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WORK BREAKDOWN STRUCTURES FOR DEFENCE MATERIEL PROJECTS

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AUSTRALIAN DEFENCE STANDARD

DEF(AUST)5664

WORK BREAKDOWN STRUCTURES FOR DEFENCE MATERIEL PROJECTS

APRIL 2004

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1. DEF(AUST) 5664 (this Standard) presents Requirements, Recommended Practices and guidance for the development of Work Breakdown Structures (WBS) for Defence Materiel projects.

2. The application of this Standard is intended to achieve a consistent approach to WBSs throughout the Australian Defence Organisation (ADO) and Defence Industry.

3. This Standard details the requirement for a WBS for a specified body of work on materiel, including new development and modifications to existing equipment.

4. This Standard details the requirement for a WBS for use by the ADO and by an ADO contractor or subcontractor.

5. This Standard is mandatory for ADO staff conducting Strategic and Complex Materiel acquisitions, and must be specified in all contracts where Earned Value Management (EVM) or design and development (or both) are requirements under a contract. This Standard is not applicable for (and, therefore, not mandatory for) contracts for off-the-shelf items (although it is mandatory where integration of off-the-shelf items is required).

6. This Standard has been developed to be recursive, in that ADO contractors must specify this Standard in their subcontracts where Earned Value Management (EVM) or design and development (or both) are requirements under those subcontracts.

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B. Definitions of Standard Work Breakdown Structure Elements (Informative)
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1. INTRODUCTION

1.1 PURPOSE

1.1.1 The purpose of this Standard is to define Requirements, Recommended Practices and guidance for the development of Work Breakdown Structures (WBS) for both Acquirer and Supplier organisations. The application of these Requirements, Recommended Practices and guidance should assist both the Australian Defence Organisation (ADO) and Defence Industry to prepare their WBSs in a consistent manner and to achieve integrated technical, cost and schedule control. This Standard provides a reference against which the ADO can:

a. develop and evaluate its internal project WBSs; and

b. evaluate a contractor's WBS for risk and effectiveness.

1.1.2 WBSs, which have been developed in accordance with this Standard, provide the basis for communication and shared understanding throughout the development and acquisition processes. The WBS is the common link that unifies the planning, scheduling, cost-estimating, budgeting, contracting, technical, configuration-management, and performance-reporting disciplines. Through consistent communications, it permits the ADO and industry managers to evaluate progress in terms of contract performance.

1.1.3 If the WBS process described is rigorously applied, then there should be:

a. a clean structure for the organisation and management of the project;

b. clear accountabilities for project outcomes; and

c. little chance of work elements being missed.

1.2 OVERVIEW AND BACKGROUND

1.2.1 The WBS is the cornerstone of a project and provides the basis for technical, cost and schedule control. As stated in the Project Management Institute (PMI) Practice Standard for Work Breakdown Structures, "[the WBS] provides the foundation for defining work as it relates to project objectives and establishes the structure for managing the work to its completion"[1]. The purpose of the WBS is to divide a project into manageable pieces of work to facilitate planning and control of cost, schedule and technical content. ADO major and minor capital acquisition activities are considered to be projects; hence, the PMI concepts are equally applicable to the ADO and its contractors. Nevertheless, the PMI standard is not sufficient for defining a WBS for use by the ADO because it has been developed as a generic Project Management (PM) standard. In the ADO, the Systems Engineering (SE) principles and practices place an additional set of requirements for WBSs over the standard PM practices because of the complexity of ADO systems and because of the design-and-development requirements typically associated with the acquisition of these systems. These additional requirements relate to technical control, and the need to integrate technical control with cost and schedule control.

1.2.2 The requirement to establish and maintain tight technical control is the main reason for the development of this revision of the Standard. The need to address technical control arises from the recognition that the WBS for Materiel Systems requiring design and development is fundamentally driven by the SE process. Technical control addresses both the requirements and the solution for the system-of-interest to ensure that sound practices are applied throughout the design-and-development process. Technical control is defined as "maintaining control over the requirements and the developing solution, so that the delivered system meets customer requirements". The concepts underpinning technical control, as defined in this Standard, have applicability irrespective of which acquisition approach (e.g. once-through, incremental or evolutionary) or which developmental approach (e.g. waterfall, incremental, evolutionary, spiral or object-oriented) is employed.

1.2.3 The emphasis on technical control has resulted in this Standard being developed to be consistent with the main SE and related commercial standards. Where applicable, linkages to the following standards are identified:

a. ANSI/EIA-632-1998, "Processes for Engineering a System";

b. AS/NZS 15288:2003 (ISO/IEC 15288:2002), "Systems engineering–system life cycle processes"; and

c. ISO/IEC 12207:1995/Amd.1:2002(E), "Information technology–software life cycle processes".

[1] Project Management Institute Practice Standard for Work Breakdown Structures, Project Management Institute, Newtown Square, Pennsylvania, USA, 2001, page 1.

1.2.4 This Standard also provides the Requirements, Recommended Practices and guidance for integrating cost and schedule control with technical control. In particular, the related requirements in AS 4817–2003, "Project performance measurement using Earned Value", including the "DMO Supplement to AS 4817–2003" are referenced and the applicable linkages are identified.

1.2.5 This Standard has been developed to be consistent with the following Australian Defence Contracting (ASDEFCON) Request For Tender (RFT) templates:

a. ASDEFCON (Strategic Materiel); and

b. ASDEFCON (Complex Materiel) Volume 2.

This Standard is not applicable to ASDEFCON (Complex Materiel) Volume 1 because that template is only used for off-the-shelf acquisitions. This Standard is also not applicable to ASDEFCON (Support), except where design-and-development work is likely to be conducted under an in-service support contract developed from that template.

1.2.6 In the main, this Standard is based on US DoD MIL-HDBK-881, 'Work Breakdown Structure', dated 2 January 1998, and uses the definitions and material from that handbook where possible. This approach reflects an agreement between the ADO and Defence Industry reached during the development of ASDEFCON (Strategic Materiel) to employ a common lexicon and, therefore, to provide a common basis for communications.

1.2.7 MIL-HDBK-881 is based on the US DoD acquisition, approval and funding processes, which are different from those of the ADO. This fact will inevitably lead to differences between this Standard and the US handbook; however, the fundamental principles are essentially the same. The major area of difference is in the various WBS templates (e.g. the ADO acquisition processes call for both a 'Mission System' and a 'Support System', and clearly treats Integrated Logistic Support (ILS) differently from the US DoD). Other areas of difference are identified throughout this Standard.

1.2.8 This introduction has identified a number of the interactions between the WBS and other elements and functional areas of an acquisition-based project. Annex C provides a more definitive overview of these interactions.

1.3 INTERPRETATION

1.3.1 This Standard defines Requirements, Recommended Practices and guidance for the development of WBSs. Requirements include the word '*shall*' and are mandatory provisions. Recommended Practices include the word '*should*', which indicates that there is discretion in their application. Nevertheless, Acquirers and Suppliers must be able to demonstrate that their WBSs accord with these Recommended Practices to the extent practicable and, therefore, the Recommended Practices are considered to be 'best endeavour' provisions. The word '*may*' identifies permissive provisions.

2. DEFINITIONS AND ACRONYMS (NORMATIVE)

2.1 DEFINITIONS

2.1.1 Defined terms are capitalised throughout this Standard to highlight that a particular meaning is intended. Lower-case use of the same terms means that the normal dictionary definition applies. For the purposes of this Standard, the following definitions are applicable:

Term	Definition
Acquirer	The stakeholder that acquires or procures a Product from a Supplier. *Note: Other terms commonly used for an acquirer are buyer, customer, and purchaser. The acquirer may at the same time be the owner, user or operating organisation.* *Note: The definition of Product includes Deliverable Services.* *Note: Internally within the ADO, Capability Development Group is the Acquirer, while the Defence Materiel Organisation is the Supplier.* [Reference: AS/NZS 15288:2003 (ISO/IEC 15288:2002).]
Component Product	An element in the structured decomposition of a system (e.g. Mission System or Support System) that forms a part of the system. Excluded are Enabling Products and Enabling Services. A Component Product is a subcategory of Product. *Note: Examples include the system, subsystems, configuration items, components, units and software items.* *Note: At the top level of the Product Breakdown Structure (PBS), the Mission System is a Component Product; however, the same is not true of the Support System.* *Note: A Component Product is the equivalent of a 'building block' internal to the 'end product' under ANSI/EIA-632-1998.*
Configuration Item	An aggregation of hardware or software that satisfies an end-use function and is designated for separate configuration management.
Contract Work Breakdown Structure	The complete WBS for a contract, which includes the ADO-approved WBS for reporting contract performance and the discretionary extension to the lower levels by the contractor, in accordance with this Standard and the contract Statement of Work (SOW). It also includes all the elements for the Products that are the responsibility of the contractor.
Contract Summary Work Breakdown Structure	A structure that encompasses an entire contract at summary level. It typically comprises 2 or 3 levels.
Deliverable Service	Any service that is, or will be, delivered to the Acquirer by the Supplier. *Note: Examples include advice, training, maintenance, engineering and supply.*
Enabling Product	Any artefact of an Enabling Service that does not form a part of the end Products that must be delivered to achieve project success, such as the Mission System and the Support System. An Enabling Product is a subcategory of Product. *Note: Examples include a software development environment, test jigs, and data such as plans, reports, specifications, and drawings.* *Note: An Enabling Product generated as part of the design and development of the Mission System could subsequently become a Component Product of the Support System (e.g. technical data, such as engineering drawings and specifications for Component Products).*

Term	Definition
Enabling Service	Functional activities and processes required to produce and, if applicable, deliver Products, as authorised by the agreement between the Acquirer and the Supplier, but are themselves not directly delivered to the Acquirer. *Note: Examples include functional domains, such as SE, PM, and ILS, as well as processes within these functional domains, such as planning, performance measurement, requirements validation, design engineering, integration and test, configuration audits, logistic support analysis and spares optimisation.* *Note: Internally within the ADO, Capability Development Group is the Acquirer, while the Defence Materiel Organisation is the Supplier.*
Materiel System	The Materiel System is the combination of the Mission System and the Support System.
Mission System	The element of the Materiel System that directly performs the operational functions. *Note: Examples include platforms (eg ship, tank, or aircraft), distributed systems (eg communications network), and discrete systems that integrate into other Mission Systems (eg a radar upgrade for a platform).* *Note: Major components of the Support System (such as simulators, Automatic Test Equipment (ATE) and Logistic Information Management Systems (LIMS)) could also be classified as Mission Systems if the level of management attention to be applied to these components warranted this classification.* *Note: The Mission System is the equivalent of the 'system-of-interest' under AS/NZS 15288:2003 (ISO/IEC 15288:2002), the 'end product' under ANSI/EIA-632-1998, and the 'Prime Mission Product (PMP)' under MIL-HDBK-881.*
Product	Any measurable, tangible, verifiable outcome, result, item or Deliverable Service, which must be produced or delivered (or both) to complete a project or part of a project. Products include Component Products. Products are expressed as nouns. *Note: Examples include Component Products of the Mission System and Support System; Enabling Products such as plans, reports and process artefacts; and Deliverable Services such as training and maintenance.* [Reference: Adapted from PMBOK® Guide – 2000 Edition and AS/NZS ISO 9000:2000]
Product Breakdown Structure	The hierarchical breakdown of a system (e.g. Mission System or Support System) into its Component Products.
Project WBS	A structure that defines the WBS for an entire project down to the lowest level necessary for effective definition and management of the project.
Supplier	An organisation or an individual that enters into an agreement with the Acquirer for the supply of a Product. *Note: A Supplier can be either external or internal to an organisation.* *Note: The definition of Product includes Deliverable Services.* [Reference: AS/NZS 15288:2003 (ISO/IEC 15288:2002).]

Term	Definition
Support System	The organisation of hardware, software, materiel, facilities, personnel, data, processes, and services required to enable the Mission System to be effectively operated and supported so that the Mission System can meet its operational requirements. The Support System includes the support required for the Component Products of the Support System. The Support System embraces the support responsibilities undertaken by the ADO, in-service support contractors and in-service support subcontractors. *Note: The Support System is the equivalent of one of the enabling systems called the 'Support System' under AS/NZS 15288:2003 (ISO/IEC 15288:2002) and is the system construct required to define the 'enabling products' for support under ANSI/EIA-632-1998.*
Validation	Confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled. [Reference: AS/NZS ISO 9000:2000]
Verification	Confirmation, through the provision of objective evidence, that specified requirements have been met. [Reference: AS/NZS ISO 9000:2000]
Work Breakdown Structure or WBS	A Product-oriented family tree, which is used to plan the development and production of a Materiel System. A WBS defines and structures all of the Product(s) to be developed, produced and, if applicable, delivered, and relates the elements of work to be accomplished to each other and to the overall project objectives.
WBS Dictionary	The collection of supporting information that defines each WBS Element, including scope, activities, Products, specifications, entry and exit criteria, etc. *Note: The WBS Dictionary definition is effectively the SOW for each WBS Element – refer Section 3.2.* [Reference: Adapted from PMI Practice Standard for Work Breakdown Structures]
WBS Element	A discrete portion of a WBS at any level of the WBS. It may be an identifiable item of hardware, software, services, data or facilities. *Note: Products and Enabling Services are the two major categories of WBS Elements.*

2.2 ACRONYMS

2.2.1 For the purposes of this Standard, the following acronyms apply:

Acronym	Description
ADO	Australian Defence Organisation
ASDEFCON	Australian Defence Contracting
CDRL	Contract Data Requirements List
CAM	Control Account Manager
CDG	Capability Development Group
CI	Configuration Item
CM	Configuration Management
CMP	Configuration Management Plan
CSWBS	Contract Summary Work Breakdown Structure
CWBS	Contract Work Breakdown Structure

Acronym	Description
DID	Data Item Description
DMO	Defence Materiel Organisation
DoD	Department of Defense
EA	Evolutionary Acquisition
EVM	Earned Value Management
EVMS	Earned Value Management System
GFE	Government Furnished Equipment
GFM	Government Furnished Material
IBR	Integrated Baseline Review
ILS	Integrated Logistic Support
IPT	Integrated Product Team
LOE	Level Of Effort
LSA	Logistic Support Analysis
NRE	Non-Recurring Engineering
PBS	Product Breakdown Structure
PM	Project Management
PMI	Project Management Institute
PMP	Project Management Plan
PSI	Prime System Integrator
PWBS	Project Work Breakdown Structure
QMS	Quality Management System
RFT	Request For Tender
SBS	System Breakdown Structure
SE	Systems Engineering
SEMP	Systems Engineering Management Plan
SOW	Statement of Work
US	United States
WBS	Work Breakdown Structure

2.3 A NOTE ON TERMINOLOGY

2.3.1 This Standard has adopted slightly different terminology from MIL-HDBK-881 to better align with current process-based standards. MIL-HDBK-881 uses the terms 'products' and 'services', which are only defined through example. Current process-based standards (such as the AS/NZS ISO 9000:2000 suite of standards) include delivered services (e.g. training) as a type of product[2], while MIL-HDBK-881 amalgamates delivered services with enabling services (where enabling services can be defined as those services, such as PM, SE, and ILS, required to develop products and to manage the development of the products). Note that the Capability Maturity Model Integrated (CMMI)® adopts a similar approach to AS/NZS ISO 9000:2000. To maximise alignment with both MIL-HDBK-881 and the current process-based standards, this Standard uses the terms 'Deliverable Service' (as a type of 'Product') and 'Enabling Service' (refer to the Definitions for all three terms). The combination of Deliverable Service and Enabling Service is equivalent to the term 'service' as used in MIL-HDBK-881; however, this combination is not used in this Standard. This approach is not considered to detract significantly from alignment with MIL-HDBK-881, while providing the benefit of alignment with current standards.

[2] Refer to the definition of 'product' in AS/NZS ISO 9000:2000, pp 10-11.

2.3.2 The PMI Practice Standard for Work Breakdown Structures uses the term ‘deliverable’ instead of ‘product’ (e.g. the definition of WBS in that standard is “a deliverable-oriented grouping of project elements […]”). Once again, for alignment with MIL-HDBK-881, this Standard has adopted the term ‘product’. The terms ‘deliverable’ and ‘product’ are considered to be identical for all intents and purposes; hence, alignment has also been achieved between this Standard and the PMI Practice Standard. Note, however, that for reasons such as technical control, this Standard is more definitive than the PMI Practice Standard.

2.3.3 This Standard does not use the term ‘System Breakdown Structure or SBS’ from IEEE Std 1220-1998, “IEEE Standard for Application and Management of the Systems Engineering Process”, due to difficulties with possible multiple meanings. The term ‘SBS’, as used in the IEEE standard, is understood to be equivalent to the term ‘WBS’, as used in this DEF(AUST); however, ‘SBS’ is sometimes interpreted to mean the system breakdown of the system-of-interest. In this Standard, the term ‘Product Breakdown Structure or PBS’ is used to provide the latter meaning.

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3. GENERAL REQUIREMENTS

3.1 STRUCTURE

Requirement 1: The WBS **shall** satisfy the following conditions:	
Integrated –	A single top WBS Element covers the total body of work.
Distinct –	Every WBS Element is a distinct Product or Enabling Service, which is mutually exclusive from other Products and Enabling Services.
Children –	Every WBS Element has either no children, or multiple children.
Descendant –	Every child WBS Element has only one parent and is a descendant of the top WBS Element.
Necessary –	Every child WBS Element is needed to deliver the parent.
Sufficient –	If all child WBS Elements are complete, their parent is complete.
Complete –	The complete scope of work is captured in the WBS.

3.1.1 Requirement 1 defines the nature of the WBS, particularly the conditions underpinning the hierarchical structure and the decomposition of the WBS into lower-level WBS Elements. Essentially, WBS Elements need to be decomposed to the level of detail necessary to plan and manage the work to satisfy the project objectives, which can be restated as a Recommended Practice, as follows:

Recommended Practice 1: The WBS **should** be decomposed to the level necessary to plan and manage the work to satisfy the project objectives.

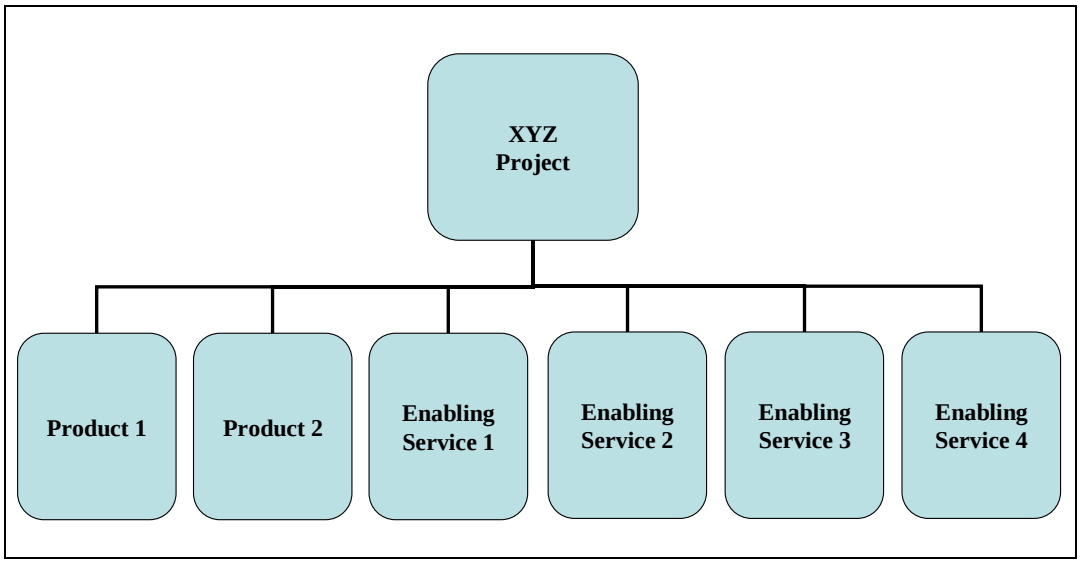

Figure 1 - Example Work Breakdown Structure

3.1.2 Figure 1 provides an example of a WBS, highlighting the decomposition of the highest-level WBS Element (i.e. the project, contract or Materiel System) into lower-level Products (e.g. Mission System and Support System) and Enabling Services (e.g. V&V, PM, SE and ILS). Note the convention of having the Products on

the left-hand side of the WBS and the Enabling Services following the Products[3]. At each subsequent level of the WBS, the Products will decompose into lower-level Products and Enabling Services, as will the Enabling Services (e.g. a Product under PM could be the Project Management Plan). Note that, in accordance with the definitions used in this Standard, a lower-level Product of an Enabling Service is termed an Enabling Product. The rationale for this approach to decomposition is explained later in this Standard.

3.1.3 The application of the different terminology used throughout this Standard is illustrated in Figure 2.

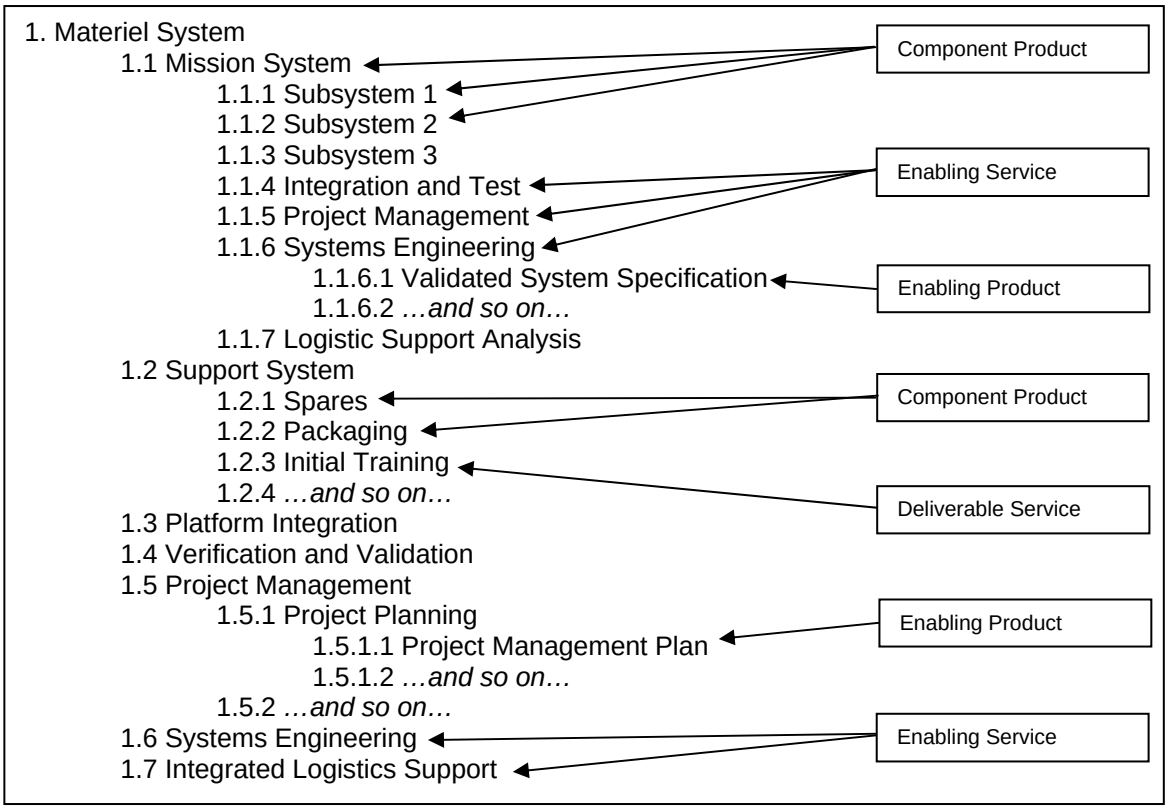

Figure 2 - Application of Terminology

3.1.4 The conditions stated in Requirement 1 are consistent with the Earned Value Management (EVM) requirements and guidance defined under Step 1 (Decompose the Project Scope) in AS 4817–2003, "Project performance measurement using Earned Value".

3.2 WORK BREAKDOWN STRUCTURE DICTIONARY

Requirement 2: Each WBS Element **shall** have a corresponding WBS Dictionary definition that clearly describes the WBS Element down to a level of detail sufficient to support the management and ultimate acceptance of the WBS Element. The following information **shall** be included in the WBS Dictionary for each WBS Element:

a. project title;

b. WBS Element identifier, which may be numeric or alphanumeric;

c. WBS Element title;

d. a description of the scope of the Product or Enabling Service, including a Statement of Work (SOW) and, if a Product, a reference to the applicable specification (e.g. title and number);

[3] A further convention is to differentiate recurring Enabling Services (such as integration and test) from non-recurring Enabling Services, with the recurring Enabling Services positioned to the left of the non-recurring Enabling Services. This approach facilitates common WBS Element numbering in projects having multiple ship-sets of major Component Products, such as ships.

e. additional information required by the EVM System (EVMS) if an EVMS is required; and

f. any other information to ensure that the work effort, responsibilities and accountabilities associated with the WBS Element are clear, complete, and understood by all parties.

3.2.1 Requirement 2 ensures that the scope of work for each WBS Element is clear and understood by all parties. For contracts, the requirements for the WBS Dictionary may be defined as part of the contract. Alternatively, it may be defined as part of the project-management system employed within an organisation (e.g. the EVMS).

Recommended Practice 2: The WBS Dictionary **should** also include the following information for each WBS Element, where the information is applicable:

a. reference to lower-level WBS Elements;

b. Contract reference;

c. entry and exit criteria, including acceptance requirements; and

d. performance measures.

3.2.2 In addition to the information defined under Requirement 2 and Recommended Practice 2, the WBS Dictionary may also include the basis of estimate for such aspects as resource requirements, schedule activity timeframes, and staff/skills profiles.

3.2.3 The initial WBS Dictionary will be based on the definitions provided in the project-management system or in a contract. The baseline definitions from ASDEFCON (Strategic Materiel) for each of the Level 2 WBS Elements used in a contract are provided at Annex B. For consistency, the same definitions for these WBS Elements are also used in this Standard. The WBS Dictionary definition is effectively the SOW for the applicable WBS Element and will be used initially for estimating purposes and ultimately for Verification that the work associated with that element is complete. The WBS Dictionary definition may refer to various contract SOW clauses rather than repeating information.

3.2.4 Note the inclusion of exit criteria and acceptance requirements in the WBS Dictionary. These aspects of the definition help to ensure that the completion requirements for a WBS Element are understood and that completion of a WBS Element is both measurable and verifiable by persons, such as management, the Acquirer, or quality assurance representatives, who are independent of those responsible for the WBS Element. The ability to Verify the completion of a WBS Element is one of the factors underpinning technical control, which is addressed under Section 6 of this Standard.

3.2.5 Generally, exit criteria for a WBS Element will form entry criteria for successor WBS Elements. For example, approval of a document, release of preliminary drawings, or satisfactory completion of a testing program could all be both exit criteria and entry criteria. These criteria, therefore, help with understanding the interrelationships between WBS Elements and provide valuable input to the subsequent development of the schedule.

3.2.6 The inclusion of performance measures in the WBS Dictionary addresses those information needs that are required to assess achievement and to identify problems and risks. Performance measures include such things as earned value techniques, practical systems and software measurement, and technical performance measures.

3.3 WORK BREAKDOWN STRUCTURE IDENTIFICATION SYSTEM

Requirement 3: The WBS **shall** employ an identification system that clearly defines the hierarchical relationships between WBS Elements.

3.3.1 Requirement 3 ensures that each WBS Element is coded with a unique WBS Element identifier, which may be numeric or alphanumeric, in such a way that the identifier allocated to a child WBS Element defines its relationship to its parent. Simple WBS identification schemes are preferred, and extraneous information needs to be avoided. An example WBS identification system is shown in Figure 3:

The Level 1 WBS Element has the WBS ID	1
The first WBS Element at Level 2 has the WBS ID	1.01
The first child WBS Element at Level 3 has the WBS ID	1.01.01
The second child WBS Element at Level 3 has the WBS ID	1.01.02
The second WBS Element at Level 2 has the WBS ID	1.02
The first child WBS Element at Level 3 has the WBS ID	1.02.01
The second child WBS Element at Level 3 has the WBS ID	1.02.02

Figure 3 - Example Work Breakdown Structure Identification System

3.3.2 It is good practice to leave unused identification 'numbers' between the different classes of WBS Elements (i.e. Products and Enabling Services) to allow the addition of further Products or Enabling Services as scope is varied, the design changes, or risk treatments need to be incorporated into the WBS.

3.4 WORK BREAKDOWN STRUCTURE TOOLS

Recommended Practice 3: The WBS **should** be prepared in a tool that enables the WBS to be contracted and expanded by WBS Element to facilitate review and to ascertain completeness.

3.4.1 ASDEFCON (Strategic Materiel), for example, requires a contractor to submit its WBS in a tool having an outline viewing mode, as it is extremely difficult to review a large WBS without the ability to contract and expand the levels of detail. Figure 4 shows a nine-page WBS contracted to level two, with the Mission System expanded to level three using Microsoft Word® Outline View:

1. Radio Frequency Surveillance System
    - 1.01 RF Surveillance Mission System
        - 1.01.01 Downconverter Subsystem
        - 1.01.02 Data Logger
        - 1.01.03 Operator Workstation
        - 1.01.04 RFS Mission System Integration and Test
        - 1.01.05 RFS Mission System Project Management
        - 1.01.06 RFS Mission System Systems Engineering
        - 1.01.07 RFS Mission System Logistic Support Analysis
    - 1.02 RF Surveillance Support System
    - 1.03 Platform Integration
    - 1.04 Verification and Validation
    - 1.05 Project Management
    - 1.06 Systems Engineering
    - 1.07 Integrated Logistics Support

Figure 4 - Facilitating the Evaluation of the Work Breakdown Structure

3.5 MAINTENANCE OF THE WORK BREAKDOWN STRUCTURE

3.5.1 The WBS and WBS Dictionary need to be updated on a routine basis over the life of the project to ensure that they remain current and to preserve the integrity of reporting and management.

Requirement 4: The WBS and WBS Dictionary **shall** be revised to incorporate changes and to reflect the current status of the project in accordance with the defined control mechanisms.

3.5.2 Any changes to the WBS would need to be subject to the defined control mechanisms to ensure that only valid and agreed changes are incorporated. These control mechanisms, including the timeframes and triggers for updating the WBS, would be defined in the Quality Management System (QMS), the contract, project plans, or some combination of these elements.

3.6 PRODUCT ORIENTATION

Requirement 5: The WBS **shall** be Product-oriented.

3.6.1 Requirement 5 may appear to be superfluous, given the definition of WBS provided in Section 2 and the generic illustration of a WBS in Figure 1. Nevertheless, there is sufficient evidence[4] to suggest that this Requirement requires further explanation and clarification to ensure that its meaning is understood in the context of this Standard. Additionally, the requirement to be Product-oriented underpins technical control, which is addressed in Section 6 of this Standard.

3.6.2 Requirement 5 stems from the understanding that the overall scope of a project or activity is defined by the Products that have to be delivered, either by the Supplier or the Acquirer. Delivery in this context also includes internal delivery between groups within either the Supplier's or Acquirer's organisations, generally in accordance with QMS requirements.

3.6.3 The situation where the Supplier is delivering Products to the Acquirer is reasonably straightforward because, in general, this will be the purpose of the agreement between the Acquirer and the Supplier (e.g. the Supplier may be delivering the Mission System, components of the Mission System, and/or components of the Support System). The reverse situation, however, where the Acquirer is delivering Products to Suppliers, requires some clarification. These Products include requirements to deliver Acquirer-provided material or to respond to Supplier-provided material. Examples of these Products from an ADO perspective include Government Furnished Material (GFM) and responses and formal comments to Supplier-provided data items. Note that, to properly capture the full scope of work, each Supplier's WBS needs to include those Products that arise when the Supplier is acting as an Acquirer.

3.6.4 Clearly, those Products that need to be delivered externally, either from the Supplier to the Acquirer or from the Acquirer to the Supplier, are fundamental in defining the work that needs to be performed (i.e. in determining the scope), which leads to the following additional Requirements:

Requirement 6: All Products that must be delivered to the Acquirer by the Supplier **shall** be identified in the Supplier's WBS.

Requirement 7: All Products that must be delivered to the Supplier by the Acquirer **shall** be identified in the Acquirer's WBS.

3.6.5 These two Requirements include those Products that are elements of higher-level Products that will ultimately be delivered (e.g. Component Products). These Requirements are further refined in Section 5 of the Standard to address traceability and other issues in the situation where the relationship between the Acquirer and the Supplier is defined through a contract. Note that the term 'identified' in these two Requirements does not mean that the Products must be incorporated into the WBS as standalone WBS Elements; instead, the Products could be identified using the WBS Dictionary.

3.6.6 The Products that need to be developed and delivered internally within either the Acquirer's or Supplier's organisations also need to be addressed in their respective WBSs to ensure that the full scope of work is identified and managed. This need leads to Recommended Practice 4:

Recommended Practice 4: All internal Products **should** be identified in the WBS.

3.6.7 Recommended Practice 4 is not a Requirement because some internal Products are not sufficiently significant to warrant inclusion in the WBS. Nevertheless, in keeping with Recommended Practice 1, internal Products will need to be included in the WBS if their inclusion is necessary to ensure that the plan is sound and that the work can be managed effectively to satisfy the required objectives.

[4] For example, see "Work Breakdown Structure Practice Standard Project–WBS vs. Activities", Berg, Cindy and Colenso, Kim, PM Network, April 2000, which may be downloaded from the PMI website.

3.6.8 Requirement 5 states that the WBS is required to be "Product-oriented", which does not mean that the WBS must only contain Products. There is no requirement under this Standard to artificially create Products so that the resultant WBS is a Product hierarchy only. EVM standards, for example, have long recognised that certain work within a project is Level Of Effort (LOE) based (e.g. PM is a typical area where LOE work abounds), and this Standard aligns with this perspective. A WBS needs to be sufficiently flexible to include LOE work, particularly given that the WBS must, under Requirement 1, capture the full scope of work. Nevertheless, the WBS hierarchy needs to be structured around the Products to be developed and delivered (either internally or externally) for reasons of scope management, as discussed in this Section, and technical control (refer Section 6).

3.6.9 As stated earlier, Enabling Services are decomposed into lower-level Enabling Products and Enabling Services. Requirement 5 suggests that the decomposition of Enabling Services also be Product-oriented. Nevertheless, the decomposition of the Enabling Service need not explicitly include the Enabling Products as lower-level WBS Elements (although they would be identified in the WBS Dictionary), particularly where there are no significant Enabling Products or the products are not central to the objectives of the Enabling Service. For example, the risk log (or risk register) is an Enabling Product associated with the risk-management process; however, it is not core to that process and, therefore, need not be included as a lower-level WBS Element within the decomposition of that Enabling Service. Furthermore, if the Acquirer has mandated a particular set of process steps in the agreement between the Acquirer and the Supplier (e.g. through mandating a particular process standard), then it makes sense to decompose the Enabling Service into the process steps defined in the agreement to ensure that all of the work effort is captured. Figure 5 builds on the earlier example provided in Figure 4 to illustrate the decomposition of the RFS Mission System SE element (i.e. WBS Element 1.01.06) into lower-level Enabling Products and Enabling Services.

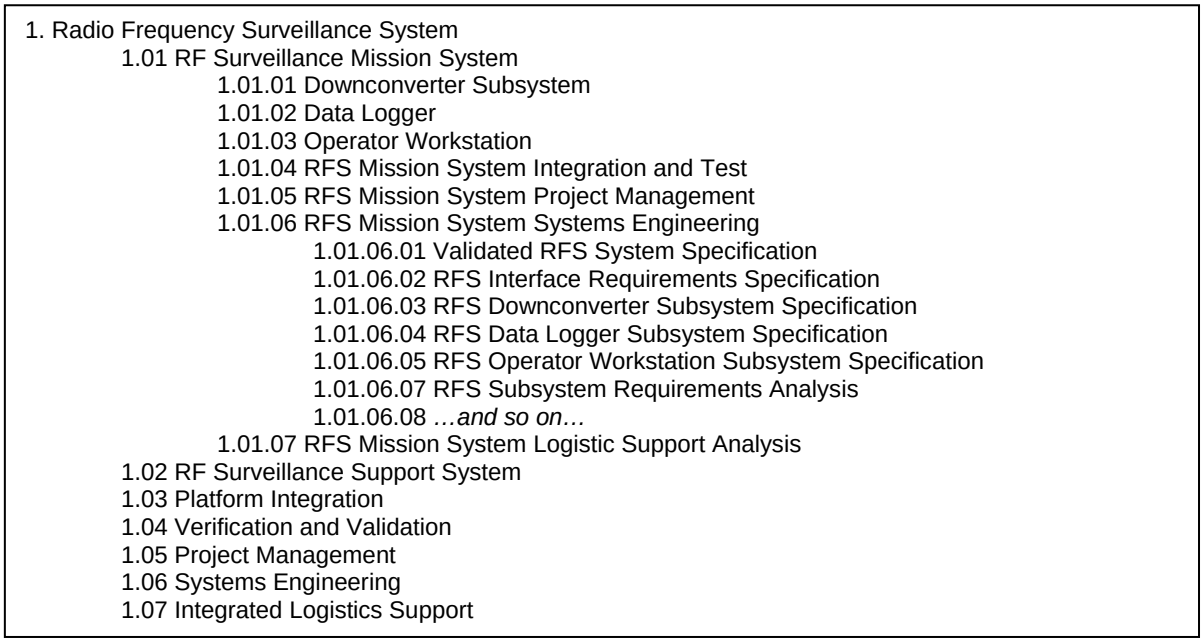

Figure 5 - Example Decomposition of Enabling Services

3.6.10 As will be explained under Section 6, the requirements for technical control place a different emphasis on Requirement 5. Under technical control, 'Product-orientation' includes the requirement for:

a. the WBS to be structured around the major end Products (e.g. Mission System and Support System), and

b. the Mission System to be 'Product-structured', such that the decomposition of the Mission System in the WBS needs to accord with the expected build structure for that system.

To highlight these differences, this Standard uses the term 'Product Breakdown Structure (PBS)' when discussing the breakdown of the Mission System and the term 'Component Product' when discussing the components of the Mission System. Similar terminology is also used for the Support System; however, this approach has been adopted simply to provide consistency across these two systems. The requirements for technical control are not applicable to the Support System, although they would be applicable to any Component Product of the Support System that needed to be designed and developed.

3.7 RESPONSIBILITY AND ACCOUNTABILITY

Requirement 8: The WBS **shall** be structured so that each WBS Element can be assigned to an individual or entity (which could be a Supplier), who is responsible for ensuring that the requirements of the WBS Element are achieved within allocated cost and schedule.

3.7.1 Requirement 8 is related to the EVM requirements and guidance defined under Step 2 (Assign Responsibility) in AS 4817–2003, "Project performance measurement using Earned Value". The EVM standard addresses the mapping of responsibilities to the required work, as defined by the WBS. Requirement 8, on the other hand, addresses the structure of the WBS to enable this mapping to occur. As such, the EVM requirement and Requirement 8 can be considered to be complementary requirements.

3.7.2 Requirement 8 is a corollary requirement to Requirement 1, and is related to Recommended Practice 1. At the top level of a WBS, either an individual or an organisation would have responsibility for the total scope of work embraced by the WBS (e.g. a project manager could have total responsibility for the scope of work within a project WBS, while a contractor would have total responsibility for the scope of work within a contract WBS).

3.7.3 At the second level of the WBS, Figure 1 highlights that the focal points (i.e. the elements against which the success of a project or contract will be judged) are the Products that need to be developed, which are either:

a. standalone internal end Products (e.g. a signed contract is an internal end Product for the solicitation stage of the Materiel Life Cycle);

b. Products that need to be delivered to the Acquirer (e.g. a Mission System);

c. Products that are Component Products or component elements of, or required steps along the path to delivering, the Products that will ultimately be delivered to the Acquirer (including deliverable Enabling Products); or

d. internal Enabling Products.

The Products represent the set of outcomes for the project or activity (i.e. the things that must be done), and responsibility and accountability for meeting these outcomes must be able to be assigned.

3.7.4 If it is not possible to assign responsibility to an individual or entity that can effectively manage the span of work, then the WBS Element may need to be further decomposed until it is possible. Note that an individual or entity can be responsible for a number of WBS Elements or a hierarchy of WBS Elements. Alternatively, if clear accountability for the delivery of the required outcomes cannot be assigned, the WBS is likely to need to be restructured.

3.7.5 Requirement 8 is not suggesting that the WBS needs to be structured around organisational arrangements. On the contrary, in accordance with Requirement 5, the WBS is required to be oriented around the required Products. After the Products (and Enabling Services) have been identified and logically structured to produce the WBS, the organisational arrangements are then mapped to the WBS. This can be achieved using an Organisational Breakdown Structure (OBS) to produce a Responsibility Assignment Matrix (RAM). This approach is illustrated in Figure 6, which has been adapted from MIL-HDBK-881[5].

[5] See Figure 3-3 of MIL-HDBK-881, dated 2 January 1998, p 26.

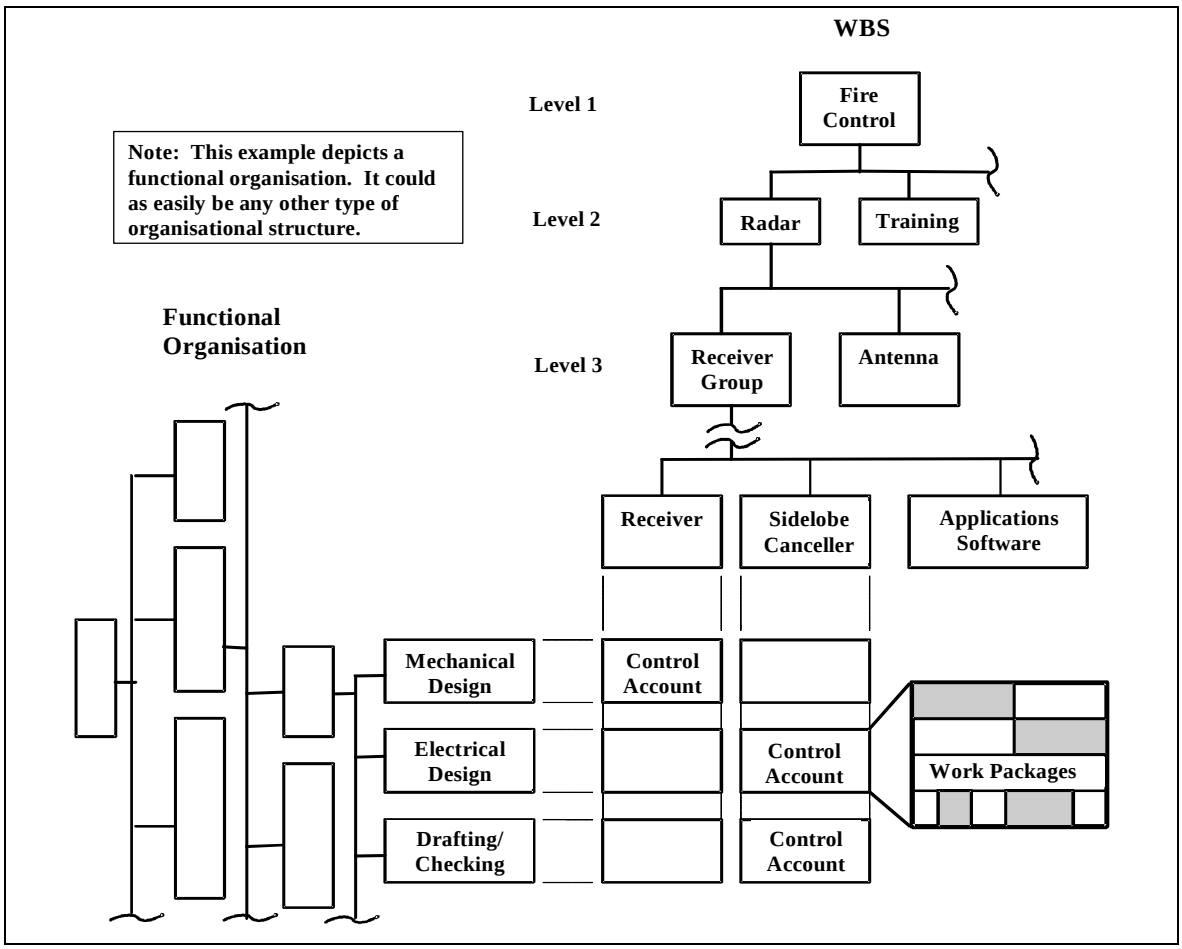

Figure 6 - Organisational Mapping to the Work Breakdown Structure

3.7.6 The approach illustrated in Figure 6 is required to ensure that, among other things, technical control can be achieved. As discussed in Section 6, technical control requires each Mission System to be structured around its expected build structure (i.e. its PBS). To ensure that the PBS is not compromised, therefore, responsibilities must be overlaid onto the PBS.

3.7.7 The following additional Recommended Practice can be derived from the relationship between the WBS and organisational arrangements, as follows:

Recommended Practice 5: The WBS **should** not be determined by organisational arrangements.

3.7.8 Although Recommended Practice 5 is directed at not letting the existing organisational structure determine the WBS, the use of Integrated Product Teams (IPTs) deliberately creates an organisational structure that maps onto the products in the WBS (i.e. the PBS determines the organisational structure, but not the other way around). IPTs are discussed further in Section 6.10.

4. WORK BREAKDOWN STRUCTURE HIERARCHY

4.1 RELATIONSHIPS

4.1.1 In general terms, the set of WBSs for a project is likely to include:

a. the Acquirer's WBS;

b. one or more Supplier WBSs; and

c. one or more lower-level Supplier WBSs at each recursion of Acquirer and Supplier.

4.1.2 This recursion is illustrated in Figure 7. Note that the diagram is not intended to suggest that there is only a single Supplier for each Acquirer.

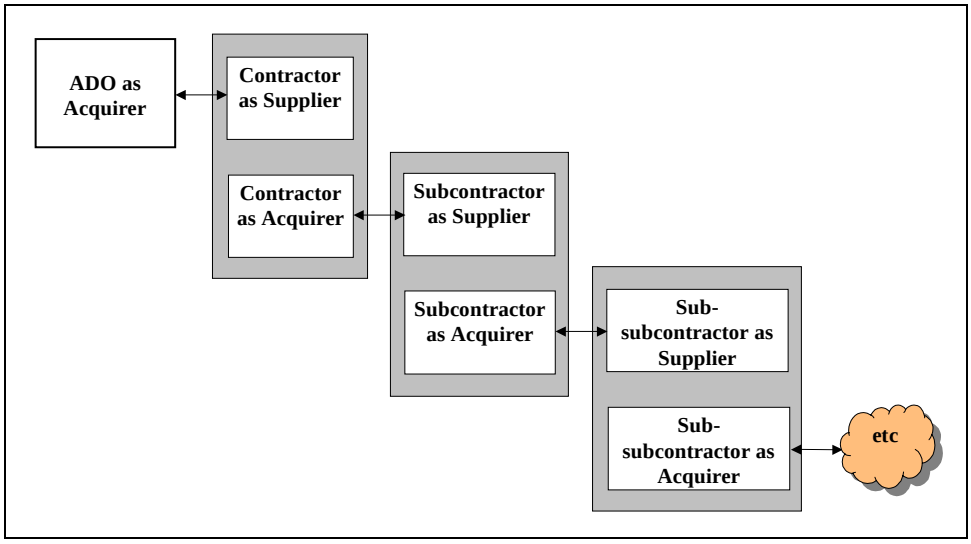

Figure 7 - Recursive Acquirer/Supplier Relationships

4.1.3 In accordance with Requirement 1, a WBS needs to capture the complete scope of work. Notwithstanding, the WBS also needs to be relevant to the organisation using the WBS. Recommended Practice 1 makes it clear that there is no requirement to produce a giant WBS that includes all of the detail contained in every WBS in the project (noting that a Contract WBS (CWBS) may contain hundreds or even thousands of elements, all of which must be maintained by the contractor)[6].

4.1.4 The WBS for each organisation in the recursive hierarchy illustrated in Figure 7 only needs to contain the Products and Enabling Services that are relevant at that level in the hierarchy, noting that, at each level below the ultimate Acquirer, each organisation's WBS will contain Products and Enabling Services that arise from its obligations as both Acquirer and Supplier[7]. With respect to Supplier-provided data items, for example, an Acquirer's WBS need only include the Products and Enabling Services associated with reviewing and responding to the data items.

4.1.5 As a general rule, the level of definition in the Acquirer's WBS associated with each successively lower-level Supplier diminishes commensurate with the level of the Supplier in the hierarchy.

4.1.6 Having established that there is not a one-to-one relationship between the WBSs at the successive levels in the organisational hierarchy illustrated in Figure 7, three specific types of WBS and their relationships need to be addressed, which are the:

a. Project WBS (PWBS), which encompasses the entire scope of work for a project;

b. Project Office Services WBS, which encompasses the entire scope of work undertaken by the Project Office during the In-Contract stage of the Materiel Life Cycle; and

c. Contract WBS (CWBS), which encompasses the entire scope of work for a contract.

[6] Certain diagrams in MIL-HDBK-881 appear to suggest this approach (e.g. see Figures 3-1 and 3-2 on pp 24&25, respectively).
[7] Internally within the ADO, this dual set of requirements also exists for organisations such as the Defence Materiel Organisation (DMO), where the DMO is a Supplier to external groups within the ADO and an Acquirer from a variety of entities, such as contractors, overseas governments (e.g. through Foreign Military Sales arrangements) and other external groups within the ADO (e.g. for facilities).

4.2 PROJECT WORK BREAKDOWN STRUCTURE

4.2.1 Figure 8 illustrates the PWBS, which highlights that, for the Defence Materiel Organisation (DMO), the PWBS can be considered to be a series of sub-projects based around the Materiel Life Cycle. Each of these sub-projects has its own objectives and end Products. For example, two of the major end Products for the First Pass stage are the First Pass Business Case and the Operational Concept Document (OCD), while the major end Product for the Solicitation stage is the signed contract. The major end Products for the In-Contract stage are the Mission System and Support System. As highlighted in Figure 8, only one of the second level WBS Elements will be active at any one time.

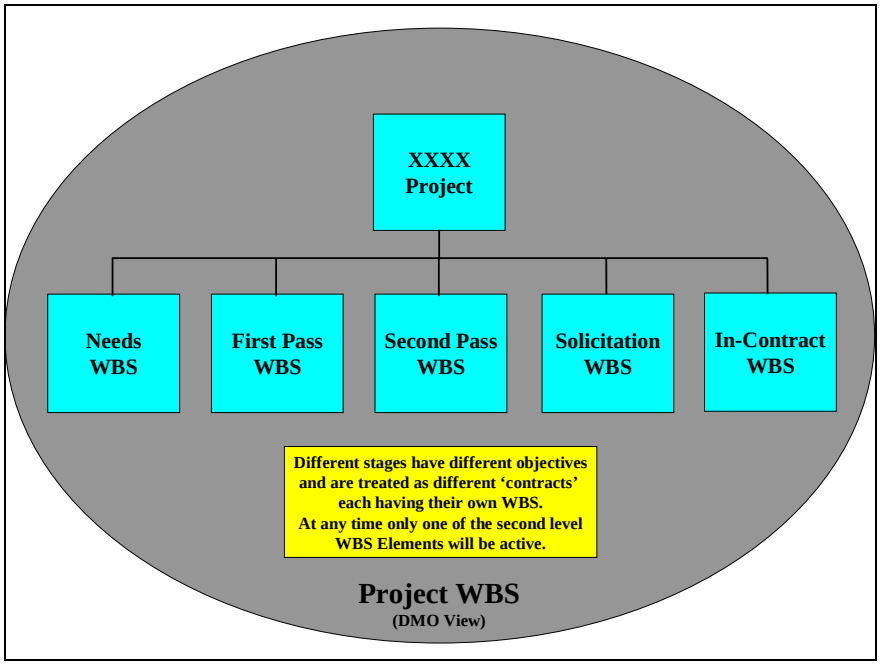

Figure 8 - Project Work Breakdown Structure

4.2.2 Figure 9 illustrates the decomposition of the Second Pass stage from a DMO perspective. Note that the major end Products for this stage are not the responsibility of the DMO; hence, WBS Element 1.03.01 only shows the DMO support to Capability Development Group (CDG) for the development of these end Products. Additionally, this decomposition highlights that, from a DMO perspective, the acquisition planning documents under WBS Element 1.03.02 can be considered to be end Products of this stage.

1. XXXX Project
    - 1.01 Needs
    - 1.02 First Pass
    - 1.03 Second Pass
        - 1.03.01 DMO Support to CDG
        - 1.03.02 DMO Acquisition Planning Documents
        - 1.03.03 DMO Contract Acceptance Review
        - 1.03.04 Second Pass Contracts/Studies
        - 1.03.05 Second Pass PO Project Management
        - 1.03.06 Second Pass PO Systems Engineering Management
        - 1.03.07 Second Pass PO Integrated Logistic Support Management
    - 1.04 Solicitation
    - 1.05 In-Contract

Figure 9 - Example Decomposition of the Second Pass Stage

4.2.3 Figure 10 provides a second example of the decomposition of the project scope; however, this figure illustrates the breakdown for the In-Contract stage. In this example, the prime contractor is providing two different Mission Systems (e.g. aircraft and simulator), while a separate contract has been established for the procurement of Government Furnished Equipment (GFE). This example also illustrates the typical approach where the facilities elements are assigned to another ADO organisation for development. Note that, in this example, the CWBS for each of the In-Service Support (ISS) contracts is separated from the associated prime-equipment contract to reflect the differing nature and scope of the contractual obligations under each of these separate contracts. The Project Office Services element includes all of the work to be undertaken by the project office, including the work required to manage the contracts, plan project office work, and interface with external stakeholders.

1.05 In-Contract
- 1.05.01 Prime Equipment
  - 1.05.01.01 Mission System #1
  - 1.05.01.02 Mission System #2
  - 1.05.01.03 Support System
  - 1.05.01.04 Verification & Validation
  - 1.05.01.05 Project Management
  - 1.05.01.06 Systems Engineering
  - 1.05.01.07 Integrated Logistic Support
- 1.05.02 GFE
- 1.05.03 Support System
  - 1.05.03.01 Facilities
  - 1.05.03.02 In-Service Support Contract #1
  - 1.05.03.03 In-Service Support Contract #2
- 1.05.04 Project Office Services
  - 1.05.04.01 Project Management
  - 1.05.04.02 Systems Engineering
  - 1.05.04.03 Integrated Logistic Support
  - 1.05.04.04 Verification & Validation
  - 1.05.04.05 Independent Verification & Validation

Figure 10 - Example Decomposition of the In-Contract Stage

4.2.4 Figure 11 provides a second example of the decomposition of the In-Contract stage, illustrating the breakdown of the project scope into a number of differing sub-elements to those shown in Figure 10, which reflects a different acquisition strategy for this example. Figure 11 illustrates the inclusion of Prime System Integrator (PSI) services into the WBS, where the PSI has responsibility for the overall performance of the delivered Materiel System, including the Mission System and Support System and the integration of these systems with any external systems. In this figure, the PSI services are shown separately; however, these services could be provided by the project office, a separate PSI contractor, or the Materiel System contractor. Figure 11 illustrates the case where a separate PSI contractor is employed. In the other two cases, the PSI services would be either integrated into the Project Office Services WBS or into the Materiel System CWBS[8], as applicable. In Figure 11, the PSI contractor is responsible for the development of the Mission System and Support System specifications, as well as the next level of specifications. The ADO is actually acquiring two equipment subsystems and a facilities component, using the specifications for these Products that have been developed by the PSI contractor. The inclusion of the Mission System and Support System in this diagram show how the Requirements and Recommended Practices for technical control are not compromised even when a separate PSI arrangement is used.

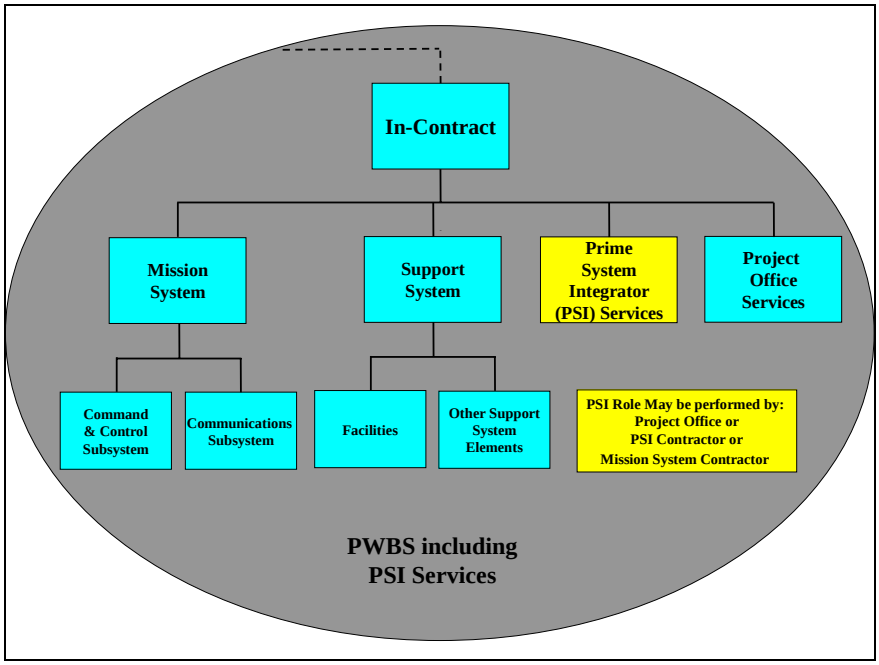

Figure 11 - Decomposition of Project Scope (In-Contract Stage)

[8] Note that the Materiel System CWBS is not shown in this figure, and its inclusion would result in the Mission System and Support System being located one level lower in the WBS.

4.2.5 Figure 10 and Figure 11 help to clarify why Recommended Practice 5 is not a Requirement, noting that, in these particular examples, the In-Contract WBSs are essentially structured around organisations. The development of these WBSs would have been undertaken by the project office as part of the analytical activity to define the most effective balance between costs, benefits and risks as part of developing the acquisition strategy. The inclusion of the Project Office Services WBS in the In-Contract element of the PWBS represents a compromise to:

a. ensure that there is no requirement to integrate the Project Office Services WBS into the respective CWBSs;

b. capture the scope of work for the project office as a single entity; and

c. ensure that the requirements for technical control for the Mission System are not affected (i.e. the PBS for the Mission System is not compromised).

4.2.6 The approach to the PWBS outlined in this Section enables the accounting requirements defined in DRB 48, "Accounting Manual", Third Edition, 2003, to be met. In particular, this approach enables the elements that must be capitalised (e.g. assets under construction) and the elements that may be expensed to be readily differentiated.

4.3 PROJECT OFFICE SERVICES WORK BREAKDOWN STRUCTURE

4.3.1 Although an ADO project office does not have an explicit Statement Of Work (SOW) (such as exists under a contract), the use of the C2 process framework, 'Acquire Materiel (Systems and Equipment)' within the DMO Quality and Environmental Management System (QEMS) provides an implicit SOW that applies across the entire Materiel Life Cycle. During the In-Contract stage, however, the project office not only has obligations arising out of QEMS, but also has obligations arising out of its agreements with its Suppliers in accordance with Requirement 7. Figure 12 illustrates these inputs to the Project Office Services WBS.

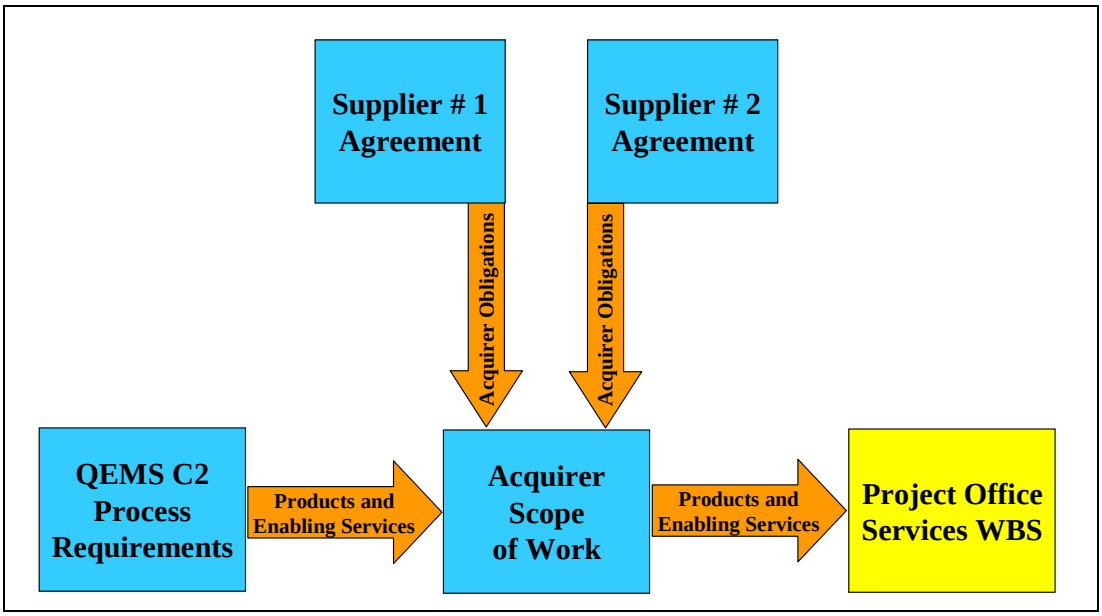

Figure 12 - Inputs to the Project Office Services Work Breakdown Structure

4.3.2 Figure 10 provided an example of the high-level decomposition of the Project Office Services WBS into lower-level Enabling Services, such as PM, SE, ILS and V&V. Note that the second level of decomposition in Figure 10 accords with the general decomposition of a WBS into Products and Enabling Services, as illustrated in Figure 1. In Figure 10, however, the Enabling Services at the highest level are all grouped under the Project Office Services WBS, which enables the complete scope of work for a project office to be captured as a single entity. Figure 13 illustrates the further breakdown of the Project Office Services WBS.

1.05.04 Project Office Services
- 1.05.04.01 Project Management
  - 1.05.04.01.01 In-Contract Project Office Setup
  - 1.05.04.01.02 Project Management Planning
  - 1.05.04.01.03 Contract #1 Contract Management
  - 1.05.04.01.04 Contract #2 Contract Management
  - 1.05.04.01.05 *… and so on for all contracts*
  - 1.05.04.01.06 GFE Management
  - 1.05.04.01.07 Transition into Operational Service Management
  - 1.05.04.01.08 Intellectual Property Management
  - 1.05.04.01.09 Quality Management
  - 1.05.04.01.10 Australian Industry Involvement Management
  - 1.05.04.01.11 Risk Management
  - 1.05.04.01.12 Communications Management
  - 1.05.04.01.13 *…other PM Enabling Services, as required…*
- 1.05.04.02 Systems Engineering
  - 1.05.04.02.01 Systems Engineering Planning
  - 1.05.04.02.02 Systems Engineering Controls
  - 1.05.04.02.03 Systems Engineering Analysis
  - 1.05.04.02.04 Materiel System PO Systems Engineering
  - 1.05.04.02.05 Mission System #1 PO Systems Engineering
  - 1.05.04.02.06 Mission System #2 PO Systems Engineering
  - 1.05.04.02.07 *… and so on for all Mission Systems*
  - 1.05.04.02.08 Support System PO Systems Engineering
  - 1.05.04.02.09 *…other SE Enabling Services, as required…*
- 1.05.04.03 Integrated Logistics Support
  - 1.05.04.03.01 ILS Planning
  - 1.05.04.03.02 ILS Controls
  - 1.05.04.03.03 Logistic Support Analysis
  - 1.05.04.03.04 Materiel System PO ILS
  - 1.05.04.03.05 Mission System #1 PO ILS
  - 1.05.04.03.06 Mission System #2 PO ILS
  - 1.05.04.03.07 *… and so on for all Mission Systems*
  - 1.05.04.03.08 Support System PO ILS
  - 1.05.04.03.09 *…other ILS Enabling Services, as required…*
- 1.05.04.04 Verification and Validation
  - 1.05.04.03.01 V&V Planning
  - 1.05.04.03.02 V&V Controls
  - 1.05.04.03.03 *…other V&V Enabling Services, as required…*
- 1.05.04.05 Independent Verification and Validation

Figure 13 - Sample Segment of the Project Office Services Work Breakdown Structure

4.3.3 Figure 13 highlights that the end Products (e.g. Mission Systems) will appear in the Project Office Services WBS, as well as in the respective contractor's CWBSs. The scope of work for the project office in relation to these end Products, however, relates to, among other things, implementing and managing the respective contracts, participating in reviews and meetings, and reviewing data items.

4.3.4 If a project is using an incremental or evolutionary acquisition strategy, the Project Office Services WBS needs to include each of the respective end Product deliveries, even though, under evolutionary acquisition, the number and scope of these deliveries are unlikely to be known. There are corollary project office responsibilities associated with each of the deliveries (e.g. witnessing testing and implementing support), which need to be captured in the Project Office Services WBS.

4.3.5 Using similar logic to the preceding paragraph, the Project Office Services WBS also needs to include each of the deliveries of end Products under a phased delivery schedule to ensure that the obligations associated with each of these deliveries are recognised, captured and managed.

4.3.6 If the Project Office has taken on the role of PSI for the Mission System, then the Project Office Services WBS will need to address the Requirements, Recommended Practices and guidance relating to technical control. The Enabling Services elements of the WBS would also need to include all of the technical processes associated with being a PSI in the domains of SE, V&V, ILS, etc. If these Enabling Services are not well-defined, then the overall scope of work for the project office will not be sufficiently identified, and resourcing requirements will not be adequately defined and understood.

4.3.7 If a particular contract includes a number of major end Products (e.g. aircraft, aircraft simulator, automatic test equipment and software support facility), then each of these Products need to be identified under each of the Enabling Services within the Project Office Services WBS to ensure that the full scope of work is identified.

This approach also enhances manageability across the Project Office Services WBS, particularly when the WBS is mapped into the project schedule.

4.4 CONTRACT WORK BREAKDOWN STRUCTURE

4.4.1 A similar perspective to the one illustrated in Figure 12 can also be derived for any Acquirer in the recursive hierarchy of Acquirer/Supplier illustrated in Figure 7. In these circumstances, however, the scope of work is defined by the organisation's obligations as both Acquirer and Supplier, as illustrated in Figure 14.

4.4.2 Figure 14 also illustrates that the only work that appears in the CWBS is the authorised work that derives from its contract with the Acquirer (either explicitly or implicitly). In the main, this work will be defined in the SOW (including annexes), although there could be work arising out of the conditions of contract (e.g. through provisions such as compliance with legislation and warranty).

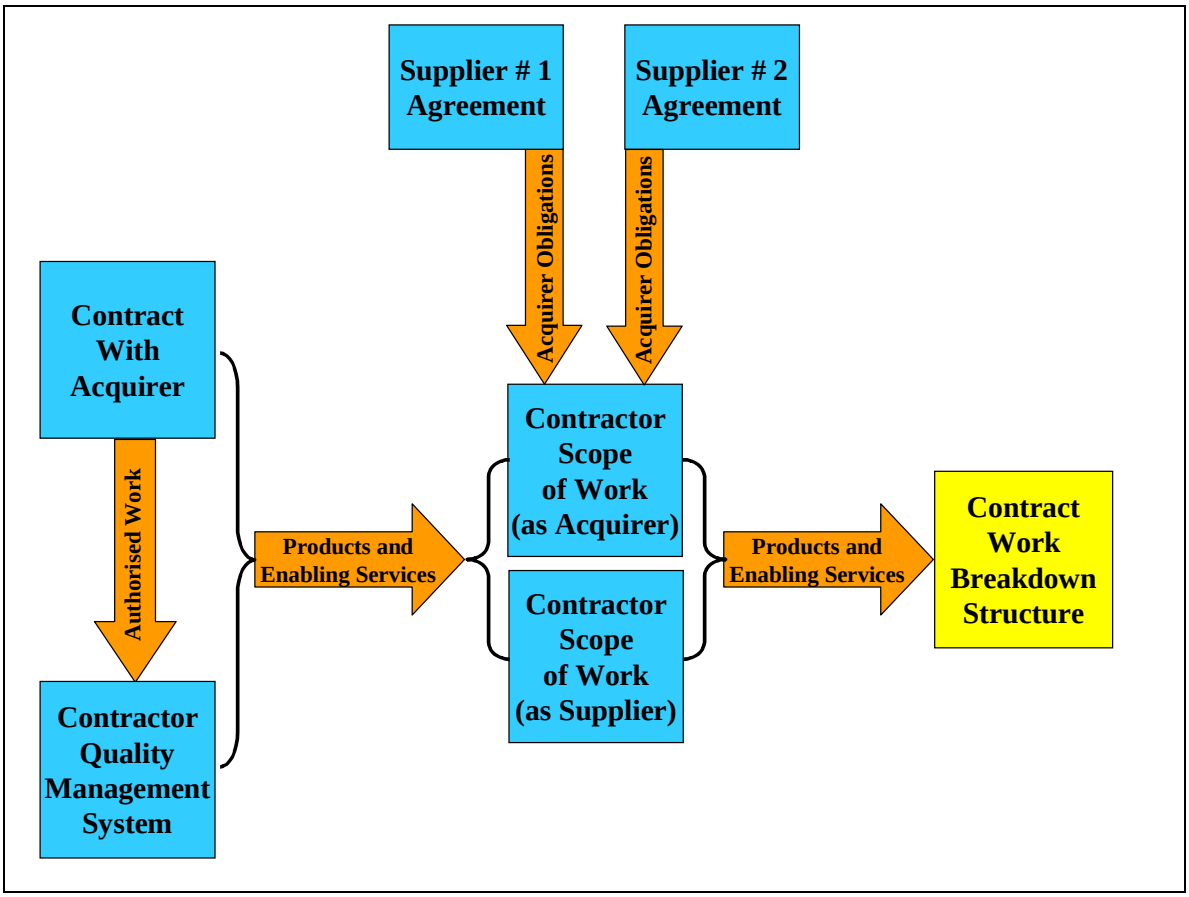

Figure 14 - Inputs to the Contract Work Breakdown Structure

4.4.3 The role of the contractor's Quality Management System (QMS) with respect to the contract is also illustrated in Figure 14. This QMS will define the processes to be employed by the contractor across the full scope of possible contractor work. The CWBS will only include the Products and Enabling Services from the QMS that are authorised through the contract, and will not include unrelated work that is not authorised through the contract. Note that Figure 14 and this discussion are not suggesting that the contract has to define all of the required work (e.g. if the contract is silent on a particular subject, but work is necessary to meet the overall requirements, then this work is still considered to be authorised work in accordance with the contract).

4.4.4 Similarly to the Project Office Services WBS, the CWBS would need to include any incremental deliveries of major Products, such as might occur under an incremental development strategy[9]. The CWBS could also differentiate between the development and production phases, where these phases are included under the same contract. Nevertheless, the key issue underpinning the CWBS is technical control, which is the subject of Section 6 of this Standard. Before technical control can be addressed, however, it is necessary to discuss the relationships between the contract and the CWBS in more detail.

[9] The Human Machine Interface (HMI) elements of a system are often developed using this type of strategy, which involves producing builds of the HMI and then delivering them to the ADO for review and feedback. This feedback is then incorporated into subsequent builds of the HMI.

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5. RELATIONSHIP OF WORK BREAKDOWN STRUCTURE TO CONTRACTS

5.1 GENERAL

5.1.1 As highlighted in Sections 3 and 4, the agreement between the Acquirer and Supplier places obligations on both the Supplier and the Acquirer. From a WBS perspective, there needs to be assurance that these obligations have been captured in the WBS, which results in two additional Recommended Practices, as follows:

> Recommended Practice 6: Traceability **should** be provided between the Supplier's WBS and the Products and Enabling Services arising out of the agreement between the Acquirer and Supplier.

> Recommended Practice 7: Traceability **should** be provided between the Acquirer's WBS and the Products and Enabling Services arising out of the agreement between the Acquirer and Supplier.

5.1.2 Recommended Practices 6 and 7 are additional refinements of Requirements 6 and 7 to include traceability, which is needed so that it is clear to reviewers of a WBS that all of the Products and Enabling Services arising out of the respective agreements have been captured in the WBS. Traceability also helps to ensure that estimates of cost and schedule are accurate. Traceability information can be captured in the WBS Dictionary, although bi-directional traceability is preferable. Note that, while the relationships between the WBS Elements in the CWBS to the Contract provisions need to be clearly traceable, there may not be one-to-one relationships, nor is it required. The Integrated Baseline Review (IBR) under EVM would be an appropriate event at which the traceability for a CWBS could be assessed.

5.2 STATEMENT OF WORK

5.2.1 By far the majority of work arising out of a contract is defined in the SOW (including annexes). While acknowledging that work could arise out of other elements of the contract, the subsequent discussion in this Section will focus solely on the SOW for reasons of clarity.

5.2.2 The WBS provides a framework for defining the technical objectives of the project. Together with the SOW, the WBS aids in establishing an indentured data listing (specification tree), defining Configuration Items, and planning supporting tasks. The SOW is the document that describes in clear and understandable terms what Products are to be delivered or what Enabling Services are to be performed. Preparation of an effective SOW requires a thorough understanding of the Products and Enabling Services needed to satisfy a particular requirement.

5.2.3 For a Supplier, there usually will not be a direct mapping of the SOW to the CWBS, and the CWBS will usually contain more detail than the SOW to identify all of the subordinate Products and Enabling Services needed to complete the work identified in the SOW. As an example, the SOW in ASDEFCON (Strategic Materiel) requires the contractor to produce a Measurement Plan and then to conduct measurement and analysis in accordance with the approved plan. The CWBS would identify the subordinate Enabling Products and Enabling Services associated with this work requirement and would need to contain sufficient detail to permit the estimation of costs and schedules associated with those tasks.

5.2.4 Organisations may have a different mapping of Products and Enabling Services to that identified in the SOW (e.g. an item appearing under Project Management in the SOW may appear under Systems Engineering in the CWBS). Such a situation can occur as a result of organisation's standard procedures or policy (e.g. one company may consider Configuration Management as a subset of Systems Engineering, whereas another company may consider it as a subset of ILS or even Project Management).

5.2.5 Figure 15 illustrates the structure of the SOW for the ASDEFCON (Strategic Materiel) RFT template[10]. The SOW body identifies the scope of work under the Contract and, although it identifies the major systems (i.e. Mission System(s) and Support System), the details of these systems are contained in Annex A – 'Specifications' and Annex B – 'Operational Concept Document'. The majority of the SOW body is concerned with the Enabling Services, such as Project Management and Systems Engineering, which are

[10] ASDEFCON (Complex Materiel) Volume 2 has a similar structure.

associated with the development of the Materiel System as well as the artefacts of those Enabling Services, such as plans (i.e. Enabling Products). Note that Figure 15 highlights that approximately 90% of the budget for a contract relates to the products covered by the specifications (i.e. the Mission System(s) and components of the Support System).

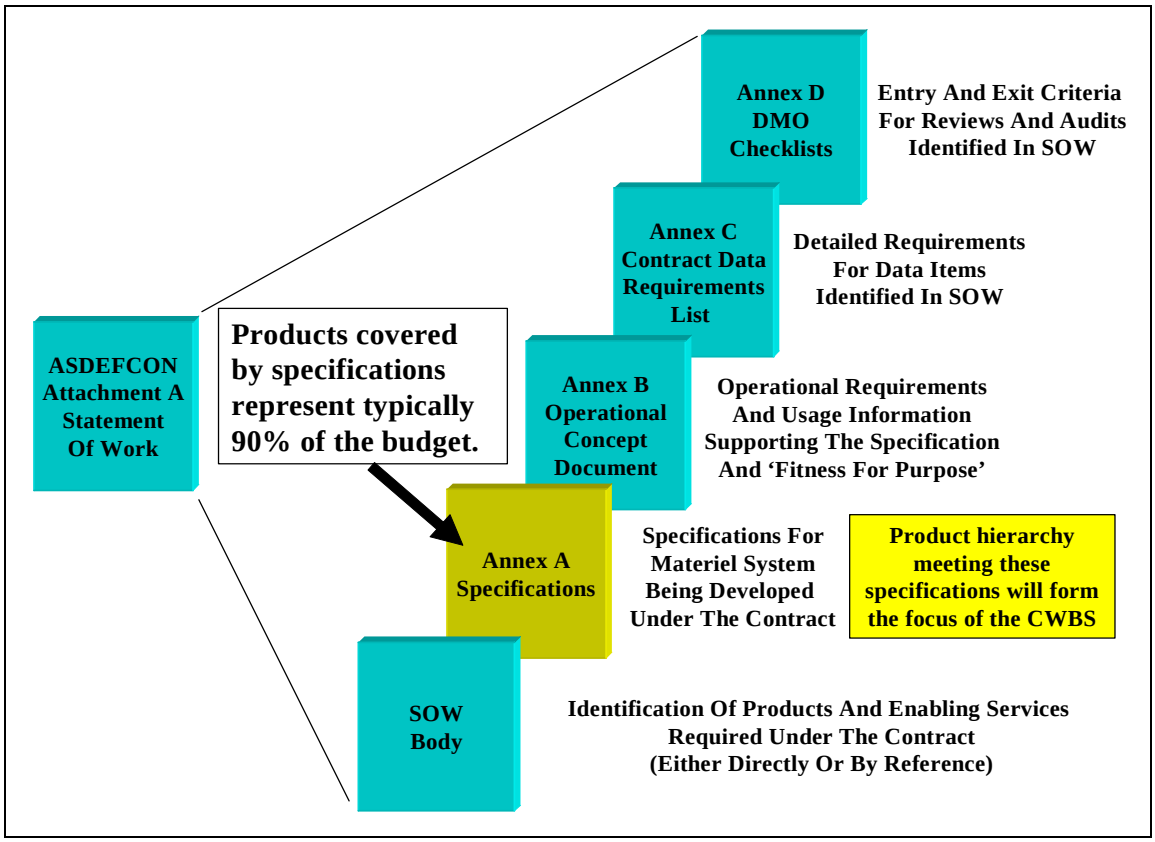

Figure 15 - ASDEFCON (Strategic Materiel) Statement of Work Structure

5.2.6 Annex A of ASDEFCON (Strategic Materiel), 'Specifications', will initially contain the Function and Performance Specification (FPS) that focuses on the capability that the Materiel System has to deliver in terms of what it has to do and how well it has to do it. In the solicitation phase of the acquisition process, different respondents will propose different solutions to meet the FPS. In this process, functions and associated performance will be further decomposed and allocated to Component Products, with the result that the specifications will become more detailed and will map to the PBS of the proposed solution. The specifications mapped to the PBS constitute the specification tree. Further information on this decomposition and its relationship to technical control is provided in Section 6.

5.2.7 Figure 16 expands the SOW body[11] to the next level of detail where the focus on Enabling Services becomes apparent.

5.2.8 The Enabling Services defined in the SOW for each of the ASDEFCON templates represent the minimum set of Enabling Services (and associated Enabling Products) that the ADO requires a contractor to undertake to satisfy corporate governance and risk-management requirements. The CWBS would be expected to elaborate on the Enabling Services and Enabling Products defined in the SOW to define a more detailed set of Enabling Services and Enabling Products that are required to satisfy the overall contract requirements.

5.2.9 The contract SOW also places obligations on the ADO to prepare for and attend reviews, supply GFE, and so on. In accordance with Requirement 7, these obligations are required to appear in the Project Office Services WBS.

5.2.10 The Contract Data Requirements List (CDRL) in any of the ASDEFCON RFT templates requires the contractor to provide data items in accordance with the management requirements defined in the CDRL (e.g. schedule) and the Data Item Description (DID). The DID identifies the format and content of the data item and is effectively a specification for that data Product. In accordance with Requirement 6, all data items specified in the CDRL are required to appear in the CWBS.

[11] Note that the structure of ASDEFCON (Complex Materiel) Volume 2 is identical.

5.2.11 The CDRL also places obligations on the ADO to review, approve, accept, or consider a contract change proposal for, data items within a certain timeframe. Once again, in accordance with Requirement 7, the scope of work associated with these obligations is required to appear in the Project Office Services WBS.

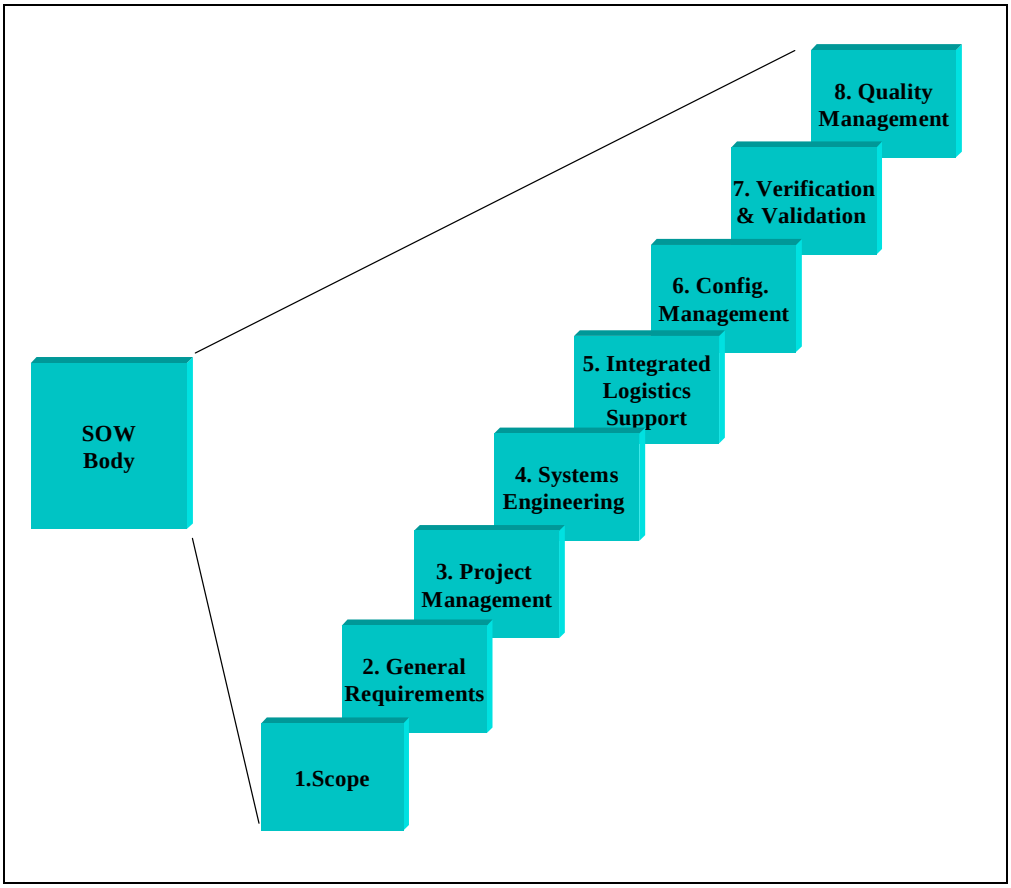

Figure 16 - Detail of ASDEFCON (Strategic Materiel) Statement of Work Body

5.3 CONTRACT SUMMARY WORK BREAKDOWN STRUCTURE

5.3.1 Figure 17 provides the Contract Summary WBS (CSWBS) that appears in the ASDEFCON (Strategic Materiel) conditions of tender (Annex E to Attachment A) to provide guidance to respondents in preparing a tendered CWBS.

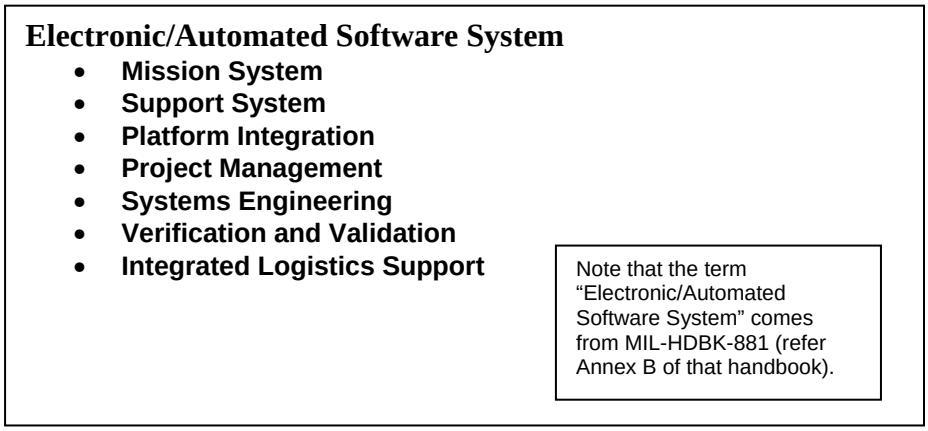

Figure 17 - Contract Summary Work Breakdown Structure

5.3.2 The definitions from ASDEFCON (Strategic Materiel) for each of the elements are provided at Annex B.

5.3.3 While the standard CSWBS included with ASDEFCON (Strategic Materiel) is titled 'Electronic/ Automated Software System', at the level of abstraction provided, there are few changes that would need to be made for the standard CSWBS to have wide applicability across ADO acquisition projects. In particular, the WBS Element 'Platform Integration' may not be relevant and, if not, the element does not need to be included.

5.3.4 Note that neither the Mission System nor the Support System is decomposed at this stage, although the Support System could reasonably be decomposed to the next level without having any impact. The guidance accompanying ASDEFCON (Strategic Materiel) recommends that drafters avoid specifying the CSWBS below Level 2 because going below this level starts to define a particular solution or implementation and, therefore, encroaches upon the Contractor's design domain. Inappropriate levels of detail in a CSWBS can:

a. artificially constrain the tenderer's design and, therefore, its tendered offer by implying a particular solution or approach is preferred; and

b. cause inappropriate subcontractual arrangements to be implemented because the CSWBS defines particular subsystems or elements of systems.

5.3.5 Notwithstanding the guidance in the ASDEFCON (Strategic Materiel) handbook, which is valid for all other WBS Elements in the CSWBS, the Support System could reasonably be decomposed as illustrated in Figure 18. Note the inclusion of 'Initial Training', which is a type of Component Product known as a Deliverable Service.

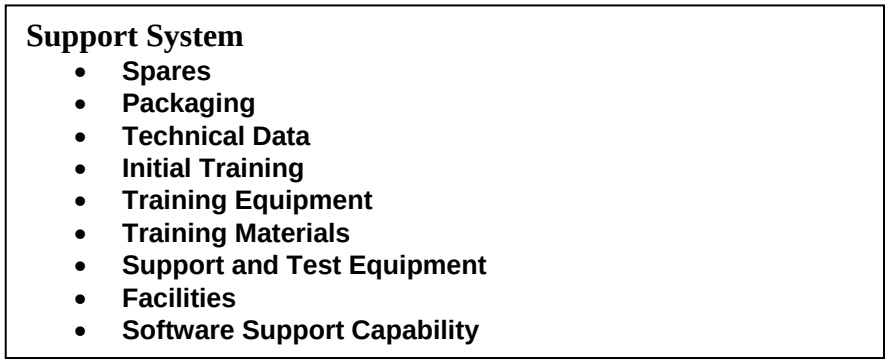

Figure 18 - Support System Breakdown

5.3.6 The guidance to avoid specifying a CSWBS below Level 2 is related to technical control (refer Section 6) because of the relationship between the PBS elements of the CSWBS and the SE processes. Nevertheless, the following Recommended Practice can be derived from this relationship.

Recommended Practice 8: The Acquirer **should** not define a PBS in its solicitation documentations in such detail that it eliminates viable solutions having a different PBS.

6. TECHNICAL CONTROL

6.1 GENERAL

6.1.1 Throughout the life-cycle of the Mission System, the SE function takes the lead in system development, which includes the development of the hierarchy of specifications for the system from the top level down to the lowest level of Configuration Item. The purpose of these efforts is to define and develop system product and process solutions that satisfy the logical architecture, and then to integrate these solutions to produce the required system.

6.1.2 The concept of technical control recognises that the development of the PBS for the Mission System is an SE function because the PBS represents the physical build structure of the system[12]. The contractor's proposed solution will identify a Product hierarchy (i.e. a PBS) for both the Mission System and Support System from which the pricing, risk and schedule will have been determined. Integrated with this PBS will be the specific Enabling Services identified in the contract SOW and in the contractor's QMS. The Mission System represents the key element to be provided under a project and the source of most of the cost and risk. In this light, the focus of the CWBS must be the Product hierarchy for the Mission System, which leads to the following Requirement:

Requirement 9: The decomposition of the Mission System in the WBS **shall** be Product-structured.

6.1.3 Technical control is achieved by the SE process of decomposing the Acquirer's system-level specifications into successively lower-level Component Product specifications, resulting in a specification tree in which the specifications for all Component Products are ultimately traceable to the Acquirer's specification. For this reason, projects that have a major Product deliverable (i.e. a Mission System) must have a Product-structured WBS. Product-structured means that all of the Component Products of the major Product are WBS Elements and that the hierarchical position of the Component Product in the WBS matches the hierarchical position in the build structure of the major Product. The relationship between the specification tree and the PBS is illustrated in Figure 19.

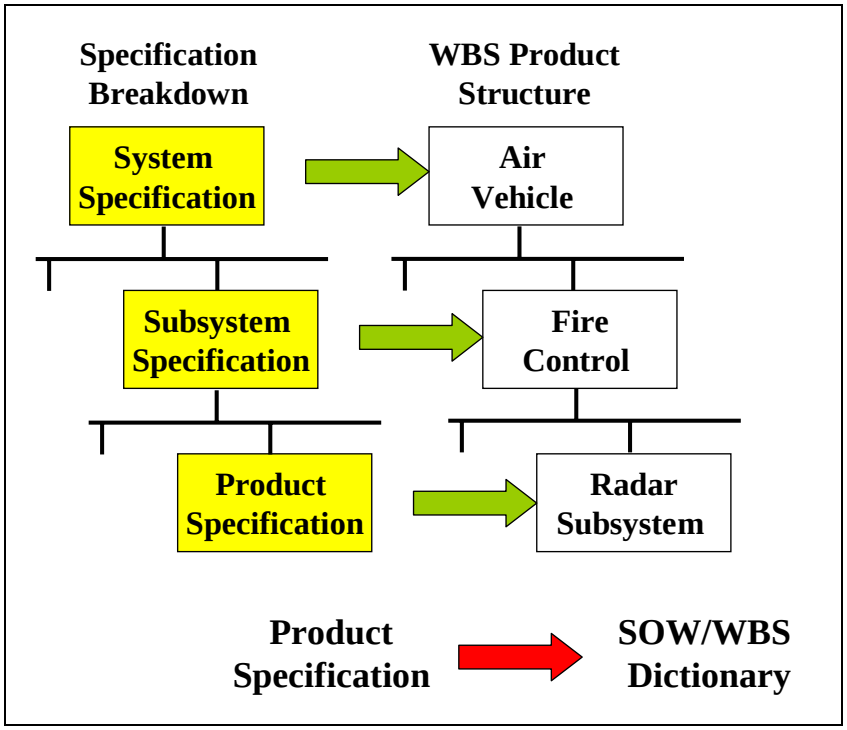

Figure 19 - Relationship between the Specification Tree and the Product Breakdown Structure

[12] There may not be a one-to-one alignment between the PBS and the physical build structure of the system due to such aspects as incremental builds (refer Figure 27).

6.2 Integration Of Technical Control With Cost And Schedule Control

6.2.1 Integration of technical control with cost and schedule control is achieved by ensuring that the Mission System Component Products identified in the specification tree are WBS Elements and that the cost and schedule needed to produce the Component Products are allocated to the Component Products. This integration is illustrated in Figure 20.

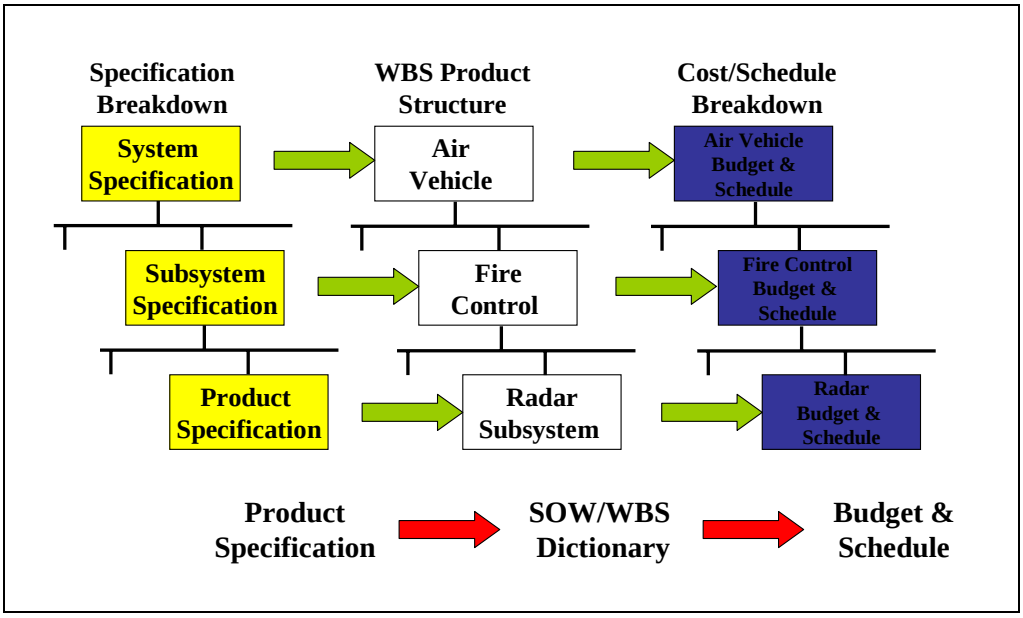

Figure 20 - Relationship between the Product Breakdown Structure and Cost & Schedule

6.2.2 In Figure 20, the System Specification maps to the physical Air Vehicle System that, in turn, maps to the Summary Level budget and schedule for the system. The Product Specification maps to the Radar Subsystem that, in turn, maps to the budget and schedule identified for this subsystem and so on. Recall that each WBS Element has a corresponding WBS Dictionary definition that is effectively the SOW for that WBS Element, as described in Section 3.2.

6.3 Work Breakdown Structure Elements as Subcontracts

6.3.1 In Figure 20, each Component Product in the WBS Component Product hierarchy (i.e. the PBS) has an associated specification, an associated budget, an associated schedule and an associated WBS Dictionary definition (or SOW); thus, each WBS Element has the key attributes of a subcontract and, for management purposes, can be treated as such. These WBS Element 'subcontracts' can be viewed as being internal to the organisation or external to the organisation.

6.3.2 The only difference between an external subcontract and an internal subcontract is that the external subcontract would contain commercial/legal terms and conditions, whereas the internal subcontract would not.

6.3.3 This discussion is not suggesting that subcontract arrangements need to be aligned with Component Products (refer to the discussion under Section 3.7); rather, that the WBS Elements have all of the attributes of a subcontract and, therefore, can be treated as such for management purposes. This perspective is another way of viewing the responsibility and accountability requirements associated with WBS Elements, as described in Section 3.7.

6.4 Cost and Schedule Estimation

Requirement 10: All costs incurred in producing a Component Product **shall** be attributed to that WBS Element, so that the cost of a Component Product is the sum of the costs of the lower-level Component Products and the costs of the Enabling Services required to produce the Component Product.

6.4.1 Both EVM and activity-based costing principles require that all costs incurred in providing a Product or Enabling Service need to be attributed to that Product or Enabling Service[13]. The application of these principles to a Component Product WBS Element is illustrated in Figure 21.

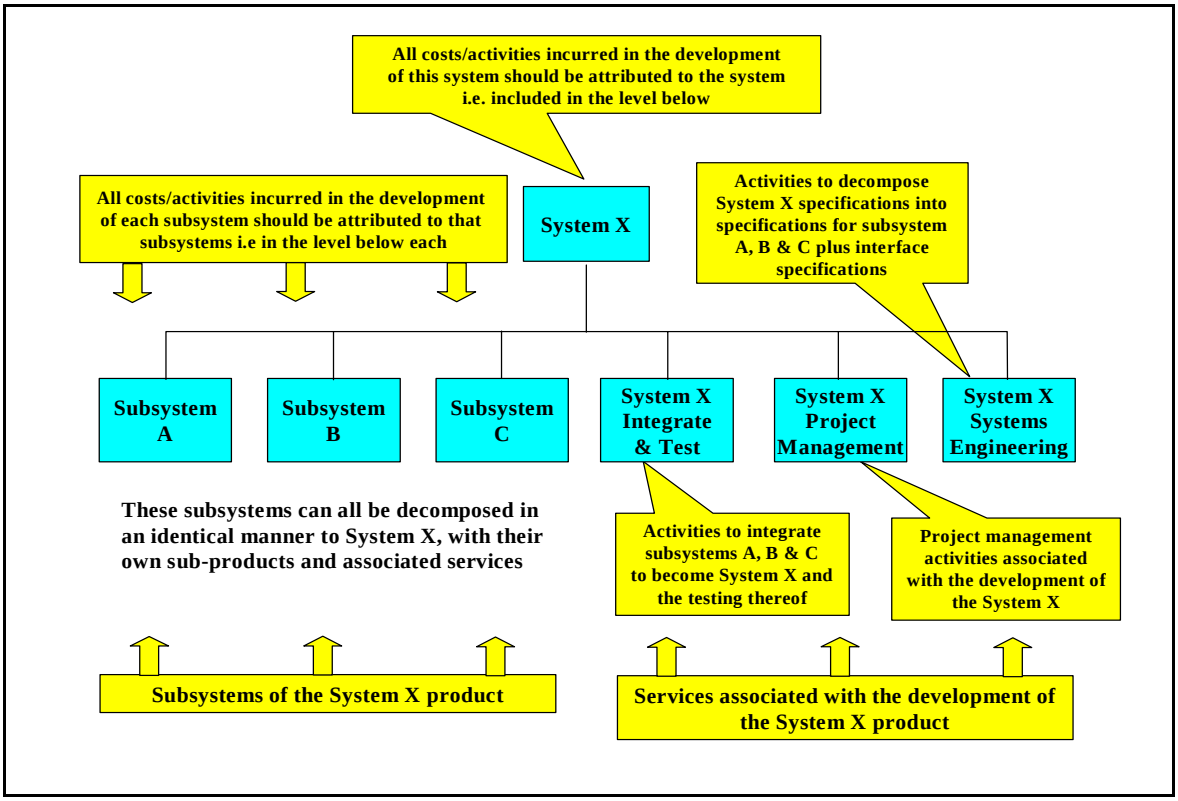

Figure 21 - Activities and Costs Attributed to the Development of a Work Breakdown Structure Product

6.4.2 In this Standard, the SE associated with any Component Product at any level of the PBS includes:

a. ensuring the specification for the Component Product and its interfaces are valid;

b. developing the specifications for the lower-level Component Products of that Component Product;

c. developing the interface specifications for those lower-level Component Products; and

d. certifying that, when lower-level Component Products that meet their specification are integrated in accordance with the interface specifications, the higher-level Component Product will meet its specification.

6.4.3 At the top level only, SE includes the definition of standard processes and tools across the project, as reflected in the Systems Engineering Management Plan (SEMP), and the development of specifications for the Mission System and the Support System, as well as for Platform Integration Products and associated Enabling Services.

6.4.4 The use of the WBS as a structure for cost-estimation facilitates project and contract management. The WBS aids the project office in planning, coordinating, controlling, and estimating the various types of project work. It provides a common framework for tracking the estimated and actual costs during the performance of each contract. The data from the various contracts supports the ADO project manager in evaluating contractor performance, preparing budgets, and preparing project life-cycle costs.

6.4.5 In adopting the concept of treating each WBS Element as a subcontract, as illustrated in Figure 22:

a. the cost associated with any WBS Element would be the sum of the costs at the next lower level;

b. the schedule to complete any WBS Element would be equal to the schedule to complete all of the tasks at the next lower level; and

c. the specification for any Component Product in the PBS would be met by the integration of all Component Products at the next lower level.

[13] Note that MIL-HDBK-881 appears to deviate from the activity-based costing principle, in that it does not explicitly include, for example, a design or SE element at the same level as the subsystems to identify the decomposition of the system level specification into the subsystem level specifications.

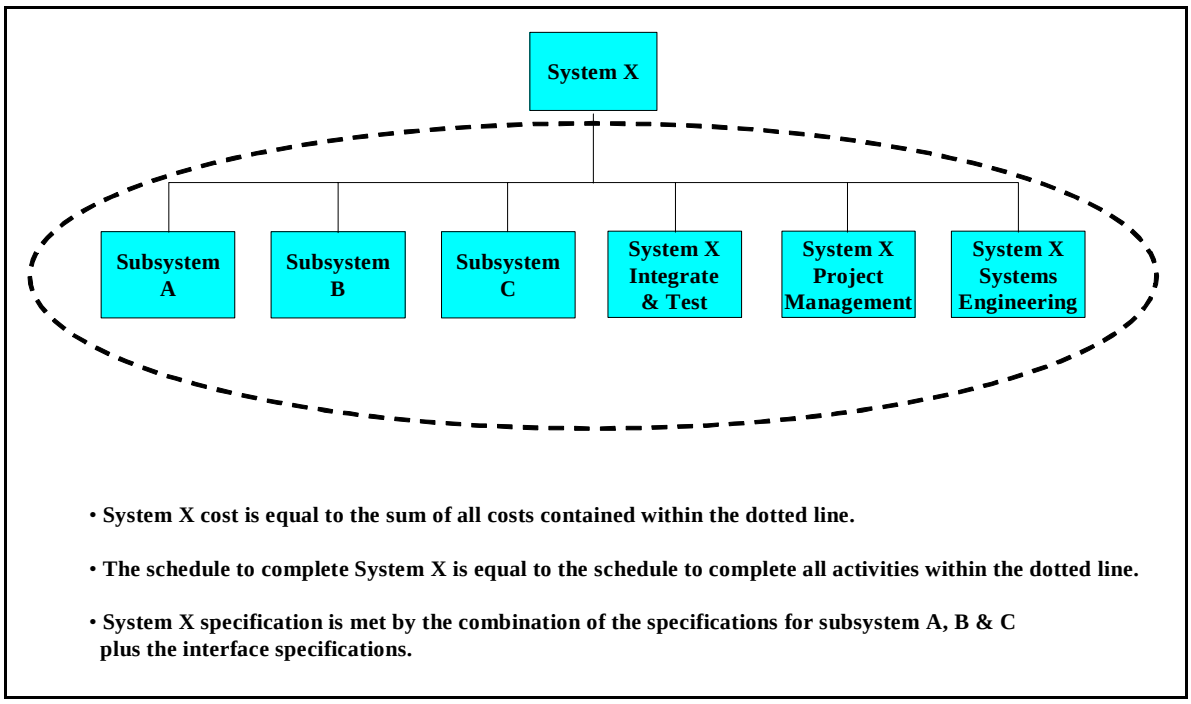

Figure 22 - Integration of Technical, Cost and Schedule Control

6.5 DESIGN ACCOUNTABILITY

Requirement 11: For each Component Product within the PBS, the WBS **shall** facilitate clear and visible accountability for ensuring that the delivered Component Product meets its specification.

6.5.1 Requirement 11 is a refinement of Requirement 8 to address the specific requirements associated with technical control.

6.5.2 Using the WBS subcontract principle makes it possible to hold a single individual or team responsible for the delivery of a 'working product' meeting specification within budget and schedule. The subcontract principle ensures that the individual or team has a SOW, a specification, a budget and schedule. The Enabling Service elements of the WBS have all of the above except for a specification.

6.5.3 To ensure clear accountability for the delivery of effective Component Products, each Component Product within the Mission System PBS needs to have a nominated design manager, who has the responsibility for delivering a compliant Product. Note that this corresponds to part of the WBS Dictionary definition of SE at all levels of the WBS. The responsibility of the design manager is identified in Figure 23.

6.5.4 Recursively applying the design manager responsibility from top to bottom of the PBS makes it clear which person or entity is responsible for delivering each Component Product and, since each Component Product in the PBS is a complete entity in some sense, it can be clearly Verified against its specification.

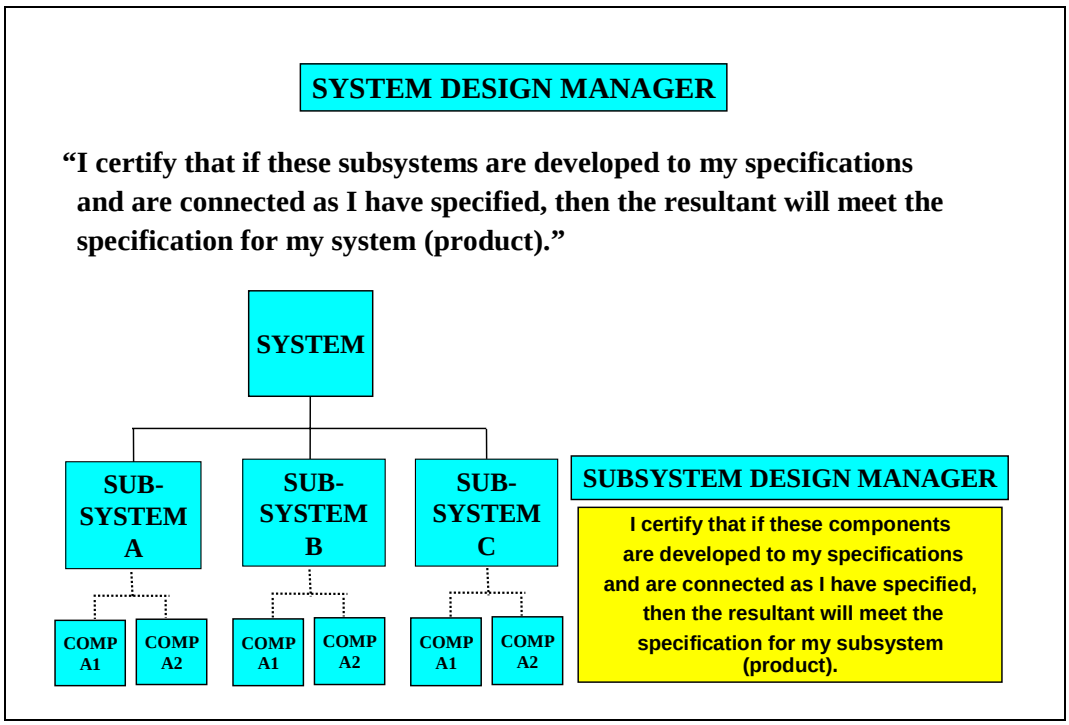

Figure 23 - Responsibility of the Design Manager

6.6 RELATIONSHIP OF DESIGN MANAGER TO COST AND SCHEDULE MANAGERS

6.6.1 Complex developmental projects almost always have a Project Manager, who is responsible for the cost, schedule and programmatic aspects of the project and a Technical Manager (e.g. Systems Engineering Manager or some equivalent competent technical authority). The Technical Manager (or equivalent) reports to the Project Manager and is responsible for the technical aspects of the project, such as ensuring that the system delivered meets specification. The Technical Manager is effectively responsible for the design at the system level.

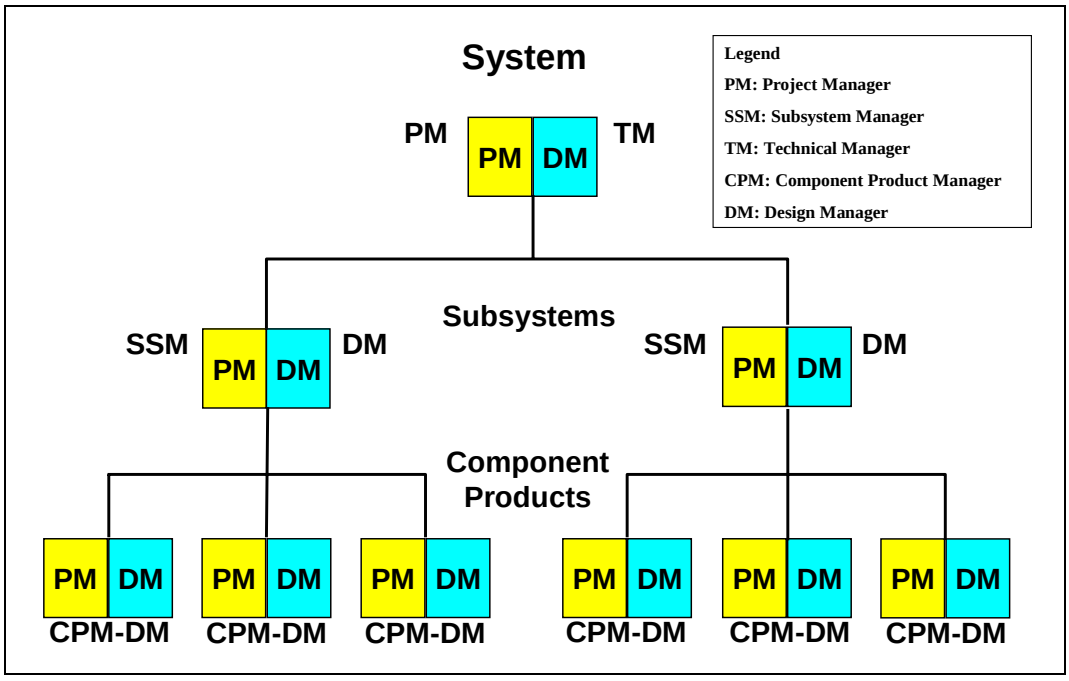

Figure 24 - Relationship between Design Manager and Cost & Schedule Manager Roles

6.6.2 Applying the design manager responsibility recursively from the top to the bottom of the PBS ensures tight technical control; however, it is also necessary to hold someone accountable for the cost, schedule and programmatic aspects of each Component Product development. Ideally, the same person could be held responsible for both technical and programmatic aspects. In practice, however, the two sets of skills are not

always coincident and, therefore, it may be necessary to have separate Component Product managers and design managers. Figure 24 is meant to depict these separate roles, noting that the Component Product manager role and design manager role may or may not be performed by the same person.[14] In projects operating under an EVMS, Control Account Managers (CAMs) are held responsible for the work packages within that control account and, therefore, if the Control Account was formed at the subsystem level, then all PM roles below that level would be work packages for which the CAM would be responsible. Note that CAMs can take on the responsibility of the design manager if they are appropriately skilled and experienced (and vice versa).

6.7 SOFTWARE WORK BREAKDOWN STRUCTURE ELEMENTS

6.7.1 It is generally incorrect to consolidate all software on a project or contract into one sub-tree of a WBS. Separating the software elements from the system, subsystem or hardware on which they are deployed, makes performance measurement and management control difficult to maintain. Furthermore, the true cost of each Component Product is not readily available for decisions concerning that Product. Rather than separately summarising software, it is important to identify software together with its supporting system, subsystem or hardware as a consolidated element that achieves some Verifiable function. If it is necessary to produce summaries for software-management purposes, then modern management systems can group and filter base data using a relevant attribute to identify software elements. By combining the software with its physical elements, software developers are able to understand the limitations of the system, subsystem or hardware (such as memory limitations, processing load, and network bandwidth). When these limitations are understood, the probability of successfully integrating the software with the system, subsystem or hardware is significantly improved. Recommended Practice 9 summarises these perspectives.

> Recommended Practice 9: The WBS **should** not artificially separate the software from the system, subsystem or hardware the software supports; the focus should be on the delivery of a working Component Product, with the software integrated with the system, subsystem or hardware.

6.7.2 Software may be associated with functionality that spans multiple hardware elements (e.g. client-server applications, cellular radio network software, and handset software). This situation may also arise with other system-wide functionality, such as middleware, communications, and encryption, each of which contributes to system performance. In order to capture the associations and the complexity associated with the work of designing and integrating such functionality, Recommended Practice 9 highlights that the software element associated with this functionality needs to be included at the lowest appropriate level in the PBS that captures the full span of the software, typically at the subsystem or system level.

6.7.3 Projects will often require the development of a software architecture that captures and lays common constraints onto lower-level software-based Component Products within a system or subsystem. The scope of activities associated with defining and promulgating such constraints needs to be assigned to a WBS Element for software architecting, usually under the lowest-level SE WBS Element[15] that covers the full span of applicable Component Products.

> Recommended Practice 10: Where the development of a software architecture is required, the Supplier **should** include a WBS Element that captures the scope of work for the development, promulgation and maintenance of the architecture.

[14] The design manager role may also be constrained by the technical regulatory requirements.
[15] The “lowest level” element may be the highest SE WBS Element in the WBS for a predominately software-based system.

6.7.4 In Figure 25, which provides a Level 3 breakdown of the Mission System, there is no software visible; the focus is on subsystems with integrated hardware and software.

1. Radio Frequency Surveillance System
    - 1.1 RF Surveillance Mission System
        - 1.1.1 Downconverter Subsystem
        - 1.1.2 Data Logger
        - 1.1.3 Operator Workstation
        - 1.1.4 RFS Mission System Integration and Test
        - 1.1.5 RFS Mission System Project Management
        - 1.1.6 RFS Mission System Systems Engineering
        - 1.1.7 RFS Mission System Logistic Support Analysis
    - 1.2 RF Surveillance Support System
    - 1.3 Platform Integration
    - 1.4 Verification and Validation
    - 1.5 Project Management
    - 1.6 Systems Engineering
    - 1.7 Integrated Logistics Support

Figure 25 - Level 3 Breakdown of the Radio Frequency Surveillance Mission System

6.7.5 In Figure 26, there is a further expansion of the Operator Workstation from Figure 25. Note that the software does not become visible until the Component Product it supports is decomposed.

1.1.3. Operator Workstation
- **1.1.3.1. Computer Platform**
    - 1.1.3.1.1. 17inch Flat Panel Display
    - 1.1.3.1.2. Keyboard
    - 1.1.3.1.3. Mouse
    - 1.1.3.1.4. 3.5 in Floppy Drive
    - 1.1.3.1.5. CD R/W
    - 1.1.3.1.6. IEEE 488 Controller Card
    - 1.1.3.1.7. High Speed Graphics Card
- **1.1.3.2. Operator Workstation Applications Computer Software Configuration Item**
    - 1.1.3.2.1. Signal Processor Control Computer Software Component
    - 1.1.3.2.2. Data Logger Control Computer Software Component
    - 1.1.3.2.3. Display Computer Software Component
    - 1.1.3.2.4. Operator Workstation Integration & Test
    - 1.1.3.2.5. Operator Workstation PM
    - 1.1.3.2.6. *… Other Enabling Services as required…*
- **1.1.3.3. Operator Workstation System Software**
    - 1.1.3.3.1. NT Operating System
    - 1.1.3.3.2. IEEE 488 Driver
- **1.1.3.4. Signal Processor**
    - 1.1.3.4.1. Signal Processing Card
    - 1.1.3.4.2. Signal Processing Computer Software Configuration Item
        - 1.1.3.4.2.1. Hilbert Transform Computer Software Component
        - 1.1.3.4.2.2. Modulation Recognition Computer Software Component
        - 1.1.3.4.2.3. Time-Stamp Module Computer Software Component
        - 1.1.3.4.2.4. SP Controller Computer Software Component
        - 1.1.3.4.2.5. *… Enabling Services as required…*
    - 1.1.3.4.3. Signal Processor Integration & Test
    - 1.1.3.4.4. Signal Processor PM
    - 1.1.3.4.5. *… Other Enabling Services as required…*
- **1.1.3.5. Operator Workstation Integration Kit**
- **1.1.3.6. Operator Workstation Integrate & Test**
- **1.1.3.7. Operator Workstation PM**
- **1.1.3.8. Operator Workstation SE**
- **1.1.3.9. Operator Workstation LSA**

Figure 26 - Lower-level Breakdown of the Radio Frequency Surveillance Operator Workstation

6.7.6 A separately contracted or stand-alone software system will include the software, data, services, and facilities required to develop and produce a software Component Product for inclusion in a higher-level system, such as a command-and-control system, radar system, or information system. Where software is considered stand-alone (e.g. it does not reside or support a specific equipment or it is considered a pure software upgrade), the

same Product-structured approach to the WBS needs to be used. Figure 27, which has been adapted from MIL-HDBK-881[16], provides an example of a WBS for a stand-alone software system.

SOFTWARE-INTENSIVE SYSTEM WBS
1. SOFTWARE-INTENSIVE SYSTEM
1.1 MISSION SYSTEM
1.1.1 APPLICATIONS S/W
1.1.1.1 BUILD 1
1.1.1.1.1…n CSCI 1...n
1.1.1.1.n+1 CSCI TO CSCI INTEG. AND CHKOUT
1.1.1.2…n BUILD 2...n
1.1.1.?.? CSCI 1...n
1.1.1.?.? CSCI TO CSCI INTEG. AND CHKOUT
1.1.1.n+1 APPLICATIONS S/W INTEG., ASSEMBLY, TEST, & CHKOUT
1.1.2 SYSTEM S/W
1.1.2.1 BUILD 1
1.1.2.1.1…n CSCI 1...n
1.1.2.1.n+1 CSCI TO CSCI INTEG. AND CHKOUT
1.1.2.2…n BUILD 2...n
1.1.2.?.? CSCI 1...n
1.1.2.?.? CSCI TO CSCI INTEG. AND CHKOUT
1.1.2.n+1 SYSTEM S/W INTEG. ASSEMBLY, TEST AND CHECKOUT
1.1.3 INTEG., ASSEMBLY, TEST AND CHECKOUT
1.1.4 HW/SW INTEGRATION
1.2 SUPPORT SYSTEM
1.3 VERIFICATION AND VALIDATION
1.4 PROJECT MANAGEMENT
1.5 SYSTEMS ENGINEERING
1.6 INTEGRATED LOGISTIC SUPPORT

Figure 27 - Sample Work Breakdown Structure for a Software-intensive System

6.7.7 The discussion in this Section leads to the following software-specific Requirement:

> Requirement 12: In projects that can be considered as software-only projects, the software Component Product structure **shall** form the PBS for the Mission System within the WBS.

6.8 ACQUIRER-PROVIDED COMPONENT PRODUCTS

6.8.1 The most common instance of Acquirer-provided Component Products relates to the use of GFE; however, the principles are applicable at each recursive level of the Acquirer/Supplier boundary. The discussion in this Section is a refinement of the discussion in Section 3.6 to address the specific requirements associated with technical control.

6.8.2 For Acquirer-provided Component Products, the Supplier needs to treat the Acquirer in the same way as they would any other Supplier of Component Products. The Acquirer-provided Component Products need to be shown in the PBS in the same way as any other Component Product, and have function, performance and interface specifications the same as any other Component Product. This discussion leads to the following Requirement:

[16] See Figure 3-6 of MIL-HDBK-881, dated 2 January 1998, p 30.

Requirement 13: Acquirer-provided Component Products **shall** be shown in the PBS elements of the Supplier WBS in the same way as the Supplier-provided Component Products.

6.8.3 The Acquirer needs to include the Component Products that it will be providing to the Supplier in its WBS and needs to attribute the cost of the Component Products to the higher-level Component Product in which it is installed, in keeping with the concepts underpinning Requirement 10.

6.9 SUPPLIERS TO MULTIPLE WORK BREAKDOWN STRUCTURE ELEMENTS FOR A CONTRACT WORK BREAKDOWN STRUCTURE

6.9.1 In many projects, a Supplier may supply Products to many different WBS Elements across the project. For example in a large communications project, one Supplier may supply a common radio type to multiple Component Products.

6.9.2 On one hand, it is desirable to have one commercially 'clean' contract with the equipment Supplier and, on the other hand, the WBS must identify the equipment where it belongs in the PBS and the cost of the equipment must be attributed to the Component Products of which they form a part.

6.9.3 All of these requirements may be satisfied by the following approach:

a. Appoint a subcontract manager to manage the equipment Supplier subcontract. This will become a WBS Element under Project Management, where the only costs attributed to this WBS Element will be the costs of managing the subcontract (i.e. none of the equipment costs would be attributed to this WBS Element).

b. Each instance of equipment across the overall WBS will be assigned a different line item within the contract with the Supplier, with an appropriate associated delivery date and location. Each line item is then associated with the WBS Element where it belongs in the PBS.

c. The WBS then identifies the equipment in its correct place within the PBS, with the usual technical responsibilities for ensuring correct Component Product specifications and interface specifications being assigned to the design manager.

d. Each Component Product manager then treats the subcontract manager as the Supplier of the equipment, but can make payments directly to the actual Supplier against the particular line items.

6.9.4 The above approach satisfies commercial requirements for a clean subcontract with the Supplier, yet maintains responsibility and authority of design managers and Component Product managers. The WBS structure associated with the Supplier subcontract managers is shown in Figure 28.

1.5 Project Management
1.5.1 Project Planning
1.5.2 Project Control
…….
–1.5.6 Common Radio Supplier Subcontract
–1.5.7 Workstation Supplier Subcontract

Figure 28 - Multiple Supplier Work Breakdown Structure Arrangements

6.9.5 The approach outlined herein leads to the following Requirement:

Requirement 14: Where a Supplier is providing Products to multiple WBS Elements in the Acquirer's WBS, the Acquirer **shall** ensure that the WBS facilitates the correct allocation of costs to those WBS Elements.

6.10 INTEGRATED PRODUCT TEAMS AND THE WORK BREAKDOWN STRUCTURE

6.10.1 A Supplier may indicate that it will be using Integrated Product Teams (IPT) to realise the requirements of the agreement between the Acquirer and the Supplier. In this situation, the IPTs need to be mapped to the Component Products of the Mission System or Support System (or both), as defined by the Supplier, and need to contain all of the necessary skill sets to be able to deliver the Component Product, including engineers,

manufacturing experts, ILS experts, customer representatives, and so on. Note that, in large projects, there will be a hierarchy of IPTs that map to the PBS of the system being delivered, as illustrated in Figure 29.

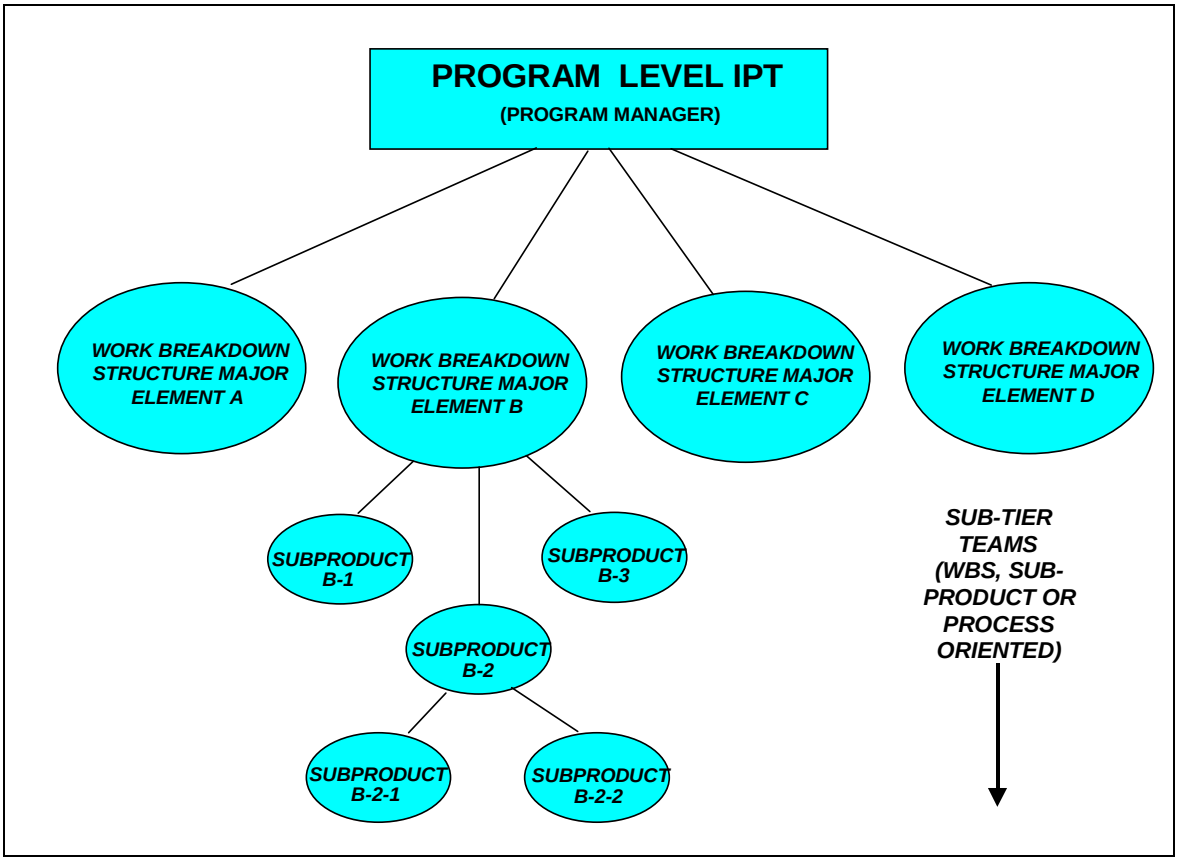

Figure 29 - Mapping of Integrated Product Teams to Component Products

6.11 Horizontal Threads of Functionality

6.11.1 In almost any complex system, there exist threads of functionality that span many Component Products, appearing to cut horizontally across the PBS – for the purposes of this discussion, these are called 'horizontal threads of functionality' or just 'horizontal threads'. System-wide control, fault isolation and fault diagnostics are examples of such horizontal threads. Achieving technical control over these horizontal threads can be difficult because of the number of interfacing subsystems and components and associated design managers. To overcome this difficulty, a design manager can be appointed to take responsibility for the horizontal threads, with the associated work scope reflected in a standalone WBS Element that is designated accordingly.

> Recommended Practice 11: Where horizontal threads of functionality are present in the Mission System PBS, the Supplier **should** include a WBS Element to ensure that these horizontal threads are appropriately managed so that the Mission System will meet its requirements.

6.12 Development Versus Production

6.12.1 Section 6.4 highlighted that both EVM and activity-based costing principles require that all costs incurred in providing a Product or Enabling Service need to be attributed to that Product or Enabling Service. These principles mean that the developmental costs (or Non-Recurring Engineering (NRE) costs), as defined through a WBS, cannot be amortised across the production articles. Typically, the developmental effort for a system or item of equipment is identified under one (or more) WBS Elements, which are separated from the production effort in accordance with the WBS subcontract principle. There are two distinct cases for incorporating the production effort into the WBS, which represent the two extremes of the spectrum, namely:

a. production of a large number of 'small' Mission Systems (e.g. radios); and

b. production of a small number of 'large' Mission Systems (e.g. ships).

6.12.2 In the first case, the outcome of the initial developmental effort would typically be a prototype, which would not be used further in the development process. This prototype would be identified as a standalone Product in

the WBS, as illustrated in Figure 30. Subsequently, the developmental effort for the first article would occur, which would also be identified as a standalone Product in the WBS, separate from, and at the same level as, the prototype. The first article WBS Element would include the effort associated with the V&V and initial configuration audits, etc that would be required to demonstrate that the first article met the specified requirements, as well as the effort to verify that the production processes, if applicable, were suitable.

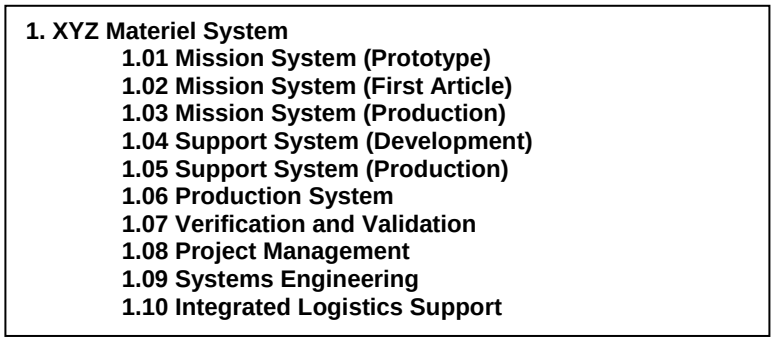

Figure 30 - Incorporating Development and Production

6.12.3 In this first case, when there is a large production run of identical units, the production articles would be typically grouped under a standalone WBS Element at the same level as the first article WBS Element, as illustrated in Figure 30.

6.12.4 In the second case, it would be unusual in the ADO for a prototype to be developed, and the initial developmental effort would be an integral part of the effort to produce the first article. For the production effort for the large Mission Systems, which could change configuration throughout the production period, each ship would typically be identified as a separate WBS Element at the same level in the WBS.

6.12.5 In between these two extremes, production effort could be batched. For example, aircraft are sometimes produced in 'lots', where a production run of a given configuration is undertaken. Subsequently, a configuration update is undertaken, which is followed by a second production run, and so on. In these instances, it would be expected that the production effort for each batch (including the accompanying design effort) would be identified as a separate WBS Element at the same level in the WBS.

6.12.6 If a production system is a significant element of a project, then the separate identification of this system as a standalone WBS Element could also be appropriate. Figure 30 illustrates the inclusion of the production system.

6.13 EVOLUTIONARY ACQUISITION

6.13.1 Where the selected Acquisition Strategy involves Evolutionary Acquisition (EA), the Materiel System functionality is delivered incrementally to the end-user. Each increment should be treated as a separate WBS Element in accordance with the WBS subcontract principle, as illustrated in Figure 31.

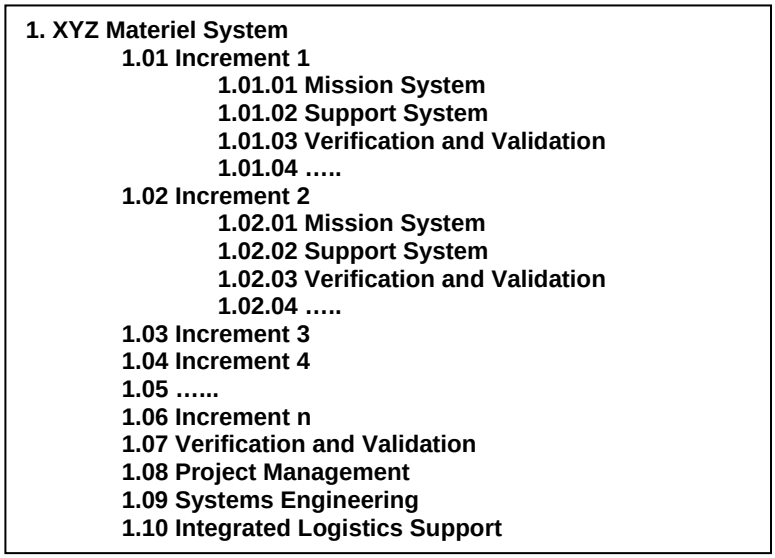

Figure 31 - Addressing Evolutionary Analysis Requirements in the Work Breakdown Structure

6.13.2 Figure 31 represents the case where the increments are defined by the Acquirer and issued to the Supplier as a series of contracts or contract amendments. In this case, the Supplier is acting as the PSI. Figure 31 should not be confused with the situation where the Supplier is defining a series of builds (i.e. developmental increments), as described in Section 6.7.

6.13.3 If the ADO project office were to be acting as the PSI during the In-Contract stage, Figure 31 would change such that each increment would most likely be represented as a separate contract (and, therefore, a separate CWBS), while WBS Elements 1.07-1.10 would be grouped under the Project Office Services WBS Element, as described in Section 4.3.

7. CONFIGURATION MANAGEMENT

7.1 GENERAL

7.1.1 Configuration management is a set of processes for establishing and managing the technical configuration of items, which addresses the evolving design and the envisaged or defined support needs. Items are identified as Configuration Items (CIs) to ensure that the requirements and the evolving design configuration is managed cost-effectively and to ensure that support requirements can be met. To this end, CIs must always be Component Products of either the Mission System or Support System and, therefore, must be designated in the WBS.

Requirement 15: The components of the Mission System and Support System that are designated as Configuration Items **shall** be Component Products in the PBS for those systems.

7.2 DESIGN CHANGES

7.2.1 If the system design for either the Mission System or Support System changes as the project progresses, then the WBS must be changed to reflect the changed design. In treating each WBS Element as a subcontract, a change to the design is a change to the Component Product specification for that subcontract; hence, if the WBS Dictionary were not to be amended, the specifications would lose their association with cost and schedule and the WBS Elements would no longer be effective as 'subcontracts'. In the normal development process, Component Products may be added, deleted or modified, and so the subcontracts must be changed to reflect these changes, including any cost and schedule changes associated with the design changes. Note also that a change to the design of a particular Component Product may have implications for other Component Products, which would need to be addressed by the appropriate design manager(s).

Requirement 16: Changes in the system design **shall** be reflected in the WBS, as such changes are effectively variations to the subcontract for the Component Product.

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8. SUPPORTABILITY REQUIREMENTS

8.1 GENERAL

> Recommended Practice 12: Where either military or commercial support-related standards specify a standardised approach to the PBS, the CWBS **should** accord with these standards for supportability reasons.

8.1.1 There are a number of military and commercial standards that provide either a standard PBS or a standardised approach to the PBS for different types of systems (e.g. aircraft, surface ships, submarines, surface vehicles and ordnance systems). These standards include (not a definitive list):

a. AECMA S1000 series;

b. DEF-STAN 00-60 Part 10, “Electronic Documentation”; and

c. any of the standards relating to the Logistic Support Analysis Record (LSAR) (e.g. DEF(AUST) 5692, MIL-STD-1388-2B, and DEF-STAN 00-60 Parts 1-3).

8.1.2 These standardised breakdowns have been developed to enhance supportability and, therefore, need to be adopted where cost-effective. Note that Recommended Practice 12 is not a Requirement because the provisions relating to technical control have precedence.

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LIST OF REQUIREMENTS (NORMATIVE)

REQUIREMENTS

Requirement 1: The WBS **shall** satisfy the following conditions:

Integrated –	A single top WBS Element covers the total body of work.
Distinct –	Every WBS Element is a distinct Product or Enabling Service, which is mutually exclusive from other Products and Enabling Services.
Children –	Every WBS Element has either no children, or multiple children.
Descendant –	Every child WBS Element has only one parent and is a descendant of the top WBS Element.
Necessary –	Every child WBS Element is needed to deliver the parent.
Sufficient –	If all child WBS Elements are complete, their parent is complete.
Complete –	The complete scope of work is captured in the WBS.

Requirement 2: Each WBS Element **shall** have a corresponding WBS Dictionary definition that clearly describes the WBS Element down to a level of detail sufficient to support the management and ultimate acceptance of the WBS Element. The following information **shall** be included in the WBS Dictionary for each WBS Element:

a. project title;

b. WBS Element identifier, which may be numeric or alphanumeric;

c. WBS Element title;

d. a description of the scope of the Product or Enabling Service, including a Statement of Work (SOW) and, if a Product, a reference to the applicable specification (e.g. title and number);

e. additional information required by the EVM System (EVMS) if an EVMS is required; and

f. any other information to ensure that the work effort, responsibilities and accountabilities associated with the WBS Element are clear, complete, and understood by all parties.

Requirement 3: The WBS **shall** employ an identification system that clearly defines the hierarchical relationships between WBS Elements.

Requirement 4: The WBS and WBS Dictionary **shall** be revised to incorporate changes and to reflect the current status of the project in accordance with the defined control mechanisms.

Requirement 5: The WBS **shall** be Product-oriented.

Requirement 6: All Products that must be delivered to the Acquirer by the Supplier **shall** be identified in the Supplier's WBS.

Requirement 7: All Products that must be delivered to the Supplier by the Acquirer **shall** be identified in the Acquirer's WBS.

Requirement 8: The WBS **shall** be structured so that each WBS Element can be assigned to an individual or entity (which could be a Supplier), who is responsible for ensuring that the requirements of the WBS Element are achieved within allocated cost and schedule.

Requirement 9: The decomposition of the Mission System in the WBS **shall** be Product-structured.

Requirement 10: All costs incurred in producing a Component Product **shall** be attributed to that WBS Element, so that the cost of a Component Product is the sum of the costs of the lower-level Component Products and the costs of the Enabling Services required to produce the Component Product.

Requirement 11: For each Component Product within the PBS, the WBS **shall** facilitate clear and visible accountability for ensuring that the delivered Component Product meets its specification.

Requirement 12: In projects that can be considered as software-only projects, the software Component Product structure **shall** form the PBS for the Mission System within the WBS.

Requirement 13: Acquirer-provided Component Products **shall** be shown in the PBS elements of the Supplier WBS in the same way as the Supplier-provided Component Products.

Requirement 14: Where a Supplier is providing Products to multiple WBS Elements in the Acquirer's WBS, the Acquirer **shall** ensure that the WBS facilitates the correct allocation of costs to those WBS Elements.

Requirement 15: The components of the Mission System and Support System that are designated as Configuration Items **shall** be Component Products in the PBS for those systems.

Requirement 16: Changes in the system design **shall** be reflected in the WBS, as such changes are effectively variations to the subcontract for the Component Product.

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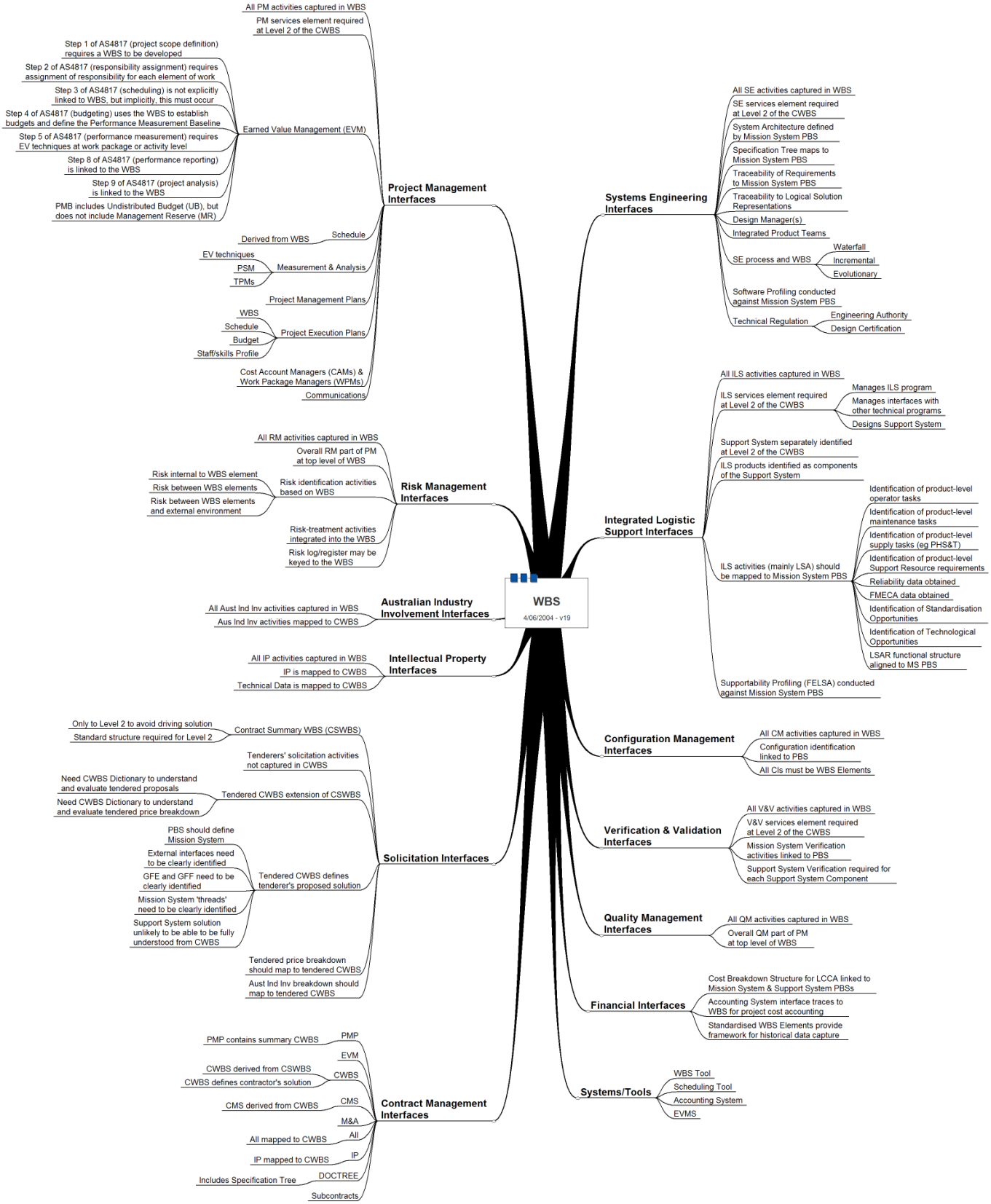
DEFINITIONS OF STANDARD WORK BREAKDOWN STRUCTURE ELEMENTS (INFORMATIVE)[17]

WBS Element	Definition
Mission System	This element includes the hardware and software used to accomplish the primary mission of the Defence materiel item. This element includes all integration, assembly, test and checkout, as well as all technical and management activities associated with individual hardware/software elements This element also includes the integration, assembly, test and checkout associated with the overall Mission System.
Support System	This element includes all of the physical support deliverables being generated under the Contract, including any effort associated with the acquisition of, and/or the design, development and production of those physical deliverables. Includes any effort associated with delivery, installation, integration, and check out. Includes the acquisition, design, development and production of any logistics resources associated with those physical deliverables (i.e., the logistics resources required for the support of Support System elements such as Facilities, S&TE, etc).
Integrated Logistics Support	This element includes the overall planning, directing, and controlling of the ILS function. This element includes the effort associated with the logistics-analysis processes, the outcome of which result in the identification of the logistics resources (both range and scale) required to support both the Mission System and the Support System. Excludes the acquisition of, and/or the design, development and production of specific Support System Components (e.g., S&TE, Facilities, Software Support Environment, Training Equipment and Materials, etc). These activities are covered under the individual Support System elements themselves. Excludes the acquisition, design, development and production of the logistics resources required for the support of the individual Support System elements themselves.
Platform Integration	This element includes the effort involved in providing technical and engineering services to the platform manufacturer or integrator during the installation and integration of the Mission System into the host vehicle.
Project Management	This element includes the business and administrative planning, organising, 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. This element includes cost, schedule, performance measurement management, warranty administration, contract management, data management, vendor liaison, subcontract management, risk, IV&V activities, lifecycle cost, transition to operational service, Australian Industry Involvement, and intellectual property.
Systems Engineering	This element includes the technical and management efforts of directing and controlling a totally integrated engineering effort of a system or program. This element includes the effort to define the system and the integrated planning and control of the technical program efforts of design engineering, specialty engineering, production engineering, and integrated test planning This element also includes the effort to transform an operational need or statement of deficiency into a description of system requirements and a preferred system configuration.

[17] The actual definitions for these (and other) WBS Elements will be defined in the contract.

WBS Element	Definition
Verification and Validation	This element includes V&V management and infrastructure for both the Mission System and the Support System as well as the actual V&V for all phases of the project. This element includes processes that demonstrate that the engineering design and development process is complete, demonstrate that the design risks have been minimised, demonstrate that the system will meet specifications and determine whether the engineering design is supportable (practical, maintainable, safe, etc.) for operational use. This element includes such tests as system demonstration, flight tests, sea trials, mobility demonstrations, stability tests, qualification operational test and evaluation, etc, and support thereto, required to prove the operational capability of the deliverable system This element also includes 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).

RELATIONSHIPS BETWEEN THE WORK BREAKDOWN STRUCTURE AND DISCIPLINES/FUNCTIONS (INFORMATIVE)



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CHECKLIST FOR DEVELOPING AND REVIEWING

WORK BREAKDOWN STRUCTURES (INFORMATIVE)

PROJECT WORK BREAKDOWN STRUCTURE AND PROJECT OFFICE SERVICES WORK BREAKDOWN STRUCTURE

1. Has an analysis been conducted of key project documents (e.g. committee papers, acquisition strategy, and Capability Definition Documents) to identify all of the obligations of the project office?
2. Have all of the Products to be developed been identified and included in the WBS?
3. Have the Enabling Services required to develop the Products been identified and included in the WBS? Do the Project WBS and Project Office Services WBS include all of the relevant Enabling Services from the C2 process framework, 'Acquire Materiel (Systems and Equipment)'?
4. Has the Prime System Integrator (PSI) been identified? If the project office is to be the PSI, does the Project Office Services WBS include the Products and Enabling Services required to undertake this role?
5. Are the Project WBS and Project Office Services WBS Product-oriented?
6. Are the WBS Elements in the Project WBS and in the Project Office Services mutually exclusive?
7. Does each WBS Element represent an aggregation of the Products and Enabling Services listed immediately below it?
8. Are the lower-level WBS Elements necessary and sufficient to deliver the parent WBS Element? Are there any WBS Elements with a single child element?
9. Does a WBS Dictionary definition exist for each Product and Enabling Service in the Project WBS and, during the In-Contract stage, in the Project Office Services WBS?
10. Are the WBS Dictionary definitions sufficient to ensure that the scope of each WBS Element is clear to all members of the project office?
11. Have the Project WBS and, for the In-Contract stage, the Project Office Services WBS been decomposed to a level where accurate estimation of resources and schedules can be made?
12. If the project office is to be the PSI, does the Project Office Services WBS accord with the Requirements and Recommended Practices associated with technical control?
13. Is each item of GFM required to be provided to each contractor identified in the Project Office Services WBS?
14. Are all of the CDRL items listed in each of the contracts identified in the Project Office Services WBS?
15. If any Government Furnished Services are required to be provided to each contractor, are these services identified in the Project Office Services WBS?
16. Are all of the Enabling Services arising out of each of the contracts (e.g. attendance at Mandated System Reviews and Progress Meetings, optional attendance at Internal Reviews, witnessing of Acceptance Verification, coordination of Acceptance Validation, and management of Independent Verification and Validation (IV&V)) identified in the Project Office Services WBS?

CONTRACT WORK BREAKDOWN STRUCTURE

1. Does the CWBS accord with the Requirements and Recommended Practices contained in this DEF(AUST)?
2. Does the CWBS include all of the Products and Enabling Services identified in the contract SOW? Are all of the CDRL items explicitly identified in the CWBS?
3. Are the high-level Enabling Service elements in the CWBS, such as Project Management and Systems Engineering, decomposed into lower-level Enabling Products and Enabling Services, as defined by the contract SOW?
4. Does the Project Authority have the skills necessary to review any proposed CWBS to ensure that it satisfies all of the ADO's technical, as well as cost and schedule, control objectives?
5. Is the specification tree traceable to the customer's originating requirements?
6. Does the PBS for each Mission System within the CWBS consist of the hierarchy of the Component Products defined by the specification tree for that Mission System?
7. Are the Enabling Services needed to develop each Component Product, such as Systems Engineering, Integration and Test, and Project Management, associated with the respective Component Products?
8. Are all costs associated with the development of a Product, including Component Products, associated with that Product?
9. Are costs and schedules associated with the Component Products in the PBS such that each Component Product in the hierarchy has an associated specification, budget and schedule?
10. Does each Component Product CWBS Element appear as a subcontract that can be considered as either an internal subcontract or an external subcontract to the organisation?
11. Does each CWBS Element have a corresponding CWBS Dictionary definition that describes the total scope of work associated with that WBS Element?
12. Is the CWBS structured such that a single person or organisation can be held responsible for the delivery of any Component Product, as defined by the specification tree?
13. Is all of the material required to be provided to each subcontractor by the contractor identified in the CWBS?
14. Are all of the subcontract CDRL items listed in each of the subcontracts identified in the CWBS?

OBTAINING AUSTRALIAN DEFENCE STANDARDS

Australian Defence Standards and other listed Applicable Documents may be obtained from the following Defence Technical Standards Document Centres listed below:

DEPARTMENT OF DEFENCE (Maritime)
Director Naval Platform Systems
Department of Defence (Navy Office)
Campbell Park Offices (CP1-4-16)
CANBERRA ACT 2600
Attention: NMR Standards Centre
Telephone: (02) 6266 2906/2946
Facsimile: (02) 6266 4994

DEPARTMENT OF DEFENCE (Land)
Land Engineering Agency
Attention: Equipment Information Officer
Raleigh Road
MARIBYRNONG VIC 3032
Postal Address: Private Bag 12
PO ASCOT VALE VIC 3032
Attention: Equipment Information Officer
Telephone: (03) 9319 5385
Facsimile: (03) 9319 5382
Army Standardisation:
http://www.leaweb.lsd.defence.gov.au/SPECS/Triservice/Directory.htm

DEPARTMENT OF DEFENCE (Aerospace)
Specifications and Standards
Defence Air Publications Agency (DAPA)
RAAF Williams
LAVERTON VIC 3027
Telephone: (03) 9256 4179
Facsimile: (03) 9256 4178
Defence Air Publications Agency (DAPA)
http://wil_rpums1.raaf.defence.gov.au/specstds/htmlfiles/specstd.htm

DOCUMENT IMPROVEMENT PROPOSAL

DEF(AUST) 5664 ISSUE A

WORK BREAKDOWN STRUCTURES FOR DEFENCE MATERIEL PROJECTS

The purpose of this form is to solicit comments to assist in maintaining the above document as both practical and realistic. When completed, the form and any additional papers should be forwarded to the sponsoring organisation identified in the front matter pages.

Note Comments submitted do not constitute or imply authorisation to waive any requirement of the document or to amend contractual requirements**.**

1. Has any part of this document created problems or required interpretation in use? Please state paragraph no(s) and any rewording suggested.

2. Has any new technology rendered any process obsolete? Suggestions supported by examples are welcome where the new process/hardware has proved satisfactory.

3. Comments on any requirements considered to be too rigid.

4. Remarks (attach any relevant data that may be of use in improving this document).

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