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1/2	1	Cog.Eng. J. C. Womack		9/5/95	R3-86	J. L. Denning		9-5-95	R3-11	1/2	
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		QA N/A				T. B. Veneziano		9/8/95	X3-71	1/2	
		Safety N/A				M. J. Wiemers		9/5/95	X3-85	1/2	1
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1/2	1	J. C. Fulton		9.25.95	R3-11	G. C. Meeers			R3-11	1/2	1
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7. Abstract

The purpose of this WHC Systems Engineering Management Plan (SEMP) is to describe the systems engineering approach and methods that will be integrated with established WHC engineering practices to enhance the WHC engineering management of the SNF Project. The scope of the SEMP encompasses the efforts needed to manage the WHC implementation of systems engineering on the SNF Project. This implementation applies to, and is tailored to the needs of the SNF Project and all its subprojects, including all current and future subprojects.

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SPENT NUCLEAR FUEL PROJECT
SYSTEMS ENGINEERING MANAGEMENT PLAN

Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

August 1995

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1.0 INTRODUCTION

1.1 PURPOSE

The strategy to accomplish the Spent Nuclear Fuel (SNF) Project mission and objectives includes the implementation of systems engineering. Systems engineering is a disciplined approach to managing the project from top to bottom and from cradle to grave, to ensure that the project is doing the "right" things.

The Purpose of this Westinghouse Hanford Company (WHC) Systems Engineering Management Plan (SEMP) is to describe the systems engineering approach and methods that will be integrated with established WHC engineering practices to enhance the WHC engineering management of the SNF Project. It is not a complete treatise on the systems engineering discipline. The format and content of this SEMP has been tailored to meet the specific needs of the SNF Project.

This SEMP is to satisfy the requirements set forth in the following documents:

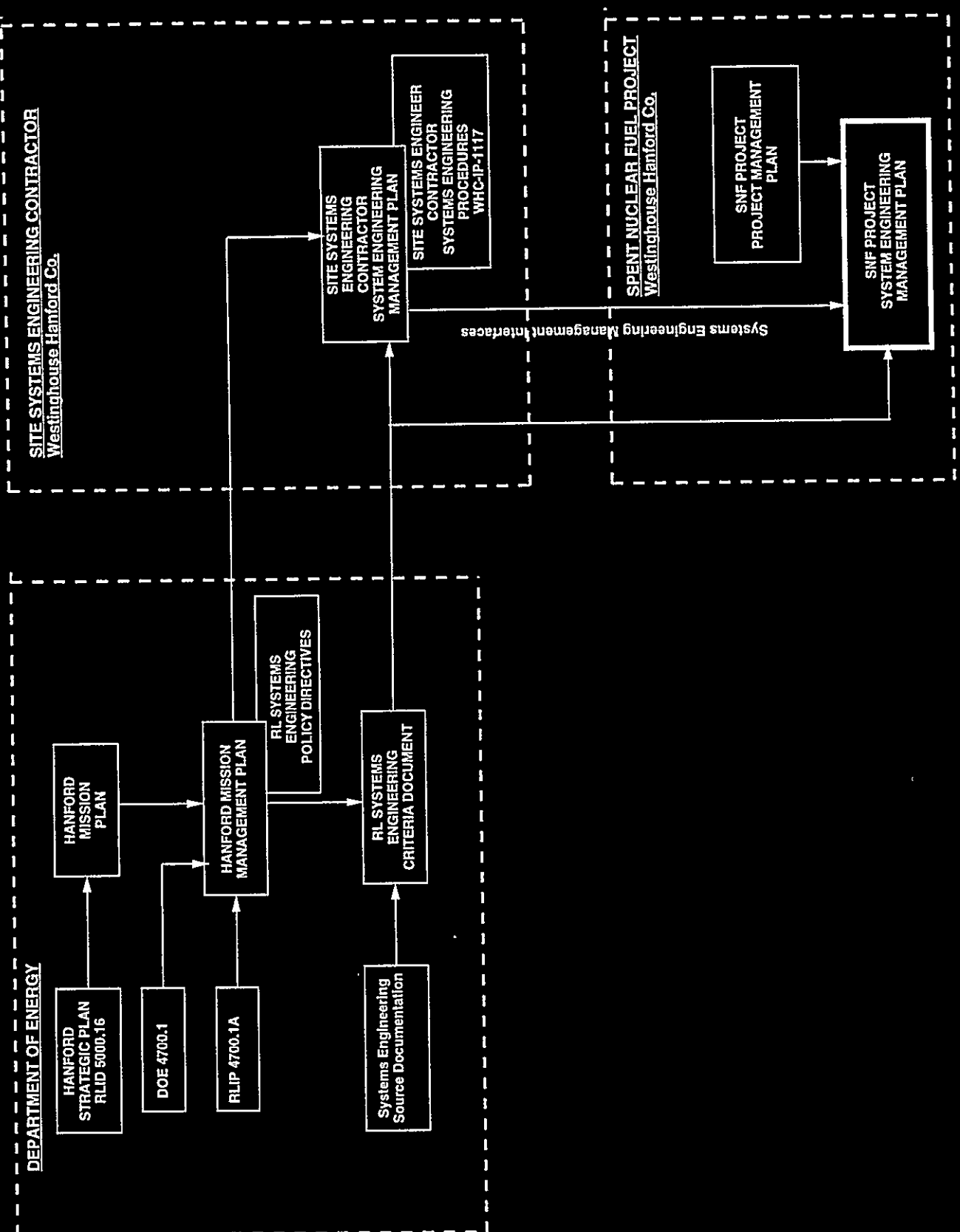
- *Systems Engineering* (DOE RLPD 4900.1), which directs that systems engineering be implemented at the Hanford site.
- *Project Management System* (DOE Order 4700.1), Chapter III, which states that the systems engineering management process is normally controlled by adherence to a SEMP, prepared and maintained at the project level.
- The *Spent Nuclear Fuel Project Management Plan* (WHC-SD-SNF-PMP-001), which directs that a SEMP will be developed for the SNF Project.
- *Site Systems Engineering Implementation Plan*, (DOE/RL-95-31, Rev. 0), which provides direction on the implementation of systems engineering at Hanford.

1.2 SCOPE AND CONTEXT

The scope of this SEMP encompasses the efforts needed to manage the WHC implementation of systems engineering on the SNF Project. This implementation applies to, and is tailored to the needs of the SNF Project and all its current and future subprojects, where the "projects" and sub-tier activities subservient to the SNF Project are referred to as subprojects. Each subproject is an organizational entity, managed as a project responsible for design, development, fabrication and test of a product. This includes project scope, configuration, cost, schedule, and performance. Participation in the subprojects is by a team including all appropriate disciplines, including operations. Each subproject may prepare its own management plan and may prepare a systems engineering management plan. A subproject SEMP is not needed if the SNF Project SEMP is adequate as tailored in the subproject management plan. Size of the subproject is an important factor in determination of the need for a separate SEMP. After operations begin a modified process, tailored to maintenance and operations is needed. This process is not included in this SEMP.

The relationship of this SEMP to the other systems engineering guidance documents is shown in Figure 1-1. The content of the WHC SNF Project SEMP will

Figure 1-1
SNF Project SEMP Context



be in agreement with the yet to be published WHC Hanford Site SEMP, the U.S. Department of Energy, Richland Operations Office (RL) Systems Engineering Implementation Plan (DOE/RL-95-31), and the SNF Project Management Plan (WHC-SD-SNF-PMP-001). All other systems engineering interfaces will be through these documents.

2.0 SYSTEMS ENGINEERING ROLES AND RESPONSIBILITIES

2.1 SNF PROJECT

The roles and responsibilities of the SNF Project organization are defined in the SNF Project Management Plan (PMP). This section of the SEMP identifies the roles and responsibilities associated with the SNF Project Systems Engineering and Integration (SE&I) Organization.

Systems engineering as implemented in the SNF Project is dependent on the involvement of all SNF Project organizations in the development and implementation of the systems engineering processes, documents and procedures, as defined in Sections 3 and 4 below. Systems engineering core competency, consistency between subprojects, and maintenance of the project technical baseline will be provided by the SNF Project SE&I Organization. The SE&I Organization personnel will facilitate the development and upkeep of systems engineering processes, databases and documentation products throughout the life of the SNF Project.

The overall SNF Project Division of Responsibility Matrix is contained in the SNF Project PMP. Also, the PMP provides additional information on management organization and responsibilities for the SNF Project as a whole. The responsibilities for all systems engineering tasks, as defined below, are presented with the description of the tasks.

2.2 SNF PROJECT SUBPROJECTS

On the subproject level, each subproject is responsible for product scope, configuration, cost, schedule, and performance. The role of SNF Project SE&I Organization in the subprojects is to integrate the subproject systems engineering efforts with those of the SNF Project, other subprojects, the National SNF Program (EM-37), and the Hanford Site Systems Engineering. The SE&I Organization will facilitate the development and maintenance of functions and requirements documents (FRDs)/ specifications, risk management, interface control, and configuration management, as required below.

Once the FRD/specifications are in place, the role of the SE&I Organization will shift to that of support of verification and validation that requirements are being met, change management, continued integration of the subprojects, which includes interface control, and configuration control. Change management includes risk, decision, and issues management. These efforts will continue up to the time that the individual SNF Project subsystems become operational.

3.0 SYSTEMS ENGINEERING TECHNICAL PRACTICES

3.1 INTEGRATED SNF PROJECT ENGINEERING PROCESS

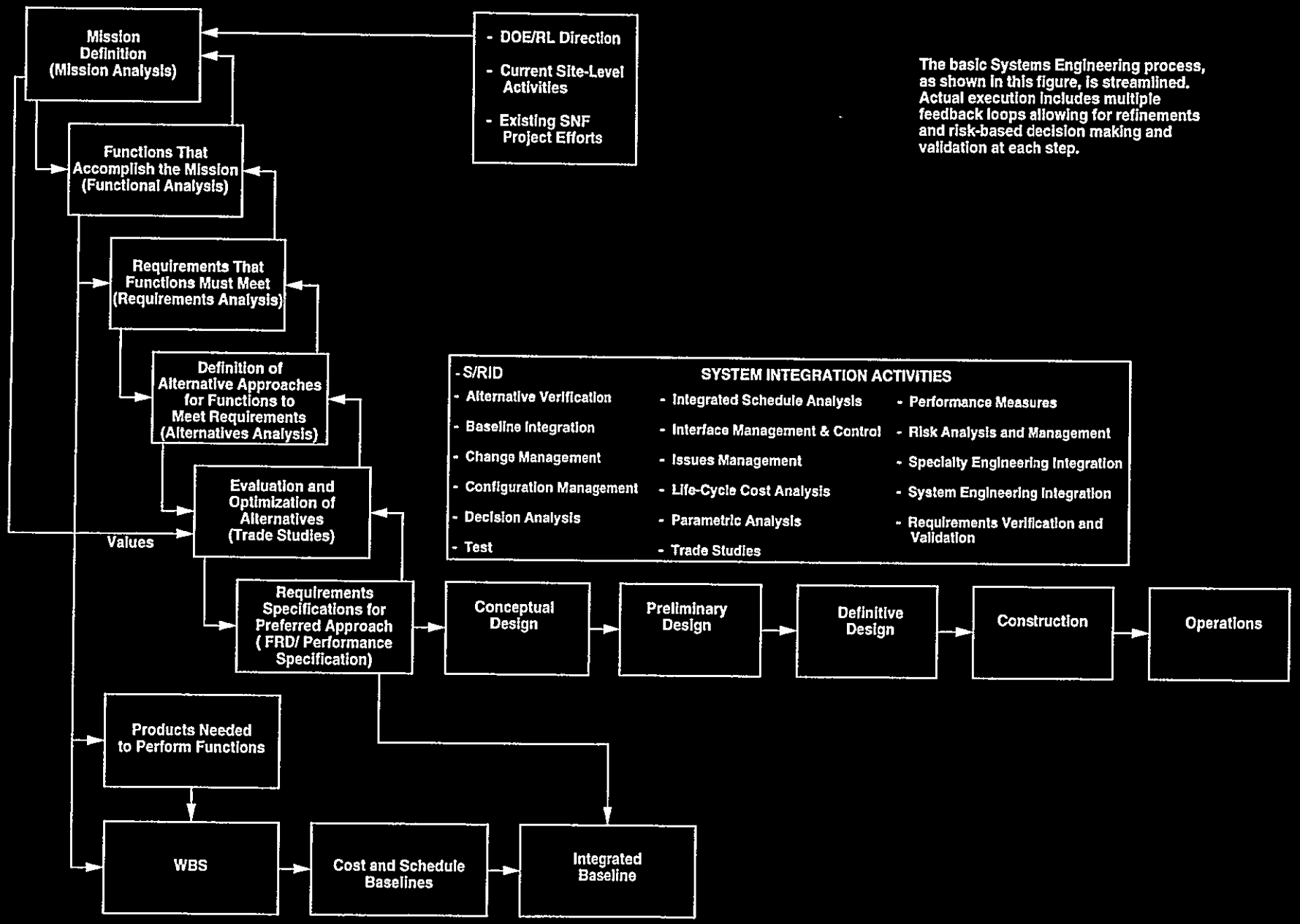
The SNF Project integrated engineering process includes the systems engineering processes. These include the processes by which the SNF Project will define its mission and determine the functions it needs to perform, the requirements that the SNF Project must meet, the structures, systems, and/or components (SSCs) which best meet these requirements, and the verification methods to be used to ensure that the design and operations requirements are met. This integrated process includes the subproject design, development fabrication, and test leading to operations, not ending with the delivery of a performance specification to be used in the subprojects design. Figure 3-1 illustrates the basic integrated SNF Project engineering process. The basic process as shown in this figure is streamlined. Actual implementation requires feedback and interaction loops allowing for refinements and risk-based decision making and validation at each step. The systems engineering portion of this process continues throughout the life of the engineering process. Between the initiation of conceptual design and start of operations, systems engineering activities focus on integration of the SNF Project, project optimization, verification and validation of requirements, and management of change. After operations begin a modified process, tailored to maintenance and operations is needed. This process is not included in this SEMP.

The integrated engineering process will be implemented through the use of the WHC Control Manual system (WHC-CM) and the tailored systems engineering processes found in the Hanford Site Systems Engineering Manual (WHC-IP-1117). The tailored Hanford Site Systems Engineering Manual (WHC-IP-1117) procedures will be used to implement the process unless they are specifically defined in this SEMP.

The system integration activities that continue through the life of the engineering process include:

- Parametric Analysis
- Trade Studies
- Alternative Verification
- Decision Analysis
- Risk Analysis and Management
- Requirements Verification and Validation
- Performance Measures
- Integrated Schedule Analysis
- Life Cycle Cost Analysis
- Asset Life-Cycle Plans
- Specialty Engineering Integration
- Configuration Management
- Change Management
- Interface Management and Control
- Issue Management
- Baseline Integration
- Systems Engineering Integration (Hanford Site and DOE EM-37)
- Systems Test

FIGURE 3-1
SNF Project Integrated Engineering Process



The basic Systems Engineering process, as shown in this figure, is streamlined. Actual execution includes multiple feedback loops allowing for refinements and risk-based decision making and validation at each step.

These processes are primarily managed by other than the SE&I Organization; but like the subproject, they are integrated by the SNF Project SE&I Organization staff assigned to the subprojects to meet the systems engineering objectives.

Figure 3-2 presents a summary of the overall Hanford Site systems engineering process information interfaces. These interfaces provide a means to integrate the systems engineering efforts at Hanford during design, development, fabrication, and test of subsystems.

3.2 SYSTEMS ENGINEERING PROCESSES

The specific processes that make up the systems engineering portions of the integrated engineering process are described below. The processes not defined below are described in WHC-CM-6-1. The *Hanford Site Systems Engineering Manual*, WHC-IP-1117, provides the procedures that will be tailored for application to the below processes.

3.2.1 Mission Analysis

The mission analysis is the first step in the overall process. The purpose of this analysis is to define the project or subproject problem, the initial unacceptable conditions, the acceptable final conditions, external constraints and interfaces, and resources required. It also establishes the basis for developing a system to resolve the project or subproject problem so that the mission can be accomplished. Thus, it defines, scopes and bounds the project or subproject. The Mission Analysis was conducted for the SNF Project in 1994. This is documented in *Spent Nuclear Fuel Project Mission Analysis*, WHC-EP-0790. Mission analyses for the subprojects are not required, but may be conducted if the subproject defines them in their subproject management plans.

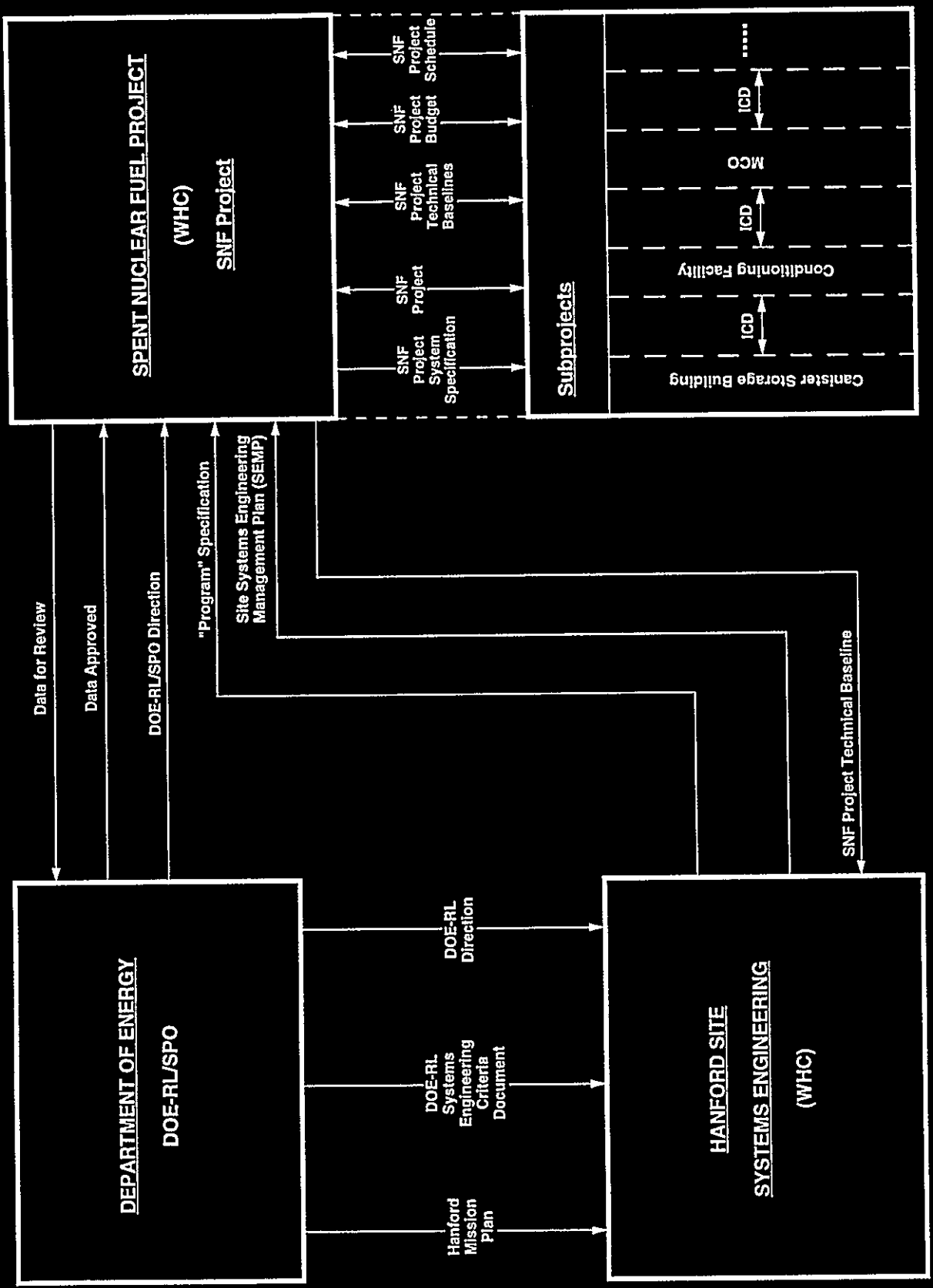
3.2.2 Functional Analysis

The functional analysis identifies the functions that must be performed in order to meet the mission. These functions are then developed at increasingly greater levels of detail in order to provide an increasingly explicit depiction of the mission. In the case of the SNF Project these greater levels of detail become the functions of the subprojects. The SNF Project functions mate to the Hanford site functions and the SNF subprojects function.

3.2.3 Requirements Analysis

Requirements analysis identifies the requirements associated with each function. Requirements define how well a function must be performed. The requirements allocated to a subprojects functions become that subprojects requirements. This analysis uses a top-down allocation of requirements from the primary sources of law, regulations, and DOE direction and orders, as well as requirements derived from studies, analyses, and test.

FIGURE 3-2
Systems Engineering Information Interfaces



A another source of requirements is the Standards/Requirements Identification Document (S/RID) process which identifies and validates environmental, safety, and health requirements for existing and future hazard category 2 facilities of the SNF Project. The S/RID process identifies standards, regulations, orders, and laws, as well as, "Best Commercial Practices" to establish a minimum set of requirements that are necessary and sufficient to implement a sound environmental, safety, and health posture. These requirements are validated and approved by the DOE-RL. The S/RID and systems engineering requirements will be integrated in a manner that is defined by the WHC Hanford Site Integration Organization. During the operation of the K Basins Standards Identification Document (S/RID) are used to document the operational requirements. S/RIDs are also created for hazard category 2 facilities associated with the SNF Project as subprojects. An S/RID source document allocation to functions will be performed prior to development of any requirements documents. The results of this sort is included in the systems engineering database, the subproject F&R document, and the subproject performance specification / FRD.

3.2.4 Alternatives Analysis

The alternatives analysis identifies alternative solutions or SSC configurations (architectures) for functions that meet the requirements of those functions. These analyses are conducted at the project and subproject levels.

3.2.5 Trade Studies

Trade studies are a portion of the engineering process of comparing or trading the strengths and weaknesses of alternative approaches or attributes. They are the basis for selection of alternatives. The trade studies shall include decision criteria that incorporate mission objectives and stakeholder values and that will result in selection of solutions that satisfy the requirements. The decision analysis process to be used is described below. These trade studies are performed at both the project and subproject levels.

3.2.6 Requirements Specification

A requirements specification is a document that is prepared to support development and/or acquisition of a structure, system, and/or component. The requirements specification can take the form of a FRD for WHC internal development use or a performance specification for purpose of acquisition. Further discussion of these documents is found in Section 3.7. These documents are prepared by the subprojects.

3.3 DECISION ANALYSIS

Decision analysis is used to:

- Create logically defensible decisions by documenting the decision process;

- Specify what criteria are to be considered, how the criteria are to be measured and evaluated, and the relative importance of the criteria;
- Clarify the underlying rationale or logic upon which the decision is based; and
- Produce a well-documented decision which can be clearly explained and justified.

The SNF Project uses a tiered approach to decision analysis. Selection of the appropriate decision analysis methods is based on the magnitude and type of decision. This is important since many decisions are based on analyses performed by other contracts and subcontractors, including those associated with established Value Engineering methodology.

The SNF Project performs decision analysis on complex decisions using multi-attribute utility theory. This decision analysis method analyzes the various components of a complex decision separately and then integrates the individual judgements to arrive at an overall decision. Multi-attribute utility theory provides the ability to address qualitative considerations in a quantitative methodology. This decision analysis method is used and documented in Section 5 of Volume 2 of the *Hanford Spent Nuclear Fuel Project Recommended Path Forward* (WHC-EP-0830).

The SE&I Organization maintains a log of the major SNF Project decisions.

3.4 TECHNICAL BASELINE

The SNF Project technical baseline is the documented body of technical information associated with the people, products, and processes required to accomplish the SNF Project's mission. The SNF Project technical, schedule and cost baselines makeup the integrated SNF Project baseline. The relationships of these baselines are illustrated in Figure 3-3. This figure shows the progression from functions and products, to the Work Breakdown Structure (WBS) to the schedule and in turn the cost baselines. The WBS also serves as a basis for the organizational structure of the SNF Project. The current SNF Project is presented in the SNF Project PMP.

Since the SNF Project is made up of subprojects that are at various levels of maturity and development, the technical baseline is composed of the subproject technical baselines that are also at various stages of development. These progressively more detailed technical baselines are called by different names. This progression of technical baselines is described in Table 3-1. Figure 3-4 illustrates the relationship of these baselines to the integrated engineering process. The contents of the technical baseline are primarily documents in the SNF Project that result from other engineering activities. The baseline development process presented reflects the SNF Project's own needs. The SNF Project baseline development integrates with the Hanford site baseline development, as shown in Figure 3-2. Only the Functional Requirements technical baseline shall be developed at both the SNF Project level and at the subprojects level. The development of all other technical baselines is performed by the subprojects.

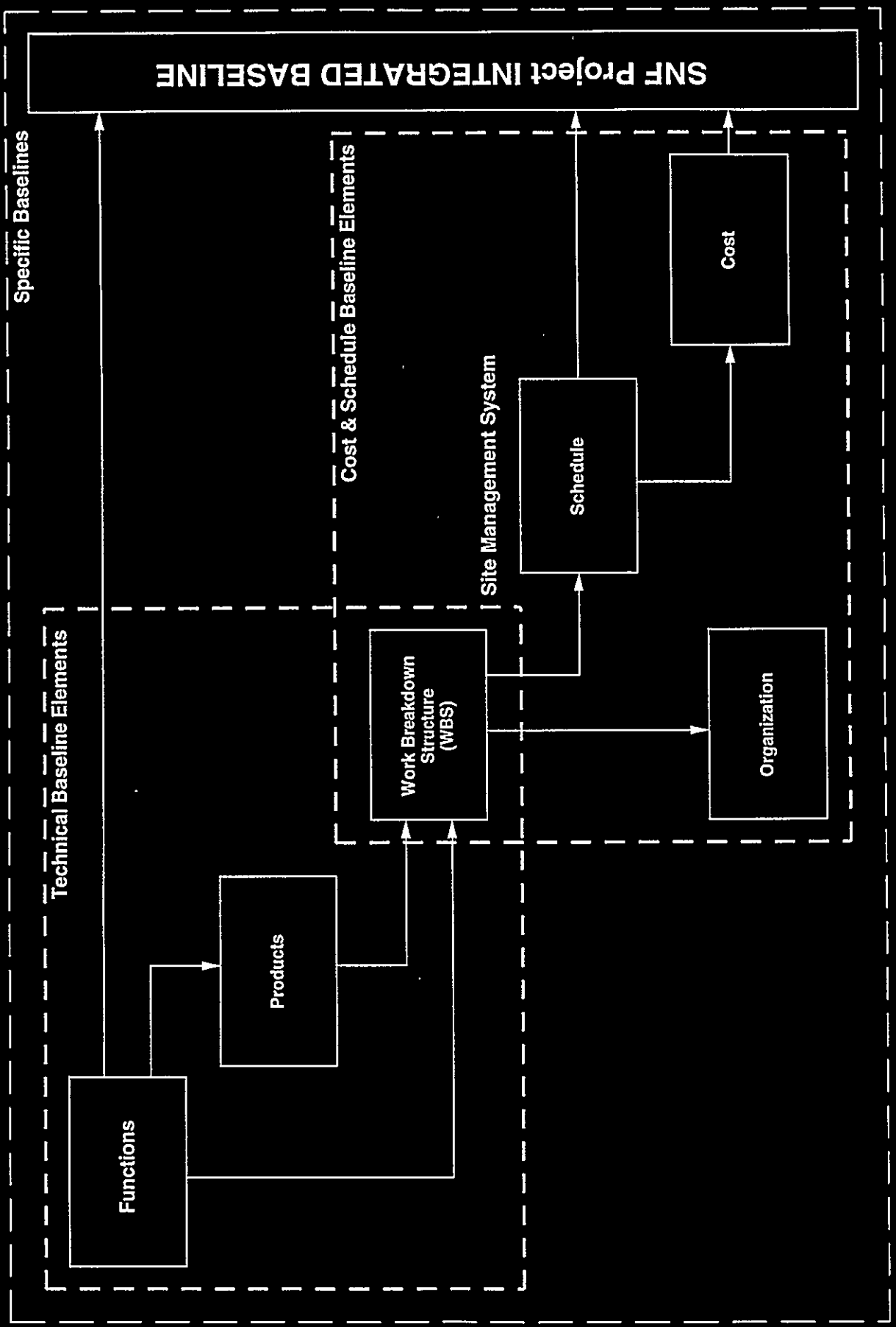


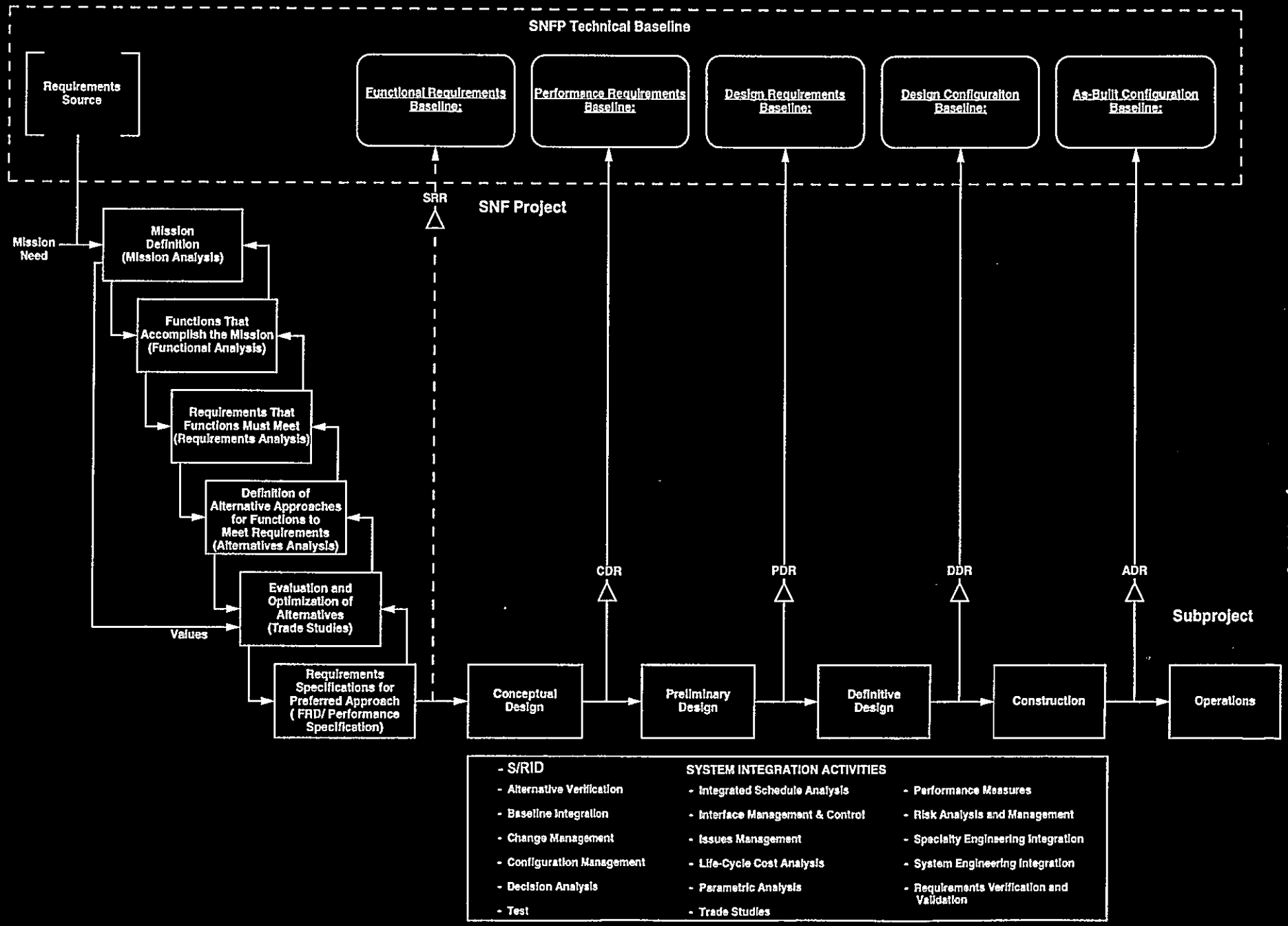
Figure 3-3
Integrated Baseline Development

Table 3-1
SNF Project Technical Baselines

Technical Baseline Title	Documentation	Responsibility
Functional Requirements Baseline	- Project Mission Analysis Report - Project Baseline Concept Description (BCD) - Project Systems Engineering Process Results (Issues, Assumptions, Trade Studies, Risks, and Decisions) - ICD Scope Sheets (major physical interfaces) - SNF Project System FRD (Specification) - Project Functions and Requirements Database	SNF Project
Performance Requirements Baseline	- Subproject FRD and/or Performance Specifications (includes S/RID Source Documents Allocation to Functions) - ICD Scope Sheets - Subproject Conceptual Design Report - Preliminary Safety Analysis Report (PSAR)	Per Subproject Management Plans
Design Requirements Baseline	- Design Specifications - ICDs - Preliminary (Title I) Design Packages - Preliminary Facility* S/RID	Per Subproject Management Plans
Design Configuration Baseline	- Construction Specifications - Test Plans and Procedures - Definitive (Title II) Design Packages - Facility* S/RID	Per Subproject Management Plans
As-Built Configuration Baseline	- Construction Specification Revisions - Test Reports - As-Built (Title III) Design Packages - Operational Procedures - Safety Analysis Report (SAR) - Final Facility* S/RID	Per Subproject Management Plans

* S/RID is prepared for Hazard Category 2 facilities.

FIGURE 3-4
SNF Project Integrated Engineering Process



K Basins Operations is an activity that was established at the time of the establishment of the SNF Project. At that time it was integrated into the SNF Project to continue the maintenance and operations of the K basins in a safe and environmentally compliant manner during the development of the other portions of the SNF Project. As such, Operations has an established As-Built Configuration Technical Baseline, Configuration Management Plan, Operational S/RIDs and Safety Analysis Report, which serves as a basis for management of risk. For these reasons the K basins operations does not need the steps leading to the As-Built Configuration Baseline.

3.4.1 Functional Requirements Baseline

The contents of the SNF Project level Functional Requirements Baseline describe the approach for the SNF Project, top level requirements and constraints, and the top level functional and architectural features. This baseline provides the necessary details for the start of conceptual design of the subprojects. The Functional Requirements Baseline has its basis in the *Systems Engineering Functions and Requirements for the Hanford Cleanup Mission: First Issue*, WHC-EP-0722. This baseline will be developed by analyzing the contents of these site baselines and applying the information to the SNF Project. The SNF Project Functional Requirements Baseline is a component of the Hanford Site Performance Baseline. The SNF Project SE&I Organization shall develop this baseline on the SNF Project level and the subproject teams shall further develop this baseline at the subproject levels.

3.4.2 Performance Requirements Baseline

The contents of each subproject baselines represent the performance requirements and SSC configurations (architectures) chosen to accomplish the SNF Project mission. This baseline forms the basis for initiating preliminary design.

3.4.3 Design Requirements Baseline

The contents of each baseline expand on the technical requirements allocated to each subproject, delineate more detailed derived requirements, and add technical requirements that reflect design configuration (architecture) decisions and preliminary design. These baselines become the basis for definitive design.

3.4.4 Design Configuration Baseline

The contents of this baseline show the progress of the subprojects in refining the design and developing the "build-to" design packages. This baseline forms the basis for the start of construction and test.

3.4.5 As-Built Configuration Baseline

The contents of this subproject baseline documents the completed construction. These baselines are the technical basis for the start of operations. Constituents of the As-Built Configuration Baseline are components of the Site As-Built, Operational, and Deactivation Baselines.

3.5 REVIEWS

This section describes the reviews that the SNF Project and subprojects will undergo. The SNF Project will adapt the review process presented in the Draft *Site Systems Engineering Criteria Document* (DOE/RL-95-58, Rev. E) and the *Site Systems Engineering Implementation Plan*, (DOE/RL-95-31, Rev. 0) to reflect the SNF Project's own needs. Also, each subproject will adapt or tailor the reviews as appropriate to their needs. The number and type of reviews described below are tailored from those described in DOE 4700.1. These reviews are design verification reviews as described in WHC-CM-6.1 EP 4.1 and will be in accordance with this EP as tailored for the subprojects and documented in the PMP for each subproject. Table 3-2 presents a summary of the systems engineering content of the reviews. Figure 3-4 illustrates the relationship of the reviews to the baselines. The SNF Project SE&I Organization will use these reviews to ensure that the efforts of all of the subprojects are integrated.

The verification and validation (V&V) of requirements provides a mechanism to insure that requirements are met by emerging designs. During the reviews described below this SE&I Organization will be responsible for conduct of these V&V functions.

3.5.1 System Requirements Review (SRR)

This review evaluates the Functional Requirements Baseline. The SRR is conducted to gain concurrence on the SNF Project objectives, approach, and top level functions, requirements, architecture, and interfaces. The SRR is conducted by the SNF Project with the SE&I Organization as the lead with DOE-RL/Nuclear Material Division (NMD)co-chairing the review. The DOE-RL Assistant Manager for Waste Management (DOE-RL/AMW)will be the approval authority. The SRR is an SNF Project level review.

3.5.2 Conceptual Design Review (CDR)

These reviews evaluate the Performance Requirements Baseline. These subproject reviews are conducted by SNF Project subprojects. The approval authority is the subproject, per the subproject PMP.

3.5.3 Preliminary Design Review (PDR)

These reviews evaluate the Design Requirements Baselines. These subproject reviews are conducted by SNF Project subprojects. The approval authority is the subproject, per the subproject PMP.

Table 3-2
SNF Project Technical Reviews

Technical Review Title	Systems Engineering Review Content	Review Manager	Review Approval Authority

System Requirements Review (SRR)	- Validate contents of SNF Project
	  - Mission Analysis Report
	  - Baseline System Description (BSD)
	  - System Specification
	  - Functional Definitions
	  - Requirements Database
	  - Risk, Issues, Assumptions, and Trade Studies Identification
	- Verify ICD Scope Sheets (major physical interfaces)
		WHC SNF Project and DOE-RL/NMD	DOE-RL/AWM

Conceptual Design Review (CDR)	- Verify documentation and design conformance to defined functions and requirements - Verify the results of the trade studies conducted as part of the conceptual design - Verify the the existence and compatibility of the interfaces among systems, subsystems, and components - Evaluate the progress on resolution of issues, risk, and assumptions	Subprojects, per Subproject Management Plans	Subprojects, per Subproject Management Plans
Preliminary Design Review (PDR)	- Verify documentation and design conformance to defined functions and requirements - Verify the results of the trade studies conducted as part of the conceptual design - Verify the the existence and compatibility of the interfaces among systems, subsystems, and components - Evaluate the progress on resolution of issues, risk, and assumptions	Subprojects, per Subproject Management Plans	Subprojects, per Subproject Management Plans

Technical Review Title	Systems Engineering Review Content	Review Manager	Review Approval Authority
Definitive Design Review (DDR)	- Verify documentation and design conformance to defined functions and requirements - Verify the results of the trade studies conducted as part of the conceptual design - Verify the the existence and compatibility of the interfaces among systems, subsystems, and components - Evaluate the progress on resolution of issues, risk, and assumptions	Subprojects, per Subproject Management Plans	Subprojects, per Subproject Management Plans
As-Built Design Review (ADR)	- Verify documentation and design conformance to defined functions and requirements this includes test reports - Verify that the requirementshave been met in the system or facility - Verify the the existence and compatibility of the interfaces among systems, subsystems, and components	Subprojects, per Subproject Management Plans	Subprojects, per Subproject Management Plans

3.5.4 Definitive Design Review (DDR)

These subproject reviews evaluate the Design Configuration Baseline. These subproject reviews are conducted by SNF Project subprojects. The approval authority is the subproject, per the subproject PMP.

3.5.5 As-Built Design Review (ADR)

These subsystem reviews evaluate the As-Built Configuration Baseline. The ADRs review the as-built subprojects SSC configurations (architecture) to ensure that the configurations function properly and meet the requirements of the contract and the approved design. These subproject reviews are conducted by SNF Project subprojects. The approval authority is the subproject, per the subproject PMP.

3.6 SYSTEMS ENGINEERING TECHNICAL DOCUMENTATION

Technical documentation consists of documents that contain the information that comprises the SNF Project technical baseline. Table 3-1 presents a list of the SNF Project technical documents and their relationship to the technical baselines. The majority of this documentation is not unique to systems engineering but results from the design documentation required by WHC engineering practices documented in WHC-CM-6-1.

3.7 REQUIREMENTS SPECIFICATION DOCUMENTATION

A requirements specification is a document that is prepared to support development and/or acquisition of a structure, system, and component. The requirements specification can take the form of a FRD or a performance specification. The requirements specifications state performance (technical) and mission requirements and allocate them to functions and systems, subsystems and/or components.

Performance requirements are derived from the functional analysis process by breaking down functions until they become detailed enough to have quantitative values. Once the functions have been decomposed into performance requirements, the performance requirements can be allocated to systems, subsystems and components. Specifications are associated with a system, subsystem and/or component. As performance requirements are allocated to these, the performance requirements are placed in the specification which is associated with that system, subsystem and/or component. Each of the performance specifications is associated with not more than one subproject. The performance specification is for use by the subprojects for purpose of acquiring systems, subsystems, and/or components from other than internal SNF Project subprojects. Performance specifications are to be prepared in accordance with WHC-CM-6-1, EP-1.2 "Engineering Specification Requirements", as single-use, non-construction, engineering specifications. Unless tailored by the subprojects, guidelines for the content and format of these single-use, engineering specifications is contained in WHC-IP-1026, EP G-1.2 and Appendix Q.

The FRD is for use by the SNF Project internal organizations for development of systems, subsystems and/or components. Unless tailored or replaced by the subprojects, the FRDs adhere to the guidelines for the content and format of single-use, engineering specifications found in WHC-IP-1026, EP G-1.2 and Appendix Q, as appropriate.

The SNF Project System FRD (Specification) states the technical and mission requirements for the SNF Project as an entity, allocates requirements to functions, documents design constraints, and defines the interfaces between or among the functions. The Hanford Site level requirements on the SNF Project will be provided to the SNF Project in this specification. This document will have the tailored format of the FRD.

The subprojects may define a need for a F&R document. This document may be used as a source of operational requirements for the development of the operational procedures. This document is a statement of the subproject functions and requirements to a level consistent with the subproject objective. The SE&I Organization supports the development of this document and insures that it is consistent with the subproject performance specification/FRD.

During the operation of the K Basins Standards Identification Document (S/RID) are used to document the operational requirements. S/RIDs are also created for hazard category 2 facilities associated with the SNF Project as subprojects. An S/RID source document allocation to functions will be performed prior to development of any requirements documents. The results of this sort is included in the systems engineering database, the subproject F&R document, and the subproject performance specification / FRD.

4.0 SYSTEMS ENGINEERING MANAGEMENT PRACTICES

4.1 FUNCTIONS AND REQUIREMENTS MANAGEMENT

Requirements traceability ensures that the technical basis for engineering decisions is maintained and that resources are effectively used. To ensure that mission and technical requirements are consistently carried through to implementation, the SNF Project will employ a computer based requirements management system. This system will provide requirement traceability by managing information about the source of the requirement, as well as its allocation to lower tier functions or end item products (e.g., structures, systems, and components). The system will ensure that no requirement is changed without first obtaining the approval of the parties responsible for the requirement percussor and successor. The system will also ensure that no requirement is considered implemented until all of its allocated parts are implemented. The SNF Project will use this system throughout product evolution to support the validation and verification processes. A significant part of the requirements management system is a database of all functions and requirements defined by the SNF Project and its subprojects. This database is implemented by the SE&I Organization on a computer database program compatible with the Hanford Site database. This database is maintained until requirements specifications (FRDs or performance specifications) are produced which address all requirements contained in the database, and requirements compliance is verified. Configuration control of the requirements in the project will be implemented through configuration control of the specifications/FRDs.

As the technical baseline matures, the requirements specifications (FRDs or performance specifications) will be replaced by more detailed lower level specifications. These lower level specifications, besides being more detailed, may change some of the requirements in the requirements specifications. As these lower level specifications are developed, the database will be updated so that it contains all the requirements currently identified by the SNF Project. The database will be decomposed to a level at which requirements specifications can be developed. During this decomposition all requirements will be traceable to the database. Once requirements specifications are developed, requirements will be traceable to their respective FRD or performance specification. This ensures that all requirements are traceable through all levels. Configuration management maintains and controls changes to the technical baseline which occur once the baseline is placed under change control.

4.2 CONFIGURATION MANAGEMENT

Configuration management maintains and controls changes to the technical baseline which occur once the baseline is placed under change control. The SNF Project will perform configuration management in accordance with The *Spent Nuclear Fuel Project Configuration Management Plan* (WHC, 1995).

4.3 TECHNICAL INTERFACE CONTROL

The SNF Project will establish an interface control process coordinated by an Interface Control Working Group (ICWG). The ICWG is a team of representatives from both the SNF Project and SNF Project elements who manage all internal interfaces and coordinate with the Hanford Site for the resolution of interfaces external to the SNF Project. The ICWG provides traceability, coordination, and documentation of interface definitions using Interface Control Documents (ICDs). The *Spent Nuclear Fuel Project Interface Control Plan* (WHC, 1995b) contains more complete information on the interface control activities that the SNF Project will conduct.

4.4 RISK MANAGEMENT

Managers are charged with the responsibility of making decisions which inherently have an element of uncertainty. Risk management is an integral part of the management process. Risk management is defined as a method of managing that concentrates on identifying and controlling the areas of events that have a potential of causing unwanted change. Risk management includes technical, programmatic, cost, schedule, and supportability risks. It does not include "insurance risk," "safety risk," or "accident risk."

The yet to be published SNF Project Risk Management Plan contains more complete information on the risk management activities conducted by the SNF Project.

4.5 WORK BREAKDOWN STRUCTURE

The SNF Project WBS represents all of the work, and only that work, which is required to achieve the end item states which have been defined as a result of the mission, functions, requirements, and alternatives analysis of the systems engineering process, including the systems engineering process itself. The SNF Project WBS is contained in the SNF Project PMP. The WBS results directly from the systems engineering process, as defined above. Subsequent updates and expansions of the WBS results from "design" efforts implemented by the subprojects and management process efforts resulting from implementation of the subproject PMPs.

The subprojects will utilize the SNF Project WBS as a basis for developing WBSs for their specific subprojects. The SNF Project WBS also provides an administrative interface to other programs and projects on the Hanford Site.

4.6 SCHEDULE

Systems engineering schedules define the engineering and technical activities performed by the SNF Project. These schedules provide SNF Project Management with a tool to evaluate progress against planned events and milestones. As lower level schedules, systems engineering schedules will be

integrated into the overall SNF Project schedule hierarchy. All SNF Project schedules will be developed in accordance with the Section 1.2 of *Management Control System* (WHC-CM-2-5). These schedules will be based on the SNF Project WBS.

The SNF Project Summary Schedule is contained in Figure 2.2 of the SNF PMP. This PMP also contains more complete information on scheduling procedures.

4.7 TECHNICAL PERFORMANCE MEASUREMENT

The SNF Project will use Technical Performance Measurement (TPM) to gain insight into the adequacy and maturity of the design, identify key parameters to be verified by the test and evaluation efforts, and provide inputs into overall SNF Project management and risk management. The TPM consists of selecting key technical parameters and tracking these parameters, comparing actual values against predicted values or values gained from other alternatives.

Technical parameters to be measured will be selected from requirements that are critical to the mission objectives, environment, or safety. These parameters will be identified during the requirements development process. Parameters selected for tracking will be key indicators and forecasters of technical success. Technical parameters have been chosen for the SNF Project. These parameters are listed as "Measures of Effectiveness" in Section 11, Volume I of the *Spent Nuclear Fuel Project Technical Baseline Document FY95* (WHC, 1995a).

Selected parameters will be tracked as a function of time. The TPM allows managers to estimate the maturity of the design or the performance of alternatives at any time. Some parameters will be tracked through the life of the SNF Project while others will be tracked only during specific SNF Project phases or to identify and resolve specific risk issues.

A major function of the systems engineering process is the integration of all efforts required to establish the technical baseline and the translation of these data into the project control system. At the Hanford Site, this project control system is the *Hanford Site Management System* (RLID 5000.12).

4.8 INTEGRATION WITHIN THE SNF PROJECT ORGANIZATIONS

The SNF Project SE&I Organization will work with other organizations within the SNF Project in order that the SNF Project efforts remain integrated. The other SNF Project organizations that are required to work, to implement the systems engineering process described above include the SNF Project engineering, operations and specialty organizations.

4.9 INTEGRATION WITHIN THE SNF SUBPROJECTS

On the SNF Project subproject level, each subproject will be responsible for product scope, configuration, cost, schedule, and performance. Subprojects will be structured to facilitate the execution of the SNF Project acquisition strategy and the development of products on the systems engineering product tree. The composition of the subprojects shall be consistent with the SNF Project WBS. Subprojects will follow their product through the product development cycle into operations. Typical subprojects include the following as appropriate:

- Project Management;
- Process Engineering;
- Systems Engineering and Integration;
- Regulatory Compliance;
- Permitting;
- Public Involvement;
- Scheduling;
- Financial;
- Technology Development;
- Quality Assurance;
- Safety;
- Operations;
- Test;
- Procurement; and
- Subcontract Management.

Staffing of the subprojects may vary through time depending on the product and its development phase. Matrix and contractor support will be included.

The SNF Project SE&I Organization will integrate systems engineering efforts within the subproject with: the SNF Project, other subprojects, National SNF Program (EM-37), and Hanford Site Systems Engineering. Key to this integration is the membership of the SE&I Organization staff on the subprojects. Interface control and configuration management are key processes in the integration of the subprojects.

4.10 INTEGRATION WITH HANFORD SITE

The SNF Project SE&I Organization must work with other organizations on the Hanford Site in order to integrate "Cleanup Hanford" efforts across the site.

The SNF Project is part of the Hanford Site cleanup and receives its top level guidance and direction form the site level. Site Systems Engineering has identified the need for the SNF Project through its functional breakdown. The SNF Project functional breakdown is a subset of the site functional breakdown. Therefore, Hanford Site systems engineering efforts have precedence over SNF Project efforts. Because of this, SNF Project SE&I will have major continuous involvement with Site Systems Engineering to ensure that the SNF Project is performing systems engineering within the bounds of site efforts. Changes made by either the site or the SNF Project will affect the other and will require integration. The Hanford site systems engineering will

be the source of the SNF Project system specification using data provided by the SNF Project.

The SNF Project SE&I Organization must work with other programs and projects on the Hanford Site in order to integrate "Cleanup Hanford" efforts across the site. In particular, Systems Engineering must integrate its systems engineering efforts with those of other programs and projects. The majority of the integration effort will focus on generation of ICDs.

4.11 INTEGRATION WITH OFFSITE SPENT NUCLEAR FUEL ORGANIZATIONS

This SEMP identifies the Hanford Site systems engineering efforts as having precedence over SNF Project efforts. The U.S. Department of Energy's (DOE) Office of Spent Nuclear Fuel Management (EM-37) also is currently pursuing a systems engineering effort for all SNF in the DOE complex. These efforts will have impacts on SNF Project systems engineering and the SNF Project will integrate its systems engineering efforts with the DOE complex-wide efforts. However, the organization with systems engineering precedence over the SNF Project remains the Hanford Site.

4.12 SNF PROJECT MANAGEMENT DOCUMENTS

For the SNF Project, management documents enable and supports the development of the integrated SNF Project technical baseline. The management documents that support SNF Project systems engineering technical practices are described in the SNF Project PMP.

5.0 GLOSSARY

ADR	As-Built Design Review
Architecture	The aggregate of all concepts and characteristics associated with a system, subsystem and/or component
BCD	Baseline Concept Description
CMP	Configuration Management Plan
Configuration	The functional and/or physical characteristics of hardware, firmware, software, or any other items as described in technical documentation and achieved in a product
Cost Baseline	A budget that has been developed from the cost estimate resulting from the designation of a configuration baseline. The cost baseline is referred to as a baseline since it is integrated with the technical and schedule baselines and subject to formal change control.
DDR	Definitive Design Review
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy - Richland Office
F&R	Functions and Requirements
FRD	Functions and Requirements Document
Function	Specific actions, activities, or processes that achieve or support the achievement of the mission. "What" must be achieved by the collective effects of all constituent parts. It is synonymous with "purpose".
Goals	Statements describing the desired end point.
ICD	Interface Control Document
ICWG	Interface Control Working Group
Interface	System boundary across which material, data, and/or energy passes.
Measure of Effectiveness	A measure of how well the problem is being solved; i.e., how well the mission is being accomplished and its end state achieved.
NSNFP	National Spent Nuclear Fuel Program (DOE-HQ-EM-37).

5.0 GLOSSARY

ADR	As-Built Design Review
Architecture	The aggregate of all concepts and characteristics associated with a system, subsystem and/or component
BSD	Baseline System Description
CMP	Configuration Management Plan
Configuration	The functional and/or physical characteristics of hardware, firmware, software, or any other items as described in technical documentation and achieved in a product
Cost Baseline	A budget that has been developed from the cost estimate resulting from the designation of a configuration baseline. The cost baseline is referred to as a baseline since it is integrated with the technical and schedule baselines and subject to formal change control.
DDR	Definitive Design Review
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy - Richland Office
F&R	Functions and Requirements
FRD	Functions and Requirements Document
Function	Specific actions, activities, or processes that achieve or support the achievement of the mission. "What" must be achieved by the collective effects of all constituent parts. It is synonymous with "purpose".
Goals	Statements describing the desired end point.
ICD	Interface Control Document
ICWG	Interface Control Working Group
Interface	System boundary across which material, data, and/or energy passes.
Measure of Effectiveness	A measure of how well the problem is being solved; i.e., how well the mission is being accomplished and its end state achieved.
NSNFP	National Spent Nuclear Fuel Program (DOE-HQ-EM-37).

Objectives	Discrete, measurable events that, if accomplished, will contribute to achieving a goal.
Performance	A quantitative measure characterizing a physical or functional attribute relating to the execution of a mission or function. Performance attributes include quantity (how many or how much), quality (how well), coverage (how much area, how far), timeliness (how responsive, how frequent), and readiness (availability, MTBF). Performance is an attribute for all system personnel, products and processes including those for development, production, verification, deployment, operations, support, training, and disposal.
PDR	Preliminary Design Review
PMP	Project Management Plan
PSAR	Preliminary Safety Analysis Report
Public Involvement	A process by which the stakeholders' views are integrated into the DOE's decision-making process. The stake-holders' issues, concerns, and values will be understood and considered when making decisions. Public involvement is a dialogue between DOE and the stakeholders. This interaction goes beyond the public receiving information and providing comments are the decision is made.
QAP	Quality Assurance Plan
Requirements	Requirements define how well a function must perform. Requirements set limits on functions and also limits on the outputs from functions. The description of a mandatory condition under which a function must be performed. Requirements are documented in technical specifications, statutes, regulations, Secretary of Energy Notices, DOE orders, or RL Directives or other official direction from the DOE customer.
Risk	A measure of uncertainty of attaining a goal, objective, or requirements pertaining to technical performance, cost, and schedule. Risk level is categorized by the probability of occurrence and consequences of occurrence. Risk is assessed for program, product, and process aspects of the system. This includes the adverse consequences of process variability. The sources of risk include technical (e.g. feasibility, operability, producibility, testability, and systems effectiveness); cost (e.g. estimates, goals); schedule (e.g. technology/material availability, technical achievements, milestones); and programmatic (e.g. resources, contractual).

SAR	Safety Analysis Report
Schedule Baseline	The time-phased plan with logical sequence of interdependent activities, milestones, and events necessary to complete the program. The schedule baseline is integrated with the cost and technical baselines and is subject to formal change control.
Schedule Risk	The risk to a program or project of not meeting the major milestones on time.
SDR	System Design Review
SEMP	Systems Engineering Management Plan
SE&I	Systems Engineering and Integration
SNF	Spent Nuclear Fuel
SNF Project	Spent Nuclear Fuel Project
Specification	A description of the essential technical requirements for items, materials, and services that includes the verification criteria for determining whether these requirements are met. A specification supports
S/RIDS	Standards Identification Document Systems
SRR	System Requirements Review
SSC	Structure, System, and Component
Systems Engineering	The systematic approach used to transform technical goals, and objectives into an optimized, operational, physical system that achieves its mission. The iterative technical and management process applied throughout a system life cycle that produces and maintains a well defined and documented system technical baseline.
Systems Engineering Management Plan (SEMP)	The document that defines the technical plan for the conduct of the fully integrated SNF Project engineering effort.
Systems Engineering Process	A comprehensive, iterative problem solving process that: (a) transforms validated customer needs and requirements into a description of a life-cycle balanced solution set of people, products, and processes; (b) generates information for decision makers; and © provides information for follow-on technical efforts.

Technical Baseline	The body of technical information associated with the people, products and processes required to accomplish a mission. The documented functions, requirements, and configuration from which the program will acquire an operational system. The technical baseline is maintained under configuration control, and is the basis for technical performance measurement. The technical baseline becomes more detailed and the body of information becomes larger as the system and/or subsystem matures.
T&E	Test and Evaluation
TPM	Technical Performance Measurement
Verification and Validation	Verification involves determining the extent to which a system was implemented in accordance with its specifications. Validation involves assessing the effectiveness of a verified system in accomplishing and sustaining its mission. For either class of testing, all critical performance characteristics will be identified and required performance will be evaluated.
Work Breakdown Structure (WBS)	A product-oriented family tree composed of hardware, software, data, and facilities which result from systems engineering efforts during the development and production of a system, and which completely defines the program or project. Displays and defines the product(s) to be developed or produced, and relates the elements of work to be accomplished to each other and to the end product.
WHC	Westinghouse Hanford Company

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EP-1.3	"Preparation of Engineering Drawings"
EP-1.5	"Interface Control"
EP-1.6	"Engineering Data Transmittal"
EP-1.7	"Engineering Document Approval and Release Requirements"
EP-1.12	"Supporting Documents"
EP-2.2	"Engineering Document Change Control"

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SEP 1.0	Mission Analysis
SEP 2.0	parametric Analysis
SEP 3.0	System Function Definition
SEP 4.0	Requirements Identification and Allocation
SEP 4.1	Requirements Analysis
SEP 5.0	Alternatives Development and Allocation of Functions
SEP 6.0	Trade Studies and Alternatives Development
SEP 7.0	Verification of Alternatives Compliance and Requirements
SEP 8.0	Decision Analysis in Alternatives Selection
SEP 8.1	Risk Assessment of Alternatives
SEP 11.1	System Specification Development
SEP 11.2	Interface Control/Product Specification Document