly and Checkout Area, the Test Chamber, and the Bench Maintenance Area. Trainer Maintenance is the responsibility of MSC. The organization responsible for maintenance at MSC is shown in Figure 2-6.

2.5.4.1 Assembly and Checkout Area. The receipt, assembly and checkout of spacecraft, prior to insertion in the Test Chamber, will be conducted in the Assembly and Checkout Area located adjacent to the Test Chamber. Maintenance tasks performed in this area will generally be confined to the A-Level, and will consist of inspection, servicing, testing, etc. Minor modifications that fall within the A-Level capability may also be performed in this area. Maintenance requirements originating in this area that are beyond the A-Level will be supported by Bench Maintenance.

2.5.4.2 Test Chamber Area. Maintenance tasks performed in this area will generally be of an unscheduled nature and confined to the A-Level. These tasks will include fault isolation to the removable package level, as well as removal, installation and system verification.



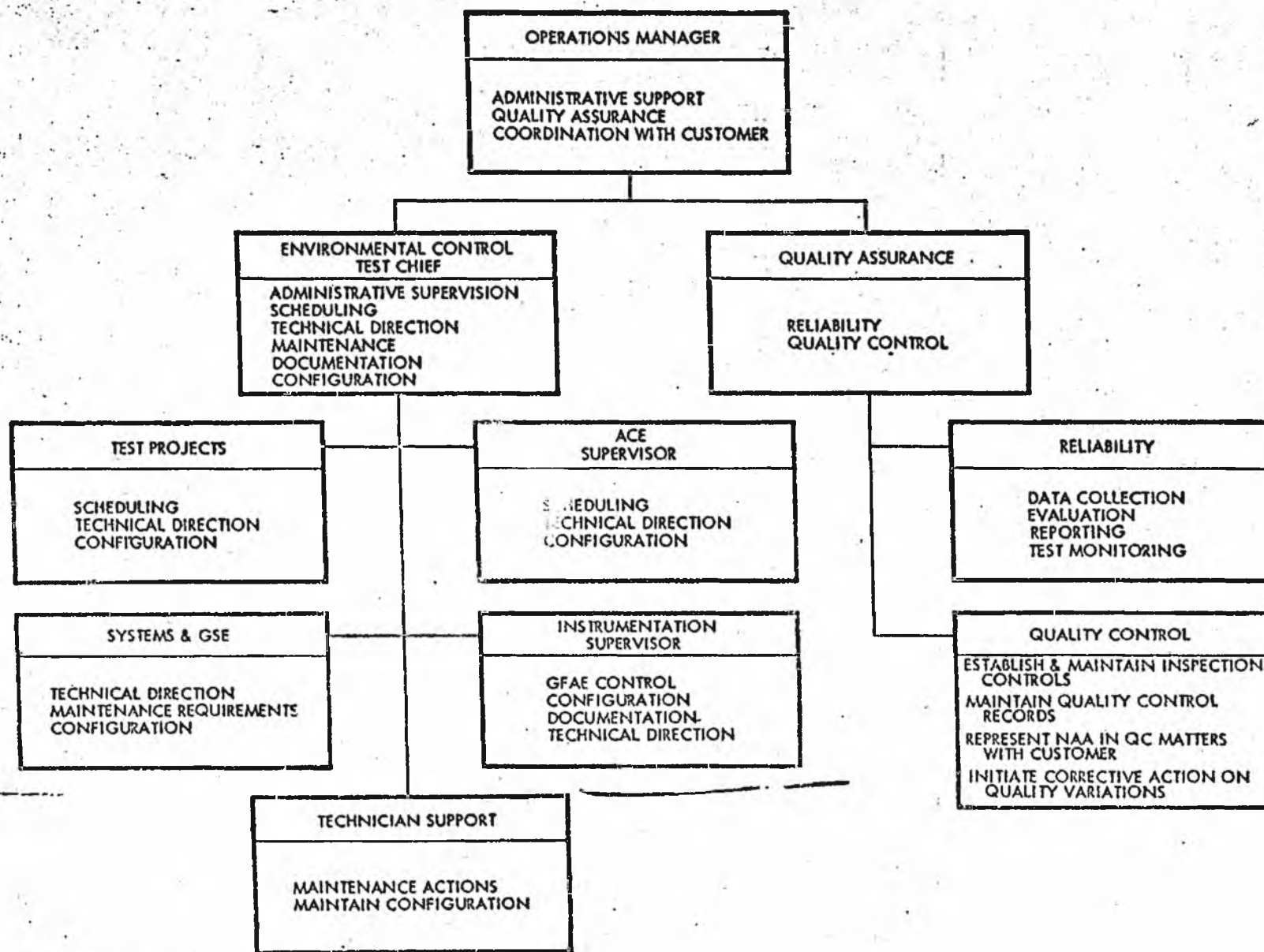


Figure 2-6. S&ID, Apollo Program Organization, Manned Spacecraft Center

2.5.4.3 Bench Maintenance Area. The Bench Maintenance Area at MSC is intended to provide B-Level maintenance support to the Assembly and Checkout Area and, in some instances, to maintenance requirements originating in the Test Chamber.

Maintenance tasks performed in this area will primarily involve fault isolation of replaceable packages to the lowest replaceable unit, and certification of the unit when repair is completed. Certain modification tasks will also be performed in the Bench Maintenance Area. These will include the installation of modified replacement units in replaceable packages, as well as other specifically authorized changes that are within the verification capability of available GSE. Maintenance requirements originating at MSC that are beyond the B-level will be referred to the contractor or subcontractor as designated in the SMR code. The Site Support List contains SMR code information.

2.5.5 El Centro Parachute Test Facility

Northrop-Ventura has prime responsibility at the El Centro Parachute Test Facility. However, NAA will provide maintenance support from S&ID-Downey on an "as required" basis. A small stock of spares is maintained at El Centro, and NAA/S&ID provides a parts man and liaison engineer to the facility.

2.5.6 Marshall Space Flight Center

The extent of maintenance to be performed at Marshall Space Flight Center (MSFC) is presently unknown. When information on the subject is available, it will be included in the plan. Once defined, the maintenance effort required at MSFC shall be a matter of separate contractual coverage.

## 2.5.7 Subcontractor Maintenance

Major subcontractors provide maintenance support at their respective manufacturing facilities, at S&ID-Downey, and at the test sites. Each of these subcontractors have prepared and submitted a support plan which delineates the maintenance support they will provide. These plans have been approved by the contractor.

2.5.7.1 Subcontractor Facilities. Equipment and personnel to accommodate C-Level maintenance will be available at subcontractor facilities to provide maximum product support.

2.5.7.2 S&ID-Downey Facility. Major subcontractors will provide equipment and personnel for the Downey Bench Maintenance Area to support the system, subsystem, and component maintenance requirements of their product. The maintenance performed here will generally be confined to the B-level, whereas C-Level maintenance will usually be performed at their respective manufacturing facilities.

2.5.7.3 Test Sites. Major subcontractors will maintain field engineers and field service engineers at the Test Sites to advise and assist NAA/S&ID maintenance personnel in the performance of maintenance on subcontractor products. Major subcontractors will provide technicians to familiarize and train the contractor's maintenance personnel in the operation and maintenance of subcontractor products.

## 2.6 PREINSTALLATION ACCEPTANCE (PIA)

Preinstallation acceptance of designated spares has been established as a requirement to ensure that the reliability of spacecraft and GSE systems and subsystems will not be compromised.

## 2.6.1 PIA Spares

Spacecraft and supporting GSE spares are classified in accordance with certain criteria and require PIA at varying depths and intervals. Some of the criteria that is considered in determining the classification of PIA spares are criticality, storage, material composition, reliability history, installation manhours, complex circuitry, and effect on vehicle system or GSE when installed.

### 2.6.1.1 PIA Spares Classification. Classification of PIA spares are as follows:

Class 1 - Critical or complex items clearly requiring site receiving, periodic, and preinstallation functional verification.

Class 2 - Items requiring site receiving and preinstallation test.

Class 3 - Items requiring site receiving, periodic, and preinstallation test. Subsequent to preinstallation test, items will be calibrated.

add 4,5 & 6

## 2.6.2 PIA Implementation

Preinstallation acceptance of designated spacecraft and supporting GSE spares will be performed at S&ID-Downey and at the Test Sites. The performance of PIA will be accomplished by Manufacturing Bench Maintenance and subcontractor maintenance support at S&ID-Downey, and site bench maintenance at the Test Sites. Maintenance tasks involved in PIA will generally fall within the B-Level capability.

## 2.7 MAINTENANCE DOCUMENTATION

Documentation is an essential requirement of the maintenance support activity, and is used to maintain control, to provide historical records, and to identify the condition of Apollo end items and materiel. Succeeding para-

graphs describe the documentation that is required to fulfill the requirements, and illustrations of the various forms involved in processing work-ware through the maintenance cycle are also included.

#### 2.7.1 Test and Inspection Record

A work book system will be initiated for the purpose of accounting each maintenance action performed on Apollo and items throughout their service life. The system is embodied in the Test and Inspection Record (TIR) Book which comprises a series of forms, and will be used to provide authorization, authorization, recording, sign-off, and verification of all work performed on the individual item involved. A TIR Book will be provided for each item as demanded necessary.

Apollo Quality Control will maintain the TIR Books and ensure that all work entries have been completed with. The following paragraphs provide a description of the purpose and use of TIR Book forms that pertain to the name of Apollo and items.

2.7.1.1 Test Preparation Sheet. The Test Preparation Sheet (TPS) is prepared to authorize and implement testing or test scheduling, maintenance, and configuration changes on Apollo and items. The TPS (see Figure 2-7) is used to initiate or document the following:

- a. Perform work to accomplish a temporary configuration change.
- b. Perform work to accomplish changes authorized by a released Engineering Order (EO) or Field Engineering Order (FEO).
- c. Perform tests in accordance with an Operational Test Procedure (OTP) or Process Specification.



- d. Document the need for procurement or fabrication of components or parts.

Apollo Test and Operations will initiate a TPS for each item of work to be performed on Spacecraft and ground support equipment. The task requirement will be entered and approved on this form prior to work being accomplished. On completion of the work item(s) described, Quality Control will verify the quality performance of the task and an inspection verification stamp will be entered on the form. The TPS provides a means of maintaining a permanent record of work performed. The flow of TPS and TPMS Forms are illustrated in Figure 2-8.

- 2.7.1.2 Test Preparation Modification Sheet. The Test Preparation Modification Sheet (TPMS) will authorize work which represents a correction, addition or deletion to a TPS as originally released. Apollo Test and Operations will prepare a TPMS (see Figure 2-9) before the TPS is completed and closed out. The TPMS shall be indexed and filed as an integral part of the original TPS.
- 2.7.1.3 TPS & TPMS Index. This document will serve as an index of all Test Preparation Sheets and Test Preparation Modification Sheets originated, and will sequentially list each TPS and TPMS prior to work being accomplished. NAA/SAID and NASA Quality Control will indicate the completion of work by inserting an inspection acceptance stamp in an appropriate block of the index (see Figure 2-10).
- 2.7.1.4 Discrepancy Record. This form will be used to record discrepancies on spacecraft, ground support equipment, and spares. A Discrepancy Record (DR) will be initiated on items which cannot be returned to design configuration, or on discrepancies which invalidate a previously accepted test. The DR (see Figure 2-11) can be initiated by either SAID Quality Control, Apollo Test and Operations, or NASA Quality Assurance and Inspection.

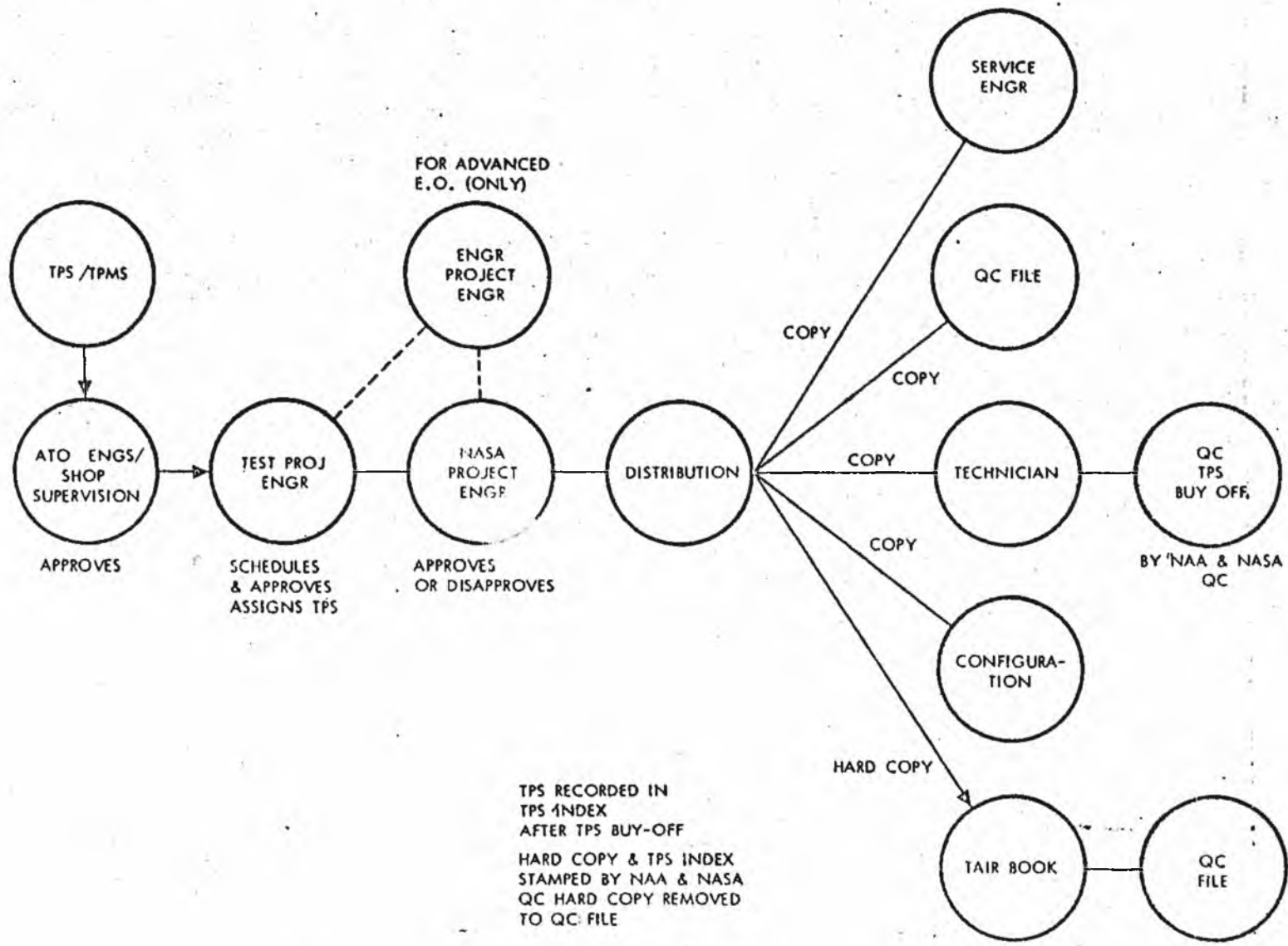


Figure 2-8. TPS & TPMS Flow Diagram



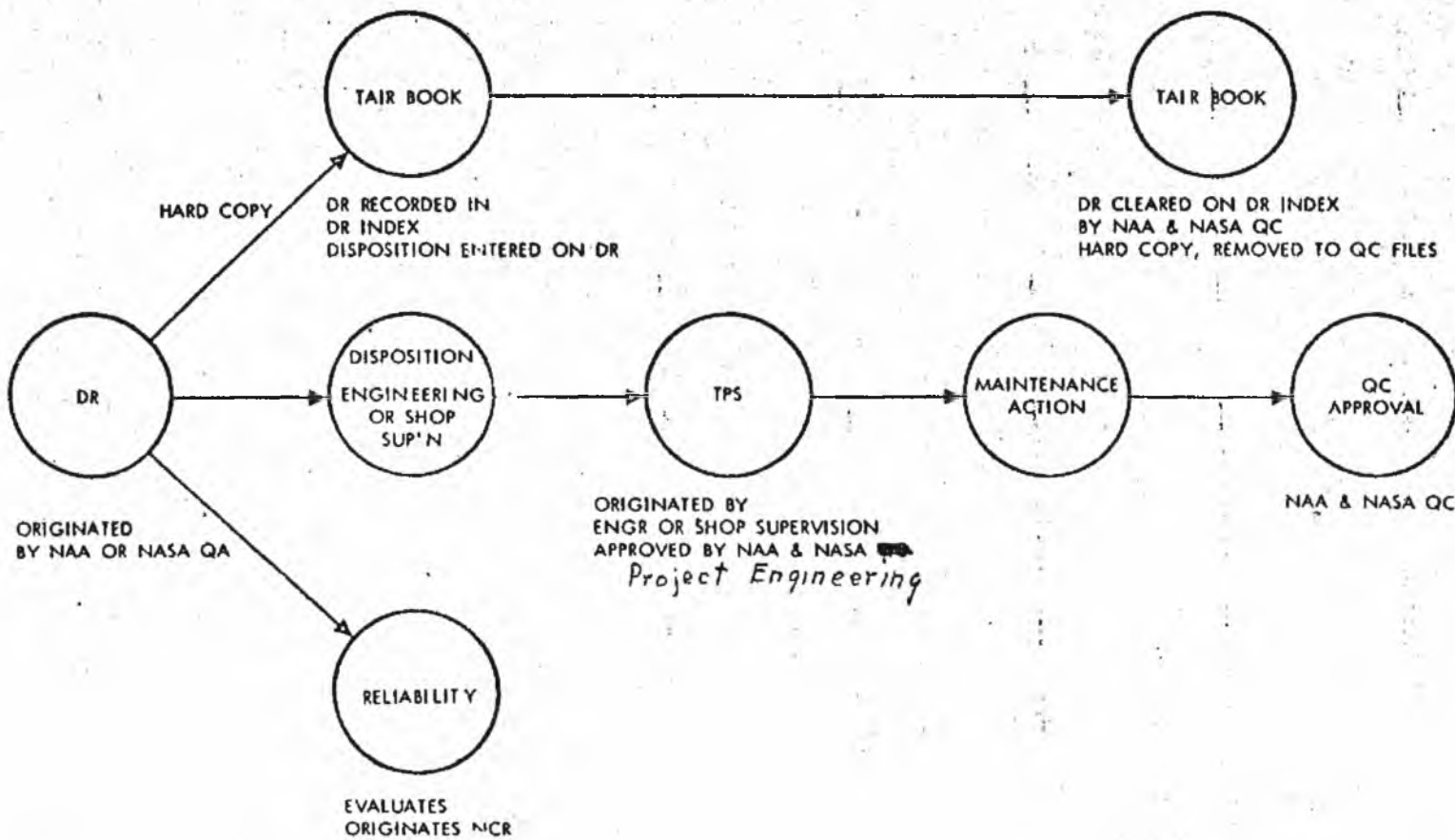






Disposition of a DR requires both S&ID and NASA Engineering approval. The flow of discrepancy records and discrepancy record squawk sheets are illustrated in Figure 2-12.

- 2.7.1.5 Discrepancy Record Squawk Sheet. A Discrepancy Record Squawk Sheet (DRSS) will be used to record minor discrepancies on spacecraft, ground support equipment, and spares. The DRSS (see Figure 2-15) will be initiated on items that can be returned to design configuration, and may be prepared by either S&ID or NASA Quality Control. Discrepancies will be entered sequentially in the DRSS and each squawk sheet shall be numbered. Corrective action on a DRSS will be determined by either ARES Engineering or ARES Shop Supervision.
- 2.7.1.6 Discrepancy Record Index. This index (see Figure 2-14) will be maintained by S&ID Quality Control, will sequentially list each DR written, and will accurately reflect DR status. Upon the satisfactory completion of a DR disposition action, the DR hard copy will be removed from the applicable TADR Book. A buy-off will be effected by entry of the DR in the Discrepancy Record Index, and verified by an S&ID and NASA Quality Control inspection verification stamp.
- 2.7.1.7 Part Removal Record. Any part or component to be removed from Apollo end items will be listed on the Part Removal Record, Form 79-Q (see Figure 2-15). In addition to part name, identification number and serial number, the reason for removal will be noted. Quality Control will verify each removal and replacement, and will also record the new part serial number and the original part number before the removal or replacement is accomplished. In conjunction with the entry on Form 79-Q, entries will also be made on the Installed Equipment Serialization Record and the Operational Time Change Items forms.



DR & DRSS FLOW

Figure 2-12. Discrepancy Record and Discrepancy Record Squawk Sheet Flow Diagram





DISCREPANCY RECORD SQUAWK SHEET

ASSEMBLY NAME \_\_\_\_\_

PAGE NUMBER \_\_\_\_\_

ASSEMBLY NUMBER \_\_\_\_\_

SERIAL NUMBER \_\_\_\_\_

NO.	SQUAWK			
DATE				
DISPOSITION			WRITTEN BY	
	DATE	TECH	NAA	CUST
NO.	SQUAWK			
DATE				
DISPOSITION			WRITTEN BY	
	DATE	TECH	NAA	CUST
NO.	SQUAWK			
DATE				
DISPOSITION			WRITTEN BY	
	DATE	TECH	NAA	CUST
NO.	SQUAWK			
DATE				
DISPOSITION			WRITTEN BY	
	DATE	TECH	NAA	CUST

Figure 2-13. Discrepancy Record Squawk Sheet







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**PART REMOVAL RECORD**

DEPARTMENT \_\_\_\_\_ MODEL \_\_\_\_\_ UNIT NO. \_\_\_\_\_ S/N \_\_\_\_\_

ITEM	SERIAL NO.		OK TO REMOVE			REMOVED BY	OK TO INSTALL			INSTALLATION OK			OPERATION OK				
	ORIG.	NEW	DATE	CO. INSP.	CUST. INSP.	CO. MECH.	DATE	CO. MECH.	CO. INSP.	DATE	CO. MECH.	CO. INSP.	DATE	CO. MECH.	CO. INSP.	CUST. INSP.	
1 PART NAME																	
2 PART NUMBER																	
1	REASON FOR REMOVAL & LOCATION																
2	REASON FOR REMOVAL & LOCATION																
1	REASON FOR REMOVAL & LOCATION																
2	REASON FOR REMOVAL & LOCATION																
1	REASON FOR REMOVAL & LOCATION																
2	REASON FOR REMOVAL & LOCATION																
1	REASON FOR REMOVAL & LOCATION																
2	REASON FOR REMOVAL & LOCATION																
1	REASON FOR REMOVAL & LOCATION																
2	REASON FOR REMOVAL & LOCATION																
1	REASON FOR REMOVAL & LOCATION																
2	REASON FOR REMOVAL & LOCATION																

FORM M 12301 REV 1-62

M 12301 -R

Part Removal Record

Figure 2-15. Part Removal Record

4-7



- 2.7.1.8 Installed Equipment Serialization Record. The Installed Equipment Serialization Record, Form 917-B (see Figure 2-16), will be used to record all part names, part numbers, serial numbers, installation date and, if applicable, property tag numbers of installed parts, assemblies, components and modules. Entries will be made by Quality Control with the assistance of Apollo Test and Operations, and verified by inspection. Appropriate entries will also be made in the Part Removal Record.
- 2.7.1.9 Operating Time and Discrepancy Record. This document, Form 917-A (see Figures 2-17 and 2-18), will be used for accountability and traceability, as well as to record operating time or cycles and discrepancies of functional time-significant items. Quality Control will make entries on this form, which will also be used in conjunction with the Operational Time Change Items form.
- 2.7.1.10 Operational Time Change Items. Quality Control will use the Operational Time Change Items, Forms 917-A (see Figure 2-19), to record the transfer of operating time/cycles from the Operational Time and Discrepancy Record when a functional assembly is absorbed into a higher assembly.

## 2.7.2 Material Condition Identification

Material condition status tags (AF Form 50 Series) are utilized in this program to identify the condition of individual items of material. These tags are attached to an item at all times, except when the item is installed as part of a system, subsystem, assembly or GSE. The following paragraphs describe the individual tags and their purpose.

- 2.7.2.1 Serviceable, Incomplete Status & Hold Tag. The Serviceable, Incomplete Status and Hold Tag, AF Form 50E (see Figure 2-20) is yellow. This tag is





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OPERATING TIME

1 PART NAME	2 PART NO.	3 SERIAL NO.	4 TYPE OR MODEL	5 OPERATION TYPE		6 DATE	
7 NEXT REPLACEMENT(S) DUE				8 TIME	9 CYCLES	10 FROM 970	
11 UNIT OF MEASUREMENT			12 PRIOR OPERATING TIME/CYCLES				
13 SYSTEM CODE				14 FACILITY			

	12 OPERATIONS																		
	A DATE	B START TIME	C STOP TIME	D OPERATION		E TOTALS		F CLOCK NO.	G OCCURRED DURING	A DATE	B START TIME	C STOP TIME	D OPERATION		E TOTALS		F CLOCK NO.	G OCCURRED DURING	
				TIME	CYS	TIME	CYS						TIME	CYS	TIME	CYS			
1										22									
2										23									
3										24									
4										25									
5										26									
6										27									
7										28									
8										29									
9										30									
10										31									
11										32									
12										33									
13										34									
14										35									
15										36									
16										37									
17										38									
18										39									
19										40									
20										41									
21										42									

FORM 917-A (REV. 3-63)

NOTE: CYCLES MUST BE RECORDED WHEN OPERATING TIME ACCUMULATES

PAGE \_\_\_ OF \_\_\_ PAGES

~~Operating Time and Discrepancy Record (Sheet 1 of 2)~~

Figure 2-17. Operating Time and Discrepancy Record (Sheet 1 of 2)







STOCK AND PART NUMBER		ITEM DESCRIPTION	CLASS	UNIT OF ISSUE	QUANTITY	ITEM NO.	SERIAL NUMBER
ASSY BOX NO.		ORDER OR CONTRACT NO.					
NAME OF ACTIVITY, MANUFACTURER OR USING ORG							
TECHNICAL ORDER COMPLIANCE RECORD							
REASON FOR HOLDING							
TECHNICAL ORDER NO. AND DATE						Insp Stamp & Date	
Date Inspco Required Prior to Issue							
Preliminary or Special Status Inspection. Indicate applicable info.		The following parts have been removed from the assembly and must be replaced to be complete.					
		Class	Qty.	Stock/Part No.			
AF FORM 50B SEP 57 Previous editions of this form may be used.		SERVICEABLE, INCOMPLETE, STATUS AND HOLD TAG					

Do not use this form for more than one year or both (1) (2) USC (1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12) (13) (14) (15) (16) (17) (18) (19) (20) (21) (22) (23) (24) (25) (26) (27) (28) (29) (30) (31) (32) (33) (34) (35) (36) (37) (38) (39) (40) (41) (42) (43) (44) (45) (46) (47) (48) (49) (50) (51) (52) (53) (54) (55) (56) (57) (58) (59) (60) (61) (62) (63) (64) (65) (66) (67) (68) (69) (70) (71) (72) (73) (74) (75) (76) (77) (78) (79) (80) (81) (82) (83) (84) (85) (86) (87) (88) (89) (90) (91) (92) (93) (94) (95) (96) (97) (98) (99) (100)

(YELLOW)

Figure 2-20. Serviceable, Incomplete Status Hold Tag

attached to items that are ready for use in all respects, or that are ready for use except for changes to be incorporated or tests to be performed.

Removal of this tag can only be made with the authority of Quality Control.

2.7.2.2 Reparable Tag. The Reparable Tag, AF Form 50D (see Figure 2-21), is green. This tag is used to identify materiel that is not serviceable but that is reparable. Whenever an item is determined to be unserviceable by test, inspection, or other means, a determination will be made as to the reparability of the item. If determined to be reparable, a Reparable Tag will be attached to the item. The tag will remain attached until the item undergoes repair, or until other disposition has been determined.

2.7.2.3 Rejected or Condemned Tag. The Rejected or Condemned Tag, AF Form 50E (see Figure 2-22), is red. This tag is attached to any item that is determined by inspection, test, or other means to be malfunctioning or unserviceable. The tag will remain attached to an item until a determination has been made as to whether or not the item is reparable. If the item is determined to be reparable, the Rejected or Condemned Tag will be removed and replaced with a Reparable Tag.

## 2.8 SUPPORT MANUALS

In accordance with contractual requirements, Apollo support manuals shall be developed by the contractor and its subcontractors to cover the Apollo spacecraft, ground support equipment and trainers. These manuals provide procedure information on end item checkout, operation and maintenance, as well as transportation and handling. Support manual management and development is fully described in the Apollo Support Plan, SID 62-702-1.





<p style="font-size: small;">REVISION: 8-6-64</p> <p style="font-size: x-small;">not more than \$1,000 or (whichever is less) for not more than one year or both. (18 USC 1345)</p> <p style="text-align: center;">○</p> <p style="font-size: x-small;"><b>WARNING</b> Unauthorized persons removing, adding, or changing this tag (or its label) may be subject to a fine of \$1,000.</p>	STOCK AND PART NUMBER ITEM DESCRIPTION CLASS		UNIT OF ISSUE	QUANTITY	ITEM NO.	SERIAL NUMBER	
				ASSY BOX NO.	ORDER OR CONTRACT NO.		
				NAME OF ACTIVITY, MANUFACTURER OR USING ORG			
				REMOVED FROM AIRCRAFT, ENGINE OR ASSEMBLY, TYPE, MODEL, SERIES, SERIAL NO.			
REASON FOR REPARABLE CONDITION		REPAIR CYCLE DATA		TIME OP (Hrs or Miles)		MAINTENANCE REQUIRED	
Exceeded Op Limits <input type="checkbox"/>	Time Expired <input type="checkbox"/>	REMOVED	BASE ACCT. NO.	Organizational		Field Depot	
Fatigue <input type="checkbox"/>	Bench Check Before Reuse <input type="checkbox"/>	RECEIVED IN BASE SUPPLY		ROUTING		WORK ORDER NO.	
Excessive Wear <input type="checkbox"/>	Remanaging Time	SHIPPED TO SEA		Dept Sym	Date In	Date Out	Insp Init
OTHER - SPECIFY (Special Instructions)		RECEIVED AT SEA					
		ORDERED BY MAINT.					
		RECEIVED IN MAINT. SHOP					
		MADE SERVICEABLE					
AF FORM 60D FEB 63		REPARABLE TAG					
		Previous editions of this form will be used.					

(GREEN)

Figure 2-21. Reparable Tag



<p style="text-align: center;"><b>WARNING</b></p> <p>UNAUTHORIZED PERSONS RE- MOVING OR DESTROYING THIS TAG OR LABEL MAY BE SUBJECT TO A FINE OF NOT MORE THAN \$1,000 OR IMPRISONMENT FOR NOT MORE THAN ONE YEAR OR BOTH. (U.S. AIRC 1.34.1)</p>	STOCK AND PART NUMBER	ITEM DESCRIPTION	CLASS	UNIT OF ISSUE	QUANTITY	ITEM NO.	SERIAL NUMBER	
					ASSY BOX NO.	ORDER OR CONTRACT NO.		
	REASON OR AUTHORITY FOR CONDEMNATION OR REJECTION				NAME OF ACTIVITY, MANUFACTURER OR USING ORG			
					REMARKS			
AF FORM 50E JAN 59		PREVIOUS EDITIONS OF THIS FORM MAY BE USED		REJECTED OR CONDEMNED TAG		INSP. STAMP & DATE		

(RED)

Figure 2-22. Rejected or Condemned Tag

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SPACE AND INFORMATION SYSTEMS DIVISION

## BIBLIOGRAPHY

The bibliography presented below contains a brief description of the purpose and content of Apollo Program documents that have been referred to at one point or another in this Plan.

### Apollo Program Plan (Confidential), SID 62-223

This document describes the effort involved in designing and developing the Apollo Command Module, Service Module, and Spacecraft Adapter, and integrating the Lunar Excursion Module (LEM) into the total spacecraft design. The Program Plan is divided into three sections: The management plans, the technical development plan, and summaries of other pertinent plans. The purpose of this document is to present to the reader a comprehensive understanding of all aspects of the total program.

### General Test Plan, SID 62-109 Series

The General Test Plan is presented in five volumes, containing test plan research and development information for Project Apollo Spacecraft. Each of the volumes is revised quarterly by the System Integration Department of Apollo Engineering.

### General Test Plan Research and Development for Project Apollo Spacecraft (Confidential), SID 62-109-1

This volume presents the overall test logic for Project Apollo and provides a summary of the testing activities relating to individual system, ground qualification, acceptance, and multiple systems. The summarized information concerns objectives, procedures, schedules, and facilities.

General Test Plan Research and Development for Project Apollo Spacecraft (Confidential). SID 62-109-2

This volume contains information on individual systems development, and detailed systems test plans for the Apollo service propulsion system, reaction control system, etc.

General Test Plan Research and Development for Project Apollo Spacecraft (Confidential). SID 62-109-3

This volume establishes and describes the ground qualification test program for Apollo Spacecraft and Ground Support Equipment (GSE).

General Test Plan Research and Development for Project Apollo Spacecraft SID 62-109-4

This volume describes the acceptance criteria for Apollo Spacecraft Equipment, and Ground Support Equipment (GSE), assembled at NAA/S&ID and its subcontractors.

General Test Plan Research and Development for Project Apollo Spacecraft (Confidential). SID 62-109-5

This volume presents detailed test plans for the multiple systems tests described in Volume I, SID 62-109-1. The test location and the manner in which NAA/S&ID will accomplish the testing is specified.

Facilities Plan for Project Apollo Spacecraft (Confidential). SID 62-153

This document reflects S&ID's plan for the facilities required to fulfill Apollo Program objectives. The requirements are established on the basis of currently defined activities and schedules. Included in the Plan are S&ID Apollo facilities, major subcontractor facilities, and the NASA facilities involving S&ID technical support or engineering effort. This plan is prepared by the Apollo Facilities Department.

Apollo Quality Control Plan, SID 62-154-1

This document describes the methods and techniques used to implement quality control procedures for the Apollo Program. Quality Control activities are summarized for the overall program during all phases of Project Apollo. This plan is updated as required by the Quality Engineering Department.

Apollo Quality Control Plan (Inspection and Test Control Point Flow Charts), SID 62-154-2

This document defines the general areas where quality inspection will be performed during the fabrication and assembly of Apollo Spacecraft and associated GSE. The specification used at each inspection point is also given. The detail inspection requirements are delineated in the Fabrication Assembly Inspection Record (FAIR) book which is described in the Apollo Manufacturing Plan, SID 62-102. The Apollo Quality Control Plan (Inspection and Test Control Point Flow Charts), SID 62-154-2, is updated as required by the Quality Engineering Department.

Apollo Reliability Plan (Confidential), SID 62-205

This document provides an overall plan for implementation and administration of the Apollo Reliability Program. The plan also presents the organization, controls, and procedures to be employed by S&ID in meeting the requirements specified in the NAS 9-150 Contract. This document is revised as required by the Apollo Reliability Department.

Apollo Support Plan, SID 62-702-1

The purpose of this document is to define the Apollo material support requirements, as well as to describe the system and methods to be used by NAA/S&ID in satisfying the requirements. This plan covers all S&ID material support functions from provisioning through inventory disposition and provides detailed guide lines for support manuals management and development.

Apollo Training Plan (Confidential). SID 62-162

This document describes the Apollo training program, and the requirements for achieving an integrated training effort for personnel participating in a mission. Apollo Logistics Training Department revises this plan as required.

Master Repair Schedule. SID 63-903

This document identifies and lists all reparable items that pertain to the Apollo Spacecraft and Ground Support Equipment. It provides information upon which preliminary scheduling and manpower programming reparable item repair can be based. The Source Maintenance Recoverability (SMR) Code—a derivative of Maintenance Analysis—is entered adjacent to each item to show whether it is provisioned, where it can be removed and replaced, where it can be repaired, and who has disposition authority. The document also forecasts the cyclic repair of the items listed.

## GLOSSARY OF TERMS

This glossary defines terms that relate to the Apollo Program in general. It is specifically applicable to the Apollo Support Plan, SID 62-702-1, the Apollo Maintenance Plan, SID 62-702-2, and will be applicable to all subsequently produced maintenance planning documentation.

ACCEPTANCE	The act of an authorized representative, by which the customer approves specific services rendered, or acknowledges that certain specified articles are in conformity with the requirements of the contract.
ACCESSIBILITY	The relative ease with which a component or an assembly can be approached to be repaired, replaced, or serviced.
ACCESSORY	A mechanism or device employed to facilitate or increase the effective use of some other mechanism or piece of equipment.
ADJUSTMENT	A means by which parts, all of a machine or device, are adjusted to one another to attain an operating standard peculiar to the unit.
AIRFRAME	Assembled structural and aerodynamic components of a spacecraft or launch vehicle.
ARTICLE	A unit of hardware, or any portion of the hardware, required by the contract.
ASSEMBLY	A combination of parts or subassemblies that may be taken apart without destruction, which has no application or use of its own, but is essential for the completeness of a more complex item with which it is combined. An assembly is an element of a component and performs functions necessary to the operation of the component as a whole.
ATTACHMENT	A Supplementary device fastened to or mounted on a machine, apparatus, or other end item, so as to vary or extend its basic function.
BENCH MAINTENANCE EQUIPMENT (BME)	Equipment required to support subsystem and component testing. It is designed to provide the capability of isolating and defining malfunctions.

**BOILERPLATE**

A simulated module for predevelopmental and developmental tests leading to the design of the spacecraft.

**BULK ITEMS**

Certain raw materials and semi-fabricated items used in the manufacture of an article, including standard, commercial, and military hardware, e.g., clips, clamps, fasteners, bolts, nuts, washers, hoses and lubricants.

**CALIBRATE**

A method of comparing an instrument, device, or dial with a standard to determine its accuracy, capacity or graduations, or devising a scale.

**CALIBRATION TESTS**

Tests conducted to determine the input-to-output characteristics of a measuring device, component, or assembly; these tests are also conducted to verify that the characteristics are within specified tolerances.

**CHECKOUT**

A sequence of operational and calibrational tests needed to determine the condition and status of a required operational function.

*Combined Systems*

**COMMAND MODULE**

The personnel and control vehicle in Apollo, containing command and communication facilities and crew provisions.

**COMMON AND STANDARD ITEMS**

Certain items of common and standard use, commercially available to industry, that adequately satisfy the requirements of the end article.

**COMMON HARDWARE**

Certain items having multiple applications, e.g., nuts, bolts, screws, washers, pins, keys, grommets, rivets, etc.

**COMMON TOOL**

Tools in general use that are applicable to a variety of material, e.g., screwdrivers, hammers, drill presses, etc.

**COMPONENT**

A functional part of a system, subsystem, or replaceable package or module that is essential to their operational completeness. A component is a combination of units or parts that together may be functionally independent of, or an independent entity within, a complete operating module or subsystem, but which provide a self-contained function necessary for proper module, subsystem, and/or system operation.

CONFIGURATION	The physical nature of an item; the physical arrangement of components which comprise a spacecraft and its dimensions.
CONSUMABLE MATERIAL	A type of item that is expended through use.
CONTRACT SCHEDULE	The prime contract executed by the Government and the prime contractor which, in addition to the terms and conditions thereof, includes by reference or otherwise, specifications, drawings, exhibits, and other data necessary to its proper discharge.
CONTRACTOR	The individual or concern that enters into a prime contract with the Government, e.g., North American Aviation, Inc.
CONTRACTOR FURNISHED EQUIPMENT (CFE)	An item of equipment provided by the contractor under the terms of a contract.
CONTROLLED ENVIRONMENT	An environment in which factors such as humidity, pressure, and temperature are under control.
CONTROLLED PARTS	Parts, assemblies, or components which require lot or serial number identification.
CORRECTIVE MAINTENANCE	Maintenance performed on a non-scheduled basis to restore equipment to a serviceable condition.
CRITICAL MATCHING ASSEMBLIES	Assemblies that are specifically matched to a particular spacecraft, GSE and item, trainer, or simulator.
CRITICAL MATCHING PARTS	Parts that are specifically identified for use on a particular spacecraft, GSE and item, trainer, or simulator.
CRITICAL MATCHING SPACECRAFT SUPPORT HARDWARE	Assemblies that require specific fit to the individual vehicle.
CUSTOMER	The National Aeronautics and Space Administration (NASA).
CUSTOMER WORK ORDER (CWO)	An S&ID form which authorizes the performance of certain work such as the overhaul, repair, or modification of equipment. The CWO is used to identify and control items during the overhaul, repair, or modification cycle.
DELIVERABLE EQUIPMENT	All manufactured hardware that is complete to the degree required, and ready for delivery to any scheduled destination.



**DIAGNOSIS**

The process of identifying a malfunction to the level of component, assembly, or part at which the maintenance action will be taken.

**DIRECT SUPPORT MATERIEL**

Property which may be incorporated into or attached to an end item, or which may be consumed or expended in the performance of a contract. It includes raw and processed material, parts, assemblies, components, and small tools and supplies which may be consumed in normal use in the performance of a contract.

**DISPLAY**

Oscilloscopes, counters, dials, printers, lights, indicators, scales, etc., used to provide visual intelligence.

**END ITEM**

A space system or any of its principal systems or subsystem elements, e.g., launch vehicle, spacecraft, ground support system, propulsion engine, or guidance system. Also, articles which will be delivered directly to a Government installation or provided as GFP to a contractor.

**ENVIRONMENT**

The aggregate of the conditions and forces that influence or affect an article and its performance throughout its service life.

**EXPENDABLES**

A category of materials that are not accountable upon issue.

**FAILURE**

An occurrence, produced by sudden or gradual deterioration, which causes equipment performance to deviate from specified limits.

**FAILURE RATE**

The average number of failures occurring per unit of time in a specified piece of equipment.

**FAULT ISOLATION**

The process of determining the cause of failure within a given system.

**GOVERNMENT FURNISHED  
EQUIPMENT (GFE)**

Equipment furnished to the contractor by the Government.

**GOVERNMENT FURNISHED  
PROPERTY (GFP)**

All property in the possession of, or acquired directly by the Government, and subsequently delivered or otherwise made available to the contractor.

**GROUND SUPPORT EQUIPMENT (GSE)**

All non-flight implements or devices required to inspect, test, adjust, calibrate, appraise, gage, measure, repair, overhaul, assemble, disassemble, transport, safeguard, record, store, actuate, or otherwise perform a function in support of the spacecraft and boilerplate during (1) tests at factory subsequent to manufacturing completion, (2) prelaunch, launch, and postlaunch operations at test sites, and (3) major development tests such as house spacecraft tests, propulsion tests, and environmental tests. This includes equipment required to support ground support equipment as defined herein.

**HANDBOOKS**

In a general sense, any small book containing specialized information or instructions.

**HARDWARE**

The physical object, as distinguished from its capability or function (actual engines, cases, pumps, the guidance system, or other components of the spacecraft or GSE). The term is also used in regard to a stage of development, e.g., the passage of a device or component from the design or planning stage into the hardware stage as the finished product.

**IDENTIFICATION**

A term referring to a controlled serial or lot number which relates the part, assembly, model, etc., to a particular lot of raw material, manufacturing process, manufacturer, manufacturing date, cure date, receiving date, purchased lot, historical data, assembly process, matched equipment, expiration date.

**INDIRECT SUPPORT MATERIEL**

Equipment, machinery, structures, and consumable material, used on a recurring basis for outfitting, maintaining or operating purposes. It also includes maintenance stock, tool crib supplies, stationery, office supplies, non-productive hardware, fuel, bottled water, dry ice, etc.

**INSPECTION**

The examination, including testing, of contract work, articles and services, to determine conformance to contract requirements.

**INSPECTION AGENCY**

A Government agency, or an agency acting on behalf of the Government, which determines that contracted work, articles and services, conform to technical requirements.

**INSPECTION, FINAL**

An inspection which may occur either at the contractor's plant or at any other designated location. Its purpose is to verify compliance with applicable drawings and/or specifications, and to insure conformance with requirements of the contract.

**INSPECTION, PRELIMINARY**

An inspection which is performed at the contractor's plant or a subcontractor's plant. Its purpose is to establish that the articles inspected are in conformity with requirements of the contract prior to shipment to the place of final inspection and acceptance.

**INSPECTION, RECORD**

Final inspection and acceptance which is acknowledged in a binding manner by an authorized representative of the customer.

**INTEGRATED SYSTEM**

The physical and functional combination of two or more systems required to complete an operational function, e.g., stabilization and control system, guidance and navigation system, reaction control system, and service propulsion system.

**INTEGRATED SYSTEMS TEST**

A test of a vehicle or stage with two or more systems involved.

**INTERCHANGEABLE UNITS**

Assemblies, subassemblies, and replaceable parts that can be substituted for one another without physical or electrical modification.

**INTERCHANGEABILITY**

A property given a part so that it may be used in more than one application.

**INTERFACE**

In a rocket vehicle or other system, a common boundary between one component and another; the junction points or the points within or between systems or subsystems where matching or accommodation must be properly achieved in order to make their operation compatible with the successful operation of all other functional entities in the space vehicle and its ground support.

**INTERIM RELEASE/EMERGENCY  
RELEASE**

An authorization to proceed with fabrication or procurement of long lead time items prior to the normal approval cycle.

LAUNCH COMMIT	That point in time when the vehicle is actually released.
LAUNCH ESCAPE SYSTEM (LES)	A system providing for command module recovery in case of mission abort after launch and prior to orbit, and consisting of the launch escape motor, launch escape tower, and tower jettison motor.
LOGISTICS SUPPORT	The support given by an organization to an activity by means of which are furnished all, or any part of, its supplies, equipment maintenance, transportation, storage, or any other like service, so as to enable the activity to carry out its intended operation more expeditiously.
LOT SCHEDULE	A schedule directing that an item be inspected, crated, and readied for shipment prior to the lot number date, and shipped in the time period assigned.
LONG LEAD TIME ITEMS	Items that cannot be delivered within a short time span because of their complexity of design, complicated manufacturing processes, or limited production or procurement cycles.
LUNAR EXCURSION MODULE (LEM)	The two-man vehicle which will land on the moon after the Apollo spacecraft enters lunar orbit.
MAINTAINABILITY	A quality of the combined features of material design and installation that permits or enhances the accomplishment of maintenance by personnel of average skill. Material design parameters include such items as the operational and environmental conditions under which the maintenance functions will be performed. Also included are repairability and serviceability, which are functions of the ease with which maintenance activities may be performed to avert or correct malfunctions.
MAINTENANCE	All actions required to retain material in, or restore it to, a serviceable condition. Its phases include servicing, repair, modification, overhaul, test, inspection, and condition determination.
MALFUNCTION	A general term used to denote the inability of a product to give satisfactory performance. It need not constitute a failure if readjustment of operator controls can restore an acceptable operating condition.

MATERIAL	The substance or goods out of which an item is, or can be, made.
MATERIEL	Items of all kinds required for the equipment, maintenance, operation, and support of activities.
MODIFICATION	A change in the design of an item, effected in order to correct a design deficiency, to facilitate production, or to improve operational effectiveness.
MODULE	A combination of components contained in one package, or so arranged that together they are common to one mounting, which provides a complete function or functions to a system and/or subsystem in which it operates. (See command module, service module, lunar excursion module, etc.)
NASA'S DELEGATED REPRESENTATIVE	A representative of NASA stationed at a supplier's plant, or a representative of the inspection agency to whom quality assurance functions have been delegated.
NON-REPARABLE ITEM	An item designed and procured with the intention of disposing of it at failure rather than attempting repair.
OVERHAUL	The rebuilding or extensive repairing and reconditioning of an item of equipment which has deteriorated through testing or extensive use.
PACKAGING	The cleaning, preservation, and packing in unit quantities; interior cushioning and bracing; design and utilization of interior and exterior containers; identification of contents of inner and outer containers; and loading.
PART	The smallest subdivision of a system; an individual piece having an inherent functional capability, but unable to function without the interaction of other parts or forces, and ordinarily not subject to disassembly without destruction.
PECULIAR AND NON-STANDARD ITEMS	Items peculiar to the equipment design of the contractor, subcontractor or supplier, for which no known common or standard item can be substituted, and for which design approval may not have been received.

PREVENTIVE MAINTENANCE	The inspection, care, and servicing required to maintain equipment and facilities in a serviceable condition.
PRIME CONTRACTOR	North American Aviation, Inc., Space and Information Systems Division.
PROCEDURES	The step-by-step manner in which any given task is performed.
PROTOTYPE MODEL	A model suitable for complete evaluation of electrical and mechanical form, design, and performance. In its final form it employs approved parts and is completely representative of final equipment.
PURCHASED PARTS	Articles manufactured by outside sources in conformance to S&ID drawings and identified by S&ID part numbers.
RECLAMATION	The process of recovering required, serviceable, and economically repairable components and materials.
RELEASE	An approval to fabricate or procure items of materiel support.
RELIABILITY	The probability that a system, subsystem, component or part, will perform its required functions under defined conditions at a designated time and for a specified operating period. Dependability probability measure.
REPAIR	The restoration of a system or equipment to a satisfactory operating condition after malfunction, damage, or deterioration.
REPAIRABILITY	The probability that when maintenance action required by equipment malfunction is taken, (1) the system will be restored to a satisfactory operating condition in a given period of time with a given manpower expenditure; and (2) the equipment will remain in satisfactory operating condition over a specified period of time.
REPLACEABLE PACKAGE	An item of equipment that may be mounted in or removed from a spacecraft, checkout console, or the like, as a single package. A replaceable package or module is a combination of components contained in one package, or so arranged that together they are common to one mounting, which provides a complete function or functions for a system and/or subsystem in which it operates.

REPLACEABLE SERIALIZED UNIT	The smallest serialized unit that can be replaced without soldering.
REPLACEMENT	The substitution of one unit for another functionally identical unit.
SERVICEABILITY	A function of equipment design, configuration, installation, and operation that indicates the degree to which maintenance requirements are minimized and simplified.
SERVICEABLE CONDITION	That condition in which the article is considered suitable for carrying out the purpose for which it was designed or authorized.
SERVICE LIFE	The period of time or number of functional performances during which an item, installed in an operational system, will be expected to remain in a serviceable condition.
SERVICE MODULE	The Apollo module containing propulsion equipment, fuel, reaction control systems, and communications power. Used for thrust after booster separation, mid-course correction, lunar orbit, lunar orbit ejection, and earth return mid-course correction. It is jettisoned prior to re-entry.
SERVICING	The work performed at regular intervals, or under a recognized system, to keep equipment operable. It includes cleaning, lubricating, adjusting, charging, and changing of filters, decelerators, etc.
SHelf LIFE	That period of time during which an item can remain in storage without having its operability affected.
SITE SUPPORT LIST	A list of materiel items essential to the support of a scheduled program at a field site.
SPACECRAFT	In the Apollo Program, any component or combination of components of the flight vehicle not part of the launch vehicle, e.g., launch escape system, command module, service module, or adapter.
SPARE PART	Any part, subassembly, or component kept in reserve for the maintenance and repair of major items of equipment.
SPECIAL TOOLS	Specially designed tools required to perform a special function of maintenance, assembly, disassembly, etc.

**SUBASSEMBLY** A combination of parts comprising a definable entity of an assembly, a unit, or a component, which performs a function essential to the proper operation of the assembly, unit, or component.

**SUBCONTRACTOR** An organization, company or manufacturer that is under contract to a prime contractor, and has been delegated the responsibility for design, manufacture, and support of a system.

**SUBSYSTEM** A major element in a system, comprised of a single module or combination of modules plus independent components that contribute to modular functions, all interconnected and interrelated within a system and performing a specific system function.

**SUPPLIER** A contractor or subcontractor actually performing the services or producing the contract articles.

**SUPPORT MANUAL** A publication containing detailed information on technical procedures, including instructions on handling, inspection, storage, operation, maintenance, checkout, repair, modification, and overhaul of given equipment.

**SYSTEM** Any combination of complete operating equipment, comprised of a grouping or interconnection of subsystems or other functional entities, capable of performing a specific operational function or functions. Included are aerospace systems, support systems, command and control systems, and all associated material.

**TEST ARTICLE** An item that appears on a contractor, subcontractor or vendor drawing, and will be utilized as a subject of a test.

**TEST SITE** A facility established at a selected geographic location for conducting a specific operation or test.

**TEST SUPPORT PART** A part that is required for a unique application to accomplish a test function, and will not appear on a contractor, subcontractor, or supplier drawing as a functional part of that drawing.

**TRACEABILITY** A term which indicates the degree of yield from search for an item's history, application, use, and location.



**TRADE-OFF**

The procedure of trading a degree of an attribute to gain a degree of another attribute, e.g., sacrificing a degree of performance to obtain a greater degree of reliability under certain conditions, or vice versa.

**UNIT**

An assembly, or any combination of parts, sub-assemblies, and assemblies mounted together, normally capable of independent operation in a variety of situations.

The following definitions have been included as a means of further clarifying the depth and scope of the three levels of maintenance.

**A-LEVEL MAINTENANCE**

All activity necessary to service, adjust, and evaluate the readiness of a system, and which can be performed with minimum delay. It includes maintenance which is within the limits of equipment configuration and within the verification capability of GSE common to systems and integrated systems checkout. Examples of system maintenance are as follows:

**Electrical:** Service, adjust, and checkout, or fault isolate to a replaceable package level (fuel cell). Remove and install replaceable package and perform system verification.

**Electronic:** Service, adjust, and checkout, or fault isolate to a replaceable package level (gyro accelerometer package). Remove and install replaceable package and perform system verification.

**Mechanical:** Service, adjust, and checkout, or fault isolate to a replaceable package (oxygen control panel). Remove and install replaceable package and perform system verification.

## B-LEVEL MAINTENANCE

Replaceable package maintenance accomplished through replacement down to the replaceable serialized unit level. It includes maintenance which is within the verification capability of GSE common to replaceable package checkout. Examples of replaceable package maintenance are as follows:

**Electrical:** Fault isolate to the replaceable serialized unit level (glycol pump, purge, valve). Service, adjust, or replace down to the serialized unit, and certify replaceable package.

**Electronic:** Fault isolate to the replaceable serialized unit level (gyro pre-amplifier - ECA). Service, adjust, or replace down to replaceable serialized unit, and certify replaceable package.

**Mechanical:** Fault isolate to the replaceable serialized unit level (pump, purge, valve, pressure relief valve). Service, adjust, and replace down to replaceable unit, and certify replaceable package.

## C-LEVEL MAINTENANCE

All maintenance activity associated with the Apollo Program which is beyond the A- and B-Levels, including total repair, modification and overhaul.

**Electrical:** Detailed disassembly to the part level (penetration of stack assembly, replacement of plates, connectors, etc.). Reassemble, adjust, calibrate, functionally check and certify.

**Electronic:** Detailed disassembly to the part level (diodes, resistors, capacitors, etched circuits, etc.). Replacement of defective parts or assemblies and reassemble. Adjust, calibrate, functionally check and certify.