Disposition of Hanford Tank Waste Sludge from Tank 241-AY-102 and the 241-A/241-AX Farm Tanks – 15298

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ABSTRACT

WRPS must retrieve the waste from double-shell tank 241-AY-102 and the single-shell tanks in the 241A and -AX Tank Farms, while finishing the ongoing retrieval of tanks in the 241-C Tank Farm. Given the limited availability of double-shell tank space, the challenge is to identify an optimum combination of double-shell tanks that can safely and efficiently serve as receiver tanks for the combined inventory of sludge wastes from these source tanks. A multiple-criteria, weighted-sum decision-making process, in conjunction with sensitivity analysis and a Pareto evaluation, was used to determine the optimum set of receiver tanks.

INTRODUCTION

The U.S. Department of Energy (DOE) manages the Hanford Site in Southeastern Washington State where decades of nuclear materials production for the Cold War yielded a legacy of nuclear waste. Today, approximately 212 million liters (56 million gallons) of radioactive waste liquids, solids and salts are stored in 177 underground storage tanks. Of these, 149 are aging single-shell tanks (SST); the other 28 are newer double-shell tanks (DST). Some SSTs are known to have leaked in the past; the resulting soil contamination threatens the nearby Columbia River.[1]

Waste in one of the tanks, DST 241-AY-102[a] is also known to have leaked outside the primary containment [2, 3]. The tank operations contractor, Washington River Protection Solutions, LLC (WRPS), has previously evaluated potential technologies [4] for retrieving the AY-102 sludge waste and transferring the waste to one or more DSTs as soon as practicable.

Early plans [5] for emptying Tank AY-102 assumed that the sludge waste would be split between two other DSTs, Tanks AZ-101 and AZ-102, recognizing that "the process strategy may be revised based on further process flow studies and thermal analyses to confirm the current process strategy or identify other appropriate tanks." One such analysis [6, 7] evaluated the thermal impacts of decanting the supernate volume from AY-102 prior to retrieval.

Waste retrieval from Tank AY-102 must be coordinated with the ongoing retrieval of sludge wastes from the remainder of the SSTs in C Farm and with the construction and operation of retrieval equipment for nine SSTs in the A and AX Farms. With limited available DST space,

[a] Hereinafter, the "241-" prefix in the official tank names for the SSTs, DSTs, and tank farms will be omitted for readability purposes.

the challenge is to identify an optimum combination of DSTs that can safely and efficiently serve as receiver tanks for the combined inventory of sludge wastes from these 12 tanks.

The decision-making process is described and includes elements for (1) identifying the potential combinations of DSTs that could be used as candidate receiver tanks, (2) evaluating each of those combinations using a set of weighted criteria and measures, and (3) determining the optimum set of receiver tanks based on the outcome of those evaluations. In addition to available space considerations, the technical issues addressed as a key part of the evaluation included:

- Whether the estimated sludge waste temperatures resulting from their addition to the receiver tank(s) exceed the limits established in the operating specification document (OSD) for DSTs
- The requirement to ensure that the storage of these sludge wastes do not create conditions that could result in a spontaneous gas release event
- The requirement to control the generation and release of flammable gases to less than 25% of the lower flammability limit.

METHODOLOGY

Multi-Attribute Evaluation

Selecting the best combination of DSTs to receive the sludge to be retrieved from Tank AY-102 while still supporting the continued retrieval of waste from the aging SSTs requires considering multiple criteria (e.g., nuclear safety, availability of resources). A summary of common methods used to solve multiple-criteria evaluation problems can be found in Triantaphyllou [8].

Structured decision-making processes for Hanford waste management activities have typically used weighted-sum methods such as Kepner-Tregoe [9] analysis. This effort included the use of this method, in conjunction with a sensitivity analysis and a Pareto evaluation.

Pareto Evaluation of Trade-Offs

Pareto optimization is a tool that can be used to reduce the set of alternatives being considered and is based on the concept that alternatives are classified as either “dominated” or “non-dominated” with respect to a set of criteria. An alternative is classified as “non-dominated” if none of the criteria can be improved in value without degrading some of the other criteria. This technique was used to help both visualize the trade-offs and add confidence to the selected alternative.

DISCUSSION

Initial brainstorming selected 13 possible combinations of receiver tanks that could be used to receive the sludge waste, from which six (Options 1 through 4, Option 6, and Option 13) were selected for detailed evaluation by the WRPS Support Team (consisting of subject matter experts from all impacted WRPS’ functions) using weighted multivariate analysis and Pareto optimization. (Refer to the Synthesis of Alternatives section for examples of a few of the options.)

The results of this initial round of evaluations predicted that the two most cost-effective scenarios (Options 4 and 6) would result in a sludge temperature in the receiver tank that exceeds the operating temperature limit imposed by the *Operating Specification Document for the Double-Shell Storage Tanks* [10]. The only scenario (Option 13) that did not result in a predicted sludge temperature exceeding the OSD limit was significantly more costly than Options 4 and 6.

Based on the results of these initial evaluations, the WRPS Decision Board directed the technical staff to identify additional scenarios that could potentially meet the OSD temperature limits and also be more cost-effective. Six additional scenarios (Options 14 to 19) were proposed and evaluated using a reduced set of evaluation criteria that were more focused on the nuclear safety/predicted sludge temperature in the receiver tank(s) vis-à-vis the estimated near-term and total project costs. From this second round of evaluations, the WRPS Support Team determined that Option 19 met the OSD temperature criteria and was the most cost-effective.

When these results were presented to the WRPS Decision Board at a subsequent meeting, an additional technical concern relating to waste compatibility was raised. The addition of waste to Tank AY-101 from Tank AY-102 could potentially result in an increased risk of corrosion in Tank AY-101, given its construction and operational similarities to Tank AY-102 [11]. The Decision Board directed the technical staff to identify a scenario that used an alternative receiver tank for Tank AY-102 sludge wastes. An alternative scenario that would transfer the sludge wastes from Tank AY-102 to Tank AP-102 was reevaluated (previously identified as Option 12 during the initial brainstorming, and dismissed because it resulted in higher predicted radiolytic heat load values in AY/AZ Farms than Option 13). Although this option mitigated the waste compatibility concerns associated with Option 19, its estimated near-term cost of implementation was significantly higher than that for Option 19. Therefore, the WRPS technical staff performed a series of corrosion tests and analyses that showed the waste compatibility issues associated with Option 19 could be effectively addressed through several mitigating actions.

The WRPS Decision Board met for the third time to consider the test results and several proposed mitigating actions. The WRPS Decision Board concluded that the risks associated with the waste compatibility issue could not be eliminated, but could be satisfactorily mitigated. As a result, Option 19 was initially recommended by the Decision Board for the disposition of the sludge wastes from Tank AY-102, the remainder of the C Farm tanks, and the nine tanks from the A and AX Farms.

During a follow-up meeting, the WRPS Decision Maker was briefed on concerns with Option 19 and reevaluated the trade-offs between Option 19 and Option 12. Although a good technical case to mitigate the waste compatibility issue can be made, impact from a potential leak in Tank AY-101 after receiving waste from Tank AY-102, may outweigh the cost and schedule benefits of Option 19.

The WRPS Decision Maker informally briefed the DOE, Office of River Protection (ORP) on the results of those trade-off evaluations. Although Option 19 clearly has significant near-term cost advantages, the construction and operational histories of Tank AY-101 are of major concern [12]. Technically, the addition of Tank AY-102 sludge should not increase the risks of Tank AY-101 leaking. However, it may not be prudent to add difficult waste to an already suspect tank. Therefore, although more costly than Option 19, the WRPS Decision Maker selected Option 12, which transfers the sludge wastes from Tank AY-102 to Tank AP-102 (rather than to Tank AY-101), a much better option from a risk standpoint.

SUPPLEMENTAL INFORMATION

This section elaborates on several aspects of the decision process, namely, the development of criteria and synthesis, quantification, and scoring of alternatives. Full details are provided in the Decision Report [13].

Identification and Weighting of Criteria

The WRPS Support Team developed the decision criteria and specific measures for each of the criteria, with a bias towards selecting those measures with quantifiable attributes. Each measure and criteria were assigned a weight (normalized to 100) by the WRPS Support Team, based on the team's consensus of the importance of the criteria and measures to the decision. The team identified seven criteria, with associated measures and weights, that are summarized in TABLE I.

TABLE I. Criteria and measures for evaluating alternatives.

Criteria (Weight)	Measures (Weight)
Health and Safety (20)	• Radiological safety/ALARA Impacts (5) • Industrial Safety Impacts (5) • Nuclear Safety/Authorization Basis Impacts (10)
Environmental Protection (5)	• Regulatory Impact and Permitting (5)
Technical (20)	• Desirability of Long-Term Use of Selected Receiver Tanks (10) • Double-Shell Tank Space Management (5) • Predicted Temperature of Sludge in Receiver Tanks (5)
Schedule (15)	• Retrieve Tank AY-102 as Soon as Practicable (10) • Consent Decree Compliance (5)
Cost (15)	• Near-Term Cost Profile (10) • Impact to Total Project Costs (5)
Operability and Maintainability (15)	• Operational Coordination (5) • Construction Coordination (5) • Simplicity of Transfer Strategy (5)
WTP/Lifecycle Impacts (10)	• Provide Suitable HLW Feed • Impact on Complexity of Waste Feed Delivery (WFD) Operations • SSC Changes Required to Support Future WFD Activities

SSC = structures, systems, and components WTP = Waste Treatment and Immobilization Plant
WFD = waste feed delivery

Finally, definitions were developed to provide a consistent way to score each measure for an alternative based on comparison to other alternatives, or the existing project baseline. Only scores of 1, 3, or 5 were allowed. TABLE II is an example of the full set of measures and definitions used for the Cost criteria. Appendix A of the Decision Report contains the measures and definitions for all of the criteria.

TABLE II. Measures and definitions used to evaluate the "Cost" criteria.

Criteria (Weight)	Measure (Weight)	Definitions
Cost (15)	**Near-Term Cost Profile (10)** Qualitative evaluation of cost profile through end of FY 2016 (considers number of receiver tanks; required ventilation system upgrades; length, hydraulic profile, routing of HIHTL, upgrade complexity; concurrent construction; duration of operations)	5 = Estimated near-term profile is more favorable than current plans 3 = Estimated near-term profile is similar to current plans and is likely to be accommodated 1 = Estimated near-term profile is less favorable than current plans
	Impact to Total Project Costs (5) Qualitative evaluation of TPC to complete C Farm, Tank AY-102, and A/AX Farm retrievals in FY 2016 (considers number of receiver tanks; required ventilation system upgrades; length, hydraulic profile, routing of HIHTL, upgrade complexity; concurrent construction; duration of operations)	5 = Estimated TPC is low compared to other alternatives 3 = Estimated TPC is comparable relative to other alternatives 1 = Estimated TPC is higher compared to other alternatives

FY = fiscal year HIHTL = hose-in-hose transfer line TPC = total project cost

During deliberations the Decision Board determined that a reduced set of measures could be used to evaluate the revised set of alternatives, based on the observation that only certain measures appeared to be the true discriminators in the evaluation of the initial alternatives. The resulting measures and weights used to evaluate the revised set of alternatives follow:

- Nuclear Safety/Authorization Basis Impacts (33%)
- Predicted Sludge Temperature in the Receiver Tank (17%)
- Near-Term Cost Profile (33%)
- Impact to Total Project Cost (17%).

These criteria were quantified in a manner similar to that previously described for the original set of options.

Synthesis of Alternatives

The synthesis of the initial set of alternatives entailed (1) prescreening DSTs to identify candidates to receive the sludge waste from Tank AY-102 and the settled solids from A and AX Farm SST retrievals, (2) then pairing subsets of those DSTs to receive specific quantities of sludge from specific source tanks, (3) eliminating redundant or unlikely options, and (4) expanding the description of the surviving alternatives.

The first step in synthesizing alternatives was to prescreen the 27 sound DSTs. Only seven were found to be suitable for formal evaluation as potential receiver tanks (AN-101, AN-106, AP-102, AP-106, AY-101, AZ-101, and AZ-102). Fifteen of the DSTs were excluded because of buoyancy displacement gas release potentials, waste compatibility concerns (e.g., tanks containing complexant concentrate), or current or future use (e.g., 242-A Evaporator feed tank and LAW Pretreatment System feed tanks). An additional five DSTs containing significant amounts of saltcake were excluded since layering sludge on top of saltcake would likely exasperate the management of flammable gas generation and release in those tanks.

The second step in synthesizing alternatives was to choose subsets of the seven DSTs to receive specific quantities of sludge from each of the sources (AY-102, A and AX Farm retrieval, and C Farm retrieval). Those factors expected to have a strong influence on cost, such as the proximity of the source tanks to the receiver DSTs (Figure 1) or potential reuse of equipment, were considered. Elements having the strongest influence on the destination of the sludge included those most likely to affect the waste temperature and flammable gas generation, such as solids depth and radiolytic heat loads. With these considerations in mind, a set of 13 options were developed using informal brainstorming techniques. Although not exhaustive, the process resulted in a representative set of options with the given technical and programmatic inputs.

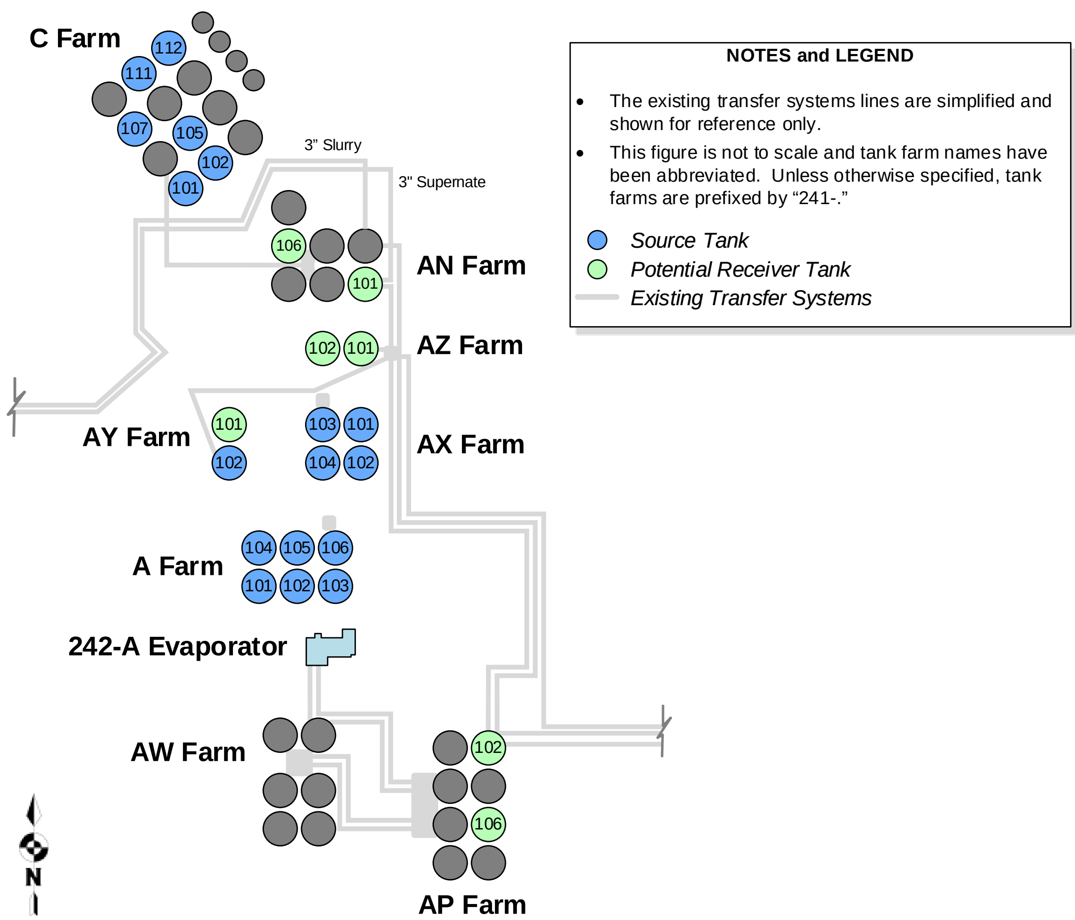

Figure 1. Proximity of source tanks to potential receiver DSTs.

In the third step, those options similar to or not likely to perform as well as some of the other options were eliminated from formal evaluation. Options 1 through 4, 6, and 13 were the six initial options that were carried into the formal evaluation; examples of two of those (Options 6 and 13) are shown in TABLE III along with two additional options introduced later (Options 12 and 19).

Further along in the decision process, as described in the DISCUSSION, the WRPS Decision Board requested the evaluation of additional options, resulting in the synthesis of Options 14 to 19. These new options focused on transferring AY-102 to AY-101 and attempting to reduce cost by reusing existing equipment when possible.

TABLE III. Definitions for Options 6, 12, 13, and 19.

Option #	Receiver Tanks	As-Received Settled Solids cm (in.)				Estimated Final Settled Solids Height cm (in.)	Estimated Final Radiolytic Heat Load W (Btu/hr)[b]
		Tank AY-102	AX Farm	A Farm	C-102 C-105		
6	AY-101	140 (54)				230 (92)	41,000 (140,000)
	AZ-101					48 (19)	50,000 (170,000)
	AZ-102			170 (65)		250 (100)	62,000 (210,000)
	AN-101				230 (89)	690 (270)[a]	10,000 (34,000)[a]
	AN-106		41 (16)		110 (44)	610 (240)[a]	47,000 (160,000)[a]
12	AY-101					97 (38)	13,000 (45,000)
	AZ-101					48 (19)	50,000 (170,000)
	AZ-102		41 (16)			140 (54)	44,000 (150,000)
	AN-101				230 (89)	690 (270)[a]	10,000 (34,000)[a]
	AN-106				110 (44)	560 (220)[a]	28,000 (94,000)[a]
	AP-102	140 (54)				160 (64)	32,000 (110,000)
	AP-106			170 (65)		170 (65)	38,000 (130,000)
13	AY-101		41 (16)			140 (54)	32,000 (110,000)
	AZ-101					48 (19)	50,000 (170,000)
	AZ-102					97 (38)	27,000 (92,000)
	AN-101				230 (89)	690 (270)[a]	10,000 (34,000)[a]
	AN-106				110 (44)	560 (220)[a]	28,000 (94,000)[a]
	AP-102	140 (54)				160 (64)	32,000 (110,000)
	AP-106			170 (65)		170 (65)	38,000 (130,000)
19	AY-101	140 (54)				230 (92)	41,000 (140,000)
	AZ-101					48 (19)	50,000 (170,000)
	AZ-102		41 (16)			140 (54)	44,000 (150,000)
	AN-101				230 (89)	690 (270)[a]	10,000 (34,000)[a]
	AN-106				110 (44)	560 (220)[a]	28,000 (94,000)[a]
	AP-106			170 (66)		170 (66)	38,000 (130,000)

[a] The final settled solids heights and heat loads include the sludge planned to be retrieved from Tanks C-107 and C-110 [25 cm (10 in.) into Tank AN-106] and Tanks C-111 and C-112 [71 cm (28 in.) into Tank AN-101] – those contributions where held constant during this analysis.

[b] The date to which radionuclides are decayed for purposes of reporting heat loads is 1/1/2013.

The fourth step involved developing a schematic for each alternative, depicting the key construction activities and transfer routings that would be required. An example for one of the alternatives is shown in Figure 2. These schematics helped estimate costs and evaluate many of the subjective measures.

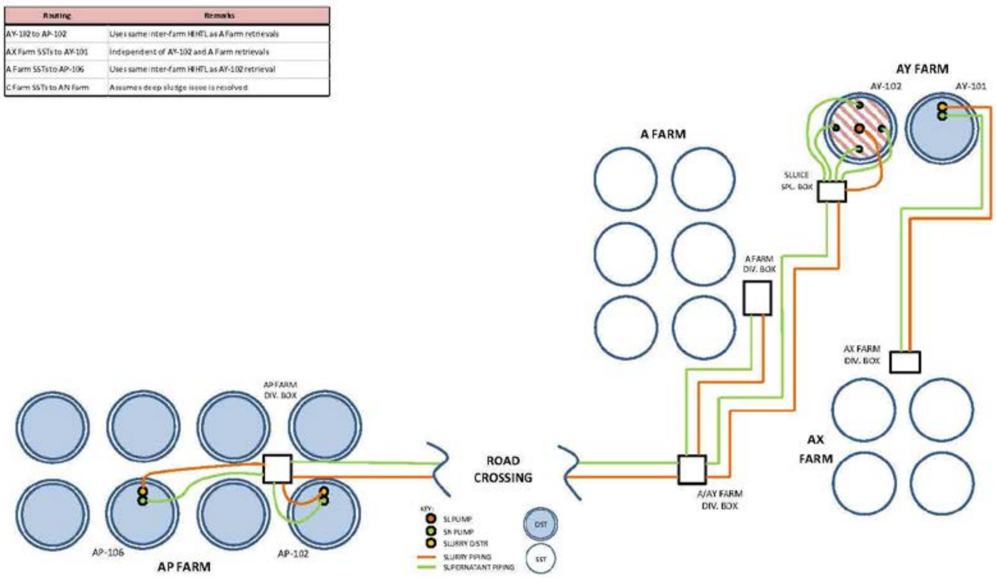

Figure 2. Example schematic for a disposition alternative.

Quantification of Alternatives

To improve the quality of the decision, the WRPS Support Team quantified the measures to the extent practical, as summarized below. Projected waste temperatures, time to lower flammability limit (TTLFL), and costs were quantified, while other measures were evaluated on a subjective or semi-quantitative basis. The quantification of the waste temperatures and TTLFL follow.

Thermal Modeling

Heat-producing radioisotopes, primarily isotopes of cesium and strontium, are present in Hanford tank wastes. Consolidation of single- and double-shell tank wastes into a few DSTs increases the total heat load in each tank, changes the distribution of radionuclides in the tank, and increases the distance of sludge though which the heat must be transferred. The resulting temperatures might exceed structural limits established for tank operations or increase the production of flammable gases beyond allowable limits, as described later in this paper.

Hanford Site contractors have developed sophisticated, three-dimensional, computational fluid dynamic models of tank behavior that can estimate maximum tank temperatures [14, 15]; however, these relatively complex models can take considerable time and effort to set up and run for individual situations. A simpler model was developed to support the AY-102 decision [16].

The results for the maximum tank temperature given by this simple model were benchmarked against actual temperature measurements for two tanks, and were found to predict the maximum solids temperature to within 8 to 11°C (15°F to 20°F) [17]. This level of accuracy was deemed acceptable for decision-making purposes.

Time to Lower Flammability Limit (TTLFL)

Hanford tank wastes generate flammable gases such as hydrogen, ammonia, and methane, which are subsequently released into the tank headspace. Under a zero ventilation condition, these gases may build up in the tank headspace and reach a flammable concentration known as the lower flammability limit (LFL). The time it takes for the tank headspace to reach the LFL after ventilation is turned off is known as the TTLFL.

Projected tank waste volumes, composition, and waste temperatures were used to estimate the flammable gas generation rate and, therefore, the TTLFL in a given tank [18], using approved methodology [19]. Two different tank waste supernate concentrations – concentrated supernatant and non-concentrated supernatant (NC) – were analyzed for each scenario to assess nuclear safety implications and post-retrieval operational flexibility.

Examples of a portion of the results for Options 1 and 12 are shown in TABLE IV, which provides a comparison of the maximum predicted solids temperatures to the maximum temperature limits from the OSD, and estimates of the time to reach 25% of the LFL at maximum predicted temperatures under zero ventilation conditions with both concentrated and NC supernatant.

TABLE IV. Temperature screening and time to 25% of the LFL under zero ventilation Options 1 and 12.

Option	Receiver Tanks	Max. Predicted Solids Temp °C (°F)	OSD Max. Waste Temp Limit °C (°F)	Days until 25% of LFL	Days until 25% of LFL (NC)	Overall Summary
1	AY-101	60 (140)	127 (260)	19	24	Not an acceptable alternative as the predicted temperature of AZ-101 exceeds the OSD limit and the estimated time to 25% of the LFL is < 1 day.
	AZ-101	200 (400)	127 (260)	<1	<1	
	AZ-102	82 (180)	127 (260)	9.0	9.0	
	AN-101	54 (130)	177 (350)	13	13	
	AN-106	110 (230)	177 (350)	4.7	4.7	
12	AY-101	36 (96)	127 (260)	33	33	More acceptable alternative as no predicted temperatures exceed the OSD limits although the estimated time to 25% of the LFL is < 5 days for AN-106.
	AZ-101	71 (160)	127 (260)	13	13	
	AZ-102	82 (180)	127 (260)	10	13	
	AN-101	54 (130)	177 (350)	13	13	
	AN-106	110 (230)	177 (350)	4.7	4.7	

LFL = lower flammability limit
NC = non-concentrated supernatant
OSD = operating specification document

TABLE V summarizes the OSD temperature and TTLFL screening results for all of the evaluated options. Options projected to exceed the maximum OSD waste temperature limits or estimated to reach 25% of the LFL under zero ventilation conditions in under one day were designated “Not Acceptable”. Those which were projected to meet the OSD temperature limits and estimated to reach 25% of the LFL under zero ventilation conditions in slightly more than one day were designated “Somewhat Acceptable”. Those which were projected to meet the OSD temperature limits and estimated to reach 25% of the LFL under zero ventilation conditions in about four to five days were designated “More Acceptable.”

TABLE V. Summary of OSD and TTLFL screening results.

Not Acceptable	Somewhat Acceptable	More Acceptable
1, 2, 4, 6	3, 14, 17	12, 13, 15, 16, 18, 19

Scoring of Alternatives

The members of the WRPS Support Team individually scored each alternative against the established criteria and measures, considering the quantified measures and input from subject matter experts on the more qualitative measures. For a given alternative, the average score from the team was computed for each measure, and the weighted score for each alternative was computed and expressed as a total number of points out of a possible 100. TABLE VI provides the scores for each of the first six alternatives evaluated using this process.

Once the weighted scores were developed, a sensitivity analysis was performed by “overweighting” each of the seven main criteria, such that the sum of the weights of all of the measures for that criteria was 50, with the weights of the balance of the criteria and measures reduced proportionately. This analysis identified how the decision might change if the relative importance of the various criteria were changed. The sensitivity analysis results are also shown in TABLE VI; the top performing alternatives are highlighted in yellow.

The sensitivity analysis presented for these six alternatives highlights two key observations regarding this decision process. First, overweighting individual criteria one at a time, did not result in certain options ever becoming the “best” selection (in TABLE VI, Options 1, 2, and 3). This included overweighting the most quantitative measures (Technical, Cost, Schedule) versus qualitative measures. Second, overweighting the most quantitative measures highlighted that the decision outcome might change if Cost or Schedule were valued more highly than Technical considerations. This is consistent with the WRPS Decision Board’s direction to focus the evaluation and trade-offs on the reduced set of evaluation criteria.

TABLE VI. Scores and rankings for the first six alternatives evaluated.

Measures	Weight	Average Scores					
		Option 1	Option 2	Option 3	Option 4	Option 6	Option 13
Health & Safety	20						
Radiological Safety/ALARA Impacts	5	4.0	4.0	4.0	4.6	4.0	1.8
Industrial Safety Impacts	5	4.1	4.1	4.1	4.1	3.7	3.7
Nuclear Safety/Authorization Basis Impacts	10	1.0	1.0	1.0	2.4	2.4	4.6
Environmental Protection	5						
Regulatory Impact and Permitting	5	3.2	3.0	3.0	3.2	3.0	3.2
Technical	20						
Desirability of Long-Term Use of Selected Receiver Tanks	10	1.6	1.6	1.6	1.4	2.8	4.5
DST Space Management	5	3.0	3.0	3.0	3.0	3.0	3.0
Predicted Temperature of Sludge in Receiver Tank	5	1.0	1.2	1.2	1.9	2.3	5.0
Schedule	15						
Retrieve AY-102 as Soon as Practicable	10	2.6	2.2	3.0	4.8	4.8	4.0
Consent Decree Compliance	5	3.0	2.6	3.8	4.6	3.0	4.4
Cost	15						
Near-Term Cost Profile	10	2.1	4.1	1.9	5.0	5.0	1.2
Impact to Total Project Costs	5	3.0	3.0	3.0	4.3	5.0	1.2
O&M	15						
Operational Coordination	5	2.6	2.6	2.8	4.6	4.0	4.4
Construction Coordination	5	2.8	3.0	3.2	3.9	2.8	3.4
Simplicity of Transfer Strategy	5	2.3	2.3	2.3	2.8	4.1	3.9
Waste Feed Delivery Impacts	10						
Provide Suitable HLW Feed	3	4.8	4.8	4.8	4.8	4.8	4.8
Impact on Complexity of WFD Operations	4	1.9	2.5	2.3	1.6	1.6	4.6
SSC Changes Required to Support Future WFD Activities	3	3.9	3.9	3.9	2.3	2.3	1.0
	100						
Possible Score out of 100		50	54	52	70	71	70
Sensitivity Cases - Possible Score out of 100							
Health & Safety		51	53	52	69	68	71
Environmental Protection		57	57	56	67	66	67
Technical		45	47	46	58	65	75
Schedule		52	51	58	80	76	75
Cost		49	62	49	80	83	51
O&M		51	53	54	72	72	73
Waste Feed Delivery Impacts		58	62	60	63	64	71

DST = double-shell tank
O&M = operations and maintenance
SSC = structures, systems, and components
WFD = waste feed delivery

OUTCOME

While the outcome of this effort comprises the final decision and recommended follow-on activities, the selected DSTs and associated source tanks are the gist of the decision. Details may change as the responsible detailed designs and flowsheets are developed, and additional inputs from the operating and process engineering organizations are considered.

Final Decision

The final decision was to implement Option 12, which comprises:

- Retrieve 140 cm (54 in.) of Tank AY-102 sludge wastes into Tank AP-102
- Retrieve 230 cm (89 in.) of Tank C-102 solid waste into Tank AN-101; retrieve 112 cm (44 in.) of Tank C-105 solid waste into Tank AN-106
- Retrieve 170 cm (65 in.) of A Farm solid wastes into Tank AP-106
- Retrieve 41 cm (16 in.) of AX Farm solid wastes into Tank AZ-102
- No additional solid waste added to either Tank AY-101 or Tank AZ-101.

Summary of Trade-Offs

The Pareto diagram in Figure 3 compares the evaluated alternatives in terms of two composite measures, "Technical" and "Programmatic." The "Technical" measures reflect the **Nuclear Safety/Authorization Basis Impacts** measure (primarily quantified by the TTLFL analysis) and **Predicted Temperature of Sludge in Receiver Tank** measure (quantified by the thermal modeling). The "Programmatic" measures were **Near-Term Cost Profile** and **Impact to Total Project Costs**. Measures that did not appear to have a significant impact on the rankings, due either to their relative low weighting and/or lack of discrimination between the alternatives, were not considered in reaching the final decision.

As expected, most of the Decision Board's deliberations centered around the non-dominated alternatives, particularly Options 4, 6, 13 and 19. After the potential adverse consequences of using AY-101 to receive AY-102 sludge were explored, the deliberations focused on the trade-offs between Options 12 and 19 with Option 12 being selected.

Follow-on Activities

About 30 recommended and optional process-related activities were identified for implementing Option 12 [20]. Two of the most significant recommended activities are:

- Performing rigorous temperature calculations for Tanks AP-102, AP-106 and AZ-102 to project the sludge and supernatant temperatures, and waste and tank heat-up rates, under normal and off-normal conditions.
- Prepare process flowsheets for the retrieval of Tank AY-102 and AX Farms.

The optional (defense-in-depth) activities include:

- Implement a long-term corrosion monitoring program for Tanks AP-102, AP-106 and AZ-102.
- Obtain post-retrieval core samples from Tanks AP-102, AP-106 and AZ-102 to confirm that the interstitial liquid composition is within chemistry controls and consistent with the process flowsheet projections.

- Update the waste chemistry controls in the OSD to encompass dilute (low NO_3) interstitial liquid compositions at higher waste temperatures using simulant testing program.

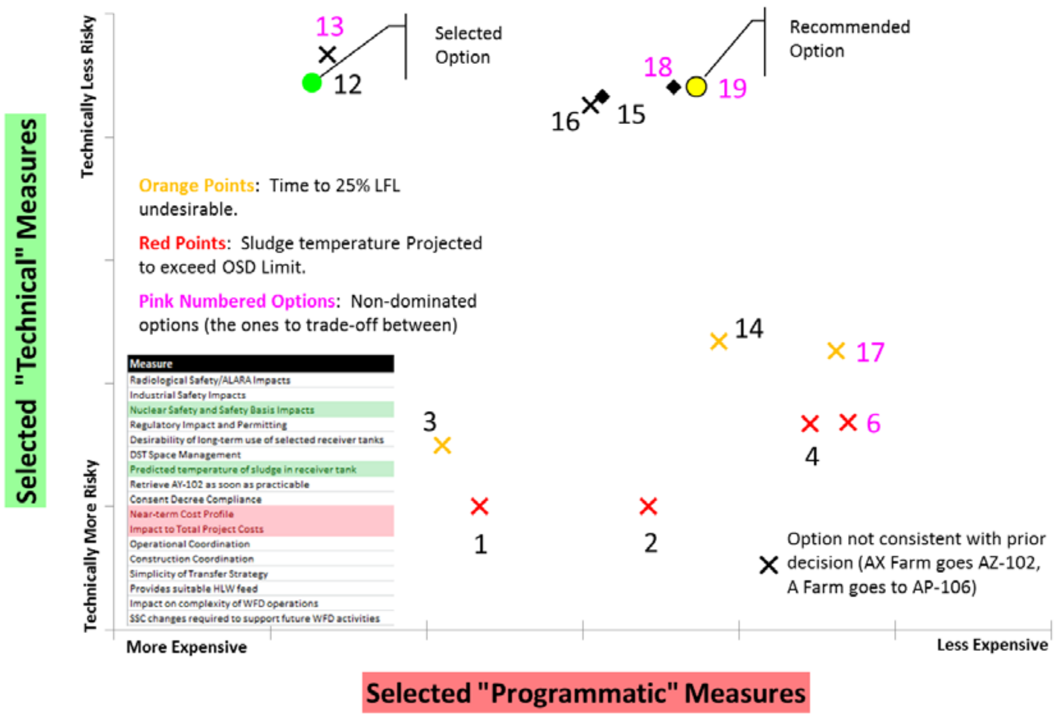

Figure 3. Pareto analysis showing trade-offs for the final selection.

CONCLUSIONS

WRPS used a disciplined process incorporating common decision analysis techniques to reach an optimal decision for the disposition of wastes from leaking Tank AY-102, while still accommodating overall RPP mission objectives for SST retrieval. The final selection considered the key criteria identified early in the decision process, as well as the risks associated with the most highly-ranked decisions. Quantifying decision criteria improved the objectivity of the selection; quantification was limited to screening level analyses that provided sufficient discrimination between alternatives without extensive analysis, allowing the decision to be made in a timely manner. The basic approach used has proven effective for past Hanford decisions. The use of Pareto optimization was a useful means of discriminating between large numbers of options and clarifying the trade-offs.

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