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# Decision Plan: Alternatives Analysis and Technology Selection for Treatment and Packaging of K Basin Sludge

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

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Richland, Washington 99352

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# Decision Plan: Alternatives Analysis and Technology Selection for Treatment and Packaging of K Basin Sludge

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# Terms

| | |
|---|---|
| CHPRC | CH2M HILL Plateau Remediation Company |
| DNFSB | Defense Nuclear Facilities Safety Board |
| DOE | U.S. Department of Energy |
| DSB | Decision Support Board |
| PNNL | Pacific Northwest National Laboratory |
| RH-TRU | remote-handled transuranic |
| RL | U.S. Department of Energy, Richland Operations Office |
| ROM | rough order-of-magnitude |
| SEB | Source Evaluation Board |
| STP | Sludge Treatment Project |
| STSC | sludge transport and storage container |
| WIPP | Waste Isolation Pilot Plant |

# 1 Introduction

This alternatives analysis decision plan describes the process that will be followed to select an integrated set of preferred technologies for the treatment and packaging of the K Basin Engineered Container and Settler Tank sludge, in preparation for transport to and disposal at the Waste Isolation Pilot Plant (WIPP). The treatment and packaging of the K Basin sludge is referred to as the Sludge Treatment Project (STP) – Phase 2, and will be managed by the CH2M HILL Plateau Remediation Company (CHPRC) on behalf of the U.S. Department of Energy (DOE), Richland Operations Office (RL).

Treatment of the sludge includes treating and packaging to meet the requirement for shipment to and disposal at WIPP as RH-TRU waste. A key aspect of this treatment is oxidizing the uranium metal, or otherwise mitigating the rate of hydrogen generation, to meet the WIPP transportation and disposal requirements for RH-TRU, as set forth in DOE/WIPP-02-3122 (*Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*).

This decision plan describes the process for identifying and evaluating candidate treatment and packaging technologies and ultimately selecting and recommending an integrated set of preferred treatment and

The K Basin Engineered Container and Settler Tank sludge represents a small fraction of the total remote-handled transuranic (RH-TRU) inventory at the Hanford Site that must be treated and packaged for disposal. In parallel with this technology selection and alternatives evaluation for K Basin Engineered Container and Settler Tank sludge material, CHPRC will be conducting a site-wide evaluation of the remaining Hanford Site RH-TRU material. This parallel evaluation will update estimates of how much RH-TRU material will be generated during the site cleanup, when it will be generated, what treatment and packaging capabilities are required, and when those capabilities are required.

The technology alternatives selected in this decision plan will be an input to the site-wide study. Ultimately, the site-wide study will address the overall treatment strategy, including an overall deployment strategy. Once this deployment strategy is finalized, decisions will be made regarding the timing and scope of any conceptual design activities needed to complete STP - Phase 2 treatment and packaging of the K Basin Engineered Container and Settler Tank sludge.

# 2 Background and Scope

The DOE, the U.S. Environmental Protection Agency, the Defense Nuclear Facilities Safety Board (DNFSB), and other stakeholder groups have long recognized that the sludge, which has accumulated in the K Basins, represents a potential risk to the public, the worker, and the environment. DOE has designated this sludge as RH-TRU waste, due to its transuranic content and characteristic dose rate (00-SFO-043, "Contract No. DE-AC06-96RL13200 – K Basins Sludge Classification"). This waste also has been designated as polychlorinated biphenyl remediation waste (EPA/ROD/R10-99/059, *Record of Decision for the 100-KR-2 Operable Unit Interim Remedial Action)*, and is easily dispersible due to its small particle size. Actions to mitigate these risks include consolidating the sludge that originally was located on the basin floors, or in the basin pits, or resulted from fuel-washing operations at the K East and K West Basins, into engineered containers.

The sludge that originally was located on the basin floors, or in the basin pits, is referred to as Engineered Container sludge. The sludge that resulted from fuel-washing operations at the K East and K West Basins is referred to as Settler Tank sludge. Both Engineered Container sludge and Settler Tank sludge will be contained in the engineered containers, which have been designed for interim storage in the K West Basin. However, RL has directed the project to segregate the Engineered Container

sludge from the Settler Tank sludge and to process them separately (07-KBC-0053," Contract No. ED-AC06-96RL13200 – Sludge Disposal Direction").

The K Basin sludge then will be retrieved into containers and transferred to the T Plant for interim storage until the sludge can be treated and packaged into a waste form suitable for transport to and disposal at WIPP as RH-TRU waste. The consolidation and interim storage of the sludge in the K West Basin and its packaging and transfer to the T Plant for continued storage are referred to as the STP – Phase 1. This stored material will become the feed for Phase 2 activities.

RL has agreed with CHPRC's proposed two-phase approach and its recommendation to use the T Plant for STP – Phase 1 interim storage [09-AMRC-0173, "Contract No. DE-AC06-08RL14788 – External Technical Review (ETR) of the Hanford K Basins Sludge Treatment Project (STP)"]. RL further directed CHPRC to identify and evaluate alternatives for the treatment and packaging of the K Basin sludge and to select and recommend an integrated set of preferred technologies that will allow the treated sludge to be acceptable for transport to and disposal at WIPP (0900129, "Contract No. DE-AC06-08RL14788 – Modification M017"). The treated sludge must meet the WIPP waste acceptance criteria and the requirements in the associated WIPP quality assurance program.

Throughout this document, the word "treatment" implies oxidation of the uranium metal in the sludge, or an equivalent process that mitigates the rate of hydrogen generation, in order to meet the WIPP transportation and waste acceptance criteria. However, some participants may choose to add a pretreatment step for the sludge, if such a pretreatment step is advantageous for a proposed treatment technology. For example, concentrating the uranium metal fraction of the sludge before treatment may allow the subsequent treatment process to proceed at a faster rate.

Proposed technologies must start with the Phase 1 stored material as feed, and any materials separated as the result of a pretreatment process must be recombined with the treated fraction before packaging.

# 3 STP – Phase 2 Alternatives Analysis Decision Plan

The alternatives analysis decision plan for STP – Phase 2 documents CHPRC's proposed approach for identifying and evaluating the technologies and processes for treating and packaging K Basin sludge, and for selecting and implementing the integrated set of preferred technologies that optimally meet the requirements for disposal of these RH-TRU wastes.

## 3.1 Decision Plan Objectives

The overall objective of the STP – Phase 2 is to treat and package K Basin sludge such that it can be certified for transport to, and disposal at, WIPP. The objective of the decision plan is to describe the decision process necessary to select the preferred treatment and packaging technologies for the K Basin sludge. This objective is consistent with and supportive of a key principle of DOE's project management approach (as outlined in DOE O 413.3A, *Program and Project Management for the Acquisition of Capital Assets*) "… to ensure (that) appropriate supporting analyses and risk evaluations are available when making a critical decision" (DNFSB, 2008, "DNFSB Quarterly Report to Congress"). This decision plan also incorporates the principles and guidance provided in DOE STD 1189 into its activities, evaluations and documentation. Many previous efforts have attempted to identify technical solutions for this difficult waste stream, but those efforts have been abandoned for a variety of technical feasibility and programmatic reasons. If successfully executed, this decision plan will enable CHPRC to meet the following objectives:

- Make a technically defensible recommendation to DOE for the STP – Phase 2 treatment and packaging technologies.
- Assure DOE and other stakeholders that a wide range of potentially applicable technologies were identified and given a reasonable opportunity to demonstrate their applicability vis-à-vis a predetermined set of performance criteria.
- Identify those technologies that can be developed and demonstrated as the optimum set for treating and packaging the K Basin sludge.
- Be perceived as an honest broker that looked at the problem of K Basin sludge treatment and packaging with a fresh set of eyes.
- Ensure that the decision is based on an alternative's performance against pre-established technical criteria, so that individual preference and bias do not affect the outcome.
- Incorporate safety-in-design objectives of DOE Standard 1189 early into the alternatives definition process
- Allow technical teams whose technologies are not selected the opportunity for a "minority report" within the framework of the technology evaluation and selection process, thereby ensuring that DOE has all the information available during its review of the CHPRC recommendation.

## 3.2 Decision Statement

The decision statement is as follows:

***Select an integrated set of technologies (one for sludge treatment and one for treated sludge packaging, or one that can accomplish both) that can be used for pre-conceptual design of a process and facility that will treat and package K Basin sludge for acceptable transport to and disposal at WIPP as RH-TRU.***

## 3.3 Decision Process and Approach

As shown in Figure 4 in Chapter 7, several tasks are required in order to identify, evaluate, and select an integrated set of preferred technologies that can be used for the treatment and packaging of the K Basin sludge as RH-TRU waste. Consistent with the DNFSB's guidance to "ensure appropriate supporting analyses and risk evaluations are available" (DNFSB, 2008), one of the early tasks is to define and develop an appropriate methodology for technology identification, evaluation, and selection, i.e., to perform an alternatives analysis.

To successfully perform an alternatives analysis, the following major actions must be taken.

- Define the decision strategy (Section 3.4).
- Document the information required to support the decision process (Section 3.5).
- Identify the decision maker and other responsible parties supporting the decision process (Chapter 4.0).
- Define the decision criteria to be used for each stage of the selection process (Chapter 5.0 and Appendices A through C).
- Describe information that will be used to reach the decision (Chapter 6.0).

- Define when information will be available to the decision maker (Chapter 7.0).

While the execution of this decision process is the responsibility of the STP, it is the project's intent that the RL management and staff will be informally briefed and kept informed throughout its duration. Examples of this are RL's participation in the weekly schedule status meetings, providing RL with draft statements of work, and presenting briefings to RL on the results of Source Evaluation Board (SEB) deliberations before a general announcement of the results.

Similarly, it is expected that a number of interested stakeholders, such as the EPA, the DNFSB, and WIPP, will be invited to attend the Decision Support Board (DSB) deliberations. While stakeholders may choose to participate in the DSB meeting, they are not voting members of the Board.

## 3.4 Decision Strategy

The alternatives analysis process will be divided into the following three rounds of evaluation (Figure 1):

- Round 1 – A request for proposal will be issued to multiple potential participants. Their proposals will be evaluated and several (nominally three to five) will be selected for initial testing.
- Round 2 – Based on test data submitted by the three to five participants selected in Round 1, test results with CHPRC-supplied simulant will be evaluated and two or three of the most promising technologies will be selected for further testing and preliminary design.
- Round 3 – Based on test data using CHPRC-supplied simulants and preliminary design information submitted by the two or three participants selected in Round 2, the bench-scale radioactive test results, and CHPRC rough order-of-magnitude (ROM) cost estimates and Hazards Review, the DSB will recommend an integrated set of preferred technologies to the STP manager. CHPRC will formulate a recommendation and will submit it to the RL decision maker.

### 3.4.1 Round 1 Evaluation

During Round 1, CHPRC will identify as many processing alternatives as possible through a public solicitation of potentially interested participants. An SEB will be selected to evaluate the submitted proposals and will down select (nominally) three to five alternatives that are judged to have the most technical merit. In accordance with CHPRC procurement procedures, the SEB evaluation will be based on predetermined criteria documented in the procurement specification and will be performed in accordance with CHPRC procurement procedures. This initial solicitation, participant submittals, and the SEB evaluation of potential treatment and packaging processes are included as Round 1 activities. Because the technologies needed for treatment are potentially much different than those for packaging, a participant may choose to team with another participant. A participant also may choose to request technical support from one of DOE's National Laboratories; e.g., Pacific Northwest National Laboratory (PNNL), Savannah River National Laboratory.

### 3.4.2 Round 2 Evaluation

During Round 2, the three to five alternatives selected in Round 1 will be further evaluated using a technology performance specification prepared by CHPRC. Participant teams for each of the selected alternatives will perform proof testing (using CHPRC-supplied simulants) and develop supporting data for their respective technical approaches. CHPRC will assign a technology advocate for each of the selected technologies. The technology advocates will serve as the liaison or interface between the participants and CHPRC. An SEB will evaluate the submitted data vis-à-vis the technology performance specification and will down select (nominally) two or three alternatives for further testing in accordance

with CHPRC procurement procedures. Preparation of the performance specification, participant proof testing, and SEB evaluation and down-selection are included as Round 2 activities.

### 3.4.3 Round 3 Evaluation

During Round 3, each of the participants for the two or three alternatives selected in Round 2 will conduct further testing (using CHPRC-supplied simulants), develop preliminary design information packages and equipment layouts, and prepare data required by the DSB as input to the decision process. The technology advocates assigned in Round 2 will continue to work with their respective participants throughout the performance of Round 3 activities. CHPRC will prepare comparable ROM cost estimates and will perform a Hazards Review for each of the alternatives during Round 3.

While the participants are performing their testing with nonradioactive simulants, proof-of-principle (limited bench-scale) testing will be performed, using radioactive samples of K Basin sludge. The DSB will evaluate the data generated by the radioactive testing as part of its scope in conjunction with its evaluation of the participant activities.

Before convening the DSB, RL, DOE's Office of River Protection, and their contractors also evaluate the viability of alternative disposal pathways. However, this activity is not intended to impede the primary objective of this alternatives analysis, namely to evaluate treatment and packaging technologies for the K Basin sludge and to select a preferred set.

The participants' technology performance data and their preliminary design information packages, the ROM cost estimates and Hazards Reviews for each of the alternatives, and the data from radioactive testing will be compiled and organized for DSB review and evaluation. The DSB will convene and deliberate using the predetermined set of evaluation criteria and weightings provided in this document. Based on the outcome of its deliberations, the DSB will formulate its recommendation for a preferred set of technologies for treatment and packaging of the K Basin sludge. The DSB will document the preferred technologies in a decision analysis summary report that will be submitted to the STP manager. CHPRC will use this summary report, along with other programmatic considerations, to formulate and transmit a project recommendation to the RL decision maker for concurrence.

## 3.5 Information Supporting Decision-Making Process

The following information is provided to frame the decision-making process required to identify, evaluate, and select appropriate technologies for the treatment and packaging of K Basin sludge for off site disposal (Phase 2).

- DOE has designated the Engineered Container and Settler Tank sludge from the K Basins as RH-TRU waste (00-SFO-043).
- DOE has defined sludge as anything in the K Basins that can pass through a 0.64 cm (0.25-in.) screen (EPA/ROD/R10-99/059; EPA, 2005, *Interim Remedial Action Record of Decision Amendment for the 100 K Area K Basins*).
- A total of ~23.5 $m^3$ (~830 $ft^3$) of sludge (referred to as Engineered Container sludge) exists from the floors and pits of the two K Basins. The composition of Engineered Container sludge primarily is iron and aluminum oxides, sand, dirt, concrete particulates, paint chips, and miscellaneous debris, as well as fuel corrosion products and metallic uranium fragments.

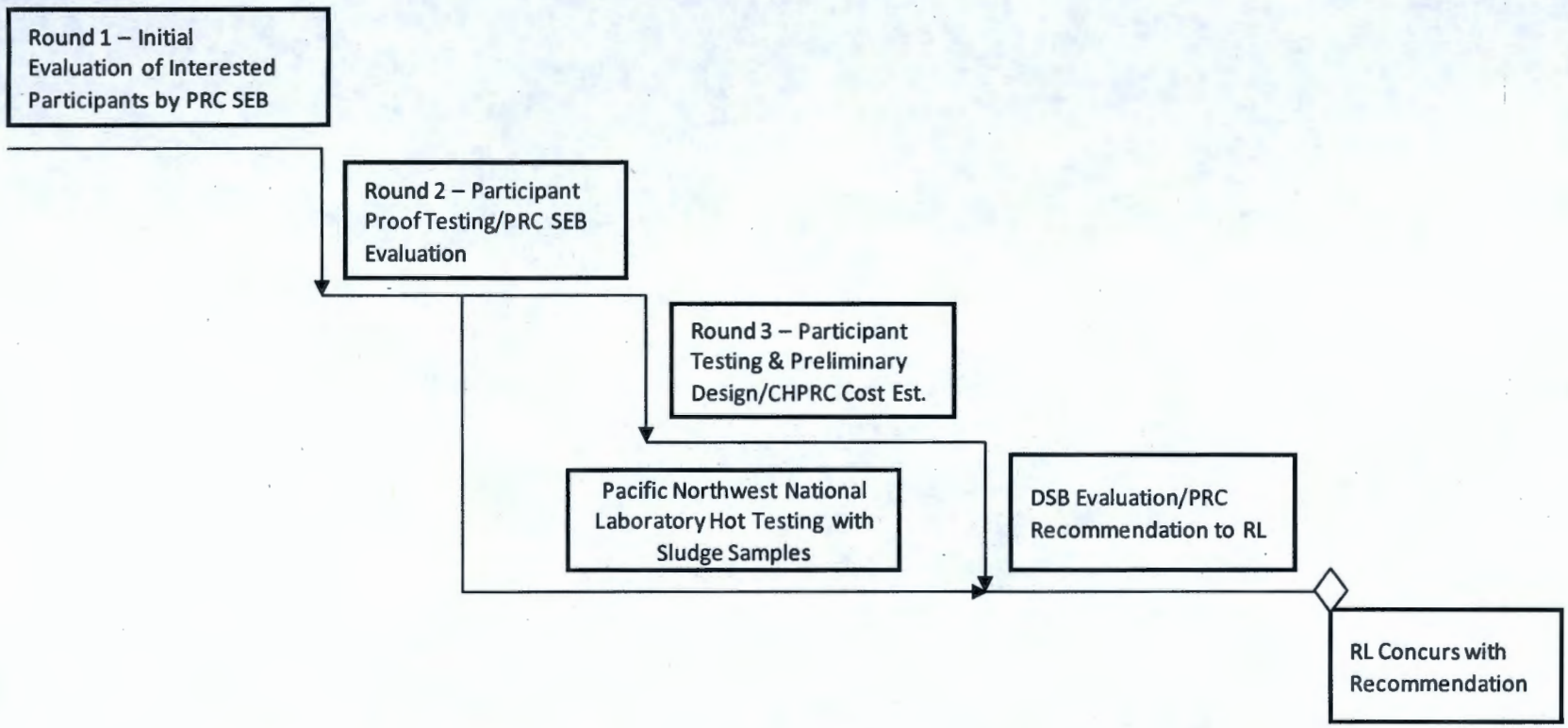


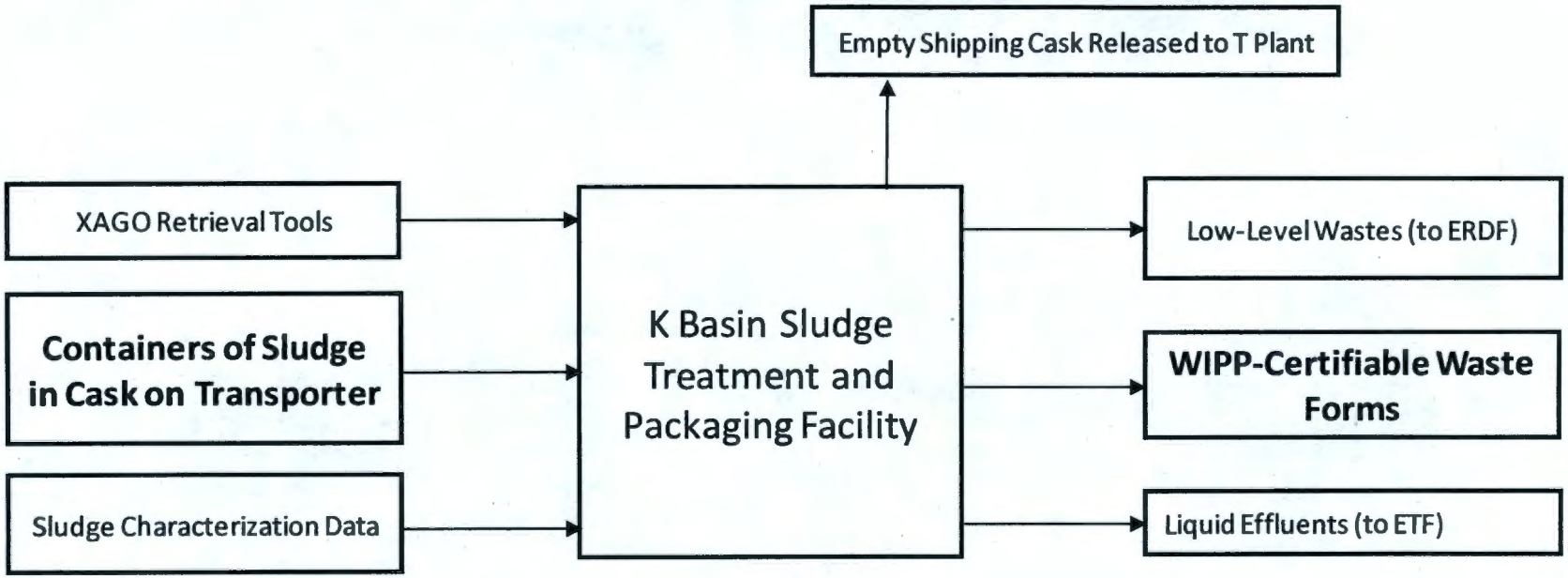

**Figure 1. Alternatives Analysis Logic for Down-Selection of K Basin Sludge Treatment and Packaging Technologies (not to scale)**

- A total of ~5.4 $m^3$ (~191 $ft^3$) of sludge (referred to as Settler Tank sludge) was generated as a result of the fuel-washing operations and was captured in the Integrated Water Treatment System. The assumed composition of Settler Tank sludge is based on characterization data of sludge samples from fuel canisters, but also may contain lesser amounts of iron and aluminum oxides, sand, and dirt than those found in the Engineered Container sludge.
- Current characterization results and process-based knowledge for K Basin sludge compositions are available in HNF-SD-SNF-TI-015, *Spent Nuclear Fuel Project Technical Databook*, Volume 2. PNNL is currently performing more detailed characterization of the Engineered Container sludge. CHPRC will sample Settler Tank sludge; PNNL's analytical results are expected in late fiscal year 2010. Sludge characterization data will be provided to participants as the data become available.
- The un-oxidized K Basin sludge will be packaged in sludge transport and storage containers (STSCs) for interim storage at the T Plant.
- It is estimated that no more than 30 STSCs will be required to store the entire K Basin sludge inventory.
- The STSCs will be transported in a shipping cask from interim storage at the T Plant to the STP – Phase 2 K Basin sludge treatment and packaging facility.
- The settler tank sludge has been segregated from the engineered container sludge and must remain segregated during treatment and packaging operations.
- The design of a tool (referred to as an XAGO tool) to retrieve sludge from STSCs is included as an STP – Phase 1 activity (HNF-39744, Volume 1, Revision 1, 2009, *Sludge Treatment Project Alternatives Analysis Summary Report*). Using the XAGO tool, waste will be delivered at the rate of 265 L/min (70 gal/min) through a 1.5-in. "D" hose with a solids loading of 5 weight percent
- STP – Phase 2 consists of the set of activities required to remove sludge from the STSCs; treat, package, and assay the sludge; and prepare the packaged sludge for transport to and disposal at WIPP.
- The STP – Phase 2 treatment and packaging facility will be required to:
  - Accept the shipping cask from T-Plant
  - Unload the STSCs from the shipping cask
  - Remove sludge from the STSCs, using the XAGO tool, and transfer to treatment
  - Treat (stabilize) the sludge
  - Package (dewater and immobilize) the treated sludge
  - Put the treated sludge into containers that will fit in an RH-72 shipping cask
  - Assay the treated sludge waste form, or otherwise determine its fissile content
  - Provide interim storage in preparation for certification and shipment to WIPP (CHPRC's Waste Management, in conjunction with the WIPP Central Characterization Program, performs final certification and preparations for shipment to WIPP).

- Design drawings and information for the STSCs, shipping cask, and sludge retrieval (XAGO) tool will be provided to the Round 2 participants who will be asked to provide preliminary design information packages and equipment layouts for each of their integrated treatment and packaging systems.

Figure 2 shows the inputs to and outputs from the K Basin sludge treatment and packaging facility.

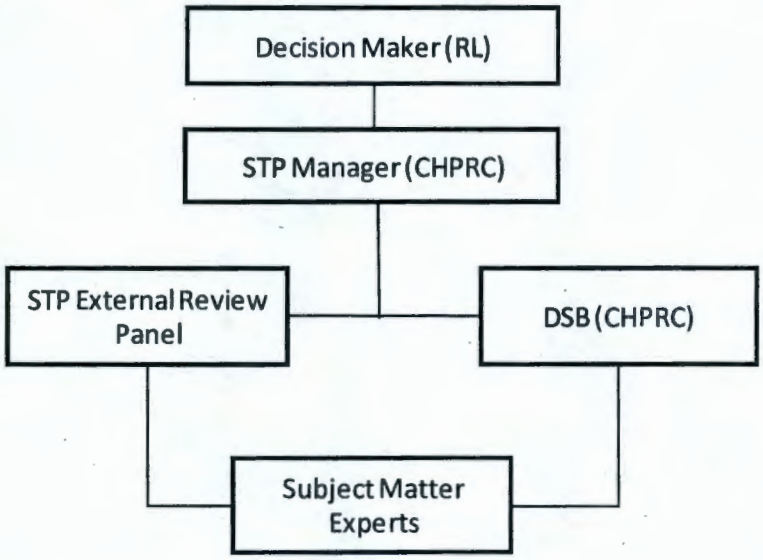
Figure 2. Inputs and Outputs for K Basin Sludge Treatment and Packaging Facility



# 4 Decision Responsibilities

This chapter discusses responsibilities of the decision-making team. Figure 3 presents the organization and structure of the team.

**Figure 3. Organization and Structure for Final Technology Down-Selection (Round 3)**




## 4.1 Decision Maker (RL)

The decision maker is the RL Federal Project Director. The decision maker will:

- Review the STP – Phase 2 alternatives analysis decision plan and future revisions to it
- Review the rating and ranking system to be used to evaluate the candidate technologies
- Concur in the preferred set of technologies for treatment and packaging of K Basin sludge, as recommended by CHPRC
- Negotiate necessary baseline changes required to implement the actions resulting from this decision on behalf of DOE.

## 4.2 STP Manager (CHPRC)

The STP manager will:

- Charter a DSB and appoint its members
- Charter an External Review Panel and appoint its members
- Recommend the preferred set of technologies for treatment and packaging of K Basin sludge to RL's decision maker
- Negotiate necessary baseline changes required to implement the actions resulting from this decision on behalf of the Contractor (CHPRC).

## 4.3 DSB (CHPRC)

The DSB is appointed by CHPRC's STP manager. The DSB will:

- Evaluate Round 3 data and information supplied to support the decision and recommend scoring and ranking to the STP manager
- Revise the decision criteria and/or the rating and ranking system, if necessary, to allow discrimination of the options evaluated
- Perform a sensitivity analysis on recommended scoring and ranking results
- Prepare the decision analysis summary that documents the results of the decision analysis.

The proposed DSB membership will consist of CHPRC and external personnel, including personnel with WIPP expertise and knowledge. The DSB membership is yet to be determined.

## 4.4 STP External Review Panel

The STP manager has chartered an External Review Panel that will function independently from the DSB. The External Review Panel will:

- Independently evaluate technical data and information supplied to support the decision and provide input requested to the DSB
- Provide periodic feedback to the STP on various issues as requested by the STP manager.

The External Review Panel standing membership consists of the following personnel:

- B. Naft, chairman
- P. Lear
- P. Loscoe
- B. Mathews
- E. Tchemitcheff

Additional ad hoc members may be added to the External Review Panel at the discretion of the STP Manager, based on specific expertise that is required.

## 4.5 Subject Matter Experts

Subject matter experts, consisting of the technology advocates and representatives from the various technical teams, will provide support to the decision-making process. These experts will provide information and support to the DSB and the External Review Panel and will be involved in supporting the testing and engineering development efforts. The subject matter experts will:

- Provide status and summarize progress of the testing and engineering development
- Identify and respond to technical issues
- Respond to information requests and provide feedback to the DSB and the External Review Panel.

# 5 Decision Criteria

Similar (but not identical, as noted below) to those used in support of the STP alternatives analysis (HNF-39744), the defined technology selection criteria are:

- Safety
- Regulatory/stakeholder acceptance
- Technical maturity
- Operability and maintainability
- Life-cycle cost and schedule (replaces programmatic considerations)
- Potential for beneficial integration with ongoing STP – Phase 1 activities [added in response to feedback from DOE's External Independent Review (EIR) Team]
- Integration with Site-wide RH-TRU processing/packaging planning, schedule, and approach (added in response to feedback from DOE's EIR Team).

Major goals and measures for each of the seven criteria are listed in the following table and further defined in Appendix A. Measures are developed in a manner that shows to what extent associated criteria are met. Weighting factors are assigned to each measure commensurate with its importance.

Once the DSB has concurred with the set of criteria, measures, and weighting factors, it will evaluate and score the integrated set of treatment and packaging technologies vis-à-vis each measure. Each technology will be given a rating of one through 10, where 10 represents the best performance and one the worst performance against the measure. Based on the total points and any other go/no-go criteria (e.g., ability to meet the WIPP waste acceptance criteria), rankings and ratings for each technology will be developed. The DSB will evaluate the data and determine the most logical and practical choice for the technology for each process function. Some additional evaluation may be required before determining the final assignment of ratings and selecting an integrated set of preferred technologies for the treatment and packaging of K Basin sludge.

Appendices B and C contain proposed assessment matrices that will be populated with necessary technical information and ranking numbers for the two technology selection decisions (one each for treatment and packaging of the K Basin sludge). This information will be provided to the DSB for its use in recommending an integrated set of preferred technologies to the decision maker for use in making the final selection of the K Basin sludge treatment and packaging technologies.

**Criteria, Goals, and Measures**

| Criteria | Goals | Measures |
|---|---|---|
| 1. Safety | Ensure worker safety<br>Ensure protection of the general public | Relative ease/difficulty in implementing adequate nuclear safety measures as measured by the number of passive (inherently safe) vs. active engineered safety features |
| 2. Regulatory/ stakeholder acceptance | Ensure compliance with environmental laws and regulations and DOE orders<br>Address sludge management concerns in *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* record of decision | Achieve acceptance of regulators and other stakeholders |
| 3. Technical maturity | Maximize confidence in process implementation | Projected Technical Readiness Level (based on technical criteria only at this stage of the project)<br>Estimated volume of waste going to WIPP |
| 4. Operability and maintainability | Maximize operability<br>Maximize maintainability | Ability for process to be remotized<br>Ability to treat and package K Basin sludge inventory in 5 to 7 years<br>Acceptability of secondary waste streams for disposal at Environmental Remediation Disposal Facility (solids) and 200 Area Effluent Treatment Facility (liquids) |
| 5. Life-cycle cost and schedule | Optimize life-cycle costs for sludge treatment and packaging facility<br>Provide acceptable schedule to stakeholders | Cost<br>• Cost of maturing technology to TRL-6<br>• Capital cost<br>• Operating and maintenance cost<br>• Deactivation and decommissioning cost<br>Schedule<br>• Facility startup<br>• Complete treatment and packaging |
| 6. Potential for beneficial integration with ongoing STP – Phase 1 activities | Optimize cost or schedule for STP – Phase 2<br>Consider co-location of needed facilities | Potential for integration of treatment and/or packaging with interim storage in T Plant<br>Potential for shared functions with those being provided by STP – Phase 1<br>Optimization of location to reduce/eliminate intermediate shipping or repackaging of the sludge material |
| 7. Integration with Site-wide RH-TRU processing/packaging planning, schedule, and approach | Optimize processes, equipment, and facilities for K Basin sludge treatment and packaging with other Hanford Site RH-TRU waste streams | Number of other Hanford Site RH-TRU waste streams that can be treated with candidate treatment process<br>Number of other Hanford Site RH-TRU waste streams that can be packaged with candidate packaging process |

TRL = technology readiness level

# 6 Required Information

Once the technology selection criteria and goals are defined and agreed upon by appropriate management authorities, an assessment of each technology will be made. The assessment scope is briefly described below.

| |
|---|
| Go/No-Go: First and foremost, it must be demonstrated that implementation of a proposed set of treatment and packaging technologies will result in a waste form that meets the WIPP waste acceptance criteria for RH-TRU for transportation and disposal. |

- ***Safety*** – a qualitative assessment of the relative safety of each candidate technology. Safety factors will include, but are not limited to, the relative ease or difficulty in implementing adequate safety measures and the number of passive (inherently safe) vs. active engineered safety features.
- ***Regulatory/Stakeholder Acceptance*** – a qualitative assessment of the relative ease or difficulty in gaining stakeholder and regulatory acceptance of the each candidate technology. The assessment will consider any issues that might create unusual difficulties associated with permitting the technology; meeting Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*, milestones; etc.
- ***Technical Maturity*** – a semiquantitative assessment of each candidate technology's readiness level that will provide assurance that the technology can be successfully implemented in a reasonable time at a reasonable cost.
- ***Operability and Maintainability*** – an assessment of each candidate technology for its inherent operability and maintainability, including, but not limited to, ease of implementation; ease of operations and process control; process stability, flexibility, and robustness; ease and frequency of maintenance; generation of secondary waste streams and compliance with Hanford Site waste acceptance criteria; and as-low-as-reasonably-achievable considerations.
- ***Life-cycle cost and schedule*** – an estimate of the costs associated with the technology development, design, construction, operation, and decontamination/decommissioning (total life-cycle), using, for example, the Office of Management and Budget present-worth evaluation methodology (OMB Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*), as recommended in the External Review Panel's report (09-AMRC-0173).
- ***Potential for beneficial integration with ongoing STP – Phase 1 activities*** – an estimate of the potential for cost/schedule optimization for STP – Phase 2 activities vis-à-vis those for STP – Phase 1.
- ***Integration with Site-wide RH-TRU processing/packaging planning, schedule, and approach*** – an assessment of how effectively the proposed treatment and packaging processes could be integrated with the processing of other RH-TRU waste streams at the Hanford Site.

To support CHPRC's assessments, each participant/or participating team will be required to develop and submit supporting technical information during Round 3 as described below:

- Process flow diagrams, including mass and energy balance, and secondary waste stream estimates in a level of detail sufficient to support the technology readiness assessment, safety assessment, and operational assessment

- Brief process descriptions in a level of detail sufficient to support the technology readiness assessment, safety review, and operational assessment
- Site/facility layout in a level of detail sufficient to support a ROM project cost estimate
- A list of process components, including size and availability, in a level of detail sufficient to support a ROM project cost estimate
- A list of process consumables (including power) in a level of detail sufficient to support a ROM project cost estimate
- An estimate of the required operational and maintenance staff necessary to sustain operations of the facility.

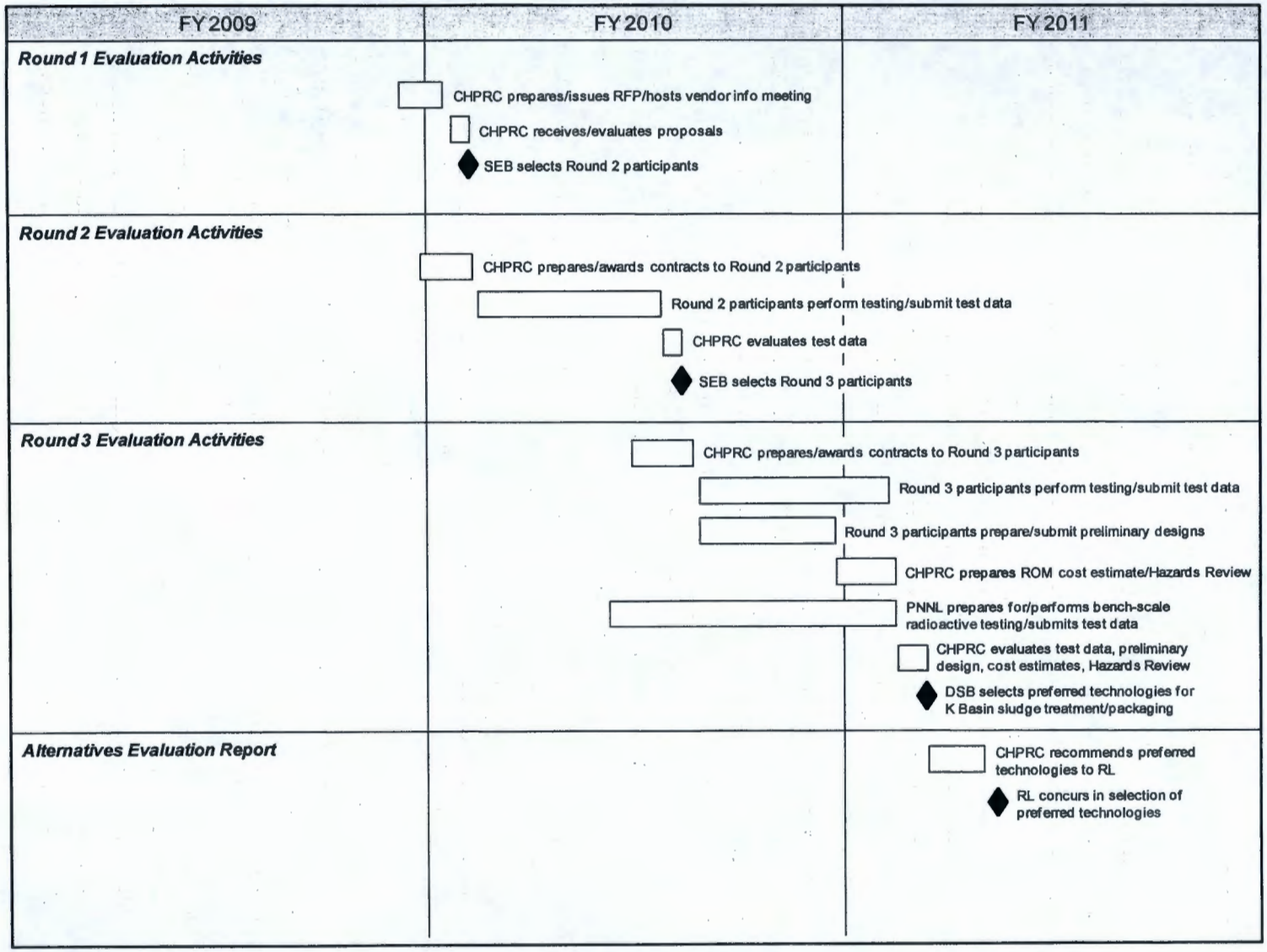
# 7 Schedule

CHPRC is scheduled to submit to RL its recommendation for an integrated set of preferred technologies to treat and package the K Basin sludge no later than February 7, 2011. Other key planning dates include:

- CHPRC issues Request for Proposal package – October 2009
- CHPRC's SEB selects Round 2 participants – November 2009
- Selected participants complete Round 2 testing – March 2010
- CHPRC's SEB selects Round 3 participants – May 2010
- Selected participants submit preliminary design information – October 2010
- Completed proof-of-principle testing with radioactive sludge samples – November 2010
- Selected participants complete Round 3 testing – November 2010
- CHPRC completes ROM cost estimates and Hazards Review – November 2010
- CHPRC's DSB selects integrated set of preferred technologies – December 2010
- CHPRC submits to RL a remedial design/remedial action work plan based on the CHPRC recommendation for the treatment and packaging of container sludge pursuant to TPA Milestone M-016-140 – March 2011

Figure 4 is a simplified version of the Primavera P6[1] schedule of the activities required to support CHPRC's evaluation and selection of the technologies needed to treat and package the K Basin sludge for transport to and disposal at WIPP as RH-TRU waste, and CHPRC's subsequent recommendation to RL.

[1] Primavera P6 is a trademark of the Oracle Corporation, Redwood Shores, California.




FY = Fiscal Year
RFP = Request for Proposal

**Figure 4. Schedule of Activities**

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# Appendix A

## Decision Criteria, Measures, and Definitions for K Basin Treatment and Packaging Technologies

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**Decision Criteria, Measures, and Definitions for K Basin Treatment and Packaging Technologies**

| Criterion | Measure | Definition* |
|---|---|---|
| Safety | Relative ease/difficulty in implementing adequate safety measures as measured by the number of passive (inherently safe) vs. active engineered safety features | 10 = Uses passive safety features and simple engineered safety features<br>5 = Requires a balance of passive and engineered safety feature<br>1 = Requires excessive number of engineered safety features with few, if any, passive safety features |
| Regulatory/stakeholder acceptance | Achieve acceptance of regulators and other stakeholders | 10 = High probability of regulatory compliance<br>5 = Moderate probability of regulatory compliance<br>1 = Low probability of regulatory compliance |
| Technical maturity | Projected Technical Readiness Level (based on technical criteria only at this stage of the project) | 10 = TRL = 4 (or greater)<br>5 = TRL = 3<br>1 = TRL<3 |
| | Estimated volume of waste going to WIPP | 10 = Volume of waste is limited by maximum allowed fissile gram equivalents (ideal)<br>5 = Volume of waste is greater than ideal, but less than twice the ideal volume<br>1 = Volume of waste is greater than twice the ideal volume |
| Operability and maintainability | Ability for process to be remotized | 10 = Easily remotized<br>5 = Somewhat difficult to remotize, but possible<br>1 = Not possible to remotize |
| | Ability to treat and package K Basin sludge inventory in 5 to 7 years | 10 = Estimated duration to process K Basin sludge inventory is <5 years<br>5 = Estimated duration to process K Basin sludge inventory is 5 to 7 years<br>1 = Estimated duration to process K Basin sludge inventory is >7 years |
| | Acceptability of secondary waste streams for disposal at ERDF (solids) and ETF (liquids) | 10 = Easily meets both ETF and ERDF waste acceptance criteria<br>5 = Easily meets either ETF or ERDF waste acceptance criteria; meets the other with difficulty<br>1 = Difficulty meeting both ETF and ERDF waste acceptance criteria |
| Life-cycle cost and schedule | Cost<br>• Cost of maturing technology to TRL-6<br>• Capital cost<br>• Operating and maintenance cost<br>• Deactivation and decommissioning cost | 10 = Minimally increases overall mission cost and scope<br>5 = Somewhat increases overall mission cost and scope<br>1 = Significantly increases overall mission cost and scope |

**Decision Criteria, Measures, and Definitions for K Basin Treatment and Packaging Technologies**

| Criterion | Measure | Definition* |
|---|---|---|
| | Schedule<br>• Facility startup<br>• Complete treatment and packaging | 10 = High probability of meeting schedule<br>5 = Moderate probability of meeting schedule<br>1 = Low probability of meeting schedule |
| Potential for beneficial integration with ongoing STP – Phase 1 activities | Potential for integration of treatment and/or packaging with interim storage in T Plant<br>Potential for shared functions with those being provided by STP – Phase1<br>Optimization of location to reduce/eliminate intermediate shipping or repackaging of the sludge material | 10 = Positive impact on STP – Phase 1 activities<br>5 = No significant impact (positive or negative) on STP – Phase 1 activities<br>1 = Negative impact on STP – Phase 1 activities |
| Integration with Site-wide RH-TRU processing/ packaging planning, schedule, and approach | Number of other Hanford Site RH-TRU waste streams that can be treated with candidate treatment process, **or**<br>Number of other Hanford Site RH-TRU waste streams that can be packaged with candidate packaging process | 10 = Process can be used to treat (package) all other identified Hanford Site RH-TRU waste streams and can be deployed in facility(ies) already existing or planned<br>5 = Process can be used to treat (package) at least one other identified Hanford Site RH-TRU waste stream<br>1 = No other identified Hanford Site RH-TRU waste stream can use proposed treatment (packaging) process |

NOTE: Measure definition will be more fully developed for each measure before initiation of the assessment process. This will be concurred by the Decision Support Board.

# Appendix B

## K Basin Sludge Treatment Technology Evaluation Matrix Criteria, Measures, and Assessment Summary

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**K Basin Sludge Treatment Technology Evaluation Matrix Criteria, Measures, and Assessment Summary**

| Criteria | Measures | Weighting Factor | Technology "A" | Technology "B" | Technology "C" |
|---|---|---|---|---|---|
| Safety | Relative ease/difficulty in implementing adequate safety measures as measured by the number of passive (inherently safe) vs. active engineered safety features | 25 | | | |
| Regulatory/stakeholder acceptance | Achieve acceptance by regulators and other stakeholders | 10 | | | |
| Technical maturity | Projected Technical Readiness Level (based on technical criteria only at this stage of the project) | 10 | | | |
| | Estimated volume of waste going to WIPP | 5 | | | |
| Operability and maintainability | Ability for treatment process to be remotized | 10 | | | |
| | Ability to treat K Basin sludge inventory in 5 to 7 years | 5 | | | |
| | Acceptability of secondary waste streams for disposal at ERDF (solids) and ETF (liquids) | 5 | | | |
| Life-cycle cost and schedule | Cost<br>• Cost of maturing treatment technology to TRL-6<br>• Capital cost<br>• Operating and maintenance cost<br>• Deactivation and decommissioning cost | 10 | | | |
| | Schedule<br>• Facility startup<br>• Complete treatment | 5 | | | |

**K Basin Sludge Treatment Technology Evaluation Matrix Criteria, Measures, and Assessment Summary**

| Criteria | Measures | Weighting Factor | Technology "A" | Technology "B" | Technology "C" |
|---|---|---|---|---|---|
| Potential for beneficial integration with ongoing STP – Phase 1 activities | Potential for integration of treatment with interim storage in T Plant | 4 | | | |
| | Potential for shared functions with those being provided by STP – Phase1 | 4 | | | |
| | Optimization of location to reduce/eliminate intermediate shipping or repackaging of the sludge material | 2 | | | |
| Integration with Site-wide RH-TRU processing/ packaging planning, schedule, and approach | Number of other Hanford Site RH-TRU waste streams that can be treated with candidate treatment process | 5 | | | |

Tri-Party Agreement = Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order.*

# Appendix C

# K Basin Sludge Packaging Technology Evaluation Matrix Criteria, Measures, and Assessment Summary

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## K Basin Sludge Packaging Technology Evaluation Matrix Criteria, Measures, and Assessment Summary

| Criterion | Measure | Weighting Factor | Technology "X" | Technology "Y" | Technology "Z" |
|---|---|---|---|---|---|
| Safety | Relative ease/difficulty in implementing adequate safety measures as measured by the number of passive (inherently safe) vs. active engineered safety features | 25 | | | |
| Regulatory/stakeholder acceptance | Achieve acceptance by regulators and other stakeholders | 10 | | | |
| Technical maturity | Projected Technical Readiness Level (based on technical criteria only at this stage of the project) | 10 | | | |
| | Estimated Volume of waste going to WIPP | 5 | | | |
| Operability and maintainability | Ability to for packaging process to be remotized | 10 | | | |
| | Ability to treat K Basin sludge inventory in 5 to 7 years | 5 | | | |
| | Acceptability of secondary waste streams for disposal at ERDF (solids) and ETF (liquids) | 5 | | | |
| Life-cycle cost and schedule | Cost<br>• Cost of maturing packaging technology to TRL-6<br>• Capital cost<br>• Operating and maintenance cost<br>• Deactivation and decommissioning cost | 10 | | | |
| | Schedule<br>• Facility startup<br>• Complete packaging | 5 | | | |

**K Basin Sludge Packaging Technology Evaluation Matrix Criteria, Measures, and Assessment Summary**

| Criterion | Measure | Weighting Factor | Technology "X" | Technology "Y" | Technology "Z" |
|---|---|---|---|---|---|
| Potential for beneficial integration with ongoing STP – Phase 1 activities | Potential for integration of packaging with interim storage in T Plant | 4 | | | |
| | Potential for shared functions with those being provided by STP – Phase 1 | 4 | | | |
| | Optimization of location to reduce/ eliminate intermediate shipping or repackaging of the sludge material | 2 | | | |
| Integration with Site-wide RH-TRU processing/ packaging planning, schedule, and approach | Number of other Hanford Site RH-TRU waste streams that can be packaged with candidate packaging process | 5 | | | |

Tri-Party Agreement = Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order.*

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