ENGINEERING CHANGE NOTICE

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	3a. USQ Required?	4. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	J.C. Womack, SE&I, R3-86, 373-9780	[] Yes [X] No	July 16, 1996

	5. Project Title/No./Work Order No.	6. Bldg./Sys./Fac. No.	7. Approval Designator
	Spent Nuclear Fuel Project	N/A	SQ

8. Document Numbers Changed by this ECN (includes sheet no. and rev.)	9. Related ECN No(s).	10. Related PO No.
WHC-SD-SNF-SEMP-001, Rev. 0	N/A	N/A

11a. Modification Work	11b. Work Package No.	11c. Modification Work Complete	11d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 11b) [X] No (NA Blks. 11b, 11c, 11d)	N/A	N/A _____ Cog. Engineer Signature & Date	N/A _____ Cog. Engineer Signature & Date

12. Description of Change

This ECN completely rewrites the current document indicating revision in four major areas: (1) By reference to the new Hanford Site Systems Engineering Policy (DOE RLPD 430.1) - this policy has been specified as a source of requirement for the SEMP document. The document describes relationship of the policy and SEMP to other documents. (2) An appendix has been added to describe a matrix for documentation responsibilities related to SNF Project and SNF Subprojects. (3) A second appendix has been added on SNF Project Design Authority/Design Agent Process to supplement the integrated engineering process. The appendix provides guidance to SNF Project Design Authorities and Design Agents concerning their roles and responsibilities. (4) Another appendix has been added to describe the SNF Project approach to risk management using a graded approach with emphasis on and description of issue management process. The risk management section was removed from the body of the previous SEMP and incorporated into the appendix. It was expanded to describe decision analysis used for the major SNF Project decisions for path forward and integrated process strategy.

13a. Justification (mark one)

Criteria Change []	Design Improvement [X]	Environmental []	Facility Deactivation []
As-Found []	Facilitate Const []	Const. Error/Omission []	Design Error/Omission []

13b. Justification Details

The above changes have been made to present the systems engineering process for the SNF Project in a concise and consistent manner. The revision became necessary to document and implement the design authority/design agent concept which simplifies and clarifies the lines of technical responsibility and authority. Another significant change was driven by a need to describe risk management in the SNF Project more explicitly.

14. Distribution (include name, MSIN, and no. of copies)

See attached Distribution

RELEASE STAMP

DATE: HANFORD

STA: 4 RELEASE ID:

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A-7900-013-1 (06/92)

15. Design Verification Required	16. Cost Impact						17. Schedule Impact (days)	
	ENGINEERING			CONSTRUCTION				
[ ] Yes	Additional	[ ] $		Additional	[ ] $		Improvement	[ ]
[X] No	Savings	[ ] $		Savings	[ ] $		Delay	[ ]

18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	[ ]	Seismic/Stress Analysis	[ ]	Tank Calibration Manual	[ ]
Functional Design Criteria	[ ]	Stress/Design Report	[ ]	Health Physics Procedure	[ ]
Operating Specification	[ ]	Interface Control Drawing	[ ]	Spares Multiple Unit Listing	[ ]
Criticality Specification	[ ]	Calibration Procedure	[ ]	Test Procedures/Specification	[ ]
Conceptual Design Report	[ ]	Installation Procedure	[ ]	Component Index	[ ]
Equipment Spec.	[ ]	Maintenance Procedure	[ ]	ASME Coded Item	[ ]
Const. Spec.	[ ]	Engineering Procedure	[ ]	Human Factor Consideration	[ ]
Procurement Spec.	[ ]	Operating Instruction	[ ]	Computer Software	[ ]
Vendor Information	[ ]	Operating Procedure	[ ]	Electric Circuit Schedule	[ ]
OM Manual	[ ]	Operational Safety Requirement	[ ]	ICRS Procedure	[ ]
FSAR/SAR	[ ]	IEFD Drawing	[ ]	Process Control Manual/Plan	[ ]
Safety Equipment List	[ ]	Cell Arrangement Drawing	[ ]	Process Flow Chart	[ ]
Radiation Work Permit	[ ]	Essential Material Specification	[ ]	Purchase Requisition	[ ]
Environmental Impact Statement	[ ]	Fac. Proc. Samp. Schedule	[ ]	Tickler File	[ ]
Environmental Report	[ ]	Inspection Plan	[ ]	N/A	[X]
Environmental Permit	[ ]	Inventory Adjustment Request	[ ]		

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision

20. Approvals

Signature	Date	Signature	Date
OPERATIONS AND ENGINEERING		ARCHITECT-ENGINEER	
Cog. Eng. J. C. Womack	7/15/96	PE	
Cog. Mgr. J. C. Womack	7/15/96	QA	
QA D. W. Smith	7/15/96	Safety	
Safety J. W. Osborne	7/16/96	Design	
Environ. C. Defigh-Price	7-16-96	Environ.	
Other		Other	
S. L. Magnani	7/15/96		
E. W. Gerber	7/15/96		
M. J. Wiemers	7/16/96	DEPARTMENT OF ENERGY	
D. W. Sidoway	7/16/96	Signature or a Control Number that tracks the Approval Signature	
M. E. Witherspoon	7/17/96		
J. L. Denning	7-15-96	ADDITIONAL	
B. S. Carlisle	7-16-96		
J. A. Swenson	7-17-96		
C. A. Thompson	7/15/96		

The following sections of the Spent Nuclear Fuel Project Systems Engineering Management Plan are revised:

1. Table of Contents, Appendices, Figures, Tables, and Acronyms:

    Replace Table of Contents, and lists of Appendices, Figures, Tables, and Acronyms entirely with revised sections.

2. Section 1.1, Purpose, Paragraph 1:

    Replace the word in the sentence "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."

    To "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 "correct" things."

3. Section 1.1, Purpose, Paragraphs 2 and 3, Replace the paragraphs with the following edited version:

    ~~The Purpose of this Westinghouse Hanford Company (WHC)~~ This SNF Project Systems Engineering Management Plan (SEMP) ~~is to~~ describes the systems engineering approach, ~~and~~ methods, and processes that are being ~~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 format has been tailored to meet ~~the~~ specific needs of the SNF Project.

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

4. Section 1.1, Purpose, Add the following requirements sources:

    - *Hanford Site Systems Engineering Policy*, U.S. Department of Energy (DOE) RLPD 430.1 (RL 1996a), which directs that systems engineering be implemented at the Hanford Site, consistent with the *Systems Engineering Criteria Document and Implementing Directive*, DOE RLID 430.1 (RL 1996b);

    - *Project Management*, WHC-CM-6-2 (WHC 1996a), states that where a SEMP is appropriate, it should be prepared in accordance with the *Project Management System*, DOE Order 4700.1 (DOE 1987);

    - *Systems Engineering Criteria Document and Implementing Directive*, DOE RLID 430.1, which provides direction on the implementation of systems engineering at the Hanford Site, based on DOE Order 430.1.

5. Section 1.1, Purpose, Change the requirements sources as follows:

    - ~~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 is controlled by adherence to a SEMP, prepared and maintained at the project level. (Note that DOE Order 4700.1 will be

phased out and canceled after meeting implementation conditions of *Life -Cycle Assessment Management*, DOE Order 430.1 (DOE 1995). Currently, DOE Order 4700.1 is a compliance document and DOE Order 430.1 is not);

- *Spent Nuclear Fuel Project Management Plan*, WHC-SD-SNF-PMP-011 (WHC 1995a), which directs that a SEMP be developed for the SNF Project; ~~and~~

~~*Site Systems Engineering Implementation Plan*, (DOE/RL-95-31, Rev. 0), which provides direction on the implementation of systems engineering at Hanford.~~

6. Section 1.2, Scope and Context, Paragraph 1, Replace the paragraph with the following edited version:

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

7. Section 1.2, Scope and Context, Paragraph 2, Insert the following as Paragraph 2:

This SEMP is intended for application to the design, development, fabrication, construction, test and startup of the Spent Nuclear Fuel Path Forward Subprojects leading to SNF Operations. After SNF Operations assumes responsibility for the system, a modified process, tailored to maintenance and operations is necessary. This process is not included in this SEMP. The K Basins engineering process is consistent with processes in this SEMP.

8. Section 1.2, Scope and Context, Paragraph 2, Replace the last paragraph with the following edited version:

Figure 1-1 depicts 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 content is derived from the *Site Systems Engineering, Site Systems Engineering Management Plan*, (WHC 1996b), DOE RLID 430.1 (RL 1996b), and the *Spent Nuclear Fuel Project Management Plan* (WHC-SD-SNF-PMP-011) (WHC 1995a). ~~will 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 process interfaces will be through these documents. Because the transition from DOE Order 430.1 is not complete, this SEMP has maintained its consistency with DOE Order 4700.1, as well.

9. Section 1.2, Scope and Context, Figure 1-1:

Figure 1-1 was revised and updated extensively, and has been replaced in its entirety. Significant changes include the following:

- Within the DOE box:

  - Replacement of old DOE SE policies and directives with the recently published SE policies and directives (i.e., RLPD 430.1 and RLID 430.1)

  - Deletion of the Hanford Strategic Plan, Hanford Mission Plan, and Hanford Mission Management Plan, RL SE source documentation, and SE criteria document, consistent with DOE's new SE policies and directives.

  - A note was added indicating DOE Order 4700.1 will be replaced by DOE Order 430.1, when it is imposed on the contractor.

- Within the Site Systems Engineering Contractor box:

  - The Issue Resolution (Process Management) Process box was added.

- Within the SNF Project box:

  - Boxes were added indicating that Subproject PMPs and SEMPs will be developed, as required.

10. Section 2.1, Spent Nuclear Fuel Project, Paragraphs 1 and 2, Replace the paragraphs with the following edited version:

Project organization The roles and responsibilities of the SNF Project organization are defined in the *Spent Nuclear Fuel Project Management Plan* (PMP), WHC-SD-SNF-PMP-011 (WHC 1995a). SNF Project Management Plan (PMP). This section of the SEMP identifies, and is limited to, the roles and responsibilities associated with the implementation of SNF Project Systems Engineering In the Projects and Suprojects. Documentation responsibilities related to SNF Project and SNF Subprojects are defined in Appendix A, which may be revised when the information is superseded by higher level Project documentation and Integration (SE&I) Organization.

Successful implementation of systems engineering Systems engineering as implemented in the SNF Project is dependent on the active involvement of all SNF Project organizations in the development and implementation of the systems engineering processes, documents, and procedures, as defined in Sections 3.0 and 4.0. The Systems Engineering and Integration (SE&I) organization provides systems engineering core competency, consistency between Subprojects, and maintenance of the Project technical baseline will be provided by the SNF Project SE&I Organization. In addition, the SE&I Organization personnel will may facilitate the development and upkeep of systems engineering processes, databases, and documentation products throughout the life of the SNF Project life.

11. Section 2.1, Spent Nuclear Fuel Project, Paragraph 3, Delete the entire paragraph:

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.~~

12. Section 2.2, Spent Nuclear Fuel Subprojects, Delete Paragraphs 1 and 2 as follows:

~~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.~~

13. Section 2.2, Spent Nuclear Fuel Subprojects, Replace the deleted paragraphs with the following paragraphs:

A new Design Authority/Design Agent concept was established as part of the design process re-engineering. This process focusses Technical responsibility and authority, including implementation of systems engineering and integration activities, with the Subproject Design Authorities. This process, along with the Design Authority and Design Agent roles and responsibilities, has been implemented in the SNF Project, as described in *Standard Engineering Practices*, WHC-CM-6-1, Interim Design Authority/Design Agent Engineering Process Requirements, EP 5.9 (WHC 1996c). Appendix B presents a description of this implementation.

Each Subproject is responsible for product scope, configuration, cost, schedule, and performance. Subproject Design Authorities are responsible for implementation of systems engineering processes and delivery of systems engineering products for their Subprojects to tie into SNF Operations. The SNF Project SE&I organization may integrate the Subproject systems engineering efforts with those of the Project, other Subprojects, the National SNF Program (EM-67), and the Hanford Site Systems Engineering. The SE&I organization will support development and maintenance of Subproject processes and documents.

Subproject roles and responsibilities change throughout the Project life-cycle. Each Subproject ensures expected operation of the Structure, System, and/or Component (SSC), prior to turn-over to SNF Operations. After the Subproject Functions and Requirements (F&Rs)/Function Design Criteria (FDC)/specifications are determined, the role of the SE&I organization will shift to supporting the verification and validation (V&V) that requirements are being met, coordinating change management, and maintaining interfaces with other Subprojects. Change management includes risk, decision, and issues management.

14. Section 2.3, Spent Nuclear Fuel Operation, Add the following new section to the SEMP:

2.3 SPENT NUCLEAR FUEL OPERATIONS

The SNF Operations is currently comprised of K Basins and Fuel Handling Operations (FHO). The K Basins focuses on existing facilities and the FHO interfaces with Path Forward activities to ensure that all systems are in place, from the beginning of fuel retrieval to interim fuel storage in the Hanford Site 200 East Area.

The SE&I will continue to ensure that the SNF Project Technical Baseline is maintained through coordination of change management and interface control processes. The SNF Operations is responsible for operating and maintaining SNF facilities within the approved Safety Analysis, Standards/Requirements Identification Documents (S/RIDs), and Operational Design Criteria; and for maintaining the physical configuration control.

15. Section 3.1, Integrated Spent Nuclear Fuel Project Engineering Process, Replace the paragraphs with the following edited version:

The SNF Project integrated engineering process includes the systems engineering processes ~~These include the processes~~ by which the SNF Project ~~will~~ defines its mission and determines the functions it needs to perform; the requirements ~~that the SNF Project~~ it 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, analysis, fabrication, and testing 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 start, systems engineering activities focus on ~~integration of the~~ SNF Project integration, project optimization, requirements verification and validation ~~of requirements~~, and change 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 Westinghouse Hanford Company (WHC) Controlled Manual system (WHC-CM) and the tailored systems engineering processes ~~found~~ in the *Hanford Site Systems Engineering Manual*, WHC-IP-1117 (WHC 1995b). The *Hanford Site Systems Engineering Manual* ~~Hanford Site Systems Engineering Manual (WHC-IP-1117). The tailored Hanford Site Systems Engineering Manual (WHC-IP-1117)~~ procedures ~~will be~~ are used to implement the process, unless ~~they~~ the procedures are ~~specifically~~ defined specifically in this SEMP.

~~The~~ System integration activities ~~that~~ continuing through the ~~life of the~~ engineering process life include:

- Parametric Analysis;
- Trade Studies;
- Alternative ~~Verification~~ Analysis;
- Decision Analysis;
- Risk Analysis and Management;

- Requirements Verification and Validation;
- ~~Performance Measures~~ Technical Performance Measurement;
- 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 (Subprojects, Hanford Site, and DOE EM-67);
- Systems Test and Evaluation;
- Standards/Requirements Identification Documentation (S/RIDs); and
- Safety Analysis Report (SAR) Requirements Management.

These activities are primarily managed ~~primarily~~ by other than the SE&I organization, although they may be supported by the SNF Project 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.~~

16. Section 3.1, Integrated Spent Nuclear Fuel Project Engineering Process, Figure 3-1:

    Figure 3-1 was revised and updated extensively, and has been replaced in its entirety. Significant changes include:

    - Updating the process flow paths to more accurately represent the iterative SE process.

    - Adding the boxes for the SNF Project Technical Baseline Description and Baseline Management Systems for managing the SNF Project requirements.

    - Adding the Subproject-specific F&R or FDC box leading into the Subproject Design Processes.

    - The addition of critical SE Reviews included.

    - Updates and editorial corrections were made to the Systems Integration Activities box.

17. Section 3.1, Integrated Spent Nuclear Fuel Project Engineering Process, Delete the final paragraph:

    ~~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.~~

18. Section 3.1, Integrated Spent Nuclear Fuel Project Engineering Process, Figure 3-2:

    Figure 3-2 was deleted. The remaining three Figures, 3-3, 3-4, and 3-5, have been renumbered to be 3-2, 3-3, and 3-4.

19. Section 3.2, Systems Engineering Processes, Replace the paragraph with the following edited version:

The Specific processes that make up the systems engineering portions of the integrated engineering process are described below in Sections 3.2.1 through 3.2.8. The processes not defined below in these sections are described in Standard Engineering Practices, WHC-CM-6-1 (WHC 1996g). The Hanford Site Systems Engineering Manual, WHC-IP-1117 (WHC 1995b), provides a description of the specific procedures, the procedures that will be tailored for application to the below processes.

20. Section 3.2.1, Mission Analysis, Replace the paragraph with the following edited version:

The Mission analysis is the first step in the overall process. The purpose of this analysis is to defines 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 the mission analysis defines, scopes, and bounds the Project or Subproject. The initial SNF Project mission analysis was conducted in 1994. This is documented in Spent Nuclear Fuel Project Mission Analysis Report, WHC-EP-0790 (WHC 1994a). 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. Mission analysis continues through the life cycle to address items such as DOE redirection, cost and schedule performance, etc. Mission analyses for Subprojects are not required, but may be conducted if the Subproject defines them in Subproject management plans.

21. Section 3.2.2, Functional Analysis, Paragraph 1, Replace the paragraph with the following edited version:

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 mission depiction of the mission. In the case of For the SNF Project, these greater levels of detail become the functions of the Subprojects and SNF Operations. The SNF Project functions mate to the Hanford-site functions and the SNF subprojects function. Process Flow Diagrams (PFD) in the Spent Nuclear Fuel Project Process Flow Diagram Summary, H-2-825867 (WHC 1996d), and Spent Nuclear Fuel Project Level 0 Process Flow Diagram, H-2-825868 (WHC 1996e), were produced to support the engineering process, and are a further development of the functions directly associated with chemical and nuclear processes.

22. Section 3.2.3, Requirements Analysis, Paragraph 1, Replace the paragraph with the following edited version:

Requirements analysis identifies the requirements associated with each function. Requirements define how well a function must be performed. The Requirements allocated to a Subproject functions become that Subproject's 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 tests.

23. Section 3.2.3, Requirements Analysis, Paragraph 2, Delete the paragraph as follows:

~~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.~~

24. Section 3.2.3, Requirements Analysis, Add the following paragraphs after paragraph 1:

Functional requirements are derived by expanding functions until they become detailed enough to define the requirements necessary to perform a function. After quantitative values are defined for these requirements, the requirements become performance requirements. After the functions have been decomposed into functional performance requirements, the requirements can be allocated to SSC. Specifications are associated with SSC.

The S/RID process 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 DOE-RL.

Other requirements sources include design studies; interfaces; analyses (including safety analyses with resulting Operating Safety Requirements and Technical Safety Requirements); trade studies; conceptual design; and verifications associated with a SSC. Safety analyses that result in the Project SAR are examples of sources of derived requirements. These derived requirements must be integrated into the requirements of the Subprojects and/or Project after the initial requirements analyses. The definition of these requirements throughout the design process results in the need for update, addition, revision, and modification of the requirements database and documentation. The S/RIDs and derived systems engineering requirements are integrated and maintained. Another source of SNF Project derived requirements are the studies that produce the U.S. Nuclear Regulatory Commission (NRC) equivalency requirements, as documented in the *Spent Nuclear Fuel Project Path Forward, Additional Nuclear Regulatory Commission Requirements*, WHC-SD-SNF-DB-003, (WHC 1995c).

During facility operation, S/RIDs and SAR are used to document the operational requirements. The S/RIDs are also created for Hazard Category 2 facilities associated with the SNF Subprojects. The SAR, along with S/RIDs, provides a source of derived safety requirements. Identification of the specific requirements is included in the Subproject F&R or FDC document, and the Subproject requirements specification, as necessary and appropriate.

The SNF Operations F&Rs are the responsibility of the SNF Project FHO Organization.

25. Section 3.2.4, Alternatives Analysis, Replace the paragraph with the following edited version:

   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, as appropriate, down to and including components.

26. Section 3.2.5, Trade Studies, Replace the paragraph with the following edited version:

   Trade studies are a portion of the engineering process of comparing or trading the strengths and weaknesses of alternative approaches or attributes. ~~They~~ Trade Studies are the basis for selection of alternatives ~~approaches or attributes~~. ~~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.

27. Section 3.2.6, Requirements Specification, Replace the paragraph with the following edited version:

   A requirements specification is a document that is prepared to support development and/or acquisition of a ~~structure, system, and/or component~~ SSC. 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.~~ be used for SSC development by WHC, or to support procurement from a vendor. These documents are further discussed in Section 3.6. These documents are the responsibility of the Subproject Design Authorities.

28. Sections 3.2.7, Design Construction, Add the following section:

   3.2.7   Design and Construction

   Design and construction processes associated with the SNF integrated engineering process are defined in *Standard Engineering Practices*, WHC-CM-6-1 (WHC 1996c) and *Project Management*, WHC-CM-6-2 (WHC 1996a), and are not repeated in this document.

29. Sections 3.2.8, Test, Add the following section:

   3.2.8   Test

   Testing will occur throughout the facility and system life cycle, including that testing that is required to support design, safety analyses, operational readiness, and post start-up process optimization. This life-cycle testing is described in the *Spent Nuclear Fuel Project Integrated Testing Strategy*, WHC-SD-SNF-CM-004 (PNNL 1996). Final testing includes acceptance testing, conducted by the Subproject to verify that the system has met design requirements; and operability testing, conducted by appropriate operations organizations to ensure that operations requirements have been met. The acceptance and operability testing will be addressed in the start-up plan currently being developed by the SNF Project FHO.

30. Section 3.3, Decision Analysis, Delete the entire section as follows:

~~**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.~~

31. Section 3.3, Technical Baseline

    Because Section 3.3 was deleted, renumber Section 3.4 and associated sections to be 3.3, etc.

32. Sections 3.3. Technical Baseline, Replace paragraphs 1 through 3 with the following edited version:

3.3   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 mission. The SNF Project technical, schedule and cost baselines ~~makeup~~ comprise the integrated SNF Project baseline. ~~The~~ Figure 3-2 depicts the relationships of these baselines, ~~and 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 SNF Project organizational structure is designed to support WBS performance. ~~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.~~ The SNF Project organization is presented in the currently published SNF Project organization charts.

Because ~~Since~~ the SNF Project is ~~made-up~~ comprised of Subprojects that are at various levels of maturity and development, the technical baseline is composed of Subproject technical baselines that are also at various development stages ~~of development~~. These progressively more-detailed technical baselines ~~are called by~~ have different names. Table 3-1 describes the progression of technical baselines. These baselines are under configuration control after initial approval.

Figure ~~3-4~~ 3-3 illustrates the relationship of these baselines to the integrated engineering process. The technical baseline contents ~~are~~ primarily ~~are~~ 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~~. The Technical Baseline Description establishes the requirements baseline down to the Subprojects. Subproject details are the prerogative of the Subprojects. Only the Functional Requirements technical baseline shall be developed at ~~both~~ the SNF Project ~~level~~ and ~~at the~~ Subproject levels. Subproject and operations organizations develop all other technical baselines. ~~The development of all other technical baselines is performed by the subprojects.~~

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

33. Sections 3.3. Technical Baseline, Figure 3-2:

    Because Figure 3-2 was deleted, renumber Figure 3-3 to be Figure 3-2, Integrated Baseline Development. This figure was revised to change the position of the Cost and Schedule Baseline Elements and to retitle the Schedule Baseline as the "Master Baseline Schedule."

34. Sections 3.3. Technical Baseline, Figure 3-3:

    Because Figure 3-2 was deleted, renumber Figure 3-4 to be Figure 3-3, Spent Nuclear Fuel Project Integrated Engineering Process. This figure was revised and updated extensively, and has been replaced in its entirety. The concept of Operational Baseline has been added; and other updates were made to be consistent with Figure 3-1.

35. Section 3.3.1, Functional Requirements Baseline, Replace the paragraph with the following edited version:

    The ~~contents of the~~ SNF Project-level Functional Requirements Baseline describes the ~~approach for the~~ SNF Project approach, top-level requirements and constraints, and the top-level functional and architectural features. This baseline provides the necessary details for ~~the~~ start of Subproject 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 (WHC 1994b). This baseline ~~will be~~ is developed by analyzing the contents of these site baselines and applying the information to the SNF Project. This is documented in the Project Technical Baseline Description. The SNF Project Functional Requirements Baseline is a component of the Hanford Site Performance Baseline. The SNF Project SE&I Organization ~~shall~~ develops this baseline ~~on~~ at the SNF Project level, and the Subproject teams ~~shall~~ further develop this baseline at the Subproject levels.

36. Section 3.3.2, Performance Requirements Baseline, Replace the paragraph with the following edited version:

> The contents of each Subproject baseline represents the performance requirements and SSC configurations (architectures) chosen to accomplish the SNF Project mission. ~~This~~ The Performance Requirements Baseline forms the basis for initiating preliminary design.

37. Section 3.3.3, Design Requirements Baseline, Replace the paragraph with the following edited version:

> The contents of each baseline expands 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~~ Design Requirements Baseline becomes the basis for definitive design.

38. Section 3.3.4, Design Configuration Baseline, Replace the paragraph with the following edited version:

> The Design Configuration Baseline ~~contents of this baseline~~ shows the progress of the Subprojects in refining the design and developing the "build-to" design packages. ~~This~~ The Design Configuration Baseline forms the basis for the ~~start~~ beginning of construction and testing.

39. Section 3.3.5, As-Built Configuration Baseline, Replace the paragraph with the following edited version:

> The As-Built Configuration Baseline ~~contents of this subproject baseline~~ documents the completed construction, and validates the operational basis. The As-Built Configuration Baseline ~~These baselines are~~ is 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.

40. Section 3.3.6, Operational Baseline, Add the following section:

3.3.6   Operational Baseline

> The Operational Baseline includes updated operational procedures, SAR, final facility S/RIDs, and physical configuration design and description. Operational Baseline items are the basis for continuing operations, and will be used as the deactivation activities starting point.

41. Section 3.4, Reviews:

> Because Section 3.3 was deleted, renumber Section 3.5 and associated sections to be 3.4, etc.

42. Section 3.4, Reviews:

> Delete Table 3-2.

43. Section 3.4, Reviews, Replace the paragraph with the following edited version:

> This section describes the ~~reviews that the~~ SNF Project and Subproject reviews. ~~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,~~ In addition, each Subproject will adapt or tailor the reviews, as appropriate, to ~~their~~ its needs. The number and type of reviews described ~~below~~ herein are tailored from those described in ~~DOE-4700.1.~~ the *Project Management System,* DOE Order 4700.1 (DOE 1987). These reviews are ~~design verification reviews as~~ described in *Standard Engineering Practices,* WHC-CM-6.1, Design Verification Requirements, EP 4.1 (WHC 1996c), 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~~ 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~~ Requirements V&V provide a mechanism to ~~insure~~ ensure that ~~requirements are met by~~ emerging designs meet requirements. ~~During the reviews described below this SE&I Organization will be responsible for conduct of these V&V functions.~~

44. Section 3.4.1, System Requirements Review, Paragraph 1, Replace Paragraph 1 with the following edited version:

    This Systems Requirements Review (SRR) 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)~~ DOE-RL/Spent Fuel Division (SFD) 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.

45. Section 3.4.1, System Requirements Review, Add the following paragraphs after Paragraph 1:

    A SRR normally would have been conducted prior to the initiation of the Subprojects' design phase, and would consist of a high-level review of SNF Project objectives; systems engineering approach; and Project-level functions, requirements, architecture, and interfaces, as appropriate. Conducting a SRR was not appropriate until the technical baseline stabilized with the approval of the Integrated Process Strategy, followed by issuance of the *Spent Nuclear Fuel Project Technical Baseline Description - Fiscal Year 1996* (WHC 1995d) in November 1995.

    The DOE-RL/SFD concurred with the *Site Systems Engineering, Systems Engineering Management Plan* (WHC 1996b), *Spent Nuclear Fuel Project Configuration Management Plan* (WHC 1995e), and *Spent Nuclear Fuel Project Interface Control Plan* (WHC 1995f); approved the Multi-Year Program Plan (MYPP) Revision; evaluated and audited the SNF Project Baseline Management System database; conducted on-board reviews; and conducted Subproject systems engineering assessments. The DOE-RL/SFD also provided top-level programmatic decision making and direction. The DOE-RL/SFD determined the total of these to be equivalent to conducting a SRR.

46. Section 3.4.2, Conceptual Design Review, Replace the paragraph with the following edited version:

    ~~These reviews evaluate~~ A Conceptual Design Review (CDR) is a Subproject review that evaluates the Performance Requirements Baseline. ~~These subproject reviews are~~ , and is conducted by a SNF Subprojects. ~~The approval authority is the subproject, per the subproject PMP.~~

47. Section 3.4.3, Preliminary Design Review, Replace the paragraph with the following edited version:

~~These reviews evaluate~~ A Preliminary Design Review (PDR) is a Subproject review that evaluates the Design Requirements Baseline, ~~These subproject reviews are~~ and is conducted by a SNF ~~Project~~ Subprojects. ~~The approval authority is the subproject, per the subproject PMP.~~

48. Section 3.4.4, Definitive Design Review, Replace the paragraph with the following edited version:

~~These subproject reviews evaluate~~ A Definitive Design Review (DDR) is a Subproject review that evaluates the Design Configuration Baseline, ~~These subproject reviews are conducted by SNF Project subprojects.~~ and is conducted by a SNF Subproject. ~~The approval authority is the subproject, per the subproject PMP.~~

49. Section 3.4.5, As-Built Design Review, Replace the paragraph with the following edited version:

~~These subsystem reviews evaluate~~ An As-Built Design Review (ADR) evaluates the As-Built Configuration Baseline. The ADR ~~review~~ evaluates the as-built Subproject's 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.~~

50. Section 3.4.6, Operational Readiness Review, Add the following section:

3.4.6 Operational Readiness Review

An Operational Readiness Review (ORR) is a major review sponsored by the DOE-RL/SFD. The ORR is used as a verification that a facility is ready for operation. The ORR will address, as a minimum:

- Facility readiness;
- Facility ability to perform its assigned mission;
- Facility operational safety;
- Facility maintenance readiness;
- Operational training; and
- Required permits and procedures completion.

The DOE ORR shall be conducted after the test phase is complete, prior to start-up.

51. Section 3.5, Systems Engineering Technical Documentation:

Because Section 3.3 was deleted, renumber Section 3.6 and associated sections to be 3.5, etc.

52. Section 3.5, Systems Engineering Technical Documentation, Replace the paragraph with the following edited version:

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 information

and their relationship to the technical baselines. The majority of this documentation is not unique to systems engineering, ~~but~~ ~~rather,~~ it results from the design documentation required by WHC engineering practices documented in *Standard Engineering Practices*, WHC-CM-6-1 (WHC 1996c).

53. Section 3.6, Requirements Documentation:

Because Section 3.3 was deleted, renumber Section 3.7 and associated sections to be 3.6, etc.

54. Section 3.6, Requirements Documentation, Add the following sections:

3.6   REQUIREMENTS DOCUMENTATION

3.6.1   Spent Nuclear Fuel Project Specification

The SNF Project Specification states the technical and mission requirements for the SNF Project, derived by the Hanford Technical Integration organization, as documented in the Hanford Site Cleanup Specification, and contained in the Hanford Site Technical Baseline Database. The Hanford Site-level requirements for the SNF Project will be provided to the SNF Project in this specification, which will become the technical basis for the SNF Project Multi-Year Work Plans (MYWP) and MYPP.

3.6.2   Functions and Requirements Documentation

The SNF Project Management Plan defines a need for an F&R or FDC document. This document is a statement of the Subproject, or operations F&R to a level consistent with the Subproject objective. The Subproject F&R or FDC contains, as a minimum, all functions allocated to that Subproject, and requirements allocated to the Subproject that affect performance of that Subproject and are not contained in the Subproject acquisition F&R. Individual Subprojects may prefer to include all F&R allocated to that Subproject.

The SE&I organization may support development of the F&R document and may ensure that it is consistent with the Subproject requirements specification. These sets of F&R documents are the Subproject F&R.

3.6.3   Requirements Specification

As requirements are allocated to a SSC, the requirements are placed in the requirements specification, which is associated with that SSC. The requirements specification is for use by a Subproject for acquiring SSC. Performance or functional specifications are to be prepared in accordance with *Standard Engineering Practices*, WHC-CM-6-1, Engineering Specification Requirements, EP-1.2 (WHC 1996c), as single-use, non-construction, engineering specifications. Unless tailored by the Subproject, guidelines for the content and format of these single-use, engineering specifications are contained in *Engineering Practice Guidelines*, WHC-IP-1026, EP G-1.2 and Appendix Q (WHC 1996f).

A requirements specification is a document that is prepared to support development and/or acquisition of a SSC. The requirements specification can be either a performance or functional specification. The requirements specifications state performance (technical) and mission requirements, and allocate them to functions and SSC.

3.6.4   Baseline Documentation and Database

Using the results of the mission and functional and requirements analyses, a single integrated SNF Project Baseline has been established for requirements integration and maintenance. This electronic database, the Baseline Management System (BMS), is designed to contain the Project baseline information. The SNF Project Technical Baseline Description (WHC 1995d) provides an integrated description of the SNF Project and the data that form the Project basis.

55. Section 4.1, Functions and Requirements Management, Replace the paragraphs with the following edited version:

Requirements traceability ensures that the technical basis for engineering decisions is maintained, which in turn allows effective resource planning and use. ~~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.~~ Requirements traceability requires information regarding the requirement source, as well as the requirement's allocation to lower-tier functions or end-item products (e.g., SSC). No requirement is changed without first obtaining approval from the parties responsible for the requirement precursor and successor. All F&R allocations are stored in an electronic database for retrieval, sorting, and report generation.

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~~ Technical Baseline will be updated so that it contains all the requirements currently identified by the SNF Project and Subprojects. After requirements specifications are developed, requirements will be traceable to their respective requirements specification. This ensures that all requirements are traceable through all levels. ~~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.~~

56. Section 4.2, Configuration Management, Replace the paragraph with the following edited version:

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 The technical baseline will be maintained, and changes will be controlled in accordance with the *Spent Nuclear Fuel Project Configuration Management Plan*. (WHC, 1995) (WHC 1995e).

57. Section 4.3, Technical Interface Control, Replace the paragraph with the following edited version:

The SNF Project will establish was established and will maintain 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 managing all internal interfaces and coordinating 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) WHC-SD-SNF-CM-003 (WHC 1995f) contains more complete information on the interface control activities that the SNF Project will conducts.

58. Section 4.4, Risk Management, Delete the first two paragraphs and replace them as follows:

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.

The SNF Project has undertaken an aggressive schedule with the goal of early fuel removal from the K Basins to reduce risks to public and employee health and safety and the environment. Disciplined implementation of risk management is required to ensure that the accelerated schedule does not result in undue safety, environmental, technical, schedule, nor financial risks. Several management methods are being applied to ensure a reasonable understanding and sound management of such risks. These methods include:

1. Implementation of an issues management program for addressing issues at the Project and Subproject levels;

2. Use of disciplined systems engineering and project management processes; and

3. Implementation of a general design strategy towards robust designs based on existing technology.

Risk management processes within Hanford Site projects have their basis in the Site-Wide Systems Engineering Risk Management Plan, which is an attachment to *Site Systems Engineering, Systems Engineering Management Plan* (WHC 1996b).

Risk management in the SNF Project is performed at multiple levels, using a graded approach, with emphasis on issues management. Major programmatic decisions have employed

quantitative or semi-quantitative analytical risk-management techniques, such as statistical evaluations or multi-attribute decision analysis. Ongoing Project and Subproject risk-management activities emphasize techniques that adjust to the accelerated pace of Project activities, including qualitative techniques such as issues management. Appendix C describes the SNF Project approach to risk management.

59. Section 4.5, Work Breakdown Structure, Replace the paragraph with the following edited version:

The SNF Project WBS represents all ~~of~~ the work, and only that work, ~~which~~ that is required to achieve the end ~~item~~ states ~~which~~ that 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~~ MYPP. The WBS results directly from the systems engineering process, as defined ~~above~~ previously. Subsequent WBS updates and expansions ~~of the WBS~~ result from "design" efforts implemented by the Subprojects and management process efforts resulting from implementation of the subproject Program Management Plans.

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

60. Section 4.6, Schedule, Replace the paragraphs with the following edited version:

The SNF **Project Master Baseline Schedules** ~~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. The planning process, which includes schedule defining, cost estimating, and budgeting, is based on the WBS. ~~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.~~ The Project Master Baseline Schedule is summarized to a Level 1 Management Summary Schedule. The Management Summary Schedule is employed in the Plan of the Week to show weekly status.

61. Section 4.7, Performance Measurement, Delete all paragraphs and replace with the following paragraphs:

~~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).~~

Performance measurement in the SNF project is accomplished as part of the project control system. A baseline schedule is established and agreed on as part of the MYPP process. Milestones defining expected performance and project deliverables as a function of the schedule are identified in the MYPP (currently termed the MYWP).

Major milestones that mark significant project events, such as design or acquisition of key project SSC, start of key operations, or completion of key documents are tracked by the DOE-RL/SFD. Intermediate milestones that record progress toward completion of major milestones are tracked by WHC. Technical progress is tracked monthly by documenting milestone completion and progress relative to the baseline schedule. Progress is statused monthly for current-year milestones as part of the Site Management System (SMS) Report and the SNF Project Monthly Program Review.

The integrated Project schedule identifies the inter-relationships of Project activities to enable an early identification of potential impacts to major milestones, when intermediate Project milestones are delayed or changed.

Monthly Site Management System reporting includes an assessment of potential impacts to future milestones. In addition, milestones beyond the current fiscal year are evaluated on an annual basis as part of the MYPP process. The Project Control System is defined in the *Spent Nuclear Fuel Project Management Plan* (WHC 1995a).

62. Section 4.8, Integration With Offsite Spent Nuclear Fuel Organizations:

Sections 4.8 through 4.11 have been reorganized. Replace these sections as shown in the following items.

Delete all paragraphs and replace with the following paragraphs:

4.8   INTEGRATION WITHIN ~~THE~~ OFFSITE SPENT NUCLEAR FUEL 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.~~

The DOE Office of Spent Nuclear Fuel Management (EM-67) currently is pursuing a systems engineering effort for all SNF in the DOE complex. These efforts will have impact on SNF Project

systems engineering; and the SNF Project will integrate its systems engineering efforts with the DOE complex-wide efforts.

63. Section 4.9, Integration With the Hanford Site:

Sections 4.8 through 4.11 have been reorganized. Replace these sections as shown in the following items.

Delete all paragraphs and replace with the following paragraphs:

~~**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.~~

4.9   INTEGRATION WITH THE HANFORD SITE

The SNF Project is part of the Hanford Site cleanup, and receives its top-level guidance and direction from the site level. Site Systems Engineering has identified the necessity for the SNF Project through its functional breakdown. The SNF Project functional breakdown is a subset of the site functional breakdown. Because of this, SNF Project SE&I will have major continuous involvement with the Hanford Site Technical Integration organization to ensure that the SNF

Project is performing systems engineering within the bounds of site efforts. Changes made by either the Hanford Site or the SNF Project will affect the other, and will require integration. The Hanford Site Technical Integration organization will be the source of the SNF Project system specification.

The SNF Project SE&I organization must work with other programs and projects on the Hanford Site to integrate "Cleanup Hanford Site" efforts across the site. In particular, SNF Project SE&I must integrate its systems engineering efforts with those of other programs and projects. The majority of the external integration effort will focus on generation of Memoranda of Understanding (MOA), which are used as ICDs.

64. Section 4.10, Integration Within Spent Nuclear Fuel Project Organizations:

Sections 4.8 through 4.11 have been reorganized. Replace these sections as shown in the following items.

Delete all paragraphs and replace with the following paragraphs:

~~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.~~

4.10 INTEGRATION WITHIN SPENT NUCLEAR FUEL PROJECT ORGANIZATIONS

The SNF Project SE&I organization will work with other organizations within the SNF Project to ensure the SNF Project efforts remain integrated. Other SNF Project organizations that are required to work to implement the systems engineering process described herein include the SNF Project engineering, operations, and supporting engineering organizations, such as Quality Assurance.

65. Section 4.11, Integration Within the Spent Nuclear Fuel Subprojects:

Sections 4.8 through 4.11 have been reorganized. Replace these sections as shown in the following items:

Delete all paragraphs and replace with the following paragraphs:

~~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.~~

4.11 INTEGRATION WITHIN THE SPENT NUCLEAR FUEL SUBPROJECTS

At the SNF Project Subproject level, each Subproject will be responsible for product scope, configuration, cost, schedule, and performance. Subprojects will be structured to facilitate execution of the Project mission, and development of products on the systems engineering product tree. The Subproject Design Authority has the Technical responsibility and authority for the Subproject products. The Subprojects composition 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.

Subproject staffing may vary throughout time, depending on the product and its development phase. Matrix and contractor support will be included.

The Project SE&I organization will integrate systems engineering efforts within the Subproject with:

- The SNF Project;
- Other Subprojects;
- National SNF Program (EM-67); 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 Subproject integration.

66. Section 4.12, Spent Nuclear Fuel Management Documents, Replace the paragraph with the following edited version:

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 (WHC 1995a).

67. Section 5.0, Glossary, and Section 6.0, References:

Switch Section 5.0, Glossary, with Section 6.0, References, so the new numbering system will be Section 5.0, References, and Section 6.0, Glossary.

68. Section 5.0, References:

This section has been revised extensively to match the new document. Replace the former WHC-SD-SNF-SEMP-001, Rev. 0, reference section completely with the new WHC-SD-SEMP-001, Rev. 1, Section 5.0, References.

69. Section 6.0, Glossary:

This section has been revised extensively to match the new document. Replace the former WHC-SD-SNF-SEMP-001, Rev. 0, glossary section completely with the new WHC-SD-SEMP-001, Rev. 1, Section 6.0, Glossary.

70. Appendices A, B, and C:

Add Appendices A, B, and C.

Spent Nuclear Fuel Project Systems Engineering Management Plan

J. C. Womack
Westinghouse Hanford Company, Richland, WA 99352
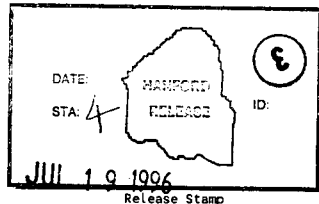U.S. Department of Energy Contract DE-AC06-87RL10930

Key Words: Systems Engineering Management Plan, Systems Engineering Process, Risk Management Process, Design Authority, Design Agent, and Documentation Responsibilities.

Abstract: The purpose of this document is to describe the systems engineering approach and methods that will be integrated with established WHC engineering practices. The methodology promotes and ensures sound management of the SNF Project. The scope of the document encompasses the efforts needed to manage the WHC implementation of systems engineering on the SNF Project including risk management process, design authority/design agent concept, and documentation responsibilities. 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

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July 1996

TABLE OF CONTENTS

i

APPENDICES

FIGURES

TABLES

ACRONYMS

ADR	As-Built Design Review
BMS	Baseline Management System
BSD	Baseline System Description
CMP	Configuration Management Plan
DDR	Definitive Design Review
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy - Richland Operations Office
DOE-RL/SFD	U.S. Department of Energy - Richland Operations Office/Spent Fuels Division
FDC	Functional Design Criteria
FHO	Fuel Handling Operations
F&R	Functions and Requirements
ICD	Interface Control Document
ICWG	Interface Control Working Group
MOU	Memorandum of Understanding
MYPP	Multi-Year Program Plan
MYWP	Multi-Year Work Plan
NSNFP	National Spent Nuclear Fuel Program (DOE-HQ/EM-67)
ORR	Operational Readiness Review
PDR	Preliminary Design Review
PFD	Process Flow Diagram
PMP	Project Management Plan
PSAR	Preliminary Safety Analysis Report
RLID	U.S. Department of Energy-Richland Operations Offices, Implementing Directive
RLPD	U.S. Department of Energy-Richland Operations Office, Policy Directive
SAR	Safety Analysis Report

ACRONYMS

SDR	System Design Review
SE&I	Systems Engineering and Integration
SEMP	Systems Engineering Management Plan
SMS	Site Management System
SNF	Spent Nuclear Fuel
S/RIDs	Standards/Requirements Identification Documents
SRR	System Requirements Review
SSC	Structure, System, and Component
T&E	Test and Evaluation
TPM	Technical Performance Measurement
V&V	Verification and Validation
WBS	Work Breakdown Structure
WHC	Westinghouse Hanford Company

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 "correct" things.

This SNF Project Systems Engineering Management Plan (SEMP) describes the systems engineering approach, methods and processes that are being integrated with established engineering practices to enhance the engineering management of the Project. It is not a complete treatise on the systems engineering discipline. The SEMP format and content have been tailored to meet specific needs of the SNF Project.

This SEMP satisfies the requirements set forth in the following documents:

- *Hanford Site Systems Engineering Policy*, U.S. Department of Energy (DOE) RLPD 430.1 (RL 1996a), which directs that systems engineering be implemented at the Hanford Site, consistent with the *Systems Engineering Criteria Document and Implementing Directive*, DOE RLID 430.1 (RL 1996b);

- *Project Management*, WHC-CM-6-2 (WHC 1996a), states that where a SEMP is appropriate, it should be prepared in accordance with the *Project Management System*, DOE Order 4700.1 (DOE 1987);

- *Project Management System,* DOE Order 4700.1, Chapter III, which states that the systems engineering management process normally is controlled by adherence to a SEMP, prepared and maintained at the project level (Note that DOE Order 4700.1 will be phased out and cancelled after meeting implementation conditions of *Life - Cycle Assessment Management*, DOE Order 430.1 (DOE 1995). Currently, DOE Order 4700.1 is a compliance document and DOE Order 430.1 is not);

- *Spent Nuclear Fuel Project Management Plan,* WHC-SD-SNF-PMP-011 (WHC 1995a), which directs that a SEMP be developed for the SNF Project; and

- *Systems Engineering Criteria Document and Implementing Directive*, DOE RLID 430.1, which provides direction on the implementation of systems engineering at the Hanford Site, based on DOE Order 430.1.

1.2 SCOPE AND CONTEXT

This SEMP encompasses the efforts necessary to manage systems engineering implementation for the SNF Project. This implementation applies, and is tailored to, SNF Project

needs, all its current and future Subprojects, and sub-tier activities. Major physical activities supporting accomplishment of the SNF Project mission are referred to as Subprojects. Each Subproject is an organizational entity, managed as a project responsible for product design, development, fabrication, and testing. This includes project scope, configuration, cost, schedule, and performance. Subproject participation is by team, involving all appropriate disciplines, including operations. Each Subproject will prepare a management plan or work plan. Each subproject may prepare a SEMP. A Subproject SEMP is not necessary if the SNF Project SEMP is adequate, as tailored in the subproject management plan. Subproject size is an important factor in determining whether a separate SEMP is necessary.

This SEMP is intended for application to the design, development, fabrication, construction, test and startup of the Spent Nuclear Fuel Path Forward Subprojects leading to SNF Operations. After SNF Operations assumes responsibility for the system, a modified process, tailored to maintenance and operations is necessary. This process is not included in this SEMP. The K Basin engineering process is consistent with processes in this SEMP.

Figure 1-1 depicts the relationship of this SEMP to other systems engineering guidance documents. The SNF Project SEMP content is derived from the *Site Systems Engineering, Site Systems Engineering Management Plan,* (WHC 1996b), DOE RLID 430.1 (RL 1996b), and the *Spent Nuclear Fuel Project Management Plan* (WHC-SD-SNF-PMP-011) (WHC 1995a). All other systems engineering process interfaces will be through these documents. Because the transition from DOE Order 430.1 is not complete, this SEMP has maintained its consistency with DOE Order 4700.1, as well.

Figure 1-1. Spent Nuclear Fuel Project Systems Engineering Management Plan Context.
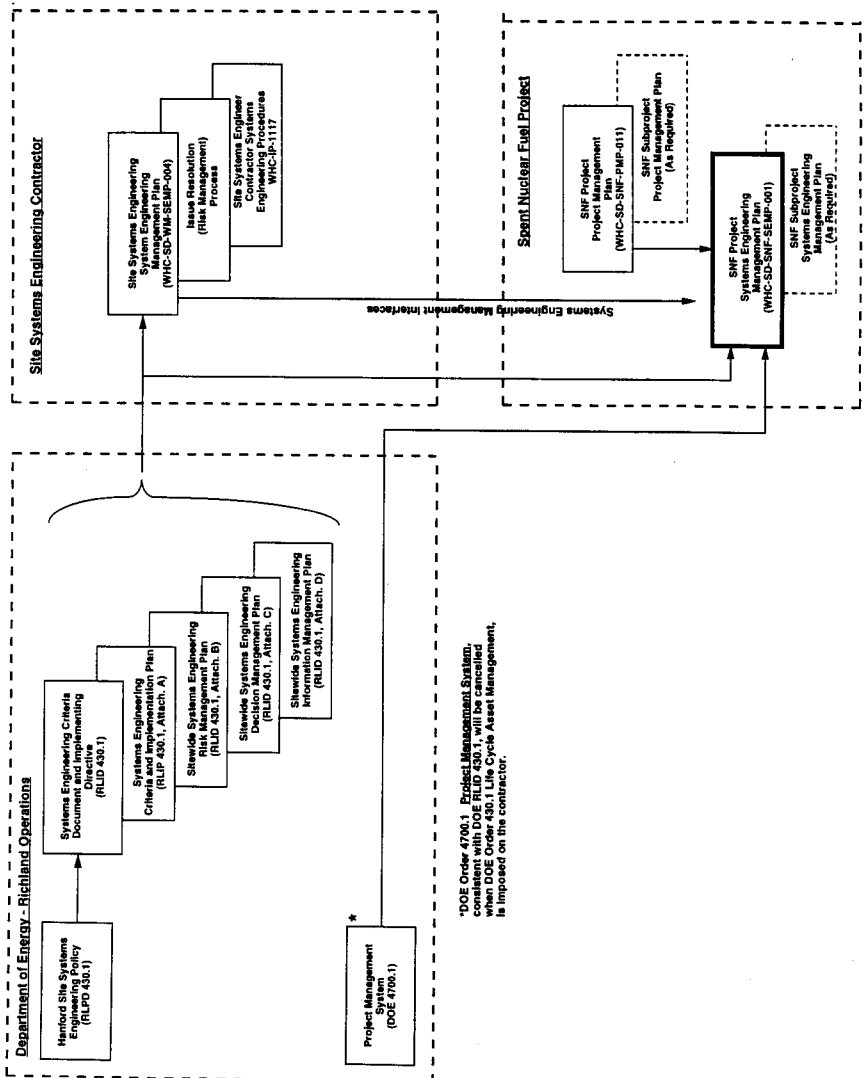
2.0 SYSTEMS ENGINEERING ROLES AND RESPONSIBILITIES

2.1 SPENT NUCLEAR FUEL PROJECT

Project organization roles and responsibilities are defined in the *Spent Nuclear Fuel Project Management Plan* (PMP), WHC-SD-SNF-PMP-011 (WHC 1995a). This section of the SEMP identifies, and is limited to, the roles and responsibilities associated with implementation of Systems Engineering in the Project and Subprojects. Documentation responsibilities related to SNF Project and SNF Subprojects are defined in Appendix A, which may be revised when the information is superseded by higher level Project documentation.

Successful implementation of systems engineering is dependent on the active involvement of all SNF Project and Subproject organizations in the systems engineering processes, documents and procedures, as defined in Sections 3.0 and 4.0. The Systems Engineering and Integration (SE&I) organization provides systems engineering core competency, consistency between Subprojects, and maintenance of the Project technical baseline. In addition, the SE&I organization may facilitate development and upkeep of systems engineering processes, databases, and documentation products throughout the SNF Project life.

2.2 SPENT NUCLEAR FUEL SUBPROJECTS

A new Design Authority/Design Agent concept was established as part of the design process re-engineering. This process focusses Technical responsibility and authority, including implementation of systems engineering and integration activities, with the Subproject Design Authorities. This process, along with the Design Authority and Design Agent roles and responsibilities, has been implemented in the SNF Project, as described in *Standard Engineering Practices*, WHC-CM-6-1, Interim Design Authority/Design Agent Engineering Process Requirements, EP 5.9 (WHC 1996c). Appendix B presents a description of this implementation.

Each Subproject is responsible for product scope, configuration, cost, schedule, and performance. Subproject Design Authorities are responsible for implementation of systems engineering processes and delivery of systems engineering products for their Subprojects to tie into SNF Operations. The SNF Project SE&I organization may integrate the Subproject systems engineering efforts with those of the Project, other Subprojects, the National SNF Program (EM-67), and the Hanford Site Systems Engineering. The SE&I organization will support development and maintenance of Subproject processes and documents.

Subproject roles and responsibilities change throughout the Project life-cycle. Each Subproject ensures expected operation of the Structure, System, and/or Component (SSC), prior to turn-over to SNF Operations. After the Subproject Functions and Requirements (F&Rs)/Function Design Criteria (FDC)/specifications are determined, the role of the SE&I organization will shift to supporting the verification and validation (V&V) that requirements are

being met, coordinating change management, and maintaining interfaces with other Subprojects. Change management includes risk, decision, and issues management.

2.3   SPENT NUCLEAR FUEL OPERATIONS

The SNF Operations is currently comprised of K Basins and Fuel Handling Operations (FHO). The K Basins focuses on existing facilities and the FHO interfaces with Path Forward activities to ensure that all systems are in place, from the beginning of fuel retrieval to interim fuel storage in the Hanford Site 200 East Area.

The SE&I will continue to ensure that the SNF Project Technical Baseline is maintained through coordination of change management and interface control processes. The SNF Operations is responsible for operating and maintaining SNF facilities within the approved safety analysis, Standards/Requirements Identification Documents (S/RIDs), and operational design criteria; and for maintaining the physical configuration control.

3.0 SYSTEMS ENGINEERING TECHNICAL PRACTICES

3.1 INTEGRATED SPENT NUCLEAR FUEL PROJECT ENGINEERING PROCESS

The SNF Project integrated engineering process includes the systems engineering processes by which the SNF Project defines its mission and determines the functions it needs to perform; the requirements it must meet; the SSC, 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 Subproject design, development, analysis, fabrication, and testing leading to operations. 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, decision making, and validation at each step. Between conceptual design initiation and operations start, systems engineering activities focus on SNF Project integration, project optimization, requirements verification and validation, and change management.

The integrated engineering process will be implemented through the use of the Westinghouse Hanford Company (WHC) Controlled Manual system and the systems engineering processes in the *Hanford Site Systems Engineering Manual*, WHC-IP-1117 (WHC 1995b). The *Hanford Site Systems Engineering Manual* procedures are used to implement the process, unless the procedures are defined specifically in this SEMP.

System integration activities continuing throughout the engineering process life include:

- Parametric Analysis;
- Trade Studies;
- Alternative Analysis;
- Decision Analysis;
- Risk Analysis and Management;
- Requirements Verification and Validation;
- Technical Performance Measurement;
- 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 (Subprojects, Hanford Site, and DOE EM-67);
- Systems Test and Evaluation;
- Standards/Requirements Identification Documentation (S/RIDs); and
- Safety Analysis Report (SAR) Requirements Management.

These activities are primarily managed by other than the SE&I organization, although they may be supported by the SNF Project SE&I organization.

3.2   SYSTEMS ENGINEERING PROCESSES

Specific processes that make up the systems engineering portions of the integrated engineering process are described in Sections 3.2.1 through 3.2.8. The processes not defined in these sections are described in *Standard Engineering Practices*, WHC-CM-6-1 (WHC 1996c). The *Hanford Site Systems Engineering Manual*, WHC-IP-1117 (WHC 1995b), provides a description of the specific procedures.

3.2.1 Mission Analysis

Mission analysis is the first step in the overall process. The analysis defines 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, the mission analysis defines, scopes, and bounds the Project or Subproject. The initial SNF Project mission analysis was conducted in 1994. This is documented in *Spent Nuclear Fuel Project Mission Analysis Report*, WHC-EP-0790 (WHC 1994a). Mission analysis continues through the life cycle to address items such as DOE redirection, cost and schedule performance, etc. Mission analyses for Subprojects are not required, but may be conducted if the Subproject defines them in Subproject management plans.

Figure 3-1. Spent Nuclear Fuel Project Integrated Engineering Process.
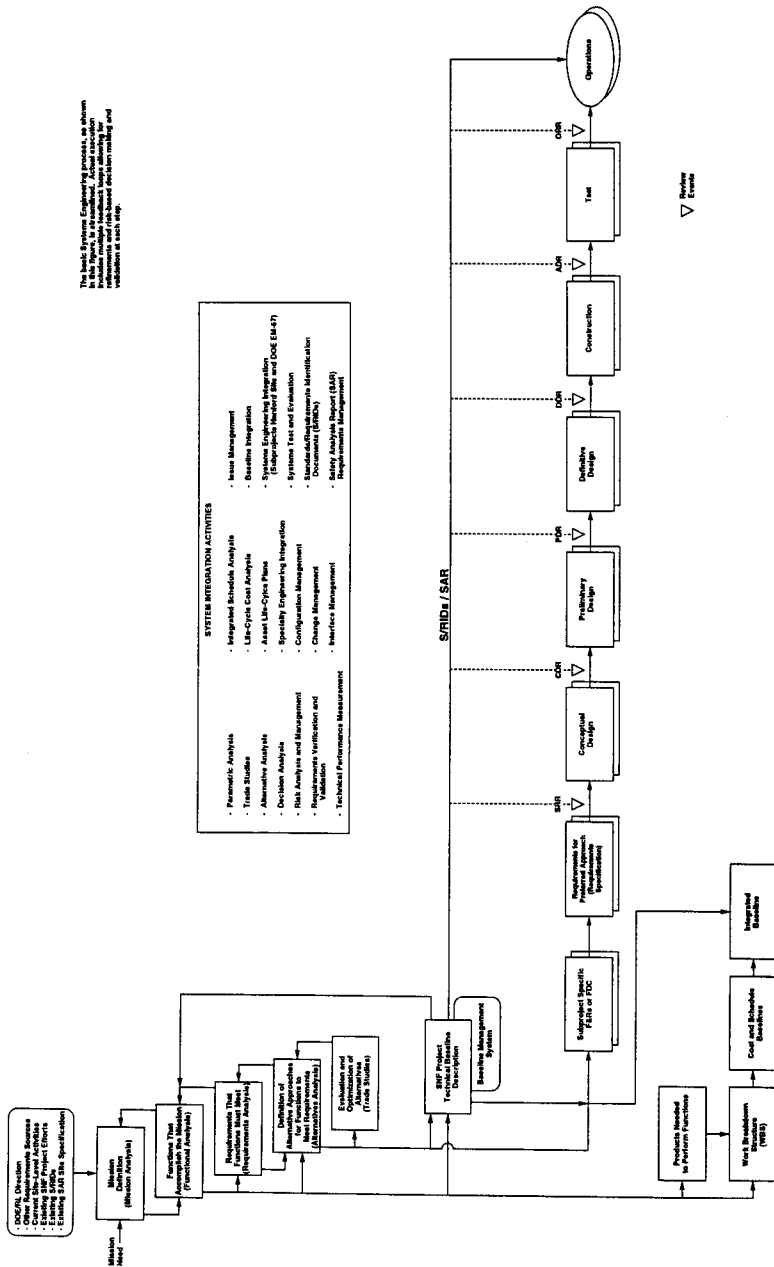
3.2.2 Functional Analysis

Functional analysis identifies the functions that must be performed to accomplish the mission. These functions are then developed at increasingly greater levels of detail to provide an increasingly explicit mission depiction. For the SNF Project, these greater levels of detail become the functions of the Subprojects and SNF Operations. The SNF Project Process Flow Diagrams (PFD) in the *Spent Nuclear Fuel Project Process Flow Diagram Summary*, H-2-825867 (WHC 1996d), and *Spent Nuclear Fuel Project Level 0 Process Flow Diagram*, H-2-825868 (WHC 1996e), were produced to support the engineering process, and are a further development of the functions directly associated with chemical and nuclear processes.

3.2.3 Requirements Analysis

Requirements analysis identifies the requirements associated with each function. Requirements define how well a function must be performed. Requirements allocated to Subproject functions become that Subproject's 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 tests.

Functional requirements are derived by expanding functions until they become detailed enough to define the requirements necessary to perform a function. After quantitative values are defined for these requirements, the requirements become performance requirements. After the functions have been decomposed into functional performance requirements, the requirements can be allocated to SSC. Specifications are associated with SSC.

The S/RID process 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 DOE-RL.

Other requirements sources include design studies; interfaces; analyses (including safety analyses with resulting Operating Safety Requirements and Technical Safety Requirements); trade studies; conceptual design; and verifications associated with a SSC. Safety analyses that result in the Project SAR are examples of sources of derived requirements. These derived requirements must be integrated into the requirements of the Subprojects and/or Project after the initial requirements analyses. The definition of these requirements throughout the design process results in the need for update, addition, revision, and modification of the requirements database and documentation. The S/RIDs and derived systems engineering requirements are integrated and maintained. Another source of SNF Project derived requirements are the studies that produce the U.S. Nuclear Regulatory Commission (NRC) equivalency requirements, as documented in the *Spent Nuclear Fuel Project Path Forward, Additional Nuclear Regulatory Commission Requirements*, WHC-SD-SNF-DB-003, WHC 1995c.

During facility operation, S/RIDs and SAR are used to document the operational requirements. The S/RIDs are also created for Hazard Category 2 facilities associated with the SNF Subprojects. The SAR, along with S/RIDs, provides a source of derived safety requirements. Identification of the specific requirements is included in the Subproject F&R or FDC document, and the Subproject requirements specification, as necessary and appropriate.

The SNF Operations F&Rs are the responsibility of the SNF Project FHO Organization.

3.2.4 Alternatives Analysis

The alternatives analysis identifies alternative solutions for SSC configurations (architectures) for functions that meet the requirements of those functions. These analyses are conducted at Project and Subproject levels, as appropriate, down to and including components.

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. Trade studies 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 requirements. 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 SSC. The requirements specification can be used for SSC development by WHC, or to support procurement from a vendor. These documents are further discussed in Section 3.6. These documents are the responsibility of the Subproject Design Authorities.

3.2.7 Design and Construction

Design and construction processes associated with the SNF integrated engineering process are defined in *Standard Engineering Practices*, WHC-CM-6-1 (WHC 1996c) and *Project Management*, WHC-CM-6-2 (WHC 1996a), and are not repeated in this document.

3.2.8 Test

Testing will occur throughout the facility and system life cycle, including that testing that is required to support design, safety analyses, operational readiness, and post start-up process optimization. This life-cycle testing is described in the *Spent Nuclear Fuel Project Integrated Testing Strategy*, WHC-SD-SNF-CM-004 (PNNL 1996). Final testing includes acceptance

testing, conducted by the Subproject to verify that the system has met design requirements; and operability testing, conducted by appropriate operations organizations to ensure that operations requirements have been met. The acceptance and operability testing will be addressed in the start-up plan currently being developed by the SNF Project FHO.

3.3   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 mission. The SNF Project technical, schedule, and cost baselines comprise the integrated SNF Project baseline. Figure 3-2 depicts the relationships of these baselines, and shows the progression from functions and products, to the Work Breakdown Structure (WBS), to the schedule, and in turn, the cost baselines. The SNF Project organizational structure is designed to support WBS performance. The SNF Project organization is presented in the currently published SNF Project organization charts.

Because the SNF Project is comprised 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 development stages. These progressively more-detailed technical baselines have different names. Table 3-1 describes the progression of technical baselines. These baselines are under configuration control after initial approval. Figure 3-3 illustrates the relationship of these baselines to the integrated engineering process. The technical baseline contents 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. The Technical Baseline Description establishes the requirements baseline down to the Subprojects. Subproject details are the prerogative of the Subprojects. Only the Functional Requirements technical baseline shall be developed at the SNF Project and Subproject level. Subproject and operations organizations develop all other technical baselines.

K Basins organization was in progress at the time the SNF Project was established and integrated into the SNF Project. At that time, K Basins organization was integrated into the SNF Project to continue K Basins maintenance and operations in a safe and environmentally compliant manner during development of the other SNF Project portions. As such, K Basins organization has an established As-Built Configuration Technical Baseline, Configuration Management Plan, Operational S/RIDs, and SAR, that serve as a basis for risk management. For these reasons, K Basins organization does not need the steps leading to the As-Built Configuration Baseline.

Figure 3-2. Integrated Baseline Development.
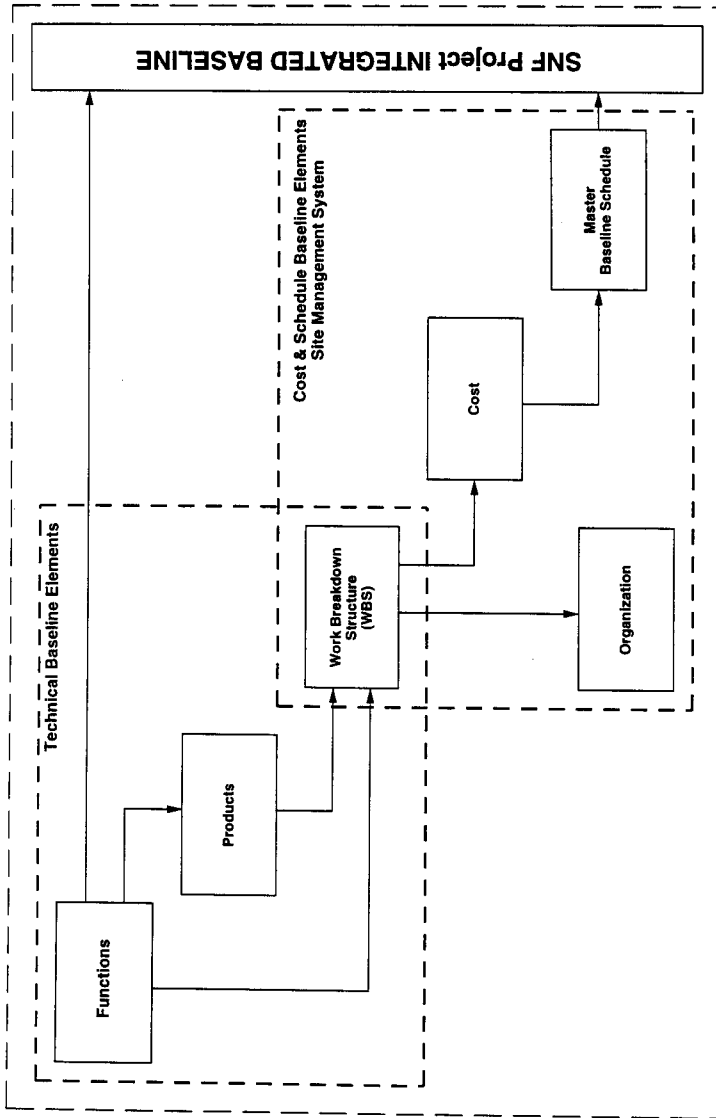
Table 3-1 SNF Project Technical Baselines.

Technical Baseline Title	Baseline Components
Functional Requirements Baseline	Project Mission Analysis Report; Project Baseline Concept Description (BCD); Project Systems Engineering Process Results (Issues, Assumptions, Trade Studies, Risks, and Decisions); Interface Control Documents (ICD) Scope Sheets (Major Physical Interfaces); Project Functions and Requirements; and Subproject F&R or FDC.
Performance Requirements Baseline	Subproject F&R and Requirements Specifications ; ICD Scope Sheets; Subproject Conceptual Design Report; and Preliminary Safety Analysis Report (PSAR).
Design Requirements Baseline	Design Specifications; ICDs; Preliminary (Title I) Design Packages; and Preliminary Facility* S/RID.
Design Configuration Baseline	Construction Specifications; Test Plans and Procedures; Definitive (Title II) Design Packages; and Facility* S/RID.
As-Built Configuration Baseline	Construction Specification Revisions; Test Reports; and As-Built (Title III) Design Packages.
Operational Baseline	Operational Procedures (Updated); Safety Analysis Report (SAR); Final Facility* S/RID; and Physical Configuration Design and Description.

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

Figure 3-3. Spent Nuclear Fuel Project Integrated Engineering Process.

3.3.1 Functional Requirements Baseline

The SNF Project-level Functional Requirements Baseline describes the SNF Project approach, top-level requirements and constraints, and top-level functional and architectural features. This baseline provides the necessary details for start of Subproject conceptual design. The Functional Requirements Baseline has its basis in the *Systems Engineering Functions and Requirements for the Hanford Cleanup Mission: First Issue*, WHC-EP-0722 (WHC 1994b). This baseline is developed by analyzing the contents of these site baselines and applying the information to the SNF Project. This is documented in the Project Technical Baseline Description. The SNF Project Functional Requirements Baseline is a component of the Hanford Site Performance Baseline. The SNF Project SE&I organization develops this baseline at the SNF Project level, and Subproject teams further develop this baseline at the Subproject levels.

3.3.2 Performance Requirements Baseline

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

3.3.3 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. The Design Requirements Baseline becomes the basis for definitive design.

3.3.4 Design Configuration Baseline

The Design Configuration Baseline contents show the progress of the Subprojects in refining the design and developing the "build-to" design packages. The Design Configuration Baseline forms the basis for the beginning of construction and testing.

3.3.5 As-Built Configuration Baseline

The As-Built Configuration Baseline documents the completed construction, and validates the operational basis. The As-Built Configuration Baseline is the technical basis for the start of operations. Constituents of the As-Built Configuration Baseline are components of Site As-Built Baselines.

3.3.6 Operational Baseline

The Operational Baseline includes updated operational procedures, SAR, final facility S/RIDs, and physical configuration design and description. Operational Baseline items are the basis for continuing operations, and will be used as the deactivation activities starting point.

3.4 REVIEWS

This section describes SNF Project and Subproject reviews. The SNF Project will adapt a review process to reflect the SNF Project's own needs. In addition, each Subproject will adapt or tailor the reviews, as appropriate, to its needs. The number and type of reviews described herein are tailored from those described in the *Project Management System*, DOE Order 4700.1 (DOE 1987). These reviews are described in *Standard Engineering Practices*, WHC-CM-6.1, Design Verification Requirements, EP 4.1 (WHC 1996c), and will be in accordance with this EP, as tailored for Subprojects and documented in the PMP for each Subproject. Figure 3-3 illustrates the relationship of the reviews to the baselines. Requirements V&V provide a mechanism to ensure that emerging designs meet requirements.

3.4.1 System Requirements Review

The System Requirements Review (SRR) evaluates the SNF Project 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/Spent Fuel Division (SFD) co-chairing the review. The SRR is a SNF Project level review.

A SRR normally would have been conducted prior to the initiation of the Subprojects' design phase, and would consist of a high-level review of SNF Project objectives; systems engineering approach; and Project-level functions, requirements, architecture, and interfaces, as appropriate. Conducting a SRR was not appropriate until the technical baseline stabilized with the approval of the Integrated Process Strategy, followed by issuance of the *Spent Nuclear Fuel Project Technical Baseline Description - Fiscal-Year 1996* (WHC 1995d) in November 1995.

The DOE-RL/SFD concurred with the *Site Systems Engineering, Systems Engineering Management Plan* (WHC 1996b), *Spent Nuclear Fuel Project Configuration Management Plan* (WHC 1995e), and *Spent Nuclear Fuel Project Interface Control Plan* (WHC 1995f); approved the Multi-Year Program Plan (MYPP) Revision; evaluated and audited the SNF Project Baseline Management System database; conducted on-board reviews; and conducted Subproject systems engineering assessments. The DOE-RL/SFD also provided top-level programmatic decision making and direction. The DOE-RL/SFD determined the total of these to be equivalent to conducting a SRR.

3.4.2 Conceptual Design Review

A Conceptual Design Review (CDR) is a Subproject review that evaluates the Performance Requirements Baseline, and is conducted by a SNF Subproject.

3.4.3 Preliminary Design Review

A Preliminary Design Review (PDR) is a Subproject review that evaluates the Design Requirements Baseline, and is conducted by a SNF Subproject.

3.4.4 Definitive Design Review

A Definitive Design Review (DDR) is a Subproject review that evaluates the Design Configuration Baseline, and is conducted by a SNF Subproject.

3.4.5 As-Built Design Review

An As-Built Design Review (ADR) evaluates the As-Built Configuration Baseline. The ADR evaluates the as-built Subproject's 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 the SNF Subprojects.

3.4.6 Operational Readiness Review

An Operational Readiness Review (ORR) is a major review sponsored by the DOE-RL/SFD. The ORR is used as a verification that a facility is ready for operation. The ORR will address, as a minimum:

• Facility readiness;

• Facility ability to perform its assigned mission;

• Facility operational safety;

• Facility maintenance readiness;

• Operational training; and

• Required permits and procedures completion.

The DOE ORR shall be conducted after the test phase is complete, prior to start-up.

3.5 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 information and their relationship to the technical baselines. The majority of this documentation is not unique to systems engineering; rather, it results from the design documentation required by WHC engineering practices documented in *Standard Engineering Practices*, WHC-CM-6-1 (WHC 1996c).

3.6 REQUIREMENTS DOCUMENTATION

3.6.1 Spent Nuclear Fuel Project Specification

The SNF Project Specification states the technical and mission requirements for the SNF Project, derived by the Hanford Technical Integration organization, as documented in the Hanford Site Cleanup Specification, and contained in the Hanford Site Technical Baseline Database. The Hanford Site-level requirements for the SNF Project will be provided to the SNF Project in this specification, which will become the technical basis for the SNF Project Multi-Year Work Plans (MYWP) and MYPP.

3.6.2 Functions and Requirements Documentation

The SNF Project Management Plan defines a need for an F&R or FDC document. This document is a statement of the Subproject, or operations F&R to a level consistent with the Subproject objective. The Subproject F&R or FDC contains, as a minimum, all functions allocated to that Subproject, and requirements allocated to the Subproject that affect performance of that Subproject and are not contained in the Subproject acquisition F&R. Individual Subprojects may prefer to include all F&R allocated to that Subproject.

The SE&I organization may support development of the F&R document and may ensure that it is consistent with the Subproject requirements specification. These sets of F&R documents are the Subproject F&R.

3.6.3 Requirements Specification

As requirements are allocated to a SSC, the requirements are placed in the requirements specification, which is associated with that SSC. The requirements specification is for use by a Subproject for acquiring SSC. Performance or functional specifications are to be prepared in accordance with *Standard Engineering Practices*, WHC-CM-6-1, Engineering Specification Requirements, EP-1.2 (WHC 1996c), as single-use, non-construction, engineering specifications. Unless tailored by the Subproject, guidelines for the content and format of these single-use,

engineering specifications are contained in *Engineering Practice Guidelines*, WHC-IP-1026, EP G-1.2 and Appendix Q (WHC 1996f).

A requirements specification is a document that is prepared to support development and/or acquisition of a SSC. The requirements specification can be either a performance or functional specification. The requirements specifications state performance (technical) and mission requirements, and allocate them to functions and SSC.

3.6.4 Baseline Documentation and Database

Using the results of the mission and functional and requirements analyses, a single integrated SNF Project Baseline has been established for requirements integration and maintenance. This electronic database, the Baseline Management System (BMS), is designed to contain the Project baseline information. The SNF Project Technical Baseline Description (WHC 1995d) provides an integrated description of the SNF Project and the data that form the Project basis.

4.0 SYSTEMS ENGINEERING MANAGEMENT PRACTICES

4.1 FUNCTIONS AND REQUIREMENTS MANAGEMENT

Requirements traceability ensures that the technical basis for engineering decisions is maintained, which in turn allows effective resource planning and use. Requirements traceability requires information regarding the requirement source, as well as the requirement's allocation to lower-tier functions or end-item products (e.g., SSC). No requirement is changed without first obtaining approval from the parties responsible for the requirement precursor and successor. All F&R allocations are stored in an electronic database for retrieval, sorting, and report generation.

As the technical baseline matures, the requirements 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 Technical Baseline will be updated so that it contains all requirements currently identified by the SNF Project and Subprojects. After requirements specifications are developed, requirements will be traceable to their respective requirements specification. This ensures that all requirements are traceable through all levels.

4.2 CONFIGURATION MANAGEMENT

The technical baseline will be maintained, and changes will be controlled, in accordance with The *Spent Nuclear Fuel Project Configuration Management Plan* (WHC 1995e).

4.3 TECHNICAL INTERFACE CONTROL

The SNF Project was established and will maintain an interface control process coordinated by an Interface Control Working Group (ICWG). The ICWG is a team of representatives managing all internal interfaces, and coordinating with the Hanford Site for 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-SD-SNF-CM-003 (WHC 1995f) contains more information regarding the interface control activities the SNF Project conducts.

4.4 RISK MANAGEMENT

The SNF Project has undertaken an aggressive schedule with the goal of early fuel removal from the K Basins to reduce risks to public and employee health and safety and the environment. Disciplined implementation of risk management is required to ensure that the accelerated schedule does not result in undue safety, environmental, technical, schedule, nor

financial risks. Several management methods are being applied to ensure a reasonable understanding and sound management of such risks. These methods include:

1.   Implementation of an issues management program for addressing issues at the Project and Subproject levels;

2.   Use of disciplined systems engineering and project management processes; and

3.   Implementation of a general design strategy towards robust designs based on existing technology.

Risk management processes within Hanford Site projects have their basis in the Site-Wide Systems Engineering Risk Management Plan, which is an attachment to *Site Systems Engineering, Systems Engineering Management Plan* (WHC 1996b).

Risk management in the SNF Project is performed at multiple levels, using a graded approach, with emphasis on issues management. Major programmatic decisions have employed quantitative or semi-quantitative analytical risk-management techniques, such as statistical evaluations or multi-attribute decision analysis. Ongoing Project and Subproject risk-management activities emphasize techniques that adjust to the accelerated pace of Project activities, including qualitative techniques such as issues management. Appendix C describes the SNF Project approach to risk management.

4.5   WORK BREAKDOWN STRUCTURE

The SNF Project WBS represents all the work, and only that work, that is required to achieve the end states that 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 MYPP. The WBS results directly from the systems engineering process, as defined previously. Subsequent WBS updates and expansions result from "design" efforts implemented by the Subprojects and management process efforts resulting from implementation of the Subproject Program Management Plans.

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

4.6   SCHEDULE

The SNF Project Master Baseline Schedules define the engineering and technical activities performed by the SNF Project. These schedules provide a tool to evaluate progress against planned events and milestones. The planning process, which includes schedule defining, cost estimating, and budgeting, is based on the WBS.

The Project Master Baseline Schedule is summarized to a Level 1 Management Summary Schedule. The Management Summary Schedule is employed in the Plan of the Week to show weekly status.

4.7   PERFORMANCE MEASUREMENT

Performance measurement in the SNF project is accomplished as part of the project control system. A baseline schedule is established and agreed on as part of the MYPP process. Milestones defining expected performance and project deliverables as a function of the schedule are identified in the MYPP (currently termed the MYWP).

Major milestones that mark significant project events, such as design or acquisition of key project SSC, start of key operations, or completion of key documents are tracked by the DOE-RL/SFD. Intermediate milestones that record progress toward completion of major milestones are tracked by WHC. Technical progress is tracked monthly by documenting milestone completion and progress relative to the baseline schedule. Progress is statused monthly for current-year milestones as part of the Site Management System (SMS) Report and the SNF Project Monthly Program Review.

The integrated Project schedule identifies the inter-relationships of Project activities to enable an early identification of potential impacts to major milestones, when intermediate Project milestones are delayed or changed.

Monthly Site Management System reporting includes an assessment of potential impacts to future milestones. In addition, milestones beyond the current fiscal year are evaluated on an annual basis as part of the MYPP process. The Project Control System is defined in the *Spent Nuclear Fuel Project Management Plan* (WHC 1995a).

4.8   INTEGRATION WITH OFFSITE SPENT NUCLEAR FUEL ORGANIZATIONS

The DOE Office of Spent Nuclear Fuel Management (EM-67) currently is pursuing a systems engineering effort for all SNF in the DOE complex. These efforts will have impact on SNF Project systems engineering; and the SNF Project will integrate its systems engineering efforts with the DOE complex-wide efforts.

4.9   INTEGRATION WITH THE HANFORD SITE

The SNF Project is part of the Hanford Site cleanup, and receives its top-level guidance and direction from the site level. Site Systems Engineering has identified the necessity for the SNF Project through its functional breakdown. The SNF Project functional breakdown is a subset of the site functional breakdown. Because of this, SNF Project SE&I will have major continuous involvement with the Hanford Site Technical Integration organization to ensure that

the SNF Project is performing systems engineering within the bounds of site efforts. Changes made by either the Hanford Site or the SNF Project will affect the other, and will require integration. The Hanford Site Technical Integration organization will be the source of the SNF Project system specification.

The SNF Project SE&I organization must work with other programs and projects on the Hanford Site to integrate "Cleanup Hanford Site" efforts across the site. In particular, SNF Project SE&I must integrate its systems engineering efforts with those of other programs and projects. The majority of the external integration effort will focus on generation of Memoranda of Understanding (MOA), which are used as ICDs.

4.10 INTEGRATION WITHIN SPENT NUCLEAR FUEL PROJECT ORGANIZATIONS

The SNF Project SE&I organization will work with other organizations within the SNF Project to ensure the SNF Project efforts remain integrated. Other SNF Project organizations that are required to work to implement the systems engineering process described herein include the SNF Project engineering, operations, and supporting engineering organizations, such as Quality Assurance.

4.11 INTEGRATION WITHIN THE SPENT NUCLEAR FUEL SUBPROJECTS

At the SNF Project Subproject level, each Subproject will be responsible for product scope, configuration, cost, schedule, and performance. Subprojects will be structured to facilitate execution of the Project mission, and development of products on the systems engineering product tree. The Subproject Design Authority has the Technical responsibility and authority for the Subproject products. The Subprojects composition 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.

Subproject staffing may vary throughout time, depending on the product and its development phase. Matrix and contractor support will be included.

The Project SE&I organization will integrate systems engineering efforts within the Subproject with:

- The SNF Project;
- Other Subprojects;
- National SNF Program (EM-67); 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 Subproject integration.

4.12   SPENT NUCLEAR FUEL PROJECT MANAGEMENT DOCUMENTS

For the SNF Project, management documents enable and support 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 (WHC 1995a).

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　　SEP 2.0, Parametric Analysis;

SEP 3.0, <u>System Function Definition</u>;

SEP 4.0, <u>Requirements Identification and Allocation</u>;

SEP 4.1, <u>Requirements Analysis</u>;

SEP 5.0, <u>Alternatives Development and Allocation of Functions</u>;

SEP 6.0, <u>Trade Studies and Alternatives Development</u>;

SEP 7.0, <u>Verification of Alternatives Compliance and Requirements</u>;

SEP 8.0, <u>Decision Analysis in Alternatives Selection</u>;

SEP 8.1, <u>Risk Assessment of Alternatives</u>;

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EP-1.5, <u>Interface Control</u>;

EP-1.6, Engineering Data Transmittal;

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6.0 GLOSSARY

Asset Life-Cycle Plans   Plans that show how much a given asset will cost from conceptual phase through deactivation. These costs form a basis for determing whether system goals and objectives are valid and achievable at specific reviews. The costs also aid in determining if constraints and boundaries are worth maintaining.

Alternative Analysis   A comparison performed on different alternatives, to determine the preferred alternative, based on selected criteria.

Architecture   The aggregate of all concepts and characteristics associated with a structure, system, and/or component (SSC).

Baseline   All technical requirements and related cost and schedule requirements.

Baseline Concept Description   A working document that provides the system concept description in an easily understood format of pictures and narrative. It is an iterative system engineering aid, that describes the system as the system evolves and grows in depth of detail, as the definition of a given system matures.

Change Management   The process of controlling changes to any approved baseline by formal action of a control board.

Conceptual Design Report   A report used to establish the functional baseline, defining mission and technical requirements. It normally precedes the demonstration/validation phase.

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.

Configuration Management   Discipline of identifying and formalizing the functional and physical characteristics of a configuration item at discrete points in the product evolution, for the purpose of maintaining the integrity of the product system and controlling changes to the baseline.

Cost Baseline   A budget that has been developed from the cost estimate, resulting from designation of a configuration baseline. The cost baseline is referred to as a baseline because it is integrated with the technical and schedule baselines, and subject to formal change control.

Decision Analysis   A technique to help manage a complex set of uncertainties. A complex uncertainty is decomposed into simpler uncertainties, which are then treated separately. Decomposition continues until it reaches a level at which either hard information can be brought to bear, or intuition can function effectively.

Derived Requirements Characteristics necessary to complete the requirements for design of a structure, system, or component that are dependent on the nature of the item solution for their initial identification. These are typically identified during conceptual design, design studies and analyses, related trade studies, and verifications.

Function Specificactions, activities, or processes that achieve or support mission accomplishment. "What" must be achieved by the collective effects of all constituent parts. It is synonymous with "purpose."

Functional Design Criteria (FDC) A document containing the functional requirements for a project.

Functions and Requirements Document(s) (F&R) A document containing the definition of functions, requirements, interfaces, and architectural concepts that are in-line with the stated mission of the Project, Subproject, or Operations.

Interface System boundary across which material, data, and/or energy passes.

Interface Management and Control A control process coordinated by an Interface Control Working Group, which is a team of representatives that manages all internal interfaces, and coordinates with other agencies to control external interfaces.

Integrated Schedule Analysis Schedules prepared to be used as a tool to evaluate progress against planned events and milestones. The schedules define the engineering and technical activities performed by the Spent Nuclear Fuel Project.

Issue Management Identification, evaluation, and resolution of issues that encompass multiple Subprojects. The issues may be pivotal in nature, schedule sensitive, or involve an interface external to the Project.

Life-Cycle Cost Analysis An analysis of the total cost of acquiring, owning, and disposing of an item over its entire lifetime.

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).

Mission Analysis Study and design efforts that relate to determination of what the project's mission should be and how it should be conducted.

Objectives Discrete, measurable events that, if accomplished, will contribute to achieving a goal.

Parametric Analysis A cost estimate procedure that uses a broad existing database gathered from hardware and software developed for similar purposes, which can be manipulated to establish a price.

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.

Preliminary Design

Work done to authenticate the development specification. Successful completion represents approval to begin detailed design.

Public Involvement

A process by which the stakeholder views are integrated into the DOE decision-making process. Stakeholder 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 after a decision has been reached.

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.

Requirements Verification and Validation

Verification consists of proof of compliance with specifications, and may be determined by test, analysis, demonstration, inspection, etc. Validation consists of proof the system accomplishes its purpose.

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).

Risk Analysis and Management	Risk management includes assessment, analysis, and handling of potential risk. Assessment is the process of examining a situation and identifying the areas of potential risk. Analysis determines the probability of events and the consequences associated with their occurrence. Handling includes techniques and methods to reduce or control risk.
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.
Safety Analysis Report	The report addresses possible hazards associated with system assembly, test, operation, and support. Special consideration is given to possible operational and environmental hazards related to the use of nuclear and other toxic materials.
Standards/Requirements Identification Document	Identifies environmental, safety, and health requirements for existing and future Hazard Category 2 facilities of the SNF Project. Also identifies standards, regulations, orders, and laws, as well as, "Best Commercial Practices" to establish a minimum set of requirements necessary and sufficient to implement a sound environmental, safety, and health posture.
Specification	A description of the essential technical requirements for items, materials, and services that include the verification criteria for determining whether these requirements are met.
Specialty Engineering Integration	The use of all engineering disciplines to simulate, analyze, and design-in supportability to obtain a balance between design, operational performance, supportability, and ownership costs.
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 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 (c) provides information for follow-on technical efforts.

Systems Engineering Integration

After a design approach has been selected, the approach is verified by testing whether the concept of each physical level meets expectations and requirements. The systems engineering integration is the unwinding of the partitioning process used to build the design.

Systems Test and Evaluation

A continuing function performed throughout the acquisition cycle. It is used to reduce acquisition risk and to provide early and continuing estimates of the system's operational effectiveness and operational suitability. Planning, testing, and analysis are all integral function parts.

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.

Technical Performance Measurement

The product design assessment that estimates, through engineering analysis, and tests the values of essential performance parameters of the current design of work breakdown structure elements.

Trade Studies

An assessment of how well each alternative meets a specific goal.

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 that result from systems engineering efforts during the development and production of a system, and that completely define 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.

APPENDIX A

DOCUMENTATION RESPONSIBILITIES

APPENDIX A

DOCUMENTATION RESPONSIBILITIES

Table A-1 presents a summary of the key documentation resulting from implementation of systems engineering within the Spent Nuclear Fuel (SNF) Project, and the responsibilities of SNF Project organizations for review and approval of these documents. Where appropriate, the responsibilities outlined in the SNF Project Management Plan, and required by WHC-CM-6-2, have been included.

Table A-1 lists SNF Project Systems Engineering Management Plan (SEMP) documentation, including key equivalent Subproject documents. Only the minimum responsibilities required for consistency across the project are indicated. Additional responsibilities may be included in appropriate Program Management Plans (PMP). Subproject PMPs that deviate from these document responsibilities must detail any deviations.

The Lead (L) coordinates the document production from beginning to end, and is an approver. Reviewers (R) are required to participate to the extent requested by the Lead, and sign off on the document. Approvers (A) are required to sign off on documentation.

This documentation responsibilities table may be revised when the information is superseded by higher-level Project documentation.

Table A-1. Documentation Responsibilities Matrix.

Documentation	Spent Nuclear Fuel Project SEMP Reference	DOE-RL/SFD	Per Subproject PMP	Project Director/Project Integration	SNF Engineering	Nuclear & Env. Safety	Schedule Integration	Baseline Control	Applied Technology	Subproject Management	Design Authority	Safety	Quality Assurance	K Basins	Fuel Handling Operations
Project Management Plan (WHC-SD-SNF-PMP-011)	1.2	A		A	R	R		L		L	R				
Subproject Project Management Plan (Required)	1.2	A		A						A	R			A	A
Project Systems Engineering Management Plan (WHC-SD-SNF-SEMP-001)	1	R		A	L			A		L	R				
Subproject Systems Engineering Management Plan (If Required)	1.2	R	*		R				R	A	R	A	A	A	A
Project Mission Analysis Report (WHC-EP-0790)	3.2.1	R		A	L	A		A		A	R			R	A
Project Trade Studies	3.2.5			A	L	R	A		R	A	R	R	R	A	R
Project Technical Baseline Description (WHC-SD-SNF-SD-005)	3.6	A		A	L	A	A	A	R	A	L	R	R	A	A
Subproject Functions and Requirements/Functional Design Criteria (Required)	3.2.7 and 3.6	A	*	A	R	R	A		R		L	R	R	A	R
Subproject Requirements Specification(s) (As Required)	3.2.8 and 3.7	R	*		R		A			A	R			A	R
Facility S/RIDs	3.2.3 and 3.6	A		A	L	L				A		L	R	A	A
Project Configuration Management Plan (WHC-SD-SNF-CM-001)	4.2									R	A			R	A
Project Interface Control Plan (WHC-SD-CM-SD-003)	4.2	R		A	R					A	L	A	A	A	R
Subproject Interface Control Document(s) (As Required)	4.2	R	*	A					L	A	L			A	R
Project Process Flow Diagrams (H-2-825867, H-2-825868)	3.6	R		A	A	L				A	A			A	
As-Built Configuration	3.3		*	A						A	L			R	A
Facility Safety Analysis Report	3.2.3	A		A	R	R				A	A	A	A	A	A
Project Integrated Test Plan	3.2.8	R		A	L					A	A	R	R	A	A

A Approval; As required in WHC-CM-6-2 and WHC-CM-3-5.
L Lead; overall responsibility (including proper coordination, integration, review, preparation, approval, etc.).
R Review.
* Additional responsibilities as defined by individual Project Management Plan.

A-3

APPENDIX B

SPENT NUCLEAR FUEL PROJECT DESIGN AUTHORITY/ DESIGN AGENT PROCESS

APPENDIX B

SPENT NUCLEAR FUEL PROJECT DESIGN AUTHORITY/
DESIGN AGENT PROCESS

B.1 INTRODUCTION

The Design Authority/Design Agent concept resulted from a need, identified by Hanford Site management, to simplify and clarify the lines of technical responsibility and authority during the various stages of the integrated engineering process (WHC 1995g and WHC 1996c).

The SNF Project has developed a tailored process that implements the Site Design Authority/Design Agent concept. The following paragraphs provide guidance to Spent Nuclear Fuel (SNF) Project Design Authorities and Design Agents regarding their functions and responsibilities.

B.2 DESIGN AUTHORITY

B.2.1 Design Authority Description

The Design Authority is the person uniquely responsible and accountable for final acceptability of a structure, system, or component (SSC), including its design baseline and safe operation (WHC 1995g). The key objective of the SNF Project Design Authority process is to empower qualified engineering professionals, representing the interests of the system owner/operator, with absolute, cradle-to-grave technical decision-making responsibility and authority at the lowest practical SSC level.

Within the SNF Project, there are currently three classes of design authorities--Project, Subproject, and Operations. The SNF Project Design Authority is appointed by the Project Director, and responsible for the design of the integrated SNF Project. Each Subproject and Operations Design Authority is delegated authority for his/her SSC by the Project Design Authority. Subproject Design Authorities may become Operations Design Authorities, as their systems pass through operability testing and readiness review.

B.2.2 Design Authority Roles and Responsibilities

B.2.2.1 Project Design Authority. The Project Design Authority is the owner of the Project design (technical) baseline, and is the integrator and administrator of the Design Authority/Design Agent process within the SNF Project. Responsibilities include:

- Implementation of Systems Engineering within the Project;

- Configuration control of the Project technical baseline, primarily through maintenance of the Technical Baseline Description document;

- Integration of Project technical activities, primarily through administration of the design authorities interface control process, and memoranda of understanding with external interfaces;

- Coordination of the Project technical management to oversee implementation of the process, by ensuring

    - SSCs are identified and well defined physically,

    - Qualified design authorities, alternates, and substitutes are approved, trained, and delegated authority for each identified SSC, and

    - Qualified Design Agents are approved; and

- Maintaining the position as the Project point-of-contact with the Site Engineer.

B.2.2.2 Subproject/Operations Design Authorities. Primary responsibilities of the Design Authority are based on the SSC technical aspects. Detailed Design Authority responsibilities are included in individual Subproject Project Management Plan (PMP). As the lead systems engineer for each SSC, the Design Authority is the technical representative for the SSC owner/operator. Key Design Authority responsibilities include:

- Implementation of the systems engineering process within the Subprojects/Facilities;

- Approving Design Agent products and deliverables;

- Development and maintenance of the system's design (technical) baseline, to include

    - Developing key design documents such as Functions and Requirements (F&R)/Functional Design Criteria (FDC), performance specifications, and safety analyses,

    - Configuration/change control on the baseline, and taking timely action to implement and communicate any changes, and

    - Requirements management including traceability to the Project technical baseline;

- Control of technical and operational interfaces;

- Acquiring/approving SSC products, including ensuring the products meet the design (technical) basis; and

- Supporting the resolution of technical issues associated with the SSC.

B.3 DESIGN AGENT

B.3.1 Design Agent Description

The Design Agent is the person responsible and accountable to perform the delegated activities, and provide the technically adequate designs in accordance with agreed requirements specified by the Design Authority. Design documents produced by the Design Agent are subject to stamping by professional engineers when specifically mandated by law or requested by the Design Authority. A Design Authority who performs Design Agent work shall be qualified formally as a Design Agent, and be designated appropriately as the Design Agent. In the SNF Project, all Design Agents are at the Subproject/Facility level.

When an offsite organization assumes Design Agent role and responsibilities, it is incumbent upon the Project manager and the Subproject/Operations Design Authority to ensure that the offsite organization has technically qualified personnel who would perform as the Design Agent(s). This requirement is specified in the WHC QA Manual, WHC-CM-4-2, QR-7.0, Section 3.2, Supplier Evaluation and Selection, Criteria 3.c (WHC 1996j). The SNF Project Design Authority or Hanford Site Engineer are normally not involved in approving offsite organization as Design Agent.

B.3.2 Design Agent Roles and Responsibilities

The responsibilities of the SNF Subproject Design Agents include:

- Producing design output documents, such as drawings, design specifications, reports, and as-built drawings;
- Preparing test procedures and documents;
- Defining inspections requirements;
- Supporting design reviews;
- Interpreting code requirements;
- Ensuring the technical adequacy of design to requirements specified by the Design Authority; and
- Performing alternative studies and analyses.

APPENDIX C

RISK MANAGEMENT IN THE SPENT NUCLEAR FUEL PROJECT

APPENDIX C

RISK MANAGEMENT IN THE SPENT NUCLEAR FUEL PROJECT

C.1 BACKGROUND AND OVERVIEW

The Spent Nuclear Fuel (SNF) Project has undertaken an aggressive schedule with the goal of early fuel removal from the K Basins to reduce risk to the public and worker health and safety, and the environment. Disciplined implementation of risk management is required to ensure that the accelerated schedule does not result in undue safety, environmental, technical, schedule, or financial risks. Several management methods are being applied to ensure a reasonable understanding and sound management of such risks. These methods include:

1. Implementation of an issues management program for addressing issues at the Project and Subproject levels;

2. Use of disciplined systems engineering and project management processes; and

3. Implementation of a general design strategy towards robust designs, based on existing technology.

Risk management processes within Hanford Site projects have their basis in the Site-Wide Systems Engineering Risk Management Plan, which is an attachment to *Site Systems Engineering, Systems Engineering Management Plan*, (WHC 1996b).

Risk management in the SNF Project is performed at multiple levels using a graded approach, with emphasis on issue management. Major programmatic decisions have employed quantitative or semi-quantitative analytical risk management techniques, such as statistical evaluations or multi-attribute decision analysis. Ongoing Project and Subproject risk management activities emphasize techniques that adjust to the accelerated pace of Project activities, including qualitative techniques such as issues management.

C.2 RISK MANAGEMENT PROCESSES FOR MAJOR STRATEGIC DECISIONS

For major strategic decisions within the SNF Project, a combination of risk identification and analysis tools have been used to provide data to evaluate safety, technical, environmental, programmatic, and schedule risks. This section describes implementation of the risk management approach, as applied in the two major strategic decision points in the Project:

• Development of the SNF Project Recommended Path Forward in October 1994; and

• Development of the Integrated Process Strategy in July 1995.

These are examples of the approach that would be used for major strategic decisions in the future.

C.2.1 Spent Nuclear Fuel Project Recommended Path Forward.

The Path Forward was the SNF Project original strategy for resolving safety and environmental concerns associated with the K Basins fuel; and providing for the safe interim storage of the material, pending establishment of a national strategy for long-term fuel management. To arrive at the Path Forward, risk-based decision techniques were used in conjunction with a variety of technical and programmatic reviews by senior experts from outside the Hanford Site. These reviews served to both identify risks, and verify that the decisions reached adequately addressed those risks.

Evaluation of the alternatives included analysis of cost, schedule, regulatory, and stakeholder drivers, and affected tribe values; independent assessments by outside experts; and the use of decision analysis techniques to ensure a comprehensive, balanced treatment of the various alternatives. An important aspect of this process was the identification of issues, their potential impacts, and how they might be mitigated. From a risk management perspective, the decision evaluation included:

- Health, safety, and environmental risk assessment;
- Multi-attribute decision analysis;
- Programmatic risk assessment; and
- External reviews.

Alternatives were modified, if necessary, to meet minimum requirements or to optimize performance with respect to technical, safety, environmental, schedule, or stakeholder criteria.

C.2.1.1 Health, Safety, and Environmental Risk Assessment. The Path Forward evaluation considered the health risk to the public, workers and environment from the release of ionizing radiation and hazardous materials. Also considered were the health risk to workers from industrial activities involved in the processes. A preliminary hazards analysis process was used to identify potential accident conditions. A qualitative determination of the accident sequence consequence and frequency was completed to provide a relative risk index. The total relative risk index and the relative risk index as a function of time were evaluated. Conclusions relative to the public, worker, and environmental risk are provided in the *Hanford Spent Nuclear Fuel Project Recommended Path Forward*, Volume 2, Appendix F (WHC 1994c).

C.2.1.2 Multi-Attribute Decision Analysis. The evaluation process identified the fundamental objectives important to making the Path Forward decision. Criteria associated with the objectives were developed such that if the individual criteria are realized, then the objectives will be achieved. The fundamental objectives for the Path Forward were:

- Minimize total costs;

- Minimize public, worker and environmental health risks;

- Minimize the schedule;

- Maximize affected tribes and stakeholder confidence;

- Maximize technical performance; and

- Maximize the likelihood of programmatic success.

The multi-attribute decision analysis evaluated the alternatives with respect to how well they achieved these objectives. Criteria associated with each of the objectives that could be quantified were identified. The relative importance of the various objectives and criteria were identified and weighted to ensure that achieving the most important criteria had greater significance than meeting the lesser criteria. Each alternative was scored for each of the objectives and criteria. The overall score reflected the relative ability of each of the alternatives to meet the objectives set forth for the Path Forward.

In the case of the path forward, the best features of the original alternatives evaluated were extracted and combined to create the Recommended Path Forward. This represented a significant reduction in risk immediately in the Project because it combined the project components that best met the overall project objectives.

C.2.1.3 Programmatic Risk Evaluation. The programmatic risk evaluation assessed the impact of uncertainties within key Project elements in the likelihood that the alternatives will achieve the established Project schedule and cost goals. The evaluation assisted the decision process in determinig not only whether an alternative can achieve the required goals, but also the magnitude of risk of delays and overruns associated with it. The focus was to identify those key components that, if effectively managed, would have the greatest influence on successfully meeting the aggressive schedule. The evaluation process clearly identified those technical and management issues that had to be addressed early in the Project. The programmatic risk evaluation is described in detail in the *Hanford Spent Nuclear Fuel Project Recommended Path Forward*, Volume 2, Appendix G (WHC 1994c).

C.2.1.4 External Reviews. As a risk mitigation measure, an independent, external, senior review group was chartered by the Project. This group reviewed methodology and results of the path forward decision analysis so that risks were identified and addressed adequately.

C.2.2 Spent Nuclear Fuel Project Integrated Process Strategy

With approval of the Path Forward in February 1995, the U.S. Department of Energy (DOE) assigned an accelerated schedule goal to begin fuel removal from K Basins by December 1997 (one year earlier than the Path Forward recommendation), to complete fuel conditioning for

dry storage as soon as feasible, and to implement those accelerations within current budget projections.

In response to these goals, the Integrated Process Strategy was developed to establish the technical framework to construct facilities and implement processes compatible with these goals. Major innovations such as repackaging the fuel into storage baskets to reduce necessary storage space and containers for the fuel; removal of fuel corrosion products and other sludges; and application of a two-step fuel drying and conditioning process were developed to enable the Project to meet these goals.

The schedule acceleration and the new process innovations required increased attention to risk management on the part of the Project.

The initial Path Forward study, subsequent technical and engineering tradeoff studies, and the integration results described in this report all use a systems engineering methodology as a basis for defining mission, functions and requirements, and decision making. Evaluation criteria were developed relative to the Systems Engineering Functions and Requirements for the overall SNF Project. The results of the studies and integration efforts feed back into the systems engineering process. The Project technical baseline, functional requirements, and requirements specifications were revised accordingly, based on strategies and guidelines defined by this document, after approval by DOE.

The evaluation process included use of decision criteria similar to those established for the Path Forward study. Key issues were identified along with various engineering alternatives for resolving the issues. The evaluation of alternatives included the use of systematic decision analysis techniques to ensure a comprehensive, balanced treatment. The decision evaluations included:

- Health, safety, and environmental risk assessment,

- Multi-attribute decision analysis; and

- External independent reviews.

C.2.2.1 Health, Safety, and Environmental Risk Assessment. The Integrated Process Strategy was evaluated from a public health and safety, worker safety, and environmental protection perspective. Worker safety was evaluated for both Hanford Site workers (i.e., non-SNF Project workers) and facility workers (i.e., those workers performing work in the facility being assessed). All Project activities and new facilities used a defense-in-depth safety philosophy to achieve a high level of assurance that adequate safety margins and environmental protection are maintained.

To support evaluation of the process options examined in the Integrated Process Strategy, a relative risk comparison was performed. The methodology involved use of a matrix based, semi-quantitative comparison, using relative risk scores. Estimates of accident consequences (radiological dose and environmental impact) and frequency (i.e., probability of occurrence per

year) were developed for the dominant accident sequences identified in the K Basins and other Project safety documentation. The product of frequency times consequences is the risk for a given postulated accident sequence. The sum of the risks from all dominant accident scenarios associated with a given process option for removal, conditioning, and storage of K Basins fuel was used as an overall risk score for the option. Risk scores were compared for numerous fuel removal options considered by this study.

For accident scenarios not specifically analyzed in the SNF Project safety documents, analysts estimated accident frequency and consequences, based on conservative assumptions. The risk assessment also included a comparison with the risk of continued storage of fuel at K Basins. The greatest risk reduction came from early removal of fuel and sludge from the K Basins.

This evaluation identified areas of comparative risk for the options being considered and enabled the Project to understand the risks associated with the Integrated Process Strategy and to develop plans to mitigate those risk areas.

C.2.2.2 Multi-Attribute Decision Analysis. A multi-attribute decision analysis was performed to evaluate the process options. This analysis allows decision makers simultaneously to evaluate proposed actions against several major programmatic and technical objectives.

The original Path Forward multi-attribute decision analysis criteria and evaluation weights were updated to reflect the direction received from the DOE, refining the goals of the Project. The major objectives used for the multi-attribute decision analysis were:

- Minimize schedule;
- Minimize total Project costs;
- Minimize health, safety, and environmental health risks;
- Maximize stakeholder confidence; and
- Optimize technical performance.

Evaluation criteria were ranked and weighted to allow application in the multi-attribute analysis. The results of this analysis identified that the process steps that formed the Integrated Process Strategy best met the Project objectives and criteria.

C.2.2.3 External Reviews. As in the case of the Path Forward study, an independent, external senior review group reviewed the results of the Integrated Process Strategy decision analysis to verify that technical analyses were sound, and that risks were adequately identified and addressed.

C.3   ONGOING SPENT NUCLEAR FUEL PROJECT MANAGEMENT

C.3.1   Systems Engineering Management

The strategy to accomplish the SNF Project mission and objectives includes the implementation of a disciplined systems engineering approach, as described in this *Spent Nuclear Fuel Project Systems Engineering Management Plan* (SEMP).

The role of systems engineering in risk management is to ensure that the mission and scope of the Project is well defined; that the functions necessary to accomplish the mission are identified; and that the requirements that must be met by each of the functions are identified. These form the Project technical baseline on which configuration control is maintained. Subprojects use the Project-level functions and requirements to develop subordinate functions and requirements. Implementation of systems engineering methods within the SNF Project is described in the body of this document. There are two specific systems engineering principles that enhance risk management within the Project, as described in the following paragraphs.

C.3.1.1   Interface Control. Formal interface control is applied with the Project when the design of physical or functional features between equipment items, or between equipment items and facilities may result in a mismatch, omission, interference, or duplication if not properly coordinated. The *Spent Nuclear Fuel Project Interface Control Plan*, WHC-SD-SNF-CM-003 (WHC 1995f) describes the Project policy for interface control.

Interfaces are identified through the development of Process Flow Diagrams, functional analysis and design activities. Interface scope sheets identify the participants, and describe the physical interface and its parameters in sufficient detail to ensure compatibility, throughout the design, procurement, and fabrication phase. An Interface Agreement records interface boundary agreements between responsible managers. Memoranda of Understanding are used for establishing interface agreements external to the SNF Project.

The SNF Project Interface Control Working Group was established to bring together the Subproject design authorities and Subproject managers to enhance interface definition and resolution of interface issues. Any interface disputes or issues unresolvable at the Design Authority and Subproject management level are elevated to the SNF Project Technical Issues Management Board for consideration.

C.3.1.2   Configuration Management . The Project has implemented a configuration management system to establish and maintain technical consistency among design requirements, physical configuration, and documentation. The *Project Configuration Management Plan*, WHC-SD-SNF-CM-001 (WHC 1995e) assists in identifying and managing structures, systems, and components that require configuration control; and controlling and statusing changes to ensure that design, performance, and operational requirements are met.

C.3.2 Technical Issues Management Board

The SNF Project Technical Issue Management Board (Board) identifies, evaluates, and resolves issues that encompass multiple Subprojects that are pivotal in nature, schedule sensitive, or involve an interface external to the Project. In resolving these SNF Project-level issues, Board decisions formally become part of the SNF Project Technical Baseline. Results are documented and retained in the SNF Project Files.

The Board is comprised of SNF Project Managers responsible for technical scope, cost, and schedule. An additional member is a DOE representative who serves to enhance communication regarding pending decisions. The Board identifies and prioritizes Project-level issues; provides management attention and visibility to resolution of issues; sponsors studies that support timely issue resolution; makes and documents decisions to be incorporated into the Technical Baseline and implemented by the Project; and incorporates risk management into the decision making process to maximize Project success through cost, schedule, and technical considerations. The Board also oversees Subproject-level issues management to ensure that each Subproject consistently is managing issues that may have an impact on the Subproject baseline.

Details of the procedures for technical issues management are defined in the *Spent Nuclear Fuel Project Technical Issue Management Board Charter* (WHC 1996g).

C.3.3 Integrated Safety Management Approach

The SNF Project has adapted the recommendations of the Defense Nuclear Facility Safety Board (DNFSB), with respect to defense-in-depth safety principles resulting in the generation of an authorization basis that provides for safe design, construction, and operation. The *Spent Nuclear Fuel Project Integrated Safety Management Plan* (ISMP), WHC-SD-SNF-PLN-012 (WHC 1996h), defines the safety processes, requirements, and responsibilities to be applied to the Project. The ISMP is based on four concepts:

- Defense-in-depth,
- Minimizing exposure,
- Hazards/safety analysis, and
- Clear delineation of safety responsibility.

The ISMP describes the graded approach to safety analysis used by the Project to select and apply analysis techniques that provide sufficient detail to assess each postulated accident or failure, the resulting consequences, and means of prevention or mitigation. This integrated approach reduces the level of safety risk associated with operations of Project facilities. Some of the key parts of the graded approach include:

- Unreviewed Safety Questions Evaluation;

- Hazards Analysis and Categorization;

- Preliminary Safety Evaluation and Classification;

- Fire Hazards and Accident Analysis;

- Criticality Safety Evaluation;

- Safety Analysis Report; and

- Technical Safety Requirements.

The ISMP identifies the authorization approach being used for each of the Subprojects, the scope of schedule for Subproject safety analysis activities, and the review and approval requirements. This also minimizes programmatic risks associated with unplanned authorization basis requirements as startup of the facility approaches.

C.3.4 Integrated Testing Strategy

Within the SNF Project, each of the Subprojects continues to define data needs as their individual designs mature. In parallel, the safety analysis effort is refining the basis for the Safety Analysis Report, and identifying data necessary to support the Project authorization basis. The fast pace of the project, coupled with a high level of parallel design activities, increases the risk that Subprojects may proceed with inconsistent assumptions, may duplicate certain tests, or may omit tests necessary to support critical assumptions. Recognizing this, the *Spent Nuclear Fuel Project Integrated Testing Strategy* (WHC, 1996i) documents the Project-level strategy that will ensure all data requirements are identified, and test plans are developed that efficiently fulfill the requirements.

C.3.5 Operational Readiness Review

It is DOE policy that operations not be started nor resumed in nuclear facilities until the facility has been brought to a state of readiness to safely conduct operations; and that the state of readiness has been verified. An operational readiness review (ORR) is a disciplined, systematic, documented, performance-based examination of facilities, equipment, personnel, procedures, and management control systems to ensure that a facility will be operated safely within its approved safety envelope, as defined by the facility safety basis.

An integrated ORR will be performed prior to the beginning of fuel loading. This integrated ORR will enhance the Project's assurance that all Subprojects and operations organizations have provided facilities and equipment that are ready for use, will perform its assigned mission, will be safe to operate, can be properly maintained, has qualified and trained staff, and has necessary permits and procedures. The Project is preparing an ORR Plan of Action to formalize the decisions necessary to execute the beginning of fuel removal operations.

C.3.6 Reporting and Evaluations

A baseline schedule and budget is established and agreed upon as part of the Multi-Year Program Planning (MYPP) process. Major milestones that mark significant project events (i.e., design or acquisition of key project components, start of key operations, or completion of key documents) are tracked by the DOE. Intermediate milestones that record progress toward completion of major milestones are tracked by the Project. Cost performance and schedule/milestone status are tracked monthly as part of the Site Management Systems (SMS) Report and the SNF Project Monthly Program review. This includes an assessment of potential impacts to future milestones from current events or situations. Plan-of-the-week meetings are conducted by the Project to address ongoing events and emerging issues.

Ongoing evaluation and reporting enhance risk management by ensuring that schedule, cost, and technical issues are raised and addressed in a timely manner. The Project Control System is defined in the *Spent Nuclear Fuel Project Management Plan* (WHC 1995a).

C.3.7 External Reviews

Ongoing independent external reviews provide an important continuing assurance that potential Project risk areas are being adequately identified and addressed. Key external reviewers include:

- The SNF Project-sponsored Senior Design Review Board, whose primary focus is on technical and Subproject management activities within the Project;

- The DOE, Richland Operations Office (RL)-sponsored Independent Review Panel (IRP), whose primary focus is on regulatory activities within the Project; and

- The Congressionally-sponsored DNFSB, whose primary focus is oversight of activities for completion of major Project milestones.

C.4 ONGOING SUBPROJECT MANAGEMENT

In addition to participating in, and providing input for, ongoing Project level activities described in Section 3.0, the Subprojects perform several additional steps that enhance risk management as described in the following paragraphs.

C.4.1 Subproject Issues Management Process

The Subproject Issue Management process ensures that SNF Subprojects have consistent issue management systems that identify key issues, resolve them in a timely manner, and document the decision basis. Issues include concerns, interfaces, or unvalidated assumptions that could have significant impact to cost, schedule, or technical baselines; and are not being resolved through technical development within the planned Subproject scope.

All Subprojects will have an issue management system that consists of the following key elements:

- Issue identification;

- An issue tracking list separate from any day-to-day action item management tool;

- Periodic reviews of progress toward issue resolution and closure against schedule;

- Documentation of issue closure, including alternative evaluation and decision rationale, as appropriate; and

- Screening for overarching issues and elevating them to the Technical Issue Management Board for resolution

The Technical Issue Management Board will review periodically each Subproject's issue management system to confirm that the requirements for Subproject issue management are being met; perform an overview of the issue screening process for overarching issues; and ensure that key issues are being identified and addressed.

The Subproject issue lists will be reviewed for completeness by representatives of the following cross-cutting functions:

- Characterization;

- Technology Integration;

- Integrated Testing;

- Operational Readiness;

- Regulatory, Permitting and Safety;

- Interface Management; and

- Systems Engineering.

C.4.2 Design/Verification Process

Subprojects involved in design and acquisition of new facilities or equipment use a substantial design verification process to ensure that requirements are met, and that equipment is functional and meets user and customer (DOE) needs. Systems engineering products verified in the design verification process include:

- FDC or F&R documents;

- Requirements Specifications;

- Conceptual Design Reports; and

C-11

- Definitive Design Packages.

    Agreement and understanding of the requirements and criteria early in the acquisition process lessens the risk of unplanned changes. Periodic design review by key Project personnel and by supporting organizations such as Quality Assurance and Safety reduce the risk of facilities or equipment that do not meet Project needs or requirements. Each Subproject develops a Project Management Plan that delineates the specific design/verification processes that will be used in that Subproject. This plan is reviewed and approved by RL.