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7. Abstract

A graded approach is being taken by the Liquid Effluents Services Program in implementing systems engineering because of the advanced state of the program. The approach is cost-effective and takes credit for related work already completed, yet retains the benefits of systems engineering. This plan describes how the Liquid Effluents Services Program will implement systems engineering so there is a common understanding. Systems engineering work to be performed and the products of that work are identified. The relation to the current planning process and integration with the sitewide systems engineering effort is described.

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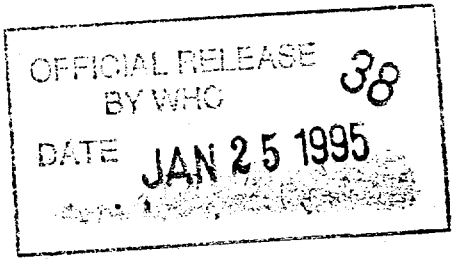

SYSTEMS ENGINEERING IMPLEMENTATION PLAN FOR THE LIQUID EFFLUENTS SERVICES PROGRAM

Issued by

Westinghouse Hanford Company

for the

U.S. DEPARTMENT OF ENERGY, RICHLAND OPERATIONS OFFICE
RICHLAND, WASHINGTON

DISCLAIMER

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CONTENTS

ABBREVIATIONS AND ACRONYMS

AKART	all known available reasonable treatment
ALARA	as low as reasonably achievable
BAT	best available technology
BMP	best management practices
DOE	U.S. Department of Energy
ETF	Effluent Treatment Facility
FDC	functional design criteria
FY	fiscal year
GPP	general plant project
LEMIS	Liquid Effluent Monitoring Information System
LERF	Liquid Effluent Retention Facility
LES	Liquid Effluents Services Program
PS	process sewer
RLPD	U.S. Department of Energy, Richland Operations Office Policy Directive
RLWS	radioactive liquid waste system
RPS	retention process sewer
SEMP	*Hanford Site Systems Engineering Management Plan*
TEDF	Treated Effluent Disposal Facility

1.0 INTRODUCTION

Systems engineering is being used to identify work to cleanup the Hanford Site, in accordance with the U.S. Department of Energy, Richland Operations Office Policy Directive (RLPD) 4900.1, *Systems Engineering*. Systems engineering is a methodology used to develop technical solutions to large or complex problems. The process transforms an identified mission need into a set of performance parameters and a preferred system configuration. The *Hanford Site Systems Engineering Management Plan* (SEMP) (Jackson 1994a) describes the systems engineering process and its products, and provides policy and guidance for the Hanford Site. The *Hanford Site Systems Engineering Manual* (Jackson 1994b) further directs and guides the uniform application of systems engineering.

1.1 PURPOSE

The policy of the U.S. Department of Energy (DOE) is to ensure that discharges to the environment meet applicable regulatory requirements and are as low as reasonably achievable (ALARA). Use of the soil column to treat and retain radionuclides and chemicals in liquid effluents is to be discontinued at the earliest practicable time. Projects have been identified by the Liquid Effluents Services (LES) Program to treat and/or minimize liquid effluents. Many of these projects are nearing completion or already operational.

Given that the purpose of systems engineering is to define the "system" to fulfill a prescribed mission, some steps in the systems engineering process either no longer apply to the LES Program or are limited to changes. For example, engineering studies were previously used to identify alternatives (Step 5 in the SEMP) and select preferred concepts (Step 8). Funding for systems engineering activities and cleanup of the Hanford Site is also limited. For these reasons, a graded approach is being taken by the LES Program in implementing systems engineering. The approach is cost-effective and takes credit for related work already completed, yet retains the benefits of systems engineering.

The purpose of this plan is to describe how the LES Program will implement systems engineering so there is a common understanding. Systems engineering work to be performed and the products of that work are identified. The relation to the current planning process and integration with the sitewide systems engineering effort is described. This plan will be updated as needed to show progress and reflect changes in the basis.

1.2 SCOPE

This plan describes the extent of the systems engineering effort for the LES Program. No other systems engineering work is planned. Changes in cost, schedule, and work scope will be controlled in accordance with WHC-CM-2-5, *Management Control System*, Section 4.1, "Change Control."

1.3 BACKGROUND

An overview of the LES Program is provided in *Liquid Effluent/Hanford Environmental Compliance FY 1995 Multi-Year Program Plan/Fiscal Year Work Plan*, WHC-SP-1097 (WHC 1994). The program mission is to eliminate use of the soil column for liquid effluent treatment, and to manage current and future liquid effluent streams in a safe, responsible, cost-effective, and legally-compliant manner. This is achieved through planning and integration; public and stakeholder interaction; definition of requirements for generators; providing timely treatment, storage, and disposal capability; and minimization of waste streams. The LES Program has the following work elements:

- Program Management - Provide overall coordination, direction, and customer interface for activities in the LES Program. Provide administrative support for program documentation, funds management, scheduling, and reporting.

- 200 Area Effluent Treatment Facility (ETF) Operations - Perform safe, cost-effective and environmentally-sound design review, construction review, startup testing, operation, and maintenance of all 200 Area liquid effluent treatment facilities.

- 300 Area Treated Effluent Disposal Facility (TEDF) Operations - Perform safe, cost-effective and environmentally-sound design review, construction review, startup testing, operation, and maintenance of all 300 Area liquid effluent treatment facilities.

- Liquid Effluents Advanced Engineering - Assist in developing long-range plans, perform engineering evaluations, investigate new feeds to treatment plants, and integrate future liquid effluent projects into the existing liquid effluent treatment facilities and infrastructure.

The LES Program is responsible for the following major systems:

- Liquid Effluent Retention Facility (LERF)
- 200 Area ETF, Project C-018H
- 200 Area TEDF, Project W-049H
- 300 Area TEDF, Project L-045H
- 300 Area Process Sewer (PS), Retention Process Sewer (RPS), and Radioactive Liquid Waste System (RLWS)
- 307 Basins
- 340 Facility
- 300 Area Process Trenches

Additional projects are underway to upgrade and/or replace current LES facilities or bring them into regulatory compliance. These projects include:

- Phase II Liquid Effluent Treatment and Disposal, Project W-252
- 200 Area Best Available Technology/All Known Available Reasonable Treatment (BAT/AKART) Implementation, Project W-291H
- 340 Facility Secondary Containment and Leak Detection, Project W-302
- 340 Facility Exhaust Stack Monitor Upgrade, Project W-337
- 307 Basin Maintenance Upgrades, Project W-345
- 300 Area Retention Process Sewer Monitoring/Diversion Upgrade, Project W-353
- 300 Area Process Sewer Piping Replacement, Project L-070

The current LES facilities and projects were all developed using traditional engineering methods.

2.0 APPLICATION OF SYSTEMS ENGINEERING

2.1 OBJECTIVES

The objectives of systems engineering for the LES Program are:

- Define the work to be performed,
- Identify and control interfaces,
- Integrate with the Hanford Site cleanup mission,
- Supplement the current planning process, and
- Augment the technical baseline.

These objectives reflect the graded approach by the LES Program in implementing systems engineering. The intent is not to revisit past decisions, nor is it to backfit work done previously. Rather the goal is to use available resources more effectively and efficiently.

2.2 ENABLING ASSUMPTIONS

The following assumptions enable the LES Program to proceed in implementing systems engineering:

- The LES Program will continue to provide integrated liquid effluent management services, including waste water treatment and disposal, to the Hanford Site for the duration of the cleanup mission.
- No new LES facilities will be needed to fulfill the cleanup mission other than upgrades to enhance operation and accommodate new feeds.

2.3 APPROACH

The approach by LES to implementing systems engineering is described below in terms of the 10-step systems engineering process in the SEMP. A description of each step is given, taken directly from the SEMP. The work already completed and the work that still needs to be performed is identified for each step.

Implementation of Systems Engineering by Liquid Effluents Services.

Step in the Systems Engineering Process	Work Completed	Work Planned
Step 1 - Mission Analysis In this step an expression of customer need/problem is analyzed to develop a comprehensive description of results, that once achieved through the performance of a system, would satisfy a customer's need or solve a customer's problem. Products from a mission analysis include definition of system objectives, conditions under which a problem is solved (i.e., system end-state), requirements and constraints that are imposed on the solution, and measures of effectiveness.	• A Mission Analysis was performed for the LES Program; the results are described in *Liquid Effluents Program Mission Analysis*, WHC-SD-WM-MAR-003 (Rev 0).	• Update the Mission Analysis for the LES Program (6/30/95). - Quantify the measures of success. - Identify the open issues; describe the plan and responsibility to resolve open issues. - Identify the additional information needed; describe the plan and responsibility to develop needed information. - Address changes in priorities of the site cleanup mission.
Step 2 - Functional Analysis This step derives the actions which a system must perform; supporting functions that must be carried out for the technical functions (i.e., management functions); interdependencies among them; and functional performance criteria. The resulting product contains a hierarchy and detailed description of the lowest level functions and interfaces.	Functions • The Functional Analysis developed in Capstone was updated and entered in the sitewide Systems Engineering data base including the function hierarchy, function flow diagrams, and function and interface definitions. [The sitewide Systems Engineering data base will define the technical baseline for the Hanford Site cleanup mission.] • Functional requirements were specified in functional design criteria documents (FDCs) for existing LES facilities. The FDCs are listed in *Liquid Effluents Program Mission Analysis*, WHC-SD-WM-MAR-003 (Rev 0). Interfaces • LES interfaces are listed in *Liquid Effluent/Hanford Environmental Compliance FY 1995 Multi-Year Program Plan/Fiscal Year Work Plan*, WHC-SP-1097 (September 1994) • LES interfaces with the Solid Waste Disposal Program are described in *Liquid Effluents Services and Solid Waste Disposal Interface Control Document*, WHC-SD-WM-PICD-001 (Rev 0). • Interfaces for Phase I and II Streams discharging to the 200 Area TEDF are described in *200 Area TEDF Interface Control Document*, WHC-SD-W049H-ICD-001 (Rev 1). (Cont'd below)	Functions • Update the Functional Analysis to support future planning (2/28/95). - Ensure all the work by LES is represented. - Include Manage the Program (Function 1) and Acquire the System (Function 2) activities. - Decompose the interfaces and coordinate with other programs. - Incorporate any changes by other programs which affect LES. • Use the results of the Functional Analysis to prepare future planning. Interfaces • Further define and document LES interfaces with other programs as identified in the sitewide functional analysis. - Issue interface control documents as supporting documents. - Control per WHC-CM-6-1, EP-2.2. • Update the inventory of Miscellaneous Streams annually until all permit applications required by *Plan and Schedule for Disposition and Regulatory Compliance for Miscellaneous Stream*, DOE/RL-93-94 (Rev 1), have been submitted. • Further develop the Liquid Effluent Monitoring Information System (LEMIS) interface with the analytical labs.

Implementation of Systems Engineering by Liquid Effluents Services (Cont'd).

Step in the Systems Engineering Process	Work Completed	Work Planned
Step 2 - Functional Analysis - Cont'd	(Cont'd above) Interfaces • Treatability limits for the ETF are defined in *200 Area Effluent Treatment Facility Delisting Petition*, DOE/RL-92-72 (Rev 1). • The process for evaluating waste for treatment in the LERF/ETF is described in *Acceptance of Feed Streams for Treatment at the LERF/ETF Complex*, WHC-SD-ETF-WAC-001 (Rev 0). • Waste acceptance criteria for the 300 Area TEDF are defined in *300 Area Liquid Effluent Facilities Administration*, WHC-IP-1000 (Rev 0), Section 3.3, "Waste Acceptance Criteria for the 300 Area Process Sewer and the Treated Effluent Disposal Facility." • The inventory of Miscellaneous Streams is given in *Revised Inventory of Miscellaneous Streams*, WHC-SD-EN-EV-014 (Rev 0).	
Step 3 - Requirement Identification Statutory, regulatory, technical, social, and economic requirements with which a system must comply are identified in this step. The product from this step is a baseline that includes sources and descriptions of the requirements in two classes: mission-driven and externally-imposed.	• Top-level requirements were identified and entered in the sitewide Systems Engineering data base (9/30/94). • Sources of physical and programmatic constraints are identified in *Liquid Effluents Program Mission Analysis*, WHC-SD-WM-MAR-003 (Rev 0). • Design requirements were specified in FDCs for existing LES facilities. The FDCs are listed in *Liquid Effluents Program Mission Analysis*, WHC-SD-WM-MAR-003 (Rev 0). • Permit conditions for existing LES facilities were negotiated with the regulators. The permits are listed in *Liquid Effluents Program Mission Analysis*, WHC-SD-WM-MAR-003 (Rev 0). (Cont'd below)	• Monitor for changes in mission-driven and external requirements (e.g., new feeds, changes in regulations which affect discharge requirements). • Revise the S/RIDs for the 200 Area Liquid Effluent Facilities based on the ETF changing from a Hazard Category 3 facility to a Radiological Facility. (Draft S/RIDs were provided to Operations Support for review.) • Complete the WHC Site S/RIDs. (Draft S/RIDs were provided to DOE-RL for review.) • Enter the requirements for Miscellaneous Streams in the sitewide Systems Engineering data base. • Submit Categorical WAC 173-216 Permit Applications for Miscellaneous Streams to Ecology per the schedule in *Plan and Schedule for Disposition and Regulatory Compliance for Miscellaneous Streams*, DOE/RL-93-94 (Rev 1). (Cont'd below)

Implementation of Systems Engineering by Liquid Effluents Services (Cont'd).

Step in the Systems Engineering Process	Work Completed	Work Planned
Step 3 - Requirement Identification - Cont'd	(Cont'd above) • Safety analyses (e.g., Safety Analysis Report, Hazard Classification Analysis, Fire Hazard Analysis) for existing LES facilities establish the safety bases for the facilities and define the envelope for safe operation. The safety analyses are listed in *Liquid Effluents Program Mission Analysis*, WHC-SD-WM-MAR-003 (Rev 0). • S/RIDs for the LERF/ETF, 200 Area TEDF, and Project W-291 Truck Unloading Facility (future) are identified in *Standards Requirements Identification Document Liquid Effluent Facilities*. (S/RIDs are requirements defined in DOE Orders, Federal and State regulations, industry codes, standards, and good practices that assure protection of the health and safety of workers and the public.) • Draft (program-level) WHC Site S/RIDs are identified in *Standards Requirements Identification Document Westinghouse Hanford Company Site*. • Operating limits for the 300 Area TEDF are identified in *300 Area Treated Effluent Disposal Facility Operating Specifications Document*, WHC-SD-L045H-PC-001 (Rev 0). • Requirements for the Miscellaneous Streams are identified in *Plan and Schedule for Disposition and Regulatory Compliance for Miscellaneous Streams*, DOE/RL-93-94 (Rev 1). • A plan and schedule to submit Categorical WAC 173-216 Permit Applications for Miscellaneous Streams is identified in *Plan and Schedule for Disposition and Regulatory Compliance for Miscellaneous Streams*, DOE/RL-93-94 (Rev 1). • Upgrades to LES facilities needed to enhance operation and accommodate new feeds are identified as general plant projects (GPPs) in *Liquid Effluent/Hanford Environmental Compliance FY 1995 Multi-Year Program Plan/Fiscal Year Work Plan*, WHC-SP-1097 (September 1994).	(Cont'd above) • Identify the requirements for upgrades to LES facilities in engineering studies and FDCs. Enter the requirements for upgrades to LES facilities in the sitewide Systems Engineering data base. • Modify existing permits as needed for LES facilities which have been upgraded.

Implementation of Systems Engineering by Liquid Effluents Services (Cont'd).

Step in the Systems Engineering Process	Work Completed	Work Planned
Step 4 - Requirements Allocation to System Functions Requirements identified in Step 3 are associated with the systems functions producing a requirement baseline for the systems engineering process.	• Top-level requirements were allocated to functions in the sitewide Systems Engineering data base (9/30/94). • Requirements for existing LES facilities are maintained as facility records.	• Allocate the requirements for Miscellaneous Streams to functions. Enter the results in the sitewide Systems Engineering data base. • Allocate the requirements for upgrades to LES facilities to functions.
Step 5 - Develop Alternative Solutions Based on the products from Steps 1-4, numerous different candidate configurations of a system solution (design strategies) are developed.	• Alternatives were identified in engineering studies for existing LES facilities. The engineering studies are listed in *Liquid Effluents Program Mission Analysis*, WHC-SD-WM-MAR-003 (Rev 0). • A plan to evaluate best management practices (BMPs) for those Miscellaneous Streams in or near known surface contamination areas, cribs, trenches, or ditches is described in *Plan and Schedule for Disposition and Regulatory Compliance for Miscellaneous Streams*, DOE/RL-93-94 (Rev 1).	• Identify options for BMPs for Miscellaneous Streams in an engineering study. • Identify alternatives for upgrades to LES facilities in engineering studies.
Step 6 - Alternative Solutions Characterization The attributes of the design alternatives are established by a comprehensive analysis. The product of this step is a comprehensive description of potential solutions to the customer's need or problem.	• Details of alternatives were developed to an extent sufficient to allow comparison in engineering studies for existing LES facilities.	• Develop details of options for BMPs for Miscellaneous Streams in an engineering study. • Develop details of alternatives for upgrades to LES facilities in engineering studies.
Step 7 - Alternative Solutions Reqmts Compliance Evaluation A prerequisite in the Hanford systems engineering model is that to be declared feasible, each alternative must meet all the requirements that are identified in Step 3. In Step 7, those configurations that meet these conditions are retained.	• Feasibility of alternatives was determined and compliance with requirements was verified in engineering studies for existing LES facilities. • A Readiness Assessment Plan has been prepared for verifying the readiness of the 200 Area TEDF to startup and is described in *Readiness Assessment Plan for the Hanford 200 Area Treated Effluent Disposal Facility*, WHC-SD-W049H-RRR-001 (Rev 0). A draft Memorandum of Understanding for DOE-RL approval was transmitted [Alaconis, W.C., "Memorandum of Understanding for the Readiness Assessment of the Hanford 200 Area Treated Effluent Disposal Facility," Letter 9457753 (to J.M. Hennig, DOE-RL, dated November 10, 1994)]. (Cont'd below)	• Conduct a Readiness Assessment of the ETF prior to startup. Revise the Readiness Assessment Plan based on the ETF changing from a hazard category 3 facility to a radiological facility. • Conduct a Readiness Assessment of the 200 Area TEDF prior to startup. • Determine the feasibility of options for BMPs for Miscellaneous Streams and verify compliance with requirements in an engineering study. (Cont'd below)

Implementation of Systems Engineering by Liquid Effluents Services (Cont'd).

Step in the Systems Engineering Process	Work Completed	Work Planned
Step 7 - Alternative Solutions Reqmts Compliance Evaluation - Cont'd	(Cont'd above) • Compliance of the 300 Area TEDF with DOE Orders was assessed and the results are documented in *Order Compliance Assessment Treated Effluent Disposal Facility*. • A Readiness Assessment was conducted that verified the readiness of the 300 Area TEDF to startup [Hatch, C.E., "300 Area Treated Effluent Disposal Facility (TEDF) Readiness Assessment," Internal Memo 86300-94-063 (to T.B. Veneziano, WHC, dated October 31, 1994)].	(Cont'd above) • Determine the feasibility of alternatives for upgrades to LES facilities, and verify compliance with requirements in engineering studies. • Conduct Readiness Assessments as needed prior to restart if substantial modifications are required for upgrades to LES facilities.
Step 8 - Design Criteria Development and Solution Selection The basis for the comparison and selection of a preferred system configuration is established. The first product from this step is the set of selection criteria. The application of these criteria results in the selection of a preferred design alternative.	• Selection criteria were developed and used to select preferred alternatives in engineering studies for existing LES facilities.	• Develop selection criteria and select preferred options for BMPs for Miscellaneous Streams in an engineering study. • Develop selection criteria and select preferred alternatives for upgrades to LES facilities in engineering studies.
Step 9 - Requirements Analysis In the situations where no candidate solution is found, relief may be sought in over-constrained requirements. To ensure full compliance, all the requirements governing the performance of a preferred system are re-examined to find the most effective relief. This step may produce a reconfiguration of a preferred system design as a result of changes in the priorities of analyzed requirements.	• Operating requirements and/or permit conditions for existing LES facilities were negotiated with regulators.	• Analyze the requirements for Miscellaneous Streams if an over-constrained condition occurs. • Analyze the requirements for upgrades to LES facilities if an over-constrained condition occurs. • Re-negotiate operating requirements and/or permit conditions with regulators as needed for affected facilities.
Step 10 - Engineering Baselining The results from Step 8 are used to develop a component of the technical baseline. The products from Step 10 are information and data baselines that are used for design and progression into the construction phase of a system development.	• As-built conditions are being recorded for existing LES facilities on completion of construction as part of project close-out.	• Update the as-built documentation for facilities affected by implementation of BMPs for Miscellaneous Streams. • Update the as-built documentation for LES facilities which have been upgraded.

3.0 REFERENCES

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Jackson, G.W., 1994b, "Transmittal of the Hanford Sitewide Systems Engineering Management Plan Revision 0" (Letter 9454364 to W.A. Rutherford, U.S. Department of Energy, Richland Operations Office, Richland, Washington, June 22, 1994), Westinghouse Hanford Company, Richland, Washington.

RLPD 4900.1, 1994, *Systems Engineering*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

WHC, 1994, *Liquid Effluent/Hanford Environmental Compliance FY 1995 Multi-Year Program Plan/Fiscal Year Work Plan*, WHC-SP-1097, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-2-5, *Management Control System*, Section 4.1, "Change Control," Westinghouse Hanford Company, Richland, Washington.