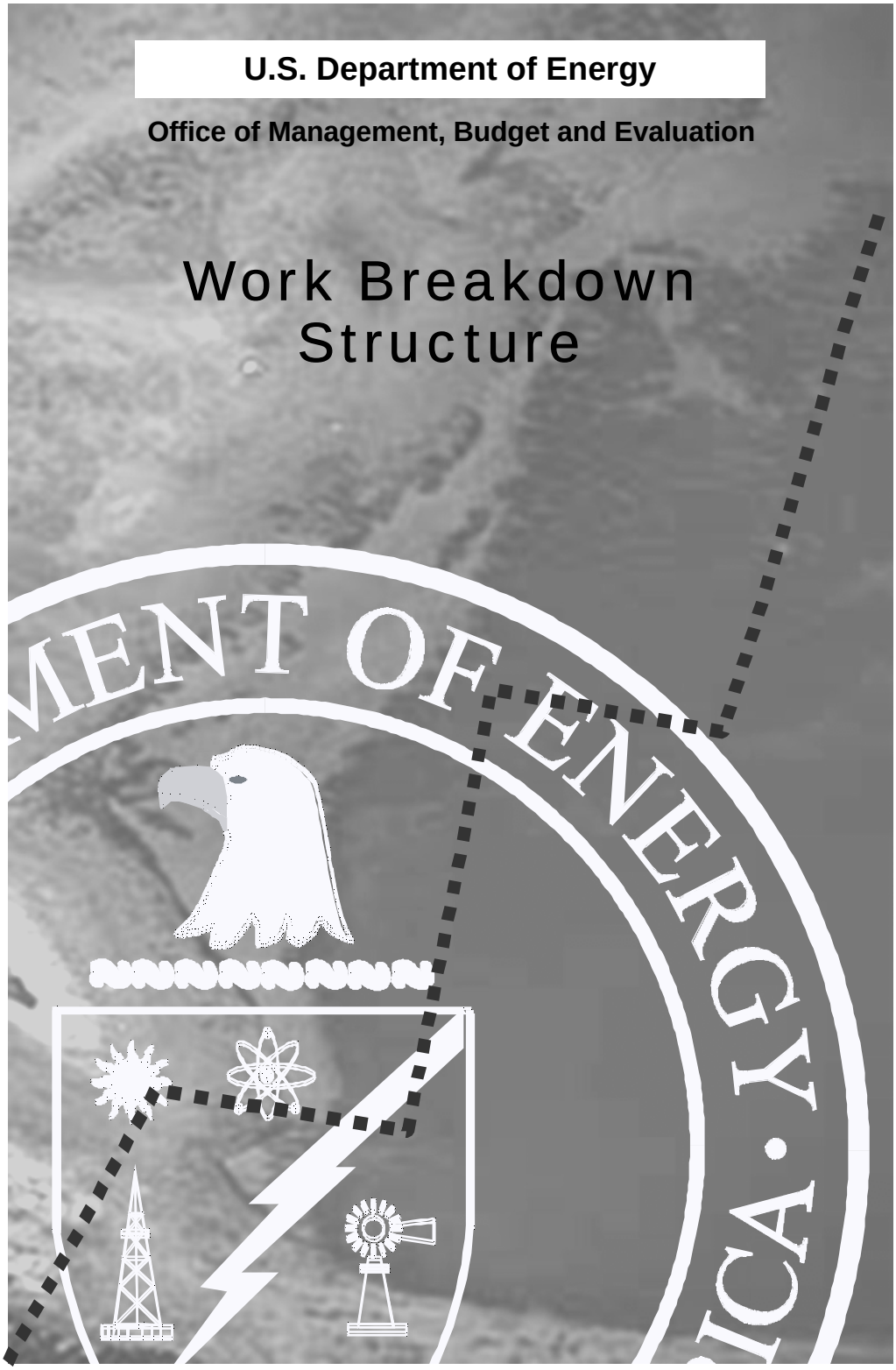
U.S. Department of Energy

Office of Management, Budget and Evaluation

Work Breakdown Structure



Initiated by: Office of Engineering and Construction Management

WORK BREAKDOWN STRUCTURE

A project work breakdown structure (WBS) is a deliverable or product-oriented grouping of project work elements shown in graphical display to organize and subdivide the total work scope of a project.

The WBS is a particularly important project tool. Considerable thought and planning should be given to its development and implementation so that subsequent changes are minimized. Major revisions to a WBS require both substantial effort and resources, due to its application to a wide array of project activities. Project WBSs, which are driven by the scope of a project, should not be confused with other uses of WBS-like systems. MIL-HDBK-881 is the accepted standard on WBS.

1.0 WBS DEVELOPMENT

A WBS is the cornerstone of effective project planning, execution, controlling, statusing, and reporting. All the work contained within the WBS is to be identified, estimated, scheduled, and budgeted. The WBS is the structure and code that integrates and relates all project work (scope, schedule, and cost). Therefore, the WBS contains the project's scope baseline necessary to achieve the technical objectives of the work described. The WBS is used as a management tool throughout the life cycle of a project to identify, assign, and track its total work scope. When initial project funding is received, the Project Director (PD) develops a WBS that identifies necessary funds according to the schedule and needs of the tasks in the WBS elements. The WBS is generally a multi-level framework that organizes and graphically displays elements representing work to be accomplished in logical relationships. The PD is to structure the project work into WBS elements (work packages) that are:

- Definable—can be described and easily understood by project participants.
- Manageable—a meaningful unit of work where specific responsibility and authority can be assigned to a responsible individual.
- Estimateable—duration can be estimated in time required to complete, and cost can be estimated in resources required to complete.
- Independent—minimum interface with or dependence on other ongoing elements (i.e., assignable to a single control account, and clearly distinguishable from other work packages).
- Integratable—integrates with other project work elements and with higher level cost estimates and schedules to include the entire project.

- Measurable—can be used to measure progress; has start and completion dates and measurable interim milestones.
- Adaptable—sufficiently flexible so the addition/elimination of work scope can be readily accommodated in the WBS framework.

Relationships among WBS elements and detailed descriptions of each element are presented in the WBS dictionary accompanying the hierarchical diagram. The WBS dictionary is a key project definition tool that defines in-depth the scope for each work element; documents assumptions about the work, including deliverables, milestones/key performance parameters, and quantities (if applicable); lists required resources and processes to accomplish the work; identifies a completion schedule, including measurable milestones; and provides links to key technical design or engineering documents.

Within DOE, there are typically two types or levels of WBSs that are developed to correspond to different needs:

- *The Project Summary WBS*. This WBS summarizes an entire project and usually consists of three levels of project and work definition. This WBS may serve as a starting point for contractors to develop their own contract-specific WBS. The Project Summary WBS is the responsibility of the integrated project team A typical project summary WBS is shown in Figure 1.
- *The Contractor WBS*. This WBS is developed by individual project contractors, based on the scope of the contract work. The contractor is generally responsible for extending the Project Summary WBS elements to create the Contractor WBS, for DOE evaluation. The Contractor WBS is built based on the scope and deliverables that are in the contract—not force-fit to the Project Summary WBS. The Contractor WBS should provide the basis for all management activities between the contractor and DOE; ensure agreement on scope, schedule, and cost; and serve as the basis for contractor accountability and reporting. A contractor WBS is shown in Figure 2.
    - The WBS hierarchical methodology includes all project phases, critical decision points, and other activities required. However, a project WBS is to be deliverable-oriented. Even though various organizational functions and project deliverables are involved, they should be related to the individual breakdowns, not aligned with a given organization. The following elements are <u>not</u> included in a WBS:

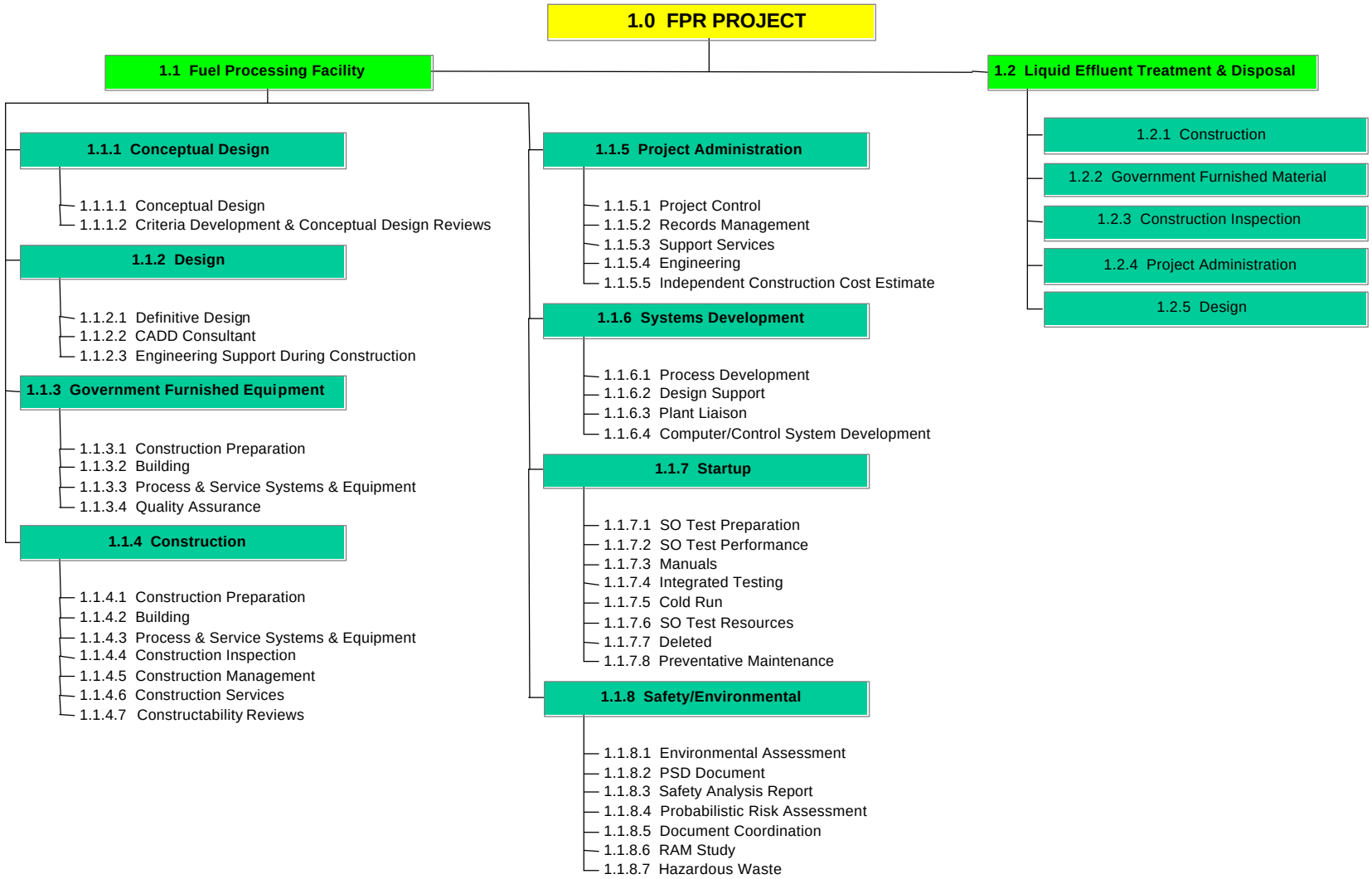


Figure 1. Project Work Breakdown Structure

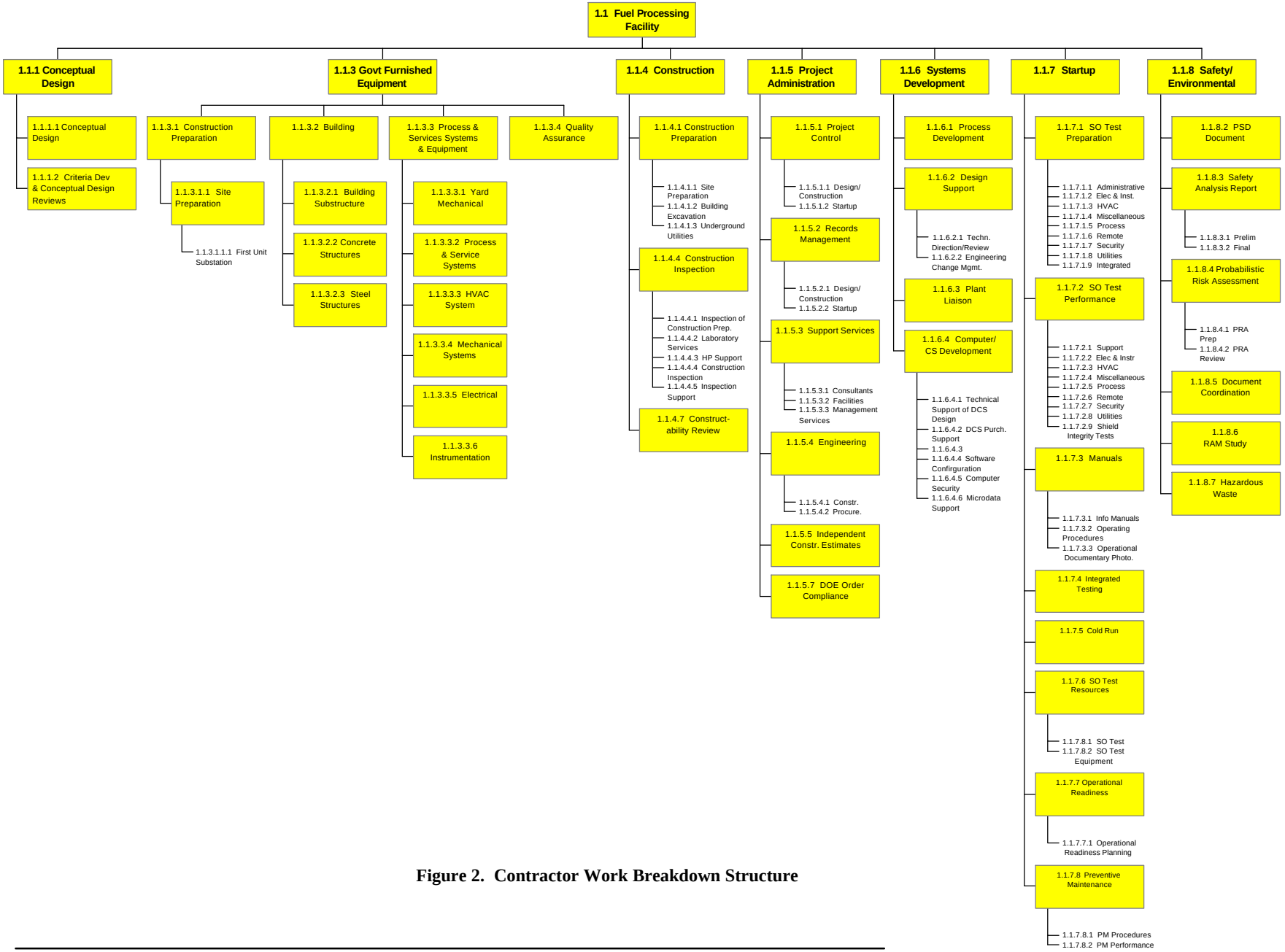


Figure 2. Contractor Work Breakdown Structure

- Do not include elements that are not products. A signal processor, for example, is clearly a product, as are mock-ups and computer software configuration items. On the other hand, things such as design engineering, requirements analysis, test engineering, aluminum stock, and direct costs, are not products. Design engineering, test engineering, and requirements analysis are all engineering functional efforts; aluminum is a material resource; and direct cost is an accounting classification. Thus, none of these are appropriate WBS elements.
- Program phases (e.g., design, development, production, and types of funds, or research, development, test and evaluation) are inappropriate as elements in a WBS.
- Rework, retesting and refurbishing are not separate elements in a WBS. They should be treated as part of the appropriate WBS element affected.
- Non-recurring and recurring classifications are not WBS elements. The reporting requirements of the contract will segregate each element into its recurring and non-recurring parts.
- Cost-saving efforts such as total quality management initiatives and warranty are not part of the WBS. These efforts should be included in the cost of the item they affect, not captured separately.
- Do not use the structure of the program office or the contractor's organization as the basis of a WBS.
- Do not treat costs for meetings, travel, computer support, etc. as separate WBS elements. They are to be included with the WBS elements with which they are associated.
- Use actual system names and nomenclature. Generic terms are inappropriate in a WBS. The WBS elements should clearly indicate the character of the product to avoid semantic confusion. For example, if the Level 1 system is vitrification, then the Level 2 item (prime mission product) is melter.
- Treat tooling as a functional cost, not a WBS element. Tooling (e.g., special test equipment, and factory support equipment like assembly tools, dies, jigs, fixtures, master forms, and handling equipment) should be included in the cost of the equipment being produced. If the tooling cannot be assigned to an identified subsystem or component, it should be included in the cost of integration, assembly, test, and checkout.
- Include software costs in the cost of the equipment. For example, when a software development facility is created to support the development of software, the effort associated with this element is considered part of the computer

software configuration items it supports. If more than one item is involved, the software effort should be included under integration, assembly, test, and checkout. Software developed to reside on specific equipment must be identified as a subset of that equipment. Organizational elements do intersect the WBS, see Figure 3, but are not the WBS.

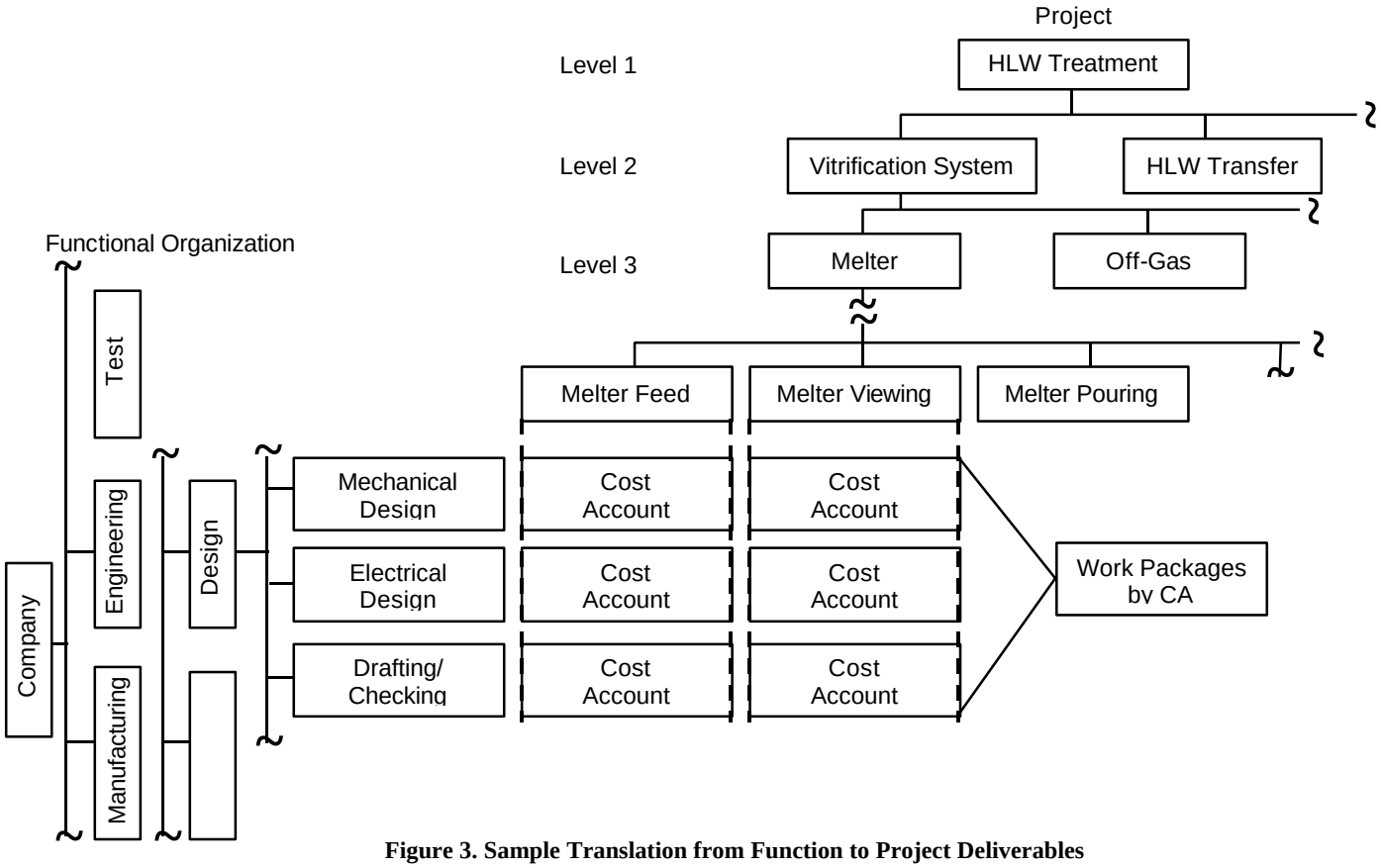


Figure 3. Sample Translation from Function to Project Deliverables

A WBS is a critical tool for organizing work, building realistic schedules and cost estimates, and reporting/tracking/controlling. It is developed and used for all projects and, in the Program Manager's case, is used for all programs. During WBS development, the WBS structure should be designed with sufficient flexibility so that future activities, elimination of work scope, and addition of work scope can be easily accommodated.

As appropriate, project team members should be involved in the design, review, comment, and approval of the WBS. In addition, project team members should be directly involved in developing the WBS dictionary, particularly those pages that describe their respective assigned scopes of work. Once completed and issued, the PD/Project Manager (PM) should conduct training sessions for project management, the Integrated Project Team and the project team in the organization/ structure, composition, purpose, value, and use of the WBS

and dictionary. Both documents should be maintained under change control, but should also be widely distributed.

The PD/PM can use the WBS as a framework for defining and assigning work, scheduling and estimating, budgeting and costing, reporting progress, managing funds, and controlling changes.

PDs/PMs have flexibility in developing WBSs to meet their objectives, and for managing, organizing, and reporting. The PD/PM can categorize work into a WBS in several ways, but they are to be based on the products or deliverables.

As can be seen, the project WBS is a useful and powerful project management tool because of its wide applicability, diversity, and flexibility.

WBSs can be developed from top-to-bottom or from bottom-to-top. The top-to-bottom approach allows for fewer initial assumptions about the structure of the project, since it begins with identifying only the major project deliverables, requirements or objectives, as opposed to starting with the most detailed, lowest level work elements in the bottom-to-top approach. In the top-to-bottom approach, the PD/PM identifies and defines all major project requirements, tasks or deliverables; groups similar units; and divides requirements into smaller, more defined elements until a work scope, schedule, and cost can be assigned to each element. The number of levels needed in the WBS depends on the project's size and complexity, technical uncertainty, organizational constraints, and contractor management's assessment of need. A good rule of thumb is to restrict the number of levels to those necessary for effective project management, and full definition of all required work; this is the tailored approach. In all cases, the WBS is a living document that changes as a project's scope and needs evolve.

Each element of the WBS is assigned its own numerical code to identify it throughout the life of the project. The coding system is hierarchical and represents the logical connection between an element and lower level subordinate elements (e.g., 1.0, 1.1, 1.1.1, 1.1.2, 1.2, 1.2.1, etc.). All codes in a project WBS are consistent with and traceable to WBSs at other responsibility levels. For instance, a Contractor WBS is logically traceable to the Project Summary WBS, which is in turn is traceable to the Program WBS.

2.0 WBS DICTIONARY

A WBS dictionary is a set of specific definitions that thoroughly describe the scope of each work element identified in the WBS. The WBS dictionary defines each WBS element down to the control account or work package level in terms of the content of the work to be performed. The dictionary is comprised of two components:

- A tabular summary of the dictionary elements cross-referenced to the WBS indenture level, the WBS revision, the element title, the project contractor WBS code, and (if desired) the contractor's accounting code.
- A work element dictionary sheet that provides the title of the work element, the project contractor WBS and the contractor's accounting codes, the budget and reporting number, and a detailed description of the work to be performed by this element, including deliverables.

Examples of these two documents are provided in Figures 4 and 5.

3.0 ORGANIZATIONAL BREAKDOWN STRUCTURE

Through the WBS, work is defined to a level where unique organizational and personal responsibilities can be established. This may occur at any one of several levels within the project and functional organization. The individual assigned responsibility for accomplishing work at the control account level is often designated a control account manager. Control accounts are divided into smaller, discrete scopes of work called work packages, and a work package manager is assigned to each work package. Integrating the WBS with the project and functional organizations assures that all contract work is accounted for, and that each element of work is assigned to the level of responsibility necessary for planning, tracking progress, accumulating costs, and reporting. Assignment of responsibility is depicted on a responsibility matrix discussed in Section 4.

Determining whether a specific scope of work is to be performed in-house or by a subcontractor or supplier is done through the use of the Make-or-Buy Plan. This plan helps define the project's acquisition management approach. This determination also enables performance of work at least cost, minimum technical risk and maximum competition, and with both customer and stakeholder involvement. However, all work scope, whether performed in-house or through a subcontract, is included in the WBS, and the WBS dictionary, and is contained in a control account(s).

Figure 4. Project Work Breakdown Structure Dictionary

PART 1 – INDEX

Indenture Level 1	2	3	4	5	Element Title	Project CWBS Code
X					FPR Project	1
	X				Fuel Processing Facility	1.1
		X			Conceptual Design	1.1.1
			X		Conceptual Design	1.1.1.1
			X		Criteria Development	1.1.1.2
		X			Government Furnished Equipment	1.1.3
			X		Construction Preparation GFE	1.1.3.1
				X	Site Preparation (CP–1A) GFE	1.1.3.1.1
			X		Building GFE	1.1.3.2
				X	Building Substructure (CP–2B) GFE	1.1.3.2.1
				X	Concrete (CP-3A)GFE	1.1.3.2.2
				X	Steel Structure (CP–3B) GFE	1.1.3.2.3
			X		Process and Service Systems	1.1.3.3
				X	Yard Mechanical (CP-5A) GFE	1.1.3.3.1
					X Process/Service (CP-5B) GFE	1.1.3.3.2
		X			HVAC Systems (CP-5C) GFE	1.1.3.3.3
				X	Mechanical Systems (CP-5D) GFE	1.1.3.3.4
				X	Electrical (CP-6A) GFE	1.1.3.3.5
				X	Instrumentation (CP-6B) GFE	1.1.3.3.6
			X		Quality Assurance	1.1.3.4
		X			Construction	1.1.4
			X		Construction Preparation	1.1.4.1
				X	Site Preparation (CP-1A)	1.1.4.1.1
				X	Building Excavation (CP-1B)	1.1.4.1.2
				X	Underground Utilities (CP-2C)	1.1.4.1.3
			X		Construction Inspection	1.1.4.4
				X	Inspection of Construction Preparation	1.1.4.4.1
				X	Laboratory Services	1.1.4.4.2
				X	HP Support	1.1.4.4.3
					X Inspection of Construction Utilities	1.1.4.4.4
				X	Inspection Support	1.1.4.4.5
			X		Constructability Review	1.1.4.7

PART 1 – INDEX (cont.)

Indenture Level 1	2	3	4	5	Element Title	FPR Project CWBS Code
		X			Project Administration	1.1.5
			X		Project Control	1.1.5.1
				X	Design/Construction	1.1.5.1.1
				X	Startup	1.1.5.1.2
			X		Records Management	1.1.5.2
				X	Design/Construction	1.1.5.2.1
				X	Startup	1.1.5.2.2
			X		Support Services	1.1.5.3
				X	Consultants	1.1.5.3.1
				X	Facilities	1.1.5.3.2
				X	Management Services	1.1.5.3.3
			X		Engineering	1.1.5.4
				X	Construction Eng.	1.1.5.4.1
				X	Procurement Eng.	1.1.5.4.2
			X		Indep. Constr. Cost Est.	1.1.5.5
			X		DOE Order Compliance	1.1.5.7
		X			Systems Development	1.1.6
			X		Process Development	1.1.6.1
			X		Design Support	1.1.6.2
				X	Tech. Direction and Review	1.1.6.2.1
				X	Eng. Change Management	1.1.6.2.2
			X		Plant Liaison	1.1.6.3
			X		Computer/CS Development	1.1.6.4
				X	Tech. Support of DCS Design	1.1.6.4.1
				X	DCS Purchase Support	1.1.6.4.2
				X	Combined with 1.1.6.4.2	1.1.6.4.3
				X	Software Configuration	1.1.6.4.4
				X	Computer Security	1.1.6.4.5
				X	Microdata Support	1.1.6.4.6
		X			Startup	1.1.7
			X		SO Test Preparation	1.1.7.1
				X	Administrative	1.1.7.1.1
				X	Electrical and Instr.	1.1.7.1.2
				X	HVAC	1.1.7.1.3
				X	Miscellaneous	1.1.7.1.4
				X	Process	1.1.7.1.5
				X	Remote	1.1.7.1.6

PART 1 – INDEX (cont.)

Indenture Level 1	2	3	4	5	Element Title	FPR Project CWBS Code
				X	Security	1.1.7.1.7
				X	Utilities	1.1.7.1.8
				X	Integrated	1.1.7.1.9
			X		SO Test Performance	1.1.7.2
				X	SO Testing Support	1.1.7.2.1
				X	Electrical and Instrumentation	1.1.7.2.2
				X	HVAC	1.1.7.2.3
				X	Miscellaneous	1.1.7.2.4
				X	Process	1.1.7.2.5
				X	Remote	1.1.7.2.6
				X	Security	1.1.7.2.7
				X	Utilities	1.1.7.2.8
				X	Shield Integrity Tests	1.1.7.2.9
			X		Manuals	1.1.7.3
				X	Information Manuals	1.1.7.3.1
				X	Operating Procedures	1.1.7.3.2
				X	Op. Documentary Photography	1.1.7.3.4
			X		Integrated Testing	1.1.7.4
			X		Cold Run	1.1.7.5
			X		SO Test Resources	1.1.7.6
				X	SO Test Spares	1.1.7.6.1
				X	SO Test Equipment	1.1.7.6.2
			X		Operational Readiness	1.1.7.7
				X	Operational Readiness Planning	1.1.7.7.1
			X		Preventive Maintenance	1.1.7.8
				X	PM Procedures	1.1.7.8.1
				X	PM Performance	1.1.7.8.2
		X			Safety/Environmental	1.1.8
			X		PSD Document	1.1.8.2
			X		Safety Analysis Report	1.1.8.3
				X	Preliminary SAR	1.1.8.3.1
				X	Final SAR	1.1.8.3.2
			X		Probabilistic Risk Assessment	1.1.8.4
				X	PRA Preparation	1.1.8.4.1
				X	PRA Review	1.1.8.4.2
			X		Document Coordination	1.1.8.5
			X		R/A/M Study	1.1.8.6
			X		Hazardous Waste Program	1.1.8.7

X		Action Teams	1.1.9
	X	Recovery Action Teams	1.1.9.1
	X	Rebaselining	1.1.9.2
		X Rebaselining/Operating	1.1.9.2.1
		X Rebaselining/Capital	1.1.9.2.2

Figure 5. Work Breakdown Structure Dictionary

PART II – ELEMENT DEFINITION

Program Title _____ **Project No**._____
Contractor_____
Contract No. _____

Indenture Level	**CWBS Code**	**Title:**	**Date:**
5	1.1.3.3.3	HVAC Systems	
Revision No.	**Approved Changes:**		
6			
Accounting Code:		**Budget and Reporting Number:**	

Element Task Description:
Work Statement (cont.)

50 Filter Holding Frames
200 Fasteners
50 Air Filters
10 Air Handling Units
12 Exhaust Air Fans
8 Supply Air Fans
2 Air Washers
136 Automatic Control Valves
517 Manual Volume Dampers
1 Helium Leak Test
53 Backdraft Dampers
71 Fire Dampers
6 Flanges
2 Cell Supply Electric Duct Heaters
1 Decon Exhaust Electric Duct Heater
1 Steam Humidifier
1 Roof Penthouse
12 Heating Water Coils
13 Chilled Water Coils
6 Heat Recovery Water Coils
6 Denitration Glovebox Exhaust Air Filters
4 Steam Unit Heaters
3 Steam Preheating Coils
8 Temperature indicating, controller, room
13 Filter Pressure Differential Indicators
25 Thermal Detectors with Remote Test Heaters
15 Duct Mounted Temperature Sensing Elements and Transmitters
4 Outside Air Temperature Switches

PART II – ELEMENT DEFINITION (cont.)

Program Title _____ Project No._____
Contractor_____
Contract No. _____

Indenture Level	**CWBS Code**	**Title:**	**Date:**
5	1.1.3.3.2	Process/Service Systems Government Furnished Equipment	
Revision No.	**Approved Changes:**		
6			
Accounting Code:		**Budget and Reporting Number:**	

Element Task Description:
Work Statement (cont.)

1 Kerosene Waste Tank
2 Solvent Collection Tanks
2 Solvent Waste Tanks
1 Third Cycle Solvent Feed Tanks
2 Organic Wash Collection Tanks
2 Process Condensate Tanks
2 Uranium Salvage Collection Tanks
2 Pre-Decontamination Sampling Tanks
1 1E Condensate Tank
2 Sodium Carbonate Wash Tanks
6 Decanters
2 CWS Decanters (First, Second, and Third Cycles)
1 Kerosene Wash Decanter
1 OWS Decanter
4 Extraction Columns
3 Scrub Columns
3 Strip Columns
2 Wash Columns
3 Carbonate Wash Columns
2 Acid Wash Columns
1 Denitrator Vessel and Auxiliary Items
1 Denitrator Off-Gas Filter Vessel
4 Evaporators
4 Concentrate Tanks (First and Third Cycles)

4.0 RESPONSIBILITY ASSIGNMENT MATRIX

Once a project WBS and organizational breakdown structure are developed, these documents may be used to develop a project responsibility assignment matrix. This matrix is simply a table for which one axis is the project WBS and the other axis is the project (and support organizations) organizational breakdown structure. Each point at which these two structures intersect becomes a work execution element, and an individual is identified who is responsible for executing the work. If desired, each intersection can also identify the value of that specific element of work in terms of both dollars and hours. An example of a portion of a responsibility assignment matrix is provided in Figure 6.

The development and use of a responsibility assignment matrix provides several advantages for the PD/PM:

- Identifies individual work responsibility and authority in a structured, easily understood format.
- Establishes a basis for a project's records management and configuration management systems.
- Serves as a basis for identifying, planning, progressing, and reporting the work of other organizations, i.e., subcontractors, suppliers.
- Develops and defines individual ownership for specific project tasks.
- Provides a basis for developing budgets, schedules, and milestones; tracking costs and spending; and preparing progress reports.

5.0 CONFIGURATION MANAGEMENT

Once an organizational breakdown structure, a WBS and dictionary, and a responsibility matrix are prepared, approved, and issued, all are maintained under change control, and all proposed changes are evaluated, reviewed, dispositioned, and documented. This is important with these particular documents because they relate to and influence the project's scope, schedule, and cost baselines.

In addition, once responsible individuals are assigned to the work tasks, these individuals assume ownership of the assigned work: baselines, milestones, performance, reporting, changes, procurements, subcontracts, testing, etc. In essence, each of these individuals becomes a sub-project manager for their assigned scope of work.

WBS ID Description	Civil/Structural C. M. Cole	Civil/Structural C. L. Fawcett	Mechanical/Remote A. C. Hohbach	Mechanical/Remote D. J. Harrell	Mechanical/Remote J. Jefimoff
111000 Conceptual Design					
113111 First Unit Substation					
113211 M-S Manip. Wall Tubes			0 $76,200		
113212 Shield Window Liners			0 $724,600		
113213 Shield Doors					
113214 K-Plug Lights			0 $174,400		
113215 Samplers					0 $445,200
113216 Tool Ports and Hatches				0 $200,166	
113231 Bridge Crane					
123100 Construction Inspection					
124100 Project Administration					
Organizational Breakdown Structure Totals	0 $16,077,175	10,163 $1,047,971	0 $975,199	0 $2,201, 728	0 $1,896,829

WBS ID Description	Mechanical/Remote R. M. Murphy	Records Management S. M. Furniss	Const. Management M. Cukers	Construction Eng. T. P. Bailey	Project Assurance J. F. Shaffer
111000 Conceptual Design					
113111 First Unit Substation					
113211 M-S Manip. Wall Tubes					
113212 Shield Window Liners					
113213 Shield Doors	0 $4,045,775				
113214 K-Plug Lights					
113215 Samplers					
113216 Tool Ports and Hatches					
113231 Bridge Crane	0 $476,100				
123100 Construction Inspection					
124100 Project Administration					
Organizational Breakdown Structure Totals	10,032 $7,545,844	103,435 $2,977,248	81,799 $5,437,860	0 $6,799	25,064 $1,994,839

Figure 6. Responsibility Assignment Matrix – Responsible Departments