NASA TECHNICAL MEMORANDUM

NASA TM X-53299

July 22, 1965

STANDARD PAYLOAD MODULE DEFINITION NETWORK FOR PHASES A, B, C & D

by Preston T. Farish - 876-2985
Industrial Operations

NASA

George C. Marshall
Space Flight Center,
Huntsville, Alabama

TECHNICAL MEMORANDUM X-53299

STANDARD PAYLOAD MODULE DEFINITION NETWORK FOR PHASES A, B, C & D

By

Preston T. Farish

George C. Marshall Space Flight Center
Huntsville, Alabama

ABSTRACT

Information intended to be used as a guideline is presented to establish the soundest practicable management baseline for planning approval and execution of future programs such as the standard payload module. The definition network and concepts proposal is presented along with preliminary definition plans. A systematic block analysis is shown to present definition network from the conceptual phase through contractor definition until the acquisition phase. Phases A, B, C, and D are outlined and defined.

NASA-GEORGE C. MARSHALL SPACE FLIGHT CENTER

NASA-GEORGE C. MARSHALL SPACE FLIGHT CENTER

TECHNICAL MEMORANDUM X-53299

STANDARD PAYLOAD MODULE DEFINITION NETWORK FOR PHASES A, B, C & D

By

Preston T. Farish

INDUSTRIAL OPERATIONS

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TECHNICAL MEMORANDUM X-53299

STANDARD PAYLOAD MODULE DEFINITION NETWORK FOR PHASES A, B, C & D

SUMMARY

Information intended to be used as a guideline is presented to establish the soundest practicable management baseline for planning approval and execution of future programs such as the standard payload module. The definition network and concepts proposal is presented along with preliminary definition plans. A systematic block analysis is shown to present definition network from the conceptual phase through contractor definition until the acquisition phase. Phases A, B, C, and D are outlined and defined.

INTRODUCTION

The Definition Network is divided into horizontal bands reflecting the significant interrelationships among the functional areas of procurement and production management; program control management; configuration management (including specification development and management); system engineering management; safety engineering management; and test and deployment management.

It should be recognized that the network and narrative information presented a typical program. Where activities portrayed on the network have been previously accomplished, the activity portrayed shall be bypassed. For example, where inventory equipment is used to satisfy a particular requirement, it is not necessary to prepare specifications and cost data, since this information has been previously obtained and is available. In every case, caution should be exercised to insure that interface requirements are completely considered.

The events shown in the blocks on the network are based on relative time, with no time span estimated between events. The lines connecting the events indicate the dependencies, constraints, and sequential time oriented relationships among the six horizontal bands. The events are grouped as follows:

a. Blocks 1 through 7 consist of Conceptual Transition Phase A.

b. Blocks 8 through 28 represent the effort which may include NASA support in Phase B (the phase which prepares for the contracting of the Definition effort).

c. Blocks 29 through 47 depict the general pattern of contractor efforts in preparing proposals during Phase B.

d. Blocks 48 through 52 indicate further effort during Phase B in contracting for Phase C.

e. Blocks 53 through 83 relate the contractor effort in defining the program under Phase C.

f. Blocks 84 through 88 present the final NASA effort under Phase C (late).

Based on the knowledge gained for conceptual phase activities, NASA prepares and issues a draft proposal to all involved agencies for review and comment on its feasibility of accomplishment, suitability of content, and timeliness. After incorporating the changes resulting from this review into the document, its issuance signifies NASA's intent to define the system for possible acquisition.

Receipt signals the application of system management procedures and the beginning of the planning effort for the Definition Phase. This planning effort is devoted primarily to the development and preparation or expansion of the development plan.

The NASA project cadre will prepare preliminary integration and implementation plans to guide future definition and acquisition effort and will act as a nucleus from which a formal project team will later evolve. The initial requirement will be to expand the development plan prepared during the conceptual phase. This will require the assistance of all the advanced planning organizations, from the various centers involved.

PRELIMINARY DEVELOPMENT PLAN PREPARED

1. The development plan is the basic initial planning document which lays out the effort required to define the system and eventually develop the System Package Plan.

2. The development plan contains the various functional concepts and rudimentary plans which will provide the basis for the development, production, logistics support, training, and operation of the system. At a later date, these concepts and plans are converted by the operational project office into formal plans of required action in each area. The plans are subsequently summarized in the System Package Plan. At this point, it should be recognized by the project office and participating agencies that the development plan becomes a more definitive program requirements baseline. Some of the required information may not be available at the time the development plan is prepared or expanded. In these cases, estimates will be used. To the greatest degree possible, all outputs from the preceding blocks will be utilized to develop the sections of the development plan. Prior to the time that the development plan is submitted to higher headquarters for approval (to establish the Program Requirements Baseline), every effort will be made to define intangibles and present firm schedules and concepts. In order to obtain approval from higher headquarters, factual data must be presented in the areas of key management decision dates and performance requirements, desired production schedules, trade-off alternatives, design criteria for the system, concepts of operation and support, and total cost of the program.

PRELIMINARY DEFINITION PLAN (BLOCK 3)

1. The Preliminary Definition Plan for conducting the Definition Phase will be prepared by the project office. At this time, the plan will be in the form of an outline of the objectives of a Definition Phase. The purpose of this preliminary plan is to establish the framework for the eventual development of a specific detailed plan tailored for the program which is to be defined. The plan is to be followed by the NASA/contractors in conducting Phases B and C in order to effectively integrate all contractors/Government agencies' efforts and to properly implement the required activities described in Blocks 9 through 87. The concept of the plan is to provide the method by which the activities on the Definition Network can be noted that before a complete detailed plan can be formulated, the results of Phase B are necessary.

2. Three of the most significant objectives to be identified at this time are:

a. The schedule of activities which will show projected completion dates of events shown on the Definition Network; i.e., a preliminary integration and implementation plan to be complied with during Phase B and C.

b. The manpower and funding required to complete Phase B and C based on the development plan and the objectives of the preliminary integration and implementation plan.

c. The required products (outputs) of Phase C.

3. Although the preliminary integration and implementation plan is controlled admistratively by the project office, all organizational elements, plus participating agencies, must actively participate in its preparation to insure that it is comprehensive but not redundant.

CONTROL OF PROGRAM REQUIREMENTS BASELINE (BLOCK 9)

1. Administrative control of the documentation constituting the program requirements baseline (Block 6) is to be exercised by the Program Control Division of the project office. Control of technical inputs to program documentation is to be exercised by the Configuration Management Division. Technical inputs include performance requirements, safety, design criteria, and other engineering information constituting the technical configuration of the system. The primary responsibility for integration, interface compatibility, and technical accuracy, rests with the Deputy Director for Engineering of the project office as supported. Changes to system performance requirements originated by engineering and approved for implementation by the Configuration Management Division will be incorporated into the development plan by the Program Control Division of the project office. Changes having an impact on time, performance, and cost requirements originated by agencies external to the project office are to be reflected in the baseline documentation prior to implementation action by the project office.

2. It is necessary at this time to establish control of program requirements by means of baseline procedures in order to insure that the program is constantly directed toward meeting, rather than exceeding or falling short of, program requirements and that clear authority is granted for requirement changes. It is further necessary to insure that actual program status is constantly reflected, by means of change procedures, through the use of prescribed program documentation. As such, the documentation constituting the program requirements baseline becomes a forcing function upon the program in terms of time, performance, and cost, and is to be employed as a mangement device for exercising positive management control of the system. By means of the above procedures, a single authority point is established as the reference base for the consideration of internal and external recommended changes to program requirements.

INITIAL FUNCTIONAL FLOWS AND ANALYSES (BLOCK 10)

An initial step during Phase B is to translate the requirements contained within the development plan into functional terms. These functional terms represent, by means of functional flow block diagrams, the initial identification of the system. This procedure is designed to insure that (1) total system requirements are considered and firmly established on a functional basis prior to equipment selection; (2) maximum flexibility of decision during initial design requirement trade-offs is permitted; (3) a firm basis is provided to evaluate potential design and technical approaches against system requirements; and (4) an early and evolving frame of reference is established to evaluate program changes and decisions. This block represents the starting point for the consideration of the design requirements in performance terms necessary to meet system objectives and the establishment of design criteria. As such, it becomes the working tool necessary for the preparation of the initial work statement described in Block 21.

SYSTEM PERFORMANCE REQUIREMENTS AND SYSTEM DESIGN CONSTRAINTS SPECIFIED (BLOCK 11)

The next step in the definition process is a system engineering task to specify the detailed performance requirements and design constraints based on the requirements specified in the development plan within the framework of the functional flows established in Block 10. This block represents the start of the detail effort required to prepare an initial system perform/design requirements specification and an initial comprehensive work statement. It also establishes the basis for the consideration of major trade-off efforts. Since this block represents the mainstream engineering effort during Phase B, it will also include the development of design criteria to be referenced within the work statement. Further, since this block represents the first detailed consideration of the entire system, a concentrated effort will be required to insure that performance requirements and design constraints are examined from a total system point of view. For example, Launch Vehicle Equipment (LVE) performance requirements must be examined in terms of impact on maintenance, safety, personnel, and facilities rather than in isolation. While it is recognized that only gross considerations can be made at this time, care must be exercised to insure that all critical areas are examined in detail.

MAJOR TRADE-OFF STUDIES AND MODES OF OPERATION IDENTIFIED (BLOCK 12)

In the process of preparing functional flows, alternate methods and functions will be identified by system engineering. Additional possible alternatives will emerge as part of the technical process of identifying performance requirements and design constraints accomplished in Block 11. In order to insure that full consideration is given to these alternate approaches, it is necessary at this point in the Definition process to identify the most likely areas for full exploration during Phase C. In identifying possible trade-offs, it is important to consider total system impact including logistic, technical, personnel, safety, operational, and training requirements in terms of time, performance, and cost. It is essential to identify the various modes of operation to insure that these modes can be further defined in technical detail.

INITIAL SYSTEM PERFORMANCE/DESIGN REQUIREMENTS SPECIFICATION PREPARED (BLOCK 13)

The project office prepares an initial total system performance/design requirements specification based upon (a) the trade-off studies and modes of operation identified; (b) the system performance requirements and design constraints described; (c) the initial flow and analyses; and (d) the development plan. This specification will state, in summary form, the system functional characteristics, the general design criteria, the system performance requirements (including reliability and maintainability), selected first-level end items where identified, and the interface requirements of first-level end items making up the system. The specification will answer the question, "What is expected of the total system in order to fulfill its intended mission?" Though Attachment 1 shows the system performance/design requirements specification prepared as a one-step action, it should be understood that there are many feedbacks from various activities during the early Phase B stage which will affect the content of the top specification. The specification provides the basis for the work statement for Phase C and Phase D. It also provides the data required to prepare other follow-on specification requirements: specification tree, end item detail specifications/Part I and Part II. Management control of the system performance/design requirements specification, as well as other specifications, will be under the Configuration Management Division of the project office. The control intended here is to establish a focal point for changes and to eventually establish and approve design requirements baseline.

PRELIMINARY SPECIFICATION TREE THROUGH FIRST LEVEL END ITEMS PREPARED (BLOCK 14)

In order to establish an initial frame of reference for further definition effort, a preliminary specification tree to the first-level end items is prepared at this time. The tree will be based upon the initial functional flows and analyses (Block 10), system performance requirements and system design constraints (Block 11), the trade-off identifications accomplished in Block 12, and initial system performance/design requirements specification (Block 13). As further definition effort occurs, this tree will be expanded to include definition to the lowest level of end items.

PLANS AND SCHEDULES PREPARED (BLOCK 15)

In Block 8, the Program Control Division reviewed the system requirements and coordinated with the applicable commands and other Government agencies. The Program Control Division, the focal point for preparation of the plans and schedules, must insure that maximum interrelation procedures are used in establishing the individual functional plans and schedules, other command inputs, such as personnel and training, construction and facilities, logistic, and operations plans for interrelated and conform to the master schedule; and all plans and schedules are consistent and complete. The initial system performance/design requirements specification (Block 13) and preliminary specification tree (Block 14) will provide the technical information required for plans and schedules. These plans and schedules are more definitive descriptions of the plans and schedules appearing in the development plan and are used to translate the development plan into the system package plan. As a final effort, all the above must be measured against the approved development plan requirements to assure a sound and detailed basis for RFP work statement preparation; and that the development plan remains unchanged in program scope, or approval is obtained for any such change.

PRELIMINARY PROGRAM BREAKDOWN STRUCTURE (PBS) COMPLETED (BLOCK 16)

After major trade-off studies and modes of operation are identified and the preliminary specification tree is defined to the system level, the preliminary

PBS is defined by the project office to the level desired for Phase C and D proposal cost preparation purposes. The hardware side of the PBS shall be directly related to the preliminary specification tree. The desired level of the hardware is usually the one below.Launch Vehicle Equipment (LVE) and Ground Support Equipment (GSE). This level is used by procurement to provide a common basis for all competing contractors to submit cost and schedule estimates. By using the PBS to summarize costs, a foundation for Phase B contractor proposals and the final reports prepared at the end of Phase C for the Phase D effort is established. This also insures equivalences of the PBS, specification tree, contract line items, and Material Program Codes.

PRELIMINARY PROGRAM MANAGEMENT NETWORK (PMN) COMPLETED (BLOCK 17)

1. The PMN graphically depicts the NASA plan to acquire the total system. It portrays the significant program milestones and the interactions of major elements of the program. To assure that the network depicts all major elements of the program, the Preliminary PBS is used in the construction of the network. A few key schedule dates, such as Initial Operating Capability, Category I Tests, Critical Design Review, etc., are shown. Although schedule dates are not assigned to all the milestones in the network, the network does portray the relative occurrence of all the milestones depicted since it shows, for each milestone, what must be accomplished before that milestone can be attained. This network is the product of extensive coordination within the project office and the participating agencies.

2. The Preliminary PMN is attached to the RFP and provides the contractors with a perspective of how their portion of the program relates to the total program. Further, it provides a common basis or starting point for all the participants involved in the Definition process. Like the plans, schedules, and engineering and management concepts it reflects, it must not be so detailed that it restricts the initiative and inventiveness the contractor is asked to apply to his proposal. This network will evolve into the Operation PMN (Block 77).

TEST AND PLANNING REQUIREMENTS PREPARED (BLOCK 19)

Requirements for flight test planning, test facilities, quantities of test items, schedule of testing, and other test requirements of a long lead time

nature must be included in the work statements (Block 21). Also, planning for site selection, installation and checkout, site activation and logistic support, are critical requirements to be included in the work statements.

SAFETY REQUIREMENTS PREPARED (BLOCK 20)

At this stage, the initial planning activity, relating to safety requirements for the system, is formally introduced into the management control procedure. A management plan will be prepared describing the safety activities at the NASA Centers and the requirements for prospective contractor support. This plan will scope the system safety engineering effort to the size and mission of the system under consideration. It will establish the requirement for a contractor prepared preliminary System Safety Engineering Plan (PSSEP) in support of the Phase C and D work Statement preparation (Blocks 21 and 22). The plan will establish safety analysis objectives by defining the least acceptable catastrophic event and set forth the minimum acceptable risk levels established for this event.

PHASE C WORK STATEMENT PREPARED (BLOCK 21)

The work statement represents a culmination of the activities accomplished up to this point in Definition and, as such, is one of the most significant events on the Definition network. To a large extent, the success of Phase C will be governed by the ability of the project office to translate information previously acquired into an effective work statement. It will contain as a minimum (1) a list of source documentation containing basic system requirements; i.e., conceptual study reports, specialized data, etc.; (2) the initial system performance/design requirements specification, including preliminary specification tree and technical study backup data; (3) a delineation of all the tasks to be accomplished by the contractor; (4) the preliminary program management network; and (5) plans and schedules, including requirements for the planning of test and deployment and a requirement for the contractor's management plan which establishes a management and technical control to achieve the objectives of the contract. The contractor's management plan is made more definitive at the beginning of Phase C (see Block 53). The work statement will contain sufficient guidance for an adequate and precise proposal from the contractors. It is vitally important that the applicable documents to be referenced in the work statements are carefully examined for duplicative requirements.

PHASE D SPECIMEN WORK STATEMENT PREPARED (BLOCK 22)

The Phase D specimen work statement is a document which is attached to, and by reference made a part of, the RFP. It contains the scope of work contemplated for the Acquisition Phase. Contractors will be asked to propose against the Phase C funded Definition Phase and the specimen work statement for Phase D. The specimen work statement makes it possible for the NASA to request a proposal for Phase D effort which the NASA may write into Phase B & C contract as a possible option to be selected by the NASA. A proposal for Phase D effort is submitted by the contractor (with Phase B & C Proposal) during Phase B. If the option method of contracting is utilized, the NASA, after completion of Phase B & C, may require the contractor to perform the work outlined in the specimen work statement at the price proposed during Phase B. This option may be altered by requiring the contractor to justify any price deviations between that proposed during Phase B and that estimated at the end of the Definition Phase as a result of the Definition process. The proposal for Phase D effort affords the NASA a cost estimate derived in a competitive environment which can be of considerable value as a basis for cost and scope of work negotiation at the end of the Definition Phase. The word "specimen" is used to differentiate this work statement from the more definitive work statement and will be a product of the Phase C definition effort.

PROCUREMENT PLAN PREPARED (BLOCK 23)

The procurement plan for Phase C and D will be prepared by the project office based upon a thorough understanding of the work statements and in consideration of advice and guidance received from the System Program Director. The procurement plan will cover all requirements specified in the local regulation on procurement plan preparation. At this point, the PCO has formed his planned approach to accomplish each major event leading to the award of a contract. This will include the establishment of milestone dates to assure lead time to perform actions such as establishment of source selection boards and their working groups (proposal evaluation boards), issuance of RFP, holding bidders' briefing, proposal evaluation, audit and price analysis, negotiations, contract writing, required reviews, and contract distribution. The completed plan will be made available to the evaluation board or source selection board and used throughout the procurement cycle.

SOURCE SELECTION BOARD (SSB) ESTABLISHED (BLOCK 24)

The source selection board or proposal evaluation board is established to evaluate and rate all proposals received. The evaluation group will be composed of a cross-section of specialist personnel from all participating organizations qualified to evaluate each essential technical and management capability required of the definition contractor. The board will assure that all procedures, criteria, and interim actions of the board conform with the requirements and limitations of procurement regulations. The board will review the definition package including the work statement, establish working groups as necessary, and develop evaluation criteria and realistic rating systems. In addition, each member of the board will review the approved procurement plan and have access thereto throughout the evaluation and source selection process.

DEFINITION PACKAGE PREPARED (BLOCK 25)

1. The Preliminary Definition Plan is now updated to reflect any changes to the definition objectives made by the project office and becomes the Definition Package and continues as such serving the project office and higher headquarters with the information necessary to conduct a Definition Phase. The Definition Package is the functional document which provides NASA with management control of the Definition Phase. The interaction between the Definition Package, the work statements, and the source selection criteria (Block 24) should be consistent. For example, a task identified in the work statement which the contractor is expected to satisfy during Phase C must serve to generate one or more of the products identified in the Definition Package; the source selection criteria should cover the required content of the contractor's final report. The Definition Package, plus the contractor's proposal (Block 46) and the contractor selection (Block 49), provide the basis for a more definitive Definition Package (Block 50).

2. Changes in requirements or scope of the Definition Phase described by the Definition Package shall be approved for inclusion in the Definition Package prior to implementation. By means of this update procedure, a continuous record of approved time, cost, and performance parameters is maintained throughout the Definition Phase.

REQUEST FOR PROPOSAL (RFP) PREPARED (BLOCK 26)

1. The products of all functional project office elements engaged up to this point are now condensed into the RFP. The PCO is responsible for the preparation of the RFP in accordance with the procurement plans reviewed and approved by the source selection board. The RFP is fundamental in establishing a sound basis for determining the order of preference of proposals received; the basis of negotiations; a contract which clearly states the complete NASA requirements; and the terms and conditions which will apply to the negotiated contract.

2. The RFP will include:

a. Work statements and other documents required by regulations, and directives.

b. Request for an estimate of the cost for conducting Phase C under fixed-price contract.

c. Type of contract anticipated for Phase D and type of incentives desired.

d. Request for cost proposal for Phase D with NASA option.

e. Provisions for a "Holding Period" to cover Phase C (late).

f. Request for estimate of the production and deployment cost.

g. Date, time, and place of submission of proposals.

3. In the preparation of the RFP, reference will be made to Blocks 29 through 46 for detailed requirements to be included in the RFP. In order to insure that the RFP will yield the type of proposals required for definition, a clear understanding of the major events involved in the preparation of proposals should be considered. Blocks 29 through 42 presents a graphic and descriptive picture of contractor actions to be accomplished in the process of proposal preparation. As such, these blocks are presented for the purpose of insuring that the RFP is properly oriented and contains the necessary requirements which will provide the information necessary for the source selection board to assess the submitted proposals. The contractor's proposal should clearly illustrate that an integrated approach was taken in preparing the proposal and that the results of

the proposal effort reflects, as a minimum, the interrelationships described in Blocks 29 through 42. In light of the above, this section of the Definition Network is different from preceding blocks in that the activities are interrelated and described for the purpose of understanding rather than as a description of necessary project office actions.

ELIGIBLE CONTRACTORS DETERMINED AND RFP TRANSMITTED (BLOCK 27)

The number of prospective contractors may vary with the nature of the procurement, its urgency, the contractor structure, and number of contractors able to meet the requirement of the NASA. The source selection board or evaluation group and the PCO will develop the source list to assure optimum competition consistent with the procurement. All companies on the SSB approved sources list will be solicited by the PCO.

PRE-PROPOSAL BRIEFING CONDUCTED (BLOCK 28)

Pre-proposal briefings are conducted for the purpose of clarifying the RFP to all prospective contractors. All contractors will be afforded an opportunity to hear all questions asked and the complete answers provided by the NASA briefing team. If questions are submitted by mail by one or more prospective contractors after the bidders' briefing, both the questions and answers shall be furnished by the NASA in writing to all contractors.

CONTRACTORS START PROPOSAL PREPARATION (BLOCK 29)

The group of activities presented in Blocks 29 through 42 represent major actions to be accomplished by the contractors in preparing their proposals and are presented for the purpose of identifying specific requirements to be specified in the RFP (see Block 26). Another purpose of these blocks is to provide the SSB with a common base for evaluating proposals. To this end, common cost estimate structure instructions are issued in the RFP. For example, all contractors will commonly price tasks determined by the project office. These tasks are based on summary levels of the preliminary PBS which is directly related to the specification tree. Specific attention is directed to the interrelationships of activities to insure that requirements specified in the RFP

are integrated to produce a comprehensive proposal. Requests for contractor review and expansion of the material included in the RFP does not imply a philosophy of change of requirements for change sake. It does recognize the potential significant improvements which can be made by the industrial competitive environment.

WORK STATEMENT REQUIREMENTS REVIEWED (BLOCK 30)

An initial activity by the contractor is the review of requirements contained in the work statement for the purpose of delegating responsibilities to various departments within his organization and for verifying the requirements contained in the work statement against his technical and management experience and capability to meet the requirements.

INITIAL SAFETY DESIGN REVIEW (BLOCK 31)

At the outset of the proposal preparation period the contractors will identify system requirements in a systematic manner on a total system basis. At this stage they will review all material developed to date noting the integration of safety considerations, the requirements for future contractor safety effort, and establishing their individual Safety Engineering Groups within their projects.

FLOWS AND ANALYSES REVIEWED (BLOCK 32)

1. Following the work statement review, the contractor will conduct a critical review of the functional flows and analyses data included as part of the work statement. In the process of review, an expansion and modification effort will be required to insure that the contractor's approach and technical experience are clearly reflected in these flows. Alternate flows to reflect alternate modes of operation and possible trade-offs will also be included. Additional modifications and expansions will be made to the analyses data for the purpose of identifying the design requirements in performance terms. This expansion effort will be continuous throughout the contractor's proposal effort and will be furnished as support data for the contractor's proposal.

2. In conducting the latter effort, the contractor should establish procedures for insuring a closed loop relationship between the flows, design requirements appearing in the specification, the PBS, trade-off efforts, and contract actions necessary for preparing the final proposal. The capability of the contractor to maintain this relationship will significantly reflect the comprehensiveness and validity of the final report.

SAFETY ANALYSIS (BLOCK 33)

Preliminary System Safety Engineering Plan (SSEP) should be developed. The plan should describe the functional, technical, analytical, and organizational techniques that would be employed to provide an acceptable system safety engineering effort and accomplish the goals established in block 20.

SELECTION AND APPROACH TO TRADE-OFFS DETERMINED (BLOCK 34)

One of the major activities of the contractor's proposal shall be to select those trade-off studies which should be investigated during Phase C. The selection of trade-offs will be made on the basis of functional flows, analysis efforts, available technical information contained in the work statement, and the contractor's experience. While major trade-off areas have been identified within the work statement, the contractor's effort shall be to select those which he feels to be the most significant and identify other which may not have been specified. In addition to selecting significant trade-offs, the contractor shall be required to present his approach to the selected trade-off areas and the method to be utilized in demonstrating the relative effectiveness of various trade-offs. Specific emphasis in the selection process should be directed toward highlighting areas of high technical risk, safety, high dollar value, or time critical phasing; i. e., those areas where the most significant returns can be anticipated.

INITIAL SYSTEM PERFORMANCE/DESIGN REQUIREMENTS SPECIFICATION REVIEWED AND EXPANDED (BLOCK 35)

One of the significant activities expected of the contractors during Phase B is to review and expand the initial system performance/design requirements specification provided with the RFP. The revised specification shall be included as an essential part of the Phase C proposal. Particular emphasis should be on expanding the interface requirements of the 1st-level end items, general and specific design-criteria and requirements, and system functional characteristics. The contractor should be apprised in the RFP of the relationships between his efforts in reviewing the flows and analyses (Block 32) provided in the RFP, his selection and approach to trade-offs (Block 31), and his expansion of the system specification. Since the system performance/design requirements specification is a critical Definition Phase product.

PRELIMINARY PBS AND PMN REVIEWED AND EXPANDED (BLOCK 36)

Once contractor top management has elected to prepare a proposal, the RFP is circulated to internal contractor organizations responsible for proposal preparation. These organizations must first understand what NASA is requesting before they can best respond; a review of the PBS and the preliminary PMN can be of great assistance in this endeavor. Based upon the system performance/design requirements specification review and expansion, the preliminary breakdown structure, and the preliminary PMN should be expanded and further detailed accordingly.

PROPOSED TECH APPROACH TO SYSTEM DEVELOPMENT COMPLETED (BLOCK 37)

While various technical approaches will be investigated by the contractor in the process of reviewing the work statement and system performance/design requirements specification, a definitive approach to system development will be established at this point in the sequence to insure that definition in depth can be achieved. This technical approach will be an integral part of the System Engineering Management process and will be reflected in the revised specification previously prepared, in subsequent steps, and in the PBS. The definitive

technical approach will also be represented by the trade-off areas selected and the type of incentive provisions subsequently proposed. The technical approach to system development selected represents the manner in which the particular contractor intends to apply resources-experience to the requirements imposed by the RFP and as such becomes a critical item to be considered during source selection proceedings.

SAFETY REVIEW (BLOCK 38)

Each contractor has established a Safety Review Board including representatives on NASA's System Safety Board. This board will pass on major safety determinations at scheduled key points during system definition and requisition. The board will review and have approval authority for all major safety reports.

PRELIMINARY SPECIFICATION TREE TO 1ST-LEVEL END ITEMS REVISED AND EXPANDED (BLOCK 39)

The RFP should require the contractors' proposals to include a review and expansion of the preliminary specification tree (Block 14) provided in the work statement. The 1st-level end items should be expanded to a lower indenture, but not necessarily to the lowest end item level unless early state-of-the-art studies have identified such end items. The specification tree must clearly reflect the proposed technical approach to system development (Block 37); the contractors' selection and approach to trade-offs (Block 31); and the results of the contractors' critical reviews of the system performance/design requirements specification (Block 32). This proposed specification tree, in turn, is the basis for the proposed PERT/Cost PBS.

During Phase B, the most fundamental and critical activity which should be required of the contractors in the RFP is to provide preliminary 1st-level end item detail specifications (Part I) within their proposal. These specifications are the narrative descriptions in terms of performance requirements of the specifications identified in the specification tree (Block 35). Each end item detail specification (Part I) includes test requirements to determine quantitative and qualitative compliance with the performance requirements. Though these

specifications are preliminary, they are fundamental to the contractors' incentive formulae (Block 42) and the preparation of the PERT/Cost networks (Block 43) to be included in their proposals.

PROPOSAL PBS PREPARED (BLOCK 40)

After the proposed specification tree and the proposed technical approach are defined by the contractor, the Proposal PBS is prepared from the Preliminary PBS as expanded in Block 33. The Proposal PBS is equivalent to the specification tree in the hardware and equipment line. The breakdown structure is more comprehensive than the specification tree since it includes items of service in addition to the equipment listed in the specification tree. The Proposal PBS enables the contractors to collect cost estimates for those summary PBS items designated in the RFP. Since the contractors will be submitting cost estimates for specified elements of the Proposal PBS, comparable cost estimates will be received on identical tasks from each bidder and in identical format (Management Summary Reports). Additionally, the Proposal PBS is the basis for construction of the Proposal Networks (Block 43).

PROPOSED INCENTIVE FORMULAE STARTED (BLOCK 42)

The contractor is required by the RFP to propose incentive arrangements for application during the Acquisition Phase. The contractors' proposals should indicate knowledge of the various schedule, cost, and performance incentives and the reasoning for the incentive approach proposed for Phase D. Usually, the definition contract will be firm fixed price. The strong possibility of receiving contracts during the Acquisition Phase and knowledge that another contractor is competing are the inherent incentives in the definition contract. The contractor, in his proposal for Phase D will indicate his proposed use of incentives and specify how he intends to insure the benefits of the incentive approach during the Acquisition Phase. It should be recognized that the incentive features proposed at this time would be used as a basis for negotiation of the Phase D option if NASA elects to incorporate an option in the Phases B & C contract.

PROPOSAL NETWORKS PREPARED (BLOCK 43)

Proposal Networks are prepared by the contractor to graphically portray his plan for satisfying the RFP. No restriction is placed on the level of detail other than that set forth in the work statement. The networks, based on elements of the proposal PBS, amplify the preliminary PMN as expanded in Block 36 and represent the contractor's plan to acquire the system described by the preliminary 1st-level end item detail specifications, (Part I).

PROPOSAL COST ESTIMATES COMPLETED (BLOCK 44)

In preparing cost estimates for the proposals, the contractor must insure that a clear link is established between the design and development effort involved and manpower and material requirements necessary to accomplish this effort. The procedures described by this manual specify the relationship to be maintained between cost and effort by means of prescribed PERT/Cost and system engineering relationships. The intent of these procedures is to establish and maintain a clear line of communication between engineering, production, and procurement. Such a procedure insures that the price analyst and PCO have a valid reference point for analyzing and validating manpower and skill levels, wage rates, and salary scales, overhead costs, materials, G&A rates, etc. While the later factors are extremely important in evaluating prospective contractors, it must be clearly recognized that cost is ultimately a function of the effort and materials necessary to meet requirements stipulated in the work statement, specifications, etc. Thus, the PERT/Cost system must be tied to the specification tree and cost estimates must be based upon, and determined by, the end items to be designed, developed, and producted.

CONTRACTORS' REVIEWS COMPLETED (BLOCK 45)

The contractor will critically review all detailed plans and schedules (see Block 15), for compliance with the RFP requirements and second, for the intricately interrelated concepts involved in developing, testing, producing, supporting, training and operating the system. This review must encompass, in detail, the proposed technical approach to system development, the preliminary 1st-level end item detail performance specifications (Part I), and the

contractor's plan of action to acquire, support, and operate the system. Both milestone and production schedules must reflect a realistic assessment of the contractor's capabilities. The contractor must consider the probability of development, test, production, and other high risk difficulties when reviewing this proposed schedule. The contractor must also carefully screen the schedules for unjustified extensions, particularly in the milestone schedules. The plans and schedules are related with the cost and manhour data through the PERT/Cost system, enabling the contractor/NASA cost estimating office to develop manhours and cost for each contract task.

CONTRACTORS' PROPOSAL COMPLETED AND SUBMITTED (BLOCK 46)

This block describes the completion of the contractors' proposals in response to the RFP. Contractors' proposal must include the proposal network; preliminary 1st-level end item detail specifications (Part I); the design approach to system development; coverage of all tasks specified in the work statement; a cost estimate of the total program; proposed incentive formulae; alternative methods and possible trade-offs in all areas; and the contractors' plans and schedules. It will stress the contractors' interpretations of the management and functional concepts contained in the RFP, and will incorporate his management organizational structure that will be used to implement the program. At the appointed time, all contractors will submit their proposals for consideration. Since the results of all previous efforts by the contractors will be reflected in the proposals, this activity represents a key milestone in the Definition effort.

REVIEW PRELIMINARY SYSTEM SAFETY ENGINEERING PLAN (SSEP) (BLOCK 47)

Included with the potential contractors plans which form a part of their total submittals will be an appreciation of the nature and scope of the Safety Engineering activity which he will conduct as the successful bidder.

The NASA proposal evaluation group will include representation from the previously established inhouse System Safety Board. A critical appraisal will be made by this group of the potential contractor's knowledge, enthusiasm, and plans for System Safety engineering.

PROPOSALS EVALUATED AND SOURCES RECOMMENDED BY SSB (BLOCK 48)

The proposals submitted will be evaluated using the source selection criteria established in Block 24 and with due consideration of the procurement plan prepared in Block 23. The number and kinds of specialists that will be used to evaluate and rate proposals will depend upon the degree of complexity of the procurement. This evaluation is accomplished by the SSB or Evaluation Group established in Block 22. From the information generated during the evaluation, the SSB determines the contractors having the highest rating based on capability, resource, management ability, experience, etc. The SSB or Evaluation Group then recommends to higher headquarters the contractors (including the two or more if appropriate for competition) who should accomplish Phase C. The number selected will depend upon the planned contract approach established in Block 23.

CONTRACTORS SELECTED BY HIGHER HEADQUARTERS (BLOCK 49)

Higher headquarters now reviews the recommendations of the SSB or Evaluation Group as well as the contractors' proposals, and selects the contractors (including the two or more if appropriate for competition) who will accomplish Phase C. Upon receipt of higher headquarters' selection of contractors, the project office prepares recommendations and instructions to be followed by the PCO for establishing the order of negotitations of the Phase C contracts with the contractors.

DEFINITION PACKAGE REVISED (BLOCK 50)

Having selected the contractors with whom negotiations will commence for accomplishing Phase C, the project office can now utilize the expected contractors structure; i.e., IAC, associate contractor, or teams, etc., and the contractors' proposals to revise and definitize the Definition Package prepared at Block 25 (see also Block 14). The essential revision is in preparing a detailed integration and implementation plan specifically tailored for the program to be defined and the contractors' organizational structures anticipated. For

example, what will be the interaction between associate contractors and IAC, if used, or what will be the interaction between system teams, if used; in other words, how will multiple contractors interact with one another and the project office during the Definition Phase. At this point, the Definition Package consists of:

1. Detailed Integration and Implementation Plan for Phase C.
2. Manpower and Funding for Phase C.
3. Required Products of Phase C.

WORK STATEMENT FOR PHASE C REVISED (BLOCK 51)

With the knowledge gained through source selection activity, a revision of the Phase C and Phase D specimen work statements are made as necessary. While information from contractors who have not been selected cannot be utilized, that information contributed by the selected contractors will be amalgamated into an improved product.

FINAL CONTRACT NEGOTIATIONS COMPLETED (BLOCK 52)

The ultimate objective of the completion of final contract negotiations is to obtain a definition contractor under the terms desired by NASA. The results of Blocks 46 through 51 will be used to hold a prenegotiation conference to establish negotiation objectives for Phases B, C, & D.development option. It is important to revise in detail each report or subproduct desired by the NASA from the contractors, establish a date when it shall be delivered to the NASA, and make arrangements for firm agreements between the negotiating parties. Each essential element of the procurement, upon which contractual agreement is desired, must be reviewed and a position established. The negotiation objectives must be coordinated with the project office or division Procurement and Production Office in order to establish the best possible NASA negotiation position. Technical representation and assistance are solicited from other organizational elements. The coordinated position will be used to accomplish final contract negotiations. The competitive climate shall be maintained since two or more contractors may be used during Phase C. Negotiations will be completed based upon the objectives established above. The NASA negotiation team will make

approved revisions to terms, conditions, and the work statement during negotiations. If two or more contractors are awarded contracts for the same tasks in Phase C, care must be taken to make sure that the contracts are identical with respect to terms and conditions, to the maximum possible extent. A 90 day holding period shall be included in the contract to cover the time period during which the final decision is being made by higher headquarters.

CONTRACTOR DEFINITION - PHASE C, BLOCKS 52 THROUGH 83

The most significant portion of the definition effort will be accomplished by the NASA/industry team during this phase of definition. Previous activities have described in some detail the scope of the program to be defined and, to some extent, a definition of the elements within the scope of the program. Phase C represents that period of time where definition in depth occurs. While preceding blocks have described activities similar to those to be accomplished during Phase C, it should be clearly recognized that the activities of Phase C represent an iteration in depth of the preceding activities, e.g., detailed end item detail specifications (Part I), firm costs for negotiating incentive contracts, and detailed plans and schedules will be produced during this phase.

PHASE C CONTRACT AWARD (BLOCK 53)

After the proposed contract has been determined to be legally sufficient, it will then be approved in accordance with division and HQ regulations. Contract distribution will then be made constituting an official NASA contract award. The contractor will then proceed to perform, accomplishing, as appropriate, Blocks 54 through 83.

CONTRACTORS' DETAILED MANAGEMENT PLANS SUBMITTED (PHASE C) (BLOCK 54)

Upon contract award, the contractor will submit a detailed management plan which will provide his procedures to achieve the objectives of the contract as well as comply with the terms and conditions of the contract. This detailed management plan is a more definitive plan of the contractor's management plan

required by the work statement (Block 51). It should include a clear explanation of how the contractor plans to specifically accomplish the objectives and tasks set forth in the work statement.

PROCUREMENT ACTIONS DURING PHASE C SPECIFIED (BLOCK 55)

During Phase C, procurement personnel will be reviewing contractor reports. For example, when the contractor has selected the equipment and facilities (Block 59), a report to the NASA may be required by the contract. A study of this report will assist in planning procurement for the Acquisition Phase and provide needed advance information for the evaluation required by Block 84. The contract may require an early report on the contractor's make or buy structure, the GFE or GFAE breakout structure, and the contractor's source selection plan. This report will be revised by production personnel and the results thereof will assist in evaluations during Block 84, as well as during negotiations of any follow-on contract. In the same manner, the PCO can evaluate and plan for the use of incentive features recommended by the contractor. The contract should, when feasible, provide for the contractor to furnish, as a subproduct at the earliest time agreed to during negotiations, the contractor's recommendations with respect to incentive contracts or provisions applicable to the Acquisition Phase. Information obtained from preliminary contractor reports, prior to completion of the definition contract, will serve to shorten considerably the procurement cycle for most contracts placed during the Acquisition Phase. The objective is to develop the maximum extent possible the complete procurement plan for Phase D development and production.

PHASE D DEVELOPMENT FUNDING PLAN SPECIFIED (BLOCK 56)

The funding plan will be initiated at this point. When it is completed, the plan will reflect the cash flow the contractor requires for optimum program accomplishment within the parameters established by imposed ceilings and other budget restrictions. This plan shall be based on financial analysis of anticipated commitments, expenditures, and obligations. Since there is a direct relationship between cash flow, technical performance, and schedules, a closed loop relationship between the funding plan, master schedule, PERT/Cost, and the defined system must be maintained in condition for audit.

PRE-BASELINE CONFIGURATION MANAGEMENT PROCEDURES ISSUED (BLOCK 57)

1. This block involves the establishment of initial controls necessary to insure that technical definition efforts are:

a. Integrated across the total system spectrum including personnel, facilities, technical publications, hardware, and computer programming or software (computer programming and other information processing methods and procedures).

b. Directed toward the common goal of a single system configuration.

c. Properly interfaced.

d. Clearly directed toward the establishment of a contract baseline for development in terms of end item detail specifications (Part I).

e. Used as a basis for evaluation of the impact of proposed changes.

2. It should be emphasized that the level of control at this point in the program is initially broad band in scope, but must become progressively more restrictive as the program proceeds. In general, the level of control must be based on, and be time phased with, the level of documentation resulting from definition. Initially, control will consist primarily of establishing and maintaining the status of identification of the system performance requirements and design criteria expressed in the development plan and work statement. As interfaces become a forcing function upon design, more restrictive control will be progressively established. By the completion of Phase C, control will be established on the basis of end item detail specifications (Part I). Since this data progressively documents the definition process, it is used to control the configuration of the system being defined, as described. It should be recognized at this point that the activities of the project office will be governed by the control level exercised and must be adjusted accordingly; e.g., emphasis by the project office will shift from design criteria establishment (Phase B) to specification review (Phase C), as the level of control and documentation progresses from gross to detail. Thus, each activity on the network, particularly the activities on the system engineering management band, are to be appropriately supported by the project office to insure technical adequacy and accuracy of the definition results.

TRADE-OFF STUDIES CONDUCTED (BLOCK 58)

A major effort of the Definition Phase shall be to conduct trade-off studies identified (Block 12) and selected (Block 34) to insure that an optimum configuration is defined for further development effort. In order to insure that total system impact of alternate technical approaches is a constant consideration, the data emanating from the system engineering will be used as the basis for trade-off (time-cost-performance, including human performance) evaluations. As decisions are reached regarding trade-offs, they will be duly reflected in the definition data. Where requirements dictate that alternate development efforts are necessary, parallel analyses will reflect these efforts until such time as sufficient data are available to justify a selected approach.

EQUIPMENT (LVE, GSE, MGE), FACILITY, AND PERSONNEL INITIAL SELECTION COMPLETED (BLOCK 59)

An integral part of engineering and system definition is the determination of the end items of Launch Vehicle Equipment (LVE), Ground Support Equipment (GSE), Maintenance Ground Equipment (MGE), facilities, and personnel required. The results of design efforts and trade-off studies provide the basis for this activity. The selection of equipment, facilities, and personnel is then translated into a specification tree.

SAFETY ANALYSIS (BLOCK 60)

The Contractor will perform safety analyses of subsystems and critical components, using Fault Tree (FT) analysis and/or other approved methods to support all design reviews.

Analyses will demonstrate that:

a. System Safety parameters have been fully considered and requirements met.

b. System Safety requirements have been imposed on the system early in the program.

c. System Safety is one of the disciplines considered in all trade-off studies.

d. Subsystem analyses will be integrated into a total FT System Safety Analyses to demonstrate that the system meets the risk levels established in the Management Plane (Block 20).

SPECIFICATION TREE PREPARED (BLOCK 61)

The activity, in preparing the specification tree, is related in a fundamental manner to, and must be dependent on, Block 54. The configuration management pre-baseline procedures issued will include the control of the specification tree for the system. The apex of the specification tree is the system performance/design requirements specification. The branches of the tree are developed from the knowledge gained by the contractors from the specification tree submitted in their proposals, as well as the end items (Contractor furnished equipment and government furnished equipment) and the facilities identified in Block 59. The tree should include the system specification, all the levels of end item detail specification (both Part I and Part II), identification specifications and requirements specification; i.e., the uniform specification program. The specification tree is the basis for the end item subdivision and the consequent PBS for PERT/Cost, and depicts those documents which will be used for acceptance of equipment and the total system.

END ITEM DESIGN SHEETS DETAILED (BLOCK 62)

The equipment (LVE-GSE-MGE) and facilities are described in terms of design requirements on End Item Design Sheets.

INCORPORATE SAFETY REQUIREMENTS (BLOCK 63)

As End Item Design sheets are completed by the Systems Analysis and Preliminary Design organizations, it becomes the responsibility of both contractor and NASA system Safety groups to incorporate pertinent safety requirements on the standard EIDF sheets.

SYSTEM AND PRELIMINARY END ITEM DETAIL SPECIFICATIONS (PART I) PREPARED (BLOCK 64)

1. The updated system performance/design requirements specification is prepared to reflect the preceding preliminary engineering accomplished and the prior system specification documentation available; i.e., the initial system performance/design requirements specification submitted in the RFP and the expansion of it in the contractor proposal. Each end item detail specification (Part I) identified in the specification tree shall be prepared in preliminary form using the integrated design requirements contained in the End Item Design Sheet (Block 62) to accomplish Section 3, "Requirements of the Specification". The preliminary end item detail specifications (Part I); identification specifications; requirements specification; and subsequent end item detail specification (Part II) to be used for acceptance. The Quality Assurance section, which includes test requirements, must be carefully prepared to insure that adequate acceptance requirements are available for the development of acceptance procedures. Quality and reliability control requirements must be included in these specifications if desired standards are to be met.

2. Through additional preliminary design engineering, the preliminary end item detail specifications (Part I) will be converted to the completed end item specifications required as the products of Phase C. It is of paramount importance in monitoring the specification effort to recognize that the entire design and development effort shall be directed contractually toward meeting the requirements contained within these specifications and that incentive awards will, for a large part, be determined by the contractor's success in meeting these specification goals.

PERSONNEL, TRAINING AND TRAINING EQUIPMENT REQUIREMENTS DETAILED (BLOCK 65)

Detailed personnel, training, and training equipment requirements will be identified by systems analysis procedures and other NASA documents identified herein. These requirements shall be based on the trade-off studies in Block 58 which have considered the impact of personnel and training requirements upon system design and equipment selection, as well as the impact on personnel and training requirements.

OPERATIONAL REQUIREMENTS DOCUMENTS PREPARED (BLOCK 66)

Having a description, in terms of design requirements, of the system to the end item level provides a basis for preparing the documentation which describes how and when to operate the system. Minimum requirements would be installation and checkout system. Minimum requirements would be installation and checkout system procedures; procedures for activating sites; maintenance, transportation, and logistic support requirements; and facility site descriptions including drawing.

DETAIL INTEGRATED SYSTEM TEST REQUIREMENTS PREPARED (BLOCK 67)

Subsequent to the submittal of End Item Design Sheets, test requirements must be specified for planning purposes. Realistic test planning cannot occur until a good description of the system to be tested is available. This description is derived from the End Item Design Sheets. The test requirements will be used to determine the deliverable hardware quantities for Phase D end items of equipment to be used for test purposes. Obviously, if the program is advancing the state-of-the-art, more Category I test systems will be required than on a more simple program and costs will be affected accordingly. Test requirements must be integrated to avoid duplication of testing. The total sequence of testing, the type of tests required and anticipated results, its geographical location, support facilities, hardware, personnel, and numbers of items to be tested by subsystem must be specified as a minimum. The severity of test requirements and their inherent technical risk will influence the degree of concurrency of system acquisition acceptable to NASA. The test requirements and test results also generate an input to the design requirements baseline (see Block 78). The overall test philosophy will be to test, to the maximum extent possible, the operational configuration. While extrapolations are necessary, these will be reduced to a minimum. In this regard, close coordination must be maintained between configuration identification and test requirements in the manner prescribed above to facilitate later detailed test planning.

SAFETY BOARD REVIEW AND APPROVAL (BLOCK 68)

At the time that firm test plans are evolved and requirements for testing of all categories are compiled the System Safety Board shall review and approve

such information prior to release. The Board's intent will be to insure that those areas of questionable safety features previously discovered and deemed critical shall be planned for testing.

DELIVERABLE HARDWARE QUANTITIES ESTIMATED (BLOCK 69)

Before a realistic master schedule can be prepared, information must be provided on the number of deliverable hardware quantities which will be utilized throughout the program. This quantity estimate must specify, as a minimum, the number of end items, and support items to be utilized for test, training, and operational purposes. Test quantities are estimated on the basis of the previously prepared detail integrated test requirements and objectives (Block 67). Training requirements are derived from the detailed information obtained in Block 64. All quantity estimates will be governed by the funding which will be available for the production of hardware quantities. Operational quantities are determined from the estimates provided by system engineering, the deployment plans and schedules directed by higher authority, and other available information. This effort initiates schedules and allocation documentation which must be monitored and updated throughout the life of the program. As increased definition is accomplished, this documentation will be used as the basis for establishing priority of deliveries, detailed production quantities, allocation and control of equipment by location, delivery monitoring, etc.

PLANS AND SCHEDULES UPDATED (BLOCK 70)

All of the plans required in the development plan (Block 15) must be updated in accordance with the contractor's definition and method of acquiring the system. The plans will again be reviewed for compatibility and consistency. They will then be utilized to update and better define the details of the master program schedule. Based on coordination between the project office and the contractors, both the revised plans and master schedule will optimize the time, cost, and performance variables. All parties derive knowledge of what must be built and how it must perform from the system and preliminary end item detail specifications (Part I) (Block 64). Funding restrictions which alter the method of performing the work are specified in Block 56. The deliverable hardware quantities estimated (Block 69) specifies the number of items to be produced for testing, training, production, and other purposes. The plans referenced above are the operational, logistic, personnel and training, facility, financial, installation and checkout, and production and at this point are brought

into focus for the preparation into the System Package Plan in Phase C (late). Since the system package plan is the basic program control document, all the above must be cross referenced to insure that no unauthorized change in scope has resulted from the additional detail.

PBS APPROVED (BLOCK 71)

Out of the specification tree, equipment (LVE-GSE-MGE), facility selection, personnel, and training requirements, the contractor's management plan, and updated plans and master schedule, additional information has been generated which should be used in conjunction with any additional NASA direction to update the Proposal PBS for development and prepare the PBS for production. The project office must review and approve this structure after checking for comprehensiveness, duplication of effort between contractors, identical relationship of specification tree and hardware side of the PBS, and any required uniformity between contractors. This review enables the project office to determine the level of detail of future PERT/Cost reporting. This structure is also the basis for detailed network construction.

START DETAILED NETWORKS AND COST ESTIMATING (BLOCK 72)

1. PERT procedures are predicated upon the use of summary data based upon detailed networks from contractors and from pertinent Government agencies. The "integration log technique" is a management device used for the control of key milestone and interface events which reflect the transfer of hardware and documentation between organizations. The integration log is an extension of the master schedule and is used by the contractors as a schedule framework for the construction of detailed networks and subsidiary schedules. The contractor uses the approved PBS as a definition of the total scope of the work required; the functional plans prepared in conjunction with the master schedule explain how and where the work is to be performed.

2. Detailed network completion enables the contractor to estimate schedules and costs for elements of the approved PBS. Following the preparation of cost estimates for work packages, an aggregation of cost by end item can be accomplished. These results are then entered on the End Item Design Sheets. Finalization of detailed networking and cost estimating cannot occur until the Design Requirements Baseline (Block 78) is established.

END ITEM DESIGN FORM COST ESTIMATES PROVIDED (BLOCK 73)

A critical step in the definition process is to provide detailed estimates of design and development costs which are realistically based on design requirements. While cost information is accumulated directly from the work packages of the PERT/Cost system for multiple uses, it should be recognized that a closed loop must be maintained between design requirements and design and development costs. As design requirements change, revised estimates must be reflected back into the PERT/Cost system. This cost information on the End Item Design Sheet provides a constant reference point for the consideration of trade-offs, design changes, and control and management of engineering effort. This interaction between PERT/Cost, design requirements, and cost estimating must be maintained as PERT/Cost information is used as a basis for contract negotiation and subsequent program status reporting.

SAFETY ANALYSIS (BLOCK 74)

Individual contractor Safety groups and the System Safety Board shall review all End Item Design Forms when scheduled for estimate to insure that adequate costs for safety tests and analysis are included.

END ITEM DETAIL SPECIFICATIONS (PART I) (LVE-GSE-MGE) AND FACILITIES COMPLETED (BLOCK 75)

The system performance/design requirements specifications and preliminary end item detail specifications (Part I) prepared in Block 64 are now up-dated to include the preliminary design engineering accomplished since Block 64 and documented on End Item Design Sheet. Specifications on end items of LVE, GSE, MGE, and RPIE or other equipment required specifically for a system operational facility may be covered by identification specifications or requirements specifications depending upon whether the equipment is Contractor Furnished Equipment (CFE) or Government Furnished Equipment (GFE)/ Government Furnished Aeronautical Equipment (GFAE). The quality and control of these specifications is the key to the success of Phase C. These specifications provide the information necessary to determine the make or buy structure (Block 77) and together with the results of Block 76 become an essential element of the contractor final report (Block 83).

AEROSPACE ANCILLARY EQUIPMENT (AAE) SPECIFICATIONS COMPLETED (BLOCK 76)

1. These are specifications of all other defined equipment not covered in Block 75. Specifications of AAE will include, but are not limited to, special equipment required to install, assembly, checkout, test, or repair the system. Specifications of AAE will also include special equipment designed to provide instruction on the operation and maintenance of the system which may be LVE, GSE, or MGE, or parts thereof to be used as training equipment; or operational procedure trainers; such as, mission simulators, flight simulators, cockpit procedure trainers, part task trainers, and unit mobile trainers. It is equipment necessary for fulfilling the system program but is not necessarily fulfilling the system mission at the moment of exercise or execution of a ready alert status. AAE may be either Government Furnished Equipment (GFE), GFAE, or Contractor Furnished Equipment (CFE). Specifications on test equipment, peculiar depot tooling, peculiar installation and checkout equipment, and trainers (i.e., training equipment beyond the bits and pieces of end items) will be end item detail specifications (Part I) in accordance with The Uniform Specification Program (USP). Specifications on training equipment i.e, Bits and Pieces on End Items) will be Identification Specifications. Number and usage for each item will be included in the specification.

2. Specifications on GFE and GFAE will be Requirement Specifications of the USP to include requirement and usage of each item. All other types of equipment not covered above will be referred to the SPO for determination of the specific type of specification required.

MAKE OR BUY PLAN PREPARED (BLOCK 77)

The contractor will prepare a proposed make or buy program indicating the equipments expected to be made by the contractor and those which are made by the contractor and those which are proposed as subcontract procurements. This equipment list is derived from the completed specification. See Blocks 75 and 76. When known, proposed sources will be shown and the degree of competition indicated. In-house production items which the contractor, or any associated division or element of the contractor, produces will be explained fully when it is not obviously an item of equipment normally produced by the contractor. The objective is to procure and fabricate equipment at a reasonable cost by making the best utilization of the technical and production capability currently available in the national industrial complex. This review of the proposed

make or buy program will insure that the prime contractor does not create in-house capability at the expense of the Government when adequate capability exists from qualified competitive sources. The contractor shall provide evidence of the best possible effort to identify and utilize existing military or commercial equipment before recommending development.

DESIGN REQUIREMENTS BASELINE APPROVED (BLOCK 78)

The system definition process generates a design requirements baseline which represents the composite of the integrated design requirements contained in each End Item Design Sheet and end item illustrations, and the end item specifications. A baseline is not a freeze which excludes further change; however, project office contractual approval is required to change the design requirements baseline. This baseline is controlled by the Configuration Management Division. It is an initial point from which revisions or changes can be documented and controlled to assure that all requirements are properly interfaced. The purpose is to insure that no gross system incompatibilities are introduced as detail design progresses; reliability, maintainability, and quality standards specified are taken into account by detail design; that equipment manufacturer's engineering drawings and release procedures are consistent and compatible with system program requirements (test, operations, maintenance, etc.); and that a common reference point is available for further detail cost and schedule planning.

SAFETY BOARD REVIEW AND APPROVAL (BLOCK 79)

Formal approval of the Design Requirements Baseline is contingent upon the review and approval of the entirety of the systems analysis design documentation by the System Safety Board. This activity is culmination of all the analytical effort expended by both the contractors' safety groups and the System Safety Board.

OPERATING PMN AND DETAILED NETWORKS COMPLETED (BLOCK 80)

The completion of end item specifications and selection of equipment enables the contractor to complete the construction and integration of his detailed networks.

An operating PMN is essentially a revision and expansion of the Preliminary and Proposal PMN (Blocks 17, 36 and 43) and reflects summary level data from the contractors' detailed networks. The detailed networks are used as the basis of detailed schedule and cost estimate and analysis of the final reports. In order that the networks accurately reflect program planning, sufficient time must be allowed for incorporating program changes into plans, schedules, and networks.

FINAL PERT TIME/COST REPORTS COMPLETED (BLOCK 81)

This block represents a product of the definition process and is a more definitive description of the schedule and cost variables contained in the contractor Phase B proposal. The final reports are based on detailed information but are presented in summarized form for ease of comprehension. These final reports correlate tasks, schedules, and costs, and are prepared from data contained in contractor detailed networks and cost systems. Contractor and Government agency detailed networks are integrated by the designated processing agency and a final report which provides this total system view is submitted. The designated outputs are displayed on the project office requested report formats. These reports should be utilized by procurement personnel in specifying time and cost parameters which are to be incorporated into the recommended incentive features.

PHASE C FINAL REPORTS AND PHASE D PROPOSALS SUBMITTED (BLOCK 83)

1. The contractors have not refined and developed their data and plans to the point of submittal of their final reports.

2. With the preparation of the final reports, the contractors have also completed their proposals for Phase D development effort portion of the Acquisition Phase. The report must include recommendations for incentives, percentage distributions, and pricing for accomplishment of the work according to the contractors' complete definitions of the system. The contractors' proposed statements of work for Phase D are part of the proposals and should be all inclusive according to the contractors' definition and understanding of the tasks.

FINAL SSB EVALUATION AND RECOMMENDATION COMPLETED (BLOCK 84)

The SSB or evaluating group review the final reports of all participating contractors and recommends contractors for the Acquisition Phase. The panel will select the most favorable recommendations of all contractors competing and revise the work statement as necessary to provide the best configuration, terms, and conditions. The results of this review are provided to the contracting officer. Depending upon time constraints and conditions during Phase C (late). It may be desirable to conduct and complete contract negotiations prior to final SSB selection. In this manner, the negotiations settling the schedules, costs, and incentives may be conducted under more advantageous competitive conditions. It would also provide the SSB with firm and final business arrangements which could be a part of their evaluation. The advantages of negotiation prior to evaluation should be weighed against the possible delays and the decision including impact on schedule of Phase C should be reflected in the Preliminary Definition Plan and Definition Directive.

PROCUREMENT PLAN DEVELOPED FOR ACQUISITION PHASE (BLOCK 85)

1. The period between Blocks 84 and 87 is to be used by procurement personnel to accomplish advance procurement planning for individual procurement actions that must take place during the Acquisition Phase. For example, the final report of the contractor will contain a list of requirements supported by end item specifications. Schedules will indicate when these requirements must be placed on contract and the estimated production time. In the same manner, production personnel must make decisions with respect to the contractor's proposed make or buy plan and furnish this information to the contracting officer. Cost analysts should furnish inputs to the contracting officer relative to estimates furnished by the definition contractors. Other aspects of the contractors' final reports and the recommendations of the SSB, which will be considered, are as follows:

a. Incentive provisions
b. Production/procurement lead time
c. Validity of cost and price estimates
d. Logistic requirements
e. LVE, GSE, MGE and spare parts requirements
f. Facility requirement
g. Personnel and training requirements

h. Government furnished property
i. Requirement for special clauses pertaining to:

1) System equipments
2) Technical or design requirements
3) Programming
4) Management controls or objectives

2. Action taken by procurement personnel during this period will accelerate preparation and final coordination of the System Package Plan. A 90-day holding period was included in the contract to cover the time period during which the final decision is being made. It may be necessary to extend this 90-day period to maintain an atmosphere of competition among contractors if external influences extend the decision time.

PROPOSED SYSTEM PACKAGE PLAN PREPARED AND FORWARDED (BLOCK 86)

1. This effort represents the translation of the development plan (Blocks 5 and 6) and prepared plans and schedules (Blocks 15, 45 and 46) into the System Package Plan. Should the program be disapproved, the development plan will be utilized for future PCP action; e.g., further research activities. The project office with support from other participating agencies will utilize the program outputs to prepare the system package plan.

2. The System Package Plan is prepared from the accumulated assessed knowledge gained by NASA and its contractors during the Definition Phase, as well as from any preceding efforts. The System Package Plan signifies that the program concept has evolved and been developed to the point where acquisition can be considered or eliminated. In addition, the System Package Plan embodies the request for the necessary funds to proceed and includes all the necessary technical and cost information to justify or eliminate the requirement to higher echelons.

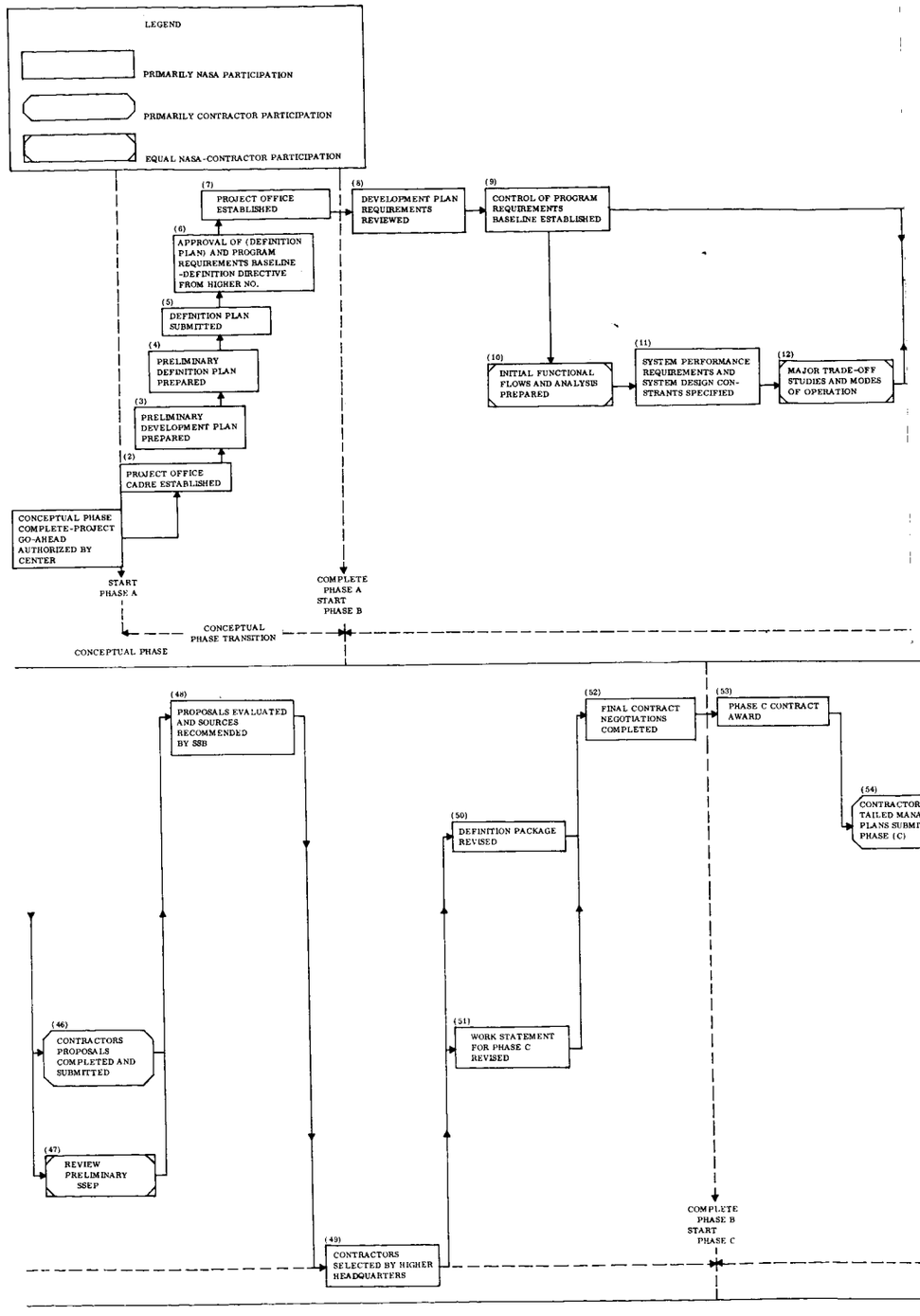
3. The request for approval of the recommendations shall be submitted by letter to higher headquarters. Those recommendations which would result in cost changes exceeding command thresholds will be formalized by PCP. Request recommending full scale development must be accompanied by a system package plan. Source selection is approved by the Director of NASA. Accordingly, the information submitted will include recommended source together with secondary source choices. All recommendations regarding the Definition Phase and the source selection must be fully documented.

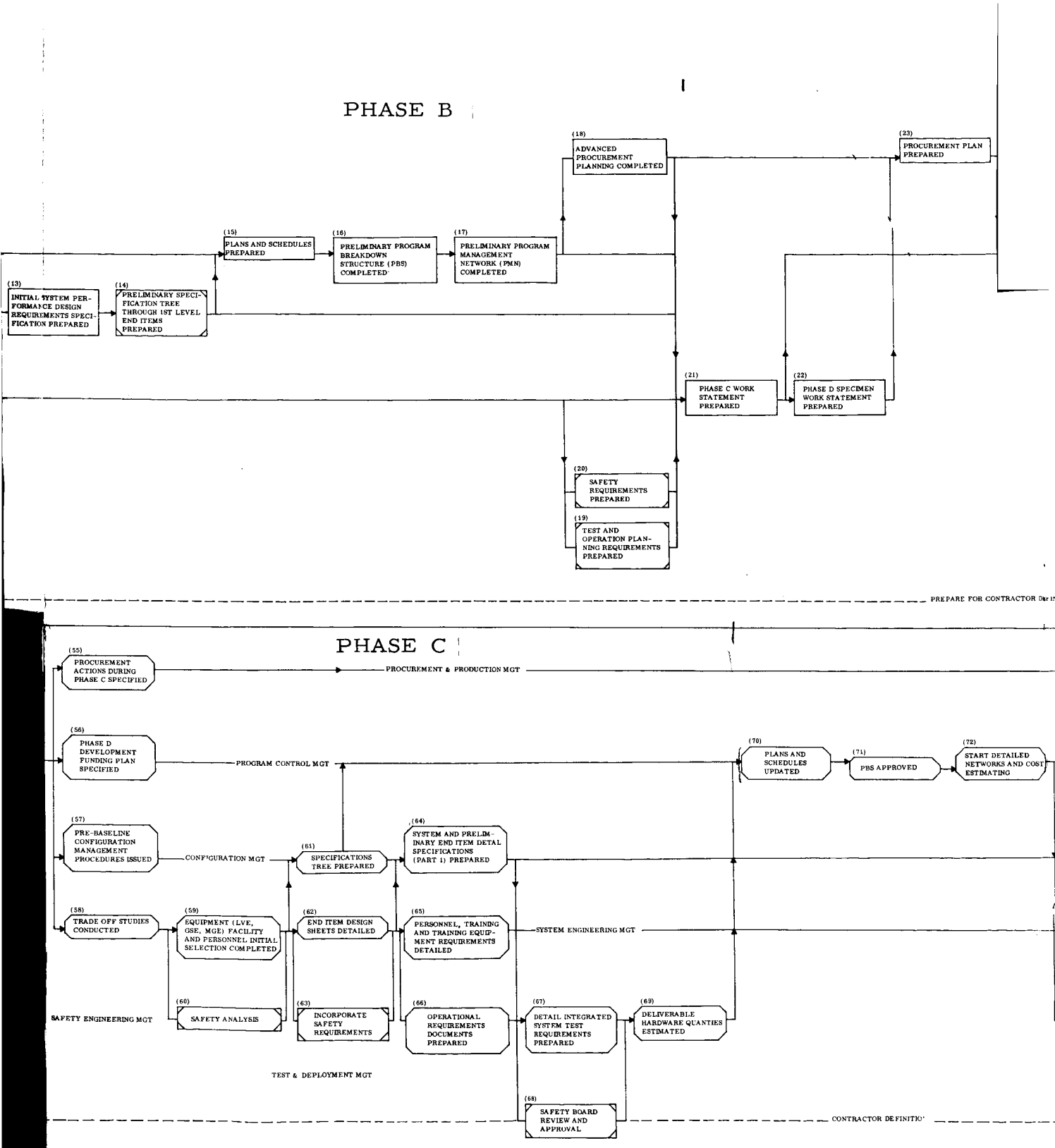
HIGHER HEADQUARTERS REVIEW AND APPROVAL COMPLETED-SYSTEM PROGRAM DIRECTIVE ISSUED (BLOCK 87)

This block represents the activity accomplished by higher headquarters in reviewing and approving the System Package Plan and related documentation submitted by the project office as well as the final selection of the contractors to conduct Phase D. Authorization to proceed is issued in the form of a System Program Directive. The System Program Directive signifies NASA approval of the program and cites the necessary funds and provides the resources to proceed with the Acquisition Phase.

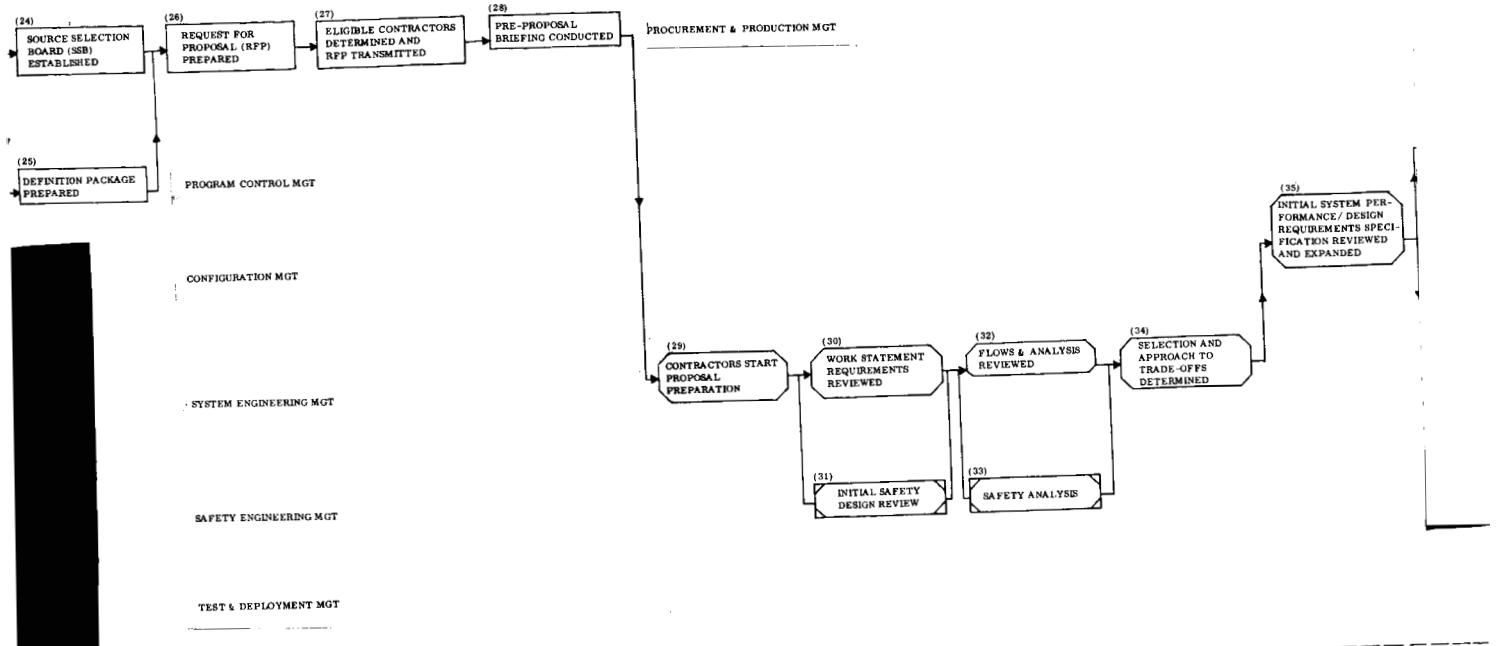
INITIAL PHASE D DEVELOPMENT CONTRACT NEGOTIATED (BLOCK 88)

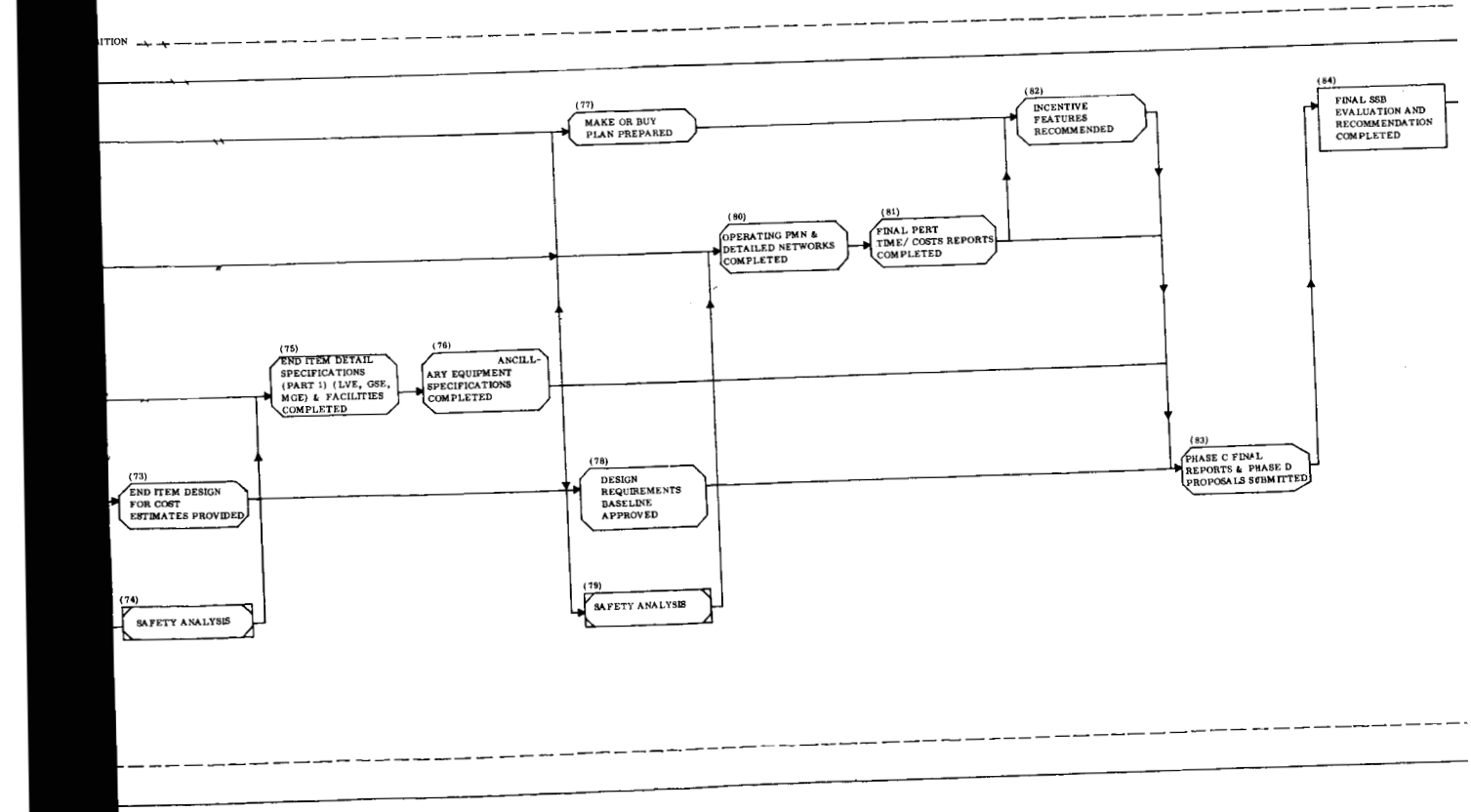
The recommendations developed during Block 84 and the work statements provided to the PCO are the basis for negotiations with the contractors selected to perform the Phase D effort. Schedules developed in the Phase D Procurement Plan (Block 85) will determine which contracts will have to be negotiated during this period in order to maintain the program schedules. Provisions will be made to incorporate changes which might be the result of redirection provided by higher headquarters during their reviews of in the system Program Directive when issued by NASA.

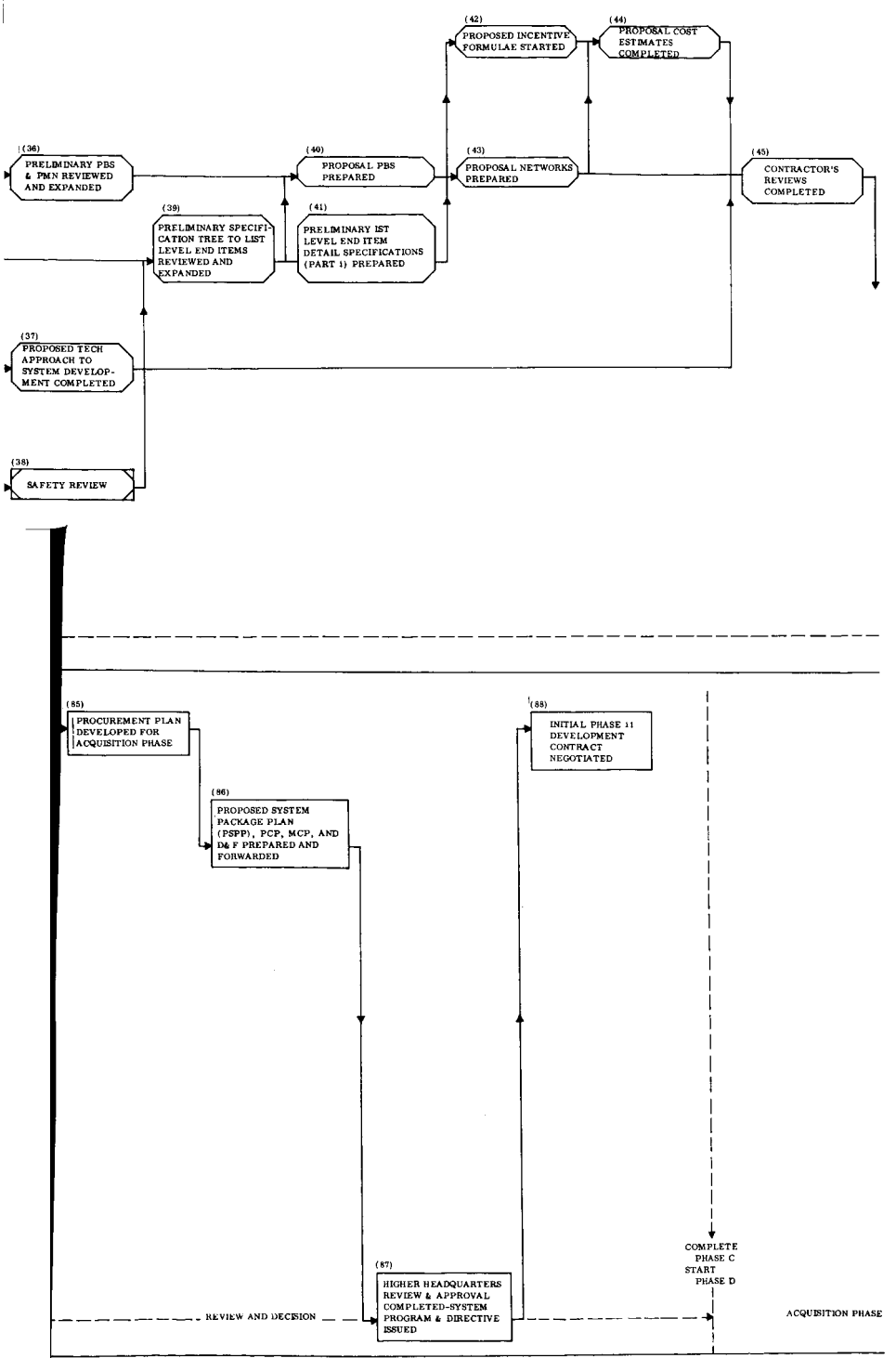

LEGEND
PRIMARILY NASA PARTICIPATION
PRIMARILY CONTRACTOR PARTICIPATION
EQUAL NASA-CONTRACTOR PARTICIPATION
(1) CONCEPTUAL PHASE COMPLETE-PROJECT GO-AHEAD AUTHORIZED BY CENTER
(2) PROJECT OFFICE CADRE ESTABLISHED
(3) PRELIMINARY DEVELOPMENT PLAN PREPARED
(4) PRELIMINARY DEFINITION PLAN PREPARED
(5) DEFINITION PLAN SUBMITTED
(6) APPROVAL OF (DEFINITION PLAN) AND PROGRAM REQUIREMENTS BASELINE -DEFINITION DIRECTIVE FROM HIGHER NO.
(7) PROJECT OFFICE ESTABLISHED
(8) DEVELOPMENT PLAN REQUIREMENTS REVIEWED
(9) CONTROL OF PROGRAM REQUIREMENTS BASELINE ESTABLISHED
(10) INITIAL FUNCTIONAL FLOWS AND ANALYSIS PREPARED
(11) SYSTEM PERFORMANCE REQUIREMENTS AND SYSTEM DESIGN CONSTRANTS SPECIFIED
(12) MAJOR TRADE-OFF STUDIES AND MODES OF OPERATION
START PHASE A
COMPLETE PHASE A START PHASE B
CONCEPTUAL PHASE TRANSITION
CONCEPTUAL PHASE
(46) CONTRACTORS PROPOSALS COMPLETED AND SUBMITTED
(47) REVIEW PRELIMINARY SSEP
(48) PROPOSALS EVALUATED AND SOURCES RECOMMENDED BY SSB
(49) CONTRACTORS SELECTED BY HIGHER HEADQUARTERS
(50) DEFINITION PACKAGE REVISED
(51) WORK STATEMENT FOR PHASE C REVISED
(52) FINAL CONTRACT NEGOTIATIONS COMPLETED
(53) PHASE C CONTRACT AWARD
(54) CONTRACTORS' DETAILED MANAGEMENT PLANS SUBMITTED PHASE (C)
COMPLETE PHASE B START PHASE C


PHASE B
(13)
INITIAL SYSTEM PERFORMANCE DESIGN REQUIREMENTS SPECIFICATION PREPARED
(14)
PRELIMINARY SPECIFICATION TREE THROUGH 1ST LEVEL END ITEMS PREPARED
(15)
PLANS AND SCHEDULES PREPARED
(16)
PRELIMINARY PROGRAM BREAKDOWN STRUCTURE (PBS) COMPLETED
(17)
PRELIMINARY PROGRAM MANAGEMENT NETWORK (PMN) COMPLETED
(18)
ADVANCED PROCUREMENT PLANNING COMPLETED
(23)
PROCUREMENT PLAN PREPARED
(21)
PHASE C WORK STATEMENT PREPARED
(22)
PHASE D SPECIMEN WORK STATEMENT PREPARED
(20)
SAFETY REQUIREMENTS PREPARED
(19)
TEST AND OPERATION PLANNING REQUIREMENTS PREPARED
PREPARE FOR CONTRACTOR
PHASE C
(55)
PROCUREMENT ACTIONS DURING PHASE C SPECIFIED
PROCUREMENT & PRODUCTION MGT
(56)
PHASE D DEVELOPMENT FUNDING PLAN SPECIFIED
PROGRAM CONTROL MGT
(70)
PLANS AND SCHEDULES UPDATED
(71)
PBS APPROVED
(72)
START DETAILED NETWORKS AND COST ESTIMATING
(57)
PRE-BASELINE CONFIGURATION MANAGEMENT PROCEDURES ISSUED
CONFIGURATION MGT
(61)
SPECIFICATIONS TREE PREPARED
(64)
SYSTEM AND PRELIMINARY END ITEM DETAL SPECIFICATIONS (PART 1) PREPARED
(58)
TRADE OFF STUDIES CONDUCTED
(59)
EQUIPMENT (LVE, GSE, MGE) FACILITY AND PERSONNEL INITIAL SELECTION COMPLETED
(62)
END ITEM DESIGN SHEETS DETAILED
(65)
PERSONNEL, TRAINING AND TRAINING EQUIPMENT REQUIREMENTS DETAILED
SYSTEM ENGINEERING MGT
SAFETY ENGINEERING MGT
(60)
SAFETY ANALYSIS
(63)
INCORPORATE SAFETY REQUIREMENTS
(66)
OPERATIONAL REQUIREMENTS DOCUMENTS PREPARED
(67)
DETAIL INTEGRATED SYSTEM TEST REQUIREMENTS PREPARED
(69)
DELIVERABLE HARDWARE QUANTIES ESTIMATED
TEST & DEPLOYMENT MGT
(68)
SAFETY BOARD REVIEW AND APPROVAL
CONTRACTOR DEFINITIO

PHASE C


(24)
SOURCE SELECTION BOARD (SSB) ESTABLISHED
(26)
REQUEST FOR PROPOSAL (RFP) PREPARED
(27)
ELIGIBLE CONTRACTORS DETERMINED AND RFP TRANSMITTED
(28)
PRE-PROPOSAL BRIEFING CONDUCTED
PROCUREMENT & PRODUCTION MGT
(25)
DEFINITION PACKAGE PREPARED
PROGRAM CONTROL MGT
CONFIGURATION MGT
SYSTEM ENGINEERING MGT
SAFETY ENGINEERING MGT
TEST & DEPLOYMENT MGT
(29)
CONTRACTORS START PROPOSAL PREPARATION
(30)
WORK STATEMENT REQUIREMENTS REVIEWED
(31)
INITIAL SAFETY DESIGN REVIEW
(32)
FLOWS & ANALYSIS REVIEWED
(33)
SAFETY ANALYSIS
(34)
SELECTION AND APPROACH TO TRADE-OFFS DETERMINED
(35)
INITIAL SYSTEM PERFORMANCE/ DESIGN REQUIREMENTS SPECIFICATION REVIEWED AND EXPANDED


(77)
MAKE OR BUY PLAN PREPARED
(82)
INCENTIVE FEATURES RECOMMENDED
(84)
FINAL SSB EVALUATION AND RECOMMENDATION COMPLETED
(80)
OPERATING PMN & DETAILED NETWORKS COMPLETED
(81)
FINAL PERT TIME/ COSTS REPORTS COMPLETED
(75)
END ITEM DETAIL SPECIFICATIONS (PART 1) (LVE, GSE, MGE) & FACILITIES COMPLETED
(76)
ANCILLARY EQUIPMENT SPECIFICATIONS COMPLETED
(73)
END ITEM DESIGN FOR COST ESTIMATES PROVIDED
(78)
DESIGN REQUIREMENTS BASELINE APPROVED
(83)
PHASE C FINAL REPORTS & PHASE D PROPOSALS SUBMITTED
(74)
SAFETY ANALYSIS
(79)
SAFETY ANALYSIS


(36)
PRELIMINARY PBS & PMN REVIEWED AND EXPANDED
(39)
PRELIMINARY SPECIFICATION TREE TO LIST LEVEL END ITEMS REVIEWED AND EXPANDED
(37)
PROPOSED TECH APPROACH TO SYSTEM DEVELOPMENT COMPLETED
(38)
SAFETY REVIEW
(40)
PROPOSAL PBS PREPARED
(41)
PRELIMINARY IST LEVEL END ITEM DETAIL SPECIFICATIONS (PART 1) PREPARED
(42)
PROPOSED INCENTIVE FORMULAE STARTED
(43)
PROPOSAL NETWORKS PREPARED
(44)
PROPOSAL COST ESTIMATES COMPLETED
(45)
CONTRACTOR'S REVIEWS COMPLETED
(85)
PROCUREMENT PLAN DEVELOPED FOR ACQUISITION PHASE
(86)
PROPOSED SYSTEM PACKAGE PLAN (PSPP), PCP, MCP, AND D& F PREPARED AND FORWARDED
(88)
INITIAL PHASE 11 DEVELOPMENT CONTRACT NEGOTIATED
(87)
HIGHER HEADQUARTERS REVIEW & APPROVAL COMPLETED-SYSTEM PROGRAM & DIRECTIVE ISSUED
REVIEW AND DECISION
COMPLETE PHASE C START PHASE D
ACQUISITION PHASE

STANDARD PAYLOAD MODULE DEFINITION NETWORK FOR PHASES A, B, C & D

By

Preston T. Farish

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

William A. Mrazek
Assistant Director for Engineering