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DEPARTMENT OF DEFENSE HANDBOOK

WORK BREAKDOWN STRUCTURES FOR DEFENSE MATERIEL ITEMS

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FOREWORD

1. This handbook is approved for use by all Departments and Agencies of the Department of Defense. It is for guidance only and should not be included as a contract requirement.

2. This handbook addresses mandatory procedures for those programs subject to DoD Instruction 5000.2. It also provides guidance to industry in extending contract work breakdown structures.

3. A Work Breakdown Structure (WBS) provides a consistent and visible framework for defense materiel items and contracts within a program. This handbook offers uniformity in definition and consistency of approach for developing the top levels of the WBS. The benefit of uniformity in the generation of work breakdown structures and their application to management practices will be realized in improved communication throughout the acquisition process.

4. This handbook is an update to MIL-HDBK-881, Work Breakdown Structures for Defense Materiel Items. MIL-HDBK-881A is based on the cooperative efforts of the military services with assistance from industrial associations. Changes to the handbook specifically address the advances in technology, modification of the acquisition process, and incorporation of new developmental concepts and approaches.

5. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Office of the Undersecretary of Defense (Acquisition, Technology, and Logistics) (OUSD(AT&L)) Acquisition Resources and Analysis, 3020 Defense Pentagon, Room 3D161, Washington, DC 20301-3020. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

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1. GENERAL INFORMATION

1.1 Handbook Purpose And Structure. This handbook presents guidelines for effectively preparing, understanding, and presenting a Work Breakdown Structure (WBS). It is intended to provide the framework for Department of Defense (DoD) Program Managers to define their program's WBS and also be valuable guidance to defense contractors in their application and extension of the contract's WBS. Section 1 defines and describes the WBS. Section 2 provides instructions on how to develop a Program WBS in the pre-award timeframe. Section 3 offers guidance for developing and implementing a Contract WBS and Section 4 examines the role of the WBS in the post-award timeframe. This handbook also provides WBS definitions for specific defense materiel items in the Appendices.

The primary objective of this handbook is to achieve a consistent application of the WBS for all programmatic needs (including Performance, Cost, Schedule, Risk, Budget, and Contractual). The discussion and guidance provided was compiled based on many years of lessons learned in employing WBS's on defense programs.

1.2 Support Documentation. The foundation for WBSs are contained in DoD Directive 5000.1 and DoD Instruction 5000.2. These documents identify responsibilities in the acquisition process from the Office of the Secretary of Defense to the DoD component field activities. Preparing a WBS is generally discussed in the context of planning and monitoring a defense system program.

DoD Directive 5000.1 requires a disciplined approach in establishing program goals over its life cycle with streamlined and effective management that "ensures accountability and maximizes creditability in cost, schedule, and performance reporting." The WBS is a critical tool in ensuring all portions of the program are covered. The WBS will also facilitate the required collaboration within the Integrated Product Team (IPT) structure by providing a tie between performance, cost, schedule, and risk information. The WBS can also facilitate the required technical rigor and integrated test and evaluation throughout the defense acquisition process.

DoD Instruction 5000.2 further outlines the required framework and provides impetus for use of a WBS. The evolution of the system through incremental development further drives the requirement to breakdown the system in a structure that clarifies which capabilities will be satisfied in what increment of the system development. The instruction goes on to set the requirements for integrated schedules, Earned Value Management (EVM) and other statutory, regulatory, and contract reporting information and milestone requirements in which the WBS is a critical thread.

In addition, the purpose of the Chairman of the Joint Chief of Staff Instruction (CJCSI) 3170.01E (in concert with CJCSM 3170.01B) is to establish the polices and procedures of the Joint Capabilities Integration and Development System (JCIDS) which directly supports the DoD acquisition process and hence WBS implications.

The Program WBS and Contract WBS help document architectural products in a system life cycle. The DoD Architecture Framework (DoDAF) Version 1.0 defines a common approach for DoD architecture description development, presentation, and integration for warfighting operations and business operations and processes.

The Defense Acquisition Guidebook (DAG) is a source of best practices and includes numerous references to the use of a WBS.

1.3 Intended Use of Handbook. This handbook is directed primarily at preparing a WBS for a defense system program. This includes all materiel items or major modifications established as an integral program element of the Future Years Defense Program or otherwise designated by the DoD component or the Under Secretary of Defense (AT&L).

The guidance is appropriate for use with any WBS developed for all acquisition phases—Concept Refinement, Technology Development, System Development and Demonstration, and Production and Deployment.

This handbook clearly delineates the overlapping responsibilities of DoD program managers and contractors relative to the execution of WBSs.

1.4 What Does a WBS Accomplish? The following three sub-paragraphs will discuss Applications, Benefits and Challenges with regard to the WBS.

1.4.1 Applications. This handbook addresses two fundamental and interrelated WBS structures: the Program WBS and the Contract WBS.

The Program WBS provides a framework for specifying program objectives. It defines the program in terms of hierarchically related, product-oriented elements and includes "other Government" elements (i.e., Program Office Operations, Manpower, Government Furnished Equipment (GFE), Government Testing). Each element provides logical summary levels for assessing technical accomplishments, supporting the required event-based technical reviews, and for measuring cost and schedule performance.

The Contract WBS is the Government-approved WBS for program reporting purposes and includes all product elements (hardware, software, data, or services), which are the contractor's responsibility. It includes the contractor's discretionary extension to lower levels, in accordance with Government direction and the Contract Statement of Work (SOW).

The goal is to develop a WBS that defines the logical relationship among all program elements to a specific level (typically Level 3) of indenture that does not constrain the contractor's ability to define or manage the program and resources. However, if the Government considers some program elements to be high cost or high risk, the system may be defined to a lower level of the WBS; this is reasonable if the product-oriented logical extension is maintained. The contractor should extend all other elements to the level and form based on the way the system is developed, produced, or managed. A secondary, but still important, goal is to provide a systematic and standardized method for gathering cost data across all programs. Having actual historical data to support cost estimates of similar defense materiel items is a valuable resource. It includes all the elements for the products (hardware, software, data, or services) which are the responsibility of the contractor.

Further, the WBS serves as a coordinating medium. Through the Program WBS and the Contract WBS, work progress is documented as resources are allocated and expended. Performance, cost, schedule, and technical data are routinely generated for reporting purposes. The WBS is the infrastructure to summarize data for successive levels of management and provide appropriate information on projected, actual, and current status of the individual elements. When appropriately structured and used in conjunction with sound systems engineering principles, cost estimating, EVM, integrated scheduling, and risk management, the WBS allows for program status to be continuously

visible so the program manager and contractor can identify, coordinate, and implement changes necessary for desired results.

The WBS is defined, developed, and maintained throughout the system life cycle based on disciplined application of the systems engineering process. Other attributes include:

a. A **product-oriented family tree** composed of hardware, software, services, data, and facilities. The family tree results from systems engineering efforts during the acquisition of a defense materiel item.

b. A WBS displays and defines the product(s) to be developed and/or produced. It **relates the elements** of work to be accomplished to each other and to the end product.

c. A WBS can be expressed to any level of detail. However, the top **three levels** are the minimum recommended any program or contract needs for reporting purposes unless the items identified are high cost or high risk. Then, and only then, is it critical to define the product at a lower level of WBS detail.

The WBS applies to the specific categories of defense materiel items listed below. These are further discussed in 1.6 and complete definitions of each are included as Appendices A through I.

a. Aircraft Systems

b. Electronic/Automated Software Systems

c. Missile Systems

d. Ordnance Systems

e. Sea Systems

f. Space Systems

g. Surface Vehicle Systems

h. Unmanned Air Vehicle Systems

i. Common Elements

The WBS requirements of a system also apply to that of a System of Systems (SoS). The SoS concept has become more prominent as the DoD drives toward integrated architectures in a joint operational environment. The Defense Acquisition Guidebook (DAG) (Section 2.3.15) outlines the DoD goal for Modular Open Systems Approach (MOSA), which enables programs to implement SoS concepts. The DAG (Section 4.2.6) goes on to define SoS engineering and outlines how a SoS should be treated and managed as a system in their own right, and should therefore be subject to the same systems engineering processes and best practices as applied to individual systems." Where applicable, a SoS WBS should be developed using the same guidelines as a single defense materiel item.

1.4.2 Benefits. The WBS assists in several ways during the program life cycle:

a. Segregates a defense materiel item into its component parts, clarifying the relationship among the parts, and clarifying the relationship of the tasks to be completed—to each other and to the end product.

b. Facilitates effective planning and assignment of management and technical responsibilities.

c. Aids status tracking of technical efforts, risks, resource allocations, expenditures, and cost/schedule/technical performance.

d. Helps ensure that contractors are not unnecessarily constrained in meeting item requirements.

e. Provides a common thread for Earned Value Management System (EVMS) and the Integrated Master Schedule (IMS), allowing consistency in understanding program cost and schedule performance. The Contract WBS includes the breakdown of work into small enough entities that can be analyzed and assessed. As part of EVMS, the Contract WBS elements provide a structure for collecting costs assessing performance. The IMS is a time-phased schedule that serves as a tool for time phasing work and assessing technical performance. Schedule activities in the IMS are traceable to the Contract WBS elements used in EVMS, allowing commonality for integrated program assessment of cost, schedule, technical performance, and associated risks.

1.4.3 Challenges. The primary challenge is to develop a WBS that defines the logical relationship between all program elements without constraining the contractor's ability to effectively execute the program.

A secondary challenge is to balance the program definition aspects of the WBS with its data-generating aspects. Using available data to build historic files to aid in the future development of similar defense materiel items is a very valuable resource. Remember, however, that the primary purpose of the WBS is to define the program's structure, and the need for data should not distort or hinder the program definition.

1.5 How is the WBS Related to Other Contract Requirements? The WBS provides a basis for effective communication throughout the acquisition process. It is a common link, which unifies planning, scheduling, cost estimating, budgeting, contracting, configuration management, and performance reporting disciplines. It permits the Government and industry managers to continually evaluate progress in terms of contract performance.

The WBS forms the basis of reporting structures used for contracts requiring compliance with ANSI/EIA 748 EVMS Guidelines and reports placed on contract such as Contractor Cost Data Reporting (CCDR), Software Resource Data Report (SRDR), Contract Performance Reports (CPR), and Contract Funds Status Reports (CFSR).

1.6 Definitions. The following definitions are intended to improve continuity and support a common understanding of program expectations.

1.6.1 Program Element (PE). The program element is the basic building block of the Future Years Defense Program. The PE describes the program mission and identifies the organization responsible to perform the mission. A PE may consist of forces, manpower, materiel (both real and personal property), services, and associated costs, as applicable.

1.6.2 Defense Materiel Item. This term identifies a system or item usually established as an integral PE or identified as a project within an aggregated PE.

1.6.3 Work Breakdown Structure (WBS). This term is defined as:

a. A product-oriented family tree composed of hardware, software, services, data, and facilities. The family tree results from systems engineering efforts during the acquisition of a defense materiel item.

b. A WBS displays and defines the product, or products, to be developed and/or produced. It relates the elements of work to be accomplished to each other and to the end product. In other words the WBS is an organized method to breakdown a product into subproducts at lower levels of detail.

c. A WBS can be expressed down to any level of interest. Generally, the top three levels are sufficient unless the items identified are high cost or high risk. Then, is it important to take the WBS to a lower level of definition.

WBSs apply to eight specific categories of defense materiel items. Summaries of those categories are provided below; complete definitions are included as Appendices A-H.

1.6.4 Common Elements. The term “Common Elements” refers to the elements listed below that are applicable to all major systems and subsystems as required:

a. Integration, assembly, test, and checkout

b. Systems engineering

c. Program management

d. Training

e. Data

f. System test and evaluation

g. Peculiar support equipment

h. Common support equipment

i. Operational and site activation

j. Industrial facilities

k. Initial spares and repair parts

These common elements are described in further detail in Appendix I.

In addition to these common elements, each defense system has a unique combination of hardware and software which defines the capability or end product of that system.

a. **Aircraft System**—applies to fixed or movable wing, rotary wing, or compound wing manned air vehicles designed for powered or unpowered (i.e., glider) guided flight

b. **Electronic/Automated Software System**—applies to electronic, automated, or software system capability

c. **Missile System**—applies to a missile in an operational environment which produces a destructive effect on selected targets, or has the capability for launching space systems

d. **Ordnance System**—applies to all munitions (nuclear, biological, chemical, psychological, and pyrotechnic) and the means of launching or firing them

e. **Sea System**—applies to surface and submersible ship platforms, systems, weapons, and equipment required for performing naval tasks at sea

f. **Space System**—applies to developing, delivering, and maintaining mission payloads in specific orbit placement, operation, and recovery of manned and unmanned space systems

g. **Surface Vehicle System**—applies to navigation over the surface

h. **Unmanned Air Vehicle**— applies to fixed or movable wing, rotary wing, or compound wing unmanned air vehicles designed for powered or unpowered (glider) guided flight

1.6.5 Level Identification. The top three levels are specified in a WBS.

a. Level 1 is the entire defense materiel item, a program element, project or subprogram, for example, an electronic system. An “electronic system” might be a command and control system, a radar system, a communications system, a management information system, a sensor system, navigation or guidance system, or electronic warfare system.

b. Level 2 elements are the major elements subordinate to the Level 1 major elements, for example, an air vehicle of a missile or aircraft system, or the complete round of an ordnance system. These major elements are prime mission products, which include all hardware and software elements. Level 2 elements also include aggregations of system level services (like system test and evaluation, or systems engineering and program management), and data.

c. Level 3 elements are elements subordinate to Level 2 major elements, including hardware and software and services. For example, the radar data processor of the fire control radar or, the Developmental Test and Evaluation (DT&E) subordinate element of System Test and Evaluation, or technical publications element of Technical Data. Lower levels follow the same process.

1.6.6 Program WBS. The Program WBS encompasses an entire program, including the Contract WBS and "other Government" elements (e.g., Program Office Operations, Manpower, GFE, Government Testing). It defines at a high level what is to be procured and consists of at least three program levels with associated definitions. The Program WBS is used by the Government program manager and contractor to develop and extend a Contract WBS. It contains uniform terminology, definitions, and placement in the product-oriented family tree structure.

1.6.7 Contract WBS. The Contract WBS is the complete WBS as included in the DoD-approved Program WBS extended to the agreed-to contract reporting level and any discretionary extensions to lower levels for reporting or other purposes. It defines the lower level components of what is to be procured and includes all the product elements (hardware, software, data, or services), which are defined by the contractor and are their responsibility. This comprehensive Contract WBS forms the framework for the contractor's management control system.

1.6.8 System of Systems. The SoS program can be a mix of existing and/or new systems being managed as a system. The overall objective for developing a SoS WBS is to provide the program management team a structure that captures the various system work and the common elements that will be accomplished at the SoS level. The mix of constituent systems may include existing, partially developed, and yet-to-be-designed independent systems. A SoS is managed as a system, thus it is baselined and should have an assigned program manager. A SoS WBS is driven by the need to capture the common elements that support the integration of the various systems into the SoS.

1.7 WBS Evolution. Throughout any system's life cycle, systems engineering leads system development. This function includes developing system specifications, functional specifications, or a set of configuration items through requirements analysis, functional analysis and allocation, synthesis and systems analysis, and controls. The important factor is satisfying total systems cost, schedule, and performance requirements at an acceptable level of risk.

As the system is defined and developed, the DoD program manager can better understand and identify the WBS structure that is appropriate for the program. Figure 1-1 provides an illustration of the system life cycle.

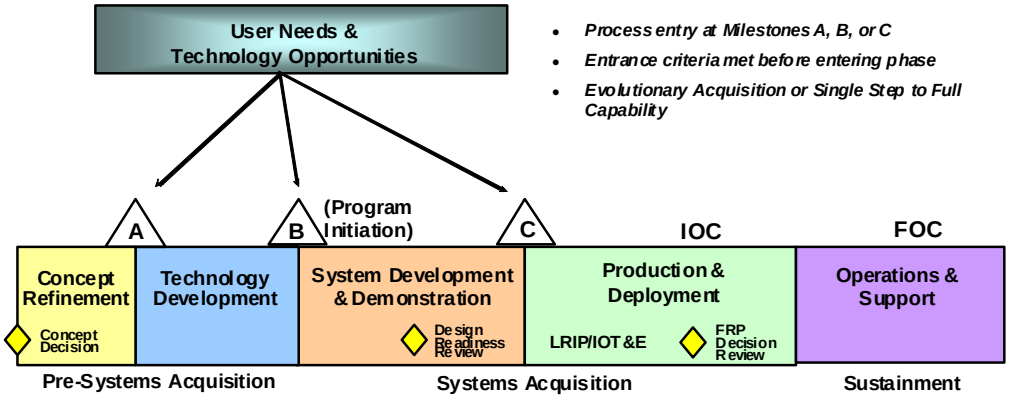


FIGURE 1-1. The Defense Acquisition Management Framework

Through the Concept Refinement to the Technology Development phase, the program WBS is usually in an early stage of development. The results of the Analysis of Material Approaches and the Analysis of Alternatives (AoA) provide the basis for the initial WBS.

Since the system is mainly a concept at this point, it is not until the System Development and Demonstration (SDD) phase that the system is broken into its component parts and a detailed WBS can be developed. In the SDD phase, configuration items that describe the Program WBS are first identified and contracts can be awarded to develop these items. By the end of SDD, the WBS is fully defined to its lowest levels that best represents the system.

Just as the system is defined and developed throughout its life cycle, so is the WBS. The WBS will be developed and maintained based on the systems engineering efforts throughout the system's life cycle. After the Program WBS has been approved (through the CCDR process), the contractor should then extend the Contract WBS to appropriate lower levels, to better define the complete contract scope. When integrated with the Program WBS, the extended Contract WBS forms a complete WBS, which will be used throughout the program's life cycle. Figure 1-2 displays this process.

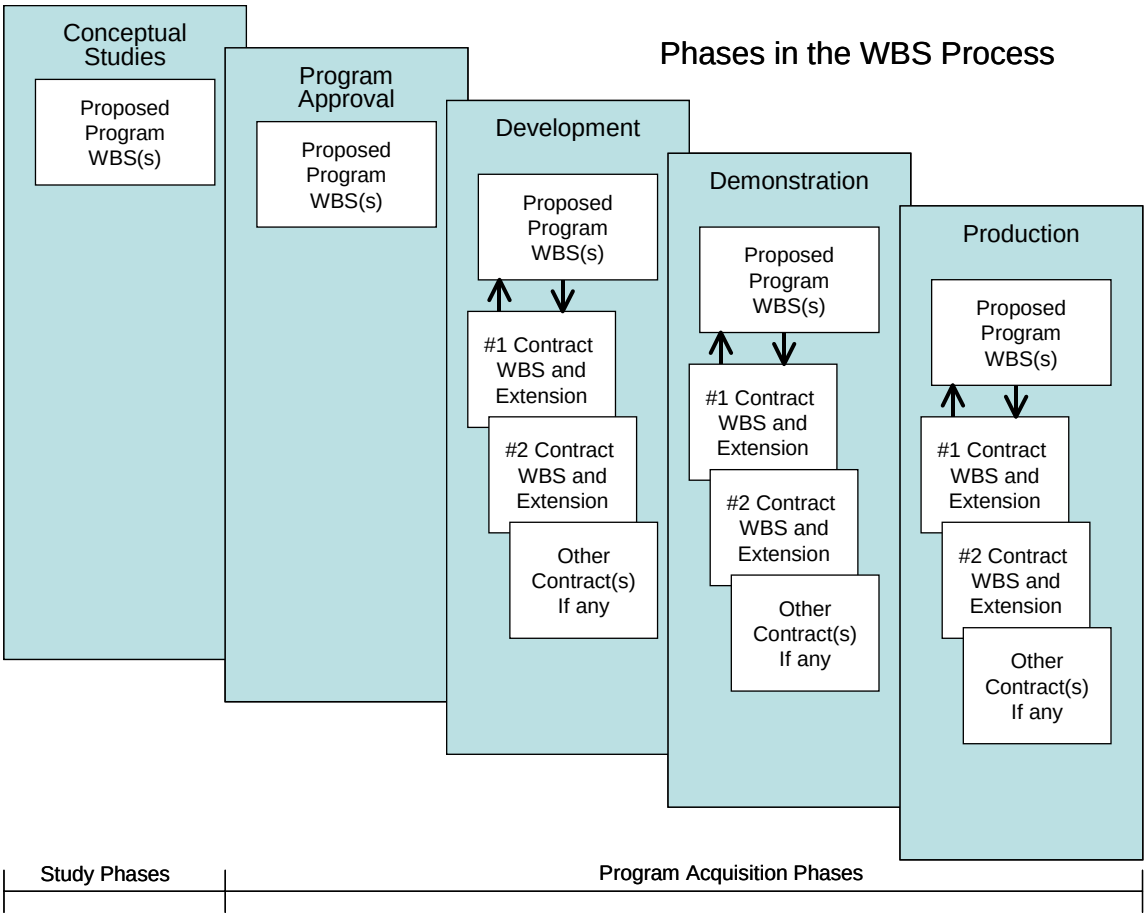


FIGURE 1-2: WBS Evolution

2. PROGRAM MANAGEMENT INSTRUCTIONS

2.1 Program WBS Attributes. The Program WBS is intended to structurally illustrate a clear understanding of the technical objectives and the end item(s) or end product(s) of the work to be performed by both Government and contract entities.

In order to use the Program WBS as a valuable framework for the technical objectives, it must be product oriented. Its elements should represent identifiable work products, whether they are equipment, data, or related service products. A WBS is a product structure, not an organizational structure, providing the complete definition of the work to be performed by all participants and the required interfaces between them.

2.2 Preparing A Program WBS.

2.2.1 Developing and Documenting a Program WBS. The program manager is responsible for maintaining the Program WBS as it develops through systems engineering and management planning processes. The WBS may span one or more of the categories or elements defined in

Appendices A-H. While these elements normally provide a basis for the Program or Contract WBS, tailoring may occur when a unique requirement exists, which these appendices do not address. In addition, although each appendix relates to a specific category of defense items, any item from any appendix which is applicable to the program may be used, as long as the integrity of the level of placement is maintained.

The Program WBS should guide development early in the program's life cycle. It will evolve through iterative analysis of the program objective, functional design criteria, program scope, technical performance requirements, and other technical documentation. The documentation should describe the entire plan to build, field, and support the system throughout its life cycle.

The Cost Analysis Requirements Description (CARD) will be the recording document for this program plan. Ultimately, the Program WBS is approved through the Cost and Software Data Reporting (CSDR) plan, which describes the Program WBS to be used and defines the approach the Government activity plans to use for collecting cost data.

2.2.2 Selecting Program WBS Elements. The WBS provides a framework for specifying the technical 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 WBS provides logical summary points for assessing technical accomplishments and for measuring the cost and schedule performance accomplished in attaining the specified technical objectives.

2.2.3 Determining Levels of Program WBS. The detailed technical objectives are defined and specified work tasks are assigned to each WBS element. Resources, materials, and processes required for attaining the objectives are added incrementally. The linkage between the requirements specification, the WBS, the Statement of Work (SOW), the Integrated Master Schedule (IMS), and Integrated Master Plan (IMP) provides specific insights into the relationship between cost, schedule, and performance. This relationship allows all items to be tracked to the same WBS elements. Therefore, the levels of the Program WBS should be related to these requirements and conform to the product-oriented family tree.

Following the Acquisition Management Framework (see Figure 1-1), when developing a Program WBS, systems engineers define the description of the system and its related levels. Early in the Concept Refinement phase an Initial Capability Document (ICD) through the Joint Capability Integration and Development System (JCIDS) is developed and systems engineering efforts transform operational needs to system performance parameters and configurations. For example, suppose the established need is to "Kill a Tank." The objective is clear and can be met through numerous capabilities. Systems engineers perform tradeoffs, which ultimately define the preliminary system level functions. In this case, the systems that will "Kill Tank" must be able to detect, maneuver, and shoot (see Figure 2-1). The Program WBS is not formed around these functional requirements, but is developed out of the products which are expected to satisfy these requirements. Therefore, during the Concept Refinement phase, no formal WBS is defined.

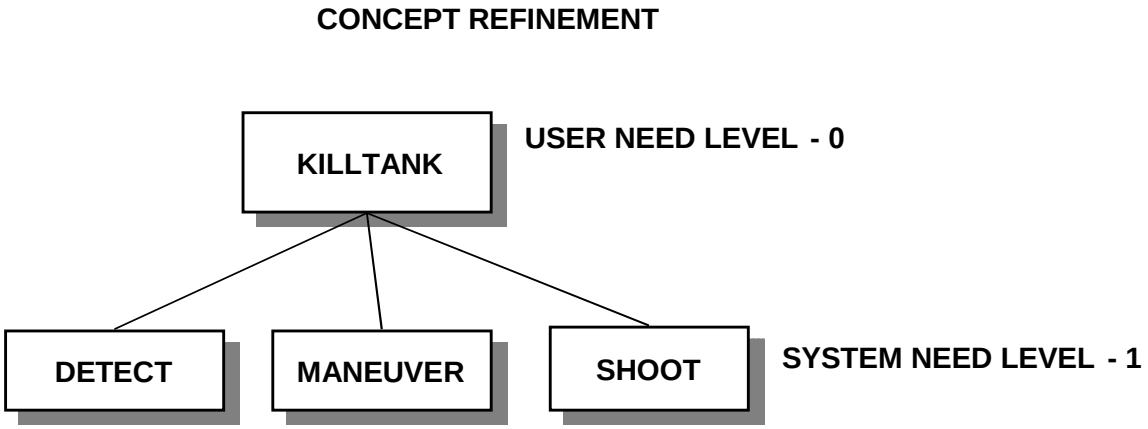


FIGURE 2-1: Functional Requirements in the Concept Refinement Phase

When the Technology Development phase is initiated, a Capability Development Document through the JCIDS is developed. Through this development process, the systems engineering efforts will focus on technology needs to meet system level capabilities. Functional requirements are assigned under a System, all meeting the mission need of "Kill Tank." If Government laboratories or in-house engineering support is accomplishing this work, a SOW may be prepared for a request for support in the Technology Development phase. Otherwise, this may have already been accomplished at the end of Concept Refinement to obtain contractual support for the Technology Demonstration phase.

The Technology Development phase should describe the system and the configuration items that make up the system. Once the system concept is determined, then major subsystems and configuration items can be identified and lower level functions defined, so that lower level system elements can be created. Again, these are not WBS elements since they do not reflect a product. In this example, using a cost effectiveness tradeoff process determined that a fire control system of an aircraft can meet the mission need. The fire control system is functionally able to detect, aim, track, and fire (see Figure 2-2).

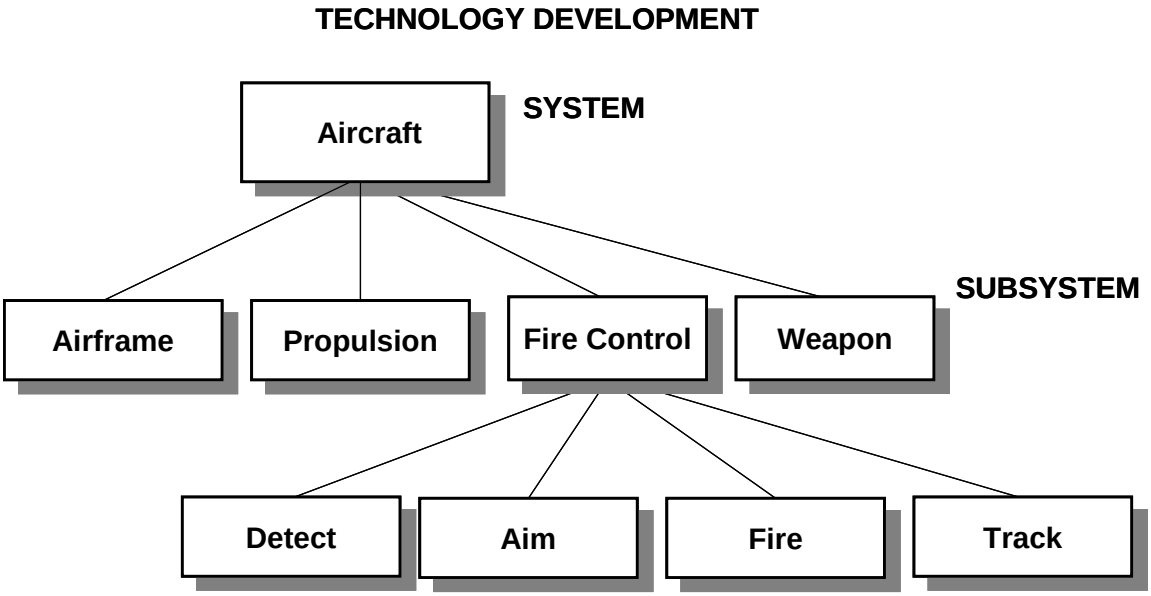


FIGURE 2-2: Identification of Major Subsystems and Functional Requirements

The relationship of the functions shown in the previous example can now be translated into products that will meet the mission need requirement. It is at this time that the preliminary Program WBS can be defined.

Generically, the WBS is defining the solution to the problem in terms of a product. (see Figure 2-3) This figure shows the hierarchical relationship of the Aircraft System to the Fire Control Subsystem and to other elements.

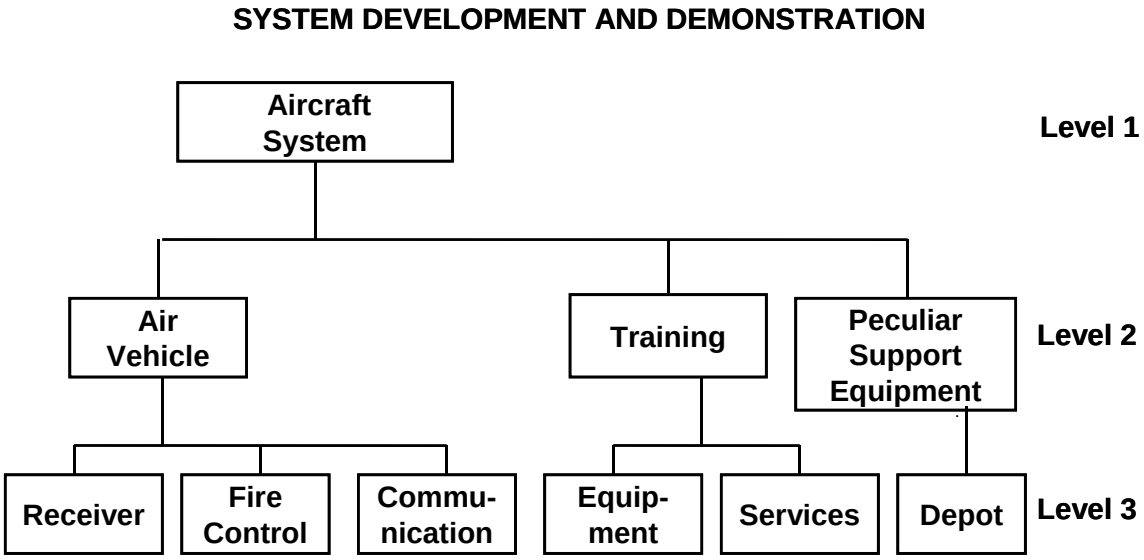
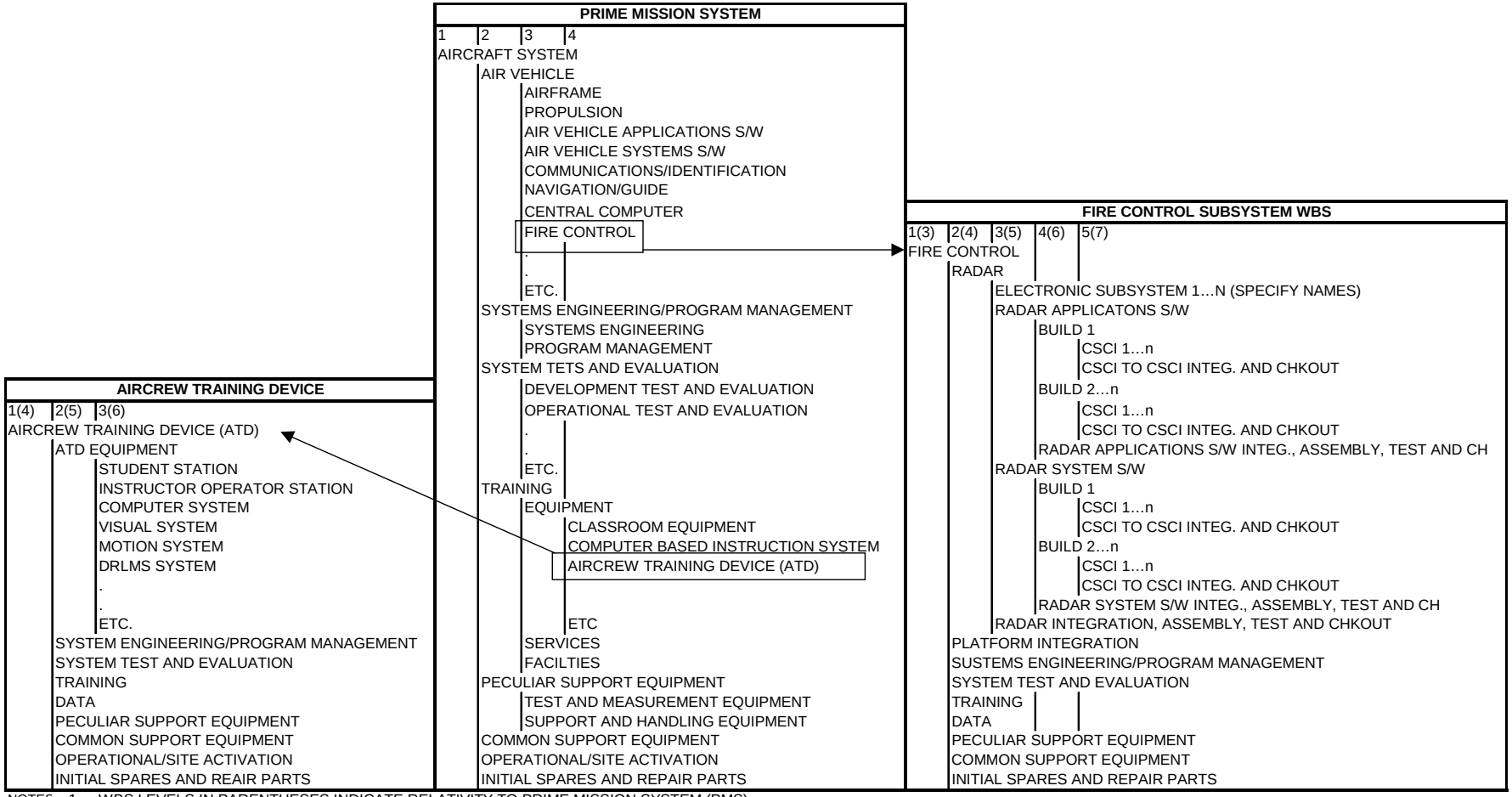


FIGURE 2-3: Program WBS Description

When System Development and Demonstration (SDD) units are being developed and produced, the Program WBS should be approved by submitting a Cost and Software Data Report (CSDR) plan, as required by DoD Instruction 5000.2. The plan describes the Program WBS being used and defines the approach the Government activity plans to use for collecting cost data.

During the SDD phase, through the JCIDS process, systems engineering efforts develop a Capabilities Production Document (CPD) and define the system configuration to its lowest level. By the end of this phase, the total system definition is complete and the Government has approved the Program WBS and each Contract WBS. As the system becomes better defined, the contractor extends the Contract WBS to the desired level, reflecting how each program is planned and will be managed. The WBS levels should be directly linked with the detailed system configuration.

Once the system has been defined, the relationship between the Program WBS and the Contract WBS can be shown. Figure 2-4 shows how the Prime Mission System is the Government Program WBS. As a result, multiple contract WBSs may be formed. In this example an Air Crew Training Device and Fire Control Subsystem are assumed to be separate contracts therefore each has a Contract WBS associated with it.



NOTES:
1. WBS LEVELS IN PARENTHESES INDICATE RELATIVITY TO PRIME MISSION SYSTEM (PMS).
2. LEVEL 2 ELEMENTS (SYSTEM ENGINEERING/PROGRAM MANAGEMENT, SYSTEM TEST AND EVALUATION, ETC.) FOR SUBSYSTEMS FO THE PMS ARE CONTAINED IN (I.E., ARE SUBELEMENTS OF THE SUBSYSTEM ELEMENT NOT THE PMS LEVEL 2 ELEMENT
3. PLACEMENT OF THE SUBSYSTEM IN THE PROGRAM WORK BREAKDOWN STRUCTURE IS RELATIVE TO ITS WBS BREAKOUT FOR CONTRACT APPLICATION

FIGURE 2-4: Work Breakdown Structure Matrix (Contract WBS)

During the Production and Deployment phase, the system is produced as defined throughout previous phases. The systems engineering efforts are actively involved in maintaining control over the system configuration as it is produced. The WBS is defined to the level appropriate for contract management and maintenance. When major modifications occur, the same WBS can be tailored; or, if the changes are substantial, a new WBS can be developed according to the same rules.

2.2.3.1 Creating the WBS Dictionary. As part of developing a Program WBS, the program manager will also develop a WBS dictionary. The dictionary lists and defines the WBS elements. Although initially prepared by the Government program manager, the contractor expands the dictionary as the Contract WBS is developed. The initial WBS dictionary should be based on the generic definitions in this handbook, made program specific to define the products being acquired.

The dictionary shows the hierarchical relationship of the elements and describes each WBS element and the resources and processes required to produce it (see Figure 2-5). It also provides a link to the detailed technical definition documents. The WBS dictionary should be routinely revised to incorporate changes and should reflect the current status of the program throughout the program's life.

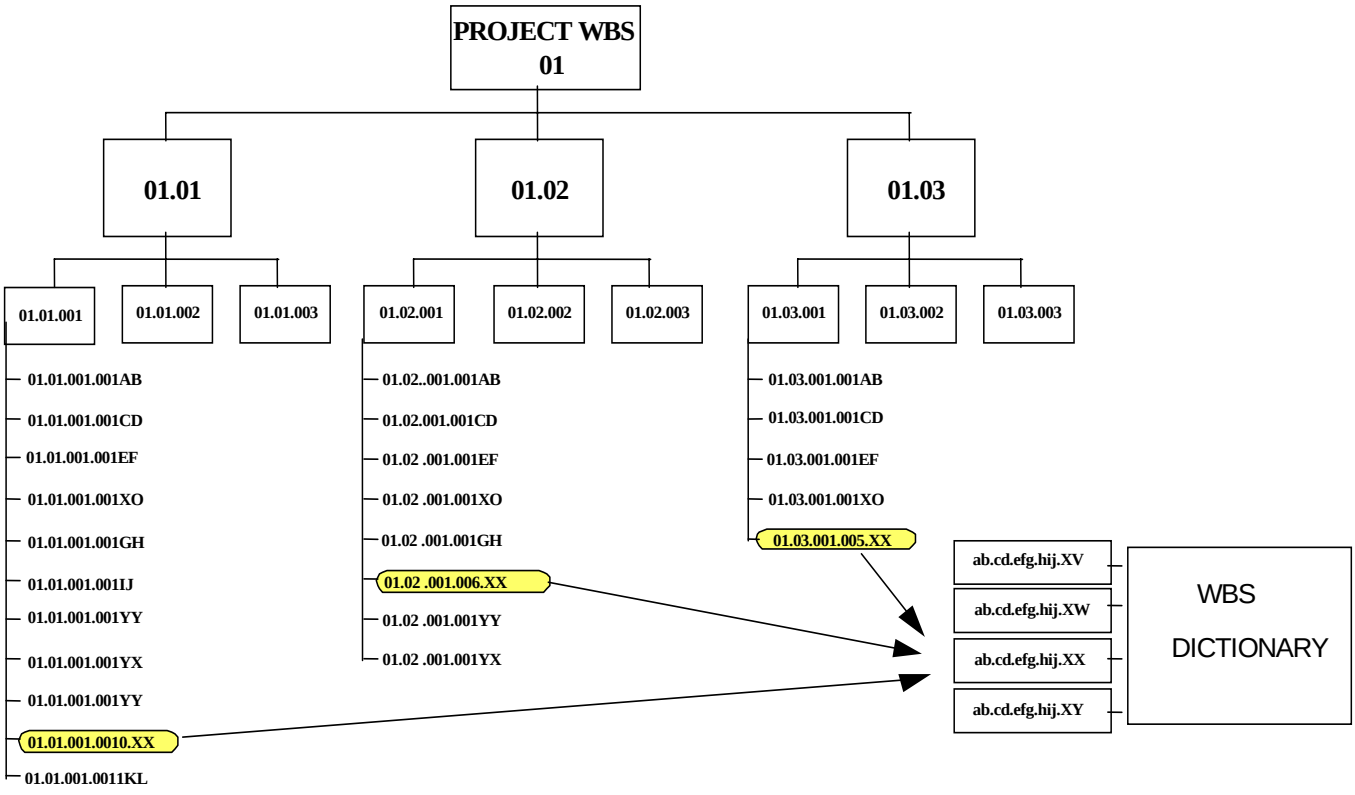


FIGURE 2-5: WBS Dictionary

2.2.4 Avoiding Pitfalls in Constructing a WBS. An effective WBS clearly describes what the program manager intends to acquire. It has a logical structure and is tailored to a particular defense

materiel item. It serves as a common thread among the specifications, SOW, Contract Line Item Number (CLIN) structure, IMS, EVMS and Risk Management. Remember, the WBS is product-oriented; addressing the products required, not the functions or costs associated with those products.

2.2.4.1 Guidance for WBS Element Exclusions.

Do not include elements that are not products (i.e., hardware, software, services, data, and facilities). A signal processor, for example, is clearly a product, as are mock-ups and Computer Software Configuration Items (CSCIs) or Software Configuration Items (SCIs). On the other hand, items like design engineering, requirements analysis, test engineering, aluminum stock, and direct costs, 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. Thus, none of these elements are appropriate WBS elements.

Program acquisition phases (e.g., SDD, Production and Deployment), and types of funds used in various phases (e.g., Research, Development, Test and Evaluation) **are inappropriate WBS elements**.

Rework, retesting and refurbishing are not separate WBS elements. They should be treated as part of the appropriate WBS element affected.

Nonrecurring and recurring classifications are not WBS elements. The reporting requirements of the CCDR will segregate each element into its recurring and nonrecurring parts.

Cost saving efforts, such as total quality management initiatives, acquisition reform initiatives, and warranty, etc. are not part of the WBS. These efforts should be included in the cost of the item they affect, not captured separately.

Do not use the organizational structure of the program office or the contractor's organization as the basis of a WBS.

Do not treat costs for meetings, travel, computer support, etc. as separate WBS elements. They are to be included with the WBS elements with which they are associated.

Generic terms are inappropriate in a WBS. The WBS elements should clearly indicate the actual system names and nomenclature 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.

Tooling is not a WBS element. Tooling (e.g., special test equipment, automatic test equipment, and factory support equipment like assembly tools, dies, jigs, fixtures, master forms, and handling equipment) should be included in the functional cost, if possible, of the equipment being produced. If tooling is used for more than one component/subassembly, the percentage usage should be apportioned to the component/subassembly as appropriate. Programming costs for production automatic test equipment (ATE) should be included here. 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.

2.2.4.2 Additional Considerations. Include software costs in the cost of the equipment. For example, when a software development facility 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, the software effort should be included under integration, assembly, test, and checkout. Software developed to reside on specific equipment must be identified as a subset of that equipment.

Integration, assembly, test, and checkout includes production acceptance testing (including first article test) of Research and Development (R&D) and production units but excludes all systems engineering/program management and system test and evaluation that are associated with the overall system.

The appendices identify integration, assembly, test, and checkout separately, except for Appendix A, Aircraft Systems. To be consistent with the historical data sets that are maintained on airframe, integration, assembly, test, and checkout are considered a sub-element of the airframe and, therefore, are included in the airframe WBS element.

This handbook does not identify Level 3 elements for the systems engineering or program management WBS elements. This allows the program manager and contractor flexibility to identify efforts that are important to the specific program. Systems engineering and program management elements can be reported together or separately and their levels will be specified by the requiring activity. For example, a need may exist to uniquely track systems engineering from program management therefore the WBS may require to separate these elements rather than combined as currently defined. The definitions in Appendix I illustrate typical systems engineering and program management efforts.

System test and evaluation should always separately identify those tests performed in the development of a system (e.g., development test and evaluation), and those tests performed by the operational user (e.g., operational test and evaluation).

2.3 Solicitation And Proposal. The WBS used for a solicitation is structured by selecting appropriate elements from the approved Program WBS. The CLINs, configuration items, contract SOW tasks, contract specifications, and contractor responses will be expressed in terms of the WBS to enhance its effectiveness in satisfying the objectives of the particular acquisition. While the relationship of the Contract WBS elements to the SOW and the CLINs should be clearly traceable, there may not be a one-to-one relationship, nor is it required.

2.3.1 Specifications and Drawings. The family of specifications and drawings, resulting from the progressive steps of the systems engineering process, provides the basis for the Program WBS, the Contract WBS, and its extensions.

2.3.2 Contractor Management Control System. The Contract WBS should serve as the framework for the contractor's management control system. That system should provide auditable and traceable summaries of internal data generated by its performance measurement procedures.

2.3.3 Acquisition Logistics. The acquisition logistics elements should be accommodated in the upper levels of the WBS. Areas for consideration include acquisition logistics management and reporting; Contractor Logistics Support; peculiar support equipment; initial spares, support data, and training; and transition to sustainment (Operations and Maintenance (O&M) Phase).

2.3.4 Planning, Programming and Budgeting Execution (PPBE). The Program WBS should be the basis for program element data to support the PPBE submittals.

2.3.5 Life-Cycle Cost. Life-cycle cost (LCC) is the total cost for the weapons or support system R&D, investment, Operating and Support (O&S), and disposal. LCC commences at the program initiation and ends with retirement or demilitarization and disposition of the system. The established WBS requirements are associated solely with those elements of R&D, investment, and O&S that are applicable to all contracted efforts.

2.3.6 Procurement. The following areas should relate to elements of the Program WBS: specifications, structure of SOWs, Contract WBS, CLIN structure, CPR, IMS, configuration items, technical and management reports, and Government-furnished equipment.

2.3.7 Reporting. All program status reporting requirements should be consistent with the Program WBS.

2.4 Contract Statement Of Work (SOW). A standardized WBS is an effective template for constructing the SOW for a system acquisition; it helps to streamline the process. The WBS structure provides a framework for defining program technical objectives. Together with the contract SOW, the WBS aids in establishing an indentured data listing (specification tree), defining configuration items, and planning support tasks. The SOW is the document that describes, in clear and understandable terms, what products are to be delivered or what services are to be performed by the contractor. Preparation of an effective SOW requires a thorough understanding of the products and services needed to satisfy a particular requirement. An explicitly written SOW facilitates effective contractor evaluation. After contract award, if the SOW is absorbed into the IMP, and if the associated tasks and schedule are absorbed into the IMS, the IMS and EVMS become better measures of contractor performance.

The WBS also provides a logical arrangement of SOW elements, serving as a convenient checklist to ensure the contractor addresses all necessary program elements and meets specific contract reporting needs.

2.5 Request For Proposal.

2.5.1 Preparing a Preliminary Contract WBS. The DoD program manager should select the individual WBS elements from the Program WBS that apply to the contract to include in the request for proposal (RFP) as described in 2.3. This is the first time for open dialogue between the Government and potential contractors. Innovative ideas or promising alternative solutions should be considered for inclusion in the RFP. The RFP will include a Contract WBS and the initial WBS dictionary. The RFP should instruct potential contractors to extend the selected Contract WBS elements to define the complete contract scope, consistent with the contractor's proposed approach for executing the program.

2.5.2 RFP Solicitation Requirements. Again, CLINs, configuration items, contract work statement tasks, contract specifications, and contractor responses should relate to the WBS to enhance its effectiveness in fully describing acquisition objectives. It is important to coordinate the development of the Program WBS and the CSDR plan with the development of the SOW to ensure consistency in document structure. When aggregated with the Program WBS, the extended Contract

WBS will form a complete Program WBS to provide a logical work flow throughout the acquisition cycle.

2.5.3 Extended Contract WBS. Contractors are expected to extend the Contract WBS to the appropriate lower level that satisfies critical visibility requirements and does not overburden the management control system. A preliminary Contract WBS should be included in the RFP, and the contractor should submit a complete Contract WBS with their proposal. The proposal should be generally based on the WBS in the RFP, although contractors should be encouraged to suggest changes needed to meet an essential RFP requirement or to enhance the effectiveness of the Contract WBS in satisfying program objectives.

2.6 Integrated Cost, Schedule, Technical Performance and Risk Management. Planning tasks by WBS elements serves as the basis for mapping the technical baseline, for estimating and scheduling resource requirements, and mitigating risks. By breaking the total product into successively smaller entities, program managers can ensure all required products are identified in terms of cost, schedule, and performance goals in order to reduce risk.

Time phasing performance budgets, assigning them to work segments, and identifying responsible units produces a plan against which actual performance can be measured. Corrective action can be taken to resolve deviations from the plan. This integrated approach to work planning also simplifies identifying the potential cost and schedule impacts of proposed technical changes.

3. GUIDANCE

3.1 Developing The Contract WBS. The Contract WBS provides the framework for the contractor's management control system. It should be tailored to the program so that it does not unnecessarily constrain the contractor in meeting defined requirements of the contract.

3.1.1 Relationship of Program WBS to Contract WBS. Contracts for WBS elements that are in the Program WBS will become Level 1 Contract WBS elements with all applicable Level 2 Common WBS elements included, resulting in the Contract WBS. Figure 3-1 depicts the development and relationship of the Program WBS with the Contract WBS. The Government activity is responsible for the FX aircraft system reflected by the Program WBS. A contract must be awarded for the fire control system reflected by the Contract WBS.

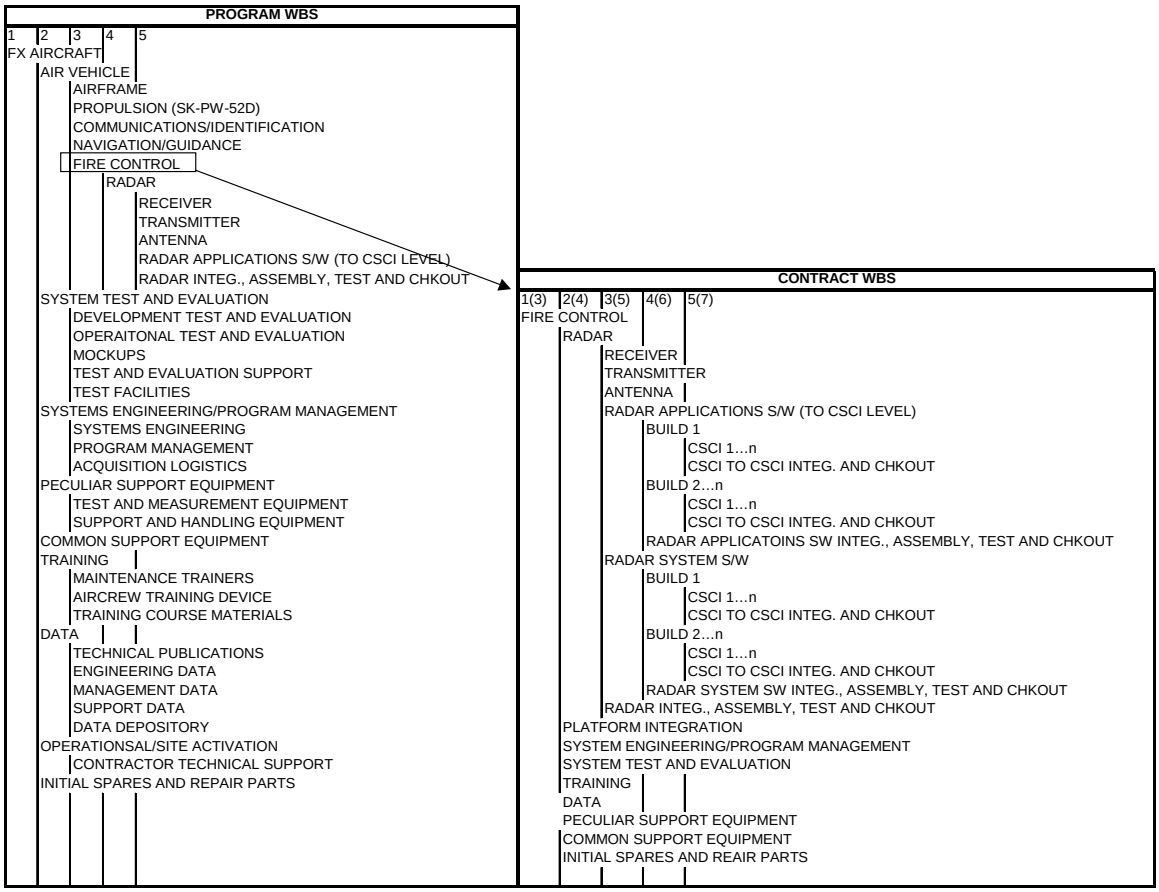


FIGURE 3-1: Relationship of Program WBS with Contract WBS

3.1.2 Subcontractors. Contractors may require subcontractors to use the WBS to fulfill contractual requirements and control the subcontract. The prime or associate contractor is responsible for incorporating WBS requirements into its subcontract. Figure 3-2 provides an example of a prime WBS and its relationship to a subcontract WBS. This shows how the prime contractor may further break down the Contract WBS to manage subcontracted work. It is the contractor's decision on how this will be done. For example, if the FX Program is awarded as a Prime contract, the Program WBS in Figure 3-1 becomes the Prime WBS represented in Figure 3-2. The Prime contractor would then subcontract for the Fire Control Subsystem. Replacing the words "Program" and "Contract" from Figure 3-1 with "Prime" and "Subcontractor" respectively, the flowdown to the WBS requirement can be shown in Figure 3-2. In this case the Program WBS could be both the Program and the Contract WBS. The relationships are still the same; the difference is in how they relate to the Government activity

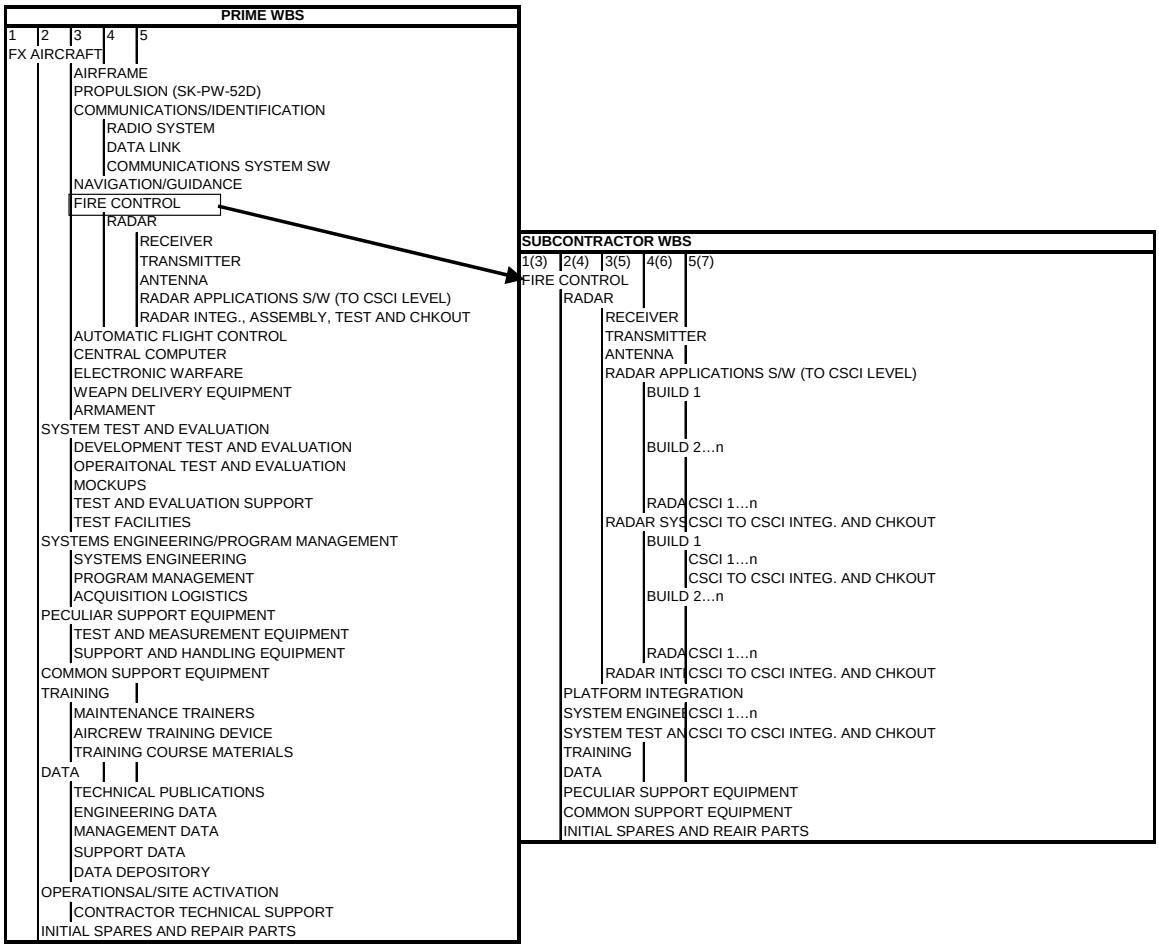


FIGURE 3-2: Relationship of Contract WBS to Subcontract WBS

3.1.3 Contractor's Organizational Structure. A WBS should not be unnecessarily influenced by a contractor's program organization. The contractor can organize according to corporate standards to effectively use a valid, product-oriented WBS.

3.1.4 Control Account Level. To provide the responsible contract manager with technical, schedule, and other needed resource information, the management control system must be keyed to the same WBS element and organizational unit. The WBS level at which the management control system is established is primarily a function of the magnitude of the program and the type of product required by the contract. The responsible organizational level is a function of the company's management span of control and upper management's desire to delegate the responsibility for WBS elements to lower management levels. In identifying control accounts, the contractor is expected to establish organizational responsibilities at meaningful and appropriate levels. Otherwise, the contractor's existing management control systems and responsibility assignments may be affected adversely.

Virtually all aspects of the contractor's management control system (i.e. technical definition, budgets, estimates, schedules, risk management, work assignments, accounting, progress assessment,

problem identification, and corrective actions) come together at the control account level. Performance visibility is directly relatable to this level of detail.

As the end product is subdivided into smaller subproducts at lower WBS levels, the work effort required by each element can be identified and assigned to functional organizational units. The contractor will assign management responsibility for technical, schedule, and other performance criteria at lower levels within the WBS. The management control system will keep the lower levels of the WBS visible as it interfaces with the organization. At the juncture of the WBS element and organization unit, control accounts are established and performance is planned, measured, recorded, and controlled. To this end, the technical requirements for the work and work product must be specified; the work scheduled, budgeted, and performed; and attainment of specified technical requirements verified.

As Figure 3-3 illustrates, at some level in a contractor's organization there is the point at which a control account is managed. Likewise, in any WBS the same point exists. Therefore, every part of a WBS is visible or accessible regardless of the contractor's organization.

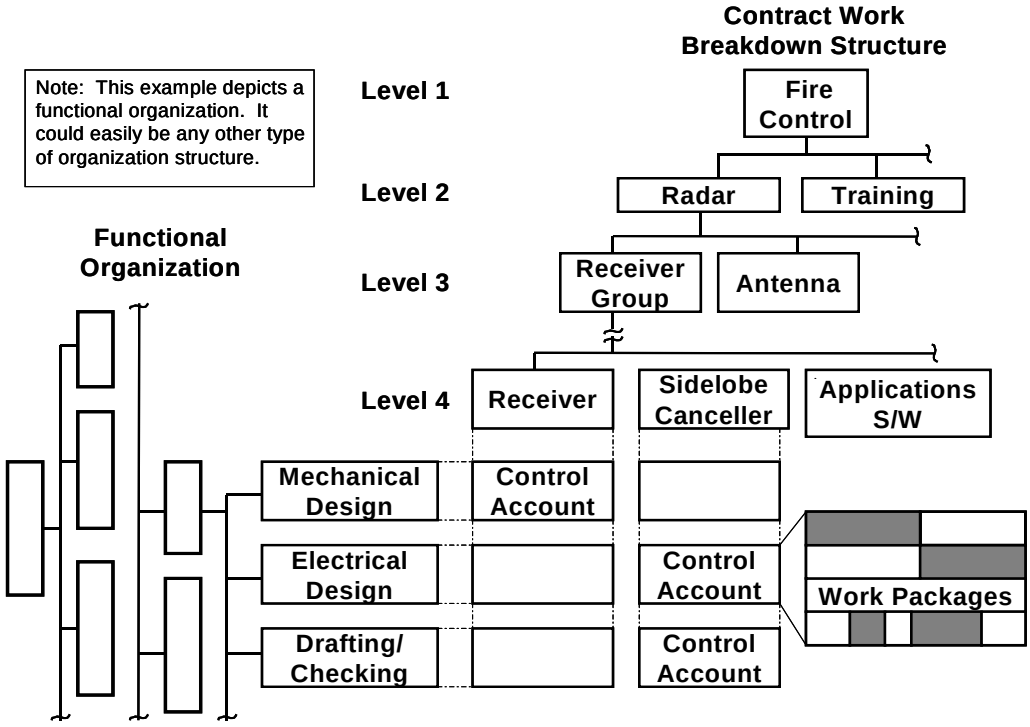


FIGURE 3-3: Translation from Function to Product

For example, the management information needed by the Government to manage the development of a radar receiver is available from the control accounts that are part of that effort's WBS. The information the contractor needs to manage the development is available from the same control accounts, which in this example are a part of the contractor's Electrical Design Department.

Figure 3-4 illustrates the same example but uses an Integrated Product Team (IPT)-structured organization and its interface with the Contract WBS.

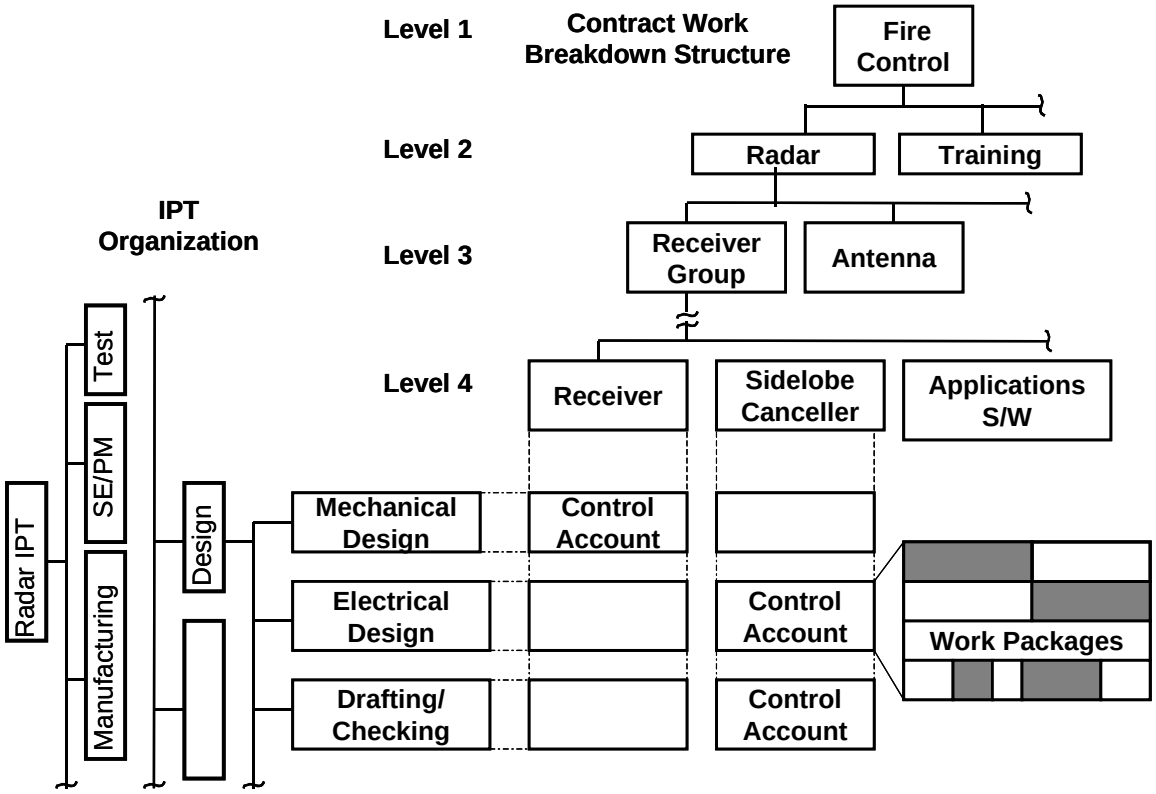


FIGURE 3-4: IPT Intersection with Contract WBS

3.2 Programmatic Issues in WBS Development.

3.2.1 System of Systems (SoS). A program can either have stand alone systems or have interfaces with other systems, such as a fighter aircraft which has interfaces with the ordnance it carries. The aircraft and ordnance programs, traditionally separate, will each have a separate Program WBS. In a SoS program, such as the Missile Defense Program or the Cheyenne Mountain Complex, the program is actually a collection of systems and thus the program WBS at the first tier will consist of the various systems that make up the SoS structure (see Figure 3-5)

Level 1	Level 2	Level 3	Level 4
System of Systems			
	Aircraft System		
		Air Vehicle (AV)	
			Reference Appendix A – Level 3
		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	
		Data	
		•	
		•	
	Electronic/Automated Software System		
		Prime Mission Product (PMP)	
			Reference Appendix B – Level 3
		Platform Integration	
		Systems Engineering/Program Management	
		System Test and Evaluation	
			Development Test and Evaluation
			Operational Test and Evaluation
			Mock-ups/System Integration Labs (SILs)
			Test and Evaluation Support
			Test Facilities
		Training	
			Equipment
			Services
			Facilities
		Data	
		•	
	UAV System		
		Air Vehicle	
			Reference Appendix H– Level 3
		Payload (1….n)	
			Reference Appendix H– Level 3
		Ground Segment	
			Reference Appendix H– Level 3
		UAV System Integration, Assembly, Test and Checkout	
		Systems Engineering/Program Management	
		System Test and Evaluation	
	System of Systems Engineering/Program Management		
	System of Sys Test and Evaluation		
		Development Test and Evaluation	
		Operational Test and Evaluation	
		Mock-ups/System Integration Labs (SILs)	
		Test and Evaluation Support	
		Test Facilities	
	Initial Spares/Repair Parts		

FIGURE 3-5: System of Systems (SoS) Generic WBS

SoS has become more and more prominent as DoD drives toward integrated architectures in a joint operational environment. The Defense Acquisition Guide outlines the DoD goal for Modular Open Systems Approach (MOSA), which can lead to a SoS approach. The systems engineering

section of the guide defines SoS engineering and outlines how a “SoS should be treated and managed as a system in their own right, and should therefore be subject to the same systems engineering processes and best practices as applied to individual systems.” In this manner, the WBS requirements of a system apply to that of a SoS.

Understanding the parent-child type relationship of various related programs and contracts and their impact on the WBS are important in the ever-increasing integrated and joint program environment. Often, individually baselined programs and their various prime or GFE elements are actually part of a SoS approach. The overall parent program, the SoS or joint program, needs to be identified with the various child programs. Each child program would develop a stand-alone WBS structure. The various child WBS elements then would be identified at Level 2 or 3, as appropriate, in the overall parent program. In some cases, common systems will be a child program to different parent programs and may actually enter the parent WBS as a different level. In any case, the parent-child relationship should be thought through and understood by the parent program and the various child programs. The parent-child challenge will repeat itself in the Contract WBS as the prime contractor decides to subcontract various portions of the system. Each substantial subcontract will in essence create a program for the subcontract and thus create a parent-child relationship between the prime and the subcontractor.

3.2.2 Software and Software Intensive Systems. Software is increasingly critical to modern weapon systems acquisition. Software is divided into two categories for WBS development. The first is software that operates on specific equipment. The second is software that may be procured separately from the operating equipment or is stand-alone that is developed for specific equipment and then must be identified as a subset of that equipment. Refer to Figure 3-1 for an example of how software should be addressed as part of specific equipment.

3.2.2.1 Software Operating on Specific Equipment. Multi-function software will be identified as a subset of the equipment WBS element, which either includes the software in the element specification or exercises the most critical performance constraint. In cases where a conflict exists between selecting either the element specification or that which exercises the most critical performance constraint, selecting 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 piece of equipment (i.e., applications software, and overall system software which facilitates the O&M of the computer systems and associated programs) will be called out at the appropriate work breakdown level.

For example, elements of software development often are high technical risk and high cost. Since all critical system software should be identified, it may be appropriate to collect lower level information. In such cases, the following structure and definitions could 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	

All integral software should be summarized in a Program or Contract WBS in conjunction with the hardware it supports. This allows for effective performance measurement and management control. When needed, a contractor's management systems can use an identifier for each software element to produce summaries for software management purposes.

3.2.2.2 Separately Contracted or Stand-Alone Software. Separately contracted or stand-alone software will include the data, services, and facilities required to develop and produce that software product. Where software is considered stand alone, the Government should use the same product-oriented WBS format. Figure 3-6 provides an example of a WBS for a standalone software system.

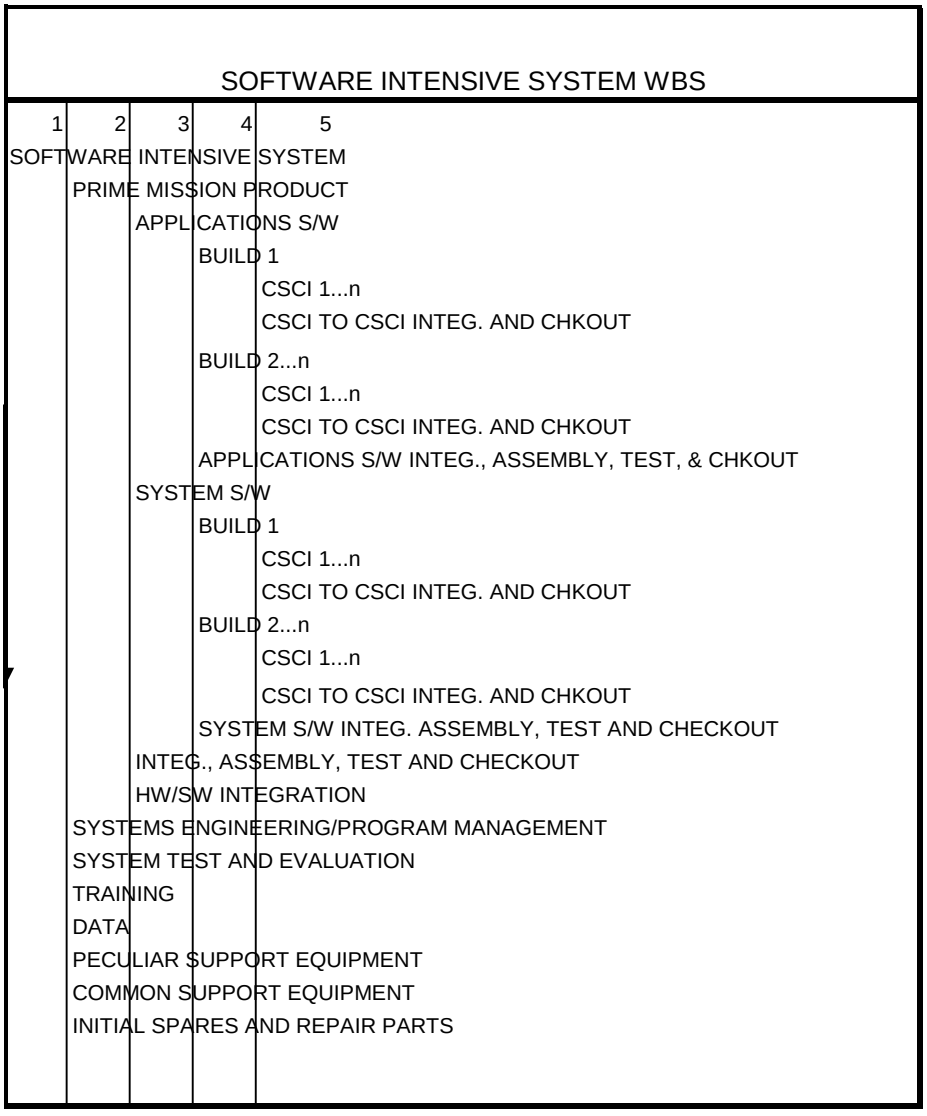


FIGURE 3-6: Example of Software Intensive System WBS

3.2.2.3 Visibility into Software Development Processes. Because the WBS is a product-oriented hierarchy, its progressive subdivision will result in common management or functional tasks (i.e., development processes, etc.) occurring in many WBS elements. For example, software may be

widespread throughout the WBS and represent high risk in the contract. In such cases, when the program manager may require specific visibility into software performance, care must be taken to not overly complicate the Contract WBS and the contractor's management system. Appropriate reporting requirements should be specified in the Statement of Work (SOW).

As Figure 3-7 shows, the contractor's management system and the WBS can provide critical detail and visibility of key software development processes (i.e., requirements analysis, design, code and test, etc.) without extending the WBS to excessively low levels or developing a separate WBS for software. The required information can be aggregated for reporting as needed using the contractor's management system.

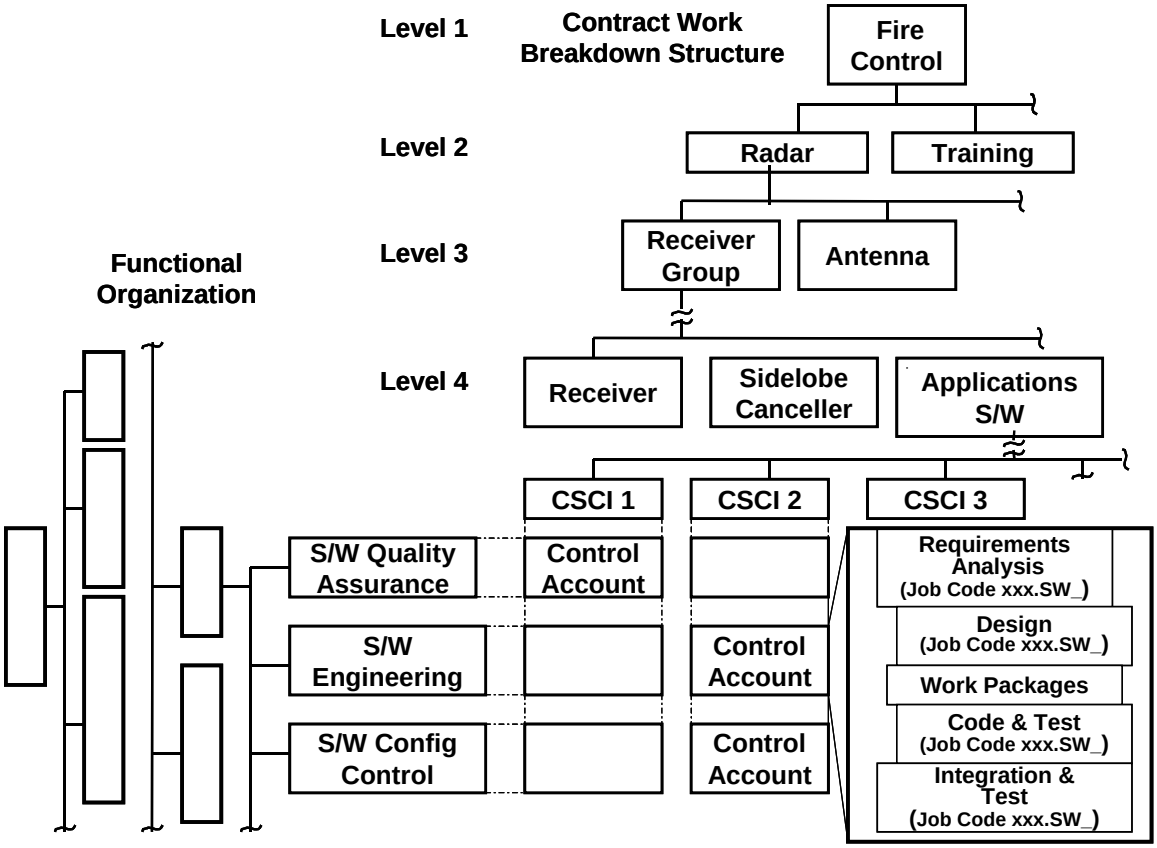


FIGURE 3-7: Linkage Between Contractor WBS and Contractor Management Systems

3.2.3 Integrated Master Plan and Integrated Master Schedule (IMP/IMS)

3.2.3.1 Integrated Master Plan (IMP). The IMP is an event-based plan consisting of a hierarchy of program events, with each event being supported by specific accomplishments, and each accomplishment associated with specific criteria to be satisfied for its completion. The IMP should provide sufficient definition to allow for the tracking of the completion of required accomplishments for each event, and to demonstrate satisfaction of the completion criteria for each accomplishment. In addition, the IMP demonstrates the maturation of the design/development of the product as it progresses through a disciplined systems engineering process. IMP events are not tied to calendar dates; each event is completed when its supporting accomplishments are completed and when this is evidenced by the satisfaction of the criteria supporting each of those accomplishments. The IMP is

placed on contract and becomes the baseline execution plan for the program/project. Although fairly detailed, the IMP is a relatively top-level document in comparison with the IMS.

3.2.3.2 Integrated Master Schedule (IMS). The IMS flows directly from the IMP and supplements it with additional levels of detail. It incorporates all of the IMP's events, accomplishments, and criteria; to these activities it adds the detailed tasks necessary to support the IMP criteria along with each task's duration and its relationships with other tasks. The IMS supports multiple views (i.e. Event-Based, WBS Based, etc) to support the users needs. This network of integrated tasks, when tied to the start date (for example, contract award), creates the task and calendar-based schedule that is the IMS. The IMS should be defined to the level of detail necessary for day-to-day execution of the program/project.

3.2.3.3 IMP/IMS Linkage. The IMS is directly traceable back to the IMP and, where applicable, should also be traceable to the program's Contract Contract WBS, SOW, EVMS, and Risk Management System. Both the IMP and the IMS should be consistent with the contractor's management and scheduling system structure and format. In general, the IMP can be thought of as the top-down planning tool and the IMS as the bottom-up execution tool for those plans. It should be noted, however, the primary purpose of the IMS is as a scheduling tool. It serves as a forecasting tool used to track technical performance and time phase the budget. Figure 3-8 illustrates these interrelationships.

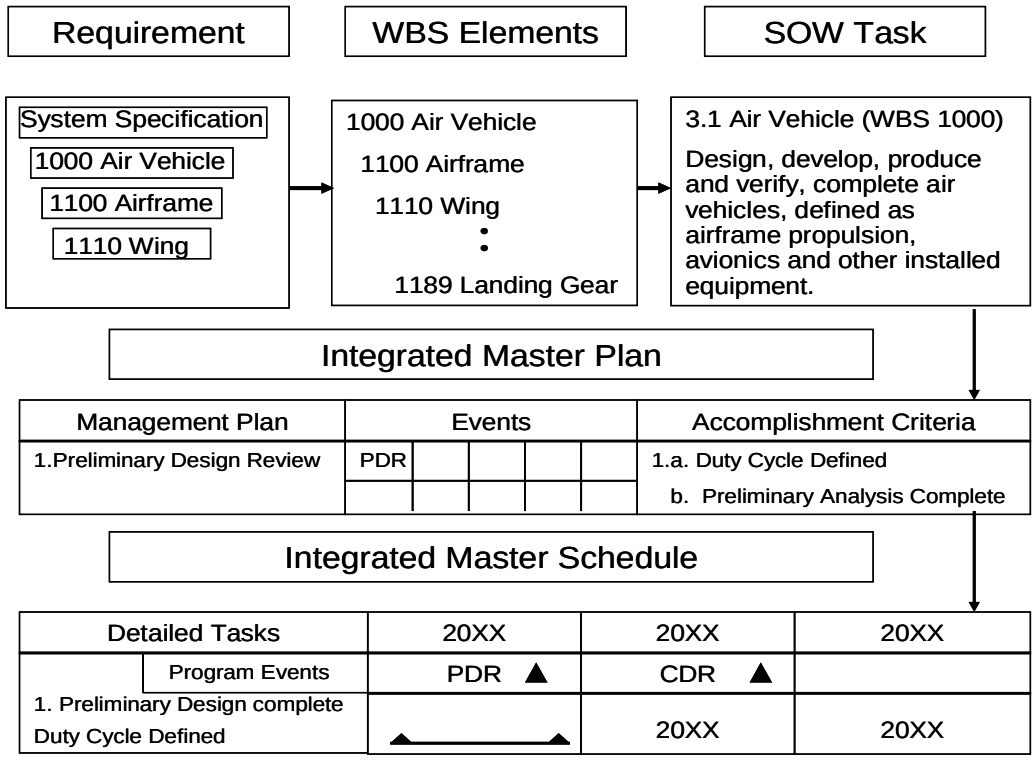


FIGURE 3-8: Relationship of IMP/IMS to WBS

3.2.4 Use of Common Elements. Common WBS elements (i.e., Integration, Assembly, Test and Checkout; Systems Engineering; Program Management; System Test and Evaluation; Training; and Data, Appendix I) should be applied to the appropriate levels within the WBS which they support. In other words, if systems engineering is required to support a Level 3 WBS element, the System Engineering WBS element would appear at Level 4 of the WBS under the Level 3 element it supports. For example, in Surface Vehicles common elements found at Level 2 of the WBS capture efforts associated with the "System" level as a total system (i.e., Training for the entire Surface Vehicle System). However, if training was required to support the Navigation System (Level 3 WBS element), the Training common element should also be associated with the element it supports (Navigation System) at Level 4 of the WBS. The training element should not be rolled into the "System" level training WBS element. The intent is to understand the total effort associated with designing, developing, and producing a WBS element. Combining them into the "System" level misses the true effort of delivering a complete Navigation System.

4. IMPLEMENTATION OF CONTRACT WORK BREAKDOWN STRUCTURE

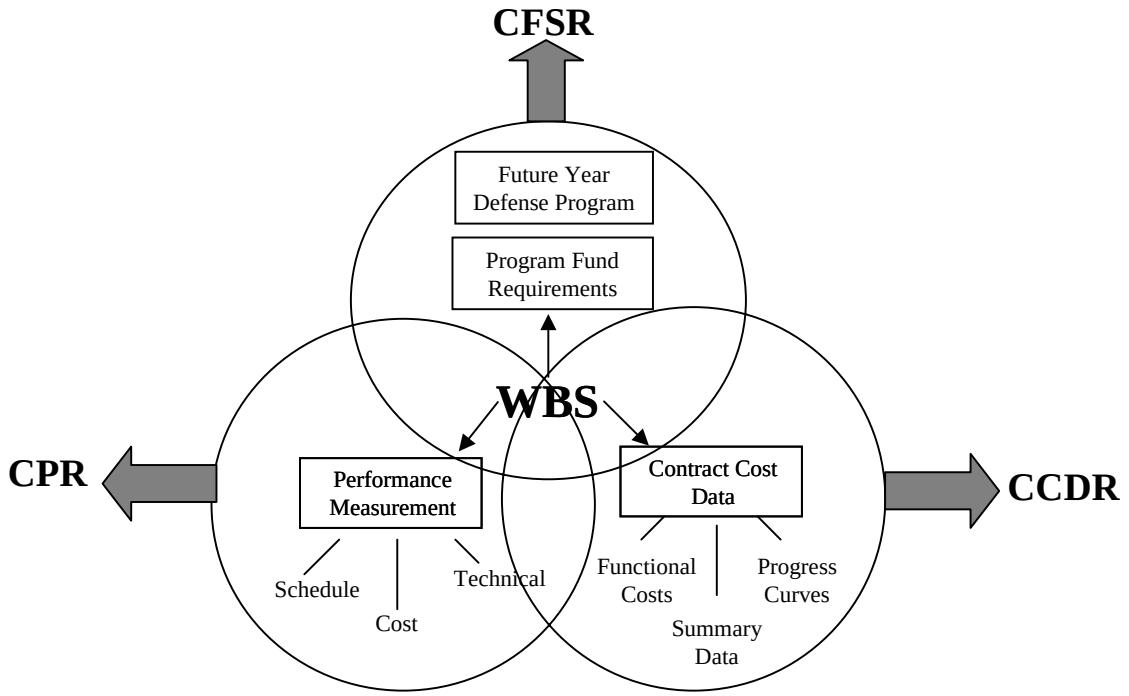
The Contract Work Breakdown Structure (CWBS) included in a successful proposal serves as the basis for negotiating a Government approved Contract WBS. The contractor may have proposed alternate approaches to accomplish the contract objectives. If the Government program manager accepts the alternatives, the Program WBS will require revision to reflect those changes. If changes are significant and broad in scope, the changes made should be evaluated at an Integrated Baseline Review (IBR).

4.1 Contract Award and Contract WBS Approval. The requirement for providing the WBS dictionary using Data Item Description DI-MGMT-81334B, "Contract WBS" identified in the Contract Data Requirements List (CDRL) is included in the contract development process. Additional WBS revisions may result from program changes. Additional contract elements will become the basis for contractor extension of the Contract WBS. Although there is no limit on the number of additional elements, each should be justified in terms of its contribution to effective program management. All extensions should be incorporated into the Contract WBS reporting level in the contract.

Users of this handbook should understand that the sequence described in the preceding paragraphs may be repeated as the program evolves, contracts are awarded, and the work effort progresses through major program phases. Revisions to the WBS are an essential component of this process. Whenever the WBS is revised, traceability to the previous WBS needs to be maintained. Once work is underway, WBS changes should be controlled to preserve the cost baseline. The Contract WBS requires a contract modification before approved changes can be incorporated.

4.2 Reporting Relationships. The contractor maintains the Contract WBS, including change traceability. In accordance with the contract terms, only changes approved by the program manager may be incorporated. The contract will indicate levels of the Contract WBS at which costs will be reported to the Government. The contractor should determine those extended Contract WBS levels that are used to trace the cost accumulations for cost control purposes. In the extensions, consideration should be given to the specific contractual, technical, and managerial requirements of the defense materiel item. The contractor has complete flexibility to extend the Contract WBS below the reporting requirement to reflect how work is to be accomplished, assuming the additional elements are meaningful product or management-oriented indentures of a higher-level element.

4.3 Support for Management Activities. Within the scope of the WBS, the contractor has flexibility to use the work breakdown elements to support on-going management activities. These may include EVM, cost estimating and managing contract funds (see Figure 4-1).



NOTES:
Contract Funds Status Report (CFSR)
Contract Performance Report (CPR)
Contractor Cost Data Report (CCDR)

FIGURE 4-1: The WBS is the Basis for DoD Reporting Requirements

4.3.1 Earned Value Management (EVM). Cost performance measurement involves periodic comparison of actual costs with time-phased budgets, analysis of performance variances, and follow-up corrective action. When planned tasks are captured in a WBS element structure and time-phased as they are expected to be accomplished, the budgets associated with those tasks become the performance measurement baseline for EVM. EVM is a key integration program management process in the management and oversight of Major Defense Acquisition Programs and Major Automated Information Systems Programs.

EVM data is reported using the Contract Performance Report (CPR). The CPR provides contract cost and schedule performance data that is used to identify problems early in the contract and forecast future contract performance. The CPR should be the primary means of documenting the ongoing communication between the contractor and the program manager to report cost and schedule trends to date and to permit assessment of their effect on future performance. This report consists of the following five formats: WBS, Organizational Categories, Baseline, Staffing, and Explanation and Problem Analyses. Format 1 provides data to measure cost and schedule performance by product-oriented Contract WBS elements, for the hardware, software, data, and services the Government is buying.

4.3.2 Cost Estimating. Use of the WBS for cost estimating facilitates program and contract management. The WBS aids the program office in planning, coordinating, controlling, and estimating the various program activities. 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.

Cost estimating data is reported through the Contractor Cost Data Reporting (CCDR) system. The purpose of CCDR is to collect historical program cost data in a joint service environment and use that data for estimate the cost of ongoing and future Government programs, particularly DoD weapon systems. The WBS, as the cornerstone of the cost estimating process, provides a logical breakdown of tasking necessary to accomplish program objectives. The WBS for ACAT I programs is approved using the Cost and Software Data Report (CSDR) Plan and data reporting uses the following three CCDR reports, based on the WBS: Cost Data Summary Report, Functional Cost-Hour and Progress Curve Report, and Software Resource Data Report..

4.3.3 Contract Funds Status. The purpose of the Contract Funds Status Report is to supply funding data by WBS to the DoD program manager and the Contracting Officer's Technical Representative (COTR) for: 1) updating and forecasting contract funding requirements, 2) planning and decision making on funding changes in contracts, 3) developing funding requirements and budget estimates in support of approved contracts, 4) determining funds in excess of contract needs and available for deobligations, and 5) obtaining rough estimates of termination costs.

4.3.4 Summary. The Contract WBS is not intended to be used as a standard. Any logical product-oriented WBS developed by the contractor will meet DoD needs for reasonably consistent program data. The WBS format is to be used as a starting point for continued tailoring. However, the same WBS will be utilized for the Integrated Master Plan (IMP), Integrated Master Schedule (IMS), Risk Management, CPR, and CCDR as applicable.

After contract award, at each point in the acquisition cycle, the Contract WBS continues to provide the framework for delineating the areas of responsibility and defining tasks required to meet the requirements of the contract.

5. NOTES SECTION

5.1 Intended Use. This handbook is directed primarily at preparing a WBS for a defense system program. This includes all materiel items or major modifications established as an integral program element of the Future Years Defense Program or otherwise designated by the DoD component or the Under Secretary of Defense (AT&L).

The guidance is appropriate for use with any WBS developed for all acquisition phases—Concept Refinement, Technology Development, System Development and Demonstration, and Production and Deployment.

This handbook clearly delineates the overlapping responsibilities of DoD program managers and contractors relative to the execution of WBSs.

5.2 Supersession Data. This handbook supersedes MIL-HDBK-881A dated 2 January 1998

5.3 Subject Term (key word) listing.

Aircraft Systems
Contract Funds Status Report
Contractor Cost Data Reporting
Contractor Performance Report
Control Accounts
Cost Estimating, Reporting
Earned Value Management
Electronic/Automated Software Systems
Integrated Master Plan
Integrated Master Schedule
Life Cycle Cost
Missile Systems
Ordnance Systems
Planning, Programming and Budgeting Execution (PPBE)
Program Management
Request for Proposal
Risk Management
Schedule
Sea Systems
Software
Space Systems
Surface Vehicle Systems
Systems Engineering
System of Systems (SoS)
Unmanned Air Vehicle Systems

5.4 Changes from Previous Issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

APPENDIX A: AIRCRAFT SYSTEMS
WORK BREAKDOWN STRUCTURE AND DEFINITIONS

A.1 SCOPE

This appendix provides the Work Breakdown Structure and Definitions for the aircraft air vehicle Definitions for WBS elements common to all defense materiel items are given in Appendix I: Common Elements, Work Breakdown Structure and Definitions

A.2 APPLICABLE DOCUMENTS

Non-Government publications. The following documents form a part of this document to the extent specified herein.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
ANSI/IEEE STD 610.12, *Standard Glossary of Software Engineering Terminology*
ANSI Standards can be found online at:
http://webstore.ansi.org/ansidocstore/default.asp

ANSI Customer Service
25 W 43rd Street, 4th Floor
New York, NY, 10036

or

The Institute of Electrical and Electronics Engineers, Inc. (IEEE) Service Center
445 Hoes Lane
Pistacataway, NJ 08855-1331
www.ieee.org

A.3 WORK BREAKDOWN STRUCTURE LEVELS

Level 1	**Level 2**	**Level 3**
Aircraft System	Air Vehicle (AV)	Airframe
		Propulsion
		AV Applications Software
		AV System Software
		Communications/Identification
		Navigation/Guidance
		Central Computer
		Fire Control
		Data Display and Controls
		Survivability
		Reconnaissance
		Automatic Flight Control
		Central Integrated Checkout
		Antisubmarine Warfare
		Armament
		Weapons Delivery
		Auxiliary Equipment
		Crew Station
	Systems Engineering/Program Management	
	System Test and Evaluation	Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups/System Integration Labs (SILs)
		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	

A.3.1 Application of Common WBS Elements (Appendix I). WBS elements which are common (i.e. Integration, Assembly, Test and Checkout; Systems Engineering/Program

Management; System Test and Evaluation; Training; and Data) should be applied to the appropriate levels within the WBS for which they support. For example, if Systems Engineering is required to support a Level 3 WBS element, the Systems WBS element would appear at Level 4 of the WBS under the Level 3 element it supports.

A.4 DEFINITIONS

A.4.1 Aircraft System. The complex of equipment (hardware/software), data, services, and facilities required to develop and produce air vehicles.

Includes:
a. Those employing fixed, movable, rotary, or compound wing

A.4.2 Air Vehicle. The complete flying aircraft.

Includes, for example:
a. Airframe, propulsion, and all other installed equipment
b. Design, development, and production of complete units; prototype and operationally configured units which satisfy the requirements of their applicable specifications, regardless of end use
c. Sub-elements to the air vehicle found in A.4.2.1 through A.4.2.18

A.4.2.1 Airframe. The assembled structural and aerodynamic components of the air vehicle that support subsystems essential to designated mission requirements.

Includes, for example:
a. Basic structure: wing, empennage, fuselage, and associated manual flight control system
b. Rotary wing pylons, air induction system, thrust reversers, thrust vector devices, starters, exhausts, fuel management, inlet control system
c. Alighting gear; tires, tubes, wheels, brakes, hydraulics, etc.
d. Secondary power, furnishings—cargo, etc.
e. Instruments; flight, navigation, engine, etc.
f. Environmental control, racks, mounts, intersystem cables and distribution boxes, etc., which are inherent to, and non-separable from, the assembled structure
g. Dynamic systems; transmissions, gear boxes, propellers, if not furnished as an integral part of the propulsion unit
h. Rotor group and other equipment homogeneous to the airframe

In addition to the airframe structure and subsystems, this element includes:

Integration, assembly, test, and checkout:

Includes for example:
a. All efforts as identified in Appendix I: Common Elements, Work Breakdown Structure and Definitions, to provide the integration, assembly, test, and checkout of all elements into the airframe to form the air vehicle as a whole

b. 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
    1. Overall air vehicle design and producibility engineering
    2. Detailed production design; acoustic and noise analysis
    3. Loads analysis; stress analysis on interfacing airframe elements and all subsystems
    4. Design maintenance effort and development of functional test procedures
    5. Coordination of engineering master drawings and consultation with test and manufacturing groups
    6. Tooling planning, design, and fabrication of basic and rate tools and functional test equipments, as well as the maintenance of such equipment
    7. Production scheduling and expediting
    8. Joining or installation of structures such as racks, mounts, etc.
    9. Installation of wiring ducting, engines, and miscellaneous equipment and painting
    10. Set up, conduct, and review of testing assembled components or subsystems prior to installation
c. All effort associated with the installation, integration, test and checkout of the avionic systems into the air vehicle including:
    1. Design of installation plans
    2. Quality assurance planning and control including material inspection
    3. Installation
    4. Recurring verification tests
    5. Integration with non-avionics airframe subsystems
d. 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

Nonrecurring avionics system integration which is associated with the individual avionics equipment boxes and avionics software in a functioning system.

Includes, for example:
a. The labor required to analyze, design, and develop avionics suite interfaces and establish interface compatibility with non-avionics support equipment systems, aircraft systems, and mission planning systems
b. Drawing preparation and establishment of avionics interface equipment requirements and specifications
c. Technical liaison and coordination with the military service, subcontractors, associated contractors, and test groups

Excludes, for example:
a. Development, testing, and integration of software (which should be included in air vehicle applications and system software)
b. Avionics system testing (included in System Test and Evaluation) and aircraft systems engineering efforts (included in Systems Engineering/Program Management).
c. All effort directly associated with the remaining Level 3 WBS elements

A.4.2.2 Propulsion. 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.

Includes, for example:
a. 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
b. Thrust reversers, thrust vector devices, transmissions, gear boxes, and engine control units, if furnished as integral to the propulsion unit
c. Other propulsion equipment required in addition to the engine but not furnished as an integral part of the engine, such as booster units
d. The design, development, production, and assembly efforts to provide the propulsion unit as an entity

Excludes, for example:
a. All effort directly associated with the elements and the integration, assembly, test, and checkout of these elements into the air vehicle
b. All ancillary equipments that are not an integral part of the engine required to provide an operational primary power source—air inlets, instruments, controls, etc.

A.4.2.3 Air Vehicle Applications Software.

Includes, for example:
a. All the software that is specifically produced for the functional use of a computer system or multiplex data base in the air vehicle (ref. ANSI/IEEE Std 610.12)
b. All effort required to design, develop, integrate, and checkout the air vehicle applications Computer Software Configuration Items (CSCIs)

Excludes, for example**:**
a. The non-software portion of air vehicle firmware development and production
b. Software that is an integral part of any specific subsystem and software that is related to other WBS Level 2 elements

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

A.4.2.4 Air Vehicle System Software. That 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. (ref. ANSI/IEEE Std 610.12)

Includes, for example:
a. Operating systems—software that controls the execution of programs
b. Compilers—computer programs used to translate higher order language programs into relocatable or absolute machine code equivalents

c. Utilities—computer programs or routines designed to perform the general support function required by other application software, by the operating system, or by system users
d. 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
e. Air vehicle system software required to facilitate development, integration, and maintenance of any air vehicle software build and CSCI

Excludes, for example:
a. All software that is an integral part of any specific subsystem specification or specifically designed and developed for system test and evaluation
b. Software that is an integral part of any specific subsystem, and software that is related to other WBS Level 2 elements

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

A.4.2.5 Communication/Identification. That equipment (hardware/software) installed in the air vehicle for communications and identification purposes

Includes, for example:
a. Intercoms, radio system(s), identification equipment (IFF), data links, and control boxes associated with the specific equipment
b. Integral communication, navigation, and identification package (if used)

Excludes, for example:
a. Speech intelligibility work performed under the Crew Station WBS element
b. Survival/radios/beacons included under the Crew Station WBS element
c. Aircrew mounted communication components included under the Crew Station WBS element

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.6 Navigation/Guidance. That equipment (hardware/software) installed in the air vehicle to perform the navigational guidance function.

Includes, for example:

a. Radar, radio, or other essential navigation equipment, radar altimeter, direction finding set, doppler compass, computer, and other equipment homogeneous to the navigation/guidance function

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.7 Central Computer. The master data processing unit(s) responsible for coordinating and directing the major avionic mission systems.

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.8 Fire Control. That equipment (hardware/software) installed in the air vehicle which provides the intelligence necessary for weapons delivery such as bombing, launching, and firing.

Includes, for example:
a. Radars and other sensors including radomes
b. Apertures/antennas, if integral to the fire control system, necessary for search, target identification, rendezvous and/or tracking
c. Self-contained navigation and air data systems
d. Dedicated displays, scopes, or sights
e. Bombing computer and control and safety devices

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.9 Data Display and Controls. The equipment (hardware/software) which visually presents processed data by specially designed electronic devices through interconnection (on- or off-line) with computer or component equipment and the associated equipment needed to control the presentation of the primary flight information 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.

Includes, for example:
a. Multi-function displays, control display units, display processors, and on-board mission planning systems

Excludes:
a. Indicators and instruments not controlled by keyboard via the multiplex data bus and panels and consoles which are included under the crew station
b. Display size/location and symbology definition included under the crew station

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.10 Survivability. Those equipments (hardware/software) installed in, or attached to, the air vehicle which assist in penetration for mission accomplishment.

Includes, for example:
a. 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

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.11 Reconnaissance. Those equipments (hardware/software) installed in, or attached to, the air vehicle necessary to the reconnaissance mission.

Includes, for example:
a. Photographic, electronic, infrared, and other sensors
b. Search receivers
c. Recorders
d. Warning devices
e. Magazines
f. Data link

Excludes, for example:
a. Gun cameras

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.12 Automatic Flight Control. Those 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 and provide lift, drag, trim, or conversion effects.

Includes, for example:

a. Flight control computers, software, signal processors, and data transmitting elements that are devoted to processing data for either primary or automatic flight control functions
b. Electronic devices required for signal processing, data formatting, and interfacing between the flight control elements; the data buses, optical links, and other elements devoted to transmitting flight control data
c. Flight control sensors such as pressure transducers, rate gyros, accelerometers, and motion sensors

Excludes:

a. Devices—linkages, control surfaces, and actuating devices—covered under the airframe WBS element
b. Avionics devices and sensors--central computers, navigation computers, avionics data buses and navigation sensors—which are included under other avionics WBS elements

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.13 Central Integrated Checkout. That equipment (hardware/software) installed in the air vehicle for malfunction detection and reporting.

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.14 Antisubmarine Warfare. That equipment (hardware/software) installed in the air vehicle peculiar to the antisubmarine warfare mission.

Includes, for example:

a. Sensors, computers, displays, etc.

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.15 Armament. That equipment (hardware/software) installed in the air vehicle to provide the firepower functions.

Includes, for example:
a. Guns, high energy weapons, mounts, turrets, weapon direction equipment, ammunition feed and ejection mechanisms, and gun cameras

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.16 Weapons Delivery. That equipment (hardware/software) installed in the air vehicle to provide the weapons delivery capability.

Includes, for example:
a. Launchers, pods, bomb racks, pylons, integral release mechanisms, and other mechanical or electro-mechanical equipments specifically oriented to the weapons delivery function

Excludes:
a. Bombing/navigation system (included in the fire control element)

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.2.17 Auxiliary Equipment. Auxiliary airframe, electronics, and/or armament/weapons delivery equipment not allocable to individual element equipments, or which provides the ancillary functions to the applicable mission equipments.

Includes, for example:
a. Auxiliary airframe equipment such as external fuel tanks, pods, and rotodomes
b. Multi-use equipment like antennas, control boxes, power supplies, environmental control, racks, and mountings, not homogeneous to the prescribed WBS elements

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

NOTE 3: 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 A.4.2.15 and A.4.2.16 of this appendix.

A.4.2.18 Crew Station. The provisions and space allocated to the human component of the weapon system that allow performance of specific functions to ensure mission success. Aircraft system human interfaces and components that sustain and protect the human operators, troops, and passengers.

Includes, for example:

a. Life support systems; flight clothing, head protection, noise attenuation systems, communication systems, anti-exposure systems, cooling systems, gravity onset protective systems, laser threat protection, chemical/biological protection, physiological monitoring systems, body armor, oxygen systems, survival equipment, personal flotation devices, flotation platforms, survival radios/beacons
b. Escape systems; ejection seats, canopy/hatch removal or penetration systems, sequencing systems, restraint systems, seat survival kits, parachutes, emergency exits, slides, crashworthy seats, armored seats, personal connection systems
c. Crash protection devices; Includes attenuating seats, airbag systems and inflatable restraints
d. Search and rescue equipment
e. Aero-medical equipment (AE)
f. Canopy/wind screen systems; transparencies, seals, actuators, frames
g. Crew, passenger, and troop compartment geometry and design, secondary structure, interior/exterior lighting, seat installations, consoles, instrument panels, glare shields, personal cargo stowage, and waste management systems
h. Display/control interfaces; display/control locations and configuration, display symbology definition, helmet mounted devices, lighting, switches, pedals, control grips such as those for the stick/yoke, throttle, cyclic and collective
i. Human interface; human factors design features, speech intelligibility, and anthropometry for air vehicle interface, control and mission tasks
j. Crew environment habitability considerations; acoustical noise, radiation hazard, thermal environment, relative humidity, air velocity and pressurization
k. Integration tests related to human interface with the air vehicle, including part task and full mission simulations, workload and situational awareness evaluations, life support system man rating, ejection tests, bailout or emergency egress, and lighting mockup evaluations.

Excludes, for example:

a. Primary structure supporting seat installations and restraints covered under the Airframe WBS element

b. Displays hardware/software covered under the Data Display and Controls WBS element
c. Wiring and plumbing for air crew support covered under the Airframe WBS element

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

A.4.3 Common Elements. WBS Levels 2 and 3. Definitions for common WBS elements applicable to the aircraft as well as all other defense materiel items are in Appendix I: Common Elements, Work Breakdown Structure and Definitions

APPENDIX B: ELECTRONIC/AUTOMATED SOFTWARE SYTEMS WORK BREAKDOWN STRUCTURE AND DEFINITIONS

B.1 SCOPE

This appendix provides the Work Breakdown Structure and definitions for the prime mission product (PMP) and platform integration. Definitions for WBS elements common to all defense materiel items are given in Appendix I: Common Elements, Work Breakdown Structure and Definitions

B.2 APPLICABLE DOCUMENTS

Government Publications. The following standards form a part of this document to the extent specified herein.

Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the:

Acquisition Streamlining and Standardization Information System (ASSIST) database (http://assist.daps.dla.mil)

Standardization Documents Order Desk
700 Robbins Avenue
Building #4, Section D
Philadelphia, PA 19111-5094

STANDARDS

MIL-STD-196E, *Joint Electronics Type Designation System*
MIL-STD-1464A, *Army Nomenclature System*
MIL-STD-1661, *Mark and Mod Nomenclature System*
MIL-HDBK-1812, *Type Designation, Assignment and Method for Obtaining*

Non-Government publications. The following documents form a part of this document to the extent specified herein.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/IEEE STD 610.12, *Standard Glossary of Software Engineering Terminology*

The following three (3) documents replaced MIL-STD-498; *Software Development and Documentation*

IEEE/EIA 12207.0; *INDUSTRY IMPLEMENTATION OF INTERNATIONAL STANDARD ISO/IEC 12207: 1995-(ISO/IEC 12207) STANDARD FOR INFORMATION TECHNOLOGY-SOFTWARE LIFE CYCLE PROCESSES*

IEEE/EIA 12207.1; *GUIDE FOR INFORMATION TECHNOLOGY-SOFTWARE LIFE CYCLE PROCESSES LIFE CYCLE DATA*

IEEE/EIA 12207.2*; GUIDE FOR INFORMATION TECHNOLOGY-SOFTWARE LIFE CYCLE PROCESSES IMPLEMENTATIONS CONSIDERATIONS*

ANSI Standards can be found online at:

http://webstore.ansi.org/ansidocstore/default.asp

ANSI Customer Service
25 W 43rd Street, 4th Floor
New York, NY, 10036

or

The Institute of Electrical and Electronics Engineers, Inc. (IEEE) Service Center
445 Hoes Lane
Pistacataway, NJ 08855-1331
www.ieee.org

B.3 WORK BREAKDOWN STRUCTURE LEVELS

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/System Integration Labs (SILs)
		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	

B.3.1 Application of Common WBS Elements (Appendix I). WBS elements which are common (i.e. Integration, Assembly, Test and Checkout; Systems Engineering/Program Management; System Test and Evaluation; Training; and Data) should be applied to the appropriate levels within the WBS for which they support. For example, if Systems Engineering is required to support a Level 3 WBS element, the Systems WBS element would appear at Level 4 of the WBS under the Level 3 element it supports.

B.4 DEFINITIONS

B.4.1 Electronic/Automated Software System. 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.

NOTE 1: To differentiate between the Electronic/Automated Software System category and other defense materiel item categories, use the following rule: When the item is a stand-alone system or used on several systems but not accounted for within the system, use the Electronic/ Automated Software System category.

NOTE 2: 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.

B.4.2 Prime Mission Product (PMP). The hardware and software used to accomplish the primary mission of the defense materiel item. (B.2 identifies specific Prime Mission Products)

Includes, for example:

a. All integration, assembly, test and checkout, as well as all technical and management activities associated with individual hardware/software elements
b. 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
c. All whole and partial prime contractor, subcontractor, and vendor breadboards, brass boards, and qualification test units
d. 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)
e. Factory special test equipment, special tooling, and production planning required to fabricate the PMP

Excludes, for example:

a. Only those "less than whole" units (e.g., test, spares, etc.) consumed or planned to be consumed in support of system level tests
b. Duplicate or modified factory special test equipment delivered to the Government for depot repair (should be included in the peculiar support equipment element)

B.4.2.1 Subsystem 1…n (Specify Names). The hardware and software components of the specific electronic/ automated software subsystem.

Includes, for example:

a. All associated special test equipment, special tooling, production planning, and all technical and management activities
b. The software components, consisting of the applications and system software required to direct and maintain the specific electronic/ automated software subsystem
c. 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

d. 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 or other mating equipments furnished by/to an integrating agency or contractor
e. Cables, conduits, connectors, shelters, and other devices associated with the operational electronic/automated software subsystem
f. The design, development, production, and assembly efforts to provide each electronic/automated software subsystem as an entity

Excludes, for example:
a. All effort directly associated with the remaining Level 3 WBS elements and the integration, assembly, test and checkout of these elements into the prime mission product

B.4.2.2 Prime Mission Product Application Software. The software that is specifically produced for the functional use of a computer system (ref. ANSI/IEEE Std 610.12).

Includes, for example:
a. Battle management, weapons control, and data base management
b. All effort required to design, develop, integrate, and checkout the PMP applications computer software configuration items (CSCIs), not including the non-software portion of PMP firmware development and production

Excludes, for example:
a. All software that is an integral part of any specific hardware subsystem specification

NOTE: All software that is an integral part of any specific equipment system, subsystem or component specification or specifically designed and developed for system test and evaluation should be identified with that system, subsystem, component 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	

1) 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.

When incremental, spiral, or other software development methods are 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.

2) 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 standard DoD or commercial practices and process.

Includes, for example:

a. Reusable software components, such as commercial off-the-shelf software, Government furnished software, or software specifically developed for reuse
b. 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
c. 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

3) CSCI to CSCI Integration and Checkout

Includes, for example:

a. Integration and test, verification and validation and the systems engineering and technical control of the CSCIs
b. 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
3. Establishing test locations, schedules, and responsibilities of those involved

Conduct 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
5. Reporting results

NOTE: Verification and validation may be accomplished to insure the performance and quality of each CSCI in comparison with other CSCIs.

Excludes, for example:

a. 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.

B.4.2.3 Prime Mission Product System Software. The 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. (ref. ANSI/IEEE Std 610.12)

Includes, for example:
a. Operating systems, compilers, and utilities
b. All effort required to design, develop, integrate, and checkout the PMP system software including all software developed to support PMP-applications-software development
c. PMP system software which is required to facilitate development, integration, and maintenance of any PMP software build and CSCI

Excludes, for example:
a. Software that is an integral part of any specific hardware subsystem specification or is specifically designed and developed for system test and evaluation

NOTE: The structure shown B.4.2.2 should be used when lower level information is desired.

B.4.2.4 Integration, Assembly, Test and Checkout. The effort as identified in Appendix I: Common Elements, Work Breakdown Structure and Definitions to provide a complete PMP system. The integration, assembly, test, and checkout element includes hardware and PMP software integration and test.

B.4.3 Platform Integration. WBS Level 2: the 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 system.

Includes, for example:
a. The labor required to analyze, design, and develop the interfaces with other host vehicle subsystems
b. Drawing preparation and establishment of equipment requirements and specifications
c. Technical liaison and coordination with the military services subcontractors, associated contractors, and test groups

Excludes, for example:
a. All integration effort not directly associated with the host vehicle and management liaison with the military services, subcontractors, and associated contractors

B.4.4 Common Elements. Definitions for common WBS elements applicable to the electronic/automated software system and all other defense materiel items are in Appendix I: Common Elements, Work Breakdown Structure and Definitions.

APPENDIX C: MISSILE SYSTEMS
WORK BREAKDOWN STRUCTURE AND DEFINITIONS

C.1 SCOPE

This appendix provides the Work Breakdown Structure and Definitions for missile systems. Definitions for WBS elements common to all defense materiel items are given in Appendix I: Common Elements, Work Breakdown Structure and Definitions.

C.2 APPLICABLE DOCUMENTS

Non-Government publications. The following documents form a part of this document to the extent specified herein.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/IEEE STD 610.12, *Standard Glossary of Software Engineering Terminology*

ANSI Standards can be found online at:

http://webstore.ansi.org/ansidocstore/default.asp

ANSI Customer Service
25 W 43rd Street, 4th Floor
New York, NY, 10036

or

The Institute of Electrical and Electronics Engineers, Inc. (IEEE) Service Center
445 Hoes Lane
Pistacataway, NJ 08855-1331
www.ieee.org

C.3 WORK BREAKDOWN STRUCTURE LEVELS

Level 1	Level 2	Level 3
Missile System	Air Vehicle	
		Propulsion (Stages I...n,]
		Payload
		Airframe
		Reentry System
		Post 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
		Booster Adapter
	Systems Engineering/Program Management	
	System Test and Evaluation	
		Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups/System Integration Labs (SILs)
		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	

C.3.1 Application of Common WBS Elements (Appendix I). WBS elements which are common (i.e. Integration, Assembly, Test and Checkout; Systems Engineering/Program Management; System Test and Evaluation; Training; and Data) should be applied to the appropriate levels within the WBS for which they support. For example, if Systems Engineering is required to support a Level 3 WBS element, the Systems WBS element would appear at Level 4 of the WBS under the Level 3 element it supports.

C.4 DEFINITIONS

C.4.1 Missile System. 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.

C.4.2 Air Vehicle. The primary means for delivering the destructive effect to the target.

Includes, for example:
a. The capability to generate or receive intelligence, to navigate and penetrate to the target area, and to detonate the warhead
b. The design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specifications, regardless of end use)
c. Sub-elements to the air vehicle (C.4.2.1-C.4.2.11)

NOTE: 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.

C.4.2.1 Propulsion (Stages 1….n, as Required). 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.

Includes, for example:
a. 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
b. Design, development, production, and assembly efforts to provide each stage as an entity

Rocket Motor/Booster is the solid propulsion system which carries within it both the fuel and oxygen required for its operation.

Includes, for example:
a. An arm and firing device, solid propellant, movable nozzles, casings, integration, etc.

Engine types are as follows:
a. Liquid propulsion engine includes, for example:

1. 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.

b. Air breathing engines obtain oxygen from the surrounding atmosphere to support the combustion of its fuel. Includes, for example:
   1. Ramjets and turbojets which may be used to provide propulsion for cruise type missiles
   2. Mainframe, compressor, combustion section, air inlets/exhaust ducts, turbine nozzle assembly, turbine rotor, bearings and housings, and fuel subsystem
   3. Air breathing systems which require various accessory components such as pumps, injectors, turbines, motors, diffusers, and igniters

NOTE: 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.

C.4.2.2 Payload. 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.

Includes, for example:
a. Arming and fuzing device, warhead, and target detection device

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.2.3 Airframe. 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.

Includes, for example:
a. Endo-atmospheric missiles
b. Wings and fins which provide aerodynamic flight control in response to electro-mechanical signals and are attached to the missile body
c. 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

NOTE: 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.

C.4.2.4 Re-entry 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.

Includes, for example:

a. Reentry vehicle (aero-structure) which provides reentry protection for the internally carried warheads
    1. 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
b. The arming and fuzing system which provides the proper electrical signals to detonate the warhead

Excludes, for example:

a. 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

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.2.5 Post Boost System

Includes, for example:

a. Exo-atmospheric missiles; provides the roll rate control and the final velocity to adjust and deploy the payload
b. Single warhead missile; structure, external protection material, velocity control system, and deployment group
c. Multiple warhead missile; structure, axial engines, attitude control equipment, propellant storage assembly, and pressurized system

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.2.6 Guidance and Control. The equipment used to control the missile flight to the target.

Includes, for example:

a. Functions; 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
    1. Inputs; interface status, inertial acceleration, and attitude changes
    2. Outputs; missile control, ordnance firing commands, status, instrumentation, and timing signals

b. Flight electrical power, missile electrical interconnection, and structure to contain the guidance and control components when the structure is not part of a separately identified airframe element

1) Exo-atmospheric missiles

Includes, for example:
a. 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

2) Endo-atmospheric missiles

Includes, for example:
a. 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

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.2.7 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 these ordnance events are stage separation, motor ignition, gas generator ignition, shroud separation, etc.

Includes, for example:
a. Through bulkhead initiators, ordnance test harnesses, and firing units/exploding bridgewires

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.2.8 Airborne Test Equipment. The instrumented payload that is interchangeable with the live warhead and suitable for developmental test firing.

Includes, for example:
a. Recovery systems, special instrumentation, telemetry equipment, etc.

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.2.9 Airborne Training Equipment. The exercise payload that is interchangeable with the live warhead and suitable for training firing.

Includes, for example:
a. Recovery systems, special instrumentation, telemetry equipment, etc., associated with the training mission

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.2.10 Auxiliary Equipment. The additional equipment generally excluded from other specific Level 3 elements.

Includes, for example:
a. Environmental control, safety and protective subsystems, destruct systems, etc., if these were not accounted for in other WBS elements
b. Equipment of a single purpose and function which is necessary for accomplishing the assigned mission

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.2.11 Integration, Assembly, Test and Checkout. The integration, assembly, test and checkout element includes all efforts as identified in Appendix I: Common Elements, Work Breakdown Structure and Definitions, to provide a complete missile.

C.4.3 Command and Launch. 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.

Includes, for example:
a. 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
b. 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)
c. Sub-elements to the command and launch element (C.4.3.1-C.4.3.7)

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.3.1 Surveillance, Identification, and Tracking Sensors. The 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 missiles:

Includes, for example:
a. Tracking of the missile system air vehicles as required for guidance and control or range safety
b. Sensors of any spectrum (radar, optical, infrared, etc.) which are external to the air vehicle

Excludes, for example:
a. Subsystems used in safety, destruct, test, or training activities
b. Unless they are required operational items

C.4.3.2 Launch and Guidance Control. The equipment to target air vehicles, make launch decisions, and command launch.

Includes, for example:
a. Control and checkout console, data displays, secure code device, programmer group, communication control console, command message processing group, and digital data group

b. Equipment at the launch facility/vehicle and/or the launch control center(s) (air, sea, or mobile)
c. Launch code processing system

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.3.3 Communications. The equipment, not resident on the air vehicle, which distributes intelligence between the air vehicle and the command and launch equipment.

Includes, for example:
a. Inter-communication subsystems of launch sites for tactical and administrative message flow and ties between sensor, data processing, launch, and guidance control subsystems
b. Communications may interface with existing fixed communication facilities or communication subsystems of launch platforms which are associated systems to the missile system

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.3.4 Command and Launch Applications Software. All the software required to direct and perform the operations of the command and launch equipment (ref. ANSI/IEEE Std 610.12).

Includes, for example:
a. Effort required to design, develop, integrate, and checkout the command and launch applications computer software configuration items (CSCIs)

Excludes, for example:
a. Non-software portion of command and launch firmware development and production

NOTE: When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used.

C.4.3.5 Command and Launch System Software. The 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).

Includes, for example:
a. All effort required to design, develop, integrate, and checkout the command and launch system software
b. All software developed to support any command and launch applications software development
c. Command and launch system software which is required to facilitate development, integration, and maintenance of any command and launch software CSCI

Excludes, for example
a. All software that is an integral part of any specific hardware subsystem specification or specifically designed and developed for system test and evaluation

NOTE: When the opportunity to collect lower level information exists, the structure and definitions in Appendix B, Electronic/Automated Software Systems, will be used.

C.4.3.6 Launcher Equipment. The means to launch the missile air vehicle from stationary sites or mobile launch platforms.

Includes, for example:
a. Vehicles, rail launchers, canisters, capsules, tubes, pods, and devices which support, suspend, or encase the air vehicle for firing
b. Associated hardware such as umbilicals, harnesses, pyrotechnics, and electronics
c. Storage facilities and checkout stations for readiness verification when these are integral to the launcher
d. Safety and protective elements when these are not integral to the launch platform or site facilities

C.4.3.7 Auxiliary Equipment. The general purpose/multi-usage ground equipment utilized to support the various operational capabilities of the command and launch equipments which is generally excluded from other specific Level 3 elements.

Includes, for example:
a. 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

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

C.4.3.8 Booster Adapter. The booster adapter provides the mechanical and electrical interface between the launch vehicle's uppermost stage and the air vehicle. It can be as simple as a snap ring device, but it is usually a more complex structural assembly. In some cases, the booster adapter may be integral with the air vehicle. Also, in other cases, it may be purchased along with the launch vehicle.

Includes, for example:

a. All of the material and effort associated with the design, development, production, integration, assembly, and test of the Booster Adapter
b. Adapter structures, attachment and release devices, thermal control, instrumentation, and umbilical provisions

C.4.4 Common WBS Elements. Definitions for common WBS elements applicable to the missile and all other defense materiel items are in Appendix I: Common Elements, Work Breakdown Structure and Definitions.

APPENDIX D: ORDNANCE SYSTEMS WORK BREAKDOWN STRUCTURE AND DEFINITIONS

D.1 SCOPE

This appendix provides the Work Breakdown Structure and Definitions for the complete round and launch system. Definitions for WBS elements common to the ordnance system and all other defense materiel items are given in Appendix I: Common Elements, Work Breakdown Structure and Definitions.

D.2 WORK BREAKDOWN STRUCTURE LEVELS

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/System Integration Labs (SILs)
		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	

D.2.1 Application of Common WBS Elements (Appendix I). WBS elements which are common (i.e. Integration, Assembly, Test and Checkout; Systems Engineering/Program Management; System Test and Evaluation; Training; and Data) should be applied to the appropriate levels within the WBS for which they support. For example, if Systems Engineering is required to support a Level 3 WBS element, the Systems Engineering WBS element would appear at Level 4 of the WBS under the Level 3 element it supports.

D.3 DEFINITIONS

D.3.1 Ordnance System. The complex of equipment (hardware/software), data, services, and facilities required to develop and produce the capability for applying munitions to a target.

Includes, for example:
a. Pyrotechnic; means of launching or firing the munitions; represented by SNAKEYE bomb, Combined Effects Munitions, GATOR, Sensor Fuzed Weapon.

Excludes, for example:
a. Aerospace guided missiles and land, sea, or air delivery vehicles

D.3.2 Complete Round. The components that are necessary for firing one shot, such as mines, bombs, rockets, torpedoes, naval guns, rifles, and artillery ammunition.

Includes, for example:
a. Structural elements, warhead or payload, fuze, safety/arming devices, guidance equipment, and propellant/propulsion equipment
    1. (for artillery ammunition) projectile including structure, warhead, fuze, guidance and control (if applicable), safety/arming devices, propelling charge, and rocket motor (if applicable)
b. Design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specifications, regardless of end use)
c. Sub-elements of the complete round element (D.3.2.1-D.3.2.7)

NOTE: 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.

D.3.2.1 Structure. Portion of the complete round which carries the payload to the target; the basic housing of a bomb or rocket, casing of a projectile, body of a torpedo, or the tactical munitions dispenser containing sub-munitions. Some ordnance rounds do not have a clearly defined “structure” but instead have three distinct sections. These sections would be represented at the next lower level WBS. Sections may include 1) Nose, or forward section (typically containing the guidance and control, and perhaps the fuse) 2) Payload Section (typically made of cast steel or heavy rolled steel and containing the payload of explosive, chemical, sub-munitions or an inert, alternative payload) 3) Base Section (some munitions may not have a separately identifiable base section, but if they do, the base may provide the obturation (gas sealing device), propulsion (base-bleed or rocket motor), and fins for projectile stabilization).

Includes, for example:
a. Those structural devices which provide stability and control (i.e., fins, parachutes, anchors)

Excludes, for example:
a. 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.

D.3.2.2 Payload. The subsystem that contains the warhead and its support assemblies.

1) Small arms ammunition
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).

2) Complex munitions containing submunitions
Payload subsystem may include guidance and control, fuze, safety/arm, and propulsion as defined in D.3.2.3, D.3.2.4, D.3.2.5, and D.3.2.6 of this appendix.

NOTE: 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.

D.3.2.3 Guidance and Control. 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.

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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.

D.3.2.4 Fuze. 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.

NOTE: 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.

D.3.2.5 Safety/Arm. The device in the complete round which controls the capability of initiating the explosive sequence (e.g., mechanical, hydrostatic, inertial, counters, and timers).

NOTE: 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.

D.3.2.6 Propulsion. 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.

Includes, for example:
a. (For artillery ammunition) cartridge case, if applicable, primer, and explosive charge

NOTE: 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.

D.3.2.7 Integration, Assembly, Test and Checkout. The integration, assembly, test, and checkout element includes all efforts as identified in Appendix I: Common Elements, Work Breakdown Structure and Definitions to provide a complete round.

D.3.3 Launch System. The equipment (hardware/software) for controlling or sending forth the munitions on a desired course or trajectory—the ordnance system less the complete round.

Includes, for example:

a. 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).
b. 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 specifications, regardless of end use).

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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.

D.3.3.1 Launcher. The structural device designed to support and hold munitions in position for firing or release.

Includes, for example:

a. Suspension and release systems, rail, rocket pods, mine racks or dispensers, and torpedo tubes
b. (For guns and artillery) tubes, recoil assemblies, breech mechanisms, mounts, and rifle stocks

D.3.3.2 Carriage. 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.

D.3.3.3 Fire Control. 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.

Includes, for example:

a. (For rifles and small arms) sighting devices and trigger mechanisms
b. (For artillery, naval guns, and heavy mortars) aiming mechanisms in traverse and elevation, radar and other sensors, computers and other equipment for performing fire control computations
c. (For air-dropped munitions) gunsights, intervalometers, and other sensor and computational devices for controlling the release of the munitions
d. (For torpedoes) sonar and other sensors, computers, control consoles, and devices for presetting torpedo speed and direction

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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.

D.3.3.4 Ready Magazine. The structure or compartment for storing ammunition or explosives in a ready-for-use condition or position (e.g., the 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).

D.3.3.5 Adapter Kits. 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.).

NOTE: 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.

D.3.3.6 Integration, Assembly, Test and Checkout. The integration, assembly, test and checkout element includes all efforts as identified in Appendix I: Common Elements, Work Breakdown Structure and Definitions to provide a complete launch system.

D.3.4 WBS Common Elements. Definitions for common WBS elements applicable to the sea system and all other defense materiel items are found in Appendix I: Common Elements, Work Breakdown Structure and Definitions

APPENDIX E: SEA SYSTEMS
WORK BREAKDOWN STRUCTURE AND DEFINITIONS

E.1 SCOPE

This appendix provides the Work Breakdown Structure and definitions for the Sea System. Definitions for WBS elements common to the sea system and all other defense materiel items are in Appendix I: Common Elements, Work Breakdown Structure and Definitions.

This WBS should be used for ship acquisition pricing data, ship design, weight data, configuration management and Integrated Logistics Support engineering data. It is permissible for the contactor's internal work breakdown structure to differ from these summary elements; however, the internal WBS should be mapped to the WBS and definitions defined in this appendix.

E.2 APPLICABLE DOCUMENTS

"Users Guide for Expanded Ship Work Breakdown Structure (ESWBS) for All Ships and Ship/Combat Systems, S9040-AA-IDX-020/SWBS 5D Volumes 1 and 2"

If there are high cost/high risk elements that must be reported below Level 3 of the WBS, users should reference the Navy ESWBS document in order to ensure consistency in reporting.

E.3 WORK BREAKDOWN STRUCTURE LEVELS

Level 1	Level 2	Level 3
Sea System		
	Ship	
		Hull Structure
		Propulsion Plant
		Electric Plant
		Command, Communication and Surveillance
		Auxiliary Systems
		Outfit and Furnishings
		Armament
		Total Ship 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/System Integration Labs (SILs)
		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	

E.3.1 Application of Common WBS Elements (Appendix I). WBS elements which are common (i.e. Integration, Assembly, Test and Checkout; Systems Engineering/Program Management; System Test and Evaluation; Training; and Data) should be applied to the appropriate levels within the WBS for which they support. For example, if Systems Engineering is required to support a Level 3 WBS element, the Systems Engineering WBS element would appear at Level 4 of the WBS under the Level 3 element it supports.

E.4 DEFINITIONS

E.4.1 Sea System. Identifies the function of equipment (hardware/software), data, services, and facilities required to attain the capability of operating or supporting the operation of naval missions or performing other naval tasks at sea.

Includes, for example:
a. Sub Elements to the Sea System (E.4.2 and E.4.3)

E.4.2 Ship. The waterborne vessel and components of a sea system.

Includes, for example:
a. All classes of surface and subsurface water vessels such as combatants, auxiliaries, amphibious, and special-purpose ships
b. Design, development, and production of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specifications, regardless of end use)
c. Sub-elements to the ship (E.4.2.1-E.4.2.9)

NOTE: Further breakouts of Level 3 elements under the Level 2 Ship element are defined in the Expanded Ship Work Breakdown Structure (ESWBS).

E.4.2.1 Hull Structure. The assembled main hull body including all hull support structure, superstructure, bulkheads, platforms, masts, and foundations.

Includes, for example:
a. Shell plating, longitudinal and transverse framing, platforms and decks, superstructure, foundations, structural bulkheads, enclosures and sponsons
b. Castings, forgings, and welds; fixed ballast; doors and closures; king-posts, masts, and service platforms; and sonar domes
c. Tank/compartment tightness testing

E.4.2.2 Propulsion Plant. The major components installed primarily for propulsion and the systems necessary to make these components operable

Includes, for example:
a. Boilers and energy converters, propulsion units, main condensers and air ejectors, shafting, bearings, propellers, combustion air supply system, uptakes, propulsion control equipment, main steam, feed water and condensate, circulating and cooling water, fuel oil service and lubricating oil system
b. Nuclear steam generators, reactors, reactor coolant and auxiliary systems, nuclear power plant control, and radiation shielding

E.4.2.3 Electric Plant. The power generating and distribution systems installed primarily for ship service and emergency power and lighting.

Includes, for example:

a. Electric power generation, power distribution switchboards, power distribution system, and lighting system

E.4.2.4 Command, Communication and Surveillance. The 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.

Includes, for example:

a. Sensing and data systems required for navigation and weapon fire control
b. Navigation equipment, interior communication systems, gun fire control system, non-electronic 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, all associated software, computer systems, fiber optic plant, inter/intranet and entertainment systems.

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: All effort directly associated with the remaining Level 3 WBS elements and the integration, assembly, test and checkout of these elements into the ship is excluded.

E.4.2.5 Auxiliary Systems. The support systems for ship control, main propulsion components, ship safety, deck operations and environmental control.

Includes, for example:

a. The auxiliary machinery and piping systems; the hull mechanical handling systems; and ship control systems and surfaces such as rudders, hydrofoils, and diving planes
b. Heating, ventilation, and air conditioning systems; refrigeration plant and equipment
c. Gasoline, JP-8, all liquid cargo piping, oxygen-nitrogen and aviation lubricating oil systems
d. Plumbing installation, saltwater service systems, fire extinguishing systems, drainage, ballast, trimming, heating, and stabilizer tank systems
e. Fresh water system, scuppers and deck drains
f. Fuel and diesel oil filling, venting, stowage and transfer systems
g. Tank heating systems, compressed air system, auxiliary steam, exhaust steam and steam drains, buoyancy control system, distilling plant
h. 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
i. Aircraft arresting gear, barriers, and barricades
j. Catapults and jet blast deflectors, replenishment at sea and cargo handling systems

k. Design, development, production, and assembly efforts to provide each auxiliary system as an entity

NOTE: All effort directly associated with the remaining Level 3 WBS elements and the integration, assembly, test and checkout of these elements into the ship is excluded.

E.4.2.6 Outfit and Furnishings. The outfit equipments and furnishings required for habitability and operability which are not specifically included in other ship elements.

Includes, for example:
a. Hull fittings
b. Boats, boat stowage and handlings
c. Rigging and canvas; ladders and gratings; nonstructural bulkheads and doors; painting, deck covering, hull insulation; cathodic protection systems; refrigerated spaces; storerooms, stowage and lockers
d. Equipment for utility space, workshops, laboratories, test areas, galley, pantry, scullery and commissary outfit
e. Furnishings for living spaces, offices, control centers, machinery spaces, medical, dental and pharmaceutical spaces; and nonpropulsion space shielding
f. Design, development, production, and assembly efforts to provide the outfit and furnishing element as an entity

E.4.2.7 Armament. The complex of armament and related ammunition handling, stowage, and support facilities; and cargo munitions handling, stowage, and support facilities.

Includes, for example:
a. Guns and gun mounts; ammunition handling systems and stowage; special weapons handling and storage
b. Rocket and missile launching devices, handling systems and stowage
c. Air launched weapons handling systems and stowage; and cargo munitions handling and stowage
d. Torpedo, mines, small arms and pyrotechnic launching devices, handling systems and stowage systems
e. Design, development, production, and assembly efforts to provide the armament element as an entity

NOTE: All effort directly associated with the remaining Level 3 WBS elements and the integration, assembly, test and checkout of these elements into the ship is excluded.

E.4.2.8 Total Ship Integration/Engineering. The 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.

Includes, for example:

a. Construction drawings, engineering calculations, weighing and weight calculations, photographs, models, and shipbuilders information drawings

E.4.2.9 Ship Assembly and Support Services. The efforts and material associated with construction which cannot be logically and practicably identified with, or related to, other Level 3 elements.

Includes, for example:

a. Staging, scaffolding, and cribbing; temporary utilities and services; molds, templates, jigs, fixtures, and special production tools; dry-docking, inspection, insurance, launching, and delivery.
b. Production and construction planning; dock, sea and inclining trials

E.4.3 WBS Common Elements. Definitions for common WBS elements applicable to the sea system and all other defense materiel items are found in Appendix I: Common Elements, Work Breakdown Structure and Definitions

Sea specific common elements are identified in Appendix I see I.3.2.1.e, I.3.2.2.d, I.3.3.1e, I.3.5.1.c. I.3.5.2.c and I.3.5.3.b.

APPENDIX F: SPACE SYSTEMS
WORK BREAKDOWN STRUCTURE AND DEFINITIONS

F.1 SCOPE

This appendix provides the Work Breakdown Structure and Definitions for the Space Vehicle, Ground Command, and Launch Vehicle. Definitions for WBS elements common to the space system and all other defense materiel items are in Appendix I: Common Elements, Work Breakdown Structure and Definitions

F.2 APPLICABLE DOCUMENTS

If there are high cost/high risk elements that must be reported below Level 4 for Space Subsystems and/or for Ground Systems of the WBS, users should reference the National Reconnaissance Office (NRO) Standard Work Breakdown Structure (NRO SWBS) in order to ensure consistency in reporting. The NRO SWBS can be found at the following site:

http://www.acq.osd.mil/pm/currentpolicy/wbs/Releasable SWBS-locked.doc

F.3 WORK BREAKDOWN STRUCTURE LEVELS

Level 1	Level 2	Level 3	Level 4
Space System			
	SEIT/PM and Other Common Elements		
	Space Vehicle (1….n as required)		
		SEIT/PM and Other Common Elements	
		Spacecraft Bus	
			SEIT/PM and Other Common Elements
			Structures and Mechanisms Subsystem
			Thermal Control Subsystem
			Electrical Power Subsystem
			Attitude Control Subsystem
			Propulsion Subsystem
			Telemetry, Tracking, and Command Subsystem
			Spacecraft Bus Flight Software
		Communication / Payload	
			SEIT/PM and Other Common Elements
			Communication (1…n as required)
			Payload (1…n as required)
			Communication/Payload Flight Software (1…n as required)
		Booster Adapter	
		Space Vehicle Storage	
		Launch Systems Integration	
		Launch Operations & Mission Support	
	Ground (1…n as required)		
		SEIT/PM and Other Common Elements	
		Ground Terminal Subsystems	
		Command and Control Subsystem	
		Mission Management Subsystem	
		Data Archive/Storage Subsystem	
		Mission Data Processing Subsystem Mission Data Analysis and Dissemination Subsystem	
		Mission Infrastructure Subsystem	
		Collection Management Subsystem	
	Launch Vehicle		

F.3.1 Application of Common WBS Elements (Appendix I). Common WBS Elements must include, as a minimum, systems engineering, integration and test, and program management (SEIT/PM). Common elements are found throughout all levels of a WBS and are located one WBS level below the product oriented WBS they support (e.g., structures and mechanisms SEIT/PM would be captured at Level 5 below the Structures and Mechanisms Subsystem). Other common elements, such as training or data, as applicable, may be included here. The table above is not complete without the application of common elements

F.4 DEFINITIONS

F.4.1 Space System. The complex of equipment (hardware/software) and all of the resources associated with the design, development, production, integration, assembly, test, and operation of the entire Space System.

Includes, for example:
a. Space Vehicle; Ground; Launch Vehicle; and any mission equipment or other items necessary to provide an operational capability in space.
b. Any efforts done within a development/acquisition contract and includes such things as Operation and Maintenance Plans and Integrated Logistic Support Plans

F.4.2 Space Vehicle (1… n as required). A complete space vehicle in a multiple or dissimilar space vehicle configuration. It contains all of the resources associated with the design, development, production, integration, assembly, and test to include verification testing of each space vehicle as required. List each unique configuration as a separate space vehicle using sequential indices for each configuration; e.g., first configuration is Space Vehicle 1, second configuration is Space Vehicle 2, etc.

Includes, for example:
a. The design, development, and production, integration, assembly, test, and checkout of complete units (i.e., the prototype or operationally configured units which satisfy the requirements of their applicable specification, regardless of end use)
b. Sub-elements to the space vehicle -Spacecraft Bus, Communication/Payload; Booster Adapter; Space Vehicle Storage; Launch Systems Integration; Launch Operations and Mission Support (F.4.2.1-F.4.2.6)

F.4.2.1 Spacecraft Bus. The principal operating space vehicle that serves as a housing or platform for carrying a payload and other mission-oriented equipment in space.

Includes, for example:
a. Structure, power, attitude determination and control, and other equipment characteristic of a spacecraft bus
b. All design, development, production, and assembly, test, and checkout efforts to provide the spacecraft bus as an entity for integration with other WBS Level 3 elements (i.e., Communication/Payload Equipment) hardware elements
c. Sub-elements to Spacecraft Bus-Structures and Mechanisms (S&M); Thermal Control (TCS), Electrical Power (EPS), Attitude Control (ACS), Propulsion (PS), Telemetry, Tracking, and Command (TT&C) subsystems; Bus Flight Software where the software cannot be broken out to the subsystem or component level; (F.4.2.1.1-F.4.2.1.8)

NOTE: On more complicated Space Vehicles, there may be an integrated multi-processor system that performs functions for both the Bus and Payloads. In these cases it is acceptable to consider the Multi-Processor system as a single payload or as part of a specific payload. The Multi-Processor System may integrate functions normally included under ACS, TT&C, Communication & other payloads. The relevant point is to keep the cost in a single element and not allocate over multiple WBS elements.

F.4.2.1.1 Structures and Mechanisms Subsystems. The complete structures and mechanisms subsystem that supports all space vehicle subsystems, including deployable elements, during launch, and on-orbit injection.

Includes, for example:

a. All the resources associated with the design, development, fabrication, assembly, quality control/assurance, and test to include verification testing of spacecraft bus structure, mechanisms, structures with integral (non-removable) thermal control, pyrotechnics, and support equipment
b. Equipment compartments, trusses, frames and shells for carrying primary loads; and secondary structures for equipment support; structural assemblies for interfacing with the booster adapter and/or with the launch vehicle
c. All load carrying devices, such as payload equipment panels that are provided to Communication/Payload equipment supplies for supporting Communication/Payload Equipment components
d. Cables, harnesses, and end items which deploy and support solar arrays, antennas and other spacecraft components to the extent that the mechanisms are separable from the components they support

Excludes, for example:

a. Positioning elements that are identified with specific elements they support, such as solar array positioners
b. Payload fairings which are included in the launch element
c. Small equipment compartments or pallets that house Communication/Payload electronics are part of Communication/ Payload element
d. Booms which are used to exclusively support Communication/Payload equipment components or assemblies in the Communication/Payload element

F.4.2.1.2 Thermal Control System. The thermal control subsystem maintains the temperatures of all spacecraft bus components, and those Communication/Payload suites without their own thermal control provisions, within acceptable limits during ground test, launch and on-orbit operations.

Includes, for example:

a. All the resources associated with the design, development, fabrication, assembly, quality control, and test to include verification testing
b. Active or passive components including cryogenic devices, liquid loops, electric cooling, multi-layer thermal insulation blankets, surface coatings (thermal paint), mirrors with optical coatings, coatings, thermal tape, heat pipes, heat sinks, insulation, conductive structures, louvers, sun shields, active coolers, heaters, thermisters, thermostats, shutters, thermal conducting elements, and radiator panels/fins, coatings, insulation, louvers, sun shields, and thermal control subsystem flight software (including algorithm development), and support equipment.

NOTE 1: In cases where Communication/Payload contains its own thermal control provisions, the thermal control components are included in the Communication/Payload WBS element

NOTE 2: **When a space vehicle structure item has integral (non-removable) thermal control provisions such as heat sinks, then that item and its integral provisions are included within the Structures and Mechanisms Subsystem**

F.4.2.1.3 Electrical Power Subsystem. This subsystem generates, converts, regulates, stores, and distributes electrical energy to spacecraft bus and Communication/Payload suites.

Includes, for example:

a. All the resources specifically related to and limited to the design, development, fabrication, assembly, quality control, and test to include verification testing of electrical power subsystem
b. Power generation, conditioning, and storage; Electric Power Subsystem software; support equipment; and electrical harnesses and cables
c. Electric power generation: solar array (to include substrates, solar cells, support structure), solar array positioner (to include drive assembly and drive electronics), radioisotope thermionic generator, other power sources,
d. Electric power conditioning: power control electronics (to include junction boxes and pyrotechnics/heater controls), power conversion electronics (to include inverters, converters and regulators), power dissipation devices (to include shunt resistor banks and dissipators)
e. Electric power storage: rechargeable batteries (to include cells, support structure and interconnects), charge control electronics

F.4.2.1.4 Attitude Control Subsystem. This subsystem determines and controls spacecraft orbital positions, attitudes, velocities and angular rates using onboard sensors and torque application devices. It may also send control signals to propulsion subsystem components (e.g. thrusters), electrical power subsystem solar array positioners, and communication/ payload positioner electronics.

Includes, for example:

a. All the resources specifically related to and limited to the design, development, fabrication, assembly, quality control, and test to include verification testing of the Attitude Control Subsystem
b. Attitude determination: attitude reference (to include star trackers/sensors, earth (horizon) sensors, sun sensors, magnetometers), inertial reference (to include inertial reference unit, rate gyros, accelerometers), Bearing and Power Transfer Assembly (BAPTA), and Global Position System (GPS) Receiver
c. Attitude control: gyro stabilization devices (to include reaction wheels, momentum wheels, control moment gyros, energy storage devices (flywheels)), magnetic control devices, spin control devices, control electronics),
d. Attitude control subsystem flight software, and attitude control subsystem support equipment
e. May also include sensors, electronics and mechanical devices for safe-mode control of the space vehicle

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.2.1.5 Propulsion Subsystem. This subsystem provides thrust for attitude control and orbit corrections as required to accomplish the specified mission. It also provides thrust for orbit injection and changes.

Includes, for example:

a. All the resources specifically related to and limited to the design, development, fabrication, assembly, quality control, and test to include verification testing of the propulsion subsystem
b. Tanks, plumbing, thrusters, solid rocket motors, liquid propellants, and support equipment

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.2.1.6 Telemetry, Tracking, and Command (TT&C) Subsystem. This subsystem performs functions such as: formatting and transmitting telemetry (on narrowband links); accepting, decoding, verifying, and storing uplink commands; and generating command and control signals for the spacecraft bus and communication/payload suites based on uplink commands and/or internally generated data. The TT&C subsystem may also: provide timing signals to the spacecraft bus and communication/payload suites; perform on-board attitude determination, ephemeris calculations and attitude control equipment control (if these are not performed by dedicated attitude control computers/electronic components); and perform thruster control, electrical power monitoring/and control (if these are not performed by dedicated propulsion subsystem and electrical power subsystem components, respectively).

Includes, for example:

a. All the resources specifically related to and limited to the design, development, fabrication, assembly, quality control, and test to include verification testing of the TT&C
b. Passive radio frequency (RF) components (such as antennas, RF plumbing), other RF (such as transmitters, receivers, transponder, modulators, demodulators, power amplifiers, traveling wave tube assembly, solid state power amplifiers, GPS receivers, downconverters, and upconverters), other electronics (such as processors, solid state memory, decoders, command units, telemetry units, command sequencers, timing units, frequency generators, signal conditioners, and data switches), TT&C System Software (including algorithm development), and support equipment

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.2.1.7 Spacecraft Bus Flight Software. All resources required to design develop, code, test, document, install, integrate and verify flight software for performing spacecraft functions.

Includes, for example:
a. Designing, developing, coding and testing those functions that are implemented in firmware (e.g. by microcode programming).
b. Algorithm development

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: If flight software cannot be separated to the Spacecraft Bus subsystems or between the Spacecraft Bus and the Communication/Payload equipment, then the combined resources will be combined in this WBS. Otherwise, Software for performing Spacecraft Bus subsystems function or Communication/Payload equipment functions is included in the appropriate subsystem or Communication/Payload Equipment WBS elements.

F.4.2.2 Communication/Payload. In some space vehicles a communications suite is the primary payload; in others, it is a secondary, but integral, element to transmit primary payload data to the ground segment and receive payload tasking from the ground segment. Thus, these two functions are combined at this level and segregated at Level 4 of the WBS.

Includes, for example:
a. All of the resources associated with the design, development, production, integration, assembly, and test to include verification testing of communication/payload suite
b. Communication suites, payload suites, flight software, and support equipment
c. Sub elements to communication/payload – communication, payload and communication/payload flight software (4.2.2.1-4.2.2.3)

Excludes, for example
a. Integration and assembly of the communication/payload into a spacecraft which is captured at the space vehicle level
b. Remote command and telemetry units supporting communication/payload which are in the TT&C subsystem

F.4.2.2.1 Communication. The Communication suite transmits and/or receives mission data between the host space vehicle, ground stations, and other space vehicles. The Communication suite may or may not include TT&C signals multiplexed with mission data.

Includes, for example:
a. All of the resources associated with the design, development, production, integration, assembly, and test to include verification testing of the Communication WBS, which consists of one or more Communication suites in a multiple Communication suite configuration
b. All required Communication suites

c. Structures and Mechanisms, Thermal Control, Optics, Sensor Package, Laser Photonics, Power Supplies, RF Electronics, Digital Electronics, Data Storage, Communication Antennas, Communication Flight Software (including algorithm development), Communication Support Equipment.

F.4.2.2.2 Payload. The Payload is the component of a space vehicle that performs the space mission. It may require support from the host vehicle bus, such as power and positioning, from ground systems and from other space systems.

Includes, for example:
a. All of the resources associated with the design, development, production, integration, assembly, and test to include verification testing of the Payload WBS, which consists of one or more Payloads in a multiple payload configuration
b. Remote command and telemetry components that interface with the Payload equipment and the TT&C subsystem for purposes of commanding Payload suites and monitoring their status
c. Hardware components such as antennas and efforts that are used for both TT&C and mission data transmit/receive functions
d. Structures and Mechanisms, Thermal Control, Optics, Sensors, Lasers, Power Supplies, RF/Analog Electronics, Digital Electronics, Data Storage, Payload Antennas, Payload Flight Software (including algorithm development), Payload Support Equipment

Excludes, for example:
a. Hardware components and efforts that are devoted exclusively to TT&C functions (except the command and telemetry interfaces described above)

F.4.2.2.3 Communication/Payload Flight System Software. All resources required to design, develop, code, test, document, install, integrate and verify flight software for performing Communication/Payload functions.

Includes, for example:
a. If some of the functions are implemented in firmware, then includes designing, developing, coded and testing of those functions (e.g. by microcode programming).
b. Algorithm development

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

Note 2: If Communication/Payload cannot be separated between the Spacecraft Bus and the Communication/Payload equipment, then the combined resources will be carried in the Spacecraft Bus WBS.

F.4.2.3 Booster Adapter. The booster adapter provides the mechanical and electrical interface between the launch vehicle's uppermost stage and the space vehicle. It can be as simple as a snap ring device, but it is usually a more complex structural assembly. In some

cases, the booster adapter may be integral with the space vehicle. Also, in other cases, it may be purchased along with the launch vehicle.

Includes, for example:
a. All of the material and effort associated with the design, development, production, integration, assembly, and test of the Booster Adapter
b. Adapter structures, attachment and release devices, thermal control, instrumentation, and umbilical provisions

F.4.2.4 Space Vehicle Storage. Those costs of holding portions of the space system while awaiting use of the system being stored, prepared for storage, or recovered from storage. It can include the costs of holding portions of the space vehicle while waiting for the use of test facilities and equipment or the completion of other portions of the space vehicle.

The storage period typically starts when production testing is complete and continues until the space vehicle is ready for shipping to the launch site.

Includes, for example:
a. Planning, preparation, storage, maintenance, removal, refurbishment, and retesting of the space vehicle and/or its subsystems
b. Costs for storage facility use and environmental control equipment

Excludes, for example:
a. Final space vehicle assembly after storing portions of the vehicle

F.4.2.5 Launch System Integration. The engineering studies and analyses required to integrate a space vehicle with its launch vehicle. This effort typically is performed by the space vehicle developer.

Includes, for example:
a. Space vehicle contractor studies, analysis, and tests supporting the integration of the space vehicle with the launch vehicle
b. Launch system integration hardware, if any, provided by the space vehicle contractor

Excludes, for example:
a. Booster adapter which is represented within its own WBS
b. Integration activities performed by the launch vehicle provider, which are included in the Launch Segment portion of the WBS

F.4.2.6 Launch Operations and Mission Support. Launch operations are those efforts performed by the provider(s) of the space vehicle and payload(s) to prepare for and support space vehicle launches, primarily at the launch base and, to a lesser degree, the space vehicle

factory. Mission support is performed by the same providers for initial on-orbit checkout of the space vehicle and may also continue through the operational phase of the program.

The mission support period typically begins shortly after launch and ends when the space vehicle achieves initial operational capability.

Launch Operations Includes, for example:

a. Satellite contractor effort associated with pre-launch planning and preparation; launch operations, and initial on-orbit operations provided by the producer/integrator of the Space vehicle and Ground portions of the Space System
b. Pre-launch preparation of the space vehicle for shipping and actual shipping of the space vehicle to the launch site
c. Space vehicle contractor participation in final assembly, checkout, fueling and launch activities
d. Space vehicle contractor telemetry review and analysis during boost phases and initial orbital operations

Mission Support Includes, for example:

a. Space vehicle contractor participation in on-orbit testing; routine monitoring of space vehicle equipment health and status; fault detection; and anomaly investigation and resolution

F.4.3 Ground (1…n as required). The Ground is defined as a fixed, transportable, or mobile assembly of hardware, software, and firmware that has a communications interface with a space vehicle to receive only, or to receive and transmit data generated and mission data collected by the space vehicle. In addition, space vehicle TT&C and mission data may be processed within collocated facilities or alternatively in remotely located facilities. For example, Ground 1 could represent a Space Operations Center and Ground 2 a Network Operations Center or some other type of Command and Control facility.

Includes, for example:

a. All of the resources associated with its design, development, production, procurement, integration, assembly, and test
b. Support for the Space System and Space Vehicle level integration and testing provided by the producer/integrator of the Ground portion of the Space System
c. Sub-elements to Ground-Ground Terminal Subsystem; Command and Control Subsystem, Command and Control System; Mission Management Subsystem; Data Archive/Storage Subsystem; Data Archive/Storage System and Application Software; Mission Data Processing Subsystem; Mission Data Analysis and Dissemination Subsystem; Mission Infrastructure Subsystem; and a Collection Management Subsystem.
d. Ground facilities/building, factory/contractor support facility, initial support and support equipment specific to the ground portion of the space system but are not associated with specific subsystems

F.4.3.1 Ground Terminal Subsystem. This subsystem receives, downconverts, demodulates, and conditions telemetry, tracking, command, and mission (payload) data. In

addition, this subsystem generates the radio frequency (RF) uplink, accepts tracking and command signals, and modulates them onto the RF uplink.

Includes, for example:
a. Resources associated with the design, development, production, procurement, assembly, test, and operational site activation of the ground terminal (GT)
b. Antennas, feeds, antenna positioners, antenna support pedestals, radomes, transmitters, receivers, up/down frequency converters, modulators, demodulators, front-end equipment (encryptors/decryptors, synchronizers), etc.
c. Ground terminal facilities/buildings, ground terminal factory/contractor support facility, ground terminal initial support, and ground terminal support equipment

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.3.2 Command and Control Subsystem. The Command and Control subsystem decodes, demultiplexes, and decrypts space vehicle telemetry, generates commands for transmission to the spacecraft, and processes tracking data to generate space vehicle ephemeris. This subsystem supports all Ground subsystems that require the capability to prepare and output commands to, and receive and process data from, the space vehicle while in operation or under test

Includes, for example:
a. Resources associated with the design, development, production, procurement, assembly, test, and operational site activation of the Command and Control Subsystem.
b. Network, computer processing and display hardware such as routers, switches, servers, workstations, storage devices, etc.
c. Software for handling, processing, and executing space vehicle commands, as well as processing and analyzing space vehicle telemetry
d. Command and control ground facilities/building, command and control factory/contractor support facility, command and control initial support and support equipment

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.3.3 Mission Management Subsystem. The Mission Management Subsystem receives tasking, generates and provides the daily and longer-term system and mission plans, schedules, and timelines for the locally controlled satellites and ground facilities.

Includes, for example:
a. Resources associated with the design, development, production, procurement, assembly, and test of the Mission Management Subsystem
b. Network, computer processing and display hardware such as routers, switches, servers, workstations, storage devices, etc. plus software for processing tasking requests, generating mission plans, assessing system performance and reporting results

c. Mission management ground facilities/building, mission management factory/contractor support facility, mission management initial support and support equipment

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.3.4 Data Archive/Storage Subsystem. The Data Archive/Storage Subsystem receives daily and longer-term system and mission data and provides archive/storage for the locally controlled satellites and ground facilities.

Includes, for example:

a. All the resources associated with the design, development, production, procurement, assembly, test, and operational site activation of the Data Archive/Storage subsystem
b. Network, computer processing and display hardware such as routers, switches, servers, workstations, storage devices, etc.
c. Software (including algorithm development) for compiling, logging, tracking, allocating space, and data retrieval while assessing system performance and reporting results
d. Data archive/storage ground facilities/building, data archive/storage factory/contractor support facility, data archive/storage initial support and support equipment

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.3.5 Mission Data Processing Subsystem. The Mission Data Processing Subsystem decodes, demultiplexes, and decrypts digital and/or analog mission data from space vehicle payloads and generates commands for payload control. This subsystem typically performs processing unique to the payload(s) on the space vehicle, as opposed to centralized processing of payload data from different types of space vehicles. This data processing could be pre-processing prior to forwarding mission data to a national processing center and/or complete end-to-end data processing for direct dissemination to users.

Includes, for example:

a. All the resources associated with the design, development, production, procurement, assembly, test, and operational site activation of the Mission Data Processing Subsystem
b. Network, computer processing and display hardware such as routers, switches, servers, workstations, storage devices, etc.
c. Software (including algorithm development) for performing pre-processing operations on the mission data such as reformatting, compressing, combining, and tagging. (It may also perform other “back end” processing functions).
d. Mission data processing ground facilities/building, Mission data processing factory/contractor support facility, Mission data processing initial support and support equipment

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.3.6 Mission Data Analysis and Dissemination Subsystem. The Mission Data Analysis and Dissemination Subsystem is responsible for analysis of mission data from the payload(s) on the space vehicle. This mission data analysis could take various forms and could be interactive with a "human-in-the-loop" or automatic.

The dissemination function routes the received data and/or the final analysis products to the appropriate ground subsystems, archive/storage locations, and also to external users.

Includes, for example:

a. All the resources associated with the design, development, production, procurement, assembly, test, and operational site activation of the Mission Data Analysis and Dissemination Subsystem
b. Network, computer processing and display hardware such as routers, switches, servers, workstations, storage devices, etc.
c. Software (including algorithm development) for performing the mission data analysis and dissemination tasks
d. Mission data analysis and dissemination processing ground facilities/building, mission data analysis and dissemination processing factory/contractor support facility, mission data analysis and dissemination processing initial support and support equipment

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.3.7 Mission Infrastructure Subsystem. The Mission Infrastructure Subsystem includes all COTS and custom hardware and software needed for 1) the interchange or transfer of wideband, narrowband data, command and control, telemetry, and other support data between system ground subsystems (e.g., between the Mission Data Analysis and Dissemination and Command and Control Subsystems), and 2) the transfer of communications between and among various programs operationally assigned to the ground site.

Includes, for example:

a. Resources associated with the design, development, production, procurement, assembly, test, and operational site activation of the Mission Infrastructure Subsystem
b. Converters, servers, switches, interface units, cabling, etc. that are needed to 1) convert data received by the receive facility, put it in the proper format, and send it to other subsystems within the system ground architecture, and 2) interchange or transfer communications within the ground site
c. Common software(including algorithm development) or operating systems that overarch 1) ground subsystems and are unique to the system ground architecture, and 2) other programs operationally assigned to the ground site
d. Addresses either an in-place Mission Infrastructure Subsystem or the build of a new subsystem. For an in-place system, this WBS addresses the construction, conversion, or expansion of the Mission Infrastructure Subsystem. For a new system, this WBS addresses the design, development, production, procurement, assembly, and test of the Mission Infrastructure Subsystem.
e. Mission infrastructure ground facilities/building, mission infrastructure factory/contractor support facility, mission infrastructure initial support and support equipment

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.3.8 Collection Management Subsystem. The Collection Management Subsystem receives and analyzes space vehicle mission results, external customer and internal tasking requests, and generates tasking for space vehicles and ground facilities.

Includes, for example:

a. Resources associated with the design, development, production, procurement, assembly, test, and operational site activation of the Collection Management Subsystem
b. Network, computer processing and display hardware such as routers, switches, servers, workstations, storage devices, etc.
c. Software (including algorithm development) for processing mission results, tasking requests, generation of tasks, etc.
d. Collection management ground facilities/building, collection management factory/contractor support facility, collection management initial support and support equipment

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

F.4.4 Launch Vehicle. This WBS includes the launch vehicle contractors' efforts to receive, store, and transport the launch vehicle and associated ground equipment; to stack and assemble the launch vehicle; to mate the space vehicle and the launch vehicle; to perform integrated system test and checkout; and to track and measure launch vehicle performance during the ascent phase.

This WBS also includes the procurement of commercial-like launch services, launch vehicle integration, and independent verification and validation (IV&V).

If the Booster Adapter is not captured under Space Vehicle, it should be captured within this element. Reference Appendix C Missile Systems for lower level elements associated with this element.

APPENDIX G: SURFACE VEHICLE SYSTEMS WORK BREAKDOWN STRUCTURE AND DEFINITIONS

G.1 SCOPE

This appendix provides the Work Breakdown Structure and definitions for the primary vehicle and secondary vehicle. This appendix provides the structure for manned and unmanned surface systems including amphibious vehicles.

Definitions for WBS elements common to the surface vehicle and all other defense materiel items are given in Appendix I: Common Elements, Work Breakdown Structure and Definitions

G.2 WORK BREAKDOWN STRUCTURE LEVELS

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
		Primary Vehicle Application Software
		Primary Vehicle System Software
		Vetronics
		Integration, Assembly, Test and Checkout
	Secondary Vehicle	
		(Same as Primary Vehicle)
	Systems Engineering/ Program Management	
	System Test and Evaluation	
		Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups/System Integration Lab (SILs)
		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	

G.2.1 Application of Common WBS Elements (Appendix I). WBS elements which are common (i.e. Integration, assembly, test and checkout; systems engineering/program management; system test and evaluation; training; and data) should be applied to the appropriate levels within the WBS for which they support. For example, if systems engineering is required to support a Level 3 WBS element, the systems engineering WBS element would appear at Level 4 of the WBS under the Level 3 element it supports.

G.3 DEFINITIONS

G.3.1 Surface Vehicle System. The complex of vetronics equipment, data, services, and facilities required to develop and produce a vehicle system with the capability to navigate over the surface. Surface vehicle categories include vehicles primarily intended for general purpose applications and those intended for mating with specialized payloads.

Includes, for example:
a. Cargo and logistics vehicles, mobile work units and combat vehicles
b. Combat vehicles serving as armored weapons platforms, reconnaissance vehicles, and amphibians

G.3.2 Primary Vehicle. The mobile element of the system embodying means for performing operational missions.

Includes, for example:
a. Means of propulsion and structure for adaptation of mission equipment or accommodations for disposable loads
b. Design, development, and production of complete units (i.e., prototype or operationally configured units which satisfy the requirements of their applicable specifications, regardless of end use)
c. Sub-elements to the primary vehicle (G.3.2.1-G.3.2.17)

G.3.2.1 Hull/Frame. The vehicle's primary load bearing component which provides the structural integrity to withstand the operational loading stresses generated while traversing various terrain profiles.

Includes, for example:
a. Simple wheeled vehicle frame or combat vehicle hull which satisfies the structural requirements and also provides armor protection
b. Structural subassemblies and appendages which attach directly to the primary structure
c. Towing and lifting fittings, bumpers, hatches, and grilles
d. Provision to accommodate other subsystems such as mountings for suspension, weapons, turret, truck body, cab, special equipment loads

NOTE: 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.

G.3.2.2 Suspension/Steering. The means for generating tractive efforts, thrust, lift, and steering forces generally at or near the earth's surface and adapting the vehicle to the irregularities of the surface.

Includes, for example:
a. Wheels, tracks, brakes, and steering gears for traction and control functions
b. Rudder thrust devices and trim vanes for amphibians
c. Springs, shock absorbers, skirts, and other suspension members

NOTE: 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.

G.3.2.3 Power Package/Drive Train. The means for generating and delivering power in the required quantities and driving rates to the driving member.

Includes, for example:
a. Engine-mounted auxiliaries such as air ducting and manifolds, controls and instrumentation, exhaust systems, and cooling means
b. Power transport components as clutches, transmission, shafting assemblies, torque converters, differentials, final drivers, and power takeoffs
c. Brakes and steering when integral to power transmission rather than in the suspension/steering element

NOTE: 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.

G.3.2.4 Auxiliary Automotive. The group of hardware and software subsystems which provide services to all of the primary vehicle subsystems (as distinguished from the special equipment subsystems) and which outfit the chassis.

Includes, for example:
a. The on-board diagnostics/prognostics system, fire extinguisher system and controls, chassis mounted accessories
b. The winch and power take-off, tools and on-vehicle equipment
c. Crew accommodations (when otherwise not provided for)

Excludes, for example:
a. Electrical subsystems and components which are now included in the vetronics WBS element.

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

G.3.2.5 Turret Assembly. The structure and equipment installations required to provide the fighting compartment element of combatant vehicles.

Includes, for example:
a. Turret armor and radiological shielding, turret rings, slip rings
b. Attachments and appendages such as hatches and cupolas
c. Accommodations for personnel, weapons, and command and control

Excludes, for example:
a. Fire control and stabilization system

NOTE: 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.

G.3.2.6 Fire Control. The equipment (hardware and software) installed in the vehicle which provides intelligence necessary for weapons delivery such as launching and firing.

Includes, for example:
a. Radars and other sensors necessary for search, recognition and/or tracking
b. Controls and displays
c. Sights or scopes
d. Range finders, computers, computer programs, turret and gun drives, and stabilization systems

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

G.3.2.7 Armament. The means for combatant vehicles to deliver fire on hostile targets and for logistics and other vehicles to exercise self-defense.

Includes, for example:
a. main gun, launchers, and secondary armament

Excludes, for example:
a. Fire control systems

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

G.3.2.8 Body/Cab. The major component to be mated to a chassis to provide a complete vehicle having a defined mission capability.

Includes, for example:
a. Accommodations for personnel, cargo, and such subsystems as need to be placed in proximity to operators

NOTE: 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.

G.3.2.9 Automatic Loading. The equipment (hardware and software) for selecting ammunition from a stored position in the vehicle, transferring it, and loading the armament system.

Includes, for example:
a. The means to eject spent cases and misfired rounds
b. Ammunition storage racks, transfer/lift mechanisms, ramming and ejecting mechanisms, as well as specialized hydraulic and electrical controls

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

G.3.2.10 Automatic/Remote Piloting. The equipment (hardware and software) installed in the vehicle used to plan and control vehicle speed and direction either autonomously or via tele-operation.

Includes, for example:
a. Equipment which senses, processes and displays imagery data—stereo vision systems; laser scanners; multiple sensor-fusion algorithms and processors; image-enhancement algorithms and processors, etc.
b. Equipment which performs intelligence analysis and planning functions—automated route planners; image-understanding algorithms and processors; computer-aided-driving algorithms and processors, etc.

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

G.3.2.11 Nuclear, Biological, Chemical. The 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.

Includes, for example:
a. 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

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

G.3.2.12 Special Equipment. The special equipment (hardware and software) to be mated to a chassis or a chassis/body/cab assembly to achieve a special mission capability.

Includes, for example:
a. All items required to convert basic vehicle configurations to special-purpose configurations
b. Blades, booms, winches, robotic arms or manipulators, etc., to equip wreckers, recovery vehicles, supply vehicles and other field work units
c. Furnishings and equipment for command, shop, medical and other special-purpose vehicles

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

G.3.2.13 Navigation. The equipment (hardware and software) installed in the vehicle which permits the crew to determine vehicle location and to plot the course of the vehicle.

Includes, for example:
a. Navigation systems such as dead reckoning, inertial, and global positioning systems
b. Landmark recognition algorithms and processors

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

G.3.2.14 Communications. The equipment (hardware and software) within the system for commanding, controlling, and transmitting information to vehicle crews and other personnel exterior to operating vehicles.

Includes, for example:
a. Radio frequency equipment, microwave and fiber optic communication links, networking equipment for multiple vehicle control, and intercom and external phone systems
b. Means for supplementary communication like visual signaling devices
c. Navigation system and data displays not integral to crew stations in the turret assembly or the driver's automotive display in the cab

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

G.3.2.15 Primary Vehicle Applications Software.

Includes, for example:
a. All the software that is specifically produced for the functional use of a computer system or multiplex data base in the primary vehicle (ref. ANSI/IEEE Std 610.12)
b. All effort required to design, develop, integrate, and checkout the primary vehicle applications Computer Software Configuration Items (CSCIs)

Excludes, for example:
a. The non-software portion of air vehicle firmware development and production
b. Software that is an integral part of any specific subsystem and software that is related to other WBS Level 2 elements

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

G.3.2.16 Primary Vehicle System Software. That 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 primary vehicle. (ref. ANSI/IEEE Std 610.12)

Includes, for example:
a. Operating systems—software that controls the execution of programs
b. Compilers—computer programs used to translate higher order language programs into relocatable or absolute machine code equivalents
c. Utilities—computer programs or routines designed to perform the general support function required by other application software, by the operating system, or by system users

d. All effort required to design, develop, integrate, and checkout the air vehicle system software including all software developed to support any primary vehicle applications software development
e. Primary vehicle system software required to facilitate development, integration, and maintenance of any primary vehicle software build and CSCI

Excludes, for example:
a. All software that is an integral part of any specific subsystem specification or specifically designed and developed for system test and evaluation
b. Software that is an integral part of any specific subsystem, and software that is related to other WBS Level 2 elements

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

G.3.2.17 Vetronics. All hardware/software used to integrate the electronic subsystems and components of the vehicle, such as computer resources, data control and distribution, controls and displays, and power generation and management.

Electronic Subsystems and components to be integrated include, for example:
a. Information systems such as command and control (C2), mission planning and logistics functions, C4ISR
b. High end real-time systems such as sensors, robotics, active protection, mission critical applications
c. High power load management systems such as the electronic turret, electric drive, autoloader
d. Automotive/utility systems such as steering, brake and throttle by wire and the auxiliary load management

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

G.3.2.18 Integration, Assembly, Test and Checkout

Includes, for example:
a. All efforts as identified in Appendix I: Common Elements, Work Breakdown Structure and Definitions, to provide the integration, assembly, test, and checkout of all elements into the hull/frame to form the primary vehicle as a whole
b. All administrative and technical engineering labor to perform integration of Level 3 primary vehicle and frame elements; development of engineering layouts; determination of overall design characteristics, and determination of requirements of design review
    1. Overall primary vehicle design and producibility engineering
    2. Detailed production design; acoustic and noise analysis

3. Loads analysis; stress analysis on interfacing frame elements and all subsystems
4. Design maintenance effort and development of functional test procedures
5. Coordination of engineering master drawings and consultation with test and manufacturing groups
6. Tooling planning, design, and fabrication of basic and rate tools and functional test equipments, as well as the maintenance of such equipment
7. Production scheduling and expediting
8. Joining or installation of structures such as racks, mounts, etc.
9. Installation of wiring ducting, engines, and miscellaneous equipment and painting
10. Set up, conduct, and review of testing assembled components or subsystems prior to installation

c. All effort associated with the installation, integration, test and checkout of the vetronic systems into the vehicle including:
   1. Design of installation plans
   2. Quality assurance planning and control including material inspection
   3. Installation
   4. Recurring verification tests
   5. Integration with non-vetronic vehicle subsystems
d. Ground checkout prior to 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

Nonrecurring vetronics system integration which is associated with the individual vetronics equipment boxes and vetronics software in a functioning system.

Includes, for example:
a. The labor required to analyze, design, and develop vetronics suite interfaces and establish interface compatibility with non-vetronics support equipment systems, vehicle systems, and mission planning systems
b. Drawing preparation and establishment of vetronics interface equipment requirements and specifications
c. Technical liaison and coordination with the military service, subcontractors, associated contractors, and test groups

Excludes, for example:
a. Development, testing, and integration of software (which should be included in air vehicle applications and system software)
b. Vetronics system testing (included in system test and evaluation) and vehicle systems engineering efforts (included in systems engineering/program management).
c. All effort directly associated with the remaining Level 3 WBS elements.

G.3.3 Secondary Vehicle. The 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.

Includes, for example:

a. 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 has limited roadability
b. The design, development, and production of complete units (i.e., prototype or operationally configured units which satisfy the requirements of their applicable specification(s), regardless of end use)

NOTE: Work breakdown structure and definitions for Secondary Vehicle are the same as those for the primary vehicle.

G.3.4 WBS Common Elements. Definitions for common WBS elements applicable to the sea system and all other defense materiel items are found in Appendix I: Common Elements, Work Breakdown Structure and Definitions

APPENDIX H: UNMANNED AIR VEHICLE SYSTEMS WORK BREAKDOWN STRUCTURE AND DEFINITIONS

H.1 SCOPE

This appendix provides the Work Breakdown Structure and definitions for the unmanned vehicle. Definitions for WBS elements common to all defense materiel items are given in Appendix I: Common Elements, Work Breakdown Structure and Definitions.

H.2 APPLICABLE DOCUMENTS

Non-Government publications. The following documents form a part of this document to the extent specified herein.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
ANSI/IEEE STD 610.12, *Standard Glossary of Software Engineering Terminology*

ANSI Standards can be found online at:
http://webstore.ansi.org/ansidocstore/default.asp

ANSI Customer Service:
25 W 43rd Street, 4th Floor
New York, NY, 10036

or

The Institute of Electrical and Electronics Engineers, Inc. (IEEE) Service Center
445 Hoes Lane
Pistacataway, NJ 08855-1331
www.ieee.org

H.3 WORK BREAKDOWN STRUCTURE LEVELS

Level 1	Level 2	Level 3
UAV System		
	Air Vehicle	
		Airframe
		Propulsion
		Communications/Identification
		Navigation/Guidance
		Central Computer
		Auxiliary Equipment
		Air Vehicle Application Software
		Air Vehicle System Software
		Integration, Assembly, Test and Checkout
	Payload (1...n)	
		Survivability
		Reconnaissance
		Electronic Warfare
		Armament
		Weapons Delivery
		Payload Application Software
		Payload System Software
		Integration, Assembly, Test and Checkout
	Ground Segment	
		Ground Control Systems
		Command and Control Subsystem
		Launch and Recovery Equipment
		Transport Vehicles
		Ground Segment Application Software
		Ground Segment System Software
		Integration, Assembly, Test and Checkout
	System Integration, Assembly, Test and C/O	
	Systems Engineering/Program Management	
	System Test and Evaluation	
		Development Test and Evaluation
		Operational Test and Evaluation
		Mock-ups/System Integration Labs (SILs)
		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	

H.3.1 Application of Common WBS Elements (Appendix I). WBS elements which are common (i.e. Integration, Assembly, Test and Checkout; System Engineering/Program Management; System Test and Evaluation; Training; and Data) should be applied to the appropriate Levels within the WBS for which they support. For example, if Systems Engineering is required to support a Level 3 WBS element, the System Engineering WBS element would appear at Level 4 of the WBS under the Level 3 element it supports.

H.4 DEFINITIONS

H.4.1 Unmanned Air Vehicle (UAV) System. The complex of equipment (hardware/software), data, services, and facilities required to develop and produce unmanned vehicles.

Includes, for example:
a. Those employing fixed, movable, rotary, or compound wing
b. Those unmanned air vehicles designed for powered or unpowered movement (i.e. gliders)

H.4.2 Air Vehicle. The complete unmanned air vehicle.

Includes, for example:
a. Airframe, propulsion, and all other installed equipment
b. Design, development, and production of complete units—prototype and operationally configured units which satisfy the requirements of their applicable specifications, regardless of end use
c. Sub-elements to the vehicle (H.4.2.1-H.4.2.8)

H.4.2.1 Airframe. The assembled structural and aerodynamic components of the air vehicle that support subsystems essential to designated mission requirements.

Includes, for example:
a. Basic structure—wing, empennage, fuselage, and associated manual flight control system
b. Rotary wing pylons, air induction system, thrust reversers, thrust vector devices, starters, exhausts, fuel management, inlet control system
c. Alighting gear—tires, tubes, wheels, brakes, hydraulics, etc.
d. Secondary power, furnishings—cargo, etc.
e. Instruments—flight, navigation, engine, etc.
f. Environmental control, racks, mounts, intersystem cables and distribution boxes, etc., which are inherent to, and non-separable from, the assembled structure
g. Dynamic systems—transmissions, gear boxes, propellers, if not furnished as an integral part of the propulsion unit
h. Rotor group and other equipment homogeneous to the airframe

H.4.2.2 Propulsion. That portion of the vehicle that pertains to installed equipment (propulsion unit and other propulsion) to provide power/thrust to propel the vehicle.

Includes, for example:

a. 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
b. Thrust reversers, thrust vector devices, transmissions, gear boxes, and engine control units, if furnished as integral to the propulsion unit
c. Other propulsion equipment required in addition to the engine but not furnished as an integral part of the engine, such as booster units
d. Engine control electronics (hardware and software integral to the propulsion system)
e. The design, development, production, and assembly efforts to provide the propulsion unit as an entity

Excludes, for example:

a. All effort directly associated with the elements and the integration, assembly, test, and checkout of these elements into the air vehicle
b. All ancillary equipments that are not an integral part of the engine required to provide an operational primary power source—air inlets, instruments, controls, etc.

H.4.2.3 Communication/Identification. That equipment (hardware/software) installed in the air vehicle for communications and identification purposes

Includes, for example:

a. Intercoms, radio system(s), identification equipment (IFF), data links, and control boxes associated with the specific equipment
b. Integral communication, navigation, and identification package (if used)

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.2.4 Navigation/Guidance. That equipment (hardware/software) installed in the air vehicle to perform the navigational guidance function.

Includes, for example:

a. Radar, radio, or other essential navigation equipment, radar altimeter, direction finding set, doppler compass, computer, and other equipment homogeneous to the navigation/guidance function

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.2.5 Central Computer. The master data processing unit(s) responsible for coordinating and directing the major avionic mission systems.

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.2.6 Auxiliary Equipment. Auxiliary airframe, electronics, and/or armament/weapons delivery equipment not allocable to individual element equipments, or which provides the ancillary functions to the applicable mission equipments.

Includes, for example:
a. Auxiliary airframe equipment such as external fuel tanks, pods, and rotodomes
b. Multi-use equipment like antennas, control boxes, power supplies, environmental control, racks, and mountings, not homogeneous to the prescribed WBS elements

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

NOTE 3: 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 H.4.3.4 and H.4.3.5 of this appendix under Payload (1…n)

H.4.2.7 Air Vehicle Applications Software.

Includes, for example:
a. All the software that is specifically produced for the functional use of a computer system or multiplex data base in the air vehicle (ref. ANSI/IEEE Std 610.12)
b. All effort required to design, develop, integrate, and checkout the air vehicle applications computer software configuration items (CSCIs)

Excludes, for example:

a. The non-software portion of air vehicle firmware development and production
b. Software that is an integral part of any specific subsystem and software that is related to other WBS Level 2 elements

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

H.4.2.8 Air Vehicle System Software. That 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. (ref. ANSI/IEEE Std 610.12)

Includes, for example:
a. Operating systems—software that controls the execution of programs
b. Compilers—computer programs used to translate higher order language programs into relocatable or absolute machine code equivalents
c. Utilities—computer programs or routines designed to perform the general support function required by other application software, by the operating system, or by system users
d. 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
e. Air vehicle system software required to facilitate development, integration, and maintenance of any air vehicle software build and CSCI

Excludes, for example:
a. All software that is an integral part of any specific subsystem specification or specifically designed and developed for system test and evaluation
b. Software that is an integral part of any specific subsystem, and software that is related to other WBS Level 2 elements

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

H.4.2.9 Integration, Assembly, Test and Checkout.

Includes, for example:
a. All efforts as identified in Appendix I: Common Elements, Work Breakdown Structure and Definitions, to provide the integration, assembly, test, and checkout of all elements into the airframe to form the air vehicle as a whole
b. 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
    1. Overall air vehicle design and producibility engineering
    2. Detailed production design; acoustic and noise analysis
    3. Loads analysis; stress analysis on interfacing airframe elements and all subsystems
    4. Design maintenance effort and development of functional test procedures

5. Coordination of engineering master drawings and consultation with test and manufacturing groups
6. Tooling planning, design, and fabrication of basic and rate tools and functional test equipments, as well as the maintenance of such equipment
7. Production scheduling and expediting
8. Joining or installation of structures such as racks, mounts, etc.
9. Installation of seats, wiring ducting, engines, and miscellaneous equipment and painting
10. Set up, conduct, and review of testing assembled components or subsystems prior to installation

c. All effort associated with the installation, integration, test, and checkout of the avionic systems into the air vehicle including:
   1. Design of installation plans
   2. Quality assurance planning and control including material inspection
   3. Installation
   4. Recurring verification tests
   5. Integration with non-avionics airframe subsystems
d. 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

Nonrecurring UAV system integration which is associated with the individual avionics equipment boxes and avionics software in a functioning system.

Includes, for example:
a. The labor required to analyze, design, and develop avionics suite interfaces and establish interface compatibility with non-avionics support equipment systems, aircraft systems, and mission planning systems
b. Drawing preparation and establishment of avionics interface equipment requirements and specifications
c. Technical liaison and coordination with the military service, subcontractors, associated contractors, and test groups

Excludes, for example:
a. Development, testing, and integration of software (which should be included in air vehicle applications and system software)
b. Avionics system testing (included in system test and evaluation) and aircraft systems engineering efforts (included in systems engineering/program management).
c. All effort directly associated with the remaining Level 3 WBS elements

H.4.3 Payload (1…n). Unmanned Air Vehicles (UAVs) may have a single or multiple payloads represented at Level 3 of the WBS. In addition to the types of payloads listed below, an UAV may also have other payloads. If a UAV has other payloads, they too should be represented within the WBS structure at Level 3 below the Level 2 Payload element. Examples of other payloads include targeting and ranging systems, bio/chemical detection sensors, meteorological sensors, and communication relay systems.

H.4.3.1 Survivability. Those equipments (hardware/software) installed in, or attached to, the air vehicle which assist in penetration for mission accomplishment.

Includes, for example:
a. Ferret and search receivers, warning devices and other electronic devices, terrain-following radar, and other devices typical of this mission function

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.3.2 Reconnaissance. Those equipments (hardware/software) installed in, or attached to, the air vehicle necessary to the reconnaissance mission.

Includes, for example:
a. Photographic, electronic, infrared, and other sensors
b. Search receivers
c. Recorders
d. Warning devices
e. Magazines
f. Data link

Excludes, for example:
a. Gun cameras

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.3.3 Electronic Warfare. That electronic warfare equipment (hardware/software) installed in the unmanned vehicle to provide the functions of electronic warfare support, electronic attack, and electronic protection (i.e., electronic countermeasures, electronic counter-countermeasures, or electronic warfare support measures). This element involves the use of electromagnetic and directed energy to control the electromagnetic spectrum or to attack the enemy.

Includes, for example:
a. Electronic countermeasures, jamming transmitters, chaff, infra-red jammers, other jamming equipment, electromagnetic deception equipment, or weapons that use electromagnetic or directed energy such as laser, RF weapons, or particle beams.

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.3.4 Armament. That equipment (hardware/software) installed in the air vehicle to provide the firepower functions.

Includes, for example:
a. Guns, high energy weapons, mounts, turrets, weapon direction equipment, ammunition feed and ejection mechanisms, and gun cameras

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.3.5 Weapons Delivery. That equipment (hardware/software) installed in the air vehicle to provide the weapons delivery capability.

Includes, for example:
a. Launchers, pods, bomb racks, pylons, integral release mechanisms, and other mechanical or electro-mechanical equipments specifically oriented to the weapons delivery function

Excludes, for example:
a. Bombing/navigation system (included in the fire control element)

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.3.6 Payload Applications Software.

Includes, for example:
a. All the software that is specifically produced for the functional use of a computer system or multiplex data base in the payload (ref. ANSI/IEEE Std 610.12)
b. All effort required to design, develop, integrate, and checkout the payload applications computer software configuration items (CSCIs)

Excludes, for example**:**
a. The non-software portion of payload firmware development and production
b. Software that is an integral part of any specific subsystem and software that is related to other WBS Level 2 elements

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

H.4.3.7 Payload System Software. That 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 payload. (ref. ANSI/IEEE Std 610.12)

Includes, for example:
a. Operating systems—software that controls the execution of programs
b. Compilers—computer programs used to translate higher order language programs into relocatable or absolute machine code equivalents
c. Utilities—computer programs or routines designed to perform the general support function required by other application software, by the operating system, or by system users
d. All effort required to design, develop, integrate, and checkout the payload system software including all software developed to support any payload applications software development
e. Payload system software required to facilitate development, integration, and maintenance of any payload software build and CSCI

Excludes, for example:
a. All software that is an integral part of any specific subsystem specification or specifically designed and developed for system test and evaluation
b. Software that is an integral part of any specific subsystem, and software that is related to other WBS Level 2 elements

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

H.4.3.8 Integration, Assembly, Test and Checkout. The efforts as identified in Appendix I: Common Elements, Work Breakdown Structure and Definitions, to provide a complete payload.

H.4.4 Ground Segment. The Ground segment is defined as a fixed, transportable, or mobile assembly of hardware, software, and firmware that has a communications interface with the vehicle to receive only, or to receive and transmit data generated and mission data collected by the air vehicle. In addition, vehicle telemetry, tracking &command (TT&C) and mission data may be processed within collocated facilities or alternatively in remotely located facilities. For example, Ground 1 could represent an operations center and Ground 2 a network operations center or some other type of command and control facility.

Includes, for example:

a. All of the resources associated with its design, development, production, procurement, integration, assembly, and test
b. Support for the system and vehicle level integration and testing provided by the producer/integrator of the ground portion of the system
c. Sub-elements to ground-ground control system, launch and recovery equipment, transport vehicles, system software and integration, assembly, test and checkout (H.4.4.1-H.4.4.5).

H.4.4.1 Ground Control Systems. This is the command and control center for the UAV system. It is utilized during pre-launch, launch, recovery, and operation of UAVs and payloads; data link that the data to be sent between the GCS and the mission vehicle and is composed of transceivers and controls and may include a global positioning system (GPS)

This subsystem receives, down converts, demodulates, and conditions telemetry, tracking, command, and mission (payload) data. In addition, this subsystem generates the RF uplink, accepts tracking and command signals, and modulates them onto the RF uplink.

Includes, for example:
a. Resources associated with the design, development, production, procurement, assembly, test, and operational site activation of the ground terminal (GT)/segment
b. Antennas, feeds, antenna positioners, antenna support pedestals, radomes, transmitters, receivers, up/down frequency converters, modulators, demodulators, front-end equipment (encryptors/decryptors, synchronizers), etc.
c. GT facilities/buildings, GT factory/contractor support facility, GT initial support, GT support equipment

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: All effort directly associated with the remaining Level 3 WBS elements and the integration, assembly, test, and checkout of these elements into the Ground is excluded. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.4.2 Command and Control Subsytem. This subsystem decodes, demultiplexes, and decrypts space vehicle telemetry, generates commands for transmission to the aircraft, and processes tracking data to generate air vehicle ephemeris. This subsystem supports all Ground subsystems that require the capability to prepare and output commands to, and receive and process data from, the air vehicle while in operation or under test.

Includes, for example:
a. resources associated with the design, development, production, procurement, assembly, test, and operational site activation of the Command and Control Subsystem.
b. network, computer processing and display hardware such as routers, switches, servers, workstations, storage devices, etc.
c. software for handling, processing, and executing air vehicle commands, as well as processing and analyzing air vehicle telemetry
d. command and control ground facilities/building, command and control factory/contractor support facility, command and control initial support and support equipment

NOTE 1: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

NOTE 2: All effort directly associated with the remaining Level 3 WBS elements and the integration, assembly, test, and checkout of these elements into the Ground is excluded. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.4.3 Launch and Recovery Equipment. This is the equipment necessary to launch and recover air vehicles during the performance of its mission.

Includes, for example:
a. Equipment required to launch the air vehicle with its mission payloads into flight
b. Air vehicle hydraulic/pneumatic launcher, rail, an jet/rocket assisted take-off (JATO/RATO) bottles for short take-off
c. Automatic landing beacon system
d. Arresting net or arresting lines
e. Parachute

NOTE: 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. This item contains embedded software—software defined in the item specification and provided by the supplier.

H.4.4.4 Transport Vehicles. Any vehicles that have been specifically designed or modified for the transportation of air vehicles, ground control station equipment or other mission equipment. This includes any vehicles used to perform movement of the prime mission vehicle, crew, maintenance equipment, and direct maintenance personnel, or any other special transport systems used in the relocation of the prime mission equipment so that it may perform its mission.

H.4.4.5 Ground Segment Applications Software

Includes, for example:
a. All the software that is specifically produced for the functional use of a computer system or multiplex data base in the ground segment (ref. ANSI/IEEE Std 610.12)
b. All effort required to design, develop, integrate, and checkout the ground segment applications Computer Software Configuration Items (CSCIs)

Excludes, for example**:**
a. The non-software portion of air vehicle firmware development and production
b. Software that is an integral part of any specific subsystem and software that is related to other WBS Level 2 elements

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

H.4.4.6 Ground Segment System Software. That 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 Ground Segment. (ref. ANSI/IEEE Std 610.12)

Includes, for example:
a. Operating systems—software that controls the execution of programs
b. Compilers—computer programs used to translate higher order language programs into relocatable or absolute machine code equivalents
c. Utilities—computer programs or routines designed to perform the general support function required by other application software, by the operating system, or by system users
d. All effort required to design, develop, integrate, and checkout the ground segment system software including all software developed to support any ground segment applications software development
e. Ground segment system software required to facilitate development, integration, and maintenance of any ground segment system software build and CSCI

Excludes, for example:
a. All software that is an integral part of any specific subsystem specification or specifically designed and developed for system test and evaluation
b. Software that is an integral part of any specific subsystem, and software that is related to other WBS Level 2 elements

NOTE: If lower level information can be collected, use the structure and definitions in Appendix B, Electronic/Automated Software Systems.

H.4.4.7 Integration, Assembly, Test and Checkout. The efforts as identified in Appendix I: Common Elements, Work Breakdown Structure and Definitions, to provide a complete ground system.

H.4.5 System Integration, Assembly, Test and Checkout. This element will be used for integration, assembly, test and checkout of A/V, Payloads, and Ground Segment to form the UAV system as a whole.

Includes, for example:
a. All efforts as identified in Appendix I: Common Elements, Work Breakdown Structure and Definitions , to provide the integration, assembly, test, and checkout of all elements to form the UAV system as a whole
b. All administrative and technical engineering labor to perform integration of A/V, Payloads and Ground Segment (Level 2 elements); development of engineering layouts;

determination of overall design characteristics, and determination of requirements of design review

1. Overall design and producibility engineering
2. Detailed production design; acoustic and noise analysis
3. Loads analysis; stress analysis on interfacing ground segment elements and all subsystems
4. Design maintenance effort and development of functional test procedures
5. Coordination of engineering master drawings and consultation with test and manufacturing groups
6. Tooling planning, design, and fabrication of basic and rate tools and functional test equipments, as well as the maintenance of such equipment
7. Production scheduling and expediting
8. Joining or installation of structures such as racks, mounts, etc.
9. Installation of seats, wiring ducting, engines, and miscellaneous equipment and painting
10. Set up, conduct, and review of testing assembled components or subsystems prior to installation

c. All effort associated with the installation, integration, test, and checkout of the UAV system as a whole:
   1. Design of installation plans
   2. Quality assurance planning and control including material inspection
   3. Installation
   4. Recurring verification tests
   5. Integration with subsystems
d. Ground checkout prior to 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

Nonrecurring ground system integration which is associated with the individual ground equipment boxes and ground software in a functioning system.

Includes, for example:

a. The labor required to analyze, design, and develop ground interfaces and establish interface compatibility
b. Drawing preparation and establishment of ground interface equipment requirements and specifications
c. Technical liaison and coordination with the military service, subcontractors, associated contractors, and test groups

Excludes, for example:

a. Development, testing, and integration of software (which should be included in other Level 3 ground elements)
b. Ground system testing (included in System Test and Evaluation) and ground systems engineering efforts (included in Systems Engineering/Program Management).
c. All effort directly associated with the remaining Level 3 WBS elements

H.4.6 Common Elements. WBS Levels 2 and 3. Definitions for common WBS elements applicable to the aircraft as well as all other defense materiel items are in Appendix I: Common Elements, Work Breakdown Structure and Definitions.

APPENDIX I: COMMON ELEMENTS
WORK BREAKDOWN STRUCTURE AND DEFINITIONS

I.1 SCOPE

This appendix provides the WBS elements common to all types of systems. Applicable Government and non-Government documents are listed. Definitions for the common WBS elements are provided in this appendix. Unique uses of common elements are also included to better define the related systems.

Elements defined in this Appendix are elements common to all acquisition programs developed by the Department of Defense. The efforts associated with common elements should be placed at the level where they support a specific element. Common elements can be found at all levels of a WBS.

Using Appendix G Surface Vehicle System as an example, common elements found at Level 2 of the WBS capture efforts associated with the system as a "whole" (I.e. training for the entire surface vehicle system). Level 3 common elements will support Level 2 elements such as the primary vehicle or secondary vehicle. Level 4 common elements are not often shown however, they support the subsystems captured at Level 3 (i.e. training for the navigation system),

I.2 APPLICABLE DOCUMENTS

None

I.3 DEFINITIONS

I.3.1 Integration, Assembly, Test and Checkout. In those instances in which an integration, assembly, test, and checkout element is used (Appendices A through H), this element 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. (Reference Section I.4.1 for space systems application)

Includes, for example:

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 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 loading and verification of firmware)
k. Conduct of production acceptance testing

Excludes, for example:

a. All systems engineering/program management and system test and evaluation which are associated with the overall system

NOTE: 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) WBS element and should never be summarized directly into a Level 3 integration, assembly, test, and checkout element.

I.3.2. Systems Engineering and Program Management. These elements are defined as the systems engineering and technical control as well as the business management of particular systems and programs. Systems engineering and program management elements can be reported together or separately and their levels will be specified by the requiring activity. This allows the program manager and contractor flexibility to identify efforts that are important to the specific program. For example, a need may exist to uniquely track systems engineering from program management therefore the WBS may require to separate these elements rather than combined as

currently defined. The definitions in Appendix I illustrate typical systems engineering and program management efforts. (Reference Section I.4.1 for space systems application)

Includes, for example:

a. 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 e.g., maintenance support, facilities, personnel, training, testing, and activation of a system

Excludes, for example:

a. Systems engineering and program management efforts that can be associated specifically with the equipment (hardware/software) element

I.3.2.1 Systems Engineering. The technical and management efforts of directing and controlling a totally integrated engineering effort of a system or program.

Includes, for example:

a. 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
b. Effort associated with developing the Systems Engineering Plan (SEP)
c. Effort to transform an operational need or statement of deficiency into a description of system requirements and a preferred system configuration
d. Technical planning and control effort for planning, monitoring, measuring, evaluating, directing, and re-planning the management of the technical program
e. All programs, where applicable; value engineering, configuration management, Human Systems Integration (Human factors engineering; Personnel; Habitability; Manpower; Training; Environment, Safety and Occupational Health; Survivability), vulnerability, maintainability, reliability, standardization, system analysis, logistic support analysis, etc.
f. Technical baseline management and event based technical reviews with independent subject matter expertise participation
g. Cross product IPT integration
h. Survivability/vulnerability analysis
i. For sea systems; the extended Ship Work Breakdown Structure (ESWBS), configuration management (812 and 813), human factors (892), standardization (893), value engineering (894), and reliability and maintainability (895) elements

Excludes, for example:

a. Actual design engineering and the production engineering directly related to the WBS element with which it is associated

Examples of Systems Engineering efforts are:

a. 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.

b. Preparation of the Systems Engineering Plan (SEP), 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.
c. Reliability engineering—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.
d. Maintainability engineering—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.
e. Human Systems Integration—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.
f. Supportability analyses—an integral part of the systems engineering process beginning at program initiation and continuing throughout program development. Supportability analyses form the basis for related design requirements included in the system specification and for subsequent decisions concerning how to most cost effectively support the system and its infrastructure over its entire life cycle.
g. System of Systems (SoS) and System Level Architecting, modeling and simulation, verification and validation and external interface definition and management.

I.3.2.2 Program Management. 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.

Includes, for example:

a. Cost, schedule, performance measurement management, warranty administration, contract management, data management, vendor liaison, subcontract management, etc.
b. Support element management, defined as the logistics tasks management effort and technical control, and the business management of the support elements. The logistics management function encompasses the support evaluation and supportability assurance required to produce an affordable and supportable defense materiel system
c. Planning and management of all the functions of logistics. Examples are,
    1. Maintenance support planning and support facilities planning; other support requirements determination; support equipment; supply support; packaging, handling, storage, and transportation; provisioning requirements determination and planning; training system requirements determination; computer resource determination; organizational, intermediate, and depot maintenance determination management; and data management

d. For sea systems; the Extended Ship Work Breakdown Structure (ESWBS), project management (897); data management (896); and supply support (8643) elements.

I.3.3 System Test and Evaluation. 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. 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.

Includes, for example:

a. Detailed planning, conduct, support, data reduction and reports (excluding the contract data requirements list data) from such testing, and all hardware/software items which are consumed or planned to be consumed in the conduct of such testing

NOTE: Test articles which are complete units (i.e., functionally configured as required by specifications) are excluded from this WBS element.

Excludes, for example:

a. All formal and informal testing up through the subsystem level which can be associated with the hardware/software element acceptance testing

NOTE: These excluded efforts are to be included with the appropriate hardware or software elements.

I.3.3.1 Development Test and Evaluation. This effort is planned, conducted and monitored by the developing agency of the DoD component. It includes 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
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.).

Includes, for example:

a. All contractor in-house effort
b. All programs, where applicable; 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, 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

c. For aircraft; avionics integration test composed of the following:
    1. 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
    2. 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
    3. 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
    4. 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
    5. Software, referring to the effort required to design, code, de-bug, and document software programs necessary to direct the avionics integration test
d. For engines; engine military qualification tests and engine preliminary flight rating tests
e. For sea systems; 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 (868); and hull vibration survey (868 9825) elements

I.3.3.2 Operational Test and Evaluation. The 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, inter-operability, reliability, maintainability, logistic requirements, etc.), cost of ownership, and need for any modifications.

Includes, for example:

a. Initial operational test and evaluation conducted during the development of a weapon system
b. Such tests as system demonstration, flight tests, sea trials, mobility demonstrations, on-orbit tests, spin demonstration, stability tests, qualification operational test and evaluation, etc., and support thereto, required to prove the operational capability of the deliverable system
c. Contractor support (e.g., technical assistance, maintenance, labor, material, etc.) consumed during this phase of testing
d. 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)

I.3.3.3 Mock-ups/System Integration Labs (SILs). 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.

SILs are often used in lieu of (or in addition to) mock-ups. SILs are risk reduction facilities where software and hardware can be developed, integrated, tested and evaluated for both stand alone functionality and/or interoperability prior to being fielded.

I.3.3.4 Test and Evaluation Support. The support elements necessary to operate and maintain, during test and evaluation, systems and subsystems which are not consumed during the testing phase and are not allocated to a specific phase of testing.

Includes, for example:
a. 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

Excludes, for example:
a. 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 be included under that element of testing

I.3.3.5 Test Facilities. The special test facilities required for performance of the various developmental tests necessary to prove the design and reliability of the system or subsystem.

Includes, for example:
a. Test tank test fixtures, propulsion test fixtures, white rooms, test chambers

Excludes, for example:
a. Brick and mortar-type facilities identified as industrial facilities

I.3.4 Training. Deliverable training services, devices, accessories, aids, equipment, and parts used to facilitate instruction through which personnel will learn to operate and maintain the system with maximum efficiency.

Includes:
a. All effort associated with the design, development, and production of deliverable training equipment and its associated software as well as the execution of training services

Excludes:
a. Overall planning, management, and task analysis function inherent in the WBS element systems engineering/program management

I.3.4.1 Equipment. Distinctive deliverable end items of training equipment, assigned by either a contractor or military service, required to meet specific training objectives.

Includes, for example:
a. Operational trainers, maintenance trainers, and other items such as cutaways, mock-ups, and models

I.3.4.2 Services. Deliverable services, accessories, and aids necessary to accomplish the objectives of training.

Includes:
a. Training course materials; contractor-conducted training (in-plant and service training); and the materials and curriculum required to design, execute, and produce a contractor developed training program
b. Materiel, courses, and associated documentation (primarily the computer software, courses and training aids)

Excludes:
a. Deliverable training data associated with the WBS element support data

I.3.4.3 Facilities. The special construction necessary to accomplish training objectives.

Includes, for example:
a. Modification or rehabilitation of existing facilities used to accomplish training objectives

Excludes:
a. Installed equipment used to acquaint the trainee with the system or establish trainee proficiency
b. The brick and mortar-type facilities identified as industrial facilities

I.3.5 Data. The deliverable data required to be listed on a contract data requirements list, DD Form 1423.

Includes:
a. Only such effort that can be reduced or avoided if the data item is eliminated
b. Government-peculiar data; acquiring, writing, assembling, reproducing, packaging and shipping the data
c. Transforming into Government format, reproducing and shipping data identical to that used by the contractor but in a different format

I.3.5.1 Technical Publications. Technical data, providing instructions for installation, operation, maintenance, training, and support, formatted into a technical manual. 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.

Includes, for example:
a. Operation and maintenance instructions, parts lists or parts breakdown, and related technical information or procedures exclusive of administrative procedures
b. Data item descriptions set forth in categories selected from the Acquisition Management Systems and Data Requirements Control List (DoD 5010.12-L)
c. For sea systems: Extended Ship Work Breakdown Structure (ESWBS), technical manuals and other data (856) element

I.3.5.2 Engineering Data. Recorded scientific or technical information (regardless of the form or method of recording) including computer software documentation. Engineering data defines and documents an engineering design or product configuration (sufficient to allow duplication of the original items) and is used to support production, engineering and logistics activities.

Includes, for example:
a. 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
b. Technical data package (reprocurement package) which includes all engineering drawings, associated lists, process descriptions, and other documents defining physical geometry, material composition, and performance procedures
c. For sea systems; Extended Ship Work Breakdown Structure (ESWBS), design support, ship's selected records (8302); design support, services, reproduction (8303); and engineering drawings and specifications (855) elements

Excludes:
a. Computer software or financial, administrative, cost or pricing, or management data or other information incidental to contract administration

I.3.5.3 Management Data. The data items necessary for configuration management, cost, schedule, contractual data management, program management, etc., required by the Government.

Includes, for example:
a. Contractor cost reports, cost performance reports, contract funds status reports, schedules, milestones, networks, integrated support plans
b. For sea systems; Extended Ship Work Breakdown Structure (ESWBS), contract data requirements (988) element

I.3.5.4 Support Data. The data items designed to document support planning in accordance with functional categories

Includes, for example:
a. Supply; general maintenance plans and reports; training data; transportation, handling, storage, and 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.

I.3.5.5 Data Depository. The facility designated to act as custodian to maintain a master engineering specification and establish a drawing depository service for Government approved documents that are the property of the U.S. Government. As custodian for the Government, the depository, authorized by approved change orders, maintains these master documents at the latest approved revision level. This facility is a distinct entity.

Includes, for example:
a. All drafting and clerical effort necessary to maintain documents

Excludes, for example:
a. All similar effort for facility's specification and drawing control system, in support of its engineering and production activities.

NOTE: 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.

I.3.6 Peculiar Support Equipment. 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 the system is not directly engaged in the performance of its mission, and which are not common support equipment (See I.3.7 below).

Includes:
a. Vehicles, equipment, tools, etc., used to fuel, service, transport, hoist, repair, overhaul, assemble, disassemble, test, inspect, or otherwise maintain mission equipment
b. 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.)
c. Any additional equipment or software required to maintain or modify the software portions of the system

Excludes:
a. Overall planning, management and task analysis functions inherent in the work breakdown structure element, systems Engineering/Program Management
b. Common support equipment, presently in the DoD inventory or commercially available, bought by the using command, not by the acquiring command

I.3.6.1 Test and Measurement Equipment. The 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.

Includes, for example:

a. 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, taps, and related software, firmware and support hardware (power supply equipment, etc.) used at all levels of maintenance
b. Packages which enable line or shop replaceable units, printed circuit boards, or similar items to be diagnosed using automatic test equipment

I.3.6.2 Support and Handling Equipment. The deliverable tools and handling equipment used for support of the mission system.

Includes, for example:

a. Ground support equipment, vehicular support equipment, powered support equipment, non-powered support equipment, munitions material handling equipment, materiel handling equipment, and software support equipment (hardware and software)

I.3.7 Common Support Equipment. The 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.

Includes:

a. Acquisition of additional quantities of this equipment needed to support the item
b. All efforts required to assure the availability of this equipment to support the item

I.3.7.1 Test and Measurement Equipment. The 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.

Includes, for example:

a. 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, taps, and related software, firmware and support hardware (power supply equipment, etc.) used at all levels of maintenance

b. Packages which enable line or shop replaceable units, printed circuit boards, or similar items to be diagnosed using automatic test equipment

I.3.7.2 Support and Handling Equipment. The deliverable tools and handling equipment used for support of the mission system.

Includes, for example:
a. Ground support equipment, vehicular support equipment, powered support equipment, non-powered support equipment, munitions material handling equipment, materiel handling equipment, and software support equipment (hardware/software)

I.3.8 Operational/Site Activation. 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.

Includes:
a. Conversion of site, ship, or vehicle
b. System assembly, checkout, and installation (of mission and support equipment) into site facility or ship to achieve operational status
c. Contractor support in relation to operational/site activation

I.3.8.1 System Assembly, Installation, and Checkout on Site. The materials and services involved in the assembly of mission equipment at the site.

Includes, for example:
a. Installation of mission and support equipment in the operations or support facilities and complete system checkout or shakedown to ensure operational status. Where appropriate, specify by site, ship or vehicle.

I.3.8.2 Contractor Technical Support. The materials and services provided by the contractor related to activation.

Includes, for example:
a. Repair of reparables, standby services, final turnover

I.3.8.3 Site Construction. Real estate, site planning and preparation, construction, and other special-purpose facilities necessary to achieve system operational status.

Includes, for example:
a. Construction of utilities, roads, and interconnecting cabling

I.3.8.4 Site/Ship/Vehicle Conversion. The materials and services required to convert existing sites, ships, or vehicles to accommodate the mission equipment and selected support equipment directly related to the specific system.

Includes, for example:
a. Operations, support, and other special purpose facilities conversion necessary to achieve system operational status, e.g., launch. Where appropriate, specify by site, ship or vehicle

I.3.9 Industrial Facilities. The construction, conversion, or expansion of industrial facilities for production, inventory, and contractor depot maintenance required when that service is for the specific system.

Includes, for example:
a. Equipment acquisition or modernization, where applicable
b. Maintenance of these facilities or equipment
c. Industrial facilities for hazardous waste management to satisfy environmental standards

Excludes, for example:
a. Capital Equipment

I.3.9.1 Construction/Conversion/Expansion. The real estate and preparation of system peculiar industrial facilities for production, inventory, depot maintenance, and other related activities.

I.3.9.2 Equipment Acquisition or Modernization. The production equipment acquisition, modernization, or transferal of equipment for the particular system. This pertains to Government owned and leased equipment under facilities contract.

I.3.9.3 Maintenance (Industrial Facilities). The maintenance, preservation, and repair of industrial facilities and equipment.

I.3.10 Initial Spares and Repair Parts. The deliverable spare components, assemblies and subassemblies used for initial replacement purposes in the materiel system equipment end item.

Includes, for example:
a. Repairable spares (reparables) 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

Excludes, for example:

a. Development test spares and spares provided specifically for use during installation, assembly, and checkout on site. Lower level WBS breakouts should be by subsystem

I.4 Unique Commodity Applications. Many of the commodity classes apply common elements in a way that is unique to their programs.

I.4.1 Space Systems. The Space community must report, at a minimum, the common elements of systems engineering, integration and test and program management (SEIT/PM).

Systems engineering (SE) refers to the resources associated with all engineering including functional specialists who provide technical planning, technical management, analysis, and support efforts for development and production activities. It includes: systems engineering, safety, quality assurance, reliability, availability, maintainability, and human engineering. SE is responsible for the analysis, derivation, allocation, and traceability of requirements and interfaces. This effort includes: establishing requirement, interfaces, analysis, models and simulations, quality, configuration control, performance assessments, and managing design, development, production and integration.

Integration and test (IT) includes the resources necessary to: integrate, perform integration and test management; requirements definitions, planning and scheduling, development of test plans and procedures, test preparations and conduct, development of software for supporting integration and test and review, analysis and documentation of test results.

Program management (PM) includes the resources necessary to manage, direct and control all effort contributing to the development, production of custom and commercial off-the-shelf (COTS) procurements and integration. It includes administration, project controls, product effectiveness, data and configuration management, subcontract management and security management.

CONCLUDING MATERIAL

Custodians:
Army – MI
Navy-NW
Air Force – 10

Preparing Activity
OSD-WB

(Project No. MISC-0285)

Review Activities:
Army-AR, AT, AV, CR
Navy-AS, MC, OS, SH
Air Force-11, 16, 19, 70, 71, 84

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil