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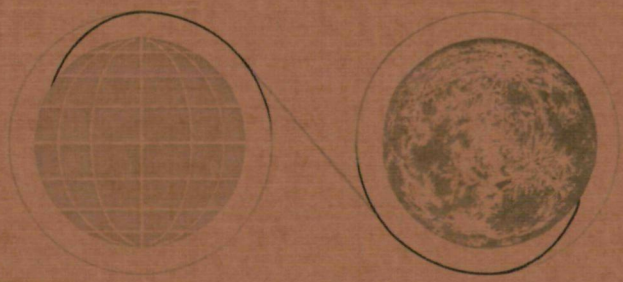

Apollo Extension Systems—Lunar Excursion Module
Phase B Final Report

Vol. XXVI Management Plan (U)

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Apollo Extension Systems — Lunar Excursion Module
Phase B Final Report

to

National Aeronautics and Space Administration
Manned Spacecraft Center
Advanced Spacecraft Technology Division
Houston, Texas 77058

by
Grumman Aircraft Engineering Corporation
Bethpage, New York

Vol. XXVI Management Plan

Contract No. NAS 9-4983
ASR 378B

8 December 1965

Preface

This report presents the results of the Phase "B" Preliminary Definition Study (Contract NAS 9-4983) of the Lunar Excursion Module (LEM) and its modifications and additions, as necessary, for use in the Apollo Extension Systems (AES). This use includes a Laboratory for Earth and lunar orbital missions, and a Shelter, a Taxi and a Truck for extended-stay lunar surface missions. The overall objective of this study was to conduct sufficient analyses to provide a basis for selection by NASA of a single concept for each mission for final definition and development.

The study results are distributed in the volumes listed below in the following manner: Volume I contains a summary of the Preliminary Project Development Plan (PDP) with emphasis on estimates of the program costs and schedules. This volume was submitted on 30 October 1965, one month in advance of the remaining final documentation. Volume II is a brief summary of the overall study. Volumes III through XVI contain the design analyses, preliminary specifications, and operations analyses for each of the AES/LEM vehicle types. Volumes XVII through XXVI contain preliminary project planning data in the areas of management, manufacturing, development testing, and support.

It was necessary to base the preliminary project planning data, including estimated costs, on a single configuration for each of the AES/LEM vehicle types. Since these PDP data were required by the end of October, the configurations had to be selected at the mid-point of the study, before the configuration studies had been completed. These configurations have been called "baseline" configurations. The continuing design analyses in the second half of the study have resulted in recommended changes to the baseline configurations. Volumes III through VI describe the "recommended" configurations, the baseline configurations, and some additional alternates which were studied. It is anticipated that NASA will make a selection from these configurations, and that these selections will then be the new baseline configurations for the next phase of AES definition studies.

The scope of this study included integration of the experimental payloads with the Shelter and Taxi, but did not include study of the integration on individual LEM Laboratory flights. At approximately the mid-point of the study, an addendum was written with the objective of providing support to the NASA Mission Planning Task Force for study of the Phase I Laboratory flights. The schedule for the addendum calls for completion of these mission planning studies in January, 1966. Therefore, the addendum efforts are not described in this report.

The volumes which comprise this report are as follows:

I	*Phase B Preliminary Definition Plan (30 Oct 1965)*
II	*Preliminary Definition Studies Summary*
III	*Phase I Laboratory Design Analysis Summary*
IV	*Phase II Laboratory Design Analysis Summary*
V	*Shelter Design Analysis Summary*
VI	*Taxi Design Analysis Summary*
VII	*Truck Design Analysis Summary*
VIII	*Phase I Laboratory Master End Item Specification*
IX	*Phase II Laboratory Master End Item Specification*
X	*Shelter Master End Item Specification*
XI	*Taxi Master End Item Specification*
XII	*Phase I Laboratory Experimental Payload Performance & Interface Specification*
XIII	*Phase II Laboratory Experimental Payload Performance & Interface Specification*
XIV	*Shelter Experimental Payload Performance & Interface Specification*
XV	*Taxi Experimental Payload Performance & Interface Specification*
XVI	*Prelaunch & Mission Operations*
XVII	*Manufacturing Plan*
XVIII	*AES Modifications to LEM Quality Control Program Plan*
XIX	*Ground Development Test Plan*
XX	*Support Equipment Specification*
XXI	*Facilities Plan*
XXII	*Support Plan*
XXIII	*Transportation Plan*
XXIV	*Training Equipment Requirements*
XXV	*Support Equipment Requirements*
XXVI	*Management Plan*

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1. INTRODUCTION

Grumman is pleased to be part of NASA's team* and use the experience and capability developed over the past eight years to complete the Phase B Study for the AES Program. Grumman management has had a deep and continuing interest in the national space goals of the United States as evidenced by their participation in a variety of space studies as well as the OAO Program, the Echo II Program, and the LEM Program. This interest is apparent currently in the extensive effort associated with studies in depth on the manned space stations, LEM Truck, and other studies directed and financed by NASA on the AES Program.

The underlying philosophy involved in planning the management and execution of the AES Program is based on our experience that a prime contractor must assume total responsibility for the system under contract. He must be accountable for design, fabrication, procurement, tests, and support of the entire system under his jurisdiction. This leads to an extensive array of facilities and manpower skills which have been developed at Grumman on OAO, LEM, and major defense programs to handle such a systems responsibility.

It is clearly understood that the use of facilities and experienced people now employed on the LEM Program will be assigned to the AES Program in a selective manner such that LEM will in no way suffer by conflicting requirements. Estimates in this report are based on current schedules as we understand them and tend to show that without a follow-on program such as AES, there would be several thousand experienced men from the LEM Program who would have to go either to a different kind of work or to a different company.

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* Reference is made to Dr. Webb's report to the Senate on 23 August 1965, when he said, "Industrial organizations, employing almost 400,000 people on NASA programs, are gaining more competence in the design and engineering of space vehicles and ground support equipment. Government facilities and trained industry and Government teams are in being. The approved, ongoing, program has produced significant scientific and technological results; at the same time, it is providing a meaningful base for future missions. Certainly, I think all of those in industry and in the government would be very much encouraged if we could make the decision to utilize, as the chairman has indicated, the present equipment, and to extend its life, and to provide these scientists and engineers with continued work in this field. All of this equipment can be upgraded for more advanced work and for work we need to do. But, it must be upgraded by these people because the work is very specialized."

2. ORGANIZATION

The single purpose program organization shown in Fig. 2-1 is proposed for the AES Program. Dr. R. H. Tripp heads the organization as Program Director. He reports to Grumman President, E. Clinton Towl, from whom he derives the authority to command all resources required for the program.

The organization consists of key managers assigned exclusively to the program and reporting functionally and administratively to the Program Director. Each manager is individually accountable for planning and meeting the cost, schedules, and performance goals which collectively constitute the overall AES Program objectives. The responsibilities of each manager have been carefully defined to prevent duplication of effort and to promote clear understanding of accountability. For example, each subsystem will be handled both within The Grumman Corporation and at the subcontractor's plant by a Subsystem Manager who will be accountable for all aspects of the management of his subsystem until it is installed in a vehicle. Each key manager will direct an organization of technical and management specialists drawn from the functional groups within the Corporation. Assignment of, and changes in program personnel on all levels requires the approval of the Program Director.

Studies of the proposed organization will continue during the Definition Phase. As a result of these studies and discussions with NASA, the organization for the Development/Operations Phase will be finalized.

2.1 FEATURES OF THE ORGANIZATION

The proposed organization takes full advantage of the experience gained on the LEM, OAO, and current AES definition programs, and provides for:

- Orderly transition of management control from the Definition Phase to the Development/Operations Phase of the AES Program
- Clear and understandable delineations of responsibility, authority and accountability
- Program evaluation and control through a Control Staff which serves the Program Director and backs-up the control elements within the functional operating groups
- Deliverable end-item accountability
- Subcontractor control through Subsystem Managers
- Total materiel control through a Materiel Manager
- Program evaluation and guidance by a top management Review Board.

2.1.1 Organization Planning Based on Overall Objectives

The proposed organization has been planned to meet the needs of the overall AES Program. The unshaded boxes indicate functions which will be staffed and operating at the inception of the Definition Phase. As the Definition Phase progresses, the functions represented by the shaded boxes*, and possibly other functions, will be implemented as required to meet specific program requirements. By the start of the Development/Operations Phase, the complete AES organization will be staffed and operating as an entity.

Along with the organization transition, in some instances, there will be a change in management and supporting-level personnel. In this way, as experienced people from LEM and OAO become available, they will replace the developmental type personnel who are expert in meeting AES definition requirements.

2.1.2 Clear and Understandable Delineations of Responsibility, Authority and Accountability

Overall accountability for the AES Program has been assigned to the Program Director, by the President of the Grumman Corporation. The AES Program Director, in turn, has delegated specifically defined charters of responsibility, authority and accountability to all key managers on the program. These charters are presented in this Management Plan under "Responsibilities and Qualifications of Key Personnel."

2.1.3 Evaluation and Control Through a Control Staff

The Program Director's Control Staff consists of specialists in:

- Reliability
- Facilities and Administration
- Configuration Management
- Data Management
- Contracts
- Program Planning and Control.

The Control Staff will coordinate the development of plans and the definition of criteria against which progress will be measured. They will monitor progress against plans in their respective specialties, detect actual or indicated deviations from these plans and recommend corrective action to the Program Director, Deputy Director, Program Manager, Vehicle, Subsystem and functional managers as appropriate. The Staff will have at its disposal a full complement of planning and control techniques and systems.

The fact that the Control Staff reports directly to the Program Director or Deputy Director will permit it to serve as an independent check of program operations and progress. It will also serve to expedite action from the Vehicle, Subsystem and functional Managers in supplying data that is necessary for the monitoring and control of the program.

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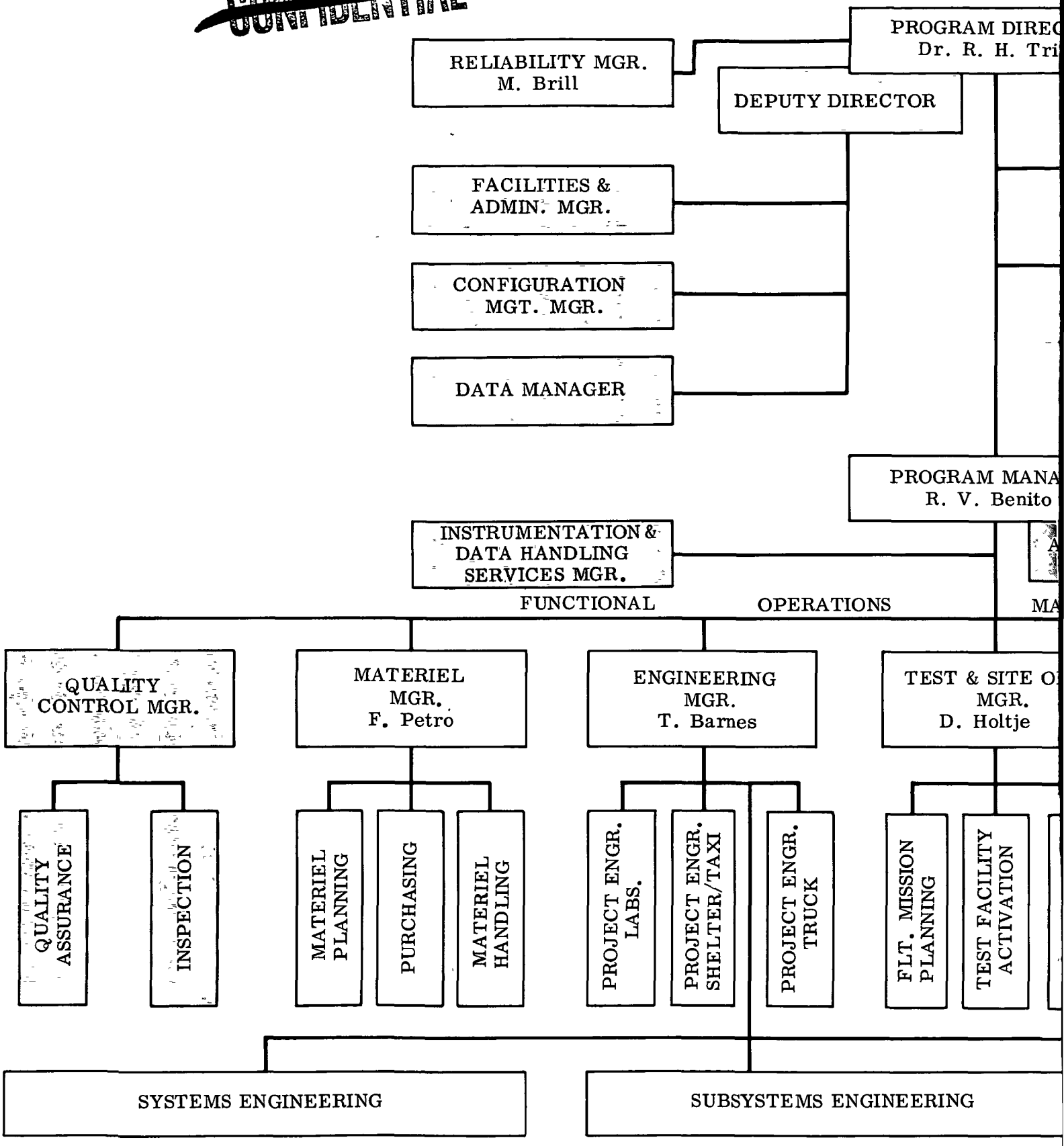
* NOTE: At the outset of the Definition Phase, all required activities associated with these functions will be supplied by portions of the organization which are already operating and have the qualified personnel. For example, individuals in the Test and Site Operations Group and in the Support Group will continue their facilities planning activities until a Facilities and Administration Manager is assigned.



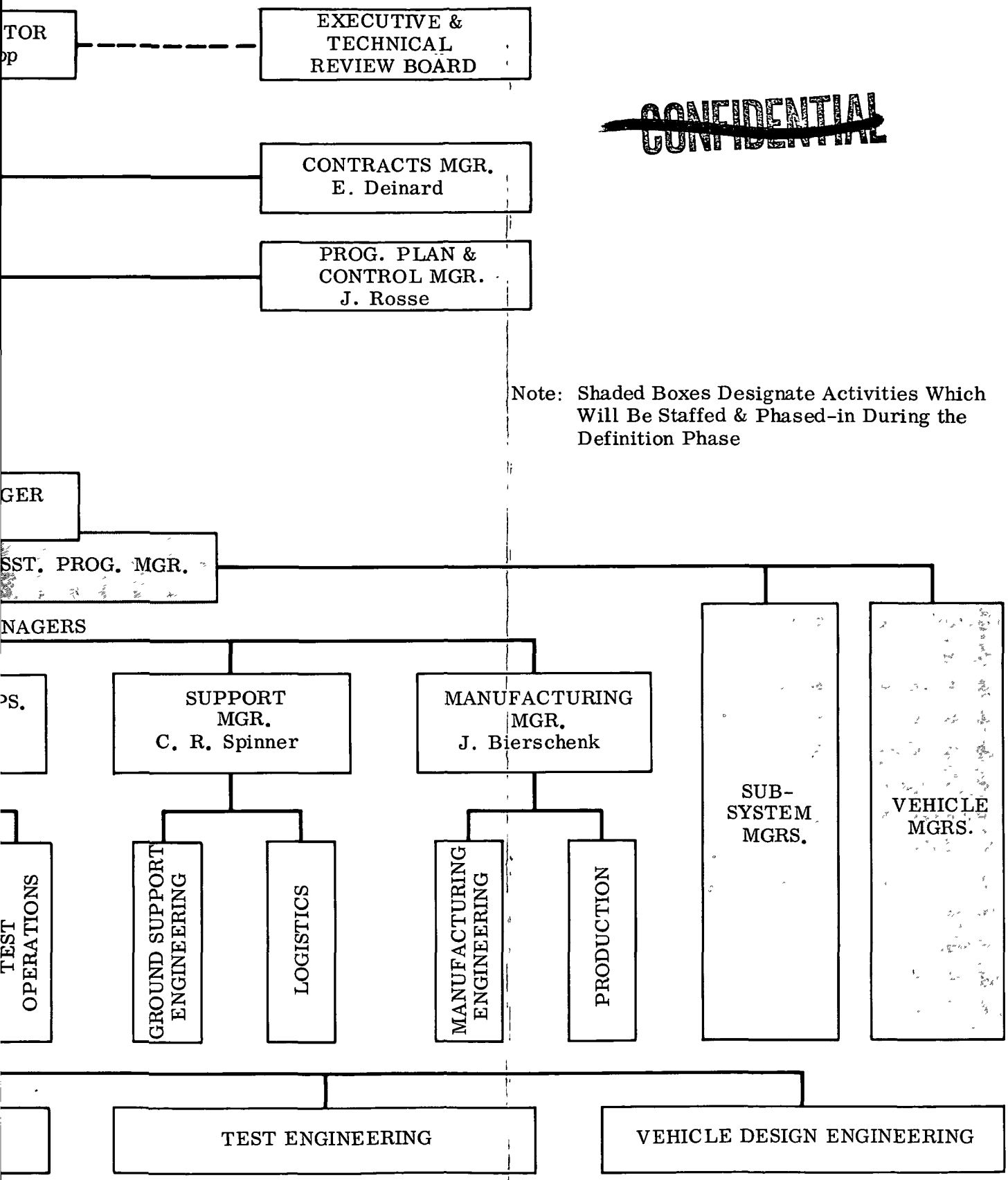


Fig. 2-1. Grumman AES Program Organization

2.1.4 Deliverable End-Item Accountability

Accountability has been established for deliverable AES end-items down to the lowest level of detail. Vehicle Managers are accountable for vehicles from inception to launch; Subsystem Managers for subsystems from inception to incorporation in a vehicle; and designated functional managers for detail items such as spares, drawings, training devices and support manuals.

2.1.5 Subcontractor Control Through Subsystem Managers

Subsystem Managers will control the efforts including cost, schedule and performance parameters, of all major subcontractors and in-house groups associated with their subsystems. Each Subsystem Manager will establish a complete subsystem plan based upon inputs from all groups involved. Using this plan as a control base, the Subsystem Manager will: apply review, evaluation and approval procedures; monitor physical progress; assign residents at subcontractor's plants; and impose any other controls individual situations may require to meet cost, schedule and performance goals.

2.1.6 Total Materiel Control

The Materiel Manager has complete accountability for all GFE and purchased materiel planning, procurement, and handling. He is the focal point for the coordination and control of all materiel from request or purchase through ultimate delivery and acceptance by the end user.

AES procurement activities will capitalize on Grumman's LEM experience through the use of personnel with LEM backgrounds as well as through continued use of LEM qualified vendors, with NASA approval.

2.1.7 Top Management Review Board

The AES Program will be guided, and its performance regularly evaluated by a top management review board which includes all of the senior executives who currently review the LEM Program. The Board includes:

- Wm. T. Schwendler, Chairman of the Executive Committee
- George F. Titterton, Sr. Vice President
- Richard Hutton, Sr. Vice President
- I. Grant Hedrick, Vice President, Engineering
- Edward Nezbeda, Vice President, Manufacturing
- John Lentini, Director, Contracts
- William Robertson, Manager, Procurement
- Hugh McCullough, Programming.

In addition, Mr. J. G. Gavin, Vice President and LEM Program Director, will serve on the Board.

3. RESPONSIBILITIES AND QUALIFICATIONS OF KEY PERSONNEL

The responsibilities and qualifications of key personnel who will be assigned at the outset of the Definition Phase are presented in the first part of this section. Responsibilities of key personnel who will be added as the Definition Phase progresses are presented in the latter part of the section.

DR. RALPH H. TRIPP, PROGRAM DIRECTOR

Dr. Tripp, the AES Program Director, is responsible for the development, production, test and operational support of Apollo Extension Systems responsive to the needs of NASA...on schedule and within cost. He, or his designated representative:

Plans overall program objectives based upon NASA AES Program requirements

Plans and implements the program organization to meet these requirements

Plans and assigns charters of responsibilities

Plans and issues program policies

Plans for the timely availability of manpower, facility and financial resources required for the program

Directs, through a Program Manager, all functional operations personnel

Directs, personally and through a Deputy Director, the Program Control Staff

Serves as the executive management contact with NASA, subcontractors, LEM and other Corporate activities

Reviews program progress and evaluates status relative to planned program objectives

Reports program progress and status to the President of the Corporation, and to the Executive and Technical Review Board

Reviews and approves all progress reports submitted to NASA.

Background

Dr. Tripp has been with Grumman for 23 years. As a senior manager, he has proven his effectiveness in directing major programs to the attainment of exacting goals. Since 1962, he has served as Program Director of the Orbiting Astronomical Observatory and recently assumed additional duties as Director of the AES Program Definition Studies. Other highlights of his background are as follows:

- Organized and headed the Structural Flight Test Department and specialized in vibration and flutter testing
- Organized and managed the Corporate Research Department and instituted the first use of IBM equipment in making engineering calculations at Grumman
- Organized and directed the Test Instrumentation Department; established the first automatic data reduction system at Grumman, including the first use of real time data analysis and demonstration flight testing
- Served as Assistant Director, Grumman Flight Test Department
- MS and PhD, Applied Mathematics and Theoretical and Applied Mechanics, University of Iowa; BA, Drake University
- Member, Instrument Society of America; past National President, District Vice-President, and Vice President of the Industries Department
- Associate Fellow, AIAA.

ROBERT V. BENITO, PROGRAM MANAGER

Mr. Benito is responsible for the management of the day-to-day operations of the AES Program within the policies established by the Program Director. Specifically, he or his designated representative:

Directs all functional operations personnel

Directs the preparation of operating procedures for program reviews, communications, and other day-to-day activities within the AES Program Organization

Serves as Program Management contact with NASA, subcontractors, LEM and other Corporate activities

Approves all technical reports and documents submitted to the customer or released for manufacture

Reviews and approves all major technical decisions which can effect cost and schedule compliance

Supervises subcontractor control activities through Vehicle, Subsystem and Materiel Managers by:

Monitoring subcontractor competitions, evaluations, negotiations, and change actions

Guiding evaluations relative to the effects of subcontractor changes on cost, schedule and technical requirements

Reviewing on an exception (deviation from plan) basis, subcontractor cost and progress reports

Conducts weekly, program status and progress meetings using pre-announced agenda. Reviews problem areas, assigns action items and associated deadlines

Reports AES Program status and progress to the Program Director every week

Serves as Chairman of the Configuration Control Board.

Background

Mr. Benito, with more than 24 years of management and engineering experience at Grumman, is currently serving as the AES Program Manager. He most recently served as Program Manager on the OV-1 Mohawk Aircraft which resulted in outstanding multi-mission capabilities of this weapon system. This association has given Mr. Benito considerable experience in the management of systems as a prime contractor manager; specifically, this included handling of subcontractor efforts and the integration of government-furnished systems and equipment into the overall system. He also gained considerable knowledge of multi-site operations. Other highlights of his background are as follows:

- Served as Grumman Systems Support Business Manager; established lines of communication for timely review and control of spares, special support equipment, training, publications, ancillary contracts, and aircraft and equipment responsibilities and bailments
- As Grumman Systems Project Engineer and Project Administrator, developed the contractual and engineering management functions for the Mohawk Program during the initial Mohawk design and testing phase
- Directed design and production engineering on F9 series aircraft
- Performed engineering consultation services for a major airline and a government agency
- MSCE, with option in Aeronautical Engineering, Polytechnic Institute of Brooklyn. Graduate studies in selected non-degree curricula
- Executive Development Seminars - Adelphi College and American Management Association.

THOMAS G. BARNES, ENGINEERING MANAGER

The Engineering Manager is responsible for the design and development of subsystems and vehicles and for the successful operation of the end products. He or his designated representative:

Directs all engineering design and development effort (including subcontractors') with regard to the AES vehicles

Directs Engineering Reliability and Maintainability efforts

Provides and monitors a detailed schedule and manpower usage plan for all engineering design and development effort consistent with approved program budgets and schedules

Is responsible for the definition of contractual and specification requirements for the basic vehicle configurations and associated performance

Is responsible for, and approves the definition of all systems checkout requirements, the establishment of all GSE performance requirements, the establishment of an overall system tolerance structure for both performance evaluation and checkout, and the functional and environmental compatibility between GSE and all flight and test vehicles.

Prepares and approves detail specifications including test requirements for all AES vehicle components and subsystems to be procured from subcontractors

Approves all technical reports and documents submitted to the customer or released for manufacture and/or test

Participates in monitoring subcontractor technical performance

Participates as a member of the Configuration Control Board.

Background

Mr. Barnes has 18 years of experience at Grumman; he is currently the AES Phase B Project Engineer. His background is as follows:

- Served as Chairman of the Apollo Mission Planning Task Force (composed of representatives of Apollo spacecraft contractors and NASA for the purpose of identifying mission-related design characteristics of the spacecraft and assembling reference missions for the overall program)
- Project engineer in Advanced Systems Space Group; directed studies for lunar orbital reconnaissance, lunar logistic systems, Advanced OSO, Nimbus Satellite and Prospector lunar surface exploration vehicle
- Served as Head of Nuclear Applications Group in Advance Systems and Project Engineer on a Navy study of nuclear-powered guided missiles
- Performed propulsion engineering on Rigel guided missile project and in Preliminary Design efforts
- MSAE, University of Michigan; one year of additional studies at Oak Ridge School of Reactor Technology.

MURRAY A. BRILL, RELIABILITY MANAGER

The Reliability Manager is responsible for defining overall reliability objectives of AES vehicles, support equipment and associated publications. He or his designated representative:

Interprets NASA requirements, develops the Grumman Reliability Plan and monitors performance against this plan

Evaluates design definitions for conformance to customer reliability requirements

Examines trade-offs in applicable specifications to determine areas in which requirements can be relaxed to reduce costs without affecting mission effectiveness

Coordinates the development of subcontractor reliability plans

Coordinates with Engineering reliability and maintainability activities

Develops quality standards for work to be accomplished

Participates as a member of the Configuration Control Board.

Background

Mr. Brill has eleven years of diversified experience in aircraft and missile design, plus three years experience as a military pilot and nine years experience in reliability and quality control. He currently serves as Reliability Control Group Leader on the AES Phase B Definition Study effort. Other highlights of his background are as follows:

- LEM Reliability Control Engineer; performed propulsion subsystem subcontractor and supplier control, failure mode effects and criticality analyses, configuration analyses, various reliability trade-off studies, and reliability apportionment, prediction, and assessment
- As Assistant Technical Director in the Systems Integration Department of the Glenn L. Martin Company, he was instrumental in developing reliability programs for several space projects and assisted in developing advanced technologies in the field of reliability
- Served as reliability specialist for Republic Aviation Corporation; established and implemented hardware reliability programs
- BSAE; graduate studies in Industrial Management, Polytechnic Institute of Brooklyn; registered Professional Engineer, State of New York.

E. C. DEINARD,* CONTRACTS MANAGER

The Contracts Manager will be responsible for all aspects of prime contract administration. He will also participate in the preparation and updating of all program cost and work authorization budgets and will be accountable for the administration of these budgets. He or his designated representative:

Participates in the preparation of a Program Financial Plan including cost and work authorization budgets, facility budgets, procurement budgets and funding consistent with contractual requirements

Monitors progress against the Program Financial Plan

Directs Prime Contract Administration including definition of contractual requirements, issuance of cost and work authorization budgets, and cost reports to NASA and Program Management as required

*NOTE: Lawrence Brown, who was Contracts Manager for Phases A and B of the AES Study Program, will be responsible for the Definition Phase until Mr. Deinard becomes available from LEM early in 1966.

Identifies work scope changes and obtains appropriate contractual coverage

Negotiates the prime contract as well as all addendums and change proposals

Receives cost estimates and prepares all cost proposals

Reviews all contractual documents including those with subcontractors

Coordinates Grumman's response to NASA inquiries for estimates, reviews, investigations, and studies of financial and contractual matters

Participates as a member of the Configuration Control Board.

Background

Mr. Deinard is currently the Deputy Business Manager of the LEM Program, and also fills the dual role of Deputy Assistant Director of Space Contracts for the company. Previously he was Business Manager of the Orbiting Astronomical Observatory (OAO) Program. Highlights of his background, prior to coming to Grumman, are:

- Contracts Manager of Titan Missile Division, American Machine and Foundry Company
- Attorney, Air Transport Association of America
- Assistant Chief, Airframe Purchase Branch, Contracts Division, Bureau of Aeronautics, Navy Department, as LTJG USNR on active duty
- Graduate of Swarthmore College and Harvard Law School.

JOHN J. ROSSE, PROGRAM PLANNING AND CONTROL MANAGER

The Program Planning and Control Manager is responsible for coordinating the development and implementation of overall program plans including integration of all subcontractor activities, anticipated personnel requirements, and program control systems. He will evaluate progress against these plans and provide concise and timely overall program control information. He or his designated representative:

Directs the development and implementation of overall plans, schedules and control systems

Assists in the development and updating of anticipated personnel requirements and evaluates these requirements in terms of budget and overall program plans

Provides Program Management with periodic status reports comparing both Grumman and subcontractor progress against schedule and manhour plans

Develops a PERT/Companion Cost System to encompass the design, development, fabrication and operational phases of the AES Program

Integrates AES plans and schedules with the Apollo/LEM Program to achieve optimum utilization of facility, material and manpower resources

Participates as a member of the Configuration Control Board.

Background

Mr. Rosse has 14 years experience in industrial engineering and program planning and control activities. He has most recently been engaged in the establishment of basic program plans and control systems for the AES Phase B Preliminary Definition Study. Other highlights of his background and experience are as follows:

- Developed and implemented corporate cost control procedures for the C-2A cargo aircraft program
- At Republic Aviation Corporation, he prepared and supervised the implementation of schedule, cost control, and PERT and PERT/COST systems for various commercial and R&D Programs (including Advanced OSO, Project FIRE, Polaris submarine trainers, reconnaissance aircraft and Life Science studies)
- Supervised preparation of work standards and forecasting of materials handling equipment, tooling and manpower requirements on both development and production contracts, including F-84, F-105, and F-103 aircraft and Swallow Drone projects
- Planned and conducted PERT seminars for corporate management and served as Republic Aviation representative on the AIA PERT subcommittee
- BS, Industrial Management, Syracuse University; graduate studies in Industrial Engineering and Management, Columbia and NYU.

FRANK PETRO, MATERIEL MANAGER

The Materiel Manager is responsible for all phases of the procurement of vendor supplied material and request of GFE material, including the handling of this material necessary to deliver it to the place and/or person for whom it is intended. He or his designated representative:

Provides detailed procurement plan consistent with the approved schedules and budgets

Prepares and justifies (including invitation to quote, obtaining quote, and bid evaluation) recommendations on source selection

Negotiates contracts with approved vendors and prepares justification package

Specifies and obtains from each vendor the data and information required by program management to properly monitor cost, schedule, and technical progress

Transmits to the vendor all official directives involving contractual matters such as purchase orders, cost and/or schedule agreements or changes

Coordinates all material handling associated with GFE and purchased equipment and hardware including: Receiving, Inspection, Storing, Transportation and Inventory

Prepares Material Status Reports as required by Program Management

Participates in Make or Buy Evaluations

Participates as a member of the Configuration Control Board.

Background

Mr. Petro is currently Assistant Purchasing Agent for the LEM Program.* In this capacity, he monitors major subcontracts, guides procurement planning, and participates in configuration control, vendor selection, major negotiations, and NASA and program presentations on vendor performance. Other highlights of his background prior to coming to Grumman include:

- Director of Engineering, Sales and Contracts with a professional service organization providing product design, engineering, documentation, inventory control and systems and procedures services for major missile, aircraft and space projects - 20 years
- Director of the Cushing-Nevell Corporation
- Ordnance Officer - US Naval Ordnance Department handling Procurement Technical Services and Technical Documentation - 6 years
- Mechanical Engineering - Brooklyn Polytechnic Institute Business Seminars - Pratt Institute - Rensselaer Polytechnic Institute

DAVID L. HOLTJE, TEST AND SITE OPERATIONS MANAGER

The Test and Site Operating Manager is responsible for conducting field tests and for the planning, staffing and activation of all the field operations. He or his designated representative:

Provides an overall Field Test and Site Operation Plan and controls performance against this plan

Provides test mission plans including test and experiment requirements, flight plans, and Operational Time Lines

Directs all field operation tests, including required documentation in accordance with approved plans, schedules and budgets

Directs vehicle checkout operations including required documentation in accordance with approved plans, schedules and budgets

Directs site activation activities including preparation of activation logic, activation task requests and bid packs, and the conduct of facility verification tests

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* Mr. Petro will assume the AES duties later in 1966 when he becomes available from LEM.

Provides support to the Mission Control Center and the Manned Space Flight Net.

Participates as a member of the Configuration Control Board.

Background

Mr. Holtje has 12 years of ground and flight test experience at Grumman, the last seven of which have been in a supervisory capacity. He is presently assigned to the Test and Operations portion of the Phase B AES effort. Concurrently he is head of the Aero Structure Section of the Flight Test Department, responsible for directing major portions of LEM test and support in the areas of test mission planning, checkout, site activation, and test facility operations. He also directs the formation of detail plans and analyses for flight testing of airframe, engine, and flight control systems on all production aircraft. Other portions of his background are as follows:

- Group leader in Structural Flight Test Group, responsible for flight loads measurement and structural integrity buildup and demonstration
- Served as flight test engineer in Structural Flight Test Group, performing automatic and semi-automatic data reduction and IBM programming
- One year as ground test engineer, concentrating on static and dynamic tests and component qualifications for aircraft and missile projects
- BSME, Stevens Institute of Technology.

C. R. SPINNER, SUPPORT MANAGER

The Support Manager is responsible for the procurement and/or design and fabrication of hardware necessary to maintain, operate, and handle the various subsystems, systems, and vehicles during the test and operational phases of the program. His responsibility will also include operational publications and training as well as logistics and spares provisioning. He or his designated representative:

Provides an overall detailed plan for the provision of Support Facilities and Services and controls performance against this plan

Directs the design, development and/or procurement of required facilities and equipment in accordance with approved specifications, schedules and budgets

Directs and implements plans and efforts required for proper maintenance of all vehicles

Provides manuals, training courses and facilities such as: operation manuals, maintenance manuals, flight and ground crew training, trainers, simulators and visual aids

Directs and implements an appropriate logistics plan in accordance with an approved schedule and budget

Provides, stores, and maintains required spares in accordance with an approved plan, schedule and budget

Performs acceptance or verification tests on all Support Department supplied hardware and equipment to the satisfaction of the party designated as user of the equipment

Participates as a member of the Configuration Control Board.

Background

Mr. Spinner is currently serving as Support Manager on the AES Phase B study effort, concerning on overall planning and preliminary definitions of ground support and test equipment, and logistics support. He formerly served for three years as Assistant Project Engineer on the LEM ground support equipment development effort, responsible for equipment design monitoring, liaison with NASA, inter-departmental coordination, and cost, manpower and schedule controls. Other highlights of his background are as follows:

- Former Ground Support Project Engineer in Preliminary Design Group, directing integrated support and GSE efforts for several aircraft, missile and space programs, including the F-111B, EA-6A, TFX (N) Missile, LEM, Apollo Space Program, and the original Apollo vehicle study
- Served as group leader for Electronics Ground Support, directing maintenance engineering analysis and support requirements for the A-6A Aircraft Program and support requirements for the OV-1 Mohawk Aircraft Program
- BSEE, Michigan State University; graduate studies in Business Management.

JOHN BIERSCHENK, MANUFACTURING MANAGER

The Manufacturing Manager is responsible for fabrication and assembly of all hardware including necessary tooling and manufacturing processes as well as manufacturing support for testing and field operations. He or his designated representative:

Directs and controls all manufacturing effort including tooling, manufacturing processes, and manufacturing test support

Provides a detailed tooling, fabrication and assembly plan consistent with approved schedules and budgets

Determines facility requirements for manufacturing and implements action to meet these requirements within approved achedules and budgets

Prepares reports on manufacturing cost, schedule, and manpower status for Program Management.

Participates in Make or Buy Evaluations

Participates as a member of the Configuration Control Board

Background

Mr. Bierschenk has 17 years of experience in aerospace manufacturing. He is presently serving as the Manufacturing Engineer on the AES Phase B Definition effort.

His past experience includes:

- As Manufacturing Engineering Consultant to Grumman's Advanced Systems Section, he performed advanced studies in producibility, manufacturing techniques, design trade-offs, project control, master manufacturing scheduling, and development of manufacturing PERT inputs
- Participated in original Apollo proposal and Mars Probe/Lander studies; served as manufacturing planning engineer and Project GSE Engineer for mechanical ground support equipment on the LEM proposal study
- Coordinated the manufacturing aspects on a series of study efforts, including the tri-service VTOL, DC-MAW anti-tank weapon, and several derivatives involving modifications to existing designs, such as the armed Mohawk Aircraft, various other Mohawk modifications, and Grumman's entry in the VA(L) attack aircraft competition
- BSME, Cornell University; currently working for MS in Industrial Management at Polytechnic Institute of Brooklyn.

FACILITIES AND ADMINISTRATION MANAGER

The Facilities and Administration Manager is responsible for coordinating the planning of all AES facilities required at Grumman's Long Island, N.Y. plants and for providing all necessary administrative services. He or his designated representative:

Prepares an overall plan of AES facilities required at Grumman's Long Island, N. Y. plants

Prepares requests, justifications, schedules and other documentation associated with these facilities

Coordinates the utilization of available LEM facilities with LEM Program Management and NASA

Provides the AES Program with necessary administrative services including office management, secretarial and reproduction services, visit clearances and security.

CONFIGURATION MANAGEMENT MANAGER

The Configuration Management Manager is responsible for developing and implementing a program configuration identification, control and accounting system which meets NASA requirements. He or his designated representative:

Prepares the AES Configuration Management Plan and monitors performance against this plan

Develops, issues and maintains the program configuration identification, control and accounting system

Advises the Materiel, Subsystems and other Managers on identification, control and accounting systems for subcontractor efforts

Serves as configuration management interface with the LEM Program

Directs the conduct of Interface Configuration Documentation formal change activities with associate contractors

Monitors in-house and subcontractor activities to assure the uniform application of the configuration identification, control and accounting system.

Administers the change control and accounting system for the Program Director

INSTRUMENTATION AND DATA HANDLING SERVICES MANAGER

The Instrumentation and Data Handling Services Manager is responsible for servicing the Instrumentation and Data Handling needs of all AES Program Departments. He or his designated representative:

Directs a comprehensive AES requirements analysis to:

Screen test requirements to optimize use of existing equipment and facility capabilities

Screen instrumentation requests to assure adequate coverage of test objectives

Effect liaison with Test and Site Operations, Engineering Support and other groups to assure concurrence on test implementation

Provide data systems engineering to optimize data flow from measurement to finished data

Develop methods to meet all data processing requirements

Provides instrumentation services for data acquisition in support of test operations

Provides data processing services including the design and definition of required computer programs and the operation of all equipment required for data reduction

Provides Measurement and Calibration services including the preparation of specifications for procurement of transducers required for ground testing and GSE and calibration procedures for physical and electrical measuring equipment. Also provides engineering support to Calibration Laboratories, consulting services to design and installation groups and assistance in vendor/subcontractor liaison

Provides System Design services including:

Specifications for procurement of equipment to satisfy signal conditioning, multiplexing, recording and data processing requirements of the test program

Detail design required to install equipment in test articles and facilities

ICD information on ground test equipment

Designs for instrumentation equipment built in-house

Subcontractor/vendor liaison.

DATA MANAGER

The Data Manager is responsible for the identification, selection, validation and control of all contractual data. He or his designated representative:

Reviews the prime contract and subcontracts, and participates in the negotiation of firm data requirements between NASA and Grumman and between Grumman and subcontractors

Develops, issues and maintains data control methods and procedures

Provides maintenance and control of all specifications, specification control drawings and standards

Prepares and monitors data schedules to assure timely receipt of data from subcontractors and to assure timely submission of data to NASA

Reviews all contractual data prior to submittal to assure completeness and compliance with applicable schedules

Maintains a contractual data summary which lists all data requirements and Grumman performance in terms of these requirements

Maintains a central data and correspondence file including facilities for identification, storage and retrieval

Receives and processes documentation and validates payment for same.

QUALITY CONTROL MANAGER

The Quality Control Manager is responsible for defining overall quality control requirements and for assuring that the AES vehicles and support equipment, including all systems, subsystems and components meet these requirements and comply with program specifications and standards. He or his designated representative:

Prepares and maintains the AES Quality Control Plan

Directs all in-house and site Inspection activities, including the development of acceptance test procedures, the supervision of manufacturing test inspection and the maintenance of data and corrective action follow-up

Directs all in-house and site Quality Assurance activities

Obtains and approves subcontractor Quality Control requirements and follows up to assure compliance

Conducts subcontractor quality control audits to assist in source selection

Coordinates the AES Quality Control Program with NASA

Participates as a member of the Configuration Control Board.

SUBSYSTEM MANAGERS

Each Subsystem Manager is responsible for the in-house and subcontractor effort associated with a specific major subsystem from inception to incorporation in a vehicle. He or his designated representative:

Prepares an overall subsystem plan which covers the design, development, manufacture, procurement and test of the subsystem and delineates support requirements

Reviews and approves subsystem specifications for in-house or subcontractor effort

Evaluates subcontractor cost and technical proposals and participates in the selection of the best qualified subcontractor

Controls in-house and subcontractor cost, schedule and technical performance against the overall plan, and utilizes whatever controls are necessary to assure the attainment of cost, schedule and performance goals associated with his subsystem

Reports subsystem progress and status to Program Management on a regular basis.

VEHICLE MANAGERS

Each Vehicle Manager is responsible for the effort associated with a specific vehicle from inception to launch. He or his designated representative:

Prepares an overall vehicle plan which covers development, manufacture, and test of the vehicle and delineates support requirements

Reviews and approves vehicle specifications and test plans

Controls cost, schedule and technical performance against the vehicle plan, and utilizes whatever controls are necessary to assure the attainment of cost, schedule and performance goals associated with his vehicle

Reports vehicle progress and status to Program Management on a regular basis.

4. PROGRAM PLANS

This section contains and AES Summary Schedule, and the PERT, Manpower and Procurement Plans which serve as control bases for the Definition Phase.

4.1 AES SUMMARY SCHEDULE

The AES Summary Schedule is shown in Fig. 4-1. It indicates the basic plan for each of the four vehicles and compares these to the LEM launch schedule. (The schedules are based upon the Flight Mission Assignment Plan for AES Planning, ML-65-1 dated 7 August 1965, and the LEM Program Schedule III Revision 1 LED 560.121-1 dated 7 September 1965.)

In accordance with NASA contractual requirements, the Phase I Laboratory vehicles will be fabricated and assembled to the LEM configuration at Grumman and subsequently modified to each particular laboratory flight configuration at KSC. The Lab I missions currently planned include earth orbit rendezvous, earth polar orbit, earth synchronous orbit and lunar orbit flights. Saturn IB and Saturn V launch vehicles will be used. As shown on the schedule these launches will occur during the time span of the last four LEM launches.

The Phase II Laboratories will be fabricated and assembled at Grumman using a modified LEM manufacturing cycle. Their missions will be similar to those of the Phase I Laboratories except that mission durations will be about 45 days instead of 14, and the experiments conducted will be different and progressively more comprehensive. All laboratory missions will be manned, requiring the CSM and its three man crew. Some of the missions will be launched by the Saturn IB, the others will use the Saturn V launch vehicle.

The Shelter and Taxi vehicles, also fabricated and assembled at Grumman, will be used for extended-stay lunar exploration missions. These missions, along with the Lab II missions, will occur in the two-year time period following the basic LEM and Lab I Missions. The Shelter will be landed unmanned on the lunar surface, capable of a 90-day storage period prior to use. It will serve as the base of operations for the two man team during their 14-day stay. The Taxi, which will separate from the CSM in lunar orbit, will land the two man team on the moon and, after a 14-day quiescent storage period during the operations from the Shelter, the Taxi's ascent stage will return them to the CSM and thence to Earth. Shelters and Taxis will be launched by the Saturn V.

More detailed schedules and planning data on these vehicles and missions are presented in other volumes of this report.

4.2 PERT PLANS

The preliminary PERT Milestone Networks for the AES Program are shown in Fig. 4-2, 4-3 and 4-4. The networks present the Grumman Plan for the tasks which constitute the Definition Phase and are based upon the following assumptions:

- A Definition Phase of 12 months duration (as directed by NASA)
- Go-ahead by December 1, 1965
- Preliminary Design Review for Laboratory I vehicle to start by July 1, 1966
- Preliminary Design Reviews for remaining vehicles to start by October 1, 1966

These assumptions are in conformance with the planning dates in the Definition Phase Study Proposal submitted to NASA by Grumman letter CTR/1065-1839 dated October 28, 1965. It should be noted that the PDR dates for these PERT Networks differ from the PDR dates shown in Fig. 4-1. The PDR dates in Fig. 4-1 are based upon the general guidelines established by NASA for this study which required all PDR's to be completed by July 1, 1966.

Figure 4-2 presents a typical vehicle network for the Engineering, Development Test, Manufacturing and procurement effort for the Definition Phase of Laboratory I. The network may also be used for the Lab II, Shelter and Taxi vehicles by phasing events and activities approximately three months later.

The Support effort is presented in the network shown in Fig. 4-3. It emphasizes the tasks for support of the Laboratory I development and shows some detail for the remaining vehicles. This network is phased in time to reflect a later completion date for the Lab II, Shelter and Taxi Preliminary Design Reviews.

The third network shown in Fig. 4-4 presents the Operations plan for the Definition Phase. It emphasizes prelaunch and launch operations, mission flight plans and constraints, and site activation.

The milestone networks described above are based upon a twelve-month Definition Phase to conform with latest NASA/Grumman planning. Other documents included in the Phase B Final Report reflect a July 1, 1966, completion date for all Preliminary Design Reviews as originally submitted in Vol. I, Phase B, Preliminary Definition Plan (October 29, 1965).

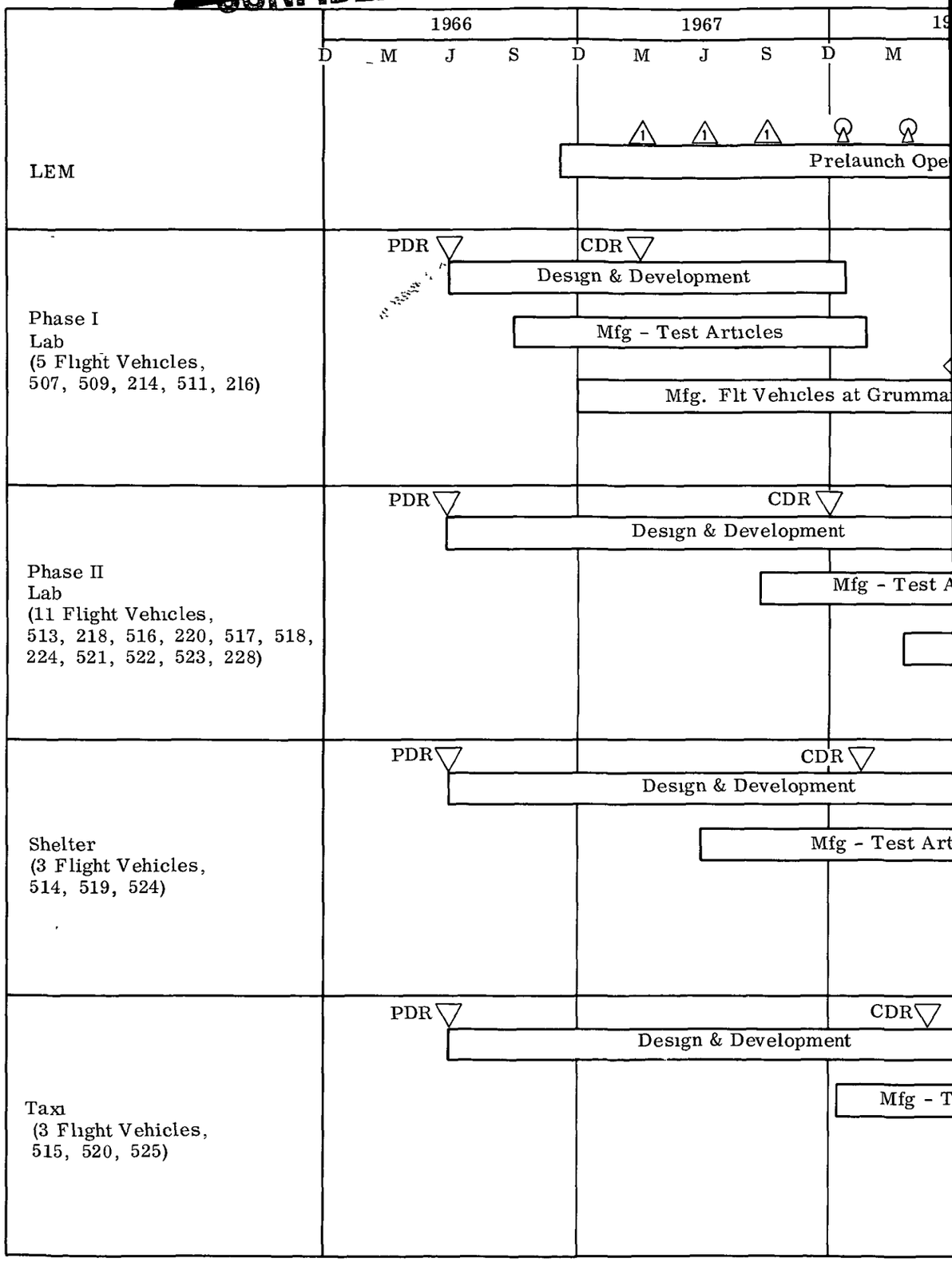
4.3 MANPOWER PLAN

The work task requirements for the AES Program dictate the need for people with high technical competence coupled with space technology experience. Grumman is in a position to meet this need by taking advantage of the technical "know-how" and experience gained on such programs as OAO, LEM, Echo II, and other company and customer sponsored space studies.

The following five graphs represent the Preliminary AES Development/Operations Phase manpower requirements versus Grumman manpower availability, assuming a hardware phase go-ahead of July 1, 1966.

Figure 4-5 shows the complete, time phased, AES manpower staffing profile. This profile is divided into four basic categories:

- Technical-including basic engineering, support engineering, service and flight test
- Manufacturing - including vehicle fabrication, support fabrication and quality control


1966
1967
19
D
M
J
S
D
M
J
S
D
M
LEM
Prelaunch Ope
PDR
CDR
Design & Development
Phase I
Lab
(5 Flight Vehicles,
507, 509, 214, 511, 216)
Mfg - Test Articles
Mfg. Flt Vehicles at Grumma
PDR
CDR
Design & Development
Phase II
Lab
(11 Flight Vehicles,
513, 218, 516, 220, 517, 518,
224, 521, 522, 523, 228)
Mfg - Test A
PDR
CDR
Design & Development
Shelter
(3 Flight Vehicles,
514, 519, 524)
Mfg - Test Art
PDR
CDR
Design & Development
Taxi
(3 Flight Vehicles,
515, 520, 525)
Mfg - T

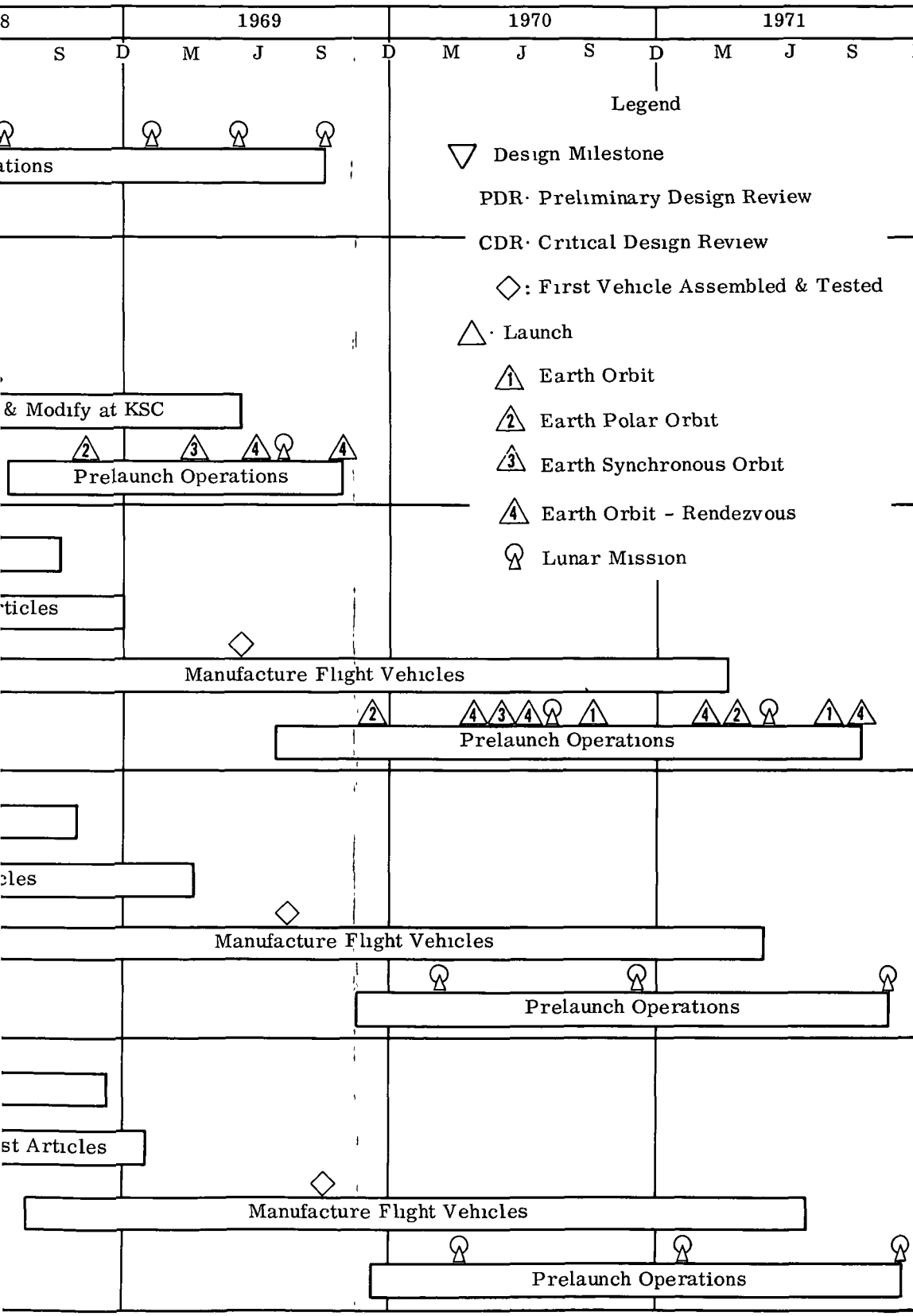


Fig. 4-1. AES Summary Schedule

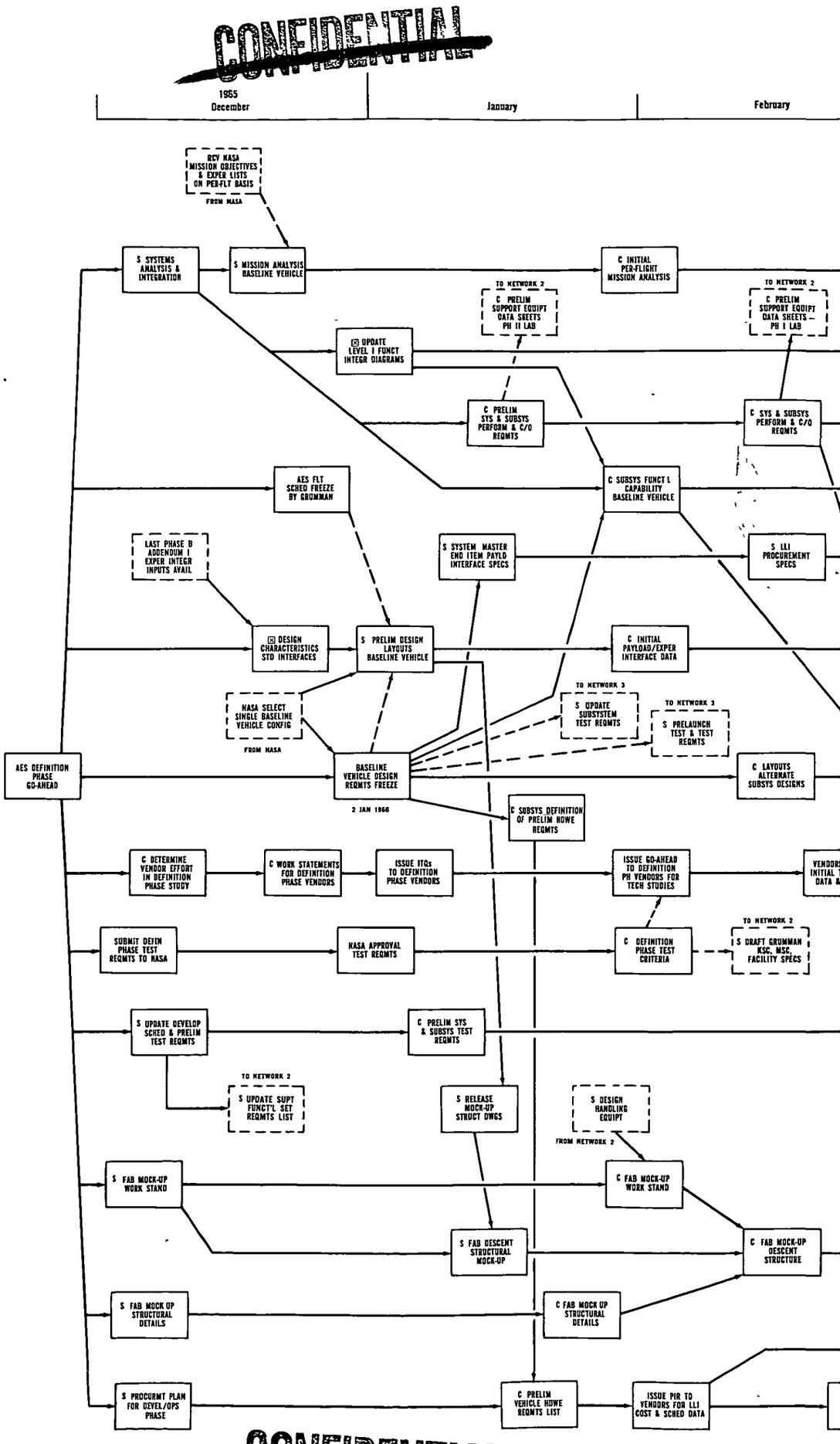


Fig 4-2

1966

March | April | May

EXPERIMENT & PAYLOAD INPUT FREEZE
1 MAR 1966

TO NETWORK 2
S DRAFT FACILITY PLAN PH I LAB

C INITIAL MOD REQMTS PER-FLT BASIS

C PER-FLIGHT MISSION ANALYSIS CAPABILITY BASELINE VEH

C SYS & SUBSYS MISSION-RELATED REQMTS

C DESIGN REQMTS FOR PER-FLT MODS

C PAYLD INTEG PER-FLT BASIS FOR BASELINE VEHICLE

C VEHICLE/SUPPORT EQUIPT INTERFACE FUNCT DIAGRAMS

TO NETWORK 2
S PREPARE PRELIM LOGISTICS REQMTS — PH I LAB

C LEVEL I VERICLE/PAYLOAD FUNCTL INTEGR DIAGRAMS

C ENVIRONMENTAL PROTECTION REQMTS

C BASELINE VEHICLE/SUPPORT FUNCT'L CAPABILITY

TO NETWORK 2
S SUPPORT FUNCTL SET SPECS

S UPDATE OF SUBSYS & VEHICLE SPECS

TO NETWORK 2
S PRELIM DRAFT TRANSPORT PLAN PH I LAB

S FINAL INPUTS TO SYS MASTER END ITEM & PAYLD INTERFACE SPECS

S INCORP OF SUBSYS CHOICE IN BASELINE VEHICLE DESIGN

C DESIGN OF EXPER/PAYLOAD INTERFACES

TO NETWORK 2
S 2ND UPDATE FUNCT'L SET EQUIPT LISTS PH I LAB

TO NETWORK 2
S DETERMINE IMPACT OF SUBSYS DESIGN ON LEM SUPPORT EQUIPT

C FINAL CHOICE FROM ALTERNATE SUBSYS DESIGNS

C DEFINITION SUBSYST/SUPPORT EQUIPT REQMTS

C SUBSYSTEM PRELIM DESIGN OF BASELINE VEHICLE

C PRELIM DESIGN BASELINE VEHICLE & DESIGN FREEZE FOR PDR

IBMIT NICAL PORT

C VENDOR SUBMISSION OF TECH DATA & FINAL REPORT

TO NETWORK 2
S PRELIM DRAFT TRANSPORT PLAN PH I LAB

S SYSTEM LEVEL TEST PLANS

C DEVEL/OPS PHASE TEST REQMTS

S SUBSYSTEM TEST LOGIC CHARTS

EXPERIMENT PAYLOAD MOCK UP SELECTION BY NASA
15 MAR 1966

S RELEASE INTERIOR ARRANGEMENT & HARDPOINT MOCK-UP DWGS

S FAB INTERIOR & HARD POINT MOCK-UPS

S RELEASE SUBSYS MOCK-UP DWGS

S RELEASE EXPER MOCK UP DWGS

S FAB EXPER MOCK-UPS

C FAB EXPER MOCK UPS

TO NETWORK 2
C DESIGN HANDLING EQUIPT

S FAB SUBSYS HARDWARE MOCK-UPS

C FAB SUBSYS HARDWARE MOCK UPS

C FAB & ASSY ASCENT STRUCT MOCK UP

S FINAL ASSY & INSTL OF SUBSYS & EXPERS (MOCK UP

TO NETWORK 2
C TRANSPORT PLAN PH I LAB

ISSUE PIRs TO ALL VENDORS FOR COST & SCHED DATA FOR PDR

RCV VENDOR COST & SCHED DATA

TINAL LIST OF LLI HARDWARE

C REVIEW OF FUND & PROCURE REQMTS FOR LLI HOWE

SUBMIT REQMTS TO NASA FOR DECISION ON LLI PROCURE
15 MAR 1966

Fig 4-2

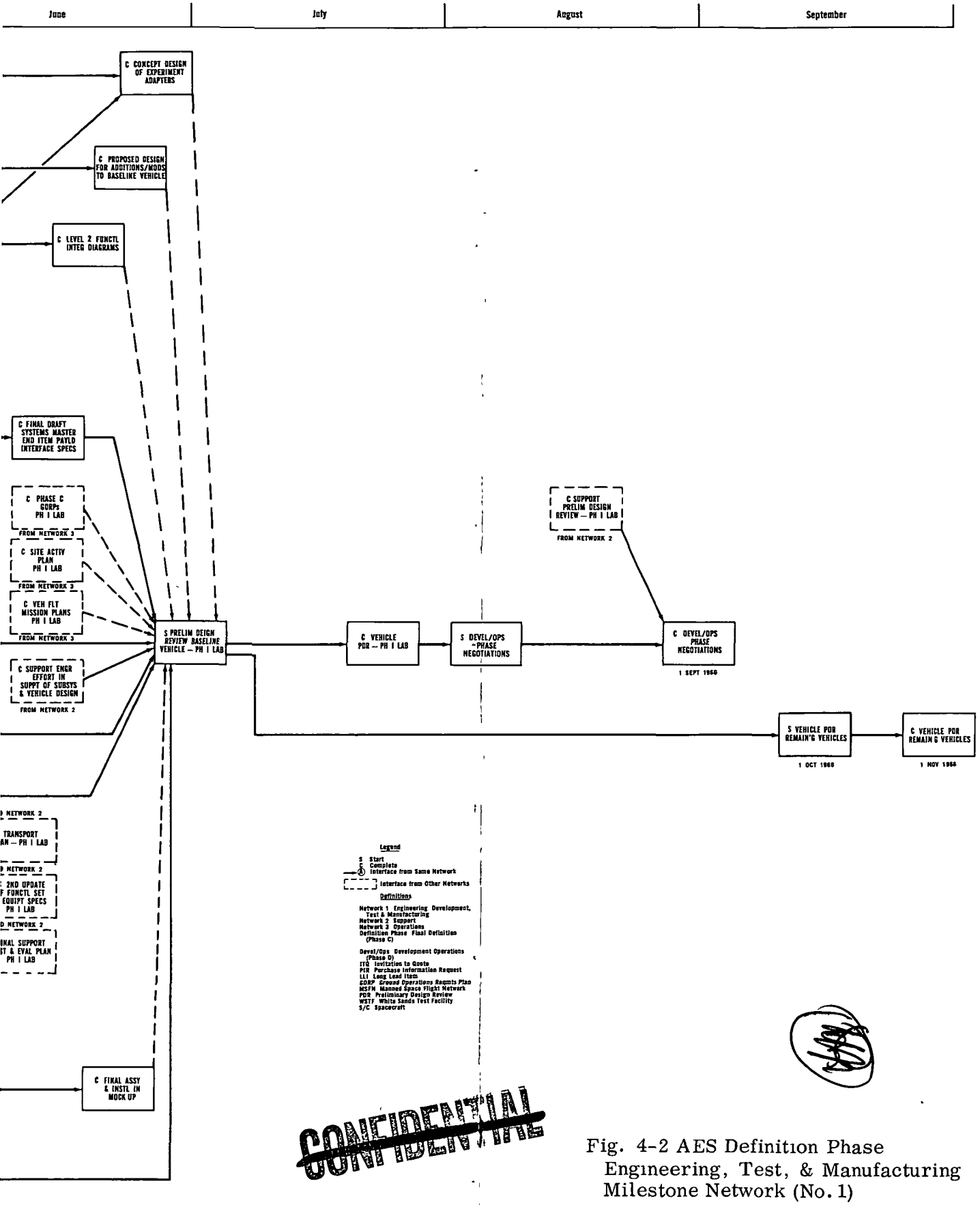


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Fig. 4-2 AES Definition Phase Engineering, Test, & Manufacturing Milestone Network (No. 1)

Fig 4-2

Grumman

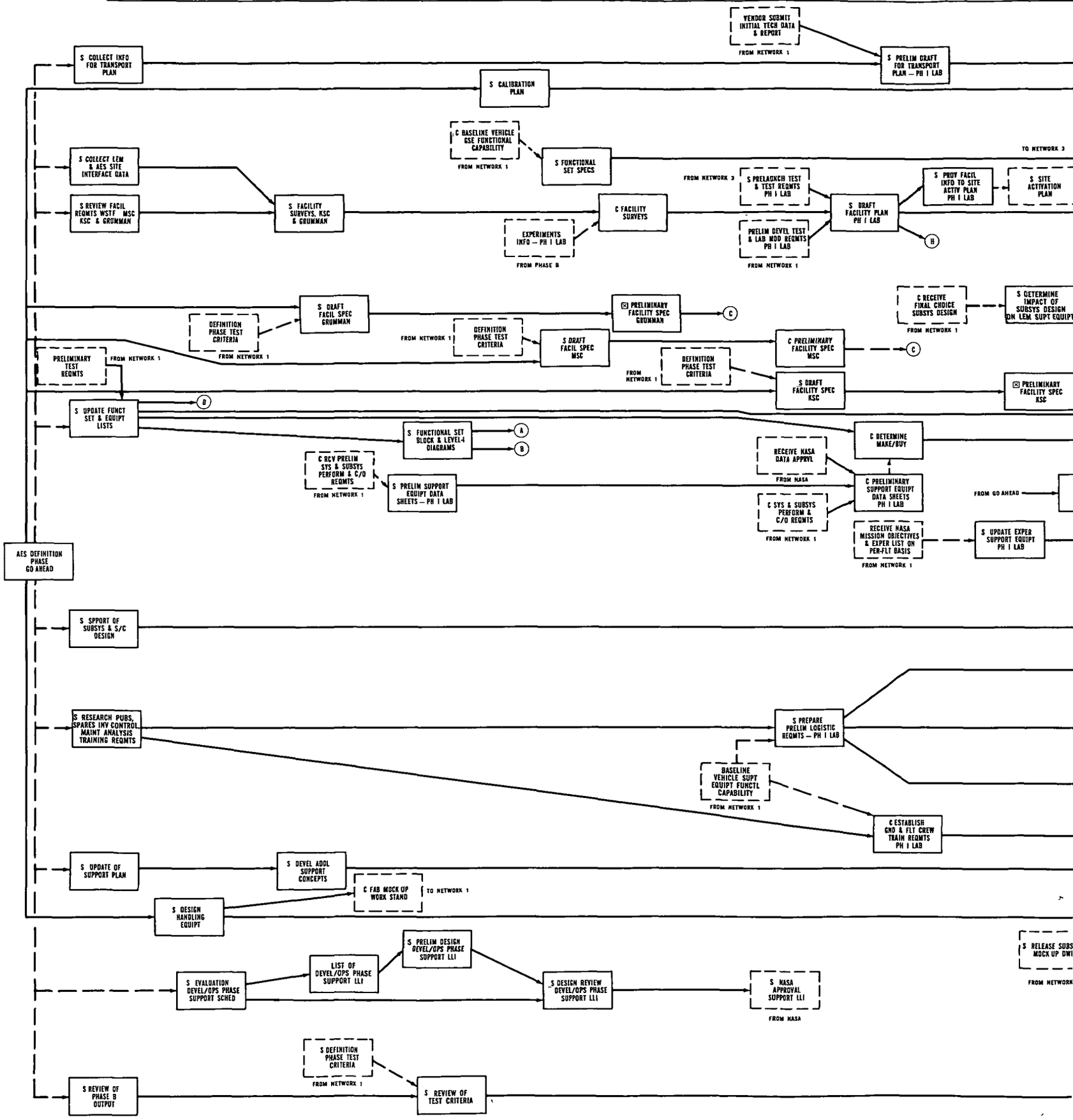

Fig 43 (1)

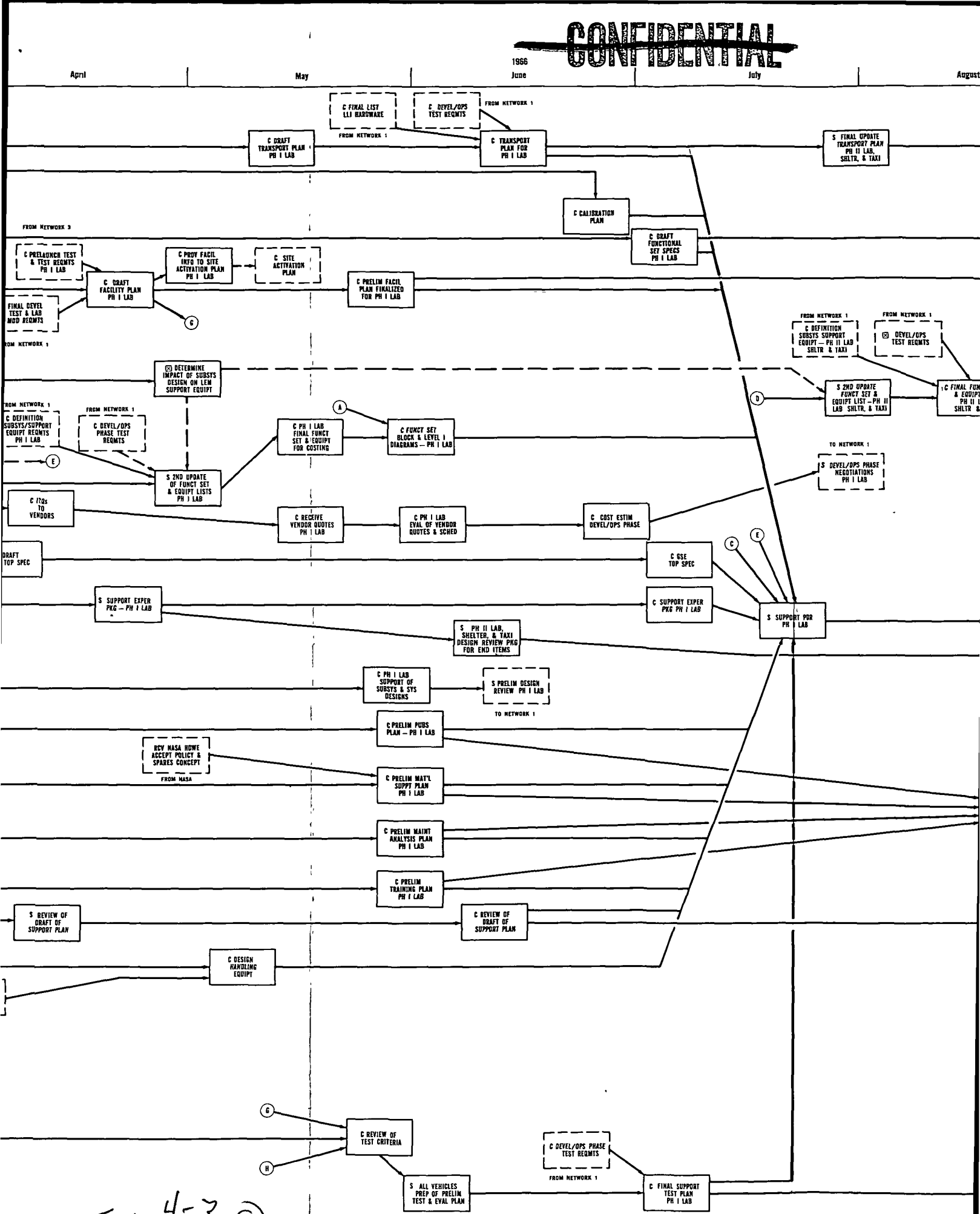
1966
April
May
June
July
August
C FINAL LIST LLI HARDWARE
FROM NETWORK 1
C DEVEL/OPS TEST REQMTS
FROM NETWORK 1
C DRAFT TRANSPORT PLAN PH I LAB
C TRANSPORT PLAN FOR PH I LAB
S FINAL UPDATE TRANSPORT PLAN PH II LAB, SHLTR, & TAXI
C CALIBRATION PLAN
FROM NETWORK 3
C DRAFT FUNCTIONAL SET SPECS PH I LAB
C PRELAUNCH TEST & TEST REQMTS PH I LAB
C DRAFT FACILITY PLAN PH I LAB
C PROV FACIL INFO TO SITE ACTIVATION PLAN PH I LAB
C SITE ACTIVATION PLAN
C PRELIM FACIL PLAN FINALIZED FOR PH I LAB
FINAL DEVEL TEST & LAB MOD REQMTS
G
FROM NETWORK 1
FROM NETWORK 1
C DEFINITION SUBSYS SUPPORT EQUIPT — PH II LAB SHLTR & TAXI
FROM NETWORK 1
DEVEL/OPS TEST REQMTS
DETERMINE IMPACT OF SUBSYS DESIGN ON LEM SUPPORT EQUIPT
D
S 2ND UPDATE FUNCT SET & EQUIPT LIST — PH II LAB SHLTR, & TAXI
C FINAL FUN & EQUIPT PH II SHLTR &
FROM NETWORK 1
C DEFINITION SUBSYS/SUPPORT EQUIPT REQMTS PH I LAB
FROM NETWORK 1
C DEVEL/OPS PHASE TEST REQMTS
A
C PH I LAB FINAL FUNCT SET & EQUIPT FOR COSTING
C FUNCT SET BLOCK & LEVEL I DIAGRAMS — PH I LAB
TO NETWORK 1
S DEVEL/OPS PHASE NEGOTIATIONS PH I LAB
E
S 2ND UPDATE OF FUNCT SET & EQUIPT LISTS PH I LAB
C ITOs TO VENDORS
C RECEIVE VENDOR QUOTES PH I LAB
C PH I LAB EVAL OF VENDOR QUOTES & SCHED
C COST ESTIM DEVEL/OPS PHASE
DRAFT TOP SPEC
C GSE TOP SPEC
C
E
S SUPPORT EXPER PKG — PH I LAB
C SUPPORT EXPER PKG PH I LAB
S SUPPORT PDR PH I LAB
S PH II LAB, SHELTER, & TAXI DESIGN REVIEW PKG FOR END ITEMS
C PH I LAB SUPPORT OF SUBSYS & SYS DESIGNS
S PRELIM DESIGN REVIEW PH I LAB
TO NETWORK 1
C PRELIM PUBS PLAN — PH I LAB
RCV NASA NOWE ACCEPT POLICY & SPARES CONCEPT
FROM NASA
C PRELIM MAT'L SUPPT PLAN PH I LAB
C PRELIM MAINT ANALYSIS PLAN PH I LAB
C PRELIM TRAINING PLAN PH I LAB
S REVIEW OF DRAFT OF SUPPORT PLAN
C REVIEW OF DRAFT OF SUPPORT PLAN
C DESIGN HANDLING EQUIPT
G
H
C REVIEW OF TEST CRITERIA
C DEVEL/OPS PHASE TEST REQMTS
FROM NETWORK 1
S ALL VEHICLES PREP OF PRELIM TEST & EVAL PLAN
C FINAL SUPPORT TEST PLAN PH I LAB

Fig 4-3 (2)

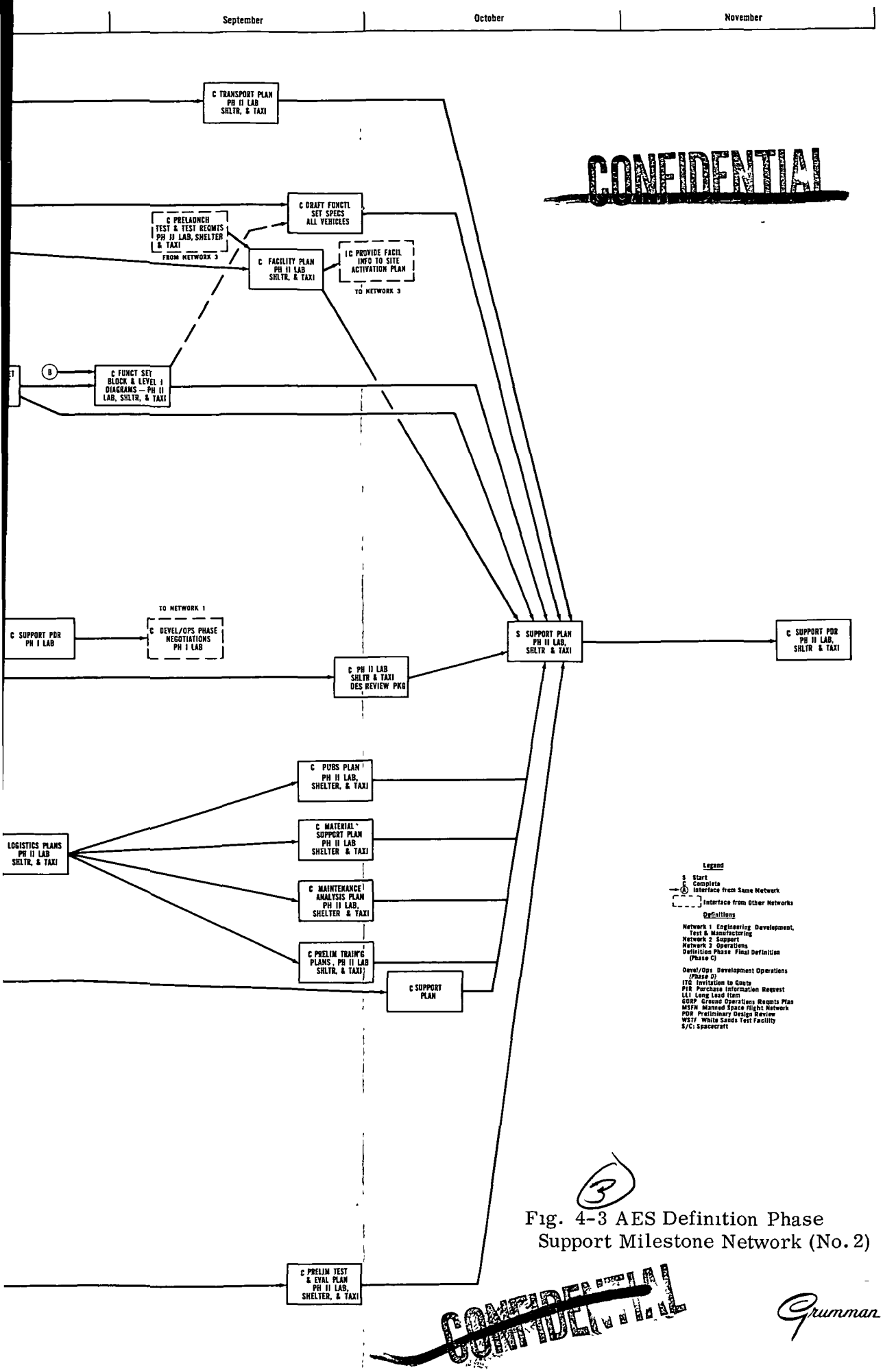

Fig. 4-3 AES Definition Phase Support Milestone Network (No. 2)

Grumman

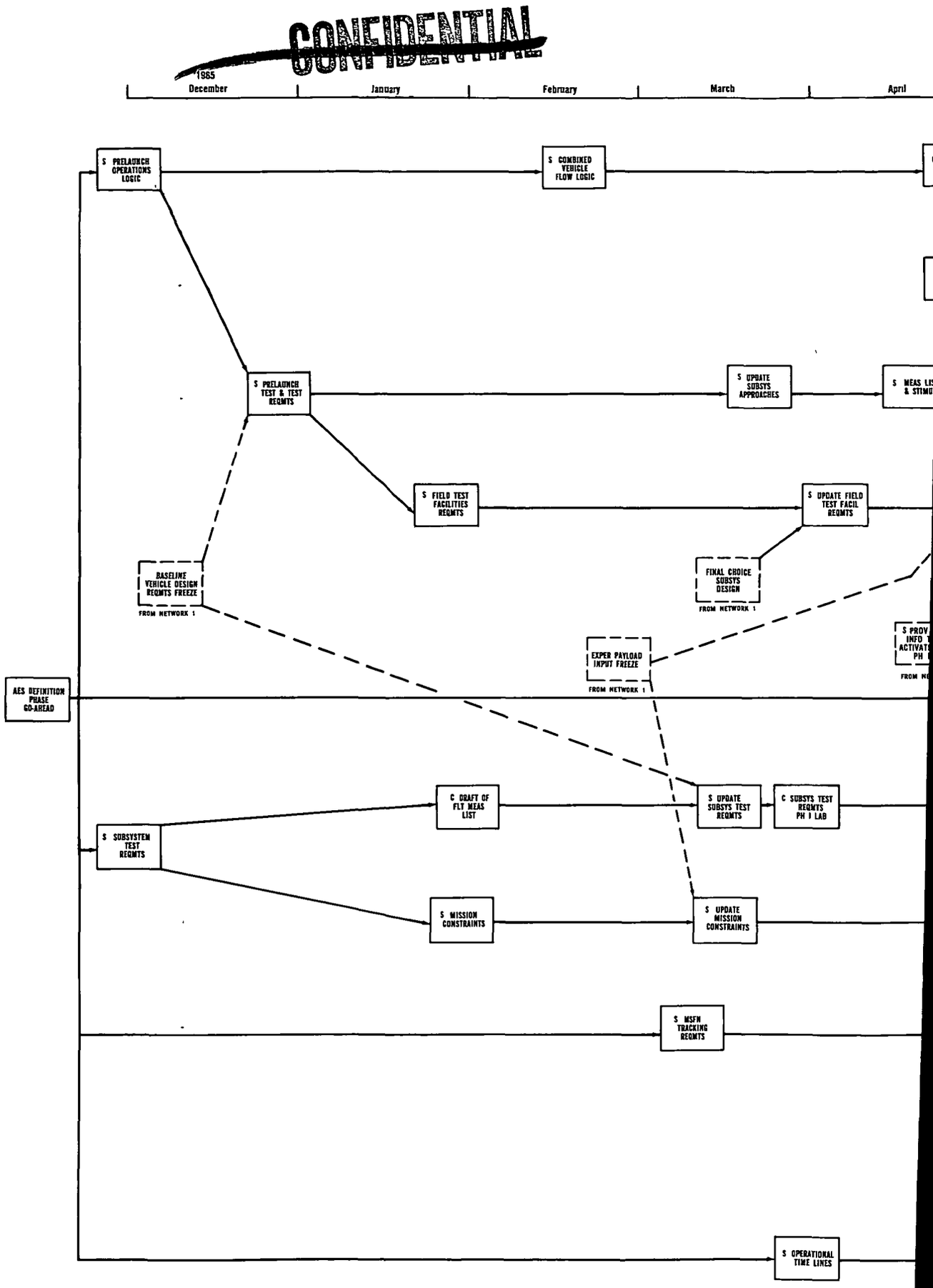

FIG 4-4

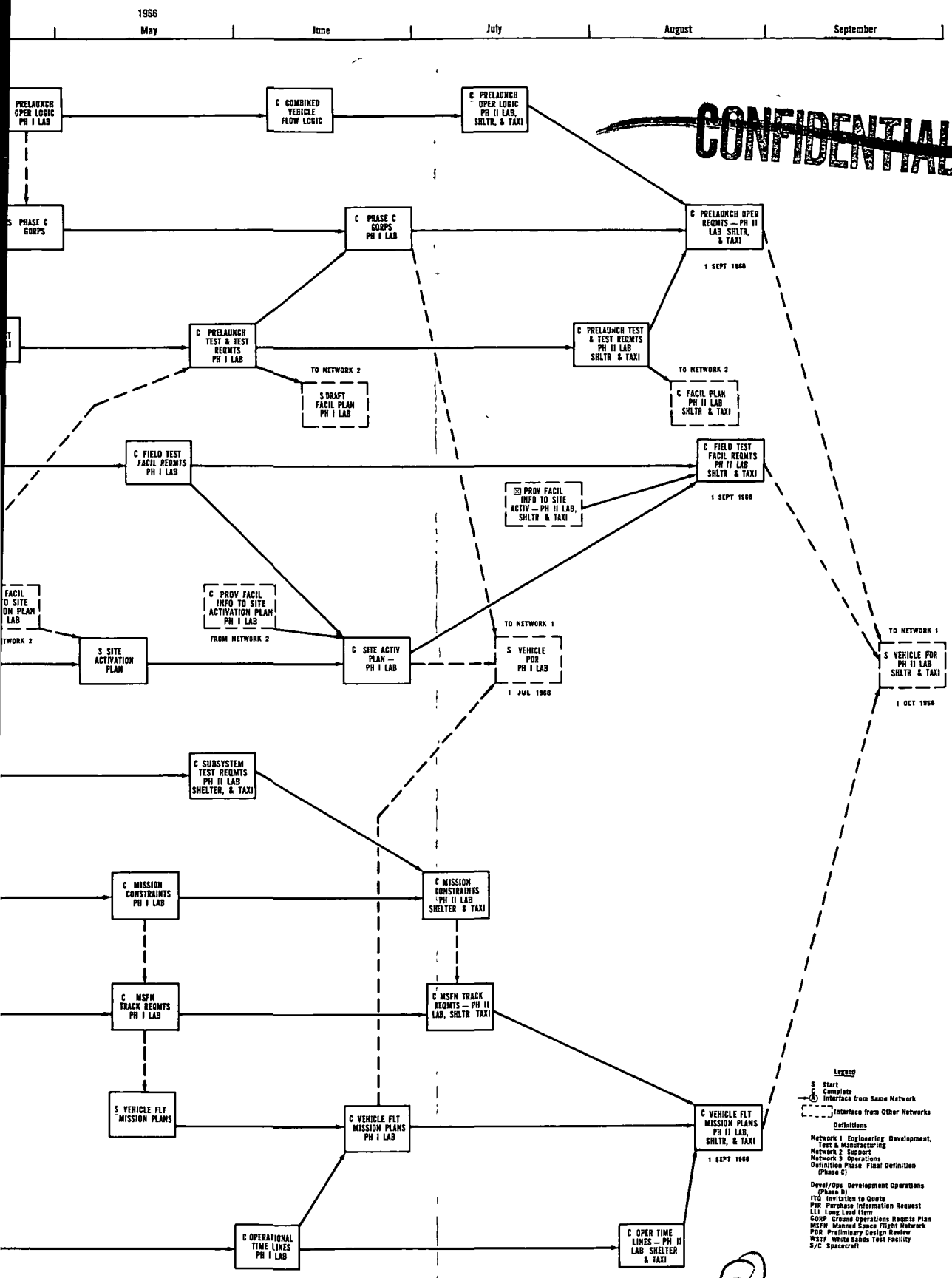

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Fig. 4-4 AES Definition Phase Operations Network (No. 3)

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Grumman

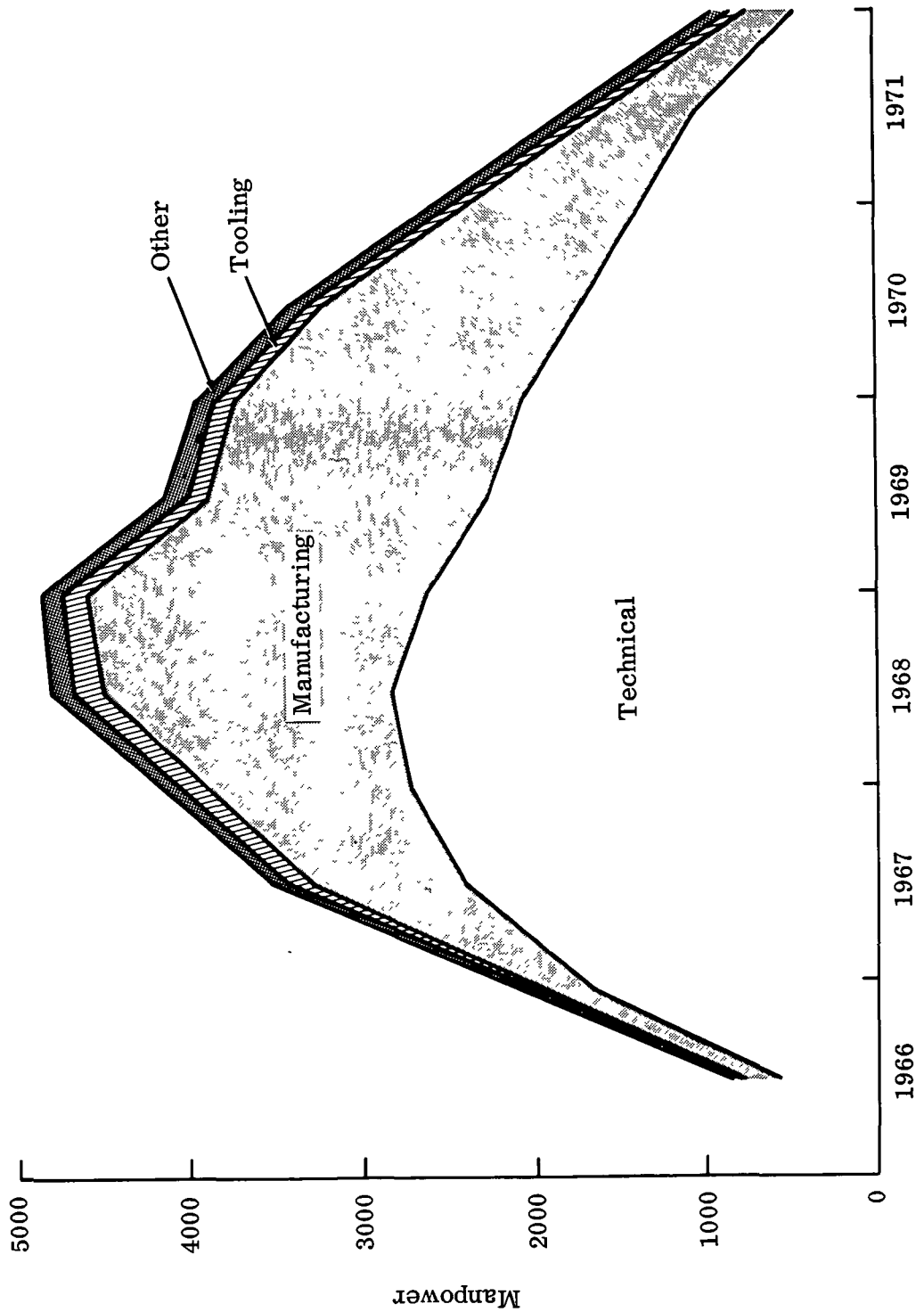

Fig. 4-5. Preliminary AES Development/Operations Phase Manpower Requirements

- Tooling - encompassing tool design and tool fabrication
- Other - covering program management, shipping and reproduction.

A clear delineation of the task requirements necessary to fulfill this manpower profile will provide a basis for selecting specific individuals for assignment to the program. This selective staffing technique, or "people plan," will be expanded in the Definition and Development/Operations Phases, to take full advantage, without interference, of the people available from the LEM and other company programs who have experience in design, development, fabrication and test of space hardware and vehicles.

Figure 4-6 represents the LEM manpower staffing requirements for the remainder of the program. The manpower groupings used here are the same as those in Fig. 4-5.

Figures 4-7, 4-8 and 4-9 compare Technical, Manufacturing and Tooling manpower requirements with the projected Corporate manpower availability. In all three categories it is evident that there is ample experienced corporate manpower available to meet the needs of the AES Program. These graphs further show that even though a portion of the available manpower has been assumed to be used by other anticipated business, the staffing requirements of the AES will still be maintained. In those instances where specific requirements exist to meet the AES schedule, Grumman will satisfy those minor needs through selective hiring.

4.4 PROCUREMENT PLAN

The AES Definition Phase Procurement Plan is presented below. This plan (including costs) was originally submitted to NASA on 28 October 1965 as part of Grumman's Definition Phase Cost Proposal, "Analysis of Anticipated Subcontracting." It is anticipated that during the Definition Phase, the selected subcontractors will be placed under firm contract and will participate in the final definition of their respective subsystems and/or equipments.

	SUBSYSTEM OR EQUIPMENT	SUBCONTRACTOR(S)	TASK
1.	Environmental Control Systems	Hamilton Standard	Study the modification and additions to the LEM Environmental Control Systems for use in Phase II Lab, Shelter and Taxi.
2.	Attitude Translation and Control Assembly	Radio Corp. of America	Study the modification to the LEM Attitude Translation and Control Assembly to provide for rate-gain requirements of the Labs.
3.	Abort Electronics Assy. and Data Entry and Display Assembly	TRW Systems Group TRW Incorporated	Study the modifications required to the abort Electronics Assembly and Data Entry and Display Assembly to interface with the Alignment Optical Telescope.

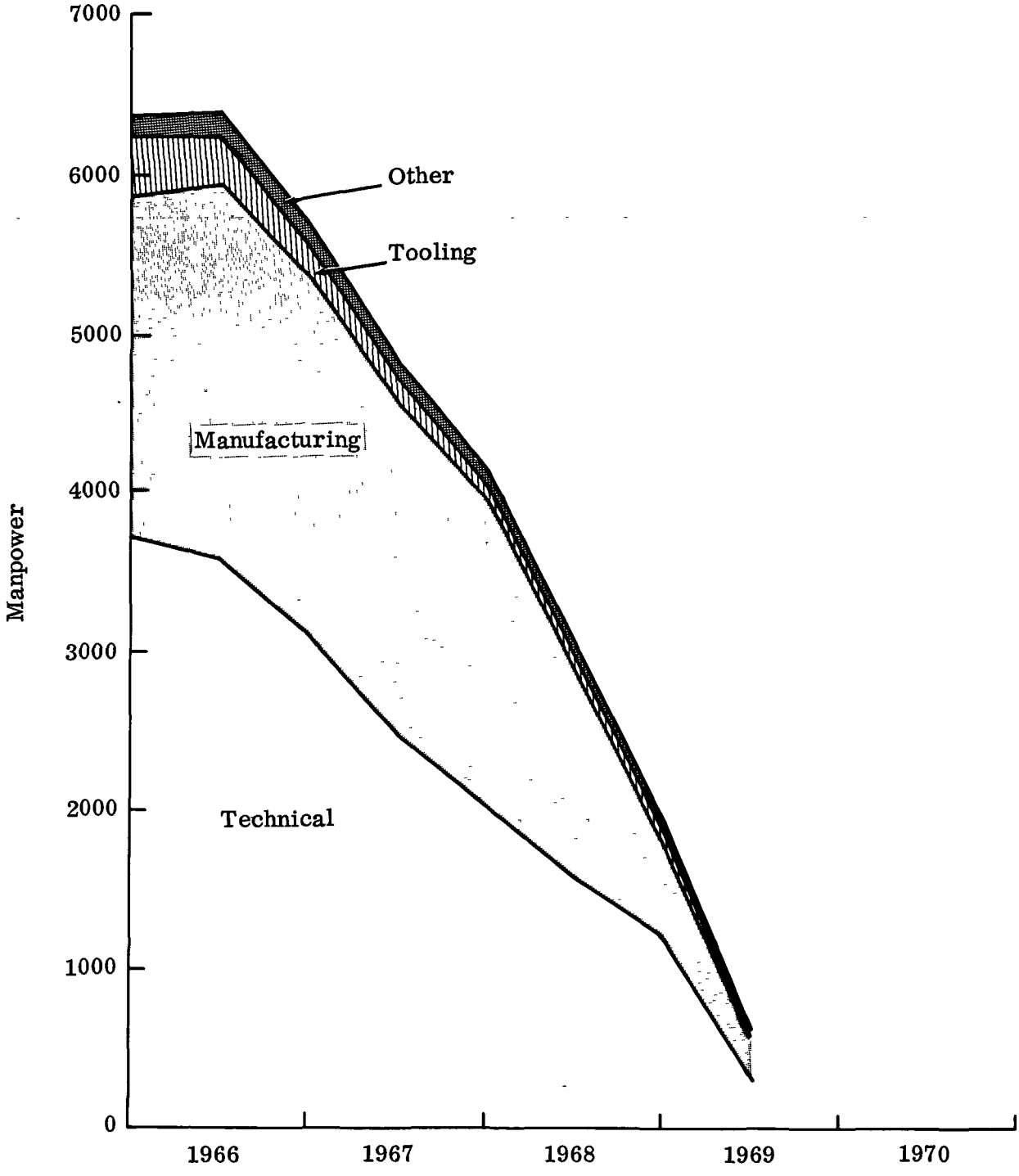

Fig. 4-6. LEM Manpower Requirements

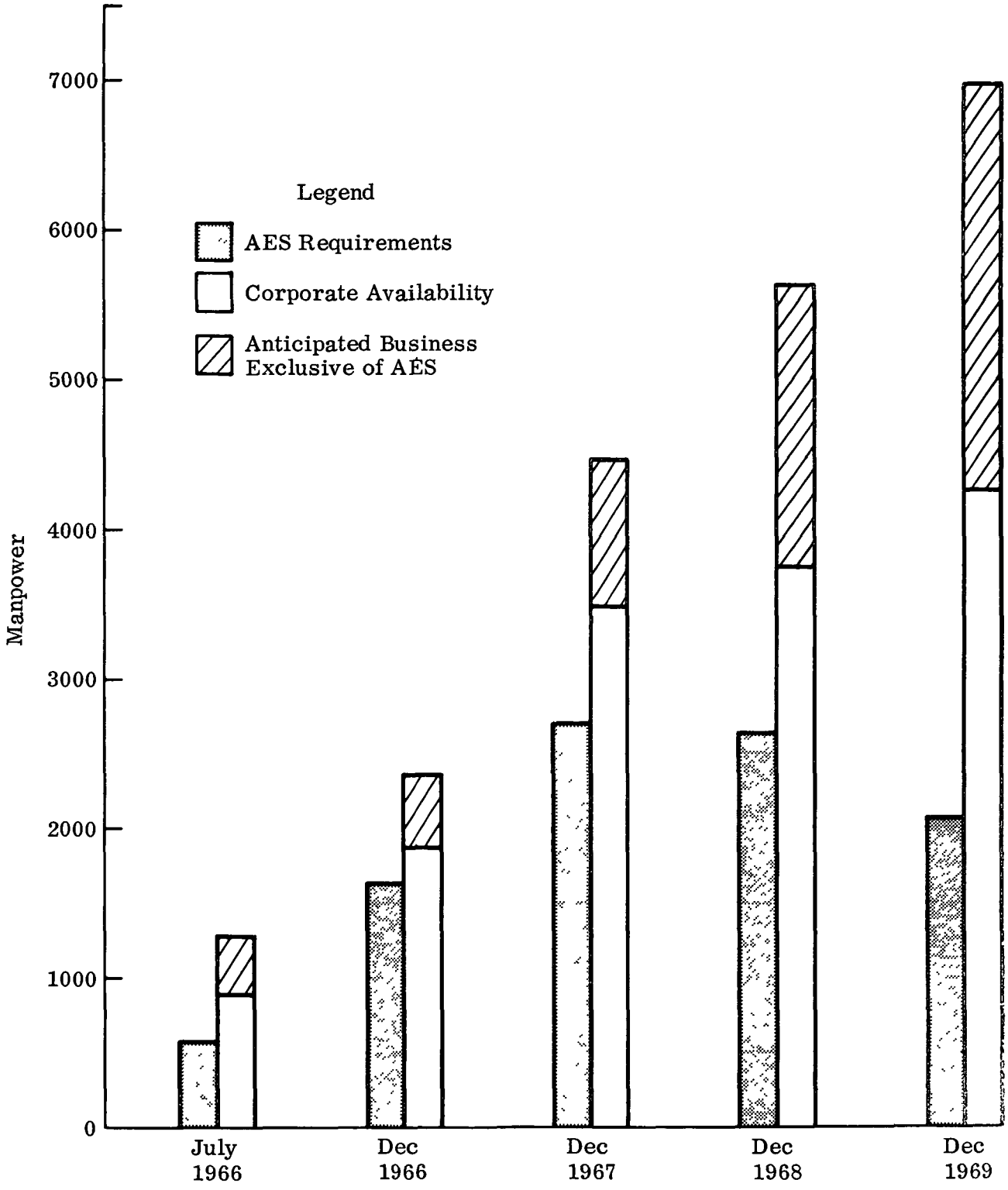

Fig. 4-7. Preliminary AES Development/Operations Phase Technical Manpower Requirements vs. Corporate Manpower Availability

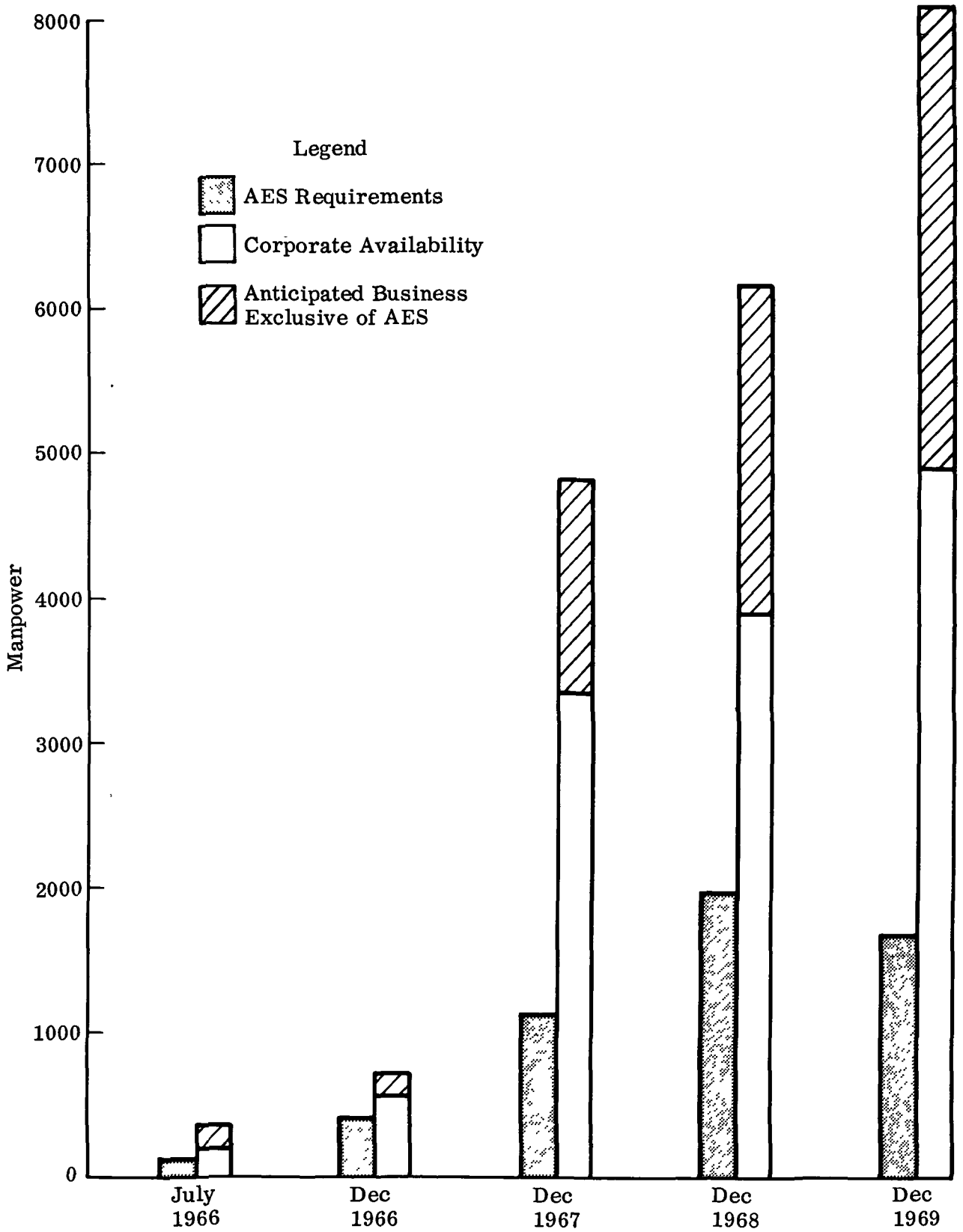

Fig. 4-8. Preliminary AES Development/Operations Phase Manufacturing Manpower Requirements vs. Corporate Manpower Availability

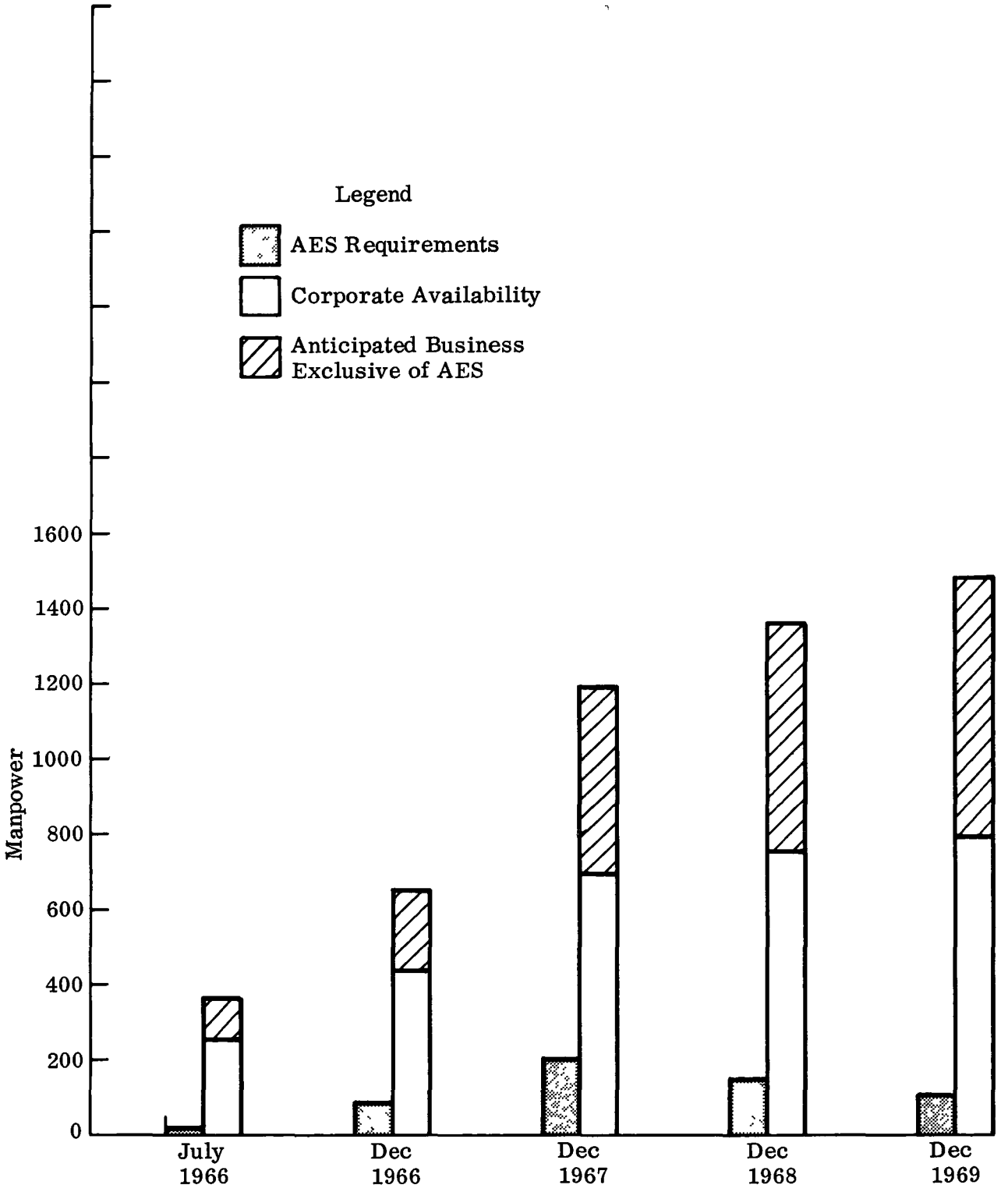

Fig. 4-9. Preliminary AES Development/Operations Phase Tooling Manpower Requirements vs. Corporate Manpower Availability

SUBSYSTEM OR EQUIPMENT	SUBCONTRACTOR(S)	TASK
4. Fuel Cells	Pratt & Whitney Allis-Chalmers General Electric	Studies of integration of Fuel Cells into the Phase II Labs and Shelter. (These studies will be four (4) mos. competitive studies. At the end of this period NASA will make a selection. An additional contract will be awarded to the selected subcontractor for an additional four (4) mos. to complete the study.)
5. Batteries	Eagle Picher Co.	Study of potential modifications to LEM Batteries for use in Phase I Labs.
6. Cryogenic Tank	Boulder Division Beech Aircraft Corp.	Studies of the use of the Cryogenic Tank configuration that has been selected by NASA for the Command Service Module, in the Phase II Labs.
7. Gaseous Storage Tanks	Airite Division Electrada Corp. Aerojet General Corp. Arde Engineering Corp.	Perform studies of gaseous storage tanks for O_2 and H_2 for the Shelter.
8. Electrical Control Assemblies	General Electric Co.	Perform studies for modifications to the LEM Electrical Control Assemblies required for Phase I Labs and Shelter.
9. Rate Gyro Assembly	Kearfott Division General Precision	Study the feasibility of modifying the existing LEM Rate Gyro Assembly to meet Phase I and II Lab requirements for long term attitude hold.
10. Mission Simulator	Link Division General Precision	Perform study for the necessary modification to the existing LEM Mission Simulator for Phase I Lab.

During the Definition Phase, a Procurement Plan for the Development/Operations Phase will be developed for all subsystems, major structures, major components, and supporting equipment. This plan will also take fullest advantage of current LEM/Apollo Program procurement experience by:

- Using as many of the existing LEM subsystems configurations as possible, thereby taking full advantage of already accomplished R & D efforts of the LEM subcontractors, and maximizing the use of supporting equipment designed for LEM and currently being provided for the various test and launch sites
- Adapting additional LEM subsystem and supporting equipment designs to AES specifications, or
- Identifying and using potential subcontractors who: (1) already have similar equipment, thus minimizing R & D costs and delays, or (2) have the experience and demonstrated capability to supply the equipment on schedule at minimum cost.

5. PROGRAM CONTROLS

The AES Program Director exercises control of all program parameters--schedule, cost, technical, data, configuration, and subcontractor--through an integrated network of controls. The framework and disciplines of the control network have been established in Phase B and expanded to the detail required to effectively control the Definition Phase.

5.1 SCHEDULE/COST CONTROLS

PERT/Time techniques as outlined in NASA PERT and Companion Cost System Handbook dated 30 October 1962, will be used to develop and control the Definition Phase. Schedules will be controlled by monitoring performance against the milestones shown on the three Preliminary PERT Networks included in Section 4.2 PERT PLANS. Cost Data will be collected and controlled through the use of the following three in-house control and reporting systems:

- Manhour Planning and Control System provides a detailed time-phased plan of manhour expenditures by labor category and related work scope definitions. Manhours charged are recorded in weekly computer print-out reports comparing actual vs. planned expenditures. Deviations from the plan are identified for corrective action
- The Manpower Planning and Control System converts the manhour plans into anticipated personnel requirements by labor category and thereby provides the basis for effective staffing of the Program
- The Material Planning and Control System provides internal control of material costs through a time-phased commitment and expenditure plan. Commitments and expenditures are compared to the plan on a monthly basis and deviations are displayed for decision and action.

The reports associated with these systems are shown in Fig. 5-1.

5.2 TECHNICAL PERFORMANCE CONTROL

Technical performance monitoring will be realized through a systematic engineering analysis and documentation effort to assure that every technical decision and engineering design solution is subjected to appropriate review and approval before succeeding sets of technical decisions and engineering solutions are made.

The key elements of the AES design control program are:

- Incorporation of all technical aspects of the program into a detailed technical program plan
- Detailed performance specifications and requirements
- Detailed test specifications, procedures and reports
- Effective change control
- Technical status reporting from all internal and subcontractor activities
- Formal design review
- Provision for contingency steps to implement recovery action if and when required.

5.3 DATA MANAGEMENT

Complete and effective documentation control on the AES Program will result from efficient utilization and control of information processing under the direction of the Data Manager.

He will, within the policy guidelines of NASA and the AES Program Director:

- Supervise the Program Documentation Organization in compliance with the NASA Control System
- Assure maximum utilization of the existing LEM documentation
- Assure meeting all the contractual data requirements of the AES Program.

During the Definition Phase, the Specification Unit will assist in the preparation of necessary specifications. In general, these will be the systems performance/design requirements specifications and contract end-item detail specifications for primary equipment, facilities and critical components. All specifications will be prepared to meet the intent of NPC 500-1, "Apollo Configuration Management Manual". Where appropriate, the existing LEM specifications will be used as the basis for AES specification.

A Data Requirements Control Unit and a Validation Unit will also be active during the Definition Phase. The Data Requirements Control Unit will:

- Negotiate firm data requirements between Grumman and NASA, and between Grumman and its vendors
- Institute control methods and procedures
- Schedule timely submittal of data from vendors
- Schedule timely submittal of data to NASA
- Review all contractual data prior to submittal for completeness and compliance with applicable requirements and schedules
- Record and maintain a contractual documentation summary for program review.

The Validation Unit will monitor the receipt of and control payment for vendor documentation submitted in the Definition Phase.

Other Data Management Units will be phased-in towards the end of the Definition Phase to provide a complete, functioning Data Management Organization by the start of the Development/Operations Phase.

In the interests of economy and efficiency, it is intended to adapt the identification system procedures and the documentation control system of the LEM Program to the needs of the AES. The aim is optimum commonality and use of drawings, documents, and other records. The experience gained on the LEM Program in the management of documentation tailored to the needs of NASA will permit a smooth transition of functions with a minimum of reorientation.

5.4 CONFIGURATION MANAGEMENT

Grumman will maintain effective configuration management on the AES Program through the continued implementation of proven systems and procedures. These systems and procedures reflect Grumman's experience on the LEM Apollo Program.

Implementation of configuration management on the AES Program will:

- Provide an effective system for management control of changes to prevent unplanned, unauthorized and unnecessary expenditures of resources
- Provide an effective system for verifying the precise configuration of each end-item
- Provide an effective system for maintaining correlation between the contract, the design and the end-item hardware of documentation.

5.5 SUBCONTRACTOR CONTROL

The major portion of subcontractor effort is associated with the design, development, manufacture and test of subsystems. The AES Subsystem Managers will exercise management control of these subcontractors. They will be supported by the Materiel Manager who provides all required procurement services and by other functional operations managers as required.

The specific steps which will be followed to select and control subcontractors are summarized below. The responsible and supporting managers are indicated after each step.

- Establish a clear definition of work to be accomplished in the specifications and vendor requirements documents - including all critical interfaces - (Engineering, Manufacturing and Quality Control Managers - with concurrence of Subsystem Manager)
- Submit work packages, including specifications, to qualified vendors for proposals and quotations (Materiel Manager)
- Review vendors' replies and select the best qualified subcontractors (Subsystem Manager assisted by the Engineering Manager, Materiel Manager, Contracts Manager, Program Planning and Control Manager and other Managers as appropriate)
- Review vendors' replies from a manufacturing standpoint (manufacturing plan, schedule, cost and facilities) to determine best qualified subcontractors (Subsystem Manager assisted by Manufacturing and Materiel Managers)
- Prepare for and conduct negotiation of price, contract type, general and special provisions, incentive provisions when applicable, work scope specifications and contract schedules (Materiel Manager guided by Subsystem Manager - assisted by Manufacturing Manager and other Managers as appropriate)
- Analyze each subcontractor's proposed program plan to insure complete program integration, and provide a basis of measuring performance and relating costs to specific work areas (Subsystem Manager assisted by Program Planning and Control Manager)
- Award subcontracts to selected vendors (Subsystem Manager through Materiel Manager)
- Regularly appraise the subcontractor's program management with particular emphasis on cost controls, adherence to subcontract and internal schedules, procurement practices, internal control of materials, effective utilization of manpower and cost reduction activities (Subsystem Manager and Materiel Manager assisted by other Managers as appropriate)
- Receive and analyze, for accuracy and compliance with contracted requirements, status and administrative reports submitted by subcontractors (Subsystem Manager assisted by the Materiel Manager and the Program Planning and Control Manager)

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

MAN-HOUR PLANNING & CONTROL REPORT

ACTUAL LABOR USED THRU

JOB DESCRIPTION & PERFORMING UNIT								ACTUAL CHARGES	PLANNED PROGRAM OF EXPENDITURES						CURRENT PROJECTION OF EXPENDITURES								
LAB TYPE	JOB NO	PRI NO	SEC NO	DESCRIPTION	P L T	CL NO	SECT	CUMULATIVE HOURS	PLANNED HRS TO DATE	CUR LESS PL $ TO DATE	PLANNED TOTAL	% TOT EXP	% TOT EST	% EXP LESS EST	INCREMENT OF WORK	WORK REMAINS	TOTAL INDICATED HOURS	REVISED PLAN TO DATE	CUM LESS REVISED PLAN	% PROD	% PROD DEV PLAN	% PROD LESS DEV PLAN	% OVER/ UNDER PL $ TOT

PROGRAM PLANNING

ANTICIPATED PERSONNEL REQUIREMENTS
MANPOWER BY MONTHS

PROGRAM _____ PAGE _____ OF _____

CONTRACT & JOB NO	CWA HOURS	HOURS EXPENDED THRU _____	ESTIMATE TO COMPLETION		ANTICIPATED UNDERRUN (–) OVERRUN (+)	19__											19__											19__										
			HOURS	M/M		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D

JOB NUMBER

EDP 1979

MATERIAL PLANNING AND CONTROL REPORT

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

DATE

PRI./DESCRIPTION		TOTAL PRI COSTS			COMMITMENTS				M/M TBR			PAYMENT/RATE OF EXP				% TOT EST	% TOT EXP	
		M/M TBR	PURCH	TOTAL	CUM RATE	CUM ACTUAL	DIFF	BALANCE TO COMMIT	CUM RATE	CUM ACTUAL	DIFF	CUM RATE	CUM ACTUAL	DIFF	UNLIQ COMMITMENT			

Fig. 5-1. Grumman Planning and Control Reports

- Monitor physical progress of the work and investigate actual and potential schedule slippages (Subsystem Manager assisted by the Materiel Manager)
- Monitor subcontractor's manufacturing activity, establish and maintain status, survey physical progress, investigate problem areas and report to Subsystem and other managers as appropriate (Manufacturing Manager)
- Analyze financial data and weigh the validity of the subcontractor's estimate-to-complete (Subsystem Manager assisted by the Materiel Manager and the Program Planning and Control Manager)
- Assign residents when necessary (Subsystem Manager)
- Analyze PERT submissions (Subsystem Manager assisted by the Program Planning and Control Manager)
- Require the subcontractor's purchasing organizations to establish and maintain proper and sufficient control applicable to lower tier subcontractors (Materiel Manager).

Each Subsystem Manager or his designee, in conjunction with the Engineering Manager, will maintain effective control of his subcontractors' technical performance by reviewing and approving their:

- Specification control documents
- Designs and reports
- Drawings and design changes
- Test procedures, plans, and reports
- Reliability predictions and trade-off studies
- Failure effects and model analyses
- Maintainability studies and reports.

Effective control of AES subcontractors will result from the implementation and/or refinement of the following during the Definition Phase:

- Detailed delineations of necessary subcontractor control steps
- Specific assignments of responsibility for all steps and interfaces
- Working relationships and lines of communication with LEM subcontractors who will participate in AES
- Assignment of experienced personnel to all facets of subcontractor control.

Grumman Aircraft Engineering Corporation • Bethpage, New York