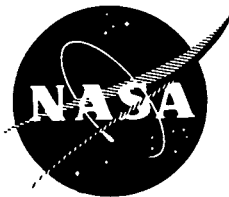


OFFICE OF
MANNED SPACE FLIGHT

APOLLO PROGRAM

APOLLO CONFIGURATION MANAGEMENT MANUAL

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JANUARY 1970

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C. 20546

PREFACE

Since the initial implementation of the Apollo Program Configuration Management requirements in May 1964 (through former NPC 500-1), significant progress has been made in developing this system. The initial requirements established by the Apollo Program Office, supplemented by the MSF field installations' requirements, have led to the establishment of a specification program and change control system that are effectively helping to control program performance, costs, and schedules.

This publication, which basically revises and supersedes NPC 500-1, includes improvements based on our experience and represents the final phase in the implementation of configuration management on the Apollo Program. This publication contains the latest requirements which are considered necessary, as a minimum, to effectively manage the configuration of all Apollo end items. This revision accomplishes the following main purposes:

- a. Reduction of all exhibits to "minimum requirements" for adequate configuration management.
- b. Recognition of field installation supplements to the former NPC 500-1.
- c. Addition of configuration management requirements for computer programs.
- d. Alignment of future Apollo configuration management requirements with the overall NASA concept of Phased Project Planning (PPP).
- e. Definition of configuration management intercenter interface responsibilities.
- f. Establishment of a configuration management audit system.
- g. Recognition of recent Department of Defense (DOD) configuration management policy manuals, standards and specifications.

This publication shall not cause any changes to be made to existing contracts. However, on additions to current contracts

and new contracts, it should be implemented to the extent practical.

Superseded Document

NPC 500-1, dated May 18, 1964 and February 1967 Reprint are canceled.

Rocco A. Petrone
Rocco A. Petrone
Apollo Program Director

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APOLLO PROGRAM
CONFIGURATION MANAGEMENT
MANUAL

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APOLLO PROGRAM
CONFIGURATION MANAGEMENT MANUAL

1.0 POLICY

This document revises and supersedes NPC 500-1 "Apollo Configuration Management Manual", dated May 18, 1964.

The definition and applicability of configuration management procedures shall take into consideration the scope of the effort in terms of costs and complexity, the degree to which a project has progressed towards completion, and the configuration management procedures now in effect.

Contracts initiated subsequent to the effectivity date of this document may at the option of individual using agencies require compliance with the following Department of Defense documentation:

- ° MIL-S-83490 "Specification, Types and Forms", dated 30 October 1968
- ° MIL-STD-480 "Configuration Control - Engineering Changes, Deviations and Waivers", dated 30 October 1968
- ° MIL-STD-481 "Configuration Control - Engineering Changes, Deviations and Waivers (Short Form)", dated 30 October 1968
- ° MIL-STD-490 "Specification Practices", dated 30 October 1968
- ° Other DOD documentation, newly released, as it becomes available for guidance.

Exceptions to DOD documentation requirements:

- a. For the preparation of "Program", "Project", and "System" specifications required by NASA contracts; compliance with the requirements, instructions, and format detailed by Exhibit I of this document shall apply.
- b. Where NASA requires the preparation of "two part" specifications, such specifications shall be prepared in accordance with the exhibits of this document which relate to the preparation of "two part" specifications.

2.0 PURPOSE

This manual establishes the configuration management requirements which will accurately define all Apollo Program end items at any point in time. Accurate definition of equipment is the basis for establishing schedules, developing realistic budget requirements and for accomplishing effective change control throughout the life of the program.

3.0 APPLICABILITY

The requirements established herein are applicable to all NASA organizations and contractors participating in the Apollo Program.

4.0 GENERAL

Revisions to various exhibits have been made based on Program needs and experience in applying configuration management on Apollo since 1964. Configuration management provides for all levels of management the necessary procedures and disciplines to achieve effective control over all space vehicle and ground system products fabricated for the Apollo Program. This control is needed on a continuing basis from initial definition of a product to the final use of the specific hardware and software, and is provided by:

- a. A Configuration Identification Baseline System which defines, through specifications and associated data, the requirements for all end items.
- b. A Configuration Control System which controls all changes to the end items.
- c. A Configuration Accounting System which documents all changes to baseline configurations and maintains an accurate record of configuration change incorporation.

4.1 Apollo Baseline System

A fundamental concept of configuration management is the establishment of "baselines" to serve as a point of departure for controlling subsequent performance and design changes from that baseline. Apollo uses three (3) baselines for establishing requirements, all documented by approved specifications. Once these baselines are defined, changes in requirements must be formally approved to insure adequate consideration of program impact with respect to contract costs, schedules and incentives as well as mission capability. Figure 1 identifies the three (3) Apollo baselines with respect to current Apollo phasing, and the types of changes required to each. Due to the nature of the Apollo R&D program, baselines are not provided at a definite period (such as end of the definition phase) but are completed in an incremental manner as specific end items such as stages/modules are developed. A major configuration management task in the baseline system is to identify the technical documentation defining the approved configuration of the system or end item throughout the period when hardware/software is acquired. Based on the design reviews performed, a baseline for a given end item is established and the specific documentation constituting that baseline is recorded. The configuration of the end item at any later date is identified by the original baseline configuration plus all the ensuing changes approved and incorporated since that time. The configuration of an end item will be known and thoroughly documented at any given point in time. Another task is the accomplishment of a minimum set of reviews and inspections necessary to validate the accuracy and adequacy of all baselines. PDR's and CDR's are self-explanatory and are defined in Exhibit XIV. The First Article Configuration Inspection (FACI) must be interpreted and applied to the Apollo Program as a function of the developmental status of each major end item. The end item to be FACI'd should be chosen based on the knowledge that, from this item on, subsequent end items will require identical performance repeatability. The FACI must establish the exact relationship between the chosen CEI (identified as the baseline configuration for subsequent items) and the configuration of the CEI(s) used for qualification testing if different. In addition, the contractor must satisfy the procuring agency that the physical hardware for each end item is built to the exact engineering drawings and specifications associated with that end item. Changes can be made to the CEI FACI'd through the procedures and requirements established in Exhibit IX. Delta-FACI's (e.g. a FACI on a subsequent CEI in the area in which changes have been made) may be conducted if necessary. FACI's are not intended to demonstrate that CEI's can perform according to specifications or can accomplish the mission requirements. The FACI should prove only that the CEI is built according to requirements and

has an identifiable relationship with an equivalent CEI(s) which was qualified by test. The requirement in the original version of this manual for the Final Configuration Review (FCR) has been made an option (to be conducted as required by a Center). Two reviews which occur during the operational phase, the DCR and FRR are defined in Apollo Program Directive Nos. 7 and 8, and require inputs from configuration management functions concerning configuration status, open items and associated data. Requirements on the selection and control of Contract End Items (CEI) are found in Paragraph 8.

4.2 Apollo Change Control System

The control of changes to Apollo hardware/software is achieved through the use of the multi-level change control system shown in Figure 2. Six levels of control are established each of which has specific criteria for submitting changes to the next higher level for approval. The requirements for submitting changes to the APO CCB (Level I) are defined in Paragraph 5.1.3. Each MSF Center has established Level II and subordinate CCB's as defined in individual Center supplements to this document. (See Paragraph 5.2.4.) Additional requirements for submittal of changes to the APO CCB and to MSF Center CCB's are published from time to time in appropriate APO directives such as Apollo Program Directive No. 34. Configuration control is the systematic evaluation, coordination and approval or disapproval of proposed changes to any baseline. Formal control of the configuration of end items starts with the establishment of the Design Requirements Baseline and continues through completion of all mission objectives. Exhibit IX is a key exhibit in this total process since it provides the basis for management decision-making after a detail specification for an item has been initially approved to define the Design Requirements Baseline for the item. All Class I changes will be submitted for approval to the appropriate CCB which is the functional body responsible for configuration control. The decision of the CCB will be recorded by means of a CCB Directive, upon which the Contracting Officer will issue the contractual authority for the contractor to effect the change. Engineering changes will be held to a minimum and should be approved only if necessary to correct safety hazards, safety of flight or necessary to comply with officially approved performance requirements. Changes which will result in substantial cost savings without compromising safety, performance or schedules should receive a high order of consideration.

4.3 Apollo Configuration Accounting System

Each Center will develop a system capable of reporting and documenting the changes made to end items, systems and equipment subsequent to the establishment of a baseline configuration. Documentation of configuration

status shall be a systematic record of approved changes, with their scheduled incorporation date into the hardware, and the actual incorporation date. Configuration Accounting Systems must be capable of:

- (a) Defining the exact baseline and all changes thereto.
- (b) Providing management personnel with the visibility necessary to permit follow-up action on decisions to assure proper action is taken by appropriate organizations, including the providing of feedback information to determine if decisions of the various levels of CCB's are being implemented as directed.

5.0 AUTHORITIES AND RESPONSIBILITIES

The Apollo Program Office, Configuration Management Office (CMO) will provide the over-all management direction required to conduct configuration management throughout the Apollo Program. Additionally, the Apollo Program Office will establish a Configuration Control Board (CCB) to operate within the administrative framework of the CMO for making decisions on changes requiring Apollo Program Office approval. Each Center Program Office will establish a Configuration Management Office (CMO) which will be responsible for the management direction required to conduct configuration management. The Program Manager will establish a Configuration Control Board (CCB) to operate within the administrative framework of his CMO for making decisions on changes. Specific responsibilities for NASA organizations are provided in the paragraphs below. Each contractor will establish a Configuration Management Office (CMO) which will be responsible for the management direction required to conduct configuration management within the contractor's organization. The contractor will also establish a Configuration Control Board (CCB) to operate within the administrative framework of the CMO for making decisions on proposed changes.

5.1 Apollo Program Office (APO)

- 5.1.1 The Apollo Program Director has overall responsibility for Apollo Configuration Management including:
 - 5.1.1.1 Issuing policies and requirements for Apollo Configuration Management.
 - 5.1.1.2 Establishing a Program Office CMO and CCB.
 - 5.1.1.3 Acting as Chairman of the CCB or designating a representative with decision authority for changes requiring Program Office approval.

5.1.1.4 Establishing and controlling intercenter interface requirements and changes to these requirements through the overall Apollo change control system.

5.1.2 Configuration Management Office (CMO), Apollo Program Office shall be responsible for:

5.1.2.1 Establishing Configuration Management operating methods and procedures and issuing the Apollo Configuration Management Manual to be implemented by all NASA organizations and contractors participating in the Apollo Program.

5.1.2.2 Assuring management compatibility of the configuration management systems established by the Centers, and coordinating intercenter configuration management agreements and procedures.

5.1.2.3 Reviewing the operation of Apollo Configuration Management and implementing changes by issuing Apollo Program Directives as required.

5.1.2.4 Approving proposed Center Supplements to the Apollo Configuration Management Manual.

5.1.2.5 Assuring that the Specification Program is defined and implemented.

5.1.2.6 Assuring that requirements in Project specifications are consistent with requirements in the Apollo Program specification.

5.1.2.7 Maintaining and distributing records of Program CCB agendas, ECP actions, directives and minutes of CCB meetings.

5.1.2.8 Assuring that follow-up action has been taken on Directives issued by the Apollo Program Director and/or the CCB.

5.1.2.9 Assuring that intercenter interface control is operating as an integral part of the Apollo change control system.

5.1.2.10 Conducting audits of MSF Center and contractor Configuration Management Systems, when deemed appropriate (Exhibit XV).

5.1.3 Configuration Control Board (CCB), Apollo Program Office

- 5.1.3.1 The Apollo Program Office CCB is the Level I CCB, and as such reviews and approves all changes that:
 - 5.1.3.1.1 Affect the requirements established in the Apollo Program Specification.
 - 5.1.3.1.2 Affect the launch date.
 - 5.1.3.1.3 Affect controlled milestone dates or hardware quantities as defined in Apollo Program Directive No. 4 (series).
 - 5.1.3.1.4 Result in a contract document, modification or supplemental agreement whose estimated dollar cost will require that the document, modification or supplemental agreement be submitted for Headquarters approval per NPC-400.
 - 5.1.3.1.5 Are proposed for Apollo Space Vehicles at KSC per Apollo Program Directive No. 34 (current issue).
 - 5.1.3.1.6 Are proposed for Apollo Hardware and Software for Saturn/Apollo Applications per Apollo Program Directive No. 18!
 - 5.1.3.1.7 Concern the assignment of In-Flight Experiments to Apollo Space Vehicles.
- 5.1.3.2 The Level I CCB will review and approve procurement plans submitted to Headquarters for approval.
- 5.1.3.3 The Level I CCB will assure that changes which have been submitted that have Inter-Center interface aspects have been coordinated and agreed upon by each Center.
- 5.1.3.4 The Level I CCB will formalize decisions by issuing a CCB Directive to the appropriate Center CMO(s).

5.2 Center Level Program Offices

5.2.1 The Program Managers at the Centers shall be responsible for:

- 5.2.1.1 Establishing a Configuration Control Board (CCB) and as required subordinate Level Boards.
- 5.2.1.2 Appointing a Chairman for the CCB who shall have decision-making authority for CCB action. The chairman of the Board will designate membership.
- 5.2.1.3 Providing support to the CCB for the technical evaluation of ECP's.
- 5.2.1.4 Establishing a Configuration Management Office.
- 5.2.1.5 The conduct of design reviews and establishing the Design and Product baselines.
- 5.2.1.6 The conduct of acceptance and inspection tests at the contractor's facility and assuring that the equipment has met the acceptance requirements prior to shipment.
- 5.2.1.7 Issuing via the Contracting Officer necessary contract changes to implement the Configuration Control Board Directives (CCBD's).

5.2.2 Center Level Program Offices, Configuration Management Office (CMO) shall be responsible for:

- 5.2.2.1 Establishing Center and contractor procedures and supplements in compliance with the Apollo Configuration Management Manual.
- 5.2.2.2 Initiating and completing the specification program and the establishment of the official specification files.
- 5.2.2.3 Assuring that requirements in System/CEI Specifications are consistent with requirements in Project Specifications.
- 5.2.2.4 Establishing internal approval/change procedures for specifications and maintaining specification status documentation.
- 5.2.2.5 Maintaining a file of record which will include the result of every ECP action. This file will become a permanent part of the applicable Contract End Item File.

- 5.2.2.6 Reviewing, approving and monitoring contractor configuration identification, control and accounting procedures.
 - 5.2.2.7 Insuring that adequate controls and safeguards have been established by each contractor for control of Class II changes.
 - 5.2.2.8 Approving, issuing and maintaining the Configuration Identification and Status Accounting Indices; CCB agendas, directives, and minutes of meetings.
 - 5.2.2.9 Assuring that follow-up action has been taken on the directives issued by the CCB.
- 5.2.3 Center Level Program Offices, Configuration Control Board (CCB) shall be responsible for:
- 5.2.3.1 Approving, rejecting or deferring for further study all Project and End Item Specification and Equipment/Facility Change Proposals.
 - 5.2.3.2 Evaluating each proposed change from all aspects, e.g., technical, interface, logistics, schedule impact, cost, technical data, contractual, etc.
 - 5.2.3.3 Coordinating with the appropriate Apollo Interface Coordination Panel those changes with Inter-Center interface impact prior to approval and issuance of a CCB Directive.
 - 5.2.3.4 Submitting, with recommendations, those changes affecting the items set forth in paragraph 5.1.3.1 to the Apollo Program Office CCB for approval.
 - 5.2.3.5 Formalizing all decisions by issuing a Configuration Control Board Directive. The Directive will establish the requirements for concurrent action with respect to development, production, and retrofit requirements to systems/equipments (including training items, ground equipment, peculiar tooling, spares, spare parts, revisions to technical manuals, engineering and technical data and software end items), and on the methods of accomplishing the changes.
 - 5.2.3.6 Operating within the administrative framework of the CMO.

5.2.4 Authorized Center Supplements

Approved MSF Center Configuration Management Manuals and Plans are recognized as official center supplements to this manual and will be implemented by the appropriate centers.

6.0 INTERFACE MANAGEMENT

Configuration management plays a key role in the control of inter-center and internal center interface requirements and changes. The importance of control over interfaces is reflected in the Apollo Program's official definition of Interface Control Documents: "ICD's are documents establishing inter-center joint agreements for interface requirements and are controlled in that these interface requirements cannot be unilaterally changed. These documents must be referenced or included in appropriate Apollo-Saturn Specifications (e.g., Project, CEI Specs) to ensure that all changes having program/project impact are processed through normal Center change control procedures." In addition the ICD criteria requires that any changes to interface control requirements, (physical, functional, design, etc.) which will have an impact on hardware or software performance, cost or schedule accomplishment must be controlled through CCB's at all affected Centers to assure that all sides of the interface are fully coordinated and informed. The organizational and policy requirements for Interface Management are contained in APD 47, (current issue).

Interface Management shall be accomplished in four distinct phases: Identification, Documentation, Implementation and Control. The Identification phase shall consist of the determination of the existence and the necessity for control of an interface. The Documentation phase is the period in which ICD's are prepared. The interfaces shall be so defined as to assure complete design compatibility. The ICD's are to be prepared and released in accordance with procedures contained herein. The Implementation phase is that part of the program during which interface requirements, as defined by the ICD's and engineering change control requirements, are contractually imposed on design organizations and/or contractors to establish an interface baseline. The Control phase is that part of the program which requires approval of proposed changes to interface requirements in order to prevent unilateral changes which could result in incompatible interfaces.

As an example, Apollo Inter-Center Interface Control Documents shall include but not be limited to the following interface areas:

Launch Vehicle	to	Spacecraft
Q Ball		Spacecraft
Q Ball		to Launch Complex
Spacecraft GSE		Launch Complex
Spacecraft		Launch Complex
Launch Vehicle		Launch Complex
Space Vehicle		Launch Complex
Spacecraft		LVGSE

Launch Vehicle	to	Manned Space Flight Network
Spacecraft		KSC Industrial Area
Launch Vehicle GSE		Launch Complex
Space Vehicle GSE		Launch Complex
Spacecraft GSE		Launch Vehicle GSE
Spacecraft		Manned Space Flight Network

Each center shall prepare and implement intracenter ICD's between Center-level interfacing end items, their applicable ground support equipment and any hardware, software or documentation elements not categorized as end items which are under cognizance of or affect two or more contractors. Intra-center ICD's shall be compatible with inter-center ICD's at and where mutual interfaces exist. Intra-center ICD's, or changes thereto, shall not be approved prior to approval of any affected inter-center ICD, or change thereto.

The Inter-Center Coordination Panels have the responsibility to coordinate, maintain, and technically approve all Inter-Center interfaces between affected NASA Centers. The Panels are charged with initiating the original preparation of, and preparing all revisions to, Interface Control Documents. The Panels must assure technical compatibility for physical, functional and procedural interface aspects from the contractors through the appropriate NASA Centers. The Panels are formed to make available the technical competence of APO, MSFC, KSC and MSC, and their contractors, for the solution of the interface problems of the launch vehicle, the spacecraft, facilities, and associated equipment.

The Inter-Center Repository receives, records, reproduces, and distributes all Apollo Inter-Center ICD's/IRN's approved by the Coordination Panels and cognizant Center Level II CCB's.

7.0 COMPUTER PROGRAM CONFIGURATION MANAGEMENT

While the configuration management requirements defined in this manual deal both with hardware and software (computer programs), it has become necessary on the Apollo program (as a result of the increasing use of "computer--based" systems) to amplify these requirements in terms more generally usable by computer program technical and management personnel. The basic product requiring control is a computer program contract end item (CPCEI), which is defined as the result of a computer programming process leading to production of a punched deck of cards, magnetic tape, or other physical media containing an ordered set in a form suitable for insertion into a digital computer. Computer programming usually requires the development of several programs and the data essential to their use. A particular application (e.g., automatic checkout of a launch vehicle, onboard guidance and navigation) may require the development of:

Operational program(s) which perform(s) the required tasks (e.g., generation of trajectory calculations, test-stimuli, etc.).

A data base which contains all the static and dynamic data supplied to the operational program (e.g., launch site co-ordinates, mathematical constants).

Support programs used for the test and evaluation of the operational program (e.g., simulation, data recording, data reduction programs).

Utility programs which include all tools necessary for the generation of the operational and support programs (e.g., compilers, assemblers, monitors, debugging aids).

The programs and data form a "programming system." For both technical and managerial reasons it is usually desirable to partition the total programming system into several CPCEI's. For example, the operational program combined with the data base may be one CPCEI, a simulation program used to test the first CPCEI may be itself a CPCEI, and the set of utility programs may be designated as another CPCEI. This selection is done by the procuring agency or contractor in the definition phase. It results in the allocation of functions to separately identified computer programs, each of which can then be conveniently produced and managed as a unit. Certain characteristics of the CPCEI and the process required to produce it affect the application of configuration management techniques as originally developed for hardware CEI's. Some of the more important characteristics are:

- a. Unlike a typical hardware production item, the major cost of CPCEI development is in the design and testing process. Fabrication of a computer program - the punching of cards or paper tape - is usually a small part of total development cost. Even in the case where many copies are required, production in the sense of making additional copies is a routine matter of reproducing the program on a computer. This does not usually require a detailed specification or engineering drawings as does the production of duplicate hardware items.
- b. The fabrication of a prototype computer program is based, in general, on handwritten coding sheets which contain a list of the program instructions. These coding sheets, produced in the design process, are usually discarded after the entire program is assembled. They are replaced by listings generated as a normal part of the assembly process. The printer-generated listings provide the only accurate record of the program configuration. To some degree, then, assembly is a self-documenting process. However, a program is usually so complex that supporting documents written by the programmer are required to make the listings understandable to computer personnel.

- c. Experience has indicated that the volume of changes to a CPCEI during its life cycle can be very high. This can be attributed to two factors:
 - 1. Many systems are designed so that expected changes can be handled by computer program modifications rather than hardware modifications.
 - 2. Many computer programs are extremely complex, running into tens and hundreds of thousands of instructions and data words. Errors are inevitable when implementing this large a number of instructions. Failures due to errors may show up throughout the entire programming process.
- d. The design and development of large-scale computer programs is usually accomplished in a modular fashion. The program is divided into "subprograms" called computer program components (CPC). A modular design aids in the debugging process by allowing for isolation of errors and ensuing changes, and it also allows for division of responsibility among several programmers.
- e. The concepts of quality assurance, control and reliability differ from that of hardware CEI's. Some of these differences are:
 - 1. Instructions do not wear out with use; hence, there are no logistic requirements related to spare parts provisioning, interchangeability, substitution, etc.
 - 2. Inspection of the physical item is not an adequate means of verifying the quality of a computer program. It must also be tested extensively in an environment that closely simulates operating conditions.
 - 3. "Quality control" and "acceptance testing," as concepts which have primary significance in relation to quantity production of equipment CEI's, do not have a comparable applicability to computer programs. The production of uniform copies - for example, in multi-site applications - is not usually a major problem in CPCEI contracts. The major problem is usually the proper adaptation of the copies to the individual requirements of each site.
 - 4. The equivalent of military standards for the control of production does not exist for computer programming. Programming design standards are generally produced for and tailored to each effort.

The programming process for a CPCEI within a system starts in the definition phase and continues throughout acquisition and operations. In order to provide computer program configuration management requirements in a complete, concise and integrated form, two exhibits are included herein as follows:

Exhibit XVIII - Preparation of Contract End Item
Detail Specification (Computer Program)

Exhibit XIX - Computer Program Identification, Control
and Accounting

Requirements stated in these exhibits are to be applied to all new computer program procurements, and integrated into ongoing programming operations as practical.

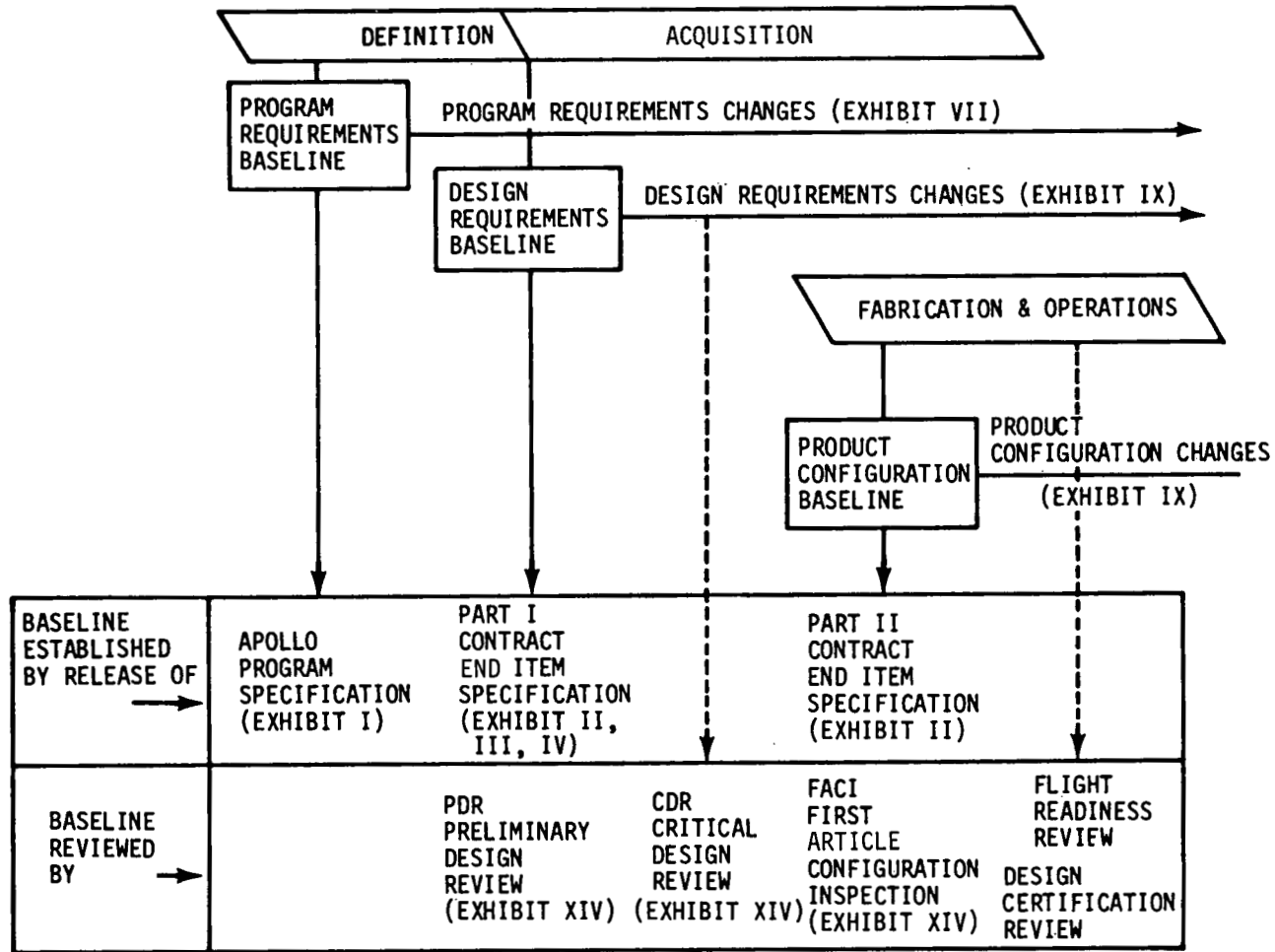
8.0 CONTRACT END ITEM SELECTION AND CONTROL

A Contract End Item (CEI) is an individual product of the contractor or an engineering description thereof which shall be formally accepted by the procuring agency. It is normally the lowest level of assembly for direct management control of the contractor by the procuring agency. The contractor's systems and procedures for documentation, communication and accountability shall tie together and reconcile his engineering and production efforts below the contract end item level. This will allow management actions to be focused at the contract end item level to demonstrate that the requirements of the procuring agency (i.e., for performance of equipment, for operation, for maintenance, and for training) are contractually fulfilled. The actions, records and documents required for this contract accountability are shown in Figure 3. This illustration is the basis for the configuration identification requirements in this Exhibit. During the proposal or definition phase of a program the contractor is involved in recommending levels of assembly for control as contract end items. As part of his effort, the contractor shall search Federal catalogs and select, as his first preference, items of inventory which can be used to meet the requirements for contract end items (or subassemblies thereof). Items of inventory shall preferably be selected for use as designed, but will also be selected for modification as may be required to meet design requirements and where this modification will have a lower total cost impact than new design. Where possible, new design will provide for maintenance by inventoried parts. The use of items already available to the procuring agency to reduce program costs, reliability and logistic problems is an obvious factor of consideration during evaluation or review of the adequacy of a contractor's technical efforts. It also allows the requirements in Figure 3 to be simplified and reduce administrative costs. The contractor shall normally select the highest level of assembly of each item produced in his plant as a contract end item. This will also normally result in reduced administrative costs. This selection should consider that:

- (a) all subassemblies of a CEI should have a common mission relationship. For example, a special mission package for a space vehicle, which provides a separate or additional capability to that vehicle may be best identified as a separate CEI rather than as a subassembly of the vehicle. The package may thereby be more readily scheduled, allocated and provide better visibility of mission requirements and capabilities.
- (b) the contract end item and its subassemblies should have a common installation and operation requirement. For example, a radio command and control set with both ground and airborne packages should be identified by a minimum of two CEI's to separately identify ground and airborne packages.
- (c) the contract end item normally should not contain a subassembly expected to have its own independent cycle of changes relating to CEI mission, e.g., a launch vehicle programmer, where changes in booster trajectory will normally be accomplished entirely within the programmer. The programmer should be a CEI so that the interchangeability of the vehicle and programmer are independently identified. This will reduce the cost of drawing maintenance and increase the significance of the part numbers for both the launch vehicle and the programmer.
- (d) the above considerations are provided to illustrate that the selection of contract end items requires analysis of both technical and administrative implications, and that final choice is a trade-off. There are no rules, other than that a CEI is an end product to be formally accepted.
- (e) a contract end item which can be produced in the contractor's plant shall be complete, delivered and formally accepted by the procuring agency at the contractor's plant. A facility or contract end item of ground equipment which can only be constructed in the field shall be formally accepted at the site of construction. Field installation, checkout and test tasks to be accomplished after acceptance are not justifiable grounds for extending production or construction efforts beyond the factory delivery date or the Beneficial Occupancy Date.
- (f) after acceptance, all contract end items, spares and technical manuals will be Government property, and shall be formally controlled as such in accordance with the requirements of the procuring agency.

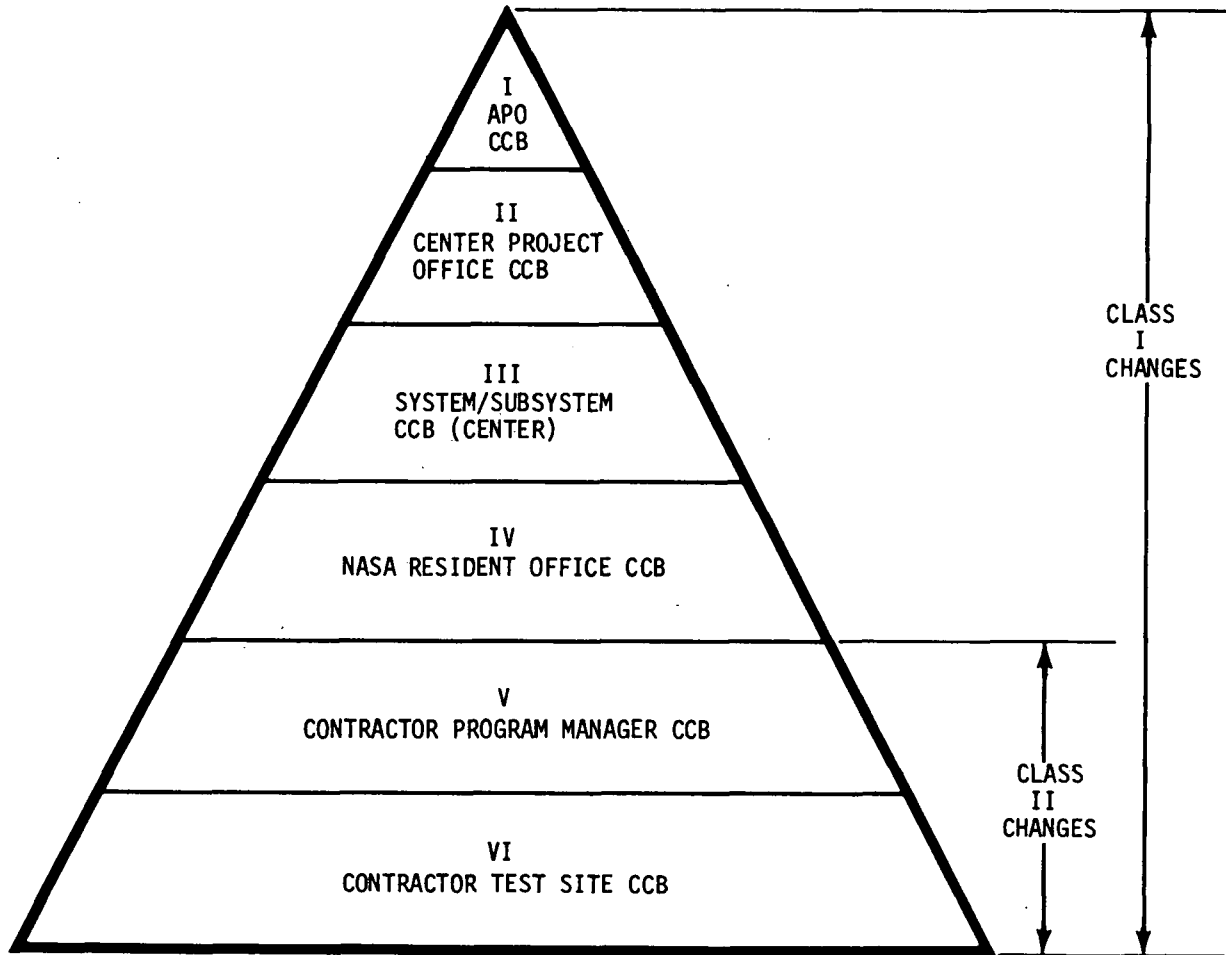
9.0 REPORT REQUIREMENTS

Basic Configuration Management reporting requirements for record purposes are contained in Exhibit XVI. These reports do not preclude the requirement for other reports which may be necessary for program visibility and control. Requirements for new reports to the APO will be levied by issuance of Apollo Program Directives and will not become exhibits to this document unless their purpose and value indicate a basic improvement in the operational aspects of Configuration Management.



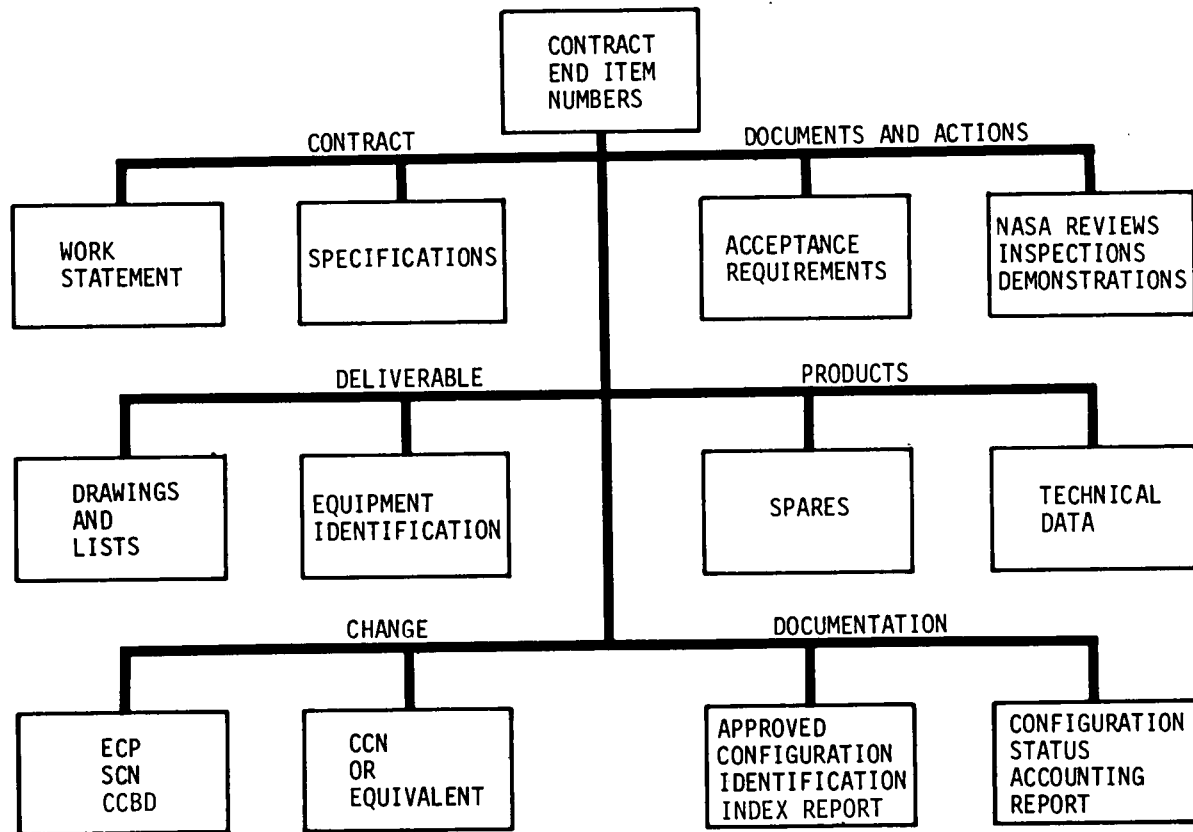
APOLLO CONFIGURATION MANAGEMENT SYSTEM

FIGURE 1



APOLLO CHANGE CONTROL ORGANIZATIONAL LEVELS

FIGURE 2



19

PRODUCTS, DOCUMENTS AND ACTIONS CONTROLLED
AT CONTRACT END ITEM LEVEL

FIGURE 3

EXHIBIT I

PREPARATION OF
PROGRAM, PROJECT AND SYSTEM
PERFORMANCE AND DESIGN
REQUIREMENTS SPECIFICATIONS

EXHIBIT I

PREPARATION OF PROGRAM, PROJECT AND SYSTEM
PERFORMANCE AND DESIGN REQUIREMENTS SPECIFICATIONS

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PREPARATION OF
PROGRAM, PROJECT AND SYSTEM PERFORMANCE AND DESIGN
REQUIREMENTS SPECIFICATIONS

1. PURPOSE

This exhibit provides NASA Apollo organizations and contractors with requirements and guidance for the preparation of Apollo Program, Project and Systems Performance and Design Requirements Specifications.

2. SCOPE

The Apollo Program Specification shall contain technical requirements for the program as an entity. Lower level specifications shall contain technical requirements for the projects and systems as entities. In this exhibit, the words program, project and system are interchangeable as applicable. These requirements relate to:

- a. Mission requirements, identification and description of the program.
- b. Program performance requirements.
- c. Performance budgets.
- d. Standard requirements applicable to all contractor designs.
- e. Program qualification and test requirements.

These specifications provide the basis for, but do not alone govern, hardware design and construction, nor are they to be used as the basis for factory acceptance of contract end items comprising the system.

3. APPLICABILITY

This exhibit is applicable to all NASA Apollo organizations and contractors and shall be used in the preparation of performance/design requirements specifications.

4. REFERENCE DOCUMENTS

Defense Standardization Manual 4120.3-M, "Standardization Policies, Procedures and Instructions", April 1, 1966.

Exhibit X, "Requirements for Configuration Identification Numbers".

5. EXPLANATION OF TERMS

(See Exhibit XVII)

6. PROCEDURAL REQUIREMENTS

Format for the specifications described in this exhibit shall be in accordance with Example "A". Specification content shall be in accordance with the following paragraphs referenced to Example "A".

Preparation of Title Page

The title page for the specification shall be as shown on the sample format.

Specification Numbers

A separate and distinct number shall be as shown on the sample format and be in accordance with the instructions of Exhibit X.

Preparation of "Section 2, Applicable Documents"

APPLICABLE DOCUMENTS - List only those documents (specifications, standards, drawings, bulletins, manuals; etc.) which are applicable to paragraphs within the body of the specification. Within the body of the specification, reference to these documents shall be made by reference to their basic document number, or other definitive designation.

Preparation of "Section 3, Requirements"

This section shall contain the following:

1. The performance and design requirements for the program.
2. The definition of those major elements which make up the program.
3. The identification of program interfaces.
4. The allocation of performance budgets and specific design constraints to the various elements of the program.

5. The identification and relationships of Contract End Items as required by the level of specification, (i.e., a system specification would identify all CEI's of the system while a program specification would only mention certain major CEI's necessary for a complete definition of the program).
6. The design constraints and standards necessary to insure compatibility of program hardware.
7. The performance requirements related to personnel utilization, operation, maintenance and logistic support of the program to the extent these define or constrain the design of program equipment.
8. The identification and use of major Government Furnished Property to be designed into and redelivered with program equipment.
9. The identification and use of major Government Furnished Property to be used with other program equipment as an independent entity.

Requirements shall be stated in quantitative physical terms with tolerances which can be verified by subsequent analytical test, or demonstrative data, or by inspection of the equipment and related supporting engineering data. Requirements shall be the basis for, and be verified by, the tests specified in Section 4.

Paragraph 3.1 "Performance"

Program performance requirements shall be specified in terms of program characteristics and operability. General introductory material may be included in this paragraph. All requirements shall be specified in appropriate sub-paragraphs. Performance requirements shall be specified to the level of detail necessary to clearly establish the program elements, limits for design, functional interfaces, and performance budgets without imposing inappropriate limitations on lower management.

Paragraph 3.1.1 "Characteristics"

Characteristics are as defined below.

Paragraph 3.1.1.1 "Mission Performance"

State the general requirements established for the program in relating it to NASA objectives and goals, and the basic overall mission requirements which are common to more than one program element. The requirements shall include such items as mission mode, command mode, payload, launch, orbital operations, non-orbital operations, and recovery aspects as appropriate. Also included shall be the definition of the mission requirements of the program in terms of the relationship to support activities. Critical performance interfaces relating program to support activities shall be specified in quantitative terms. Specific performance parameters peculiar to the program shall be specified. Requirements which are peculiar to the program shall be specified in quantitative terms and shall not be phrased as goals but rather as requirements.

Paragraph 3.1.1.2 "Logistics"

Summarize the requirements established for the program by logistics considerations as they affect equipment design. The type of maintenance to be performed shall be specified. Requirements shall be compatible with the Mission Performance requirements of paragraph 3.1.1.1 and the Reliability requirements of paragraph 3.1.3.1.

Paragraph 3.1.1.3 "Personnel and Training"

Specify personnel requirements which must be integrated into program design. Requirements shall be the basis for contractor design/development decisions and for determination of personnel training and training equipment/facility requirements.

Paragraph 3.1.2 "Program Definition"

Program definition shall include:

- a. Incorporation, either directly or by reference, of specific products of systems engineering which portray the relationships of the items of equipment to be developed.
- b. Identification of the program elements of the system each of which may include one or more contract end items, and each of which may be assigned to a different contractor or NASA Center for integrated development.

- c. Identification of the individual items of equipment (contract end items) which must be developed and thus translate the operational requirements into equipment development tasks. (Individual items of equipment, CEI's, need not be identified in the Program Specification if they are more appropriately covered in the Project/System Specifications).

Paragraph 3.1.2.1 "Systems Engineering Documentation"

Incorporate, either directly or by reference, the program level functional schematics and the top level functional flows. Program level system layout drawings or other graphic portrayals which establish the general relationship of primary systems equipment and facilities shall be included. A top level Specification Tree shall be included or referenced. (See Figure 1.) Documentation shall be included to the level of detail necessary to clearly establish the elements of the program and the functional interfaces between the elements.

Paragraph 3.1.2.2, "Program Element List"

List the program elements. (For a program specification an element may be a project such as a launch vehicle, spacecraft, etc.) A single design activity may be made responsible for more than one program element, but an element cannot be split and made the responsibility of more than one design activity.

Paragraph 3.1.2.3, "Contract End Item List"

This paragraph shall include a list of contract end items which comprise a project or system. The following information shall be included for each item listed:

- a. CEI number
- b. Nomenclature
- c. The CEI into which it installs. An additional listing of major items of government furnished property (requirements items) which must be delivered as part of the system shall be included herein, identified by Federal Stock Number if applicable.

Paragraph 3.1.3, "Operability"

Include performance requirements which are general measures of efficiency of the program equipment.

Paragraph 3.1.3.1, "Reliability"

Specify reliability requirements of the program. These requirements shall be stated in quantitative terms, defining the conditions under which the requirements are to be met. A reliability apportionment model may be included to support the apportionment of reliability values.

Paragraph 3.1.3.2 "Maintainability"

State the quantitative requirements for maintainability. The basic approach to maintenance in terms of service and access requirements for equipment shall be specified: e.g., "maintenance on the launch pad is restricted to removal and replacement of the failed unit," etc. It shall include ground and space vehicle maintenance concepts as well as maintenance and repair cycle requirements.

Paragraph 3.1.3.3 "Useful Life"

Specify the anticipated useful life of a program element without reference to anticipated useful life of parts of a project or system, e.g., "the intended mission service of the launch vehicle is one year."

Paragraph 3.1.3.4 "Natural Environment"

Standards of natural environment which all program equipment must be designed to withstand if unprotected from the elements shall be specified, e.g., wind loading, precipitation, ranges in temperature, humidity, atmospheric pressure, wind shear, vertical gust velocities, turbulence, etc. The standards for space environment shall be included, if appropriate, e.g., energy input from solar radiation; particle mass and energy spectrums, etc.

Paragraph 3.1.3.5 "Transportability"

Requirements for transportability which are common to all program equipment to support mission operations, mission support operations, and logistics shall be specified.

Paragraph 3.1.3.6 "Human Performance"

Human performance and engineering requirements for the program shall be specified or referenced in applicable documents.

Paragraph 3.1.3.7 "Safety"

Specify those safety requirements established as basic to all program equipment, e.g., "all ordnance devices to be used as part of this program shall use Class II explosives as the energy source."

Paragraph 3.1.3.8 "Dangerous Materials and Components"

Summarize the requirements established due to the use of dangerous materials such as: liquid propellants, solid propellants, explosive ordnance, electro-explosive devices, toxic, corrosive and/or radioactive materials, etc. Typical requirements are: establishment of Interstate Commerce Commission hazard classifications; determination of criteria for safe handling, storage, transporting, maintenance, checkout and installation; determination of sensitivity levels to the effect of radio frequency and electromagnetic fields both internal and external to the system; determination of criteria for siting of facilities; etc.

Paragraph 3.1.3.9 "Induced Environment"

Specify general induced environment constraints of program equipment. For example: "The noise and vibration levels associated with the system and its elements in required combinations shall be controlled under all source conditions and usage to levels on tolerance to personnel, structure, equipment, and facilities as specified in MIL-STD-803."

Paragraph 3.1.3.10 "Life Support"

Specify the requirements and constraints of system and equipment design to maintain a controlled healthful and safe environment and to provide for the sustenance and welfare of personnel in accomplishing operations, maintenance, and control tasks. State specific quantitative levels and limitations to be controlled under all source conditions and usage levels of tolerance to personnel for such items as: noise and vibration; environmental control; composition of atmosphere; concentration of noxious compounds; food and water supply; oxygen and water regeneration; sanitation, personnel hygiene and water disposal; acceleration, shock, and vibration; etc.

Paragraph 3.2 "Program Design and Construction Standards"

Specify minimum program design and construction standards which have general applicability to program equipment and are applicable to major classes of equipment (e.g., space vehicle equipment, ground equipment) or are applicable to "particular design disciplines." "Particular design discipline" is identified with the particular speciality of an engineer and the kind of equipment which he designs; e.g., mechanical, electrical, hydraulic, etc. To the maximum extent possible, established NASA or NASA designated military standards and specifications shall be incorporated. Requirements which add to, but do not conflict with, specified requirements may be included in individual contract end item specifications. Standards may include such items as:

- a. Selection of specifications and standards
- b. Materials, parts, and processes
- c. Standard, commercial and qualified parts
- d. Moisture and fungus resistance
- e. Corrosion of metal parts
- f. Interchangeability and replaceability
- g. Workmanship
- h. Electromagnetic interference
- i. Identification and marking
- j. Storage
- k. Drawing standards
- l. Coordinate system standards

Design criteria requirements limited to specific disciplines may be listed under the following titles:

- a. Electrical
- b. Mechanical
- c. Hydraulic
- d. Civil
- e. "Other Disciplines", etc.

Paragraph 3.3 "Requirements for Program Elements"

Include the requirements for each element of the program. Defined requirements for an element shall include a discrete package of performance requirements, functional interfaces and contract end items allocated to one industrial or NASA organization directly responsible for that element. An element may include unrelated items of equipment where allocations are made to take advantage of special capabilities existing in one organization. The principal purpose of program elements is to specify and fix responsibilities for program performance. They shall be so selected that functional requirements peculiar to each element and the functional interfaces between elements can be specified. The requirements specified in paragraph 3.2, and subparagraphs thereto, are common to all elements and shall not be allocated to individual elements. Requirements specified in paragraph 3.1, and subparagraphs thereto, shall be allocated to a single element or allocated among the elements.

Paragraph 3.3.1 "Requirements for Program Element A"

The title of this paragraph shall include the name of the program element. Specify, in appropriate subparagraphs, the performance requirements for each functional area of the element, e.g., structure, propulsion, guidance and navigation, etc. These include requirements allocated and/or budgeted from paragraph 3.1 as well as requirements which are peculiar to the element and cannot be referenced directly to requirements specified in paragraph 3.1. The interfaces of the element being specified with other elements shall be stated. Interfaces shall be specified to the level of detail necessary to permit concurrent and mutually compatible design and development of all elements. (See 3.3.1 Example A.)

(For project/systems specifications only a separate subparagraph shall reference a list of all contract end items included in the project/system.)

Paragraph 4.0, "Quality Assurance"

Requirements for formal test/verification of program performance and design characteristics and operability shall be specified. Requirements may be incorporated by reference to such documents as the Apollo Test Requirements, the Apollo Reliability and Quality Assurance Program Plan and other NASA test and reliability publications. The content of this section is limited to the specification of test requirements and shall not incorporate, either directly or by reference, detail test planning documents and instructions.

EXHIBIT I

Test requirements shall include engineering evaluation and test requirements which necessitate integrated project and system testing in direct support of design and development activity. Test requirements with respect to program reliability shall be detailed as well as test requirements for formal qualification of program equipment.

Requirements shall be specified to the level of detail which:

- a. Specifies a verification requirement and the method for verifying such performance requirement specified in paragraph 3.1.1 and 3.1.3. Tests/verifications to demonstrate that requirements specified in paragraphs 3.2 and 3.3 have been met shall be added only upon specific direction of the procuring agency. Tests/verifications to demonstrate compliance with requirements which are contained in Section 4 of Part I of individual contract end item specifications shall be added only at the specific direction of the procuring agency.
- b. Permits ready identification of each verification requirement specified in Section 4 with the appropriate performance requirement in Section 3.
- c. Specifies each requirement for verification to the level of detail necessary to establish the scope and accuracy of the test method.

Preparation of Section 5, "Preparation for Delivery"

Specify requirements for the preparation of equipment for delivery which are peculiar to the program and are other than standard practice. It shall include specific instructions to include such non-standard practice in appropriate end item specifications. It may impose requirements to comply with standard practice by referencing appropriate NASA and military specifications and standards to be used as the basis for preparing Section 5 of each contract end item specification.

Preparation of Section 6, "Notes"

Any information pertinent to the program which should be made known as background information shall be stated.

Preparation of Section 10, "Appendix"

The Appendix or Appendices shall contain requirements which are a part of the specification but which, for convenience in specification maintenance, are incorporated as an Appendix, e.g., requirements of a temporary nature or of limited effectivity. Appendices may be bound as separate documents for convenience of handling, e.g., when only a few parameters of the system are classified, an appendix containing only the classified material may be established. Where parameters are placed in the appendix, the paragraph of Section 10.0 shall be referenced in the main body of the cognizant specification in the place where the parameter would normally have been specified.

EXAMPLE "A"

Specification No. _____

Dated _____

Page 1

1. SCOPE

This specification defines the performance, design and test requirements for the Apollo Program as defined by the Apollo Program Development Plan. All elements and contract end items of the Apollo Program shall conform with these requirements. All requirements shall be fully reflected in subsidiary Apollo specifications.

2. APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced and the content of this specification, the content of this specification shall take precedence.

SPECIFICATIONS

Federal
Military
Contractor

STANDARDS

Federal
Military
Contractor

DRAWINGSBULLETINSOTHER PUBLICATIONS

Manuals
Regulations
Handbooks
Etc. (Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

EXAMPLE "A"Specification No. _____
Dated _____
Page 23. REQUIREMENTS3.1 Performance3.1.1 Characteristics3.1.1.1 Mission Performance3.1.1.2 Logistics3.1.1.3 Personnel and Training3.1.2 Program Definition3.1.2.1 Systems Engineering Documentation3.1.2.2 Program Element List3.1.2.3 Contract End Item List (Project
and Systems Specifications only)3.1.3 Operability3.1.3.1 Reliability3.1.3.2 Maintainability3.1.3.3 Useful Life3.1.3.4 Natural Environment3.1.3.5 Transportability3.1.3.6 Human Performance3.1.3.7 Safety3.1.3.8 Dangerous Materials and Components3.1.3.9 Induced Environment3.1.3.10 Life Support

EXAMPLE "A"

Specification No. _____
Dated _____
Page 3

3.2 Program Design and Construction Standards

3.2.1 General Requirements (In numbered paragraphs
as appropriate)

Selection of Specification and Standards

Materials, Parts and Processes

Standard, Commercial and Qualified Parts

Moisture and Fungus Resistance

Corrosion of Metal Parts

Interchangeability and Replaceability

Workmanship

Electromagnetic Interference

Identification and Marking

Storage

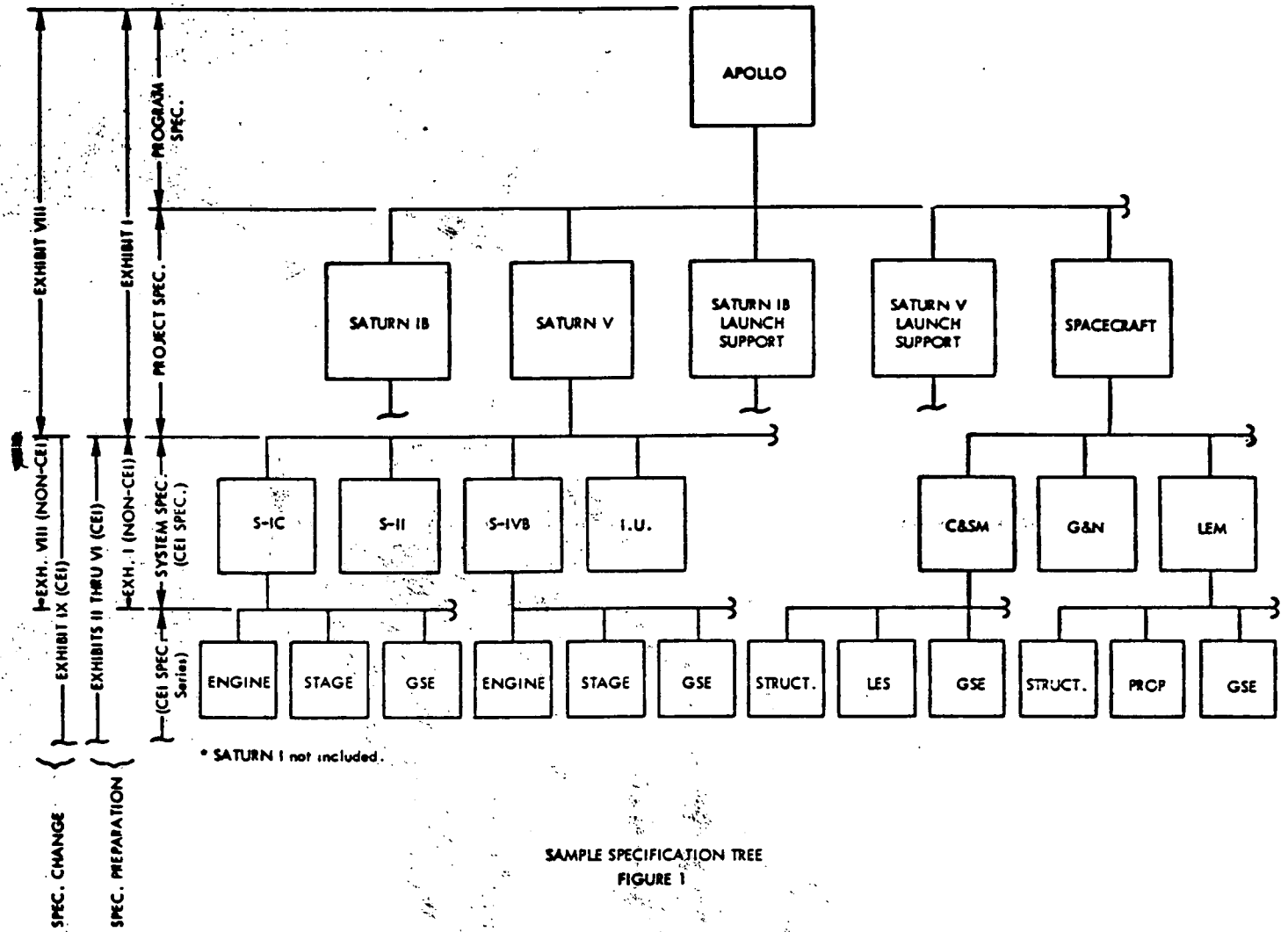
3.3 Requirements for Program Elements

3.3.1 (Program Element A)

3.3.2 (Program Element B)

(Repeat as necessary to provide a separate 3.3.X
paragraph for each Program Element)

4. QUALITY ASSURANCE
5. PREPARATION FOR DELIVERY
6. NOTES
7. APPENDICES



SAMPLE SPECIFICATION TREE
FIGURE 1

EXHIBIT II

PREPARATION OF CONTRACT END ITEM
DETAIL SPECIFICATION
(PRIME EQUIPMENT)

EXHIBIT II

PREPARATION OF CONTRACT END ITEM
DETAIL SPECIFICATION
(PRIME EQUIPMENT)

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PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(PRIME EQUIPMENT)

1. PURPOSE

This Exhibit provides NASA Apollo organizations and contractors with requirements and guidance for the preparation of the detail specification for each Contract End Item (CEI) and for the addenda thereto.

2. SCOPE

These instructions define the content and format for each of the two parts of the Contract End Item Detail Specification (Prime Equipment). Also included are instructions for the preparation of addenda to the CEI Specification.

2.1 CEI Specification

Each CEI Specification is made up of two parts:

Part I - Performance and Design Requirements:

This Part of the CEI Specification shall be used to specify requirements peculiar to the design, development, test, and qualification of the contract end item.

Part II- Product Configuration Requirements:

This Part of the CEI Specification shall be used to specify exact configuration information peculiar to the production, quality control, acceptance testing, and preparation for delivery of each contract end item.

2.2 Specification Addenda

An addendum to a CEI Specification is a "short form" specification to establish requirements for a new end item, which in terms of performance, design and construction is so much like an existing CEI that it is practical to restrict design and development to a "make from" basis.

For filing and distribution, an addendum specification must always be accompanied by a copy of the specification to which it relates. See sample format "E".

3. APPLICABILITY

A Contract End Item Detail Specification (Prime Equipment) shall be prepared for each equipment or system designated as a deliverable contract end item, which cannot be specified using the simplified formats for: (1) the Identification Specification (see Exhibit IV), or (2) the Requirements Specification (see Exhibit V). This Exhibit is applicable to development/activation prime support equipment, e.g., test site support equipment, equipment instrumentation and range instrumentation packages, site activation test and checkout equipment, and Direct Support - Real Property Installed Equipment (DS-RPIE). This Exhibit is not applicable to contract end items which are facilities. CEI Specifications shall be compatible with the Program and other performance Specifications of Exhibit I.

4. REFERENCE DOCUMENTS

AFM 71-4	29 May 1968	"Packaging and Handling of Dangerous Materials for Transporting by Military Aircraft"
DSM 4120.3-M	1 April 1966	"Standardization Policies, Procedures and Instructions"
Exhibit X		"Requirements for Configuration Identification Numbers"
MIL-D-1000	1 March 1965	"Drawings, Engineering and Associated Lists"
MIL-I-8500	10 October 1960	"Interchangeability and Replaceability of Component Parts for Aircraft and Missiles"
MIL-P-116E	1 November 1965	"Preservation, Methods of"
MIL-STD-100A	1 October 1967	"Engineering Drawing Practices"
MIL-STD-129D	28 December 1964	"Marking for Shipment and Storage"
NHB 5300-4 (1B)	April 1969	"Quality Provisions for Aeronautical and Space System Contractors"
NHB 8080.1	May 1964	"Apollo Test Requirements"
NPC 200-3	April 1962	"Inspection Systems Provisions for Suppliers of Space Materials, Parts, Components and Services"
NPC 250-1	30 July 1963	"Reliability Program Provisions for Space Systems Contractors"

5. EXPLANATION OF TERMS

(See Exhibit XVII.)

6. PROCEDURAL REQUIREMENTS

6.1 Contract End Item Detail Specification

The CEI Specification specifies requirements for a single CEI type-model-series. The CEI Specification is composed of two distinct parts, each of which has a different use in the contractual control of CEI acquisition. Each of the two parts, when prepared in compliance with these instructions, is complete in content and format with respect to its intended use. The CEI Specification is controlled and accounted as an entity, using a single configuration chart and a single specification change log (see Exhibit VII). Part I is a product of a program definition phase or requirements analysis and is the engineering instrument used to contract for design and development of the CEI. Contractor compliance with Part I is determined by evaluation of qualification, reliability and other test records. Part II of the CEI Specification is a product of the design and development contract. Part II specifies the CEI in terms of the detail product configuration requirements of the item qualified (or to be qualified) under the terms and conditions of the design and development contract. The integrity of Part II must be established prior to its acceptance by NASA.

Acceptance of equipment by Part II of the specification is dependent upon the accuracy with which it specifies detail configuration requirements of the qualified (or to be qualified) CEI, and the adequacy of quality assurance requirements established to control the quality of each individual unit of the CEI to be produced. The integrity of Part II is established by review. The review (First Article Configuration Inspection - FACI) is accomplished by cross-comparison of the data specified in Part II with qualification, reliability and other test records; and with the configuration fabricated as the first unit to be accepted. The configuration qualified (or to be qualified) under the terms and conditions of the design and development contract shall be clearly identifiable with the configuration specified in Part II. Part II must be identical to the actual configuration of the article to undergo FACI. Part II is established as the valid engineering instrument to be implemented contractually for direct control of the CEI. Contractor compliance shall be determined by normal quality control procedures. The FACI article and all subsequent deliveries shall be accepted in accordance with Part II of the Contract End Item Specification. These requirements shall take precedence over any other requirements for acceptance which may also apply and be in conflict. For instructions on the preparation of computer program CEI Specifications see Exhibit XVIII.

6.2 Addenda to Contract End Item Detail Specifications

Origination of an addendum to a CEI detail specification creates in effect a new specification. It is used when an item to be designed and developed is so like an existing CEI that it is desirable to restrict design activity to the same criteria with additions/deletions. An addendum changes a basic CEI detail specification by adding or deleting requirements on a paragraph-by-paragraph basis. Addenda shall be identified with a specific issue of a basic specification. The specification so created (basic specification plus addenda) then becomes controlled and maintained as a separate and distinct specification, to be updated and revised as necessary.

6.3 Detail Instructions for the Preparation of Contract End Item Detail Specification, Part I

The following instructional paragraphs are numbered or otherwise identified to refer directly to the sample formats attached. The sample formats are:

Sample Format "A" - CEI Specification Part I Title Page

Sample Format "B" - Part I of CEI Specification

General deviations from the requirements of this instruction require prior approval of the procuring agency. Each CEI detail specification which deviates from the general requirements of this instruction shall cite, in Section 10, "Appendix", the procuring agency instrument authorizing the deviation.

"Title Page" - The title page shall conform to sample format "A", and include the following information.

"Specification Number"	An identifier unique to this CEI. (See Exhibit X)
" Revision Identification"	Sequentially assigned character(s) to uniquely identify each revision of the specification.
"Release Date"	Date formally released by the preparing agency.
"CEI Number"	Contract End Item Number (See Exhibit X)
"Approved Nomenclature"	In accordance with Exhibit X, and standard practice.
"Project and/or System Identification"	List the project and/or system or systems which the CEI is designed to support. For CEI's

which cannot be identified with specific systems enter the phrase, "Not System Equipment".

"Approval Block"

The preparing activity (with contract number) and the NASA office with engineering responsibility for the CEI shall validate the specification (Center Project Office or equivalent).

The title page shall be followed by introductory material as appropriate, including the End Item Configuration Chart and Specification Change Log. Such introductory material shall be followed immediately by Part I of the specification.

Section 1, "Scope" - Begin with the opening sentence/paragraph as shown in sample format "B". Subsequent sentence/paragraphs, as indicated by sample format "B", shall briefly describe the intended general use of the CEI without direct reference to the system or equipment to which it is related. Material included may be descriptive, qualitative and/or quantitative. The primary output or use, as well as the primary input or operator requirements of the CEI, shall be included.

Section 2, "Applicable Documents" - Begin with the lead phrase contained in sample format "B". List those documents (specifications, standards, drawings, bulletins, manuals, etc.), which are applicable to paragraphs within the body of the specification. Within the body of the specification, reference to those documents shall be by basic document number and/or other applicable designation. Refer to Defense Standardization Manual 4120.3-M for further instructions on listing of applicable documents.

Section 3, "Requirements" - Specify performance and design requirements for the CEI. Include the functional requirements for the CEI and establish requirements which are measures of the efficiency/effectivities of the CEI. Define the CEI and specify design constraints and standards necessary to assure compatibility of the CEI with the total program project or system. For CEI's which directly support a program, project(s) or system(s), performance and design requirements are allocated from, identical with, or in recognition of, requirements established by the program, project, or system specification. When "system engineering" procedures are a part of the contract, the requirements appearing in this Section shall be based on the "system engineering" documentation developed as a result of "system engineering" procedures. Quantitative requirements shall be included within the principal sub-paragraphs.

NOTE: Referring specifically to CEI's which support a project(s) or system(s), it may be desirable or necessary to establish requirements for performance, design, and construction which exceed minimum requirements imposed by the program. When such updated requirements are established, they shall clearly be identified as updated requirements. The relationship between the updated requirements and minimum requirements necessary for the program compatibility shall be included in Part I, Section 6, "Notes", together with the reasons therefor.

Paragraph 3.1, "Performance" - Specify CEI performance in terms of functional requirements. Include requirements which establish the efficiency/effectiveness of the CEI. Requirements shall be specified to the level of detail necessary to establish limits for design.

Paragraph 3.1.1, "Performance Characteristics" - Specify the limiting functional characteristics of the contract end item. This includes performance characteristics which are established by, and are the product of analysis, as well as performance characteristics which are determined by design. Descriptive and introductory material may be included. Quantitative requirements shall be specified in the subparagraphs.

Paragraph 3.1.1.1, "Primary Performance Characteristics"

Specify the primary performance characteristics of the CEI. These requirements are the product of analysis, stated in terms which do not pre-select design solutions. Primary performance characteristics are the limiting performance parameters which must be specified to constrain design within requirements established by primary mission/use of the CEI, e.g., for spacecraft, this could include limiting mission profiles, etc.; for an engine, this could include thrust, thrust to weight ratio, etc. Requirements shall be stated in quantitative terms, with tolerances, using standard, measurable properties of the CEI itself.

Paragraph 3.1.1.3, "Secondary Performance Characteristics" - Specify the secondary performance characteristics of the CEI. These characteristics generally pre-suppose, or are recorded after, a basic design approach has been established, and in this sense are a product of the design process. Secondary performance characteristics are those parameters which are not necessarily mission/use critical, but which may be specified to properly constrain complete design of the CEI, e.g., for a spacecraft, this could include such things as various emergency operation characteristics, etc.; for an engine, this could include maximum continuous operating time at emergency rated power, etc. Requirements shall be stated in quantitative terms, with tolerances, using standard, measurable properties of the CEI itself.

Paragraph 3.1.2, "Operability"- Specify operability requirements, including reliability, maintainability, transportability, etc., as well as ability to operate in the natural and enforced environments, human performance features, safety features, etc. For CEI's which directly support a project(s) or system(s), operability requirements are allocated from, identical with, or in recognition of, requirements established by the program specification. To the extent practical, such requirements shall be incorporated by reference to the program specification and program documentation. Quantitative requirements shall be specified in subparagraphs.

Paragraph 3.1.2.1, "Reliability" - Specify reliability, in quantitative terms, with tolerances, such as mean time to failure based on the system reliability measure. All measures will include the definition of success probability at a stated confidence level, and time periods necessary for complete demonstration of reliability requirements.

Paragraph 3.1.2.2, "Maintainability" - Specify maintainability requirements in quantitative terms, with tolerances, e.g., mean time to repair; maintenance man-hours per operation hour; etc. Include, where applicable, ground and airborne maintenance concepts, maintenance and repair cycles and service and access requirements.

Paragraph 3.1.2.3, "Useful Life" - Specify useful life requirements for the CEI. Include requirements for shelf-life as well as operating life, and combinations thereof.

Paragraph 3.1.2.4, "Natural Environment" - Standards of natural environment which the CEI is to withstand shall be specified, e.g., wind loading; precipitation; ranges in temperature; humidity; atmospheric pressure; wind shear; vertical gust; velocities; turbulence; etc. For CEI's which support a program, project(s), or system(s) specification, this paragraph shall cite the "Environmental" paragraph of the program, project(s) or system(s) specification, amending it for application to this CEI. For CEI's which require an artificial environment at all times, this paragraph shall be marked "Not applicable -- This CEI requires a controlled environment at all times."

Paragraph 3.1.2.5, "Transportability" - Requirements peculiar to transportability shall be specified. Requirements peculiar to "transport mode" specified in paragraph 3.2.1.2, "Detailed Interface Definition", shall not be redundantly specified. Specify also restrictions on the maximum dimensions of weight of the CEI as crated for shipment, and include peculiar or unusual tie-down requirements imposed by specified methods of transportation. If mobility is a significant feature of the CEI, include the time, in terms of man-hours and/or elapsed time, allocated to prepare the CEI for transport. Also specify detail requirements for packaging and packing for shipment wherein the packing and packaging methods themselves require development and qualification.

Paragraph 3.1.2.6, "Human Performance" - Human performance requirements for the CEI shall be specified. For CEI's which directly support a program, project, or system, cite the appropriate paragraph(s) of the program, project or system specification which establish the human performance/human engineering requirements for all program equipments, and incorporate requirements peculiar to the CEI.

Paragraph 3.1.2.7, "Safety" - Requirements for the CEI which must be specified to preclude or limit hazard to personnel and/or equipment shall be specified. To the extent practical, these requirements shall be imposed by citing established and recognized standards. For CEI's which directly

support a program, project(s), or system(s), cite the appropriate paragraph(s) of the program, project, or system specification which establishes program safety requirements, amending it for applicability to the CEI. Limiting personnel safety requirements peculiar to the CEI due to unusual hazard in its manufacture, test, transport, storage, operation, or maintenance which are not provided by standard industrial and NASA practices and regulations, and not provided by safety requirements imposed by the program, project, or system specification shall be specified. These hazards include flamability limits, susceptibility to accidental explosion, production of noxious or toxic gases, use or production of hazardous chemicals, ease of access and exit, emergency exit, etc. Equipment safety shall be specified by "fail safe" or emergency operation requirements. Include requirements for redundancy, interlocks, noise and vibration, emergency and stand by circuits, and other requirements intended principally to prevent damage to or recovery of the CEI itself in the event of failure or damage.

Paragraph 3.1.2.8, "Induced Environment" - Specify the limiting induced environment criteria applicable to the CEI. To the extent requirements peculiar to noise and vibration are specified in paragraph 3.1.2.7, "Safety," they shall not be redundantly specified. Include induced environment required for transportability and storage. For CEI's which support a program, project(s), or system(s), the "Induced Environment" paragraph in the program specification shall be cited, amending it for application to this CEI.

Paragraph 3.2, "CEI Definition" - Specify the mechanical and functional relationship of the CEI to other equipments/facilities and identify individual components incorporated in the CEI which require individual specifications.

Paragraph 3.2.1, "Interface Requirements" - Specify, either directly or by reference, requirements imposed on the design of the CEI because of its functional, physical and procedural relationships to other equipments/facilities. This includes schematic arrangement data which establishes limits for detail design, and is the product

of program definition. It also includes detailed interface definition, which is in part the product of design and is developed during the design and development phase of the CEI. General and/or descriptive data may be included in the basic paragraph. Quantitative requirements shall be incorporated in subparagraphs.

Paragraph 3.2.1.1, "Schematic Arrangement" -
The relationship of the CEI to other equipments/facilities with which it must interface, shall be graphically portrayed. Incorporate, whether directly or by reference, a schematic diagram, inboard profile, or equivalent engineering drawing of the CEI. The graphic portrayal of the CEI shall be accomplished to the level of detail necessary to identify the existence of physical interfaces between the CEI and other identified equipments/facilities and the nature of the interface, e.g., mechanical, hydraulic, electrical, etc.

Paragraph 3.2.1.2, "Detailed Interface Definition"-
Specify in quantitative terms with tolerances, the mechanical, functional, and procedural relationship of the CEI to interfacing equipment and facilities, to the level of detail necessary to permit detail design. Mechanical relationship of the CEI to interfacing equipment/facilities shall be expressed in terms of dimensions, with tolerances of the CEI and related equipment/facilities, at the point(s) of contact, referenced to a common datum plane or point. The means of mechanical connection shall be specified, e.g., bolt circle; toggle clamp; mounting pad; etc. Tolerances shall be established to permit the widest practical latitude in manufacture while maintaining the engineering integrity of the CEI. Functional interfaces shall specify the input/output requirements of the CEI in terms of voltages, pressures, accelerations, limiting temperature ranges, thermal shock limitations, loads, purity requirements for chemicals, etc. They may be the result of direct mechanical interconnect of the CEI to other equipments/facilities, or they may be the result of performance relationship, e.g., auto-pilot gain and space vehicle bending modes, ignition response and space vehicle pitch and roll rates, etc. (in circumstances where there are distinct modes for equipment, e.g., storage mode, checkout mode, transport mode, operational mode, emergency modes, etc., and the functional interfaces differ with the change in mode, the requirements shall be specified in a manner

to be clearly identifiable with each mode.) Tolerances established for functional interfaces shall be as broad as practical to permit use of unsophisticated equipment while maintaining the engineering integrity of the CEI. Incorporate, either directly or by reference, interface control drawings and/or other engineering documentation necessary to specify the mechanical and functional interfaces of the CEI with other equipment/facilities.

Paragraph 3.2.2, "Component Identification" - Identify components, or component equivalent items, incorporated in the CEI which, because of their engineering or supply significance, must be individually specified. List these items within the categories established and defined in subparagraphs. The terms "component" and "property", include mechanical assemblies such as motors, drives, etc., as well as materials such as hydraulic fluids, fuels, lubricants, bonding agents, lox, etc., and tapes and/or decks containing computer programs, if part of the CEI. (For instructions on the preparation of a requirement specification for Government-Furnished Property, see Exhibit V; for instructions on the preparation of specifications for components and assemblies below CEI level, see Exhibit VI.)

Paragraph 3.2.2.1, "Government-Furnished Property List" - List the Government-Furnished Property which the CEI must be designed to incorporate. The listing shall identify the property by reference to its nomenclature, specification number, CEI number and, if appropriate, its part number. The term "Government-Furnished Property" includes both components and materials which must be incorporated into the design of the CEI.

NOTE: The GFP list is a product of program definition phase and shall be available prior to the acquisition (design and development) phase.

Paragraph 3.2.2.2, "Engineering Critical Components List" - List the engineering critical components within the CEI. Engineering critical components shall be identified by nomenclature, specification number, and, if appropriate, basic part number. Components other than those listed as engineering critical shall be considered individually qualified, for purposes of procurement to support the CEI, upon acceptance by the procuring agency of the CEI itself as a qualified item.

NOTE: The contractor will be required to submit the specifications for engineering critical components to the procuring agency for review and approval prior to the start of qualification of the component. The contractor will deliver both the specification and qualification data for an engineering critical component to the procuring agency at the time of delivery of the qualification data for the CEI itself. The identification of engineering critical components is normally accomplished during the program definition phase, and should be available prior to the design and development phase.

Paragraph 3.2.2.3, "Logistics Critical Components List" - List the logistics critical components within the CEI. Logistics critical components shall be identified by their nomenclature, specification number and, if appropriate, part number.

NOTE: The individual specifications for logistics critical components will normally be delivered to the procuring agency at the time of delivery of the qualification data on the CEI itself. The procuring agency will establish requirements for the selection of logistics critical components, and for the delivery of specifications for them, as part of the design and development contract.

This paragraph of the specification shall be amended to incorporate individual logistics critical items as they are identified during the progress of design and development.

Paragraph 3.2.3. "Technical Manuals" - Reference Section 6, Part II, which identifies the technical manuals which can be identified with the CEI, and which are necessary to its operation and maintenance.

Paragraph 3.3., "Design and Construction" - Specify design and construction requirements for the CEI. This includes both general design features, e.g., dimensions and weight, as well as detail standards and specifications, which must be satisfied by the design and construction of the CEI. To the maximum

extent possible, requirements included, other than those included in paragraph 3.3.1, shall be specified by reference to established NASA or NASA-designated military standards and specifications. Descriptive material may be included in the basic paragraph. For CEI's which directly support a program, a project(s) or system(s), the content of subparagraphs, with the exception of paragraph 3.3.1, represents recognition of a requirement established within the program, project, or system specification. The appropriate paragraphs of the program, project, or system specification shall be referenced, and amended for applicability to the CEI. Introductory requirements specified in subparagraphs shall include, but not be limited to, the following:

Paragraph 3.3.1, "General Design Features" - Specify design features and physical characteristics of the CEI, e.g., size, weight, shape, individual critical dimensions, etc. Requirements specified may be descriptive, e.g., "access panels shall not be designed to carry primary structural loads," or expressed in quantitative terms, e.g., "the nominal diameter of the command module shall not exceed 13 feet." Requirements shall normally be verifiable by inspection of the CEI. Arrangement drawings, three-view drawings, list drawings, and equivalent engineering documentation may be incorporated either directly or by reference.

Paragraph 3.3.2, "Selection of Specifications and Standards" - Specify requirements, criteria, and constraints pertinent to the selection and imposition of NASA, Federal, military and contractor specifications and standards, e.g., "all standards or specifications, other than those established and approved for use by NASA must be approved by the procuring agency prior to incorporation into the CEI specification." For a list of specifications and standards, see Federal Supply Classification Listing of DOD Standardization Documents or NASA equivalent. For use of specifications and standards, see DOD Manual 4120.3-M. For selection and preparation of drawings use MIL-D-1000 with NASA Drawing Specification Cover Sheet, and MIL-STD-100. Form 1, 2 or 3 drawings in accordance with MIL-D-1000 shall be specified by the procuring agency.

Paragraph 3.3.3, "Materials, Parts, and Processes" - Specify requirements for, or prohibit the use of, individual and/or types of materials, parts and processes. Materials, parts and processes included in this paragraph shall be identified by reference to pertinent specifications.

Paragraph 3.3.4, "Standard and Commercial Parts" - Specify requirements pertinent to the use of standard and commercial parts.

Paragraph 3.3.5, "Moisture and Fungus Resistance" - Specify moisture and fungus resistance requirements.

Paragraph 3.3.6, "Corrosion of Metal Parts" - Specify requirements for the use of protective coatings, and other corrosion control requirements. Whenever dissimilar metals are in direct contact, the method for controlling electrolytic corrosion shall be specified.

Paragraph 3.3.7, "Interchangeability and Replaceability" - Specify requirements for components, assemblies and parts of the CEI to be interchangeable and replaceable. Requirements are for the purpose of establishing a condition of design, and are not to define the conditions of interchangeability that are required by the assignment of part numbers. For example, "all access plates for the spacecraft shall be designed to be readily removed and replaced by quick disconnects, and shall be interchangeable within a type, model, series of the spacecraft to the extent required by MIL-I-8500."

Paragraph 3.3.8, "Workmanship" - Specify the general requirements for workmanship incident to fabrication of the CEI. These requirements shall make the information available to the designer so that it will be properly called out on drawings and other engineering documentation. A sample entry might read: "The CEI, including all parts and assemblies, shall be constructed and finished in accordance with NASA-STD _____ or MIL-STD _____."

Paragraph 3.3.9, "Electromagnetic Interference" - Specify requirements related to electromagnetic interference, in terms of the environment which

the CEI must accept and the environment which it generates.

Paragraph 3.3.10, "Identification and Marking" - Specify the identification and marking requirements for the CEI. Identification and Marking includes coding requirements for wiring, plumbing, identification and hazardous conditions, etc. A sample entry might read: "All electrical wiring contained in this CEI shall be identified in accordance with NASA-STD _____ or MIL-STD _____."

NOTE: Identification requirements for purposes of configuration management will be made a contractual requirement as part of the configuration management package, using Exhibits X and XI, and will not be incorporated into the CEI specification.

Paragraph 3.3.11. "Storage" - Specify requirements peculiar to making the CEI storable. This shall include, but not be limited to, specification of maximum storage duration, storage environment, restrictions pertaining to maintenance while in storage, etc. To the extent that storage environment has been specified in paragraphs 3.1.2.8 and 3.2.1.2, it shall not be redundantly specified.

Section 4, "Quality Assurance Provisions" - Requirements shall include applicable content of "Apollo Test Requirements," NHB 8080.1; NASA Quality Publication NPC 200-3; and NASA Reliability Publication NPC 250-1. Requirements for formal verification of the performance, design, and construction of the CEI shall be specified. Formal verification of performance, design, and construction of the CEI shall determine acceptance of design and development engineering, under the terms and conditions of the design and development contract. Formal verification of performance, design, and construction of the CEI shall determine acceptance of design and development engineering, under the terms and conditions of the design and development contract. Formal verification requirements shall be specified to a level of detail which:

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- a. Specifies a verification requirement and method in Section 4 for each performance and design requirement in Section 3 of Part I. The methods of verification specified shall include inspection of the CEI, review of analytical data, demonstrations, test and review of test data.
- b. Specifies each requirement for verification, other than by inspection of the CEI to the level of detail necessary to clearly establish the scope and accuracy of the test method.
- c. Permits ready identification of each verification requirement specified in Section 4 with the appropriate performance/design requirement paragraphs in Section 3, of Part I.
- d. Allocates verification requirements to the subparagraphs.

NOTE: Formal verification to be specified shall not incorporate, either directly or by reference, detail test planning documentation and operating instructions. Requirements specified shall be the basis for preparation and validation of such documents.

Paragraph 4.1, "Phase I Test/Verification" -
The term "Phase I/Test Verification," is defined to include all test and verification of the CEI, other than that accomplished during the formal Phase II test (see Paragraph 4.2). Phase I test/verification is sub-divided into the following broad types on the basis of primary reasons for acquiring the test data:

- a. Engineering Test and Evaluation: An integral part of the development process, oriented primarily to acquire data to support the design and development process, e.g., spacecraft structural test, materials test, etc.

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- b. Preliminary Qualification Tests: Formal tests oriented primarily to achieve interim acceptance of performance and design characteristics, prior to committing the CEI to: (1) manned operation, (2) integrating testing with other equipments and/or facilities, and (3) a costly, complete formal qualification program, e.g., preliminary flight rating tests for engines, preliminary explosive classification tests for ordnance and propellants, etc.
- c. Formal Qualification Tests: Formal tests oriented primarily to satisfy specified requirements for formal demonstration of performance and design adequacy of the CEI.
- d. Reliability Tests and Analyses: Formal tests and analyses oriented primarily to satisfy specified requirements for demonstrated reliability.

NOTE: Data which is included in reliability analyses comes from many sources. "Reliability Tests," as used herein, are limited to testing which would not be accomplished except for the need for reliability data. Requirements shall be specified for recording data resulting from other than reliability tests for reliability analysis.

- e. Engineering Critical Component Qualification: Formal qualification of identified and specified components/assemblies which are contained in, and/or are a part of, a CEI. All requirements for Phase I test/verification shall be included in sub-paragraphs.

Paragraph 4.1.1, "Engineering Test and Evaluation"
(or Development Test) - Engineering tests which satisfy one or more of the following criteria:

- a. Require use of Government test facilities, e.g., verification of requirements specified in paragraph 3.1.2.4, "Environmental," other than Phase II testing.

- b. Are intended to be the only source of data to satisfy specific requirements in Section 3, e.g., static test of spacecraft structure to satisfy requirements in paragraph 3.1.1.1, "Primary Performance Characteristics," and/or paragraph 3.3.1, "General Design Features," screen room testing to satisfy requirements in paragraph 3.3.9, "Electromagnetic Interference," etc.
- c. Must be accomplished as part of an integrated test program involving other system/inventory equipment, e.g., verification of requirements in paragraph 3.2.1.2, "Detailed Interface Requirements." Routine engineering and laboratory tests accomplished in support of design and development, which do not satisfy one or more of the criteria above, shall not be specified.

NOTE: Requirements for verification included in the project or system specification, which are directly related to requirements specified herein, may be incorporated by reference to avoid redundancy.

Paragraph 4.1.2, "Preliminary Qualification Tests" - Specify only those preliminary qualification tests which require formal recognition by NASA, e.g., verification of requirements specified in paragraph 3.1.2.7, "Safety" prior to the introduction of the CEI into a Government test facility; preliminary flight rating tests on engines prior to first flight and/or start of formal qualification; etc. Preliminary qualification testing accomplished by the contractor in support of design and development which does not require recognition by NASA, other than that it is within the general terms and conditions of the contract, shall not be specified. Requirements for preliminary qualifications shall reference specific requirements in Section 3 if these tests are to be the formal basis for the verification that specific requirements of Section 3 have been satisfied.

Paragraph 4.1.3, "Formal Qualification Tests" - Specify requirements for formal qualification of the CEI to demonstrate and/or verify that each requirement established in Section 3 has been satisfied. The requirements and method of verification for each requirement specified in Section 3 shall be specified with the following exceptions:

- a. The requirement in Section 3 has been identified with, and verification that it has been satisfied, has been accomplished by, one of the tests included in paragraphs 4.1.1 and 4.1.2.
- b. The requirement in Section 3 is peculiar to paragraph 3.1.2.1, "Reliability." Verification of reliability requirements shall be treated in paragraph 4.1.4.
- c. The requirement in Section 3 is peculiar to Phase II type system testing and will be identified in paragraph 4.2.

Verification of each requirement shall be accomplished by inspection, or review of analytical data, or by demonstration, or test and review of test data, or combinations of these. This paragraph may contain a sub-paragraph for each of the principal methods of verification, and specify the requirements of Section 3 to be verified by the method.

Paragraph 4.1.4, "Reliability Tests and Analyses" - Requirement for analyses to verify requirements of paragraph 3.1.2.1 which have been satisfied, shall be specified. This shall include the sources of data, volume of data, and assumptions basic to the validity of raw data input, and analytical method. Requirements for testing which are to be accomplished specifically and solely to acquire reliability data shall be included to the level of detail necessary to establish the scope and accuracy of the reliability data to be acquired, and the scope of the test program.

Paragraph 4.1.5, "Engineering Critical Component Qualification" - Identify, for each of the engineering critical components listed in paragraph 3.2.2.2, the specification which contains its formal qualification test requirements.

Paragraph 4.2, "Phase II Integrated Test Requirements" - For CEI's which directly support a project(s) or system(s), this paragraph shall identify requirements specified in Section 3 which cannot be verified until the CEI is assembled into or used with other project or system equipment, and verification that the requirement has been satisfied must be listed as a Phase II test requirement.

Section 5, "Preparation for Delivery" - This Section is not applicable to Part I of the End Item Detail Specification. CEI requirements pertinent to the transportation and handling of the CEI, which must be incorporated in design, shall be specified in paragraph 3.1.2.5, "Transportability." CEI requirements pertinent to transportation environment and storage environment which must be incorporated in design shall be specified in paragraph 3.2.1.2, "Detailed Interface - Definition," and paragraph 3.3.11., "Storage," respectively. Requirements for preparation of the produced hardware for delivery and shipment are contained in Section 5 of Part II of the specification.

Section 6, "Notes" - This Section shall include information which is stated here for administrative convenience only, and is not a part of the specification for the CEI in the contractual sense, i.e., it shall not include requirements which constrain design, development, and qualification of the CEI and require compliance by a contractor. Information of importance to the procuring agency in using the particular specification as a contractual instrument for acquisition of the CEI, either initially, or for follow-on procurement shall be included.

Paragraph 6.1, "Supplemental Information" - Background information or rationale which will be of assistance in understanding the specification itself or using the CEI it specifies, may be included, e.g., technical data and/or manual ordering instructions.

Paragraph 6.2, "Alternate Source Qualification" - When a CEI is fabricated by an alternate source (other than the one who initially developed and qualified the CEI design) formal qualification testing of the CEI will be required to demonstrate and verify the capability of the alternate source to produce the CEI to the requirements of this specification without degradation in its performance or reliability. (See Part II, Paragraph 10.2).

Section 10, "Appendix" - Requirements specified in the Appendix are contractually a part of the specification, and to the extent they impose requirements on design, development and qualification of the CEI, they must be satisfied. This section shall include, but not be limited to requirements which are:

- a. Bound separately for convenience as in the case of a classified appendix or a large body of statistical data.
- b. Are of a temporary nature, as in the case of an interim performance requirement for early test models of the CEI. (Requirements peculiar to early test units of the CEI shall be specified in the appendix which adds to, deletes, changes, or establishes new requirements applicable to Sections 3 and 4 of Part I.) Instrumentation requirements for the test units of the CEI shall be specified only to the level of detail necessary to establish the type and total capacity, of the instrumentation. Requirements (with the exception of instrumentation) shall be specified to the level of detail required by the paragraph in Section 3 and 4 of Part I to which they are related.

6.4 Detailed Instructions for the Preparation of Contract End Item Detail Specification, Part II.

The following instructional paragraphs are numbered or otherwise identified to refer directly to the sample formats attached. The sample formats are:

Sample Format "C" - CEI Specification Part II
Title Page

Sample Format "D" - Part II of CEI Specification

"Title Page"- The title page shall conform to the format of Sample Format "C". The identifying information appearing on this page shall be identical to the respective element of information appearing on the CEI Specification Title Page for Part I.

Section 1, "Scope" - This Section of Part II of the CEI Specification shall begin with the opening paragraph shown in Sample Format "D", followed by paragraph 1.1, "Product Configuration Baseline Acceptance". Paragraph 1.1 shall begin with the statement shown in Sample Format "D".

Section 2, "Applicable Documents" - This Section of the CEI Specification shall begin with the lead phrase contained in Sample Format "D". Categorization of entries shall conform with Sample Format "D". List only those documents (specifications, standards, bulletins, manuals, etc.), which are applicable to paragraphs within the body of the Specification. Within the body of the Specification, reference to those documents shall be made by reference to their basic document number or other appropriate designation. Refer to Defense Standardization Manual 4120.3-M for further instructions on listing of applicable documents.

Section 3, "Requirements" - This Section shall specify performance, product configuration and standards of manufacture, manufacturing processes, and production which must be verified at the time and place of delivery to establish the quality of the CEI as manufactured. Each requirements to be specified must satisfy the following criteria:

- a. There shall be a direct means of testing/verifying that the requirement has been satisfied in Section 4, Part II.
- b. The test/verification which formally demonstrates that the requirement has been satisfied shall be accomplished at the place of manufacture of the CEI.
- c. The requirements must be verified at the time of acceptance to assure that manufacturing control has been maintained, and that the CEI, as fabricated, will function to satisfy the requirements of its use.

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- d. The requirement shall be specified in physically measurable terms, with tolerances.

Introductory material may be included in basic paragraph "Section 3" and requirements shall be specified in sub-paragraphs.

Paragraph 3.1, "Performance" - Specify performance requirements for the CEI which are in consonance with the criteria stated in paragraph 3, "Requirements." Performance features included herein shall be specified at environmental conditions normal to the manufacturing process and/or the place of acceptance, and not attempt to simulate the environment in which the CEI will be used. This paragraph shall specify those performance features which cannot be assumed as the natural consequence of drawing compliance. Requirements shall be specified in terms of the CEI itself, in terms of physically measurable properties, with tolerances. Performance requirements may include features which must be verified by preassembly, station, or manufacturing test/verification. Requirements for test/verifications, which shall be accomplished prior to final assembly, may be specified directly, or by reference to manufacturing and processing specifications. Requirements shall be to the level of detail necessary to establish limits for the test/verification method to be specified in Section 4, Part II. Individual requirements shall be specified in sub-paragraphs.

Paragraph 3.2, "Product Configuration"- Specify the product configuration requirements for the CEI. Include a listing of Government-furnished property incorporated in the CEI during fabrication. Specify the production drawings for fabrication of the CEI. Standards and specifications for fabrication of the CEI which define quality and construction which is to be a condition of acceptance of the CEI shall be included. Basic paragraph 3.2 may include descriptive material or material included for purposes of continuity. Requirements shall be specified in sub-paragraphs.

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Paragraph 3.2.1, "Manufacturing Drawings" - Begin with the statement shown in Sample Format "D". Specify the drawings which are the basis for control of production of the CEI. The production drawings shall be incorporated by reference to the top drawing for the CEI. The method of reference shall clearly specify that incorporation of the top drawing by reference includes all drawings and engineering data assembled by the top drawing. Drawings specified herein shall reflect all engineering changes approved for incorporation into the CEI.

NOTE: This includes changes approved by the procuring agency as well as changes released by the contractor which do not require procuring agency approval.

Drawings specified shall identify by exact part number, each item of Government-furnished property required for assembly into the CEI during the manufacturing process. The top drawing to be referenced shall be identified to the CEI by including, on the drawing, the CEI number, drawing number, CEI nomenclature, and code for the design activity (Manufacturers' Code Handbook H4-1). Other identifying data may be included. (See Exhibit X).

Paragraph 3.2.2, "Government-Furnished Property List"- Each item of Government-furnished property specified for incorporation into the CEI during the manufacturing process, by the production drawings incorporated in paragraph 3.2.1, "Production Drawings," shall be identified by nomenclature and part number,

Paragraph 3.2.3, "Standards of Manufacturing, Manufacturing Processes, and Production" - Include those standards of manufacture, manufacturing processes, and production, which, because of their significance, must be specifically identified as part of the production configuration baseline. Specify only those standards and specifications which are of such nature that any change to them shall be considered as Class I engineering

change and require prior approval of the procuring agency, e.g., standards for identification and marking or wiring and tubing, since such marking is basic to safety and to the preparation of manuals; standards for a bonding process, where a change may require a requalification of the structural integrity of the CEI; etc. To the maximum extent possible, requirements shall be incorporated by reference to established Government standards approved for NASA use. Contractor and/or industry standards must be specifically approved by the procuring agency prior to incorporation. Requirements shall be specified to the level of detail necessary to clearly establish limits for the test/verifications to be specified in Section 4, Part II. Individual requirements shall be specified in sub-paragraphs.

Section 4, "Quality Assurance" - This Section shall begin with the paragraph contained in Sample Format "D". It shall include applicable content of "Apollo Test Requirements," NHB 8080.1: NASA Quality Publications NHB 5300-4(1B) and NPC 200-3, and NASA Reliability Publication NPC 250-1. Specify only the specific test/verifications which must be accomplished to satisfy all requirements specified in Section 3 of Part II. Test/verifications to assure control of quality during the manufacturing process not specifically included shall be accomplished by routine manufacturing level surveillance as required by the local representative of the procuring agency (NASA Plant Representative, or equivalent). Each test/verification specified shall be witnessed, or the contractor record of the test/verification reviewed, at time of acceptance of each unit of the CEI, hence all tests/verifications included are identified as acceptance test verifications. Test/verifications shall be accomplished during the manufacturing process, or at time of delivery, to establish the quality of the CEI as fabricated and assembled. Each test/verification requirement shall be specified to the level of detail necessary to:

- a. Identify each test/verification with the requirement in Section 3 of Part II, which it satisfies.

- b. Establish the method for each test/verification. Methods of test/verification include inspection, demonstration, test or combinations thereof.
- c. Establish, for each method related to each test/verification, specific limits which shall represent a clear basis for decision as to the quality, and the acceptability, of the CEI.
- d. Establish the accuracy of each test/verification. Introductory material may be included in basic paragraph, Section 4. Requirements shall be specified in sub-paragraphs.

Paragraph 4.1, "Product Performance and Configuration Requirement/Quality Verification Cross Reference Index" - This index identifies each quality verification in Section 4, Part II, with the requirement in Section 3 of Part II, which it verifies. The index shall be an ordered list of the requirements in Section 3 of Part II, in the order in which they are specified and identified by the paragraph number establishing the requirement.

Paragraph 4.2, "Test/Verifications"- The test/verifications required to satisfy each requirement in Section 3 of Part II shall be specified. Each inspection, demonstration and test shall be specified to a level of detail which clearly establishes the validity and accuracy of the test/verification. The test/verification shall permit a clear, non-subjective determination of the quality of the CEI. The tests/verifications specified in sub-paragraphs shall be specified to a level of detail which satisfies the following criteria:

- a. Inspections and/or demonstrations shall be stated to quantitatively specify and define the limits for the acceptable condition. In general, verification of quality by inspection and/or demonstration in support of acceptance testing shall be limited to verification of construction features of the CEI, e.g., inspection for proper wire coding; determination of specific physical

dimensions; inspection of production records to verify installation of Government-furnished property; etc.

- b. Tests shall be specified, in quantitative terms with tolerances, to the level of detail necessary to clearly establish the test method, the credibility of the test method, the validity of the test data, and the actual measurement values.
- c. Where records generated during the manufacturing process are to be used as part of acceptance test/verification, the method of establishing the validity of the record, as well as record content shall be specified.

Paragraph 4.2.1, "Drawing Compliance" - Specify the method for verifying that the CEI, as fabricated and assembled is configured to conform to the drawings specified in paragraph 3.2.1 of Part II, and has incorporated the Government-furnished property specified in paragraph 3.2.2 of Part II. To the extent practical, this shall be accomplished by inspection at the time and place of acceptance of the CEI. The "as manufactured" configuration of the CEI's which cannot be inspected in fully assembled condition, to the level of detail necessary to fully establish configuration conformance to the drawing (complex CEI's hermetically sealed units, electronic equipment assembled into cabinets, etc.), shall be verified by reference to manufacturing records (see Exhibit XIII).

Section 5, "Preparation for Delivery" - Specify the requirements for preservation, packaging, packing, marking, and otherwise preparing the CEI for shipment. The levels of packing, are as defined in Federal Standard 102. Where approved NASA or NASA designated Military Specifications, or NASA equivalent, are adequate to satisfy current requirements for the item and components thereof, a reference should be incorporated in lieu of providing

duplicated detailed requirements. Where suitable specifications do not exist, requirements peculiar to the CEI shall be specified in sub-paragraphs.

Paragraph 5.1. "Preservation and Packaging" - The requirements for preservation and packaging shall be specified and shall include cleaning and drying as may be required and appropriate preservation method selected from Section 3 of Specification MIL-P-116, or applicable NASA Specification. Selection of proper method shall be determined by the characteristics of the item and anticipated transit and storage conditions. Include as part of the packaging requirements any appropriate wrappings, interior cushioning and unit containers. Requirements shall be specified in sub-paragraphs to include, but not be limited to:

Paragraph 5.1.1, "Cleaning" - The applicable cleaning process from paragraph 3.2 of Specification MIL-P-116 or NASA equivalent, shall be specified.

Paragraph 5.1.2, "Drying" - The drying process applicable to the CEI from paragraph 3.3 of Specification MIL-P-116, or NASA equivalent shall be specified.

Paragraph 5.1.3, "Levels of Packaging" - Specify the preservation and packaging requirements related to each of the specific storage periods defined in the following sub-paragraphs.

Paragraph 5.1.3.1, "Immediate Use" - Specify preservation and packaging requirements incident to preparing the CEI for shipment and immediate use at destination. Preservation and packaging for immediate use is defined to be the minimum needed to adequately protect the item(s) against environmental and physical hazards during handling and transit to destination for immediate use. Normally, requirements compatible with MIL-P-116 will suffice for this level unless, because of peculiar item characteristics, additional environmental protection is required.

Paragraph 5.1.3.2, "Limited Storage" - Specify preservation and packaging requirements incident to preparing the CEI for shipment as well as limited storage. Preservation and packaging requirements for this protective level shall be sufficient to provide adequate protection to the item(s) against environmental and physical hazards during handling and transit to destination and for a specified storage period.

Paragraph 5.1.3.3, "Extended Storage" - Specify preservation and packaging requirements incident to preparing the CEI for shipment as well as extended storage. Preservation and packaging requirements for extended storage shall be adequate to protect the item(s) against environmental and physical hazards during handling and transit and under adverse storage conditions for an indeterminate period.

Paragraph 5.1.3.4, "Intermediate Packaging" Requirements for intermediate packaging, in preparing the CEI for shipment and/or storage, shall be specified. Intermediate packaging shall consist of placing a quantity of identical unit packages into a consolidating or intermediate container for ultimate overpacking into an exterior shipping container.

Paragraph 5.2, "Packing" - The requirements for packing shall include specification of the appropriate exterior shipping container and the placement of a specified quantity of packages therein, and shall specify or otherwise delineate the necessary blocking, bracing, and cushioning required. In instances where the unit container serves also as the exterior shipping container, the container shall be specified under "Packaging" shall reflect the acceptable utilization of the same container to provide for two exterior requirements. Packing requirements shall be provided for two basic modes of transportation and for, as applicable, both continental United States and overseas movement. In the selection of a shipping container, consideration should be given to insuring that it is of minimum cube required and, insofar as possible,

within a 15% maximum in tare weight.

Paragraph 5.2.1, "Domestic Shipment" - The term "domestic shipment" denotes movement within the continental United States. Include the packing requirements peculiar to the mode of transport.

Paragraph 5.2.1.1, "Air" - Packing for domestic shipment by air shall be specified and shall be the minimum required to afford adequate protection against handling and transit hazards normally encountered in air shipment.

Paragraph 5.2.1.2, "Surface" - Packing for domestic shipment by surface carrier shall be specified and shall be the minimum required to afford adequate protection against handling and transit hazards encountered in rail or truck movement.

Paragraph 5.2.2, "Overseas Shipment" - The term "overseas shipment" denotes movement from a point of origin within the continental United States to a destination point outside the continental United States, or the converse, or point-to-point movement entirely outside the continental United States.

Paragraph 5.2.2.1, "Air" - Packing for overseas shipment by air shall be specified and shall provide adequate physical and environmental protection against handling and transit hazards normally encountered in shipment via military or commercial air. Domestic containers used for shipment within the continental United States will generally provide the required protection.

Paragraph 5.2.2.2, "Surface" - Packing for overseas shipment by surface carrier shall be specified and shall provide maximum protection to contents against handling, transit, and storage conditions encountered in shipment by ocean going carriers.

Paragraph 5.3, "Shipment" - Shipment information and limitations shall be specified. This shall include identification of special features necessary to protect items during movement or storage, including, but not limited to, trailers, dollies and wheeled containers that are designed to facilitate handling and installation of equipment at destination. Also, identify the specific air, ship, or ground carrier means of transportation if shipment of the end item is to be limited to particular modes of transport. Where modifications of the transporting vehicle are required, this specification shall state, "Required modifications to (vehicle model number, Federal Stock Number, and nomenclature) are to be in accordance with (number and title of specification describing the modification)." The requirements for marking shall cover complete identification of the product, both on packages and shipping containers, normally as required by MIL-STD-129 and/or any other marking requirements as directed. All precautionary marking required by ICC or CAB regulations, AFM 71-4 or necessary marking for safety purposes shall be specified either in detail or through reference to the governing documents or directives.

Section 6, "Notes" - This Section of the specification is not contractually binding. It shall include information of particular importance to the procuring agency in using Part II of this specification as a contractual instrument, or administrative or background information, e.g., ordering instructions for technical data and/or manuals pertinent to the CEI.

Section 10, "Appendix" - This Section of the specification shall include requirements which are part of Section 3 and/or 4, but are bound separately for convenience, e.g., classified material; book form drawings of the computer program for automatic checkout equipment; etc. Also include requirements established for test units of the CEI only. This includes requirements peculiar to accepting the CEI in a configuration instrumented for test.

Paragraph 10.1. "Acceptance Requirements for Units of the CEI in a Test Configuration" -
During design and development of the CEI, individual units of the CEI, in a test configuration, must be accepted by the procuring agency to recognize transfer of accountability and/or permit destruction of the unit in test, or to deliver the unit as Government-furnished property to a second contractor to permit integrated system testing. The format and general content of a Part II used for purposes of accepting units of the CEI in a test configuration shall conform to the requirements established herein for a Part II used to accept hardware for the mission. Part II's used as a basis for acceptance of units of a CEI in a test configuration shall satisfy the requirements for minimum specification content contained in paragraphs 3.2.1, 3.2.2, and 4.2.1 of Part II. Further detail content shall be as defined by the procuring agency. Instrumentation requirements shall be included. Instrumentation requirements specified shall be limited to establishing the total capability or capacity of the instrumentation to be installed, and the quality of installation, and shall not include details of calibration, channel assignments, and instruments, etc., which change frequently and hence would make maintenance of the specification unnecessarily burdensome.

Paragraph 10.2 "Alternate Source Qualification" -
When a CEI is fabricated by an alternate source (other than the one who initially developed and qualified the CEI) verification is required of the capability of the alternate source to produce the CEI to the requirements of this specification without degradation in its performance or reliability.

Such verification shall require the performance of complete qualification testing in accordance with paragraph 4.1.3 "Formal Qualification Tests". of Part I of this specification; or as otherwise specified by the procuring agency.

6.5 Detailed Instructions for the Preparation of Contract End Item Detail Specification Addenda

Frequently, a requirement develops for a CEI which is very similar to an existing CEI. When this occurs, it is desirable to create the new CEI by accomplishing minimum redesign of the existing CEI. To accomplish this, it is necessary to maintain visibility throughout the design and development cycle of differences in performance, design and configuration requirements between the two CEI's. This visibility is acquired and maintained by creating the specification for the new CEI as an addendum to the specification for the existing CEI.

The use of a specification addendum presents a formal means of writing a specification for a new CEI by changing the specification for an existing CEI in a manner which permits ready comparison of the exact relationship between two items of equipments. This is accomplished by writing the new specification by direct reference to the existing specification on a paragraph-by-paragraph basis, recording in the new specification and noting each addition, deletion, change, or where no change is necessary, the words "no change". The paragraph numbering between the two documents will be identical, with the exception of paragraphs added to the new document which do not have an exact counterpart in the existing specification.

A specification created in this manner is a new and complete specification in every sense. The method of preparing a specification for a new CEI by creating an addendum to an existing specification shall be used when the following considerations are satisfied:

- a. There is sufficient reason to establish direct relationship between the new CEI and an existing CEI as a basis for design and development, e.g., progressing from one type, model, series of a CEI to another; minor changes must be accomplished to a very limited number of units of a CEI for a specific mission, as is the case with space boosters.

- b. The basic specification, to which the addendum is prepared, complies with the requirements of this exhibit, with respect to format and content.

The specification created by use of an addendum must be identified and maintained as a separate specification. Both the specification created by use of an addendum, and the basic specification to which the addendum is prepared shall have independent change cycles. A specification change notice to either is not automatically a change to both. Each change to either must be reviewed, and if it is desirable to change both the basic specification and the specification prepared as an addendum, two separate specification change notices must be prepared.

When a new specification is created by the preparation of an addendum to an existing specification, an "Addendum Notice" shall be prepared which conforms to the format and includes the content required by sample format "E". The "Addendum Notice" shall be the first entry in Section 2, "Applicable Documents." All of the data in the "Addendum Notice" refer to the specification used as the basic document for preparation of the addenda. Each item of data to be entered shall be transcribed from the title page and specification change log of the basic specification.

Note: For filing and distribution an Addendum Specification must always be accompanied by the specification to which it relates. See Sample Format "E".

SAMPLE FORMAT "A"

Specification No. _____

Revision No. _____

Release Date _____

Page I-1

CONTRACT END ITEM DETAIL SPECIFICATION
(Prime Equipment)

PART I

PERFORMANCE AND DESIGN
REQUIREMENTS

(CEI Number)

(APPROVED NOMENCLATURE)
FOR
(PROJECT OR SYSTEM NAME)

Approved by _____
(Preparing Activity)

Approved by _____
(NASA Office)

Date _____

Approval Date _____

Contract Number _____

SAMPLE FORMAT "B"

Specification No. _____

Release Date _____

Page I-2

1. SCOPE

This part of this specification establishes the requirements for performance, design, test and qualification of one type-model-series of equipment identified as (insert nomenclature and contract end item number). This CEI is used to (provide) (accomplish) . . . This CEI requires . . .

2. APPLICABLE DOCUMENTS

The following documents, of exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and other detail content of Section 3, 4, 5, and 10, the detail requirements of Sections 3, 4, 5, and 10 shall be considered a superseding requirement.

PROJECT AND SYSTEM DOCUMENTSSPECIFICATIONS

Federal
Military
Contractor

STANDARDS

Federal
Military
Contractor

DRAWINGSBULLETINSOTHER PUBLICATIONS

Manuals
Regulations
Handbooks
Etc.

(Copies of specifications, standards, drawings, bulletins, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

SAMPLE FORMAT "B"

Specification No. _____
Release Date _____
Page I-3

3. REQUIREMENTS

3.1 Performance

3.1.1 Performance

3.1.1.1 Primary Performance Characteristics

3.1.1.2 Secondary Performance Characteristics

3.1.2 Operability

3.1.2.1 Reliability

3.1.2.2 Maintainability

3.1.2.3 Useful Life

3.1.2.4 Natural Environment

3.1.2.5 Transportability

3.1.2.6 Human Performance

3.1.2.7 Safety

3.1.2.8 Induced Environment

3.2 CEI Definition

3.2.1 Interface Requirements

3.2.1.1 Schematic Arrangement

3.2.1.2 Detailed Interface Definition

SAMPLE FORMAT "B"

Specification No. _____
Release Date _____
Page I-4

- 3.2.2 Component Identification
 - 3.2.2.1 Government-Furnished Property List
 - 3.2.2.2 Engineering Critical Components List
 - 3.2.2.3 Logistics Critical Components List
- 3.2.3 Technical Manuals
- 3.3 Design and Construction
 - 3.3.1 General Design Features
 - 3.3.2 Selection of Specifications and Standards
 - 3.3.3 Materials Parts and Processes
 - 3.3.4 Standard and Commerical Parts
 - 3.3.5 Moisture and Fungus Resistance
 - 3.3.6 Corrosion of Metal parts
 - 3.3.7 Interchangeability and Replaceability
 - 3.3.8 Workmanship
 - 3.3.9 Electromagnetic Interference
 - 3.3.10 Identification and Marking
 - 3.3.11 Storage

4. QUALITY ASSURANCE PROVISIONS

- 4.1 Phase I, Test/Verification
 - 4.1.1 Engineering Test and Evaluation (or Development Test)
 - 4.1.2 Preliminary Qualification Tests
 - 4.1.3 Formal Qualification Tests
 - 4.1.4 Reliability Tests and Analyses
 - 4.1.5 Engineering Critical Component Qualification
- 4.2 Phase II, Integrated Test Requirement

SAMPLE FORMAT "B"

Specification No. _____
Release Date _____
Page I-5

- 5. PREPARATION FOR DELIVERY
- 6. NOTES
 - 6.1 Supplemental Information
 - 6.2 Alternate Source Qualification
- 10. APPENDIX

SAMPLE FORMAT "C"

Specification No. _____

Revision No. _____

Release Date _____

Page II-1

CONTRACT END ITEM DETAIL SPECIFICATION
(PRIME EQUIPMENT)

PART II

PRODUCT CONFIGURATION AND ACCEPTANCE TEST
REQUIREMENTS

(CEI Number)

(APPROVED NOMENCLATURE)

Approved by: _____
(Preparing Activity)

Approved by: _____
(NASA Office)

Date _____

Approval Date: _____

Contract Number: _____

SAMPLE FORMAT "D"

Specification No. _____

Release Date _____

Page II-2

1. SCOPE

This part of this specification establishes the requirements for complete identification and acceptance of all units of (insert contract end item number and nomenclature) to be formally accepted by the National Aeronautics and Space Administration.

1.1 Product Configuration Baseline Acceptance

The product configuration baseline shall be established by FACI of serial number (insert CEI serial number). This unit and all subsequent units, regardless of intended use, shall be accepted to the configuration defined by serial number (insert same serial number) unless changes thereto have been formally approved by the procuring agency.

2. APPLICABLE DOCUMENTS

The following documents of exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and other detail content of Sections 3,4,5, and 10, the detail content of Section 3, 4, 5, and 10 shall be considered a superseding requirement.

SPECIFICATIONS

Federal
Military
Contractor

STANDARDS

Federal
Military
Contractor

DRAWINGSBULLETINS

SAMPLE FORMAT "D"

Specification No. _____
Release Date _____
Page II-3

OTHER PUBLICATIONS

- Manuals
- Regulations
- Handbooks
- Etc.

(Copies of specifications, standards, drawings, bulletins, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

SECTION 3. REQUIREMENTS

3.1 Performance

3.2 Product Configuration

3.2.1 Manufacturing Drawings

The configuration of this contract end item shall be in accordance with (contractor's top drawing number), and drawings and engineering data assembled thereunder.

3.2.2 Government Furnished Property List

3.2.3 Standards of Manufacturing, Manufacturing Processes and Production

3

SECTION 4. QUALITY ASSURANCE

The contractor responsible for the manufacture of this CEI is responsible for accomplishment of each test/verification required herein.

4.1 Product Performance and Configuration Requirements/Quality Verification Cross Reference Index

4.2. Test Verifications

4.2.1 Drawing Compliance

4.2.2

4.2.3

Specification No. _____

Release Date _____

Page II-4

4.2.4.....

Etc.

SECTION 5, PREPARATION FOR DELIVERY

5.1 Preservation and Packaging

5.1.1 Cleaning

5.1.2 Drying

5.1.3 Levels of Packaging

5.1.3.1 Immediate Use

5.1.3.2 Limited Storage

5.1.3.3 Extended Storage

5.1.3.4 Intermediate Packaging

5.2 Packing

5.2.1 Domestic Shipment

5.2.1.1 Air

5.2.1.2 Surface

5.2.2 Overseas Shipment

5.2.2.1 Air

5.2.2.2 Surface

5.3 Shipment

SECTION 6. NOTES

SECTION 10. APPENDIX

10.1 Acceptance Requirements for Units of the CEI in a Test Configuration

10.2 Alternate Source Qualification

SAMPLE FORMAT "E"

- - - A D D E N D U M N O T I C E - - -

This Specification has been prepared as an Addendum to:

Specification No. _____

Revision _____

Release Date _____

CEI No. _____

FOR

(Approved Nomenclature)

Used With

(PROJECT OR SYSTEM NAME) (PROGRAM)

This (Addendum) Specification must always be accompanied by the Specification (above) to which it relates.

The exact content of Specification (insert same number as above) used as the basic document for this addendum is the revision referenced above plus the following Specification Change Notices to Specification (insert same number as above).

EXHIBIT III

PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(FACILITY)

EXHIBIT III
PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(FACILITY)

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3. APPLICABILITY.III-1
4. REFERENCE DOCUMENTS.III-1
5. EXPLANATION OF TERMSIII-1
6. PROCEDURAL REQUIREMENTS.III-2

FORMATS AND ILLUSTRATIONS

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PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(FACILITY)

1. PURPOSE

This Exhibit provides NASA Apollo organizations and their contractors with requirements and guidance for the preparation of the detailed specification for each facility contract end item.

2. SCOPE

These instructions are applicable to the specification for facility end items categorized as independent facilities. The instructions define the content and format for each of two parts of the Facility Contract End Item Detail Specification, (FCEI Specification.)

Part I - Facility Criteria

Part I of the FCEI Specification is used to specify requirements peculiar to the design, development and qualification of the Facility Contract End Item.

Part II - Facility Construction Contract Plans and Specifications

Part II of the FCEI Specification is used to specify exact configuration information peculiar to the contracting, construction and testing/quality control of the Facility Contract End Item.

3. APPLICABILITY

A Facility Contract End Item Detail Specification shall be prepared for each facility designated as an independent contract item. Instructions for the preparation of specifications for Direct Support-Real Property Installed Equipment (DS-RPIE) are included in Exhibit II.

4. REFERENCE DOCUMENTS

NPC-325-1

"Design Criteria and Construction Standards"

5. EXPLANATION OF TERMS

See Exhibit XVII.

6. PROCEDURAL REQUIREMENTS

6.1 The Contract End Item Detail Specification (Facility)

The FCEI Specification is composed of two parts, each of which has distinct and different uses in FCEI acquisition. Each of the two parts, when drafted to comply with these instructions, is complete in content and format with respect to its intended use. The FCEI Specification is controlled and accounted as an entity, using a single Configuration Chart and a single Specification Change Log, Exhibit VII. Part I, Facility Criteria, is a product of a Program Definition Phase or requirements analysis, and is the engineering instrument used to contract for design and development of the FCEI. Compliance with Part I is determined by evaluation of quality, content, and completeness of the facility criteria document. Part II of the FCEI Specification, the construction bid package (contract, plans and specification), is a product of the design (and development, if applicable) contract. Part II specifies the FCEI in terms of the detailed configuration requirements of the facility suitable for contracting actual facility construction. The integrity of Part II must be established prior to its acceptance and/or subsequent issuance by the procuring agency. Acceptance and issuance of Part II is dependent upon the accuracy with which it specifies detail configuration requirements of the FCEI, and the adequacy of quality of each individual unit of the FCEI to be produced/procured. The integrity of Part II is established by audit. The audit is accomplished by cross-comparison of the data specified in Part II, with the facility criteria, standard construction practices, and adherence to governing exhibits, regulations, and codes. Part II is thus established as the valid engineering instrument to be implemented contractually for direct control of FCEI acquisition. Compliance with the terms of Part II (bid package) is determined by normal construction control procedures of the construction agency. The title page for the FCEI Specification shall conform to the following instructions referenced directly to sample format "A":

- a. "Specification Number" - A unique identifier, within system, to this FCEI. (See Exhibit X.)
- b. "Revision Number" - Sequentially assigned character(s) to uniquely identify each revision of the specification.
- c. "Release Date" - Date formally released by the procuring agency.
- d. "CEI" - Contract End Item Number. (See Exhibit X.)
- e. "Approved Nomenclature" - In accordance with standard practice.
- f. "System Identification" - List the system or systems which the FCEI is designed to support.

- g. "Approval Block" - The preparing agency and NASA office with engineering responsibility for the FCEI shall validate the specification.

6.2 Preparation of Facility Contract End Item Detail Specification, Part I, Facility Criteria

The following instructional paragraphs provide specific direction for the preparation of facility criteria documents. General deviations from the requirements of this exhibit require prior approval of the procuring agency or program office as appropriate. Facility criteria, which deviate from the general requirements of this exhibit, must cite, in an appendix, the instrument authorizing the deviation. The design requirements facility contract end item shall be specified in a facility criteria document. In recognition of the scope and nature of criteria required for given facilities, the following guide shall be used:

- 6.2.1 Facility Categories. There are two general categories of facilities which support systems. The first is one which is functionally integrated with facility equipment. The second is the type of facility which is used with the system, but is functionally independent of the system. An integrated facility is one which satisfies one or more of the following criteria:

- a. Basic structural and architectural features are designed specifically to accommodate the requirements unique to the system.
- b. The facility services form one or more complex interfaces with the system.

NOTE: As used herein, routine power, water, air or steam service connections are not considered "complex" interfaces.

- c. The total system, including facility, forms a self-contained, independent entity capable of operation without outside supply or services for a specified period of time.

A detailed and complete criteria document shall be accomplished for each facility categorized as an integrated facility. For all other system facilities, the criteria document shall be limited to specification of physical design constraints necessary to support general system requirements.

- 6.2.2 Preparation of the Criteria Document. Part I of the FCEI Specification shall be prepared to comply with the following instructions:

- 6.2.2.1 Section 1, "Scope". Begin as follows:
 "This part of this specification establishes the requirements and basic restraints/

constraints imposed upon the development of a design for (insert nomenclature) facility in support of (insert system nomenclature)." Subsequent sentence/ paragraphs shall briefly describe the intended purpose and general use of the facility with respect to the system to which it is related.

- 6.2.2.2 Section 2, "Applicable Documents". Begin as follows: "The following documents, of the exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced, and other detailed contents of this specification, the detailed requirements herein shall be considered superseding." List within this section those documents which are applicable to paragraphs within the body of the specification. Within the specification, reference to these documents shall be made by reference to their basic document number or other definitive designation.
- 6.2.2.3 Section 3, "Requirements". This section shall contain performance and design requirements for the facility. Include the functional requirements for the facility, and establish requirements which are measures of the efficiency/effectiveness of the facility. Define the facility, identify critical interfaces, and specify design constraints and standards necessary to assure compatibility with existing or contemplated hardware. For integrated facilities, performance and design requirements are allocated from, identical with, or in recognition of requirements established by the program specification. Requirements shall be specified in terms of the facility itself and not be referenced to equipment with which the facility must be compatible. The following represents an outline of specific information required in the FCEI Specification; however, it is not to be construed as preventing the addition of such information as may be required to properly identify the peculiar system facility requirements.
- 6.2.2.4 Section 3.1, "General Concept". Describe in detail the use to which the facility will be put; describe the flow of personnel, material, and functions to be performed in the facility, including time elements, etc.; identify the maintenance and logistic

policies to be employed; establish design-useful life requirements; establish facility self-sufficiency requirements and special facility survival requirements.

6.2.2.5 Section 3.2, "Siting and Layout".

- a. Provide an area plan showing location of facility with respect to general area.
- b. Provide a detailed site plan showing:
 - (1) Access requirements, special width requirements.
 - (2) Required relationships between outside elements.
 - (3) Clearances.
 - (4) Parking, loading, required setbacks, paving, etc.
- c. Provide a floor-plan layout of the required facility showing:
 - (1) Dimensional requirements.
 - (2) Height requirements (cross section).
 - (3) Doors, widths of entrances.
 - (4) Clear space requirements (no column intrusion allowed).
 - (5) Locate special electrical or mechanical provisions.
 - (6) Blockouts, elevations, anchor bolts, or other provisions for equipment.

6.2.2.6 Section 3.3, "General Criteria".

- a. Civil
 - (1) Axle or wheel loads on roads
 - (2) Special lane width of roads.
 - (3) Turn and weight provisions for special vehicles.
 - (4) Jack loads, transfer requirements.
 - (5) Parking (number of vehicles).

EXHIBIT III

- (6) Grades on roads.
- (7) Special water and sewage requirements. Quantity and nature of water and sewage, if special.
- (8) Special fire protection requirements (exterior).
- (9) Fencing and security.
- (10) Location and types of existing utilities, if any (water, gas, sewer, electrical, storm drainage).

b. Architectural

- (1) Personnel occupancy, types, hours per day.
- (2) Designation of use of areas within facility.
- (3) Types of special doors required.
- (4) Floor level requirements. Floor drainage.
- (5) Window requirements, if any.
- (6) Controlling dimension requirements.
- (7) Clear ceiling heights.
- (8) Exterior architectural treatment (concrete, masonry, brick, etc.). Indicate whether treatment is to match existing, if applicable.
- (9) Explosive safety requirements for construction.

c. Structural

- (1) Crane and hoist location and loads. Control requirements.
- (2) Floor and roof loads. Special loads. Seismic loads, wind loads, clear interior heights.
- (3) Clear span and column-free areas.
- (4) Blast loads, shielding requirements.
- (5) Personnel ladders, elevators.
- (6) Transfer piers, dock loads.

EXHIBIT III

- (7) General configuration of building, number of stories.
- (8) Barricades and shielding for explosive blast areas.

d. Mechanical

- (1) Interior potable water.
- (2) Environment limits. Temperature, humidity, ventilation.
- (3) Compressed air.
- (4) Fire protection.
- (5) Vibration and acoustical requirements.
- (6) Equipment cooling requirements.

e. Electrical

- (1) Power requirements - type and magnitude.
- (2) Light intensities.
- (3) Communications requirements.
- (4) Grounding

f. Equipment (provide layout and list each piece of equipment)

- (1) Equipment name.
- (2) Units required. (number)
- (3) Purpose of equipment.
- (4) Size of equipment (governing dimensions, weight).
- (5) Power requirements - heat gain, BTUs per hour, type cooling, in-out temperatures, relative humidities.
- (6) Minimum access requirements - front, back, sides.

6.2.2.7 Section 4, "Quality Assurance Provisions". This section shall identify special testing, quality control procedures, and/or performance verification requirements necessary to assure the adequacy of special or unique facility provisions. Standard facility verification requirements shall not be included herein.

6.3 Preparation of Facility Contract End Item Detail
Specification, Part II, Facility Construction Contract
Plans and Specifications

This part of the FCEI Specification shall be based on Part I of this specification. Content, and scope of this portion of the specification, as well as the actual facility acquisition procedures and requirements, are prepared by architectural/engineering activities, and their type and format are not prescribed by this publication.

SAMPLE FORMAT "A"

Specification No. _____

Revision No. _____

Release Date _____

CONTRACT END ITEM DETAIL SPECIFICATION

(FACILITY)

CRITERIA

AND

DESIGN

(CEI PROJECT NUMBER)

(APPROVED NOMENCLATURE)

FOR

(SYSTEM NAME) (SYSTEM)

Approved By _____
(Preparing Activity)

Approved By _____
(Apollo Program
Office or
equivalent)

Date _____

Date _____

EXHIBIT IV

PREPARATION OF CONTRACT END ITEM
DETAIL SPECIFICATION
(IDENTIFICATION ITEM)

EXHIBIT IV

PREPARATION OF CONTRACT END ITEM
DETAIL SPECIFICATION
(IDENTIFICATION ITEM)

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PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(IDENTIFICATION ITEM)

1. PURPOSE

This Exhibit provides NASA Apollo organizations and contractors with requirements and guidance for the preparation of a contract end item (CEI) detail specification for an item of equipment categorized as an "Identification Item".

2. SCOPE

These instructions define the content and format for a CEI specification for a contract end item categorized as an "Identification Item".

3. APPLICABILITY

An "Identification Item" is one which satisfies the following criteria:

- a. It can be qualified by inspection and/or simple demonstration.
- b. Once in manufacturing, quality control at manufacturing level can be the basis for verification of quality, and acceptance can be based on verification that the item, as fabricated and assembled, conforms to the drawings. Acceptance testing to verify performance will not be specified.
- c. Because of its use, relationship to other end items, and simplicity of function and design, few, if any, design changes are anticipated once the product configuration baseline for the item is established.

4. REFERENCE DOCUMENTS

DSM 4120.3-M	1 April 1966	"Standardization Policies, Procedures and Instructions"
NHB 5300-4(1B)	April 1969	"Quality Provisions for Aeronautical and Space System Contractors"
NHB 8080.1	May 1964	"Apollo Test Requirements"
NPC 200-3	April 1962	"Inspection Systems Provisions for Suppliers of Space Materials, Parts, Components and Services"
NPC 250-1	30 July 1963	"Reliability Program Provisions for Space System Contractors"

5. EXPLANATION OF TERMS

See Exhibit XVII.

6. PROCEDURAL REQUIREMENTS

Examples of end items specified in this type of specification are handling equipment, special tools, adapters, brackets, mounting fixtures, dollies, work stands, reuseable containers, off-the-shelf commercial items with minor contractor modifications, etc.

NOTE: A number of closely related items may be assembled and controlled as piece-parts under a single drawing and part number as a kit, if they are related functionally, and will be allocated as a unit for initially equipping the using agency. Under these circumstances, the "kit" requires only a single identification specification.

The format of this specification is based on the premise that the requirements specification is a brief, concise document, and that few changes will be required; hence, it is more economical to reissue the complete specification with a specification change log that permits changes to individual parts of the document on an "add" and "delete" basis and permits use of the configuration chart as the only means of recording changes to the specification. (See Exhibit VII for specification maintenance instructions.) All CEI specifications are prepared in two distinct parts: Part I specifies performance/design and qualification requirements. Part II specifies product configuration, quality assurance and preparation for delivery requirements. For a detailed definition of the nature and use of each of the two parts of a CEI specification, see Exhibit II, paragraph 6. The following instructional paragraphs are numbered or otherwise identified to refer directly to sample format "A".

Specification Title Data

The title of the specification shall be "Contract End Item Detail Specification (Identification Item) Performance/Design/Product Configuration Requirements" and shall include the following:

"Approved Nomenclature"

"Project/System Name"

List the project(s) or systems(s) which the CEI is designed to support. For CEI's which cannot be identified with a project(s) or systems(s), e.g., equipment storage cabinets, enter the phrase "Not Project(s) or System(s) Equipment".

Specification Identification and Authentication Data

Specification identification and authentication data shall include the following:

"Specification Number"	An identifier, unique, within a project or system, to this CEI. (See Exhibit X.)
"Revision"	Sequentially assigned character(s) to uniquely identify each revision of the specification number and revision identification which may be composed of alphabetic and/or numeric characters, or both. (See Exhibit X.)
"Release Date"	Date formally released by the preparing activity.
"CEI Number"	Contract End Item Number. (See Exhibit X.)
"Approval Block"	The preparing activity (contractor or Government organization preparing the specification) shall formally approve the specification. The procuring agency (Apollo Project Office or equivalent) shall formally approve the specification.

6.1 Instructions for the Preparation of Part I, "Performance/Design and Qualification Requirements"

The following instructions are applicable to the preparation of Part I of the specification:

- 6.1.1 Section 1, "Scope" This section of the specification shall begin with opening sentence/paragraph as shown in sample format "A". A subsequent sentence/paragraph, as indicated by sample format "A", shall briefly describe the intended general use of the CEI.
- 6.1.2 Section 2, "Applicable Documents" This section of the CEI specification shall begin with the opening sentence/paragraph contained in sample format "A". List those documents (specifications, standards, drawings, bulletins, manuals, etc.) which are applicable to paragraphs within the body of this part of the specification (Sections 3 and 4 of Part I). Within the body of the specification, reference to these documents shall be made by reference to their basic document number or other definitive designation. Refer to Defense Standardization Manual 4120.3-M for further instructions on listing of applicable documents.

- 6.1.3 Section 3, "Requirements" Performance/design requirements shall be specified to the level of detail necessary to establish the use of the CEI in support of other projects, systems or equipment and facilities, and to establish that the requirement is unique and cannot be satisfied from existing NASA inventory. Requirements shall be specified quantitatively in terms of measurable physical properties with tolerances. Government furnished property to be incorporated in the design of the CEI shall also be specified. For CEI's which support projects or systems, incorporate either directly or by reference the engineering product of analysis record generated as a product of analysis.
- 6.1.4 Section 4, "Quality Assurance" This section shall include applicable content of "Apollo Test Requirements", NHB 8080.1; NASA Quality Assurance Publication NHB 5300.4(1B) and NPC 200-3; and NASA Reliability Publication NPC 250-1. Specify the demonstrations/verifications necessary to establish that the item, as designed and developed, satisfies each requirement established in Section 3 of Part I. Accomplishment of the verifications shall constitute qualification of the CEI. For identification items, qualification is limited to inspection and simple demonstrations. Requirements shall be specified to the level of detail necessary to clearly establish the validity and accuracy of the verification method.
- 6.1.5 Section 5, "Preparation for Delivery" This section is not applicable to Part I of a CEI specification. See Exhibit II, paragraph 6.
- 6.2 Instructions for the Preparation of Part II "Product Configuration and Qualification Assurance Requirements"
- The following instructions are applicable to the preparation of Part II of the specification. (See Sample Format "B".)
- 6.2.1 Section 1, "Scope" Begin with the opening sentence/paragraph contained in sample format "B". Descriptive material identifying the relationship of this CEI to other projects of systems equipment may be included.
- 6.2.2 Section 2, "Applicable Documents" Begin with the opening sentence/paragraph contained in sample format "B". The general instructions for Section 2 of Part I are applicable, with the exception that this section references only documents which are applicable to Sections 3, 4, and 5 of Part II.
- 6.2.3 Section 3, "Requirements" Begin with the opening sentence/paragraph contained in sample format "B".

Normally, for identification items, this section should be limited to a requirement to comply with the drawing. Standards of manufacture, manufacturing processes and production which must be verified at time and place of delivery to establish the quality of the CEI, shall be specified. All requirements shall be specified at environmental conditions normal to the place of acceptance, and shall not attempt to simulate the environment in which the CEI shall be used. Requirements shall be specified in physically measureable quantitative terms, with tolerances, in terms of the CEI itself, and without direct reference to equipments or facilities with which the CEI must be compatible. Requirements shall be specified to the level of detail necessary to establish limits for the verifications to be specified in Section 4 of Part II.

- 6.2.4 Section 4, "Quality Assurance" This section shall include applicable content of "Apollo Test Requirements", NHB-8080.1; NASA Quality Assurance Publication NHB 5300.4(1B) and NPC 200-3; and NASA Reliability Publication NPC 250-1. The method of confirming that the CEI, as fabricated and assembled, complies with the production drawings and the verification/demonstrations necessary to assure that the CEI, as manufactured and assembled, satisfies the requirements of Section 3 of Part II shall be specified. Each demonstration/verification shall be specified to the level of detail necessary to establish the validity and accuracy of the verification method, and present a clear, nonsubjective determination of the quality of the CEI.
- 6.2.5 Section 5, "Preparation for Delivery" This section shall specify requirements for preservation, packaging, packing, and marking or otherwise preparing the CEI for shipment. To the extent practical this shall be accomplished by referencing established standards. Where established standards are inadequate, see Exhibit II, Part II, paragraph "Section 5, Preparation for Delivery".
- 6.2.6 Section 6, "Notes" This section of the specification shall include information of particular importance to the procuring agency, i.e., ordering information for technical data.
- 6.2.7 Section 10, "Appendix" This section of the CEI specification shall include requirements of limited applicability, such acceptance of the CEI in an instrumented configuration. See Exhibit II, Part II, paragraph "Section 10, Appendix".

SAMPLE FORMAT "A"

CONTRACT END ITEM DETAILED SPECIFICATION
(IDENTIFICATION ITEM)
PERFORMANCE/DESIGN/PRODUCT CONFIGURATION REQUIREMENTS
(APPROVED NOMENCLATURE)
for

Project or System Name Project or System

Spec. No. _____

Revision _____

Release Date _____

CEI No. _____

Approved (Preparing Agency) _____

Contract Number _____

Approved (Procuring Agency) _____

Part I "Performance/Design and Qualification Requirements"

1. Scope

This part of this specification establishes performance/design requirements for one type-model-series of an equipment identified as (insert nomenclature _____). This contract end item (provides) _____ (accomplishes) _____.

2. Applicable Documents

The following documents of exact issue shown form a part of this part of this specification to the extent specified herein.

3. Requirements

4. Quality Assurance

SAMPLE FORMAT "B"

Part II, "Product Configuration and Quality Assurance Requirements"

1. Scope

This part of this specification establishes the product configuration requirements for one type-model-series of equipment identified as (insert nomenclature)_____.

2. Applicable Documents

The following documents of exact issue shown form a part of this specification to the extent specified herein.

3. Requirements

The configuration of this contract end item shall be in accordance with contractor's top drawing number and drawing and engineering data assembled thereunder.

4. Quality Assurance

5. Preparation for Delivery

6. Notes

10. Appendix

10.1 Acceptance of CEI in an Instrumented Configuration.

EXHIBIT V

PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(REQUIREMENT ITEMS)

EXHIBIT V

PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(REQUIREMENT ITEMS)

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PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(REQUIREMENT ITEMS)

1. PURPOSE

This Exhibit provides NASA Apollo organizations and contractors with requirements and guidance for the preparation of a Contract End Item (CEI) detail specification for items of equipment categorized as "Requirement Items."

2. SCOPE

These instructions define the content and format for the CEI specification for contract end items categorized as "Requirement Items."

3. APPLICABILITY

A "Requirement Item" is one which satisfies the following criteria:

- a. It has been developed.
- b. It is an item which is Government Furnished Equipment (GFE).
- c. It is necessary to support an item or items being developed, either to be used with, or to be assembled into, the item(s) being developed.

4. REFERENCE DOCUMENTS

The following documents are to be considered as reference material for the purpose of interpreting the requirements of this exhibit but do not form a part of this exhibit:

EXHIBIT V

AFM 67-1 (or NASA equivalent)		"USAF Supply Manual, Volume I, Part II, Chapter II."
DSM 4120.3-M	1 April 1966	"Standardization Policies, Procedures and Instructions"
H-2-1		"Cataloguing Handbook, Federal Supply Classification, Part I, Groups and Classes."
NHB 5300-4 (1B)	April 1969	"Quality Provisions for Aeronautical and Space System Contractors"
NHB 8080.1	May 1964	"Apollo Test Requirements"
NPC 200-3	April 1962	"Inspection Systems Provisions for Suppliers of Space Materials, Parts, Components and Services."
NPC 250-1	30 July 1963	"Reliability Program Provisions for Space System Contractors"

5. EXPLANATION OF TERMS

See Exhibit XVII

6. PROCEDURAL REQUIREMENTS

The requirements specification is a single document which specifies the items of equipment existing in inventory (see paragraph 3b) necessary to support or to be installed in the contract end items being designed/developed by a single contractor.

NOTE: Contract end items in development which must, during the progress of development, be transferred among contractors, are not to be classified as "in inventory" or carried in a requirement specification.

One requirements specification shall be prepared by each contractor responsible for development of contract end items, and shall include all inventory items necessary to support the end items in development.

6.1 Instructions for Preparation of a Requirements Specification

The format for the requirements specification title page shall be in accordance with Sample Format "A". The following instructional paragraphs are numbered or otherwise identified to refer directly to Sample Format "B":

- 6.1.1 Section 1 "Scope" Begin with the opening sentence/paragraph as shown in sample format "B". A brief, descriptive entry shall be included which establishes the relationship of the required item(s) to the contract end item(s) and the project or system with which they will be used. A sample entry might read: ". . . support the guidance system of the spacecraft."
- 6.1.2 Section 2 "Applicable Documents" Begin with the opening sentence/paragraph as shown in sample format "B". Due to the nature and use of this specification, reference to individual specifications and documents cited in the body of the specification, peculiar to individual items of equipment, shall not be redundantly included.
- 6.1.3 Section 3 "Requirements" Begin with the opening sentence/paragraph as shown in sample format "B". Each subparagraph shall identify one requirement item which is specified in detail in an individual appendix to this specification. Each subparagraph shall include the following:
 - a. Subparagraph number. (Used as the basic reference to each single appendix.)
 - b. Federal Stock Class Code. (Refer to H-2-1 Cataloguing Handbook Federal Supply Classification, Part I-Groups and Classes: and AFM 67-1, USAF Supply Manual, Volume I-Part II-Chapter II; or NASA equivalent.)
 - c. Part number.

- d. Nomenclature.
- e. Number of the contract end item into which the requirement item installs.

NOTE: For those items which are used "as delivered" from the inventory as an end item, and which are not installed in other project or system/equipment, enter the words "Not Applicable."

For ease in specification maintenance, no particular sequence, other than subparagraph number, shall be established for entries in Section 3. Items shall be added to the end of the list at the time it is determined that the item shall be supplied from inventory. If an item is cancelled, the paragraph number shall not be used to reidentify a new item. The word "cancelled" and the date of cancellation shall be typed in the "paragraph" column in lieu of the paragraph number for the cancelled item, and the respective appendix removed from the specification. Instructions for the preparation and content of the appendices are included herein. The Federal stock class code, where applicable, and the nomenclature for a cancelled item, shall be printed in their respective columns. Three months after cancellation, the Federal stock class code and nomenclature data for a cancelled item may be removed from the specification; however, the particular paragraph number of a cancelled item shall not be reused to reidentify another item, and the word "cancelled" and the date of cancellation shall continue to be printed in the "paragraph" column in all succeeding revisions to the specification.

- 6.1.4 Section 4 "Quality Assurance" Include applicable content of "Apollo Test Requirements", NHB 8080.1; NASA Quality Publications NHB 5300.4(1B) and NPC 200-3; and NASA Reliability Publication NPC 250-1. Quality assurance requirements for items of equipment shall include necessary requalification to a new use, environment, or uprated performance requirement. Requirements for requalification shall be specified for each item in the individual appendix specifying the item. Quality assurance requirements shall include receiving "bench checks" of the requirement item to be accomplished by the contractor preparing the requirement specification. If these "bench checks" are complex, they require close coordination with the manufacturer of the item.
- 6.1.5 Section 5 "Preparation for Delivery" Requirements basic to preparing each item specified herein for delivery shall be included in the respective appendix which specifies the item.
- 6.1.6 Section 6 "Notes" Administrative information of importance to the procuring agency in the use of this

specification may be included herein, e.g., identification of manufacturer of individual items specified which are complex and will require the coordinated effort of the original manufacturer and the contractor preparing the requirement specification to develop valid receiving tests or verifications for the item.

- 6.1.7 Section 10 "Appendix" The requirement specification shall include an individual appendix for each requirement item. Each appendix shall conform to the format illustrated in sample format "B" and comply with the following instructions which are numbered or otherwise identified to refer directly to sample format "B".
- 6.1.7.1 "Appendix" Enter the subparagraph number of the paragraph in Section 3 which identifies the item.
- 6.1.7.2 "Federal Stock Class Code" Enter the Federal stock class code included in the respective subparagraph of Section 3.
- 6.1.7.3 Section 1 "Scope" Include the opening sentence/paragraph shown in sample format "B". Subsequent information of a general or descriptive nature may be included.
- 6.1.7.4 Section 2 "Applicable Documents" The reference to the document used as a basis for identifying the particular inventory item specified in this appendix shall be included e.g., technical information file, government specification, manufacturers' specification, technical manual, etc.
- 6.1.7.5 Section 3 "Requirements" Specify the performance/design requirements which the item must satisfy. Requirements shall be limited to those necessary to establish project or system compatibility, and to establish the physical/functional interface relationship of the item to other project system/equipments facilities. Requirements shall be specified to a level of detail necessary to permit the NASA end item manager to select alternate items to the one specifically identified above, to satisfy this requirement. Descriptive material which outlines the use of the item in the project or system shall be included. All performance/design requirements shall be stated in physically measurable terms, with tolerances,

in terms of the item itself and not by relating it to equipment/facilities with which it must be compatible. To the extent applicable, the product of functional analysis, or similar record generated as a product of "systems engineering," may be incorporated.

- 6.1.7.6 Section 4 "Quality Assurance" Include applicable content of "Apollo Test Requirements," NHB 8080.1; NASA Quality Assurance Publications NHB 5300.4(1B) and NPC 200-3; and NASA Reliability Publication NPC 250-1. Specify, in subparagraphs, requirements for requalification of the item of equipment to a new use of environment, and/or specification of receiving tests/verifications to be accomplished by the contractor receiving the inventory item for installation into program equipment.
- 6.1.7.7 Paragraph 4.1 "Requalification" When applicable, specify the requirements and methods for accomplishing requalification of the item to a new use or environment. Tests/verifications shall be specified to the level of detail necessary to establish the scope and accuracy of the test method. Formal test/verifications shall not incorporate, either directly or by reference, detail test planning documentation and operating instructions. Requirements shall be the basis for preparation and validation of such documents.
- NOTE: No entry shall be made in this paragraph until the exact item to be used to satisfy the requirement has been selected and the related technical data reviewed.
- 6.1.7.8 Paragraph 4.2 "Receiving Tests" Specify requirements for tests/verifications to be accomplished by the receiving contractor prior to installation of the item into a contract end item. Reference technical manuals, specifications or other technical data to be supplied by NASA which specifies such tests, or which shall be the basis for preparation of a test/verification specification by the receiving contractor. Tests/verifications shall be specified in physically measurable terms, with tolerances, in terms

of the item itself and without direct reference to detail methods for accomplishing the test. Tests/verifications shall be specified to the level of detail necessary to clearly establish the validity and accuracy of the test method and permit a clear, non-subjective determination of the quality of the item.

- 6.1.7.9 Section 5 "Preparation for Delivery" This paragraph shall be limited to descriptive information to assist NASA in determining the nature of packing and packaging requirements for the item for shipment to the contractor. It shall include anticipated length of storage prior to use, storage environment, etc.

SAMPLE FORMAT "A"

Specification No. _____

Revision No. _____

Release Date _____

CONTRACT END ITEM DETAIL SPECIFICATION

(REQUIREMENT ITEMS)

PERFORMANCE/DESIGN

AND

PRODUCT CONFIGURATION

REQUIREMENTS

(CEI NUMBER)

(APPROVED NOMENCLATURE)

FOR

(PROJECT OR SYSTEM NAME) (PROJECT OR SYSTEM)

Approved By _____
(Preparing Activity)

Approved By _____
(NASA Office)

Date _____

Date _____

Contract Number _____

SAMPLE FORMAT "B"

1. SCOPE

The items of equipment specified herein must be supplied from NASA inventory to support _____.

2. APPLICABLE DOCUMENTS

Because of the nature and use of this specification, references to documents applicable to each particular item of equipment are stated in the paragraph which specifies the item of equipment and are not redundantly recorded herein.

3. REQUIREMENT

Each of the following subparagraphs reference an appendix which identifies an end item of equipment to be supplied from NASA inventory. In the appendix, features and characteristics are specified for each end item of equipment which must be satisfied to assure compatibility of performance and design of the item with project or system requirements.

Subparagraph No. (Appendix)	Federal Stock Class Code	Part Number	Nomenclature	The CEI Into Which It Installs
3.1 _____	_____	_____	_____	_____
3.2 _____	_____	_____	_____	_____
3.3 _____	_____	_____	_____	_____

4. QUALITY ASSURANCE

Requirements for quality assurance for items included herein are specified in their respective appendix in Section 10, "Appendices."

5. PREPARATION FOR DELIVERY

Requirements for preparation for delivery of each item specified herein are included in the individual appendix which specifies the item in detail.

6. NOTES

10. APPENDIX

SAMPLE FORMAT "C"

Appendix _____ Federal Stock Class Code _____

1. SCOPE

This appendix establishes the requirement for one item of equipment from NASA inventory identified as (insert nomenclature and type-model-series, and other identifying data,) for the (insert/project or system nomenclature.)

2. APPLICABLE DOCUMENTS

3. REQUIREMENTS

4. QUALITY ASSURANCE

4.1 Requalification4.2 Receiving Tests

5. PREPARATION FOR DELIVERY

EXHIBIT VI

PREPARATION OF DETAIL SPECIFICATION
(CRITICAL COMPONENTS)

EXHIBIT VI

PREPARATION OF DETAIL SPECIFICATION
(CRITICAL COMPONENTS)

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FORMATS AND ILLUSTRATIONS

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PREPARATION OF
DETAIL SPECIFICATIONS
(CRITICAL COMPONENTS)

1. PURPOSE

This Exhibit provides NASA Apollo organizations and contractors with requirements and guidance for the preparation of detail specifications for critical components which are part of a contract end item.

2. SCOPE

Administrative and specification requirements are established for the preparation of detail specifications for components which have been identified in a contract end item detail specification, as:

- a. Engineering critical components
- b. Logistic critical components

Critical component detail specifications, with the contract end item detail specification to which they apply, shall fully define all qualification requirements for the contract end item (CEI).

3. APPLICABILITY

Applies to all critical component specifications which are incorporated by reference in a contract end item (CEI) detail specification (refer to Exhibits II and III), and which are to be approved by the procuring agency at the time the CEI has been qualified.

4. REFERENCE DOCUMENTS

The following documents of the exact issue shown, or part thereof as further described, form a part of this exhibit:

Exhibit II	"Preparation of Contract End Item Detail Specification (Prime Equipment)."
Exhibit III	"Preparation of Contract End Item Detail Specification (Facility)."

5. EXPLANATION OF TERMS

See Exhibit XVII.

6. PROCEDURAL REQUIREMENTS

6.1 General Requirements

NASA shall normally state the complete requirements for design and manufacture of a contract end item in a contract end item

detail specification. Normally, the CEI, and all of its parts, will be qualified as an entity, and the engineering data and qualification test results submitted in accordance with the CEI specification will fully provide the logistic and reprourement requirements. In preparing a CEI specification for large and complex equipment, the contractor, or procuring agency, will list therein, certain components of the CEI to be individually specified and qualified as engineering or logistic critical components. Components so listed in an approved CEI specification shall be specified and processed in accordance with this exhibit.

6.1.1 Engineering Critical Component Selection The contractor in conjunction with NASA, shall designate components of a CEI as engineering critical components when one or more of the following applies:

- a. Qualification of the component will suffice to qualify the entire CEI.
- b. Reliability of the component is critical, i.e., it will jeopardize crew safety, mission success or significantly affect the ability of the CEI to perform its overall function.
- c. Technical complexity and/or producibility of the component is sufficiently critical to warrant an individual specification.
- d. The CEI cannot be adequately qualified except by separately qualifying the component.

The contractor shall list all engineering critical components in Part I of the CEI specification (see Exhibits II and III). Once Part I of the CEI has been formally approved, the contractor shall add or delete critical components therein by submitting a design requirements ECP. (See Exhibit IX.) The contractor shall proceed in accordance with this exhibit when the CEI specification or ECP is approved.

6.1.2 Logistics Critical Component Selection The contractor, in conjunction with NASA, shall designate components of a CEI as logistics critical components when one or more of the following applies:

- a. The component is an item for which the provisioning of spares or selection of spares is required.
- b. The component has been identified for multiple source procurement, by NASA.

The contractor, in conjunction with NASA, shall list all logistic critical components in Part I of the CEI specification. Once Part I of the CEI has been formally approved, the contractor shall add or delete critical components therein by submitting a design requirements ECP. (See Exhibit IX.) The contractor shall proceed in accordance with this exhibit when the CEI specification or ECP is approved.

6.2 Preparation of Engineering Critical Component Specifications

The contractor shall prepare these detail specifications in accordance with the format and instructions contained in Exhibit II and as modified in the following subparagraphs. Specifications for engineering critical components shall contain both a Part I and Part II.

6.2.1 Specification Part I, Section 3, "Requirements"

The contractor shall, to the maximum extent practical, abbreviate the detailed content of this section. Applicable paragraphs in the parent specification for the CEI, of which the component is a part, shall be incorporated by reference. All requirements in the component specification shall be compatible with the requirements in the CEI specification.

6.2.1.1 Paragraph 3.2 in Exhibit II shall not be used in the preparation of component specifications.

6.2.2 Specification Part I, Section 4, "Quality Assurance Provisions" Quality assurance provisions shall be limited to the following requirements:

6.2.2.1 The qualification testing required for the component shall be completely specified. (See Exhibit II, Section 4, Quality Assurance provisions, and paragraph 4.1.3, "Formal Qualification Test.")

6.2.2.2 The reliability testing and analysis, to the extent required for the component, shall be specified. (See Exhibit II, Section 4, Quality Assurance Provisions, and 4.1.4, "Reliability Tests and Analyses".)

6.2.3 Specification Part II, "Product Configuration and Acceptance Test Requirements" The contractor shall prepare Part II of critical component specifications in accordance with the format and instructions contained in Exhibit II and as modified in the following subparagraphs.

6.2.3.1 The contractor shall complete only those subparagraphs in Part II which are essential for reprourement of the item from another source (e.g., production control and acceptance testing requirements).

6.2.3.2 Subparagraphs which are not essential for reprourement shall be entered with the notation "not applicable" or "N/A."

6.2.3.3 The requirements for Part II shall be mutually established with the procuring agency at the time the critical component is provisioned (i.e., provisioned by either the contractor or procuring agency, whoever has the logistic support responsibility).

6.2.4 Engineering Critical Component Specification Title Page. The title page for engineering critical component specifications shall be prepared in accordance with sample format "A" of this exhibit. The specification document and the critical component specified shall be identified by standard configuration identification numbers (refer to Exhibit X).

6.2.4.1 The specification identification number of the design activity shall be entered as shown. It shall include the latest revision letter assigned by the contractor at the time of initial submittal for formal approval by the procuring agency.

6.2.4.2 The code identification number of the design activity shall be entered as shown.

6.2.4.3 The permanent drawing number (which is, or is included in, the part number for the critical component) and nomenclature for the critical component, as assigned by the design activity, shall be entered as shown.

6.2.4.4 The signatures of the authorized personnel who approved the specification at the time of initial formal approval by the procuring agency, shall be the only signatures entered.

6.3 Preparation of Logistic Critical Component Specifications

Specifications for logistic critical components shall be prepared in accordance with the format for Part II, "Product Configuration and Acceptance Test Requirements," only, as described in Exhibit II.

6.4 Administrative Requirements

Critical components shall be managed at contract end item levels of control and as stated in the subparagraphs below.

6.4.1 Specifications and Engineering Drawings. Critical component specifications shall be prepared and maintained by the contractor and shall be approved by the procuring agency. Engineering drawings for critical components shall always be prepared and controlled as part of the drawing "trees" for the CEI of which the component is a part.

EXHIBIT VI

- 6.4.1.1 The specification shall be presented for preliminary approval at the request of the procuring agency and submitted for final approval at the completion of qualification testing of the component.
 - 6.4.1.2 Qualification testing shall be certified as complete on the title page of the specification by the contractor or by the procuring agency as directed by the Center program office.
 - 6.4.1.3 Specification approval and certification shall constitute completion of qualification testing, unless further authorized by ECP.
 - 6.4.1.4 Drawings, or data other than the specification, shall be submitted for critical components unless otherwise specified by contract.
- 6.4.2 Qualification Testing. Qualification of critical components shall be accomplished as part of the qualification program for the CEI of which they are a part.
- 6.4.2.1 Test schedules shall be planned for completion prior to acceptance of the first CEI to be delivered for the intended use of type-model-series. Normally, this will be at the time of FACI for the CEI.
 - 6.4.2.2 Test data shall be subject to review and surveillance by the local representative of the procuring agency.
 - 6.4.2.3 Test data and other reports shall be prepared for submittal unless otherwise specified by the procuring agency.

SAMPLE FORMAT "A"

Specification No. _____

Code Identification No. _____

ENGINEERING CRITICAL COMPONENT SPECIFICATION

PART I

PERFORMANCE/DESIGN AND
QUALIFICATION REQUIREMENTS

and

PART II

PRODUCT CONFIGURATION AND
ACCEPTANCE TEST REQUIREMENTS

for

(Permanent Drawing Number and Nomenclature)

Approved by: _____
(Designee)
(Design Activity Contractor's
Name)

Approved by: _____
(Designee)
(Procuring Agency's Name)

EXHIBIT VII

SPECIFICATION MAINTENANCE

EXHIBIT VII

SPECIFICATION MAINTENANCE

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SPECIFICATION MAINTENANCE

1. PURPOSE

This Exhibit provides NASA Apollo organizations and contractors with requirements and guidance for the preparation of Specification Change Notices, and for the formal recording of changes to all specifications discussed in Exhibits I through VI.

2. SCOPE

These instructions define the format and content for the following documents, which pertain to the preparation of Specification Change Notices, and for the approval, control, format, and recording thereof.

a. Specification Change Notice Sample Format "A"

Note: Where using agencies exercise the option of Paragraph 1. Policy (page 1 of this document) Specification Change Notices shall be prepared and used as specified by the "Changes and Revisions" requirements of MIL-STD-490.

b. Specification Change Log Sample Format "B"

c. Specification Configuration Chart Sample Format "C"

d. Specification Identification Index Sample Format "D"

3. APPLICABILITY

Contractors to NASA are responsible for the compliance of their subcontractors, vendors and suppliers.

4. REFERENCE DOCUMENTS

The following exhibits of this document shall be considered as reference material for the purpose of interpreting the requirements of this exhibit, but do not form a part of this exhibit:

Exhibit I "Preparation of Program, Project and System Performance and Design Requirements Specification"

Exhibit II "Preparation of Contract End Item Detail Specification (Prime Equipment)"

Exhibit III "Preparation of Contract End Item Detail Specification (Facility)"

Exhibit IV "Preparation of Contract End Item Detail Specification (Identification Item)"

- Exhibit V "Preparation of Contract End Item
Detail Specification (Requirement Items)"
- Exhibit VI "Preparation of Detail Specification
(Critical Components)"
- Exhibit IX "Preparation of Engineering Change Proposals
for Contract End Items."

5. EXPLANATION OF TERMS

See Exhibit XVII

6. PROCEDURAL REQUIREMENTS

The preparation and formal recording of specification change notices shall be accomplished as required by this exhibit. The following instruments are used to formally transmit and/or record changes to approved specifications, and shall be prepared to comply with the following instructions referenced to the formats attached:

6.1 Specification Change Notice (SCN)

The specification change notice is used to record exact changes to all approved specifications. Each ECP which changes the established baseline shall note the effect of the change on specifications and shall have an SCN enclosed with it. The SCN shall, when submitted for approval, reflect the change to the specification that will result if the ECP is approved. By definition, all Class I engineering changes require an SCN and vice versa. SCN's will not be distributed to other activities on the specification distribution list until the SCN has been approved by the procuring agency. Errata changes of a minor nature that correct typographical errors, punctuation, etc., shall be collected and submitted with the next technically required ECP and accompanying SCN. Errors in specified dimensions, parameters, tolerance, etc, shall not be classed as errata changes, and shall require formal approval of the procuring activity. Each SCN to a specification shall be inserted in front of the page it modifies.

6.1.1 Preparation of the SCN. The SCN format is illustrated in sample format "A". The instructions for completing the SCN are as follows:

6.1.1.1 Block Completion. All blocks shall contain an entry. The date shall correspond to the date entered on the related ECP. If the information

is not available, use TBD (to be determined); if it is not applicable, use N/A. If all data cannot be included within the space allocated on the forms, use attachments as necessary, with appropriate references in the blocks.

6.1.1.2 Supersession. When a contractor is requested to resubmit an SCN, the resubmitted SCN shall retain the same SCN number with a new date. An SCN may be revised and resubmitted for the following reasons:

- a. A revision to the ECP.
- b. As requested by the procuring agency.
- c. Contractor initiated, e.g., typographical corrections, supplying the latest engineering information, etc.

When the revision and resubmittal of an SCN cannot be correlated with specific CCB direction, the contractor shall clearly state the reason for revision in the submittal letter. When an SCN is revised and resubmitted, the resubmitted SCN shall show that the previous dated SCN has been superseded. The contractor shall not cancel an SCN that has been formally submitted to the procuring organization without formal approval of the procuring agency. An SCN may be cancelled prior to submission to the procuring agency. In such cases, contractor records shall show that cancellation was the result of "in-house" activity.

6.1.1.3 SCN Numbers. (See Exhibit X)

6.1.1.4 Preliminary/Final SCN's. Preliminary SCN's shall be clearly marked as such. Final SCN's shall be indicated by the completion of block 5, citing the contractual authority, e.g., a Contract Change Notification (CCN). When mutually agreed between the contractor and the procuring agency, final SCN's may be transmitted on a periodic basis in a group rather than individually on an as accomplished basis.

6.1.1.5 Effectivity (Block 6). Block 6 shall be completed to show the Contract End Item Serial Numbers of all articles affected by the SCN.

6.1.1.6 Effect of Change (Block 7). Block 7 shall indicate specifically the specification change to be made. In those instances when an

ECP does not result in an actual change to the text of the specification, the entry in this block shall merely state that this ECP is added to the Specification Change Log. If the change to the specification is in the wording of a paragraph, include, verbatim, the statement of change to the specification, which shall call out the paragraph and be in one of the following forms:

- a. Add: _____
- b. Delete: _____
- c. Change from _____ to _____

6.2 Specification Change Log

The Specification Change Log is used with all types of specifications to formally record contractually authorized Specification Change Notices to an approved revision of the specification. Therefore, the Specification Change Log, in addition to reflecting an identification of applicable SCN's, shall in fact, serve as a continuation of the specification configuration chart described in paragraph 6.3. The contractor will be required to submit a revised and current log, as a cover sheet, to each final SCN submitted for approval. The Specification Change Log shall be prepared to comply with sample format "B". A Specification Change Log shall be prepared and submitted with each SCN and ECP. On those ECP's that do not affect the words and criteria in the specification and merely change hardware, the SCN prepared will indicate only that the ECP has been added to the change log.

6.3 Specification Configuration Chart

The Specification Configuration Chart shall be prepared to comply with sample format "C". The Configuration Chart is a summary record which identifies approved engineering change proposals with individual revisions to the specification. The chart shall not be updated by the contractor, except by means of complete revision and updating of the entire specification, subject to the approval of the procuring organization and in accordance with this exhibit. The Specification Configuration Chart shall be inserted between the title page and the first page of the specification. A Specification Configuration Chart shall be prepared and submitted with each revision of a Specification.

6.4 Specification Revisions

A revision is defined as the reissue of the specification, with all the SCN's incorporated in the body of the specification. A specification shall not be revised without specific approval of the procuring agency. The specification revision shall incorporate the information identified on the latest approved Specification Change Log. Configuration charts shall be revised to incorporate all applicable ECP entries which were recorded in the log. At the discretion of the CMO, the specification may be maintained by requiring replacement pages which shall accompany the SCN. The CMO will establish a procedure to indicate that a replacement page has been used and properly inserted in the applicable specification.

6.5 Specification Identification Index

6.5.1 The Specification Identification Index shall be prepared to comply with the sample format "D". The Specification Identification Index is a record which identifies all specifications, and all approved changes thereto. This document will be prepared by the contractor. Publication and distribution of the index will be as specified by the procuring agency. The procuring agency, through copies of CCB Directives, will keep the contractor advised which SCN's will appear in the index. There will be a separate page for each specification. The initial issue will include all specifications which are part of the design requirements baseline. As requirements for additional items are established, additional specifications will be added to the index.

6.5.1.1 Preparation of the Specification Identification Index:

1. Nomenclature. Enter the title of the specification being reported.
2. Enter the number of the specification being reported.
3. Enter the contract end item number assigned by the contractor for this item of hardware.

EXHIBIT VII

4. Enter the initial part number assigned to the contract end item (this normally occurs upon release of engineering).
5. Enter the date the contractor has scheduled for FACI of the CEI being reported. Enter a "C" after the date to indicate action completed.
6. Enter the date scheduled for submittal of Part II of the specification, as established at the critical design review. Enter a "C" after the date to indicate action completed.
7. Enter the date scheduled for approval of Part II of the specification in question. Enter a "C" after the date to indicate action completed.
8. Enter the SCN number of each approved SCN, and the respective ECP number.
9. Enter the title of each SCN.
10. Enter the specification name and number of each associate contractor and specification number affected by the change.
11. Enter the SCN number for the associated contractor specification affected by the change.
12. Enter the name of the contractor responsible for the CEI being reported.

(CONTRACTORS NAME)		PAGE _____ OF _____
SPECIFICATION CHANGE NOTICE		DATE _____
NO. _____		SUPERSEDING _____
1. ECP NO.	2. TYPE, MODEL, SERIES	3. SPEC. NO.
4. CONTRACT	5. CONTRACTUAL AUTHORITY	FILE OPPOSITE SPEC. PAGE NO.
6. EFFECTIVITY		
7. EFFECT OF CHANGE		

SAMPLE FORMAT "A"

EXHIBIT VII

(CONTRACTOR'S NAME)		AS OF (DATE)		
SPECIFICATION CHANGE LOG		SUPERSEDING (DATE)		
SPECIFICATION NO.				
SCN NO.	ECP NO.	SCN DATE	PAGES AFFECTED	ITEM EFFECTED
1	1034	5-6-61	1 AND 2	THIS COLUMN SHALL BE USED TO INDICATE END ITEM AFFECTED, FOR AIR VEHICLE, IDENTIFICATION, OR REQUIREMENT SPECIFICATIONS AS APPLICABLE.
2	4050	5-20-61	LOG	
3	1113	5-30-61	LOG	
4	1440	6-26-61	3 AND 4	

SAMPLE FORMAT "B"

SPECIFICATION NO. _____		
PAGE _____		
SPECIFICATION CONFIGURATION CHART		
SPECIFICATION ISSUE	ECP'S	PRODUCTION EFFECTIVITY
BASIC (DATE)	ORIGINAL DESIGN ECP'S (LIST ALL ECP'S CONSTITUTING THE BASELINE CONFIGURATION) INCORPORATED ECP'S (LIST ALL ECP'S APPLIED AGAINST THE END ITEM SUBSEQUENT TO THE BASELINE AND CURRENT WITH THE BASIC ISSUE OF THE SPECIFICATION).	(EFFECTIVITY OF THE SPECIFICATION ON PRODUCTION ARTICLE OR ITEM SERIAL NUMBER, AS APPLICABLE).
A (DATE)	INCORPORATED ECP'S (LIST ALL ECP'S APPLIED AGAINST THE END ITEM SUBSEQUENT TO THE BASIC ISSUE AND CURRENT WITH THE "A" ISSUE OF THE SPECIFICATION).	(ETC.)
B (DATE)	INCORPORATED ECP'S	(ETC.)
C (DATE)	INCORPORATED ECP'S	(ETC.)

SAMPLE FORMAT "C"

SPECIFICATION IDENTIFICATION INDEX

① NOMENCLATURE		② SPECIFICATION			
AGENDA D		AE 60-506A		③ EID 27-9370	
SPACECRAFT				④ PART 27-97145-1	
⑤ FACI - SCHEDULED DATE 25 SEPT 63					
⑥ SPECIFICATION, PART II SCHEDULED SUBMITTAL DATE 25 AUG 63					
⑦ SPECIFICATION, PART II SCHEDULED APPROVAL DATE 1 OCT 63					
SCN ⑧	ECP	⑨ TITLE	⑩ OTHER SPECS AFFECTED	⑪ RELATED SCN	
1	10	CALIBRATION CHANGE	BELL 256 2456S ACOUSTICA 1586B	41 20	
⑫ LOCKHEED					

SAMPLE FORMAT "D"

EXHIBIT VIII

PROCEDURES FOR
PROGRAM, PROJECT AND SYSTEM
REQUIREMENTS SPECIFICATION CHANGES

EXHIBIT VIII

PROCEDURES FOR
PROGRAM, PROJECT AND SYSTEM
REQUIREMENTS SPECIFICATION CHANGES

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FORMATS AND ILLUSTRATIONS

Figure 1 Configuration Control Board Directive.VIII-5/6
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PROCEDURES FOR
PROGRAM, PROJECT AND SYSTEM REQUIREMENTS
SPECIFICATION CHANGES

1. PURPOSE

This Exhibit provides NASA Apollo organizations with requirements and guidance for uniform procedures for preparing, formatting and processing requirements changes to the Apollo Program Specification and requirements changes to Project and System Specifications when these specifications are not CEI Specifications.

2. SCOPE

This Exhibit establishes requirements for configuration control by NASA organizations and for submittal of requirements changes which will affect the Apollo Program, Project and/or System Specifications. This Exhibit includes procedures by which the NASA organizations shall document and propose changes for submittal and record formal approval or disapproval, as required. These procedures are based on:

- a. The use of program baselines to establish the departure points for configuration control of the system.
- b. The use of a program performance/design requirements specification to define and document the program requirements baseline, and requirements changes thereto.
- c. The use of project and system performance/design requirements specifications to define and document the project and system requirements baselines and requirements changes thereto.
- d. The use of Engineering Change Proposal (ECP) procedures in MIL-STD-480 as tailored to Apollo requirements for program management.

Proposals for changing the design, production, test, retrofit, or support of deliverable contract end items shall be processed in accordance with Exhibit IX.

3. APPLICABILITY

This Exhibit is applicable during the Definition and Acquisition Phases of a program.

4. REFERENCE DOCUMENTS

The following documents are to be considered as reference material for the purpose of interpreting the requirements of this Exhibit, but do not form a part of this Exhibit:

MIL-STD-480	30 October 1969	"Configuration Control-Engineering Changes, Deviations and Waivers."
Exhibit I		"Preparation of Program, Project and System Performance and Design Requirements Specifications."
Exhibit VII		"Specification Maintenance."
Exhibit IX		"Preparation of Engineering Change Proposals for Contract End Items."
Exhibit X		"Requirements for Configuration Identification Numbers."

5. EXPLANATION OF TERMS

See Exhibit XVII.

6. PROCEDURAL REQUIREMENTS

6.1 Background Information

The Definition Phase is characterized by the completion of the Apollo Program Specification and the associated Project, System, and End Item (Part I) Specifications. These specifications are based on the operational requirements to carry out the Apollo mission. The Program Specification is the single authoritative top level specification which establishes requirements which are applicable to all Program elements. The Program Specification is prepared by the Apollo Program Office. The Project Specification is the single authoritative second level specification which establishes requirements which are applicable to a single Project and directly supports the Program level requirements. The System Specifications are the next tier of specifications that support the Project level requirements. The Project/System Specifications are prepared by the NASA Centers and/or contractors as directed by the procuring agency. At the conclusion of the definition phase, the program will have been defined in terms of contract end items (CEIs). The contract end item specifications shall establish the design requirements baseline for each end item. Thereafter, configuration control will be accomplished at contract end item level.

6.2 General Requirements

Requirements changes shall be processed as requirements ECPs in accordance with this instruction. Additionally, each ECP will be accompanied by a SCN. MIL-STD-480 is the policy document used as a guide for proposing requirements changes. The ECP procedures provide the Apollo Program Manager and Center Program Managers with:

- a. A uniform procedure for submitting proposed changes to approved requirements which have defined the formal requirements baseline for program definition, design and development.
- b. A method for documenting the technical, fiscal and mission impact of the proposed change on the management of the program.

6.3 Processing of Requirements Changes

Approved requirements are documented in an approved specification. Changes in these requirements shall be documented by Specification Change Notices (SCNs) or by complete revision of the specification as provided by Exhibit VII. Specific requirements in the specification shall be designated as defining the appropriate requirements baseline. This baseline establishes the departure point for configuration control of the requirements. Changes which affect the defined baseline shall be further approved and documented by requirements ECP change procedures. All contractor changes to contract end items submitted for approval to the Program Manager's Configuration Control Board (CCB) shall be reviewed for effects on specification requirements. In the event the Contractor's ECP affects a Project/System Specification, the Program Manager's CCB will require initiation of a requirements ECP to change the specification. The ECP will be processed through the Program Manager's CCB. All proposed changes to Project/System Specifications will be reviewed for effect on the Program Specification. In the event a change to a Project/System Specification affects the Program Specification, the Program Manager's CCB will require initiation of a requirement ECP to change the Program Specification. The ECP will be processed through the Program Manager's CCB to the Apollo Program Office CCB. All proposed requirements changes to the Apollo Program Specification under consideration by the Apollo Program Office will be coordinated through Configuration Management Office channels and Program Manager's CCB for program impact prior to the issuance of a Program Specification Change.

6.4 Approval of Requirements Changes

The Apollo Program Director's CCB shall exercise full control over all decisions pertaining to program requirements ECPs. The Center level Program Manager's CCB shall exercise full control over all decisions pertaining to Project and Systems Requirements ECPs. The CCB chairman is responsible for making all decisions in accordance with established policy and directives. He will formalize his decisions by issuing a Configuration Control Board Directive (CCBD), (see Figure 1). Each CCB member shall formalize his official position relative to the decision of the chairman by indicating either a concurrence or non-concurrence on the CCBD. Backup sheets explaining these positions where required will be made a part of the official file. The CCB will be directive on all NASA organizations.

- 6.4.1 A formal CCB agenda will be prepared and distributed for timely action on ECPs. Routine ECPs will normally be scheduled for 14 days of review. Urgent ECPs will be scheduled for a 48-hour review. Emergency ECPs will be scheduled for immediate action.
- 6.4.2 CCB meetings will be held at regular intervals, or as called by the chairman, to meet urgent or other requirements. One of the following courses of action will be taken:
- a. The ECP may be approved as written.
 - b. The ECP may be disapproved, with reasons clearly stated.
 - c. The ECP may be approved with specific changes clearly stated.
 - d. Decision may be deferred for investigation, with responsibility for resolution assigned to a specific person.
 - e. Decision may be referred to higher headquarters if judged to be beyond the authority of the CCB.
- 6.4.3 The decision or other action will be documented on the CCBD. The CCB action shall not be complete until all elements of the CCBD are completed and the form signed by the CCB chairman.

6.5 Preparation of the Configuration Control Board Directive

The Configuration Control Board Directive has been prepared for use by the Apollo Program Director's CCB and the Program Manager's CCB. Items 3, 6, 7, 8, 9, 10, 12, 18 and 20 will not be used on CCB Directives related to Program, Project and System Specification Requirements Changes.

6.6 Preparation of the ECP Form

The ECP form in MIL-STD-480 shall be used as a guide for formal submission of requirements ECPs.

6.7 Waivers and Deviations

When an authorized departure from approved requirements is necessary, waivers or deviations as applicable may be processed in accordance with the procedures, and forms, prescribed by MIL-STD-480.

(1) <input type="checkbox"/> SV <input type="checkbox"/> AGE <input type="checkbox"/> FAC <input type="checkbox"/> TRAINING <input type="checkbox"/> GIE <input type="checkbox"/> DS <input type="checkbox"/> RPIE	NASA ORG. _____ CONFIGURATION CONTROL BOARD DIRECTIVE	PAGE <u> 1 </u> OF _____ DATE: DAY MO. YR.				
(2) CCB NUMBER	(19) ECP TITLE					
(3) CONTRACTOR:	(4) ECP NO.	(4A) DATE:				
(5) SUPERSEDES ECP NO.	(5A) DATE:	(20) NOMENCLATURE, CONTRACT END ITEM				
(6) END ITEM NO.	(21) EFFECTIVITIES					
(7) END ITEM PART NO.	FIRST LAST TYPE FIRST LAST TYPE	(22) PROCUREMENT ACTION REQUIRED				
(8) TCTR NO. & TYPE		A. END ITEM MOD.				
PART NO CHANGE: <input type="checkbox"/> YES <input type="checkbox"/> NO		B. SPARES MOD.				
(10) SPARES AFFECTED <input type="checkbox"/> YES <input type="checkbox"/> NO		C. TECHNICAL DATA				
(11) INTERFACE REQUIREMENTS		TYPE LEGEND P - PRODUCTION S - RETROFIT				
(12) DESIGN DEFICIENCY <input type="checkbox"/> YES <input type="checkbox"/> NO						
(13) ECP NOTED IN BLOCK (4) IS <input type="checkbox"/> APPROVED AS WRITTEN <input type="checkbox"/> DISAPPROVED <input type="checkbox"/> APPROVED WITH CHANGES. AS NOTED BELOW						
(14) SPECIFICATION NO.	REMARKS:		(23)			
(15) SPECIFICATIONS AFFECTED: PROGRAM SPEC NO. <input type="checkbox"/> YES <input type="checkbox"/> NO		TECHNICAL	CONCUR	NON CONCUR		
(16) PROJECT SPEC. NO. <input type="checkbox"/> YES <input type="checkbox"/> NO		RELIABILITY				
(17) SYSTEM SPEC NO. <input type="checkbox"/> YES <input type="checkbox"/> NO		TEST				
(18) CEI SPEC NO. <input type="checkbox"/> YES <input type="checkbox"/> NO		MANUFACT.				
		QUAL. CONTROL				
	CONTRACTS					
	COSTS					
	SCHEDULE					
	OPERATIONS					
	LOGISTICS					
PROGRAM MANAGER CCB-MSB	CONCUR	NON CONCUR	PROGRAM MANAGER MSC-IMCC	CONCUR	NON CONCUR	CHAIRMAN PROGRAM MANAGER CCB CHAIRMAN APOLLO PROGRAM DIRECTOR CCB
PROGRAM MANAGER CCB-MSFC			OTHER			
PROGRAM MANAGER CCB-KSC			OTHER			

Figure 1

ECP NUMBER	CCB DIRECTIVE DATA AMPLIFICATION SHEET	DATE (Day, month & year)
ECP DATE		PAGE OF PAGES
19. CONTINUATION SECTION (Refer to block number & title of date on Directive from)		
20. COMMENTS		

Figure 1 (Cont'd)

EXHIBIT IX

PREPARATION OF
ENGINEERING CHANGE PROPOSALS
FOR
CONTRACT END ITEMS

EXHIBIT IX

PREPARATION OF
ENGINEERING CHANGE PROPOSALS
FOR
CONTRACT END ITEMS

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FORMATS AND ILLUSTRATIONS

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PREPARATION OF
ENGINEERING CHANGE PROPOSALS
FOR CONTRACT END ITEMS

1. PURPOSE

This Exhibit provides NASA Apollo organizations and contractors with requirements and guidance for uniform procedures for preparing, formatting, and processing engineering changes to contract end items of equipment and facilities and Direct Support Real Property Installed Equipment (DS-RPIE).

2. SCOPE

This Exhibit establishes requirements for configuration control and for submittal of Engineering Change Proposals (ECP's) in accordance with MIL-STD-480. These procedures are based on:

- a. The use of management baselines to establish the departure points for configuration control of contract end items.
- b. The use of contract end item detail specifications to define and document these baselines, and engineering changes thereto.
- c. The use of MIL-STD-480 as written for its primary purpose.

The procedures in this exhibit shall be used for proposing changes in all contract end items of equipment and facilities and DS-RPIE to be formally accepted by the National Aeronautics and Space Administration for use on the Apollo Program. This includes both system and non-system contract end items.

3. APPLICABILITY

This Exhibit is applicable to contract end item definition, design, development, fabrication, and test phases of the program.

4. REFERENCE DOCUMENTS

4.1 Applicable Documents

The following documents of the exact issue shown, or parts thereof as further described, form a part of this Exhibit:

MIL-STD-480 30 October 1968 "Configuration Control -
Engineering Changes, Deviations
and Waivers"

4.2 Reference Documents

The following documents are contained in the text for reference purposes only, and do not form a part of this Exhibit:

- Exhibit II - "Preparation of Contract End Item Detail Specification (Prime Equipment)."
- Exhibit III - "Preparation of Contract End Item Detail Specification (Facilities)."
- Exhibit IV - "Preparation of Contract End Item Detail Specification (Identification Item)."
- Exhibit V - "Preparation of Contract End Item Detail Specification (Requirement Items)."
- Exhibit VII - "Specification Maintenance."
- Exhibit X - "Requirements for Configuration Identification Numbers."
- Exhibit XI - "Requirements for Configuration Identification and Acceptance Contract End Items and Related Data."

5. EXPLANATION OF TERMS

(See Exhibit XVII.)

6. PROCEDURAL REQUIREMENTS

6.1 Background Information

The Apollo Program Managers will manage the acquisition of a contract end item (CEI) by the use of contract end item specifications in conjunction with MIL-STD-480. Together, these documents establish the basis for configuration control of the CEI. Partial configuration control is implemented at the start of the acquisition phase, i.e., when the contractor is authorized to proceed with detail design and development in accordance with approved requirements in the CEI specification. Full configuration control is implemented at the time of acceptance of a CEI manufactured to the configuration required for a particular series of space vehicles. Thus, programs for contract end items of equipment and facilities are defined by detail specifications are phased for progressive configuration control to the requirements specified therein, and are controlled to these requirements by the application of MIL-STD-480. This method of programming and configuration control is illustrated in Figure 1, and is explained below.

6.2 General Requirements

Formal configuration control, in accordance with this Exhibit, shall be implemented and maintained on all programs involving the formal acceptance of contract end items of equipment or facilities and DS-RPIE. Configuration control shall be implemented and maintained by use of the program phasing and baseline concepts of configuration management. These concepts are illustrated in Figure 1 and are related to the design, development and fabrication activities of a typical program. Variations in the typical program, e.g., a program for the delivery of just one item, do not alter the necessity for the configuration management concepts and elements shown in Figure 1.

6.2.1 Definition Phase During the Definition Phase, the Apollo Program Specification shall be completed. The end of the Definition Phase is denoted as the point wherein the Program, Project and System specifications and the CEI specifications, Part I, are complete.

6.2.2 Acquisition Phase

6.2.2.1 Design Requirements Baseline

6.2.2.1.1 The procuring agency will, at the start of the Acquisition Phase, perform a Preliminary Design Review to approve Part I of the CEI specification; and will designate specific requirements therein as defining the design requirements baseline; and will authorize the contractor to proceed with detail design and development of the CEI, including further development of the specification.

6.2.2.1.2 The design requirements baseline is a defined departure point for configuration control. Once a design requirements baseline has been defined and approved, design and development of the CEI shall be accomplished in accordance with baseline requirements unless formal approval to change these requirements is obtained from the procuring agency. The contractor may propose such a change and shall process any change to Part I of the CEI specification as a Class I change when

EXHIBIT IX

the change affects a requirement in the specification that has been designated by the procuring agency as defining the design requirements' baseline.

- 6.2.2.1.3 The contractor shall document specification changes by Specification Change Notice (SCN), or by revision of the specification, as provided in Exhibit VII and as directed by the CMO.

6.2.2.2 Product Baseline

- 6.2.2.2.1 The contractor shall, as part of his design and development effort, prepare a Contract End Item Detail Specification, Part II, "Product Configuration and Acceptance Test Requirements," which specifies the requirements for delivery of all CEI's which are to be formally accepted by NASA. This includes first acceptance, and all subsequent acceptances, irrespective of intended use. The specified requirements of Part II are a product of released engineering design and all CEI's shall be manufactured in accordance with this released engineering design.
- 6.2.2.2.2 The contractor shall submit to the procuring agency for formal approval a complete baseline issue of the specification (Parts I and II) no less than 30 days prior to the acceptance of that CEI which will formally implement the product configuration baseline. This issue shall be verified as representing the status of released engineering for that CEI, and as accurately documenting the product configuration of the CEI.
- 6.2.2.2.3 The procuring agency will formally approve the complete specification at the time of acceptance of that CEI, which establishes the Product Configuration Baseline. This will normally occur as part of the FACI held at the contractor's plant or site of construction.

6.2.2.2.4 The contractor shall, after the complete specification has been approved, process any change to the specification as a Class I engineering change. Also, any change to CEI's to be accepted after establishing the product configuration baseline shall be processed in accordance with the requirements in MIL-STD-480.

6.3 MIL-STD-480 Requirements

MIL-STD-480 shall be used, as required by this Exhibit, for the preparation of ECP's submitted for approval to change the design requirements or Product Configuration baseline of a contract end item. The following subparagraphs supplement the standard and unless specifically stated otherwise, MIL-STD-480 applies as written.

6.4 Processing and Approval of ECP's

The instructions in this paragraph apply to the processing and approval of all ECP's for a contract end item. MIL-STD-480 shall apply as written, and as supplemented in the following subparagraphs to provide for Configuration Control Board (CCB) procedures.

6.4.1 Submittal of ECP's The contractor shall submit all ECP's as required by MIL-STD-480. ECP's requiring coordination shall be distributed in parallel as follows:

- a. The local Government representative.
- b. The Configuration Control Board.
- c. The affected contractor.

6.4.2 Approval of Class I Changes Approval of ECP's for contract end items shall be in accordance with MIL-STD-480. ECP's shall be approved by the appropriate Program Manager's Configuration Control Board, with the exception of Program Performance Design Requirements Baseline, which will be approved by the Apollo Program Director's CCB. The CCB is not a voting board. The Program Manager or a CCB Chairman acting in

his behalf, is responsible for making all decisions in accordance with established policy and directives. He will formalize his decisions by issuing a Configuration Control Board Directive (CCBD) which will be directive on the Contracting Officer of the procuring agency. The procuring agency will reflect the exact requirements of the CCBD in the contract authorization. This authorization shall constitute the sole authority for the contractor to implement the change. ECP's requiring approval of the Apollo Program Director's CCB will be transmitted to the appropriate Program Manager's CCB for implementation after approval.

- 6.4.2.1 A formal CCB agenda will be prepared and distributed for timely support of submitted ECP's. Routine ECP's will normally be scheduled for 14 days of review. Urgent ECP's will be scheduled for a 48-hour review. Emergency ECP's will be scheduled for immediate action.
- 6.4.2.2 CCB meetings will be held at regular intervals, or as called by the Chairman, to meet emergency and other requirements. The contractor may be invited to attend CCB meetings to present technical data supporting his ECP. One of the following courses of action will be taken:
 - a. The ECP may be approved as written.
 - b. The ECP may be disapproved, with reasons clearly stated.
 - c. The ECP may be approved, with specific changes clearly stated.
 - d. Decision may be deferred for investigation, with responsibility for resolution assigned to a specific person.
 - e. Decision may be referred to higher headquarters if judged to be beyond the authority of the Center CCB.
- 6.4.2.3 The Program Manager's CCB shall assure that changes having intra-center interface considerations have been coordinated and agreements established. The interface change shall be recorded in the CCBD. The Program Manager's CCB shall coordinate with the appropriate Apollo Coordination Panel those changes that affect another Center's end item. After Panel agreement, the Program Manager's CCB shall issue a CCBD implementing the interface agreement.

EXHIBIT IX

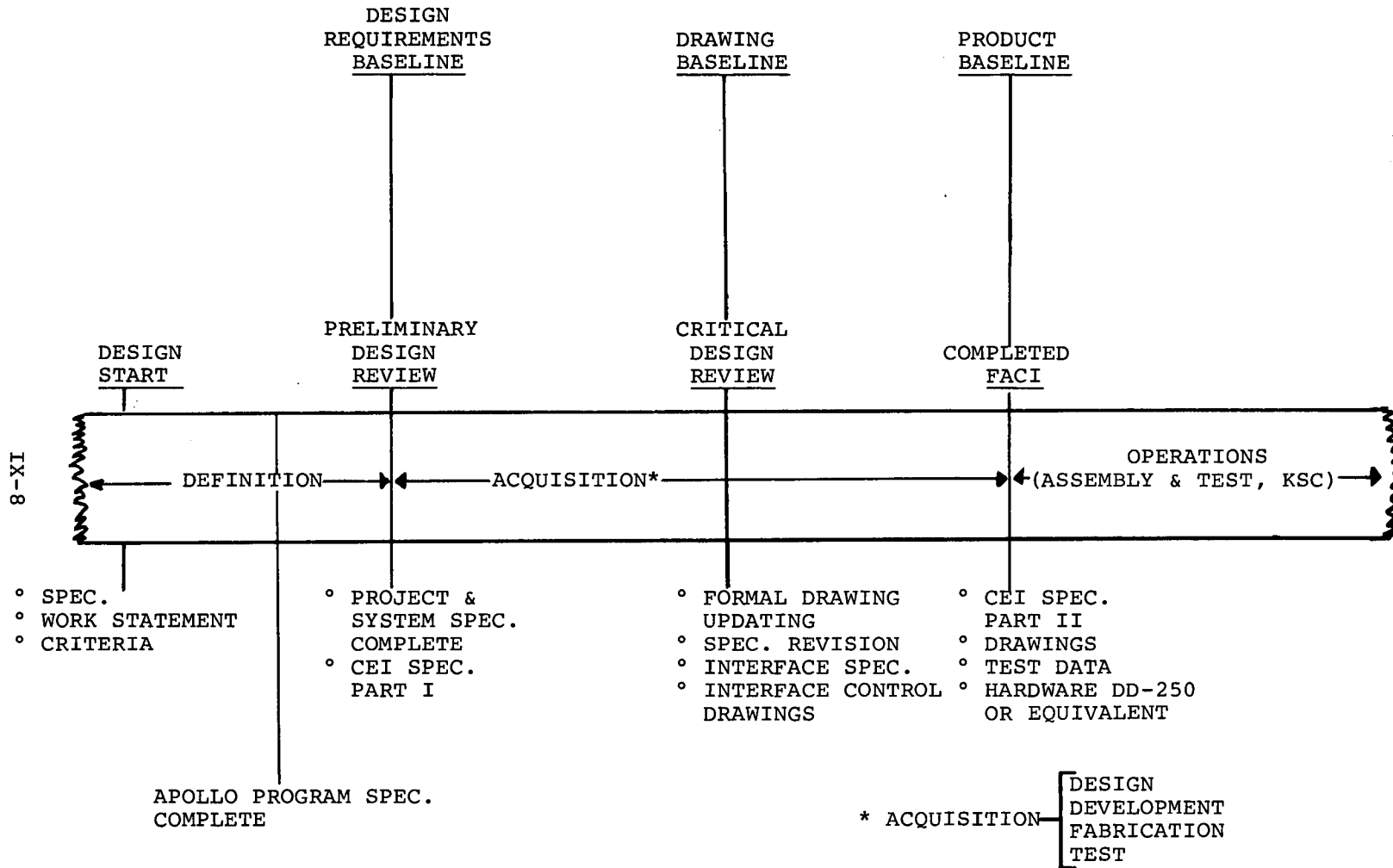
- 6.4.2.4 The decision or other action will be documented in the CCBD. (See Exhibit VIII for format of CCB Directive.) Each member will formalize his concurrence or non-concurrence on the CCBD. The CCB action shall not be completed until all elements of the CCBD are completed, and the form signed by the CCB Chairman.
- 6.4.2.5 Completed CCBD forms for approved ECP's shall be forwarded to the Contracting Officer who will authorize the contractor to proceed.

6.4.3 Submittal and Approval of Class II Changes Class II engineering changes shall be handled as required in MIL-STD-480. In addition, all changes incorporated in the CEI specification, and which do not require submittal of an ECP, shall be submitted as follows:

- 6.4.3.1 The contractor shall submit a copy of the SCN, or revision, for each Class II change to the designated local Government representative of the procuring agency at the time the SCN, or revision, is prepared and authorized by the contractor.
- 6.4.3.2 The designated local Government representative will review and may, within two working days of receipt, disapprove the classification of the SCN, or revision, as a Class II change. If the contractor disagrees with the determination of the Government representative, he may submit the SCN to the CCB for final resolution of the classification.

6.5 Preparation of the ECP Form

The contractor shall use the ECP Form and/or message format in MIL-STD-480 for the preparation of all ECP's. The requirements of MIL-STD-480 shall apply to the preparation of all ECP's. The standard identification numbers in Exhibit X shall be used on all ECP's, or as directed by the procuring activity.



SPAN OF CONFIGURATION CONTROL FOR TYPICAL ACQUISITION PROGRAM

Figure 1

EXHIBIT X

REQUIREMENTS FOR CONFIGURATION
IDENTIFICATION NUMBERS

EXHIBIT X

REQUIREMENTS FOR CONFIGURATION
IDENTIFICATION NUMBERS

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REQUIREMENTS FOR CONFIGURATION
IDENTIFICATION NUMBERS

1. PURPOSE

This exhibit provides NASA and contractor organizations with requirements for assigning and controlling configuration identification numbers.

2. SCOPE

This exhibit establishes a system for assigning a complete set of identifying numbers to be used in controlling the configuration of all contract end item equipments, facilities, sites and spares. The numbers are:

- a. Specification identification numbers
- b. Contract end item numbers
- c. Serial numbers
- d. Drawing and part numbers
- e. Change identification numbers
- f. Code identification numbers

These numbers are the only identifiers to be used to formally and precisely identify configuration. This exhibit fully defines the method of construction and meaning of the numbers. The set, composed and assigned as required by this exhibit, shall be used to identify equipments and documents as required by Exhibit XI.

3. APPLICABILITY

This exhibit applies to the configuration identification of all contract end item equipments, facilities, and spares which are formally accepted by the procuring agency. It applies to all contracts with the procuring agency for systems engineering or system integration involving these deliverable items. Contractors to the procuring agency shall be responsible for the compliance of their subcontractors, vendors and suppliers.

4. REFERENCE DOCUMENTS

4.1 Applicable Documents

The following documents of the exact issue shown, or part thereof as further described, form a part of this exhibit:

EXHIBIT X

MIL-STD-100A	1 October 1967	"Engineering Drawing Practices"
MIL-STD-480	30 October 1968	"Configuration Control - Engineering Changes, Deviations and Waivers"

5. EXPLANATION OF TERMS

See Exhibit XVII.

6. PROCEDURAL REQUIREMENTS

Configuration identification numbers are assigned by contractors rather than by the procuring agency to:

- a. Assure the timely availability of all required configuration identifiers for correct entry on engineering data when these data are initially prepared.
- b. Improve the effectiveness of both contractor and procuring agency operations by establishing a complete responsibility for identification at the source of design and manufacture.
- c. Reduce time delays and costs which may result from improper identification, misinterpretation and attendant rework.

6.1 General Requirements

The formal requirements of configuration management have substantially increased the significance of the numbers used to identify the configuration of a product. These configuration identification numbers are used in combination to provide complete identification of the product as required for technical and contractual purposes. Table "A" abstracts the prime characteristics, use, and relationships of the configuration identification numbers.

- 6.1.1 Contractor Responsibility. The contractor shall assign and control configuration identification numbers in accordance with this exhibit without further approval of the procuring agency.
- 6.1.2 Numbers Assigned by Other Design Activities. Where the contract end item of a contractor incorporates the design of a Government agency or the design of a sub-contractor, vendor or supplier, the contractor shall use the configuration identification numbers assigned by these design activities without reidentification except as specifically authorized in this exhibit.

- 6.1.3 Use of Additional Identifiers. Numbers other than the configuration identification numbers described in this exhibit shall not be used for configuration management purposes. Specific examples include:
- a. Registration numbers (e.g., "tail" numbers) assigned by the Government.
 - b. Type designations for the contractor's contract end item, or component thereof, assigned by the Government.
 - c. Other reference designations (e.g., aero numbers) used by the Government.
 - d. Federal Stock Number assigned by the Government to provide a Government Inventory Control.
 - e. "Manufacturing" or "production line" numbers used by the contractor to denote the sequence in which contract end items are manufactured.
 - f. "Synthetic" part numbers used by the contractor to denote a subassembly of manufacture not covered by an engineering assembly drawing.
 - g. Material codes used by the manufacturer for material control.

6.2 Specification Identification Numbers

The contractor shall assign and control the identification numbers for specifications, specification change notices (SCNs) and specification revisions as required by the following subparagraphs. These numbers shall identify all specifications and standards required to control design of systems/equipments to be formally accepted by the procuring agency.

6.2.1 Composition of Specification Identification Numbers.

6.2.1.1 Composition of Specification Numbers.

Contractor prepared specification documents, shall be identified by a number consisting of a document identification number and suffix codes in accordance with paragraph 6.2.2, and shall not exceed a total of 15 characters. (See Figure 1A)

6.2.1.2 Composition of Specification Change Notice (SCN) Numbers. SCNs shall be identified by a number consisting of an SCN number, a dash, a specification page number and an SCN suffix letter assigned as required in paragraph 6.2.3. (See Figure 1B)

6.2.1.3 Composition of Government or Industry Specification Numbers. Government or Industry specifications and standards shall be identified

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by the number assigned by the Government agency or industry association to the specification or standard document. These specifications and standards shall not be reidentified by the contractor unless altered or selected.

- 6.2.2 Assignment of Specification Numbers. The contractor shall assign one number to each specification document to be prepared and maintained by the contractor. The number shall be assigned as follows:
- 6.2.2.1 Document Identification Number. The contractor's document identification number, including combinations of numerals, letters and dashes, shall follow the prefix code. Once assigned to an approved specification, the number shall not thereafter be changed or reassigned to another specification.
- 6.2.2.1.1 The document identification number may be codified in accordance with the contractor's internal systems and procedures providing that such codes will not be changed and do not duplicate the suffix information described in paragraph 6.2.2.2.
- 6.2.2.1.2 The contractor shall assign a new document identification number to an addendum specification which has been created from an existing specification. An addendum specification is a new and complete specification in every sense. It shall be maintained by its own SCN and revision sequence which shall be independent of the change sequence applicable to the specification from which the addendum was created.
- 6.2.2.2 Specification Suffix Code. The suffix code shall follow the document identification number. It shall consist of an upper case (capital) letter assigned in alphabetical sequence to identify the latest approved revision of the specification.
- 6.2.2.2.1 When it is necessary to refer to one item in a requirement items specification, the item shall be identified by the specification number described in paragraph 6.2.2, and an additional suffix code consisting of the paragraph number in Section 3 of the specification which identifies the item (refer to Exhibit V). This item code shall follow the revision letter.
- 6.2.2.2.2 When a component specification applies to more than one source, each source

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shall be identified by the specification number described in paragraph 6.2.2 and an additional suffix code consisting of a separate dash number tabulating each alternate source in the specification. This source code shall follow the revision letter.

6.2.2.3 Examples of specification identification numbers are shown in Table B.

6.2.3 Assignment of Specification Change Notice (SCN) Numbers.

The contractor shall assign one SCN number for each SCN to be prepared by the contractor. One SCN is required for all changes, to a single approved specification, to be approved by one ECP (refer to Exhibits VII, VIII, and IX). The SCN number shall identify the SCN as part of, and subordinate to, the specification which it changes. The number shall be assigned as follows:

6.2.3.1 The first character(s) shall be a numeral(s) to identify one SCN for one specification and its assigned sequence within that specification. This SCN number shall be assigned in numerical sequence beginning with the number 1 (one) for the first SCN number assigned.

6.2.3.1.1 The SCN sequence number shall be a common identifier for all SCN sheets prepared as part of one specification change.

6.2.3.1.2 Once an SCN has been submitted to the procuring agency, its SCN sequence number shall not thereafter be changed or assigned to another SCN within the same specification, even though the SCN is subsequently disapproved.

6.2.3.2 The SCN sequence number shall be followed by a dash and, on each sheet of the SCN, the page number of the specification affected by that sheet of the SCN.

6.2.3.2.1 The content of an SCN sheet is limited to one page of a specification.

6.2.3.2.2 Multiple sheets identified by the same SCN sequence numbers are used where more than one specification page is affected (See Exhibit VII).

6.2.3.3 The specification page number shall be followed by a lower case suffix letter assigned in alphabetical sequence within one SCN page number.

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This suffix shall be applied only when more than one SCN sheet of one SCN is required to describe the change for a single specification page.

6.2.3.4 Examples of SCN numbers are shown in Table B.

6.2.4 Specification Identification Number Assignment Log.

The contractor shall establish and maintain a Specification Identification Number Assignment Log of all specification numbers and SCN numbers assigned to specifications prepared and maintained by the contractor. The log shall be readily available for routine surveillance by the local representative of the procuring agency on a non-interference-with-production basis.

6.2.5 Changes in Specification Numbers.

The document identification number portion of a specification number is a permanently assigned non-duplicated number which identifies the basic specification document. Subsequent changes and revisions to these documents shall be identified in accordance with the following subparagraphs:

6.2.5.1 Rough drafts prepared for coordination prior to formal approval by the procuring agency shall be identified by a document identification number only. No revision letters or SCN numbers shall be assigned.

6.2.5.1.1 The revision letter "A" shall be assigned to the first issue formally approved by the procuring agency.

6.2.5.1.2 Each subsequent change to these approved specifications shall be identified by an assigned SCN number unless otherwise directed by the procuring agency in accordance with paragraph 6.2.5.1.3.

6.2.5.1.3 Revision letters shall be assigned only when directed by the procuring agency and as specifically described in a Configuration Control Board Directive (CCBD) to incorporate previously approved SCNs and/or major specification revisions.

6.2.5.1.4 Component specifications which are contractually required to be formally approved by the procuring agency (refer to Exhibit VI) shall, from the time of formal approval, be controlled by the use of SCN numbers and revision letters assigned in accordance

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with paragraphs 6.2.5.1.2 and 6.2.5.1.3. When formal approval is not required the contractor shall assign revision letters, SCN numbers and/or completely revise component specifications in accordance with his own standard practice.

6.3 Contract End Item CEI Number

The CEI number is a permanent number assigned by the contractor to identify all units comprising one contract end item family (type-model-series).

6.3.1 Definition of a Contract End Item Type-Model-Series.

A contract end item type-model-series constitutes a block of one or more deliverable CEI units to which all of the following apply:

- a. The type-model-series shall be a line item requirement in a contract.
- b. All units shall be designed to and controlled by one contract end item detail specification.
- c. All units shall be identified and documented by one top drawing and a subordinate structure of installation, subassembly and detail drawings.
- d. Within this basic drawing structure, configuration differences in production between units shall be identified and documented by adding and/or limiting the design application of parts and assemblies comprising the affected units.
- e. Each unit shall be formally accepted by the procuring agency and accountability transferred by means of a receiving and inspection report, DD Form 250 or NASA equivalent.
- f. The type-model-series shall be the foundation for provisioning spares (by a contractor or the procuring agency) and for the preparation of operating and maintenance manuals for the CEI type-model-series.

The contract end item type-model-series, as identified by the CEI number, establishes the contractual interface between the contractor and the procuring agency, and is the level of control for all design requirements changes (to CEI detail specification), and Class I engineering changes (to design configuration) to be formally approved by the procuring agency (see Exhibit IX). All Class I engineering changes will be approved for production and/or retrofit incorporation in all unexpended units within a type-model-series or, if limited to incorporation on some but not all units, the series designation of the affected units shall be changed to establish a new series.

6.3.2 Assignment and Control of CEI Numbers.

The CEI number shall be assigned by the contractor at the time the document identification number of the CEI specification is assigned, or the first production drawing for the CEI is released, whichever occurs first.

- 6.3.2.1 The CEI number shall consist of a basic number for the type-model-series followed by a code letter for the series.
- 6.3.2.2 The basic number, including combinations of letters, numerals and dashes, shall precede a series code. Once assigned to a contract end item whose design, development and/or manufacture has been contractually authorized by the procuring agency, this portion of the CEI number shall not thereafter be assigned to another contract end item type and model.
- 6.3.2.3 The basic number may be, or include, portions of the contractor's specification document identification number and/or top drawing number for the CEI, at the contractor's option.
- 6.3.2.4 The last digit of the CEI number shall be the series letter "A." Once assigned this letter shall be the permanent series designation for all contract end items comprising the type-model-series, including follow-on procurement within the series.
- 6.3.2.5 A new series designation for the same basic number shall be assigned only when contractually authorized by the procuring agency wherein all of the following apply:
 - a. The new series is specified by a new contract end item specification, or specification addendum.
 - b. All units in the new series are identified by a new top drawing. The subordinate structure of installation, subassembly and detail drawings may be made applicable as required to the new series by a common release which shows design application for both series (see Exhibits XI and XII).
 - c. A new basis for acceptance, provisioning, operations and maintenance is established.

6.4 Contract End Item Serialization

Contract end item serial numbers are used in configuration management to:

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- a. Identify individual contract end items within a family of CEIs.
- b. Establish this identity as a specific address for all contractual and management actions; this address to be the same as the effectivity (usage) of engineering design and engineering changes which result from these actions.
- c. Relate the specific part number configuration of each contract end item to their engineering effectivity so that it will be built, allocated and changed in accordance with required design.

The contractor shall assign all serial numbers in accordance with this exhibit, and these serial numbers shall be the only serial numbers used by the contractor and the procuring agency as a CEI unit identification and engineering effectivity for configuration management.

6.4.1 Assigning Contract End Item Serial Numbers.

These numbers shall begin with the numeral 1 (one) and shall be assigned in unbroken numerical progression within one contract end item type-model-series. The CEI number and serial number shall denote the engineering effectivity of design. The CEI number and serial number shall be affixed to each contract end item unit manufactured and allocated in accordance with this engineering effectivity and design (see Exhibit XI).

6.5 Drawing and Part Number

The drawing and part number is assigned by the contractor to identify, in common, all parts and assemblies that are interchangeable in all applications where used. A part number must not be changed if it is still interchangeable after incorporating a change. This action would create excess inventories and artificial shortages. The prime function of a part number, therefore, is to control assembly and replacement on the basis of interchangeability. The determination of non-interchangeability is a technical consideration. Part numbers shall not be changed for any other purpose (e.g., to indicate that an assembly includes a change but which did not make the assembly non-interchangeable).

6.5.1 Assignment of Drawing and Part Numbers. Drawing and part numbers, for other than standards, shall be assigned by the contractor in accordance with the requirements in MIL-STD-100

6.5.2 Changing Part Numbers. The contractor shall change the part number in accordance with the requirements in MIL-STD-100, and the following requirements.

6.5.2.1 When a material, process or protective treatment is changed to such an extent that any of the conditions in MIL-STD-100, exist.

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- 6.5.2.2 When a physical part, component, subassembly or contract end item is reworked in production or retrofit by a kit into a later number version of the item, and is completely interchangeable with all items identified by the later number, the physical part shall be reidentified to the number of the later version.
- 6.5.2.3 The contractor may establish a part or component for which the contractor is the design activity as a company standard, identified by a standard specification identification number when all of the following apply:
- a. The part or component has a multiple usage and is expected to have a design application in more than one contract end item.
 - b. The part or component is non-repairable (throw away) and will not be provisioned by the procuring agency or contract below the level identified by the standard specification identification number.
 - c. The part or component is completely specified in a specification document, specification control drawing or source control drawing with respect to performance, durability, reliability, form, fit, qualification, and inspection requirements.
 - d. Unless otherwise concurred in by the procuring agency, one or more alternate sources is approved and qualified to supply the item.
- 6.5.3 Initiation of Part Number Changes. Engineering changes may be incorporated and documented by drawing change letter control only (without changing part number) up to the cut-off date established by the contractor for incorporation of changes in the factory on the first unit of a CEI type-model-series, or component thereof, to be formally accepted by the procuring agency, and providing that all such changes are made effective on CEI serial number 1 and on. Thereafter drawing change letter control shall continue and, in addition, part numbers shall be changed as required by paragraph 6.5.2.
- 6.5.4 Changes in Higher Level Assembly Part Numbers. When a CEI contains a non-interchangeable item, the part number of the non-interchangeable item of its next assembly, and of all progressively higher assemblies shall be changed only up to and including the assembly where interchangeability is re-established. Part numbers shall not be changed above this level of assembly for any reason.

6.6 Part Number Serialization

The contractor (or his subcontracted design activity) shall serialize all engineering critical and logistic critical components (refer to Exhibit VI) of a CEI by drawing and part number. The contractor may also serialize other assemblies or parts of a contract end item as he may require.

6.6.1 Assigning Serial Numbers to Components, Assemblies and Parts. The drawing number shall be the base for serializing a critical component, assembly, or part.

6.6.1.1 Serial numbers shall be permanently assigned in numerical sequence within the drawing number.

6.6.1.2 A new serial number sequence shall not be assigned when the part number is changed to identify a non-interchangeable design.

6.6.1.3 The serial number of a reworked or retrofit item shall not be changed even though the item has been identified by a new part number.

6.7 Change Identification Numbers

The change identification number is a packaging number assigned by the contractor to package all engineering data defining an engineering change, and is used to control, sequence and account for production and retrofit accomplishment of the change. These changes are classified in accordance with MIL-STD-480. This classification determines the method used to compose a change identification number.

6.7.1 Composition of a Class I Change Identification Number. The complete Class I change identification number contains three basic parts. These are:

- a. Prefix designations which relate the change to the contract end item, to the contractor and to the system program affected by the Class I change.
- b. An eleven (11) character ECP sequence number which identifies each individual Class I engineering change. The ECP is the basic "delta" increment for configuration control and accounting by the procuring agency of the approved system and contract end item configuration.
- c. A correction code to distinguish between ECP documents containing minor editorial corrections and the original copy.

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The contractor shall construct the complete Class I change identification number in accordance with the pattern shown in Figure 2. The example identifies the 31st ECP processed by contractor 15802 for the 114 system. The change affects CEI 376524B and other CEIs produced by the contractor as noted by the ECP dash number. These requirements for constructing a Class I change identification number include and incorporate the requirements in MIL-STD-480.

- 6.7.1.1 The system designation number will be provided to all contractors by the procuring agency at the beginning of a system program.
- 6.7.1.2 The contractor shall assign ECP numbers consecutively from a separate series for each system program (i.e., program identified by a system designation number), or the ECP series may be established in accordance with MIL-STD-480 for contract end items not a part of a system program. The first ECP processed shall be ECP number 1 (one). Once assigned the ECP number shall be retained for all subsequent submissions of the proposal, and for all ECP Type, revisions and/or correction codes which may be appended to that number.
- 6.7.1.3 Class I engineering changes affecting more than one CEI number under the cognizance of a single contractor shall be identified by a basic ECP number with a separate dash number assigned for CEI affected. Each dash numbered ECP must be complete in itself for the CEI change being proposed. The purpose of dash numbers is to relate all CEIs affected by a change.
- 6.7.1.4 The contractor shall assign one of the following type codes to each ECP. The type code may be changed to reflect a new condition of the ECP if it is necessary on resubmittal of a proposal.

<u>Type of ECP</u>	<u>Type Code</u>
Preliminary	P
Formal	F

Class I ECP justification codes and change priorities shall be assigned in accordance with the requirements of MIL-STD-480.

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- 6.7.1.5 The contractor shall identify each formal revision to the ECP with an "R1" for the first revision, "R2" for the second revision, etc.

Note: The requirements for using the revision code are described in Exhibits VIII and IX.

- 6.7.1.6 The ECP sequence number shall consist of the basic ECP number followed by a dash and dash number, a type code, a revision identification and a correction code as applicable. The total number of characters for numerals, dashes and letters shall not exceed eleven (11). The ECP sequence number is the number which is shown in configuration index and accounting reports as the ECP number because reporting formats are designed to otherwise display prefix information.

- 6.7.1.7 The contractor shall denote that an ECP document has been corrected editorially but not otherwise changed by a "C1" for the first correction, "C2" for the second correction, etc. The correction sequence shall begin anew for each revision.

EXAMPLE: R1-C1 is the first correction of the first revision; R1-C2 is the second correction of the first revision; R2-C1 is the first correction of the second revision.

- 6.7.2 Composition of a Class II Change Identification Number. Class II change identification numbers may be constructed in accordance with the contractor's internal systems and procedures providing that these procedures are compatible with MIL-STD-480.

6.8 Code Identification Numbers

This shall be the five-digit number of the contractor or Government agency as shown in Cataloging Handbook H4-1, "Federal Supply Code for Manufacturers."

- 6.8.1 Contractor Code Identification Numbers. Contractors having more than one division, each having an H4-1 code, shall use the code of the division which is the design activity, and shall also use the code of the division which is the manufacturer when a different division (refer to Exhibit XI).
- 6.8.2 Government Agency Code Identification Numbers. When a Government agency is a design activity or a manufacturer, the H4-1 code of the responsible Government agency shall be used. If no H4-1 code has been assigned, the mnemonic abbreviation of the agency shall be used.

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CONFIGURATION IDENTIFICATION NUMBERS

NUMBER	CHARACTERISTIC	USE AND RELATIONSHIP
Specification Number	Requirements Number	Denotes technical requirements. Is used to identify system, contract end item and component specifications and relate these documents to program baselines. It is also used to identify company standards.
Contract End Item Number (CEI)	Permanent Number	Denotes type-model series. It is used to identify the level at which technical and contractual requirements shall be managed.
Drawing and Part Number	Transient Number	Denotes interchangeability and non-interchangeability. It is used to control assembly and replacement at all levels including the contract end item itself.
Serial Number	Permanent Sequence Number	1. Used with a CEI number to denote each unit in a type-model-series and be the engineering effectivity to which all management actions are specifically addressed. 2. Used with a drawing and part number to denote each unit in a family of non-interchangeable parts which, when reworked or modified to be interchangeable, are reidentified the same.
Change Identification Number	Packaging Number	Denotes the content of a change. It is used to package, control, sequence and account for all engineering production and retrofit actions required for a single change.
Code Identification Number	Number Modifier	Denotes design activity and/or manufacturing source. It is used with above contractor assigned numbers to assure unique identification.

TABLE A

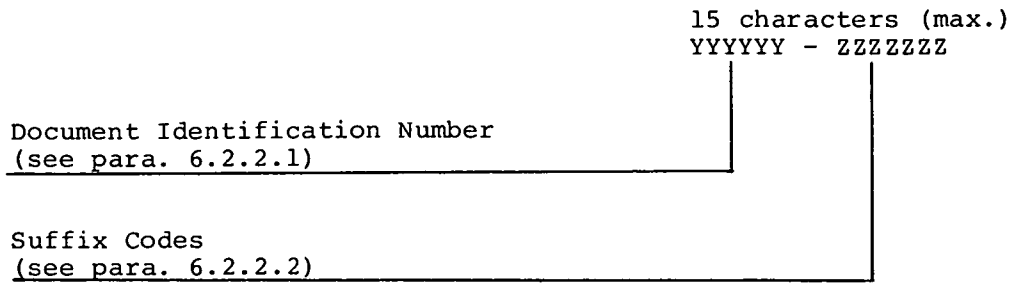


Figure 1A
Specification Number

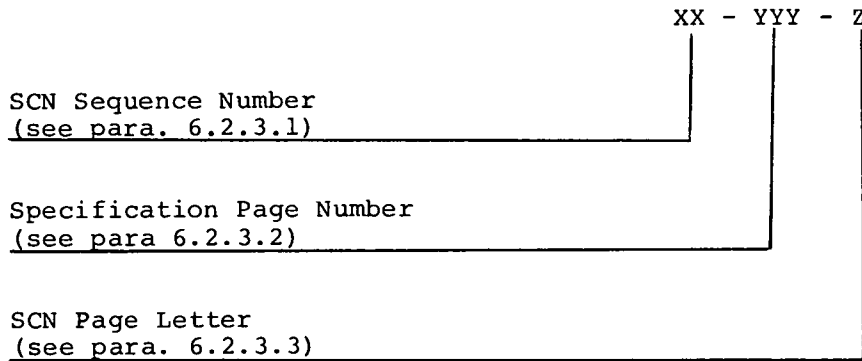


Figure 1B
Specification Change Notice Number

CONSTRUCTION OF SPECIFICATION AND SCN NUMBERS

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SPECIFICATION NUMBER	DESCRIPTION OF EXAMPLE
123456	Specification draft for coordination
123456A	First formally approved issue of the same specification
10-40b	The second SCN sheet to a change affecting page 40 of specification 123456A which was approved as SCN #10
123456B	Revised specification incorporating the first revision directed by a CCBD
382159A	First formally approved addendum specification made from 123456B and to be maintained by SCN's and revisions independent of the parent specification

TABLE B

EXAMPLES OF SPECIFICATION IDENTIFICATION NUMBERS

CONSTRUCTION OF THE CLASS I
CHANGE IDENTIFICATION NUMBER

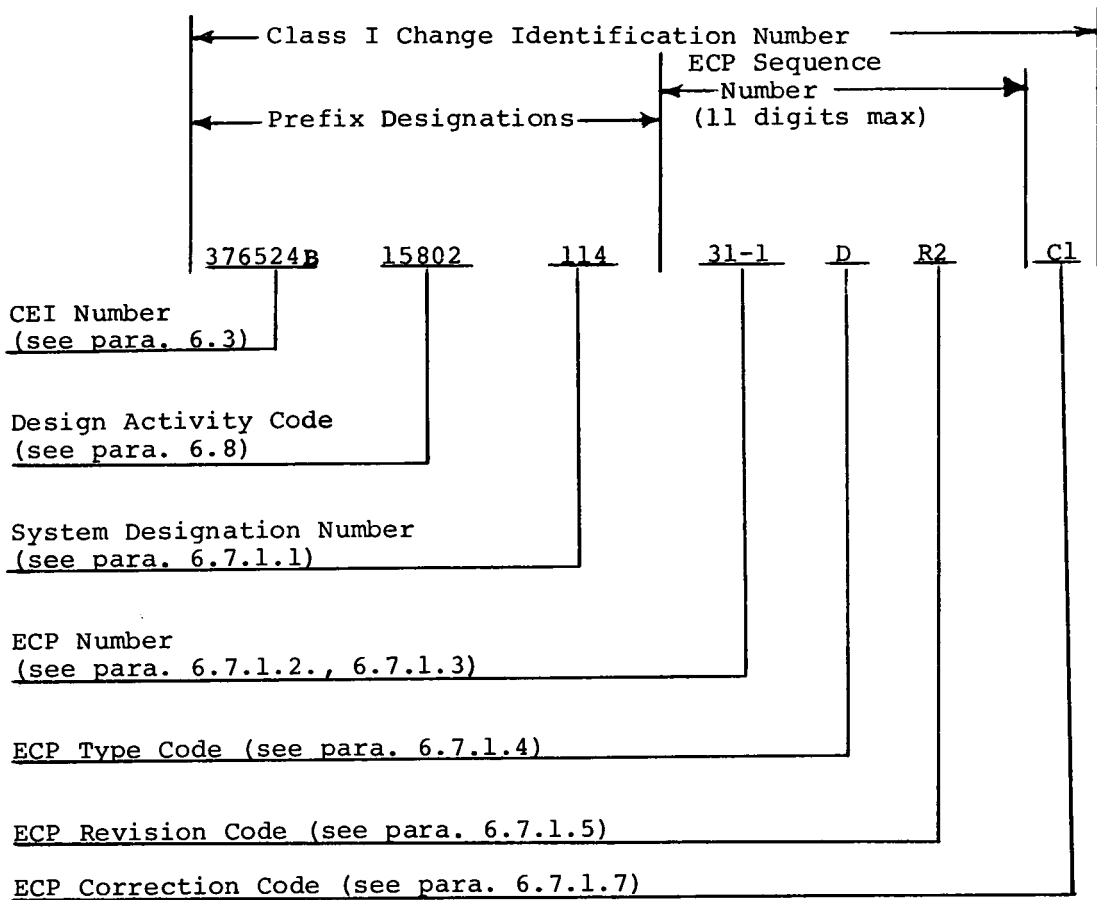


Figure 2

EXHIBIT XI

REQUIREMENTS FOR CONFIGURATION
IDENTIFICATION AND ACCEPTANCE OF
CONTRACT END ITEMS AND
RELATED DATA

EXHIBIT XI

REQUIREMENTS FOR CONFIGURATION
IDENTIFICATION AND ACCEPTANCE OF
CONTRACT END ITEMS AND
RELATED DATA

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REQUIREMENTS FOR CONFIGURATION
IDENTIFICATION AND ACCEPTANCE OF
CONTRACT END ITEMS AND
RELATED DATA

1. PURPOSE

This exhibit provides NASA and contractor organizations with requirements for identifying and interrelating contract end item equipments, facilities, spares, technical documents, and engineering data which are to be formally accepted by the procuring agency.

2. SCOPE

This exhibit establishes requirements for identifying configuration at parts, component, subassembly and contract end item levels of assembly of systems/equipments. It establishes the documentation relationship by which the identified configuration will be accepted as contract end items. This exhibit pertains to:

- a. Engineering specifications, drawings, lists and release records.
- b. Acceptance documents.
- c. Name plates and alternate means for the identification and marking of hardware and containers.
- d. Technical documents.

3. APPLICABILITY

This exhibit applies to contract end items and related documents which are to be formally accepted or approved by the procuring agency for systems programs or for any other use. It applies to all contracts with the procuring agency for these items and documents, and for systems engineering and/or system integration contracts involving these items and documents. Contractors to the procuring agency shall be responsible for the compliance of their subcontractors, vendors, and suppliers.

4. REFERENCE DOCUMENTS

4.1 Applicable Documents

The following documents of the exact issue shown, or part thereof as further described, form a part of this exhibit:

Exhibit X		"Requirements for Configuration Identification Numbers"
MIL-STD-100A	1 October 1967	"Engineering Drawing Practices"
MIL-STD-129D	28 December 1964	"Marking for Shipment and Storage"
MIL-STD-130C	29 September 1967	"Identification Marking of U.S. Military Property"
MIL-STD-480	30 October 1968	"Configuration Control - Engineering Changes, Deviations and Waivers"

5. EXPLANATION OF TERMS

(See Exhibit XVII.)

6. PROCEDURAL REQUIREMENTS

These procedures are based on the policies and practices of the procuring agency for configuration management. It is recommended that contractors review and understand these policies and practices as a part of implementing the procedural requirements in this exhibit.

6.1 General Requirements

Configuration shall be identified:

- a. At every level of assembly (piece parts through final assembly).

- b. On every deliverable item produced by the contractor and formally accepted by the procuring agency (i.e., equipments, facilities, spares, technical documents).
- c. By engineering drawings and specifications. These data, as approved and formally released, shall be the source of all configuration requirements for the production of all other deliverable products and documents.
- d. At all times subsequent to formal acceptance (through later testing, assembly, checkout, and operational usage to ultimate consumption) by proper update of engineering drawings and specifications to cover incorporated changes.

The contractor shall identify configuration by the set of numbers defined in Exhibit X for use as applied in accordance with the procedural requirements of this exhibit. Numbers other than those defined for use in Exhibit X shall not be used for configuration management.

6.2 Implementation Requirements

As part of implementing this exhibit, the contractor shall demonstrate to the procuring agency that he has adequate policies, organization and procedures for configuration management.

6.2.1 Contractor Responsibilities. The responsibilities of the contractor for configuration identification are:

- 6.2.1.1 To compose and assign all configuration identification numbers in accordance with Exhibit X.
- 6.2.1.2 To apply these numbers to documents and equipments in accor-

dance with the requirements in this exhibit.

- 6.2.1.3 To continuously maintain the relationship and continuity between these documents and equipments so that the development and qualification of equipment, it's production and logistic support will match engineering and contract requirements.

6.3 Engineering Drawings

The contractor shall use MIL-STD-100 and its directly referenced documents, to completely identify configuration on drawings.

6.3.1 Identification Numbers

- 6.3.1.1 All standard configuration identification numbers shall be shown on engineering drawings or in engineering release records.
- 6.3.1.2 All standard configuration identification numbers shall be on submitted engineering drawings and lists.
- 6.3.1.3 The same drawings and configuration identification numbers used for manufacture or construction of, and change to, deliverable equipments and facilities shall be used for the manufacture of spares and preparation of operations and maintenance manuals for these same equipments and facilities.
- 6.3.1.4 These same drawings and identification numbers shall be used for manufacturing additional quantities of these same equipments and facilities.
- 6.3.1.5 All drawings shall contain the code identification number of the design activity for the drawing.
- 6.3.1.6 Existing drawings shall not be revised to retroactively incorporate the identification requirements in Exhibit X. As existing drawings are re-released for a l-and-on effectivity for a new contract end item type-model-

series, they shall be redressed to be in accordance with Exhibit X.

- 6.3.2 Application Data. All production and construction drawings which together document the technical description of a CEI shall be interrelated by drawing application data which may be entered on the drawings or in the engineering release records for the drawings, and will provide the information required in the following subparagraphs.
- 6.3.2.1 The "PART NO." created by the drawing for callout in the list of materials of the parts "NEXT ASSEMBLY."
 - 6.3.2.2 The "NEXT ASSEMBLY" part number(s) of all immediate next assemblies of each "PART NO."
 - 6.3.2.3 "REQ'D PER N/A" (Required Per Next Assembly) shall contain the total number of "PART NO." items required to make one of each "NEXT ASSEMBLY."
 - 6.3.2.4 The "END ITEM NO." in which each "NEXT ASSEMBLY" is to be installed.
 - 6.3.2.4.1 If the design activity is a sub-contractor, vendor or supplier whose end product is a sub-assembly part of the contractor's CEI, the "END ITEM NO." will be the top drawing number of his end product.
 - 6.3.2.5. The "SERIAL NO." of the contract end items in which each "NEXT ASSEMBLY" is to be installed. "X & UP" or "X & ON" notations shall be used.
 - 6.3.2.5.1 If the design activity is a sub-contractor, vendor or supplier whose end product is a sub-assembly part of the contractor's CEI, the "SERIAL NO." will be the part number serialization assigned by the supplier within the top drawing number.

NOTE: The procuring agency regularly accepts contract end items from one source and supplies them for installation in equipments to be supplied as a contract end item by ano-

ther source. An example is an engine supplied for installation in an aerospace vehicle. In these cases the installing contractor shall always identify the supplied contract end item in the list of material of his drawing as Government-furnished.

6.3.2.6 The top drawing or release record of a contractor's CEI or of the end product of a subcontractor, vendor or supplier shall contain no application data.

6.3.3 Revision Block. All production and construction drawings shall contain a revision block in accordance with the format in MIL-STD-100. This block shall be maintained as follows:

6.3.3.1 Up to the time of cutoff established by the contractor for changes to be incorporated prior to formal acceptance by the procuring agency of the first CEI in the type-model-series, the production or construction drawings shall be maintained by change letter control and drawing revisions noted in the revision block in accordance with standard practice.

6.3.3.2 At and subsequent to this cutoff all drawing revisions shall be identified by a change identification number in addition to a drawing revision letter and date. This identification shall be permanently retained even if the drawing is completely redrawn.

6.3.3.3 The "DESCRIPTION" column of the revision block shall identify the change identification number and relate it to the drawing revision letter as follows:

6.3.3.3.1 The contractor shall first enter the note "CLASS I" or "CLASS II" to indicate the classification of the change in accordance with MIL-STD-480 (refer to Exhibits VIII and IX).

- 6.3.3.3.2 The contractor shall next enter the change identification number of the Class I or Class II change.
- 6.3.3.3.3 The contractor shall then note any other pertinent revision letter data.
- 6.3.3.4 Drawings may be changed by an ancillary document of the drawing (e.g., an E.O., ECN, etc.) rather than by drawing revision, in which case the ancillary document shall contain the data required in paragraphs 6.3.3.3.1 and 6.3.3.3.2.
 - 6.3.3.4.1 When ancillary documents are incorporated in the drawing, the data in paragraphs 6.3.3.3.1 and 6.3.3.3.2 shall be transcribed and entered in the revision block of the drawing for the appropriate revision letter.
- 6.3.3.5 There may be more than one classified change per revision letter. There shall not be more than one revision for one classified change.
- 6.3.4 List of Material. Vendor parts components and sub-assemblies, other than standards, shall normally be listed by vendor part number. Specification identification numbers shall be used only until the vendor part number is assigned and obtained.
 - 6.3.4.1 When more than one source can satisfy the design application, only one source shall be made a requirement for the CEI unit that is FACI'd (refer to Exhibit XIV), and all subsequent units, unless alternate sources are formally approved by the procuring agency.
 - 6.3.4.2 If an additional source is approved as an alternate and interchangeable, the item shall continue to be identified by one vendor drawing and part number accompanied by an alternate and interchangeable note referencing the other drawing and part number(s) and the governing specification identification number.
- 6.3.5 Top Drawings, Sites and Interconnects. In configuration management, all production and construction drawings are part of some prime equipment item or identification item (see Table A). All items shall have a top

drawing, shall be formally accepted by the procuring agency at the contractor's plant or site of construction, and shall be controlled thereafter as Government property. In system programs, this property is then installed in higher order contract end items which are also formally accepted. Lastly, the integrated installation at each location is accepted and turned over to a using agency.

- 6.3.5.1 The contractor's top drawing for a contract end item shall define the configuration in which it may be removed and replaced for maintenance or modification.
- 6.3.5.2 Loose equipment is a delivery condition. Knockdowns for shipment and kits of identification items shall not be shown on production drawings.
- 6.3.5.3 Special shipping and storage containers shall be identified as prime equipment items or identification items (see Table A) as determined by their specifications.
- 6.3.5.4 Site construction shall be documented by a top drawing as a facility contract end item and shall be formally accepted by the procuring agency at the Beneficial Occupancy Date (B.O.D.). Field runs shall be dimensioned to the extent required to control interfaces, provide clearance for future installations and data for replenishing spares.
- 6.3.5.5 Equipped facilities shall be a prime equipment contract end item consisting of the site after B.O.D., installed GFE (accepted contract end items), RPIE and interconnects (including accepted identification items, and/or parts called out as part of the facility top drawing).
- 6.3.5.6 A complete complex or base shall be a prime equipment contract end item documented by a top drawing when required to call out inter-site cabling, splice-ins, conduit, etc.

6.4 Equipment Identification Nameplates and Markings

The contractor shall identify deliverable contract end item equipments, aerospace facilities and spares by nameplates and markings as required by this Section. Nameplates and markings

shall be made and affixed in accordance with MIL-STD-130, and MIL-STD-129, or NASA equivalent, as supplemented and, in case of conflict, superseded by these instructions. All configuration identification information on these nameplates and markings shall be taken from and agree with production or construction drawings and/or their engineering release records.

- 6.4.1 Contract End Items (CEI's). The contractor shall identify each deliverable contract end item unit with a nameplate arranged as shown in Figure 1 and containing the information shown thereon. CEI nameplates shall be located for convenient examination by service and operating crews when the CEI is in an operationally ready position.
- 6.4.2 Engineering Critical Components. The contractor shall identify each engineering critical component with a nameplate arranged as shown in Figure 1 and containing the information shown thereon except:
- 6.4.2.1 Note 1 "Leave blank."
- 6.4.2.2 Note 2 shall be the part serial number (not the CEI serial number).
- 6.4.2.3 Note 3 shall be the part number of the critical component (not the CEI part number).
- 6.4.2.4 Note 4 shall be the specification and revision number of the critical component specification (not the CEI Detail Specification and revision number).
- 6.4.3 Identification Items. The contractor shall identify each identification item (see Table A) by a nameplate or equivalent containing the "CONFIGURATION IDENTIFICATION" data shown in Figure 1, notes (1) through (6).
- 6.4.4 Requirement Items. Requirement items (see Table A) are GFE. The contractor shall re-identify GFE only as required by Modification Instructions which he accomplishes and logs in historical records supplied with the GFE. When a requirement item is altered or selected by a contractor it shall be identified as a contract end item by the contractor in accordance with paragraph 6.4.1 or 6.4.3, or as a part thereof.
- 6.4.5 Minimum Marking Requirements for CEI's and Components. The contractor shall mark CEI's and critical components, which are too small for complete identification, with the following minimum configuration data:

- 6.4.5.1 The part number.
 - 6.4.5.2 The serial number.
 - 6.4.5.3 The design activity code identification number, and the manufacturer's code identification number, if different.
- 6.4.6 Serialization. The contractor shall serialize all contract end items and critical components. Other parts and assemblies may be serialized at the contractor's option.
- 6.4.7 Parts and Standards. The contractor shall mark all parts and company standards with their part number or standard specification identification number, serial number (if used), the design activity code identification number, and the manufacturer's identification number code (if different). The contractor need not comply with this practice when:
- 6.4.7.1 The part is too small, or would be physically or functionally damaged by this identification. In this situation shipping containers shall carry the required identification, if used.
 - 6.4.7.2 The part is encapsulated within another or otherwise permanently assembled and is not replaceable as a unit.
 - 6.4.7.3 The part is a permanent part of a constructed facility.
- 6.4.8 Shipping and Storage Containers. The contractor shall mark shipping and storage containers as required by MIL-STD-129, supplemented to include the "CONFIGURATION IDENTIFICATION" data shown in Figure 1 as defined in paragraphs 6.4.1 through 6.4.7.

6.5 Technical Documents

When Technical Documents (Operations and Maintenance Manuals, Modification Instructions, Illustrated Parts Breakdowns, etc.) are required by the procuring agency the contractor shall insure that the following minimum requirements for relationship and identification are satisfied:

- a. The Technical Documents must relate to the engineering data (specifications and drawings) on which they are based.
- b. The Technical Documents must identify the specific contract end item configuration(s) to which they apply.

- c. The Technical Documents must cross reference changes or revisions to the approved engineering change proposal being incorporated in the contract end item.

6.5.1. Operations and Maintenance Manuals. When different production configurations of a contract end item are to be accepted (as identified by the production incorporation of Class I changes), the contractor shall clearly organize the material in technical manuals so that they may readily be used to operate and maintain these different configurations. This capability shall be retained until full retrofit to a standard configuration has been accomplished.

6.5.1.1 Configuration Chart. The contractor shall include a configuration chart, or equivalent display, in each operations and maintenance manual. The function of the configuration chart is to relate the technical manual, its revisions and/or supplements to the configurations they describe and support. The recommended format should be similar to a chart used in specifications to document their revision status, and will therefore permit direct comparison with the revision status of a technical manual. The configuration chart shall be inserted immediately behind the title page.

6.6 Acceptance by the Procuring Agency

Formal acceptance by the procuring agency shall include all procedures and data necessary for inspection, testing or verification, and approval of contract end items, spares or other equipment or data requiring transfer of title to an authorized Government agency.

6.6.1 Acceptance Requirements

- 6.6.1.1 Acceptance testing will be conducted as specified in Part II of a CEI Specification to verify compliance with the functional requirements in the specification.
- 6.6.1.2 Identification will be verified by inspection of nameplates or the title pages of Operations and Maintenance Manuals to assure correspondence with drawings.
- 6.6.1.3 Certification shall be made by the contractor and verified by the procuring agency that the equipment has been manufactured to the applicable configuration required by engineering

EXHIBIT XI

- drawings and specifications (refer to Exhibit XIII).
- 6.6.1.3.1 The specification for the item presented for acceptance shall be reconciled with the applicable approved engineering changes (ECP's) incorporated as a specified requirement.
 - 6.6.1.3.2 The specification for the acceptance item shall be reviewed to ensure that all waivers and/or deviations from the specification are approved and accepted by the procuring agency.
 - 6.6.1.4 Shortages shall be verified from engineering data and recorded on the acceptance document (see paragraph 6.6.1.8).
 - 6.6.1.5 An equipment historical record will be prepared for each end item as a vehicle for recording the history of calendar or cyclic life components within the end item as well as for recording approved engineering changes incorporated in production (and later by retrofit).
 - 6.6.1.6 Technical Documents will be verified to the extent specified by the procuring agency, on the equipment to which they are applicable, individually or as part of a system as appropriate.
 - 6.6.1.7 Engineering data shall be provided by the contractor and will include the following as required within the applicable contract:
 - 6.6.1.7.1 An approved contract end item specification.
 - 6.6.1.7.2 A complete set of released engineering drawings prepared in accordance with MIL-STD-100.
 - 6.6.1.7.3 All applicable interface drawings and/or data with approval completed as directed by the procuring agency.
 - 6.6.1.8 Every contract item accepted by NASA will be accepted by execution of a Material Acceptance and Receiving Report (DD Form 250 or equivalent).

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- 6.6.1.8.1 The DD-250 (or equivalent) shall identify, by serial number, all controlled subassemblies and/or requirement items within the prime end item.
- 6.6.1.8.2 All shortages or other departures from contractual acceptance requirements will be included on the DD-250 (or equivalent).

6.7 System Acceptance

All equipments, facilities, spares, technical documents, and engineering data comprising a system shall be accepted in accordance with the foregoing paragraphs. System acceptance consists of successful completion of a test program as specified in the system performance requirements design general specification. Each Apollo system programmed will undergo acceptance procedures in accordance with the preceding configuration documentation requirements.

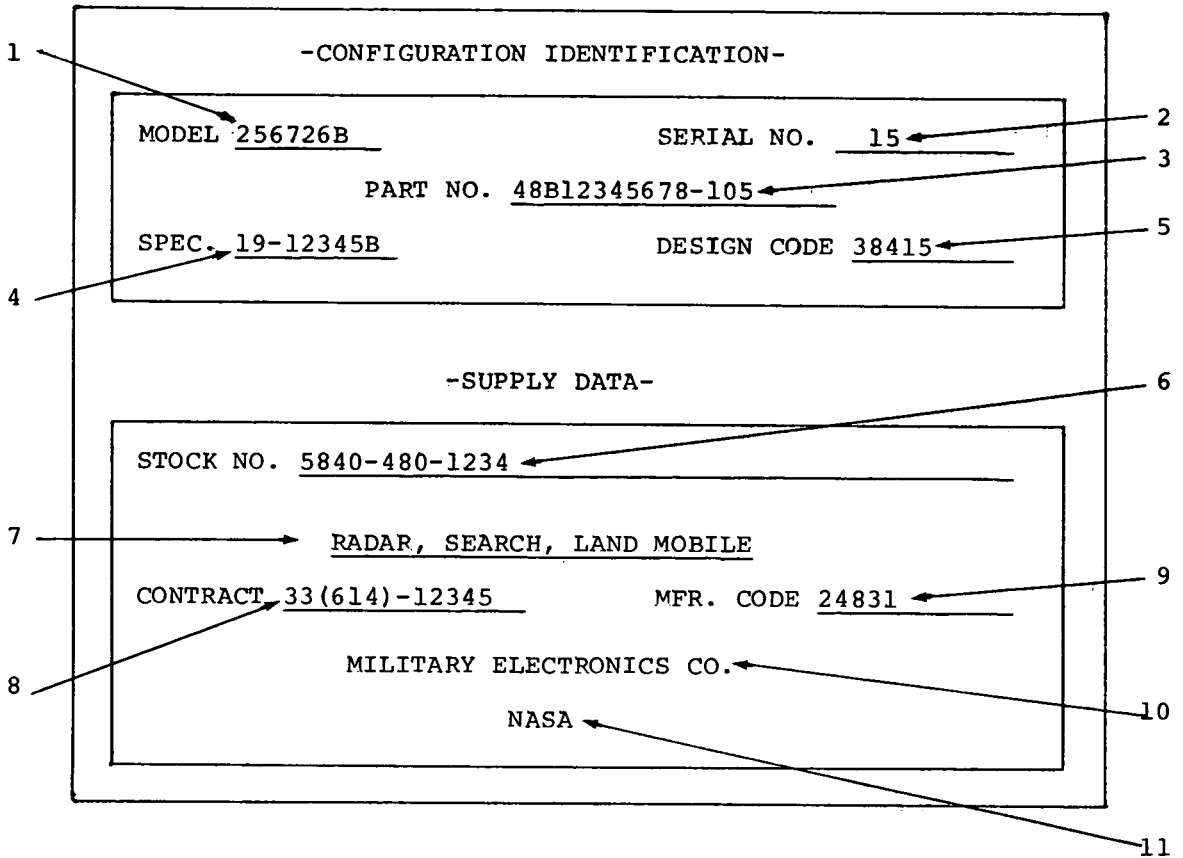
TABLE A
EQUIPMENT CATEGORIES

EQUIPMENT REQUIREMENTS	CONTRACT END ITEMS		
	REQUIRE- MENT CEI's	IDENTIFI- CATION CEI's	PRIME EQUIPMENT CEI's
Equipment is supplied by contractor	No	Yes	Yes
Contractor will prepare individual specifications for each CEI	No	Yes	Yes
Major provisioning action required	No	Yes	Yes
Contractor will prepare individual technical manuals for each CEI	No	No	Yes
100% acceptance testing required	No	No	Yes
Engineering changes are expected after item has been formally accepted	No	No	Yes

These items are GFE. _____

These items are secondary support items delivered by the contractor. _____

These items are prime items. They provide the basis for configuration control, including the control of Identification and Requirement CEI's. _____



NOTES:

- 1 CONTRACT END ITEM NUMBER
- 2 CONTRACT END ITEM SERIAL NUMBER
- 3 CONTRACT END ITEM PART NUMBER
- 4 CONTRACT END ITEM DETAIL SPECIFICATION AND REVISION NUMBER
- 5 DESIGN ACTIVITY CODE FROM CATALOGING HANDBOOK H4-1
- 6 FEDERAL STOCK CLASS AND FEDERAL ITEM IDENTIFICATION NUMBER
- 7 NOMENCLATURE
- 8 MANUFACTURING CONTRACT NUMBER
- 9 MANUFACTURER'S CODE FROM CATALOGING HANDBOOK H4-1
- 10 MANUFACTURER'S COMPANY NAME
- 11 GOVERNMENT OWNERSHIP SYMBOL

SAMPLE CONTRACT END ITEM NAMEPLATE

FIGURE 1

EXHIBIT XII

ENGINEERING RELEASE RECORD REQUIREMENTS

EXHIBIT XII

ENGINEERING RELEASE RECORD REQUIREMENTS

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ENGINEERING RELEASE RECORD REQUIREMENTS

1. PURPOSE

This Exhibit provides NASA and contractor organizations with the minimum requirements of the procuring agency for achieving proper relationships between identification elements in an engineering data file.

2. SCOPE

This exhibit establishes minimum requirements and capabilities to be provided by the contractor's engineering release system pertaining to:

- a. Elements of data required.
- b. Contractor's production release functional capabilities.
- c. Release of engineering changes.
- d. Contractor's field release functional capabilities.

The exhibit does not establish, or require the contractor to provide, standardized formats for an engineering release system.

3. APPLICABILITY

This exhibit is applicable to all contracts requiring submission of engineering data. Contractors to NASA shall be responsible for the compliance of their sub-contractors, vendors and suppliers.

4. REFERENCE DOCUMENTS

The following documents are referenced in the text of this exhibit for reference purposes only, and do not form a part of this exhibit:

Exhibit X	"Requirements for Configuration Identification Numbers."
-----------	--

Exhibit XIV

"Formal Configuration Management Reviews, Inspections and Demonstrations."

5. EXPLANATION OF TERMS

See Exhibit XVII.

6. PROCEDURAL REQUIREMENTS

6.1 General Requirements

The contractor shall prepare and maintain engineering release records in accordance with his formats, systems, and procedures, and the minimum requirements in this exhibit. The contractor's formats, systems, and procedures may include information in addition to these minimum requirements providing that the portion thereof which constitutes engineering release records:

- a. Is limited to an expression of configuration requirements defined by engineering data.
- b. Does not reflect a hardware or other product condition that varies from the engineering requirements contained in these data.
- c. Does not reflect manufacturing status.

Only one release record (which may be multisheet) shall be maintained for each drawing number. Drawings released by a subcontractor, vendor, supplier, or another contractor shall not be re-released by the contractor.

6.2 Elements of Data Required

The contractor's engineering release records shall contain the standard configuration identification numbers (refer to Exhibit X) and other elements of information listed in this subparagraph.

6.2.1 Contract End Item (CEI) Elements:

CEI Number.

CEI Serial Numbers.

Top Drawing Number.

CEI Specification Identification Number.

6.2.2 Drawing Elements:

Drawing Number.

Drawing Title.

Code Identification Number

Number of Sheets.

Date of Release.

Change Letters.

Date of Change Letter Release.

Ancillary Document Numbers (ECNs, E.O.s, Variations, etc.).

Specification Document, Specification Control Drawing or Source Control Drawing Number.

6.2.3 Part Number Elements

Controlling Drawing Number.

Part Numbers Released.

Change Letter which created Part Number.

Change Identification Number which created Part Number.

6.3 Contractor's Production Release Functional Capabilities

To the extent that the contractor has detail design responsibility, the contractor's release function and documentation, including drawings and associated lists, shall be capable of determining these released engineering requirements:

6.3.1 The composition of any part number at any level in terms of subordinate part numbers, except for standard parts.

6.3.2 All next higher using (next assembly) part numbers of any part, except for parts assembling into standard parts.

6.3.3 The composition of any CEI in terms of part numbers and subordinate CEI numbers.

- 6.3.4 The CEI number and CEI serial numbers (effectivity) on which any subordinate part is used. This does not apply to subcontractors, vendors, and suppliers who are not producing CEIs.
- 6.3.5 The Class I and Class II Change Identification Numbers, which have been partially or completely released for any CEI Number and CEI Serial Number.
- 6.3.6 The CEI numbers and CEI serial numbers, which constitute the effectivity of any change identification number.
- 6.3.7 The Class I and Class II change identification numbers, which have been partially or completely released for any part number.
- 6.3.8 The standard specification numbers or standard part numbers used within any non-standard part number.
- 6.3.9 The subcontractor, vendor, or supplier part numbers which have been assigned in response to critical component specification documents, specification control drawings, or source control drawings issued by the contractor.
- 6.3.10 The contractor's specification document, specification control drawings, or source control drawing numbers associated with any subcontractor, vendor or supplier part number.

6.4 Release of Engineering Changes

The contractor's release function and documentation shall be capable of identifying engineering changes, and of retaining the record of superseded configuration requirements, affecting items which have been formally accepted by the procuring agency.

- 6.4.1 All Class I and Class II engineering changes released for production incorporation shall be identified by change identification numbers and shall be completely released prior to formal acceptance of the CEI unit where first installed.
 - 6.4.1.1 The configuration released for each CEI unit at the time of its formal acceptance shall be retained in release records for the time required by retention of records requirements in the contract, or as otherwise provided in paragraphs 6.5 through 6.5.3.

- 6.4.2 All engineering design released for incorporation in any CEI which has been formally accepted shall be identified by change identification numbers which are different than those assigned in accordance with paragraph 6.4.1, above.

6.5 Contractor's Field Release Functional Capabilities

Engineering data defining formally accepted equipment which is under the jurisdiction of the contractor, and which is progressing through testing or through activation programs, shall be maintained current with all field activity requirements and released as follows:

- 6.5.1 Superseded requirements may be replaced by superseding requirements in the release records for formally accepted units of a CEI type, model, series which are supported by the contractor and which were accepted prior to the FACI (refer to exhibit XIV) of the CEI type, model, series; i.e., at the contractor's option, superseded requirements need not be retained in the release record for these units.
- 6.5.2 After FACI, superseded requirements shall be retained (as a reference release) and superseding requirements added (as a requirements release) in the release records for all units of the CEI which have been formally accepted and are under the jurisdiction of the contractor; i.e., the multiple release procedure shall be used.
 - 6.5.2.1 Superseded requirements shall be retained in multiple release records until status accounting records indicate superseded configurations are no longer in inventory.
- 6.5.3 Engineering changes to CEIs which have been formally accepted by the procuring agency, and which are not under the jurisdiction of the contractor, shall be released for service action; i.e., the multiple release procedure shall not be used.

EXHIBIT XIII

REQUIREMENTS FOR VERIFYING THE
INCORPORATION OF CLASS I ENGINEERING CHANGES

EXHIBIT XIII

REQUIREMENTS FOR VERIFYING THE
INCORPORATION OF CLASS I ENGINEERING CHANGES

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REQUIREMENTS FOR VERIFYING THE
INCORPORATION OF CLASS I ENGINEERING CHANGES

1. PURPOSE

This Exhibit provides NASA Apollo organizations and contractors with requirements and guidance for inspecting and recording the incorporation of Class I engineering changes in deliverable contract end items, vendor items and subassemblies which are part of contract end items.

2. SCOPE

The requirements in this Exhibit identify the contractor capabilities necessary to control internally the incorporation of Class I engineering changes (hereafter referenced to as "engineering change") in contract end items. The contractor's internal system of controls shall be capable of:

- a. Reconciling engineering work authorizations to contract requirements.
- b. Verifying that released engineering and purchase order data are in accordance with contract requirements.
- c. Assuring that engineering changes are manufactured and installed as required for formal acceptance.
- d. Documenting engineering change incorporation as required for formal acceptance.

3. APPLICABILITY

This Exhibit applies to all contracts with NASA for deliverable manufactured products.

4. REFERENCE DOCUMENTS

The following documents of the exact issue shown, or part thereof as further described, for a part of this exhibit:

NHB 5300.4(1B)	April 1962	"Quality Provisions for Aeronautical and Space System Contractors."
NPC 200-3	April 1962	"Inspection System Pro- vision for Suppliers of Space Materials, Parts, Components, and Services"

Exhibit VII	"Specification Maintenance."
Exhibit IX	"Preparation of Engineering Change Proposals for Contract End Items."
Exhibit XI	"Requirements for Configuration Identification and Acceptance of Contract End Items and Related Data."
Exhibit XII	"Engineering Release Record Requirements."
Exhibit XIV	"Formal Configuration Management Reviews, Inspections, and Demonstrations."

5. EXPLANATION OF TERMS

(See Exhibit XVII).

6. PROCEDURAL REQUIREMENTS

It is Apollo Program policy that each engineering change will be incorporated in all units within one type-model-series of the contract end item affected. Complete verification of the incorporation of engineering changes is required to assure that retrofit kits and spares will be ordered and shipped to the proper location. The requirements of this exhibit are based on manufacturing and quality control capabilities which the contractor must possess if he is to successfully contract with the Government, and comply with the requirements in NHB 5300.4(1B) or NPC 200-3 as applicable to his contract.

6.1 Verification Requirements

Contractual authorization is required by the contractor to design, manufacture and install engineering changes. The contractor shall control the design, manufacture and installation of each engineering change as directed by contract.

- 6.1.1 Contract Reconciliation. The contractor shall assure that his ECP has been prepared in accordance with Exhibit IX, and that the ECP and other engineering work authorizations are in accordance with contractual authority.

6.1.2 Technical Verification. The contractor shall verify by an engineering release record (having the capabilities required by Exhibit XII) that the effectivities of all engineering data for a Class I engineering change are compatible with contractual authorizations which approved and authorized the change.

The contractor shall also verify that:

- 6.1.2.1 The engineering release includes the release of a final Specification Change Notice (SCN) or revision as approved with the ECP specification. (refer to Exhibit VII.)
- 6.1.2.2 No qualification requirements are established or changed by engineering data unless specifically authorized by contract and/or contract change.
- 6.1.2.3 Any changes in acceptance test requirements have been converted to procedures, and that these procedures are within the specifications, schedules, and costs authorized by contract and/or contract change.
- 6.1.2.4 Vendor purchase orders and change notices are in accordance with specifications, schedules and costs authorized by contract and/or contract change.
- 6.1.2.5 Manufacturing requirements are in accordance with the specifications, schedules and costs authorized by contract and/or contract change.

Note: Any revision in previously approved specifications, effectivity, delivery schedule or increase in cost will require prior approval of the procuring agency before proceeding with production.

6.2 Production Capability Requirements.

The contractor shall verify that all contract end items are manufactured in accordance with released engineering data by assuring that:

- 6.2.1 Part Numbers are not changed except as required by approved and released engineering data which have identified a non-interchangeable condition.
- 6.2.2 Synthetic numbers or codes are either clearly marked "Manufacturing Designation Only," or are removed before acceptance of equipment by NASA.
- 6.2.3 Material controls are capable of verifying that any specific engineering changes which are required as a result of the Class I change have been incorporated in specific units of either interchangeable or non-interchangeable vendor items.
- 6.2.4 Manufacturing controls are capable of identifying the specific engineering changes which have been incorporated in specific units of either interchangeable or non-interchangeable "bench" and lot produced sub-assemblies.
- 6.2.5 Manufacturing controls are established to properly route vendor items and sub-assemblies containing engineering changes to the contract end items on which these engineering changes are to be installed as required by released engineering data.

6.3 Inspection, Audit and Surveillance

The contractor's quality control function, independent of his technical and production functions, shall:

- 6.3.1 Audit manufacturing orders as required to verify complete conversion of engineering data for each engineering change to shop action exactly as released and assure that the manufacturing and quality control documentation used by the contractor is auditable to released engineering data.
- 6.3.2 Inspect material control, manufacturing control and assembly operations (as described in paragraph 6.2) and verify that each change is completely incorporated in the contract end item unit for which it first applies or that any missing part of the change is listed as a shortage.
- 6.3.3 Verify that the requirements for subsequent incorporations of each change are contained in production orders; that routine material and manufacturing controls will suffice to assure that these installations will be accomplished as required by released engineering, or will be shown as shortages.

- 6.3.4 Maintain an adequate surveillance in accordance with approved standard practices to assure the proper incorporation and documentation of subsequent installations of each engineering change.

6.4 Documentation of Incorporated Engineering Changes

The contractor shall maintain engineering change incorporation records, provided by his internal system of controls having the capabilities described by the subparagraphs below:

- 6.4.1 An inspection file showing, by an inspector's acceptance of shop travellers, receiving reports, etc., the part numbers and serial numbers manufactured which are on the contract end item unit where each engineering change is first installed.
- 6.4.2 A record for each contract end item unit in which an engineering change is first installed. This record shall show that the required subassemblies, by part number and serial number, were installed.

CAUTION: The level of assembly where an engineering change is installed and related to a particular contract end item unit may be above the level of assembly where interchangeability was reestablished. Therefore, part number identification, alone, will not verify that a change has been incorporated.

- 6.4.3 A Break of Inspection (BOI) record for each contract end item unit to document any demodification actions resulting from removals and replacements after the initial installation has been accepted by the inspector.
- 6.4.4 A shortage report for each contract end item unit to record any part of any engineering change which has not been installed

6.5 NASA Acceptance

NASA acceptance of contract end items will be accomplished at the contractor's plant (or site of construction in the case of facilities) in accordance with:

- 6.5.1 The terms and conditions of the contract.
- 6.5.2 The requirements for formal identification and acceptance (see Exhibit XI).

- 6.5.3 Formal agreements reached at previous Configuration Management reviews and demonstrations (see Exhibit XIV).
- 6.5.4 The contractor's inspection acceptance files, Change Incorporation Records (CIR's), BOI's and shortage reports as reconciled at the time of acceptance.

EXHIBIT XIV

FORMAL CONFIGURATION MANAGEMENT
REVIEWS, INSPECTIONS AND DEMONSTRATIONS

FORMAL CONFIGURAITON MANAGEMENT
REVIEWS, INSPECTIONS AND DEMONSTRATIONS

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FORMAL CONFIGURATION MANAGEMENT
REVIEWS, INSPECTIONS AND DEMONSTRATIONS

1. PURPOSE

This exhibit provides NASA and contractor organizations with the objectives of joint contractor/procuring agency formal configuration management reviews and inspections and defines contractor tasks and responsibilities associated with these reviews, demonstrations and inspections.

2. SCOPE

This exhibit defines the product of each of the reviews related to configuration management. The three important reviews associated with configuration management are the Preliminary Design Review (PDR), the Critical Design Review (CDR), and the First Article Configuration Inspection (FACI).

3. APPLICABILITY

This exhibit is applicable to NASA MSF Centers and contractors responsible for the accomplishment of configuration management reviews.

4. REFERENCE DOCUMENTS

None

5. EXPLANATION OF TERMS

See Exhibit XVII

6. PROCEDURAL REQUIREMENTS

The administrative aspects of the Preliminary Design Review, Critical Design Review and First Article Configuration Inspection are common. The following paragraphs establish responsibilities for the organization, representation and conduct of these reviews, and the basic policy which shall govern the output/products of these reviews. It is emphasized that other reviews may be performed during any phase of the program at the discretion of NASA. By mutual agreement of the procuring agency and the contractor, the review of several CEI's may be accomplished at a single review. Representatives of contractors responsible for the design/development of equipment/facilities which interface with the CEI in review may participate in the review. Participation in a review or acceptance of a report of a review

by representatives of the procuring agency shall not be interpreted as approval of the design approach for or acceptance of the CEI. The representatives of the procuring agency designated to participate in the review or accept reports shall submit a formal report to the Project Director stating recommendations for post-review action. Normally, all reviews shall be accomplished at the contractor's facility.

6.1 Procuring Agency Responsibilities

The Procuring Agency is responsible for conducting each review and shall:

- a. Establish the time, place and agenda for each review.
- b. Chair each review.
- c. Schedule a PDR, CDR, and FACI for each contract end item (categorized as either prime equipment items or identification items).
- d. Formally acknowledge the accomplishment of each review and formally notify the contractor of requirements for post-review action.

6.2 Contractor Responsibilities

The contractor will participate in each review and shall:

- a. Have available all end items and associated documentation required for performance of the review.
- b. Prepare and distribute minutes of each review to the procuring agency.

6.3 Conducting Preliminary Design Review

The Preliminary Design Review is a formal technical review of the basic design approach for a contract end item. The PDR is accomplished prior to, or very early in, the detail design phase to establish the system compatibility of the design approach. The primary product of a preliminary design review is formal identification of specific engineering documentation which establishes the physical and functional interface relationship of the CEI to

other system (or inventory) equipment/facilities. Prior to the preliminary design review, the interface relationship of the CEI to other system (or inventory) equipment/facilities shall be established to the level of detail necessary to identify the nature of each interface. The schedule for the origination of detailed interface control drawings shall be established at the preliminary design review. The PDR shall be accomplished when the basic design approach has been selected by the contractor and preliminary documentation has been accomplished. The specific documentation to be reviewed, and detail action to be accomplished, at a given PDR shall be determined by the procuring agency at the time the agenda for the review is established. The following shall be accomplished as a part of each PDR:

- a. The compatibility of the selected design approach with Part I of the detail specification for the CEI shall be established.
- b. The compatibility of the CEI with other system equipment/facilities shall be established. This shall be accomplished by review of pre-design drawings, schematic diagrams, layout drawings, envelope drawings, inboard profiles, review of performance characteristics for functional compatibility, etc. Since system engineering will be accomplished, system compatibility of the CEI shall be established by review of the schematic block diagrams, functional block diagrams and other system engineering documentation.
- c.. The integrity of the selected design approach shall be established. This shall be accomplished by review of analyses, breadboard models, mockups, circuit logic diagrams, packaging techniques, etc. This is accomplished by the contractor as the basis for selection of the design approach presented
- d. The parts of the design to be subjected to detailed value engineering analysis shall be identified.
- e. The producibility of the selected design shall be established. This shall be accomplished by review of requirements for special tools and facilities necessary to manufacture the CEI in the quantities required.

6.4 Conducting Critical Design Review

The Critical Design Review is a formal technical review of the design of a contract end item (CEI). The CDR is accomplished when the detail design is essentially complete, to formally establish the design as the basis for supporting activities, e.g., preparation of spares selection documentation, preparation of technical data, etc. The primary product of the CDR is formal identification of specific engineering documentation, which defines the design of the CEI, and which will be released for manufacture of the unit which establishes the product configuration baseline ("First Article" or equivalent). The engineering documentation identified by the review, and updated until first, article configuration inspection, shall be the basis for supporting activities which must precede acceptance of the first article which normally occurs at the first article configuration inspection. Prior to the CDR, the exact interface relationship of the CEI to other system (or inventory) equipment/facilities shall be established, and shall appear on approved interface drawings which fix the physical interfaces for the CEI, or in approved engineering documentation which fix the functional interfaces for the CEI. The CDR shall be accomplished immediately prior to committing the design to manufacture of the unit which established the product configuration baseline (First Article). The specific documents to be reviewed, and action to be accomplished, at a given CDR shall be determined by the procuring agency at the time the agenda for the review is established. The following shall be accomplished as part of each CDR:

- a. The compatibility of the CEI, as designed, with Part I of the detail specification for the CEI shall be established.
- b. The system compatibility of the completed design shall be established. This shall be accomplished by comparison of the interface control drawings with the engineering drawings for the CEI. Since system engineering or functional analysis will be accomplished, schematic block diagrams, functional block diagrams, and other system engineering documentation shall be used to support the interface control drawings in establishing system compatibility of the CEI.

- c. The integrity of the design shall be established by review of analytical and test data. By mutual agreement of the procuring agency and the contractor, the critical design review of several CEI's may be accomplished at a single review meeting. Representatives of contractors responsible for the design/development of equipment/facilities which interface with the CEI in review may participate in the CDR.

6.5 CONDUCTING FIRST ARTICLE CONFIGURATION INSPECTION

The First Article Configuration Inspection is a formal technical review to establish the Product Configuration Baseline for the CEI. The primary objectives of a FACI are to formally accept the Part II CEI detail specification as an audited and approved document, to establish the similarity between the manufactured hardware and the released engineering and identify the differences and to establish a precisely known baseline against which changes may be proposed and adequately evaluated. FACI's are to be performed without regard to whether it will perform its intended function. At this point in time the primary concern is to determine if the item has been built to released engineering and tested to approved documentation. In the event the item is found to be incompatible or not capable of being used as originally intended through other associated test programs, (ie. Qualification Test, Environmental Test, Integrated System Test, etc.) or in actual use, the FACI is the firm baseline for evaluating change proposals. During the FACI it is important to perform an examination and review of the contractors engineering, manufacturing and quality assurance methods, disciplines, and documentation to insure that;

a. Engineering

1. Specification, drawings and part numbers comply with this document and Center supplements.
2. Drawings are checked and approved prior to release to manufacturing.
3. Drawing release system is adequate.
4. E.O.'s are handled like drawings, and drawings incorporate E.O.'s on a timely basis.

b. Manufacturing

1. Changes cannot be incorporated independently of engineering.
2. Planning paper, job sheets, travelers etc. reflect only released engineering, approved production methods and processes.
3. Blueprint cribs have the latest released engineering on file.
4. Hardware "as built" is in fact identical to "as released" engineering.

c. Quality Assurance

1. "In process" inspection steps are adequate and any steps requiring inspection are verified.
2. All inspections are accomplished against released engineering.
3. Issuance of inspector stamps are rigidly controlled.
4. Accomplishment of tests against the Part II specification are validated and test results certified.

Part II of the CEI detail specification, once audited and accepted at the FACI, serves as the basic documentation for configuration management of the CEI for the remainder of the acquisition phase. All changes to the CEI, once the FACI has been accomplished, shall be implemented only to reflect approved changes to Part II of the CEI detail specification. A major engineering change (new type-model-series), or an indication that the configuration being produced does not accurately reflect released engineering, may require reaccomplishment of the complete FACI. The specific documentation and hardware to be reviewed and detail actions to be accomplished at the time the agenda for the review is established. The following shall be accomplished as a part of each FACI:

- a. The configuration of a selected unit of the CEI, as documented by released engineering, shall be compared directly with the as-manufactured configuration of the same unit, as documented by part numbers and serial numbers appearing on the manufactured parts and assemblies, and in manufacturing records. When necessary, the as-manufactured parts shall be compared directly with the engineering drawing. The released

engineering for the selected unit shall be the drawings and documents assembled by the top drawing number specified in Part II of the CEI detail specification. Differences between the Configuration specified in Part II of the CEI specification and the as-manufactured configuration presented for review shall be documented on the DD Form 250 "Material Inspection and Receiving Report" (or NASA equivalent).

- b. The configuration of the CEI qualified (or to be qualified), as documented by released engineering and/or manufacturing records, shall be directly compared to the configuration of the unit of the CEI FACI'ed, as documented by released engineering and/or manufacturing records. Differences between the configuration of the CEI qualified and the CEI FACI'ed shall be made a matter of record in the minutes of the FACI. (The unit qualified should be identical to the unit FACI'ed modified only to permit installation of instrumentation if required.)
- c. The validity of acceptance testing, as specified in Part II of the CEI detail specification, shall be verified by direct comparison of the test method and test data with the performance/design requirements for the CEI. The comparison shall be accomplished to the level of detail necessary to establish that the methods and instrument readings, as required by the contractors internal test procedures, satisfy Part II of the detail specification and are adequate to verify the quality of the CEI. If changes to the acceptance testing as specified in Part II of the detail specification prove to be necessary, the specification change notice shall be prepared and a copy attached to the minutes of the FACI. The formal specification change shall be processed through normal procedure.
- d. Where the procuring agency has ordered delivery of engineering drawings of the CEI, the initial submittal of these drawings shall be those audited at the FACI, or later revisions of those audited at the FACI. Drawings to be used at the FACI should have all approved changes incorporated.
- e. Where the procuring agency has ordered delivery of specific records of the baseline configuration of the CEI, e.g., entries to be forwarded for inclusion in a system configuration index, such data shall be audited by direct comparison with released engineering.

- f. If circumstances warrant, the contractors engineering release system and change control procedures shall be reviewed and validated. The procuring agency reserves the prerogative to reaccomplish all or any portion of the required audits, inspections and tests. Procuring agency action to accept or reject the unit of the CEI presented for FACI will be accomplished by the appropriate agency in accordance with normal acceptance procedures. The procuring agency will forward to the Contractor a FACI report summarizing the results of the inspection.

EXHIBIT XV

CONFIGURATION MANAGEMENT AUDITS

EXHIBIT XV

CONFIGURATION MANAGEMENT AUDITS

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CONFIGURATION MANAGEMENT AUDITS

1. PURPOSE

Configuration Management Audits may be ordered by the procuring agency at any time or place to verify the adequacy of Configuration Management procedures and implementation as practiced by NASA and contractor organizations, and to determine needed corrective action.

2. SCOPE

This exhibit provides NASA and contractor organizations with requirements and responsibilities for the conduct and the product of Configuration Management Audits. Although it is directed towards the surveillance of major program elements, it does not preclude or usurp center or contractor authority to conduct comparable audits for lesser program elements.

3. REFERENCE DOCUMENTS

None

4. EXPLANATION OF TERMS

See Exhibit XVII

5. PROCEDURAL REQUIREMENTS AND RESPONSIBILITIES

The following paragraphs define the requirements and establish the policies and responsibilities for Configuration Management Audits. They will establish an organized, systematic approach to adequate audits in consonance with NASA and Apollo Program Documentation.

5.1 Policies

The Apollo Program Office Configuration Management Office (CMO) or the Center Program Office CMO, as appropriate, will be responsible for the establishment of policies, the assignment of responsibilities, and the development and implementation of procedures for Configuration Management audits in their respective areas of interest. In general, the Apollo Program Office CMO will conduct audits of Center Configuration Management systems while the Center Program Office CMO's will conduct audits at Project and Contractor level. This does not preclude the Apollo Program Office from conducting a configuration management audit at Project or Contractor level when warranted.

5.2 Organization

The appropriate CMO will be responsible for the determination of the need for an audit and for the organization of the audit team.

5.3 Representation

The responsible CMO will designate a chairman for each audit team. The team chairman will appoint other personnel to the team from APO, NASA Center, or supporting contractor organizations as may be appropriate.

5.4 Planning

The team chairman will be responsible for development, release, and distribution of a detailed plan and agenda for the conduct of each Configuration Management Audit.

5.4.1 A preliminary meeting of the audit team members shall be called as directed by the Team Chairman. All personnel having an interest in or possessing pertinent knowledge of the audit subject shall be invited to attend this preliminary meeting. At this preliminary meeting, the following activities shall be performed:

- a. Discussion of the purpose, needs and causes that initiated the audit action.
- b. Perform a breakdown of audit elements and assign individual responsibilities to the team members by the chairman.
- c. Evaluate the scope of the audit, manhours available, and establish time schedules for performance of pre-audit actions and the audit itself.

5.4.2 An individual review shall be performed by each team member of background data and information concerning his assigned element(s) of responsibility. This review shall include the compilation of specific information and audit plan details to be used in the performance of the audit.

5.4.3 A pre-audit meeting of the team members shall be called by the chairman after completion of the individual reviews and prior to "audit notification." At this meeting, plans will be finalized concerning the pending audit. All pertinent data which may significantly affect schedule, elements of the audit, facilities, personnel, etc., shall be presented at this meeting for discussion and resolution or decision.

5.4.4 The final draft of the audit plan will be made available to all members of the team and to supporting organizations at the time of audit notification.

5.5 Audit Scheduling and Notification

A Configuration Management Audit will be scheduled for each major program and contractor. Audits of lesser program elements may be directed and scheduled by the Apollo Program Office CMO or Center Program Office CMO where a problem is known or suspected to exist.

5.5.1 A master audit schedule will be established by the responsible CMO. This schedule will be updated as required.

5.5.2 Once the plans for conducting the audit are complete, notification shall be made to the affected parties at least thirty days prior to the audit. The notification will be made by the Chairman of the audit team. The notification shall include the following as applicable:

- a. Audit subject
- b. Inclusive dates of audit
- c. Audit team members
- d. Site of audit
- e. Copy of the audit plan
- f. Request for conference room space, organizational charts, documentation, telephone facilities, etc.

5.6 Conduct of the Audit

The audit shall be conducted in accordance with the following:

5.6.1 Conduct a pre-audit conference at which team members will meet with appropriate personnel at the site. The team chairman will explain all objectives, plans procedures, responsibilities, and personnel area assignments of the evaluation for the understanding of all concerned.

5.6.2 Conduct the audit utilizing this manual and other applicable documents.

- 5.6.3 Conduct a daily meeting of all participating parties, or individuals, as the chairman sees fit, at the end of each day to review the day's activities, adjust schedules as needed, and to coordinate the following day's activities.
- 5.6.4 Consolidate daily results in preparation for exit critique.
- 5.6.5 Conduct exit critique with center personnel, and discuss the preliminary results of the evaluation. The center personnel should be given an opportunity to explain any unusual or discrepant information obtained. This critique will normally be held the day following completion of the audit and will continue until the team chairman signifies adjournment.

5.7 Audit records and Reports

Each team member shall be responsible for providing and maintaining accurate records of conditions found within his assigned area.

- 5.7.1 A preliminary report which summarizes findings shall be presented to the team chairman by each team member prior to the exit critique. This report should contain an accurate description of individual non-conformances in sufficient detail as to provide conclusive evidence of the existing situation. These preliminary reports should be the basis for discussion during the exit critique.

5.7.1.1 Findings should be worked in the following format:

- a. Finding: A statement of the fact(s) identifying the particular problem area without embellishment.
- b. Determination: Based upon data available, an analysis is made and conclusions are drawn.
- c. Recommendation(s): Corrective action(s) required at the center or its field operation.

- 5.7.2 Maintenance of minutes will be the responsibility of the audit team chairman. This responsibility encompasses all official gatherings of audit personnel, and specifically, the preliminary meeting, pre-audit meeting, pre-audit conference, daily audit meetings, and exit critique.
- 5.7.3 A final audit report will be prepared by the team and published as soon as practical after the conclusion of the audit. This report shall be a consolidation of the preliminary reports submitted by the team members and a summarization of minutes of meetings. This report will contain a complete description of audit actions using the following elements as an organizational guide:
- i. Contents
 - ii. Summary
- I. General
- a. Audit Title
 - b. Participating Organization
 - c. Audit Subject
 - d. Audit Site
 - e. Inclusive dates of audit
 - f. Participating Personnel
- II. Introduction
- a. Reasons for audit
 - b. Objectives and scope
 - c. Background Information
- III. Planning
- a. Selection of Team
 - b. Preliminary Meeting
- IV. Performance
- a. Areas of Investigation
 - b. Preliminary Meeting
- V. Conclusions
- a. Items recorded for information only
 - b. Action Items reported
 - 1. Items corrected during audit
 - 2. Items for which formal corrective action is (has been) requested.
 - c. Corrective action responsibilities and assignments

- 5.7.4 The Apollo Program Office CMO will assign an appropriate identifying number to the audit report.
- 5.7.5 The audit team chairman will transmit copies of all final audit reports to appropriate center, and Apollo Program Office (OMSF) personnel.

5.8 Audit Follow-up

The responsible CMO will prepare a directive or letter of instruction from the Apollo Program Director or Center Director, as appropriate, to implement corrective action for deficiencies identified during the audit. The CMO's will also take all proper follow-up action (including a repeat audit if necessary) to verify that directed corrective actions are implemented.

6. AUDIT CHECKLIST

The following questions cover a wide range of data to illustrate the type of information which may be of concern to an audit team. Some of them may be deleted, and other questions may be added to satisfy the need of each particular audit.

6.1 Organization

- a. Is there a current organization chart?
- b. Where in the organization is the configuration management office established?
- c. How many personnel are in CMO? Civil Service? Contractor support?
- d. How many personnel are there in the Contractor's CMO?
- e. Are there organization charts of the CMO?
- f. Are there current writeups of the individual job responsibilities?
- g. How do these writeups compare with the actual job responsibilities?
- h. Is there a flow chart showing the implementation of approved engineering changes?
- i. Is there a flow chart showing the approval of engineering changes?
- j. Does Configuration Management have the approval of top management?
- k. Are there existing policies and/or procedures for implementing configuration management?
- l. Is interface control a part of the Configuration Management functions?

6.2 Training

- a. Is there a configuration management training course?
- b. What personnel take the course?
- c. Have all engineering management personnel taken the course?
- d. How often is the course given?
- e. What written material is utilized in giving the course?

6.3 Configuration Management Office Functions

- a. Do Configuration Management Plans, Manuals, Procedures, Flow Charts, Requirements, Documents, etc. exist and are they implemented and followed?
- b. Do files contain all specifications?
- c. Are specifications adequate?
- d. Are specifications up-to-date?
- e. Is there a specification tree?
- f. Is there a specification index?
- g. Do the project personnel have instructions on how to prepare specifications?
- h. Are standard technical requirements (standardization, humidity, packing, etc.) enumerated for specifications?
- i. If a deviation occurs, what procedure is followed?
- j. Is there a Part II CEI Specification?
- k. Was the Part II CEI Specification approved at FACI? Are material and process specifications used?
- l. Do change (ECP) files contain all applicable change paper?
- m. Are meaningful agendas and minutes published for CCB meetings?
- n. Are changes pre-coordinated with other CCB/CMO when interface is affected?
- o. Are CCBD's accurate, concise and do they have proper descriptions of required actions when appropriate?
- p. Does an adequate Configuration Identification and Accounting Index exist?
- q. Does a change tracking system exist which follows a change from initiation to incorporation?
- r. Does the affected Contracts office implement CCBD's as directed thereby?
- s. Are Class II changes monitored?
- t. Does Quality Assurance monitor configuration?
- u. Are "process specs" controlled where necessary (Approval and changes by CCB action)?
- v. Are formal ECP's submitted for waivers and deviations?
- w. Are ECP's adequate, descriptive and timely?
- x. Does the CMO participate in Design Reviews and Inspections? To what extent?
- y. Are specifications and all SCN's/ECP's approved by CCBD's?

- z. Are adequate Acceptance Data Packages required and maintained at all sites and Centers?
- aa. Are field "make-work" changes fed-back to all required areas? Are affected drawings updated and subsequent effectivities covered by ECP's?
- bb. Are MRB actions monitored to ensure Configuration changes do not occur by MRB actions?
- cc. Do like solutions (Part II specs) exist for all requirements for subsequent effectivities unless changed by approved ECP after the specification is baselined? Does contractor's release system stop EO release by closing out internal authorizing paper (such as MCR's) unless an ECP is approved?
- dd. Is there a drawing manual. Is it followed?
- ee. Is there a procedure which describes the release function? Is it effectively followed?
- ff. Does the release system release only approved drawings and documents?
- gg. Are revisions to drawings and documents released only upon approval by cognizant change authority?
- hh. Do Contracting Office functions implement CCBD's completely and in a timely manner?

6.4 Configuration Control Board

- a. Is there a change control system?
- b. Is it in writing?
- c. Is the procedure well distributed?
- d. Is the procedure followed?
- e. How many CCB's are there? What levels?
- f. Do all changes go through the CCB?
- g. Is approval authority limited to the chairman of the CCB?
- h. How is a change presented to the CCB?
- i. How does the CCB document their decisions?
- j. Is there a log of ECP numbers?
- k. To whom does the chairman of the CCB report?
- l. Are all affected organizations represented on the CCB and do they regularly attend meetings?
- m. Is approval authority delegated by the CCB Chairman? To whom and to what extent?
- n. Does the CCB meet on a regularly scheduled basis?
- o. Are CCBD's signed at meetings?
- p. Does the CCB approve "Product Improvement" changes which do not have significant cost or performance gains?
- q. Is there a follow-up system to assure compliance with published policies and procedures?

6.5 Design Reviews and Inspections

- a. Do plans exist for conduct of PDR, CDR and FACI?
- b. Are reviews scheduled?
- c. Are minutes kept which are descriptive of the conduct?
- d. Are specifications baselined (approved) by CCBD's at appropriate points?

- e. Are CCBD's contractually implemented?
- f. Do Part I Requirements and Part II Design Definition changes require ECP's to be submitted (formal change control implemented) after approval?
- g. At FACI:
 - 1. Was the Release system checked for adequacy?
 - 2. Was the part number system checked?
 - 3. Were all approved ECP's checked for incorporation?
 - 4. Was manufacturing documentation checked to ensure incorporation of latest engineering drawing changes?
 - 5. Did actual hardware configuration agree with the released engineering drawings?
 - 6. Did follow-up occur which closed out open Configuration Management action items?

6.6 Hardware/Software Modifications Requiring Retrofit by Kit

- a. Is there a tracking system for approved modifications?
- b. How are these modifications picked up?
- c. How are these modifications closed out?
- d. When are these modifications closed out?
- e. Can the number of open modifications be determined at any time?
- f. Is there a means of determining whether a modification will delay a launch or delivery by late completion?

EXHIBIT XVI

CONFIGURATION IDENTIFICATION
AND ACCOUNTING REPORTS REQUIREMENTS

EXHIBIT XVI

CONFIGURATION IDENTIFICATION
AND ACCOUNTING REPORTS REQUIREMENTS

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CONFIGURATION IDENTIFICATION
AND ACCOUNTING REPORTS REQUIREMENTS

1. PURPOSE

This exhibit establishes the requirements for generating and maintaining the necessary information for preparation of the Configuration Identification Index Report (CIIR) and the Configuration Status Accounting Report (CSAR). These two reports may be combined into a single report: Configuration Identification and Accounting Index.

2. SCOPE

This exhibit identifies and defines the data elements necessary for the generation of these reports. The requirements set forth herein are considered the minimum for Apollo configuration management, and may be added to as Center needs require. Any format which contains these minimum reporting requirements and satisfies the Center's needs will be acceptable.

3. REFERENCES

Exhibit XVII	"Explanation of Terms"
MIL-STD-480	30 October 1968
	"Configuration Control - Engineering Changes, Deviations and Waivers"

4. RESTRICTIONS

This exhibit shall not be used by a contractor as authorization to acquire Automatic Data Processing System (ADPS) equipment, personnel, other equipment or facilities without specific authorization from the contracting officer through formal channels.

5. APPLICABILITY

This exhibit applies to all Apollo organizations, NASA or contractor, responsible for the preparation of Configuration Identification Indexes and Configuration Status Accounting Reports, and to all organizations and contractors providing the data elements described herein. Each contractor under contract to the procuring agency shall be responsible for the compliance of his subcontractors, vendors, or suppliers to the extent his subcontractors, vendors or suppliers are involved in configuration management reporting.

6. RESPONSIBILITIES

The responsibility for publication of reports and/or data submittal to the publishing agency shall be as directed by the procuring agency.

7. CONFIGURATION MANAGEMENT REPORTS

7.1 Configuration Identification Index Report (CIIR)

The Configuration Identification Index Report is the one authoritative document which depicts the approved configuration of all contract end items and, as such, must contain the following information as a minimum.

7.1.1 Upon completion of the first article configuration inspection, but no later than the signing of the DD250 (or NASA equivalent), the following baseline information shall be prepared and submitted for inclusion in the CIIR.

- a. Contractor
- b. End item nomenclature
- c. Specification number
- d. End item identification number
- e. Baseline part number
- f. Serial number

7.1.2 After establishing the baseline configuration at FACI, all changes shall be processed in accordance with MIL-STD-480 as implemented by the Centers. Upon approval of ECP's by the NASA, the following information shall be prepared and submitted for inclusion in the CIIR.

- a. Contractor
- b. CCBD number
- c. ECP number
- d. ECP title
- e. Effectivity
- f. New part number
- g. Modification instruction number
- h. Estimated man-hours for incorporation
- i. Contractual authority

7.2 Configuration Status Accounting Report (CSAR)

7.2.1 To insure adequate control and timely modification of delivered hardware, and to prepare a document which will serve as an authoritative source for the actual configuration of all delivered hardware, the following information shall be prepared and submitted, as available and on a schedule as agreed to by the procuring agency, for inclusion in the CSAR.

- a. Contractor
- b. ECP number
- c. ECP title
- d. End item identification number
- e. Effectivity
- f. Contractual authority
- g. CCB directive
- h. Modification instruction numbers

- i. New part number
- j. Affected end items
- k. Location
- l. Kit identification number
- m. Incorporation date (production)
- n. Scheduled kit delivery date
- o. Actual kit delivery date
- p. Incorporation date (retrofit)
- q. End item serial number (spares/chassis)
- r. Old part number (spares)
- s. New part number (spares)
- t. Kit identification number (spares)
- u. Scheduled kit incorporation date (spares)
- v. Actual kit incorporation date (spares)
- w. Location (spares)

7.3 Definition of Data Elements

- 7.3.1 Contractor. The name of the contractor who has cognizance over the end item.
- 7.3.2 End Item Nomenclature. The official name, title or designation of the end item.
- 7.3.3 Specification Number. The number of the specification to which the end item was built.
- 7.3.4 End Item Identification Number. Numeric designation or identifying number assigned to the end item.
- 7.3.5 Baseline Part Number. The initial or original part number assigned to the baselined end item. (Same as drawing number.)
- 7.3.6 Serial Number. All serial numbers assigned to the end item.
- 7.3.7 ECP Number. The number assigned by the contractor to the ECP.
- 7.3.8 ECP Title. Short title indicating nature of change.
- 7.3.9 Effectivity. Serial number of those items that will be retrofitted and those that will have the change incorporated in production.
- 7.3.10 New Part Number. The new part number that will be assigned to the end item after the incorporation of the ECP.
- 7.3.11 Modification Instruction Number. The contractor's retrofit number associated with field changes. Not required for ECP's that affect production only.

- 7.3.12 Contractual Authority. The number of the contractual change notice that authorized the contractor to incorporate the change.
- 7.3.13 Configuration Control Board Directive. All changes after baselining are approved by cognizant Configuration Control Boards by means of Configuration Control Board Directives. In the case of new ICDs or changes to ICDs (IRNs) CCB approval will occur after panel technical approval prior to contractual implementation.
- 7.3.14 Affected End Items. The identification numbers of all end items affected by an ECP, including the end items of another contractor.
- 7.3.15 Location. The geographical location where the retrofit change will be incorporated in the end item.
- 7.3.16 Kit Identification Number. Identification number of the retrofit kit to be used for incorporating the ECP in a particular serial number of the end item. Not required for production changes.
- 7.3.17 Incorporation Date. The scheduled date by which the change is expected to have been incorporated in the end item and approved by Quality Control.
- 7.3.18 Spare/Chassis End Item Serial Number. The serial numbers of the spares or chassis effected by the ECP.
- 7.3.19 Old Part Number (Spares). The part number of the spare/chassis effected by the ECP.
- 7.3.20 New Part Number (Spares). The new part number which an existing spare/chassis will become upon incorporation of the ECP.
- 7.3.21 Kit Identification and Internal Control Number (Spares). The contractor's identification numbers associated with the retrofit kits that will be used for retrofit of spares.
- 7.3.22 Incorporation Date (Spares). The scheduled date by which the change is expected to have been incorporated in the spare and approved by Quality Control, and/or the actual date when it was incorporated.
- 7.3.23 Location (Spares). Geographical location where the retrofit change will be incorporated in the spare.

7.4 Source of Data

A predominant amount of the data required by paragraph 7.0 is obtained from the ECP package, FACI package, engineering release package, contract change notice, etc. However, certain data elements should be derived or obtained from a certain source or in a particular manner in order to maintain effective control.

7.4.1 Configuration Control Board. When a contractor's ECP effects or requires a change in another contractor's end items, it is essential that these interface changes not only be technically coordinated and approved but that the Configuration Identification and Accounting Index accurately reflects the relationship and ties together these changes. The single authoritative document that indicates coordination and approved the interface changes must be referenced in the Index with the corresponding ECP's; thus, changes incorporated by interfacing contractors can be related back to a single approving authority. Two interface conditions are discussed below to indicate what constitutes the proper data element for the Configuration Control Board Directive entry.

7.4.1.1 Two Interfacing Contractors Under Contract to the Same NASA Center.
The Program Manager's CCB would assure that the required interface coordination and agreements have been accomplished. In this case, the approval for the interface change would be contained in the CCB Directive. Thus, all ECP's required by the contractors to comply with this interface change must reference the CCB Directive as the interface authority.

7.4.1.2 Two Interfacing Contractors Under Contract to Different NASA Centers: In this case the necessary interface coordination and agreements would be accomplished by the appropriate inter-center Coordination Panels with agreements reflected on the interface documentation by approval signatures. Each Program Manager's CCB would implement these agreements by issuing CCB Directives. In this case the changes are being implemented to comply with an inter-center Panel agreement, thus any subsequent ECP's shall reference the authorizing CCB.

8. REPORT FORMATS

8.1 The format for these reports shall be as defined and directed by the procuring agency and shall contain as a minimum the information required by this exhibit.

EXHIBIT XVII

EXPLANATION OF TERMS

EXHIBIT XVII

EXPLANATION OF TERMS

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EXPLANATION OF TERMS

1. PURPOSE

This Exhibit provides contractors and Government agencies with explanations of the words, terms and phrases which characterize the terminology used throughout the Apollo Configuration Management Manual.

2. SCOPE

The terms selected for inclusion in this Exhibit are those which are most frequently encountered. While these terms are explained in applicable exhibits, they are repeated herein for emphasis and the user's convenience.

3. APPLICABILITY

This exhibit is applicable to NASA agencies and contractors, and shall be applied in conjunction with other exhibits of the manual when made a contractual requirement.

4. EXPLANATION OF TERMS

4.1 Acquisition Engineering

The engineering required for development, procurement, manufacturing, installation and checkout, during the Acquisition Phase of systems/equipment.

4.2 Acquisition Phase

The period starting after the establishment of the Design Requirements Baseline (end of the Definition Phase) until the acceptance by the user of the last operating unit in a certain series, and all required updating changes resulting from the testing have been identified, approved, and incorporated, whichever occurs later.

4.3 Aerospace Ground Equipment (AGE)

All equipments required on the ground to make a system, command and control system, support system, subsystem, or end item of equipment operational in its intended environment. This includes all equipment required to install, launch, arrest, guide, control, direct, inspect, test (other than development tests), adjust, calibrate, appraise, gauge, measure, assemble, disassemble, handle, transport, safeguard, store, actuate, service, repair, overhaul, maintain, or operate the system, subsystem, end item or component. This definition applies regardless of the method of development, funding or procurement.

4.4 Apollo Program Specification

This specification is formatted to include all system and functional area design, development, test and qualification requirements including software in a single document. This specification is the basic reference for control of the technical scope of the total system.

4.5 Change Proposal (See Exhibit IX)

The document which proposes system/equipment changes in accordance with applicable bulletins, regulations, and other directives.

4.6 Change Proposal/Number (See Exhibit X)

The sequence number assigned to the change proposal in accordance with the project office instructions.

4.7 Configuration

The complete technical description required to fabricate, test, accept, operate, maintain, and logistically support systems and equipment.

4.8 Configuration Accounting

Act of reporting and documenting changes made to systems/equipment subsequent to the establishment of a baseline configuration in order to maintain a configuration status.

4.9 Configuration Control

Systematic evaluation, coordination, and approval or disapproval of proposed changes to any baseline.

4.10 Configuration Control Board (CCB)

The functional body within the CMO of the Project Office or equipment directorate, responsible for configuration control. These boards will be chaired by the project director or his designated representative. It is not a voting board. The Program Director or a CCB chairman acting on his behalf, is responsible for making all decisions.

4.11 Configuration Identification

The technical documentation defining the approved configuration of systems/equipment under design, development, test and manufacturing.

4.12 Configuration Identification Index

A document prepared initially during the design and development period of system/equipment development, and continued through the acquisition phase. The document is arranged in tabular form and has provisions for inclusion of all changes which result from contractor or program office action.

4.13 Configuration Identification Numbers

The relationship of numbers which, individually or in combination, permit accurate selection of the configuration required to perform a given function.

These numbers are:

- a. CEI numbers
- b. Part numbers
- c. Change numbers
- d. Manufacturer's code identification numbers

4.14 Configuration Management

The formal set of procedural concepts by which a uniform system of configuration identification, control, and accounting is established and maintained for all NASA systems/equipment and components thereof.

4.15 Configuration Management Office (CMO)

The organization within the Project Office or equipment directorate, which is responsible for the formalization, issuance and maintenance of the three aspects of configuration management - configuration identification, control, and accounting; for the administration of the CCB; for the direction and supervision of the specification program; and for the transfer of all configuration documentation as applicable.

4.16 Configuration Status

The official NASA documented indication of the actual configuration of a serially numbered system or equipment at any given time in relation to an approved configuration.

4.17 Contract End Item (CEI)

An arbitrary designation for the portions of a system/equipment identification as a result of a formal functional analysis. It is a functional entity physically related and selected for the purpose of system development, procurement, and logistics. The following criteria shall be used in the selection of an end item:

- a. An end item shall be procurable by the government to a single specification.
- b. An end item shall be identified by a single top drawing which has been prepared in conformance with appropriate military specifications.
- c. An end item shall be identified by a separate and distinct part number and serial number.
- d. The physical and functional characteristics of an end item shall be such that its configuration can be controlled and documented economically regardless of the number of changes approved and/or incorporated therein.
- e. The location of the distinct/separate parts of an end item should be such that they are not remotely located with respect of one part to another, i.e., black boxes should be located in the same area AVE system compartment, same maintenance area, etc.
- f. By definition, magnetic tapes and card decks used with checkout equipment are classified as end items and subject to change control.

4.18 Contract End Item Detail Specification (Facility) (See Exhibit III)

The FCEI specification is composed of two distinct parts, each of which has distinct and different uses in FCEI acquisition. Part I, facility criteria, is a product of a Program Definition Phase or requirements analysis, and is the engineering instrument used to contract for design and development of the FCEI. Part II of the FCEI specification, the construction bid package (contract, plans and specification), is a product of the design and development contract. Part II specifies the FCEI in terms of the detailed product configuration requirements of the facility suitable for contracting actual facility construction.

4.19 Contract End Item Detail Specification (Identification Item) (See Exhibit IV)

A CEI specification is prepared for each end item of equipment categorized as an identification item. An "identification item" is one which satisfies the following criteria:

- a. It can be qualified by inspection and/or simple demonstration.
- b. Quality control at the production level can be the basis for verification of quality, and acceptance can be based on verification that the item conforms to the drawings.

- c. Because of its use and simplicity of function and design, few design changes are anticipated once the product configuration baseline for the item is established.

4.20 Contract End Item Detail Specification (Prime Equipment)
(See Exhibit II)

The CEI (prime equipment) specification specifies designs, development, test and acceptance requirements for a single CEI type-model-series, which cannot be defined by the simplified formats of an identification specification or a requirements specification. The CEI specification is composed of two distinct parts each of which has distinct and different uses in the contractual control of CEI acquisition. Part I is a product of a Program Definition Phase or requirements analysis, and is the engineering instrument used to contract for design and development of the CEI. Part II of the CEI specification is a product of the design and development contract. Part II specifies the CEI in terms of the detail product configuration requirements of the item qualified (or to be qualified) under the terms and conditions of the design and development contract.

4.21 Contract End Item Detail Specification (Requirement Items)
(See Exhibit V)

A CEI specification is prepared for each end item of equipment categorized as a requirement item. A "requirement item" is one which satisfies the following criteria:

- a. It has been developed.
- b. It is in NASA inventory.
- c. It is required to support an item or items being developed, either to be used with, or to be assembled into, that item(s).

4.22 Contract End Item Number

The CEI number is a permanent number assigned by the contractor to identify a contract end item.

4.23 Critical Design Review (CDR)

The critical design review is a formal technical review of the design of a contract end item (CEI). The CDR is accomplished when the detail design is essentially complete in order to formally establish the design as the basis for supporting activities, e.g., preparation of provisioning documentation preparation of technical manuals, actual provisioning of initial spares, etc. The primary product of the CDR is formal identification and NASA approval of specific engineering documentation which defines the design of the CEI, and which will be released for manufacturing of the unit that establishes the product configuration baseline ("first article", or equivalent).

4.24 Definition Phase

The period preceding the Acquisition Phase, during which the Apollo Program Specification is completed and Part I of the end item specification is completed.

4.25 Design Requirements Baseline

The design requirements baseline is established at the beginning of the Acquisition Phase and consists of the composite of design requirements for a single contract end item contained in an approved Part I to the detail specification for the CEI. Part I of the specification for essentially all CEI's is available at a single point in time, the design requirements baseline for all CEI's can be clearly identified as a system baseline.

4.26 Detail Specification (Critical Components) (See Exhibit VI)

Detail specifications are required for components which have been identified in a contract end item detail specification as "engineering critical components" and/or "logistic critical components".

4.27 Direct Support Real Property Installed Equipment (DS-RPIE)

Individual RPIE items of equipment, systems or subsystems that are essential to the launching and guidance of a space vehicle, the absence of which would preclude the system's performing its assigned mission.

4.28 Effectivity

The specific contract end item family and serial number(s) to which part numbers, ECP's, CCN's, DD 250's waiver documents, etc., are addressed.

4.29 Engineering Critical Components

Components of a CEI are designated engineering critical when:

- a. Qualification of the component will suffice to qualify the entire CEI.
- b. Reliability of the component is critical, i.e., it will jeopardize crew safety, mission success, or significantly affect the ability of the CEI to perform its overall functions.
- c. Technical complexity and/or producibility is sufficiently critical to warrant an individual specification, and the CEI cannot be adequately qualified except by separately qualifying the component.

4.30 Engineering Data

Engineering documents such as specifications, drawings, standards, lists, or other information prepared by a design activity relating to the design, manufacture, procurement, procurement, test, or inspection of items and services.

4.31 Engineering Release Record

The official data file which records and interrelates engineering data, and changes thereto, which technically describe and are to be or have been used to build, operate and maintain equipments, facilities and systems.

4.32 Field Release

The release of engineering data which changes formally accepted equipment which is under the jurisdiction of a contractor and is progressing through field testing or an activation program.

4.33 First Article Configuration Inspection (FACI)

The First Article Configuration Inspection (FACI) is a formal technical review which establishes the product configuration baseline for the contract end item. The primary product of the FACI is formal acceptance, by the procuring agency, of Part II of the end item detail specification as an audited and approved document.

4.34 Ground Instrumentation Equipment (GIE)

That equipment used for acquiring and recording any measurement parameter concerning performance and environmental data of the Space Vehicle Equipment.

4.35 Interface

A region common to two or more elements, systems, projects or programs, characterized by mutual physical, functional and procedural properties. Specifically, an Apollo (Inter-Center) interface is restricted to Apollo/Saturn Space Vehicles and supporting equipment; is controlled by an Apollo Inter-Center Coordination Panel and affected Center Level II Configuration Control Boards (CCB's); and affects the concerned interfacing Centers and/or their contractors.

4.36 Interface Control Documents (ICD's)

ICD's are either drawings or documentation that record the compatible design relationships between two or more interfacing end-item designs.

4.37 Interface Revision Notice (IRN)

An IRN is a standard form used by those organizations responsible for ICD completion or maintenance to record changes to an approved ICD or IRN.

4.38 Logistic Critical Components

Components of a CEI are designated logistic critical when:

- a. Replacement or repair of the component is complicated by short supply or long lead time.
- b. At a spares selection conference, NASA identifies the component for multiple source procurement or repro-curement.

4.39 Maintenance Support Equipment (MSE)

That AGE required to restore a system or end item to operating condition. MSE includes equipment to perform such functions as inspect, adjust, calibrate, handle, transport, remove, install, repair, assemble, and disassemble.

4.40 Modification

A modification is a change to systems/equipment and spares approved after the updating changes are identified, approved, and placed on contract.

4.41 Multiple Release

An engineering release record or act in which superseded and superseding information are both retained. Effectivities for superseded parts are coded as a reference release (no manufacture or procurement) and retained on the record along with the effectivities for superseding parts, coded as a requirements release (manufacture or procurement required). The sum of limited effectivities for superseded parts and the effectivities of the superseding part should equal the original complete effectivity.

4.42 NASA Engineering Responsibility

Accountability for the integrity of design, development, and performance of NASA systems/equipment.

4.43 Operating Support Equipment (OSE)

That Aerospace Ground Equipment (AGE) which is a functional part of a system which operates with the Space Vehicle (SVE) or end item as an essential operating element thereof. OSE also includes identical equipment required in the factory to check out the Space Vehicle.

4.44 Operational Engineering

The engineering required to evaluate and resolve problems revealed by operational flight missions.

4.45 Operational Phase

The period from acceptance by the user of the first operating unit until launch. The operational phase overlaps the acquisition phase.

4.46 Operational Use

For the purpose of this manual, applying to the items of systems/equipment necessary to fulfill mission requirements.

4.47 Preliminary Design Review (PDR)

This is a formal, technical review of the basic design approach for a contract end item. The PDR is accomplished prior to, or very early in, the detail design phase in order to establish the system compatibility of the design approach. The primary product of a preliminary design review is formal identification of specific engineering documentation which establishes the physical and functional interface relationship of the CEI to other system equipment/facilities.

4.48 Preliminary Interface Revision Notice (PIRN)

An IRN is "preliminary" (PIRN) until approved by Inter-Center Panel Co-Chairmen and by affected Center Level II CCB's through officially issued CCB's. It then becomes an official change to the parent ICD.

4.49 Prime Equipment Item

The more complex contractor designed contract end items that require extensive functional tests while in the assembled condition.

4.50 Product Configuration Baseline

The technical description comprised of the CEI specification and applicable engineering drawings, against which the First Article Configuration Inspection (FACI) is performed, will, upon satisfactory completion of the inspection, constitute the product configuration baseline for the CEI series.

4.51 Production Release

The engineering release of a production or construction drawing for manufacture, construction or procurement of the items thereon, and for their incorporation in CEI's by other than service action.

4.52 Program Element

A portion of a system which performs a single major function including one or more contract end items, and is normally assigned a single contractor for integrated design and development, e.g., propulsion, guidance, facilities, communication, etc.

4.53 Real Property Installed Equipment (RPIE)

Non-expendable equipment which has been purchased and installed by the construction contractor through Government Construction Appropriations and included in or on real property.

4.54 Reference Release

An engineering release record or act in which the item released is coded to indicate that no manufacture or procurement is required. Used for specifications, interface drawings and other items which are part of the engineering documentation but which do not require production, and for multiple releases.

4.55 Released Engineering

The current and total set of drawings and specifications for a product which have been completed, formally recorded, and made available for manufacturing and/or procurement.

4.56 Requirements ECP

An ECP which proposes changes to the requirements contained in specifications prepared in accordance with Exhibit I.

4.57 Requirements Release

An engineering release record or act in which the items released are coded to indicate that manufacture or procurement is required as authorized by contract.

4.58 Space Vehicle Equipment (SVE)

That equipment which becomes airborne after a launch and includes the launch vehicle, as well as the spacecraft.

4.59 Synthetic Number or Code

A number or code assigned to a production assembly, station, or status, which is other than a part or assembly defined and identified on an engineering drawing.

4.60 System Requirements Baseline

This baseline is defined by the Apollo Program Specification. The approved performance requirements contained in the Program Specification shall establish the system requirements baseline for the Definition Phase.

4.61 Training Equipment (TRE)

TRE is defined as the equipment required to train government (including astronauts) and/or contractor personnel in order that they can perform their functions in accomplishing mission objectives.

4.62 Uniform Specification

The complete contract end item technical description used for production release and configuration management. It will include the referenced military and contractor specifications, documents, engineering drawings, production test requirements, and corresponding production tests. These specifications will result from technical data created in the development program.

4.63 Uniform Specification Program (See Exhibits I through VII)

The concept of the Uniform Specification Program (USP) is based on the fact that the system/equipment is not procured by single identifiable systems, but rather by separate end items of contractor peculiar items, and commercial "off the shelf" items. It is recognized that an end item specification program must be correlated with system procurement programs and methods. Therefore, a basic action of the USP is the preparation of contract end item detail specifications for each provisional end item of the program. The utilization of the contract end item detail specification thus derived shall be as follows:

- a. Determination of overall system performance for operational use.
- b. Rigid control by the Configuration Control Board (CCB).
- c. Acceptance of end items by NASA.
- d. Complete identification of specifications covering all end items required to support the program.
- e. Support reprourement of identical end items where required, or similar end items if exact duplication of performance is not critical.

EXHIBIT XVIII

PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(COMPUTER PROGRAM)

EXHIBIT XVIII

PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(COMPUTER PROGRAM)

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PREPARATION OF
CONTRACT END ITEM DETAIL SPECIFICATION
(COMPUTER PROGRAM)

1. PURPOSE

This exhibit provides instructions for the preparation of the detailed specification for each computer program contract end item (CPCEI) and for any necessary addenda thereto.

2. SCOPE

These instructions are applicable to the specification for end items categorized as "computer program". The instructions contained herein define the content and format for each of the two parts of the CPCEI detail specification. Also included are instructions for the preparation of addenda to the CPCEI specification.

2.1 CPCEI Specification

The computer program contract end item (CPCEI) specification is the detailed specification of computer programs which have been designated as end items by the procuring agency. The two parts to the CPCEI specification are:

Part I - Performance and Design Requirements:

This part is used to specify requirements peculiar to the design, development, test, and qualification of the CPCEI. Part I is usually a product of the definition phase and is used to contract for the design and development of the CPCEI.

Part II - Computer Program Technical Description:

The Part II specification is the detailed technical description of a CPCEI as actually implemented by the contractor. The Part II specification is a product of a program acquisition phase and is one of the instruments used for CPCEI acceptance. The Part II specification defines the product configuration base-

line. It also serves as an instrument for subsequent use by in service and/or contractor personnel in diagnosing trouble, making adaptation changes, and designing modifications to the CPCEI.

2.2 Specification Addenda

An addendum to a CPCEI specification establishes requirements for a new end item which, in terms of performance and design, is so much like an existing CPCEI that it is desirable to refer to an existing specification on an "add" and "delete" basis.

3. APPLICABILITY

This exhibit is applicable to NASA agencies and NASA contractors responsible for the development of computer programs which are classified as end items. Guidelines for the selection of end items are given in Exhibit XI. Each contractor to the Government shall be responsible for compliance by his subcontractors, vendors, and suppliers to the extent that his subcontractors, vendors, and suppliers participate in the preparation of this type of specification.

4. APPLICABLE DOCUMENTS

DSM 4120.3-M	1 April 1966	"Standardization Policies, Procedures and Instructions"
Exhibit X		"Requirements for Configuration Identification Numbers"
MIL-STD-480	30 October 1968	"Configuration Control - Engineering Changes, Deviations and Waivers"

5. EXPLANATION OF TERMS

(See Exhibit XVII)

6. PROCEDURAL REQUIREMENTS

These procedures are based on the policies and practices of the procuring agency for configuration management. It is recommended that contractors review these policies and practices as part of implementing the procedural requirements in this exhibit.

6.1 Computer Program Contract End Item Detail Specification

The CPCEI specification defines requirements for a computer program that has been identified as a CPCEI. The CPCEI specification is composed of two distinct parts. Each of which has distinct and different uses in the contractual control of CPCEI acquisition. Each of the two parts, when prepared to comply with

these instructions, is complete in content and format with respect to its intended use. The CPCEI specification is controlled and accounted as an entity, using a single end item configuration chart, and a single specification change log. (See Exhibit VII)

Part I is a product of a program definition phase or requirements analysis and is the technical requirements document used to contract for design and development of the CPCEI. Contractor compliance with Part I is determined by evaluation of qualification and other test records. The Part I specification describes in mathematical, logical, and operational language all of the detail necessary to initiate and carry out the design of a required computer program contract end item. In addition to providing the primary "design to" guide for the computer programming design and development effort during the acquisition phase, this document provides (a) the basis for approval by the procuring and using agencies of the fine detail of the performance of the computer programs to be developed, (b) the instrument which defines all essential interfaces with other computer programs, equipment, and communications links, (c) the direct basis for the development of support documentation associated with operation and use of the computer program, and (d) the basic vehicle for configuration control of the design of the CPCEI throughout acquisition and operational phases of the system cycle.

Part II of the CPCEI specification is a product of the acquisition phase. It provides a complete technical description of the CPCEI functions, structures, operating environment, and constraints, data organization, diagrammatic/narrative flows, and source statement/machine language listings. Part II must be identical to the actual CPCEI which results from the contractor's developmental work during the acquisition phase, and which is qualified (or to be qualified) under the terms and conditions of the contract as meeting the detailed performance requirements initially specified in Part I of the CPCEI detail specification. The integrity of Part II is established by First Article Configuration Inspection (FACI) prior to its acceptance by the procuring agency. Acceptance is dependent upon the accuracy and completeness with which it describes both the gross and detailed structure and functioning of the computer program.

6.2 Addenda to Computer Program Contract End Item Detail Specifications

Origination of an addendum to a CPCEI detail specification creates a new specification. It is used when an item to be designed and developed is so like an existing CPCEI that it is desirable to restrict design activity to "engineer to the same criteria, with these additions/deletions." An addendum changes a basic CPCEI detail specification by adding or deleting requirements on a paragraph-by-paragraph basis. Addenda shall be identified with a specific issue of a basic specification. The specification so created (basic specification plus addenda) then becomes controlled and maintained as a separate and distinct specification, to be updated and revised as necessary, independent of changes to the basic specification from which it was created.

6.3 Detailed Instructions for the Preparation of the CPCEI Specification

The contents of the CPCEI Specification shall be arranged in accordance with the format and paragraph headings given in 6.3.1 (Part I) and 6.3.2 (Part II). General deviations from the requirements of this exhibit require prior approval of the procuring agency. Each CPCEI detail specification which deviates from the general requirements of this exhibit shall cite, in Section 10 "Appendix", the procuring agency instrument authorizing the deviation. For convenience in describing the minimum essential content, the paragraphs outlined in 6.3.1 and 6.3.2 are arranged in a format which shall apply if the specification is to be issued as a single document. However, each part of the specification required for a large computer program is typically too complex and bulky to be published and distributed physically in one bound volume. In this case, each part may be arranged into separate volumes corresponding to individual functional elements, or as determined by mutual agreement between the contractor and the procuring agency to meet the requirements of a particular system.

Note: In the descriptions to follow, the term "computer program component" (CPC) is used to denote the separately produced subprograms which comprise a CPCEI. These subprograms are usually separately compilable, perform a specified function or set of functions that are related, and are produced by a single programmer. The Part II Specification contains a detailed description of each CPC in a CPCEI and denotes the relationship between them.

6.3.1 CPCEI Part I Specification

This subparagraph contains a description of the paragraph headings of a CPCEI Part I Specification.

"Title Page" - (Computer Program Contract End Item Detail Specification) - The title page shall conform to the format of Sample Format "A" and include the following information referenced to Sample Format "A":

"Specification Number"	An identifier unique, within the system, to this CPCEI. (See Exhibit X.) For CPCEI's, the first two (2) characters (the prefix code) shall be "CG".
"Revision Identification"	Sequentially assigned character(s) to uniquely identify each revision of the specification.
"Release Date"	Date formally released by the preparing agency.

Note: The specification number and revision identification may be composed of either, or both, alpha and/or numeric characters. Under no circumstances shall the combination of specification number and revision identification exceed 15 characters. (See Exhibit X.)

"CEI"	Contract End Item Number. (See Exhibit X.)
"Approved Nomenclature"	In accordance with Exhibit X and standard practice.
"System Identification"	List the system or systems which the CPCEI is designed to support. For CPCEIs which cannot be identified with specific systems, enter the phrase "Not System Computer Programs".

The title page shall be followed by introductory material as appropriate, including the End Item Configuration Chart and the Specification Change Log.

"Introductory Page" - (Part I of CPCEI Specification) -
The introductory page shall conform to the format of Sample Format "B". The identifying information appearing on this page shall be identical to the respective element of information appearing on the CEI specification title page. The preparing activity and the NASA office with computer program responsibility for the CPCEI shall validate the basic Part I in the approval blocks. A general outline of the following paragraphs is given in Sample Format "C".

Section 1, "Scope" - This section of the CPCEI specification shall begin with the following opening phrase: "This part of this specification establishes the requirements for performance, design, test, and qualification of a CPCEI identified as (insert nomenclature and contract end item number). This CPCEI is used to (provide) (accomplish) This CPCEI requires" Subsequent sentence-paragraph(s) shall contain a summary of the purpose of the specification, a brief description of the functions to be performed, and a brief summary of the content and composition of the specification.

Section 2, "Applicable Documents" - This section of the CPCEI specification shall begin with the following lead phrase: "The following documents, of exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and the detailed content of Sections 3, 4, and 10, the detailed requirements in Sections 3, 4, and 10 shall be considered superseding requirements." Those documents (specifications, standards, drawings, bulletins, manuals, etc.) which are applicable to paragraphs within other sections of the specifications shall be listed. Within the body of the specification, reference to those documents shall be by reference to their basic document number or other definitive designation. The format in listing the applicable documents shall comply with the Defense Standardization Manual 4120.3-M.

Section 3, "Requirements" - This section shall contain performance and design requirements for the CPCEI. This section shall include the functional requirements for the CPCEI and establish those requirements which will be used for verifica-

tion during test. This section shall define the CPCEI and specify design constraints and standards necessary to assure compatibility of the CPCEI with other computer programs and equipments. Performance and design requirements included herein are allocated from, identical with, or in recognition of, requirements established by the system specification. Requirements included in the system specification, which are directly related to requirements specified herein, shall be incorporated by reference. Requirements shall be specified to the level of detail necessary to establish limits for design. Quantitative requirements shall be specified within the three principal subparagraphs included herein. General and descriptive material may be included in the basic Section 3.

Paragraph 3.1, "Performance" - This paragraph shall specify the functional requirements of the CPCEI. Quantitative requirements shall be specified within the principal subparagraphs included herein. General and descriptive material may be included in basic paragraph 3.1.

Paragraph 3.1.1, "System Requirements" - This paragraph shall specify the limits and/or capacities of the CPCEI performance. Requirements specified herein are the product of analysis, as well as those contained in the system specification. These characteristics are the performance parameters which must be specified to constrain design within requirements established by primary mission/use of the CPCEI, e.g., for a space tracking system; this could include track capacity, number and type of inputs processed, etc. Requirements included herein shall be stated in quantitative terms, with tolerances where applicable.

Paragraph 3.1.2, "Operational Requirements" - This paragraph shall specify, in subparagraphs defined below, the operational requirements of the CPCEI. Requirements shall be stated in quantitative terms, with tolerances where applicable. General and descriptive material may be included in basic paragraph 3.1.2, which shall incorporate, either directly or by reference, a functional block diagram or equivalent representation of the CPCEI. The graphic portrayal shall be accomplished to the level of detail necessary to illustrate the functional operation of the CPCEI, the relationships between these functions, and the relationships between the functions and other identified system functions. This diagram is not intended to be restrictive on computer program design in any way.

Requirements for separately identified CPCEI functions shall be described in subsequent paragraphs as appropriate. A

subparagraph shall be included for each operational function, plus special functions such as sequencing control, displays, error detection and recovery, input and output control, real-time diagnostics, operational data recording, etc. The descriptions of these CPCEI functional requirements shall include the relative sequencing, periodicities, options, and other important relationships of each as appropriate.

Paragraph 3.1.2.1, "Function 1" - The basic paragraph shall begin with descriptive and introductory material which defines the function and its relationship to other functions. Then, the following three subparagraphs shall specify the quantitative requirements concerning the function.

Paragraph 3.1.2.1.1, "Source and Type of Inputs" - This paragraph shall specify the source(s) and type(s) of input information associated with this function of the CPCEI. This shall include a description of the information, its source(s) and, in quantitative terms, units of measure, limits and/or ranges of units of measures, accuracy/precision requirements, frequency of arrival information, etc., where applicable.

Paragraph 3.1.2.1.2, "Destination and Types of Outputs" - This paragraph shall specify the destination(s) and type(s) of output information associated with this function of the CPCEI as a result of the processing described in paragraph 3.1.2.1.3. This shall include a description of the information, its destination(s) and, in quantitative terms, units of measure, accuracy/precision requirements, frequency of output information, etc., where applicable.

Paragraph 3.1.2.1.3, "Information Processing" - This paragraph shall specify the information processing associated with this function. The paragraph shall incorporate a detailed prose and mathematical description, including necessary logical concepts, timing requirements, mathematical techniques, required accuracies with tolerances, data manipulation considerations, and options. A graphic portrayal of this function shall be included for clarity as appropriate.

Paragraph 3.1.2.n, "Function n"-

Paragraph 3.1.2.n.1, "Source and Type of Inputs" -

Paragraph 3.1.2.n.2, "Destination and Types of Outputs" -

Paragraph 3.1.2.n.3, "Information Processing" -

Paragraph 3.1.3, "Data Base Requirements" - This paragraph shall specify, in descriptive and quantitative terms, the requirements for all parameters which affect the design of the CPCEI. The detailed definition of parameters shall include a description of the data and quantitative definitions of units of measure, ranges of units of measure, and accuracy/precision requirements where applicable. In addition, wherever applicable, this paragraph shall specify the methods necessary to convert these parameters into a form suitable for use by the computer program. In the case of a multi-site system in which the actual data values of certain parameters will vary among site installations, the complete set of such site adaptation parameters shall be identified either directly in a separate subparagraph or by reference.

Paragraph 3.1.4, "Human Performance" - Human performance/human engineering requirements for the CPCEI shall be specified in this paragraph; for example, minimum times for human decision making, maximum time for program responses, maximum display densities of information, clarity requirements for displays, etc. For CPCEIs which directly support a system(s), this paragraph shall cite the appropriate paragraph(s) of the system specification which establish the human performance/human engineering requirements for all system equipment, and incorporate requirements peculiar to this CPCEI on an add and/or delete basis.

Paragraph 3.2, "CPCEI Definition" - This paragraph shall, in subparagraphs included herein, specify the functional relationship of the CPCEI to other equipment/computer programs and identify government furnished computer programs incorporated in the CPCEI. General and/or descriptive material may be included in basic paragraph 3.2.

Paragraph 3.2.1, "Interface Requirements" - This paragraph shall specify, either directly or by reference, requirements imposed on the design of the CPCEI because of its relationship to other equipment/computer programs. It shall also include detailed interface definitions resulting from contractor analysis and requirements contained in the system specification. General and/or descriptive material may be included in basic paragraph 3.2.1. Quantitative requirements shall be included in the subparagraphs included herein.

Note: Interfaces defined in this section shall include, at a minimum, all relevant characteristics of the computer, such as memory size, word size, access and operation times, interrupt capabilities, and special hardware capabilities. If the compiler/assembler is another, or part of another, CEI, the computer program language(s) to be employed shall be specified

as one of the interfaces in subparagraph 3.2.1.2. If the compiler/ assembler is a Government-furnished component to be incorporated into this CPCEI, it shall be referenced in subparagraph 3.2.2. If the compiler/assembler is to be constructed as part of the development of this CPCEI, the language characteristics are to be defined under paragraph 3.1, "Operational Requirements".

Paragraph 3.2.1.1, "Interface Block Diagram" - The relationship of the CPCEI to other equipment/computer programs with which it must interface shall be graphically portrayed in this paragraph. This paragraph shall incorporate, in subparagraphs as appropriate, either directly or by reference, a functional block diagram or equivalent representation of the interface requirements of the CPCEI. The graphic portrayal of the CPCEI shall be accomplished to the level of detail necessary to identify the functional interfaces between the CPCEI and other identified equipment/computer programs.

Paragraph 3.2.1.2, "Detailed Interface Definition" - This paragraph shall specify, in subparagraphs as appropriate, the functional relationship of the CPCEI to interfacing equipment and computer programs. This information shall be given in quantitative terms, with tolerances where applicable, to the level of detail necessary to permit design of the CPCEI. Functional interfaces shall specify the input/output requirements of the CPCEI in terms of data rate, message format, etc. In addition, this paragraph shall specify design requirements imposed upon other equipment/computer programs as a result of the design of this CPCEI, e.g., card formats, operator console equipment, display formats, etc. This paragraph shall incorporate, either directly or by reference, interface drawings and/or other documentation necessary to specify the functional interfaces of this CPCEI with other equipment/computer programs.

Paragraph 3.2.2, "Government-Furnished Property List" - This paragraph shall list the government-furnished computer programs which the CPCEI must be designed to incorporate. The listing shall identify the programs by nomenclature, specification number, model number if appropriate, and associated documentation.

Paragraph 3.3, "Design Requirements" - This paragraph shall specify, in appropriate subparagraphs, requirements which affect the design of the CPCEI and are distinguishable from the performance requirements of paragraph 3.1. These requirements result from general considerations of CPCEI use-

ability. These may include but are not limited to requirements for:

- a. The use of programming standards to assure compatibility among computer program components (CPC-subprograms or groups of functionally related subprograms).
- b. Program organization, such as overall program segmentation.
- c. Program design resulting from consideration of modifications to the CPCEI during operation; for example, on-site modification requirements and the permissible amount of operational degradation allowed during installation of modifications may be specified.
- d. Special features, to facilitate the testing of the CPCEI. For example, special procedures for the design of computer program component interfaces, requirements for intermediate printouts, and commentary on the program listing may be required.
- e. Expandability, to facilitate the growth of the CPCEI.

Section 4, "Quality Assurance Provisions" - Requirements for formal verification of the performance of the CPCEI in accordance with the requirements of Section 3 of this specification shall be specified in this paragraph. Formal verification of performance of the CPCEI shall determine acceptance of the CPCEI. This paragraph shall specify formal verification requirements to a level of detail which:

- a. Designates verification requirements and methods in Section 4 for performance and design requirements in Section 3. The methods of verification to be specified herein may include inspection of the CPCEI, review of analytical data, demonstration tests, and review of test data.
- b. Specifies requirements for verification to the level of detail necessary to clearly establish the scope and accuracy of the test method.
- c. Permits ready identification of each verification requirement specified in Section 4 with the appropriate performance/design requirement paragraph in Section 3.
- d. Allocates verification requirements to the subparagraphs included herein.

Note: This section shall not incorporate, either directly or by reference, detailed test planning documentation and operating instructions. Requirements specified herein shall be the basis for preparation and validation of such documents. All test/verification requirements shall be specified within the subparagraphs included herein.

Paragraph 4.1, "Implementation Test Requirements" - The term "Implementation Test" is defined to include all tests of the CPCEI other than that accomplished during the integration tests (see paragraph 4.2). The implementation test requirements shall be specified in the following subparagraphs.

Subparagraph 4.1.1, "Design and Development Testing" - This subparagraph shall specify the requirements for computer program component and program tests conducted in the acquisition phase prior to the preliminary qualification tests. These are tests performed on the individual computer program components and groups of components to establish that the CPCEI is ready for preliminary qualification testing. These requirements shall be specified in sufficient detail to permit design of such tests and to serve as a guide to the programmers in computer program component debugging.

Note: Verification requirements included in a higher level specification (e.g., system specification) may be incorporated by reference to avoid duplication.

Subparagraph 4.1.2, "Preliminary Qualification Testing" - This subparagraph shall identify the requirements for preliminary qualification testing. These tests shall verify each requirement of Section 3, which can be tested in a simulated environment. They are typically held at the contractor's development facility and may serve as the basis for transfer of the CPCEI to the user's facility.

This subparagraph shall specify only those preliminary qualification requirements which require formal recognition by the procuring agency. It shall specify, to whatever extent is possible, the location and relative scheduling of the tests, the computer-based system components which will not be available (and hence must be simulated or ignored), the objectives of the tests, and the program functions to be tested.

Subparagraph 4.1.3, "Special Test Requirements" - In this subparagraph all special verification test requirements, if any, not included in the above two subparagraphs shall be specified.

Paragraph 4.2, "Integration Test Requirements" - This paragraph shall identify requirements specified in Section 3 which cannot be verified until the CPCEI is assembled into or used with the computer-based system environment and other CPCEI's. Final verification that all requirements in Section 3 have been satisfied shall be considered here.

Integration test requirements shall be specified in the following subparagraphs.

Subparagraph 4.2.1, "General" - This subparagraph shall specify CPCEI tests which are required in direct support of system integration, i.e., integration of the CPCEI, hardware, external environment (communication lines, etc.) and operating personnel into an operative computer-based system. Consideration should be given to the impact of training on CPCEI test design. Such tests, prior to formal acceptance tests, usually involve attempting to run parts of the CPCEI functions on a limited basis as components of the computer-based system are installed sequentially. This subparagraph shall identify each performance/design requirement to be verified in each test.

Subparagraph 4.2.2, "Acceptance/Qualification Test" - This subparagraph shall specify requirements for formal qualification of the integrated CPCEI to demonstrate and/or verify that the requirements established in Section 3 have been satisfied. This paragraph shall, in subparagraphs as appropriate, specify the requirement and method of verification for the requirements specified in Section 3.

Verification of the requirements may be accomplished by inspection, or review of analytical data, or by demonstration, or test and review of test data, or combinations of these.

Section 5, "Preparation for Delivery" - This section is not applicable to Part I of the CPCEI specification. Requirements for preparation of the CPCEI for shipment and delivery are contained in Section 5, Part II of this specification.

Section 6, "Notes" - This section shall include information which is stated here for administrative convenience only and is not a part of the specification for the CPCEI in the contractual sense, i.e., it shall not include requirements which constrain design, development, and qualification of the CPCEI and require compliance by the contractor.

This section of the specification shall include information of particular importance to the procuring agency in using this particular specification as a contractual instrument for acquisition of the CPCEI, either initially or for follow-on procurement.

Background information or rationale which will be of assistance in understanding the specification itself or using the CPCEI it specifies may be included herein, e.g., technical data ordering instructions.

Section 10, "Appendix" - Requirements specified in the appendix are contractually a part of the specification, and to the extent they impose requirements on design, development, and qualification of the CPCEI, they must be satisfied. This section may include, but not be limited to, requirements which are:

- a. Bound separately for convenience, as in the case of a classified appendix or a large body of statistical data.
- b. Of a temporary nature, as in the case of an interim performance requirement peculiar to early test models of the CPCEI. Requirements peculiar to early test articles of the CPCEI shall be specified in an appendix which adds to, deletes, changes, or established new requirements applicable to Section 3 or 4 of Part I.

Instrumentation requirements for test articles of the CPCEI shall be specified only to the level of detail necessary to establish the type and total capacity of the instrumentation. Requirements specified herein (with the exception of instrumentation) shall be specified to the level of detail required by the paragraphs in Sections 3 and 4 of Part I to which they relate.

If any terms, symbols, and abbreviations are used in the body of this specification whose meanings are not widely known, they may be defined in a Glossary in this section.

EXHIBIT XVIII

SAMPLE FORMAT "A"

Specification No. _____

Revision No. _____

Release Date _____

CONTRACT END ITEM DETAIL SPECIFICATION
(COMPUTER PROGRAM)

PERFORMANCE/DESIGN
AND
PRODUCT CONFIGURATION
REQUIREMENTS

(CEI Number)

(APPROVED NOMENCLATURE)

FOR

(PROJECT OR SYSTEM NAME)

(PROJECT OR SYSTEM)

Approved by _____
(Preparing Activity)

Approved by _____
(NASA Office)

Date _____

Approval Date _____

Contract Number _____

SAMPLE FORMAT "B"

Specification No. _____

Revision No. _____

Release Date _____

CONTRACT END ITEM DETAIL SPECIFICATION
(COMPUTER PROGRAM)

PART I

PERFORMANCE/DESIGN
REQUIREMENTS

(CEI Number)

(APPROVED NOMENCLATURE)

FOR

(PROJECT OR SYSTEM NAME)

(PROJECT OR SYSTEM)

Approved by _____
(Preparing Activity)

Date _____

Approved by _____
(NASA Office)

Approval Date _____

Contract Number _____

SAMPLE FORMAT "C"

GENERAL OUTLINE OF CPCEI SPECIFICATION PART I

TITLE PAGE (Overall CPCEI Specification)

INTRODUCTORY PAGE (Part I)

1. SCOPE

2. APPLICABLE DOCUMENTS

3. REQUIREMENTS

3.1 Performance

3.1.1 System Requirements

3.1.2 Operational Requirements

3.1.2.1 Function 1

3.1.2.1.1 Source and Type of Inputs

3.1.2.1.2 Destination and Types of Outputs

3.1.2.1.3 Information Processing

3.1.2.2 Function 2

. .

. .

. .

3.1.2.n Function n

3.1.3 Data Base Requirements

3.1.4 Human Performance

3.2 CPCEI Definition

3.2.1 Interface Requirements

3.2.1.1 Interface Block Diagram

3.2.1.2 Detailed Interface Definition

3.2.2 Government-Furnished Property List

3.3 Design Requirements

4. QUALITY ASSURANCE PROVISIONS

4.1 Implementation Test Requirements

4.1.1 Design and Development Testing

4.1.2 Preliminary Qualification Test

4.1.3 Special Test Requirements

4.2 Integration Test Requirements

4.2.1 General

4.2.2 Acceptance/Qualification Test

6. NOTES

10. APPENDIX

6.3.2 CPCEI Part II Specification

This subparagraph describes the paragraph headings of a CPCEI Part II Specification. The overall outline of the CPCEI Specification Part II is contained in Sample Format "D" with all major paragraphs and subparagraph headings listed.

Throughout the Part II Specification, the phrase "Computer Program Component" is used to refer to subprograms (separately compilable groups of computer program instructions and data) or groups ("packages") of functionally related subprograms.

A discussion of the contents of these major paragraphs and subparagraphs follows.

"Introductory Page" - (Part II of CPCEI Specification) - The introductory page shall conform to the format of Sample Format "E". The identification appearing on this page shall be identical to the respective elements of information appearing on the CPCEI specification title page. The procuring agency shall validate the basic Part II in the approval blocks.

Section 1, "Scope" - This section shall contain the following lead phrase: "This specification establishes the requirements for complete identification and acceptance of (insert contract end item number and nomenclature) to be formally accepted by the procuring agency, subsequent to establishment of the product configuration baseline. The product configuration baseline shall be established by First Article Configuration Inspection (FACI) for serial number (insert CPCEI serial number).

Section 2, "Applicable Documents"

This section of the specification shall begin with the following lead phrase: "The following documents, of exact issue shown, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and the detail content of Sections 3, 4, 5, and 10, the detail contents of Sections 3, 4, 5, and 10 shall be considered a superseding requirement." List those documents (specifications, standards, bulletins, manuals, etc.) which are applicable to paragraphs within other sections of the specification. Within the body of the specification, reference to these documents shall be by reference to their basic document number or other definitive designation.

Section 3, "Requirements"

This section shall specify the detailed configuration of the CPCEI. This section shall contain a complete technical description of the CPCEI structure and functions, the data base, and the individual CPC's. General and/or descriptive material may be included in basic Section 3 lead paragraph.

Paragraph 3.1, "CPCEI Characteristics"

This paragraph shall contain a description of the overall structure and functions of the CPCEI. This description shall include: the allocation of functions to the CPC's that comprise the CPCEI; flow charts; timing and sequencing characteristics of the CPCEI; and a graphic portrayal of storage allocation. This description shall be given in the following paragraphs.

Paragraph 3.1.1, "Functional Allocation"

The relationship of each computer program component (CPC) to the performance and design requirements of the Part I Detail Specification shall be specified in this paragraph. This relationship will be specified to the level of detail necessary to identify how the computer program components are associated with the requirements of the functions specified in the Part I specification. If the CPC's are grouped into functional entities ("packages") for separate stages of development and checkout, this grouping shall be delineated.

Paragraph 3.1.2, "CPCEI Flow Chart"

This paragraph shall graphically portray the operations performed by the CPCEI. This shall be done by a (series of) flow chart(s) which depict(s) the processing being performed, the sequence of operations and the decision points. A "top-level" flow chart shall be used to depict in a single figure the overall information flow of the CPCEI. This diagram shall reference lower level flow charts included in this paragraph, as appropriate, to provide more detailed information. The lowest level flow charts shall be those which identify as functional entities the computer program components described in Section 3 below. All symbols used in the flow chart shall be defined either directly in this paragraph, or on the individual flow chart sheets, or by reference to a documented set of standards.

Paragraph 3.1.3, "CPCEI Timing and Sequencing"

This paragraph shall describe the timing and sequencing of operations of the computer program components relative to each other. If the sequencing is dynamically controlled during the CPCEI's operations, this description shall include the method

for sequence control and the logic and input conditions of that method. Such factors as timing variations, plus such internal operations as data transfers in and out of core, disc, drum, or tape memory, sensing of discrete input signals, and the timing relationships between interrupt operations within the CPCEI, shall be included.

Paragraph 3.1.4, "Storage Allocation"

The relationship of the CPCEI storage requirements to the total computer equipment storage capability shall be graphically portrayed in this paragraph. This paragraph shall incorporate, in subparagraphs as appropriate, either directly or by reference, a schematic diagram, or equivalent representation. This graphic portrayal of the CPCEI shall be accomplished to the level of detail necessary to identify such requirements as: Data base allocation, computer program allocation, computer temporary memory allocation, and spare storage allocation. If allocations cannot be specified precisely or portrayed graphically in a manner meaningful for program design, the algorithms used to allocate storage will be described.

Paragraph 3.1.5, "Data Base Characteristics"

This paragraph shall include a detailed definition of the content and storage location of each file, table, and item within each table that is incorporated in the CPCEI data base, as well as the storage location of each computer program component contained in the CPCEI. This paragraph shall contain the following:

1. "File Description". A list of files that have been incorporated in the computer program data base shall be included. This shall include a descriptive title for each file, length of file, and format, etc.
2. "Table Description". A list of tables that have been incorporated in the computer program data base shall be included. This shall include a descriptive title for each table, method of indexing the table, length of table, and block format for items and itemless tables, etc.
3. "Item Description". A list of all items contained in the computer program data base shall be included. This shall include for each item, a descriptive title, most significant bit, number of bits, coding type, scaling factor, and, if appropriate, units and item value, etc.
4. "Graphic Table Description". The relationship of the items specified in 3 above "Item Description" to the

EXHIBIT XVIII

tables listed in 2 above and the relationship of tables specified in 2 above to the files listed in 1 above will be graphically portrayed. This shall incorporate, in subparagraphs as appropriate, either directly or by reference, a diagram or equivalent representation. The graphic portrayal of each table shall be accomplished to the level of detail necessary to identify words per block, untagged items, bits/items, bit allocation, number of blocks and type of table construction.

5. "Data Organization". A definition of the relationship of the items, tables, and files contained within the data base and the computer program components described in Paragraph 3.2, to locations in computer storage, shall be included. This paragraph shall incorporate such information as the following:
 - a. A list of files, specifying for each file the address in storage and number of tables contained in the file, etc.
 - b. A list of tables, specifying for each table the location within the file and number of words contained in the table, etc.
 - c. A list of items, identifying item location within the table, number of bits, item type, scaling, etc.
 - d. A list of computer program components, specifying for each the storage address and number of words allocated.
6. "CPCEI Constants". A list of all constants (e.g., fixed values assigned to the parameters defined in the Part I CPCEI specification) contained in the CPCEI, other than those which are defined as "Adaptation Data" below, shall be included. The list contained herein shall include, as a minimum, a description of each constant and its actual numerical or coded value.
7. "Adaptation DATA". For multi-site computer based systems, the actual data required to adapt the CPCEI to the environment associated with each site shall be listed. For convenience, this information may be contained in Section 10, "Appendix".
8. "Relationship of Computer Program Components to Data Base". The relationship of the various computer program components to the various tables and items contained in the CPCEI data base shall be graphically portrayed. This paragraph shall incorporate, in subparagraphs as appropriate, either directly or by reference, a diagram or equivalent representation. This graphic

portrayal of the relationship of CPC's to the data base shall be accomplished to the level of detail necessary to identify the tables and items within the tables required by each computer program component to the relationship of the CPC to each table/item (e.g., sets the item, uses the item, etc.). The use of such tables and items by each CPC shall be fully described in the appropriate subparagraph under paragraph 3.2.

Paragraph 3.2, "Computer Program Component Characteristics"

The individual computer program components (CPC's) shall be described in separate paragraphs as required. This description shall be given at a level of detail that will define the design and configuration of the CPC sufficiently to allow for CPC modification and adaptation in the operation phase. Each CPC shall be described in words, flow charts, and with a listing of the instructions used. The basic paragraph 3.2 shall contain the following lead phrase: "This paragraph contains the detailed technical descriptions of the computer program components identified in Paragraph 3.1 of this specification. The instruction listings contained herein by inclusion or reference specify the exact configuration of the (name of CPCEI). . ." The following paragraphs will be repeated for each CPC.

Note: The contents of paragraphs 3.2.1-3.2.n to follow represent information that corresponds in general to "programming specifications" normally produced by analysts, and "coding specifications" normally produced by programmers, during the acquisition phase. The format described below is intended to allow for use of such technical documentation directly as portions of the Part II CPCEI specification, thus eliminating the need for redocumentation. Other formats may be allowed at the discretion of the procuring agency if they meet this intent.

Paragraph 3.2.1, "Computer Program Component #1"

The basic paragraph shall identify the CPC by including as a minimum the title, tag (symbolic code), and component identification number. It shall also include a brief abstract of the functions of the CPC, the language(s) in which it is written, and its major functional interfaces. The CPC shall then be described in detail in subparagraphs as follows:

Subparagraph 3.2.1.1, "CPC No. 1 Description"

This paragraph shall describe in words, figures, equations, and references to the flow chart(s) of Subparagraph 3.2.1.2, the functions and design of the CPC.

This subparagraph shall contain, as appropriate, a description of: the program logic and data flow; equations to be solved; algorithms used to solve these equations; timing and accuracy

characteristics; and any special conditions for operation of the CPC. The description shall be sufficiently detailed to facilitate understanding of, and modification to, the listing given in subparagraph 3.2.1. Equation derivations and numerical analysis shall not be included herein, but may be included in Section 6, "Notes".

Subparagraph 3.2.1.2, "CPC No.1 Flow Chart"

This subparagraph shall graphically portray the operations performed by the CPC. This shall be done by a (series of) flow chart(s) which depict the processing described in subparagraph 3.2.1.1, including the sequence of operations and decision points, in the CPC. The "highest level" flow chart shall depict on a single sheet the overall information flow of the CPC and shall reference the flow chart(s) in paragraph 3.1.2 that identifies the CPC. In general, the lowest level flow chart identifies all decision points in the CPC and references higher level charts as appropriate. All flow charts shall use descriptive symbols and shall reference the program listing of the CPC by use of statement labels or tags. All symbols used in the flow chart shall be defined in this subparagraph, or by reference to paragraph 3.1.2 above, or by reference to a documented set of standards, or on the individual flow chart sheets.

Subparagraph 3.2.1.3, "Interfaces"

This subparagraph shall describe the relationship of the CPC to other CPC's to that part of the data base external to the CPC, and, to other CPCEI's where applicable. Appropriate subparagraphs shall include:

- (a) The exact format, content and source of all input data.
- (b) The exact format, content and destination of all output data.
- (c) A list of the subroutines called by the CPC.
- (d) A list of other CPC's which call the CPC.
- (e) A list of external (to the CPC) tables, buffers, constants, and control registers used by the CPC.

Subparagraph 3.2.1.4, "CPC Data Organization"

This paragraph shall contain, or refer to a portion of subparagraph 3.2.1.6 if appropriate, a list and description of all data items and tables which are unique to and included within the CPC, and shall describe the areas of memory available for temporary storage. This list shall include all internally

defined symbols and their equivalence and meaning.

Subparagraph 3.2.1.5, "Limitations"

This subparagraph shall summarize any known or anticipated limitations of the CPC. A listing of all restrictions and constraints which apply to the CPC shall be provided, including timing requirements, limitations of algorithms and formulas used, limits of input and output data, associated error correction sensing, and the error checks programmed into the routines.

Subparagraph 3.2.1.6, "Listing"

This subparagraph shall contain a complete listing of instructions contained in the computer program component(s). The type of listing provided in this paragraph shall be established between the contractor and the procuring agency. The listing will show the relationship to the flow diagrams above by appropriate use of statement labels or tags. For convenience, the listing may be included in Section 10, "Appendix".

Paragraph 3.2.2, "Computer Program Component #2"

.
. .
.

Paragraph 3.2.ⁿ, "Computer Program Component #ⁿ"

.
. .
.

Section 4, "Quality Assurance"

This section shall specify the tests which must be accomplished to demonstrate that the CPCEI performance and configuration is as specified in Section 3 of Part II of this specification.

Paragraph 4.1, "Test Specifications Cross Reference Index"

In this paragraph, all Test Plan and Test Specification documents shall be referenced, with cross indexing to the CPCEI functions being tested and the CPCEI components and other computer programs required for the tests. This paragraph shall also describe or

reference special simulation capabilities required for test/verification of the CPCEI.

Paragraph 4.2, "Other Quality Assurance Provisions"

This paragraph shall reference applicable standards and/or specify the test/verification requirements, methods and procedures which apply to duplication of the computer program (e.g., tapes and/or card decks) which are covered by the specification.

Section 5, "Preparation for Delivery"

This section shall specify, in subparagraphs as appropriate, the requirements for packaging, marking and otherwise preparing the CPCEI for shipment. Where approved existing Government Specifications are adequate to satisfy current requirements for the item and components thereof, these shall be incorporated by reference in lieu of providing duplicate detailed requirements in this section. Where suitable specifications do not exist, requirements peculiar to the CPCEI shall be specified in appropriate subparagraphs included herein.

Paragraph 5.1, "Delivery Procedures"

This paragraph shall describe the delivery procedures of the completed CPCEI. Delivery procedures include a description of the product packaging (card decks, tapes, manuals) involved, where they shall be stored or delivered to, and the contractors responsibilities for, during, and after delivery.

Paragraph 5.2, "Markings"

This section shall contain subparagraphs specifying in detail the identification markings to appear on every separable portion of the CPCEI to be delivered by the contractor and formally accepted by the procuring agency.

Section 6, "Notes"

This section of the specification is not contractually binding. It shall include information of particular importance to the procuring agency in using Part II of this specification as a contractual instrument, or administrative or background information, e.g., ordering instructions for technical data pertaining to the computer program, or specific information related to the use of the program in future assembly and integration testing. It shall not include requirements which constrain design, development, or qualification of the CPCEI. It shall reference the technical manuals which can be singularly and peculiarly identified with the CPCEI, and which are necessary to its operation and maintenance.

For each CPC this paragraph shall include any pertinent information not included in the above subparagraphs, such as rejected alternative CPC designs, the rationale behind the design, reference material in support of the algorithms used, and suggestions for future modifications to the CPC if changes in requirements should materialize. It shall also describe as appropriate the pertinent tests which were performed to verify the final implementation of the CPC, with key test results included or referenced.

Section 10, "Appendix"

This section of the specification may contain requirements which are part of Section 3 and/or of Section 4, but are bound separately for convenience. Examples are computer-produced listings, multi-site adaptation requirements, etc.

SAMPLE FORMAT "D"GENERAL OUTLINE OF CPCEI SPECIFICATION PART II

INTRODUCTORY PAGE (PART II)

1. SCOPE
2. APPLICABLE DOCUMENTS
3. REQUIREMENTS
 - 3.1 CPCEI Characteristics
 - 3.1.1 Functional Allocation
 - 3.1.2 CPCEI Flow Chart
 - 3.1.3 CPCEI Timing and Sequencing
 - 3.1.4 Storage Allocation
 - 3.1.5 Data Base Characteristics
 - 3.2 Computer Program Component Characteristics
 - 3.2.1 Computer Program Component #1
 - 3.2.1.1 Description
 - 3.2.1.2 Flow Charts
 - 3.2.1.3 Interfaces
 - 3.2.1.4 CPC Data Organization
 - 3.2.1.5 Limitations
 - 3.2.1.6 Listings
 - 3.2.2 Computer Program Component #2
 - .
 - .
 - 3.2.n Computer Program Component # n
4. QUALITY ASSURANCE
 - 4.1 Test Specifications Cross Reference Index
 - 4.2 Other Quality Assurance Provisions
5. PREPARATION FOR DELIVERY
 - 5.1 Delivery Procedures
 - 5.2 Markings
6. NOTES
10. APPENDIX

SAMPLE FORMAT "E"

Specification No. _____

Revision No. _____

Release Date _____

CONTRACT END ITEM DETAIL SPECIFICATION

(COMPUTER PROGRAM)

PART II

COMPUTER PROGRAM

DESIGN

(CEI NUMBER)

(APPROVED NOMENCLATURE)

6.3.3 CPCEI Specification Addenda

Frequently, a requirement develops for a CPCEI which is very similar to an existing CPCEI. When this occurs, it is desirable to create the new CPCEI by accomplishing minimum re-design of the existing CPCEI. To accomplish this, it is necessary to maintain visibility, throughout the design and development cycle, of differences in performance, design, and configuration requirements between the two CPCEI's. This visibility can often be acquired and maintained by creating the specification for the new CPCEI as an addendum to the specification for the existing CPCEI.

The use of a specification addendum presents a formal means of writing a specification for a new CPCEI, by changing the specification for an existing CPCEI in a manner which permits ready comparison of the exact relationship between the two CPCEI's. This is accomplished by writing the new specification by direct reference to the existing specification on a paragraph-by-paragraph basis, recording in the new specification specific references to each paragraph in the existing specification and noting each addition, deletion, or change. Where no change is necessary, the phrase "no change" shall be used. The paragraph numbering between the two documents shall be identical, with the exception of paragraphs added to the new document which do not have an exact counter-part in the existing specification.

A specification created in this manner is a new and complete specification in every sense. The method of preparing a specification for a new CPCEI by creating an addendum to an existing specification shall be used when the following conditions are satisfied:

- (a) There is sufficient reason to establish a direct relationship between the new CPCEI and an existing CPCEI as a basis for design and development, e.g., progressing from one type, model, series of a CPCEI to another; or when minor changes must be accomplished to a very limited number of components of a CPCEI for a specific mission.
- (b) The basic specification, to which the addendum is prepared, complies with the requirements of this exhibit with respect to format and content.

The specification created by use of an addendum must be identified and maintained as a separate specification. Both the specification created by use of an addendum, and the basic specification to which the addendum is prepared, shall have independent change cycles. A specification change notice to either is not automatically a change to both. Each change

EXHIBIT XVIII

to either must be reviewed, and if it is desirable to change both the basic specification and the specification prepared as an addendum, two separate specification change notices must be prepared.

When a new specification is created by the preparation of an addendum to an existing specification, an Addendum Notice shall be prepared which conforms to the format and includes the content required by sample format F. The Addendum Notice shall be the first entry in Section 2, "Applicable Documents". All of the entries in the Addendum Notice refer to the original CPCEI specification as the basic document for preparation of the addenda CPCEI. Each entry shall be transcribed from the title page and specification change log of the basic specification.

Note: For filing and distribution, an addendum specification must always be accompanied by a copy of the specification to which it relates. See Sample Format "F".

SAMPLE FORMAT "F"

--A D D E N D U M N O T I C E--

This Specification has been prepared as an Addendum to:

Specification No. _____
Revision _____
Release Date _____
CEI No. _____

FOR

(Approved Nomenclature)

Used With

(PROJECT OR SYSTEM NAME)

(PROJECT OR SYSTEM)

This (addendum) specification must always be accompanied by the specification (above) to which it relates.

The exact content of specification (insert same number as above) used as the basic document for this addendum is the revision referenced above plus the following specification change notices to specification (insert same number as above).

EXHIBIT XIX

COMPUTER PROGRAM IDENTIFICATION,
CONTROL & ACCOUNTING

EXHIBIT XIX

COMPUTER PROGRAM IDENTIFICATION,
CONTROL & ACCOUNTING

CONTENTS

<u>Paragraph</u>	<u>Page</u>
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4. REFERENCE DOCUMENTS.....	XIX-1
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COMPUTER PROGRAM IDENTIFICATION,
CONTROL & ACCOUNTING

1. PURPOSE

This Exhibit provides requirements to insure that Computer Program Control End Items (CPCEI's) are properly selected, identified, controlled, reviewed and accounted for. In addition, general information and guidance is provided to allow adequate integration of CPCEI requirements into the overall configuration management process.

2. SCOPE

The requirements of this Exhibit provide the basis for managing and controlling computer program development in the following areas:

- a. Selection of CPCEI's.
- b. Identification and marking.
- c. Configuration and change control.
- d. Technical Reviews and Inspections.
- e. Configuration Accounting.

3. APPLICABILITY

This Exhibit is applicable during the definition, acquisition and operation of computer programs design, development, test and updating.

4. REFERENCE DOCUMENTS

The following exhibits of this document, and other documents shown form a part of this Exhibit:

Exhibit VII		"Specification Maintenance"
Exhibit IX		"Preparation of Engineering Change Proposals for Contract End Items"
MIL-STD-480	30 October 1968	"Configuration Control - Engineering Changes, Deviations, and Waivers"

5. GENERAL GUIDELINES

5.1 Computer Program Contract End Item

A computer program is the ordered set of instructions and data required to control the operation of a digital computer. The end product of the process required to produce a program is usually a punched deck of cards, magnetic tapes, or other physical media containing the ordered set in a form suitable for insertion into a digital computer. Under control of the instructions, the computer acts upon the data to perform a set of well-defined and logically related functions. A computer program contract end item (CPCEI) is defined in this exhibit as a computer programming end product whose development, as designated by the procuring agency, is subject to configuration management.

5.2 Definition Phase

A computer programming task usually requires the development of several programs and the data essential to other end items, the design constraints and practices to be followed in its development, and requirements for its qualification. These items are documented in a CPCEI Part I Specification. If the Part I Specification is produced by a contractor, it is reviewed by the procuring agency. Upon satisfactory completion of this review the Part I Specification is established as the Design Requirements Baseline for use in the acquisition phase. Its initial function is to govern the design, development and testing of computer programs throughout the acquisition phase. Its continuing function throughout the system life cycle is to serve as the baseline against which the impact of proposed performance and design changes is assessed.

5.3 Acquisition Phase

The activities of the acquisition phase result in the development of a fully assembled CPCEI that has been qualified in a simulated environment prior to integration into the computer based system. It can be conveniently divided into two subphases:

5.3.1 The Design Subphase

The design process begins with a definition of the structure of the computer program as a whole, in terms of functions allocated to individual subprograms, storage allocation, computer program operating sequences, and the format of the data base. The preliminary design approach is re-

viewed at the Preliminary Design Review (PDR) with respect to the requirements of the Part I Specification. Successful completion of this review is prerequisite to the detailed design of the computer program components (CPC's) which comprise the CPCEI. The design of each CPC or convenient groups of CPC's is documented in a programming specification which is sufficiently detailed to enable a programmer to code and debug the CPC. The CPC design is then reviewed by the procuring agency in a Critical Design Review (CDR). Successful completion of this review is prerequisite to coding the CPC. Other activities in the design subphase include the development of a test plan based on the quality assurance requirements of the Part I Specification, development of a programming standards manual based in part on the design requirements of the Part I Specification, and the initiation of formal change control and accounting of the Part I Specification.

5.3.2 The Implementation Subphase

During this subphase the contractor codes and debugs all CPC's produces detailed test specifications, tests the CPC's in groups until all the CPC's have been assembled together, demonstrates the validity of the CPCEI by means of a preliminary qualification test in a simulated environment, and completes the documentation of the CPCEI. The completed technical description is documented in the Part II CPCEI Specification which contains the description of the overall design, the programming specifications, flow charts, and listings. Other documents such as operator handbooks, progress reports, and PERT reports are produced as appropriate in the subphase. The terminating milestone for the implementation subphase is First Article Configuration Inspection (FACI). The primary objectives of FACI are to determine if the CPCEI is properly marked and documented, and to establish the completed Part II Specification as the Product Configuration Baseline. The Part II Specification then serves in the operation phase as an instrument for use by government or contractor personnel in diagnosing troubles, adapting the computer program to environmental and operating requirements of specific site locations, and designing minor or major changes to the computer program system.

5.4 Operational Phase

In this phase the CPCEI is integrated with the hardware and personnel of the computer based system, qualified and/or formally accepted in the system, and maintained between uses. The CPCEI may be modified for use in several installations or for use on a mission-by-mission basis. Change Control and accounting for both the Part I and Part II Specification is effected throughout the operational phase.

6. SELECTION OF CPCEI's

The CPCEI is typically a computer program which is one of many elements in a large system. In Apollo many of the required computer programs do not fall into this category. For example, a trajectory simulation program may work only within a computer and not with other equipment used during a mission. It is therefore necessary that some broad interpretations be given in the programs to be identified as CPCEI's. The designation of which computer programs are to be subjected to the formal requirements of this exhibit is left to the discretion of the procuring agency. The designation should be made on the basis of criticality, cost, and need for formal control, subject to the following guidelines:

- a. At a minimum, operational programs used in direct real-time support of a mission (including training and prelaunch checkout) should be classified as CPCEI's.

In this context, "direct real-time support" means that the results of computer processing are used to monitor or control the course of the mission or training exercise.

- b. Certain non-real-time or offline programs, such as support and utility programs associated with a CPCEI, or data processing programs used for telemetry deduction, may be designated as CPCEI's if:
 1. the status of the program directly affects mission schedules;
 2. changes to the configuration of the program directly affects the configuration of designated end items; or
 3. the programming effort requires a large expenditure of resources. In these cases it may be desirable to achieve a high level of management procedures.

The identification of CPCEI's is complicated by the multi-mission use of computer programs in the Apollo program. Many systems rely on programmable digital computers to provide the flexibility required to support a rapid succession of diverse missions. A computer program supporting a particular real-time function may change radically from mission to mission. This characteristic must be recognized in establishing configuration management for the life cycle of the system.

6.1 Identification Guidelines

The degree to which a program, performing the same general function on a mission-to-mission basis, can change for each mission use may vary greatly. In some cases only data may change; in other cases slight program revisions may be required; in still other cases extensive modifications may result. It is difficult to establish rigid rules to determine if a program used in a particular mission should be classified as a new CPCEI or be considered as a change to an existing CPCEI. The following guidelines, however, should be followed in determining whether or not a program is to be re-identified as a new end item (i.e., given a new identification number and defined in a new specification):

- 6.1.1 A program originally used in a particular mission may be modified and used without re-identification for a succeeding mission if:
- a) changes to its design are minor enough so that new design reviews are not required.
 - b) the existing specification can be conveniently modified by the use of Specification Change Notices (SCN's).
 - c) the original program will not be used again.
- 6.1.2 A program should be re-identified for use in succeeding missions if:
- a) new design reviews are required.
 - b) new subfunctions requiring additional subprograms are required.
 - c) a change of computing equipment causes a significant reprogramming effort.
 - d) a new specification is required to incorporate extensive modifications made over a period of time.
 - e) slight changes are required, but the original program will be used again.

A series of programs which are re-identified for each mission use may be given the same CPCEI number and differentiated by the use of a unique series

identifier letter. Since some part of the program may be similar from mission to mission it may not be necessary to produce a completely new specification for each mission. A specification addendum referenced to some previous specification may be sufficient for a particular mission.

In some instances it may be desirable to identify portions of a program as separate end items. An executive routine, for example, may be mission independent, while the application programs its controls may change greatly from mission to mission. A single specification may therefore be adequate for the development of the executive, while a series of specifications may be needed for the test programs. The identification of the executive and test programs as separate end items would facilitate management control of this type of effort.

In all cases, it is the procuring agency's responsibility to identify which programs are new end items. The requirements of configuration management are such that some degree of flexibility is allowed in this process to account for differences in the nature of computer programming tasks.

7. CONFIGURATION IDENTIFICATION

A CPCEI is identified by a detailed specification and set of identification numbers.

7.1 CPCEI Specification

The format and content for a CPCEI Specification is given in exhibit XVIII. As for hardware CEI's the specification is divided into two parts; Part I is the "design to" document resulting from the requirements analysis in the definition phase; Part II is the "response to" document describing the product as produced in the acquisition phase.

The Part I Specification contains performance requirements, design constraints, interface specifications, and test requirements, all of which are essential inputs to the contractors design efforts; the Part II Specification contains the overall design approach, programming specifications, flow charts and program listings - information which is needed for the control of the design process, and eventually to describe the completed CPCEI.

7.2 Identification Numbers and Markings

Numbers must be assigned to a CPCEI, its parts, and its specifications to assure that these items may be properly identified.

The selection of a numbering system must be consistent and provide unique identifiers for all items. The detailed requirements for the numbering system used in NASA are given in EXHIBIT X.

The required CPCEI numbers are:

- 7.2.1 Specification Number: consisting of a prefix code, a document identifier number, and a suffix code indicating the latest approved version of the document.
- 7.2.2 End Item Number: the unique reference number by which the end item can always be identified. It is assigned in the definition phase as soon as the end item is identified. The end item number consists of a unique end item identifier plus a series number to distinguish end items within a series.
- 7.2.3 Part Number: a number for each identified "part" which is within the end item. For a CPCEI, a "part" is defined to be the card decks, magnetic tapes, etc., in which the program is contained. A physical part as defined above may in many cases correspond to a logical part, a computer program component (CPC). To facilitate identification:
 - a) Each card deck containing a CPC is given a header card and a trailer card. Each card contains the name and number of the CPCEI and the name and part number of the subprogram. These cards are treated as comment cards by the assembler or compiler; that is, they have no program functions other than identifying a particular card deck.
 - b) Each card is marked by a printed CPCEI number and a punched sequence number identifying its location within the deck. In a large enough project it is recommended that the CPCEI numbers be preprinted on the cards for convenience. The punched sequence number not only serves as a unique card identifier (when coupled with the CPCEI number) but also allows the computer or ADP equipment to be used in ordering a "shuffled" deck of cards.

- c) Each CPC card deck is color-coded for easy identification. The band or case of each subprogram deck is marked by the CPCEI number and part number.
- d) Each tape reel, tape cannister, disc, or other storage medium used is marked with the CPCEI number and part number. Where appropriate, the information is included in machine readable form for example, as a tape header block.

8. CONFIGURATION CONTROL

CPCEI Configuration control is the establishment of technical control points called "baselines" and the systematic evaluation, coordination, and disposition of all proposed changes to these baselines. The CPCEI Specification is used to document the baselines for a CPCEI. There are two baselines formally established for the acquisition and operation of a computer program: the design requirements baseline, and the product configuration baseline.

8.1 The Design Requirements Baseline

The design requirements baseline, (DRB) is established at the beginning of the acquisition phase by procuring agency approval of the performance, design and qualification requirements in the Part I Specification. Once established, it becomes the controlling document for the design and testing activities of the contractor. Any change or addition to it must be submitted as a design requirements change and must be formally approved before the change can be designed and developed by the contractor. The DRB functions throughout both the acquisition and operation phase, although usually the volume of requirements changes will diminish in the operation phase. All approved changes to the DRB must be reflected in supporting technical documentation and in the end item itself. All proposed changes are formally submitted as Engineering Change Proposals (ECP).

8.2 The Product Configuration Baseline

The Part II Specification is established as the product configuration baseline after successful completion of the First Article Configuration Inspection (FACI). At this time Part II is audited to determine if it adequately describes the fully-assembled CPCEI. From this point on, all changes to the Part II Specification must be formally accounted for and controlled.

8.3 Change Control

The term "change" refers to any alteration to an established CPCEI baseline.

8.3.1 Change Classification

Changes to an established baseline are considered to be either of two types, Class I or Class II.

8.3.1.1 Class I changes: changes which, because of their criticality, require formal procuring agency approval before a contractor can effect them. Changes are designated as Class I whenever one or more of the following is affected:

- a) Operational capability as specified in the baselined Part I CPCEI specification.
- b) Contract price or schedule.
- c) Systems equipment, computer programs, or facilities produced by other contractor(s) to the extent that the affected other contractor(s) must accomplish a change to maintain compatibility at the interface(s).

8.3.1.2 Class II changes: Changes which the contractor may effect without prior approval by the procuring agency and at no additional cost to the procuring agency. Such changes may include:

- a) Changes to correct editorial errors.
- b) Changes to correct computer program errors.
- c) Other changes of a minor nature, within categories specifically defined by the procuring agency, e.g., adaptation data or re-compiling within specified limits.

The criteria given above are derived mainly from change processing requirements given in MIL-STD-480. The major difference is in the classification of computer program error changes as Class II changes. Under strict interpretation of MIL-STD-480 a computer program change of any type after FACI would be classified as a Class I change, because the corresponding product configuration baseline would also have to be changed.

In a computer programming effort, the number of these changes can be large even after FACI. The contractor must be given leeway in making such changes without having to wait for the approval of the procuring agency. To avoid unnecessary delays, the contractor may make the changes immediately. The contractor must update the Part II Specification to reflect the change and notify the procuring agency of the change.

8.3.2 Change Processing

The contractor initially classifies all proposed changes which result from his efforts. The initial determination is made according to guidelines given above and is subject to review by a representative of the procuring agency. Class I changes are documented in an Engineering Change Proposal (ECP) as defined in Exhibit IX.

9. TECHNICAL REVIEWS AND INSPECTIONS

9.1 Preliminary Design Review

The purpose of the PDR is to evaluate the contractor's initial design approach prior to the implementation of this approach. This review gives the procuring agency the opportunity to determine early in the programming process if the contractor is designing a product that actually satisfies the requirements of the Part I Specification. It also serves as a check on the compatibility of the CPCEI interfaces with other end items. The output of the review is either concurrence by the procuring agency of the design approach or a set of action items to be acted on by the contractor.

The PDR is held when the contractor's design activity has progressed to the point where functions have been allocated to individual computer program components (CPC's) and flow charts showing the data flow between all CPC's have been produced. This occurs early in the design subphase of the acquisition phase. The following is accomplished in the PDR:

- a) The compatibility of the selected design approach with Part I of the CPCEI Specification is established. This is accomplished by review of flow charts, storage allocation charts, timing estimates, descriptions of significant algorithms, and other engineering documents as required by the procuring agency. An initial presentation of the information required in section 3.1 of the Part II Specification may be used as the

- basis for this review.
- b) The integrity of the design approach is established. This is accomplished by review of algorithms, proposed programming techniques, design simulation results, estimated storage requirements, etc.
 - c) The compatibility of the CPCEI with other computer programs, or equipment external to the computer in which the CPCEI is used, is established. This is accomplished by review of proposed data formats, timing constraints, interface drawings, and other systems engineering documents as determined by the procuring agency.

9.2 Critical Design Review (CDR)

After approval of the preliminary design approach, the contractor will design, in detail, each computer program component identified at the PDR. This design activity results in programming specifications which are the basis for detailed flow charting, coding, and testing for the CPC's. Prior to "release" to a programmer, the programming specification must be reviewed by the procuring agency to determine if the CPC has been properly designed according to the requirements of the Part I Specification. The successful completion of this review, the Critical Design Review (CDR), is prerequisite to coding of the CPC by the contractor (except for any coding which may be required for the purposes of the CDR).

In a large system several CDR's may be required, since the individual CPC's will be designed over a period of time. It is the responsibility of the procuring agency to schedule the CDR's so that the contractor's design activities can be expedited. Several CPC's may be reviewed at a single CDR. A particular CDR may be accomplished solely by a review of technical documents or may require the participation of contractor personnel depending on the complexity and criticality of the CPC's. In all cases the contractor must have available as a minimum:

- a) documents which establish the interface relationship between the CPC and its environment; and
- b) that portion of Section 3.2 of the CPCEI Specification Part II which pertains to the CPC. This information, which may be in draft form when approved, will serve as the programming specification for the CPC.

Other information that may be required, includes:

- a) test results for selected algorithms, or
- b) simulation results indicating the feasibility and integrity of the CPC design approach.

The CDR's are held prior to committing the CPC design to coding and debugging. The following is accomplished as a part of the CDR's:

- a) The compatibility of the CPC design with the requirements tested in the Part I CPCEI Specification is established, and the integrity of the design is evaluated.
- b) The system compatibility of the CPC design is established by comparison of applicable interface control documents.

The result of a CDR is either approval by the procuring agency of the CPC design or a set of action items requiring effort by the contractor.

9.3 First Article Configuration Inspection (FACI)

FACI establishes the adequacy of the Part II Specification as an accurate and complete description of the CPCEI. The primary product of FACI is formal acceptance by the procuring agency of Part II of the CPCEI Specification as an audited and approved document which constitutes the product configuration baseline. During FACI, the audit is accomplished by establishing the exact relationship of the CPCEI to its detailed technical description in the Part II CPCEI Specification.

In general, FACI is held upon completion of the Part II CPCEI Specification and preliminary qualification testing of the CPCEI in a simulated environment. If the CPCEI is developed at the contractor's facility for subsequent shipment to the user's facility, FACI should be held prior (and prerequisite) to this shipment. If the CPCEI is developed at the user's facility, FACI should be held prior to final qualification testing of the computer based system. The contractor must have available at FACI:

- a) The Part II CPCEI Specification;
- b) the card decks, tapes, etc., properly marked, which contain the CPCEI;
- c) the results of preliminary qualification tests; and
- d) additional engineering documents as required by the procuring agency.

The following is accomplished as a part of each FACI for CPCEI's:

- a) The configuration of the CPCEI as evidenced by identification markings on the tapes and card decks involved compares directly to the Part II CPCEI Specification. The existence of each program component (i.e., subprograms) and part (tapes, card deck, etc.) of the implemented CPCEI is verified.

- b) The completeness of the Part II Specification is verified (i.e., Part II must be complete and must describe the CPCEI to the procuring agency's satisfaction). All changes resulting from FACI must be incorporated before Part II is approved. The audited Part II Specification then becomes the product configuration baseline.
- c) The results of preliminary acceptance testing (tests of the entire CPCEI in a simulated environment) are audited to determine:
 - 1. the status of the CPCEI as a working system element,
 - 2. the validity of the qualification test results,
 - 3. if all modifications resulting therefrom have been incorporated in the Part II CPCEI Specification.
- d) Where the procuring agency has ordered delivery of specific configuration management records of the CPCEI, such data is audited by direct comparison of the information contained in the Part II Specification.
- e) The contractor's computer program release system and change control procedures are reviewed and validated.

9.4 Post-FACI Reviews

The procuring agency may require a series of post-FACI reviews. These reviews are held to:

- a) ensure that all changes to the CPCEI since FACI have been properly incorporated and accounted for; and
- b) determine if the CPCEI can be certified as ready for use in a mission. This is accomplished by review of any major design changes since FACI and by review of final qualification test results.

The manner, type and number of these reviews is left to the discretion of the procuring agency; but, as a minimum, one review shall be held prior to use in a mission. The end result of this review is acceptance of the CPCEI for mission use. This review is usually held as part of an overall review for the system in which the CPCEI operates.

10. CONFIGURATION ACCOUNTING

In order to maintain CPCEI Configuration Status to the degree necessary for effective configuration control, the contractor must prepare and update change documentation, keep an index of all maintained items, and a description of the components of the CPCEI. See Exhibits VII and IX.

10.1 Version Description Document

A version Description Document is used to accompany the

release of a CPCEI or any part thereof. It contains the identification of the computer program element delivered, and includes pertinent additional information relating to status, and usage. This includes:

- a) element identification (by name and number);
- b) inventory of material contained (e.g., tapes, decks of the CPCEI, ability programs, support problems, documentation);
- c) a list of all Class I and II changes;
- d) interface capability and adaptation instructions;
- e) operational description; and
- f) installation instructions.

10.2 CPCEI Maintenance

In addition to change paper generated for each error correction (after FACI), the following accounting procedures are required to protect the CPCEI and ensure that the Part II Specification adequately reflects the configuration of the CPCEI.

- a) Each time a part (subprogram card deck, master program tape, permanent memory, etc.) is modified, and successfully reassembled or recompanied, the suffix of its part number must be increased by one. In this manner the suffix serves as a version number for the part. A modification may encompass several program changes and may be reported at periodic intervals to minimize paper work.
- b) The appropriate documents (including the listings) must be updated to reflect the number and configuration of the modified part.
- c) Where appropriate, one master card deck and two copies of the latest version of the CPCEI master tapes shall be maintained. In addition, the two previous versions of the master tape(s) shall be maintained with appropriate listings.

EXHIBIT XX

PREPARATION OF
INTERFACE CONTROL DOCUMENTATION
AND INTERFACE REVISION NOTICES

EXHIBIT XX

PREPARATION OF
INTERFACE CONTROL DOCUMENTATION
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PREPARATION OF INTERFACE CONTROL
DOCUMENTATION AND INTERFACE
REVISION NOTICES

1. PURPOSE

This Exhibit provides NASA Apollo organizations and contractors with requirements and guidance for the preparation of Apollo Program Interface Control Documentation (ICD) and revisions thereto, Interface Revision Notices (IRNs).

2. SCOPE

These instructions define the content of the following documentation which pertains to Apollo Program Interface Management and for its coordination approval and implementation.

- a. Interface Control Documentation (ICD)
- b. Interface Revision Notice (IRN)

3. APPLICABILITY

An Interface Control Document (ICD) shall be prepared and implemented for each Apollo Program interface. Each ICD shall include both sides of each interface and shall be physically, functionally and procedurally compatible between interfacing centers, applicable contractors and applicable specifications. This Exhibit is applicable to all NASA centers and their contractors.

4. REFERENCE DOCUMENTS

EXHIBITS:	I	Preparation of Program, Project and System Performance and Design Requirements Specifications
	II	Preparation of Contract End Item Detail Specification (Prime Equipment)
	III	Preparation of Contract End Item Detail Specification (Facility)
	IV	Preparation of Contract End Item Detail Specification (Identification Item)
	V	Preparation of Contract End Item Detail Specification (Requirement Items)
	VI	Preparation of Detail Specification (Critical Components)
	IX	Preparation of Engineering Change Proposal for Contract End Items

- XI Requirements for Configuration Identification and Acceptance of Contract End Items and Related Data
- XIV Formal Configuration Management Reviews, Inspection, and Demonstrations
- XVI Configuration Identification and Accounting Reports Requirements
- XVII Explanation of Items

5. EXPLANATION OF TERMS

See Exhibit XVII

6. PROCEDURAL REQUIREMENTS

6.1 Background Information

Interface areas are normally identified during preparation of Part I of the applicable specification(s). They are documented, technically coordinated to assure that compatibility exists between the interfacing areas, approved technically and by Configuration Control Board (CCB) action, incorporated by reference in Part I of the applicable specifications, implemented by affected centers and contractors, and are subject to Class I change control upon approval.

6.2 General Requirements

6.2.1 Type of Interfaces All physical interfaces, and related functional and procedural interface requirements are to be reflected within each interface area identified. Technical analysis of the conditions within each area shall determine the interfaces to be controlled.

6.2.1.1 Physical Interfaces are those interfaces involving the mechanical assembly and spatial relationship between interconnecting parts of Inter-Center Contract End Items (CEI's). The requirements include physical and clearance envelopes that are established to avoid interferences and to permit access.

6.2.1.2 Functional Interfaces are those interfaces related to physical interfaces involving specific system design characteristics. The requirements include structural loads, fluid flows, and electrical circuit characteristics; as well as those interfaces involving the interaction or influence of conditions imposed by one system or component upon another, or from

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external sources, e.g., shock, vibration, heat transfer, acoustics, pressure, radiation, atmospheric aberrations, etc.

6.2.1.3 Procedural Interfaces are those interfaces related to physical interfaces involving the sequence of events occurring in the assembly, alignment, service, maintenance, test and operation of related systems, hardware, and computer programs.

6.2.2 Preparation - Interface Control Documentation or revisions thereto, shall be prepared so as to include only the essential information required to completely define the interface. The following criteria shall be used to define the necessary information to be included:

6.2.2.1 All design criteria and design requirements which establish the overall technical direction for hardware and software interface design, describing the general parameters and constraints, including limits and tolerances, under which the hardware and software must function.

6.2.2.2 Physical and functional design details, and operational and procedural requirements including their limits and tolerances, the changing of which will have an impact on hardware or software, performance, cost or schedule accomplishments, (information that must be controlled through CCB's at all affected Centers to assure that all sides of the interface are fully coordinated).

6.2.2.3 The ICD shall not include information such as operational or procedural requirements that by nature normally vary up until the launch date, and does not make control between Centers practical or necessary.

6.2.3 Origination and Changes

6.2.3.1 Origination of ICDs - An Interface Control Document, or changes thereto, may be originated at any Center or by any of its contractors. When originated by a contractor it shall be a part of an Engineering Change Proposal (ECP).

6.2.3.2 Changes to ICDs - Contractor originated changes will be submitted as Preliminary Interface Revision Notices (PIRN's) and received as a part of an ECP change package by the applicable Center CCB's. All

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PIRN's shall be routed by the CCB to the organization Panel Chairman or Co-Chairman (at the Center receiving the ECP) for review and evaluation. A copy of the ECP(s) shall accompany the PIRN's and the change(s) shall be handled as a package. Approved PIRN's may become IRN's.

- 6.2.3.3 Effectivities - Effectivities for ICD's/IRN's shall be assigned to, and on, each ICD/IRN for the Apollo Program end items for which the Center is responsible. Where effectivities cover "subsequent" items, the ICD/IRN shall note all applicable effectivities.
- 6.2.3.4 Approval - Each ICD or IRN shall be submitted to the appropriate Panel Co-Chairmen or Senior Representatives. The Panel Chairman first receiving the document will apply the Apollo Interface Control Document form decal, which provides a signature block for the approval signatures of the Panel Co-Chairmen or Senior Representatives. Differences must be worked out by the Co-Chairmen and Senior Representatives until all concerned have evidenced their approval by signature, or the document is invalidated and returned to the originator with appropriate comment. The Panel Co-Chairmen will forward approved documents to each affected Center Level II CCB(s) for approval/disapproval and implementation by CCB.
- 6.2.4 Implementation - Once approved by the affected Apollo Program Manager (Center) CCB's (and forwarded to the Repository for release) ICD's and approved changes (IRN's) thereto shall be unilaterally implemented by the appropriate Center/Project contracts office against the affected contractor(s). Contractor impact response shall be in the form of ECP's submitted to affected CCB's thru established contractual channels. Where major impacts might be expected, the Centers, unless implementation is directed by the Apollo Program Director CCB, may request contractor(s) impact(s) in the form of an ECP(s) and resolve Inter-Center incompatibilities thru joint Apollo Program Management, CCB action, or by forwarding recommendations to the Apollo Program Director CCB for resolution prior to implementation.
- 6.2.5 Interface Revision Notice (IRN) Processing - Interface Revision Notices (IRN's) shall be used to document approved changes against an approved ICD.

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Technical and program approval of an IRN will result in incorporation of the IRN in a subsequent revision of the ICD.

6.2.5.1 Interface Control Document Revisions shall be prepared to incorporate only approved IRN's in an ICD. Each revision shall be alpha-designated and shall indicate the identity of the change.

6.2.5.2 After Panel approval, IRN's and revised ICD's shall be submitted for approval to affected CCB's in accordance with established change procedures.

6.2.6 ICD Maintenance - A revision to an ICD shall be made to incorporate approved IRN's when a maximum of six approved IRN's are outstanding or any IRN is outstanding for 90 days.