INEEL/CON-99-00626
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IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

Assessing Technical and Programmatic Viability of Nuclear Waste and Material Stream Disposition Plan

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August 10, 1999 – August 12, 1999

13th International Conference on Systems Engineering (INCOSE '99)

ASSESSING TECHNICAL AND PROGRAMMATIC VIABILITY OF NUCLEAR WASTE AND MATERIAL STREAM DISPOSITION PLANS

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Introduction

The U. S. Department of Energy (DOE), Office of Environmental Management (EM) has responsibility for cleanup and disposition of nuclear wastes and excess materials that are a legacy of the nuclear arms race. In fulfilling this responsibility, EM applies a systems engineering approach to:

- Identify baseline disposition plans for the wastes and materials (storage, stabilization, treatment, and disposal)
- Assess the path viability, and develop integration opportunities to improve the disposition viability or to combine, eliminate, and/or simplify activities, technologies, and facilities across the DOE Complex
- Evaluate the baseline and alternatives to make informed decisions
- Implement and track selected opportinities.

This paper focuses on processes used to assess the disposition path viability – the likelihood that current planning for disposition of nuclear waste and materials can be implemented. To provide the proper context for discussion of assessment processes, an overview of EM's systems engineering process is first presented.

Systems Engineering Process Overview

EM project integration teams implement a structured process for developing and improving management of nuclear waste and materials from their current state to a final disposition. Project integration teams consist of subject matter experts from across the DOE complex facilitated by systems engineers.

Identify and Maintain Technical Baseline

System baseline definition identifies the driving or "what" requirements and baseline plans (technical and schedule) for disposition of waste and material inventories at facilities across the DOE complex. Project integration teams use disposition maps to depict the complex-wide baseline and show interfaces and interdependencies among the sites and waste and material types. A typical disposition map is shown in Figure 1. Disposition maps represent the baseline functional breakdown, similar to a functional flow block diagram, for each site's waste and material streams.

Assess Path Viability and Develop Integration Alternatives

Systems engineers facilitate workshops and conduct trade studies to assess viability of baseline disposition plans. In addition, systems engineers identify integration opportunities that are alternatives to the baseline that eliminate duplicate technologies, improve schedules, avoid capital expenditures, and consolidate waste and material streams.

For example, the baseline disposition plan for a high-level waste stream may be to vitrify in glass and ship to a high-level waste repository. A viability assessment of the baseline might show that this plan is at risk because of the large volume of waste and incompatibilities in the site closure schedule with the schedule for repository availability. An alternative disposition path could be to separate the waste into high and low-level fractions, dispose of the fractions in high and low-level waste repositories, respectively. This could reduce the volume of high-level waste and balance site closure with repository availability. Such assessments are the focus of EM systems engineering activities and of this paper.

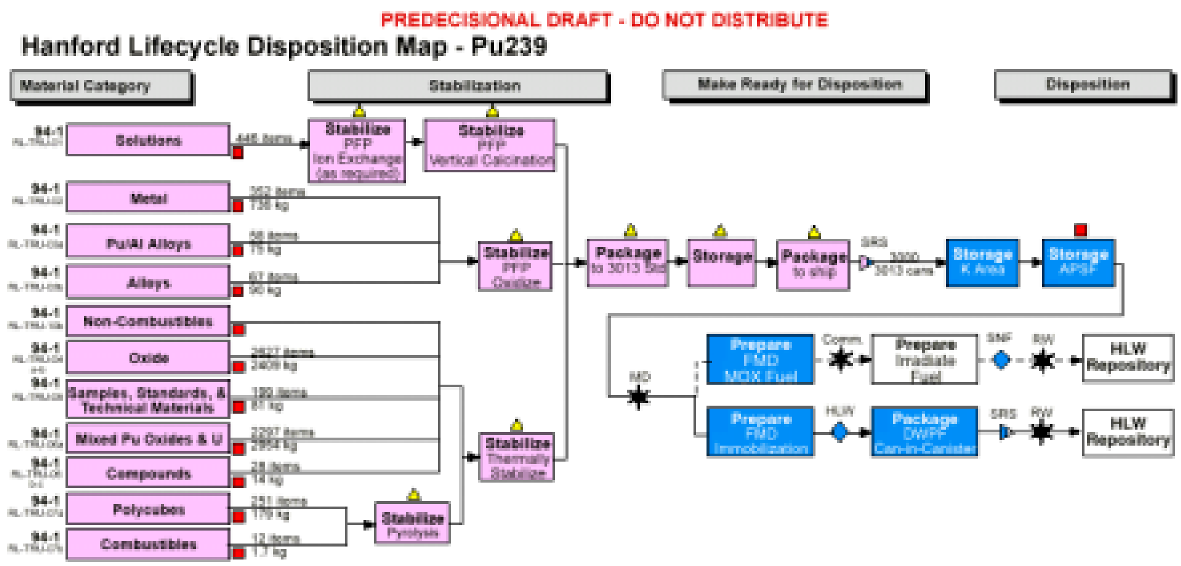

Figure 1. Typical Baseline Disposition Map

Evaluate Baseline and Alternatives to Make Informed Decisions

Once viability is determined, problems and barriers facing the path can be understood, alternate paths can be developed to solve or circumvent barriers, and comparisons can be made with baseline paths to determine a recommended alternative. Five criteria are used to compare alternatives: technical feasibility, cost, schedule, programmatic risk, and integration benefits. This process is discussed further following discussion of the viability assessment process.

Implement and Track Selected Opportunities

Selected alternatives move into the implementation and verification steps of the process. Project integration teams analyze recommendation opportunities with interfaces to other system elements to determine the impact on the system as a whole.

Baseline Disposition Path Viability Assessments

The methodology to assess baseline disposition path viability for both nuclear waste and nuclear material is a three-step process. However, Step 2, a detailed path viability assessment, is applied only if subject matter experts determine that the Step 1 assessment does not adequately identify and/or define disposition path viability.

Step 1. Assess Disposition Path Viability

In the first step, subject matter experts assess disposition path viability using programmatic risk guidance shown in Table 1.

Step 2. Assess Disposition Path Viability Using Maturity Scales (Optional)

If subject matter experts determine the first step did not adequately identify and/or define a disposition path's programmatic risk, a more detailed assessment can be performed using maturity scales such as the examples shown in Figure 2.

- For disposition paths where technology development is a concern, the Processing & Storage Process Maturity and Processing & Storage Hardware Equipment Maturity scales can be used to provide greater insight relative to the Technology category of programmatic risk

- The Requirements Maturity, Processing & Storage Hardware Maturity, and NEPA scales can be used to provide more detailed insight to the Work Scope category of programmatic risk

- The End-State Interface Maturity scale can be used to provide greater insight relative to the Inter-Site/Program Dependency category of programmatic risk

- The Processing & Storage Hardware Equipment, Facility/Equipment Readiness, and Operational Safety Readiness scales can be used to provide greater insight relative to the Facility/Equipment Limitations category of programmatic risk.

Level	Maturity Assessment Criteria
10	No currently identified solution that meets requirements.
9	Design concept and/or technology application formulated.
8	Cold feasibility demonstrated.
6	Hot feasibility demonstrated.
5	End-to-end design (flowsheet) complete.
4	Cold prototype demonstrated at end use site.
2	Hot prototype demonstrated at end use site.
0	Process integrated into operations.

Figure 2. Processing & Storage Process Maturity (PM) Scale

Step 3. Assess Programmatic Risk

Upon completing the disposition path viability assessments in Step 1 and, optionally, Step 2, the disposition path is assessed for programmatic risk as follows:

- If assessment scores identified that the disposition path is **not** viable (scores of 4 and 5 from Table 1), but the site **does have** approved budget and schedule to correct the problem, the path is not a programmatic risk. A green circle on the disposition map denotes a path in this category

- If assessment scores identified that the disposition path is **not** viable (scores of 4 and 5 from Table 1), and the site **does not have** approved budget and schedule to correct the problem, the path is a programmatic risk. A red square on the disposition map denotes paths in this category

- If assessment scores identified that the disposition path **may not** be viable (score of 3 or 2 from Table 1), but the site **does have** approved budget and schedule to correct the problem, the path is not a programmatic risk. A green circle on the disposition map denotes paths in this category.

- If assessment scores identified that the disposition path **may not** be viable (score of 3 or 2 from Table 1), and the site **does not have** approved budget and schedule to correct the problem, the path is a programmatic risk. A yellow triangle on the disposition map denotes paths in this category.

- If assessment scores identified that the disposition path **is** viable (scores of 1 Table 1), the path is not a programmatic risk. A green circle on the disposition map denotes paths in this category.

Comparing Baselines and Alternative Disposition Paths

As stated previously, baseline disposition path assessments are a method to identify whether a problem (or opportunity) exists. Once a problem is identified through a baseline disposition path assessment it is necessary to clearly define the problem, define alternative problem solutions, and qualitatively compare the baseline and alternatives. The purpose of this comparison is to select a preferred alternative to recommend.

Qualitative comparisons use five criteria to compare alternatives: technical feasibility, cost, schedule, programmatic risk, and integration benefits. Alternatives are compared using a matrix similar to a Consumer Report® chart. Figure 3 is a tool for performing the baseline and alternative comparisons. Figure 3 illustrates the Consumer Report® chart format with the five evaluation criteria and provides guidance for evaluating the criteria. Comparison results are submitted for approval and implementation in accordance with EM's Systems Engineering Process.

Conclusion

DOE has applied a systems engineering process to management of EM's nuclear waste and excess nuclear materials to better integrate activities, facility usage, and technology needs across the complex of sites. This process has evolved over the past three years to its current state. At the heart of the process are assessments to determine the viability of baseline plans for disposition of waste and materials. These assessments identify opportunities for integration. Alternative solutions for the opportunities are identified and compared against established criteria to obtain recommendations for management approval and implementation.

The process is proving successful. Results from initial efforts identified potential cost savings and avoidance of over $24 billion and accelerated cleanup schedules with no significant increase in risk. Over $3.2 billion in savings have already been incorporated. The processes to assess the technical and programmatic viability of planned nuclear waste and material dispositions are key to past and future success.

Table 1. Cribsheet Format: Programmatic Risk Definitions

Risk Categories	Technology	Work Scope Definition	Inter-Site/Program Dependency	Facility/Equipment Limitation (facility only)
5 (high)*	• Technical approach not identified • Key technologies do not exist • Current investments do not support technology needs	• Waste/material end-state not determined • Quantities/characteristics unknown • Process operations not identified • Disposition location not identified	• Activity involves multiple sites • No concurrence reached between sites	• Facility does not exist; no plans for a new facility
4 (high)*	• Technical approach identified for majority of scope. • Most key technologies tested; some only at laboratory scale • Current investments identified and support needs	• Waste/material end-state determined; verbal concurrence reached • Quantities/characteristics unknown • Process operations identified;not demonstrated • Disposition location not approved	• Activity involves multiple sites/Program Offices; verbal concurrence reached • waste/material acceptance criteria not resolved • Funding not identified; no receipt or treatment schedule	• Facility exists; does not meet code • Facility does not exist; plans for a new facility exist • Facility requires major modifications
3*	• Technical approach identified • Critical technologies identified and demonstrated at pilot scale • Current investments identified and support full scale demonstration	• Waste/material end-state determined; expected acceptance by stakeholders/ Tribal Nations • Quantities/characteristics broadly known • Process operations identified; expected acceptance by stakeholders/Tribal Nations • Disposition location identified; EIS being prepared	• Activity impacts another site/Program Office; verbal concurrence reached • Receiving Program Office/facility reviewing data for waste/material acceptability • Funding identified; no receipt or treatment schedule	• Facility exists; not operational • Facility exists; operational; lacks capacity • Facility requires modifications
2*	Consumer Report®	• Waste/material end-state determined; supported by stakeholders/Tribal Nations • Quantities/characteristics well known • Process operations identified; supported by stakeholders and Tribal Nations • Disposition location identified; EIS ROD prepared	• No impact to another site/Program Office or other-site/Program Office concurrence documented • Receiving facility verified waste/ material acceptability • Funding identified; no receipt or treatment schedule	• Equipment requires minor modifications • Operating commercial facility exists; contracts not in place
1 (low)*	• Technical approach in execution • Technologies operating to specification • Investments not required	• Waste/material end-state determined; supported by stakeholders/Tribal Nations • Quantities/characteristics well known • Process operations identified; supported by stakeholders/Tribal Nations • Disposition location identified; EIS ROD pending	• No impact another site/Program Office or other-site/Program Office concurrence documented • Receiving facility verified waste/ material acceptability • Funding identified in approved PBS/ADS; facility ready to receive	• Facility/ equipment has sufficient capacity • Facility operational • Commercial facility operational; contracts in place

Figure 3. Consumer Report Evaluation Methodology

Criteria	Alternative 1 (Baseline)	Alternative 2	Alternative 3	Evaluation Methodology
Technical Feasibility	Same as Baseline	Significantly Better than Baseline	Moderately Worse than Baseline	Score baseline and each alternative for Table 1, *Technica*l and *Facilities/ Equipment Limitations*. Based on range of scores, complete CR.
Cost	Same as Baseline	Moderately Better than Baseline	Moderately Worse than Baseline	Determine range of life-cycle costs for baseline and each alternative. Based on range, complete CR.
Schedule	Same as Baseline	Moderately Better than Baseline	Same as Baseline	Significantly Better: > 3-yr. acceleration Moderately Better: 1 – 3 yr. acceleration Same as Baseline: < 1-yr. acceleration/delay Moderately Worse: 1 – 3 yr. delay Significantly Worse: > 3-yr. delay
Risk	Same as Baseline	Significantly Better than Baseline	Moderately Worse than Baseline	Score baseline and each alternative for Table 1, *Work Scope Definition and Inter-Site/Program Dependency*. Based on range of scores, complete CR.
Integration Benefits	Same as Baseline	Moderately Better than Baseline	Significantly Better than Baseline	Identify additional benefits for each alternative and score quantitatively.