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MILITARY STANDARD

TECHNICAL REVIEWS AND AUDITS FOR SYSTEMS, EQUIPMENTS, AND COMPUTER SOFTWARE

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MIL-STD-1521B

DEPARTMENT OF DEFENSE

WASHINGTON, D.C. 20301

Technical Reviews and Audits for Systems, Equipments, and Computer Software

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Hq ESD/ALET, Hanscom AFB, MA 01731 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

This standard has been designed to take advantage of current technological advancement and management procedures in conducting reviews and audits.

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SECTION 1

SCOPE

1.1 Purpose. This standard prescribes the requirements for the conduct of Technical Reviews and Audits on Systems, Equipments, and Computer Software.

1.2 Classification. The following technical reviews and audits shall be selected by the program manager at the appropriate phase of program development. Each review/audit is generally described in Section 3, Definitions, and more specifically defined in a separate appendix.

System Requirements Review (SRR)
System Design Review (SDR)
Software Specification Review (SSR)
Preliminary Design Review (PDR)
Critical Design Review (CDR)
Test Readiness Review (TRR)
Functional Configuration Audit (FCA)
Physical Configuration Audit (PCA)
Formal Qualification Review (FQR)
Production Readiness Review (PRR)

NOTE: A typical engineering and test flow relative to program activities is illustrated in Figure 1.

1.3 Application. Technical Reviews and Audits defined herein shall be conducted in accordance with this standard to the extent specified in the contract clauses, Statement of Work (SOW), and the Contract Data Requirements List. Guidance in applying this standard is provided in Appendix J. The contracting agency shall tailor this standard to require only what is needed for each individual acquisition.

SECTION 2

REFERENCED DOCUMENTS

2.1 Reference documents are not included in this document. The Statement of Work shall be referenced for applicable documents.

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

SECTION 3

DEFINITIONS

TECHNICAL REVIEWS AND AUDITS

3.1 System Requirements Review (SRR). The objective of this review is to ascertain the adequacy of the contractor's efforts in defining system requirements. It will be conducted when a significant portion of the system functional requirements has been established.

3.2 System Design Review (SDR). This review shall be conducted to evaluate the optimization, correlation, completeness, and risks associated with the allocated technical requirements. Also included is a summary review of the system engineering process which produced the allocated technical requirements and of the engineering planning for the next phase of effort. Basic manufacturing considerations will be reviewed and planning for production engineering in subsequent phases will be addressed. This review will be conducted when the system definition effort has proceeded to the point where system characteristics are defined and the configuration items are identified.

3.3 Software Specification Review (SSR). A review of the finalized Computer Software Configuration Item (CSCI) requirements and operational concept. The SSR is conducted when CSCI requirements have been sufficiently defined to evaluate the contractor's responsiveness to and interpretation of the system, segment, or prime item level requirements. A successful SSR is predicated upon the contracting agency's determination that the Software Requirements Specification, Interface Requirements Specification(s), and Operational Concept Document form a satisfactory basis for proceeding into preliminary software design.

3.4 Preliminary Design Review (PDR). This review shall be conducted for each configuration item or aggregate of configuration items to (1) evaluate the progress, technical adequacy, and risk resolution (on a technical, cost, and schedule basis) of the selected design approach, (2) determine its compatibility with performance and engineering speciality requirements of the Hardware Configuration Item (HWCI) development specification, (3) evaluate the degree of definition and assess the technical risk associated with the selected manufacturing methods/processes, and (4) establish the existence and compatibility of the physical and functional interfaces among the configuration item and other items of equipment, facilities, computer software, and personnel. For CSCIs, this review will focus on: (1) the evaluation of the progress, consistency, and technical adequacy of the selected top-level design and test approach, (2) compatability between software requirements and preliminary design, and (3) on the preliminary version of the

operation and support documents.

3.5 Critical Design Review (CDR). This review shall be conducted for each configuration item when detail design is essentially complete. The purpose of this review will be to (1) determine that the detail design of the configuration item under review satisfies the performance and engineering specialty requirements of the HWCI development specifications, (2) establish the detail design compatibility among the configuration item and other items of equipment, facilities, computer software and personnel, (3) assess configuration item risk areas (on a technical, cost, and schedule basis), (4) assess the results of the producibility analyses conducted on system hardware, and (5) review the preliminary hardware product specifications. For CSCIs, this review will focus on the determination of the acceptability of the detailed design, performance, and test characteristics of the design solution, and on the adequacy of the operation and support documents.

3.6 Test Readiness Review (TRR). A review conducted for each CSCI to determine whether the software test procedures are complete and to assure that the contractor is prepared for formal CSCI testing. Software test procedures are evaluated for compliance with software test plans and descriptions, and for adequacy in accomplishing test requirements. At TRR, the contracting agency also reviews the results of informal software testing and any updates to the operation and support documents. A successful TRR is predicated on the contracting agency's determination that the software test procedures and informal test results form a satisfactory basis for proceeding into formal CSCI testing.

3.7 Functional Configuration Audit (FCA). A formal audit to validate that the development of a configuration item has been completed satisfactorily and that the configuration item has achieved the performance and functional characteristics specified in the functional or allocated configuration identification. In addition, the completed operation and support documents shall be reviewed.

3.8 Physical Configuration Audit (PCA). A technical examination of a designated configuration item to verify that the configuration item "As Built" conforms to the technical documentation which defines the configuration item.

3.9 Formal Qualification Review (FQR). The test, inspection, or analytical process by which a group of configuration items comprising the system are verified to have met specific contracting agency contractual performance requirements (specifications or equivalent). This review does not apply to hardware or software requirements verified at FCA for the individual configuration item.

3.10 Production Readiness Review (PRR). This review is intended to determine the status of completion of the specific actions which must be satisfactorily accomplished prior to executing a production go-ahead decision. The review is accomplished in an incremental fashion during the Full-Scale Development phase, usually two initial reviews and one final review to assess the risk in exercising the production go-ahead decision. In its earlier stages the PRR concerns itself with gross level manufacturing concerns such as the need for identifying high risk/low yield manufacturing processes or materials or the requirement for manufacturing development effort to satisfy design requirements. The reviews become more refined as the design matures, dealing with such concerns as production planning, facilities allocation, incorporation of producibility-oriented changes, identification and fabrication of tools/test equipment, long lead item acquisition etc. Timing of the incremental PRRs is a function of program posture and is not specifically locked in to other reviews.

OTHER DEFINITIONS

3.11 For further guidance on cost terminology see the latest edition of DODI 5000.33, Uniform Budget/Cost Terms and Definitions.

3.12 New titles are being phased in for the levels of maintenance. They are (with their former terms): On Equipment (Organizational), Off Equipment - On Site (Intermediate), Off Equipment - Off Site (Depot). See the latest edition of AFR 66-14, Equipment Maintenance Policies, Objectives, and Responsibilities.

3.13 For definitions of the various levels of repair, see the latest edition of MIL-STD-280A, Definition of Item Levels, Item Exchangeability, Models, and Related Terms.

3.14 Configuration item. Hardware or software, or an aggregation of both, which is designated by the contracting agency for configuration management.

SECTION 4

GENERAL REQUIREMENTS

4.1 Contractor Participation and Responsibilities. The contractor shall be responsible for conducting the Technical Reviews and Audits in accordance with the following requirements except as amended by the contract.

4.1.1 Subcontractors and Suppliers. The contractor shall be responsible for insuring that subcontractors, vendors, and suppliers participate in formal Reviews/Audits, as appropriate.

4.1.2 Location. Unless otherwise specified in the Statement of Work, the Reviews/Audits shall be conducted at the contractor's facility or at a designated subcontractor facility, if approved by the contracting agency. Accordingly, the contractor shall be required to provide the necessary resources and material to perform the Review/Audit effectively. This includes the following items to the extent appropriate for the type and scope of Review/Audit required by the contract:

a. Meeting agenda/plans

b. Conference room(s)

c. Applicable system engineering data, specifications, drawings, manuals, schedules, and design and test data

d. Specialty study results

e. Trade study results

f. Risk analysis results

g. Mockups, breadboards, in-process hardware, and finished hardware

h. Test methods and data

i. Meeting minutes

4.1.3 Contractor Requirements. The contractor shall be responsible for establishing the time, place and agenda for each Review/Audit in consonance with the master milestone schedule, subject to coordination with the contracting agency. This should be accomplished sufficiently in advance of each Review/Audit to allow adequate preparation for the meeting by both the contractor and the contracting agency (see 6.2). In addition, the contractor shall:

4.1.3.1 Insure that each Review/Audit schedule is compatible with the availability of the necessary information and contract

articles, e.g., system engineering data, trade study results, producibility analysis results, risk analysis results, specifications, manuals, drawings, reports, hardware, software, or mockups.

4.1.3.2 Prepare for each Review/Audit in sufficient detail consistent with the scope and magnitude of the Review/Audit.

4.1.3.3 Designate a Co-Chairperson for each Review/Audit. Participating contractor and subcontractor personnel or those chosen to make presentations shall be prepared to discuss in technical detail any of the presented material within the scope of the review.

4.1.3.4 Provide a stenographer or other acceptable method to record inputs to official meeting minutes. Minutes shall be recorded only as dictated by either Co-Chairperson and shall consist of significant questions and answers, action items, deviations, conclusions, recommended courses of action resulting from presentations or discussions. Conclusions from discussions conducted during side meetings shall be summarized in the main meeting at an appointed time, and appropriate comments shall be read into the official minutes. Recommendations not accepted should also be recorded together with the reason for non-acceptance. The minutes of each daily session shall be available for review by both the contractor and contracting agency personnel at the conclusion of each day's session (see 6.2).

4.1.3.5 Clearly record all action items in the minutes and identify whether contracting agency and/or contractor action is required for its resolution. (See Figure 2 for Sample Action Item Form).

4.1.3.6 Publish and distribute official minutes.

4.2 Contracting Agency Participation.

4.2.1 Serves as Co-Chairperson.

4.2.2 Provides the name, organization, and security clearance of each participating individual to the contractor prior to each Review/Audit.

4.2.3 Reviews the daily minutes and ensures that they reflect all significant contracting agency inputs.

4.2.4 Provides formal acknowledgement to the contractor of the accomplishment of each Review/Audit after receipt of Review/Audit minutes (see 6.1). The contracting agency establishes the adequacy of the contractor's review performance by notification of:

a. Approval -- to indicate that the review was satisfactorily

completed.

b. Contingent approval -- to indicate that the review is not considered accomplished until the satisfactory completion of resultant action items.

c. Disapproval -- to indicate that the review was seriously inadequate.

4.3 Sample Forms. A sample action item form and sample certification attachment are provided for guidance purposes (see Figures 2, 3 and 4).

SECTION 5

DETAILED REQUIREMENTS

5.1 The appropriate Reviews or Audits will be conducted as specified in the following appendices (as selected and/or modified in the contract):

5.1.1 System Requirements Review. See Appendix A.

5.1.2 System Design Review. See Appendix B.

5.1.3 Software Specification Review. See Appendix C.

5.1.4 Preliminary Design Review. See Appendix D.

5.1.5 Critical Design Review. See Appendix E.

5.1.6 Test Readiness Review. See Appendix F.

5.1.7 Functional Configuration Audit. See Appendix G.

5.1.8 Physical Configuration Audit. See Appendix H.

5.1.9 Formal Qualification Review. See Appendix I.

5.1.10 Application Guide For Tailoring MIL-STD-1521. See Appendix J.

5.1.11 Production Readiness Review. See Appendix K.

SECTION 6

NOTES

6.1 Intended use. This standard prescribes the requirements for conducting Technical Reviews and Audits on Systems, Equipments, and Computer Software. Official acknowledgement by the contracting agency of the accomplishment of a Review/Audit is not to be interpreted as approval of statements made in the minutes or of matters discussed at the Review/Audit and does not relieve the contractor from requirements which are a part of the contract.

6.2 Data requirements list and cross reference. When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of the DOD FAR clause on data requirements (currently DOD FAR Supplement 52.227-7031) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this standard is cited in the following paragraphs.

Paragraph No.	Data Requirement Title	Applicable DID No.
4.1.3	Conference Agenda	DI-A-7088
4.1.3.4	Conference Minutes	DI-A-7089

(Data item descriptions related to this standard, and identified in section 6 will be approved and listed as such in DOD 5000.19-L., Vol. II, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.3 Changes from previous issue. Asterisks or vertical lines are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

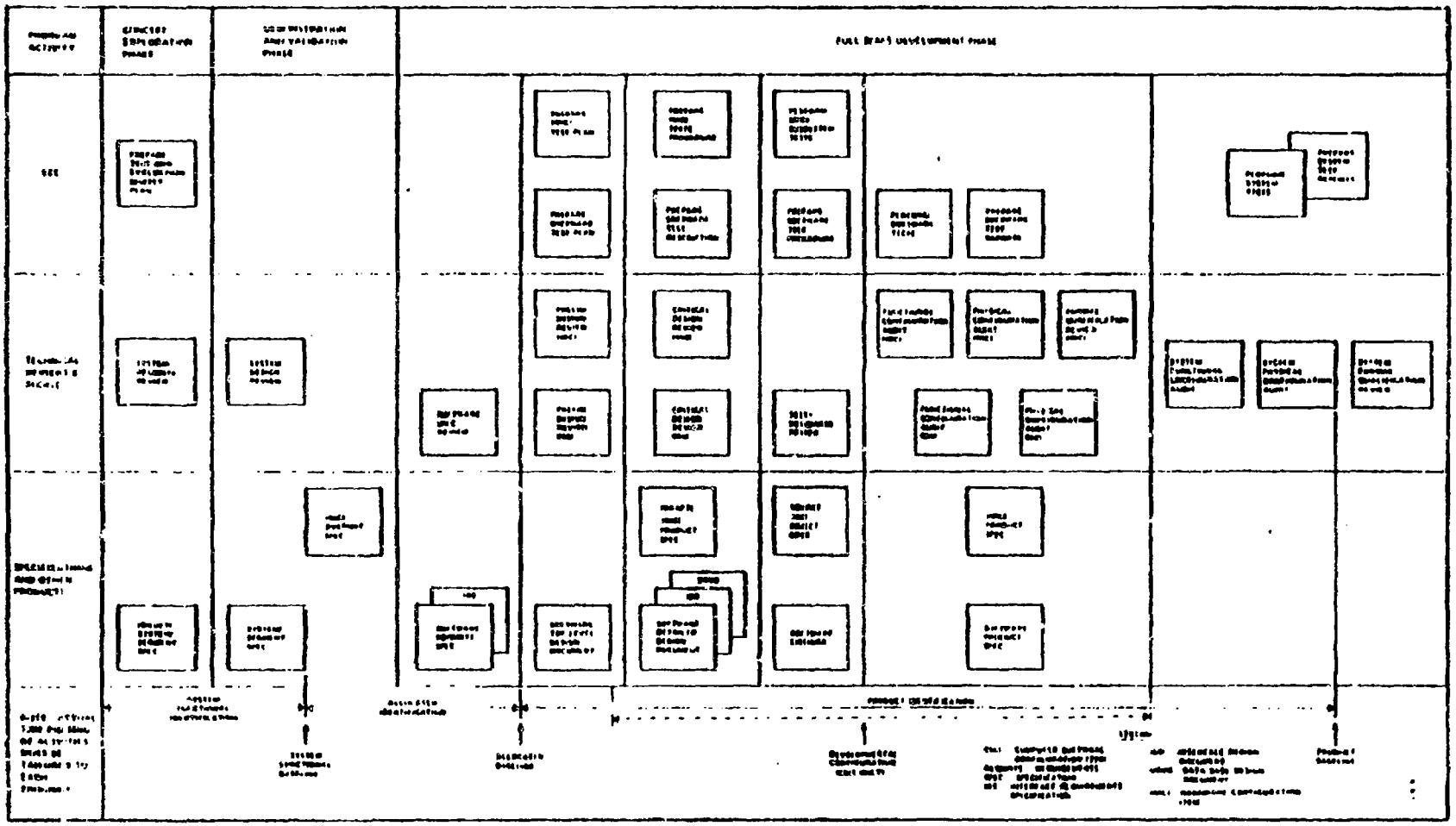

FIGURE 1. Engineering and Test Flow.

ACTION ITEM

CONTROL NUMBER _____

DATE OF MEETING	SUBJECT:	LOCATION
ACTION REQUIRED/COMPLIANCE		DUE DATE _____
ASSIGNED TO: _____		ORIGINATOR
		AGENCY
FOLLOW UP STATUS: _____		
ASSIGNEE:		
DATE COMPLETED:		DOCUMENT NO.

COORDINATORS			TECHNICAL APPROVAL
PHONE	AGENCY	SIGNATURE	DATE
PHONE	AGENCY	SIGNATURE	DATE
PHONE	AGENCY	SIGNATURE	DATE

CONTRACTING AGENCY	DATE	CONTRACTOR	DATE	CONTRACTS	DATE

Figure 2 Sample Action Item Form

10. System Requirements Review (SRR).

10.1 General. The SRRs are normally conducted during the system Concept Exploration or Demonstration and Validation phase. Such reviews may be conducted at any time but normally will be conducted after the accomplishment of functional analysis and preliminary requirements allocation (to operational/maintenance/training Hardware Configuration Items (HWCIs), Computer Software Configuration Items (CSCIs), facility configuration items, manufacturing considerations, personnel and human factors) to determine initial direction and progress of the contractor's System Engineering Management effort and his convergence upon an optimum and complete configuration.

10.2 Purpose. The total System Engineering Management activity and its output shall be reviewed for responsiveness to the Statement of Work and system/segment requirements. Contracting agency direction to the contractor will be provided, as necessary, for continuing the technical program and system optimization.

10.3 Items to be Revieved. Representative items to be revieved include the results of the following, as appropriate:

a. Mission and Requirements Analysis

b. Functional Flow Analysis

c. Preliminary Requirements Allocation

d. System/Cost Effectiveness Analysis

e. Trade Studies (e.g., addressing system functions in hardware/firmware/software)

f. Synthesis

g. Logistics Support Analysis

h. Specialty Discipline Studies (i.e., hardware and software reliability analysis, maintainability analysis, armament integration, electromagnetic compatibility, survivability/vulnerability (including nuclear), inspection methods/techniques analysis, energy management, environmental considerations).

i. System Interface Studies

j. Generation of Specifications

k. Program Risk Analysis

l. Integrated Test Planning

m. Producibility Analysis Plans

n. Technical Performance Measurement Planning

o. Engineering Integration

p. Data Management Plans

q. Configuration Management Plans

r. System Safety

s. Human Factors Analysis

t. Value Engineering Studies

u. Life Cycle Cost Analysis

v. Preliminary Manufacturing Plans

w. Manpower Requirements/Personnel Analysis

x. Milestone Schedules

10.3.1 The contractor shall describe his progress and problems in:

10.3.1.1 Risk identification and risk ranking (the interrelationship among system effectiveness analysis, technical performance measurement, intended manufacturing methods, and costs shall be discussed, as appropriate).

10.3.1.2 Risk avoidance/reduction and control (the interrelationships with trade-off studies, test planning, hardware proofing, and technical performance measurement shall be discussed, as appropriate).

10.3.1.3 Significant trade-offs among stated system/segment specification requirements/constraints and resulting engineering design requirements/constraints, manufacturing methods/process constraints, and logistic/cost of ownership requirements/constraints and unit production cost/design-to-cost objectives.

10.3.1.4 Identifying computer resources of the system and partitioning the system into HWCIs and CSCIs. Include any trade-off studies conducted to evaluate alternative approaches and methods for meeting operational needs and to determine the effects of constraints on the system. Also include any evaluations of logistics, technology, cost, schedule, resource limitations, intelligence estimates, etc., made to determine their impact on the system. In addition, address the following specific tradeoffs related to computer resources:

a. Candidate programming languages and computer architectures evaluated in light of DoD requirements for approved higher order languages and standard instruction set architectures.

b. Alternative approaches evaluated for implementing security requirements. If an approach has been selected, discuss how it is the most economical balance of elements which meet the total system requirements.

c. Alternative approaches identified for achieving the operational and support concepts, and, for joint service programs, opportunities for interservice support.

10.3.1.5 Producibility and manufacturing considerations which could impact the program decision such as critical components, materials and processes, tooling and test equipment development, production testing methods, long lead items, and facilities/personnel/skills requirements.

10.3.1.6 Significant hazard consideration should be made here to develop requirements and constraints to eliminate or control these system associated hazards.

10.3.2 Information which the contractor identifies as being useful to his analysis and available through the contracting agency shall be requested prior to this review (e.g., prior studies, operational/support factors, cost factors, safety data, test plan(s), etc.). A separate SRR may be conducted for each of the operational support subsystems depending upon the nature and complexity of the program.

10.4 Post Review Action. After completing the SRR, the contractor shall publish and distribute copies of Review minutes. The contracting agency officially acknowledges completion of the SRR as indicated in paragraph 4.2.4.

20. System Design Review (SDR).

20.1 General. The SDR shall be conducted to evaluate the optimization, traceability, correlation, completeness, and the risk of the allocated requirements, including the corresponding test requirements in fulfilling the system/segment requirements (the functional baseline). The review encompasses the total system requirements, i.e., operations/maintenance/test/training hardware, computer software, facilities, personnel, preliminary logistic support considerations. Also included shall be a summary review of the System Engineering Management Activities (e.g., mission and requirements analysis, functional analysis, requirements allocation, manufacturing methods/process selection, program risk analysis, system/cost effectiveness analysis, logistics support analysis, trade studies, intra- and inter-system interface studies, integrated test planning, specialty discipline studies, and Configuration Management) which produced the above system definition products. A technical understanding shall be reached on the validity and the degree of completeness of the following information:

a. System/Segment Specification

b. The engineering design/cost of the system (see Section 3, Definitions).

c. Preliminary Operational Concept Document

d. Preliminary Software Requirements Specification

e. Preliminary Interface Requirements Specification(s)

f. As appropriate:

(1) Prime Item Development Specification

(2) Critical Item Development Specification

20.2 Purpose. An SDR shall be conducted as the final review prior to the submittal of the Demonstration and Validation Phase products or as the initial Full Scale Development Review for systems not requiring a formal Demonstration and Validation Phase but sufficiently complex to warrant the formal assessment of the allocated requirements (and the basis of these requirements) before proceeding with the preliminary design of HWCIs or the detailed requirements analysis for CSCIs. The SDR is primarily concerned with the overall review of the operational/support requirements (i.e., the mission requirements), updated/completed System/Segment Specification requirements, allocated performance requirements, programming and manufacturing methods/processes/planning, and the accomplishment of the System Engineering Management activities to insure that the definition

effort products are necessary and sufficient. The purposes of the SDR are to:

20.2.1 Insure that the updated/completed System/Segment Specification is adequate and cost effective in satisfying validated mission requirements.

20.2.2 Insure that the allocated requirements represent a complete and optimal synthesis of the system requirements.

20.2.3 Insure that the technical program risks are identified, ranked, avoided, and reduced through:

a. Adequate trade-offs (particularly for sensitive mission requirements versus engineering realism and manufacturing feasibility to satisfy the anticipated production quantities of corresponding performance requirements);

b. Subsystem/component hardware proofing;

c. A responsive test program; and

d. Implementation of comprehensive engineering disciplines (e.g., worst case analysis, failure mode and effects analysis, maintainability analysis, producibility analysis and standardization.)

20.2.4 Identify how the final combination of operations, manufacturing, maintenance, logistics and test and activation requirements have affected overall program concepts; quantities and types of equipment, unit product cost (see Section 3, Definitions, paragraph 3.11), computer software, personnel, and facilities.

20.2.5 Insure that a technical understanding of requirements has been reached and technical direction is provided to the contractor.

20.3 Items to be Reviewed. The SDR shall include a review of the following items, as appropriate:

20.3.1 System Engineering Management Activities, e.g.:

a. Mission and Requirements Analysis

b. Functional Analysis

c. Requirements Allocation

d. System/Cost Effectiveness

e. Synthesis

f. Survivability/Vulnerability (including nuclear)

g. Reliability/Maintainability/Availability (R/M/A)

h. Electromagnetic Compatibility

i. Logistics Support Analysis (to address, as appropriate, integrated logistics support including logistics support concept, maintenance, supply, software support facilities, etc.)

j. System Safety (emphasis shall be placed on system hazard analysis and identification of safety test requirements)

k. Security

l. Human Factors

m. Transportability (including Packaging and Handling)

n. System Mass Properties

o. Standardization

p. Electronic Warfare

q. Value Engineering

r. System Growth Capability

s. Program Risk Analysis

t. Technical Performance Measurement Planning

u. Producibility Analysis and Manufacturing

v. Life Cycle Cost/Design to Cost Goals

w. Quality Assurance Program

x. Environmental Conditions (Temperature, Vibration, Shock, Humidity, etc.)

y. Training and Training Support

z. Milestone Schedules

aa. Software Development Procedures

20.3.2 Results of significant trade studies, for example:

a. Sensitivity of selected mission requirements versus

realistic performance parameters and cost estimates.

b. Operations design versus maintenance design

c. System centralization versus decentralization

d. Automated versus manual operation

e. Reliability/Maintainability/Availability

f. Commercially available items versus new developments

g. National Stock Number (NSN) items versus new development

h. Testability trade studies (Allocation of fault detection/isolation capabilities between elements of built-in test, on board/on-site fault detection/isolation subsystems, separate support equipment, and manual procedures)

i. Size and weight

j. Desired propagation characteristics versus reduction in interference to other systems (optimum selection of frequencies)

k. Performance/logistics trade studies

l. Life cycle cost reduction for different computer programming languages

m. Functional allocation between hardware, software, firmware and personnel/procedures

n. Life Cycle Cost/system performance trade studies to include sensitivity of performance parameters to cost.

o. Sensitivity of performance parameters versus cost

p. Cost versus performance

q. Design versus manufacturing consideration

r. Make versus buy

s. Software development schedule

20.3.3 Updated design requirements for operations/maintenance functions and items.

20.3.4 Updated requirements for manufacturing methods and processes.

20.3.5 Updated operations/maintenance requirements for facilities.

20.3.6 Updated requirements for operations/maintenance personnel and training.

20.3.7 Specific actions to be performed include evaluations of:

a. System design feasibility and system/cost effectiveness

b. Capability of the selected configuration to meet requirements of the System/Segment Specification

c. Allocations of system requirements to subsystems/configuration items

d. Use of commercially available and standard parts

e. Allocated inter- and intra- system interface requirements

f. Size, weight, and configuration of HWCIs to permit economical and effective transportation, packaging, and handling consistent with applicable specifications and standards

g. Specific design concepts which may require development toward advancing the state-of-the-art

h. Specific subsystems/components which may require "hardware proofing" and high-risk long-lead time items

i. The ability of inventory items to meet overall system requirements, and their compatibility with configuration item interfaces

j. The planned system design in view of providing multi-mode functions, as applicable

k. Considerations given to:

(1) Interference caused by the external environment to the system and the system to the external environment.

(2) Allocated performance characteristics of all system transmitters and receivers to identify potential intra-system electromagnetic (EM) incompatibilities.

(3) Non-design, spurious and harmonic system performance characteristics and their effect on electromagnetic environments of operational deployments.

l. Value Engineering studies, preliminary Value Engineering Change Proposals (VECPs) and VECPs (as applicable).

20.3.8 Review the Preliminary Operational Concept Document, and sections 1.0, 2.0, 3.0, 5.0, 6.0, and 10.0 of the System/Segment Specification, all available HWCI Development Specifications, preliminary Software Requirements, and Interface Requirements Specifications for format, content, technical adequacy, completeness and traceability/correlation to the validated mission/support requirements. All entries marked "not applicable (N/A)" or "to be determined (TBD)" are identified and explained by the contractor.

20.3.9 Review section 4.0 of the System/Segment Specification, all available hardware Development Specifications, and preliminary Software Requirements and Interface Requirements Specifications for format, content, technical adequacy, and completeness. All available test documentation, including HWCI/subsystem and system test plans, shall be reviewed to insure that the proposed test program satisfies the test requirements of section 4.0 of all applicable specifications. All entries labeled "not applicable (N/A)" or "to be determined (TBD)" in section 4.0 of any applicable specification are identified and explained by the contractor.

20.3.10 Review the system, HWCI, and CSCI design for interaction with the natural environment. If any effect or interaction is not completely understood and further study is required, or it is known but not completely compensated for in the design, the proposed method of resolution shall also be reviewed. All proposed environmental tests shall be reviewed for compatibility with the specified natural environmental conditions.

20.3.11 Maintenance functions developed by the contractor to determine that support concepts are valid, technically feasible, and understood. In particular, attention is given to:

a. R/M/A considerations in the updated System/Segment Specification

b. Maintenance design characteristics of the system

c. Corrective and preventive maintenance requirements

d. Special equipment, tools, or material required

e. Requirements or planning for automated maintenance analysis

f. Item Maintenance Analysis compatibility with required maintenance program when weapon is deployed

g. Specific configuration item support requirements

h. Forms, procedures, and techniques for maintenance analysis

i. Maintenance related trade-off studies and findings (includes commercially available equipment, software fault diagnostic techniques)

j. Logistic cost impacts

k. Support procedures and tools for computer software which facilitate software modification, improvements, corrections and updates

l. Hardness critical items/processes

20.3.12 System compliance with nuclear, non-nuclear and laser hardening requirements. High risk areas or design concepts requiring possible advances of the state-of-the-art as a result of survivability critieria shall be identified, and prepared approach(es) to the problem reviewed. Prepared test programs shall be reviewed for sufficiency and compatibility with the specified threat environment and existing simulation test facilities.

20.3.13 The optimization, traceability, completeness, and risks associated with the allocated technical requirements, and the adequacy of allocated system requirements as a basis for proceeding with the development of hardware and software configuration items. Include any available preliminary Software Requirements and Interface Requirements Specifications.

20.3.14 Manufacturing (HWCIs only).

20.3.14.1 Production feasibility and risk analyses addressed at the SRR shall be updated and expanded. This effort should review the progress made in reducing production risk and evaluate the risk remaining for consideration in the Full Scale Development Phase. Estimates of cost and schedule impacts shall be updated.

20.3.14.2 Review of the Production Capability Assessment shall include:

20.3.14.2.1 A review of production capability shall be accomplished which will constitute an assessment of the facilities, materials, methods, processes, equipment and skills necessary to perform the full scale development and production efforts. Identification of requirements to upgrade or develop manufacturing capabilities shall be made. Requirements for Manufacturing Technology (MANTECH) programs will also be identified as an element of this production assessment.

20.3.14.3 Present the management controls and the design/manufacturing engineering approach to assure that the equipment is producible.

20.3.14.4 Present a review of trade-off studies for design requirements against the requirement for producibility, facilities, tooling, production test equipment, inspection, and capital equipment for intended production rates and volume.

20.3.14.5 The analysis, assessments and trade-off studies should recommend any additional special studies or development efforts as needed.

20.4 Post Review Action. After completing the SDR, the contractor shall publish and distribute copies of Review Minutes. The contracting agency officially acknowledges completion of the SDR as indicated in paragraph 4.2.4.

30. Software Specification Review (SSR).

30.1 General. The SSR shall be a formal review of a CSCI's requirements as specified in the Software Requirements Specification and the Interface Requirements Specification(s). Normally, it shall be held after System Design Review but prior to the start of CSCI preliminary design. A collective SSR for a group of configuration items, treating each configuration item individually, may be held when such an approach is advantageous to the contracting agency. Its purpose is to establish the allocated baseline for preliminary CSCI design by demonstrating to the contracting agency the adequacy of the Software Requirements Specification (SRS), Interface Requirements Specification(s) (IRS), and Operational Concept Document (OCD).

30.2 Items to be reviewed. The contractor shall present the following items for review by the contracting agency:

a. Functional overview of the CSCI, including inputs, processing, and outputs of each function.

b. Overall CSCI performance requirements, including those for execution time, storage requirements, and similar constraints.

c. Control flow and data flow between each of the software functions that comprise the CSCI.

d. All interface requirements between the CSCI and all other configuration items both internal and external to the system.

e. Qualification requirements that identify applicable levels and methods of testing for the software requirements that comprise the CSCI.

f. Any special delivery requirements for the CSCI.

g. Quality factor requirements; i.e., Correctness, Reliability, Efficiency, Integrity, Usability, Maintainability, Testability, Flexibility, Portability, Reusability, and Interoperability.

h. Mission requirements of the system and its associated operational and support environments.

i. Functions and characteristics of the computer system within the overall system.

j. Milestone schedules.

k. Updates since the last review to all previously delivered

software related CDRL items.

1. Any actions or procedures deviating from approved plans.

30.3 Post Review Action. After completing the SSR, the contractor shall publish and distribute copies of Review Minutes. The contracting agency officially acknowledges completion of the SSR as indicated in paragraph 4.2.4.

30.3.1 The accomplishment of the SSR shall be recorded on the configuration item Development Record by the contractor (see MIL-STD-483, Appendix VII).

40. Preliminary Design Review (PDR)

40.1 General. The PDR shall be a formal technical review of the basic design approach for a configuration item or for a functionally related group of configuration items. It shall be held after the hardware Development Specification(s), the Software Top Level Design Document (STLDD), the Software Test Plan (STP), the HWCI Test Plan, and preliminary versions of the Computer System Operator's Manual (CSOM), Software User's Manual (SUM), Computer System Diagnostic Manual (CSDM), and Computer Resources Integrated Support Document (CRISD) are available, but prior to the start of detailed design. For each configuration item the actions described below may be accomplished as a single event, or they may be spread over several events, depending on the nature and the extent of the development of the configuration item, and on provisions specified in the contract Statement of Work. A collective PDR for a group of configuration items, treating each configuration item individually, may be held when such an approach is advantageous to the contracting agency; such a collective PDR may also be spread over several events, as for a single configuration item. The overall technical program risks associated with each configuration item shall also be reviewed on a technical, cost, and schedule basis. For software, a technical understanding shall be reached on the validity and the degree of completeness of the STLDD, STP, and the preliminary versions of the CSOM, SUM, CSDM, and CRISD.

40.2 Items to be Reviewed. The contractor shall present the following for review by the contracting agency:

40.2.1 HWCIs:

a. Preliminary design synthesis of the hardware Development Specification for the item being reviewed.

b. Trade-studies and design studies results (see paragraph 20.3.2 of SDR for a representative listing).

c. Functional flow, requirements allocation data, and schematic diagrams.

d. Equipment layout drawings and preliminary drawings, including any proprietary or restricted design/process/components and information.

e. Environment control and thermal design aspects

f. Electromagnetic compatibility of the preliminary design

g. Power distribution and grounding design aspects

h. Preliminary mechanical and packaging design of consoles,

racks, drawers, printed circuit boards, connectors, etc.

i. Safety engineering considerations

j. Security engineering considerations

k. Survivability/Vulnerability (including nuclear) considerations

l. Preliminary lists of materials, parts, and processes

m. Pertinent relability/maintainability/availability data

n. Preliminary weight data

o. Development test data

p. Interface requirements contained in configuration item Development Specifications and interface control data (e.g., interface control drawings) derived from these requirements

q. Configuration item development schedule

r. Mock-ups, models, breadboards, or prototype hardware when appropriate

s. Producibility and Manufacturing Considerations (e.g., materials, tooling, test equipment, processes, facilities, skills, and inspection techniques). Identify single source, sole source, diminishing source.

t. Value Engineering Considerations, Preliminary VECPs and VECPs (if applicable).

u. Transportability, packaging, and handling considerations

v. Human Engineering and Biomedical considerations (including life support and Crew Station Requirements).

w. Standardization considerations

x. Description and characteristics of commercially available equipment, including any optional capabilities such as special features, interface units, special instructions, controls, formats, etc., (include limitations of commercially available equipment such as failure to meet human engineering, safety, and maintainability requirements of the specification and identify deficiencies).

y. Existing documentation (technical orders, commercial manuals, etc.,) for commercially available equipment and copies of contractor specifications used to procu

equipment shall be made available for review by the contracting agency.

z. Firmware to be provided with the system: microprogram logic diagrams and reprogramming/instruction translation algorithm descriptions, fabrication, packaging (integration technology (e.g., LSI, MSI), device types (e.g., CMOS, PMOS)), and special equipment and support software needed for developing, testing, and supporting the firmware.

aa. Life Cycle Cost Analysis

ab. Armament compatibility

ac. Corrosion prevention/control considerations

ad. Findings/Status of Quality Assurance Program

40.2.2 CSCIs:

a. Functional flow. The computer software functional flow embodying all of the requirements allocated from the Software Requirements Specification and Interface Requirements Specification(s) to the individual Top-Level Computer Software Components (TLCSCs) of the CSCI.

b. Storage allocation data. This information shall be presented for each CSCI as a whole, describing the manner in which available storage is allocated to individual TLCSCs. Timing, sequencing requirements, and relevant equipment constraints used in determining the allocation are to be included.

c. Control functions description. A description of the executive control and start/recovery features for the CSCI shall be available, including method of initiating system operation and features enabling recovery from system malfunction.

d. CSCI structure. The contractor shall describe the top-level structure of the CSCI, the reasons for choosing the components described, the development methodology which will be used within the constraints of the available computer resources, and any support programs which will be required in order to develop/maintain the CSCI structure and allocation of data storage.

e. Security. An identification of unique security requirements and a description of the techniques to be used for implementing and maintaining security within the CSCI shall be provided.

f. Reentrancy. An identification of any reentrancy requirements and a description of the techniques for implementing reentrant routines shall be available.

g. Computer software development facilities. The availability, adequacy, and planned utilization of the computer software development facilities shall be addressed.

h. Computer software development facility versus the operational system. The contractor shall provide information relative to unique design features which may exist in a TLCSC in order to allow use within the computer software development facility, but which will not exist in the TLCSC installed in the operational system. The contractor shall provide information on the design of support programs not explicitly required for the operational system but which will be generated to assist in the development of the CSCI(s). The contractor shall also provide details of the Software Development Library controls.

i. Development tools. The contractor shall describe any special simulation, data reduction, or utility tools that are not deliverable under the terms of the contract, but which are planned for use during software development.

j. Test tools. The contractor shall describe any special test systems, test data, data reduction tools, test computer software, or calibration and diagnostic software that are not deliverable under terms of the contract, but which are planned for use during product development.

k. Description and characteristics of commercially available computer resources, including any optional capabilities such as special features, interface units, special instructions, controls, formats, etc. Include limitations of commercially available equipment such as failure to meet human engineering, safety and maintainability requirements of the specification and identify deficiencies.

l. Existing documentation (technical orders, commercial manuals, etc.) for commercially available computer resources and copies of contractor specifications used to procure computer resources shall be made available for review by the contracting agency.

m. Support resources. The contractor shall describe those resources necessary to support the software and firmware during operational deployment of the system, such as operational and support hardware and software, personnel, special skills, human factors, configuration management, test, and facilities/space.

n. Operation and support documents. The preliminary versions of the CSOM, SUM, CSDM, and CRISD shall be reviewed for technical content and compatability with the top-level design documentation.

o. Updates since the last review to all previously delivered software related CDRL items.

p. Review considerations applicable to 40.2.1 as appropriate.

40.2.3 Support Equipment (SE):

a. Review considerations applicable to paragraph 40.2.1 and 40.2.2 as appropriate.

b. Verify testability analysis results. For example, on repairable integrated circuit boards are test points available so that failures can be isolated to the lowest level of repair (See Section 3 Definitions, for "Levels of repair").

c. Verify that the Government furnished SE is planned to be used to the maximum extent possible.

d. Review progress of long-lead time SE items, identified through interim release and SE Requirements Document (SERD) procedures.

e. Review progress toward determining total SE requirements for installation, checkout, and test support requirements.

f. Review the reliability/maintainability/availability of support equipment items.

g. Identify logistic support requirements for support equipment items and rationale for their selection.

h. Review calibration requirements.

i. Describe technical manuals and data availability for support equipment.

j. Verify compatibility of proposed support equipment with the system maintenance concept.

k. If a Logistic Support Analysis (LSA) is not done, then review the results of SE trade-off studies for each alternative support concept. For existing SE and printed circuit board testers, review Maintainability data resulting from the field use of these equipments. Review the cost difference between systems using single or multipurpose SE vs. proposed new SE. Examine technical feasibility in

using existing, developmental, and proposed new SE. For mobile systems, review the mobility requirements of support equipment.

l. Review the relationship of the computer resources in the system/subsystem with those in Automatic Test Equipment (ATE). Relate this to the development of Built In Test Equipment (BITE) and try to reduce the need for complex supporting SE.

40.3 Evaluation of Electrical, Mechanical, and Logical Designs

40.3.1 HWCIs. The material of paragraph 40.2.1 above shall be evaluated to:

a. Determine that the preliminary detail design provides the capability of satisfying the performance characteristics paragraph of the HWCI Development specifications.

b. Establish compatibility of the HWCI operating characteristics in each mode with overall system design requirements if the HWCI is involved in multi-mode functions.

c. Establish the existence and nature of physical and functional interfaces between the HWCI and other items of equipment, computer software, and facilities.

40.3.2 CSCIs. The material of paragraph 40.2.2 above shall be evaluated to:

a. Determine whether all interfaces between the CSCI and all other configuration items both internal and external to the system meet the requirements of the Software Requirements Specification and Interface Requirements Specification(s).

b. Determine whether the top-level design embodies all the requirements of the Software Requirements and Interface Requirements Specifications.

c. Determine whether the approved design methodology has been used for the top-level design.

d. Determine whether the appropriate Human Factors Engineering (HFE) principals have been incorporated in the design.

e. Determine whether timing and sizing constraints have been met throughout the top-level design.

f. Determine whether logic affecting system and nuclear safety has been incorporated in the design.

40.4 Electromagnetic Compatibility. Review HWCI design for compliance with electromagnetic compatibility/electromagnetic interference (EMC/EMI) requirements. Use Electromagnetic Compatibility Plan as the basis for this review. Check application of MIL-STDs and MIL-Specs cited by the system/equipment specification(s) to the HWCI/Subsystem design. Review preliminary EMI test plans to assess adequacy to confirm that EMC requirements have been met.

40.5 Design Reliability.

40.5.1 Identify the quantitative reliability requirements specified in the hardware Development and Software Requirements Specification(s), including design allocations, and the complexity of the CSCIs.

40.5.2 Review failure rate sources, derating policies, and prediction methods. Review the reliability mathematical models and block diagrams as appropriate.

40.5.3 Describe planned actions when predictions are less than specified requirements.

40.5.4 Identify and review parts or components which have a critical life or require special consideration, and general plan for handling. Agencies so affected shall present planned actions to deal with these components or parts.

40.5.5 Identify applications of redundant HWCI elements. Evaluate the basis for their use and provisions for "on-line" switching of the redundant element.

40.5.6 Review critical signal paths to determine that a fail-safe/fail-soft design has been provided.

40.5.7 Review margins of safety for HWCIs between functional requirements and design provisions for elements, such as: power supplies, transmitter modules, motors, and hydraulic pumps. Similarly, review structural elements; i.e., antenna pedestals, dishes, and radomes to determine that adequate margins of safety shall be provided between operational stresses and design strengths.

40.5.8 Review Reliability Design Guidelines for HWCIs to insure that design reliability concepts shall be available and used by equipment designers. Reliability Design Guidelines shall include, as a minimum, part application guidelines (electrical derating, thermal derating, part parameter tolerances), part selection order of preference, prohibited parts/materials, reliability apportionments/predictions, and management procedures to ensure compliance with the guidelines.

40.5.9 Review for HWCIs preliminary reliability demonstration plan; failure counting ground rules, accept-reject criteria, number of test articles, test location and environment, planned starting date, and test duration.

40.5.10 Review elements of reliability program plan to determine that each task has been initiated toward achieving specified requirements.

40.5.11 Review subcontractor/supplier reliability controls.

40.6 Design Maintainability

40.6.1 Identify the quantitative maintainability requirements specified in the hardware Development and Software Requirements Specifications; if applicable, compare preliminary predictions with specified requirements.

40.6.2 Review HWCI preventive maintenance schedules in terms of frequencies, durations, and compatibility with system schedules.

40.6.3 Review repair rate sources and prediction methods.

40.6.4 Review planned actions when predictions indicate that specified requirements will not be attained.

40.6.5 Review planned designs for accessibility, testability, and ease of maintenance characteristics (including provisions for automatic or operator-controlled recovery from failure/malfunctions) to determine consistency with specified requirements.

40.6.6 Determine if planned HWCI design indicates that parts, assemblies, and components will be so placed that there is sufficient space to use test probes, soldering irons, and other tools without difficulty and that they are placed so that structural members of units do not prevent access to them or their ease of removal.

40.6.7 Review provisions for diagnosing cause(s) of failure; means for localizing source to lowest replaceable element; adequacy and locations of planned test points; and planned system diagnostics that provide a means for isolating faults to and within the configuration item . This review shall encompass on-line diagnostics, off-line diagnostics, and proposed technical orders and/or commercial manuals.

40.6.8 Review for HWCIs the Design for Maintainability Checklist to insure that listed design principles shall lead to a mature maintainability design. Determine that contractor design engineers are using the checklist.

40.6.9 Evaluate for HWCIs the preliminary maintainability demonstration plan, including number of maintenance tasks that shall be accomplished; accept-reject criteria; general plans for introducing faults into the HWCI and personnel involved in the demonstration.

40.6.10 Review elements of maintainability program plan to determine that each task has been initiated towards achieving specified requirements.

40.6.11 Insure that consideration has been given to optimizing the system/item from a maintainability and maintenance viewpoint and that it is supportable within the maintenance concept as developed. Also, for HWCIs insure that a Repair Level Analysis (RLA) has been considered.

40.7 Human Factors

40.7.1 The contractor shall present evidence that substantiates the functional allocation decisions. The Review shall cover all operational and maintenance functions of the configuration item. In particular, ensure that the approach to be followed emphasizes the functional integrity of the man with the machine to accomplish a system operation.

40.7.2 Review design data, design descriptions and drawings on system operations, equipments, and facilities to insure that human performance requirements of the hardware Development and Software Requirements Specifications are met. Examples of the types of design information to be reviewed are:

a. Operating modes for each display station, and for each mode, the functions performed, the displays and control used, etc.

b. The exact format and content of each display, including data locations, spaces, abbreviations, the number of digits, all special symbols (Pictographic), alert mechanisms (e.g., flashing rates), etc.

c. The control and data entry devices and formats including keyboards, special function keys, cursor control, etc.

d. The format of all operator inputs, together with provisions for error detection and correction.

e. All status, error, and data printouts - including formats, headings, data units, abbreviations, spacings, columns, etc.

These should be presented in sufficient detail to allow contracting agency personnel to judge adequacy from a human usability standpoint, and design personnel to know what is required, and test personnel to prepare tests.

40.7.3 Make recommendations to update the System/Segment, or Software Requirements Specification and Interface Requirements Specification(s) in cases where requirements for human performance need to be more detailed.

40.7.4 Review man/machine functions to insure that man's capabilities are utilized and that his limitations are not exceeded.

40.8 System Safety

40.8.1 Review results of configuration item safety analyses, and quantitative hazard analyses (if applicable).

40.8.2 Review results of system and intra-system safety interfaces and trade-off studies affecting the configuration item.

40.8.3 Review safety requirements levied on subcontractors.

40.8.4 Review known special areas of safety, peculiar to the nature of the system (e.g., fuel handling, fire protection, high levels of radiated energy, high voltage protection, safety interlocks, etc.).

40.8.5 Review results of preliminary safety tests (if appropriate).

40.8.6 Generally review adequacy and completeness of configuration item from design safety viewpoint.

40.8.7 Review compliance of commercially available configuration items or configuration item components with system safety requirements and identify modifications to such equipment, if required.

40.9 Natural Environment

40.9.1 Review contractor's planned design approach toward meeting climatic conditions (operating and non-operating ranges for temperature, humidity, etc.) that are specified in the HWCI Development Specification.

40.9.2 Insure that the contractor clearly understands the effect of, and the interactions between, the natural aerospace environment and HWCI design. In cases where the effect and interactions are not known or are ambiguous, insure that studies are in progress or planned to make these determinations.

40.9.3 Current and forecast natural aerospace environment parameters may be needed for certain configuration items; e.g., display of airbase conditions in a command and control system, calculation of impact point for a missile, etc. Insure

compatibility between the configuration item design and appropriate meteorological communications by comparing characteristics of the source (teletype, facsimile, or data link) with that of the configuration item. Insure that arrangements or plans to obtain needed information have been made and that adequate display of natural environmental information shall be provided.

40.10 Equipment and Part Standardization

40.10.1 Equipment and Components:

a. Review current and planned contractor actions to determine that equipment or components for which standards or specifications exist shall be used whenever practical. (Standard item with NSN should have first preference).

b. Review specific trade-offs or modifications that may be required of existing designs if existing items are, or will be, incorporated in the HWCI.

c. Existing designs will be reviewed for use or non-use based on the potential impact on the overall program in the following areas:

(1) Performance

(2) Cost

(3) Time

(4) Weight

(5) Size

(6) Reliability

(7) Maintainability

(8) Supportability

(9) Producibility

d. Review HWCI design to identify areas where a practical design change would materially increase the number of standard items that could be incorporated.

e. Insure that Critical Item Specifications shall be prepared for hardware items identified as engineering or logistics critical.

40.10.2 Parts Standardization and Interchangeability:

a. Review procedures to determine if maximum practical use will be made of parts built to approved standards or specifications. The potential impact on the overall program is to be evaluated when a part built to approved standards and specifications cannot be used for any of the following reasons:

(1) Performance

(2) Weight

(3) Size

(4) Reliability/Mantainability/Availability

(5) Supportability

(6) Survivability (including nuclear)

b. Identify potential design changes that will permit a greater use of standard or preferred parts and evaluate the trade-offs.

c. Insure understanding of parts control program operations for selection and approval of parts in new design or major modifications.

d. Review status of the Program Parts Selection List.

e. Review status of all non-standard parts identified.

f. Review pending parts control actions that may cause program slippages, such as non-availability of tested parts.

40.10.3 Assignment of Official Nomenclature:

a. Insure understanding of procedure for obtaining assignment of nomenclature and approval of nameplates.

b. Determine that a nomenclature conference has been held and agreement has been reached with the contracting agency on the level of nomenclature; i.e., system, set, central, group, component, sub-assembly, unit, etc.

40.11 Value Engineering

40.11.1 Review the Contractor's in-house incentive Value Engineering Program, which may include but not be limited to the following:

a. Contractor's Value Engineering organization, policies and procedures.

b. Contractor's Value Engineering Training Program.

c. Potential Value Engineering projects, studies and VECPs.

d. Schedule of planned Value Engineering tasks/events.

e. Policies and procedures for subcontractor Value Engineering Programs.

40.12 Transportability

40.12.1 Review HWCI to determine if design meets contracts requirements governing size and weight to permit economical handling, loading, securing, transporting, and disassembly for shipment within existing capabilities of military and commercial carriers. Identify potential outsized and overweight items. Identify system/items defined as being hazardous. Ensure packaging afforded hazardous items complies with hazardous materials regulations.

40.12.2 Identify HWCIs requiring special temperature and humidity control or those possessing sensitive and shock susceptibility characteristics. Determine special transportation requirements and availability for use with these HWCIs.

40.12.3 Review Transportability Analysis to determine that transportation conditions have been evaluated and that these conditions are reflected in the design of protective, shipping, and handling devices. In addition to size and weight characteristics, determine that analysis includes provisions for temperature and humidity controls, minimization of sensitivity, susceptibility to shock, and transit damage.

40.13 Test

40.13.1 Review all changes to the System/Segment, HWCI Development, Software Requirements, and Interface Requirements Specifications subsequent to the established Allocated Baseline to determine whether Section 4.0 of all these specifications adequately reflects these changes.

40.13.2 Review information to be provided by the contractor regarding test concepts for Development Test and Evaluation (DT&E) testing (both informal and formal). Information shall include:

a. The organization and responsibilities of the group that will be responsible for test.

b. The management of his in-house development test effort provides for:

(1) Test Methods (plans/procedures)

(2) Test Reports

(3) Resolution of problems and errors

(4) Retest procedure

(5) Change control and configuration management

(6) Identification of any special test tools that are not deliverable under the contract.

c. The methodology to be used to meet quality assurance requirements/qualification requirements, including the test repeatability characteristics and approach to regression testing.

d. The progress/status of the test effort since the previous reporting milestone.

40.13.3 Review status of all negative or provisional entries such as "not applicable (N/A)" or "to be determined (TBD)" in Section 4.0 of the System/Segment, hardware Development, Software Requirements or Interface Requirements Specifications. Review all positive entries for technical adequacy. Insure that associated test documentation includes these changes.

40.13.4 Review interface test requirements specified in Section 4.0 of the hardware Development, Software Requirements, and Interface Requirements Specifications for compatibility, currency, technical adequacy, elimination of redundant test. Insure that all associated test documents reflect these interface requirements.

40.13.5 Insure that all test planning documentation has been updated to include new test support requirements and provisions for long-lead time support requirements.

40.13.6 Review contractor test data from prior testing to determine if such data negates the need for additional testing.

40.13.7 Examine all available breadboards, mock-ups, or devices which will be used in implementing the test program or which affect the test program, for program impact.

40.13.8 Review plans for software Unit testing to ensure that they:

a. Address Unit level sizing, timing, and accuracy requirements.

b. Present general and specific requirements that will be demonstrated by Unit testing.

c. Describe the required test-unique support software, hardware, and facilities and the interrelationship of these items.

d. Describe how, when, and from where the test-unique support items will be obtained.

e. Provide test schedules consistent with higher level plans.

40.13.9 Review plans for CSC integration testing to ensure that they:

a. Define the type of testing required for each level of the software structure above the unit level.

b. Present general and specific requirements that will be demonstrated by CSC integration testing.

c. Describe the required test-unique support software, hardware, and facilities and the interrelationship of these items.

d. Describe how, when, and from where the test-unique support items will be obtained.

e. Describe CSC integration test management, to include:

(1) Organization and responsibilities of the test team

(2) Control procedures to be applied during test

(3) Test reporting

(4) Review of CSC integration test results

(5) Generation of data to be used in CSC integration testing.

f. Provide test schedules consistent with higher level plans.

40.13.10 Review plans for formal CSCI testing to ensure that they:

a. Define the objective of each CSCI test, and relate the test to the software requirements being tested.

b. Relate formal CSCI tests to other test phases.

c. Describe support software, hardware, and facilities required for CSCI testing; and how, when, and from where they will be obtained.

d. Describe CSCI test roles and responsibilities.

e. Describe requirements for Government-provided software, hardware, facilities, data, and documentation.

f. Provide CSCI test schedules consistent with higher-level plans.

g. Identify software requirements that will be verified by each formal CSCI test.

40.14 Maintenance and Maintenance Data (HWCIs)

40.14.1 Describe System Maintenance concept for impact on design and SE. Review adequacy of maintenance plans. Coverage shall be provided for On Equipment (Organizational), Off Equipment - On Site (Intermediate), Off Equipment - Off Site (Depot) level maintenance of Government Furnished Equipment (GFE), and Contractor Furnished Equipment (CFE). (See Section 3, Definitions, para 3.12 for levels of maintenance.)

40.14.2 Determine degree of understanding of the background, purpose, requirements, and usage of Maintenance (failure) Data Collection and Historical/Status Records. (Ref Data Item titled, "Reliability and Maintainability Data Reporting and Feedback Failure Summary Reports").

40.14.3 Describe method of providing Maintenance, Failure, Reliability, Maintainability Data to contracting agency.

40.14.4 Describe how requirements are submitted to the contracting agency for Equipment Classification (EQ/CL) Codes (formerly Work Order Number Prefix/Suffix Codes) when this requirement exists.

40.14.5 Review plans for (and status of) Work Unit Coding of the equipment. Work Unit codes shall be available for documenting Maintenance Data commencing with configuration item/Subsystem Testing. (Ref. Data Item titled "Technical Orders" and the military specification on work unit coding).

40.15 Spares and Government Furnished Property (GFP).

40.15.1 Review logistics and provisioning planning to insure full understanding of scope of requirements in these areas and that a reasonable time-phased plan has been developed for accomplishment. Of specific concern are the areas of: provisioning requirements,

GFP usage, and spare parts, and support during installation, checkout, and test.

40.15.2 Review provisioning actions and identify existing or potential provisioning problems - logistic critical and long-lead time items are identified and evaluated against use of the interim release requirements.

40.15.3 Review plans for maximum screening and usage of GFP, and extent plans have been implemented.

40.15.4 Review progress toward determining and acquiring total installation, checkout, and test support requirements.

40.16 Packaging/SDPE (Special Design Protective Equipment)

40.16.1 Analyze all available specifications (System/Segment, HWCI Development, Software Requirements, Interface Requirements, and Critical Items) for packaging (Section 5) requirements for each product fabrication and material specification.

40.16.2 Evaluate user/operational support requirements and maintenance concepts for effect and influence on package design.

40.16.3 Establish that time phased plan for package design development is in consonance with the development of the equipment design.

40.16.4 Review planned and/or preliminary equipment designs for ease of packaging and simplicity of package design, and identify areas where a practical design change would materially decrease cost, weight, or volume of packaging required.

40.16.5 Review requirements for SDPE necessary to effectively support configuration item during transportation, handling and storage processes. Insure SDPE is categorized as a configuration item utilizing specifications conforming to the types and forms as prescribed in the contract. Review SDPE development/product specifications for adequacy of performance/interface requirements.

40.16.6 Determine initial package design baselines, concepts, parameters, constraints, etc., to the extent possible at this phase of the configuration item development process.

40.16.7 Insure previously developed and approved package design data for like or similar configuration items is being utilized.

40.16.8 Establish plans for trade studies to determine the most economical and desirable packaging design approach needed to satisfy the functional performance and logistic requirements.

40.16.9 Verify the adequacy of the prototype package design.

40.16.10 Review Section 5 of Specification to insure full understanding by contractor for contractor requirements. Identify package specification used for hazardous materials.

40.17 Technical Manuals

40.17.1 Review status of the "Technical Manual Publications Plan" to insure that all aspects of the plan have been considered to the extent that all concerned agencies are apprised of the technical manual coverage to be obtained under this procurement. The suitability of available commercial manuals and/or modifications thereto shall also be determined.

40.17.2 Review the availability of technical manuals for validation/verification during the latter phases of DT&E testing.

40.17.3 If a Guidance Conference was not accomplished or if open items resulted from it, then review as applicable provisions for accomplishing TO in-process reviews, validation, verification, prepublication, and postpublication reviews.

40.18 System Allocation Document

40.18.1 Review the Draft System Allocation Document f[illegible] completeness and technical adequacy to extent completed.

40.18.2 The format shall provide the following minimum information:

a. Drawing Number
b. Issue
c. Number of Sheets
d. Location
e. Configuration Item Number
f. Title
g. Part Number
h. Serial Number
i. Specification Number
j. Equipment Nomenclature
k. Configuration Item Quantity
l. Assembly Drawing

40.19 Design Producibility and Manufacturing

40.19.1 The contractor shall demonstrate and present evidence that manufacturing engineering will be integrated into the design process.

a. The contractor shall provide evidence of performing producibility analyses on development hardware trading off design requirements against manufacturing risk, cost, production, volume, and existing capability/availability.

Evidence of such analyses may be in the contractor's own format but must conclusively demonstrate that in-depth analyses were performed by qualified organizations/individuals and the results of those analyses will be incorporated in the design.

b. Preliminary manufacturing engineering and production planning demonstrations shall address: material and component selection, preliminary production sequencing, methods and flow concepts, new processes, manufacturing risk, equipment and facility utilization for intended rates and volume, production in-process and acceptance test and inspection concepts. (Efforts to maximize productivity in the above areas should be demonstrated.)

c. Management systems to be utilized will insure that producibility and manufacturing considerations are integrated throughout the FSD effort.

40.19.2 The producibility and manufacturing concerns identified in the SRR and the SDR shall be updated and expanded to:

a. Provide evidence that concerns identified in the Manufacturing Feasibility Assessment and the Production Capability Estimate have been addressed and that resolutions are planned or have been performed.

b. Make recommendations including manufacturing technology efforts and provide a schedule of necessary actions to the program office to resolve open manufacturing concerns and reduce manufacturing risk.

40.20 Post Review Action

40.20.1 After completing the PDR, the contractor shall publish and distribute copies of Review minutes. The contracting agency officially acknowledges completion of a PDR as indicated in paragraph 4.2.4.

40.20.2 The accomplishment of the PDR shall be recorded on the configuration item Development Record by the contractor.

50. Critical Design Review

50.1 General. The CDR shall be conducted on each configuration item prior to fabrication/production/coding release to insure that the detail design solutions, as reflected in the Draft Hardware Product Specification, Software Detailed Design Document (SDDD), Data Base Design Document(s) (DBDD(s)), Interface Design Document(s) (IDD(s)), and engineering drawings satisfy requirements established by the hardware Development Specification and Software Top Level Design Document (STLDD). CDR shall be held after the Computer Software Operator's Manual (CSOM), Software User's Manual (SUM), Computer System Diagnostic Manual (CSDM), Software Programmer's Manual (SPM), and Firmware Support Manual (FSM) have been updated or newly released. For complex/large configuration items the CDR may be conducted on an incremental basis, i.e., progressive reviews are conducted versus a single CDR. The overall technical program risks associated with each configuration item shall also be reviewed on a technical (design and manufacturing), cost and schedule basis. For software, a technical understanding shall be reached on the validity and the degree of completeness of the SDDD, IDD(s), DBDD(s), STD, CRISD, SPM, and FSM, and preliminary versions of the CSOM, SUM, and CSDM.

50.1.1 Equipment/Facilities configuration items. The detail design as disclosed by the hardware Product Specification, drawings, schematics, mockups, etc., shall be reviewed against the HWCI Development Specification performance requirements. For other than facilities, the result of a successful CDR shall be the establishment of the design baseline for detailed fabrication/production planning i.e., the contractor is permitted to use the detail design as presented at CDR and reflected in the hardware Product Specification for planning for production and, if specifically authorized, for initial fabrication/production efforts.

50.1.2 Computer Software configuration items (CSCIs). The CDR for a CSCI shall be a formal technical review of the CSCI detail design, including data base and interfaces. The CDR is normally accomplished for the purpose of establishing integrity of computer software design at the level of a Unit's logical design prior to coding and testing. CDR may be accomplished at a single review meeting or in increments during the development process corresponding to periods at which components or groups of components reach the completion of logical design. The primary product of the CDR is a formal identification of specific software documentation which will be released for coding and testing. By mutual agreement between the contractor and the contracting agency, CDRs may be scheduled concurrently for two or more CSCIs.

50.1.2.1 Since computer software development is an iterative process, the completion of a CDR for a CSCI is not necessarily sufficient for maintaining adequate visibility into the remaining

development effort through testing.

50.1.2.2 Additional In-Progress Reviews may be scheduled post-CDR which address:

a. Response to outstanding action items

b. Modifications to design necessitated by approved ECPs or design/program errors

c. Updating sizing and timing data

d. Updated design information, as applicable

e. Results obtained during in-house testing, including problems encountered and solutions implemented or proposed.

50.2 Items to be Reviewed. The contractor shall present the following for review by the contracting agency:

50.2.1 HWCIs

a. Adequacy of the detail design reflected in the draft hardware Product Specification in satisfying the requirements of the HWCI Development Specification for the item being reviewed.

b. Detail engineering drawings for the HWCI including schematic diagrams.

c. Adequacy of the detailed design in the following areas:

(1) Electrical design

(2) Mechanical design

(3) Environmental control and thermal aspects

(4) Electromagnetic compatibility

(5) Power generation and grounding

(6) Electrical and mechanical interface compatibility

(7) Mass properties

(8) Reliability/Maintainability/Availability

(9) System Safety Engineering

(10) Security Engineering

(11) Survivability/Vulnerability (including nuclear)

(12) Producibility and Manufacturing

(13) Transportability, Packaging and handling

(14) Human Engineering and Biomedical Requirements (including Life Support and Crew Station Requirements)

(15) Standardization

(16) Design versus Logistics Trade-offs

d. Interface control drawings

e. Mock-ups, breadboards, and/or prototype hardware

f. Design analysis and test data

g. System Allocation Document for HWCI inclusion at each scheduled location.

h. Initial Manufacturing Readiness (for example, manufacturing engineering, tooling demonstrations, development and proofing of new materials, processes, methods, tooling, test equipment, procedures, reduction of manufacturing risks to acceptable levels).

i. Preliminary VECPs and/or formal VECPs

j. Life cycle costs

k. Detail design information on all firmware to be provided with the system.

l. Verify corrosion prevention/control considerations to insure materials have been chosen that will be compatible with operating environment.

m. Findings/Status of Quality Assurance Program

50.2.2 CSCIs.

a. Software Detailed Design, Data Base Design, and Interface Design Document(s). In cases where the CDR is conducted in increments, complete documents to support that increment shall be available.

b. Supporting documentation describing results of analyses, testing, etc., as mutually agreed by the contracting agency and the contractor.

c. System Allocation Document for CSCI inclusion at each scheduled location.

d. Computer Resources Integrated Support Document.

e. Software Programmer's Manual

f. Firmware Support Manual

g. Progress on activities required by CSCI PDR (para 40.2.2).

h. Updated operation and support documents (CSOM, SUM, CSDM).

i. Schedules for remaining milestones.

j. Updates since the last review to all previously delivered software related CDRL items.

50.2.3 Support Equipment (SE):

a. Review requirements (paragraphs 50.2.1 and 50.2.2) for SE.

b. Verify maximum considerations GFE SE

c. Identify existing or potential SE provisioning problems

d. Determine qualitative and quantitative adequacy of provisioning drawings and data

e. Review reliability of SE

f. Review logistic support requirements for SE items

g. Review calibration requirements

h. Review documentation for SE.

50.3 Detailed Evaluation of Electrical, Mechanical, and Logical Designs.

50.3.1 HWCIs. Detailed block diagrams, schematics, and logic diagrams shall be compared with interface control drawings to determine system compatibility. Analytical and available test data shall be reviewed to insure the hardware Development Specification has been satisfied.

50.3.1.1 The contractor shall provide information on firmware which is included in commercially available equipment or to be included in equipment developed under the contract. Firmware in this context includes the microprocessor and associated sequence of micro-instructions necessary to perform the allocated tasks. As a minimum, the information presented during CDR shall provide

descriptions and status for the following:

a. Detailed logic flow diagrams

b. Processing algorithms

c. Circuit diagrams

d. Clock and timing data (e.g., timing charts for micro-instructions)

e. Memory (e.g., type (RAM, PROM), word length, size (total and spare capacity))

f. Micro-instruction list and format

g. Device functional instruction set obtained by implementation of firmware.

h. Input/output data width (i.e., number of bits for data and control.)

i. Self-test (diagnostics) within firmware.

j. Support software for firmware development:

(1) Resident assembler

(2) Loader

(3) Debugging routines

(4) Executive (monitor)

(5) Non-resident diagnostics

(6) Cross assembler and higher level language on host computer

(7) Instruction simulator

50.3.2 CSCIs. The contractor shall present the detailed design (including rationale) of the CSCI to include:

a. The assignment of CSCI requirements to specific Lower-Level Computer Software Components (LLCSCs) and Units, the criteria and design rules used to accomplish this assignment, and the traceability of Unit and LLCSC designs to satisfy CSCI requirements, with emphasis on the necessity and sufficiency of the Units for implementing TLCSC design requirements.

b. The overall information flow between software Units, the method(s) by which each Unit gains control, and the sequencing of Units relative to each other.

c. The design details of the CSCI, TLCSCs, LLCSCs, and Units including data definitions, timing and sizing, data and storage requirements and allocations.

d. The detailed design characteristics of all interfaces, including their data source, destination, interface name and interrelationships; and, if applicable, the design for direct memory access. The contractor shall also give an overview of the key design issues of the interface software design, and indicate whether data flow formats are fixed or subject to extensive dynamic changes.

e. The detailed characteristics of the data base. Data base structure and detailed design, including all files, records, fields, and items. Access rules, how file sharing will be controlled, procedures for data base recovery/regeneration from a system failure, rules for data base manipulation, rules for maintaining file integrity, rules for usage reporting, and rules governing the types and depth of access shall be defined. Data management rules and algorithms for implementing them shall be described. Details of the language required by the user to access the data base shall also be described.

50.4 Electromagnetic Compatibility:

a. Review contractor EMC design of all HWCIs. Determine compliance with requirements of the Electromagnetic Compatibility Plan and HWCI specifications.

b. Review system EMC including effects on the electromagnetic environment (inter-system EMC) and intra-system EMC. Determine acceptability of EMC design and progress toward meeting contractual EMC requirements.

c. Review EMC test plans. Determine adequacy to confirm EMC design characteristics of the system/HWCI/subsystem.

50.5 Design Reliability:

50.5.1 Review the most recent predictions of hardware and software reliability and compare against requirements specified in hardware Development Specification and Software Requirements Specification. For hardware, predictions are substantiated by review of parts application stress data.

50.5.2 Review applications of parts or configuration items with minimum life, or those which require special consideration to

insure their effect on system performance is minimized.

50.5.3 Review completed Reliability Design Review Checklist to insure principles have been satisfactorily reflected in the configuration item design.

50.5.4 Review applications of redundant configuration item elements or components to establish that expectations have materialized since the PDR.

50.5.5 Review detailed HWCI reliability demonstration plan for compatibility with specified test requirements. The number of test articles, schedules, locations, test conditions, and personnel involved are reviewed to insure a mutual understanding of the plan and to provide overall planning information to activities concerned.

50.5.6 Review the failure data reporting procedures and methods for determination of failure trends.

50.5.7 Review the thermal analysis of components, printed circuit cards, modules, etc. Determine if these data are used in performing the detailed reliability stress predictions.

50.5.8 Review on-line diagnostic programs, off-line diagnostic programs, support equipment, and preliminary technical orders (and/or commercial manuals) for compliance with the system maintenance concept and specification requirements.

50.5.9 Review software reliability prediction model and its updates based upon test data and refined predictions of component usage rates and complexity factors.

50.6 Design Maintainability

50.6.1 Review the most recent predictions of quantitative maintainability and compare these against requirements specified in the HWCI Development Specification and Software Requirements Specification.

50.6.2 Review preventive maintenance frequencies and durations for compatibility with overall system requirements and planning criteria.

50.6.3 Identify unique maintenance procedures required for the configuration item during operational use and evaluate their total effects on system maintenance concepts. Assure that system is optimized from a maintenance and maintainability viewpoint and conforms with the planned maintenance concept. This shall include a review of provisions for automatic, semi-automatic, and manual recovery from hardware/software failures and malfunctions.

50.6.4 Identify design-for-maintainability criteria provided by the checklist in the design detail to insure that criteria have, in fact been incorporated.

50.6.5 Determine if parts, assemblies, and other items are so placed that there is sufficient space to use test probes, soldering irons, and other tools without difficulty and that they are placed so that structural members of units do not prevent access to them or their ease of removal.

50.6.6 Review detailed maintainability demonstration plan for compatibility with specified test requirements. Supplemental information is provided and reviewed to insure a mutual understanding of the plan and to provide overall planning information to activities concerned.

50.7 Human Factors

50.7.1 Review detail design presented on drawings, schematics, mockups, or actual hardware to determine that it meets human performance requirements of the HWCI Development Specification and Software Requirements Specification, Interface Requirements Specification(s), and accepted human engineering practices.

50.7.2 Demonstrate by checklist or other formal means the adequa of design for human performance.

50.7.3 Review each facet of design for man/machine compatibility. Review time/cost/effectiveness considerations and forced trade-offs of human engineering design.

50.7.4 Evaluate the following human engineering/biomedical design factors:

a. Operator controls

b. Operator displays

c. Maintenance features

d. Anthropometry

e. Safety features and emergency equipment

f. Work space layout

g. Internal environmental conditions (noise, lighting, ventilation, etc.)

h. Training equipment

i. Personnel accommodations

50.8 System Safety

50.8.1 Review configuration item detail design for compliance to safety design requirements.

50.8.2 Review acceptance test requirements to insure adequate safety requirements are reflected therein.

50.8.3 Evaluate adequacy of detailed design for safety and protective equipment/devices.

50.8.4 Review configuration item operational maintenance safety analyses and procedures.

50.9 Natural Environment

50.9.1 Review detail design to determine that it meets natural environment requirements of the hardware Development Specification.

50.9.2 Insure that studies have been accomplished concerning effects of the natural environment on, or interactions with, the HWCI. Studies which have been in progress shall be complete at this time.

50.9.3 Determine whether arrangements have been made to obtain current and/or forecast natural environment information, when needed for certain HWCIs. Assure compatibility of HWCI and source of information by comparing electrical characteristics and formats for the source and the HWCI.

50.10 Equipment and Parts Standardization.

50.10.1 Equipment and Components. Determine that every reasonable action has been taken to fulfill the standardization requirements for use of standard items (standard item with NSN should be first preference) and to obtain approval for use of non-standard or non-preferred items. Accordingly, the following criteria shall be evaluated:

a. Data sources that were reviewed.

b. Factors that were considered in the decision to reject known similar, existing designs.

c. Factors that were considered in decisions to accept any existing designs which were incorporated, and the trade-offs, if any, that had to be made.

50.10.2 Parts

a. Determine whether there are any outstanding non-standard or

non-preferred parts approval requests and action necessary for approval or disapproval. (Status of parts control program operations).

b. Identify non-standard-non-preferred parts approval problems and status of actions toward resolving the problems.

c. Review potential fabrication/production line delays due to non-availability of standard or preferred parts. In such cases, determine whether it is planned to request use of parts which may be replaced by standard items during subsequent support repair cycles. Assure that appropriate documentation makes note of these items and that standard replacement items shall be provisioned for support and used for repair.

d. Require certification that maximum practical interchangeability of parts exists among components, assemblies, and HWCIs. Reservations concerning interchangeability are identified, particularly for hardness critical items.

e. Sample preliminary drawings and cross check to insure that parts indicated on the drawings are compatible with the Program Parts Selection List.

50.10.3 Assignment of Official Nomenclature.

a. Determine whether official nomenclature and approval of nameplates have been obtained to extent practical.

b. Determine whether DD Form 61, Request for Nomenclature, has been processed to the agreed level of indenture.

c. Insure that approved nomenclature has been reflected in the Development and Product Specifications.

d. Identify problems associated with nomenclature requests (DD-61s) together with status of actions towards resolving the problems.

e. Insure that a software inventory numbering system has been agreed to and implemented to the CSCI level.

50.11 Value Engineering (VE)

50.11.1 Review status of all VECPs presented per the terms of the contract.

50.11.2 Review any new areas of potential Value Engineering considered profitable to challenge.

50.11.3 If required by contract (funded VE program), review the actual Value Engineering accomplishments against the planned VE program.

50.12 Transportability

50.12.1 Review transportability evaluations accomplished for those items identified as outsized, overweight, sensitive, and/or requiring special temperature and humidity controls.

50.12.2 Review actions taken as a result of the above evaluation to insure adequate facilities and military or commercial transporting equipment are available to support system requirements during Production and Deployment Phases.

50.12.3 Review design of special materials handling equipment, when required, and action taken to acquire equipment.

50.12.4 Insure DOD Certificates of Essentiality for movement of equipment have been obtained for equipment exceeding limitations of criteria established in contract requirements.

50.12.5 Insure transportability approval has been annotated on design documents and shall remain as long as no design changes are made that modify significant transportability parameters.

50.12.6 Identify equipment to be test loaded for air transportability of material in Military Aircraft.

50.13 Test

50.13.1 Review updating changes to all specifications subsequent to the PDR, to determine whether Section 4.0 of the specifications adequately reflects these changes.

50.13.2 Review all available test documentation for currency, technical adequacy, and compatibility with Section 4.0 of all Specification requirements.

50.13.3 For any development model, prototype, etc., on which testing may have been performed, examine test results for design compliance with hardware Development, Software Requirements, and Interface Requirements Specification requirements.

50.13.4 Review quality assurance provisions/qualification requirements in HWCI Product, Software Requirements, or Interface Requirements Specifications for completeness and technical adequacy. Section 4.0 of these specifications shall include the minimum requirements that the item, materiel, or process must meet to be acceptable.

50.13.5 Review all test documentation required to support test

requirements of Section 4.0 of HWCI Product Specifications for compatibility, technical adequacy, and completeness.

50.13.6 Inspect any breadboards, mockups, or prototype hardware available for test program implications.

50.13.7 Review Software Test Descriptions to ensure they are consistent with the Software Test Plan and they thoroughly identify necessary parameters and prerequisites to enable execution of each planned software test and monitoring of test results. As a minimum, test descriptions shall identify the following for each test:

a. Required preset hardware and software conditions and the necessary input data, including the source for all data.

b. Criteria for evaluating test results.

c. Prerequisite conditions to be established or set prior to test execution.

d. Expected or predicted test results.

50.14 Maintenance and Maintenance Data

50.14.1 Review adequacy of maintenance plans.

50.14.2 Review status of unresolved maintenance and maintenance data problems since the PDR.

50.14.3 Review status of compliance with Data Item titled "Reliability, Maintainability Data Reporting and Feedback Failure Summary Reports."

50.15 Spare Parts and Government Furnished Property (GFP).

50.15.1 Review provisioning planning through normal logistics channels and Administrative Contracting Officer (ACO) representative (Industrial Specialist) to insure its compatibility (content and time phasing) with contractual requirements (data and SOW items). The end objective is to provision by a method which shall insure system supportability at operational date of the first site. Also accomplish the following:

a. Insure contractor understanding of contractual requirements, including time phasing, instructions from logistics support agencies, interim release authority and procedure, and responsibility to deliver spare/repair parts by need date.

b. Determine that scheduled provisioning actions, such as, guidance meetings, interim release and screening, are being accomplished adequately and on time.

c. Identify existing or potential provisioning problems.

50.15.2 Determine quantitative and qualitative adequacy of provisioning drawings and data. Verify that Logistics Critical Items are listed for consideration and that adequate procedures exist for reflecting design change information in provisioning documentation and Technical Orders.

50.15.3 Insure support requirements have been determined for installation, checkout, and test for approval by contracting agency. Insure screening has been accomplished and results are included into support requirements lists.

50.15.4 Determine that adequate storage space requirements have been programmed for on-site handling of Installation and Checkout (I&C), test support material, and a scheme has been developed for "down streaming" and joint use of insurance (high cost) or catastrophic failure support items.

50.15.5 Assure that Acquisition Method Coding (AMC) is considered.

50.16 Packaging/SDPE

50.16.1 Review proposed package design to insure that adequate protection to the HWCI, and the media on which the CSCI is recorded, is provided against natural and induced environments/hazards to which the equipment will be subjected throughout its life cycle, and to insure compliance with contractual requirements. Such analysis shall include, but not be limited to, the following:

a. Methods of preservation

b. Physical/mechanical/shock protection including cushioning media, shock mounting and isolation features, load factors, support pads, cushioning devices, blocking and bracing, etc.

c. Mounting facilities and securing/hold-down provisions

d. Interior and exterior container designs.

e. Handling provisions and compatibility with aircraft materials handling system (463L)

f. Container marking

g. Consideration and identification of dangerous/hazardous commodities

50.16.2 Review design of SDPE HWCI to determine if a category I container is required. The analysis of the proposed container or handling, shipping equivalent shall encompass as a minimum,

a. Location and type of internal mounting or attaching provisions

b. Vibration - shock isolation features, based on the pre-determined fragility rating (or other constraint of the item to be shipped.)

c. Service items (indicators, relief valves, etc.)

d. Environmental control features

e. External handling, stacking and tie-down provisions with stress ratings

f. Dimensional and weight data (gross and net)

g. Bill-of-material

h. Marking provisions including the center-of-gravity location

i. For wheeled SDPE (self-powered or tractor/trailer) the overall length, width, and height with mounted item, turning radius, mobility, number of axles, unit contact load, number of tires, etc.

j. Position and travel of adjustable wheels, titling, or other adjustments to facilitate loading.

50.16.3 Review the results of trade studies, engineering analyses, etc., to substantiate selected package/SDPE design approach, choice of materials, handling provisions, environmental features, etc.

50.16.4 Insure that package/SDPE design provides reasonable balance between cost and desired performance.

50.16.5 Review all preproduction test results of the prototype package design to insure that the HWCI is afforded the proper degree of protection.

50.16.6 Review Section 5, Packaging, of the HWCI Product Specification for correct format, accuracy and technical adequacy.

50.16.7 Review contractor procedures to assure that the requirements of Section 5, Preparation for Delivery of the approved HWCI Product Specification, will be incorporated into the package design data for provisioned spares.

50.17 System Allocation Document

50.17.1 Review maintenance of the System Allocation Document since PDR.

50.17.2 Insure plans are initiated for configuration item re-allocations that may be necessary due to actions occurring prior to, or during, CDR.

50.18 Design Producibility and Manufacturing

50.18.1 Review the status of all producibility (and productivity) efforts for cost and schedule considerations.

50.18.2 Review the status of efforts to resolve manufacturing concerns identified in previous technical reviews and their cost and schedule impact to the production program.

50.18.3 Review the status of Manufacturing Technology programs and other previously recommended actions to reduce cost, manufacturing risk and industrial base concerns.

50.18.4 Identify open manufacturing concerns that require additional direction/effort to minimize risk to the production program.

50.18.5 Review the status of manufacturing engineering efforts, tooling and test equipment demonstrations, proofing of new materials, processes, methods, and special tooling/test equipment.

50.18.6 Review the intended manufacturing management system and organization for the production program in order to show how their efforts will effect a smooth transition into production.

50.19 Post Review Action

50.19.1 After completing the CDR, the contractor shall publish and distribute copies of Review minutes. The contracting agency officially acknowledges completion of a CDR as indicated in paragraph 4.2.4.

50.19.2 The accomplishment of the CDR shall be recorded on the configuration item Development Record by the contractor.

60. Test Readiness Review (TRR).

60.1 General. The TRR shall be a formal review of the contractor's readiness to begin formal CSCI testing. It is conducted after software test procedures are available and CSC integration testing is complete. The purpose of TRR is for the contracting agency to determine whether the contractor is in fact ready to begin CSCI testing. A technical understanding shall be reached on the informal test results, and on the validity and the degree of completeness of the Computer System Operator's Manual (CSOM), Software User's Manual (SUM), and Computer System Diagnostic Manual (CSDM).

60.2 Items to be reviewed. The contractor shall present the following for review:

60.2.1 Requirements changes. Any changes to the Software Requirements Specification or Interface Requirements Specification(s) that have been approved since SSR, and which impact CSCI testing.

60.2.2 Design changes. Any changes to the Software Top-Level Design Document, Software Detailed Design Document, Data Base Design Document(s), or Interface Design Document(s) that have been made since PDR and CDR, and which impact CSCI testing.

60.2.3 Software test plans and descriptions. Any changes to approved Software Test Plans and Software Test Descriptions.

60.2.4 Software test procedures. Test procedures to be used in conducting CSCI testing, including retest procedures for test anomalies and corrections.

60.2.5 CSC integration test cases, procedures, and results. CSC integration test cases and procedures used in conducting informal CSC integration tests and the test results.

60.2.6 Software test resources. Status of the development facility hardware, Government Furnished Software (GFS), test personnel, and supporting test software and materials, including software test tool qualification and review of the traceability between requirements and their associated tests.

60.2.7 Test limitations. Identification of all software test limitations.

60.2.8 Software problems. Summary of software problem status including all known discrepancies of the CSCI and test support software.

60.2.9 Schedules. Schedules for remaining milestones.

60.2.10 Documentation Updates. Updates to all evolving and previously delivered CDRL items (e.g., CSOM, SUM, CSDM).

60.3 Post Review Action.

60.3.1 After completing the TRR, the contractor shall publish and distribute copies of Review Minutes. The contracting agency officially acknowledges completion of a TRR as indicated in paragraph 4.2.4.

60.3.2 The accomplishment of the TRR shall be recorded on the Configuration Item Development Record by the contractor.

70. Functional Configuration Audit.

70.1 General. The objective of the Functional Configuration Audit (FCA) shall be to verify that the configuration item's actual performance complies with its hardware Development or Software Requirements and Interface Requirements Specifications. Test data shall be reviewed to verify that the hardware or computer software performs as required by its functional/allocated configuration identification. For configuration items developed at Government expense, an FCA shall be a prerequisite to acceptance of the configuration item. For software, a technical understanding shall be reached on the validity and the degree of completeness of the Software Test Reports, and as appropriate, Computer System Operator's Manual (CSOM), Software User's Manual (SUM), and Computer System Diagnostic Manual (CSDM).

70.1.1 The FCA for a complex configuration item may be conducted on a progressive basis, when so specified by the contracting agency, throughout the configuration item's development and culminates at the completion of the qualification testing of the configuration item with a review of all discrepancies at the final FCA. The FCA shall be conducted on that configuration of the configuration item which is representative (prototype or preproduction) of the configuration to be released for production of the operational inventory quantities. When a prototype or preproduction article is not produced, the FCA shall be conducted on a first production article. For cases where configuration item qualification can only be determined through integrated system testing, FCA's for such configuration items will not be considered complete until completion of such integrated testing.

70.1.2 Recommendations of configuration item acceptance or non-acceptance to the local contract management agency are based upon and governed by procedures and requirements outlined in subsequent paragraphs.

70.2 Contract Requirements

70.2.1 The schedules for the FCA shall be recorded on the configuration item development record by the contractor. A configuration item cannot be audited without the contracting agency authentication of the functional and allocated baseline. In addition, the contractor shall submit the final draft Product Specification for the configuration item to be audited to the contracting agency for review prior to FCA.

70.3 Contractor Responsibility

70.3.1 Prior to the FCA date (for configuration items to be audited), the contractor shall provide the following information to the contracting agency (this information shall be provided in addition to the general requirements of Section 4.):

a. Contractor representation (the test manager should be in attendance).

b. Identification of items to be audited:

(1) Nomenclature

(2) Specification identification number

(3) Configuration Item number

(4) Current listing of all deviations/waivers against the configuration item, either requested of, or approved by the contracting agency.

(5) Status of Test Programs to test configured items with automatic test equipment (when applicable).

70.4 Procedures and Requirements

70.4.1 The contractor's test procedures and results shall be reviewed for compliance with specification requirements.

70.4.2 The following testing information shall be available for the FCA team.

a. Test plans, specifications, descriptions, procedures, and reports for the configuration item.

b. A complete list of successfully accomplished functional tests during which pre-acceptance data was recorded.

c. A complete list of successful functional tests if detailed test data are not recorded.

d. A complete list of functional tests required by the specification but not yet performed. (To be performed as a system or subsystem test).

e. Preproduction and production test results

70.4.3 Testing accomplished with the approved test procedures and validated data (witnessed) shall be sufficient to insure configuration item performance as set forth in the specification Section 3 and meet the quality assurance provisions/qualification requirements contained in the specification Section 4.

70.4.4 For those performance parameters which cannot completely be verified during testing, adequate analysis or simulations shall have been accomplished. The results of the analysis or simulations will be sufficient to insure configuration item performance as outlined in the specification.

70.4.5 Test reports, procedures, and data used by the FCA team shall be made a matter of record in the FCA minutes.

70.4.6 A list of the contractor's internal documentation (drawings) of the configuration item shall be reviewed to insure that the contractor has documented the physical configuration of the configuration item for which the test data are verified.

70.4.7 Drawings of HWCI parts which are to be provisioned should be selectively sampled to assure that test data essential to manufacturing are included on, or furnished with, the drawings.

70.4.8 Configuration items which fail to pass quality assurance test provisions/qualification requirements are to be analyzed as to the cause of failure to pass. Appropriate corrections shall be made before a configuration item is subjected to a requalification.

70.4.9 A checklist shall be developed which identifies documentation and hardware and computer software to be available and tasks to be accomplished at the FCA for the configuration item. See Pre-FCA checksheet.

70.4.10 Retests or additional tests shall be performed to assure compliance with paragraph 70.4.3.

70.4.11 Acknowledge accomplishment of partial completion of the FCA for those configuration items whose qualification is contingent upon completion of integrated systems testing.

70.4.12 For CSCIs the following additional requirements shall apply:

a. The contractor shall provide the FCA team with a briefing for each CSCI being audited and shall delineate the test results and findings for each CSCI. As a minimum, the discussion shall include CSCI requirements that were not met, including a proposed solution to each item, an account of the ECPs incorporated and tested as well as proposed, and a general presentation of the entire CSCI test effort delineating problem areas as well as accomplishments.

b. An audit of the formal test plans/descriptions/procedures shall be made and compared against the official test data. The results shall be checked for completeness and accuracy. Deficiencies shall be documented and made a part of the FCA minutes. Completion dates for all discrepancies shall be clearly established and documented.

c. An audit of the Software Test Reports shall be performed to validate that the reports are accurate and completely describe the CSCI tests.

d. All ECPs that have been approved shall be reviewed to ensure that they have been technically incorporated and verified.

e. All updates to previously delivered documents shall be reviewed to ensure accuracy and consistency throughout the documentation set.

f. Preliminary and Critical Design Review minutes shall be examined to ensure that all findings have been incorporated and completed.

g. The interface requirements and the testing of these requirements shall be reviewed for CSCIs.

h. Review data base characteristics, storage allocation data and timing, and sequencing characteristics for compliance with specified requirements.

70.5 Post Audit Actions

70.5.1 After completion of the FCA, the contractor shall publish and distribute copies of FCA minutes. The contracting agency officially acknowledges completion of the FCA as indicated in paragraph 4.2.4.

70.5.2 The accomplishment of the FCA shall be recorded on the configuration item Development Record by the contractor.

80. Physical Configuration Audit (PCA)

80.1 General. The Physical Configuration Audit (PCA) shall be the formal examination of the as-built version of a configuration item against its design documentation in order to establish the product baseline. After successful completion of the audit, all subsequent changes are processed by engineering change action. The PCA also determines that the acceptance testing requirements prescribed by the documentation is adequate for acceptance of production units of a configuration item by quality assurance activities. The PCA includes a detailed audit of engineering drawings, specifications, technical data and tests utilized in production of HWCIs and a detailed audit of design documentation, listings, and manuals for CSCIs. The review shall include an audit of the released engineering documentation and quality control records to make sure the as-built or as-coded configuration is reflected by this documentation. For software, the Software Product Specification and Version Description Document shall be a part of the PCA review.

80.1.1 The PCA shall be conducted on the first article of configuration items and those that are a reprocurement of a configuration item already in the inventory shall be identified and selected jointly by the contracting agency and the contractor. A PCA shall be conducted on the first configuration item to be delivered by a new contractor even though PCA was previously accomplished on the first article delivered by a different contractor.

80.1.2 Formal approval by the contracting agency of the configuration item Product specification, and the satisfactory completion of a PCA results in establishment of the product baseline.

80.1.3 Recommendations of configuration item acceptance or nonacceptance to the responsible contract adminstration office (CAO) are based upon and governed by procedures and requirements outlined in subsequent paragraphs.

80.1.4 A final review shall be made of all operation and support documents (i.e., Computer System Operator's Manual (CSOM), Software User's Manual (SUM), Computer System Diagnostic Manual (CSDM), Software Programmer's Manual (SPM), Firmware Support Manual (FSM)) to check format, completeness, and conformance with applicable data item descriptions.

80.2 Contract Requirements

80.2.1 The schedules for the PCA shall be recorded on the configuration item Development Record by the contractor. A current set of listings shall be provided for each CSCI being audited. The contractor shall submit the final draft of the

product specification for the configuration item to be audited to the contracting agency for review prior to PCA.

80.3 Contractor Responsibility

80.3.1 The contractor shall provide the following information to the contracting agency (this information shall be provided in accordance with the general instructions of Section 4 and the contractual requirements):

a. Contractor representation (the test manager should be in attendance).

b. Identification of items to be accepted by:

(1) Nomenclature

(2) Specification Identification Number

(3) Configuration item Identifiers

(4) Serial Numbers

(5) Drawing and Part Numbers

(6) Identification Numbers

(7) Code Identification Numbers

(8) Software inventory numbering system

c. A list delineating all deviations/waivers against the configuration item either requested or contracting agency approved.

80.3.2 The PCA cannot be performed unless data pertinent to the configuration item being audited is provided to the PCA team at time of the audit. The contractor shall compile and make this information available for ready reference. Required information shall include:

a. Configuration item product specification.

b. A list delineating both approved and outstanding changes against the configuration item.

c. Complete shortage list.

d. Acceptance test procedures and associated test data.

e. Engineering drawing index including revision letters.

f. Operating, maintenance, and illustrated parts breakdown manuals.

g. Proposed DD Form 250, "Material Inspection and Receiving Report".

h. Approved nomenclature and nameplates.

i. Software Programmer's Manuals (SPMs), Software User's Manuals (SUMs) Computer System Operator's Manual (CSOM), Computer System Diagnostic Manual (CSDM), and Firmware Support Manual (FSM).

j. Software Version Description Document.

k. FCA minutes for each configuration item.

l. Findings/Status of Quality Assurance Programs.

80.3.3 The contractor shall assemble and make available to the PCA team at time of audit all data describing the item configuration. Item configuration data shall include:

a. Current approved issue of hardware development specification, Software Requirements Specification, and Interface Requirements Specification(s) to include approved specification change notices and approved deviations/waivers.

b. Identification of all changes actually made during test.

c. Identification of all required changes not completed.

d. All approved drawings and documents by the top drawing number as identified in the configuration item product specification. All drawings shall be of the category and form specified in the contract.

e. Manufacturing instruction sheets for HWCIs identified by the contracting agency.

80.3.4 The contractor shall identify any difference between the physical configurations of the selected production unit and the Development Unit(s) used for the FCA and shall certify or demonstrate to the Government that these differences do not degrade the functional characteristics of the selected units.

80.4 PCA Procedures and Requirements

80.4.1 Drawing and Manufacturing Instruction Sheet Review Instructions:

a. A representative number of drawings and associated manufacturing instruction sheets for each item of hardware, identified by the contracting agency Co-Chairperson, shall be reviewed to determine their accuracy and insure that they include the authorized changes reflected in the engineering drawings and the hardware. Unless otherwise directed by the contracting agency Co-Chairperson, inspection of drawings and associated manufacturing instruction sheets may be accomplished on a valid sampling basis. The purpose of this review is to insure the manufacturing instruction sheets accurately reflect all design details contained in the drawings. Since the hardware is built in accordance with the manufacturing instruction sheets, any discrepancies between the instruction sheets and the design details and changes in the drawings will also be reflected in the hardware.

b. The following minimum information shall be recorded for each drawing reviewed:

(1) Drawing number/title (include revision letter)

(2) Date of drawing approval

(3) List of manufacturing instruction sheets (numbers with change letter/titles and date of approval) associated with this drawing.

(4) Discrepancies/comments

(5) Select a sample of part numbers reflected on the drawing. Check to insure compatibility with the Program Parts Selection List, and examine the HWCI to insure that the proper parts are actually installed.

c. As a minimum, the following inspections shall be accomplished for each drawing and associated manufacturing instruction sheets:

(1) Drawing number identified on manufacturing instruction sheet should match latest released drawing.

(2) List of materials on manufacturing instruction sheets should match materials identified on the drawing.

(3) All special instructions called on the drawing should be on the manufacturing instruction sheets.

(4) All dimensions, tolerances, finishes, etc., called out on the drawing should be identified on the manufacturing instruction sheets

(5) All special processes called out on the drawing should be identified on the manufacturing instruction sheets.

(6) Nomenclature descriptions, part numbers and serial number markings called out on the drawing should be identified on the manufacturing instruction sheets.

(7) Review drawings and associated manufacturing instruction sheets to ascertain that all approved changes have been incorporated into the configuration item.

(8) Check release record to insure all drawings reviewed are identified.

(9) Record the number of any drawings containing more than five outstanding changes attached to the drawing.

(10) Check the drawings of a major assembly/black box of the hardware configuration item for continuity from top drawing down to piece-part drawing.

80.4.2 Review of all records of baseline configuration for the HWCI by direct comparison with contractor's engineering release system and change control procedures to establish that the configuration being produced does accurately reflect released engineering data. This includes interim releases of spares provisioned prior to PCA to ensure delivery of currently configured spares.

80.4.3 Audit of contractor's engineering release and change control system to ascertain that they are adequate to properly control the processing and formal release of engineering changes. The minimum needs and capabilities set forth below are required of his engineering release records system. The contractor's formats, systems, and procedures are to be used. Information in addition to the basic requirements is to be considered part of the contractor's internal system.*

80.4.3.1 As a minimum, the following information shall be contained on one release record supplied by the contractor, subcontractor, or vendor for each drawing number, if applicable:

a. Serial numbers, top drawing number, specification number;

b. Drawing number, title, code number, number of sheets, date

---

* Contract Administration Office (CAO) Quality Assurance Representative (QAR) records can be reviewed for purpose of determining the contractor's present and most recent past performance.

of release, change letter, date of change letter release, engineering change order (ECO) number.

80.4.3.2 The contractor's release function and documentation will be capable of determining:

a. The composition of any part at any level in terms of subordinate part numbers (disregard standard parts);

b. The next higher assembly using the part number, except for assembly into standard parts;

c. The composition of the configuration item or part number with respect to other configuration items or part numbers;

d. The configuration item and associated serial number on which subordinate parts are used. (This does not apply to contractors below prime level who are not producing configuration items);

e. The accountability of changes which have been partially or completely released against the configuration item;

f. The configuration item and serial number effectively of any change.

g. The standard specification number or standard part numbers used within any nonstandard part number;

h. The contractor specification document and specification control numbers associated with any subcontractor, vendor, or supplier part number.

80.4.3.3 The engineering release system and associated documentation shall be capable of:

a. Identifying changes and retaining records of superseded configurations formally accepted by the contracting agency;

b. Identifying all engineering changes released for production incorporation. These changes shall be completely released and incorporated prior to formal acceptance of the configuration item;

c. Determining the configuration released for each configuration item at the time of formal acceptance.

80.4.3.4 Engineering data shall be released or processed through a central authority to ensure coordinated action and preclude unilateral release of data.

80.4.3.5 Engineering change control numbers shall be unique.

80.4.4 Difference between the configuration of the configuration item qualified and the configuration item being audited shall be a matter of record in the minutes of the PCA.

80.4.5 For HWCI acceptance tests data and procedures shall comply with its product specification. The PCA team shall determine any acceptance tests to be reaccomplished, and reserves the prerogative to have representatives of the contracting agency witness all or any portion of the required audits, inspections, or tests.

80.4.6 HWCIs which fail to pass acceptance test requirements shall be repaired if necessary and be retested by the contractor in the manner specified by the PCA team leader in accordance with the product specification.

80.4.7 The contractor shall present data confirming the inspection and test of subcontractor equipment end items at point of manufacture. Such data shall have been witnessed by Government representative.

80.4.8 The PCA team reviews the prepared back-up data (all initial documentation which accompanies the configuration item) for correct types and quantities to ensure adequate coverage at the time of shipment to the user.

80.4.9 Configuration items which have demonstrated compliance with the product specification are approved for acceptance as follows:

a. The PCA team shall certify by signature that the configuration item has been built in accordance with the drawings and specifications.

80.4.10 As a minimum, the following actions shall be performed by the PCA team on each CSCI being audited:

a. Review all documents which will comprise the Software Product Specification for format and completeness

b. Review FCA minutes for recorded discrepancies and actions taken

c. Review the design descriptions for proper entries, symbols, labels, tags, references, and data descriptions.

d. Compare Top-Level Computer Software Component (TLCSC) design descriptions with Lower-Level Computer Software Components (LLCSC) descriptions for consistency

e. Compare all lower-level design descriptions with all software listings for accuracy and completeness

f. Check Software User's Manual(s), Software Programmer's Manual, Computer System Operator's Manual, Firmware Support Manual, and Computer System Diagnostic Manual for format completeness and conformance with applicable data item descriptions. (Formal verification/acceptance of these manuals should be withheld until system testing to ensure that the procedural contents are correct)

g. Examine actual CSCI delivery media (card decks, tapes, etc.,) to insure conformance with Section 5 of the Software Requirements Specification.

h. Review the annotated listings for compliance with approved coding standards (e.g. Appendix C of DOD-STD-2167).

80.5 Post Audit Actions

80.5.1 Contracting agency acceptance or rejection of the configuration item and the configuration item product specification presented for PCA must be furnished to the contractor in writing by the responsible contract management agency or other designated agency after completion of PCA.

80.5.2 After completion of the PCA, the contractor shall publish and distribute copies of PCA minutes. The contracting agency officially acknowledges completion of the PCA as indicated in paragraph 4.2.4.

80.5.3 The accomplishment of the PCA shall be recorded on the configuration item Development Record by the contractor.

90. Formal Qualification Review.

90.1 General. The objective of the FQR shall be to verify that the actual performance of the configuration items of the system as determined through test comply with the hardware Development Specification, Software Requirements and Interface Requirements Specifications, and to identify the test report(s)/data which document results of qualification tests of the configuration items. The point of Government certification will be determined by the contracting agency and will depend upon the nature of the program, risk aspects of the particular hardware and software, and contractor progress in successfully verifying the requirements of the configuration items. When feasible, the FQR shall be combined with the FCA at the end of configuration item/subsystem testing, prior to PCA. If sufficient test results are not available at the FCA to insure the configuration items will perform in their system environment, the FQR shall be conducted (post PCA) during System testing whenever the necessary tests have been successfully completed to enable certification of configuration items. For non-combined FCA/FQRs, traceability, correlation, and completeness of the FQR shall be maintained with the FCA and duplication of effort avoided.

90.2 Requirements.

90.2.1 In cases where the FQR and the FCA can be accomplished in a single combined Audit/Review, contractor and Government "certification" of the configuration items shall be accomplished after completion of the FCA and such certification shall be considered as accomplishment of the FQR.

90.2.2 When the agency responsible for qualification of the configuration items at the contracting agency judges that the system is not ready for FQR at the time of FCA, the FQR will be delayed until it is determined that sufficient information on the system's qualification is available. The FQR may be delayed up to the end of System testing if deemed necessary.

90.2.3 When a separate FQR is necessary, the contractor shall notify the contracting agency of the sufficiency of the configuration items test results to substantiate a FQR and coordinate the agenda with the Deputy Director for Test and Deployment. The FQR team will be assembled in the same manner as that required for the FCA team. No duplication of FCA effort shall occur at the FQR; however, the following additional efforts must be accomplished:

90.2.3.1 A review of the FCA minutes must be performed and the FQR shall be considered as an extension of FCA. New/additional qualification data shall be audited and reviewed to insure qualification of the configuration items against the System/Segment, Software Requirements, and Interface Requirements

Specifica-

90.2.3.2 Any testing accomplished against configuration item qualification during System testing shall be considered.

90.2.3.3 The contractor shall, after notification of certification by the contracting agency enter the date of system certification of qualification and the identity of the test reports/documentation which sets forth the results of the associated test(s) in the configuration item Development Record.

90.2.4 All other factors such as: agenda, team organization, review procedures, data to be reviewed, etc., shall be accomplished as delineated in the FCA and General Requirements and Procedures sections of this standard to the extent necessary to accomplish the FQR.

90.3 Post Review Action

90.3.1 After the conduct of the FQR, the contractor shall publish and distribute copies of FQR minutes. The contracting agency will officially acknowledge the conduct of the Review as indicated in paragraph 4.2.4.

SAMPLE CERTIFICATION ATTACHMENT

PRE-FCA CHECK SHEET

NOMENCLATURE _____

CONFIGURATION ITEM NO. _____ DATE _____

CONTRACTOR REQUIREMENTS	YES	NO
1. Waiver/Deviation List Prepared	____	____
2. Qualification Test Procedures Submitted	____	____
3. Qualification Testing Completed	____	____
4. Qualification Test Results Compiled & Available	____	____
5. Facilities for Conducting FCA Available	____	____
6. Qualification Test Procedures Reviewed and Approved	____	____
7. Qualification Testing Witnessed	____	____
8. Qualification Test Data and Results Reviewed and Approved	____	____

COMMENTS _____

Figure 3
Page 1 of 11

SAMPLE CERTIFICATION ATTACHMENT

FUNCTIONAL CONFIGURATION AUDIT (FCA)

FOR

CONFIGURATION ITEM NO. (S) _____

CONTRACT NO. _____

PRIME CONTRACTOR:

_____

_____

_____

EQUIPMENT MANUFACTURERS:

_____

_____

_____

APPROVED BY _____
(CONTRACTOR)

APPROVED BY _____
(CONTRACTING AGENCY)

DATE _____

DATE _____

Figure 3
Page 2 of 11

DEFINITIONS:

COMMENT: A note explaining, illustrating, or criticizing the meaning of a writing. Items of this nature should be explored by the contractor and/or the Contracting Agency, but corrective action is NOT necessary to successfully accomplish a FCA.

DEFICIENCY: Deficiencies consist of two types: (1) conditions of characteristics in any hardware/software which are not in compliance with specified configuration, or (2) inadequate (or erroneous) configuration, identification which has resulted, or may result in configuration items that do not fulfill approved operational requirements.

SCOPE/PURPOSE

Scope:

Functional Configuration Audit (FCA) was conducted on the following configuration item:

Configuration Item No.	Nomenclature	Part No.	Serial No.

PURPOSE: The purpose of this FCA was to verify that the configuration item's performance complies with the Type B Development Specification.

Figure 3
Page 4 of 11

FUNCTIONAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 1
(For Equipment/Computer Software)

Contract: _____ Date _____

Contractor: _____

Configuration Item No.: _____

_____

Qualification Test Procedures and Results. The qualification test/analysis results have been reviewed to ensure that testing is adequa properly done, and certified. (All test procedures and interface documents shall be reviewed to assure that the documents have been approved by the Contracting Agency. All test data sheets shall be reviewed to assure that the test was witnessed by a representative o the Contracting Agency.)

Attached is a list of the documents reviewed.

Check One

Procedures and results reviewed satisfy the requirements and are accepted. See Attachment __ for comments.

Attached is a list of deficiencies.

Signature(s) of FCA Team Member(s)

* _____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

*Sub-Team Chairperson

Figure 3
Page 5 of 11

SPECIFICATION/TESTING REVIEW

Configuration Item No. _____ Nomenclature _____

Specification No. _____

Test Procedures _____

Spec Ref / TF Ref	Description	Test Result

Figure 3
Page 6 of 11

FCA DEFICIENCY SUMMARY LIST

CONFIGURATION ITEM NO. _____ NOMENCLATURE _____

CONFIGURATION ITEM NUMBER	REPORT REFERENCE	DESCRIPTION	RESPONSIBILITY FOR CORRECTION	PLACE OF INSPECTION	INSPECTED BY

Figure 3
Page 7 of 11

FUNCTIONAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 2
(For Equipment/Computer Software)

Contract: _____ Date _____

Contractor: _____

Configuration Item No.: _____

_____

Review Deviations/Waivers. A review of all deviations/waivers to military specifications and standards that have been approved. The purpose is to determine the extent to which the equipment(s)/computer software undergoing FCA vary from applicable specifications and standards and to form a basis for satisfactory compliance with these specifications and standards.

In accordance with this paragraph, all applicable deviations/waive have been reviewed with the following results:

Check One

☐ The equipment(s)/computer software listed on Certification Sheet No. 1 of this report complies with all applicable specifications and standards. See Attachment __ for comments.

☐ Attached is a list of discrepancies and/or comments.

Signature(s) of FCA Team Member(s)

* _____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

*Sub-Team Chairperson

Figure 3
Page 8 of 11

A. Deviation/Waiver Review Team Instructions. All approved waivers and deviations to military specifications and standards shall be reviewed and recorded. Also, record any part of the FCA which fails to meet specifications or standards but is not an approved waiver/deviation.

B. Results of Team Review. List the deviations/waivers against the equipment/computer software being FCA'd that were reviewed.

Figure 3
Page 9 of 11

WAIVERS/DEVIATIONS

CONFIGURATION ITEM NO. _____ NOMENCLATURE _____

REFERENCE (Spec, STD, Etc.)	CCB OR MRB APPROVAL/DIRECTIVE	REQUIREMENT WAIVED	REMARKS

Figure 3
Page 10 of 11

SAMPLE CERTIFICATION ATTACHMENT

FORMAL QUALIFICATION REVIEW
(For Equipment/Computer Software)

Contract: _____ Date _____

Contractor: _____

Configuration Item No.: _____

_____

Formal Qualification Review. Qualification Test/Analysis results have been reviewed to verify that the actual performance of the configuration item complies with its development or requirements specification(s) and that sufficient test results are available to ensure the configuration item will perform in its system environment.

Attached is a list of the documents reviewed.

Check One

☐ Results reviewed satisfy FQR requirements and the configuration item is qualified for entry into the Government Inventory.

☐ Results reviewed are unsatisfactory/insufficient for FQR. FQR will be delayed until it is determined that sufficient information on the configuration items Qualification is available.

Signature(s) of FCA Team Member(s)

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

Figure 3
Page 11 of 11

SAMPLE CERTIFICATION ATTACHMENT

SAMPLE PCA CHECKLIST

The following hardware, computer software, documentation shall be available, and the following tasks shall be accomplished at the PCA.

Hardware:

Computer Software:

Documentation:

		Yes	No
(1)	Approved final draft of the configuration item product specification.	____	____
(2)	A list delineating both approved and outstanding changes against the configuration item.	____	____
(3)	Complete shortage list.	____	____
(4)	Acceptance test procedures and associated test data.	____	____
(5)	Engineering Drawing Index.	____	____
(6)	Operating, maintenance, and illustrated parts breakdown manuals.	____	____
(7)	List of approved material review board actions on waivers.	____	____
(8)	Proposed DD Form 250, "Material Inspection and Receiving Report".	____	____
(9)	Approved nomenclature and nameplates.	____	____
(10)	Manuscript copy of all CSCI manuals.	____	____
(11)	Computer Software Version Description Document.	____	____
(12)	Current set of listings and updated design descriptions or other means of design portrayal for each CSCI.	____	____
(13)	FCA minutes for each configuration item.	____	____

Figure 4
Page 1 of 20

SAMPLE CERTIFICATION ATTACHMENT

SAMPLE PCA CHECKLIST (CONTINUED)

Tasks:	Yes	No
(1) Define Product Baseline.	____	____
(2) Specification Review and Validation.	____	____
(3) Drawing review.	____	____
(4) Review acceptance test procedures and results.	____	____
(5) Review shortages and unincorporated design changes.	____	____
(6) Review deviations/waivers.	____	____
(7) Examine proposed DD 250.	____	____
(8) Review contractor's Engineering Release and Change Control System.	____	____
(9) Review system allocation document.	____	____
(10) Review Software User's Manuals, Software Programmer's Manuals, Computer System Diagnostic Manual, Computer System Operator's Manual, and Firmware Support Manual.	____	____
(11) Review CSCIs for the following:		
(a) Top-level and lower-level Computer Software Component design descriptions or alternative design portrayals.	____	____
(b) Top-level and lower-level Computer Software Component interface requirements.	____	____
(c) Data base characteristics, storage allocation charts and timing and sequencing characteristics.	____	____
(12) Review packaging plan and requirements.	____	____
(13) Review status of Rights in Data.	____	____

Figure 4
Page 1a of 20

SAMPLE CERTIFICATION ATTACHMENT

PHYSICAL CONFIGURATION AUDIT (PCA)

FOR

CONFIGURATION ITEM NO.(s) _____

CONTRACT NO. _____

PRIME CONTRACTOR:	EQUIPMENT MANUFACTURERS:
_____	_____
_____	_____
_____	_____
APPROVED BY (DESIGNEE)	APPROVED BY (DESIGNEE)
CONTRACTOR	CONTRACTING AGENCY
DATE _____	DATE _____

Figure 4
Page 2 of 20

DEFINITION OF TERMS

COMMENT - A note explaining, illustrating, or criticizing the meaning of a writing. Items of this nature should be explored by the contractor and/or the Contracting Agency, but corrective action is NOT necessary to successfully accomplish a PCA.

DISCREPANCY - A not explaining, illustrating, or criticizing the difference between writings. A note showing the variance between what exists and what is acceptable. Items of this nature shall be rectified by the contractor prior to successful accomplishments of a PCA.

Figure 4
Page 3 of 20

SCOPE/PURPOSE

A Physical Configuration Audit (PCA) was conducted on the following end items of equipment/computer software:

CONFIGURATION ITEM	NOMENCLATURE	PART NUMBER	SERIAL NO.	NSN

The purpose of the PCA was to ensure accuracy of the identifying documentation and to establish a product baseline.

The establishment of a product baseline for equipment/computer software is not to be construed as meeting Contracting Agency requirements for delivery by the contractor of an operational system meeting approved acceptance criteria.

PHYSICAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 1
(For Equipment/Computer Software)

Contract: _____ Date _____

Contractor: _____

_____

_____

Product baseline. The following documents of the issue and date shown comprise the product baseline for the listed equipment(s)/ computer software:

SPEC NO.	ASSEMBLY TOP DRAWING NO.	ISSUE	EQPT./COMP. SOFTWARE NOMENCLATURE	CONFIGURATION ITEM NO.

Signature(s) of PCA Team Member(s)

** _____	_____
* _____	_____
_____	_____
_____	_____
_____	_____
_____	_____

**Team Chairperson
*Sub-Team Chairperson

PHYSICAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 2
(For Equipment/Computer Software)

Contract: _____ Date _____

Contractor: _____

_____

_____

Specification Review and Validation. Specifications have been reviewed and validated to assure that they adequately define the configuration item and the necessary testing, mobility/transportability, and packaging requirements.

Check One

☐ The Type C Specifications are complete and adequately define the configuration item. They shall, therefore, constitute the product baseline. See Attachment __ for comments.

☐ The Type C Specifications are unacceptable. Attached is a list of discrepancies.

Signature(s) of FCA Team Member(s)

* _____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

*Sub-Team Chairperson

Figure 4
Page 6 of 20

A. Specification Review and Validation Instructions. The detailed specifications listed in paragraph B. Below shall be reviewed for compliance with the applicable requirements. Each Specification shall serve as the basic document for configuration control of the subject configuration items. The information contained within the specifications shall be audited at the PCA.

B. Review and Validation Results:

1. Specifications Reviewed and Validated

SPEC NO.	PART NO.	DATE	EQPT./COMP. SOFTWARE NOMENCLATURE	CONFIGURATION ITEM NO.

2. Specifications Reviewed and Disapproved: (Provide attachment for causes.)

PHYSICAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 3
(Equipment)

Contract: _____ Date _____

Contractor: _____

_____

_____

Drawing Review. Drawings have been compared with the equipment to ensure that the latest drawing change letter has been incorporated into the equipment, that part numbers agree with the drawings, and that the drawings are complete and accurately describe the equipment.

Attachment __ is a list of the drawings reviewed.

Check One

☐ The drawings are complete and accurately describe the equipment. See attachment __ for comments.

☐ Attachment __ is a list of discrepancies.

Signature(s) of PCA Team Members(s)

* _____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

*Sub-Team Chairperson

Figure 4
Page 8 of 20

A. Drawing Review Results. The following drawings were reviewed by the PCA drawing reviewing sub-teams:

DOCUMENT NUMBER	DOCUMENT TITLE

Figure 4
Page 9 of 20

PHYSICAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 4
(Equipment)

Contract: _____ Date _____

Contractor: _____

_____

_____

Acceptance Test Procedures and Results. The acceptance test results have been reviewed to ensure that testing is adequate, properly done, and certified.

Attachment __ is a list of the documents reviewed.

Check One

☐ Procedures and results reviewed satisfy the requirements and are accepted. See Attachment __ for comments.

☐ Attachment __ is a list of discrepancies.

Signature(s) of PCA Team Member(s)

* _____ _____

_____ _____

_____ _____

_____ _____

_____ _____

*Sub-Team Chairperson

Figure 4
Page 10 of 20

PHYSICAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 5
(For Equipment/Computer Software)

Contract _____ Date _____

Contractor: _____

_____

_____

Review of Shortages and Unincorporated Design Changes. The shortages and unincorporated design changes listed on the proposed DD Form 250, "Material Inspection and Receiving Report", and other records have been reviewed.

Check One

There are no shortages or unincorporated design changes.

Attachment __ is a list of shortages and/or unincorporated design changes, and the recommended corrective action required.

Signature(s) of PCA Team Member(s)

* _____ _____

_____ _____

_____ _____

_____ _____

_____ _____

*Sub-Team Chairperson

Figure 4
Page 11 of 20

A. Review of Shortages and Unicorporated Design Changes. All shortages and unicorporated design changes listed on the proposed DD Form 250, "Material Inspection and Receiving Report", shall be reviewed by the Contracting Agency or their designated representatives for a determination of what changes should be accomplished in the field and what changes should be accomplished at the contractor's facility. The Contracting Agency shall also determine if the reported shortages and unincorporated changes are complete.

B. Results. List the shortages and unincorporated design changes that were reviewed in compliance with requirements.

PHYSICAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 6
(For Equipment/Computer Software)

Contract: Date _____

Contractor: _____

_____

_____

Review Deviations/Waivers. A review of all deviations/waivers to military specifications and standards that have been approved. The purpose is to determine the extent to which the equipment(s)/computer software undergoing PCA vary from applicable specifications and standards and to form a basis for satisfactory compliance with these specifications and standards.

In accordance with this paragraph, all applicable deviations/waivers have been reviewed with the following results:

Check One.

The equipment(s)/computer software listed on Certification Sheet No. 1 of this report complies with all applicable specifications and standards. See Attachment __ for comments.

Attachment __ is a list of discrepancies and/or comments.

Signature(s) of PCA Team Member(s)

* _____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

*Sub-Team Chairperson

A. Deviation/Waiver Review Team Instruction. All approved waivers and deviations to military specifications and standards shall be reviewed and recorded. Also, record any part of the PCA which fails to meet specifications or standards but is not an approved waiver/deviation.

B. Results of Team Review. List the deviations/waivers against the equipment/computer software being PCA's that were reviewed.

PHYSICAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 7
(For Equipment/Computer Software)

Contract: _____ Date _____

Contractor: _____

_____

_____

Examination of the Proposed DD 250. The DD Form 250 has been examined to ensure that it adequately defines the equipment/computer software and that unaccomplished tasks are inlcuded as deficiencies.

Check One

☐ The DD Form 250 adequately defines the equipment/computer software and all unaccomplished tasks are included as deficiencies.

☐ Attachment __ is a list of discrepancies and/or comments.

Signature(s) of PCA Team Member(s)

* _____	_____
_____	_____
_____	_____
_____	_____
_____	_____

*Sub-Team Chairperson

Figure 4
Page 15 of 20

A. Examination of the Proposed DD Form 250. The proposed DD Form 250 shall be examined for completeness and an accurate definition of the equipment/computer software. Unaccomplished tasks, shortages, and certain specified discrepancies uncovered at the PCA shall be included in the DD Form 250. If the equipment/computer software is to be shipped from the plant, the Program Office representative will recommend to the CAO that the DD Form 250 be executed in accordance with the terms of the contract.

B. Results. Include a statement that the proposed DD Form 250 was examined and was recommended.

Figure 4
Page 16 of 20

PHYSICAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 8
(For Equipment/Computer Software)

Contract: _____ Date _____

Contractor: _____

_____

_____

Review of Contractor's Engineering Release and Change Control System. The contractor's engineering release system and change control procedures have been reviewed to ensure that they are adequate to properly control the processing and formal release of engineering changes.

Check One

The contractor's engineering release system and change control procedures are adequate for the processing and formal release of engineering changes. See Attachment __ for comments.

Attachment __ is a list of deficiencies.

Signature(s) of PCA Team Member(s)

* _____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

*Sub-Team Chairperson

Figure 4
Page 17 of 20

PHYSICAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 9
(For Equipment/Computer Software)

Contract: _____ Date: _____

Contractor: _____

_____

_____

System Allocation Document Review. The following System Allocation book form drawings have been reviewed and validated to ensure that they adequately identify, and are compatible with, the shipping instructions.

Check One

☐ The System Allocation Document is complete and adequately defines the equipment/computer software scheduled for each location.

☐ The System Allocation Document is unacceptable. Attached is a list of discrepancies.

☐ This task is not required by contract.

Signature(s) of PCA Team Member(s)

* _____ _____

_____ _____

_____ _____

_____ _____

_____ _____

*Sub-Team Chairperson

Figure 4
Page 18 of 20

A. System Allocation Document Instructions:

1. The System Allocation Documents, both Part I and Part II, applicable to the contract shall be reviewed to determine their accuracy and insure that they adequately describe the equipment/computer software.

2. The following information shall be recorded:

Part I.

a. System employment and configuration.
b. Specification reference.
c. Location.
d. Mission Equipment.
   Configuration Item Number
   Short Title
   Part Number
   Serial Number
e. Installed equipment/computer software.
   Configuration Item Number
   Short Title
   Part Number
   Serial Number
f. Drawing Title and Number
g. Number of sheets
h. Issue Number.

Part II.

a. Location.
b. Specification Number
c. Equipment/computer software nomenclature.
d. Configuration Item Quantity.
e. Assembly Drawing Number

3. Insure that the System Allocation Documents are compatible w the priorities and shipping instructions.

B. System Allocation Document Review Results. The following System Allocation Documents were reviewed by the PCA Reviewing Sub-Team:

DOCUMENT NUMBER	DOCUMENT TITLE

PHYSICAL CONFIGURATION AUDIT

CERTIFICATION SHEET NO. 10
(Equipment)

Contract: _____ Date _____

Contractor: _____

_____

1. Review of Logistics Support Plan for Pre-operational Support. The Logistics Support Plan for Pre-operational Support has been reviewed to ensure that it is adequate to support the acquisition phase and is compatible with the operational phase maintenance concept and support requirements.

Check One

☐ The contractor's Logistic Plan for pre-operational support will fulfill the acquisition phase requirements and is compatible with operational phase needs.

☐ Attachment __ is a list of deficiencies.

. Review of Long Lead Time Items and Provisioned Items Processed to PCA. Long Lead Time items released and items provisioned, prior to PCA have been reviewed to ensure that obsolete items resulting from pre-PCA design changes are purged from the system. Where basic items may be upgraded by rework or modification these actions have been verified as accomplished or in process based upon design change notice.

Check One

☐ Long lead time items and provisioned items processed, prior to PCA, are all of current configuration at time of PCA or are in work.

☐ Attachment __ is a list of deficiencies.

Signature(s) of PCA Team Member(s)

* _____ _____ _____

_____ _____

_____ _____

_____ _____

*Sub-Team Chairperson

Figure 4
Page 20 of 20

100. Application Guide for Tailoring MIL-STD-1521

100.1 Scope

This appendix sets forth guidance for the cost effective application of the requirements of this standard when this standard is contractually invoked during the acquisition process. This appendix serves as guidance for the activity responsible for the preparation of contract requirements and does not form a part of the contract.

100.2 Purpose

The guidelines contained herein implement the Department of Defense Directive 4120.21, Specification and Standards Application, which requires all DOD components to apply selectively and tailor military specifications and standards prior to their contractual imposition and:

a. Eliminate inapplicable and unnecessary requirements.

b. Provide for adding/modifying necessary technical review and audit factors not included in MIL-STD-1521.

c. Eliminate redundancy and inconsistency with other contract specifications and standards.

100.3 Objective

The objective of this guide is to establish the applications and limitations of tailoring MIL-STD-1521. MIL-STD-1521 is not a stand-alone document. It is dependent upon the work effort specified in the contractual requirements (e.g., SOW, etc.) The tailoring of specifications should take place in all phases of military procurement, but is especially applicable to the initial stages of solicitation package preparation and contract negotiation. Depending upon the type of end-item(s) under procurement, the reviews and audits outlined by MIL-STD-1521 may or may not be required for all programs.

100.4 Considerations for Tailoring

100.4.1 Relationship to the Statement of work

The Program Manager must keep in mind that technical reviews provide visibility into the contractor's implementation of the work effort required under the terms of the SOW and the contract to assure timely and effective attention to the technical interpretation of contract requirements. The key to tailoring MIL-STD-1521 is to match the MIL-STD-1521 requirements against the details of the applicable SOW/Contractual task requirements. It will become immediately obvious that MIL-STD-1521 may contain

technical review factors that are not applicable to the contract under consideration. (For example, if a contract does not include computer software, all references to the review of Computer Software materials in MIL-STD-1521 will not apply.) When MIL-STD-1521 is used, then a task containing the applicable requirements will be specified in the SOW. Review factors not set forth in MIL-STD-1521 but considered necessary because of the nature of the particular program should be added in the SOW. By carefully going through this evaluative process the technical review and audit requirements will become program specific rather than an all purpose document to be continually negotiated during contract performance.

100.4.2 Elimination of Redundancy and Ambiguity

While MIL-STD-1521 is the broad program document for technical reviews and audits, other standards in existence also require technical reviews or audits. For example, MIL-STDs for reliability, maintainability, system engineering and others can require reviews and/or audits. Review of these aspects of the design would also be required under MIL-STD-1521; therefore, if such standards are contractually stipulated together with MIL-STD-1521, the SOW should include a provision to show how and whether the technical review requirements of these other standards can be combined with technical reviews/audits in MIL-STD-1521 Combining reviews does not nullify other MIL-STD(s), "Plans", etc, which contain requirements for reviews/audits. The contract should require the minimal integrated, comprehensive technical design review effort that will provide the desired visibility and assurance of contract compliance.

100.4.3 Contractor Participation in Tailoring

When requiring a particular review or audit, it is important that the topics to be reviewed are aligned to the program requirements. Therefore, the offeror should be given an opportunity to recommend changes and identify topics/items he considers appropriate. The program office should request, in the instructions for proposal preparation, that the offeror recommend the MIL-STD-1521 topics/items and their related details to be covered at the various reviews or audits required by the SOW. This will allow the offeror to tailor the topics/items and details by additions and deletions for the particular review/audit. In addition, it must be recognized that effecive tailoring requires several points of review. The requirement, however, for the review/audit must be finalized prior to contract award.

100.4.4 Complexity

a. System/Segment/subsystem/configuration item complexity and type of program is central in determining both the need for and the number of such reviews. When developing a small

non-complex system some reviews may not be required, or, if required, may be limited in Scope. The tailoring procedures discussed earlier should result either in the exclusion of MIL-STD-1521 or in a tailored MIL-STD-1521 that reflects a limited scope technical review effort. Conversely, in a very complex development the review process will increase in levels and numbers of reviews.

b. In addition to the above, the degree of application is dependent upon the configuration item state of development (example, new design vs. commercially available) or the degree of any modifications, if involved. For example: a newly developed item may require the majority of the review topics/items and audits, while a commercially available configuration item with the appropriate documentation, i.e., verified test results, specifications, drawings, etc. may require reviews or audits limited to its application to the program and its interfaces. In the case of modified designs one must consider the degree and effect of the modifications. Reviews and audits may be limited to the modifications and their interfaces.

100.5 Scheduling of Technical Reviews and Audits

The schedule for Technical Reviews and Audits is extremely important. If they are conducted too early, the item for review will not be adequately defined. Conversely, if the review is too late, the program commitments could have been made erroneously, and correction will be both difficult and costly. For planning purposes, a good method for scheduling technical reviews is to relate them to the documentation requirements. For example, schedule a PDR after the hardware Development Specification or Software Top Level Design Document and Software Test Plan are available, since the essence of the PDR is to assess the contractor's approach to meeting these requirements of these documents. Scheduling of audits are dependent not only on documentation availability but also on hardware/software availability, and the completion of the acceptance qualification tests. Table 1 contains a list of the primary documentation associated with each review or audit and the estimated time phasing:

TABLE 1
SCHEDULING TECHNICAL REVIEWS AND AUDITS

Review	Time Phase	Primary Documentation
SRR	Usually accomplished in the Concept Exploration phase. However, may be used in other phases when the	Various analysis and trade study reports used to develop the system/segment

Review	Time Phase	Primary Documentation
	Concept Exploration phase is not accomplished.	requirements for the specification.
SDR	Usually in the Demonstration and Validation phase.	System/Segment Specification, preliminary Operational Concept Document, preliminary Software Requirements and Interface Requirements Specifications, analyses, trade studies, Drawings Level I DOD-D-1000.
SSR	Usually early in Full Scale Development	Software Requirements Specification, Interface Requirements Specifications, Operational Concept Document.
PDR	Usually accomplished in the Demonstration and Validation and/or Full Scale Development Phase	Development, Type B Performance Specification, Drawings Level I DOD-D-1000, Software Top Level Design Document, Software Test Plan, preliminary Computer Resources Integrated Support Document, preliminary Computer System Operator's Manual, preliminary Software User's Manual, preliminary Computer System Diagnostic Manual.
CDR	Usually accomplished in the Full Scale Development phase	Draft Product, Type C Specification, and referenced documentation, Drawings Level I or II DOD-D-1000, Software Detailed Design Document, Interface Design Document(s), Data Base Design Document(s),

Review	Time Phase	Primary Documentation
		Software Test Description, Computer Resources Integrated Support Document, Software Programmer's Manual, Firmware Support Manual, Informal Test Descriptions/Test Procedures, Software Development File(s).
TRR	Usually accomplished in the Full Scale Development phase	Software Test Procedure, Informal software test results (of development tests).
FCA	Usually accomplished at end of Full Scale Development	Test plans, test descriptions, test procedures, Software Test Reports, Computer System Operator's Manual, Software User's Manual, Computer System Diagnostic Manual.
PCA	Usually accomplished early in the initial production when the developing contractor is preselected as the production contractor. However, may be accomplished at the end of Full Scale Development when the developing contractor is not preselected as the production contractor. And the PCA is repeated with each subsequent contractor or break in production.	Final Part II Specification/Type C Product Specifications and referenced documents and drawings. Drawings Level II or III DOD-D-1000. Software Product Specification, Version Description Document.

Although the time frame for reviews and audits is suggested above, they may vary depending on the particular program. The schedule for each review or audit may be requested from the offeror as part of his proposal, or as part of the system engineering management plan (which can be part of the proposal).

110. Production Readiness Review (PRR)

110.1 For specific guidance, see AFSCR 64-2, Production Readiness Review.

Custodian:
Air Force - 13

Preparing Activity:
Air Force - 13

Review Activity:
Air Force - 10,11,80,85

(Project CMAN-0-006)

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 8, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 9 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

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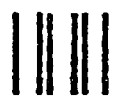

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
[illegible]	

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION (Mark one)
	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER (Specify): _____
3b. ADDRESS (Street, City, State, ZIP Code)	

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER (Last, First, MI – Optional)	7b. WORK TELEPHONE NUMBER (Include Area Code) – Optional
7c. MAILING ADDRESS (Street, City, State, ZIP Code) – Optional	8. DATE OF SUBMISSION (YYMMDD)

DD FORM 1426 PREVIOUS EDITION IS OBSOLETE.

MILITARY STANDARD
TECHNICAL REVIEWS AND AUDITS FOR SYSTEMS, EQUIPMENTS, AND COMPUTER SOFTWARE

TO ALL HOLDERS OF MIL-STD-1521B:

1. THE FOLLOWING PAGES OF MIL-STD-1521B HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
vi	19 Dec 1985	vi	4 June 1985
7/8	19 Dec 1985	7/8	4 June 1985
19	19 Dec 1985	19	4 June 1985
20	4 June 1985	(Reprinted without change)	
25	19 Dec 1985	25	4 June 1985
26	19 Dec 1985	26	4 June 1985
29	19 Dec 1985	29	4 June 1985
30	19 Dec 1985	30	4 June 1985
35	19 Dec 1985	35	4 June 1985
36	4 June 1985	(Reprinted without change)	
37	4 June 1985	(Reprinted without change)	
38	19 Dec 1985	38	4 June 1985
38a	19 Dec 1985	New page	
55	19 Dec 1985	55	4 June 1985
56	19 Dec 1985	56	4 June 1985
56a	19 Dec 1985	New page	
71	19 Dec 1985	71	4 June 1985
72	4 June 1985	(Reprinted without change)	
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119	19 Dec 1985	119	4 June 1985
119a	19 Dec 1985	New page	
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125	19 Dec 1985	New page	
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Custodians:
Air Force - 13

Preparing Activity:
Air Force - 13

Review Activities:
Air Force - 10, 11, 80, 85

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FIGURES

APPENDIXES

3.10 Production Readiness Review (PRR). This review is intended to determine the status of completion of the specific actions which must be satisfactorily accomplished prior to executing a production go-ahead decision. The review is accomplished in an incremental fashion during the Full-Scale Development phase, usually two initial reviews and one final review to assess the risk in exercising the production go-ahead decision. In its earlier stages the PRR concerns itself with gross level manufacturing concerns such as the need for identifying high risk/low yield manufacturing processes or materials or the requirement for manufacturing development effort to satisfy design requirements. The reviews become more refined as the design matures, dealing with such concerns as production planning, facilities allocation, incorporation of producibility-oriented changes, identification and fabrication of tools/test equipment, long lead item acquisition etc. Timing of the incremental PRRs is a function of program posture and is not specifically locked in to other reviews.

OTHER DEFINITIONS

3.11 For further guidance on cost terminology see the latest edition of DODI 5000.33, Uniform Budget/Cost Terms and Definitions.

3.12 New titles are being phased in for the levels of maintenance. They are (with their former terms): On Equipment (Organizational), Off Equipment - On Site (Intermediate), Off Equipment - Off Site (Depot). See the latest edition of AFR 66-14, Equipment Maintenance Policies, Objectives, and Responsibilities.

3.13 For definitions of the various levels of repair, see the latest edition of MIL-STD-280A, Definition of Item Levels, Item Exchangeability, Models, and Related Terms.

3.14 Configuration Item. Hardware or software, or an aggregation of both, which is designated by the contracting agency for configuration management.

3.15 Engineering Data: Engineering documents such as drawings, associated lists, accompanying documents, manufacturer specifications, manufacturing planning documentation, and standards or other information prepared by a design activity and relating to the design, manufacture, procurement, test, or inspection of hardware items or services, as defined in DOD-STD-100 and DOD-D-1000.

10. System Requirements Review (SSR).

10.1 General. The SRRs are normally conducted during the system Concept Exploration or Demonstration and Validation phase. Such reviews may be conducted at any time but normally will be conducted after the accomplishment of functional analysis and preliminary requirements allocation (to operational/maintenance/training Hardware Configuration Items (HWCIs), Computer Software Configuration Items (CSCIs), facility configuration items, manufacturing considerations, personnel and human factors) to determine initial direction and progress of the contractor's System Engineering Management effort and his convergence upon an optimum and complete configuration.

10.2 Purpose. The total System Engineering Management activity and its output shall be reviewed for responsiveness to the Statement of Work and system/segment requirements. Contracting agency direction to the contractor will be provided, as necessary, for continuing the technical program and system optimization.

10.3 Items to be Reviewed. Representative items to be reviewed include the results of the following, as appropriate:

a. Mission and Requirements Analysis

b. Functional Flow Analysis

c. Preliminary Requirements Allocation

d. System/Cost Effectiveness Analysis

e. Trade studies (e.g. addressing system functions in mission and support hardware/firmware/software).

f. Synthesis

g. Logistics Support Analysis

h. Specialty Discipline Studies (i.e., hardware and software reliability analysis, maintainability analysis, armament integration, electromagnetic compatibility, survivability/vulnerability (including nuclear), inspection methods/techniques analysis, energy management, environmental considerations).

i. System Interface Studies

j. Generation of Specification

k. Program Risk Analysis

l. Integrated Test Planning

m. Producibility Analysis Plans

n. Technical Performance Measurement Planning

o. Engineering Integration

p. Data Management Plans

q. Configuration Management Plans

r. System Safety

s. Human Factors Analysis

t. Value Engineering Studies

u. Life Cycle Cost Analysis

v. Preliminary Manufacturing Plans

w. Manpower Requirements/Personnel Analysis

x. Milestone Schedules

10.3.1 The contractor shall describe his progress and problems in:

10.3.1.1 Risk identification and risk ranking (the interrelationship among system effectiveness analysis, technical performance measurement, intended manufacturing methods, and costs shall be discussed, as appropriate).

10.3.1.2 Risk avoidance/reduction and control (the interrelationships with trade-off studies, test planning, hardware proofing, and technical performance measurement shall be discussed, as appropriate).

10.3.1.3 Significant trade-offs among stated system/segment specification requirements/constraints and resulting engineering design requirements/ constraints, manufacturing methods/process constraints, and logistic/cost of ownership requirements/constraints and unit production cost/design-to-cost objectives.

10.3.1.4 Identifying computer resources of the system and partitioning the system into HWCIs and CSCIs. Include any trade-off studies conducted to evaluate alternative approaches and methods for meeting operational needs and to determine the effects of constraints on the system. Also include any evaluations of logistics, technology, cost, schedule, resource limitations, intelligence estimates, etc., made to determine their impact on the system. In addition, address the following specific trade-offs related to computer resources:

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f. Survivability/Vulnerability (including nuclear)

g. Reliability/Maintainability/Availability (R/M/A)

h. Electromagnetic Compatibility

i. Logistic Support Analysis to address, as appropriate, integrated logistics support including maintenance concept, support equipment concept, logistics support concept, maintenance, supply, software support facilities, etc. (MIL-STD-1388-1 and 2)

j. System Safety (emphasis shall be placed on system hazard analysis and identification of safety test requirements)

k. Security

l. Human Factors

m. Transportability (including Packaging and Handling)

n. System Mass Properties

o. Standardization

p. Electronic Warfare

q. Value Engineering

r. System Growth Capability

s. Program Risk Analysis

t. Technical Performance Measurement Planning

u. Producibility Analysis and Manufacturing

v. Life Cycle Cost/Design to Cost Goals

w. Quality Assurance Program

x. Environmental Conditions (Temperature, Vibration, Shock, Humidity, etc).

y. Training and Training Support

z. Milestone Schedules

aa. Software Development Procedures

20.3.2 Results of significant trade studies, for example:

a. Sensitivity of selected mission requirements versus

realistic performance parameters and cost estimates.

b. Operations design versus maintenance design, including support equipment impacts.

c. System centralization versus decentralization

d. Automated versus manual operation

e. Reliability/Maintainability/Availability

f. Commercially available items versus new developments

g. National Stock Number (NSN) items versus new development

h. Testability trade studies (Allocation of fault detection/isolation capabilities between elements of built-in test, on board/on-site fault detection/isolation subsystem, separate support equipment, and manual procedures)

i. Size and weight

j. Desired propagation characteristics versus reduction interference to other systems (optimum selection frequencies)

k. Performance/logistics trade studies

l. Life cycle cost reduction for different computer programming languages

m. Functional allocation between hardware, software, firmware and personnel/procedures

n. Life Cycle Cost/system performance trade studies to include sensitivity of performance parameters to cost.

o. Sensitivity of performance parameters versus cost

p. Cost versus performance

q. Design versus manufacturing consideration

r. Make versus buy

s. Software development schedule

t. On-equipment versus off-equipment maintenance tasks, including support equipment impacts

u. Common versus peculiar support equipment

20.3.3 Updated design requirements for operations/maintenance functions and items.

20.3.4 Updated requirements for manufacturing methods and processes.

i. Maintenance related trade-off studies and findings (includes commercially available equipment, software fault diagnostic techniques)

j. Logistic cost impacts

k. Support procedures and tools for computer software which facilitate software modification, improvements, corrections and updates

l. Hardness critical items/processes

m. Support equipment concept.

20.3.12 System compliance with nuclear, non-nuclear and laser hardening requirements. High risk areas or design concepts requiring possible advances of the state-of-the-art as a result of survivability criteria shall be identified, and prepared approach(es) to the problem reviewed. Prepared test programs shall be reviewed for sufficiency and compatibility with the specified threat environment and existing simulation test facilities.

20.3.13 The optimization, traceability, completeness, and risks associated with the allocation technical requirements, and the adequacy of allocated system requirements as a basis for proceeding with the development of hardware and software configuration items. Include any available preliminary Software Requirements and Interface Requirements Specifications.

20.3.14 Manufacturing (HWCIs only).

20.3.14.1 Production feasibility and risk analyses addressed at the SRR shall be updated and expanded. This effort should review the progress made in reducing production risk and evaluate the risk remaining for consideration in the Full Scale Development Phase. Estimates of cost and schedule impacts shall be updated.

20.3.14.2 Review of the Production Capability Assessment shall include:

20.3.14.2.1 A review of production capability shall be accomplished which will constitute an assessment of the facilities, materials, methods, processes, equipment and skills necessary to perform the full scale development and production efforts. Identification of requirements to upgrade or develop manufacturing capabilities shall be made. Requirements for Manufacturing Technology (MANTECH) programs will also be identified as an element of this production assessment.

20.3.14.3 Present the management controls and the design/manufacturing engineering approach to assure that the equipment is producible.

20.3.14.4 Present a review of trade-off studies for design requirements against the requirement for producibility, facilities, tooling, production test equipment, inspection, and capital equipment for intended production rates and volume.

20.3.14.5 The analysis, assessments and trade-off studies should recommend any additional special studies or development efforts as needed.

20.3.15. Engineering Data. Evaluate the contractor's drawing system, reviewing the drafting room manual, the preparation and review procedures, change control procedures, flowdown of requirements to subcontractors and vendors, and other aspects fundamental to the acceptability of Level 3 drawings. If available, review completed drawings from other programs or the normal company product line to determine compliance with the company procedures.

20.4 Post Review Action. After completing the SDR, the contractor shall publish and distribute copies of Review Minutes. The contracting agency officially acknowledges completion of the SDR as indicated in paragraph 4.2.4.

quipment shall be made available for review by the contracting agency.

z. Firmware to be provided with the system: microprogram logic diagrams nd reprogramming/instruction translation algorithm descriptions, fabrication, ackaging (integration technology (e.g., LSI, MSI), device types (e.g., CMOS, MOS)), and special equipment and support software needed for developing, esting, and supporting the firmware.

aa. Life Cycle Cost Analysis

ab. Armament compatibility

ac. Corrosion prevention/control considerations

ad. Findings/Status of Quality Assurance Program

ae. Support equipment requirements.

0.2.2 CSCIs:

a. Functional flow. The computer software functional flow embodying all f the requirements allocated from the Software Requirements Specification and nterface Requirements Specification(s) to the individual Top-Level Computer oftware Components (TLCSCs) of the CSCI.

b. Storage allocation data. This information shall be presented for ach CSCI as a whole, describing the manner in which available storage is llocated to individual TLCSCs. Timing, sequencing requirements, and relevant quipment constraints used in determining the allocation are to be included.

c. Control functions description. A description of the executive ontrol and start/recovery features for the CSCI shall be available, including ethod of initiating system operation and features enabling recovery from ystem malfunction.

d. CSCI structure. The contractor shall describe the top-level tructure of the CSCI, the reasons for choosing the components described, the evelopment methodology which will be used within the constraints of the vailable computer resources, and any support programs which will be required n order to develop/maintain the CSCI structure and allocation of data storage.

e. Security. An identification of unique security requirements and a escription of the techniques to be used for implementing and maintaining ecurity within the CSCI shall be provided.

f. Reentrancy. An identification of any reentrancy requirements and a description of the techniques for implementing reentrant rountines shall be available.

g. Computer software development facilities. The availability, adequacy, and planned utilization of the computer software development facilities shall be addressed.

h. Computer software development facility versus the operational system. The contractor shall provide information relative to unique design features which may exist in a TLCSC in order to allow use within the computer software development facility, but which will not exist in the TLCSC installed in the operational system. The contractor shall provide information on the design of support programs not explicitly required for the operational system but which will be generated to assist in the development of the CSCI(s). The contractor shall also provide details of the Software Development Library controls.

i. Development tools. The contractor shall describe any special simulation, data reduction, or utility tools that are not deliverable under the terms of the contract, but which are planned for use during software development.

j. Test tools. The contractor shall describe any special test systems, test data, data reduction tools, test computer software, or calibration and diagnostic software that are not deliverable under terms of the contract, but which are planned for use during product development.

k. Description and characteristics of commercially available computer resources, including any optional capabilities such as special features, interface units, special instructions, controls, formats, etc. Include limitations of commercially available equipment such as failure to meet human engineering, safety and maintainability requirements of the specification and identify deficiencies.

l. Existing documentation (technical orders, commercial manuals, etc.) for commercially available computer resources and copies of contractor specifications used to procure computer resources shall be made available for review by the contracting agency.

m. Support resources. The contractor shall describe those resources necessary to support the software and firmware during operational deployment of the system, such as operational and support hardware and software, personnel, special skills, human factors, configuration management, test, and facilities/space.

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n. Operation and support documents. The preliminary versions of the CSOM, SUM, CSDM, and CRISD shall be reviewed for technical content and compatability with the top-level design documentation.

o. Updated since the last review to all previously delivered software related CDRL items.

p. Review considerations applicable to 40.2.1 as appropriate.

40.2.3 Support Equipment (SE):

a. Review considerations applicable to paragraph 40.2.1 and 40.2.2 as appropriate.

b. Verify testability analysis results. For example, on repairable integrated circuit boards are test points available so that failure can be isolated to the lowest level of repair (See Section 3 Definitions, for "Level of repair").

c. Verify that the Government furnished SE is planned to be used to the maximum extent possible.

d. Review progress of long-lead time SE items, identified through interim release and SE Requirements Document (SERD) procedures.

e. Review progress toward determining total SE requirements for installation, checkout, and test support requirements.

f. Review the reliability/maintainability/availability of support equipment items.

g. Identify logistic support requirements for support equipment items and rationale for their selection.

h. Review calibration requirements.

i. Describe technical manuals and data availability for support equipment.

j. Verify compatibility of proposed support equipment with the system maintenance concept.

k. If a Logistic Support Analysis (LSA) is not done, then review the results of SE trade-off studies for each alternative support concept. For existing SE and printed circuit boards testers, review Maintainability data resulting from the field use of these equipments. Review the cost difference between systems using single or multipurpose SE vs. proposed new SE. Examine technical feasibility in

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using existing, developmental, and proposed new SE. For mobile systems, review the mobility requirements of support equipment.

l. Review the relationship of the computer resources in the system/subsystem with those in Automatic Test Equipment (ATE). Relate this to the development of Built In Test Equipment (BITE) and try to reduce the need for complex supporting SE.

m. Verify on-equipment versus off-equipment maintenance task trade study results, including support equipment impacts.

n. Review updated list of required support equipment.

40.2.4 Engineering Data. Review Level 1 engineering drawings for ease of conversion to higher levels and, if available, review Level 2 and 3 drawings for compliance with requirements. The review of engineering data, as defined in paragraph 3.15, should consider the checklist items discussed in para 100.6, as properly tailored.

40.3 Evaluation of Electrical, Mechanical, and Logical Designs

40.3.1 HWCIs. The material of paragraph 40.2.1 above shall be evaluated to:

a. Determine that the preliminary detail design provides the capability of satisfying the performance characteristics paragraph of the HWCI Development specifications.

b. Establish compatibility of the HWCI operating characteristics in each mode with overall system design requirements if the HWCI is involved in multi-mode functions.

c. Establish the existence and nature of physical and functional interfaces between the HWCI and other items of equipment, computer software, and facilities.

40.3.2 CSCIs. The material of paragraph 40.2.2 above shall be evaluated to:

a. Determine whether all interfaces between the CSCI and all other configuration items both internal and external to the system meet the requirements of the Software Requirements Specification and Interface Requirements Specification(s).

b. Determine whether the top-level design embodies all the requirements of the Software Requirements Specification and Interface Requirements Specification(s).

c. Determine whether the approved design methodology has been used for the top-level design.

d. Determine whether the appropriate Human Factors Engineering (HFE) principals have been incorporated in the design.

e. Determine whether timing and sizing constraints have been met throughout the top-level design.

f. Determine whether logic affecting system and nuclear safety has been incorporated in the design.

(11) Survivability/Vulnerability (including nuclear)

(12) Producibility and Manufacturing

(13) Transportability, Packaging and handling

(14) Human Engineering and Biomedical Requirements (including Life Support and Crew Station Requirements)

(15) Standardization

(16) Design versus Logistics Trade-offs

(17) Support equipment requirements

d. Interface control drawings

e. Mock-ups, breadboards, and/or prototype hardware

f. Design analysis and test data

g. System Allocation Document for HMCI inclusion at each scheduled location.

h. Initial Manufacturing Readiness (for example, manufacturing engineering, tooling demonstrations, development and proofing of new materials, processes, methods, tooling, test equipment, procedures, reduction of manufacturing risks to acceptable levels).

i. Preliminary VECPs and/or formal VECPs

j. Life cycle costs

k. Detail design information on all firmware to be provided with the system.

l. Verify corrosion prevention/control considerations to insure materials have been chosen that will be compatible with operating environment.

m. Findings/Status of Quality Assurance Program

50.2.2 CSCIs.

a. Software Detailed Design, Data Base Design, and Interface Design Document(s). In cases where the CDR is conducted in increments, complete documents to support that increment shall be available.

b. Supporting documentation describing results of analyses, testing, etc., as mutually agreed by the contracting agency and the contractor.

c. System Allocation Document for CSCI inclusion at each scheduled location.

d. Computer Resources Integrated Support Document.

e. Software Programmer's Manual

f. Firmware Support Manual

g. Progress on activities required by CSCI PDR (para 40.2.2).

h. Updated operation and support documents (CSOM, SUM, CSDM).

i. Schedules for remaining milestones.

j. Updates since the last review to all previously delivered software related CDRL items.

50.2.3 Support Equipment (SE):

a. Review requirements (paragraphs 50.2.1 and 50.2.2) for SE.

b. Verify maximum considerations GFE SE

c. Identify existing or potential SE provisioning problems

d. Determine qualitative and quantitative adequacy of provisioning drawings and data

e. Review reliability of SE

f. Review logistic support requirements for SE items

g. Review Calibration requirements

h. Review documentation for SE.

50.2.4. Engineering Data. Continuing from the results of the Preliminary Design Review (PDR), review engineering data as defined in para 3.15, as to suitability for intended use. The review should consider the checklist items discussed in para 100.6, as properly tailored.

50.3 Detailed Evaluation of Electrical, Mechanical, and Logical Designs

50.3.1 HWCIs. Detailed block diagrams, schematics, and logic diagrams shall be compared with interface control drawings to determine system compatibility. Analytical and available test data shall be reviewed to insure the hardware Development Specification has been satisfied.

50.3.1.1 The contractor shall provide information on firmware which is included in commercially available equipment or to be included in equipment developed under the contract. Firmware in this context includes the microprocessor and associated sequence of micro-instructions necessary to perform the allocated tasks. As a minimum, the information presented during CDR shall provide

70. Functional Configuration Audit.

70.1 General. The objective of the Functional Configuration Audit (FCA) shall be to verify that the configuration item's actual performance complies with its hardware Development or Software Requirements and Interface Requirements Specifications. Test data shall be reviewed to verify that the hardware or computer software performs as required by its functional/allocated configuration identification. For configuration items developed at Government expense, an FCA shall be a prerequisite to acceptance of the configuration item. For software, a technical understanding shall be reached on the validity and the degree of completeness of the Software Test Reports, and as appropriate, Computer System Operator's Manual (CSOM), Software User's Manual (SUM), and Computer System Diagnostic Manual (CSDM).

70.1.1 The FCA for a complex configuration item may be conducted on a progressive basis, when so specified by the contracting agency, throughout the configuration item's development and culminates at the completion of the qualification testing of the configuration item with a review of all discrepancies at the final FCA. The FCA shall be conducted on that configuration of the configuration item which is representative (prototype or preproduction) of the configuration to be released for production of the operational inventory quantities. When a prototype or preproduction article is not produced, the FCA shall be conducted on a first production article. For cases where configuration item qualification can only be determined through integrated system testing, FCA's for such configuration items will not be considered complete until completion of such integrated testing.

70.1.2 Recommendations of configuration item acceptance or non-acceptance to the local contract management agency are based upon and governed by procedures and requirements outlined in subsequent paragraphs.

70.1.3. Continuing with the results of the Critical Design Review (CDR), review engineering data as defined in para 3.15, as to the suitability for intended use. The review should consider the checklist items discussed in para 100.6, as properly tailored.

70.2 Contract Requirements

70.2.1 The schedules for the FCA shall be recorded on the configuration item development record by the contractor. A configuration item cannot be audited without the contracting agency authentication of the functional and allocated baseline. In addition, the contractor shall submit the final draft Product Specification for the configuration item to be audited to the contracting agency for review prior to FCA.

70.3 Contractor Responsibility

70.3.1 Prior to the FCA date (for configuration items to be audited), the contractor shall provide the following information to the contracting agency (this information shall be provided in addition to the general requirements of Section 4.):

a. Contractor representation(the test manager should be in attendance).

b. Identification of items to be audited:

(1) Nomenclature

(2) Specification identification number

(3) Configuration item number

(4) Current listing of all deviations/waivers against the configuration item, either requested of, or approved by the contracting agency.

(5) Status of Test Program to test configured items with automatic test equipment (when applicable).

70.4 Procedures and Requirements

70.4.1 The contractor's test procedures and results shall be reviewed for compliance with specification requirements.

70.4.2 The following testing information shall be available for the FCA team.

a. Test plans, specifications, descriptions, procedures, and reports for the configuration item.

b. A complete list of successfully accomplished functional tests during which pre-acceptance data was recorded.

c. A complete list of successful functional tests if detailed test data are not recorded.

d. A complete list of functional tests required by the specification but not yet performed. (To be performed as a system or subsystem test).

e. Preproduction and production test results.

70.4.3 Testing accomplished with the approved test procedures and validated data (witnessed) shall be sufficient to insure configuration item performance as set forth in the specification Section 3 and meet the quality assurance provisions/qualification requirements contained in the specification Section 4.

70.4.4 For those performance parameters which cannot completely be verified during testing, adequate analysis or simulation shall have been accomplished. The results of the analysis or simulations will be sufficient to insure configuration item performance as outlined in the specification.

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70.4.5 Test reports, procedures, and data used by the FCA team shall be made a matter of record in the FCA minutes.

70.4.6 A list of the contractor's internal documentation (drawings) of the configuration item shall be reviewed to insure that the contractor has documented the physical configuration of the configuration item for which the test data are verified.

70.4.7 Drawings of BMCI parts which are to be provisioned should be selectively sampled to assure that test data essential to manufacturing are included on, or furnished with, the drawings.

70.4.8. Configuration Items (CIs) which fail to pass quality assurance test provisions are to be analyzed as to the cause of failure to pass. Appropriate corrections shall be made to both the CI and associated engineering data before a CI is subjected to requalification.

70.4.9 A checklist shall be developed which identifies documentation and hardware and computer software to be available and tasks to be accomplished at the FCA for the configuration item. See Pre-FCA checksheet.

70.4.10 Retests or additional tests shall be performed to assure compliance with paragraph 70.4.3.

70.4.11 Acknowledge accomplishment of partial completion of the FCA for those configuration items whose qualification is contingent upon completion of integrated systems testing.

70.4.12 For CSCIs the following additional requirements shall apply:

a. The contractor shall provide the FCA team with a briefing for each CSCI being audited and shall delineate the test results and findings for each CSCI. As a minimum, the discussion shall include CSCI requirements that were not met, including a proposed solution to each item, an account of the ECPs incorporated and tested as well as proposed, and a general presentation of the entire CSCI test effort delineating problem areas as well as accomplishments.

b. An audit of the formal test plans/descriptions/procedures shall be made and compared against the official test data. The results shall be checked for completeness and accuracy. Deficiencies shall be documented and made a part of the FCA minutes. Completion dates for all discrepancies shall be clearly established and documented.

c. An audit of the Software Test Reports shall be performed to validate that the reports are accurate and completely describe the CSCI tests.

d. All ECPs that have been approved shall be reviewed to ensure that they have been technically incorporated and verified.

e. All updated to previously delivered documents shall be reviewed to ensure accuracy and consistency throughout the documentation set.

f. Preliminary and Critical Design Review minutes shall be examined to ensure that all findings have been incorporated and completed.

g. The interface requirements and the testing of these requirements shall be reviewed for CSCIs.

h. Review data base characteristics, storage allocation data and timing, and sequencing characteristics for compliance with specified requirements.

70.5 Post Audit Actions

70.5.1 After completion of the FCA, the contractor shall publish and distribute copies of FCA minutes. The contracting agency officially acknowledges completion of the FCA as indicated in paragraph 4.2.4.

70.5.2 The accomplishment of the FCA shall be recorded on the configuration item Development Record by the contractor.

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80. Physical Configuration Audit (PCA)

80.1 General. The Physical Configuration Audit (PCA) shall be the formal examination of the as-built version of a configuration item against its design documentation in order to establish the product baseline. After successful completion of the audit, all subsequent changes are processed by engineering change action. The PCA also determines that the acceptance testing requirements prescribed by the documentation is adequate for acceptance of production units of a configuration item by quality assurance activities. The PCA includes a detailed audit of engineering drawings, specifications, technical data and tests utilized in production of HWCIs and a detailed audit of design documentation, listings, and manuals for CSCIs. The review shall include an audit of the released engineering documentation and quality control records to make sure the as-build or as-coded configuration is reflected by this documentation. For software, the Software Product Specification and Version Description Document shall be a part of the PCA review.

80.1.1 The PCA shall be conducted on the first article of configuration items and those that are a reprocurement of a configuration item already in the inventory shall be identified and selected jointly by the contracting agency and the contractor. A PCA shall be conducted on the first configuration item to be delivered by a new contractor even though PCA was previously accomplished on the first article delivered by a different contractor.

80.1.2 Formal approval by the contracting agency of the configuration item Product specification, and the satisfactory completion of a PCA results in establishment of the product baseline.

80.1.3 Recommendations of configuration item acceptance or nonacceptance to the responsible contract administration office (CAO) are based upon and governed by procedures and requirements outlined in subsequent paragraphs.

80.1.4 A final review shall be made of all operation and support documents (i.e., Computer System Operator's Manual (CSMOM), Software User's Maual (SUM), Computer System Diagnostic Manual (CSDM), Software Programmer's Manual (SPM), Firmware Support Manual (FSM)) to check format, completeness, and conformance with applicable data item descriptions.

80.1.5. Continuing with the results of the Functional Configuration Audit (FCA), review engineering data as defined in para 3.15, as to the suitability for intended use. The review should consider the checklist items discussed in para 100.6, as properly tailored.

80.2 Contract Requirements

80.2.1 The schedules for the PCA shall be recorded on the configuration item Development Record by the contractor. A current set of listings shall be provided for each CSCI being audited. The contractor shall submit the final draft of the

product specification for the configuration item to be audited to the contracting agency for review prior to PCA.

80.3 Contractor Responsibility

80.3.1 The contractor shall provide the following information to the contracting agency (this information shall be provided in accordance with the general instructions of Section 4 and the contractural requirements):

a. Contractor representation (the test manager should be in attendance).

b. Identification of items to be accepted by:

(1) Nomenclature

(2) Specification Identification Number

(3) Configuration item Identifiers

(4) Serial Numbers

(5) Drawing and Part Numbers

(6) Identification Numbers

(7) Code Identification Numbers

(8) Software inventory numbering system

c. A list delineating all deviations/waivers against the configuration item either requested or contracting agency approved.

80.3.2 The PCA cannot be performed unless data pertinent to the configuration item being audited is provided to the PCA team at time of the audit. The contractor shall compile and make this information available for ready reference. Required information shall include:

a. Configuration item product specification.

b. A list delineating both approved and outstanding changes against the configuration item.

c. Complete shortage list.

d. Acceptance test procedures and associated test data.

e. Engineering drawing index including revision letters.

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non-complex system some reviews may not be required, or, if required, may be limited in Scope. The tailoring procedures discussed earlier should result either in the exclusion of MIL-STD-1521 or in a tailored MIL-STD-1521 that reflects a limited scope technical review effort. Conversely, in a very complex development the review process will increase in levels and numbers of reviews.

b. In addition to the above, the degree of application is dependent upon the configuration item state of development (example, new design vs. commercially available) or the degree of any modifications, if involved. For example: a newly developed item may require the majority of the review topics/items and audits, while a commercially available configuration item with the appropriate documentation, i.e., verified test results, specifications, drawings, etc. may require reviews or audits limited to its application to the program and its interfaces. In the case of modified designs one must consider the degree and effect of the modifications. Reviews and audits may be limited to the modifications and their interfaces.

100.5 Scheduling of Technical Reviews and Audits

The schedule for Technical Reviews and Audits is extremely important. If they are conducted too early, the item for review will not be adequately defined. Conversely, if the review is too late, the program commitments could have been made erroneously, and correction will be both difficult and costly. For planning purposes, a good method for scheduling technical reviews is to relate them to the documentation requirements. For example, schedule a PDR after the hardware Development Specification or Software Top Level Design Document and Software Test Plan are available, since the essence of the PDR is to assess the contractor's approach to meeting these requirements of these documents. Scheduling of audits are dependent not only on documentation availability but also on hardware/software availability, and the completion of the acceptance qualification tests. Table 1 contains a list of the primary documentation associated with each review or audit and the estimated time phasing:

100.6. Tailoring Guidance for Engineering Data Reviews. Engineering Data reviews are conducted as part of the formal design reviews/audits in MIL-STD-1521. Use Figure 5, Review Checklist for Engineering Data, to help prepare for and conduct these reviews and audits. Note discrepancies on Figure 6, Engineering Data Discrepancy Sheet. Because reviews and audits are successively more detailed, more items on the checklist will apply as the program progresses. When all reviews and audits are completed, all items on the tailored checklist should be accomplished.

TABLE 1
SCHEDULING REVIEWS AND AUDITS

Review	Time Phase	Primary Documentation
SRR	Usually accomplished in the Concept Exploration phase. However, may be used in other phases when the	Various analysis and trade study reports used to develop the system/segment

110. Production Readiness Review (PRR)

110.1 For specific guidance, see AFSCR 84-2, Production Readiness Review.

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REVIEW CHECKLIST FOR ENGINEERING DATA

I. The following questions and considerations should be used prior to conducting an engineering data review. These are suggested guidelines, and should be used as such.

II. Pre-briefing preparation:
  a. Answer these questions:
    1. What is the purpose of the Review?
    2. What does the Contract require?
    3. How will the drawings be used?
  b. Arrange briefings:
    1. The Contractor shall brief the team on contractual requirements and status.
    2. The Engineering Data Management Officer (EDMO) or Chairperson should brief the team on the review procedures.
    3. Discuss corrective action procedures.

III. The Data Review:
  a. Build the package:
    1. Select sample of top assembly drawings.
    2. Look at Parts List of the top assembly or major subassembly drawings.
    3. Are other subassembly drawings listed in the top parts list?
    4. Are all drawings listed in the top parts list available?
    5. Are all drawings listed in the subassembly parts list available?
    6. Is manufacturing planning documentation available?
  b. Examine the engineering data for the following:
    1. Is the drawing legible and suitable for reproduction?
    2. Are processes/specifications listed?
    3. Look at notes on all drawings. Are all notes understandable? Are notes clear and concise?
    4. Are peculiar symbols, abbreviations, etc, explained?
    5. Are all dimensions and tolerances shown?
    6. Is the material identified?
    7. Are any reports referenced? If so, are they supplied in the package?
    8. Are copies of non-government specifications supplied as part of the package?
    9. Correct use of limited rights legends (DAR/FAR)?
    10. Are control drawings (particularly Source and Specification Control) properly used and marked? (DOD-STD-100)
    11. Are hardness critical items and hardness critical process markings correct?
    12. Are electrostatic discharge sensitive (ESDS) symbology and cautions included, as appropriate?
    13. Have changes been incorporated as required in the contract?

14. Are index and data lists available and correct?

15. Is there a distribution statement on each piece of engineering data?

16. Have specific marking requirements (MIL-STD-130) been defined?

17. Are acceptance test requirements included on all subassembly/detail drawings for items that might be spared separately by competitive reprocurement?

18. Is the proper engineering design information included for the level of drawing stated in the contract?

19. Could a military standard or specification be used in lieu of drawings?

20. Are applicable security classifications marked correctly?

21. Are the contractual requirements adequate?

22. Does the drawing package appear to be adequate to support the intended end use (i.e. logistics support, competitive reprocurement, etc)?

c. Record all deficiencies/discrepancies on the Engineering Data Discrepancy Sheet (see Figure 6) in sufficient detail to completely define the problem and action required for compliance.

At the end of the review, the EDMO (or Review Team Chief) collects all discrepancy sheets, signs them, and determines appropriate disposition. After resolution of discrepancies, the sheets will be filed in the Engineering Data Files.

Sheet ___ of ___

FIGURE 6

_____
(PROGRAM NAME)

Engineering Data Discrepancy Sheet

(To be used with the Review Checklist)

PRIME AND SUBCONTRACTOR/VENDOR NAME:_____

TYPE OF REVIEW:_____

REVIEWER'S NAME	DRAWING/DOCUMENT NUMBER	REV	DATE

DISCREPANCIES

ACTION REQUIRED/COMPLIANCE DUE DATE_____

PROGRAM OFFICE EDMO (or Team Chief) Signature_____

AIR LOGISTICS EDMO SIGNATURE_____

ACTION AGENCY: ____Contractor ___Program Office
____Contract Administration Office ___Other

This block to be used by Action Agency

DISCREPANCIES CORRECTED BY: _____ _____
(Signature) (Date)

After resolution, return to the Program Office EDMO

Custodian:
Air Force - 13

Preparing Activity:
Air Force - 13

Review Activity:
Air Force - 10, 11, 80, 85

(Project CMAN-0-006)

NOTICE
OF CHANGE

MIL-STD-1521B (USAF)
NOTICE 2
17 JUL 1992

MILITARY STANDARD

TECHNICAL REVIEWS AND AUDITS FOR SYSTEMS, EQUIPMENT, AND COMPUTER SOFTWARE

TO ALL HOLDERS OF MIL-STD-1521B(UASF)

1. Pages 71 through 82, Appendix H, and pages 85 through 116 of Appendix I: DELETE. The contents of the pages listed are now contained in MIL-STD-973, "CONFIGURATION MANAGEMENT".

2. Retain this notice and insert before table of contents.

3. Holders of MIL-STD-1521B(UASF) will verify that the information above has been entered. This notice page will be retained as a check sheet. This issuance is a separate publication. Each notice is to be retained by stocking points until the Military Standard is completely revised or cancelled.

Preparing activity:
Air Force - 13

(Project CMAN-0033)

Review Activities:
Air Force - 10,11,80,85

AMSC N/A

AREA CMAN

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

NOT MEASUREMENT SENSITIVE

MIL-STD-881B
25 March 1993

SUPERSEDING
MIL-STD-881A
25 April 1975

MILITARY STANDARD

WORK BREAKDOWN STRUCTURES

FOR

DEFENSE MATERIEL ITEMS

AMSC F6914 AREA MISC

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

FOREWORD

1. This military standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: AFMC/FMA, Wright-Patterson Air Force Base, Ohio 45433, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of the document or by letter.

3. This military standard is applicable to all defense materiel items (or major modifications) (a) established as an integral program element of the Future Years Defense Program (FYDP), or (b) otherwise designated by the DoD Component or the Under Secretary of Defense (Acquisition).

4. The practices and procedures contained in this standard are applicable to systems, equipment, and other designated materiel items which are referred to as defense materiel items. Work breakdown structures (WBS) provide a consistent and visible framework for defense materiel items (as well as contracts within a program) that facilitate:

a. A more effective management and technical base for planning and assigning management and technical responsibilities within government offices responsible for the acquisition of defense materiel items and contractors furnishing the items.

b. The basis for communication throughout the acquisition process by providing the common link unifying the planning, scheduling, cost estimating, budgeting, contracting, configuration management, and performance reporting disciplines.

c. More consistent control over and reporting of the progress and status of engineering and other contractor efforts, resource allocations, cost estimates, expenditures, and procurement actions throughout the acquisition of defense materiel items.

d. Acquisition decisions which consider total life cycle effects, including development, production, activation, operational use, and phase-out.

5. The uniformity in definitions and approach for developing the top three levels of the work breakdown structure established by this standard is expected to assure compatibility of multiple-data requirements. The benefits expected from increased uniformity in the generation of work breakdown structures and their application to management practices will be realized by the improved interpretation and reconciliation of all reports prepared to this uniform framework throughout the acquisition of a defense materiel item.

6. This military standard is based on the cooperative efforts of the military services with assistance from industrial associations.

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CONTENTS (CONTINUED)

CONTENTS (CONTINUED)

FIGURE PAGE

APPENDICES

1. SCOPE

1.1 Purpose. This standard establishes criteria governing the preparation and employment of work breakdown structures for use during the acquisition of designated defense materiel items to display and define the products to be developed or produced.

1.2 Application.

1.2.1 The work breakdown structure requirements established by this standard are associated solely with the acquisition of defense materiel items (or major modifications) that are (a) established as an integral program element of the Future Years Defense Program (FYDP), or (b) otherwise designated by the DoD Component or the Under Secretary of Defense (Acquisition). Specifically, it pertains to only those elements of research and development and investment that are applicable to contracted efforts.

1.2.2 This standard is to be used by both contractors and DoD Components (Government activities) in the development of work breakdown structures for the acquisition of defense materiel items.

1.2.3 Work breakdown structures in use on existing programs will continue to be used on these programs unless it is considered mutually advantageous to the Government and the contractor(s) to apply this standard. Approval for substitution should follow guidance in paragraph 4.1.1.

2. APPLICABLE DOCUMENTS

2.1 Government Documents.

2.1.1 Specifications, Standards, and Handbooks. This section is not applicable to this standard.

2.1.2 Other Government Documents, Drawings, and Publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PAMPHLETS

Contractor Cost Data Reporting (CCDR)

NAVMAT P-5241	Navy Materiel Command Pamphlet
AMC-P 715-8	Army Materiel Command Pamphlet
AFLCP 800-15	Air Force Logistics Command Pamphlet
AFSCP 800-15	Air Force Systems Command Pamphlet

Cost/Schedule Control System Criteria Joint Implementation Guide

NAVSO P3627	Assistant Secretary of the Navy (S&L) Pamphlet
AFSCP 173-5	Air Force Systems Command Pamphlet
AFCCP 173-5	Air Force Communications Command Pamphlet
AFLCP 173-5	Air Force Logistics Command Pamphlet
AMC-P 715-5	Army Materiel Command Pamphlet
DLAH 8400.2	Defense Logistics Agency Handbook
DCAA P7641.47	Defense Contract Audit Agency Pamphlet

(The above pamphlet numbers identify two single documents: Contractor Cost Data Reporting (CCDR) System (Stock Number 0518LP1003001), and Cost/Schedule Control Systems Criteria Joint Implementation Guide (Stock Number 0518LP1002010). These two documents can be ordered by stock number from the Standardization Documents Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA 19111-5094.

2.2 Non-Government Publications. This section is not applicable to this standard.

2.3 Order of Precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 General. Terms will be as defined herein and in the appendices of this document.

3.2 Program Element. A program element is the basic building block of the Future Years Defense Program (FYDP). It is a description of the mission to be undertaken and a list of the organizational entities identified to perform the mission assignment. A program element may consist of forces, manpower, materiel (both real and personal property), services, and associated costs, as applicable.

3.3 Defense Materiel Item. Defense materiel item is a term used within the DoD to identify a system or item that is usually established as an integral program element or is identified as a project within an aggregated program element.

3.4 Work Breakdown Structure. A work breakdown structure (WBS) is a product-oriented family tree composed of hardware, software, services, data and facilities which results from systems engineering efforts during the acquisition of a defense materiel item. A work breakdown structure displays and defines the product(s) to be developed and/or produced and relates the elements of work to be accomplished to each other and to the end product(s). The work breakdown structures prescribed by this standard have been organized within the seven categories of defense materiel items and consist of the upper three levels of the work breakdown structure.

3.4.1 Categories of Defense Materiel Items. The seven categories of defense materiel items identified in 3.4 are as follows:

a. Aircraft Systems
b. Electronic/Automated Software Systems
c. Missile Systems
d. Ordnance Systems
e. Ship Systems
f. Space Systems
g. Surface Vehicle Systems

3.4.2 Level Identification. The three work breakdown structure levels specified in 3.4 are as follows:

Level 1: Level 1 is the entire defense materiel item; for example, the Minuteman ICBM System or the LHA Ship System. Level 1 is usually directly identified in the DoD programming/budget system either as an integral program element or as a project or subprogram within an aggregated program element.

Level 2: Level 2 elements are major elements of the defense materiel item and are subordinate to level 1; for example, a ship, an air vehicle, a tracked vehicle, and aggregations of services (such as system test and evaluation, and systems engineering/program management) and data.

Level 3: Level 3 elements are elements subordinate to level 2 major elements; for example, an electric plant, an airframe, the power package/drive train, or type of service (such as development test and evaluation, contractor technical support, training services), or type of data (such as technical publications). Lower levels follow the same process.

3.5 Program Work Breakdown Structure. A program work breakdown structure is defined as the work breakdown structure that covers the acquisition of a specific defense materiel item and is related to contractual effort. A program work breakdown structure includes all applicable elements consisting of at least the first

three levels of the work breakdown structure and extended by the DoD Component (program manager) and/or contractor(s). A program work breakdown structure has uniform element terminology, definition, and placement in the family tree structure.

3.6 Contract Work Breakdown Structure. A contract work breakdown structure is defined as the complete work breakdown structure for a contract. It includes the DoD approved work breakdown structure for reporting purposes and its discretionary extension to the lower levels by the contractor, in accordance with this standard and the contract work statement. It includes all the elements for the products (hardware, software, data, or services) which are the responsibility of the contractor.

3.7 Work Breakdown Structure Element. A work breakdown structure element is a discrete portion of a work breakdown structure. A work breakdown structure element may be an identifiable item of hardware, software, services, data or facilities.

3.8 Systems Engineering. Systems engineering is defined as a comprehensive, iterative technical management process to:

a. Translate an operational need into a configured system meeting that need through a systematic, concurrent approach to integrated design of the system and its related manufacturing, test, and support processes;

b. Integrate the technical inputs of the entire development community and all technical disciplines (including the concurrent engineering of manufacturing, logistics, and test) into a coordinated effort that meets established program cost, schedule, and performance objectives;

c. Ensure the compatibility of all functional and physical interfaces (internal and external) and ensure that system definition and design reflect the requirements for all system elements: hardware, software, facilities, people, and data; and

d. Characterize technical risks, develop risk abatement approaches, and reduce technical risk through early test and demonstration of system elements (ref. DoD Instruction 5000.2).

3.9 Configuration Item. A configuration item is an aggregation of hardware or software that satisfies an end-use function and is designated by the government for separate configuration management (ref. MIL-STD-973).

3.10 Acquisition. Acquisition is a term used within the DoD to denote the directed, funded effort that is designed to provide a new or improved materiel capability in response to a validated need (ref. DoD Directive 5000.1). Acquisition commences with the conceptual phase and is completed at the end of the production phase. It excludes all operating and support activities.

3.11 Integration, Assembly, Test and Checkout. See Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. page H-2), for a complete definition. In those instances in which an integration, assembly, test and checkout element is used (Appendices A through G), it includes all effort of technical and functional activities associated with the design, development, and production of mating surfaces, structures, equipment, parts, materials, and software required to assemble the level 3 equipment (hardware/software) elements into a level 2 mission equipment (hardware/software) as a whole and not directly part of any other individual level 3 element.

3.12 Functional Categories. Although this standard does not address functional categories, for each work breakdown structure element there is a functional breakout. The cost of any specified work breakdown

structure element at any level is composed of one or more functional categories. Functional categories include engineering, tooling, quality control, manufacturing, and purchased equipment, and are defined in Chapter 4 of the referenced pamphlet, Contractor Cost Data Reporting (CCDR) System. DoD regulations reference and establish requirements for functional breakouts on specified work breakdown structures. Functional categories are not work breakdown structure elements and are not to be represented as such in work breakdown structures.

3.13 Nonrecurring and Recurring. Work breakdown structure elements can contain both nonrecurring and recurring effort. Nonrecurring effort includes all design, development, test (except acceptance testing), basic and rate tools, and manufacturing support to engineering for the design, development and test effort. Recurring effort includes the manufacturing of the test and production units (including acceptance testing), sustaining engineering and sustaining tooling. The DoD approved Contractor Cost Data Reporting (CCDR) Plan establishes the requirements for reporting nonrecurring and recurring breakouts on work breakdown structures specified for contractor cost data reporting to the government. Nonrecurring and recurring definitions are given in Chapter 4 of the referenced pamphlet, Contractor Cost Data Reporting (CCDR) System.

4. GENERAL REQUIREMENTS

4.1 Relationships. The structures and definitions contained in this standard shall be the basis for structures used for contracts requiring compliance with the Cost/Schedule Control Systems Criteria (C/SCSC), per DoD instructions, and the reporting systems of Cost Performance Reports (CPR), Contract Funds Status Reports (CFSR), Cost/Schedule Status Reports (C/SSR), and Contractor Cost Data Reporting (CCDR). This section summarizes the overall relationship between this standard and those policy issuances. Consult the DoD regulations for instructions related to the referenced documents.

4.1.1 Contractor Cost Data Reporting (CCDR) Plan. The CCDR Plan procedures in DoD regulations are the framework for work breakdown structure development and approval. Those procedures begin during the development of the Statement of Work (SOW) and before the issuance of solicitations to industry for advanced development prototype and/or engineering and manufacturing development contracts and continue through the completion of the production program. The CCDR Plan, as a key integration planning document for a program, shall be used by DoD Components to ensure that program work breakdown structures are developed in accordance with this standard. This planning process is extremely important since the resulting approved program work breakdown structure (1) defines the program and (2) is used to organize the solicitation(s) and identify for prospective contractors the upper level contract work breakdown structure. The final contract work breakdown structure, incorporating any changes negotiated with the contractor, is the basis for contract organization. The statement of work, contract line items, and reporting requirements must all be consistent with the program work breakdown structure approved in the CCDR Plan.

4.1.2 Cost/Schedule Control Systems Criteria (C/SCSC). When a contract requires that a contractor's cost and schedule management control system comply with the C/SCSC requirements identified in DoD instructions, the system is reviewed to ensure that the contract work breakdown structure is used as the framework for organization, planning, budgeting, accounting, analysis, and revision of all contract work. The C/SCSC does not establish the adequacy of the contract work breakdown structure. The contract work breakdown structure contained in the contract is based on the approved CCDR Plan (or the DoD Component approved plan, if appropriate). Contract work breakdown structure development begins before a solicitation is released to industry. After contract award, C/SCSC compliance reviews ensure that the contractor is using the contract work breakdown structure properly to manage the contract.

4.1.3 Cost Reports. The CCDR, CPR, and C/SSR forms require use of contract work breakdown structure reporting elements, and the CFSR may require contract work breakdown structure element reporting. Submission of these reports is required during performance of applicable contracts; certain CCDR forms are also required with contractor responses to solicitations. The CCDR Plan shows the CCDR submission requirements to be incorporated in solicitations and contracts and indicates other cost reporting requirements, such as CPR and CFSR. Contractual reporting is through the contract data requirements list (CDRL). During contract negotiation, any needed adjustments may be proposed by either party. As a general rule, routine reporting is at level 3 of the contract work breakdown structure (level 2 for CFSR, when applicable), except for high-cost, high-risk, or other high-interest elements that are at lower levels. The appropriate contract work breakdown structure level specified for routine reporting shall be evaluated carefully by the DoD Component with the contractor to ensure only the minimum amount of reporting necessary to achieve effective management control is required.

4.2 Work Breakdown Structure. The DoD Component shall develop a program work breakdown structure for defense materiel items prior to program initiation by selecting appropriate elements from one or more of the work breakdown structure(s) set forth in Appendices A through G of this standard that are applicable to the program. Approval of this program work breakdown structure shall be obtained in accordance with DoD regulations. From this approved program work breakdown structure the individual contract work breakdown

structure(s) will be developed by the DoD Component and negotiated with the contractor(s). The negotiated contract work breakdown structure(s) will then be extended to lower levels by the contractor(s) to define the complete contract scope. When aggregated with the program work breakdown structure, the extended contract work breakdown structures shall form a complete work breakdown structure which will be used throughout the acquisition cycle. Figure 1 depicts the evolution and relationship of the work breakdown structure(s) to the various acquisition stages.

4.3 Program Management. The program work breakdown structure and contract work breakdown structure extensions can be used as a framework for technical and management activities. The program office should employ the program work breakdown structure and its contract work breakdown structure extensions as a coordinating medium in planning for further systems engineering, resource allocation, cost estimates, contract actions, and work execution. The reporting of progress, performance, and engineering evaluations as well as financial data, shall be based on the program work breakdown structure.

4.4 Solicitation and Proposal Action. The contract work breakdown structure used for solicitation will be structured by selecting appropriate elements from the approved program work breakdown structure. The contract line items, configuration items, contract statement of work tasks, contract specifications, and contractor responses will be expressed in terms of the work breakdown structure to enhance its effectiveness in satisfying the objectives of the particular acquisition. While the relationship of the contract work breakdown structure elements to the statement of work tasks and the contract line items should be clearly traceable, there may not be a one-to-one relationship, nor is it required.

4.5 Specifications and Drawings. The family of specifications and drawings resulting from the progressive steps of systems engineering will conform to the evolved program work breakdown structure and its extensions.

4.6 Contractor Management Control System. The contract work breakdown structure shall serve as the framework for the contractor's management control system which shall provide auditable and traceable summarizations of internal data generated by its performance measurement procedures.

4.7 Integrated Logistics Support (ILS). The integrated logistics support element will be accommodated as indicated in the upper levels of the work breakdown structure in Appendices A through G. Aggregations of work breakdown structure elements for logistics support management and reporting will be accomplished by summation of those level 2 ILS elements which are fully ILS elements (that is, training, peculiar support equipment and initial spares) plus those portions of level 2 elements identified as ILS elements at level 3 (such as support data and ILS management).

4.8 Planning, Programming and Budgeting System. The program work breakdown structure shall be used whenever it is necessary to subdivide the program element data for the planning, programming and budgeting system. The program work breakdown structure shall also be used in cost estimating for future programs and procurement actions.

4.9 Life-Cycle Cost. Life cycle cost is the total cost for the research and development, investment, operation and support, and disposition of a weapon or support system. It commences at the start of the conceptual stage and ends with the retirement/demilitarization of the system from the inventory. The work breakdown structure requirements established by this standard are associated solely with the acquisition of defense materiel items (or major modifications) and, specifically, those elements of research and development and investment that are applicable to all contracted efforts.

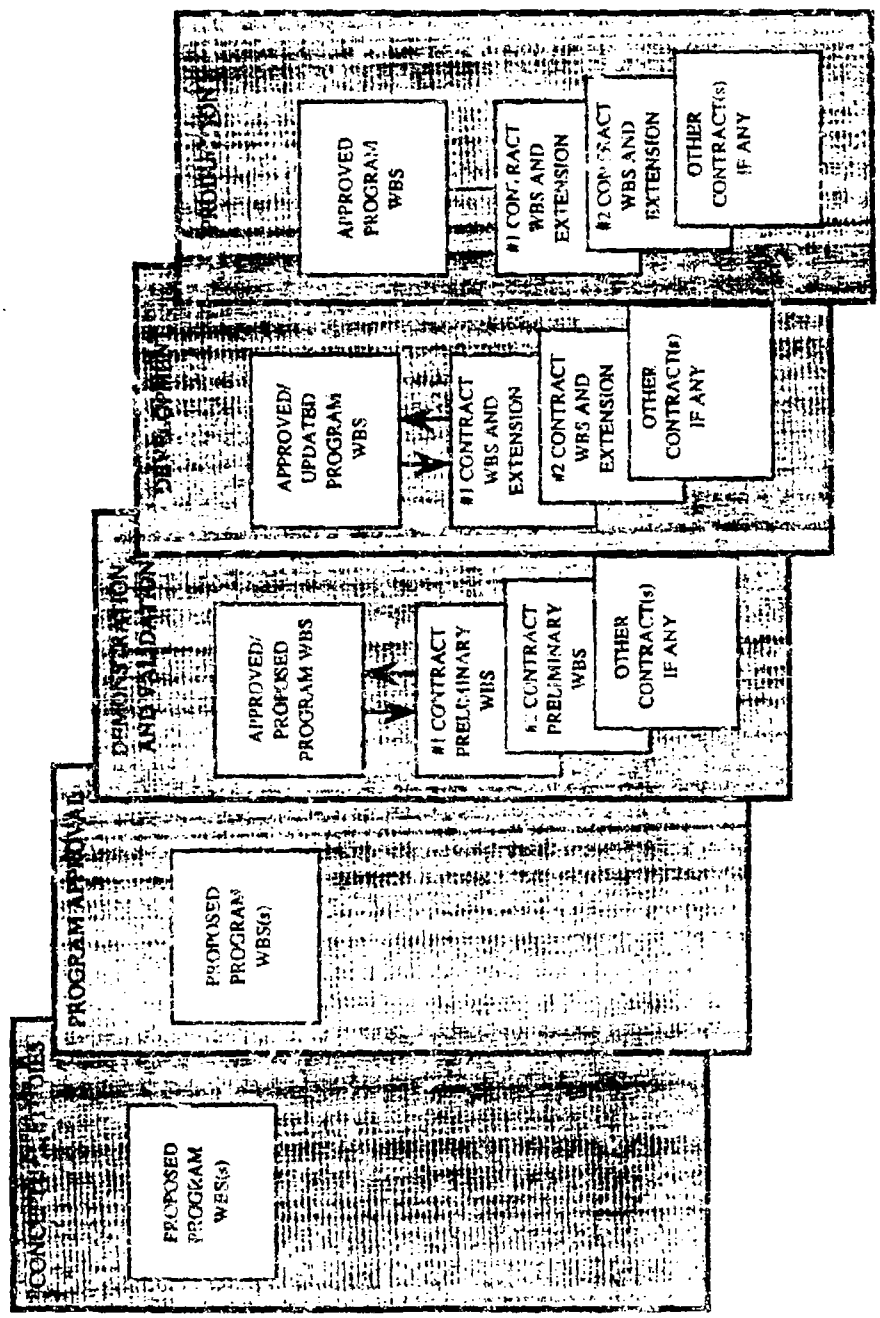

Figure 1. THE EVOLUTION OF A WORK BREAKDOWN STRUCTURE

4.10 Procurement. The following shall be relatable to elements of the program work breakdown structure:

a. Structure of work statements
b. Contract work breakdown structures
c. Contract line items
d. Configuration items
e. Technical and management reports
f. Government-furnished items

4.11 Reporting. All reporting requirements for the program shall be consistent with the program work breakdown structure. The organization of reporting requirements shall not be construed by either the DoD Component or the contractor as determining the manner in which the defense materiel item is to be designed or produced.

5. DETAILED REQUIREMENTS

5.1 Work Breakdown Structure. The appropriate category or categories of work breakdown structure(s) and related definitions prescribed herein shall be used in the preparation of the program work breakdown structure for the specific defense materiel item under consideration.

5.1.1 Aircraft Systems. The work breakdown structure and definitions for an aircraft system shall be as specified in Appendix A.

5.1.2 Electronic/Automated Software Systems. The work breakdown structure and definitions for an electronic/automated software system shall be as specified in Appendix B.

5.1.3 Missile Systems. The work breakdown structure and definitions for a missile system shall be as specified in Appendix C.

5.1.4 Ordnance Systems. The work breakdown structure and definitions for an ordnance system shall be as specified in Appendix D.

5.1.5 Ship Systems. The work breakdown structure and definitions for a ship system shall be as specified in Appendix E.

5.1.6 Space Systems. The work breakdown structure and definitions for a space system shall be as specified in Appendix F.

5.1.7 Surface Vehicle Systems. The work breakdown structure and definitions for a surface vehicle system shall be as specified in Appendix G.

5.2 Program Work Breakdown Structure.

5.2.1 Preparation. The program work breakdown structure that encompasses the entire acquisition of a specific defense materiel item shall be prepared by the DoD Component (Program Manager). This will be accomplished by selecting, through systems engineering and management planning processes, applicable elements from one or more of the work breakdown structure(s) specified in Appendices A through G. While the categories and elements specified in Appendices A through G normally will provide the basis for constructing a program work breakdown structure(s), deviations are permitted when a unique requirement exists which these appendices have not addressed.

5.2.1.1 The preparation of the initial program work breakdown structure is normally accomplished by the DoD Component as a result of systems engineering efforts conducted during concept formulation or its equivalent. The initial program work breakdown structure shall be developed to be available for use as the program moves into demonstration and validation and/or engineering and manufacturing development. The systems engineering effort identifies the category of defense materiel items and work breakdown structure elements considered to be most suitable to satisfy the operational needs. Therefore, in preparing a program work breakdown structure for a specific defense materiel item, a selection of the level 2 and level 3 elements from one or more of the work breakdown structures identified in Appendices A through G shall be made. Unless a unique requirement exists which the work breakdown structures as described by this standard have not addressed, only the work breakdown structure elements specified in this standard shall be utilized; and these elements shall be identified with uniform nomenclature, definition, and structural placement. Figure 2, Program Work Breakdown Structure, depicts a format for developing and documenting a program work breakdown structure. Although this structure is normally limited to the upper three levels, additional elements at lower levels may be specified.

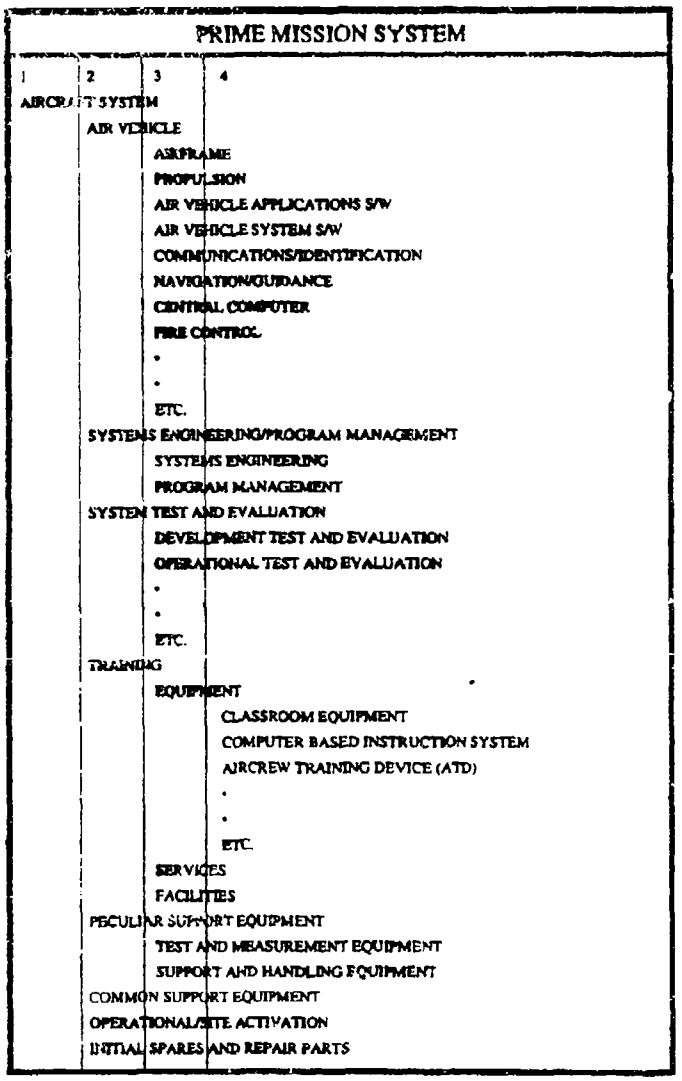

Figure 2. PROGRAM WORK BREAKDOWN STRUCTURE

5.2.1.2 When deviation from the prescribed elements and definitions in this standard is necessary because of a unique requirement, additional or substitute elements, properly defined, may be used once DoD approval procedures have been complied with and approval has been obtained.

5.2.1.3 The program work breakdown structure is not intended to be constraining. During demonstration and validation or subsequent development efforts, changes may be proposed. Such alternatives shall be evaluated by the DoD Component in terms of the benefits offered in context with the overall program objectives. The changes adopted at the end of the demonstration and validation or subsequent effort shall be reflected in the approved program work breakdown structure. The appropriate elements of the approved structure shall be included in the negotiated contract work breakdown structure(s) and work statements for follow-on development effort.

5.3 Contract Work Breakdown Structure.

5.3.1. Preparation. Only one contract work breakdown structure shall be used in each request for proposal and the ensuing contract. The DoD Component shall structure the upper levels of the contract work breakdown structure by selecting those elements of the program work breakdown structure which apply to the contract and organizing them into a framework which supports the objectives of the program work breakdown structure. Individual subsystems/equipment elements may be extended to lower levels to provide management visibility and control. Figure 3, Work Breakdown Structure Matrix, depicts a format suitable for documenting the subdivision of a program work breakdown structure into contract work breakdown structures for each contractor/source. In the example, the program work breakdown structure level 3 element Fire Control becomes level 1 of the contract work breakdown structure, and all other level 2 common program work breakdown structure elements (ref. Appendix H) are included at level 2 of the contract work breakdown structure. A separate contract for a level 4 program work breakdown structure element, such as Aircrew Training Device, also follows the same procedure. The same contract work breakdown structure drawn from the program work breakdown structure shall be used for each phase (development and production) of a program. The work breakdown structure element System Test and Evaluation is an exception since it is not used for production.

5.3.2 Relationship to Program Work Breakdown Structure. Work breakdown structure "level" commonality between the approved program work breakdown structure and the individual contract work breakdown structure need not be maintained, provided that the approved program work breakdown structure element nomenclature and definitions are not violated. Contract work breakdown structure levels may be different from program work breakdown structure levels. For example, level 3 in the program work breakdown structure may be level 1 or 2 in the contract work breakdown structure. In addition, not all program work breakdown structure elements may be in each contract work breakdown structure. Traceable summarization of individual contract work breakdown structures into the approved program work breakdown structure shall be maintained.

5.3.3 Changes to Contract Work Breakdown Structures. When submitting and negotiating proposals, contractors may propose alternatives to the contract work breakdown structure elements selected in order to enhance effectiveness of the structure in satisfying the objectives of the particular project. Changes proposed by the contractor shall require approval following DoD regulations and procedures. After necessary adjustments are made based on a contractor's proposal and contract negotiations, the elements selected for the contract shall become the basis for further evolutionary extension by the contractor during the contracted effort. All

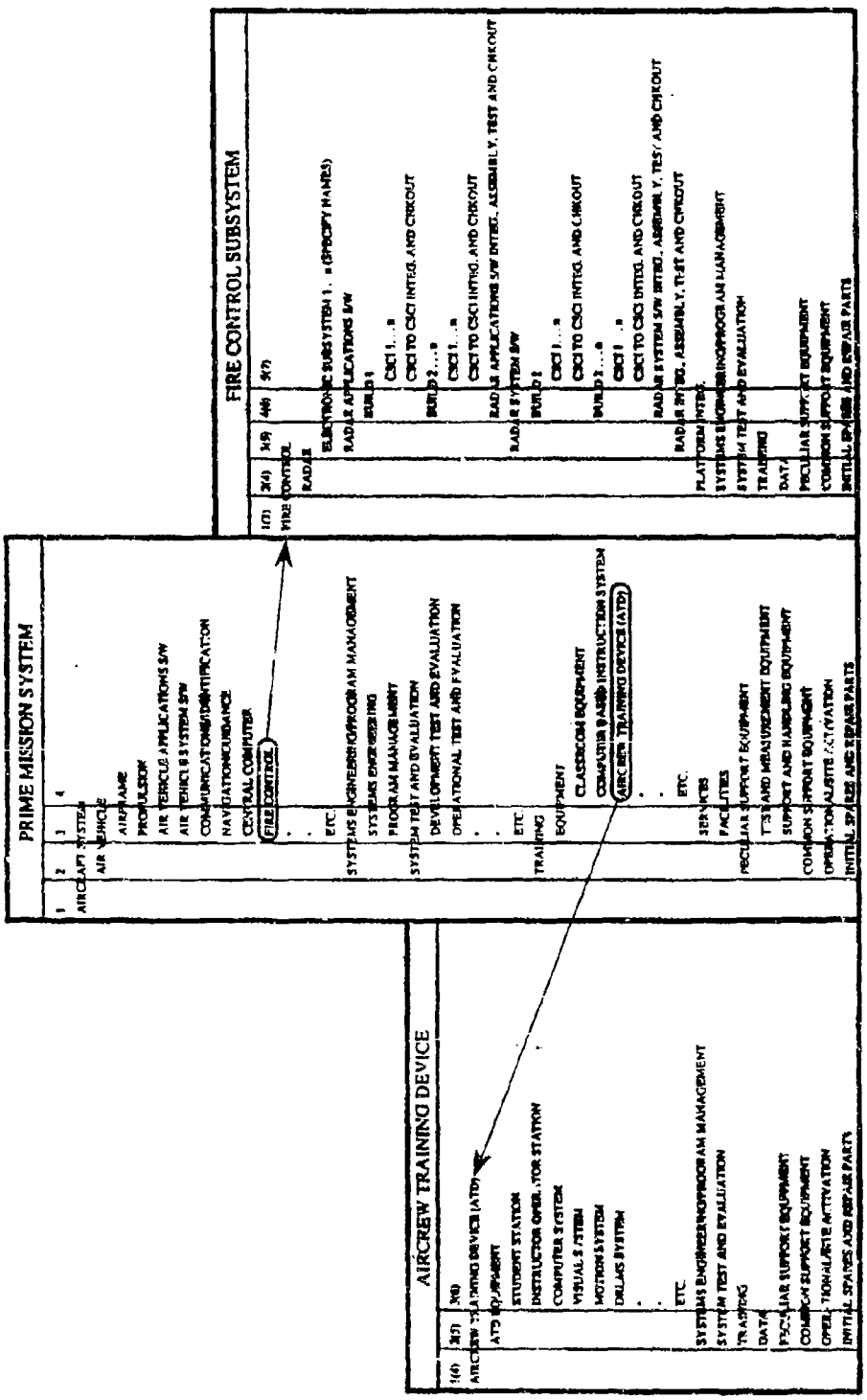

Figure 3. WORK BREAKDOWN STRUCTURE MATRIX

extensions must sum to the contract work breakdown structure provided by the DoD Component and documented in the approved CCDR Plan.

5.3.4 Extension of Contract Work Breakdown Structure. The contract shall indicate the levels of contract work breakdown structure at which costs shall be reported to the government. Traceability of cost accumulations shall be required to those extended contract work breakdown structure levels which are used by the contractor for cost control purposes.

5.3.4.1 In the extended contract work breakdown structure, consideration shall be given to the specific contractual, technical, and managerial requirements of the defense materiel item. Lower levels may be configuration items, service elements, items of data or meaningful product or management-oriented lower indentures of a higher-level element. The contractor has complete flexibility in extending the contract work breakdown structure below the reporting requirement to reflect how work is to be accomplished, assuming lower elements to be meaningful product or management-oriented lower indentures of a higher-level element. Particular attention shall be given to ensure the correlation of lower levels of the contract work breakdown structure to the specification tree, contract line items, configuration items, data items, and work statement tasks.

5.3.4.2 The lowest level of the extended contract work breakdown structure for project planning, control, and support will be that necessary to reach manageable units of functional tasks and should reflect the way the work is actually being performed by the contractor. For configuration management, the contract work breakdown structure will be extended sufficiently to identify all configuration items. This standard does not require that the contract work breakdown structure level used for program control also be the level needed for configuration control.

5.3.5 Contractually Specified Levels. The contract work breakdown structure provided by the DoD Component shall be attached to and be a part of the solicitation documents. The contract work breakdown structure, as negotiated, shall be attached to the contract. Information as to the extended contract work breakdown structure content shall be available to the government program manager upon request.

5.4 Other Preparation Guidance.

5.4.1 General.

5.4.1.1 The definitions and terminology presented in the appendices to this standard shall be used by the DoD Component as the basis for structuring the specific terminology and definitions for each work breakdown structure element. The contractor(s) shall prepare specific definitions for the contract work breakdown structure (ref. 6.3).

5.4.1.2 Modification and changes such as redesign, rework, re-engineering, retooling, retesting, and refurbishing shall be associated with the work breakdown structure element identified in the contract and affected by the change.

5.4.1.3 The level 2 program work breakdown structure elements Systems Engineering/Program Management and System Test and Evaluation are defined to include any overall systems effort. These elements exclude subsystem or component efforts that can be associated with a hardware/software element. (For example, acceptance tests, qualification tests, and systems engineering for a particular hardware/software component shall be included as part of the effort associated with the component, and not with the level 2 elements of System Test and Evaluation and Systems Engineering/Program Management.) This does not preclude the inclusion of an element titled Systems Engineering/Program Management or System Test and Evaluation in individual contract work breakdown structure(s) even though the contract is for subsystems or components of a program.

In this case, these efforts shall be summarized into the subsystem or component, rather than the program work breakdown structure level 2 elements of Systems Engineering/Program Management and System Test and Evaluation.

5.4.2 Software. Software shall be accommodated in the appropriate levels of the work breakdown structure. Software shall be identified with the hardware it supports.

5.4.3 Application to Other Than Major Programs. The work breakdown structure practices and procedures contained in this standard may be applied to other than major programs as specified in paragraph 1.2. A program work breakdown structure can be developed for any subsystem/program regardless of size or complexity, by proper application of the product-oriented structuring concepts set forth in this standard.

5.4.3.1 For example, given a radar subsystem within an aggregated program element which is to be managed as a system entity, the radar becomes the level 1 mission system, i.e., radar system. Subordinate to this level 1 radar system is the level 2 (mission) radar equipment and required generic elements to structure the subsystem as a complete system entity. The level 2 radar equipment is logically exp ded into level 3 subsystem elements, such as transmitter, receiver, antenna, antenna pedestal, and integration, assembly, test and checkout. Common elements, such as Training, Peculiar Support Equipment, Data, and System Test and Evaluation, are identified at level 2 and extended to lower levels as required for the management and control of all elements necessary to meet the radar system mission requirements in an operational environment.

5.4.3.2 For subsystems/programs involving two or more contractors, this same technique is appropriate for applying a program work breakdown structure to individual contract work breakdown structures by contractor/source.

5.4.4 Acquisition Phase. The program work breakdown structure and contract work breakdown structure(s) shall be established initially at the award of the development contract and extended during development. A single program work breakdown structure, element nomenclature, and definition in accordance with the guidelines prescribed herein shall be maintained throughout the acquisition phases to insure traceability. For purposes of this standard, the acquisition phase will include all applicable contracted efforts.

5.4.5 Placement of Multi-Function Equipment/Software in the Work Breakdown Structure. Flexibility is required in the systems engineering and design process, therefore latitude in placement of the multi-function hardware/software in the program work breakdown structure is permitted. This latitude will be limited, however, by the following principle: multi-function hardware/software will be part of the work breakdown structure element which either includes the equipment in the element's specification or exercises the most critical performance constraint. (Critical performance constraint is that which primarily drives the design of the software.) In cases where the application of this rule results in a conflict in the selection of the proper element, the specification relationship shall take precedence.

5.4.6 Work Breakdown Structure for Subcontracts. The prime contractor shall be responsible for traceable summarizations of subcontractor data supporting its prime contract work breakdown structure elements. As required, the prime contractor shall negotiate a work breakdown structure with the subcontractor that permits the prime contractor to fulfill its work statement and contract work breakdown structure requirements, and which provides adequate control of the subcontractor.

6. NOTES

6.1 Intended Use. This military standard is applicable to all defense materiel items (or major modifications) (a) established as an integral program element of the Future Years Defense Program (FYDP), or (b) otherwise designated by the DoD Component or the Under Secretary of Defense (Acquisition).

6.2 Guidance for Contractual Application. The requirements of this standard may be modified when deviations from the prescribed elements and definitions in this standard are necessary because of unique requirements (see 5.2.1.1. and 5.2.1.2.).

6.3 Data Requirements. The following Data Item Description (DID) must be listed, as applicable, on the Contract Data Requirements List (DD Form 1423) when this standard is applied on a contract, in order to obtain the data, except where DoD FAR supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title
5.4.1.1	DI-MGMT-81334	Contract Work Breakdown Structure and Definitions

6.4 Subject Term (Key Word) Listing.

Acquisition
Contract
Contract Funds Status Report (CFSR)
Contract Work Breakdown Structure
Contractor Cost Data Reporting (CCDR)
Cost Performance Report (CPR)
Cost/Schedule Control Systems Criteria (C/SCSC)
Cost/Schedule Status Report (C/SSR)
Defense Materiel Item
Program Management
Program Work Breakdown Structure
Systems Engineering
Work Breakdown Structure

6.5 Changes from Previous Issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:
Army - MI
Navy - NM
Air Force - 10

Review Activities:
Army - AR, AT, AV, CR, MI
Navy - AS, NW, MC, OS, SH
Air Force - 11, 14, 19, 25, 26, 70, 71, 80, 82, 84

Preparing Activity:
Air Force - 10

(Project No. MISC-0051)

APPENDIX A
WORK BREAKDOWN STRUCTURE AND DEFINITIONS
AIRCRAFT SYSTEMS

10. SCOPE

10.1 This appendix provides the aircraft system work breakdown structure. Definitions for the aircraft air vehicle are provided in this appendix. Definitions for common WBS elements applicable to the aircraft and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

20.1 Government Documents.

20.1.1 Specifications, Standards, and Handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

STANDARDS

MIL-STD-1374	Weight and Balance Data Reporting Forms for Aircraft (Including Rotorcraft)

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA 19111-5094.)

20.2 Non-Government Publications. This section is not applicable to this standard.

30. WORK BREAKDOWN STRUCTURE

30.1 Levels. The following is the work breakdown structure for an aircraft system.

Level 1	Level 2	Level 3
Aircraft System		
	Air Vehicle	
		Airframe
		Propulsion
		Air Vehicle Applications Software
		Air Vehicle System Software
		Communications/Identification
		Navigation/Guidance
		Central Computer
		Fire Control
		Data Display and Controls

Level 1	Level 2	Level 3
		Survivability
		Reconnaissance
		Automatic Flight Control
		Central Integrated Checkout
		Antisubmarine Warfare
		Armament
		Weapons Delivery
		Auxiliary Equipment
	Systems Engineering/Program Management	
	System Test and Evaluation	
		Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups
		Test and Evaluation Support
		Test Facilities
	Training	
		Equipment
		Services
		Facilities
	Data	
		Technical Publications
		Engineering Data
		Management Data
		Support Data
		Data Depository
	Peculiar Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Common Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Operational/Site Activation	
		System Assembly, Installation and Checkout on Site
		Contractor Technical Support
		Site Construction
		Site/Ship/Vehicle Conversion
	Industrial Facilities	
		Construction/Conversion/Expansion
		Equipment Acquisition or Modernization
		Maintenance (Industrial Facilities)
	Initial Spares and Repair Parts	

40. DEFINITIONS

40.1 Aircraft System. The aircraft system element refers to the complex of equipment (hardware/software), data, services, and facilities required to develop and produce the capability of employing those fixed or movable wing, rotary wing, or compound wing, manned/unmanned air vehicles designed for powered or unpowered (glider) guided flight.

40.1.1 Air Vehicle. The air vehicle element refers to the complete flying aircraft, including airframe, propulsion, and all other installed equipment. It includes the design, development, and production of complete units (i.e., prototype and operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use).

40.1.1.1 Airframe. The airframe element refers to the assembled structural and aerodynamic components of the air vehicle that support subsystems essential to designated mission requirements. It includes, for example, the basic structure (i.e., wing, empennage, fuselage, and associated manual flight control system), rotary wing pylons, air induction system, thrust reversers, thrust vector devices, starters, exhausts, fuel management system, inlet control system, alighting gear (i.e., tires, tubes, wheels, brakes, hydraulics, etc.), secondary power, furnishings (i.e., crew, cargo, passenger, troop, etc.), instruments (i.e., flight, navigation, engine, etc.), environmental control, life support and personal equipment, racks, mounts, intersystem cables and distribution boxes, etc., which are inherent to and nonseparable from the assembled structure, dynamic systems (i.e., transmissions, gear boxes, propellers, if not furnished as an integral part of the propulsion unit), rotor group, and other equipment homogeneous to the airframe. In addition to the airframe structure and subsystems, this element includes:

a. Integration, Assembly, Test and Checkout. The integration, assembly, test and checkout element includes all efforts as identified in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. page H-2), to provide the integration, assembly, test and checkout of all elements into the airframe to form the air vehicle as a whole. This includes all administrative and technical engineering labor to perform: integration of level 3 air vehicle and airframe elements; development of engineering layouts; determination of overall design characteristics, and determination of requirements of design review. It includes overall air vehicle design and producibility engineering; detailed production design; acoustic and noise analysis; loads analysis; and stress analysis on interfacing airframe elements and all subsystems; design maintenance effort and development of functional test procedures. It also includes coordination of engineering master drawings and consultation with test and manufacturing groups. It includes tooling planning, design, and fabrication of basic and rate tools and functional test equipments, as well as the maintenance of such equipment. It also includes production scheduling and expediting; joining or installation of structures such as racks, mounts, etc.; installation of seats, wiring ducting, engines, and miscellaneous equipment and painting. Also included are set up, conduct and review of testing assembled components or subsystems prior to installation. This element also contains all effort associated with the installation, integration, test and checkout of the avionic systems into the air vehicle including: design of installation plans; quality assurance planning and control including material inspection; installation; recurring verification tests; and integration with nonavionics airframe subsystems. Also included are: ground checkout prior to flight test; production acceptance testing and service review; quality assurance activities and the cost of raw materials, purchased parts, and purchased equipment associated with integration and assembly.

b. Nonrecurring Avionics System Integration. The nonrecurring avionics system integration element is associated with the individual avionics equipment boxes and avionics software in a functioning system. This element includes: the labor required to analyze, design, and develop the avionics suite interfaces and establish interface compatibility with non-avionics support equipment systems, aircraft systems, and mission planning systems; drawing preparation and establishment of avionics interface equipment requirements and specifications; and technical liaison and coordination with the military service, subcontractors, associated contractors, and test

groups. Development, testing, and integration of software should be included in air vehicle applications and system software. This element excludes avionics system testing (included in System Test and Evaluation) and aircraft systems engineering efforts (included in Systems Engineering/Program Management).

All effort directly associated with the remaining level 3 WBS elements is excluded. NOTE: The structure and equipment which comprise the airframe can be identified by the use of the weight and balance reporting forms for aircraft (including rotorcraft) in MIL-STD-1374.

40.1.1.2 Propulsion. The propulsion element refers to that portion of the air vehicle that pertains to installed equipment (propulsion unit and other propulsion) to provide power/thrust to propel the aircraft through all phases of powered flight. This element includes the engine as a propulsion unit within itself (e.g., reciprocating, turbo with or without afterburner, or other type propulsion) suitable for integration with the airframe. It also includes thrust reversers, thrust vector devices, transmissions, gear boxes, and engine control units, if furnished as an integral part of the propulsion unit. This element also includes other propulsion equipment required in addition to the engine but not furnished as an integral part of the engine, such as booster units. It also includes the design, development, production, and assembly efforts to provide the propulsion unit as an entity. All effort directly associated with the elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded. All ancillary equipments that are not an integral part of the engine required to provide an operational primary power source (i.e., air inlets, instruments, controls, etc.) are excluded.

40.1.1.3 Air Vehicle Applications Software. The air vehicle application software element includes all the software that is specifically produced for the functional use of a computer system or multiplex data base in the air vehicle. This element refers to all effort required to design, develop, integrate, and checkout the air vehicle applications Computer Software Configuration Items (CSCIs), not including the nonsoftware portion of air vehicle firmware development and production (ref. ANSI/IEEE Std 610.12). This element excludes software that is an integral part of any specific subsystem and software that is related to other WBS level 2 elements. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used.

40.1.1.4 Air Vehicle System Software. The air vehicle system software element is defined as software designed for a specific computer system or family of computer systems to facilitate the operation and maintenance of the computer system and associated programs for the air vehicle; examples include operating systems (i.e., software that controls the execution of programs), compilers (i.e., computer programs used to translate higher order language programs into relocatable or absolute machine code equivalents), and utilities (i.e., computer programs or routines designed to perform general support function required by other application software, by the operating system or by system users) (ref. ANSI/IEEE Std 610.12). This element refers to all effort required to design, develop, integrate and checkout the air vehicle system software including all software developed to support any air vehicle applications software development. It is defined as air vehicle system software required to facilitate development, integration, and maintenance of any air vehicle software build and CSCI. This excludes all software that is an integral part of any specific subsystem specification or specifically designed and developed for system test and evaluation. This element also excludes software that is an integral part of any specific subsystem, and software that is related to other WBS level 2 elements. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used.

40.1.1.5 Communications/Identification. The communications/identification element refers to that equipment (hardware/software) installed in the air vehicle for communications and identification purposes. It includes, for example, intercoms, radio system(s), identification equipment (IFF), data links, and control boxes associated with the specific equipment. When an integral communication, navigation, and identification package is used, it will be included here. This item contains embedded software, that is, software defined in the item specification

and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.6 Navigation/Guidance. The navigation/guidance element refers to that equipment (hardware/software) installed in the air vehicle to perform the navigational guidance function. This element includes, for example, radar, radio, or other essential navigation equipment, radar altimeter, direction finding set, doppler compass, computer, and other equipment homogeneous to the navigation/guidance function. This item contains embedded software that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.7 Central Computer. The central computer element refers to the master data processing unit(s) responsible for coordinating and directing the major avionic mission systems. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. This item specifically excludes those computers identified by individual functions listed in or under other level 3 WBS elements. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.8 Fire Control. The fire control element refers to that equipment (hardware/software) installed in the air vehicle which provides the intelligence necessary for weapons delivery such as bombing, launching, and firing. This element includes, for example, radars and other sensors including radomes; apertures/antennas, if integral to the fire control system, necessary for search, target identification, rendezvous and/or tracking; self-contained navigation and air data systems; dedicated displays, scopes, or sights; and bombing computer and control and safety devices. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.9 Data Display and Controls. The data display and controls element refers to that equipment (hardware/software) which provides visual presentation of processed data by specially designed electronic devices through interconnection (on or off-line) with computer or component equipment, and associated equipment needed to control the presentation of data. This element provides the necessary flight and tactical information to the crew for efficient management of the aircraft during all segments of the mission profile under day and night all-weather conditions. Excluded are indicators/instruments not controlled by keyboard via the multiplex data bus and panels and consoles which are included under the airframe. It includes multi-function displays, control display units, display processors, and on-board mission planning systems. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.10 Survivability. The survivability element refers to those equipments (hardware/software) installed in, or attached to, the air vehicle which assist in penetration for mission accomplishment. This element includes, for example, ferret and search receivers, warning devices and other electronic devices, electronic

countermeasures, jamming transmitters, chaff, infra-red jammers, terrain-following radar, and other devices typical of this mission function. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.11 Reconnaissance. The reconnaissance equipment element refers to those equipments (hardware/software) installed in, or attached to, the air vehicle necessary to the reconnaissance mission. This element includes, for example, photographic, electronic, infrared, and other sensors; search receivers; recorders; warning devices; magazines; and data link. Gun cameras are excluded. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.12 Automatic Flight Control. The automatic flight control element refers to electronic devices and sensors, which, in combination with the flight controls subsystem (under airframe), enable the crew to control the flight path of the aircraft as well as to provide lift, drag, trim, or conversion effects. This element includes flight control computers, software, signal processors, and data transmitting elements that are devoted to processing data for either primary or automatic flight control functions. Electronic devices required for signal processing, data formatting, and interfacing between the flight control elements are included, as are the data buses, optical links, and other elements devoted to transmitting flight control data. Flight control sensors such as pressure transducers, rate gyros, accelerometers, and motion sensors are also included. Excluded from this element are the devices such as linkages, control surfaces, and actuating devices covered under the airframe WBS element. Also excluded are avionics devices and sensors such as central computers, navigation computers, avionics data buses and navigation sensors which are included under other avionics WBS elements. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.13 Central Integrated Checkout. The central integrated checkout element refers to that equipment (hardware/software) installed in the air vehicle for malfunction detection and reporting. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.14 Antisubmarine Warfare. The antisubmarine warfare element refers to that equipment (hardware/software) installed in the air vehicle peculiar to the antisubmarine warfare mission. This element includes, for example, sensors, computers, displays, etc. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.15 Armament. The armament element refers to that equipment (hardware/software) installed in the air vehicle to provide the firepower functions. This element includes, for example, guns, high energy weapons, mounts, turrets, weapon direction equipment, ammunition feed and ejection mechanisms, and gun cameras. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.16 Weapons Delivery. The weapons delivery element refers to that equipment (hardware/software) installed in the air vehicle to provide the weapons delivery capability. This element includes, for example, launchers, pods, bomb racks, pylons, integral release mechanisms, and other mechanical or electro-mechanical equipments specifically oriented to the weapons delivery function. This element excludes the bombing/navigation system which is included in the fire control element. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.17 Auxiliary Equipment. The auxiliary equipment element refers to auxiliary airframe, electronics, and/or armament/weapons delivery equipment not allocable to individual element equipments, or which provide the ancillary functions to the applicable mission equipments. It includes, for example, auxiliary airframe equipment such as external fuel tanks, pods, and rotodomes. It also includes such multi-use equipment as antennas, control boxes, power supplies, environmental control, racks, mountings, etc. which are not homogeneous to the prescribed WBS elements. Auxiliary armament/weapons delivery equipment includes flares and ejection mechanisms, ejector cartridges, and other items peculiar to the mission function that are not identifiable to the armament or weapons delivery elements set forth in 40.1.1.15 and 40.1.1.16 of this appendix. This item contains embedded software, that is, software defined in the item specification and provided by the supplier. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

Definitions for common WBS elements applicable to the aircraft and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. pages H-1 through H-10).

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APPENDIX B
WORK BREAKDOWN STRUCTURE AND DEFINITIONS
ELECTRONIC/AUTOMATED SOFTWARE SYSTEMS

10. SCOPE

10.1 This appendix provides the electronic/automated software system work breakdown structure. Definitions for the prime mission product (PMP) and platform integration are provided in this appendix. Definitions for common WBS elements applicable to the electronic/automated software system and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

20.1 Government Documents.

20.1.1 Specifications, Standards, and Handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

STANDARDS

MIL-STD-196	Joint Electronics Type Designation System
MIL-STD-1464	Army Nomenclature System
MIL-STD-1661	Mark and Mod Nomenclature System
MIL-STD-1812	Type Designation, Assignment and Method for Obtaining
DOD-STD-2167	Defense System Software Development

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA 19111-5094.)

20.2 Non-Government Publications. This section is not applicable to this standard.

30. WORK BREAKDOWN STRUCTURE

30.1 Levels. The following is the work breakdown structure for an electronic/automated software system. For any subsystem, specify by name or nomenclature, if assigned.

Level 1	Level 2	Level 3
Electronic/Automated Software System		
	Prime Mission Product (PMP)	
		Subsystem 1...n (Specify Names)
		PMP Applications Software
		PMP System Software
		Integration, Assembly, Test and Checkout
	Platform Integration	
	Systems Engineering/Program Management	
	System Test and Evaluation	
		Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups
		Test and Evaluation Support
		Test Facilities
	Training	
		Equipment
		Services
		Facilities
	Data	
		Technical Publications
		Engineering Data
		Management Data
		Support Data
		Data Depository
	Peculiar Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Common Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Operational/Site Activation	
		System Assembly, Installation and Checkout on Site
		Contractor Technical Support
		Site Construction
		Site/Ship/Vehicle Conversion

Level 1	Level 2	Level 3
	Industrial Facilities	Construction/Conversion/Expansion Equipment Acquisition or Modernization Maintenance (Industrial Facilities)
	Initial Spares and Repair Parts	

40. DEFINITIONS

40.1 Electronic/Automated Software System. The electronic/automated software system element refers to the complex of equipment (hardware/software), data, services, and facilities required to develop and produce an electronic, automated, or software system capability such as a command and control system, radar system, communications system, information system, sensor system, navigation/guidance system, electronic warfare system, support system, etc. The decision rule used to differentiate between the Electronic/Automated Software System category and other defense materiel item categories is: When the item is a stand alone system or used on several systems, but not accounted for in these other systems, the Electronic/Automated Software System category will be used. When the opportunity to collect lower level information on electronic and software items exists, regardless of which defense materiel item category is selected, the structure and definitions in this appendix apply.

40.1.1 Prime Mission Product (PMP). The PMP element refers to the hardware and software used to accomplish the primary mission of the defense materiel item. It includes all integration, assembly, test and checkout, as well as all technical and management activities associated with individual hardware/software elements. Also included are integration, assembly, test and checkout associated with the overall PMP. When the electronic/automated software system comprises several PMPs, each will be listed separately at level 2. Also included are all whole and partial prime contractor, subcontractor, and vendor breadboards, brassboards, and qualification test units. It also includes the design, development and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use). It excludes only those "less than whole" units (e.g., test, spares, etc.) consumed or planned to be consumed in support of system level tests. This element also includes factory special test equipment, special tooling, and production planning required to fabricate the PMP. Duplicate or modified factory special test equipment delivered to the government for depot repair is excluded and should be included in the peculiar support equipment element.

40.1.1.1 Subsystem 1...n (Specify Names). This element refers to all hardware and software components of the specific electronic/automated software subsystem, including all associated special test equipment, special tooling, production planning, and all technical and management activities. The software components consist of the applications and system software required to direct and maintain the specific electronic/automated software subsystem. This element includes all in-plant integration, assembly, test and checkout of hardware components and software into an electronic/automated software subsystem including the subsystem hardware and software integration and test. Also included are the interface materials and parts required for the in-plant integration and assembly of other level 4 components into the electronic/automated software subsystem and all materials and parts of other mating equipments furnished by/to an integrating agency or contractor. It includes, for example, cables, conduits, connectors, shelters, and other devices associated with the operational electronic/automated software subsystem. It also includes the design, development, production, and assembly efforts to provide each electronic/automated software subsystem as an entity. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the PMP is excluded.

40.1.1.2 PMP Applications Software. The applications software element is defined as software that is specifically produced for the functional use of a computer system (ref. ANSI/IEEE Std 610.12). Examples are battle management, weapons control, and data base management. This element refers to all effort required to design, develop, integrate and checkout the PMP applications computer software configuration items (CSCIs), not including the nonsoftware portion of PMP firmware development and production. This excludes all software that is an integral part of any specific hardware subsystem specification.

All software that is an integral part of any specific equipment system and subsystem specification or specifically designed and developed for system test and evaluation should be identified with that system, subsystem, or

effort. It may be appropriate to collect lower level information when it exists. In such cases, the following structure and definitions should be used:

LEVEL 4	LEVEL 5
Build 1 ..n (Specify Names)	CSCI 1...n (Specify Names) CSCI to CSCI Integration and Checkout
Integration, Assembly, Test and Checkout	

a. Build 1...n (Specify Names) - A software build is an aggregate of one or more CSCIs that satisfies a specific set or subset of requirements based on development of software as defined in DOD-STD-2167A. When incremental, spiral, or other software development method is used, multiple builds may be necessary to meet program requirements. A build is a separately tested and delivered product. Within builds are CSCIs. When a build is complete, a portion or all of one or more CSCIs will be completed. Therefore, a CSCI may appear in more than one build, but will be successively more functional as each build is completed.

b. Computer Software Configuration Item (CSCI) 1...n (Specify Names) - An aggregation of software or any of its discrete portions which satisfies an end use function and has been designated by the government for configuration management. CSCIs are the major software products of a system acquisition which are developed in accordance with DOD-STD-2167. This includes reusable software components, such as commercial off-the-shelf software, government furnished software, or software specifically developed for reuse. This element includes Computer Software Components (CSCs) which are functionally or logically a distinct part of a CSCI, distinguished for convenience in designing and specifying a complex CSCI as an assembly of subordinate elements. It includes the effort associated with the requirements analysis, design, coding and testing, CSCs integration and testing, CSCI formal qualification testing, and software problem resolution of each CSCI.

c. CSCI to CSCI Integration and Checkout - Includes integration and test, verification and validation and the systems engineering and technical control of the CSCIs. Integration and test is the planning, conducting and analysis of tests that verify correct and proper performance of each CSCI operating as a whole with other CSCIs. Planning includes: (1) defining test scope and objectives, (2) establishing the test approach, acceptance criteria, verification methods, order of integration, inputs, and methods to record results, and (3) establishing test locations, schedules, and responsibilities of those involved. The conducting and analysis of tests encompasses: (1) developing test procedures, (2) preparing test data and expected results, (3) executing the test procedures and recording test results, (4) reducing test results,identifying errors, and preparing test data sheets, and (5) reporting results. Verification and validation is the effort that may be accomplished to insure the performance and quality of each CSCI with other CSCIs. This element excludes the software integration and checkout associated with the individual CSCIs.

(NOTE: The defined software structure for lower level information is appropriate whether it is associated with a specific system or subsystem or considered software intensive or stand alone. Reference Appendix I, User Guide, for guidelines on developing a stand alone software work breakdown structure.)

40.1.1.3 PMP System Software. The PMP system software element is defined as software designed for a specific computer system or family of computer systems to facilitate the operation and maintenance of the computer system and associated programs, for example, operating systems, compilers, and utilities (ref. ANSI/IEEE Std 610.12). This element refers to all effort required to design, develop, integrate and checkout the PMP system software including all software developed to support any PMP applications software

development. It is defined as PMP system software which is required to facilitate development, integration, and maintenance of any PMP software build and CSCI. This excludes all software that is an integral part of any specific hardware subsystem specification or is specifically designed and developed for system test and evaluation. The structure shown in paragraph 40.1.1.2 should be used when lower level information is desired.

40.1.1.4 Integration, Assembly, Test and Checkout. The integration, assembly, test, and checkout element includes all effort as identified in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. page H-2) to provide a complete PMP system. The integration, assembly, test and checkout element includes hardware and PMP software integration and test.

40.1.2 Platform Integration. The platform integration element refers to all effort involved in providing technical and engineering services to the platform manufacturer or integrator during the installation and integration of the PMP into the host vehicle. This element includes: the labor required to analyze, design, and develop the interfaces with other host vehicle subsystems; drawing preparation and establishment of equipment requirements and specifications; and technical liaison and coordination with the military services, subcontractors, associated contractors, and test groups. Specifically excluded from this element is all integration effort not directly associated with the host vehicle and management liaison with the military services, subcontractors, and associated contractors.

Definitions for common WBS elements applicable to the electronic/automated software system and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. pages H-1 through H-10).

APPENDIX C
WORK BREAKDOWN STRUCTURE AND DEFINITIONS
MISSILE SYSTEMS

10. SCOPE

10.1 This appendix provides the missile system work breakdown structure. Definitions for the missile air vehicle and command and launch equipment are provided in this appendix. Definitions for common WBS elements applicable to the missile and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. WORK BREAKDOWN STRUCTURE

30.1 Levels. The following is the work breakdown structure for a missile system.

Level 1	Level 2	Level 3
Missile System		
	Air Vehicle	
		Propulsion (Stages 1...n, As Required)
		Payload
		Airframe
		Reentry System
		Pos. Boost System
		Guidance and Control
		Ordnance Initiation Set
		Airborne Test Equipment
		Airborne Training Equipment
		Auxiliary Equipment
		Integration, Assembly, Test and Checkout
	Command and Launch	
		Surveillance, Identification and Tracking Sensors
		Launch and Guidance Control
		Communications
		Command and Launch Applications Software
		Command and Launch System Software
		Launcher Equipment
		Auxiliary Equipment
	Systems Engineering/Program Management	

Level 1	Level 2	Level 3
	System Test and Evaluation	
		Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups
		Test and Evaluation Support
		Test Facilities
	Training	
		Equipment
		Services
		Facilities
	Data	
		Technical Publications
		Engineering Data
		Management Data
		Support Data
		Data Depository
	Peculiar Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Common Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Operational/Site Activation	
		System Assembly, Installation and Checkout on Site
		Contractor Technical Support
		Site Construction
		Site Conversion
	Industrial Facilities	
		Construction/Conversion/Expansion
		Equipment Acquisition or Modernization
		Maintenance (Industrial Facilities)
	Initial Spares and Repair Parts	

40. DEFINITIONS

40.1 Missile System. The missile system element refers to the complex of equipment (hardware/software), data, services, and facilities required to develop and produce the capability of employing a missile weapon in an operational environment to produce the destructive effect on selected targets. Examples include Trident, Peacekeeper, Tomahawk, Maverick, Sidewinder, etc.

40.1.1 Air Vehicle. The air vehicle element refers to the primary means for delivering the destructive effect to the target, including the capability to generate or receive intelligence, to navigate and penetrate to the target area and to detonate the warhead. It also includes the design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use).

40.1.1.1 Propulsion (Stages I...n, As Required). The propulsion system provides the thrust to propel the air vehicle on its intended flight. The propulsion system may be composed of one or more stages which ignite, burn, and are jettisoned sequentially over the course of missile flight. The propulsion element may be solid, liquid, or air-breathing. It includes, for example, structure (integral to the propulsion system), propellant, controls, instrumentation, and all other installed subsystem equipment integral to the rocket motor or engine as an entity within itself. It also includes the design, development, production, and assembly efforts to provide each stage as an entity. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

a. Rocket Motor/Booster. A rocket motor/booster refers to the solid propulsion system which carries within it both the fuel and oxygen required for its operation. It includes, for example, an arm and firing device, solid propellant, movable nozzles, casings, integration, etc.

b. Engine. The engine includes both liquid propulsion systems and air breathing systems. The liquid propulsion engine includes, for example, the main engines, verniers/auxiliary engines, fluid supply system, liquid propellant, attitude control equipment, structure (integral to the engine), raceway, interstage, combustion section, turbines, nozzles, rotors, etc. The air breathing engine obtains oxygen from the surrounding atmosphere to support the combustion of its fuel. Ramjets and turbojets are examples of air breathing engines which may be used to provide propulsion for cruise-type missiles. This element includes the following subsystems for air breathing engines: mainframe, compressor, combustion section, air inlets/exhaust ducts, turbine nozzle assembly, turbine rotor, bearings and housings, and fuel subsystem. In addition to basic components, air breathing engine systems require various accessory components such as pumps, injectors, turbines, motors, diffusers, and igniters.

40.1.1.2 Payload. The payload element refers to the subsystem containing the warhead and its support assemblies where no reentry system exists. Normally, payload consists only of the warhead and its associated arming and fuzing equipment. However, with complex munitions containing submunitions, the payload subsystem may mimic the larger system by having its own guidance and control, fuze, safe-arm, and propulsion. This element includes, for example, arming and fuzing device, warhead, and target detection device. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.3 Airframe. The airframe element includes the structural framework that provides the aerodynamic shape, mounting surfaces and environmental protection for the missile components which are not directly applicable to other specific level 3 air vehicle subsystems. The airframe for endo-atmospheric missiles normally includes such items as wings and fins which provide aerodynamic flight control in response to electro-mechanical signals and are attached to the missile body; and structural body assemblies including the structure, covers, such as passive nosepieces, skins, adhesives, and fairings not directly applicable to any other level 3 air

vehicle subsystem. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.4 Reentry System. For exo-atmospheric missiles, the reentry system is the aggregate of prime equipment items consisting of a deployment module, reentry vehicles, payload, penetration aids and ascent shroud, which provide structural support and environmental protection of nuclear payloads during the ground deployment and flight. The reentry vehicle is the aero-structure which provides reentry protection for the internally carried warheads and the arming and fusing system which provides the proper electrical signals to detonate the warhead. Where the system has the capability for independent maneuvers, the reentry vehicle will contain navigation, guidance, control, sensors, and processing systems which provide the reentry systems capability to acquire and track targets and execute the necessary flight path to the selected target. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.5 Post Boost System. In exo-atmospheric missiles, the post boost system provides the roll rate control and the final velocity to adjust and deploy the payload. For a single warhead missile, this element includes the structure, external protection material, velocity control system, and deployment group. In the case of the multiple warhead missile, the element includes structure, axial engines, attitude control equipment, propellant storage assembly, and pressurized system. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.6 Guidance and Control. The guidance and control element refers to the equipment used to control the missile flight to the target. Functions include acquiring and tracking targets, receiving guidance intelligence data from various sources including sensors and feedback from control commands to follow the necessary flight path to intercept the target. The inputs may also include interface status, inertial acceleration, and attitude changes. The outputs include missile control, ordnance firing commands, status, instrumentation, and timing signals. In addition, the equipment provides flight electrical power, missile electrical interconnection, and a structure to contain the guidance and control components when the structure is not part of a separately identified airframe element. For exo-atmospheric missiles, this includes missile cables, stage cables, stage connectors, airborne power supply, electronic battery, ordnance battery, ordnance initiation set, missile electronic and computer assembly, inertial measurement unit, the guidance and control software, in flight coolant assembly, and guidance and control integration, assembly, test and checkout. For endo-atmospheric missiles, this includes seekers, mission computer, global positioning receiver, inertial platform, inertial sensors, altimeter, data link, power subsystems, windows/domes, distributive systems, autopilot, flight control actuators, guidance and control software, and guidance and control integration, assembly, test and checkout. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.7 Ordnance Initiation Set. In exo-atmospheric missiles, the ordnance initiation set initiates all ordnance events throughout the missile and ground system (except reentry system components). Upon receipt of an electrical signal from the missile guidance and control system, the ordnance initiation set firing units convert the signal into ordnance outputs to the detonating cords. Among those ordnance events are: stage separation, motor ignition, gas generator ignition, shroud separation, etc. This element includes the through bulkhead initiators, ordnance test harnesses, and firing units/exploding bridgewires. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.8 Airborne Test Equipment. The airborne test equipment element refers to an instrumented payload that is interchangeable with the live warhead and suitable for developmental test firing. This element includes, for example, recovery systems, special instrumentation, telemetry equipment, etc. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.9 Airborne Training Equipment. The airborne training equipment element refers to an exercise payload that is interchangeable with the live warhead and suitable for training firing. This element includes, for example, recovery systems, special instrumentation, telemetry equipment, etc., associated with the training mission. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.10 Auxiliary Equipment. The auxiliary equipment element refers to that additional equipment generally excluded from other specific level 3 elements. This element includes, for example, environmental control, safety and protective subsystems, destruct systems, etc., if these were not accounted for in other WBS elements. It also includes equipment of a single purpose and function which is necessary for accomplishing the assigned mission. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the air vehicle is excluded.

40.1.1.11 Integration, Assembly, Test and Checkout. The integration, assembly, test and checkout element includes all efforts as identified in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. page H-2), to provide a complete missile.

40.1.2 Command and Launch. The command and launch element refers to the subsystems installed at a launch site or aboard launch vehicles required to store, make ready, and launch the air vehicles of the missile system. This element includes those equipments required to acquire and condition the necessary intelligence of selected targets, reach launch decisions, command the launch, and provide guidance and control where such capability is not self contained aboard the air vehicle. It also includes the design, development and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use).

40.1.2.1 Surveillance, Identification and Tracking Sensors. The surveillance, identification, and tracking sensors element refers to those sensors required to support missile systems by maintaining surveillance against incoming targets and providing the data required for targeting, launch, midcourse guidance and homing where such capability is not self-contained aboard a missile system air vehicle. For all classes of missile systems, they may include tracking of the missile system air vehicles as required for guidance and control or range safety. Subsystems used in safety, destruct, test, or training activities are not included unless they are required operational items. This element may include, for example, sensors of any spectrum (radar, optical, infrared, etc.) which are external to the air vehicle.

40.1.2.2 Launch and Guidance Control. The launch and guidance control element refers to the equipment to target air vehicles, make launch decisions, and command launch. This includes such items as the control and checkout console, data displays, secure code device, programmer group, communication control console, command message processing group, and digital data group. It also includes equipment at the launch facility/vehicle and/or the launch control center(s) (air, sea, or mobile). It also includes the launch code processing system.

40.1.2.3 Communications. The communications element refers to the equipment, not resident on the air vehicle, which distributes intelligence between the air vehicle and the command and launch equipment. This element includes inter-communication subsystems of launch sites for tactical and administrative message flow and ties between sensor, data processing, launch, and guidance control subsystems. Communications may interface with existing fixed communication facilities or communication subsystems of launch platforms which are associated systems to the missile system.

40.1.2.4 Command and Launch Applications Software. The command and launch applications software element includes all the software required to direct and perform the operations of the command and launch equipment (ref. ANSI/IEEE Std 610.12). This element refers to all effort required to design, develop, integrate, and checkout the command and launch applications computer software configuration items (CSCIs),

not including the nonsoftware portion of command and launch firmware development and production. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used.

40.1.2.5 Command and Launch System Software. The command and launch system software element is defined as software designed for a specific computer system or family of computer systems to facilitate the operation and maintenance of the computer system and associated programs, for example, operating systems, compilers, and utilities (ref. ANSI/IEEE Std 610.12). This element refers to all effort required to design, develop, integrate and checkout the command and launch system software including all software developed to support any command and launch applications software development. It is defined as command and launch system software which is required to facilitate development, integration, and maintenance of any command and launch software CSCI. This excludes all software that is an integral part of any specific hardware subsystem specification or specifically designed and developed for system test and evaluation. When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used.

40.1.2.6 Launcher Equipment. The launcher equipment element refers to the means to launch the missile air vehicle from stationary sites or mobile launch platforms. It includes vehicles, rail launchers, canisters, capsules, tubes, pods and devices which support, suspend or encase the air vehicle for firing. It also includes associated hardware such as umbilicals, harnesses, pyrotechnics, and electronics. This element may include storage facilities and checkout stations for readiness verification when these are integral to the launcher. It may include safety and protective elements when these are not integral to the launch platform or site facilities.

40.1.2.7 Auxiliary Equipment. The auxiliary equipment element refers to the general purpose/multi-usage ground equipment utilized to support the various operational capabilities of the command and launch equipments and are generally excluded from other specific level 3 elements. This element includes, for example, power generators, power distribution systems, environmental control, cabling, malfunction detection, fire prevention, security systems, and other common-usage items not applicable to specific elements of the ground based equipment.

Definitions for common WBS elements applicable to the missile and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. pages H-1 through H-10).

APPENDIX D
WORK BREAKDOWN STRUCTURE AND DEFINITIONS
ORDNANCE SYSTEMS

10. SCOPE

10.1 This appendix provides the ordnance system work breakdown structure. Definitions for the complete round and launch system are provided in this appendix. Definitions for common WBS elements applicable to the ordnance system and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS.

This section is not applicable to this appendix.

30. WORK BREAKDOWN STRUCTURE

30.1 Levels. The following is the work breakdown structure for an ordnance system.

Level 1	Level 2	Level 3
Ordnance System		
	Complete Round	
		Structure
		Payload
		Guidance and Control
		Fuze
		Safety/Arm
		Propulsion
		Integration, Assembly, Test and Checkout
	Launch System	
		Launcher
		Carriage
		Fire Control
		Ready Magazine
		Adapter Kits
		Integration, Assembly, Test and Checkout
	Systems Engineering/Program Management	
	System Test and Evaluation	
		Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups
		Test and Evaluation Support
		Test Facilities

Level 1	Level 2	Level 3
	Training	
		Equipment
		Services
		Facilities
	Data	
		Technical Publications
		Engineering Data
		Management Data
		Support Data
		Data Depository
	Peculiar Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Common Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Operational/Site Activation	
		System Assembly, Installation and Checkout on Site
		Contractor Technical Support
		Site Construction
		Site Conversion
	Industrial Facilities	
		Construction/Conversion/Expansion
		Equipment Acquisition or Modernization
		Maintenance (Industrial Facilities)
	Initial Spares and Repair Parts	

40. DEFINITIONS

40.1 Ordnance System. The ordnance system element refers to the complex of equipment (hardware/software), data, services, and facilities required to develop and produce the capability for applying munitions to a target. It includes the munitions (nuclear, biological, chemical, psychological, and pyrotechnic) and the means of launching or firing the munitions, and is represented by MK48 torpedo system, SNAKEYE bomb, Combined Effects Munitions, GATOR, Sensor Fuzed Weapon, 8-inch Howitzer, and .223 caliber ammunition. Excluded are aerospace guided missiles and land, sea, or air delivery vehicles.

40.1.1 Complete Round. The complete round element refers to all the components that are necessary for firing one shot, such as mines, bombs, rockets, torpedoes, naval guns, rifles, and artillery ammunition. It includes structural elements, warhead or payload, fuze, safety/arming devices, guidance equipment, and propellant/propulsion equipment. For artillery ammunition, the complete round consists of the projectile including structure, warhead, fuze, guidance and control (if applicable), safety/arming devices, propelling charge, and rocket motor (if applicable). It also includes the design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use).

40.1.1.1 Structure. The structure element refers to the portion of the complete round which carries the payload to the target. It is the basic housing of a bomb or rocket, casing of a projectile, body of a torpedo, or the tactical munitions dispenser containing submunitions. It also includes those structural devices which provide stability and control (i.e., fins, parachutes, anchors). All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the complete round is excluded.

40.1.1.2 Payload. The payload element refers to the subsystem that contains the warhead and its support assemblies. In some munitions, such as small arms ammunition, the payload may only be the warhead (i.e., a projectile assembly containing the kill mechanism of the round and its associated high explosives, chemicals, biological agents, nuclear devices, and pyrotechnics). With complex munitions containing submunitions, such as Combined Effects Munitions, the payload subsystem may include guidance and control, fuze, safety/arm, and propulsion as defined in 40.1.1.3, 40.1.1 4, 40.1.1.5, and 40.1.1.6 of this appendix. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the complete round is excluded.

40.1.1.3 Guidance and Control. The guidance and control element refers to the complex of electronic equipment (hardware/software) which evaluates and correlates the path of the complete round with target information, and which performs the necessary functions to enable the payload to intercept the target. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the complete round is excluded.

40.1.1.4 Fuze. The fuze element refers to the mechanical or electronic device in the complete round designed to detonate or to set forces into action to detonate the charge or primer under desired conditions. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the complete round is excluded.

40.1.1.5 Safety/Arm. The safety/arm element refers to the device in the complete round which controls the capability of initiating the explosive sequence (e.g., mechanical, hydrostatic, inertial, counters, and timers). All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the complete round is excluded.

40.1 1.6 Propulsion. The propulsion element refers to the chemical, mechanical, or electrical devices, such as explosive powder charges, chemical precision initiation charges, electric power modules, and rocket motors which provide the forces to transport the complete round from the launch position to the target. For artillery ammunition, this element includes the cartridge case, if applicable, and primer as well as the explosive charge itself. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the complete round is excluded.

40.1.1.7 Integration, Assembly, Test and Checkout. The integration, assembly, test and checkout element includes all efforts as identified in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. page H-2), to provide a complete round.

40.1.2 Launch System. The launch system element refers to the equipment (hardware/software) for controlling or sending forth the munitions on a desired course or trajectory – the ordnance system less the complete round. It is defined as rifles, artillery pieces, naval guns, mortar cannons, machine guns, and the equipment for launching torpedoes and rockets or dropping bombs (e.g., the launcher, fire control equipment, and the ready magazine). It includes all effort associated with the design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use).

40.1.2.1 Launcher. The launcher element refers to the structural device designed to support and hold munitions in position for firing or release (e.g., suspension and release systems, rail, rocket pods, mine racks or dispensers, and torpedo tubes). For guns and artillery, it includes tubes, recoil assemblies, breech mechanisms, mounts, and rifle stocks. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the launch system is excluded.

40.1.2.2 Carriage. The carriage element refers to the primary equipment (hardware/software) which serves as a platform to accommodate the other level 3 elements and provides mobility to the complete launch system (e.g., T-frame, hull/chassis, wheels, tires, tubes, brakes, hydraulics, and secondary power batteries/generators), which are an integral part of the carriage itself and not directly a part of other level 3 elements. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the launch system is excluded.

40.1.2.3 Fire Control. The fire control element refers to the equipment (hardware/software) for controlling the direction, volume, and time of fire or release of munitions through the use of electrical, electronic, optical, or mechanical systems, devices or aids. For rifles and small arms, it includes sighting devices and trigger mechanisms. For artillery, naval guns, and heavy mortars, it additionally includes aiming mechanisms in traverse and elevation, radar and other sensors, computers and other equipment for performing fire control computations. For air-dropped munitions, it includes gunsights, intervalometers, and other sensor and computational devices for controlling the release of the munitions. For torpedoes, it includes sonar and other sensors, computers, control consoles, and devices for presetting torpedo speed and direction. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the launch system is excluded.

40.1.2.4 Ready Magazine. The ready magazine element refers to the structure or compartment for storing ammunition or explosives in a ready-for-use condition or position (e.g., part of a gun or firearm which holds the ammunition ready for chambering and feed mechanisms for placing the ammunition in a position ready for chambering). All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the launch system is excluded.

40.1.2.5 Adapter Kits. The adapter kits element refers to the equipment (hardware/software) for adapting the launch system to particular applications (e.g., vehicle adapter kits for adaptation to different aircraft models, kits for backpacking, etc.). All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the launch system is excluded.

40.1.2.6 Integration, Assembly, Test and Checkout. The integration, assembly, test and checkout element includes all efforts as identified in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. page H-2), to provide a complete launch system.

Definitions for common WBS elements applicable to the ordnance system and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. pages H-1 through H-10).

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APPENDIX E
WORK BREAKDOWN STRUCTURE AND DEFINITIONS
SHIP SYSTEMS

10. SCOPE

10.1 This appendix provides the ship system work breakdown structure. Definitions for the ship are provided in this appendix. Definitions for common WBS elements applicable to the ship and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements. This work breakdown structure must be used for ship acquisition pricing data, ship design, weight data, configuration management and ILS engineering data. It is permissible for the contractor's internal work breakdown structure to differ from these summary elements with the approval of the appropriate government organization. The approved internal management work breakdown structure must be traceable to and capable of being reported to the work breakdown structure and definitions defined by this appendix. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS.

This section is not applicable to this appendix.

30. WORK BREAKDOWN STRUCTURE

30.1 Levels. The following is the work breakdown structure for a ship system.

Level 1	Level 2	Level 3
Ship System		
	Ship	
		Hull Structure
		Propulsion Plant
		Electric Plant
		Command and Surveillance
		Auxiliary Systems
		Outfit and Furnishings
		Armament
		Integration/Engineering
		Ship Assembly and Support Services
	Systems Engineering/Program Management	
	System Test and Evaluation	
		Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups
		Test and Evaluation Support
		Test Facilities

Level 1	Level 2	Level 3
	Training	
		Equipment
		Services
		Facilities
	Data	
		Technical Publications
		Engineering Data
		Management Data
		Support Data
		Data Depository
	Peculiar Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Common Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Operational/Site Activation	
		System Assembly, Installation and Checkout on Site
		Contractor Technical Support
		Site Construction
		Site Conversion
	Industrial Facilities	
		Construction/Conversion/Expansion
		Equipment Acquisition or Modernization
		Maintenance (Industrial Facilities)
	Initial Spares and Repair Parts	

40. DEFINITIONS

40.1 Ship System. The ship system element refers to the complex of equipment (hardware/software), data, services, and facilities required to attain the capability of operating or supporting the operation of naval weapons, or performing other naval tasks at sea.

40.1.1 Ship. The ship element refers to the waterborne vehicle of a ship system. It includes all types of surface and subsurface water vehicles such as combatants, auxiliaries, amphibious, and special-purpose ships. It includes the design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use).

40.1.1.1 Hull Structure. The hull structure element refers to the assembled main hull body with all structure subdivision. This element includes, for example, shell plating, longitudinal and transverse framing, platforms and decks, superstructure, foundations, structural bulkheads, enclosures and sponsors; castings, forgings, and welds; fixed ballast; doors and closures; king-posts, masts, and service platforms; and sonar domes. It also includes compartment testing.

40.1.1.2 Propulsion Plant. The propulsion plant element refers to those major components installed primarily for propulsion and the systems necessary to make these components operable. This element includes, for example, boilers and energy converters, propulsion units, main condensers and air ejectors, shafting, bearings, propellers, combustion air supply system, uptakes, propulsion control equipment, main stream, feed water and condensate, circulating and cooling water, fuel oil service and lubricating oil system. It also includes nuclear steam generators, reactors, reactor coolant and auxiliary systems, nuclear power plant control, and radiation shielding.

40.1.1.3 Electric Plant. The electric plant element refers to the power generating and distribution systems installed primarily for ship service and emergency power and lighting. This element includes, for example, the electric power generation, power distribution switchboards, power distribution system, and lighting system.

40.1.1.4 Command and Surveillance. The command and surveillance element is defined as all equipment (hardware/software) and associated systems installed to receive information from off-ship source, to transmit to off-ship receivers, and to distribute information throughout the ship. It also includes sensing and data systems required for navigation and weapon fire control. This element includes, for example, navigation equipment, interior communication systems and equipment, gun fire control system, nonelectronic countermeasure systems, electronic countermeasure systems, missile fire control systems, antisubmarine warfare fire control and torpedo fire control systems, radar systems, radio communication systems, electronic navigation systems, space vehicle electronic tracking systems, sonar systems, electronic tactical data systems, and all associated software.

40.1.1.5 Auxiliary Systems. The auxiliary systems element is defined as those systems required for ship control, safety, provisioning, and habitability. It includes the auxiliary machinery and piping systems; the hull mechanical handling systems; and ship control surfaces such as rudders, hydrofoils, and driving planes. This element includes, for example, heating, ventilation air conditioning systems; refrigerating spaces; plant and equipment; gasoline, JP-5, all liquid cargo piping, oxygen-nitrogen and aviation lubricating oil systems; plumbing installation, saltwater service systems, fire extinguishing systems, drainage, ballast, trimming, heating, and stabilizer tank systems; fresh water system, scuppers and deck drains; fuel and diesel oil filling, venting, stowage and transfer systems; tank heating systems, compressed air system, auxiliary steam, exhaust steam and steam drains, buoyancy control system, distilling plant; and steering system, mooring, towing, anchor and aircraft handling systems, deck machinery, elevators, moving stairways, stores strikedown and stores handling equipment, operating gear for retracting and elevating units, aircraft elevators; aircraft arresting gear, barriers, and barricades; catapults and jet blast deflectors, replenishment at sea and cargo handling systems.

40.1.1.6 Outfit and Furnishings. The outfit and furnishings element is defined as those outfit equipments and furnishings required for habitability and operability which are not specifically included in other ship elements. This element includes, for example, hull fittings; boats, boat stowage and handlings; rigging and canvas; ladders and gratings; nonstructural bulkheads and doors; painting, deck covering, hull insulation; storerooms, stowage and lockers; equipment for utility space, workshops, laboratories, test areas, alley, pantry, scullery and commissary outfit; furnishings for living spaces, offices, control centers, machinery spaces, medical, dental and pharmaceutical spaces; and nonpropulsion space shielding.

40.1.1.7 Armament. The armament element is defined as the complex of armament and related ammunition handling, stowage, and support facilities; and cargo munitions handling, stowage, and support facilities. This element includes, for example, guns, and gun mounts; ammunition handling systems and stowage; special weapons handling and storage; rocket and missile launching devices, handling systems and stowage; air launched weapons handling systems and stowage; and cargo munitions handling and stowage.

40.1.1.8 Integration/Engineering. The integration/engineering element is defined as that engineering effort and related material associated with the design, development, and rework to provide the ship as a whole exclusive of that included under the Systems Engineering/Program Management element. This element includes, for example, construction drawings, engineering calculations, weighing and weight calculation, photographs, models, and shipbuilders information drawings.

40.1.1.9 Ship Assembly and Support Services. The ship assembly and support services element is defined as those efforts and material associated with the construction which cannot be logically and practicably identified with, or related to other level 3 elements. This element includes, for example, staging, scaffolding, and cribbing; temporary utilities and services; molds, templates, jigs, fixtures, and special production tools; dry-docking, inspection, insurance, launching, and delivery.

Definitions for common WBS elements applicable to the ship and all other defense materiel items are found in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. pages H-1 through H-10).

APPENDIX F
WORK BREAKDOWN STRUCTURE AND DEFINITIONS
SPACE SYSTEMS

10. SCOPE

10.1 This appendix provides the space system work breakdown structure. Definitions for the launch vehicle, orbital transfer vehicle, space vehicle, ground command, control, communications and mission equipment, flight support operations and services, and storage are provided in this appendix. Definitions for common WBS elements applicable to the space system and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS.

This section is not applicable to this appendix.

30. WORK BREAKDOWN STRUCTURE

30.1 Levels. The following is the work breakdown structure for a space system.

Level 1	Level 2	Level 3
Space System		
	Launch Vehicle	
		Propulsion (Single Stage Only)
		Stage I
		Stage II...n (As Required)
		Strap-On Units (As Required)
		Shroud (Payload Fairing)
		Guidance and Control
		Integration, Assembly, Test and Checkout
	Orbital Transfer Vehicle	
		Propulsion (Single Stage Only)
		Stage I
		Stage II...n (As Required)
		Strap-On Units (As Required)
		Guidance and Control
		Integration, Assembly, Test and Checkout
	Space Vehicle	
		Spacecraft
		Payload I...n (As Required)
		Reentry Vehicle
		Orbit Injector/Dispenser
		Integration, Assembly, Test and Checkout

Level 1	Level 2	Level 3
	Ground Command, Control, Communications and Mission Equipment	
		Sensor I...n (As Required)
		Telemetry, Tracking and Control
		External Communications
		Data Processing Equipment
		Launch Equipment
		Auxiliary Equipment
	Systems Engineering/Program Management	
	System Test and Evaluation	
		Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups
		Test and Evaluation Support
		Test Facilities
	Training	
		Equipment
		Services
		Facilities
	Data	
		Technical Publications
		Engineering Data
		Management Data
		Support Data
		Data Depository
	Peculiar Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Common Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Operational/Site Activation	
		System Assembly, Installation and Checkout on Site
		Contractor Technical Support
		Site Construction
		Site/Ship/Vehicle Conversion

Level 1	Level 2	Level 3
	Flight Support Operations and Services	
		Mate/Checkout/Launch
		Mission Control
		Tracking and C^3
		Recovery Operations and Services
		Launch Site Maintenance/Refurbishment
	Storage	
		Planning and Preparation
		Storage
		Transfer and Transportation
	Industrial Facilities	
		Construction/Conversion/Expansion
		Equipment Acquisition or Modernization
		Maintenance (Industrial Facilities)
	Initial Spares and Repair Parts	

40. DEFINITIONS

40.1 Space System. The space system element refers to the complex of equipment (hardware/software), data, services, and facilities required to attain and/or maintain an operational capability in space. To achieve an operational capability in space it is necessary to have the ability to develop, deliver, and maintain mission payload(s) in specific orbit. This requires the ability to develop and produce a capability for the placement, operation, and recovery of both manned and unmanned space systems. Space systems include launch vehicles, orbital transfer vehicles, shrouds, space vehicles, communications, command and control facilities and equipment, and any mission equipment or other items necessary to provide an operational capability in space.

40.1.1 Launch Vehicle. The launch vehicle element refers to the primary means for providing initial thrust to place a space vehicle into its operational environment. The launch vehicle is the prime propulsion portion of the complete flyaway (not to include the orbital transfer vehicle and space vehicle). The launch vehicle may be of a single-stage or multiple-stage configuration. This element includes, for example, the structure, propulsion, guidance and control, and all other installed equipment integral to the launch vehicle as an entity within itself. It also includes the design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use).

40.1.1.1 Propulsion (Single Stage Only). The propulsion element refers to the means for generating the launch vehicle into its operational orbit or its intended path. This element includes, for example, the engine, structure, propellant and fuel, distribution and control of propellant and fuel, starting means, safety devices, and internal environmental control when grouped as a functional entity. It also includes the design, development, production, and assembly efforts to provide the propulsion subassembly as an entity. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the launch vehicle is excluded.

40.1.1.2 Stage I. This element refers to the launch vehicle stage which provides initial lift-off propulsion for the complete launch vehicle (flyaway) and cargo. This element includes, for example, the structure, propulsion, controls, instrumentation, and all other installed subsystem equipment integral to the stage as an entity within itself. It also includes the design, development, production, and assembly efforts to provide Stage I as an entity. Strap-on units are excluded. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the launch vehicle is excluded.

40.1.1.3 Stage II...n (As Required). This element refers to the second and subsequent launch vehicle stages (if applicable) which are used to place a space vehicle into its operational environment. This element provides propulsion following separation of the first stage and subsequent stages (if applicable), and includes the structure, propulsion, controls, instrumentation, separation subsystems, and all other installed subsystem equipment integral to the stage as an entity within itself. It also includes the design, development, production, and assembly efforts to provide each stage as an entity. Strap-on units are excluded. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the launch vehicle is excluded.

40.1.1.4 Strap-On Units (As Required). In the event strap-on units are employed, this element refers to the solid or liquid propulsion assemblies that provide additional thrust or propellant to assist the launch vehicle in placing a spacecraft into its operational orbit. This element refers to a complete set of strap-on units and includes, for example, the case, nozzle, igniter, tanks, mounting structure, cordage, etc. It also includes the design, development, production, and assembly efforts to provide the strap-on units as an entity. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the launch vehicle is excluded.

40.1.1.5 Shroud (Payload Fairing). This element refers to the protective covering and equipment which is mated to the launch vehicle and protects the cargo (i.e., orbital transfer vehicle or space vehicle/orbital transfer vehicle combination) prior to and during the launch vehicle ascent phase. This item includes the structure, instrumentation, separation, power, and thermal control subsystems, and integration, assembly, test and checkout. The structure includes, for example, the shroud structure, mechanisms and hinges. The instrumentation includes hardware and software required to measure the environment and loads being experienced by the shroud during the ascent phase until shroud separation and deployment. The separation subsystem includes, for example, the sequencers, ordnance, and other necessary mechanisms to assure a successful shroud separation from the launch vehicle and cargo. The power system provides the necessary generation, storage and distribution of electrical power and signals, hydraulic power, and any other power required by the shroud. The thermal control system maintains (within allowable limits) the temperature of the shroud and/or any mission equipment within it. The thermal control function may be accomplished either passively or actively. This includes, for example, thermal paint, insulation, and heatshield tiles.

40.1.1.6 Guidance and Control. The guidance and control equipment (hardware/software) refers to the means for generating or receiving guidance intelligence, conditioning the intelligence to produce control signals, and generating appropriate control forces. Controllers may interface with the structure by actuating moveable aero surfaces or with the propulsion system to produce control reaction forces or may independently produce reaction forces for control. If the design is such that electronics are packaged into a single rack or housing as an assembly, this rack or housing will be considered part of the guidance and control system. This element includes, for example, the guidance intelligence system, computer, sensing elements, etc. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the launch vehicle is excluded.

40.1.1.7 Integration, Assembly, Test and Checkout. The integration, assembly, test and checkout element includes all efforts as identified in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. page H-2), to provide a complete launch vehicle.

40.1.2 Orbital Transfer Vehicle. The orbital transfer vehicle refers to any transportation system which is utilized for placing spacecraft in an operational environment following launch vehicle separation/deployment. Orbital transfer vehicle includes, for example, "upper-stages" and orbital maneuvering vehicles. The orbital transfer vehicle may be of a single-stage or multiple-stage configuration. This element includes the structure, propulsion, guidance and control, all other installed equipment, and all software integral to the vehicle. It also includes the design development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use).

40.1.2.1 Propulsion (Single Stage Only). The propulsion element refers to the means for generating the orbital transfer vehicle into its operational orbit. This element includes, for example, the engine, structure, propellant and fuel, distribution and control of propellant and fuel, starting means, safety devices, and internal environmental control when grouped as a functional entity. It also includes the design, development, production, and assembly efforts to provide the propulsion structure as an entity. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the orbital transfer vehicle is excluded.

40.1.2.2 Stage I. This element refers to the orbital transfer vehicle stage which provides initial propulsion for the orbital transfer vehicle following separation or deployment from the launch vehicle. This includes, for example, the structure, propulsion, controls, instrumentation, separation, and all other installed subsystem equipment integral to the stage as an entity within itself. It also includes the design, development, production, and assembly efforts to provide Stage I as an entity. Strap-on units are excluded. All effort directly associated

with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the orbital transfer vehicle is excluded.

40.1.2.3 Stage II...n (As Required). This element refers to the second orbital transfer vehicle stage and subsequent stages (as required) which are used to place a space vehicle into its operational environment. This provides propulsion following separation of the first stage, and includes the structure, propulsion, controls, instrumentation, separation subsystems, and all other installed subsystem equipment integral to the stage as an entity within itself. It also includes the design, development, production, and assembly efforts to provide each stage as an entity. Strap-on units are excluded. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the orbital transfer vehicle is excluded.

40.1.2.4 Strap-On Units (As Required). In the event strap-on units are employed, this element refers to the solid or liquid propulsion assemblies that provide additional thrust or propellant to assist the orbital transfer vehicle in placing a space vehicle into its operational orbit. This element refers to a complete set of strap-on units and includes, for example, the case, nozzle, igniter, tanks, mounting structure, cordage, etc. It also includes the design, development, production, and assembly efforts to provide the strap-on units as an entity. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the orbital transfer vehicle is excluded.

40.1.2.5 Guidance and Control. The guidance and control equipment (hardware/software) refers to the means for generating or receiving guidance intelligence, conditioning the intelligence to produce control signals, and generating appropriate control forces. Controllers may interface with the structure by actuating moveable aero surfaces or with the propulsion system to produce control reaction forces or may independently produce reaction forces for control. If the design is such that electronics are packaged into a single rack or housing as an assembly, this rack or housing will be considered part of the guidance and control element. This element includes, for example, the guidance intelligence system, computer, sensing elements, etc. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the orbital transfer vehicle is excluded.

40.1.2.6 Integration, Assembly, Test and Checkout. The integration, assembly, test and checkout element includes all efforts as identified in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. page H-2), to provide a complete orbital transfer vehicle.

40.1.3 Space Vehicle. The space vehicle element refers to a complete vehicle, or group of vehicles placed into space (operational orbit environment). This element includes spacecraft, payload, reentry vehicle and orbit injection/dispenser and integration, assembly, test and checkout. It also includes the design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use).

40.1.3.1 Spacecraft. The spacecraft element refers to the principal operating space vehicle which serves as a housing or platform for carrying a payload and other mission-oriented equipments in space. This element includes, for example, structure, power, attitude determination and control, and other equipments characteristic of spacecraft. It also includes all design, development, production, and assembly efforts to provide the spacecraft as an entity. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the space vehicle is excluded.

40.1.3.2 Payload. The payload element refers to that equipment provided for special purposes in addition to the normal equipment integral to the spacecraft or reentry vehicle. It includes, for example, experimental equipment placed on board the vehicle, flight crew equipment (space suits, life support, and safety equipment).

communications, displays and instrumentation, telemetry equipment and other equipments that are specifically mission-oriented to collect data for future planning and projection purposes. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the space vehicle is excluded.

40.1.3.3 Reentry Vehicle. The reentry vehicle element refers to the principal operating vehicle specifically designed to safely reenter the atmosphere in order to land a payload (experimental equipment or crew). This element includes, for example, navigation and guidance, power supply, command and control, attitude control, environmental control, propulsion, and other equipments homogeneous to the reentry vehicle. It also includes all design, development, production, and assembly efforts to provide the reentry vehicle as an entity. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the space vehicle is excluded.

40.1.3.4 Orbit Injector/Dispenser. The orbit injector/dispenser element refers to the function of placing orbiting objects in the planned orbital path. This element includes, for example, the structure, propulsion, instrumentation and stage interface, separation subsystem, and other equipment necessary for integration with other level 3 elements. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the space vehicle is excluded.

40.1.3.5 Integration, Assembly, Test and Checkout. The integration, assembly, test and checkout element includes all efforts as identified in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. page H-2), to provide a complete space vehicle.

40.1.4 Ground Command, Control, Communications and Mission Equipment. The ground command, control, communications and mission equipment element refers to the ground hardware/software equipment used for: communicating between control and tracking facilities, monitoring the health and status of space vehicles, commanding the space vehicle's hardware, adjusting the space vehicle's orbit as required for space vehicle health or mission purpose. It includes the design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use). Examples of two configurations for the ground command, control, communications and mission equipment are: the parabolic dish-based antenna system and the phased array-based antenna system. If a ground site has multiple antenna configurations, each will have its own separate command and control equipment, communications equipment, data processing equipment and test equipment.

40.1.4.1 Sensor I...n (As Required). This element includes those hardware and software elements/components which comprise the sensor system. Typical hardware normally includes the antenna, platform/pedestal, radome, transmission equipment, reception equipment and other sensor subsystems. It also includes the design, development, production, and assembly efforts to provide each sensor as an entity.

40.1.4.2 Telemetry, Tracking and Control. The telemetry, tracking and control element refers to the hardware/software elements that facilitate launch decisions and command and control of the aerospace vehicle. This element includes, for example, supplementary means for guidance of those aerospace vehicles not having completely self-contained guidance and control and means to command destruct. It also includes control and check-out consoles, data displays, and mission records.

40.1.4.3 External Communications. The external communications element includes, for example, the hardware/software components that allow the ground station to communicate with any external data link or source (i.e.,telephone (analog) lines, digital data lines, nonsatellite radio receivers). While the terrestrial data lines may connect to radio of other satellite communications stations, the external communications subsystem

ends where these links physically connect to the secure communications, modulation/demodulation (modem) or coder/decoder equipment.

40.1.4.4 Data Processing Equipment. The data processing equipment includes the hardware/software components that provide the activities and means to condition data generated at the launch site or aboard the space vehicle, or data received from associated systems to accommodate the needs of command and control or mission data processing. This element includes, for example, central processing unit (computer), peripheral equipment, and the software required to operate the data processing equipment.

40.1.4.5 Launch Equipment. The launch equipment element refers to the means to launch the aerospace vehicle from stationary sites. This element may include storage facilities and checkout stations for readiness verification when these are integral to the launcher. It may also include safety and protective elements when these are not integral to the launch platform or facilities.

40.1.4.6 Auxiliary Equipment. The auxiliary equipment element refers to the general purpose/multi-usage ground equipment utilized to support the various operational capabilities of the command and launch equipments. This element includes, for example, power generators, power distribution systems, environmental control, cabling, malfunction detection, fire prevention, security systems, and other common-usage items not applicable to specific elements of the ground based equipment.

40.1.5 Flight Support Operations and Services. The flight support operations and services element refers to the mate/checkout/launch; mission control; tracking; and command, control and communications (C^3); recovery operations and services; and launch site maintenance/refurbishment. This element supports the launch vehicle, orbital transfer vehicle, and/or space vehicle during an operational mission.

40.1.5.1 Mate/Checkout/Launch. This element refers to preflight operations and services subsequent to production and/or storage, and the actual launch of the complete system and payload. It includes effort and materials to conduct equipment receiving and checkout at launch site, preflight assembly and checkout, pre/post flight data reduction and analysis, and any prelaunch flight control/mission control planning.

40.1.5.2 Mission Control. The mission control element includes, for example, the personnel and material required to operate individual mission control centers and to perform ground command and control with the space vehicles. It includes the mission control centers such as, Constellation Command Center, the Battle Management/Command Control Center (BM/C^3), the Space Asset Support System Control Center, and the Space Transportation Control Center. (It excludes the tracking and communications centers; these are included in WBS element 40.1.5.3.)

40.1.5.3 Tracking and C^3. The tracking and C^3 element refers to the personnel and material required to perform the functions of telemetry, tracking, controlling, and data retrieval for the mission control systems. These systems may be located on the ground or in space, such as, the Satellite Control Facility; the Remote Tracking Station; the Tracking, Data, Relay Satellite System; and other ground/space tracking systems. (It excludes the initial acquisition of the tracking and C^3; acquisition of these systems are included in WBS element 40.1.4.)

40.1.5.4 Recovery Operations and Services. The recovery operations and services element refers to all contractor effort and material necessary to effect recovery of the space vehicle or other mission equipment. This element includes, for example, the launch site recovery forces, reentry site recovery forces, logistics support to recovery forces, logistics support to the recovery operations, communications, and transportation of recovered equipment to assigned facilities.

40.1.5.5 Launch Site Maintenance/Refurbishment. The launch site maintenance/refurbishment element refers to the organization maintenance/management of launch vehicle facilities, mission equipment, and support at the launch base. This element includes the requirements to clean up and refurbish each launch site after each launch.

40.1.6 Storage. The storage element refers to those costs of holding portions of the space system while awaiting use of the system. These periods of holding are those resulting from schedule changes and/or technological problems exogenous to the portion of the space system being stored, prepared for storage, or recovered from storage.

40.1.6.1 Planning and Preparation. The planning and preparation element refers to all planning and preparation costs for the storage of all systems/subsystems associated with the launch vehicle, orbital transfer vehicle, and space vehicle equipment. It includes the generation of any storage/maintenance instructions and documents necessary for the storage and maintenance of repairable systems/subsystems.

40.1.6.2 Storage. The storage element refers to the storage and maintenance cost incurred while the systems/subsystems of the launch vehicle, orbital transfer vehicle, and space vehicle equipment are in storage.

40.1.6.3 Transfer and Transportation. The transfer and transportation element refers to transfer and storage costs incurred when the systems/subsystems of the launch vehicle, orbital transfer vehicle, and space vehicle equipment are required to be transferred from one location and stored in another location. This item also includes costs of relocating systems/subsystems from one storage area to another storage area when necessitated by mission requirements.

Definitions for common WBS elements applicable to the space system and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. pages H-1 through H-10).

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APPENDIX G
WORK BREAKDOWN STRUCTURE AND DEFINITIONS
SURFACE VEHICLE SYSTEMS

10. SCOPE

10.1 This appendix provides the surface vehicle system work breakdown structure. Definitions for the primary vehicle and secondary vehicle are provided in this appendix. Definitions for common WBS elements applicable to the surface vehicle and all other defense materiel items are in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. pages H-1 through H-10). This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS.

This section is not applicable to this appendix.

30. WORK BREAKDOWN STRUCTURE

30.1 Levels. The following is the work breakdown structure for a surface vehicle.

Level 1	Level 2	Level 3
Surface Vehicle System		
	Primary Vehicle	
		Hull/Frame
		Suspension/Steering
		Power Package/Drive Train
		Auxiliary Automotive
		Turret Assembly
		Fire Control
		Armament
		Body/Cab
		Automatic Loading
		Automatic/Remote Piloting
		Nuclear, Biological, Chemical
		Special Equipment
		Navigation
		Communications
		Integration, Assembly, Test and Checkout
	Secondary Vehicle	Same as Primary Vehicle
	Systems Engineering/Program Management	

Level 1	Level 2	Level 3
	System Test and Evaluation	
		Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups
		Test and Evaluation Support
		Test Facilities
	Training	
		Equipment
		Services
		Facilities
	Data	
		Technical Publications
		Engineering Data
		Management Data
		Support Data
		Data Depository
	Peculiar Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Common Support Equipment	
		Test and Measurement Equipment
		Support and Handling Equipment
	Operational/Site Activation	
		System Assembly, Installation and Checkout on Site
		Contractor Technical Support
		Site Construction
		Site Conversion
	Industrial Facilities	
		Construction/Conversion/Expansion
		Equipment Acquisition or Modernization
		Maintenance (Industrial Facilities)
	Initial Spares and Repair Parts	

40.0 DEFINITIONS

40.1 Surface Vehicle System. The surface vehicle system element refers to the complex of equipment, data, services and facilities required to develop and produce a vehicle system with the capability to navigate over the surface. Surface vehicle category includes vehicles primarily intended for general purpose applications and those intended for mating with specialized payloads. This element includes cargo and logistics vehicles, mobile work units and combat vehicles. It also includes combat vehicles serving as armored weapons platforms, reconnaissance vehicles, and amphibians.

40.1.1 Primary Vehicle. The primary vehicle element refers to the mobile element of the system embodying means for performing operational missions. This element includes means of propulsion and structure for adaptation of mission equipment or accommodations for disposable loads. It also includes the design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use).

40.1.1.1 Hull/Frame. The hull/frame element refers to the vehicle's primary load bearing component which provides the structural integrity to withstand the operational loading stresses generated while traversing various terrain profiles. This element could be a simple wheeled vehicle frame or a more complicated combat vehicle hull which satisfies not only the structural requirements but also provides armor protection. It includes all structural subassemblies and appendages which attach directly to the primary structure. This element, for example, includes towing and lifting fittings, bumpers, hatches and grilles. It also includes provision to accommodate other subsystems such as mountings for suspension, weapons, turret, truck body, cab, special equipment loads, etc. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.2 Suspension/Steering. The suspension/steering element refers to the means for generating tractive efforts, thrust, lift, and steering forces generally at or in proximity to the earth's surface and adapting the vehicle to the irregularities of the surface. This element includes, for example, wheels, tracks, brakes, and steering gears for traction and control functions; and rudder thrust devices and trim vanes for amphibians. It also includes springs, shock absorbers, skirts, and other suspension members. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.3 Power Package/Drive Train. The power package/drive train element refers to the means for generating power and delivering power in the required quantities and driving rates to the driving member. This element includes for example, engine-mounted auxiliaries such as air ducting and manifolds, controls and instrumentation, exhaust systems, and cooling means. It also includes such power transport components as clutches, transmission, shafting assemblies, torque converters, differentials, final drivers, and power takeoffs. It may include brakes and steering when these are integral to power transmission rather than in the suspension/steering element. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.4 Auxiliary Automotive. The auxiliary automotive element refers to the group of subsystems (hardware/software) which provide services to all of the primary vehicle subsystems, as distinguished from the special equipment subsystems, and which outfit the chassis. This element includes, for example, the vehicle electrical or electronics system, on-board diagnostics/prognostics system, fire extinguisher system and controls, chassis mounted accessories such as the winch and power take-off, tools and on-vehicle equipment. When otherwise not provided for, it includes crew accommodations. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.5 Turret Assembly. The turret assembly element refers to the structure and equipment installations required to provide the fighting compartment element of combatant vehicles. This element includes turret armor and radiological shielding, turret rings, slip rings, attachments and appendages such as hatches and cupolas, and accommodations for personnel, weapons, and command and control. It excludes fire control and stabilization system. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.6 Fire Control. The fire control element refers to that equipment (hardware/software) installed in the vehicle which provides intelligence necessary for weapons delivery such as launching and firing. This element includes, for example, radars and other sensors necessary for search, recognition and/or tracking; controls and displays; sights or scopes; range finders, computers, computer programs, turret and gun drives, and stabilization systems. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.7 Armament. The armament element refers to the means for combatant vehicles to deliver fire on hostile targets and for logistics and other vehicles to exercise self-defense. This element includes, for example, the main gun, launchers, and secondary armament. Fire control systems are excluded. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.8 Body/Cab. The body/cab element refers to the major component to be mated to a chassis to provide a complete vehicle having a defined mission capability. This element includes accommodations for personnel, cargo, and such subsystems as need to be placed in proximity to operators. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.9 Automatic Loading. The automatic loading element consists of that equipment (hardware/software) providing the means to select ammunition from a stored position in the vehicle and transferring to and loading the armament system. This element also includes the means to eject spent cases and misfired rounds. Components include all ammunition storage racks, transfer/lift mechanisms, ramming and ejecting mechanisms as well as specialized hydraulic and electrical controls. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.10 Automatic/Remote Piloting. The automatic/remote piloting element refers to that equipment (hardware/software) installed in the vehicle which is used to plan and control vehicle speed and direction either autonomously or via tele-operation. This includes equipment which senses, processes and displays imagery data such as stereo vision systems, laser scanners, multiple sensor fusion algorithms and processors, image enhancement algorithms and processors, etc. This also includes equipment which performs intelligence analysis and planning functions such as automated route planners, image understanding algorithms and processors, computer aided driving algorithms and processors, etc. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.11 Nuclear, Biological, Chemical. The nuclear, biological, chemical element refers to those subassemblies or components which provide nuclear, biological, chemical protection and survivability to the vehicle crew, either individually or collectively, during a nuclear, biological, chemical attack. This includes a positive pressure system; micro-climate cooling; air conditioning and purification system; ventilated face piece (mask); nuclear, biological, chemical detection and warning devices; decontamination kits; and chemical

resistant coatings. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.12 Special Equipment. The special equipment element refers to that special equipment (hardware/software) to be mated to a chassis or a chassis/body/cab assembly to enable the achievement of a special mission capability. It includes all items required to convert basic vehicle configurations to special-purpose configurations. This element includes, for example, blades, booms, winches, robotic arms or manipulators, etc., to equip wreckers, recovery vehicles, supply vehicles and other field work units. It also includes the furnishings and equipment for command, shop, medical and other special-purpose vehicles. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.13 Navigation. The navigation element refers to that equipment (hardware/software) installed in the vehicle which permits the crew to determine vehicle location and to plot the course of the vehicle. It includes navigation systems such as dead reckoning, inertial, and global positioning systems. Landmark recognition algorithms and processors are also included. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.14 Communications. The communications element refers to that equipment (hardware/software) which provides the means within the system for commanding, controlling, and transmitting information to vehicle crews and other personnel exterior to operating vehicles. This element includes radio frequency equipment, microwave and fiber optic communication links, networking equipment for multiple vehicle control, and intercom and external phone systems. It also includes the means for supplementary communication such as visual signaling devices. It may include navigation system and data displays when these are not integral with the equipment of crew stations of the turret assembly or the driver's automotive display of a cab. All effort directly associated with the remaining level 3 WBS elements and the integration, assembly, test and checkout of these elements into the primary vehicle is excluded.

40.1.1.15 Integration, Assembly, Test and Checkout. The integration, assembly, test and checkout element includes all efforts as identified in Appendix H, Work Breakdown Structure Definitions, Common Elements (ref. page H-2), to provide a complete surface vehicle.

40.1.2 Secondary Vehicle. The secondary vehicle element refers to those vehicles required to supplement, expand, or otherwise contribute to the capabilities of primary vehicles to provide the vehicle system with the required operational characteristics. Secondary vehicles are not necessarily self-contained operational units capable of operating outside the system. This element includes, for example, cargo and tank trainers of truck-trailers systems, carriers and tanker units of articulated train-type systems, and transporters as employed in systems when the primary vehicle had limited roadability. It also includes the design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use). The work breakdown structure and definitions for secondary vehicle will be the same as specified for the primary vehicle.

Definitions for common WBS elements applicable to the surface vehicle and all other defense materiel items are in Appendix H. Work Breakdown Structure Definitions, Common Elements (ref. pages H-1 through H-10).

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APPENDIX H
WORK BREAKDOWN STRUCTURE DEFINITIONS
COMMON ELEMENTS

10. SCOPE

10.1 This appendix provides the work breakdown structure and definitions for common WBS elements applicable to all types of systems. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

20.1 Government Documents.

20.1.1 Specifications, Standards, and Handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications (DODISS) and supplement thereto, cited in the solicitation.

STANDARDS

MIL-STD-499	Engineering Management
MIL-STD-1388-1	Logistic Support Analysis
MIL-STD-1464	Army Nomenclature System
MIL-STD-1661	Mark and Mod Nomenclature System
MIL-STD-1812	Type Designation, Assignment and Method for Obtaining

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA 19111-5094.)

20.1.2 Other Government Documents, Drawings, and Publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DOD 5010.12-L Acquisition Management Systems and Data Requirements Control List (AMSDL)

(Copies of DOD 5010.12-L are available from the Standardization Documents Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA 19111-5094.

20.2 Non-Government Publications. This section is not applicable to this standard.

30. DEFINITIONS

30.1 Integration, Assembly, Test and Checkout. In those instances in which an integration, assembly, test and checkout element is used (Appendices A through G), it will include all effort of technical and functional activities associated with the design, development, and production of mating surfaces, structures, equipment, parts, materials, and software required to assemble the level 3 equipment (hardware/software) elements into a level 2 mission equipment (hardware/software) as a whole and not directly part of any other individual level 3 element. Integration, assembly, test and checkout includes all effort associated with the following:

a. The development of engineering layouts, determination of overall design characteristics, and determination of requirements of design review

b. The set up, conduct and review of testing assembled components or subsystems prior to installation

c. The detailed production design, producibility engineering planning (PEP), and manufacturing process capability, including the process design development and demonstration effort to achieve compatibility with engineering requirements and the ability to produce economically and consistent quality

d. Inspection activities related to receiving, factory and vendor liaison

e. Design maintenance effort

f. Quality planning and control

g. Tooling (initial production facilities, factory support equipment) including its planning, design and fabrication

h. Administrative engineering

i. The joining or mating and final assembly of level 3 equipment elements to form a complete prime mission equipment when the effort is performed at the manufacturing facility

j. Integration of software (including the loading and verification of firmware)

k. The conduct of production acceptance testing

Integration, assembly, test and checkout excludes all systems engineering/program management and system test and evaluation which are associated with the overall system.

When an integration, assembly, test and checkout element is utilized at lower levels of the contract work breakdown structure, it will be summarized into the next higher level equipment (hardware/software) work breakdown structure element and should never be summarized directly into a level 3 integration, assembly, test and checkout element.

30.2 Systems Engineering/Program Management. The systems engineering/program management element is defined as the systems engineering and technical control as well as the business management of particular systems and programs. This element encompasses the overall planning, directing, and controlling of the definition, development, and production of a system or program, including functions of logistics engineering and integrated logistics support (ILS) management, e.g., maintenance support, facilities, personnel, training, testing,

and activation of a system. Systems engineering/program management effort that can be associated specifically with the equipment (hardware/software) element is excluded. Systems engineering/program management elements to be reported and their levels will be specified by the requiring activity. Examples of systems engineering/program management elements and their definitions are provided as follows:

a. Systems Engineering. The systems engineering element is defined as the technical and management efforts of directing and controlling a totally integrated engineering effort of a system or program as described in MIL-STD-499. This element encompasses the systems engineering effort to define the system and the integrated planning and control of the technical program efforts of design engineering, specialty engineering, production engineering, and integrated test planning. This element includes but is not limited to: the systems engineering effort to transform an operational need or statement of deficiency into a description of system requirements and a preferred system configuration; and the technical planning and control effort for planning, monitoring, measuring, evaluating, directing and replanning the management of the technical program. It specifically excludes the actual design engineering and the production engineering directly related to the WBS element with which it is associated. Examples of systems engineering efforts include:

1) System definition, overall system design, design integrity analysis, system optimization, system/cost effectiveness analysis, and intra-system and inter-system compatibility assurance, etc.: the integration and balancing of reliability, maintainability, producibility, safety, human health, environmental protection, and survivability; security requirements, configuration management and configuration control, quality assurance program, value engineering, preparation of equipment and component performance specifications, design of test and demonstration plans; determination of software development or software test facility/environment requirements;

2) Preparation of the Systems Engineering Management Plan (SEMP), specification tree, program risk analysis, system planning, decision control process, technical performance measurement, technical reviews, subcontractor and vendor reviews, work authorization, and technical documentation control;

3) Reliability engineering defined as the engineering process and series of tasks required to examine the probability of a device or system performing its mission adequately for the period of time intended under the operating conditions expected to be encountered;

4) Maintainability engineering defined as the engineering process and series of tasks required to measure the ability of an item or system to be retained in or restored to a specified condition of readiness, skill levels, etc., using prescribed procedures and resources at specific levels of maintenance and repair;

5) Human factors engineering defined as the engineering process and the series of tasks required to define, as a comprehensive technical and engineering effort, the integration of doctrine, manpower and personnel integration, materiel development, operational effectiveness, human characteristics, skill capabilities, training, manning implication, and other related elements into a comprehensive effort; and,

6) Logistics Support Analysis (LSA) element defined by MIL-STD-1388-1 as the selective application of scientific and logistic engineering tasks, efforts and analysis undertaken during the acquisition process, as part of the systems engineering and design effort, to assist in complying with supportability and other ILS objectives; it includes, but is not limited to, the generic tasks required for support element determination and the analysis required to identify and verify its adequacy.

All programs, where applicable, include: value engineering, configuration management, human factors, maintainability, reliability, survivability/vulnerability, system safety, environmental protection, standardization, systems analysis, logistics support analysis, etc.

For ships this includes the Extended Ship Work Breakdown Structure (ESWBS) Configuration Management (811), Human Factors (892), Standardization (893), Value Engineering (894), and Reliability and Maintainability (895) elements.

b. Program Management. The program management element is defined as the business and administrative planning, organizing, directing, coordinating, controlling, and approval actions designated to accomplish overall program objectives which are not associated with specific hardware elements and are not included in systems engineering. Examples of these activities are:

1) Cost, schedule, performance measurement management, warranty administration, contract management, data management, vendor liaison, subcontract management, etc.

2) ILS element management defined as the logistics tasks management effort and technical control, and the business management of the elements of ILS. The logistics management function encompasses the Integrated Support Plan (ISP), ILS Management Team (ILSMT) participation, ILS evaluation and supportability assurance required to produce an affordable and supportable defense materiel system. This element includes the planning and management of all the functions of logistics and logistic support analysis, e.g., maintenance support planning; support facilities planning; other ILS requirements determination; support equipment; supply support; Packaging, Handling, Storage, and Transportation (PHST); provisioning requirements determination and planning; training system requirements determination; computer resource determination; organizational, intermediate, and depot maintenance determination management; and data management.

For ships this includes the Extended Ship Work Breakdown Structure (ESWBS) Project Management (897); Data Management (896); ILS Engineering, Maintenance (851); ILS Engineering, Support and Test Equipment (852); and ILS Engineering, Supply Support (853) elements.

30.3 System Test and Evaluation. The system test and evaluation element refers to the use of prototype, production, or specifically fabricated hardware/software to obtain or validate engineering data on the performance of the system during the development phase (normally funded from RDT&E) of the program. This element includes the detailed planning, conduct, support, data reduction and reports (excluding the Contract Data Requirements List (CDRL) data) from such testing, and all hardware/software items which are consumed or planned to be consumed in the conduct of such testing. It also includes all effort associated with the design and production of models, specimens, fixtures, and instrumentation in support of the system level test program. NOTE: Test articles which are complete units (i.e., functionally configured as required by specifications) are excluded from this work breakdown structure element. All formal and informal testing up through the subsystem level which can be associated with the hardware/software element are excluded. Acceptance testing is also excluded. These excluded efforts are to be included with the appropriate hardware or software elements.

30.3.1 Development Test and Evaluation. The development test and evaluation element refers to that test and evaluation conducted to: (a) demonstrate that the engineering design and development process is complete; (b) demonstrate that the design risks have been minimized; (c) demonstrate that the system will meet specifications; (d) estimate the system's military utility when introduced; (e) determine whether the engineering design is supportable (practical, maintainable, safe, etc.) for operational use; (f) provide test data with which to examine and evaluate trade-offs against specification requirements, life cycle cost, and schedule; and (g) perform the logistics testing efforts to evaluate the achievement of supportability goals, the adequacy of the support package for the system, (e.g., deliverable maintenance tools, test equipment, technical publications, maintenance instructions, and personnel skills and training requirements, etc.). Development test and evaluation includes all contractor in-house effort and is planned, conducted and monitored by the developing agency of the DoD Component.

All programs, where applicable, include models, tests and associated simulations such as wind tunnel, static, drop, and fatigue; integration ground tests; test bed aircraft and associated support; qualification test and evaluation (QT&E), development flight test, test instrumentation, environmental tests, ballistics, radiological, range and accuracy demonstrations, test facility operations, test equipment (including its support equipment), chase and calibrated pacer aircraft and support thereto, and logistics testing.

For aircraft, include avionics integration test composed of the following: (a) test bench/laboratory, including design, acquisition, and installation of basic computers and test equipments which will provide an ability to simulate in the laboratory the operational environment of the avionics system/subsystem; (b) air vehicle equipment, consisting of the avionics and/or other air vehicle subsystem modules which are required by the bench/lab or flying test bed in order to provide a compatible airframe avionics system/subsystem for evaluation purposes; (c) flying test bed, including requirements analysis, design of modifications, lease or purchase of test bed aircraft, modification of aircraft, installation of avionics equipment and instrumentation, and checkout of an existing aircraft used essentially as a flying avionics laboratory; (d) avionics test program, consisting of the effort required to develop test plans/procedures, conduct tests, and analyze hardware and software test results to verify the avionics equipments' operational capability and compatibility as an integrated air vehicle subsystem; and (e) software, referring to the effort required to design, code, de-bug, and document software programs necessary to direct the avionics integration test.

For engines, include engine military qualification tests and engine preliminary flight rating tests.

For ships, include model basin, hydrostatic, fatigue, shock, special sea tests and trials, etc., including the Extended Ship Work Breakdown Structure (ESWBS) Trials Agenda Preparation, Data Collection & Analysis (842); Dock and Sea Trials (9823); and Hull Vibration Survey (9825) elements.

30.3.2 Operational Test and Evaluation. The operational test and evaluation element refers to that test and evaluation conducted by agencies other than the developing command to assess the prospective system's military utility, operational effectiveness, operational suitability, logistics supportability (including compatibility, interoperability, reliability, maintainability, logistic requirements, etc.), cost of ownership, and need for any modifications. Initial operational test and evaluation conducted during the development of a weapon system will be included in this element. This element encompasses such tests as system demonstration, flight tests, sea trials, mobility demonstrations, on-orbit tests, spin demonstration, stability tests, qualification operational test and evaluation (QOT&E), etc., and support thereto, required to prove the operational capability of the deliverable system. It includes contractor support (e.g., technical assistance, maintenance, labor, material, etc.) consumed during this phase of testing. It also includes performing the logistics testing efforts to evaluate the achievement of supportability goals and the adequacy of the support for the system (e.g., deliverable maintenance tools, test equipment, technical publications, maintenance instructions, personnel skills and training requirements, and software support facility/environment elements).

30.3.3 Mock-ups. The mock-ups element refers to the design engineering and production of system or subsystem mock-ups which have special contractual or engineering significance, or which are not required solely for the conduct of one of the above elements of testing.

30.3.4 Test and Evaluation Support. The test and evaluation support element refers to all support elements necessary to operate and maintain systems and subsystems during test and evaluation which are not consumed during the testing phase and are not allocated to a specific phase of testing. This element includes, for example, repairable spares, repair of reparables, repair parts, warehousing and distribution of spares and repair parts, test and support equipment, test bed vehicles, drones, surveillance aircraft, tracking vessels, contractor technical support, etc. Operational and maintenance personnel, consumables, special fixtures, special instrumentation,

etc., which are utilized and/or consumed in a single element of testing and which should therefore be included under that element of testing are excluded.

30.3.5 Test Facilities. The test facilities element refers to those special test facilities required for performance of the various developmental tests necessary to prove the design and reliability of the system or subsystem. This element includes, for example, test tank test fixtures, propulsion test fixtures, white rooms, test chambers, etc. The brick and mortar-type facilities identified as industrial facilities are excluded.

30.4 Training. The training element is defined as the deliverable training services, devices, accessories, aids, equipment, and parts used to facilitate instruction through which personnel will acquire sufficient concepts, skills, and aptitudes to operate and maintain the system with maximum efficiency. This element includes all effort associated with the design, development, and production of deliverable training equipment as well as the execution of training services. This element and its subelements exclude the overall planning, management, and task analysis function inherent in the WBS element Systems Engineering/Program Management.

30.4.1 Equipment. The equipment element is defined as those distinctive deliverable end items of training equipment, assigned by either a contractor or military service, required to meet specific training objectives. This element includes: operational trainers, maintenance trainers and other items such as cutaways, mock- ups, and models.

30.4.2 Services. The services element is defined as the deliverable services, accessories, and aids necessary to accomplish the objectives of training. This element includes, for example, training course materials; contractor-conducted training including in-plant and service training; and the materials and curriculum required to design, execute and produce a contractor developed training program. It also includes the material, courses, and associated documentation (primarily the computer software, courses and training aids). This element excludes the deliverable training data associated with the WBS element Support Data.

30.4.3 Facilities. The facilities element refers to the special construction necessary to accomplish training objectives. It also includes the modification or rehabilitation of existing facilities used to accomplish training objectives. The installed equipment used for the purpose of acquainting the trainee with the system or establishing trainee proficiency is excluded. The brick and mortar-type facilities identified as industrial facilities are also excluded.

30.5 Data. The data element refers to all deliverable data required to be listed on a Contract Data Requirements List, DD Form 1423. The data requirements will be selected from the Acquisition Management Systems and Data Requirements Control List (DoD 5010.12-L). This element includes only such effort that can be reduced or will not be incurred if the data item is eliminated. If the data are government peculiar, include the efforts for acquiring, writing, assembling, reproducing, packaging and shipping. It also includes the effort for transforming into government format with reproduction and shipment if data are identical to that used by the contractor, but in a different format.

30.5.1 Technical Publications. The technical publications element is defined as technical data which provides instructions for the installation, operation, maintenance, training, and support of a system or equipment which is formatted into a technical manual. A technical manual normally includes operation and maintenance instructions, parts lists or parts breakdown, and related technical information or procedures exclusive of administrative procedures. This data may be presented in any form (regardless of the form or method of recording). Technical orders that meet the criteria of this definition may also be classified as technical manuals. This element includes the data item descriptions set forth in categories selected from the DoD 5010.12-L.

For ships include Extended Ship Work Breakdown Structure (ESWBS) ILS Engineering, Technical Manuals and Other Data (856) element.

30.5.2 Engineering Data. The engineering data element is defined as recorded information (regardless of the form or method of recording) of a scientific or technical nature (including computer software documentation). Engineering data does not include computer software or financial, administrative, cost or pricing, or management data or other information incidental to contract administration.

a. Engineering data is required to define and document an engineering design or product configuration (sufficient to allow duplication of the original items) and is used to support production, engineering and logistics activities. This element includes, for example, all final plans, procedures, reports, and documentation pertaining to systems, subsystems, computer and computer resource programs, component engineering, operational testing, human factors, reliability, availability, and maintainability, and other engineering analysis, etc.

b. A technical data package (reprocurement package) includes all engineering drawings, associated lists, process descriptions, and other documents which define the physical geometry, material composition, performance procedures.

This element excludes the LSAR and support data delivered under 30.5.4 of this section.

For ships include Extended Ship Work Breakdown Structure (ESWBS) Design Support, Ship's Selected Records (8302); Design Support, Services, Reproduction (8303); and ILS Engineering, Engineering Drawings and Specifications (855) elements.

30.5.3 Management Data. The management data element is defined as those data items necessary for configuration management, cost, schedule, contractual data management, program management, etc., required by the government in accordance with functional categories selected from the DODISS and DoD 5010.12-L. This element includes contractor cost reports, cost performance reports, contractor fund status reports, schedules, milestones, networks, integrated support plans, etc.

For ships include Extended Ship Work Breakdown Structure (ESWBS) Contract Data Requirements (988) element.

30.5.4 Support Data. The support data element is defined as those data items designed to document the support planning in accordance with functional categories selected from DoD 5010.12-L. This element includes, for example, LSA documentation and LSA record maintenance and delivery, supply, general maintenance plans and reports, training data, transportation, handling, packaging information, facilities data, data to support the provisioning process and all other support data, and software supportability planning and software support transition planning documents.

30.5.5 Data Depository. The data depository element is defined as a facility designated to act as custodian in establishing and maintaining a master engineering specification and drawing depository service for government approved documents that are the property of the U.S. Government. This element represents a distinct entity of its own and includes all effort of drafting, clerical, filing, etc., required to provide the service. As custodian for the government, the contractor is authorized by approved change orders to maintain these master documents at the latest approved revision level. When documentation is called for on a given item of data retained in the depository, the charges (if charged as direct) will be to the appropriate data element. All similar effort for the contractor's internal specification and drawing control system, in support of its engineering and production activities, is excluded.

30.6 Peculiar Support Equipment. The peculiar support equipment element is defined to include the design, development, and production of those deliverable items and associated software required to support and maintain the system or portions of the system while not directly engaged in the performance of its mission, and which have application peculiar to a given defense materiel item. This element includes, for example, vehicles, equipment, tools, etc., used to fuel, service, transport, hoist, repair, overhaul, assemble, disassemble, test, inspect, or otherwise maintain the mission equipment. It also includes any production of duplicate or modified factory test or tooling equipment delivered to the government for use in maintaining the system (factory test and tooling equipment initially used by the contractor in the production process but subsequently delivered to the government will be included as cost of the item produced). It also includes any additional equipment or software that will be required to maintain or modify the software portions of the system. This element and its subelements specifically exclude the overall planning, management and task analysis functions inherent in the work breakdown structure element systems engineering/program management, and the common support equipment presently in the DoD inventory or commercially common within the industry which is bought by the using command and not by the acquiring command.

30.6.1 Test and Measurement Equipment. The test and measurement equipment element is defined as peculiar or unique testing and measurement equipment which allows an operator or maintenance function to evaluate operational conditions of a system or equipment by performing specific diagnostics, screening or quality assurance effort at an organizational, intermediate, or depot level of equipment support. It includes test measurement and diagnostic equipment, precision measuring equipment, automatic test equipment, manual test equipment, automatic test systems, test program sets, appropriate interconnect devices, automated load modules, tap(s), and related software, firmware and support hardware (power supply equipment, etc.) used at all levels of maintenance. It includes packages which enable a line or shop replaceable unit, printed circuit boards, or similar items to be diagnosed using automatic test equipment.

30.6.2 Support and Handling Equipment. The support and handling equipment element is defined as the deliverable tools and handling equipment used for support of the mission system. It typically includes ground support equipment, vehicular support equipment, powered support equipment, nonpowered support equipment, munitions material handling equipment, materiel handling equipment, and software support equipment (hardware/software).

30.7 Common Support Equipment. The common support equipment element refers to those items required to support and maintain the system or portions of the system while not directly engaged in the performance of its mission, and which are presently in the DoD inventory for support of other systems. This element includes all efforts required to assure the availability of this equipment for support of the particular defense materiel item. It also includes the acquisition of additional quantities of this equipment if caused by the introduction of the defense materiel item into operational service.

30.7.1 Test and Measurement Equipment. The test and measurement equipment element is defined as common testing and measurement equipment which allows an operator or maintenance function to evaluate operational conditions of a system or equipment by performing specific diagnostics, screening or quality assurance effort at an organizational, intermediate, or depot level of equipment support. It includes test measurement and diagnostic equipment, precision measuring equipment, automatic test equipment, manual test equipment, automatic test systems, test program sets, appropriate interconnect devices, automated load modules, tap(s), and related software, firmware and support hardware (power supply equipment, etc.) used at all levels of maintenance. It includes packages which enable a line or shop replaceable unit, printed circuit boards, or similar items to be diagnosed using automatic test equipment.

30.7.2 Support and Handling Equipment. The support and handling equipment element is defined as the deliverable tools and handling equipment used for support of the mission system. It typically includes ground

support equipment, vehicular support equipment, powered support equipment, nonpowered support equipment, munitions material handling equipment, materiel handling equipment, and software support equipment (hardware/software).

30.8 Operational/Site Activation. The operational/site activation element refers to the real estate, construction, conversion, utilities, and equipment to provide all facilities required to house, service, and launch prime mission equipment at the organizational and intermediate level. This element includes conversion of site, ship, or vehicle; system assembly, checkout, and installation (of mission and support equipment) into site facility or ship to achieve operational status. It also includes contractor support in relation to operational/site activation.

30.8.1 System Assembly, Installation, and Checkout on Site. The system assembly, installation, and checkout on site element refers to the materials and services involved in the assembly of mission equipment at the site. This element includes, for example, installation of mission and support equipment in the operations or support facilities and the complete system checkout or shakedown to insure achievement of operational status. Where appropriate, specify by site, ship or vehicle.

30.8.2 Contractor Technical Support. The contractor technical support element refers to all materials and services provided by the contractor related to activation. This element includes repair of reparables, standby services, final turnover, etc.

30.8.3 Site Construction. The site construction element refers to the real estate, site planning/preparation, construction, and other special-purpose facilities necessary to achieve system operational status. This element also includes the construction of utilities, roads, and interconnecting cabling.

30.8.4 Site/Ship/Vehicle Conversion. The site/ship/vehicle conversion element refers to all materials and services required to provide for the conversion of existing sites, ships, or vehicles to accommodate the mission equipment and selected support equipment directly related to the specific system. This element includes operations, support, and other special purpose (e.g., launch) facilities conversion necessary to achieve system operational status. Where appropriate, specify by site, ship, or vehicle.

30.9 Industrial Facilities. The industrial facilities element refers to the construction, conversion, or expansion of industrial facilities for production, inventory, and contractor depot maintenance required when that service is for the specific system. This element includes, for example, equipment acquisition or modernization, where applicable, and maintenance of these facilities or equipment. This element also includes industrial facilities for hazardous waste management to satisfy environmental standards.

30.9.1 Construction/Conversion/Expansion. The construction/conversion/expansion element refers to the real estate and preparation of system peculiar industrial facilities for production, inventory, depot maintenance, and other related activities.

30.9.2 Equipment Acquisition or Modernization. The equipment acquisition or modernization element refers to production equipment acquisition, modernization, or transferal of equipment for the particular system. (Pertains to government owned and leased equipment under facilities contract.)

30.9.3 Maintenance (Industrial Facilities). The maintenance (industrial facilities) element refers to the maintenance, preservation, and repair of industrial facilities and equipment.

30.10 Initial Spares and Repair Parts. Initial spares and repair parts element is defined as the deliverable spare components, assemblies and subassemblies used for initial replacement purposes in the materiel system equipment end item. This element includes the repairable spares and repair parts required as initial stockage to

support and maintain newly fielded systems or subsystems during the initial phase of service, including pipeline and war reserve quantities, at all levels of maintenance and support. This element excludes development test spares and spares provided specifically for use during installation, assembly and checkout on site. The lower level WBS breakouts should be by subsystem.

APPENDIX I
USER GUIDE

10. SCOPE

10.1 This appendix presents a User Guide for preparing, understanding and presenting a work breakdown structure (WBS). The guide discusses the requirement for a work breakdown structure, provides a general understanding for developing a program work breakdown structure, shows how to develop and implement a contract work breakdown structure, and presents examples of work breakdown structures for various applications. The primary objective of this guide is to achieve a consistent application of the work breakdown structure. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

10.2 The foundation for the requirement and development of the work breakdown structure is described in DoDD 5000.1, DoDI 5000.2, and DoD 5000.2-M. These documents identify responsibilities in the acquisition process from the Office of the Secretary of Defense to the DoD Component field activities. The requirement to prepare a work breakdown structure is generally discussed in the context of planning and monitoring a defense materiel system program.

10.3 This guide is directed primarily at the preparation of a work breakdown structure for a defense materiel item. This includes all defense materiel items (or major modifications) (a) established as an integral program element of the Future Years Defense Program (FYDP); or (b) otherwise designated by the DoD Component or the Under Secretary of Defense (Acquisition).

10.3.1 The guidance is also appropriate for use with any work breakdown structure developed at any phase during the acquisition process, including concept exploration and definition, demonstration and validation, engineering and manufacturing development, and production.

10.3.2 This guide provides the framework for preparing a complete work breakdown structure. The guidelines are directed at both contractors and DoD Components (Government activities) in the development of work breakdown structures for the acquisition of defense materiel items.

20. APPLICABLE DOCUMENTS

20.1 Government Documents.

20.1.1 Specifications, Standards, and Handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications (DODISS) and supplement thereto, cited in the solicitation.

STANDARDS

MIL-STD-196	Joint Electronics Type Designation System
DOD-STD-2167	Defense System Software Development

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA 19111-5094.)

20.1.2 Other Government Documents, Drawings, and Publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PAMPHLETS

Contractor Cost Data Reporting (CCDR)

NAVMAT P-5241	Navy Materiel Command Pamphlet
AMC-P 715-8	Army Materiel Command Pamphlet
AFLCP 800-15	Air Force Logistics Command Pamphlet
AFSCP 800-15	Air Force Systems Command Pamphlet

Cost/Schedule Control System Criteria Joint Implementation Guide

NAVSO P3627	Assistant Secretary of the Navy (S&L) Pamphlet
AFSCP 173-5	Air Force Systems Command Pamphlet
AFCCP 173-5	Air Force Communications Command Pamphlet
AFLCP 173-5	Air Force Logistics Command Pamphlet
AMC-P 715-5	Army Materiel Command Pamphlet
DLAH 8400.2	Defense Logistics Agency Handbook
DCAA P7641.47	Defense Contract Audit Agency Pamphlet

(The above pamphlet numbers identify two single documents: Contractor Cost Data Reporting (CCDR) System (Stock Number 0518LP1003001), and Cost/Schedule Control Systems Criteria Joint Implementation Guide (Stock Number 0518LP1002010). These two documents can be ordered by stock number from the Standardization Documents Order Desk, 700 Robbins Avenue, Building #4, Section D, Philadelphia, PA 19111-5094.)

20.2 Non-Government Publications. This section is not applicable to this standard.

30. DEFINITIONS

30.1 Program Work Breakdown Structure. A program work breakdown structure is defined as the work breakdown structure that covers the acquisition of a specific defense materiel item and is related to contractual effort. A program work breakdown structure includes all applicable elements consisting of at least the first three levels of the work breakdown structure and extended by the DoD Component (program manager) and/or contractor(s). A program work breakdown structure has uniform element terminology, definition, and placement in the family tree structure.

Level 1: Level 1 is the entire defense materiel item; for example, an aircraft system, such as a helicopter, bomber, transport aircraft, fighter aircraft or reconnaissance aircraft. Level 1 is usually directly identified in the DoD programming/budget system either as an integral program element or as a project or subprogram within an aggregated program element.

Level 2: Level 2 elements are major elements of the defense materiel item; for example, air vehicle which includes all hardware and software elements, aggregations of system level services (e.g., system test and evaluation, and systems engineering/program management) and data.

Level 3: Level 3 elements are elements subordinate to level 2 major elements; for example, propulsion, fire control, navigation guidance, armament, or type of service (e.g., development test and evaluation, contractor technical support, training services), or types of data (e.g., technical publications). Lower levels follow the same process.

30.2 Contract Work Breakdown Structure. A contract work breakdown structure is defined as the complete work breakdown structure for a contract. It includes the DoD approved work breakdown structure for reporting purposes and its discretionary extension to the lower levels by the contractor, in accordance with this standard, and the contract work statement. It includes all the elements for the products (hardware, software, data, or services) which are the responsibility of the contractor.

40. BACKGROUND

40.1 Purpose. When the decision is made to develop and acquire a new or updated system, several factors are considered when planning or monitoring efforts. One of these factors is determining the work breakdown structure to use for the system. A work breakdown structure is a product-oriented family tree, composed of hardware, software, services, data and facilities, which results from systems engineering efforts during the development and production of a defense materiel item, and which completely defines the program. A work breakdown structure displays and defines the product(s) to be developed or produced and relates the elements of work to be accomplished to each other and to the end product. Therefore, the work breakdown structure plays a significant role in planning and assigning management and technical responsibilities and in monitoring and controlling the progress and status of engineering efforts, resource allocations, cost estimates, expenditures, and cost and technical performance.

40.2 Work Breakdown Structure Applications. The work breakdown structure provides a framework for specifying the objectives of the program by first defining the program in terms of hierarchically related product-oriented elements and the work processes required for their completion. Each element of the work breakdown structure provides logical summary points for assessing technical accomplishments and for measuring the cost and schedule performance accomplished in attaining the specified technical objectives.

For each work breakdown structure element, the detailed objectives are defined as well as the specific work tasks assigned to each contractor organization element and the resources, materials, and processes required to attain the objectives. As resources are employed and work progresses on the task, current technical, schedule, cost, and estimate at completion data are reported. The data may then be summarized to provide successive levels of management with the appropriate report on planned, actual, and current projected status of the elements for which they are responsible. Management will thus be better able to maintain visibility of status and to apply efforts to assure desired performance.

40.2.1 Technical Management. The work breakdown structure provides a framework for defining the technical objectives of the program. Together with the contract statement of work, the work breakdown structure aids in establishing an indentured data listing (specification tree), defining configuration items, and planning support tasks.

40.2.1.1 Contract Statement of Work. The statement of work (SOW) is the document which describes in clear understandable terms what products are to be delivered or services to be performed by the contractor. Preparation of an effective SOW requires an understanding of the products and services that are needed to

satisfy a particular requirement. A SOW prepared in explicit terms will facilitate effective contractor evaluation after contract award. The SOW becomes the standard for measuring contractor performance. Therefore, the SOW must clearly define the work to be performed. In preparing the SOW for a system acquisition, the use of a standardized work breakdown structure as a template for constructing the SOW will help streamline the process. Use of the work breakdown structure will also provide the framework and facilitate a logical arrangement of the SOW elements, provide a convenient checklist to ensure all necessary elements of the program are addressed, and direct the contractor to meet specific contract reporting needs.

40.2.1.2 Indentured Data Listing. An indentured data listing (specification tree), developed by systems engineering, structures the performance parameters for the system or systems being developed. It subdivides the system(s) into its component elements and identifies the performance objectives of the system(s) and its elements. The performance characteristics are explicitly identified and quantified. Completed, the indentured data listing represents a hierarchy of performance requirements for each component element of the system for which design responsibility is assigned. Because specifications may not be written for each product on the work breakdown structure, the indentured data listing may not match the work breakdown structure completely.

40.2.1.3 Configuration Management. Configuration management is the process of managing the technical configuration of items being developed whose requirements must be specified and controlled (ref. MIL-STD-973). In establishing the requirement for configuration management on a program, the DoD Component needs to designate which contract deliverables are subject to configuration management controls. A contract deliverable designated for configuration management is called a Configuration Item. For software, this item is called a computer software configuration item (CSCI). Configuration management involves defining the baseline configuration for the configuration items, controlling the changes to that baseline, and accounting for all approved changes. The framework for designating the configuration items on a program is the work breakdown structure which needs to be extended sufficiently to clearly define all elements subject to configuration management.

40.2.2 Financial Management. The work breakdown structure assists management in measuring cost and schedule performance. By breaking the total product into successively smaller entities, management can ensure that all required products are identified in terms of cost and schedule performance goals. The planning of work by work breakdown structure elements serves as the basis for estimating and scheduling resource requirements. The assignment of performance budgets to scheduled segments of contract work and identified to responsible organization units produces a time phased plan against which actual performance can be compared and appropriate corrective action taken when deviations from plan are identified. This integrated approach to work planning also simplifies the identification of potential cost and schedule impacts of proposed technical changes.

40.2.2.1 Contract Budgeting. Funds management involves periodic comparison of actual costs with time phased budgets, analysis of performance variances, and follow-up corrective action, as required. When work breakdown structure product elements and the supporting work are scheduled, a solid base for time phased budgets is made. Assignment of planned resource cost estimates to scheduled activities (tasks) and summarization by work breakdown structure element by time period results in a time phased program/contract budget, which becomes the performance measurement baseline.

40.2.2.2 Cost Estimating. Use of the work breakdown structure for cost estimating facilitates program and contract management. The work breakdown structure aids the DoD program office to plan, coordinate, control, and estimate the various program activities that DoD and the contractors are conducting. It provides a common framework for tracking the estimated and actual costs during the performance of each contract. The data from the various program contracts support the DoD program manager in evaluating contractor performance, preparing budgets, and preparing program life-cycle costs, e.g., as programs move through the various phases

of the acquisition process (conceptual design, development, and production) the actual experience to date and the estimates for the remaining phases provide the basis for reassessment of the total program costs.

40.2.2.3 Data Bases. Cost information collected by work breakdown structure element can be used for pricing and negotiating contracts and contract changes, and for follow-on procurement. DoD is accumulating a growing cost data base of similar work breakdown structure elements from different programs. Such historical cost data can be used to develop learning curves and for regression analysis and other technique to estimate the cost requirements for like elements of new programs. Actual cost data collected by DoD o each program can be compared to the original estimates to identify trends and to establish the validity of es mating techniques. Contractors will similarly benefit from such data bases. Since contractors tend to provide similar products on similar programs, the cost history accumulated on their programs can assist them in estimating and bidding future contracts and budgeting new work.

40.3 Relationship to Other Contract Requirements. The work breakdown structure is the basis for communication throughout the acquisition process. It provides the common link unifying the planning, scheduling, cost estimating, budgeting, contracting, configuration management, and performance reporting disciplines. The structure and definitions contained in this standard will be the basis for structures used for contracts requiring compliance with the Cost/Schedule Control Systems Criteria (C/SCSC), and reports placed on contract such as Contractor Cost Data Reporting (CCDR), Cost Performance Reports (CPR), Contract Funds Status Reports (CFSR), and Cost/Schedule Status Reports (C/SSR). This capability permits the contractor to evaluate progress in terms of contract performance. Consult the referenced documents for program applicability and specific requirements per paragraph 20.1.2 in this appendix.

50. DETAILED REQUIREMENTS

50.1 Scope. Work is effort performed by people to transform or create products to solve identified problems in order to verifiably meet specified objectives. Just as the organizational structure hierarchically structures the people who perform work, so the work breakdown structure hierarchically structures the products to be produced on which the people work. Examples of these products include equipment (hardware/software), data, services and facilities for such systems as missile systems, helicopter systems, automated software systems, etc.

Work breakdown structure elements depict products in a manner in which technical accomplishment can be incrementally verified and measured and provide the conceptual framework for integrated planning and control of the work. For example, program management benefits all hardware, software, and data products in indeterminable proportion. From a management control perspective, such work is essentially indirect to the hardware, software, and data products, but direct to the contract or program. As a result, when program management is separately identified within the framework of the work breakdown structure, the work performed can be verified and measured. It is for these reasons that the work breakdown structure is a valuable tool.

50.2 Purpose. The development of any work breakdown structure is intended to achieve a clear understanding and statement of the technical objectives and the end item(s) (or end product(s)) of the work to be performed. The process of identifying these objectives assists in structuring the product elements during the work breakdown structure development. Objectives derived from the overall program objective are identified in such a way that products support economically and technically identifiable subsystems of the program objectives. This process may be repeated until the component level is reached. In this manner, subsystems support a total system capability.

In order to use the work breakdown structure as a framework for structuring the technical objectives of a program, in addition to its use as a management tool for cost and schedule control, it is important that the work

breakdown structure be product oriented. Its elements should represent identifiable work products whether they be equipment (hardware/software), data or relatable service products. Because any work breakdown structure is a product structure, not an organization structure, complete definition of the effort encompasses the work to be performed by all participants.

50.3 Acquisition Process. The work breakdown structure is developed during the acquisition process of a defense materiel item. Government and industry view this process from different perspectives, but the ultimate objective is consistent. Figure I-1 provides an overview of the work breakdown structure development process. The DoD acquisition process is where this standard is utilized. Figures I-2 and I-3 depict the overall process from both the DoD and industry perspective and how the WBS flow relates to this process.

50.4 Preparing a Program Work Breakdown Structure. The DoD program manager is responsible for developing and maintaining the program work breakdown structure. The DoD program manager will structure a program work breakdown structure for a defense materiel item prior to program initiation by selecting appropriate elements from one or more of the work breakdown structure(s) set forth in appendices A through G. The result will initially map the program work breakdown structure. Although the appendices relate to specific categories of defense materiel items, any item from any appendix may be used which is applicable to the program, as long as the integrity of the level of placement is maintained.

50.4.1. Develop Program Work Breakdown Structure. The program work breakdown structure should be developed early in the conceptual stages of the program and be based initially on the work breakdown structures identified in appendices A through G. The program work breakdown structure evolves during conceptual design from an iterative analysis of the program objective, functional design criteria, program scope, technical performance requirements, proposed methods of performance, including acquisition strategy, as well as drawings, process flow charts, and other technical documentation. It is important the documentation describe the DoD plan to build, integrate, and field the system. The Cost Analysis Requirements Document (CARD) will be the recording document for this program plan. Ultimately, the program work breakdown structure must be approved through the CCDR plan process. Through this process, the levels of reporting and elements for appropriate RFP selection are determined.

50.4.2 Program Work Breakdown Structure Element Selection Requirements. The program work breakdown structure elements must be selected by the DoD Component and be structured in such a way that products and services may be readily summarized into the program work breakdown structure. The program work breakdown structure and contract work breakdown structure extensions will be used as a framework for technical and management activities. The DoD Component will employ the program work breakdown structure and its contract work breakdown structure extensions as a coordinating medium in planning for further systems engineering, resource allocation, cost estimates, contract actions, and work execution. The reporting of progress, performance, and engineering evaluations, as well as financial data, will be based on the program work breakdown structure. Figure I-4 provides an example of a top level program work breakdown structure.

50.4.3 Levels of Program Work Breakdown Structure. The program work breakdown structure contains the top three levels expanded to identify elements with a significant degree of technical or cost risk. When program work breakdown structure levels are stipulated to an excessively low level of a program, the contractor's normal method of operation may be hampered, or excessive reporting requirements may result. The SOW and CDRLs are the place to clearly communicate all program requirements. Figure I-5 provides an expanded program work breakdown structure which incorporates elements necessary for contract visibility and control. This program WBS is based on Appendix A and uses those WBS elements applicable to the system.

50.4.4 Considerations in Constructing a WBS. The following should be kept in mind when constructing a work breakdown structure:

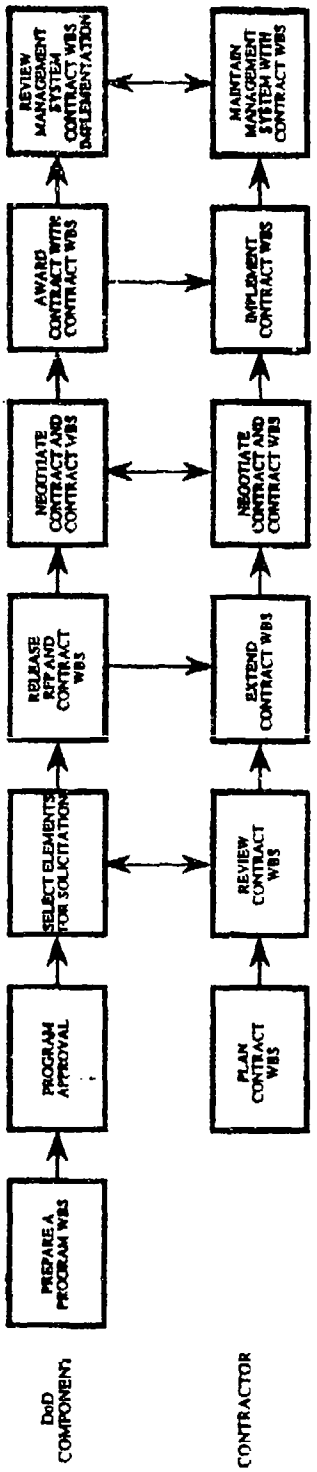

Figure 1-1. WORK BREAKDOWN STRUCTURE DEVELOPMENT PROCESS

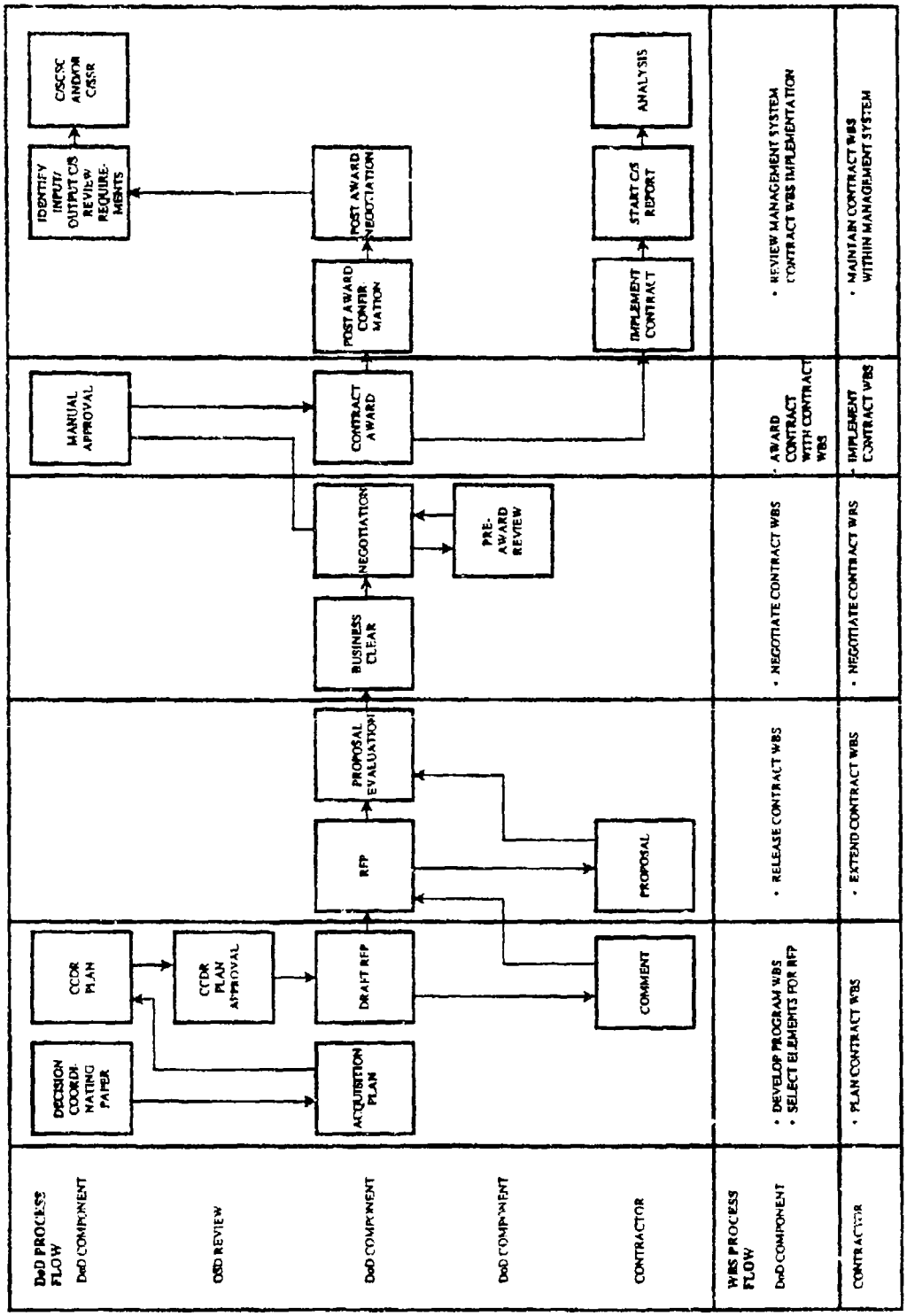

Figure I-2. DoD PROCESS FLOW

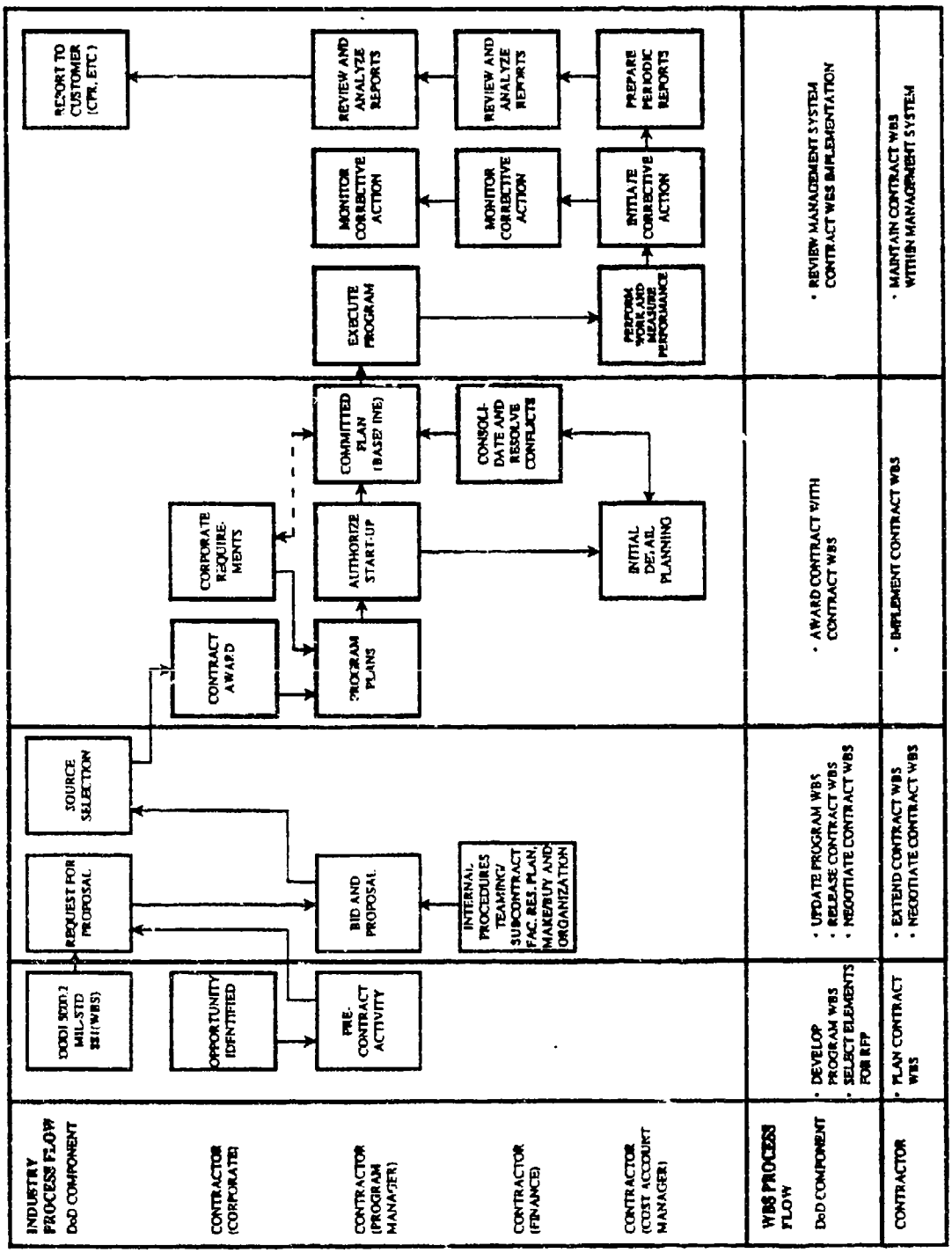

Figure I-3. INDUSTRY PROCESS FLOW

PROGRAM WBS		
1	2	3
FX AIRCRAFT		
	AIR VEHICLE	
		AIRFRAME
		PROPULSION (SK-PW-52D)
		COMMUNICATIONS/IDENTIFICATION
		NAVIGATION/GUIDANCE
		FIRE CONTROL
		AUTOMATIC FLIGHT CONTROL
		CENTRAL COMPUTER
		ELECTRONIC WARFARE
		WEAPON DELIVERY EQUIPMENT
		ARMAMENT
	SYSTEM TEST AND EVALUATION	
		DEVELOPMENT TEST AND EVALUATION
		OPERATIONAL TEST AND EVALUATION
		MOCKUPS
		TEST AND EVALUATION SUPPORT
		TEST FACILITIES
	SYSTEMS ENGINEERING/PROGRAM MANAGEMENT	
		SYSTEMS ENGINEERING
		PROGRAM MANAGEMENT
		INTEGRATED LOGISTIC SUPPORT
	PECULIAR SUPPORT EQUIPMENT	
		TEST AND MEASUREMENT EQUIPMENT
		SUPPORT AND HANDLING EQUIPMENT
	COMMON SUPPORT EQUIPMENT	
	TRAINING	
		MAINTENANCE TRAINERS
		AIRCREW TRAINING DEVICE
		TRAINING COURSE MATERIALS
	DATA	
		TECHNICAL PUBLICATIONS
		ENGINEERING DATA
		MANAGEMENT DATA
		SUPPORT DATA
		DATA DEPOSITORY
	OPERATIONAL/SITE ACTIVATION	
		CONTRACTOR TECHNICAL SUPPORT
	INITIAL SPARES AND REPAIR PARTS	

Figure I-4. TOP LEVEL PROGRAM WORK BREAKDOWN STRUCTURE

PROGRAM WBS			
1	2	3	4
PX AIRCRAFT			
	AIR VEHICLE		
		AIRFRAME	
			WING
			FUSELAGE
			EMPENNAGE
			FLIGHT CONTROLS SUBSYSTEM
			HYDRAULIC SYSTEM
			ENVIRONMENTAL CONTROL
			CREW STATION SYSTEM
			LANDING AND ARRESTING GEAR SYSTEM
			INTEG., ASSEMBLY, TEST AND CHECKOUT
		PROPULSION (SK-PW-SD)	
		COMMUNICATIONS/IDENTIFICATION	
			RADIO SYSTEM
			DATA LINK
			COMMUNICATIONS SYSTEM SOFTWARE
		NAVIGATION/GUIDANCE	
		FIRE CONTROL	
			RADAR
			COMPUTER
			CONTROLS AND DISPLAYS
			SYSTEM SOFTWARE
		AUTOMATIC FLIGHT CONTROL	
		CENTRAL COMPUTER	
			COMPUTER
			SYSTEM SOFTWARE
		ELECTRONIC WARFARE	
		WEAPON DELIVERY EQUIPMENT	
		ARMAMENT	
	SYSTEM TEST AND EVALUATION		
		DEVELOPMENT TEST AND EVALUATION	
			WIND TUNNEL ARTICLES AND TEST
			STATIC ARTICLES AND TEST
			FATIGUE ARTICLES AND TEST
			CONTRACTOR FLIGHT TESTS
		OPERATIONAL TEST AND EVALUATION	
		MOCKUPS	
		TEST AND EVALUATION SUPPORT	
		TEST FACILITIES	
	SYSTEMS ENGINEERING/PROGRAM MANAGEMENT		
		SYSTEMS ENGINEERING	
		PROGRAM MANAGEMENT	
		INTEGRATED LOGISTIC SUPPORT	
	PECULIAR SUPPORT EQUIPMENT		
		TEST AND MEASUREMENT EQUIPMENT	
		SUPPORT AND HANDLING EQUIPMENT	
	COMMON SUPPORT EQUIPMENT		
	TRAINING		
		MAINTENANCE TRAINERS	
		AIRCREW TRAINING DEVICE	
		TRAINING COURSE MATERIALS	
	DATA		
		TECHNICAL PUBLICATIONS	
		ENGINEERING DATA	
		MANAGEMENT DATA	
		SUPPORT DATA	
		DATA DEPOSITORY	
	OPERATIONAL/SITE ACTIVATION		
		CONTRACTOR TECHNICAL SUPPORT	
	INITIAL SPARES AND REPAIR PARTS		

Figure I-5. EXPANDED PROGRAM WORK BREAKDOWN STRUCTURE

a. Many elements of a program are not products. A signal processor, for example, is clearly a product, as are mock-ups, and Computer Software Configuration Items (CSCIs). Design engineering, requirements analysis, test engineering labor, aluminum, and direct costs, etc., are not products. Design engineering, test engineering, and requirements analysis are all engineering functional efforts; aluminum is a material resource; and direct cost is an accounting classification. As such, none of these elements are appropriate as work breakdown structure elements (ref. Chapter 4 of Contractor Cost Data Reporting (CCDR) System for functional category definitions).

b. Program phases (e.g., design, development, production), and types of funds (e.g., Research, Development, Test and Evaluation) are inappropriate elements of a work breakdown structure.

c. Rework, retesting and refurbishing should be treated as work on the appropriate work breakdown structure element affected, not as separate elements of a work breakdown structure.

d. Nonrecurring and recurring classifications are not work breakdown structure elements. The reporting requirements of Contractor Cost Data Reporting (CCDR) will segregate each work breakdown structure element into its nonrecurring and recurring parts (ref. Chapter 4 of Contractor Cost Data Reporting (CCDR) System).

e. Cost saving efforts such as total quality management initiatives, could cost, warranty, etc., are not work breakdown structure elements. These efforts should be included in the cost of the item they affect and not captured separately.

f. The organizational structure of the program office or the contractor should not be the basis for development of a work breakdown structure. The work breakdown structure should always retain its product orientation.

g. Costs for meetings, travel, computer support, etc., are to be included with the work breakdown structure elements for which they are associated. They are not to be treated as separate work breakdown structure elements.

h. The use of generic terms in a work breakdown structure is improper. The system(s) name and/or nomenclature is required. The work breakdown structure elements should be clearly named to indicate the character of the product to avoid semantic confusion. For example, if the Level 1 system is Fire Control, then the Level 2 item (prime mission product) is Fire Control Radar. The name or nomenclature for the electronic subsystem should be developed using MIL-STD-196, when appropriate. Figure I-6 provides a reference on how to use MIL-STD-196 to identify the nomenclature for electronic systems.

i. Tooling (e.g., special test equipment, and factory support equipment such as: assembly tools, dies jigs, fixtures, master forms, handling equipment, etc.) should be included in the cost of the equipment being produced. It is a functional cost (ref. CCDR System, Chapter 4) not a work breakdown structure element. If the tooling cannot be assigned to an identified subsystem or component, it should be included in the cost of integration, assembly, test, and checkout. Any additional quantities produced for equipment support or maintenance in the field should be included and reported under Peculiar Support Equipment. This same philosophy applies to software. For example, when a software development facility/environment is created to support the development of software, the effort associated with this element is considered part of the CSCI it supports; or if more than one CSCI is involved, it should be included in integration, assembly, test and checkout.

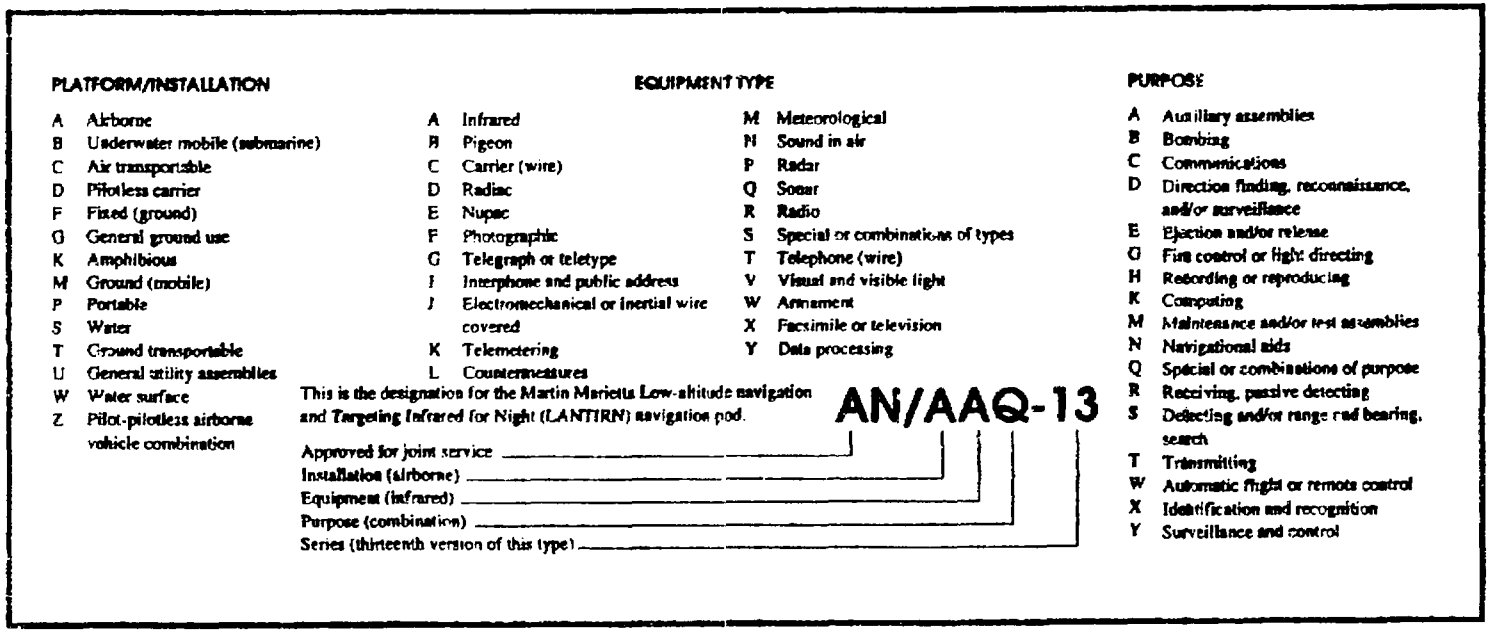

Figure I-5. EXAMPLE OF TYPE DESIGNATOR FOR ELECTRONIC EQUIPMENT

j. Software that is being developed to reside on specific equipment must be identified as a subset of that equipment.

k. The definition of integration, assembly, test, and checkout is on page H-2. This definition should be read carefully before the work breakdown structure is developed. Note that integration, assembly, test, and checkout includes production acceptance testing (including first article test) of R&D and production units, but excludes all systems engineering/program management, and system test and evaluation which are associated with the overall system. Each appendix identifies integration, assembly, test and checkout separately with the exception of the aircraft system appendix (Appendix A). For aircraft systems, the integration, assembly, test, and checkout is a subelement of (and included in) the airframe work breakdown structure element to be consistent with the historical data sets that are maintained on airframe.

l. This standard does not identify Level 3 elements for the systems engineering/program management work breakdown structure element. This allows the government and contractor flexibility to identify efforts that are important to the specific program. The definition given provides typical systems engineering/program management efforts.

m. System test and evaluation always separately identifies those tests performed in the development of a system (i.e., development test and evaluation), and those tests performed by the operational user (i.e., operational test and evaluation).

Figure I-7 provides an example of both a correct and an incorrect work breakdown structure.

50.4.5 Software in the Work Breakdown Structure. This standard recognizes the importance of software within the DoD environment. Software is identified in each appendix. In addition, Appendix B, Electronic/Automated Software Systems, describes software in more detail. The software definitions are consistent with policies and practices discussed in DoD-STD-2167.,

50.4.5.1 Contracts with Hardware/Software. Software that is being developed to reside on specific equipment must be identified as a subset of that equipment. Multi-function software will be identified as a subset of the equipment work breakdown structure element which either includes the software in the element specification or exercises the most critical performance constraint. Figure I-8 provides an example of how software should be addressed as part of a specific equipment. In cases where the application of this rule results in a conflict in the selection of the proper element, the specification relationship will take precedence. For example, an aircraft's electronic equipment typically has software included in each of the subsystem elements. Software that resides and interfaces with more than one equipment, i.e., applications software, and overall system software which facilitates the operation and maintenance of the computer systems and associated programs (e.g., operating systems, compilers, and utilities) will be called out at the appropriate work breakdown level with the program (ref. ANSI/IEEE Std 610.12 for definitions of applications and system software).

It is incorrect to summarize all software on a program or contract in a work breakdown structure (ref. Figure I-7). By separating these elements from the hardware they support, performance measurement and management control over each equipment is difficult to maintain since the true cost of each equipment is not readily available. Rather than a separate summarization, software should be identified with the hardware it supports. (When needed, contractor management systems can use an identifier for each software element to produce internal summaries for software management purposes.)

50.4.5.2 Software-Only Contracts. Separately contracted or stand alone software will include the software, data, services, facilities required to develop and produce a software product for a command and control system, radar system, information system, etc. Where software is considered stand alone (i.e., does not reside or

CORRECT

PROGRAM WBS

1	2	3	4
FX AIRCRAFT			
	AIR VEHICLE		
		AIRFRAME	
			WING
			FUSELAGE
			EMPENNAGE
			FLIGHT CONTROLS SUBSYSTEM
			HYDRAULIC SYSTEM
			ENVIRONMENTAL CONTROL
			CREW STATION SYSTEM
			LANDING AND ARRESTING GEAR SYSTEM
			INTEG. ASSEMBLY, TEST AND CHKOUT
		PROPULSION (EX-PW-52D)	
		COMMUNICATIONS/IDENTIFICATION	
			RADIO SYSTEM
			DATA LINK
			COMMUNICATIONS SYSTEM SOFTWARE
		NAVIGATION/GUIDANCE	
		FIRE CONTROL	
			RADAR
			COMPUTER
			CONTROLS AND DISPLAYS
			SYSTEM SOFTWARE
		AUTOMATIC FLIGHT CONTROL	
		CENTRAL COMPUTER	
			COMPUTER
			SYSTEM SOFTWARE
		ELECTRONIC WARFARE	
		WEAPON DELIVERY EQUIPMENT	
		ARMAMENT	
	SYSTEM TEST AND EVALUATION		
		DEVELOPMENT TEST AND EVALUATION	
			WIND TUNNEL ARTICLES AND TEST
			STATIC ARTICLES AND TEST
			FATIGUE ARTICLES AND TEST
			CONTRACTOR FLIGHT TESTS
		OPERATIONAL TEST AND EVALUATION	
		MOCKUPS	
		TEST AND EVALUATION SUPPORT	
		TEST FACILITIES	
	SYSTEMS ENGINEERING/PROGRAM MANAGEMENT		
		SYSTEMS ENGINEERING	
		PROGRAM MANAGEMENT	
		INTEGRATED LOGISTIC SUPPORT	
	PECULIAR SUPPORT EQUIPMENT		
		TEST AND MEASUREMENT EQUIPMENT	
		SUPPORT AND HANDLING EQUIPMENT	
	COMMON SUPPORT EQUIPMENT		
	TRAINING		
		MAINTENANCE TRAINERS	
		AIRCREW TRAINING DEVICE	
		TRAINING COURSE MATERIALS	
	DATA		
		TECHNICAL PUBLICATIONS	
		ENGINEERING DATA	
		MANAGEMENT DATA	
		SUPPORT DATA	
		DATA DEPOSITORY	
	OPERATIONAL/SITE ACTIVATION		
		CONTRACTOR TECHNICAL SUPPORT	
	INITIAL SPARES AND REPAIR PARTS		

INCORRECT

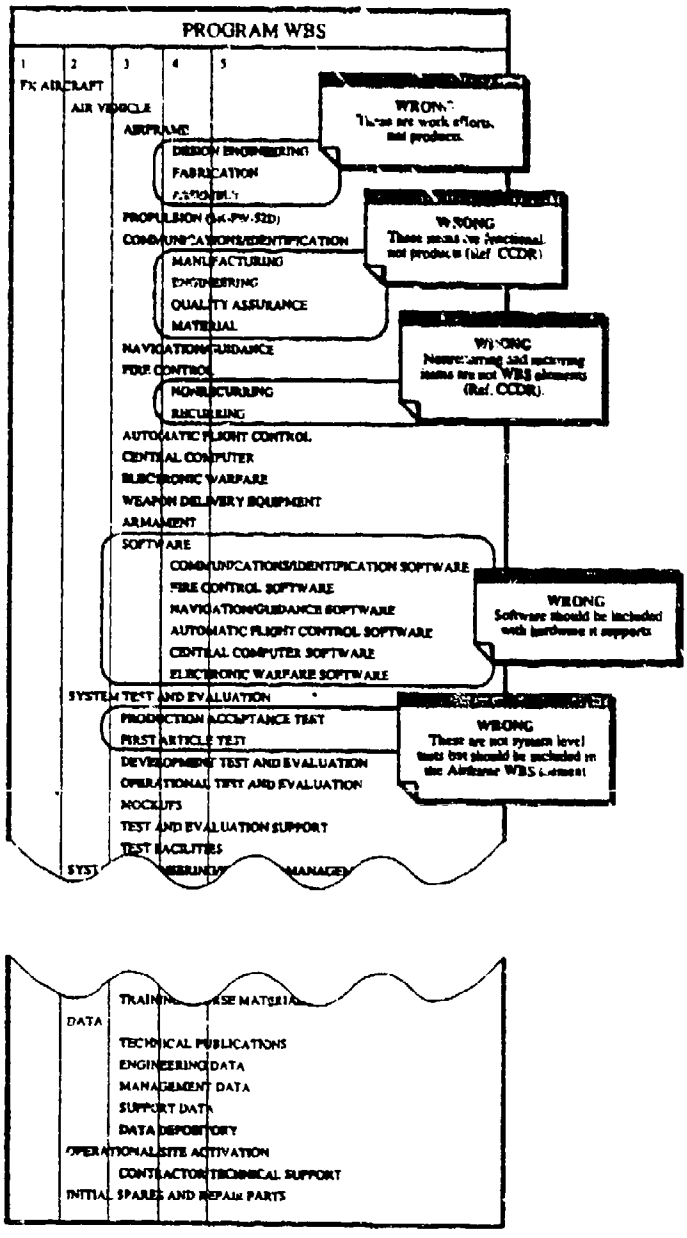

Figure I-7 COMPARISON OF CORRECT AND INCORRECT PROGRAM WBSs

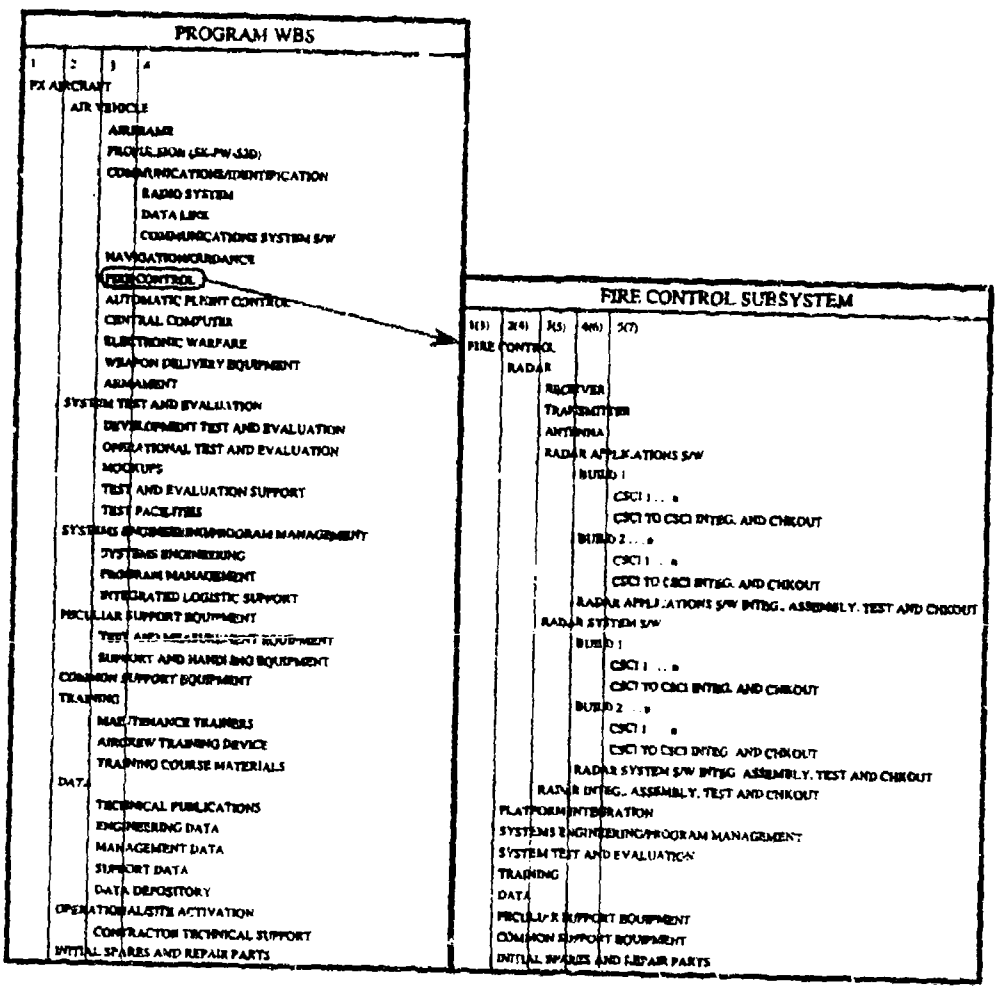

Figure I-8. SOFTWARE AS PART OF A SYSTEM/SUBSYSTEM

support a specific equipment, a pure software upgrade, etc.), the DoD Component will use the same work breakdown structure format as identified in Appendix B, Electronic/Automated Software Systems, adjusted to reflect the appropriate levels of the work breakdown structure. Figure I-9 provides an example of a work breakdown structure for stand alone software.

50.4.6 WBS Dictionary. When developing a program work breakdown structure, the DoD Component will also develop a WBS Dictionary (ref. page 14, para. 5.4.1.1). The program work breakdown structure dictionary lists and defines the work breakdown structure elements. Although initially prepared for the program work breakdown structure by the DoD Component, it is expanded by the contractors as they develop and extend their contract work breakdown structure. The WBS Dictionary should be based on the generic definitions in this standard, made to be program specific to define the products being acquired.

The dictionary lists elements to show their hierarchical relationship to each other and describes each work breakdown structure element and the resources and processes required to produce it; it also provides a link to the detailed technical definition documents. The work breakdown structure dictionary should be revised to reflect changes and should be maintained in a current status throughout the life of the program.

50.4.7 Program Work Breakdown Structure Approval. Final approval of the program work breakdown structure is achieved through approval of the CCDR plan process. Changes may be required due to program restructuring or changes with the way the contractor will meet the technical requirements. Changes are approved following the CCDR Plan procedures in DoD regulations.

50.5 Preparing a Contract Work Breakdown Structure. The individual work breakdown structure elements will be selected from the program work breakdown structure by the DoD Component for inclusion in a Request for Proposal (RFP). This will be accomplished by selecting the appropriate program work breakdown structure elements for the products that will be required by each contract. Contracts for WBS elements that are at Level 3 or below in the Program Work Breakdown Structure will be moved to Level 2 and all other applicable Level 2 Common WBS elements will be included. The result is the contract work breakdown structure. Figure I-10 depicts the development and relationship of the Program Work Breakdown Structure with the Contract Work Breakdown Structure. Each RFP includes the contract work breakdown structure, and the initial WBS Dictionary prepared by the DoD Component. The RFP should instruct potential contractors to extend the selected contract work breakdown structure elements to define the complete contract scope.

50.5.1 RFP Solicitation Requirements. The contract line items, configuration items, contract work statement tasks, contract specifications, and contractor responses will be relatable to the work breakdown structure to enhance its effectiveness in satisfying the objectives of the particular acquisition. It is important to develop the program work breakdown structure and the CCDR plan with the development of the SOW so as to form consistency in document structure. When aggregated with the program work breakdown structure, the extended contract work breakdown structure will form a complete work breakdown structure of the program for use throughout the acquisition cycle.

50.5.2 Extend Contract Work Breakdown Structure. The Contractor extends the contract work breakdown structure in the RFP and submits the complete contract work breakdown structure with its proposal. The proposal submitted should be based on the work breakdown structure in the RFP. Contractors may suggest changes to the RFP contract work breakdown structure elements when a change is needed to meet an essential requirement of the RFP or to enhance the effectiveness of the contract work breakdown structure in satisfying program objectives. The contractor should extend the contract work breakdown structure to the appropriate level which satisfies the critical visibility requirements and does not overburden the contractor management system.

PROGRAM/CONTRACT WBS				
1	2	3	4	5
STAND ALONE SOFTWARE				
	PRIME MISSION PRODUCT (PMP)			
		APPLICATIONS SOFTWARE		
			BUILD 1 . . . n	
				CSCI 1 . . . n
				CSCI TO CSCI INTEG. AND CHKOUT
			APPLICATIONS S/W INTEG., ASSEMBLY, TEST AND CHKOUT	
		SYSTEM SOFTWARE		
			BUILD 1 . . . n	
				CSCI 1 . . . n
				CSCI TO CSCI INTEG. AND CHKOUT
			SYSTEM S/W INTEG., ASSEMBLY, TEST AND CHKOUT	
		INTEGRATION, ASSEMBLY, TEST AND CHKOUT		
	SYSTEMS ENGINEERING/PROGRAM MANAGEMENT			
	SYSTEM TEST AND EVALUATION			
		DEVELOPMENT TEST AND EVALUATION		
		OPERATIONAL TEST AND EVALUATION		
		MOCK-UPS		
		TEST AND EVALUATION SUPPORT		
		TEST FACILITIES		
	TRAINING			
		EQUIPMENT		
		SERVICES		
		FACILITIES		
	DATA			
		TECHNICAL PUBLICATIONS		
		ENGINEERING DATA		
		MANAGEMENT DATA		
		SUPPORT DATA		
		DATA DEPOSITORY		
	PECULIAR SUPPORT EQUIPMENT			
		TEST AND MEASUREMENT EQUIPMENT		
		SUPPORT AND HANDLING EQUIPMENT		
	COMMON SUPPORT EQUIPMENT			
	OPERATIONAL/SITE ACTIVATION			
		SYSTEM ASSEMBLY, INSTALLATION AND CHKOUT		
		CONTRACTOR TECHNICAL SUPPORT		
		SITE CONSTRUCTION		
		SITE/SHIP/VEHICLE CONVERSION		
	INDUSTRIAL FACILITIES			
		CONSTRUCTION/CONVERSION/EXPANSION		
		EQUIPMENT ACQUISITION OR MODERNIZATION		
		MAINTENANCE (INDUSTRIAL FACILITIES)		
	INITIAL SPARES AND REPAIR PARTS			

Figure I-9. STAND ALONE SOFTWARE

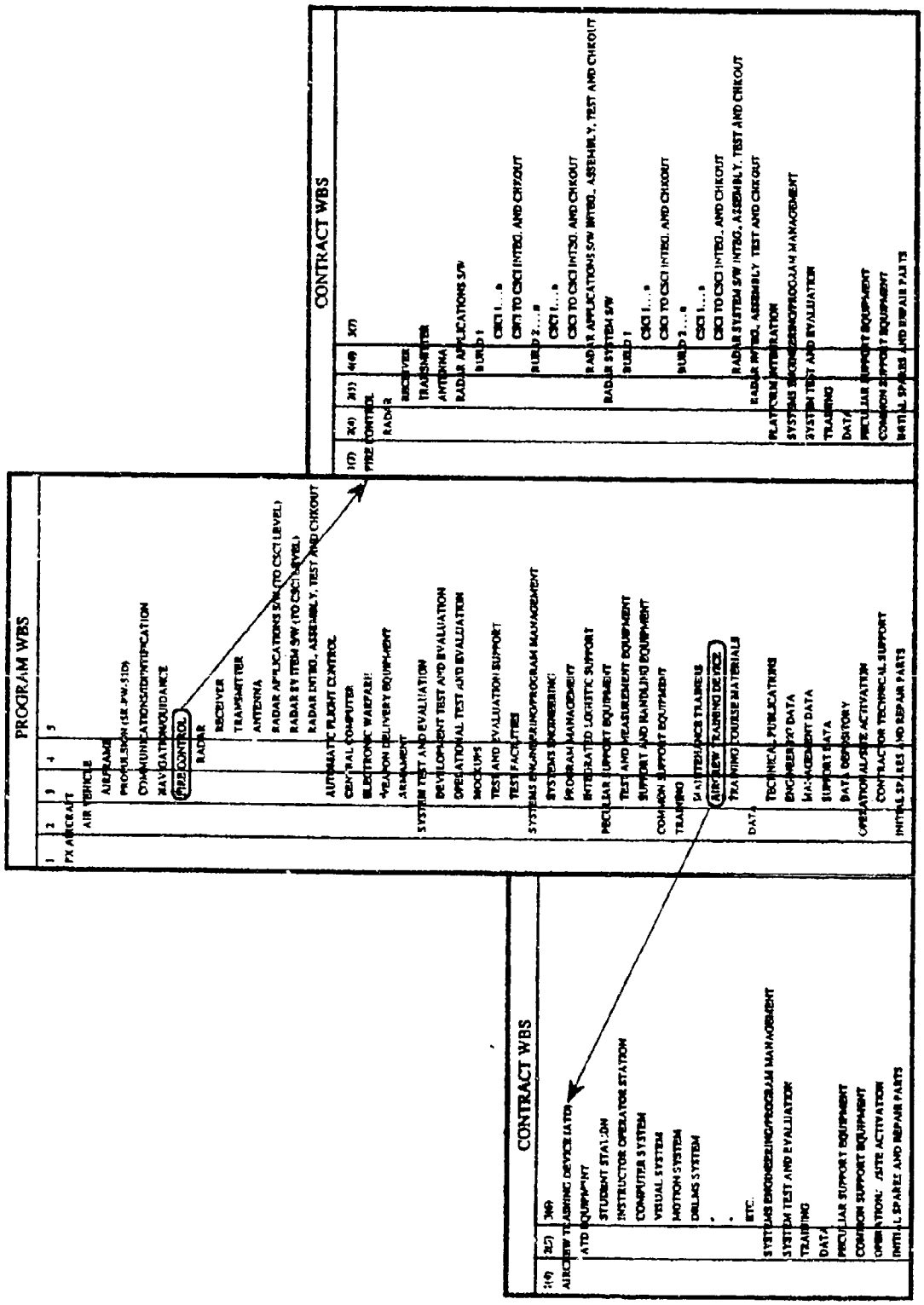

Figure I-10. RELATIONSHIP OF PROGRAM WBS WITH CONTRACT WBS

50.6 Implementation of Contract Work Breakdown Structure. After contractors are selected, contract WBSs are negotiated as part of contract negotiations. The proposed contract work breakdown structure included in the successful proposal serves as the basis for negotiating an approved contract work breakdown structure. The contractor may have proposed alternate approaches to better accomplish the contract objectives. The alternatives, if accepted by the DoD Component, may impact the proposed program work breakdown structure. Revisions will be required to the program work breakdown structure and the contract work breakdown structure to reflect these changes. After adjustments and contract negotiations, the elements selected for the contract will become the basis for contractor extension during the contracted effort. All extensions must sum to the contract work breakdown structure reporting level in the contract.

50.6.1 Contract Work Breakdown Structure Approval and Contract Award. Following approval of the negotiated contract, including the contract work breakdown structure, the contract is awarded. The contract identifies the requirement for providing the WBS Dictionary through the contract data requirements list (CDRL). While strong efforts should be placed on early and accurate work breakdown structure planning, work breakdown structure revisions may result from expansion or contraction of program/contract scope and the movement of a program through its various stages. Normally, changes to the work breakdown structure should not be made after contracts are awarded and work is underway unless major rescoping of the program occurs. Users of this guide should understand that the sequence shown in preceding paragraphs may be iterative as the program evolves, contracts are awarded, and the work effort progresses through major program phases. Whenever the work breakdown structure is revised, the ability to crosswalk and track back to the previous work breakdown structure must be maintained.

50.6.2 Implementation with Subcontractors. Contractors may require the use of the work breakdown structure by subcontractors to permit fulfillment of contractual requirements and provide adequate control of the subcontract. Such subcontractors, whose work accounts for a major segment of the subcontracted portion of the prime contract, will be delineated in contracts at the time of award. It will be the prime or associate contractor's responsibility to incorporate into the contract with the affected subcontractors the work breakdown structure requirements. Figure I-11 provides an example of a prime work breakdown structure and its relationship to a subcontract work breakdown structure.

50.6.3 Maintain Contract Work Breakdown Structure. The contractor maintains the contract work breakdown structure, including change traceability. Only DoD Component approved changes may be incorporated in accordance with the contract terms. The contract will indicate the levels of contract work breakdown structure at which costs will be reported to the government. Traceability of cost accumulations will be required to those extended contract work breakdown structure levels which are used by the contractor for cost control purposes. In the extended contract work breakdown structure, consideration will be given to the specific contractual, technical, and managerial requirements of the defense materiel item. The contractor has complete flexibility in extending the contract work breakdown structure below the reporting requirement to reflect how work is to be accomplished, assuming lower elements to be meaningful product or management-oriented lower indentures of a higher-level element.

50.7 Relationship with Contractor Management System. As the end product is subdivided into smaller subproducts at lower work breakdown structure levels, the work effort required by each element can be identified to functional organization units. At some point within the work breakdown structure, the contractor will assign management responsibility for technical, schedule, and cost performance. The cost management system will provide the necessary visibility of the lower levels of the work breakdown structure as it interfaces with the organization. At the juncture of the work breakdown structure element and organization unit, cost accounts are usually established and performance is planned, measured, recorded and controlled. To do so, the technical requirements for the work and work product must be specified, the work scheduled, budgeted, and

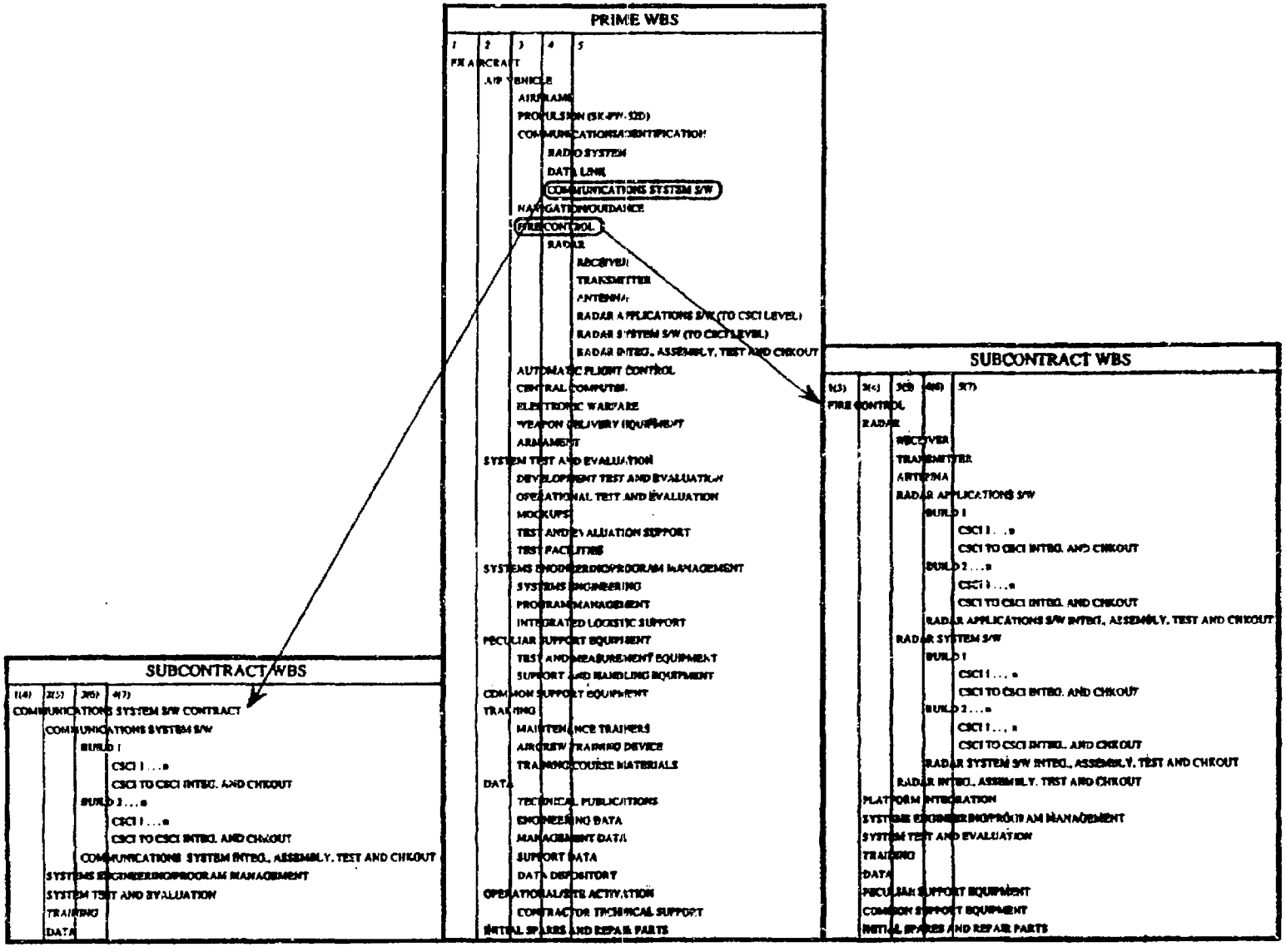

Figure 1-11. PRIME WBS TO SUBCONTRACT WBS

performed, and product attainment of specified technical requirements verified. The responsible manager is called a cost account manager.

50.7.1 Contractor Organizational Structure. People performing work are organized to facilitate effective management. Whether the organization is designed along program, function, natural work teams or matrix lines, the organizational structure reflects the way the people who will accomplish the work have been organized. To assign specific work tasks, the organizational structure must be linked effectively with the work breakdown structure. This linkage can occur at any level of the work breakdown structure. Figure I-12 depicts the linkage between the work breakdown structure and the contractor's organizational structure.

50.7.2 Process-Oriented Breakdown Structure. One way to assess contractor performance is through the review of selected process or subprocess data. When contractors are structured using Integrated Product Teams (IPTs) this data is often needed to guide and evaluate manufacturing and other process improvement initiatives. Both development and production activities have data which can be gathered to determine process/subprocess improvement. Figures I-13 and I-14 provide some examples of development and production activities and their processes. Figure I-15 depicts the linkage between the work breakdown structure and the process-oriented breakdown within the contractor's cost management system. Visibility to specific processes can be attained through job coding (.FAB) without extending the work breakdown structure to extremely low levels.

50.7.3 Cost Account Level. To provide the responsible (cost account) manager with the technical, schedule, and cost information needed to manage the organization's work on the work breakdown structure element for which the manager is responsible, the management control system must be keyed to the same work breakdown structure element and organization unit. The appropriate work breakdown structure level at which a cost account is established is primarily a function of the magnitude of the program and the type of product. The responsible organization level is a function of the management span of control and upper management's desire to delegate technical, schedule, and cost responsibility for product/contract work breakdown structure elements to lower management levels. In identifying cost accounts, the contractor must be allowed to establish organizational responsibilities at meaningful and appropriate levels, otherwise the contractor's existing management control systems and responsibility assignments may be affected adversely. For example, when software is a major component of cost and DoD wants it identified separately, care must be taken to not unnecessarily complicate the contractor work breakdown structure and contractor management system. To meet these needs, special reporting requirements are specified in the SOW. In this example, Figure I-16 shows how the cost management system with job coding (.SW_) and the work breakdown structure can provide needed detail and visibility without extending the work breakdown structure to extremely low levels.

Virtually all aspects of the contractor's management control system, including technical definition, budgets, estimates, schedules, work assignments, accounting, progress assessment, problem identification, and corrective actions, come together at the cost account. Performance visibility is directly relatable to the level and content of the cost account. NAVSO P3627, AFSCP 173-5, AFCCP 173-5, AFLCP 173-5, AMC-P 715-5, DLAH 8400.2, and DCAA P7641.47 contains a detailed explanation of the cost account and related performance measurement concepts.

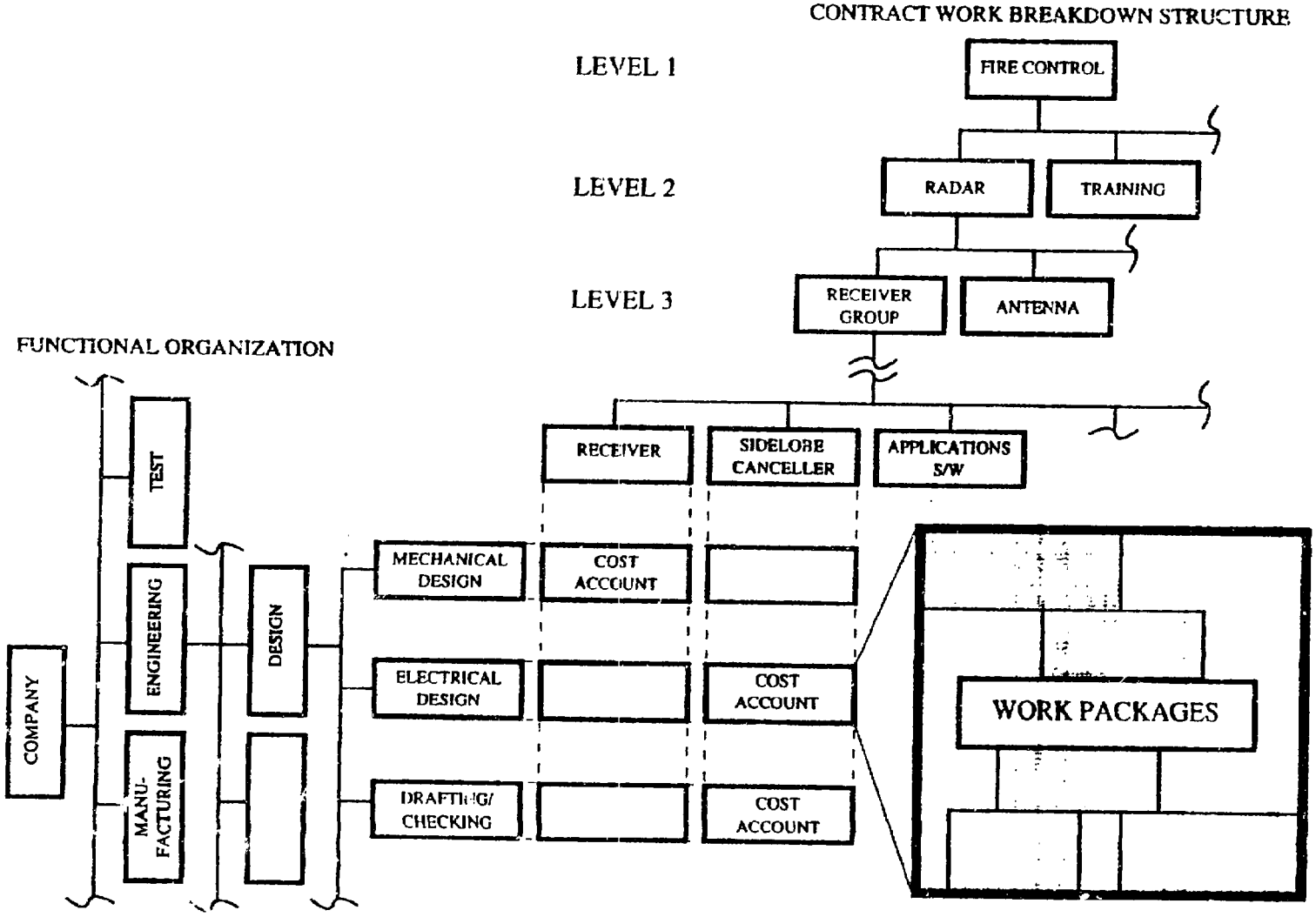

Figure I-12. TRANSLATION FROM FUNCTION TO PRODUCT

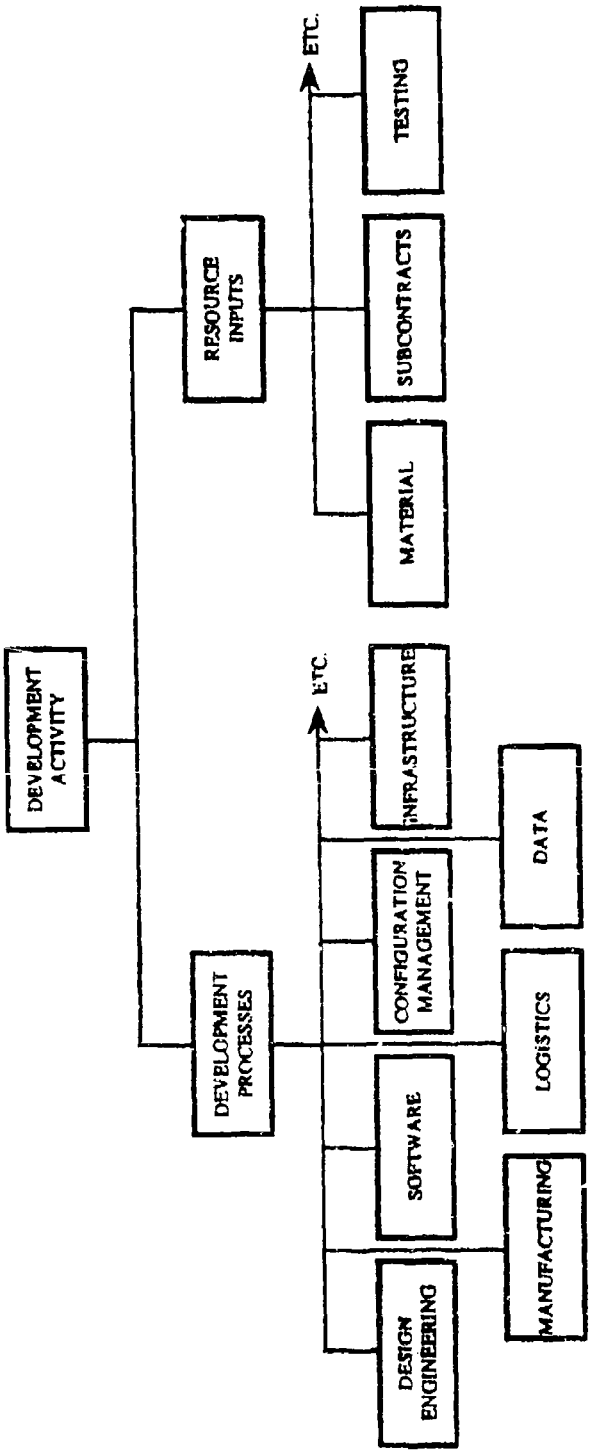

Figure I-13. DEVELOPMENT ACTIVITIES AND PROCESSES

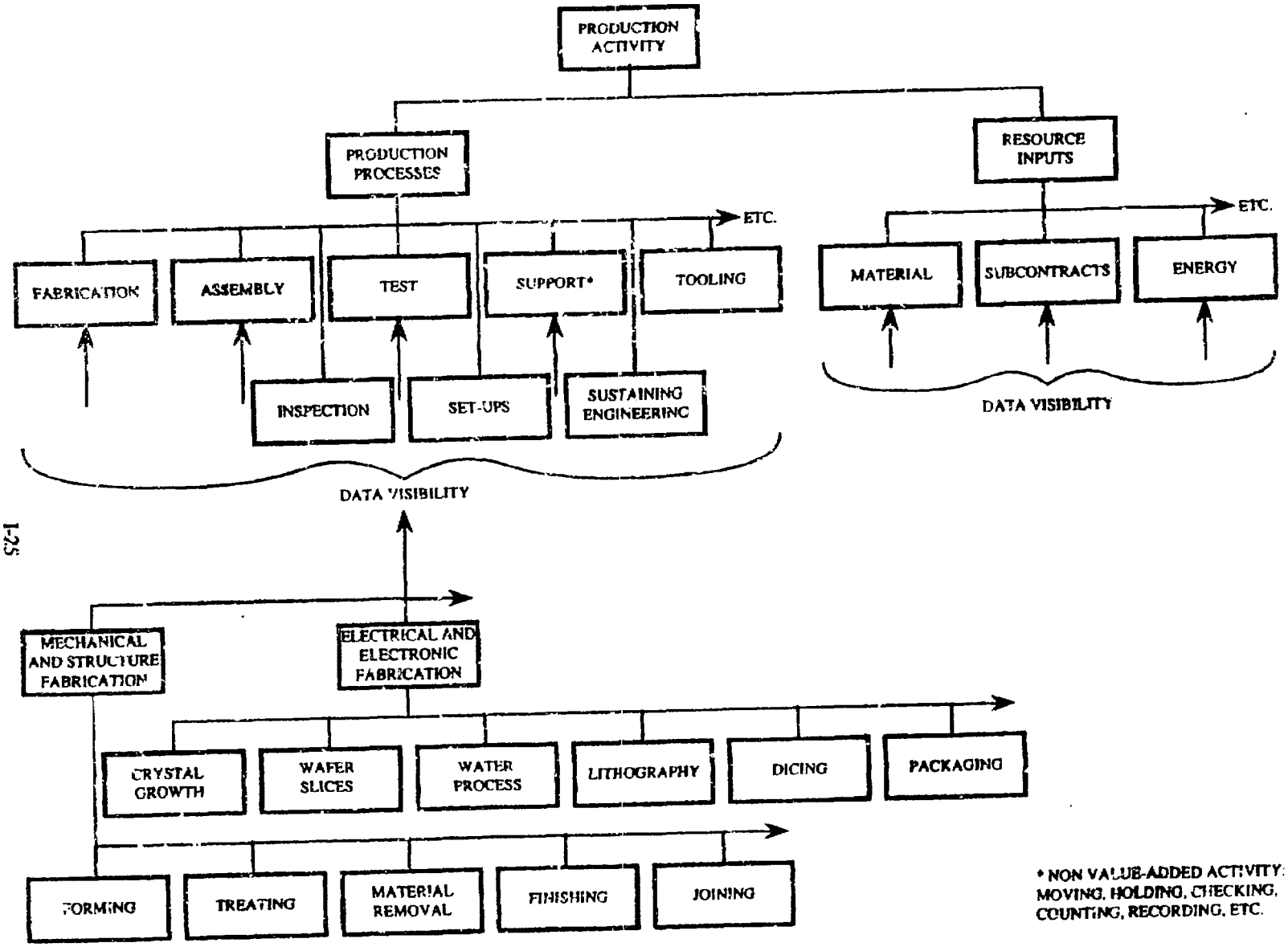

Figure I-14. PRODUCTION ACTIVITIES AND PROCESSES

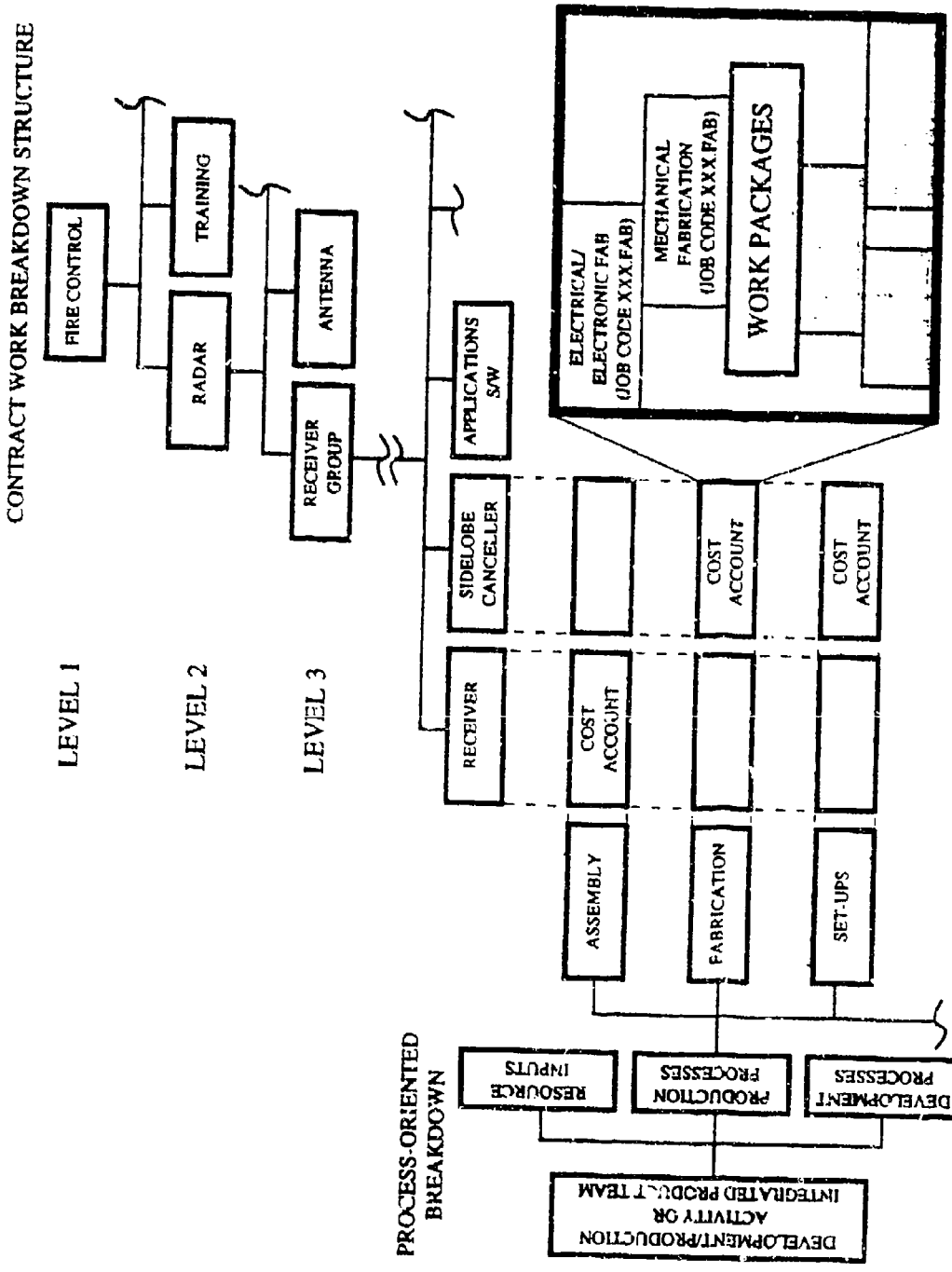

Figure 1-15. LINKAGE BETWEEN WORK BREAKDOWN STRUCTURE AND PROCESS-ORIENTED BREAKDOWN

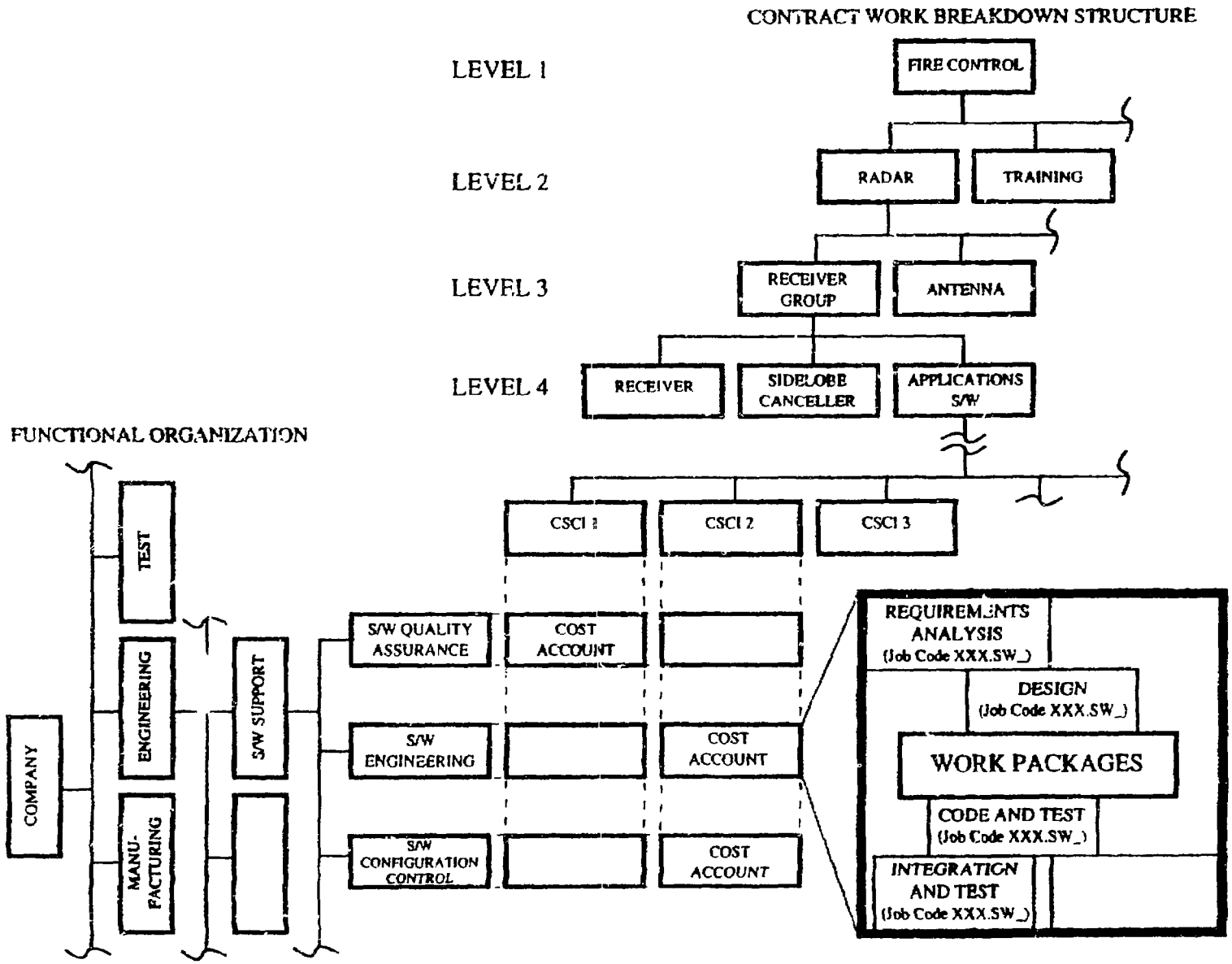

Figure I-16. LINKAGE BETWEEN CONTRACTOR WBS AND CONTRACTOR MANAGEMENT SYSTEMS

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

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	F6914	930325

3. DOCUMENT TITLE

Work Breakdown Structures For Defense Materiel Items

4. NATURE OF CHANGE (*Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.*)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (*Include Zip Code*)	d. TELEPHONE (*Include Area Code*) (1) Commercial (2) AUTOVON (*If applicable*)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (*Include Area Code*)	
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ADDRESS (*Include Zip Code*) Air Force Materiel Command Product Management Division (FMA) Wright-Patterson AFB, Ohio 45433	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	