

**Savannah River Site
High Level Waste Salt Disposition
Systems Engineering Team**

**HLW Salt Disposition Alternatives Identification
Preconceptual Phase I
Summary Report**

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HLW Salt Disposition Alternatives Identification
Preconceptual Phase I Summary Report

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1.0 Executive Summary

The High Level Waste (HLW) Salt Disposition Systems Engineering Team (henceforth referred to as Team) was formed on March 13, 1998, under the sponsorship of the WSRC High Level Waste Vice President and General Manager. The Team is chartered to identify options, evaluate alternatives and recommend a selected alternative(s) for processing HLW salt to a permitted waste form. This requirement arises because the existing In Tank Precipitation (ITP) process, as currently configured, cannot simultaneously meet the HLW production and Authorization Basis safety requirements. DOE-SR concurs with this approach.

For the past two years, chemistry studies aimed at developing an understanding of the reaction mechanisms and kinetics associated with the ITP process have been underway. These studies are intended to lead to closure of DNFSB Recommendation 96-1 and the results will be input to the process for evaluating alternatives.

The Team is comprised of appropriately qualified experts from WSRC and its partners, with outside consultant support from academia, National Laboratories and the DOE complex. Team membership is identified in the HLW Salt Disposition Systems Engineering Team Charter. The overall methodology for achieving the Team's mission is described in the Systems Engineering Management Plan.

Multiple approaches were used to identify alternative processes to meet the production and safety requirements for salt disposition. Formal brainstorming sessions with a range of stakeholders were supplemented by historical reviews and literature surveys. In addition, a Briefing Package for soliciting site wide experience was distributed to SRS Operations and Engineering. DOE complex and other chemical processing experience, e.g. Corps of Engineers, ORNL, BNFL, were accessed for ideas through knowledgeable individuals on the site. All ideas were captured on a "Pro Forma" sheet included in the briefing package.

The resulting list of approximately 130 alternatives was evaluated against a set of minimum screening criteria which included scientific maturity, engineering maturity, implementation feasibility, safety, licensable and feasibility of permitting the final waste form. Alternatives were either accepted as written, modified by combination or addition, or dropped. Ranking was performed within technology categories in order to focus on the alternatives with the highest potential for success. The result of the exercise was an "initial list" of eighteen alternatives selected for further evaluation, which were grouped in categories including: Crystallization, Electrochemical Separation, Ion Exchange, Precipitation, Solvent Extraction and Vitrification.

The main focus of the Team's work in Phase II will be on the application of screening criteria for performance of a preliminary technical and programmatic risk assessment of the eighteen alternatives to establish a short list for detailed evaluation. New ideas or alternatives will continue to be identified over the coming weeks. The same structured systems engineering approach will be applied to any new or modified alternatives throughout the study until a final alternative(s) is recommended.

This report meets the major milestone Phase I Deliverable specified in the team charter.

2.0 Purpose

The purpose of this report is to summarize the process used by the Team to systematically develop alternative methods or technologies for final disposition of HLW salt. Additionally, this report summarizes the process utilized to reduce the total list of identified alternatives to an “initial list” for further evaluation.

The results of the process utilized are captured in the Position Paper on the Evaluation Leading to the “Initial List” of Alternatives (ref. 1). The initial list of alternatives are described in Section 7.3 of this report.

This report constitutes completion of the team charter major milestone Phase I Deliverable. (Milestone Date 4/17/98)

3.0 Introduction

The High-Level Waste System is a set of seven different interconnected processes (Figure 1) operated by the High Level Waste and Solid Waste Divisions. These processes function as one large treatment plant that receives, stores, and treats high-level wastes at SRS and converts these wastes into forms suitable for final disposal. The three major permitted disposal forms are borosilicate glass, planned for disposal at a Federal repository; saltstone grout, disposed in vaults on the SRS site; and treated water effluent, released to the environment.

These processes currently include:

- 1) High-Level Waste Storage and Evaporation (F and H Area Tank Farms)
- 2) Salt Processing (In-Tank Precipitation and Late Wash Facilities)
- 3) Sludge Processing (Extended Sludge Processing Facility)
- 4) Vitrification (Defense Waste Processing Facility)
- 5) Wastewater Treatment (Effluent Treatment Facility)
- 6) Solidification (Saltstone Facility)
- 7) Organic Destruction (Consolidated Incineration Facility)

F and H Tank Farm, Extended Sludge Processing, Defense Waste Processing Facility, Effluent Treatment Facility, Saltstone Facility and the Consolidated Incineration Facility are all operational. In Tank Precipitation Facility operations are limited to safe storage and transfer of materials. The Late Wash Facility has been tested and is in a dry lay-up status. The In-Tank Precipitation Facility (ITP) initiated radioactive operation in Tank 48H in September of 1995. During pump operation in December of 1995, benzene evolved from Tank 48H at higher rates than expected, though the operational safety limit was never approached. The benzene was generated as a byproduct of the process from the catalytic decomposition of sodium tetraphenylborate (NaTPB).

In August 1996, the Defense Nuclear Facility Safety Board (DNFSB) issued Recommendation 96-1. The DNFSB recommended that operating and testing in the ITP Facility not proceed without an improved understanding of the mechanisms of benzene generation, retention, and release. In response to Recommendation 96-1 efforts to explain, through chemistry research, benzene generation, retention and release were conducted from August 1996 through March 1998.

These studies indicated that production goals and safety requirements for processing of HLW could not be accomplished in the ITP Facility as configured. This resulted in a WSRC recommendation to the Department of Energy in January 1998 to conduct a systems evaluation of salt disposition options and to recommend the preferred alternative. The salt will remain in storage until an alternative salt pre-

treatment process is identified and implemented. Alternative processes will be evaluated throughout 1998.

In March 1998, a team was selected to perform a structured systems engineering analysis of options for salt disposition. Guidance for the Team is documented in the charter (ref. 1). The task of salt disposition evaluation is broad based in technical scope and is not limited to any single process. Precipitation methods, ion exchange processes, other chemical or mechanical separation techniques, direct vitrification options, or combinations of these options are being considered.

Although the process selected will be specifically for HLW salt disposition, the team must address the system impact for all HLW facilities. Additionally, the selected alternative must interface safely and efficiently with the remainder of processing facilities outside of HLW. Timeliness of the selection of alternatives is key to support tank farm space/water inventory management and the Federal Facility Agreement (FFA) for tank closure.

3.1 HLW System Mission

The mission of the HLW System is to receive and store SRS high-level wastes in a safe and environmentally sound manner and to convert these wastes into forms suitable for final disposal. The planned forms are: 1) borosilicate glass to be sent to a Federal repository, 2) saltstone to be disposed of on site, and 3) treated wastewater to be released to the environment. Also, the storage tanks and facilities used to process the high-level waste must be left in a state such that they can be decommissioned and closed in a cost-effective manner and in accordance with appropriate regulations and regulatory agreements.

The FFA requires removal of the waste from the high-level waste tanks to resolve several safety and regulatory concerns. Tanks have leaked observable quantities of waste from primary to secondary containment. Other tanks have known penetrations above the liquid level, although no waste has been observed to leak through these penetrations. The "old style" tanks do not meet EPA secondary containment standards for storage of hazardous waste, (effective January 12, 1987).

The FFA for SRS addresses the DOE committed schedule for removing the wastes from the tanks.

All high-level wastes in storage at SRS are Land Disposal Restricted (LDR) wastes, which are prohibited from permanent storage. Since the planned processing of these wastes will require considerable time and therefore

continued storage of the waste, DOE has entered into a compliance agreement with the EPA and SCDHEC. This compliance agreement is implemented through the Site Treatment Plan (STP) which requires processing of all the high-level waste at SRS according to a schedule negotiated between the parties

The problem confronting the HLW overall mission is that the currently configured in-tank precipitation process cannot simultaneously meet the HLW flowsheet production goals and the safety requirements. The WSRC recommended that alternative concepts and technologies be evaluated. The HLW Salt Disposition Systems Engineering Team was formed and chartered to perform this task. The Mission Need defined for the Team is:

“The SRS HLW salt needs to be immobilized for final disposition in support of environmental protection, safety, and current and planned missions”.

3.2 HLW System Overview

Figure 1 schematically illustrates the routine flow of wastes through the HLW System. The various processes within the system and external processes are shown in rectangles. The numbered streams identified in italics are the interface streams between the various processes. The discussion below represents the HLW system configuration as of January 1998.

Incoming high-level wastes are received into HLW Storage and Evaporation (F and H Tank Farms) (Stream 1). The function of HLW Storage and Evaporation is to safely concentrate and store these wastes until downstream processes are available for further processing. The decontaminated liquid from the evaporators are sent to Wastewater Treatment (ETF) (Stream 13).

The insoluble sludges that settle to the bottom of waste receipt tanks in HLW Storage and Evaporation are slurried using hydraulic slurring techniques and sent to Extended Sludge Processing (ESP) (Stream 2). In ESP, sludges high in aluminum are processed to remove some of the insoluble aluminum compounds. All sludges, including those that have been processed to remove aluminum, are washed with water to reduce their soluble salt content. The spent washwater from this process is sent back to the HLW Storage and Evaporation (Stream 3). The washed sludge is sent to Vitrification (DWPF) for feed pretreatment and vitrification (Stream 4).

Saltcake is redissolved using hydraulic slurring techniques similar to sludge slurring. As currently designed, the salt solutions from this operation, and other salt solutions from HLW Storage and Evaporation, were intended for feed to Salt Processing (ITP) (Stream 5). In ITP, the salt solution would be

processed to remove radionuclides, which are concentrated into an organic precipitate. The decontaminated filtrate would then be sent to Tank 50. A concentrated organic precipitate, containing most of the radionuclides, is produced by the process. This precipitate is washed with water to remove soluble salts. However, some soluble corrosion inhibitors which interfere with DWPF processing must be left in the precipitate after washing because the precipitate is stored in carbon steel tanks, which are susceptible to corrosive attack by uninhibited precipitate wastes.

The precipitate is transferred to Late Wash for further washing in stainless steel tanks to reduce the level of soluble corrosion inhibitors to acceptable levels for the DWPF process (Stream 7). The washwater from this process is returned to ITP to be reused in the ITP process (Stream 8).

The washed precipitate from Late Wash is then sent to the DWPF vitrification building (221-S). In the vitrification building, the precipitate is catalytically decomposed and separated into two streams: a mildly contaminated organic stream and an aqueous stream containing virtually all of the radionuclides. The mildly contaminated organics are stored at DWPF and eventually transferred to Organic Destruction (CIF) (Stream 11). The aqueous stream is combined with the washed sludge from ESP, which has undergone further processing and the mixture vitrified.

The washed sludge from ESP (Stream 4) is chemically adjusted in the DWPF to prepare the sludge for feed to the glass melter. As part of this process, mercury is stripped out, purified and sent to mercury receivers (Stream 12). The aqueous product from organic decomposition is added to the chemically adjusted sludge. The mixture is then combined with glass frit and sent to the glass melter. The glass melter drives off the water and melts the wastes into a borosilicate glass matrix, which is poured into a canister. The canistered glass waste form is sent on to site interim storage, and will eventually be disposed of in a Federal repository (Stream 9).

The water vapor driven off from the melter along with other aqueous streams generated throughout the DWPF vitrification building are recycled to HLW Storage and Evaporation for processing (Stream 10).

Overheads from the HLW Storage and Evaporation evaporators are combined with overheads from evaporators in the F and H Area Separations processes and other low-level streams from various waste generators. This mixture of low-level wastes is sent to the ETF (Stream 13).

In the ETF, these low-level wastes are decontaminated by a series of cleaning processes. The decontaminated water effluent is sent to the H Area outfall and

eventually flows to local creeks and the Savannah River (Stream 14). The contaminants removed from the water are concentrated and sent to Tank 50 (Stream 15).

In Tank 50 the concentrate from the ETF is combined with the decontaminated filtrate from the ITP and sent to Saltstone (Stream 6). In the Saltstone Facility the liquid waste is combined with cement formers and pumped as a wet grout to Landfill, a vault (Stream 16). In the vault, the cement formers hydrate and cure, forming a saltstone monolith. The Saltstone Facility vaults will eventually be closed as a landfill.

HLW System Major Interfaces

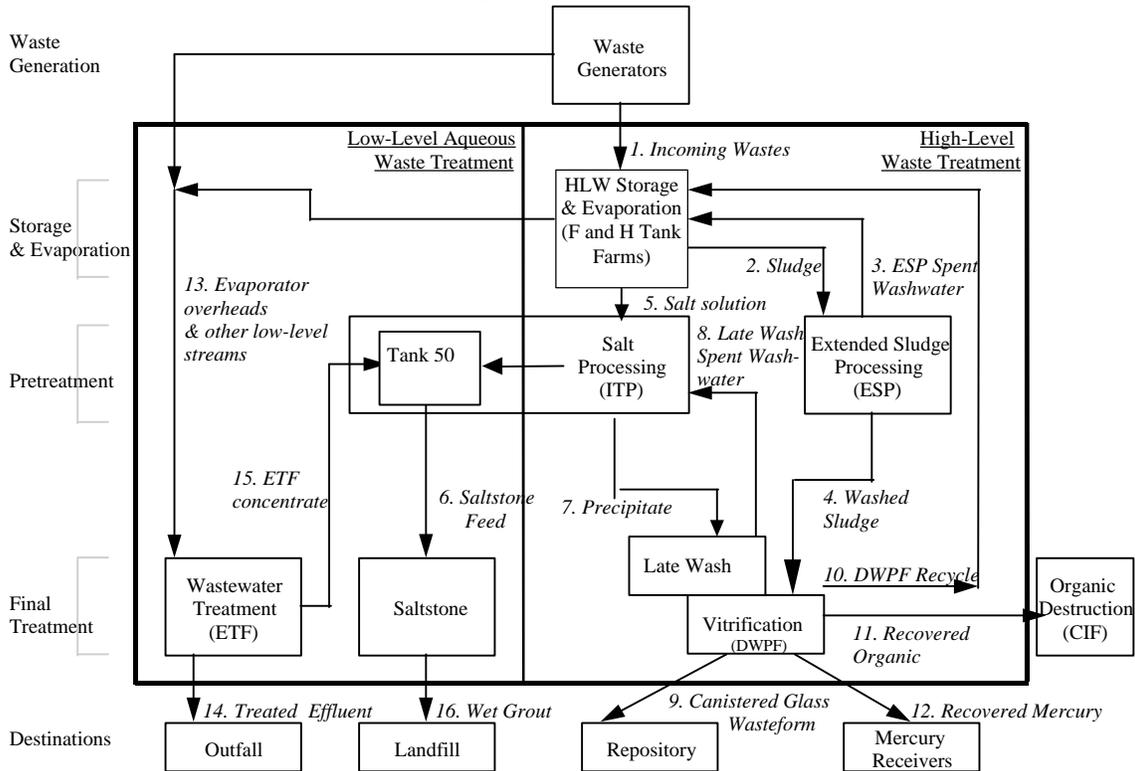


Figure 1. HLW System Major Interfaces

4.0 Systems Engineering Team

The WSRC recommendation to DOE for the evaluation of alternative technologies and/or concepts to the currently configured ITP process resulted in the formation of the SRS High Level Waste Salt Disposition Systems Engineering Team. DOE-SR concurs with this approach (ref. 2). The Charter and membership of the Team are discussed below.

4.1 Team Charter

The Team was chartered on March 13, 1998 (ref. 3). The Charter discusses the Team's objective, the required team membership attributes, the requirement to follow the Systems Engineering approach, and the major deliverables and milestones expected of the Team.

4.2 Team Membership

The members of the Team, their role on the Team and company affiliation are shown below:

<u>Team Member</u>	<u>Role</u>	<u>Company Affiliation*</u>
Steve Piccolo	Team Leader	WSRC
Gary Abell	Systems Engineering	WSRC
Jeff Barnes	Operations	WSRC
John Carlson (Ed Murphy-Alternate)	Safety & Regulatory Eng.	WSMS
Dr. Ed Cussler	Chemical Engineering/Academia	Univ. of Minnesota
Peter Hudson	Waste Processing	BNFL
Dr. Lucien Papouchado	Science/Site Research	WSRC
Ken Rueter	Process Engineering	WSRC
Dr. Jack Watson	Science/National Lab Research	ORNL
Gene Kosiancic	Process Engineering Consultant	Independent Contractor

*WSRC: Westinghouse Savannah River Company

*WSMS: Westinghouse Safety Management Solutions, Inc.

*BNFL: BNFL Savannah River Corporation

*ORNL: Oak Ridge National Laboratory

Additional information, including biographies of team members, is provided in Candidate Selection for the HLW Salt Disposition Systems Engineering Team (ref. 4).

5.0 Systems Engineering Process Overview

The HLW Salt Disposition Team developed a Systems Engineering Management Plan (SEMP) (ref. 5). The SEMP outlines the steps and sequences of a systematic engineering process utilized by the Team in identifying and selecting the alternatives on the “initial list”. In essence, the Systems Engineering (SE) approach mandates that the correct problem is defined, a mission is created to solve the problem, and a definition of what the solution must do (functions) and how well it must do it (requirements) be addressed (ref. 6) before selecting solutions.

Use of the SE approach, to identify a preferred alternative to the currently configured ITP process, is required by the HLW Salt Disposition Systems Engineering Team Charter.

The SE approach is a top down process and is recognized as a viable technical management approach to define and control the development of complex technical programs/systems with many uncertainties, interfaces, and elements. The main goal of the SE approach is to deliver an end product that meets cost, schedule, and technical requirements while minimizing the environmental, safety, and health risks. The use of this approach will enable the HLW Salt Disposition Systems Engineering Team to meet its intended goal. The major process steps are discussed below and are illustrated in Figure 2.

- Definition and Development

Definition and development represents the logical sequence of activities and decisions designed to transform facility operational needs and customer requirements into a preferred system concept, design, and its related performance parameters to meet the Mission Need. Definition and development steps include:

- Mission Definition and Analysis
- Functions and Requirements
- Alternative Designs, Evaluation, and Selection
- Verification and Validation

- Technical Program Planning and Control

Technical program planning and control encompasses management activities to effectively plan and control the activities to meet program technical requirements. These steps include:

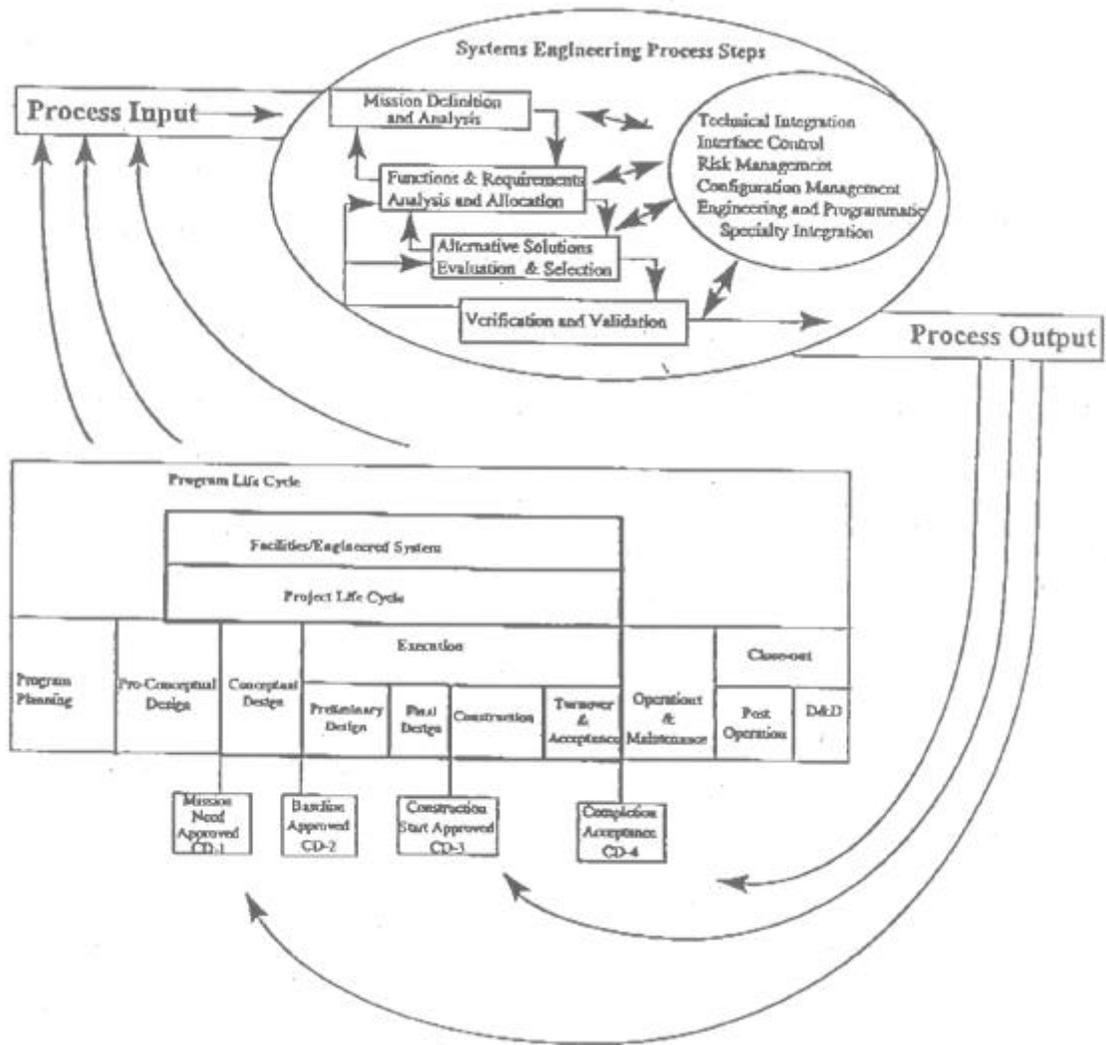
- Technical Integration

- Interface Control
- Risk Management (technical, programmatic, life cycle cost)
- Configuration Management
- Deliverables and Schedules

- Engineering and Programmatic Specialty Integration

This integration is the timely and appropriate application of engineering efforts and specialty disciplines such as chemical processing, reliability, maintainability, life cycle cost, human factors, safeguards and security, environmental, authorization basis/safety, health, etc. This type of integration ensures that all aspects of the project are reviewed from the specialized areas important to project formulation, implementation, and operation.

Iterations of each aspect of the SE process will occur as the Team develops flow sheet detail for the alternatives and performs risk analysis.



CD = Critical Decision (DOE)
 D&D = Decontamination & Decommission

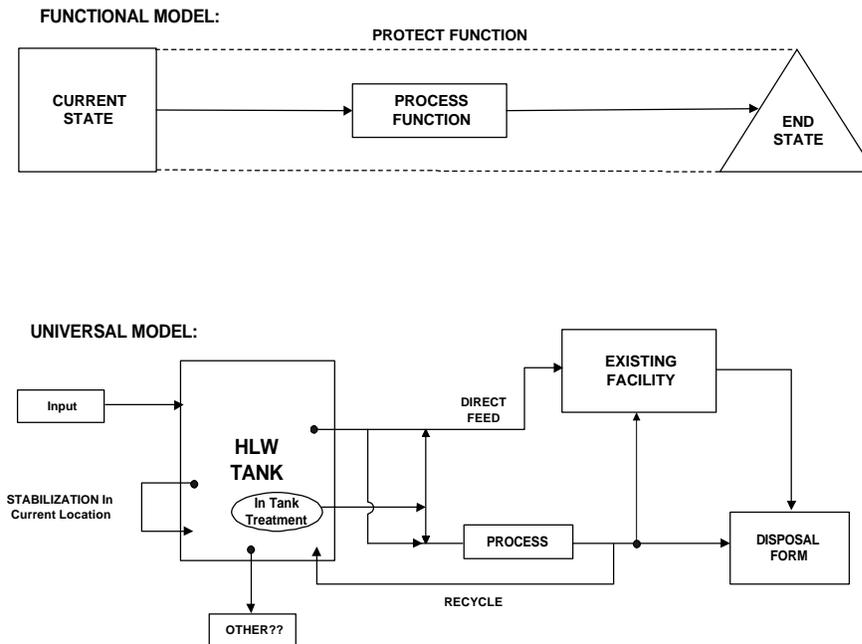
Figure 2. Relationship of the Systems Engineering Process and Project Life Cycle

6.0 Initial Design Input

The HLW Salt Disposition Team developed the necessary and sufficient Level 1, 2, and 3 functions and requirements that any potential alternative would have to meet. These functions and requirements were based on a Problem Statement and Mission Need. In addition, the Team identified the external interfaces with which the alternative solutions would interface. Finally, the Team developed a “Functional Model” and a “Universal Model” which envelop all generic scenarios for alternatives.

These models were used to initiate thought on alternatives to the in-tank precipitation process while still ensuring consideration of the Team Mission Statement and overall HLW system interfaces.

HLW SALT DISPOSITION SYSTEM ENGINEERING TEAM MODEL



The information, discussed above, is considered design input and resides in the “Preconceptual – Phase I Initial Design Input” document (ref. 7).

7.0 Alternatives

The Team's "initial list" of selected alternatives is summarized in Section 7.3. The list contains 18 alternatives for HLW salt disposition. The rigorous and systematic approach used to identify and evaluate approximately 130 suggestions, ideas, and concepts submitted to the Team for consideration is defined in Position Paper on the Evaluation Leading to the "Initial List" of Alternatives (ref. 1).

The structured SE approach allows new or modified alternatives to be considered. Processes used for Alternative Identification (section 7.1) and subsequent Evaluation and Selection (section 7.2) will be applied to new or modified alternatives.

7.1 Alternative Identification Process

Early in the Preconceptual phase, the Team established the methodology for searching out possible alternatives. The Position Paper on Identifying Alternatives to the In-Tank Precipitation Process (ref. 8) describes the methods utilized to gather information. Identification of Alternatives Briefing Package (ref. 9) was developed and distributed to collect engineering and operations input across the SRS. Formal brainstorming sessions were held with important stakeholders and customer representatives. Independent subject matter experts were consulted from National Laboratories, academia and the chemical industry for alternative identification. Literature searches were tasked to National Laboratories as a cross check to the Team experience and expertise.

7.2 Evaluation Process and Selection Criteria

The process selected for evaluation and selection of alternatives (ref. 5) needed to encompass wide ranges of technical options and combinations of ideas. To ensure SE principles for structured analysis were applied, three levels of decisions were performed.

Alternatives were organized by technology category. Broad screening criteria, technical maturity and likelihood of successful deployment, were applied to the technology categories. The next step screened individual alternatives within each technology category against more detailed criteria. The third step ranked the alternatives or combination of alternatives.

The technology categories are as follows:

- **Crystallization (CR)** – Separation of the cesium from non-radioactive salts by fractional crystallization
- **Electrochemical (EC)** – Electrochemical processes which achieve separation/destruction of different ionic components in the system
- **Elutable Ion Exchange (EX)** – Separation of cesium from HLW salt by regenerable ion exchange
- **Non-elutable Ion Exchange (NX)** – Separation of cesium from HLW salt by non-regenerable ion exchange
- **Geological (GL)** – Alternatives more dependent on geology than processing
- **Inorganic Precipitation (PI)** – Separation of the desired substance by addition of an inorganic precipitant
- **Organic Precipitation/Modify ITP (POM)** – Separation of cesium by addition of an organic precipitant with extensive use of the existing ITP Facility
- **Organic Precipitation/New Process (PON)** – Separation of cesium using a facility substantially different from the existing ITP Facility
- **Solvent Extraction (SE)** – The use of a solvent for separating cesium based on either an alkaline or acidic feed stream
- **Vitrification (VT)** – Disposition of the salt by vitrifying it either in DWPF or using new equipment or facilities
- **Miscellaneous (ML)** – Approaches not covered by the other categories

All technology categories survived the screening process. Individual alternatives were either accepted for further consideration, combined in whole or part with other ideas for further consideration, or dropped.

The Team screened approximately 130 alternatives and established an initial list of 18 for further evaluation. The list of 18 alternatives represents portions, combinations, modifications or hybrids of the original Pro-Formas, of which 26 were completely dropped.

7.3 Selected Alternatives

The alternatives selected for further evaluation are described in more detail in the Position Paper on the Evaluation Leading to the “Initial List” of Alternatives (ref. 1). Listed below is a brief description of each alternative.

Fractional Crystallization - DWPF Vitrification

The conceptual process would selectively remove sodium salts from acidified salt solution as sodium nitrate crystals leaving behind a liquid containing most of the cesium for vitrification at DWPF. The decontaminated crystals would be dissolved, neutralized and made into a Class A waste (grout) at the Saltstone Facility

Electrochemical Separation and Destruction – DWPF Vitrification

The conceptual process would utilize an electrochemical cell through which filtered supernate would be transferred to an electrochemical cell to convert nitrates and nitrites to hydroxides. The resultant liquid would be pumped through an electro-chemical membrane to produce two streams. The first stream is a small volume of alkaline solution enriched in cesium for feed to DWPF, the second is a large volume of caustic solution for recycle to the tank farm and/or saltstone disposal.

Elutable Ion Exchange - DWPF Vitrification

The conceptual process uses an elutable ion exchange resin (e.g. crown ether) to remove cesium and a second elutable resin for strontium, plutonium and uranium removal. The radionuclides would be eluted with nitric acid and vitrified at DWPF. The decontaminated salt solution would be made into a Class A waste (grout) at the Saltstone Facility.

Potassium Removal followed by TPB Precipitation

The conceptual process would use a potassium specific resin to remove most (~90%) of the potassium from salt solution prior to precipitation with sodium tetraphenyl borate (TPB). This would dramatically reduce the use of TPB and resulting benzene production. The cesium precipitate would be vitrified in DWPF, together with the monosodium titanate used for removal of the strontium, plutonium, and uranium. The potassium and decontaminated salt solution would be made into a Class A waste (grout) at the Saltstone Facility.

Acid Side Ion Exchange - DWPF Vitrification

The conceptual process would employ one of several effective cesium removal resins in an acidic flowsheet such as ammonium molybdophosphate on polyacrylonitrile resin. If elutable, the eluate containing cesium would be fed to DWPF. If non-elutable, the loaded resin would be vitrified at DWPF. The decontamination salt solution would be made into Class A waste (grout) at the Saltstone Facility.

Crystalline Silicotitanate (CST) Ion Exchange – DWPF Vitrification

The conceptual process would employ CST resin for cesium removal coupled with monosodium titanate (MST) addition for strontium, plutonium and uranium removal. The loaded CST resin and MST would be vitrified at DWPF. The decontaminated salt solution would be made into Class A waste (grout) at the Saltstone Facility.

Crystalline Silicotitanate (CST) Ion Exchange – New Facility Vitrification

The conceptual process would employ CST resin for cesium removal coupled with monosodium titanate (MST) addition for strontium, plutonium and uranium removal. The loaded CST resin and MST would be vitrified at a new dedicated vitrification facility. The decontaminated salt solution would be made into Class A waste (grout) at the Saltstone Facility.

Zeolite Ion Exchange - DWPF Vitrification

The conceptual process would utilize zeolite resin to remove cesium and a second zeolite resin to remove strontium, plutonium, and uranium. The loaded resins would be vitrified at DWPF. The decontaminated salt solution would be made into Class A waste (grout) at the Saltstone Facility.

Crystalline Silicotitanate (CST) Ion Exchange – Ceramic Waste Form

The conceptual process would employ CST resin for cesium removal coupled with monosodium titanate (MST) addition for strontium, plutonium and uranium removal. The loaded CST resin would be converted to a ceramic waste form. The ceramic would be stored on site until the cesium activity was negligible (~300 years).

Reduced Temperature ITP

The conceptual process is a variation on the current In-Tank Precipitation (ITP) flowsheet. The flowsheet process would be the same but modifications would be required to maintain TPB slurry and filtrate temperatures below 25°C. This would increase precipitate stability and reduce benzene generation.

Catalyst Removal ITP

The conceptual process is a variation on the current ITP flowsheet. This process requires an additional process step to remove both solid catalyst (entrained sludge) and soluble catalyst (metal ions in the salt solution). This would increase precipitate stability and reduce benzene generation.

ITP with Enhanced Safety Features

The conceptual process is similar to the current ITP flowsheet. The modifications would compensate for Authorization Basis safety issues with Engineered Safety Features.

Small Tank TPB Precipitation

The conceptual process would be a series of Continuous Stirred Tank to conduct a TPB precipitation. This is followed by a chilled concentrate tank for storage of the precipitate. This reduces cycle time and total inventory, thereby reducing the hazardous material source term. The downstream process would be similar to the current ITP flowsheet.

Caustic Side Solvent Extraction - DWPF Vitrification

The conceptual process would encompass multiple extraction, scrub and strip stages with a diluent and an extractant such as a crown ether for cesium removal. The cesium would then be stripped from the solvent with dilute acid and vitrified at DWPF. The decontaminated salt solution would be made into a Class A waste (grout) at the Saltstone Facility.

Acid Side Solvent Extraction - DWPF Vitrification

The conceptual process would first acidify the salt solution with nitric acid and would then encompass multiple extraction, scrub and strip stages with appropriate diluent and an extractant such as cobalt dicarbonyl for cesium removal. The cesium would then be stripped from the solvent with acid and vitrified at DWPF. The decontaminated salt solution would be made into a Class A waste (grout) at the Saltstone Facility.

Direct Vitrification

The conceptual process would treat all of the salt solution in a new vitrification facility. A high throughput melter(s) would be required to meet the production requirements.

Supernate Separation – DWPF Vitrification

The conceptual process would direct feed concentrated supernate liquid to DWPF to be mixed with sludge for vitrification. Dissolved saltcake would be treated with MST for strontium, plutonium, and uranium removal. The loaded MST would be vitrified in DWPF. The partially decontaminated salt solution would be made into a Class C waste (grout) in a modified Saltstone or new facility.

Direct Disposal as Grout

The conceptual process would treat the salt solution with MST for strontium, plutonium, and uranium removal. The loaded MST would be vitrified at DWPF. The treated salt solution would be grouted in a new facility to meet Class C waste limits. This option would consider the use of High Level Waste tanks for grout disposal.

8.0 Conclusions

The structured Systems Engineering approach utilized by the team successfully captured and evaluated a wide range of alternatives for SRS HLW salt disposition. The evaluation considered the best solution options of approximately 130 alternatives and resulted in 18 alternatives for further evaluation.

The continuing evaluation (Team Charter Phase II) has been initiated. Phase II is focused primarily on continuing the risk assessment process and development/application of weighted evaluation criteria necessary to establish a short list. Risk evaluation in Phase II is searching for critical technology issues that could cause failure to implement a given technology. The evaluation criteria to be used in the process of establishing the short list encompass the following:

- Technology risk will assess the unknowns with new technology or new applications of existing technology.
- Interface risk will assess impact on current HLW and Solid Waste operations.
- Safety risk will assess nuclear safety, process hazards and accident conditions as well as permit and license requirements.
- Design risk will assess primarily three topical areas:
 - current completeness of identified functions and requirements
 - identification of complex operation conditions
 - identification and adjustment of design assumptions
- Cost/schedule risk will assess the potential risk for implementation (science to engineering) of each alternative focusing on infrastructure, material, operational interfaces and complex construction feasibility.

The Team will continue with the scheduled evaluations as defined in the team charter.

9.0 References

The following references were listed in Sections 1.0 to 8.0 of this report.

1. High Level Waste Salt Disposition Systems Engineering Team Position Paper on the Evaluation Leading to the “Initial List” of Alternatives
2. Greg Rudy to James M. Owendoff letter dated March 16, 1998
3. Charter for the SRS High Level Waste Salt Disposition Systems Engineering Team
4. Candidate Selections for the HLW Salt Disposition Systems Engineering Team
5. WSRC-RP-98-00163, Systems Engineering Management Plan for Development of Alternatives to Process and Dispose of High Level Waste Salt (U)
6. High Level Waste Salt Disposition Interface Requirements, Revision C
7. Preconceptual-Phase I Initial Design Input
8. High Level Waste Salt Disposition Systems Engineering Team Position Paper on Identifying Alternatives to the In-Tank Precipitation Process
9. Identification of Alternatives Briefing Package

10.0 List of Abbreviations

The following abbreviations are used through the report and are listed for clarification.

1. **CD** - Critical Decision
2. **CIF** - Consolidated Incineration Facility
3. **Cs** - Cesium
4. **D&D** - Decontamination and Decommission
5. **DNFSB** - Defense Nuclear Facility Safety Board
6. **DOE** - Department of Energy
7. **DOE-SR** - Department of Energy - Savannah River
8. **DWPF** - Defense Waste Processing Facility
9. **e.g.** - that is
10. **EPA** - Environmental Protection Agency
11. **ESP** - Extended Sludge Processing
12. **ETF** - Effluent Treatment Facility
13. **FFA** - Federal Facility Agreement
14. **HLW** - High Level Waste
15. **ITP** - In-Tank Precipitation
16. **MST** – Monosodium Titanate
17. **N/A** - Not Applicable
18. **NaTPB** - Sodium Tetrphenylborate
19. **ORNL** - Oak Ridge National Laboratory

- 20. **SCDHEC** - South Carolina Department of Health and Environmental Control
- 21. **SE** - Systems Engineering
- 22. **SEMP** - Systems Engineering Management Plan
- 23. **SRS** - Savannah River Site
- 24. **TBD** - To Be Determined
- 25. **WSMS** - Westinghouse Safety Management Solutions, Inc.
- 26. **WSRC** - Westinghouse Savannah River Company