U.S. Department of Energy
Office of River Protection
P.O. Box 450, MSIN H6-60
Richland, Washington 99352

0072329

FEB 27 2007

07-TPD-008

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

RECEIVED
FEB 28 2007
EDMC

Dear Ms. Hedges:

INFORMATION REQUESTED IN SUPPORT OF MILESTONE M-62-08

Reference: Ecology letter from J. A. Hedges to R. J. Schepens, ORP, "Missed Milestone M-62-08," dated December 26, 2006. 0071919

This letter responds to the Washington State Department of Ecology (Ecology) letter of December 26, 2006 (Reference) and is intended to provide the information requested therein to the extent possible at this time. The U.S. Department of Energy (DOE), Office of River Protection (ORP) has not submitted a Hanford Federal Facility Agreement and Consent Order change request for Milestone M-62-08 due to the ongoing strategy discussions involving senior management representing Ecology, the U. S. Environmental Protection Agency, DOE-ORP and Richland Operations Office.

A summary of our current knowledge associated with supplemental Low-Activity Waste treatment options is provided in this response as agreed to in discussions with you and members of your staff. Some of the requested information will take additional time to provide. In those cases, dates have been provided when the additional information can be provided to Ecology. Enclosure 1 provides the available Supplemental Technologies information. Enclosure 2 provides information specific to Bulk Vitrification.

Please note that the information presented in this response is preliminary and does not provide the basis for determining the future of a supplemental treatment technology to support the River Protection Project long term mission. The future supplemental Low-Activity Waste treatment method will be determined when results from the on-going testing of treatment options have been completed and evaluated and the Final Tank Closure and Waste Management Environmental Impact Statement and Record of Decision are issued. Evaluation of the DBVS test results to date justifies continued support by ORP for the Demonstration Bulk Vitrification System as a Research and Development project for comparison with other treatment options.

It is our understanding that Ecology will use the submitted information to develop a preliminary position on the viability of supplemental treatment in the future. Given the current state of developmental testing and the complexities associated with Tank Farm System Plan Model, I request the opportunity to present the content and supporting information associated with our submittal during a meeting including your executive staff.

If you have any questions, you may contact me, or your staff may contact T. Zack Smith, Assistant Manager for Tank Farms Project, (509) 373-0421.

Sincerely,

Roy J. Schepens, Manager
Office of River Protection

TPD:BJH

Enclosures (2)

cc w/encl:
P. K. Brockman, CH2M HILL
F. R. Miera, CH2M HILL
J. E. Van Beek, CH2M HILL
S. Harris, CTUIR
C. L. Whalen, Ecology
T. Holm, EnviroIssues
T. C. Post, EPA
S. L. Leckband, HAB
G. Bohnee, NPT
K. Niles, Oregon Energy
R. Jim, YN
TPA Milestone
Administrative Record M-62-08
CH2M HILL Correspondence
Environmental Portal, LMSI

Supplemental Technologies

(Washington State Department of Ecology [Ecology] information requests are provided in italics)

Response to Bullet 1 through Bullet 3 from Ecology letter, dated December 26, 2006, for each technology considered please provide the following information by January 30, 2007:

- ***Bullet 1*** *– Description of the technology.*

(Discussions held on 1/11/07 with Ecology resulted in the following clarifications to the request:)

Bulk Vitrification/Steam Reforming Technology Descriptions:

1. *Provide system description for Bulk Vitrification technology.*
2. *Provide system description for Steam Reforming technology.*
3. *Additionally, provide description for Fractional Crystallization pre-treatment process for information only.*

Bulk Vitrification System Description:

RESPONSE: It is anticipated that if bulk vitrification is selected as the supplemental treatment technology as a result of the Tank Closure and Waste Management (TC & WM) Environmental Impact Statement (EIS) and Record of Decision (ROD), a supplemental Low Activity Waste (LAW) treatment plant employing this technology would be modeled after the Demonstration Bulk Vitrification System (DBVS). The DBVS is a full-sized test facility that would receive waste from Single-Shell Tank (SST) 241-S-109; mix the waste with soil or other materials, dry soil or minerals/waste mixture; and blend in glass-former additives to produce a dried waste/additive mixture. The DBVS would then use the In Container Vitrification™ (ICV™) process to convert the dried mixture into boxes of vitrified waste. The ICV™ boxes would be cooled and interim stored until they are transferred to the Integrated Disposal Facility (IDF) for disposal onsite. The DBVS would treat the process off-gas to a level that is protective of human health and the environment and that meets applicable requirements. Secondary liquid wastes would be filtered and sent to the Effluent Treatment Facility (ETF) for treatment and disposal. Figure 1 shows the relationship between the main process systems in the DBVS. These process systems include:

- Clean Soil System;
- Waste Receipt System;
- Waste Mixer/Dryer and Condensate Recovery Systems;
- Dried Waste Handling System;
- In-Container Vitrification™ System;

- Off-Gas Treatment System (OGTS); and
- Secondary Waste Storage System.

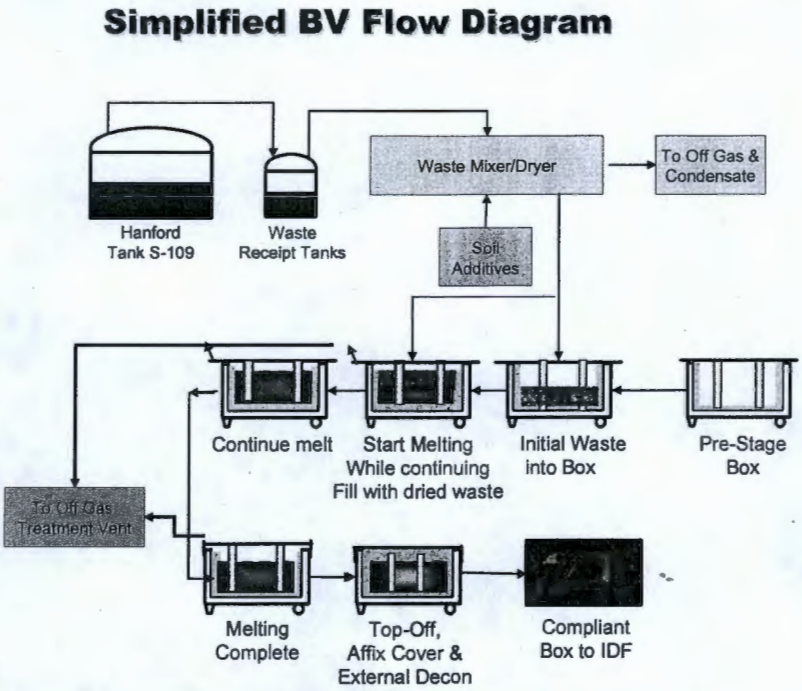


Figure 1. Simplified DBVS Flow-Diagram

Clean Soil System
The Clean Soil System receives and mechanically conveys clean soil or other minerals with glass-forming additives to a total of six impingement tanks that allow solid materials to be fed by gravity into the waste processing vessels. One tank would feed soil to the Waste Mixer/Dryer, while the remaining three soil tanks feed top-off soil to three separate ports in the ICV™ box. Two additional tanks would feed glass-forming additives to the Waste Mixer/Dryer.

Waste Receipt System
The Waste Receipt System consists of a pump skid and three waste staging tanks. This system would receive, sample, and transport waste from the 241-S-109 SST to the Waste Mixer/Dryer and Condensate Recovery Systems. The pump skid would transfer batches of waste from S-109 to one of three waste staging tanks for storage until it is needed for processing. The waste would be sampled to verify that it complies with the DBVS waste feed acceptance criteria.

Waste Mixer/Dryer and Condensate Recovery Systems
The Waste Mixer/Dryer converts waste liquid into a blended and dried feed product suitable for vitrification. Heat and vacuum would be used to dewater the waste feed/soil

mixture. During evaporation the Waste Mixer/Dryer would be operated at 60 °C (or higher) under a vacuum of approximately 660 mm Hg. The Waste Mixer/Dryer would mix its contents with rotating plows that direct the waste from the ends of the mixer/dryer towards its center. The evaporated water would be pulled through a Sintered Metal Filter (SMF) to remove particulates before the vapors reach the Condensate Recovery System. Particulates captured in the filter would be returned to the dryer drum via back-pulsing of the filters.

Waste drying is a batch process with approximately eight dryer loads required for each ICV™ box. Each dryer load would begin with an initial charge of gravity-conveyed clean soil via the impingement tank located above the dryer. After preheating the soil, waste feed would gradually be added from the waste staging tanks until the correct ratio of waste- to-soil is achieved. Once the entire batch of waste feed is added, the product would be dried to a target water content of about 3wt% water. Glass former additives would then be added and mixed with the dryer product. Finally, the Waste Mixer/Dryer would discharge the dried waste to the Dried Waste Handling System through a valve located on the bottom of the dryer, then the batch process would repeat.

Mechanical Waste Handling System
The Mechanical Waste Handling System transfers the dried waste and soil or other mineral mixture from the dryer to a waiting ICV™ box. The dried waste would be transferred into a discharge chute at a rate controlled by airlock valves. As the airlock valves open, dried waste would then be gravity fed into the ICV™ box. Both airlock valves would be used to provide an even distribution of dried waste to the two entry points in the ICV™ box. The process is repeated for each dryer batch.

In Container Vitrification™ System
The ICV™ system is designed to receive a waste/soil mixture, contain the bulk vitrification process, and serve as the final disposal container for the product. The ICV™ box would provide primary confinement for dried waste received from the dryer, molten glass during processing, and final waste product.

The soil or mineral/waste mix would be melted within the box, using electric power supplied through graphite electrodes. A starter path would be used to initiate the melt. On completion of the melt and after a cooling period, sufficient top-off soil would be added to ensure that the box is at least 90 percent full and a nominal 10-inches of soil layer covers the melt. Once the chutes, electrical connections, ventilation and instrument harness have been disconnected, the ICV™ box would be moved to the storage pad using an air pallet.

Off-Gas Treatment System
The OGTS is used to cool, filter, scrub, and chemically treat the various process off-gas and vent streams before exhaust fans discharge them through a monitored exhaust stack to the atmosphere. Off-gas produced during the ICV™ process would be drawn through two SMFs connected in series and the collected particulates returned to the dryer by vacuum transfer and re-introduced into the melt process.

Additional air drawn from the waste staging tank vents would be combined with ICV™ process off-gas after the SMFs and fed into the off-gas wet scrubber treatment skid. The gas would be quenched with a caustic solution to cool it before entering the scrubber. This would remove most of the acidic gases (e.g., NO_x, CO_2) and particulates. After the scrubber, the off-gas would be passed through a mist eliminator, cooled in the condenser, and passed through a second mist eliminator. Ambient air, air from the secondary waste storage tank vents, and air from the dryer off-gas is combined with the scrubbed off-gas, then heated and passed through a series of two High-Efficiency Particulate Air (HEPA) filters.

The filtered off-gas would then be drawn through a High-Efficiency Gas Absorber (HEGA) filter and polishing filter. The HEGA filter is used to remove residual radioactive iodine and organic carbon from the off-gas stream. The polishing filter would capture filter media particles that may exist in the HEGA filter effluent and would prevent them from entering the Selective Catalytic Reduction (SCR) unit.

After passing through the HEGA filter skid, the off-gas would be mixed with filtered ambient air and drawn into the SCR unit, where it is preheated to bring it to the required operating temperature before entering the SCR reactor. As the off-gas passes through the SCR, NO_x would be reacted with ammonia in a catalyst bed to produce water vapor and nitrogen gas. A second catalytic bed would oxidize any remaining CO to CO_2. Hot off-gas from the SCR reactor would pass through the exhaust side of the air-to-air heat exchanger to preheat the incoming off-gas before being discharged through the exhaust stack. After the stack monitor has sampled and measured the off-gas for the discharge flow, temperature, and contaminants being exhausted to the atmosphere, the treated off-gas would be discharged through the stack by one of two exhaust fans.

Secondary Waste Treatment System

The Secondary Waste Treatment System provides for the storage of the secondary liquid waste effluents from the dryer condensate and off-gas scrubber solution, and load out of these effluents for transfer to the ETF. Two staging tanks would be provided for interim storage of each of these secondary waste streams, and would be sized such that the secondary waste generated during the production of a single ICV™ box can be contained in two of the tanks (one for dryer condensate and one for off-gas scrubber solution). This approach would provide time for secondary waste sampling prior to transfer to the ETF.

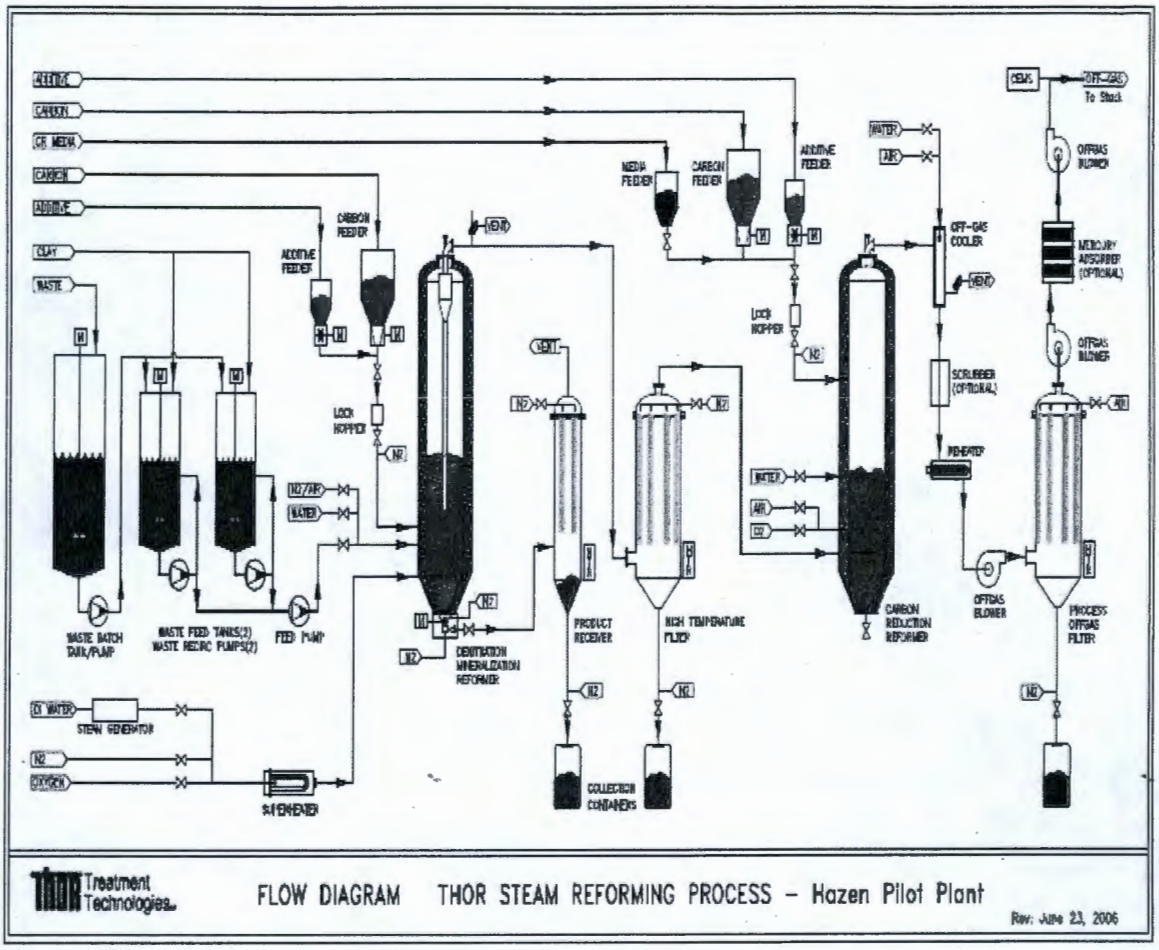
Steam Reforming System Description:

Steam Reforming will be evaluated as a supplemental treatment technology in the TC & WM EIS. Steam reforming technology is a thermal process that destroys organic materials and produces a solid residue through reaction with steam. Steam reforming has been used on a large scale by the petrochemical industry to produce hydrogen for at least 65 years. More recently, the process has been commercialized as an alternative to incineration for radioactive waste treatment. The most efficient utilization of the technology is accomplished with a fluidized bed.

Steam reforming involves multiple sequential and parallel competitive physical transformations (e.g., evaporation of water, depolymerization, pyrolysis, and devolatilization of organics; and inorganic compound dissociation), and chemical steps involving solid-state (solid-solid), heterogeneous (gas-solid), and homogeneous (gas-gas) oxidation/reduction reactions. In order to select appropriate inorganic additives, organic reductant additives, and fluidizing/feed atomizing gases, a general understanding of local and bulk chemistry is useful.

To utilize the Steam Reforming technology for treatment of LAW at the Hanford Site, a set of sequential reformers would need to be used. The first reformer would spray the LAW mixed with kaolin clay into a hot fluidized-bed (~650-750°C) where the water and acids in the wastes are evaporated and the nitrate is decomposed to nitrogen and nitrogen oxide gas species. The slightly pressurized fluidized bed is maintained and heated with a superheated steam that is mixed with Oxygen and Nitrogen. Carbon is also added to this reformer which acts as a reductant. The residue left on the bed, which is composed mainly of non-volatile metals, is converted into chemically stable mineral forms such as nepheline, sodalite, and nosean. As the bed of granular particles increases in volume, it can be removed and pneumatically transported to dry waste packaging systems. This reformer is called the Denitration and Mineralization Reformer (DMR). The second reformer is called the Carbon Reduction Reformer (CRR). This reformer further reduces any remaining NOx gases and oxidizes any residual organics.

The off-gases are filtered through a sintered metal HEPA filter, and then vented to the atmosphere. The solid, final end product is collected from the filters after both the DMR and the CRR. The product varies in sizes from "fines" (<500 microns) to ~0.5 cm. This product would then be incorporated into a monolithic form (yet to be determined) to meet the disposal criteria for IDF.



Fractional Crystallization Pretreatment System Description:

In December 2004, Fractional Crystallization (FC) was selected for evaluation as a potential pretreatment process for Hanford tank waste. FC has the following **potential** advantages over the current baseline for pretreatment of Hanford waste, ion exchange:

- Cs, Tc and I are depleted in the LAW product stream and are concentrated in the high level waste product stream.
- No chemicals are added to the waste or used in the process.
- No secondary waste streams (e.g., spent resins) are generated by the process.
- Dose rates in the facility remain low because there is no buildup of radionuclides, e.g., as with loaded resins, so less shielding is required.
- With multiple FC cycles, the resultant Cs decontamination is superior to any other pretreatment technique.

- The process has a long and diverse history of successful industrial applications.

History

Crystallization of Hanford Site waste and Hanford-type wastes has been practiced in the Hanford Site 242-A, and 242-S Evaporators, and similar industrial processes for many years. The operational 242-A evaporator has been used to reduce waste volume by evaporating water and crystallizing sodium salts from Hanford Site waste. However, it does not perform selective (or fractional) crystallization and the sodium salts are not separated and decontaminated from the residual liquor.

The processes used to crystallize and decontaminate sodium salts found in Hanford Site waste are currently practiced in commercial industries at high production rates[1], such as sodium carbonate and sodium nitrate production. Fractional Crystallization, as a method to separate pure sodium chloride, borate, carbonate, and sulfate salts from brine containing organic matter, sulfides, tungsten, iodine, and other impurities was practiced by Kerr-McGee Chemical Corporation at Searles Lake, California. The process uses temperature swings and crystal seeding, as well as physical separations to improve yields and purity of the multi-product plant. Solubility data developed for the Searles Lake FC processes are still in use today.[2]

Process

The scientific theory behind the FC process is simple. The medium-curie feed arrives at the facility as an aqueous salt solution. Water is evaporated at reduced temperature and pressure until low-activity sodium salts precipitate from mother liquor.

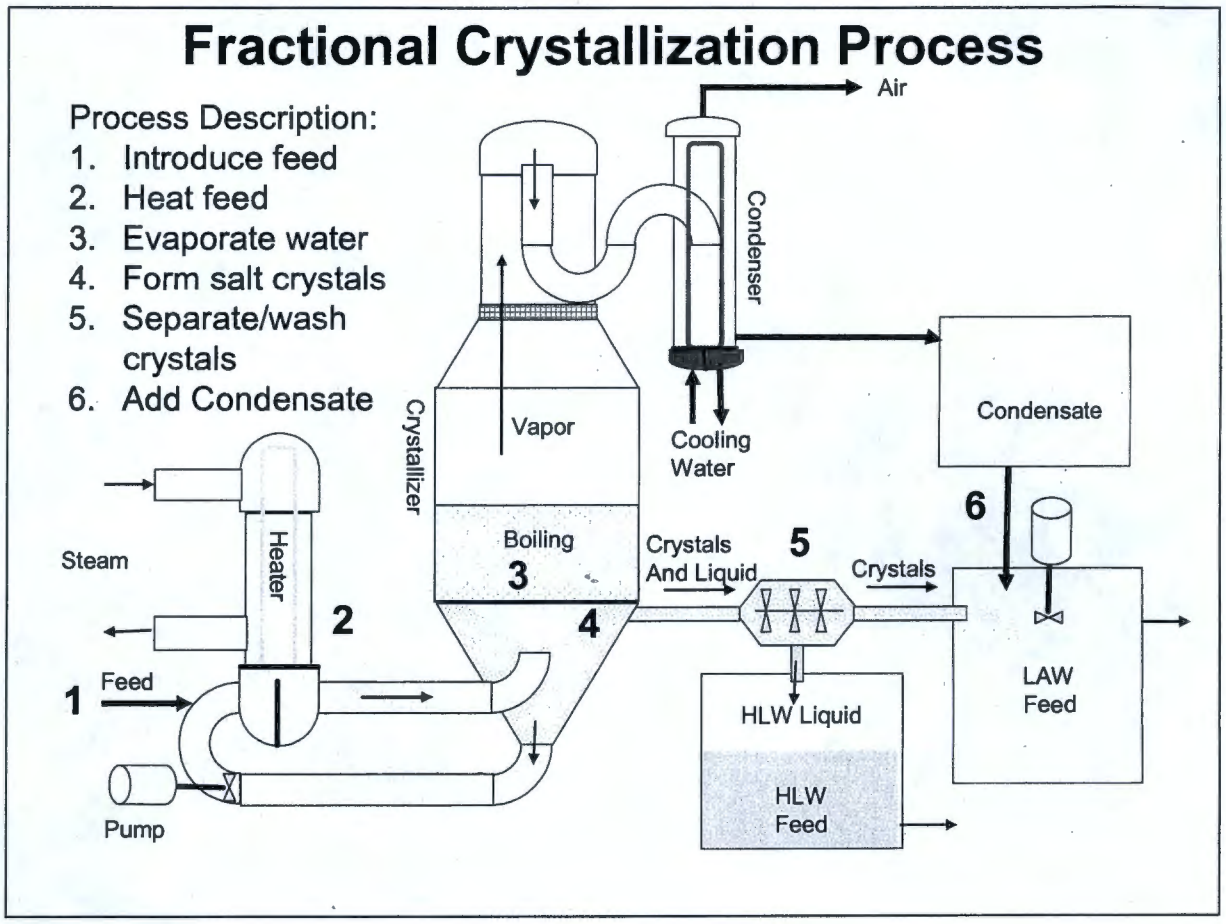
Highly radioactive components in the waste, such as Cs, Tc and I, remain dissolved in the mother liquor for two reasons: (1) The concentrations of radionuclide salts in solution are so low that they never approach saturation; e.g., the concentration of ^{137}Cs in a typical feed solution is 1×10^{-5} M while the solubility of $CsNO_3$ in water is about 1 M; and (2) the radionuclide ions are too large to substitute for the non-radioactive ions in the salt crystals; e.g., the ionic radii of Na^+ and Cs^+ are 0.95 Å and 1.69 Å, respectively. There is insufficient room in the crystal structure for a Cs^+ ion to substitute for a Na^+ ion without great stress being placed on the crystal lattice.

The precipitated low-activity sodium salts are separated from the high-activity mother liquor by centrifugation or filtration, washed with saturated salt solution to remove residual mother liquor, and re-dissolved in water to form the LAW stream. The contaminated wash solution is recycled to the crystallizer. The high-activity mother liquor is returned to the tank farm for storage in a double-shell tank until it becomes feed for the Waste Treatment and Immobilization Plant (WTP).

---

[1] A modern industrial soda ash crystallizer produces 100 tons/hour $Na_2CO_3 \cdot 1H_2O$.

[2] Teeple, J.E., 1929, The Industrial Development of Searles Lake Brines, Chemical Catalog Co., New York, NY.


Fractional Crystallization Process
Process Description:
1. Introduce feed
2. Heat feed
3. Evaporate water
4. Form salt crystals
5. Separate/wash crystals
6. Add Condensate
Air
Condenser
Condensate
Vapor
Cooling Water
Crystallizer
Boiling
3
Steam
Heater
2
4
Crystals And Liquid
5
Crystals
6
1
Feed
Pump
HLW Liquid
HLW Feed
LAW Feed

- ***Bullet 2*** *– Waste package performance data in comparison with the baseline borosilicate glass (WTP [LAWA] [BP1]).*

(Discussions held on 1/11/07 with Ecology resulted in the following clarifications to the request:)

1. *Provide a summary of glass performance at several different testing levels (reference Waste Management Paper and attach).*
2. *Add recent Protect Consistency Test (PCT) and Vapor Hydration Test (VHT) data from simulant test FS38C glass samples to supplement data in the WM paper and supply LAWA BP1 PCT and VHT data for reference.*
3. *Supply glass only PA performance data for LAWA BP1 and bulk vitrification baseline glass.*
4. *Describe how future tests including ES31F, FS38D, DBVS cold testing, and DBVS Hot testing will determine performance of the remainder of the package.*
5. *Provide a timeline for obtaining this data including specific agreed to Research Development & Demonstration (RD&D) Permit requirements established to provide the data.*

RESPONSE: The waste package performance data would be provided to Ecology by March 15, 2007.

- ***Bullet 3*** *– U.S. Department of Energy (DOE) analysis and conclusions from engineering and full scale tests. Ecology has received some test data reports, but we are also interested in DOE's analysis of that data as it relates to lessons learned about the sensitivity of the technology, operational sensitivities, the application to future tests, etc*

(Discussions held on 1/11/07 with Ecology resulted in the following clarifications to the request:)

Bulk Vitrification:

1. *Provide a narrative of simulant full-scale test results.*
2. *Provide a copy of the 38C test report when it becomes available (March 31, 2007).*
3. *Provide examples of how lessons learned from one simulant test have been applied to subsequent simulant testing.*
4. *Include a statement as to why we are confident that we are converging on the ultimate answers for bulk vitrification technology.*
5. *Discussion as to how the DBVS RD&D program would build on simulant testing that has, or is to be conducted.*

Steam Reforming:

1. *Overview of Hanford Site simulant testing to date would be provided via project test reports.*

2. *Lessons learned to date overview.*
3. *Future project testing activities and associated schedules.*

BULK VITRIFICATION RESPONSE:

In the past 22 months, four full-scale bottoms up/feed while melt tests have been completed. These tests were performed to provide full-scale data on the ICV™ box design, operating conditions around the box, and waste form performance using a LAW simulant. The results of the first three tests, 38A, 38A-1 and 38B are documented in a test report that has been provided to Ecology. The 38C test report will be provided to Ecology upon release currently scheduled for March 2007.

The first full-scale test was test 38A conducted in March 2005. This was the first full-scale test of the bottoms up/feed-while-melt operating concept. Previous full-scale tests conducted in 2003 used top-down melt operations. Test 38A was intended to evaluate the new box and refractory design. A sodium bicarbonate-based simulant was used as feed to the box. Approximately 88 hours into the test, a small amount of iron slag and glass leaked from the box from a breach in the box side wall. The test was terminated at that time. Subsequent evaluation determined that an inadequate refractory package design was the root cause of the leak.

Test 38A-1 was conducted in August 2005. The purpose of this test was to evaluate the redesigned ICV™ box and refractory package. Improvements to the refractory package included eliminating the insulating panels on the box floor, replacing them with refractory blocks to improve support to the cast refractory panels, adding sumps in the bottom panels to collect any reduced metal during the melt, and improving the connection of the refractory panels. Test 38A-1 successfully processed all the planned sodium bicarbonate and S-109 simulant feed material. The revised refractory package performed very well, with no leakage of glass through the side panels and only minor leakage through the bottom panels into the refractory sand. Approximately 250 kg of reduced metal was collected, mostly from the sumps. Relatively high plenum temperatures were measured and some distortion of the ICV™ box lid was observed.

Test 38B was conducted in November 2005. The purpose of this test was to continue the evaluation of the ICV™ box and refractory package, and determine the effectiveness of various process changes to reduce the amount of metal deposits. These changes included the reduction in the starter path mass and slowing the initial power ramp up. This test used the six-tank composite simulant as the feed material. Problems with the non-prototypic test simulant feed and OGTS limited the amount of simulant fed to the box to ~60% of plan although the melt duration slightly exceeded the plan. As in test 38A-1, there was no glass leakage through the refractory side panels. There was less leakage into the bottom refractory sand than observed during test 38A-1. Less than 1 kg of metal was collected. The ICV™ plenum temperatures were lower and the improvements to the lid cooling design prevented lid distortion. The plenum briefly pressurized on at least three occasions, resulting in short-lived (~5 seconds) releases of ICV™ plenum gases.

Test 38C was conducted in May 2006. The purpose of this test was to verify the effectiveness of previous improvements in the ICV™ box design and vitrification operations by processing a full load of S-109 simulated waste. A significant cold cap was maintained over the melt pool for the majority of the test. Changes to the test simulant feed and OGTS were implemented to improve reliability and prevent a pressurization event. These were successful as the box plenum remained at a vacuum through the test. Post-melt examination revealed that the changes to refractory joint sealing further improved the glass retention, with minimal movement of glass into the refractory sand. There was evidence of significant Molten Ionic Salt (MIS) formation and movement through the cast refractory panels into the sand. This was an unanticipated consequence of the change to the high nitrate S-109 simulant and operation with a thick cold cap.

Subsequent to test 38C, efforts to determine the causes of and solution to the MIS issue have been continuously underway. These efforts include large numbers of small-scale and large-scale crucible tests to evaluate process changes, with validation to occur at both engineering-scale and full-scale (test 38D). The first engineering-scale test, 30J has been completed and successfully replicated formation of MIS and its migration into the refractory. Subsequent engineering-scale tests 30K and 31F would evaluate the effectiveness of the process changes to prevent migration of the MIS into the refractory prior to validation in full-scale test 38D.

The DBVS project has been characterized by the incorporation of lessons learned from previous tests into subsequent tests as well as the baseline design. This is inherent in the execution of a research, development and demonstration project. Some examples are discussed below:

- Evaluation of the refractory performance in test 38A resulted in a significant redesign of the ICV™ refractory package. This redesign improved the structural support of the package, the sealing of the refractory joints and the effectiveness of the refractory sand freeze plane.

- The need to provide better electrical isolation of components was identified and improvements continue to be implemented. These improvements reduce the likelihood of glass leaks by eliminating resistance heating and enhance data collection.

- The large masses of reduced metal observed in tests 38A and 38A-1 led to the need to limit the amount of carbon available and to moderate temperatures early in the melt. This led to changes in the starter path configuration in tests 38B and 38C as well as changes to the power ramp schedule.

- The ICV™ lid hot spots observed in test 38A-1 led to a change in the lid design to improve cooling. This revised design was demonstrated successfully in tests 38B and 38C.

The ICV™ testing program has provided and would continue to provide invaluable information regarding the feasibility of bulk vitrification as a supplemental technology. Significant progress has been made since the initial top-down melts conducted in 2003. The glass performance has always exceeded requirements. The ICV™ box and refractory package performance has been significantly improved as a result of lessons learned in the full-scale tests. Process changes to improve retention of contaminants in the glass have been and are continuing to be made. The ICV™ process has matured and uncertainties have been reduced. The DOE Office of River Protection (ORP) is confident that the DBVS team is converging on an acceptable level of assurance that there are no outstanding technical unknowns which would prevent successful demonstration of this technology.

The DBVS RD&D program would build on the full-scale tests performed to date and planned. Additionally, the completion of the series 22 and 33 laboratory testing activities at Pacific Northwest National Laboratories would validate that the proposed LAW waste feed that is planned for the Supplemental Treatment Process, would produce an acceptable waste product suitable for final disposition. Equipment design has been enhanced/modified based on results from laboratory, engineering and full-scale test results. Operating procedures and protocols would be similarly influenced. The DBVS RD&D tests would provide prototypic data using both simulants and actual S-109 tank waste to support a decision on supplemental treatment.

STEAM REFORMING RESPONSE: Steam Reforming information from the Idaho Demonstration Project (Hanford Site simulant testing, lessons learned and future project testing activities) to be provided by ORP by March 15, 2007.

Information Specific to Bulk Vitrification

Specific to the Bulk Vitrification (BV) technology, please provide the following additional information by January 30, 2007:

- ***Bullet 4*** *– U.S. Department of Energy (DOE) current plan, schedule and funding requirements for addressing each of the BV External Review Panel (ERP) findings/issues.*

(Discussions held on 1/11/07 with the State of Washington Department of Ecology (Ecology) resulted in the following clarifications to the request:)

1. *Provide Ecology with a copy of the December 28, 2006 draft Project Improvement Plan (PIP) that includes planned actions to address each of the External Review Panel technical issues, areas of concern, and suggested improvements.*
2. *The PIP provides the schedule (project phase) and incremental cost estimate (ROM cost range).*
3. *Discuss actions funded this Fiscal Year (FY) (e.g. melt structure confinement, preliminary analyses for consideration of the modification of Dangerous Waste Tracking System and Off-Gas Treatment System).*
4. *Discuss potential for funding other actions in FY 2008 with Tank Farm Contractor (TFC) cost efficiencies, with the remaining actions funded with congressional funding expected beginning in FY 2009.*

RESPONSE: Attachment 1 is a copy of the December 28, 2006 draft PIP that includes, in Appendix A, planned response actions to address each of the ERP technical issues, areas of concern, and suggested improvements (Attachment 1). In addition to the response actions, the Item Response Matrix also provides incremental cost impacts and schedule information. The expected incremental costs for each of the proposed response actions is provided as a low-to-high cost range and the schedule for each response action is provided for the phase of the Project that execution of the response action is planned.

Funding is available in the current FY (FY 2006 carryover funds and Tank Farm efficiencies) for several of the more significant response actions including the completion of the PIP to address the ERP Findings, and the Integrated Dryer/Large Scale Melt Test 38D. As discussed with Ecology during monthly status meetings, the Project is conducting 130-liter dryer testing, formulation studies to resolve the Molten Ionic Salt issue; and preliminary design for the melt structure enclosure, dried waste mechanical feed system, and a simplification of the off-gas treatment system. Later this FY, testing of the full-scale dryer would

be conducted followed by an integrated test of the dryer, mechanical feed system, Sintered Metal Filters (SMF), and an integrated full-scale melt.

No FY 2008 congressional funding is expected; however, as was the case this FY, the TFC would strive to gain cost efficiencies in FY 2008 work scope to provide funding for resolution of additional ERP identified items prior to the planned restart of Demonstration Bulk Vitrification System (DBVS) construction in FY 2009.

- ***Bullet 5*** *-- Vendor confirmation of performance assumptions in the Specification Sheet for major equipment such as the Dryer, Sintered Metal Filters, the Wet Scrubber System, and other off gas treatment equipment. Include current plans for full scale testing of unit operations at AMEC's Horn Rapids facility.*

(Discussions held on 1/11/07 with Ecology resulted in the following clarifications to the request:)

1. *Describe our procurement process that issues a specification to the selected vendor that the vendor is contractually required to meet.*
2. *Explain that, with few exceptions, our process for equipment procurement does not depend on "vendor confirmation" of equipment performance.*
3. *Testing of the equipment is performed during and/or at fabrication completion to verify the equipment performs as required. Remedies are provided in the contract to correct vendor deficiencies.*
4. *Describe which full-scale equipment would be tested this FY at Horn Rapids Test Site (HRTS) during dryer testing and the Integrated Dryer/38D Melt Test (IDMT).*
5. *Add a discussion specific to the SMF.*

RESPONSE: With few exceptions (e.g. mill certifications), the Project's engineered equipment procurement process does not request vendor confirmation that specifications can be met prior to completion of equipment fabrication. The standard procurement process issues performance specifications to qualified vendors that the vendors are contractually required to meet. Vendors are required to fabricate equipment in accordance with an approved Quality Assurance Plan. For safety-related engineered equipment, the plan must meet requirements of NQA-1 and the vendor must be on the Hanford Site Evaluated Suppliers List. Quality Assurance oversight is performed by CH2M HILL Hanford Group, Inc. (CH2M HILL) staff during fabrication. In-process and factory acceptance testing is conducted for engineered equipment to verify that performance specifications have been satisfied prior to the intended use. Vendors are contractually required to correct any deficiencies identified during equipment testing. The typical

contract also includes a warranty clause that specifies remedies for deficiencies discovered operation of the equipment.

In cases where risk analysis determines that it is important to assess equipment operation prior to installation at the DBVS facility, testing is performed by the Project. This FY at the HRTS, the Project is conducting full-scale testing of the dryer, SMF, and the In Container Vitrification™ (ICV™) melt process. Testing of the dryer and the IDMT was the subject of briefings to Ecology during monthly Supplemental Technology meetings earlier this FY.

One of the main objectives of the IDMT is to demonstrate off-gas SMF operation during a full-scale melt, as recommended by the ERP. One of two full-scale SMFs would be configured in the IDMT off-gas treatment system to produce prototypic particulate loading of the SMF. The IDMT off-gas treatment system is designed and would be operated to entrain melt gas particulate in the ICV™ exhaust line leading to the SMF so that particulate is captured by the SMF and does not settle in the exhaust line. An important feature of DBVS operations is that the melt gas particulates are captured, collected and recycled to the ICV™ for the purpose of increasing the overall glass retention of radionuclides.

The IDMT off-gas system has also been designed to allow for pre-filtering prior to the SMF, if needed. Pre-filtering would only be exercised in the event that the SMF cleaning efficiency degrades significantly, or if the SMF loads more quickly than it can be cleaned via normal back-pulsing. This pre-filtering is accomplished by "valving-in" an existing HRTS baghouse prior to the SMF. This baghouse SMF configuration would provide qualitative data on the efficiency of a roughing filter prior to the SMF and form the basis for investigating use of a roughing filter in the DBVS off-gas system, as recommended by the ERP.

- ***Bullet 6*** *-- Results from the October and November 2006 130L Dryer Test and an analysis of throughput and control reliability expected in full-scale operation. Specifically, we are concerned that the system as configured does not have adequate control reliability and cannot meet the throughput requirements needed. Please provide an analysis of the performance of the Dryer considering these elements. Also provide evaluations and recommendations from the vendor addressing advantages or disadvantages of a dry batch operation, as opposed to a wet batch operation.*

(Discussions held on 1/11/07 with Ecology resulted in the following clarifications to the request:)

1. *Copies of the 130-liter dryer test report to be provided by March 15, 2007.*

2. *The dryer test report would also include a discussion of the test result's implication to full-scale dryer operation.*
3. *Provided below is a discussion of the rationale for selection of the dry-batch dryer operation process that was previously approved by Ecology in their review of the DBVS Research Development & Demonstration (RD&D) Permit application, and the engineering design submittals required by the RD&D Permit.*

RESPONSE: The Additional 130L Dryer Testing Test Report, RPP-RPT-31688, (identified in item 1 above) would be issued in February 2007. It would document testing conducted at the fabricator facility, Littleford Day, Inc, (LDI) in October and November 2006 and January 2007. This report would be prepared by CH2M HILL after review by NUKEM, the subcontractor providing technical oversight and management of LDI. This dryer report would include a discussion of the test result's implications to full-scale dryer testing and operation, including heat transfer and scale-up calculations. Copies and a presentation of final results would be provided to Ecology after issuance of the report.

Previous presentations and test reports have noted that wet batch methodology provides the highest drying throughput, while dry batch methodology provides the least risk for solids agglomeration in the dryer. Testing of S-109 simulant with Horn Rapids Test Site soil and glass-formers by DMJM Technology identified a moisture range of 5-15 weight percent where the drying mass became extremely sticky, and this agglomeration caused the test dryer to stop. This moisture range in the entire dryer bed mass is avoided by providing incremental liquid feed additions to the dried solid mass – i.e., dry batch methodology. While this methodology limits dryer throughput compared to drying a completely wet mixture to end point, it negates the risk of dryer agglomeration. Recovery from agglomeration in the laboratory takes minimal effort but would take significant cost and time in the full-scale unit with radioactive material, and possibly involve design and construction of new systems. Because agglomeration risk is eliminated, and current schedule projections have identified that reduced throughput from dry batch methodology would not impact melt operation, this method was chosen for the preferred operation of the dryer. The test report mentioned above would provide an expanded discussion of operational methodology, specifically comparing wet and dry batch addition sequencing.

(Note – Responses to Bullets 7 & 8 have been combined)

- ***Bullet 7*** *– A conceptual model of how DOE envisions using the BV technology to supplement the Waste Treatment and Immobilization Plant (WTP) and list all assumptions. Include the location and number of lines in each BV facility, the expected throughput, specific tank wastes that could be treated in each facility, pre-treatment requirements if waste does not undergo processing in the WTP Pretreatment facility, and the recycling of effluents.*

- ***Bullet 8*** *– Provide a Rough Order of Magnitude life cycle cost comparison with a second Low Activity Waste (LAW) vitrification facility. Identify all assumptions for construction, operation and decommissioning of the production BV facility(s), as well as and waste disposal costs.*

(Discussions held on 1/11/07 with Ecology resulted in the following clarifications to the request:)

1. *Technology Comparison*

   - *LAW vitrification facility (equivalent to the WTP LAW facility) or an 8-line Bulk Vitrification Facility*
   - *A rough order of magnitude cost estimate would be developed for both facilities assumed to be located near the WTP and to have equivalent throughput and operating durations.*
   - *Second LAW vitrification costs would be based on WTP Estimate at Completion costs and would be similar (if not equal) to those costs presented in the Start LAW First Report (RPP-29981). BV costs would be based on a scale up of the east area 4-line BV facility*
   - *Costs would be rolled up to the following categories:*
     - *Project Management*
     - *Engineering Design*
     - *Procurement*
     - *Construction*
     - *Startup and Testing*
     - *Operations*
     - *Other Project Costs*
     - *Facility Decommissioning*
     - *Contingency*
   - *Cost would be presented in unesculated 2006 dollars and would not include contractor fee. This would provide an equivalent cost comparison of the two technologies. Other factors in the technology selection decision would be identified but not discussed in detail. This would reinforce the point that the technology selection is not purely a cost driven decision.*

2. *Schedule Optimization*

   - *A narrative discussion of how the WTP schedule impacts the ability to start supplemental LAW treatment and impacts the continued tank retrieval (e.g. available Double-Shell Tank space) would be provided.*

- *This narrative would then lead in to a discussion of the concept of supplemental pretreatment that would allow the supplemental treatment mission to start before the WTP.*
- *A general discussion on the benefits of putting a portion of the supplemental treatment capacity in the West Area would be provided.*
- *A life cycle cost estimate only for the supplemental pretreatment facility would be summarized to demonstrate the additional investment needed to provide the benefits of a separate and earlier partial supplemental treatment facility.*

RESPONSE: SEE ATTACHMENT 2 ***"Draft Supplemental Treatment Technology Cost Comparison Update"***

ATTACHMENTS

1. Project Improvement Plan (PIP)
2. Preliminary River Protection (RPP) Baseline Description
3. Preliminary Supplemental Treatment Cost Comparison

Demonstration Bulk Vitrification System Project Improvement Plan

Response to the Demonstration Bulk Vitrification System Expert Review Panel Final Report

Draft - December 28, 2006

CH2M HILL Hanford Group, Inc.
Richland, Washington 99352

Executive Summary

In May 2006, CH2M HILL Hanford Group, Inc. chartered an Expert Review Panel (ERP) to review the current design status of the Demonstration Bulk Vitrification System (DBVS). It was the consensus of the ERP that bulk vitrification is a technology that requires further development and evaluation to determine its potential for meeting the Hanford waste stabilization mission. No fatal flaws (issues that would jeopardize the overall DBVS mission that cannot be mitigated) were found, given the current state of the project. However, a number of technical issues were found that could significantly affect the project's ability to meet its overall mission, if not satisfactorily resolved. In addition, there were a number of areas of concern identified that need technical and management attention. The ERP also identified a number of suggested improvements for the DBVS project to consider.

This Project Improvement Plan (PIP) provides the methodology and planning basis for developing DBVS project activities that respond to the ERP identified technical issues, areas of concern, and suggested improvements. This PIP identifies DBVS project activities that respond to each of the ERP identified items, identifies the project phase for implementing the specific activities, and transfers the actions to DBVS project activities that are managed via the project schedule. Additionally, the PIP includes Department of Energy (DOE) EM-21 technical review recommendations and associated responses. A preliminary cost impact range for implementing the project activities is estimated. This PIP also provides the tools necessary to monitor progress of identified activities, document closure of open items, and provide a summary level roadmap between originally identified ERP items and the DBVS project phase in which response activities will be scheduled.

Item specific activities, objectives, and integration relationships are identified in an Item Response Matrix (IRM) found in Appendix A. Summary level relationships between ERP categorized items and DBVS project response timing are presented in Appendix B.

Key project response activities include:

- Verification that DBVS project plans and design will satisfy DOE information needs relating to the choice of supplemental technologies;
- Performance of additional laboratory, engineering and full scale testing to validate DBVS process controls and waste package acceptability. This includes testing of key process equipment such as the mixer dryer and the sintered metal filters.
- Performance of additional sensitivity analyses to more fully define the operating envelop, and to ensure that design and operating plans address these off-normal contingencies.
- Simplification of the existing design and control suites to improve operability and enhance safety.
- Modification of the design to enhance the DBVS confinement strategy in order to improve safety margins.

- Development of an enhanced testing strategy to improve the understanding of technetium transport in the DBVS waste package.
- Modification of DBVS equipment specifications to ensure proper implementation of national standards and appropriate specification of vendor testing requirements.

The preliminary cost impact range for these activities is $2.3M to $4.3M. There is no expected effect on the project baseline schedule.

Acronyms/Abbreviations

AC	Area of Concern
AMEC	AMEC Earth and Environment Inc.
CH2M HILL	CH2M HILL Hanford Group, Inc.
DBVS	Demonstration Bulk Vitrification System
DOE	U.S. Department of Energy
ERP	Expert Review Panel
HLW	High-Level Waste
ICV™	In Container Vitrification™
IDF	Integrated Disposal Facility
IRM	Item Response Matrix
IST	Item Summary Table
LAW	Low-Activity Waste
ORP	Office of River Protection
PIP	Project Improvement Plan
RA	Response Activity
SI	Suggested Improvement
TI	Technical Issue
WTP	Waste Treatment Plant

Table of Contents

Executive Summary ..... *ii*
Acronyms/Abbreviations ..... *iv*
Table of Contents ..... *v*
1. Introduction *1*
1.1. Background **1**
1.2. Purpose and Scope **2**
1.3. Plan Review and Concurrence **2**
2. Plan Methodology *2*
2.1. Item Identification **3**
2.2. Item Response Matrix **5**
2.3. Response Activities **5**
2.4. Project Phase **6**
2.5. Technical Prioritization **8**
2.6. Cost Impact Range **8**
2.7. Programmatic Summary **8**
2.8. Response Activity Progress **13**
3. Project Implementation *13*
Appendix A – Item Response Matrix *14*
A.1 Technical Issues **14**
A.2 Areas of Concern **32**
A.3 Suggested Improvements **46**
A.4 EM-21 Recommendations **52**

1. Introduction

This document provides the framework for the CH2M HILL response to the recently completed Expert Review Panel (ERP) and Department of Energy (DOE) EM 21 technical reviews of the Demonstration Bulk Vitrification System (DBVS).

1.1. Background

The Department of Energy's (DOE) Office of River Protection (ORP) is charged with the safe management, retrieval, treatment and disposal of over 53 million gallons of radioactive hazardous chemical wastes currently stored in 177 aging underground single-shell and double-shell tanks at the Hanford site near Richland, Washington. Currently, a large Waste Treatment Plant (WTP) is under construction to separate the retrieved tank waste into high-level waste (HLW) and low-activity waste (LAW) fractions and to vitrify those separated wastes for either onsite disposal as LAW, or for offsite disposal at the proposed Yucca Mountain national repository as HLW. Completion of waste retrieval, treatment and disposal, as well as tank farm closure, will eliminate much of the risk posed by the tank waste to the Hanford groundwater, the Columbia River, and the public.

DOE is considering approaches to supplement the WTP LAW treatment capability, either by expanding the existing WTP low-activity waste capability or by developing and deploying supplemental treatment technologies which might prove to be more cost effective. One of the candidates for supplemental treatment is an adaptation of In Container Vitrification ™ (ICV™) technology available from AMEC Earth and Environmental, Inc. (AMEC). DOE has contracted with CH2M HILL Hanford Group, Inc. (CH2M HILL) to design and construct a full scale demonstration system to test this technology with radioactive tank waste. This Demonstration Bulk Vitrification System (DBVS) project is currently finalizing design and development activities with plans to initiate construction within the next two years.

In order to assure itself and DOE that the DBVS design is compliant with supplemental treatment programmatic requirements and mission needs, CH2M HILL conducted an external review of the current state of the design and development of the DBVS system. A group of 16 independent experts and consultants, representing a broad spectrum of technology experts, academia, and nuclear waste processing industry experts, was identified and chartered as the Expert Review Panel (ERP). The objective of the ERP was to determine whether the DBVS system, as designed, could be expected to:

- Meet the requirements defined in the system specification
- Produce a waste product that meets Hanford's Integrated Disposal Facility (IDF) disposal requirements
- Receive operational approval by DOE authorities and other regulators.

In September 2006, the ERP concluded the review and issued their results and recommendations in, "A Comprehensive Technical Review of the Demonstration Bulk Vitrification System" (RPP-31314).

1.2. Purpose and Scope

The purpose of this Project Improvement Plan (PIP) is to describe the methodology for addressing each of the items identified by the DBVS ERP. Additionally, the PIP includes EM 21 technical review recommendations and associated responses. Each item identified has the potential to impact a number of DBVS project activities with a varying degree of magnitude. This plan provides a means of understanding the relationship each issue response has with ongoing DBVS project activities and with other ERP issues. Identification of these project relationships will allow development of issue response activities (RAs) that are appropriately prioritized, sequenced, and funded.

The scope of this plan is focused on the technical issues, areas of concern, and suggested improvements identified by the DBVS. The ERP identified no fatal flaws, 19 technical issues, 26 areas of concern, and 13 areas of suggested improvement. In January of 2006, a DOE EM-21 commissioned review team conducted a review of the DBVS project and documented 40 recommendations, many of which are similar to and overlap with ERP review comments. RAs with the EM-21 review are also incorporated into this plan.

1.3. Plan Review and Concurrence

This PIP will be developed, reviewed, and commented on by DBVS Project representatives, selected technical leads from the DBVS ERP, appropriate ORP representatives, and other technical and programmatic support. This plan will be approved by the CH2M HILL DBVS Project and released as a supporting RPP document.

Once issued, this plan will become a "living document" that will be reviewed and updated periodically to ensure it is reflective of ongoing item resolution and to provide a means for tracking status of each identified item.

2. Plan Methodology

This section of the plan describes the methods used to clarify the details of an identified item (issue, concern, or suggestion), identify project activities that respond to the item, qualitatively establish RA technical priority (high, medium, low), identify the project phase for specific resolution activities, present a project impact cost range, and provide a means of tracking item resolution status.

The focal point of this plan is the development of an Item Response Matrix (IRM) for each of the four categories of identified items (issues, concerns, suggestions, and EM-21 recommendations). The IRM ensures all subcomponents of ERP items are identified and

addressed by RAs with specific objectives that respond to the originally identified items. Sequencing of RAs will be accomplished through the IRM identification of the appropriate project phase for implementing each RA. These RAs can then be integrated into the DBVS project schedule. The IRM will also identify and establish DBVS technical priority, project impact cost range and may serve as a future means of tracking disposition and completion of each component of the ERP identified items. The development of an Item Summary Table (IST) provides a summary level overview that links the originally identified items to a specific ERP review subject area and identifies the DBVS project phases where RAs will be scheduled to resolve each item.

A summary of the methodology is provided in Figure 1.

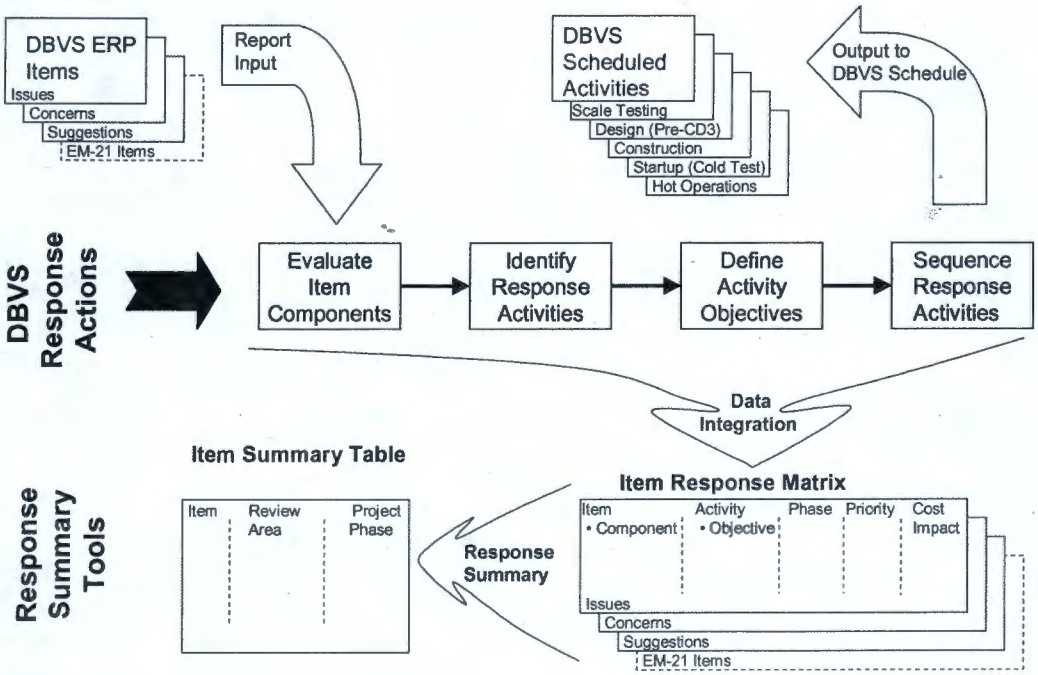


Figure 1, Plan Methodology

2.1. Item Identification

This project improvement plan responds specifically to the ERP and EM-21 DBVS technical reviews that occurred in 2006.

2.1.1 Expert Review Panel

The DBVS ERP reviews were focused on five main areas:

- Mission integration
- Overall process flowsheet
- Vitrification and product qualification
- Equipment design, including operations and maintenance
- Safety

Each focus area developed lines of inquiry and review plans based on answering five primary questions:

- Are there any flaws in the current design or operational plans that would prevent the DBVS system from meeting safety or technology demonstration objectives?
- Will the DBVS system meet minimum product quality and demonstration production rate requirements?
- Is the technical basis of the DBVS flow sheet sound?
- Is the DBVS Equipment and Facility design basis adequate to bound the construction and operating costs for the demonstration?
- What are the primary outstanding safety and technical risks/uncertainties for the DBVS?

During the review, the ERP identified multiple items related to individually assigned focus area. The ERP established four categories for grouping of identified items:

- Fatal flaws – the issue will cause failure of the DBVS, and cannot be resolved (no fatal flaws were identified)
- Technical issues – the identified issue will result in a failure of the DBVS to meet established DBVS system, mission, or safety performance requirements unless addressed prior to start of hot operations of the DBVS facility (19 technical issues were identified)
- Areas of concern – the identified concerns may result in a change to design, or may require additional testing to determine if the design is adequate (now or later) (26 areas of concern were identified)
- Suggested improvements – improvements that the project should consider to improve safety, cost, schedule, or efficiency during the test operations (13 suggested improvements were identified)

The ERP team met to discuss, consolidate, and concur on conclusions. The ERP conclusions were summarized and documented in DBVS ERP Final Report titled, "*A Comprehensive Technical Review of the Demonstration Bulk Vitrification System, Technical Assessment Conducted by an Independent and External Team of Experts*" (RPP-31314). The report discusses each of the five focus areas, emphasizing specific points within each area. The original detailed individual and sub-team reports are included in "*A Comprehensive Technical Review of the Demonstration Bulk Vitrification System, Detailed Technical Write-ups*" (RPP-31337). These individual team reports include more detailed analysis used to prepare the summary findings of the DBVS ERP Final Report.

2.1.2 EM-21 Review

A requested technical assistance review of the DBVS Project occurred in January of 2006. The DOE Office of River Protection submitted a request for technical assistance to DOE EM-21 for provision of Subject Matter Experts in the areas of glass science, melter technology, refractories, and Technetium (Tc) chemistry to specifically:

- Assess and provide recommended refinements to existing methods and/or new methods to reduce the amount of soluble Tc salts that form in the BV waste package and provide comments related to the overall Tc mass balance;
- Assess impact of metal inclusions on glass product quality and recommend potential process improvements that would mitigate their impact;
- Evaluate potential performance of the BV product with respect to reference borosilicate glasses and glass quality standards, and recommend potential process improvements that would enhance product durability and leach properties.

This EM-21 review resulted in recommendations documented in, "*Technical Assessment of Bulk Vitrification Process/Product for Tank Waste Treatment at the Department of Energy Hanford Site*" (RPP-30570). Similar to the ERP suggested improvements, most of the EM-21 recommendations can be aligned to one or more of the response actions identified in the IRM included in this PIP.

2.2. Item Response Matrix

Because of the multiple categories of items identified, many of which may have common RAs, a DBVS project tool provides a convenient method for consolidating and integrating RAs. The Item Response Matrix (IRM) summarizes identified items and specific details (components) of those items and presents project RAs and objectives that lead toward resolution of the identified item. Each item, component, and RA is assigned a unique alpha numeric indexing number to allow easy referencing and cross-linking of common RAs to multiple item components. To assist in DBVS project implementation of the RAs, an activity priority is assigned and the appropriate project phase with an estimated cost impact range is identified.

The IRM is divided into four sections to address each of the review item categories (Technical Issues, Areas of Concern, Suggested Improvements, and EM-21 Recommendations). Cross referencing between the sections integrates the response actions associated with common subject areas. The IRM can be found in Appendix A.

2.3. Response Activities

Most identified items contain multiple components that address a unique attribute of the item. The DBVS project team has identified specific RAs that directly address or lead to activities that will address each identified item. Activity objectives are established to ensure the intent of the originally identified item is appropriately understood and addressed. The RAs and objectives are included in the IRM (Appendix A).

The ERP Final Report (RPP-31314) and ERP Technical Write-ups (RPP-31337) are the primary source of input for determining original item intent. Review of this plan by selected ERP members will serve as a secondary method for ensuring the intent of the originally identified items is appropriately represented.

2.4. Project Phase

The identified items and RAs represent a spectrum of inter-related tasks that will occur through completion of DBVS hot operations. The intent of this plan is to identify the RAs and use the DBVS project schedule to manage implementation of the activities. In order to facilitate the integration of the RAs into the DBVS project schedule, the appropriate project phase where each of the activities is anticipated to occur is identified. Activities are aligned with one of the following project phases:

- Design – DBVS activities associated with modifying the final design and leading to DOE Critical Decision 3 (CD-3) authorizing construction.
- Scale Testing – DBVS testing and development activities occurring at laboratory scale, engineering scale, or full scale (off-site) to support design decisions or validation. Because of the wide range of activities associated with this phase, testing activities will be further categorized into the laboratory scale, engineering scale, and full scale testing programs.
- Construction – DBVS activities involving procurement, construction, and design refinement that occur after receiving CD-3 approval.
- Start Up – DBVS activities associated with start up and cold testing of the installed system. This includes system acceptance testing and operational readiness activities.
- Hot Operations – DBVS activities associated with the operations of the system during its demonstration and development mission to process up to 50 boxes of immobilized LAW.

RA phases are included in the IRM (Appendix A). Figure 2 demonstrates how the RA phases integrate into the overall DBVS project schedule. The category-specific RAs (i.e., technical issues, concerns, etc.) occurring within a defined project phase are identified as a common activity bar integrated within the project schedule. The activity bars are indexed to the identified items addressed within each project phase. When a RA to a higher category item (i.e. technical issue) also addresses a lower category item (i.e. suggested improvement) the lower category response activity is indexed to the schedule bar for the higher category. As development of RA details evolve, more detailed sequencing and scheduling will be integrated into the DBVS project schedule using the RA information and objectives identified in the IRM.

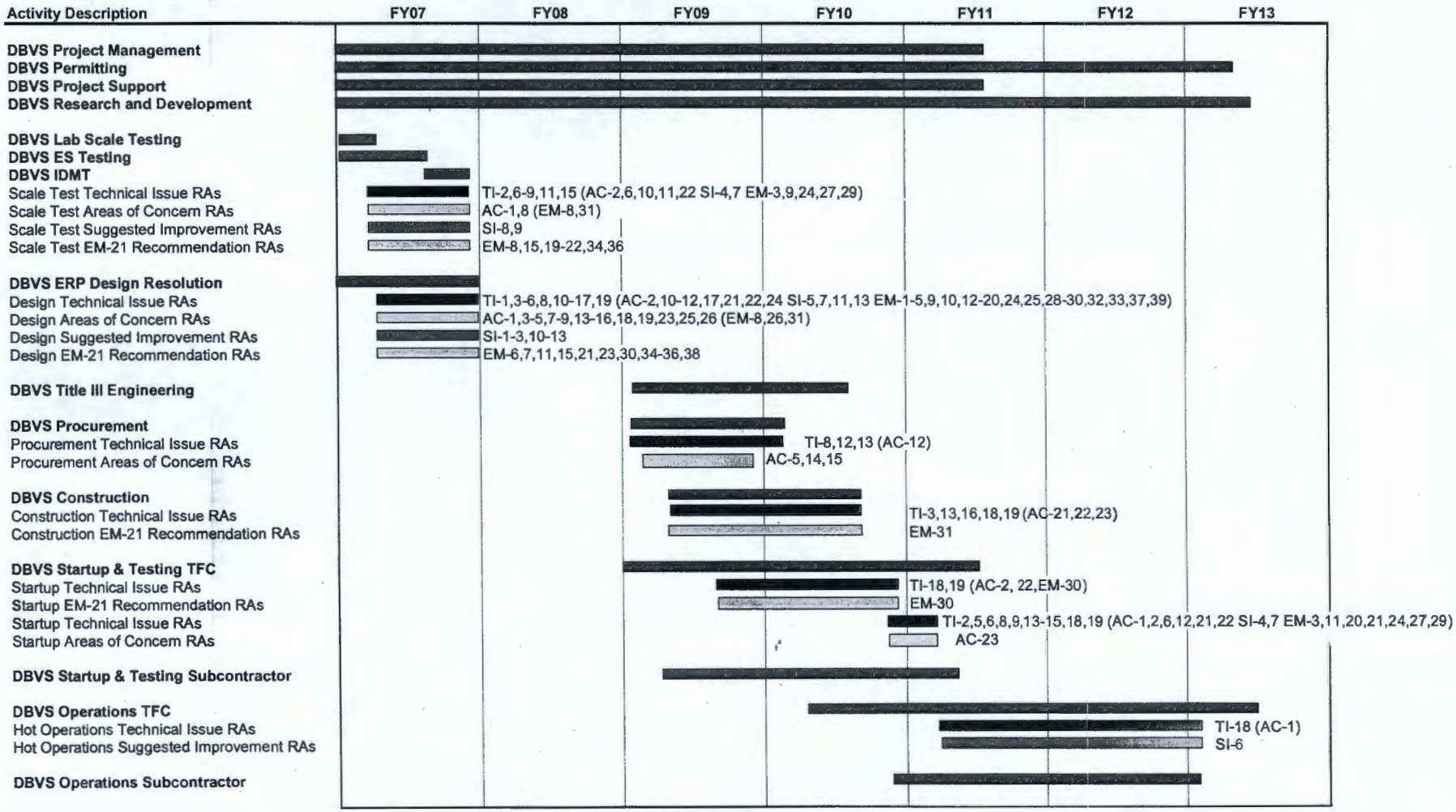


Figure 2, Response Activity Phase Integration with DBVS Project Schedule

2.5. Technical Prioritization

In order to maintain focus on the highest priority technical issues that resulted from the ERP/EM-21 reviews, a qualitative activity prioritization ranking has been included in the IRM. The qualitative ranking process will categorize an issue as high, medium or low risk and will be applied to all identified issues. A high risk categorization assigned to an item signifies that the issue has a significant impact to the project which would require technical resolution prior to advancing the project to the next phase (e.g. resolution of laboratory/bench scale testing issues prior to initiation of large scale development testing). Conversely, a low risk categorization assignment would allow for project continuation while these low risk, non time critical mitigating actions are resolved.

In general the ERP identified Technical Issues are ranked as high priority because of their potential to "*...result in a failure of the DBVS to meet established DBVS system, mission, or safety performance requirements...*" with the most of the other items assigned a lower priority. It should be noted that many lower priority issues will likely be resolved by completing items driven by the higher priority activities.

2.6. Cost Impact Range

In order to plan for the implementation of the RAs identified in this PIP, an estimated cost range associated with each RA is needed. Because many of the RAs are still conceptual in nature and some rely on future decisions and require actions that will only be determined after completing other RAs, costs will be presented as a preliminary estimated range. The low end of the range represents work scope having least impact (e.g. a value engineering study confirms the as designed system is the most appropriate alternative). The high end of the range represents work scope having the most reasonably conceivable impact (e.g. a value engineering study recommends a significant configuration change to system necessitating additional lab scale, engineering scale, and full scale testing). Cost estimates are based in many cases on the expert opinion of selected DBVS project personnel and are considered preliminary ranges. Cost ranges for RAs are included in the IRM (Appendix A).

2.7. Programmatic Summary

Summarizing the components and RAs associated with the fifty-eight identified ERP and forty EM-21 items provides a program level summary of the project response. The following Item Summary Tables (IST) present a summary of item components and RAs "rolled-up" to their originally identified ERP/EM-21 items. The IST identifies each item according to the original review subject area (ERP/EM-21 Final Reports) and correlates it to the DBVS project phases that RAs are expected to be implemented in. Because this presentation format represents a "rolled-up" summary, some items may have implementation activities that span multiple project phases.

DBVS ERP Item Summary Table– Technical Issues											
		ERP Review Area					RA Project Phase				
		[illegible]	[illegible]	Solution	Equipment Design	Safety	[illegible]	Construction	Start-up (Cold Testing)	Hot Operations
1	Mission Objectives	●						●			
2	Integrated System Testing	●					● ● ●			●	
3	Off-normal Recovery		●					●	●		
4	System Complexity		●					●			
5	Data Acquisition		●					●		●	
6	Soil Transport				●		●	●		●	
7	Soil Bridging				●		● ●				
8	Feed System Uncertainty				●		● ●	●	●	●	
9	Dried Material Control				●		● ●			●	
10	Vitrification Process Control			●				●			
11	Technetium Mass Balance			●				●			
12	Off-Gas Design Criteria				●			●	●		
13	Equipment Testing Needs				●			●	●	●	
14	Off-Gas System Control				●			●		●	
15	Metal Filter Performance				●		●	●		●	
16	Melt Box Containment					●		●	●		
17	Safety Performance					●		●			
18	Operating Contractor					●			●	●	●
19	Abnormal Condition Safety					●		●	●	●	

DBVS ERP Item Summary Table – Areas of Concern

AC #	Topic Summary	ERP Review Area: Mission Integration	Process Flowsheet	Vitrification	Equipment Design	Safety	RA Project Phase: Scale Testing: Lab	Scale Testing: Eng	Scale Testing: Full	Design (Pre CD-3)	Construction	Start Up (Cold Testing)	Hot Operations
1	Tc and Cs DFs		●					●	●	●		●	●
2	Process Chemistry Knowl.		●				●	●	●	●		●	
3	Hydrocyclone Performance				●					●			
4	Feed Tank Solids Build Up				●					●			
5	Feed Tank Epoxy Coating				●					●	●		
6	Batch Drying Time				●			●	●			●	
7	Dryer - Hot Weather Impact				●					●			
8	Vitrification Control Process			●					●	●			
9	Feed Qualification			●						●			
10	Prototypic Testing			●				●	●	●			
11	Off-Gas Code Compliance				●				●	●			
12	Scrubber Performance Test				●					●	●	●	
13	HEPA Filter Design Criteria				●					●			
14	Carbon Cell Residence Time				●					●	●		
15	Charcoal Fire Potential				●					●	●		
16	Off-Gas Filter Failure				●					●			
17	Design Optimization				●					●			
18	Scrubber Capacity				●					●			
19	Secondary Waste Assump.				●					●			
20	Future Use Potential				●			--		--	--	--	--
21	Maintenance Strategy				●					●	●	●	
22	Readiness Requirements				●				●	●	●	●	
23	Rad Material Accumulation					●				●	●	●	
24	Operational Complexity					●				●			
25	Hazard Category Rationale					●				●			
26	Chemical Safety Analysis					●				●			

DBVS ERP Item Summary Table – Suggested Improvements											
		ERP Review Area					RA Project Phase				
SI #	Topic Summary	Mission Integration	Process Flowsheet	Vitrification	Equipment Design	Safety	Lab Scale Testing Eng Full	Design (Pre CD-3)	Construction	Start Up (Cold Testing)	Hot Operations
1	Organics Characterization		●					●			
2	Separate Delivery Systems				●			●			
3	Common Sample Systems				●			●			
4	Continuous Dryer Mode				●		● ●			●	
5	Dryer above Mixer				●			●			
6	Decontaminated Soil Disposal Path				●						●
7	Compositional Variability				●		● ●	●		●	
8	Engineered Refractory Sys			●			●				
9	ICV™ Lid Redesign			●			●				
10	Safety Objectives					●		●			
11	Top-tier Document Update					●		●			
12	Align Safety Documents with STD-3009					●		●			
13	ALARA Presentation					●		●			

EM-21 Recommendations Item Summary Table

EM #	Topic Summary	EM-21 Review Area: Technetium	Metal Inclusion	Product Performance	Other	RA Project Phase: Scale Testing: Lab	Eng	Full	Design (Pre CD-3)	Construction	Start Up (Cold Testing)	Hot Operations
1	Tc Surrogate	●							●			
2	Verify Surrogate Performance	●							●			
3	Scale Test Correlations	●					●	●	●		●	
4	Tc in HEPA Filters	●							●			
5	TC Distribution in Glass	●							●			
6	Tc Volatilization	●							●			
7	Quantify Rate of Tc Loss	●							●			
8	Constant Cold Cap Thickness	●						●	●			
9	Feed Distribution Uniformity	●						●	●			
10	Tc Refractory Penetration	●							●			
11	Limit Tc Loss	●							●		●	
12	Metal Inclusion Mechanisms		●						●			
13	Starter Path Contribution		●						●			
14	Electrode Contribution		●						●			
15	Low-Iron Glass Composition		●			●			●			
16	Metal Inclusion Testing		●						●			
17	Tc Recycle Impact on Inclusions		●						●			
18	Tc Enriched Metal Inclusions		●						●			
19	Leach Testing with Inclusions		●			●		●	●			
20	Test Date for Entire Glass Volume			●				●	●		●	
21	Leach Test Waste Package Mtls.			●		●		●	●		●	
22	Eng. – Full Scale Test Disparity			●			●					
23	Heat Treatment Appropriateness			●					●			
24	Recycled Solids Composition			●				●	●		●	
25	Leachable Tc in Waste Package			●					●			
26	Cs Distribution in Waste Package			●					●			
27	Non-Radioactive Testing Scope			●		●	●	●			●	
28	Evaluate Design Functions				●				●			
29	Alternate SMF Material				●			●	●		●	
30	Integrated Flowsheet Model				●				●			
31	MACT performance review				●				●	●		
32	Cs – Tc Interactions				●				●			
33	Leachable Fraction Ratio Basis				●				●			
34	Zirconia Segregation				●			●	●			
35	Zirconia Addition in Mixer				●				●			
36	Fine Zircon Substitution				●			●	●			
37	Gravity Feed into Melter				●				●			
38	Ground Fault Detection System				●				●			
39	Curbing around Melter				●				●			
40	Ramped Trench for Melter				●	--			--	--	--	--

2.8. Response Activity Progress

As RA implementation begins, it will be necessary to provide a status for each activity, as well as have the ability to adjust the RA scope and objectives based on more recent and emerging information. The IRM and IST are designed to allow for future statusing at the individual RAs level or the "rolled-up" originally identified item level. The addition of a status column to the IRM and IST will provide this functionality and can be tailored to reflect the intended audience needs and expectations.

3. Project Implementation

The initial review and approval of this PIP represents the DBVS project commitment and methodology to address each of the items (and components) identified by the ERP and EM-21 independent reviews. Following DOE and ERP team leads review and agreement on comment disposition, concurrence with the approach presented in the final PIP will be assumed.

Approval of this PIP addresses the ERP findings and observations that support approval of the DBVS project to continue in accordance with the established baseline, and additionally represents completion of CH2M HILL Performance Based Incentive (PBI) 4.2.b.[1] In addition to fulfilling the intent of PBI-4.2.b, implementation of this PIP allows integration of other DBVS external review issues (e.g. EM-21 technical review) and provides the tools for the DBVS project to effectively track and manage the implementation of the RAs.

[1] DOE Contract No. DE-AC27-99RL-14047, Modification No. M120, Section J, Appendix D, PBI-4

Appendix A – Item Response Matrix

A.1 Technical Issues

					Priority	Impact Range ($K)
TI-1 The DBVS, as currently planned, will not completely meet all objectives assigned it in the Justification of Mission Need.	**TI-1.1:** For collection of data for system design, the project should identify the data it needs and then ensure that such data is generated. **TI-1.2:** DOE should provide the project with specific guidance on the complete set of data needed to make decisions relating to Supplemental Treatment, and the down-selection of technology. The project then should convert DOE's data needs into test objectives identified in the ITEMP, and would do well to consider formally including them in a Data Quality Objective (DQO).	**RA-1:** DOE review the Justification for Mission Need (JMN) and clearly define its expectations with respect to each of the stated objectives in the JMN.	TI-1.1 TI-1.2	Design	High	--
		RA-2: Conduct a facilitated session (including DOE participation) to define the data needed from each DBVS process system over the "50 container" campaign to determine the technical feasibility of the DBVS and to compare DBVS with alternate low-level waste treatment technologies as provided in M-62-08. (i.e., program decision data which defines exactly what information is needed to support a decision to proceed/not proceed with BV as a supplemental technology.) • Program decision • Waste package performance • O&M data • Waste feed envelope data	TI-1.1 TI-1.2 AC-2 SI-1 SI-7 EM-19 EM-24 EM-25 EM-28 EM-33	Design	High	Low $20K High $30K
		RA-3: Translate the results of facilitated session into specific test objectives and update the DBVS Integrated Test and Evaluation Management Plan (ITEMP).	TI-1.2	Design	High	Low $2K (1 week) High $20K (2 months)
		RA-4: Revise the DBVS DQO using the objectives from the updated ITEMP.	TI-1.2	Design	High	Low $4K High $40K

[a] Project Phase Definition

- Design – DBVS activities associated with modifying the final design and leading to DOE Critical Decision 3 (CD-3) authorizing construction.
- Scale Testing – DBVS testing and development activities occurring at laboratory scale (L/S), engineering scale (E/S), or full scale (F/S) (off-site) to support design decisions or validation. Because of the wide range of activities associated with this phase, testing activities will be further categorized into the laboratory scale, engineering scale, and full scale testing programs.
- Construction – DBVS activities involving procurement, construction, and design refinement that occur after receiving CD-3 approval.
- Start Up – DBVS activities associated with start up and cold testing of the installed system. This includes system acceptance testing and operational readiness activities.
- Hot Operations – DBVS activities associated with the operations of the system during its demonstration and development mission to process up to 50 boxes of immobilized LAW.

Risk Reduction Matrix Section 1: DBVS - ERR Technical Issues						
					Impact	Impact Range ($K)
TI-2 Insufficient integrated system testing prior to radioactive DBVS operations is planned.	**TI-2.1:** Perform additional testing at both the engineering- and full-scale beyond that currently envisioned for the DBVS prior to radioactive operations is necessary. **TI-2.2:** Perform integrated testing of the ICV process in combination with the feed dryer and OGTS to demonstrate adequate processing of the dried material. **TI-2.3:** Address the effect of the dried feed system on bulk vitrification production rate, process stability, salt behavior, pressure stability, and off-gas treatment performance prior to integrated DBVS operations. **TI-2.4:** Expand DBVS operations to complete development of integrated system controls, balancing of the off-gas system, and training operators. **TI-2.5:** Detail the non-radioactive testing necessary to determine how to operate the DBVS, and the testing to establish that the project is ready to proceed to radioactive operations.	**RA-5:** <u>Large Scale Crucible Testing</u> • Determine viability of formulation changes to mitigate effects of MIS migration on vitrified product.	TI-2.1 TI-2.3 TI-11 EM-3 EM-21 EM-27	L/S Test	High	Low $0 (per baseline) High $100K (2 add'l tests)
		RA-6: <u>22L Dryer Testing</u> • Produce feed for large scale crucible melt testing. • Demonstrate acceptable dryer operation with MIS formulation (e.g., carbon source and ground soil).	TI-2.1 TI-2.2 TI-11 EM-27	L/S Test	High	$0 (per baseline)
		RA-7: <u>Engineering Scale Melt Testing</u> • ES-30J: Purpose is to duplicate MIS formation at engineering scale using S-109 simulant to provide a baseline for measuring effectiveness of future MIS mitigation activities. • ES-31F: Purpose is to demonstrate MIS mitigation using methods developed at crucible scale.	TI-2.1 TI-2.3 TI-11 AC-10 AC-21 SI-7 EM-3 EM-25 EM-27	E/S Test	High	Low $0 (per baseline) High $350K (1 add'l test)
		RA-8: <u>130L Dryer Testing</u> • Confirm dry batch operating mode with low iron formulation. • Demonstrate dryer temperature control methods for product moisture control, including continuous feed. • Demonstrate "semi-batch" operation (feed & bleed). • Demonstrate acceptable dryer operation with MIS formulation (carbon source in and ground soil). • Produce feed for engineering scale melt tests.	TI-2.1 TI-2.2 TI-2.3 TI-2.4 TI-2.5 TI-8 TI-11 AC-10 AC-21 SI-7 EM-27	E/S Test	High	Low $0 (per baseline) High $20K (1 add'l test)

Item Response Matrix Section 1: DBVS ERP Technical Issues						
						Impact Range ($K)
		RA-9: Full Scale Dryer Testing • Using prototypic melt feed, demonstrate: o Moisture process control o SMF operation o Support systems operation o Continuous and discrete liquid feed to the dryer • Verify process flow sheet design and dried product assumptions. • Verify safety analysis assumptions, behavior and fate of non-radioactive constituents of potential concern. • Examine feasibility of indirect dryer product moisture monitoring (instrumentation). • Determine effects on dryer and dried product of extended (non-heated) dryer plow rotation. • Demonstrate viability of semi-continuous dried product discharge. • Measure composition of OGTS SMF recycled solids	TI-2.1 TI-2.2 TI-2.3 TI-2.4 TI-2.5 TI-8 TI-11 AC-10 AC-21 SI-4 SI-7 EM-24 EM-27	F/S Test	High	Low $0K (per baseline - complete in 3 weeks) High $280K (add'l 3 weeks plus $50K materials)
		RA-10: Full Scale ICV Melt Testing • Demonstrate repeatable glass performance from previous full scale melts using dried product from actual full scale dryer. • Demonstrate MIS mitigation in vitrified product. • Demonstrate stable operation of ICV off-gas SMF including Cs decontamination factor. • Demonstrate process controls for the stable integration of dryer and melt systems, including semi-continuous dryer dried product discharge to manage ICV cold-cap layer. • Verify safety analysis assumptions, behavior and fate of non-radioactive constituents of potential concern (e.g., Re, Cs, and I). • Demonstrate the ability to maintain minimum required inlet flow to the ICV while maintaining adequate ICV box vacuum during the melt.	TI-2.1 TI-2.2 TI-2.3 TI-2.4 TI-2.5 TI-11 AC-1 AC-10 AC-21 AC-23 SI-7 EM-9 EM-25 EM-27	F/S Test	High	Low $0 (per baseline) High $100K (revise safety analysis or design if unable to maintain proper flow)

Item Response Matrix Section 1 - DBVS & KP Technical Issues						
				Project	Priority	Impact Range ($K)
		RA-11: Perform five non-radioactive melts as part of the "50 container" campaign at the installed DBVS prior to radioactive operations. • Establish specific performance and decision criteria for each element of the process prior to integrated cold system testing. • Demonstrate integrated equipment operations. • Demonstrate package acceptability. • Demonstrate integrated OGTS operation. • Train operators and de-bug procedures.	TI-2.1 TI-2.2 TI-2.3 TI-2.4 TI-2.5 TI-11 AC-22 EM-27	S/U	High	$0 (absorb in 50 box campaign)
TI-3 There is no present plan for recovery from off-normal conditions.	**TI-3.1:** Prepare a computer model of the DBVS that can predict the consequences of off-normal conditions.	**RA-12:** Using prepared dynamic model of OGTS, test additional off-normal conditions such as valve failures, filter pluggage, volume surges, and transients that occur during a trip to bypass ventilation.	TI-3.1 TI-19 AC-17	Design	High	Low $0 (per baseline)
	TI-3.2: Prepare an action plan with corrective process actions for the off-normal conditions.	**RA-13:** Using prepared DBVS process material balance perform additional sensitivity analyses to off-normal conditions (integrate with TI-19).	TI-3.1 TI-19 AC-17	Design	High	Low $15K (1 month contract support) High $45K (3 months contract support)
	TI-3.3: Prepare a manual that covers all of the necessary safety-related reporting and administrative steps. **TI-3.4:** Delineate the steps required to record the nature of the occurrence, its consequences and the corrective actions taken.	**RA-14:** Conduct facilitated session to evaluate potential for off-normal conditions in order to: • Identify and rank potential off-normal conditions. • Develop unit recovery actions. • Evaluate design versus recovery actions. • Identify recommended design changes to enhance ability to recover. • Develop action plan that reflects developed recovery actions.	TI-3.2 TI-16 EM-39	Design	High	$15K

Item Response Matrix Section 1. DBVS ERP Technical Issues						
				Proc.	Activity	Impact Range ($K)
		RA-15: Modify design to incorporate identified changes and/or incorporate into procedures.	TI-3.2	Design	High	Low $10K (minor change) High $100K (major design change - e.g., relocation)
		RA-16: Develop Abnormal Operating Procedures, which define reporting requirements (e.g., nature of the occurrence and consequences) and recovery actions.	TI-3.3 TI-3.4	Const.	High	$0K (per baseline)
TI-4 The entire DBVS (flow sheet, system design and operations) is too complex.	**TI-4.1:** Isolate parts of the system to the extent feasible, such that the extensive interconnections and interdependencies are reduced. This will enhance system operability and maintainability. **TI-4.2:** Perform a control optimization exercise to examine the origin of each Technical Safety Requirement (TSR) level control, identify the associated analysis/evaluation conservatisms, determine the sensitivity to the conservatisms, and evaluate the necessity of each of the conservatisms. **TI-4.3:** Examine any design attributes that are driving the need for a control and assess whether there are reasonable alternatives that would result in simpler or fewer controls. **TI-4.4:** Evaluate the frequency and magnitude of surveillances,	**RA-17:** Conduct VE session to identify opportunities to simplify DBVS design: • Focus on OGTS & DWTS • Develop alternatives to existing design • Rank alternatives • Recommend design simplification changes (e.g., mechanical DWTS feed system) for further evaluation	TI-4.1 TI-8 TI-14 TI-15 AC-2 AC-17 AC-18 AC-24 SI-5 EM-37 EM-40	Design	High	$0 (complete)
		RA-18: Perform preliminary engineering on recommendations to: • Evaluate feasibility • Confirm cost/schedule effects • Confirm recommendations meet the goal of simplifying the design • Select alternative	TI-4.1	Design	High	$630K* (A-E proposal)
		RA-19: Modify DBVS final design to incorporate recommendations.	TI-4.1	Design	High	$1.4M* (A-E proposal) * assume design/ procure/construct cost bounded within existing baseline

				Project Phase	Priority	Impact Range ($K)
	readings, recordings, and adjustments in the safety administrative control programs for viability and human factors issues. **TI-4.5:** Update the project Human Factors analysis, consistent with the latest control suite. **TI-4.6:** Develop and employ a comprehensive sampling plan for the entire DBVS that will meet the project mission goals. **TI-4.7:** Develop a simplified version of the flow sheet for technical communication purposes. It should show schematically on one sheet all the process steps and major equipment pieces (i.e., volumes, masses, concentrations, flow rates, temperatures, and important radionuclides). It should not show valves or other equipment items unless they are essential to understanding operation of the system.	**RA-20:** Conduct TSR control options facilitated session: • Evaluate proposed controls • Identify conservatism/sensitivity to conservatism • Evaluate sensitivity of controls to conservatism • Identify controls which can be relaxed, combined with other controls or otherwise simplified • Recommend changes to controls	TI-4.2 TI-4.3 TI-4.4	Design	High	$15K
		RA-21: Incorporate into Safety documentation (PDSA, PrHOA, SEL, etc.).	TI-4.2 TI-4.3 TI-4.4	Design	High	$0 (covered by existing staff)
		RA-22: Update project human factors analysis consistent with latest control suite.	TI-4.5	Design	High	$30K (2 months contract support)
		RA-23: Revise Sampling and Analysis Plan (see TI-5).	TI-4.6	Design	High	Included in RA-25
		RA-24: Generate simplified flow sheet from existing detailed flow sheet.	TI-4.7	Design	High	Included in RA-13
TI-5 The sampling and data acquisition system (plan and hardware) is not designed	**TI-5.1:** <u>Radioactive Waste in the DBVS Receipt Tanks</u> • Recirculate waste at a higher flow rate. • Install sampling systems far from any pipe bend.	**RA-25:** Revise integrated DBVS Sampling & Analysis Plan (SAP) based on the updated ITEMP and DQO from TI-1. The SAP covers sampling and analysis in all areas (e.g., OGTS, process, secondary liquid waste) and covers the complete "50 container" campaign. The SAP specifies: • What samples to take • Where the samples are taken • How to take the samples (technique & sample size)	TI-5.1 TI-5.2 TI-5.3 TI-5.4 TI-4 AC-2 AC-9 EM-19	Design	High	$60K (4 months contract support; assume Ecology involvement)

Item Requirements Matrix Section 1 to DBVS ERP Technical Issues						
					Priority	Impact Range ($K)
to gather important process and design information.	**TI-5.2:** ICV™s - Core Drilling System Obtain truly representative samples of the finished vitrified product. **TI-5.3:** Off-Gas Sample the off-gas at the stack during operations using continuous monitoring equipment and record sample data. (The ERP notes that the current design does not include any samplers that could support: 1) identification of the chemical reactions occurring, 2) tracking of the entrainment/accumulations of radionuclides, and 3) determination of all the needs for a production facility (per DQO Section 4.1.3.3). **TI-5.4:** Secondary Liquid Waste Samples are manually taken from the four liquid waste tanks by dipping a 1-liter sample bottle through a sample port located atop each tank. That is acceptable for a test facility but the ERP believes that a better system should be used for a future production facility. **TI-5.5:** Instrumentation When a comprehensive sampling plan is available, an evaluation should be made of the current instrumentation design to	• What analysis to perform • Who collects and analyzes the samples • When are samples taken (frequency)	EM-20			
		RA-26: Perform a GAP analysis of the design of the existing DBVS sampling and data acquisition systems versus the revised DQO & SAP. Identify any needed developmental testing of sampling systems.	TI-5.1 TI-5.2 TI-5.3 TI-5.4 TI-5.5	Design	High	$0 (covered by existing staff)
		RA-27: Modify the baseline design to incorporate the results of the GAP analysis (e.g., instrumentation and sample ports).	TI-5.1 TI-5.2 TI-5.3 TI-5.4 TI-5.5	Design	High	Low $50K (dried waste sampler) High $250K (add'l stack monitoring & sample ports)
		RA-28: Validate sampling and data acquisition systems performance during cold testing.	TI-5.1 TI-5.2 TI-5.3 TI-5.4 TI-5.5	S/U	High	$0 (per baseline)

Item Resolution Matrix Section 1 DBVS-ERP Technical Issues						Impact Range ($K)
	determine if this instrumentation is sufficient to support RD&D type test campaigns. In addition, a complete instrumentation and control performance evaluation is needed to ensure that the control of the DBVS system can be maintained.					
TI-6 The soil will not transport as currently designed.	**TI-6.1:** Hopper flow tests (either full scale or appropriately scaled) should be conducted with soils of varying moisture content, particle shape factors determined, and assure that the vendor's performance curves are validated to establish confidence in equipment specifications. Bounding limits specified for moisture content and maximum sieved particle size of the soil delivered to DBVS are necessary to assure reliable operation of the feed system.	**RA-29:** Perform soil and glass former transport properties testing for the anticipated range of soil/former particle size, particle shape, and moisture properties.	TI-6.1 TI-7	L/S Test	High	$25K (allowance)
		RA-30: Perform an engineering (re)evaluation to select soil and glass former handling system(s) that • Incorporates a soil drying subsystem to ensure control of initial soil moisture content. • Simplifies design of the conveyance equipment. • Minimizes the potential for particulate re-entrainment and bridging in filled and partially filled cyclones. • Facilitates demonstration of overall system operation.	TI-6.1	Design	High	Low $0 (covered by existing staff) High $20K (2 months contract support)
		RA-31: Determine the need for scaled equipment testing based on the results of the engineering evaluation and properties testing and perform as required. • Material holdup • Hopper bridging • Conveyance rate	TI-6.1	E/S Test	High	Low $0 High $25K (allowance)
		RA-32: Modify the baseline design to incorporate the results of the engineering evaluation and testing.	TI-6.1	Design	High	$100K (soil dryer & consolidate solid feed systems into single system)

				Project Phase	Priority	Impact Range ($K)
		RA-33: Validate the handling systems performance during cold testing.	TI-6.1	S/U	High	$0 (per baseline)
TI-7 The soil will bridge in the hopper and not feed the dryer.	**TI-7.1:** The ERP recommends that a few simple "bridging " and minimum conveying velocity tests be conducted as a function of moisture content, as well as a scaled filled cyclone re-entrainment observation.	Addressed in the scope of Project Activities for TI-6.	TI-7.1	L/S Test E/S Test	High	Included in TI-6 activities
TI-8 Because of the uncertainty in the particle size, moisture content, etc. of the as-dried material, it is difficult to evaluate the solids feed system design.	**TI-8.1:** The ERP recommends that the DBVS Project consider specialized systems with controlled and regulated gas injection or bypass pipeline technology for materials that do not have a natural tendency for dense phase conveying. A proper purge control system may need to be designed and tested to avoid pipeline blockages.	**RA-34:** Conduct VE session to identify alternatives to DWTS (see TI-4).	TI-8.1	Design	High	Included in TI-4 activities
		RA-35: Conduct testing of dried waste properties from 130L and full scale dryers (see TI-2) in order to: • Determine dried waste flow properties at varying moisture levels (full scale). • Determine particle size distribution (130L & full scale). • Determine particle density, particle shape, agglomeration, and other physical properties important to transfer (full scale).	TI-8.1 AC-10 AC-21	E/S Test F/S Test	High	$25K (allowance)
		RA-36: Re-evaluate DWTS design based on updated dried waste properties data.	TI-8.1	Design	High	$0 (covered by existing staff)
		RA-37: Modify design to reduce potential for plugging and to simplify recovery.	TI-8.1	Design	High	Included in DWTS redesign (RA-18/19)
		RA-38: FAT will be run to demonstrate successful dried waste transport and recovery actions.	TI-8.1	Const.	High	$0 (per baseline)
		RA-39: Test DWTS performance during non-radioactive operational testing: • Verify process flow rates. • Verify ability to recover from upsets (e.g., power loss).	TI-8.1 TI-9 AC-21	S/U	High	$0 (per baseline)

Item Response Matrix Section 1 – DBVS-ERP Technical Issues					Priority	Impact Range ($K)
		• Verify ability to process at expected range of dried waste physical properties.				
TI-9 There is considerable uncertainty with regard to the consistency of the dried material and how it will be controlled.	The ERP recommends that a solid approach to dryer control be considered to ensure that material is successfully transported and reliable fed to the ICV™. This is a major issue which needs additional testing and development using the 130L sized dryer with S-109 liquid feed simulant, actual Hanford soil and Becker plows to: **TI-9.1:** Verify that a product moisture level of between 1 and 3% can be maintained by controlling the bed temperature. **TI-9.2:** Investigate the potential for operating the dryer in a continuous liquid and solids feed and solids discharge mode. **TI-9.3:** Verify that the substitution of zircon sand for zirconium dioxide does not materially change the solids product characteristics. **TI-9.4:** Generate data for the design and operation of the SMFs and for the vacuum pump and condenser. **TI-9.5:** Determine the variability of the basic data used in sizing the full scale unit.	**RA-40:** Conduct 130L dryer development testing: • Verify product moisture level can be controlled using bed temperature and feed rate into dryer. • Verify that continuous liquid feed to the dryer is possible. • Verify semi-continuous discharge of dried product and makeup of soil/glass formers ("bleed & feed"). • Verify acceptable dryer product produced with zircon sand. • Verify acceptable dryer performance with Becker blades.	TI-9.1 TI-9.2 TI-9.3 TI-9.5 TI-9.7 AC-6 AC-10 AC-21	E/S Test	High	Included in RA-8

		RA-41: Conduct full scale dryer qualification testing:
		• Verify product moisture level can be controlled using bed temperature and feed rate into dryer.
		• Verify continuous liquid feed to the dryer is possible.
		• Verify semi-continuous discharge of dried product and makeup of soil/glass formers ("bleed & feed").
		• Verify acceptable dryer product produced with zircon sand.
		• Verify acceptable dryer performance with Becker blades.
		• Generate data to support SMF operation and validate design:
		  o Back pulse frequency
		  o Back pulse efficiency
		  o Filter efficiency as measured by process condensate contamination levels
		• Validate processing rate scale up from 130L to full scale
		• Gather Becker plow blade wear data in order to project blade life and confirm "50 box life"
		• Confirm agglomerates affecting DWTS do not form (see TI-8)
			TI-9.1
			TI-9.2
			TI-9.3
			TI-9.4
			TI-9.5
			TI-9.6
			TI-9.7
			AC-6
			AC-10
			AC-21
				F/S Test	High	Included in RA-9

Item Response Matrix Section 1: DBVS-ERP Technical Issues						
				Project Phase	Priority	Impact Range ($K)
	TI-9.6: Determine effects of Becker blades and their wear rates. **TI-9.7:** Determine if large agglomerates will be formed and determine what effect they will have on the pneumatic conveying system.	**RA-42:** Conduct operational acceptance testing at DBVS site.	TI-9.1 TI-9.4 TI-9.7 AC-6 AC-10 AC-21	S/U	High	$0 (per baseline)
		RA-43: Conduct cold operational testing (5 boxes).	TI-9.1 TI-9.7 AC-6 AC-10 AC-21	S/U	High	$0 (absorb in 50 box campaign)
TI-10 Formation of secondary phases is not sufficiently understood for reliable process control.	**TI-10.1:** The ERP recommends that the DBVS Project carry out an experimental program designed to provide the data needed for process control. This would include small-scale experiments to elucidate mechanisms and explore potential improvements, and larger-scale tests (engineering and full-scale) to develop definite control measures and limits and to demonstrate effective and reliable process control. It should be noted that if one-fourth of the technetium were present in a soluble form, it is not clear that the containers produced by a production bulk vitrification system would meet IDF disposal requirements. The experimental program to develop control measures should also look at methods, both physical and chemical, to retard the mobility of the technetium if present in a	**RA-44:** Update ITEMP to incorporate on-going secondary phase mitigation strategy (Fe, MIS, SO_4) in order to minimize soluble Tc in the ICV (e.g., CRB sand, lid). • Small crucible scale • 22L dryer screening • Large crucible scale • 130L dryer testing • Engineering scale melts (30J/31F/33-series) • Integrated Dryer and Melt Test (IDMT) (dryer & 38D melt) • Balance of Mission testing	TI-10.1 AC-8 EM-3 EM-10 EM-12 EM-13 EM-14 EM-15 EM-16 EM-17 EM-18 EM-19	Design	High	Included in RA-3
		RA-45: Evaluate IDMT results with respect to process controls required to mitigate and prevent secondary phases (e.g., cold cap management, process chemistry, melt temperature).	TI-10.1 EM-21	Design	High	$0 (per baseline)
		RA-46: Document results of IDMT evaluation in IDMT test report.	TI-10.1	Design	High	$0 (per baseline)
		RA-47: Update the Process Control Plan.	TI-10.1	Design	High	$0 (per baseline)

Item Resolution Matrix Section 1 - DBVS ERP Technical Issues						Impact Range ($K)
	soluble form. Thus, fly ash could be added to the sand around the CRB (or be a part of the aggregate used to make the CRB), and thus limit the mobility of any soluble technetium not incorporated into the glass.					
TI-11 Failure to close the technetium mass balance threatens the viability of bulk vitrification as a supplemental treatment technology.	**TI-11.1:** The project should better quantify this unaccounted for fraction. Testing at an engineering scale with technetium and at full scale with a technetium surrogate would both be advisable, given the importance of the issue. Test objectives should be defined with numerical success criteria that are to be met prior to DBVS radioactive operations.	**RA-48:** Conduct a scientific symposium with representatives from WTP, SR, SRNL, PNNL, UC-Berkely, Catholic University to design a "best consensus" series of potential experiments to improve the understanding of technetium mass balance. If practical, adjust experimental design and test plans in TI-2 to reflect this consensus.	TI-11.1 AC-1 EM-1 EM-2 EM-4 EM-5 EM-7 EM-25 EM-32 EM-33	Design	High	Low $60K (5 people/1 week @ $300/hr; minimal changes) High $200K (add'l qual/lab testing)
TI-12 Design criteria for the OGTS have not been clearly defined.	**TI-12.1:** The ERP recommends that the DBVS Project should improve its design and specifications control as required by ASME NQA-1. Where there is uncertainty of design criteria, worst case scenarios should be used to establish the correct design criteria.	**RA-49:** Determine which specifications/data sheets to review. • Review criteria (OGTS, affect on safety/environment, etc.)	TI-12.1	Design	High	$0 (covered by existing staff)
		RA-50: Review equipment design specifications in order to: • Ensure correct design criteria have been specified and are consistent with the baseline PFD. • Ensure necessary and sufficient codes and standards are called out and are applied appropriately. • Ensure design criteria account for transient conditions. • Ensure design criteria account for upset conditions. • Ensure compliance with ASME NQA-1.	TI-12.1 AC-5 AC-11 AC-13 AC-14	Design	High	Low $0 (covered by existing staff) High $20K (2 months contract support)
		RA-51: Document the results of the specification review. Identify: • Specifications requiring changes • Justification for specifications not changed	TI-12.1 TI-13	Design	High	$0 (covered by existing staff or RA-50 contract)

Item Response Matrix Section 1, DBVS ERP Technical Issues						Impact Range ($K)
		• Identify any changes to equipment already procured				
		RA-52: Update specifications to correct inconsistencies identified in the specifications review.	TI-12.1	Design	High	Low $8K (change 10 specs @ 8 hrs/spec) High $24K (change 30 specs @ 8 hrs/spec)
		RA-53: Update the design of equipment already procured to implement changes.	TI-12.1	Design	High	$0
		RA-54: Modify already procured equipment as necessary.	TI-12.1	Const.	High	$0
TI-13 Testing requirements in equipment specifications have been inadequately defined.	**TI-13.1:** The ERP recommends that testing protocols be included in the equipment specifications to establish the performance envelope of the equipment. Field testing protocols should also be established to define the performance envelope of the OGTS.	**RA-55:** Update the ITEMP to clearly define the performance envelope testing strategy. • Risk/benefit • Project phase • Field testing protocols	TI-13.1 TI-17 AC-12 AC-21	Design	High	Included in RA-3
		RA-56: Determine which tests are appropriate for performance by vendors.	TI-13.1 TI-12 AC-13	Design	High	$0 (covered by existing staff)
		RA-57: Update equipment specifications to enhance vendor testing requirements in accordance with the updated ITEMP and the results from the evaluation performed in TI-12.	TI-13.1 TI-12 AC-13	Design	High	Incorporate with RA-52 Incremental cost: Low $10K High $25K (allowance)
		RA-58: Provide updated specifications to vendors.	TI-13.1	Const.	High	$0
		RA-59: Develop system sub-test plans per the ITEMP.	TI-13.1	Const.	High	$0 (covered by existing staff)

				Driver	Priority	Impact Range ($K)
		RA-60: Perform testing in accordance with equipment specifications.	TI-13.1	Const.	High	Low $0 High $100K (allowance for increased vendor testing)
		RA-61: Perform testing in accordance with system sub-test plans.	TI-13.1	S/U	High	$0 (per baseline)
TI-14 Potentially large variations in system component pressure losses and the hysteresis within the control system could result in unacceptable response time to achieve proper flow.	**TI-14.1:** The ERP recommends that a complete instrument and control performance and interaction evaluation is carried out to ensure that control of the system can be achieved and maintained.	**RA-62:** Simplify OGTS design (see TI-4).	TI-14.1	Design	High	Included in RA-18/19
		RA-63: Model the simplified OGTS design. • Validate steady state design, including component pressure losses. • Evaluate system transients, including control system response and startup/shutdown to identify any areas of instability. • Evaluate system operating envelope to include melt off-gas production rate, filter loading, system in-leakage, etc. • Safety system operation (e.g., transition to bypass). • Evaluate system upset conditions (i.e., equipment failures).	TI-14.1	Design	High	Low $20K High $50K (allowances for new model runs)
		RA-64: Modify OGTS design to correct deficiencies identified by the model.	TI-14.1	Design	High	Included in RA-18/19
		RA-65: Validate OGTS operation during integrated operational testing.	TI-14.1	S/U	High	$0 (per baseline)
TI-15 The sintered metal filters will frequently blind, with a significant risk of release of contamination.	**TI-15.1:** The ERP recommends that testing be performed to demonstrate that the SMF will not load more quickly than it can be cleaned. In addition, testing must be performed to ensure that there is only minimal deterioration in the performance of the SMF after repeated cleaning. The cleaning efficiency must be determined.	**RA-66:** Characterize the OGTS SMF fines that are formed during the mixer dryer scale testing.	TI-15.1	Design	High	$0 (per baseline)
		RA-67: Modify the OGTS design to add a roughing filter and heater ahead of the SMF (ref. TI-4).	TI-15.2 AC-15	Design	High	Included in RA-18/19
		RA-68: Test SMF performance during the IDMT to: • Determine filter cleaning efficiency. • Determine filter loading characteristics.	TI-15.1 TI-15.2 AC-10 EM-29	F/S Test	High	$0 (per baseline)

Item Response Matrix Section 1: DBVS/ERP Technical Issues						
				Project	Priority	Impact Range ($K)
	The above information is also needed to design the vacuum transfer system. **TI-15.2:** The ERP also recommends that the DBVS investigate the potential use of a "roughing" filter in front of the SMF to reduce the dust loading.	**RA-69:** Validate flow sheet assumptions for melter off-gas dust loading (mass rate and particle size) during IDMT.	TI-15.1 TI-15.2	F/S Test	High	$0 (per baseline)
		RA-70: Dynamic model evaluation of the effects of the SMF plugging on other OGTS components. • ICV pressure. • Bypass system HEPA filters.	TI-15.1	Design	High	$20K (A-E proposal)
		RA-71: Validate OGTS performance during cold testing at DBVS.	TI-15.1 TI-15.2	S/U	High	$0 (per baseline)
TI-16 Testing and safety analysis have not adequately addressed the ICV melt box performance for containment of the melt product, volatile radionuclides, and generated NOx.	The ERP recommends that the DBVS Project consider several alternative actions that would help resolve this issue: **TI-16.1:** A risk-reduction/cost-optimization study of double-containment (e.g., small containment building with a safety significant ventilation system) versus single containment for the ICV Box. **TI-16.2:** A focused effort to reliably detect hot spots in the melt box and development of the associated recovery plan. **TI-16.3:** Development of criteria and requirements for melt termination and restart. **TI-16.4:** Install detectors to monitor NOx generation rates and pressurization in the ICV™ Box.	<u>ICV Box Containment</u> **RA-72:** Modify design to provide an actively ventilated melt area enclosure.	TI-16.1	Design	High	$1.8M ($300K design/ $1.5M procure & construct)
		RA-73: Evaluate alternatives to control toxic off-gas releases. • Existing bypass design. • Secondary confinement (localized and area around box). • Passive confinement (i.e., leak tight ICV).	TI-16.1	Design	High	Included in RA-17
		RA-74: Conduct control decision meeting to determine if changes to the existing PDSA toxic off-gas control strategy are needed.	TI-16.1 TI-16.4	Design	High	$0 (per baseline)
		RA-75: Update safety analysis to reflect results of control decision meeting. • Chapter 2, *Facility Description* • Chapter 3, *Hazard and Accident Analyses* • Chapter 4, *Safety Structures, Systems, and Components* • Chapter 5, *Derivation of Technical Safety Requirements*	TI-16.1 TI-16.4	Design	High	$0 (per baseline)
		RA-76: Update SEL to reflect PDSA Chapter 4 changes.	TI-16.1 TI-16.4	Design	High	$0 (per baseline)

Item Response Matrix Section 1 - DBVS ERP Technical Issues						
						Impact Range ($K)
		RA-77: Update design as needed.	TI-16.1 TI-16.4	Design	High	Assume minor changes covered in Title III budget
		ICV Box Hot Spots **RA-78:** Evaluate methods of detecting and recovering from melt box hot spots (see TI-3).	TI-16.2	Design	High	Included in RA-14
		Melt Termination/Restart **RA-79:** Incorporate requirements for melt termination and restart in DBVS facility operating procedures.	TI-16.3	Const.	High	$0 (per baseline)
TI-17 The safety performance of the DWTS to contain the dried waste under normal and accident conditions is not yet fully understood and defensible.	The ERP recommends that the DBVS Project consider the following actions: **TI-17.1:** Preparation of a DWTS confinement performance justification and development of a communications strategy with regulators and oversight organizations to effectively defend the chosen design approach. **TI-17.2:** Performance tests to demonstrate the adequacy of DWTS design approach, particularly if any containment components could be viewed as unconventional. **TI-17.3:** Installation and maintenance of a Safety Significant active, confinement ventilation system or leakage alarm system for portions of the DWTS with single physical boundary containment. (or in conjunction with a melt box	DWTS Confinement **RA-80:** Update confinement strategy (white paper) to reflect: • Secondary confinement below dryer. • Actively ventilated melt area enclosure. Communicate the confinement strategy with regulators and oversight organizations.	TI-17.1	Design	High	$20K (1 month contract support)
		RA-81: Conduct control decision meeting to determine if changes to the existing PDSA toxic off-gas control strategy are needed.	TI-17.3	Design	High	$0 (per baseline)
		RA-82: Update safety analysis to reflect results of control decision meeting. • Chapter 2, *Facility Description* • Chapter 3, *Hazard and Accident Analyses* • Chapter 4, *Safety Structures, Systems, and Components* • Chapter 5, *Derivation of Technical Safety Requirements*	TI-17.3	Design	High	$0 (per baseline)
		RA-83: Update SEL to reflect PDSA Chapter 4 changes.	TI-17.3	Design	High	$0 (per baseline)
		RA-84: Update design as needed.	TI-17.3	Design	High	Assume minor changes covered in Title III budget

Item Response Matrix Section 1, DBVS ERP Technical Issues						Impact Range ($K)
	containment building).	DWTS Performance Tests **RA-85:** Develop DWTS testing requirements (see TI-13).	TI-17.2	Design	High	Included in TI-13 actions
TI-18 The DBVS Project plans to assign operational responsibility to a sub-contractor who has little formal nuclear facility operating experience.	**TI-18.1:** The ERP recommends that the DBVS Project flow down a required set of tank farm safety and operational standards to the DBVS subcontractor. Before being released to operate DBVS, the subcontractor should formally evaluate CH2M HILL initiatives in ISMS, Voluntary Protection Program, Human Performance, Enhanced Work Planning/Worker Involvement, and Safe Work Practices for implementation. The manner in which CH2M HILL will execute its oversight and safety assurance responsibilities should be clearly described in an interface working document. In addition, CH2M HILL and AMEC should collaborate to develop a commissioning/startup strategy and a deliberate operations plan that will develop experience prior to introducing radioactive waste to DBVS.	**RA-86:** CH2M HILL to provide operations oversight (Operation managers and Senior Supervisory Watch personnel) for DBVS operations in accordance with resource-loaded schedule.	TI-18.1 AC-22	S/U & Hot Ops.	High	$0 (per baseline)
		RA-87: CH2M HILL to provide specialized support: • RadCon • Industrial Hygiene • System Engineering • Waste Management	TI-18.1	S/U & Hot Ops.	High	$0 (per baseline)
		RA-88: DBVS commissioning/start up strategy and training program to be developed in conjunction with CH2M HILL.	TI-18.1	Const.	High	$0 (per baseline)
		RA-89: Operations contractor to develop safety program addressing: • Integrated Safety Management • Voluntary Protection Program • Human Performance Initiative	TI-18.1	Const.	High	$0 (per baseline)
		RA-90: Evaluate operations contractor safety and conduct of operations performance during non-rad operations.	TI-18.1 AC-22	S/U	High	$0 (per baseline)
		RA-91: Develop Memorandums of Understanding to clearly define CH2M HILL/Operations Contractor interfaces in: • Operations oversight • Safety	TI-18.1	Const.	High	$0 (per baseline)
TI-19 Project uncertainty with various portions of the unit operations	**TI-19.1:** The ERP recommends that the DBVS Project consider a comprehensive identification of the process and chemistry uncertainties that could lead to off-normal conditions that would warrant unique approaches to	**RA-92:** Expand DBVS process sensitivity analysis: • NO_x ratios and generation rates • Scrubber efficiencies • Feed variability • Melt off-gas particulate rates and distribution • Equipment decontamination factors • Impact on secondary liquid waste composition	TI-19.1 TI-3 AC-1 AC-2 AC-17 AC-18 EM-30	Design	High	Included in RA-13

Item Response Matrix Section 1: DBVS ERP Technical Issues						
				Proj. Phase	Priority	Impact Range ($K)
and process chemistry may heighten safety vulnerability under abnormal conditions.	emergency preparedness. The project should also consider rigorous process and scenario training for operators, including how to react to abnormal conditions, how to divert potential upsets and how to handle emergencies. The project should develop a deliberate operations preparation plan to accomplish this training and experience prior to introducing radioactive waste to the DBVS.	**RA-93:** Evaluate results of new sensitivity analyses which could lead to unique off-normal conditions affecting emergency preparedness and operator response.	TI-19.1	Design	High	$0 (covered by existing staff)
		RA-94: Incorporate sensitivity analysis results in: • RPP-20528, *Supplemental Treatment Test and Demonstration Facility Process Flowsheet* • Building Emergency Plan • Operating procedures • Training program	TI-19.1	Const.	High	$0 (per baseline)
		RA-95: Evaluate effectiveness of BEP, procedures, and training during emergency response drills.	TI-19.1	S/U	High	$0 (per baseline)

A.2 Areas of Concern

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
AC-1 Decontamination calculated for Technetium and Cesium across the DBVS are questionably large.	**AC-1.1:** Re-examine the decontamination factors for the various process steps in order to ensure that they are valid and that the method of combining them to obtain an overall system decontamination factor is valid. This can be accomplished by: • Sampling the filter both before and after filtration to determine if the decontamination factors are valid. • Obtain material balances for technetium and cesium across the DBVS.	**RA-96:** Re-evaluate effects of decontamination factor assumptions on facility releases and dose rates. • Flow sheet sensitivity (see TI-19). • Revise ALARA analysis to incorporate (as an appendix) the flow sheet sensitivity results and their effect on facility dose rates. • Compare flow sheet sensitivity results for stack and secondary liquid wastes against permit and ETF waste acceptance criteria to ensure they are within limits.	AC-1.1	Design	Medium	$0 (sensitivity analysis covered in RA-13; balance covered by existing staff)
		RA-97: Update design as needed to mitigate effects of changed decontamination factor assumptions.	AC-1.1	Design	Medium	Assume minor changes covered in Title III budget

		RA-98: Verify decontamination factor assumptions during testing:
		• See TI-11 for Tc.
		• See TI-2 for Cs
		• IDMT
		  o Dryer condensate to evaluate dryer SMF performance.
		  o OGTS SMF dust to evaluate Cs/Re capture.
		• Cold operational testing at DBVS
		  o Secondary liquid wastes (scrubber and dryer condensate).
			
			AC-1.1
			AC-1.1
			AC-1.1
			
			AC-1.1
				
				Design
				E/S Tests
				F/S Test
				
				S/U
					
					High
					High
					Medium
					
					Medium
						$0 (per baseline)

[a] Project Phase Definition

- Design – DBVS activities associated with modifying the final design and leading to DOE Critical Decision 3 (CD-3) authorizing construction.
- Scale Testing – DBVS testing and development activities occurring at laboratory scale (L/S), engineering scale (E/S), or full scale (F/S) (off-site) to support design decisions or validation. Because of the wide range of activities associated with this phase, testing activities will be further categorized into the laboratory scale, engineering scale, and full scale testing programs.
- Construction – DBVS activities involving procurement, construction, and design refinement that occur after receiving CD-3 approval.
- Start Up – DBVS activities associated with start up and cold testing of the installed system. This includes system acceptance testing and operational readiness activities.
- Hot Operations – DBVS activities associated with the operations of the system during it's demonstration and development mission to process up to 50 boxes of immobilized LAW.

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
		o Off-gas samples per DQO (see TI-1.2). • Hot Operations o Secondary liquid wastes (scrubber and dryer condensate). o Off-gas samples per DQO (see TI-1.2). o Process samples per DQO (see TI-1.2). o RadCon surveys to monitor for radiological material buildup.	AC-1.1	Hot Ops	Medium	
AC-2 There is a lack of a basic understanding of the process chemistry.	**AC-2.1:** The ERP recommends that additional chemical information be obtained both by sampling to obtain chemical information during and after DBVS test runs and by laboratory experiments. In all cases, acquisition of chemical data should be driven by a need to understand observations made during the test runs and have the goal of furthering understanding of process chemistry as it relates to meeting DBVS mission goals.	Area of Concern is addressed through Project Response Activities for TI-1, TI-4, TI-5, and TI-19.	AC-2.1	E/S Tests F/S Test Design S/U	High	Covered in response activities for TI-1, TI-4, TI-5, and TI-19
AC-3 The hydrocyclone may not provide adequate separation of the smaller particle size solids expected in the S-109 feed.	**AC-3.1:** The ERP recommends that either the technical case be made that solid fines cannot be picked up in S-109 and transferred to DBVS or that the hydrocyclone be replaced by a more efficient filter.	**RA-99:** Document technical evaluation of whether solids will be retrieved to the DBVS along with saltcake brine during operation of the tank S-109 partial waste retrieval system (PWRS). If solids exceeding the ULD are estimated to be present, evaluate whether hydrocyclone currently included in tank S-109 PWRS or a replacement solid separation device is suitable to separate these solids.	AC-3.1	Design	Medium	$10K (1 man-month)
AC-4 Given that there is no	**AC-4.1:** The ERP recommends that solids separation be improved (see recommendation against Area of Concern 3 above) such that	**RA-100:** Calculate the bounding solids mass based on the maximum allowed unit liter dose (ULD) (per PDSA) in the incoming S-109 waste. • Determine potential for plugging waste receipt tank	AC-4.1	Design	Medium	$0 (covered by existing staff)

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
mechanical agitation in the DBVS feed tanks, solids could build up over time (assumes the solids/liquid separation step is not adequate).	solids do not enter the receipt tanks and/or the project enhance the waste receipt system design to include mixing in the receipt vessels. Also see suggested improvement 2.	outlet. • Determine effect on tank dose rates. • Determine potential for plugging process piping. **RA-101:** Verify existing design will not produce significant post-receipt precipitation in the DBVS feed. **RA-102:** Evaluate design based on results of calculation and modify as necessary. e.g.: • Add Tank mixing capability. • Increase recirculation flow rate. • Improve S-109 solids separation.	AC-4.1 AC-4.1 SI-2	Design Design	Medium Medium	$0 (covered by existing staff) Low $0 High $20K (allowance for bigger pump)
AC-5 The epoxy coating on the waste storage tanks may not provide adequate corrosion protection.	**AC-5.1:** The ERP recommends that the project validate that this isn't an issue or change the coating requirements to withstand the environment in the vessel.	**RA-103:** Review primary waste tank coating requirements in the specification (see TI-12). **RA-104:** Ensure primary waste tanks manufacturer provides coating that meets specification requirements. (For disposition of existing procured tanks, see Nonconformance Report CH-06-NCR-019.)	AC-5.1 AC-5.1	Design Const.	Medium Medium	Included in RA-50 $0 (per baseline)
AC-6 The batch drying time may exceed the specified 8-hour duration by as much as 1-1/2 hours.	**AC-6.1:** This will be covered in the tests recommended against Technical Issue 9	Area of Concern is addressed through Project Response Activities for TI-9.	AC-6.1	E/S Tests F/S Test S/U	High	Covered in response activities for TI-9
AC-7 Temperatures predicted in the mixer/dryer	**AC-7.1:** The ERP recommends that the project decide if this is acceptable or if additional cooling needs to be provided.	**RA-105:** Review the project dryer ISO container heat load calculation and verify it is appropriately conservative. **RA-106:** If the project calculation is non-conservative, evaluate the temperature sensitivity of equipment inside of the ISO container for compatibility with anticipated internal	AC-7.1 AC-7.1	Design Design	Medium Medium	$0 (per baseline) $0 (covered by existing staff)

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
container during hot weather may not allow for the proper operation of controls and equipment.		temperature. **RA-107:** Modify design as necessary to increase equipment temperature rating or the ISO container cooling capacity.	AC-7.1	Design	Medium	Low $0 High $5K (allowance for larger heat pump)
AC-8 The lack of a validated approach for control of the ICV™ process puts the project's ability to proceed to radioactive operations at risk.	**AC-8.1:** The project should complete development of its Process Control Plan, and begin testing its effectiveness in engineering- and full-scale tests as soon as possible. Demonstrating the effectiveness of the PCP should be considered a prerequisite for full-scale system commissioning.	**RA-108:** Incorporate germane sections of current DBVS Process Control Plan (RPP-Plan-23239) into IDMT Test Plan and Test Instructions. • Melter controls. • Dryer controls. • OGTS SMF controls.	AC-8.1	Design	High	$0 (per baseline)
		RA-109: Develop additional process controls and incorporate into IDMT Test Plan and Test Instructions. • Cold cap management. • MIS mitigation. • Enhanced dryer operation. o Continuous liquid waste feed. o Semi-continuous dried waste discharge.	AC-8.1 EM-8	Design	High	$0 (per baseline)
		RA-110: Evaluate effectiveness of the above process controls: • Acceptable glass product. • Acceptable control of secondary phases (see TI-10). • Acceptable equipment operation.	AC-8.1	F/S Tests	High	$0 (per baseline)
		RA-111: Update the DBVS Process Control Plan.	AC-8.1	Design	High	$0 (per baseline)
		RA-112: Validate acceptable process control during cold operational testing at DBVS.	AC-8.1	S/U	High	$0 (per baseline)
AC-9 A feed	**AC-9.1:** The feed qualification step should include such activities as determination that the feed	**RA-113:** Develop a feed qualification position paper: • Define the process by which DBVS assures that the feed composition is within the demonstrated	AC-9.1	Design	Medium	$20K (1 month contract support)

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
qualification step is needed as part of the process control plan.	composition is within the demonstrated bounds of the process, a flow sheet run to identify any potential process problems, thermogravimetric analysis to avoid problems associated with high temperature phase transformations, and other activities needed to ensure safe and reliable production of a compliant product.	bounds of the process. • Determine process sampling requirements (integrate with TI-5). • Determine testing and analysis requirements. • Determine process control requirements. **RA-114:** Implement position paper requirements into lower tier documents. • Data Quality Objectives • Sampling and Analysis Plan • Process Control Plan **RA-115:** Modify design as necessary (integrate with TI-5).	AC-9.1 AC-9.1 AC-9.1 AC-9.1 AC-9.1	Design Design Design Design Design	High Medium Medium Medium Medium	$0 (covered by existing staff) Included in RA-27
AC-10 The lack of prototypic testing prevents the project from predicting future compliance from past success.	**AC-10.1:** The project should carry out prototypic testing at an engineering scale or greater to demonstrate that product requirements can be met with the process that will be used by the DBVS. This could be accomplished as part of commissioning. However, performing this testing prior to commissioning would allow the project to avoid excessive delays if modifications to the DBVS were necessary.	Area of Concern is addressed through Project Response Activities for TI-2, TI-8, TI-9, and TI-15.	AC-10.1	E/S Tests F/S Test Design	High	Covered in response activities for TI-2, TI-8, TI-9, and TI-15
AC-11 Equipment manufacturers' standard practice appears to have taken precedence over code compliance for	**AC-11.1:** The ERP recommends that the DBVS Project specify full compliance to ASME AG-1 Code to ensure equipment design, manufacturing, quality and testing requirements are met. The equipment specification must clearly define that the complete code and standards apply, including the general requirements, materials, design,	Area of Concern regarding AG-1 is addressed through Project Response Activities for TI-12. Area of Concern regarding SMF is addressed through Project Response Activities for TI-15.	AC-11.1 AC-11.2	Design Design F/S Test	High High	Covered in response activities for TI-12 & TI-15

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
the OGTS.	manufacturing, quality assurance and design control, as they relate to the specified equipment. **AC-11.2:** The ERP also recommends that the DBVS investigate the potential use of a "roughing" filter in front of the SMF to reduce the dust loading.					
AC-12 The Wet Scrubber specification does not require performance testing to demonstrate the specified removal efficiencies.	**AC-12.1:** The ERP recommends that testing protocols be included in the equipment specifications. Qualification testing will determine the suitability of the equipment for the application and establish the performance envelope of the equipment at design, operating and upset conditions.	Area of Concern is addressed through Project Response Activities for TI-13.	AC-12.1	Design Const. S/U	High	Covered in response activities for TI-13
AC-13 Design Criteria for the HEPA filters (e.g., concentration of acid gases) have not been established.	**AC-13.1:** The ERP recommends that the DBVS Project establish design criteria, rewrite or strengthen procurement specifications, and require appropriate performance testing by the vendors.	**RA-116:** Review Hanford standard HEPA filter procurement specification to ensure these filters are acceptable for DBVS use. • Acid gas compatibility • Temperature rating • Flow capacity **RA-117:** Update specifications in conjunction with Project Response Activities for TI-12 and TI-13.	AC-13.1 AC-13.1 AC-16	Design Design	Medium Medium	Covered in RA-50 Covered in RA-52
AC-14 Carbon cells for HEGA filters do not meet the required residence time	The ERP recommends that the DBVS Project: **AC-14.1:** 1) establish design criteria; **AC-14.2:** 2) perform laboratory-	**RA-118:** Review the procurement specification for the HEGA filters to verify compliance with the design residence time for the carbon cells. If non-compliant, alternative HEGA filters may be procured and/or the OGTS design modified.	AC-14.1 EM-31	Design	Medium	Covered in RA-50

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
as specified in the Procurement Specification and ASME AG-1 Code.	scale testing to validate charcoal adsorber (testing should include the possibility of selective desorption and potential chemical interaction of contaminants); **AC-14.3:** 3) rewrite or strengthen procurement specifications; and **AC-14.4:** 4) require appropriate performance testing by the equipment manufacturers.	**RA-119:** Conduct a literature review to identify data on operations and potential desorption of Charcoal adsorbers and potential chemical interactions of contaminants. Review data on carbon bed adsorbers used in the WTP vitrification OGTS for applicability to the DBVS design. Document in a project position paper.	AC-14.1	Design	Medium	Low $0 (use existing staff) High $15K (1 month contract support)
		RA-120: Conduct laboratory and/or vendor testing of HEGA filters, if necessary, to validate performance.	AC-14.2	Const.	Medium	Low $0 High $25K (allowance for lab tests)
		RA-121: Revise the procurement specification for the HEGA filters as necessary in conjunction with Project Response Activities for TI-12.	AC-14.3 AC-14.4	Design	Medium	Covered in RA-52
AC-15 There exists a potential for a charcoal fire due to concentrations of NO_x in the HEGA skid.	**AC-15.1:** In addition to the same recommendations listed for Area of Concern #17, the ERP recommends that the DBVS Project consider multiple carbon beds with impregnated charcoal formulated specifically for the gaseous contaminant to be removed. This could result in a step process to remove acid gases, organic compounds, etc.	**RA-122:** Conduct a literature review to identify data on operations and potential desorption of Charcoal adsorbers and potential chemical interactions of contaminants (e.g., poisoning, deactivation, fire). Review data on carbon bed adsorbers used in the WTP vitrification OGTS for applicability to the DBVS design. Document in a project position paper.	AC-15.1	Design	Medium	Covered in RA-119
		RA-123: Conduct laboratory and/or vendor testing of HEGA filters, if necessary, to validate performance.	AC-15.1	Design Const.	Medium	Covered in RA-120
AC-16 The OGTS emergency by-pass filter system could quickly load with particulate during upset conditions, resulting in a filter failure and	**AC-16.1:** The ERP recommends that the DBVS Project redesign the OGTS Emergency By-Pass System to handle Abnormal or Upset design conditions.	**RA-124:** Modify design to include a knock-out pot or similar equipment upstream of the HEPA filters to reduce particle loading on the filters as defense in depth for an unexpected excursion.	AC-16.1	Design	Medium	Covered in RA-18/19
		RA-125: Update specification in conjunction with Project Response Activities for AC-13.	AC-16.1	Design	Medium	Covered in RA-52

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
release of contaminants to the atmospheres.						
AC-17 There appears to be little, if any, design optimization.	**AC-17.1:** The ERP recommends that the DBVS Project conduct a design optimization study primarily aimed at simplifying the overall design and improving the robustness of the plant functionality and that an operational research model of the DBVS system be constructed and used to support the plant and operability studies.	Area of Concern is addressed through Project Response Activities for TI-3, TI-4, and TI-19.	AC-17.1	Design	High	Covered in response activities for TI-3, TI-4, and TI-19
AC-18 The scrubber system may not be able to treat unexpectedly large amounts of gases and solids, resulting in unacceptable amounts of material being directed to the ETF.	**AC-18.1:** The ERP recommends that the DBVS Project reduce where possible the very large volume of air introduced throughout the DBVS, e.g., the off-gas makeup air, and/or reduce the amount of caustic used in the OGTS (this is related to reducing the amount of air used and to the amount of nitrogen dioxide produced in the melter).	**RA-126:** Evaluate optimum air addition in conjunction with Project Response Activities for TI-4.	AC-18.1	Design	High	Covered in response activities for TI-4
		RA-127: Evaluate effects of changing NO_x ratios on the scrubber system in conjunction with Project Response Activities for TI-19.	AC-18.1	Design	High	Covered in response activities for TI-19
		RA-128: Evaluate affects of changing NO_x ratios on the secondary liquid waste in conjunction with Project Response Activities for TI-19.	AC-18.1	Design	High	Covered in response activities for TI-19
AC-19 Assumptions about types and amounts of chemical entering the Secondary Waste Treatment System.	**AC-19.1:** The ERP recommends that the DBVS Project examine and validate the assumptions about the materials that are especially toxic and in significant amounts and those materials that form solids during off-gas neutralization in the wet scrubber.	**RA-129:** Completed evaluation of DBVS hazardous chemical usage and production. Determined both total and regulatory quantities.	AC-19.1	Design	Low	$0 (complete)
		RA-130: Incorporated results of the evaluation into the PDSA.	AC-19.1	Design	Medium	$0 (complete)

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
AC-20 The potential for future use of the DBVS facility as a single line production facility and gap filler capability might not be adequately addressed in the existing design.	**AC-20.1:** Reevaluate the cost effectiveness of establishing increased service and design life performance requirements to support future operational use of the facility without the need for service life extension or unnecessary equipment maintenance, repair, modernization or replacement. **AC-20.2:** Establish a graded RAM program, require the subcontractor to conduct a graded to RCM analysis and define appropriate data quality objective requirements to collect necessary operability and maintainability data to support either a service life extension program or improved life cycle performance data for a production facility. **AC-20.3:** Evaluate contractual methods that will better ensure that DBVS complies with DOE maintenance management requirements and develop a better defined, coherent maintenance strategy that supports the immediate demonstration objectives while preserving the option to continue future production use in a more cost effective manner.	Recent discussions with regulators, DOE, and CH2MHILL have concluded the DBVS facility will not be operated beyond the demonstration mission. Therefore, no project actions will be performed in response to this area of concern.	N/A	N/A		--

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
AC-21 An adequate maintenance strategy has not been developed and incorporated into the demonstration facility requirements.	**AC-21.1:** Develop or require the subcontractor to develop and evaluate an integrated operating and maintenance cycle plan to best support demonstration objectives. Conduct a task analysis using this plan to evaluate the adequacy of current staff estimates for project cost and schedule implications.	Integrated O&M Planning **RA-131:** Document DBVS integrated operating and maintenance approach in accordance with the current DBVS schedule. • Maintenance Strategy Plan • Preventive Maintenance Plan • Work Control Procedures • Conduct of Operations Plan	AC-21.1	Const. S/U	Medium	$0 (per baseline)
	AC-21.2: Review existing Project Documentation, strengthen flow down of requirements and eliminate contradictions and inconsistencies in Operations, Maintenance and Training sections especially between the project Execution Plan and the Statement of Work of the Subcontract.	**RA-132:** Evaluate DBVS equipment reliability as needed to develop critical spare parts list. Document results of evaluation in a project position paper.	AC-21.1	Design	Medium	$0 (covered by existing staff)
		RA-133: Review project Cost Estimating Input Sheets to validate adequate O&M resources have been included in the project baseline estimate.	AC-21.1	Design	Medium	$0 (covered by existing staff)
		Requirements Flow Down **RA-134:** Prepare future project Statements of Work consistent with the Operations, Maintenance, and Training requirements contained in the Project Execution Plan.	AC-21.2	Design	Medium	$0 (per baseline)
	AC-21.3: Evaluate existing contract requirements for vendors to conduct component performance testing under normal operating and design conditions and strengthen contract mechanisms to ensure adequate performance testing of procured equipment has been performed.	Performance Testing **RA-135:** Ensure adequate component performance testing is incorporated into specifications in conjunction with Project Response Activities for TI-13.	AC-21.3	Design	High	Covered in response activities for TI-13
	AC-21.4: Reevaluate the need for and perform additional testing to support design and performance requirements and to better understand and plan for the maintenance that may be required to support reliable operations	Additional Testing **RA-136:** Ensure identification of adequate testing in conjunction with Project Response Activities for TI-2, TI-8, and TI-9.	AC-21.4	Design	High	Covered in response activities for TI-2, TI-8, and TI-9

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
	especially as it pertains to the dryer and dried waste handling systems.					
AC-22 Readiness requirements for ultimate hot operations may be underestimated	**AC-22.1:** Accelerate Operational Readiness Checklist development and integrated readiness planning. Add a dedicated and graded operational proficiency period into the schedule to support achievement of readiness objectives. **AC-22.2:** Build a realistic, scaled Ancillary Waste Transfer Enclosure (AWTE) mock up facility based on the final design or retaining and modifying, as necessary, the most recent AWTE mock-up built and used to facilitate the current AWTE design from ergonomic and accessibility standpoints for future use in initial training and qualification programs and to support developing worker radiological work proficiency. **AC-22.3:** Evaluate the need for conducting additional integrated cold testing and the impact on the demonstrations overall objectives and the ability of the integrated test plan to meet those objectives, if more than 2 boxes are needed to complete the test program. **AC-22.4:** Ensure that clear roles and responsibilities are documented and published soon to implement a combined readiness program to start at the earliest opportunity and	Readiness **RA-137:** Execute Startup and Readiness Review activities in accordance with the project schedule. (Also see TI-18).	AC-22.1	Const.	Medium	$0 (per baseline)
		Mock-Ups **RA-138:** During development of the Training Program, define requirements for mockups and implement, as req'd.	AC-22.2	Const.	Medium	$0 (per baseline)
		RA-139: Conduct Training and Drills involving operations in radiological environments (e.g., AWTE) before hot operations.	AC-22.2	S/U	Medium	$0 (per baseline)
		RA-140: Evaluate performance during the 5 cold operation evolutions.	AC-22.2	S/U	Medium	$0 (per baseline)
		Integrated Cold Testing **RA-141:** Evaluate the need for additional integrated cold testing in conjunction with Project Response Activities for TI-2.	AC-22.3	Scale Tests	High	$0 (covered by existing staff)
		Roles and Responsibilities **RA-142:** Review Project Execution Plan (PEP) to ensure clear roles and responsibilities.	AC-22.4	Design	Medium	$0 (covered by existing staff)
		RA-143: Revise PEP as required.	AC-22.4	Design	Medium	$0 (covered by existing staff)
		RA-144: Prepare future SOW's consistent with Roles and responsibilities as defined in the PEP.	AC-22.4	Design	Medium	$0 (covered by existing staff)

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
	address how key programs, such as the Cognizant System Engineer Program will be implemented and executed.					
AC-23 Insufficient consideration to accumulation of radioactive materials throughout the DBVS could lead to avoidable radiation exposure during operations and extra complexity of the decontaminatio n and decommissionin g effort.	The ERP recommends that the DBVS Project **AC-23.1:** Develop a conceptual D&D plan and examine potential risks such as accumulations, deposits and plate-outs specific to the DBVS. **AC-23.2:** Materials accumulation assumptions should be incorporated into the hazards and safety analyses material-at-risk, and also into recommendations from the ALARA Analysis Report.	**RA-145:** Re-perform Radiological/ALARA review of final configuration of waste receipt system, dryer, DWTS, and OGTS up to the first filtration for potential radiological buildup locations.	AC-23.1 AC-23.2 AC-25 EM-26	Design	Medium	$0 (covered by existing staff)
		RA-146: Redesign areas having high potential for accumulation: • Alternate component • Ease of component replacement	AC-23.1 AC-23.2	Design	Medium	Low $0 High $50K (allowance)
		RA-147: Evaluate potential for plate out of radioactive material in the ICV lid and OGTS piping (see TI-2) and ensure the design accommodates this condition.	AC-23.1 AC-23.2 AC-25 EM-26	Design	Medium	Covered in RA-10
		RA-148: Prepare D&D Plan in accordance with WA 7890008967, *Permit for Dangerous and or Mixed Waste Research, Development, and Demonstration, December 13, 2004.*	AC-23.1	Const.	Medium	$0 (per baseline)
		RA-149: Validate material accumulation through non-radiological testing at the DBVS site.	AC-23.1	S/U	Medium	$0 (per baseline)
AC-24 Safety Control Strategy Complexity – The large number of TSR-level safety systems and DBVS-specific administrative	**AC-24.1:** Performance of a control optimization exercise to examine the origin of each TSR-level control, identify the associated analysis/evaluation conservatisms, determine the sensitivity to the conservatisms, and evaluate the necessity of each control. **AC-24.2:** Examination of any	Area of Concern is addressed through Project Response Activities for TI-4.	AC-24.1 AC-24.2 AC-24.3 AC-24.4	Design	High	Covered in response activities for TI-4

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
controls may be excessive from the standpoint of human factors and operational complexity.	design attributes that are driving the need for a safety control, and assess whether there are reasonable alternatives that would result in simpler or fewer controls. **AC-24.3:** Evaluation of the frequency and magnitude of surveillances, readings, recordings and adjustments in the safety administrative control programs for viability and human factors issues. **AC-24.4:** Perform an update of the project Human Factors analysis, consistent with the latest identified control suite.					
AC-25 The documented rationales for the revised Hazard Categorization is insufficient.	**AC-25.1:** A revision to the DBVS Hazard Categorization report to better describe the basis for the HC determination. **AC-25.2:** Additional effort should be expended to formulate a robust and defensible MAR assumption that accounts for (a) assumed characteristics of out-of-spec waste, (b) the maximum waste that can be resident in the facility at any point in time without credit for engineered and administrative controls, and (c) address potential accumulation of MAR in the DBVS components.	**RA-150:** Completed review and update the DBVS Hazards Categorization reports (RPP-19143 and RPP-RPT-30883) as necessary to better describe the basis for the hazards categorization determination. **RA-151:** Completed re-evaluation of the Material-At-Risk (MAR) in the DBVS Hazards Categorization report to ensure (a) out-of-specification waste and/or ICV containers have been incorporated, (b) the maximum waste that can be resident in the facility at any point in time without credit for engineered and administrative controls, and (c) address potential accumulation of MAR in the DBVS components. See also Project Activities in response to AC-23.	AC-25.1 AC-25.2	Design Design	Low Low	$0 (complete) $0 (complete)
AC-26 Identification of	**AC-26.1:** Develop a comprehensive list of bulk cold and generated chemicals,	**RA-152:** Completed a comprehensive list of bulk chemicals used to update the PrHOA and the PDSA is documented in RPP-CALC-27737, *TQ's and RQ's of Chemicals Added or*	AC-26.1 AC-26.2	Design	Low	$0 (complete)

Item Response Matrix Section 2, DBVS-ERP Areas of Concern						
Statement of AOC (AC- #)	ERP Potential Mitigation • Component (AC-#.#)	Response Activity • Activity Objective (AC-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
Potential Chemical Hazards – Safety documentation and analysis does not provide for a complete accounting of chemicals used and generated by the DBVS	systematically estimate the associated quantities of each, and specify their locations and forms. **AC-26.2:** The results should be used to validate or update the PrHOA and the PDSA accident analyses. **AC-26.3:** Additionally, the project should use the results to compare the quantities of all the chemical species to the TQ values used to evaluate applicability of the PSM Rule. **AC-26.4:** The project should consider a review of the 14 elements of the PSM Rule and evaluate how application to the DBVS could assist in ensuring safety.	*Generated by DBVS.* **RA-153:** Review the 14 elements of the PSM Rule and evaluate how application to the DBVS could assist in ensuring safety. Document in a project white paper.	AC-26.3 AC-26.4	Design	Medium	$0 (covered by existing staff)

A.3 Suggested Improvements

Item Response Matrix Section 3, DBVS-ERP Suggested Improvements						
Statement of Suggested Improvement (SI- #)	ERP Potential Mitigation • Component (SI-#.#)	Response Activity • Activity Objective (RA-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
SI-1 The DBVS Project should consider additional characterization with regard to organic materials likely to be present in the waste feed.	**SI-1.1:** Testing a representative suite of organic compounds found in waste tanks other than S-109 to determine decomposition products under DBVS operating conditions, especially as they occur in the vitrfier and in the ICVTM plenum, and evaluate their potential to interfere with normal DBVS operation would mitigate these concerns.	**RA-154:** Include the Suggested Improvement as an element of TI-1. Waste feed envelope data will address organics.	SI-1.1	Design	High	Covered in response activities for TI-1
SI-2 The DBVS Project should consider designing separate delivery systems for agitation of the tank during characterization, agitation of the	**SI-2.1:** With the unknown duration to mix the tank contents and delays trying to feed the dryer from one tank whilst mixing another tank for characterization it is recommended that the project use separate systems for each function.	**RA-155:** Perform sensitivity study that evaluates DBVS 201-hour box production cycle and cost/benefit evaluation of increasing system complexity. (coordinate with AC-4)	SI-2.1	Design	Low	$0 (covered by existing staff)

[a] Project Phase Definition

- Design – DBVS activities associated with modifying the final design and leading to DOE Critical Decision 3 (CD-3) authorizing construction.
- Scale Testing – DBVS testing and development activities occurring at laboratory scale (L/S), engineering scale (E/S), or full scale (F/S) (off-site) to support design decisions or validation. Because of the wide range of activities associated with this phase, testing activities will be further categorized into the laboratory scale, engineering scale, and full scale testing programs.
- Construction – DBVS activities involving procurement, construction, and design refinement that occur after receiving CD-3 approval.
- Start Up – DBVS activities associated with start up and cold testing of the installed system. This includes system acceptance testing and operational readiness activities.
- Hot Operations – DBVS activities associated with the operations of the system during it's demonstration and development mission to process up to 50 boxes of immobilized LAW.

Item Response Matrix Section 3, DBVS-ERP Suggested Improvements						
Statement of Suggested Improvement (SI- #)	ERP Potential Mitigation • Component (SI-#.#)	Response Activity • Activity Objective (RA-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
tank during dryer feeding, and delivery to the waste sampler system.						
SI-3 The DBVS Project should consider a common design/supplier for the two sampler systems.	**SI-3.1:** Although the two samplers are located close to each other and are sampling the same materials they are different designs and from two different manufacturers. The project should consider a common design/supplier for these sample systems.	**RA-156:** Modify the design to specify a common design/supplier.	SI-3.1	Design	Low	$0 (per baseline)
SI-4 The DBVS Project should investigate the options/ benefits of operating the dryer in a continuous mode	**SI-4.1:** The logic of having a batch process in the middle of what is basically a continuous process is not ideal. It is recommended that the project investigate the options/benefits of operating the dryer in a continuous mode and see how this affects the overall DBVS process.	Suggested Improvement is addressed through Project Response Activities for TI-2.	SI-4.1	E/S Tests F/S Test S/U	High	Covered in response activities for TI-2
SI-5 The DBVS Project should consider mounting the dryer above the melter in order to simplify the feed systems.	**SI-5.1:** The current dryer product feed to the mixer is extremely complex and has major issues (see comments in section on solids handling). If the dryer were mounted above the mixer it is felt that the feed systems could be significantly simplified.	Suggested Improvement is integrated with Project Response Activities for TI-4.	SI-5.1	Design	High	Covered in response activities for TI-4

Item Response Matrix Section 3, DBVS-ERP Suggested Improvements						
Statement of Suggested Improvement (SI- #)	ERP Potential Mitigation • Component (SI-#.#)	Response Activity • Activity Objective (RA-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
SI-6 The DBVS Project should determine the disposal path for decontaminatio n soil prior to startup.	**SI-6.1:** The route for disposal of soil used to decontaminate the dryer before maintenance should be determined so that an acceptable method for disposal is defined before operation begins.	**RA-157:** Decontamination soil will be transferred in a standard waste box and disposed as solid waste in accordance with Hanford Site solid waste disposal procedures.	SI-6.1	Hot Ops	Low	$0 (per baseline)
SI-7 The DBVS Project should perform additional testing to further assess compositional variability.	Additional considerations for future testing need to consider the following process and composition parameters: **SI-7.1:** Effect of oxidative leaching in the WTP pretreatment facility. This has been noted in the project's planning documentation. **SI-7.2:** Effect of cases of low waste loading, e.g., 5 wt.% Na_2O on processing conditions and glass product. The current flow sheet does not support the addition of additional alkali as a glass former in contrast to WTP. **SI-7.3:** Compositional variation due to uncertainty in analytical and process measurements; could skew ratio of waste to glass formers +5% or more. **SI-7.4:** Effect of feed pile thickness on process, e.g., melt stability and rate, off-gas	Suggested Improvement is integrated with Project Response Activities for TI-1 and TI-2.	SI-7.1 SI-7.2 SI-7.3 SI-7.4 SI-7.5 SI-7.6	E/S Tests F/S Test Design S/U	High	Covered in response activities for TI-1 and TI-2

Item Response Matrix Section 3, DBVS-ERP Suggested Improvements						
Statement of Suggested Improvement (SI- #)	ERP Potential Mitigation • Component (SI-#.#)	Response Activity • Activity Objective (RA-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
	composition, retention of Tc, I, and organic Destruction Removal Efficiency (DRE). **SI-7.5:** Effect of moisture content of feed on process: e.g., pressure fluctuations, gas release, melt stability and rate, off-gas composition, retention of Tc, I, and organic DRE. **SI-7.6:** Effect of recycle on feed properties and process operations.					
SI-8 The DBVS Project should consider developing an "engineered" refractory system to provide better leak-tightness for separate salt layers.	**SI-8.1:** This could consist of chemical additives (e.g., fly ash) to inhibit the mobility of soluble technetium, or of physical changes to the equipment (e.g., redesign of the refractory to ensure that all joints remain under compression).	**RA-158:** Evaluate refractory performance following completion of IDMT and redesign if required.	SI-8.1	F/S Test	Low	$0 (per baseline)
SI-9 The DBVS Project should consider redesigning the ICV™ lid to reduce lid warping potential.	**SI-9.1:** Test report results indicate AMEC may address potential warpage only with a change in the bleed air distribution system. Reliance on effective air distribution, flow rate and temperature may not be prudent; the project should reconsider the lid's design.	**RA-159:** Evaluate lid performance following IDMT to confirm earlier successful 38C test results.	SI-9.1	F/S Test	Low	$0 (per baseline)

Item Response Matrix Section 3, DBVS-ERP Suggested Improvements						
Statement of Suggested Improvement (SI- #)	ERP Potential Mitigation • Component (SI-#.#)	Response Activity • Activity Objective (RA-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
SI-10 The DBVS Project should consider more explicitly stating its project-specific Safety Objectives in its Project documentation.	**SI-10.1:** In order to help resolve these issues, the project should consider the issuance of a statement of overall radiological, chemical and industrial safety objectives… Consideration should also be given to the specific identification of uncertainties in estimation of worker risk with a plan to conduct tests or collect measurements in order to reduce uncertainty.	**RA-160:** Review project documentation for consistency and revise as necessary.	SI-10.1 SI-11 SI-13	Design	Low	$0 (covered by existing staff)
SI-11 The DBVS Project should consider updating its top-tier documents to ensure consistency in safety goals, performance metrics, and implementing requirements.	**SI-11.1:** The project should update top-tier DBVS documents to ensure consistency in safety goals, performance metrics, and implementing requirements. The ORP should issue a statement of overall radiological and chemical and industrial safety objectives. CH2M HILL and AMEC should translate the safety objectives into realistic goals and performance measures. The project should develop a clear statement of the intention and implications of the final Hazard Categorization and perform updates to safety-related project documentation to uniformly reflect those intentions. The project should implement document configuration management and appropriate safety-related review of changes.	Suggested Improvement is addressed through Project Response Activities for SI-10 above.	SI-11.1	Design	Low	$0 (covered by existing staff)

Item Response Matrix Section 3, DBVS-ERP Suggested Improvements						
Statement of Suggested Improvement (SI- #)	ERP Potential Mitigation • Component (SI-#.#)	Response Activity • Activity Objective (RA-#)	Responds to: (XX-#.#)	Project Phase[a]	Priority	Impact Range ($K)
SI-12 The DBVS Project should consider more closely aligning its safety documentation with STD-3009 guidance and giving greater consideration to DBVS as a stand-alone facility with unique operational characteristics.	**SI-12.1:** Consideration should be given to the development of bounding and representative accidents using the hazardous conditions identified and binned in the DBVS PrHOA. Consideration could be given to either the preparation of simple scoping calculations more tailored to the configuration and conditions of the DBVS, or a more comprehensive discussion of why the Tank Farms analysis is applicable to the DBVS. Consideration should also be given to the identification of a set of operational modes (as well as anticipated abnormal conditions and their recovery), followed by a process to verify that the selected controls are applicable and sufficient.	**RA-161:** Revised the PDSA to more closely align with STD-3009 guidance.	SI-12.1	Design	Low	$0 (complete)
SI-13 The DBVS Project should strengthen the presentation of its commitment to ALARA implementation in top tier project documents.	**SI-13.1:** The text of the top tier Project documentation should be modified to accurately reflect the project's commitment to ALARA as well as the other aspects of safety in design and operations.	Suggested Improvement is addressed through Project Response Activities for SI-10 above.	SI-13.1	Design	Low	$0 (covered by existing staff)

A.4 EM-21 Recommendations

Item Response Matrix Section 4, DBVS EM-21 Recommendations					
Statement of EM-21 Recommendation (EM-#)	Project Response Activity • Activity Objective (RA-#)	Responds To: (XX-#)	Project Phase[a]	Priority	Impact Range ($K)
EM-1 The panel believes that Re is the best surrogate for Tc in the cold BV tests; however, results must be validated in hot tests with Tc, prior to full-scale radioactive testing in DBVS.	Recommendation is addressed through Project Response Activities for TI-11.	EM-1	Design	High	Covered in response activities for TI-11
EM-2 The panel recommends that research-scale experiments be conducted to verify the continued validity of the surrogate relationship in glass or to establish a new relationship, if substantial BV process changes that could modify Tc or Re speciation in the glass are implemented.	Recommendation is addressed through Project Response Activities for TI-11.	EM-2	Design	High	Covered in response activities for TI-11
EM-3 Once again, the panel recommends research-scale melt experiments be effectively used to establish boundaries or re-establish correlations to map to the larger scale tests when needed.	Recommendation is addressed through Project Response Activities for TI-2 and TI-10.	EM-3	E/S Tests F/S Test Design S/U	High	Covered in response activities for TI-2 and TI-10
EM-4 The panel makes two suggestions to alleviate this difficulty (Tc in HEPA filters): 1) addition of a removable filter material, such as glass wool, in a	Recommendation is addressed through Project Response Activities for TI-11.	EM-4	Design	High	Covered in response activities for TI-11

[a] Project Phase Definition

- Design – DBVS activities associated with modifying the final design and leading to DOE Critical Decision 3 (CD-3) authorizing construction.
- Scale Testing – DBVS testing and development activities occurring at laboratory scale (L/S), engineering scale (E/S), or full scale (F/S) (off-site) to support design decisions or validation. Because of the wide range of activities associated with this phase, testing activities will be further categorized into the laboratory scale, engineering scale, and full scale testing programs.
- Construction – DBVS activities involving procurement, construction, and design refinement that occur after receiving CD-3 approval.
- Start Up – DBVS activities associated with start up and cold testing of the installed system. This includes system acceptance testing and operational readiness activities.
- Hot Operations – DBVS activities associated with the operations of the system during it's demonstration and development mission to process up to 50 boxes of immobilized LAW.

Item Response Matrix Section 4, DBVS EM-21 Recommendations					
Statement of EM-21 Recommendation (EM-#)	Project Response Activity • Activity Objective (RA-#)	Responds To: (XX-#)	Project Phase[a]	Priority	Impact Range ($K)
filter assembly in front of the HEPA filter to provide a more easily measured material, 2) an off-gas sampler with the gas run through a liquid scrubber (or mass filter) system for calculation of the Tc load.					
EM-5 The panel recommends that additional tests of Tc distribution within the glass be conducted.	Recommendation is addressed through Project Response Activities for TI-11.	EM-5	Design	High	Covered in response activities for TI-11
EM-6 To minimize volatilization of Tc that might arrive in particulate form and/or by in-situ oxidation in the filter, the SMF must be operated well below 311°C.	**RA-162:** Revised flow sheet to operate the SMF < 300 °C.	EM-6	Design	Low	$0 (complete)
EM-7 Quantify rate-controlled parameters of Tc (and Re) loss from fusion layer of cold cap.	Recommendation is addressed through Project Response Activities for TI-11.	EM-7	Design	Low	Covered in response activities for TI-11
EM-8 Maintain a constant cold cap thickness with a cool top surface.	Recommendation is addressed through Project Response Activities for AC-8.	EM-8	F/S Test Design	High	Covered in response activities for TI-8
EM-9 Improve uniformity of feed distribution over the melt surface.	**RA-163:** Demonstrate adequacy of existing feed system in IDMT as part of TI-2. • Conduct IDMT. • Evaluate IDMT results. • Revise design as required.	EM-9	F/S Test Design	High	Low $0 High $100K (additional feed port)
EM-10 Reduce Tc penetration into the refractory liner.	Recommendation is addressed through Project Response Activities for TI-10 and TI-11.	EM-10	Design	High	Covered in response activities for TI-10 & TI-11
EM-11 Limit Tc loss with faster reaction in strong feed pellets.	**RA-164:** Evaluate dryer performance during IDMT and the five cold DBVS runs. **RA-165:** Determine if Tc losses as simulated using Re are acceptable.	EM-11 EM-11	F/S Test S/U Design	High High	$0 (per baseline) Covered in response activities for TI-11

Item Response Matrix Section 4, DBVS EM-21 Recommendations					
Statement of EM-21 Recommendation (EM-#)	Project Response Activity • Activity Objective (RA-#)	Responds To: (XX-#)	Project Phase[a]	Priority	Impact Range ($K)
	RA-166: Modify design as necessary.	EM-11	Design	High	Low $0 High $100K (add pelletizer to dryer)
EM-12 The panel recommends that an effort be made to determine the details of the mechanisms by which metal inclusions are formed as the fastest and most economical way to learn how to eliminate them. The panel recommends lab-scale testing to quantify the rate of formation of inclusions by each fundamental mechanism, because the effects of each mechanism cannot be separated in large-scale tests, where it is impractical or impossible to control and measure local conditions adequately.	Recommendation is addressed through Project Response Activities for TI-10.	EM-12	Design	High	Covered in response activities for TI-10
EM-13 Reduce role of starter path in production of inclusions.	Recommendation is addressed through Project Response Activities for TI-10.	EM-13	Design	High	Covered in response activities for TI-10
EM-14 Reduce role of electrodes in production of inclusions.	Recommendation is addressed through Project Response Activities for TI-10.	EM-14	Design	High	Covered in response activities for TI-10
EM-15 Develop a low-iron glass composition.	**RA-167:** Determined feasibility of very low iron glass. Reference 34005-RT-0006, *DBVS Series 38 Full-Scale Testing SPt1, SPt2, 38A, 38A-1, and 38B Test Report.* For engineering and full scale testing of very low iron glass see Project Response Activities for TI-10.	EM-15 EM-15	L/S Test Design	High High	$0 (complete)
EM-16 Additional testing should be performed to determine the key factors that influence and control: (i) enrichment of Tc in the metal phase; (ii) mass fraction of metal that is formed; and (iii) size and spatial distribution of the metal phase within the product. The results should be used to determine	Recommendation is addressed through Project Response Activities for TI-10.	EM-16	Design	High	Covered in response activities for TI-10

Item Response Matrix Section 4, DBVS EM-21 Recommendations					
Statement of EM-21 Recommendation (EM-#)	Project Response Activity • Activity Objective (RA-#)	Responds To: (XX-#)	Project Phase[a]	Priority	Impact Range ($K)
the preferred combination of process changes to best mitigate the impacts of metal inclusions.					
EM-17 Testing should be performed to determine the effects of including the projected Tc recycle stream into the feed on the Tc enrichment in the metal phase.	Recommendation is addressed through Project Response Activities for TI-10.	EM-17	Design	High	Covered in response activities for TI-10
EM-18 Modeling should be performed to address the expected impact on Tc release of a glass phase with Tc-enriched metal inclusions.	Recommendation is addressed through Project Response Activities for TI-10.	EM-18	Design	High	Covered in response activities for TI-10
EM-19 Leach testing should be performed on prototypical product material composed of glass, metal inclusions, and crystals.	**RA-168:** Leach testing will be performed in accordance with test plans and SAPs for the testing phase and with the DQO for DBVS operations. (reference TI-1 and TI-5)	EM-19	L/S Tests F/S Test Design	High	$0 (per baseline)
EM-20 Test data need to be collected to show that the entire volume of glass meets the requirements.	Recommendation is addressed through Project Response Activities for TI-5.	EM-20	F/S Test Design	High	Covered in response activities for TI-5
EM-21 Interactions of the glass product during leaching should be assessed from all of the waste-package materials, including refractories, metal inclusions, and graphite electrodes.	**RA-169:** Interaction of glass product with refractory during leaching is documented in PNNL-15126, *Laboratory Testing of Bulk Vitrified Low-Activity Waste Forms to Support the 2005 Integrated Disposal Facility Performance Assessment.*	EM-21	L/S Test	High	$0 (complete)
	RA-170: Assess minimization of interaction of glass product with secondary phases through execution of Project Response activities for TI-10.	EM-21	Design	High	Covered in response activities for TI-10
	RA-171: Execute determination of equivalency treatment (DET) testing in accordance with RPP-PLAN-28064, *Testing Plan to Support Determination of Equivalent Treatment for Bulk Vitrification* (reference TI-2).	EM-21	L/S Test F/S Test S/U	High	$0 (per baseline)
EM-22 The apparent disparity between the amount of	**RA-172:** Confirm that crystallization seen in early top-down engineering scale melts has been resolved with the	EM-22	E/S Test	Medium	$0 (per baseline)

Item Response Matrix Section 4, DBVS EM-21 Recommendations					
Statement of EM-21 Recommendation (EM-#)	Project Response Activity • Activity Objective (RA-#)	Responds To: (XX-#)	Project Phase[a]	Priority	Impact Range ($K)
crystallizations seen in samples from engineering-scale and full-scale tests needs to be resolved.	use of castable refractory introduced with the change to bottom-up engineering scale melt tests.				
EM-23 The appropriateness of the container centerline cooling (CCC) heat treatment as a realistic worst case needs to be evaluated.	**RA-173:** Confirm CCC profile is conservative with respect to DBVS container thermal profile by performing additional thermal modeling.	EM-23	Design	Medium	$10K (1 month additional thermal modeling)
	RA-174: Modify the cooling profile used in crucible scale tests to incorporate bounding case as required.	EM-23	Design	Medium	$0 (per baseline)
	RA-175: If the revised cooling profile better matches the DBVS container profile, then incorporate in future balance of mission crucible testing.	EM-23	Design	Medium	$0 (per baseline)
EM-24 The composition of the recycled solids from the SMF needs to be determined, with particular emphasis on sulfur content, as well as halides and Tc.	Recommendation is addressed through Project Response Activities for TI-1 and TI-2.	EM-24	F/S Test Design S/U	High	Covered in response activities for TI-1 & TI-2
EM-25 The amount of leachable Tc in the waste package needs to be better understood and the effects of Tc recycle need to be included.	Recommendation is addressed through Project Response Activities for TI-1, TI-2, and TI-11.	EM-25	Design	High	Covered in response activities for TI-1, TI-2, and TI-11
EM-26 The distribution of high specific gamma activity radionuclides, such as Cs (which is very volatile), to non-glass locations within the waste package needs to be determined.	Recommendation is addressed through Project Response Activities for AC-23	EM-26	Design	Medium	Covered in response activities for AC-23
EM-27 The panel recommends sufficient non-radioactive testing (from small-scale through full-scale at the DBVS) be conducted prior to initiation of radioactive testing.	Recommendation is addressed through Project Response Activities for TI-2.	EM-27	L/S Test E/S Test F/S Test S/U	High	Covered in response activities for TI-2

Item Response Matrix Section 4, DBVS EM-21 Recommendations					
Statement of EM-21 Recommendation (EM-#)	Project Response Activity • Activity Objective (RA-#)	Responds To: (XX-#)	Project Phase[a]	Priority	Impact Range ($K)
EM-28 It is recommended that an evaluation be performed to ensure that the somewhat disparate needs of these functions [i.e., as a test system and a production process demonstration system] are fully met by the design.	Recommendation is addressed through Project Response Activities for TI-1.	EM-28	Design	High	Covered in response activities for TI-1
EM-29 The panel recommends consideration of an alternative SMF material, such as one of the Inconels or Hastelloys, if available to address the concerns above. In addition, the spectrum of potential Cs and Tc compounds should be reviewed to ensure that none are sufficiently volatile at 300°C to present a significant means of transport through the filters.	Recommendation is addressed through Project Response Activities for TI-15.	EM-29	F/S Test Design S/U	High	Covered in response activities for TI-15
EM-30 An integrated flow-sheet model, which includes all secondary waste and recycle streams, needs to be developed.	**RA-176:** Developed an integrated DBVS flow sheet model that includes secondary and recycle streams. Refer to TI-19 for studies and assessment of equipment decontamination factor sensitivities.	EM-30 EM-30	Design Design	Low High	Low $0 (covered by existing staff) High $10K (1 month contract support)
EM-31 It is recommended that expected system performance be reviewed against MACT requirements to ensure the carbon bed is adequately sized and that provisions for replacement and disposal are in place as the material becomes exhausted.	Recommendation is addressed through Project Response Activities for AC-14.	EM-31	Design Constr.	Medium	Covered in response activities for TI-14
EM-32 The results of this work should be reviewed, and if necessary, further testing should be performed with both of these species present. The consequences of these interactions should be evaluated in terms of their impact on the estimated dose from the waste	Recommendation is addressed through Project Response Activities for TI-11.	EM-32	Design	High	Covered in response activities for TI-11

Item Response Matrix Section 4, DBVS EM-21 Recommendations					
Statement of EM-21 Recommendation (EM-#)	Project Response Activity • Activity Objective (RA-#)	Responds To: (XX-#)	Project Phase[a]	Priority	Impact Range ($K)
package and assumptions that are made with respect to shielding.					
EM-33 Testing is recommended to provide a more fundamental understanding of the basis for the observed leachable fraction ratios.	Recommendation is addressed through Project Response Activities for TI-1 and TI-11.	EM-33	Design	High	Covered in response activities for TI-1 and TI-11
EM-34 Eliminate zirconia segregation.	**RA-177:** Modified flow sheet to replace zirconia with zircon. **RA-178:** Validated acceptable performance of zircon in large scale test 38C.	EM-34 M-36 EM-34 EM-36	Design F/S Test	Low Low	$0 (complete) $0 (complete)
EM-35 Add zirconia with soil in the mixer.	**RA-179:** Modified flow sheet to add zircon (replaces zirconia from EM-34) with the soil in the mixer/dryer.	EM-35	Design	Low	$0 (Complete)
EM-36 Substitute fine zircon for zirconia.	Recommendation is addressed through Project Response Activities for EM-34.	EM-36	F/S Test Design	Low	$0 (complete)
EM-37 Consider gravity feed from the mixer/dryer into melter.	Recommendation is addressed through Project Response Activities for TI-4.	EM-37	Design	High	Covered in response activities for TI-4
EM-38 Add ground fault detection system.	**RA-181:** Verified that the power module design includes ground fault detection capability.	EM-38	Design	Low	$0 (complete)
EM-39 Place a curb around the melter.	Accounting of a container breach/glass spill off-normal is addressed through Project Response Activities for TI-3.	EM-39	Design	High	Covered in response activities for TI-3
EM-40 Consider placing the melter in a ramped trench.	Ramp configuration will be considered for the production BVS facility.	EM-40	Future	Low	--

Preliminary River Protection Project (RPP) Baseline Description

Purpose

The purpose of this preliminary baseline description is to describe the supplemental Low Activity Waste (LAW) treatment planning basis for the RPP mission as described in *Alignment of Tank Farms Contractor (TFC) Lifecycle Baseline* (Baseline Change Request [BCR] RPP-06-003, Rev. 1). The RPP baseline planning assumptions, as defined by BCR RPP-06-003, currently in the approval cycle, define a supplemental LAW treatment configuration that includes a 4-line bulk vitrification facility in the 200 East Area and a 4-line bulk vitrification facility coupled with a supplemental pretreatment facility in the 200 West Area. The West Area tanks that are processed through the supplemental LAW Treatment facilities are:

West Area LAW Supplemental Treatment Tanks (Contain Soluble Na)	
Tanks Treated by 2019 (11 tanks)	**Tanks Retrieved by 2019 (16 tanks)**
S-109	S-109
S-105	S-105
SY-101	SY-101
SY-103	SY-103
U-201	U-201
U-202	U-202
U-203	U-203
SX-106	SX-106
U-106	U-106
S-106	S-106
S-103	S-103
	U-103
	SX-103
	SX-115
	S-108
	S-107
Tanks Treated after 2019 (60 tanks)	**Tanks Retrieved after 2019 (55 tanks)**
U-103	SX-104
SX-103	TX-113
SX-115	S-104
S-108	TX-116
S-107	SX-111
SX-104	TX-118

West Area LAW Supplemental Treatment Tanks (Contain Soluble Na)	
Tanks Treated by 2019 (11 tanks)	**Tanks Retrieved by 2019 (16 tanks)**
TX-113	SX-107
S-104	SX-101
TX-116	U-108
SX-111	TX-106
TX-118	TX-112
SX-107	TY-101
SX-101	TX-105
U-108	TX-109
TX-106	S-110
TX-112	SX-110
TY-101	TX-115
TX-105	S-111
TX-109	TX-102
S-110	TX-117
SX-110	TX-114
TX-115	TY-103
S-111	TX-110
TX-102	TY-105
TX-117	SX-114
TX-114	TX-111
TY-103	U-110
TX-110	TX-101
TY-105	SX-109
SX-114	S-101
TX-111	TY-104
U-110	TX-103
TX-101	U-109
SX-109	TX-108
S-101	SX-105
TY-104	T-101
TX-103	TX-104
U-109	T-108
TX-108	TY-102
SX-105	U-105
T-101	T-106
TX-104	TY-106
T-108	U-102
TY-102	T-103

West Area LAW Supplemental Treatment Tanks (Contain Soluble Na)	
Tanks Treated by 2019 (11 tanks)	**Tanks Retrieved by 2019 (16 tanks)**
U-105	T-109
T-106	T-102
TY-106	SX-112
U-102	TX-107
T-103	SX-108
T-109	SX-102
T-102	U-104
SX-112	U-111
TX-107	U-107
SX-108	U-112
SX-102	U-101
U-104	
U-111	
U-107	
U-112	
U-101	
Notes:	
1) The above tanks will contribute soluble sodium to LAW Supplemental Treatment based on BBI inventory and wash factors used to simulate retrieval with water.	
2) West Area tanks not included above are S-102, S-112, 11 TRU tanks, and tanks with no soluble Na (SX-113 and U-204)	
3) Tank schedule is from BCR RPP-06-003, Tank Farm Baseline	

The data and concepts presented here are preliminary in nature, represent the current understanding of supplemental LAW treatment facilities, and may not be representative of data or concepts produced in a Final Technologies Report as currently required by the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) Milestone M-62-08. This data may also not be representative of the supplemental treatment technologies analysis that will be provided in the Tank Closure and Waste Management Environmental Impact Statement (TC & WM EIS) that is currently being prepared. As a result, this preliminary baseline description is not a decision-making document but was prepared for informational purposes only in order to respond to a specific request from the Washington State Department of Ecology (Ecology) relative to HFFACO Milestone M-62-08. No decisions regarding supplemental treatment or pretreatment can or will be made until the Final TC & WM EIS and Record of Decision (ROD) are issued. Based on those analyses, public comments, and the final agency decision, modifications may be needed to baseline planning assumptions, cost analyses, etc.

RPP Mission

The U.S. Department of Energy (DOE) RPP Mission is to retrieve and treat Hanford Site tank waste and close the tank farms to protect the Columbia River. This mission includes retrieving the waste currently stored in the Hanford Site Tank Farms Single-Shell Tanks (SST) and Double Shell Tanks (DST) and delivering the waste to a treatment system that will transform the waste into a form suitable for final disposal. The tank farm tanks and other supporting systems and equipment will then be closed[1] in accordance with appropriate regulatory and statutory requirements.

The principal factor affecting the RPP mission and schedule is treatment of the tank waste. The waste is divided by pretreatment into High Level Waste (HLW) and LAW fractions that will be treated in separate facilities. The Waste Treatment and Immobilization Plant (WTP) is currently under construction and includes separate facilities to treat both HLW and LAW through vitrification processes. Based on the design capacity of the WTP facilities, the entire inventory of Hanford Site HLW will be treated nearly twice as fast as the entire inventory of Hanford Site LAW. This difference in throughput capacity can be remedied by additional LAW treatment capacity know as supplemental LAW treatment. DOE anticipates that if there is sufficient LAW treatment capacity to finish both HLW and LAW treatment missions simultaneously, the duration of the RPP mission will be minimized. Figure 1 highlights the LAW treatment mission superimposed on the entire WTP mission.

[1] Tank farm closure alternatives will be evaluated in the upcoming TC & WM EIS, and DOE's decision(s) will be documented in a Record of Decision (ROD). Public comments on the EIS's analyses may cause modifications to the alternatives and underlying assumptions.

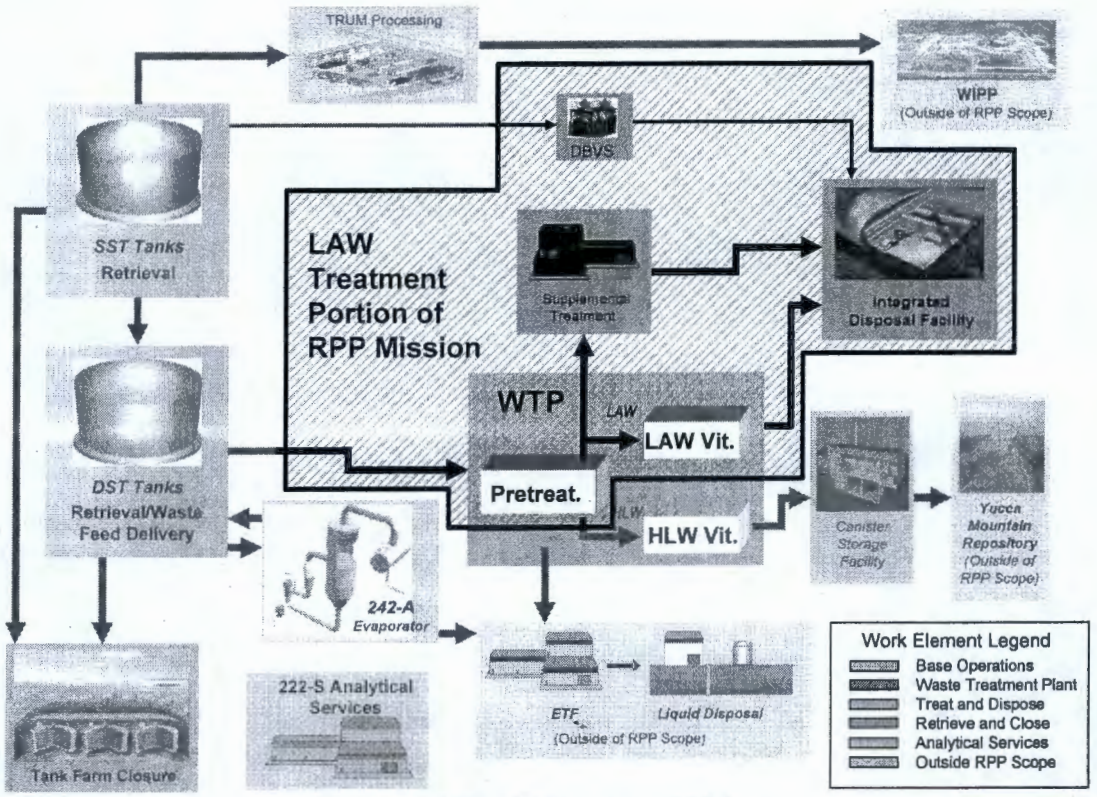


Figure 1, RPP LAW Treatment Mission

Supplemental Treatment Mission Alignment

Previous mission planning concepts included a supplemental LAW treatment facility located near the WTP that was fed exclusively from the WTP pretreatment facility. In 2005, a variety of technical issues combined with budget reductions impacted the RPP mission to such an extent that the WTP and TFC re-planned their baseline mission activities. The delay in the WTP schedule impacted the supplemental LAW treatment mission because of the previous reliance on pre-treated feed from the WTP pretreatment facility. The Tank Farms retrieval mission was also impacted by the WTP delay because the available DST space would be used up before the WTP could begin treating waste. The concept of a supplemental pre-treatment facility feeding a smaller LAW supplemental treatment plant was developed and presented in the BCR RPP-06-03. The employment of a supplemental LAW treatment capacity that is not dependent on the WTP facilities is expected to have the following advantages:

- Start-up and LAW processing could be accomplished prior to WTP start-up. Two DSTs and at least two SSTs could be processed prior to WTP start-up;
- Operation would free additional DST space to support the retrieval mission with out interruption. Two DSTs could be dedicated to support 200 West Area SST retrievals;

- Locating the facility in the 200 West Area could reduce the volume (40%) and quantity (50%) of required cross-site transfers of retrieved wastes from West Area to East Area DST's;
- Minimizes design complexity of a supplemental pretreatment facility by targeting the more dilute 200 West Area LAW feed;
- Avoids overwhelming the WTP pretreatment system with dilute feed that could be processed in a less robust supplemental pretreatment process; and
- Allows LAW processing to continue independent of WTP operational upsets.

A supplemental LAW treatment facility not reliant on WTP for feed, must include some capability to pretreat the tank waste by filtering solids and reducing the cesium concentration. To assure compliance with the existing Nuclear Regulatory Commission (NRC) agreements regarding LAW, cesium must be removed to levels below 0.05 Ci/l Cesium-137 at 7M sodium solution concentration. Supplemental treatment system shielding design considerations may result in additional cesium removal to protect workers from radiation (currently expected to be 0.0086 Ci/l Cesium-137 at 7M sodium solution concentration). This capability could be provided by a supplemental pretreatment facility that is tailored to provide necessary treatment for the targeted waste feed tanks.

The current RPP baseline (BCR RPP-06-003) includes a supplemental pretreatment facility located in the 200 West Area that employs a cesium ion-exchange technology used by the WTP Pretreatment Facility. An alternate supplemental pretreatment technology, fractional crystallization, is currently being developed and tested. While final technology selection will not be made until the TC & WM EIS and ROD are issued, the ion-exchange technology is used as a planning basis because it represents the most mature and understood technology choice.

Hanford Tank Waste Operations Simulator (HTWOS) modeling estimates the LAW feed in the West Area tanks accounts for approximately one-quarter of the total LAW treatment mission. The remaining three-quarters of the LAW feed could be accommodated by the WTP LAW facility and a supplemental treatment facility located in the 200 East Area; both would receive pretreated feed directly from the WTP pretreatment facility.

While final supplemental LAW treatment technology selection will not be made until the TC & WM EIS and ROD are issued, bulk vitrification is used as the planning basis because its modular nature provides the ability to appropriately size the east and west supplemental treatment facilities from both a location and timing standpoint. HTWOS modeling estimates a 4-line bulk vitrification facility in the 200 West Area and a 4-line bulk vitrification facility in the 200 East Area will be sufficient to meet the supplemental LAW treatment mission needs.

The RPP baseline concept presented in BCR RPP-06-003 includes a 4-line bulk vitrification facility located in the 200 West Area that receives feed primarily from a supplemental pretreatment facility starting operation in 2014, and a 4-line bulk

vitrification facility located in the 200 East Area that receives feed from the WTP Pretreatment Facility when it becomes available after 2016. While the addition of the supplemental pretreatment facility represents additional scope to the RPP baseline, it is included in the planning basis because of the mission advantages of eliminating the reliance on WTP startup to begin the LAW treatment mission and avoids further delay of SST tank retrieval. Table 1 provides an estimate[2] of the additional cost associated with a supplemental pretreatment facility.

Cost Category	**Supplemental Pretreatment**	
	Category Costs ($M)*	Phase Costs ($M)*
Project Management	22.0	
Engineering - Design	12.8	
Procurement	9.6	
Construction	14.7	
Startup and Testing	11.5	
Contingency	57.1	
Design-Construct-Startup total		**127.7**
Annual Operating Costs		**11.3**
Decommissioning total		**5.1**

* All costs presented in un-escalated Fiscal Year 2006 dollar basis

Table 1, Supplemental Pretreatment Cost Estimate

Most of the life-cycle costs (63%) for supplemental pretreatment are operating costs over an assumed 20 year period. The baseline operating costs for a supplemental pretreatment facility are estimated to be approximately $11.3 million per year. The 20 years of pretreatment operations represents approximately 25 percent of the WTP LAW pretreatment mission that would not be needed and therefore would result in some offsetting cost savings for WTP operating expenses. The WTP pretreatment facility annual operating costs are estimated to be approximately $27.4 million, resulting in a 20 year operating cost of $548 million. While not directly equivalent to supplemental pretreatment because of differing treatment scope and facility capacity, some percentage of the WTP pretreatment operating cost could be saved due to the operation of a supplemental pretreatment facility. It is not currently possible to estimate any offsetting savings for WTP LAW pretreatment with the current level of WTP operations planning information available.

[2] Estimate details from "Alignment of TFC Life-cycle Baseline", BCR RPP-06-003, Rev. 1

Purpose

The purpose of this preliminary supplemental treatment cost comparison is to present the current understanding of cost data associated with a second Low Activity Waste (LAW) vitrification facility and an equivalently sized full-scale bulk vitrification facility. The data presented here are preliminary in nature, represent the current understanding of supplemental LAW treatment facilities, and may not be representative of data produced in a Final Technologies Report as currently required by the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) Milestone M-62-08. These data may also not be representative of the supplemental treatment technologies analysis that will be provided in the Tank Closure and Waste Management Environmental Impact Statement (TC&WM EIS) that is currently being prepared. As a result, this preliminary supplemental treatment cost comparison is not a decision-making document but was prepared for informational purposes only in order to respond to a specific request from the Washington State Department of Ecology (Ecology) relative to HFFACO Milestone M-62-08. No decisions regarding supplemental treatment or pretreatment can or will be made until the Final TC & WM EIS and Record of Decision (ROD) are issued. Based on those analyses, public comments, and the final agency decision, modifications may be needed to baseline planning assumptions, cost analyses, etc.

Comparison Summary

This comparison describes two alternatives for treating the excess LAW that the Waste Treatment and Immobilization Plant (WTP) LAW facility does not have the capacity to treat during the time the High Level Waste (HLW) treatment mission is accomplished. The HLW treatment mission length is assumed to be the limiting component in the River Protection Project (RPP) treatment mission duration. Cost estimates are developed for a second LAW vitrification facility and 8-line bulk vitrification facility. When presented in un-escalated Fiscal Year (FY) 2006 dollars, the second LAW total life-cycle cost is approximately $3.2 B and the 8-line bulk vitrification total life-cycle cost is approximately $2.6 B. Table 1 summarizes the cost estimate results organized by time sequenced life-cycle phases.

	Design-Construct-Startup Phase ($M)*	**Operations Phase 20 years ($M)***	**Decommissioning Phase ($M)***
Second LAW	1,254	1,771	151
8-line BV	650	1,904	22

* All costs presented in un-escalated FY 2006 dollars

Table 1, Cost Comparison Summary

RPP Mission

The U.S. Department of Energy (DOE) RPP Mission is to retrieve and treat Hanford Site tank waste and close the tank farms to protect the Columbia River. This mission includes retrieving the waste currently stored in the Hanford Site tank farms Single-Shell Tanks (SST) and Double Shell Tanks (DST) and delivering the waste to a treatment system that will transform the waste into a form suitable for final disposal. It is anticipated that the tank farm tanks and other supporting systems and equipment will then be closed[1] in accordance with appropriate regulatory and statutory requirements.

The principal factor affecting the RPP mission and schedule is treatment of the tank waste. The waste is divided by pretreatment into HLW and LAW fractions that will be treated in separate facilities. The WTP is currently under construction and includes separate facilities to treat both HLW and LAW through vitrification processes. Based on the design capacity of the WTP facilities, the entire inventory of Hanford Site HLW will be treated nearly twice as fast as the entire inventory of Hanford Site LAW. This difference in throughput capacity can be remedied by additional LAW treatment capacity known as supplemental LAW treatment. DOE anticipates that if there is sufficient LAW treatment capacity to finish both HLW and LAW treatment missions simultaneously, the duration of the RPP mission will be minimized. Figure 1 highlights the LAW treatment mission superimposed on the entire WTP mission.

M-62-08

HFFACO Milestone M-62-08 is focused on identifying and selecting the most appropriate supplemental LAW treatment technology and implementation baseline to augment the LAW treatment capability provided by the WTP facilities. Early reviews[2] of potential supplemental LAW treatment technologies identified bulk vitrification and steam reforming as the leading technology options for Hanford Site LAW treatment. A Demonstration Bulk Vitrification System (DBVS) project was initiated at the Hanford Site to develop the necessary technical and cost data to compare this technology to a second WTP LAW facility.[3]

---

[1] Tank farm closure alternatives will be evaluated in the upcoming TC & WM EIS, and DOE's decision(s) will be documented in a Record of Decision (ROD). Public comments on the EIS's analyses may cause modifications to the alternatives and underlying assumptions.

[2] CH2M-0303565 letter, CH2M HILL Hanford Group, Inc. Recommendation for Further Testing of Supplemental Testing of Supplemental Technologies, dated September 12, 2003.

[3] As noted above, alternative supplemental treatment technologies will be analyzed in the upcoming TC & WM EIS.

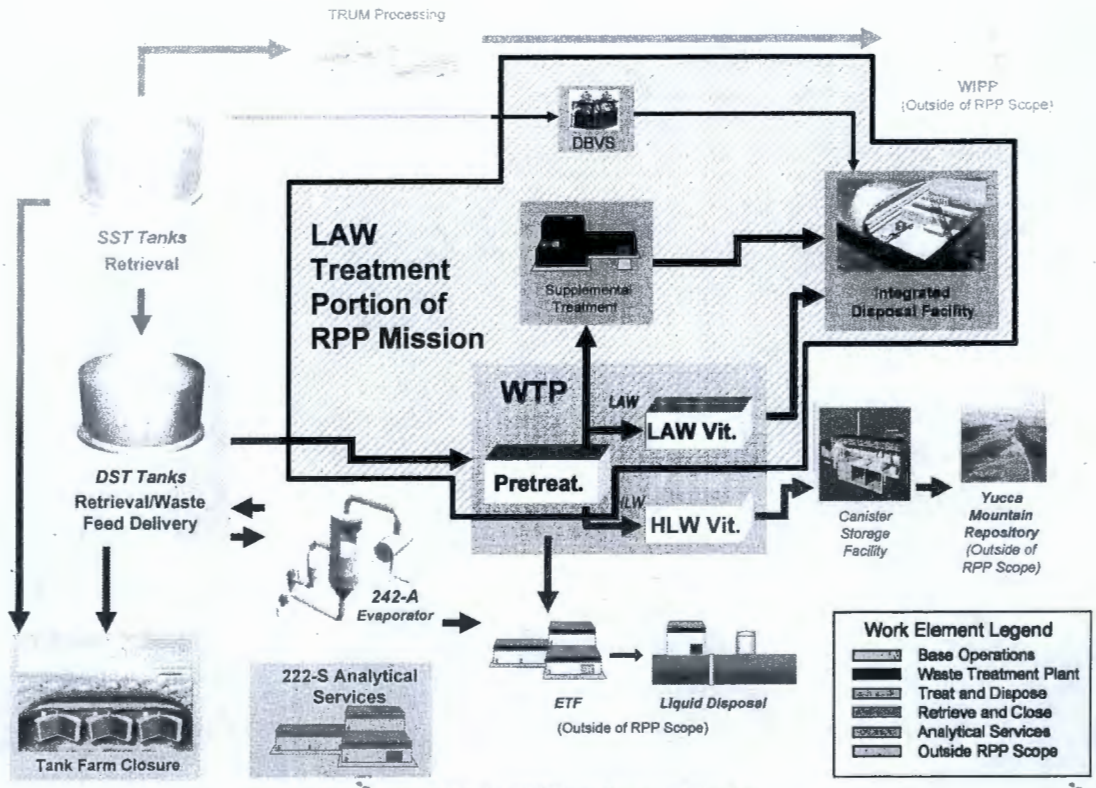


Figure 1, RPP LAW Treatment Mission

Supplemental LAW Treatment Mission

In order to properly size the supplemental LAW treatment facilities, it is necessary to first understand the scope of the supplemental LAW treatment mission. The scope is determined by estimating the difference between the WTP LAW treatment capacity and the capacity needed to ensure the total LAW treatment mission is completed at approximately the same time as the WTP HLW treatment mission. The amount of sodium (Na) processed through the LAW treatment facilities is a measure of facility capacity.

The supplemental LAW treatment mission scope has been estimated using the Hanford Tank Waste Operations Simulator (HTWOS) model. The HTWOS model has been used to evaluate multiple RPP mission planning scenarios. Typically the percent of LAW Na sodium processed by the supplemental LAW treatment facility ranges from 40 percent to 60 percent[4]. The HTWOS model supporting Baseline Change Request (BCR) RPP-06-003 estimates approximately 46 percent of the LAW Na will be processed through the LAW supplemental treatment facility. For purposes of this preliminary cost comparison, it is assumed that the supplemental LAW treatment facility and the WTP LAW facility will each process 50 percent of the LAW Na, and will therefore be equal in capacity.

[4] RPP System Plan, ORP-11242, Rev. 2

Bulk Vitrification

The DBVS project is a Resource Conservation and Recovery Act research and demonstration project intended to demonstrate, using full-scale equipment, the viability of the bulk vitrification technology to adequately treat actual Hanford Site tank waste. The DBVS project completed detailed design in July 2006. An independent Expert Review Panel (ERP) composed of nationally recognized experts in relevant fields reviewed the project and concluded there were no fatal flaws preventing the acceptable completion of the DBVS project. The one-melter DBVS project is intended to serve as the starting point for developing a production-scale, supplemental treatment facility employing sufficient melter lines that, in combination, would meet the necessary supplemental LAW treatment capacity, if bulk vitrification is selected as the supplemental treatment technology as a result of the TC & WM EIS and ROD.

As discussed above, for comparison purposes the supplemental LAW treatment facility will be modeled with the same waste throughput capacity as the WTP LAW facility. The modeling assumptions in Tank Farm Contractor Operation and Utilization Plan (TFCOUP), Rev. 6 assume the initial WTP LAW melter capacity is enhanced to achieve a net glass production rate of 34 Metric Tons of Glass per day (MTG/d)[5]. When adjusted for an average modeled Na loading of 13 percent (~ 17 percent Na_2O loading), the WTP LAW processing capacity is ~ 4.42 metric tons of Na per day (MTNa/d). This is the target sodium processing rate for the supplemental LAW treatment facility.

A full production capacity bulk vitrification facility will contain multiple melter lines that effectively replicate the DBVS melter system. The number of melter lines needed to meet the supplemental LAW treatment capacity will dictate the size of the supplemental bulk vitrification treatment facility. HTWOS model calculates an average Na loading at 15 percent (~ 20 percent Na_2O loading) for bulk vitrification. Using 15 percent Na loading and a net bulk vitrification glass production rate of 3.66 MTG/d[6] for each melter line, it is estimated[7] that 8 melter lines provides the same LAW treatment throughput as second LAW vitrification facility.

Cost Comparison

While the M-62-08 Technologies Report will likely develop a more customized implementation scenario for each considered technology, there is sufficient baseline information available today to develop a rough cost comparison between a second WTP LAW vitrification facility and a full capacity bulk vitrification facility with 8 melter lines. The following simplifying assumptions were used in the development of the cost comparison:

- Both facilities were assumed to be located in the same location near the WTP where the feed will be provided from the WTP Pretreatment facility.

---

[5] Tank Farm Contractor Operation and Utilization Plan (TFCOUP), HNF-SD-WM-SP-012, Rev. 6, Table A-1, Section A2.2.1

[6] TFCOUP Rev. 6, Table A-1, Section A2.3.2

[7] (4.42 MTNa/d)/(.15 MTNa/MTG{waste loading])/(3.66 MTG/d per melter line)=8.05 melter lines

- Costs associated with Hanford Site infrastructure service upgrades necessary to support the facility (e.g., new electrical substation) were assumed to be equivalent for both technologies and therefore are not presented in this comparison.
- Consistent with life-cycle modeling assumptions from TFCOUP, Rev. 6, a twenty-year processing duration was used when calculating operating costs.
- Costs were based on data developed for FY 2006 baseline work products (WTP May 2006 Estimate at Completion and Tank Farms BCR RPP-06-003) and are presented in FY 2006 dollars. Contractor fees are not included.
- Analytical Laboratory needs were considered equivalent. No new analytical capability was included in either comparison.
- Differences in the disposal costs between the two supplemental treatment options was insignificant to the evaluation and therefore not included in the cost comparison.
- The difference in disposal costs were determined based on baseline assumptions for IDF construction and operations, and the volumetric use of IDF space to a LAW waste form (either LAW canisters or BV boxes).

Second LAW Vitrification Facility

The cost of a supplemental treatment plant consisting of a second LAW vitrification facility was estimated from WTP baseline costs by duplicating the WTP LAW facility with the following key differences:

- Some support systems provided by the WTP Balance of Facilities buildings will have to be provided with appropriate capacity, including:
  - Uninterruptible power supply;
  - Glass former supply;
  - Compressed air supply;
  - Process and heating steam supply; and
  - Chilled water supply.
- It is assumed that there are no research and development costs associated with the second LAW vitrification facility, since the technology is assumed to be essentially identical to WTP LAW.

The estimate for construction of the second LAW vitrification facility is based in the WTP December 2005 Estimate at Completion and has been adjusted to reflect the assumptions and estimates in the WTP May 2006 Estimate at Completion. Simplifying assumptions were applied to account for differences in design, procurement, construction and balance of facility support systems. The operating cost was based on estimates developed to support the RPP life-cycle baseline (BCR RPP-06-003) with assumptions adjusted and updated to reflect the current operating plans for the WTP.

Table 2 summarizes the estimated life-cycle costs divided into three time sequenced phases over the life-cycle of each facility. Key assumptions are presented in Appendix A.

Bulk Vitrification Facility

A supplemental treatment plant consisting of eight bulk vitrification melter lines can be estimated by replicating the one melter line DBVS project costs but recognizing that all costs should not simply be multiplied by eight. The Research & Development (R&D) and testing work associated with DBVS are considered sunk costs, not capital costs, and are excluded from the production scale system costs.

There is an economy of scale associated with some project costs (e.g., design, startup, and project management) that result in a lower multiplication factor than those items that are replicated eight times (e.g., melter line equipment) from the DBVS project. The costs presented here are based on DBVS project costs (BCR RPP-06-003) and have been adjusted by RPP life-cycle planning assumptions to represent estimated costs for an eight line bulk vitrification facility.

Table 2 summarizes the estimated life-cycle costs divided into three time sequenced phases representing the life-cycle of the facility. Key assumptions are presented in Appendix A.

Cost Category	**2nd LAW Facility**		**8-line BV Facility**	
	Category Costs ($M)*	Phase Costs ($M)*	Category Costs ($M)*	Phase Costs ($M)*
Project Management	Included below		27.5	
Engineering - Design	77.8		24.9	
Procurement	426.6		236.7	
Construction	480.5		146.9	
Startup and Testing	184.0		7.8	
Contingency	85.5		206.2	
Design-Construct-Startup total		**1,254.4**		**650.0**
Operations (20 years) total		**1,770.5**		**1,903.5**
Decommissioning total		**151.2**		**22.3**
Total Life-cycle		**3,176.1**		**2,575.9**

* All costs presented in un-escalated FY 2006 dollar basis

Table 2, Supplemental Treatment Cost Estimates

Scope Uncertainties

The cost information presented above was specifically gathered to represent two supplemental LAW treatment facilities. Cost information was derived from baseline estimates that reflect project assumptions at the time the cost information was developed. As information for both technologies matures and the RPP mission is more clearly defined, more mature and reliable cost comparisons can be made. Key areas of potential change include:

Bulk Vitrification Confinement Systems – As the DBVS design matures, questions raised regarding the acceptability of the DBVS confinement systems may dictate a more robust confinement system that could consume some of the project contingency.

LAW Treatment Capacity Needs – Emerging data regarding the amount of process Na necessary to be added to the tank waste during processing suggests the LAW treatment capacity may have to be increased by as much as 50 percent. This could double the supplemental LAW processing throughput evaluated in this paper. While these discussions are preliminary and final outcomes will not be known for some time,[8] flexibility in deploying the supplemental treatment system could be an important attribute.

This Appendix presents key cost estimating assumptions used to develop the Second LAW Vitrification Facility and the Bulk Vitrification Facility cost estimates. Detailed assumptions can be found in respective contractor baseline documents (WTP May 06 Estimate At Completion (EAC) and Tank Farm Contractor BCR RPP-06-003).

[8] Final outcomes are dependent on the completion of analyses in the TC&WM EIS and issuance of a ROD.

Appendix A – Cost Estimate Assumptions

Second LAW Assumptions

The second LAW vitrification facility estimate was initially developed to support a specific construction and operating scenario that assumed a four-year construction cycle leading to operations in 2017. The project funding profile was built using direct correlations to the WTP LAW and Balance of Facility (BoF) budgeted costs as represented by the December 2005 EAC. The cost estimate was then adjusted to be consistent with the estimates and assumptions in the May 2006 EAC. Estimates for WTP operating and Decontamination & Decommissioning (D&D) costs are based on the assumptions in the RPP life-cycle baseline as defined by BCR RPP-06-003. The following assumptions were used to adjust EAC estimates to reflect the second LAW vitrification project scenario:[9]

1. 15 percent of the WTP LAW and BoF Engineering budget is for Environmental & Nuclear Safety and Construction. Permitting costs are included in the environmental support.
2. There are no changes to the vendor/fabricators.
3. No Research & Technology (R&T) work is included since all the technical issues in LAW and BoF have been resolved.
4. Project Management and Bechtel National, Inc. Overhead Services are based on the same percentage as accounted for in the WTP LAW.
5. Contingency for the facility is equivalent to Bechtel Risk Analysis Contingency (BecRAC) for the WTP LAW facility.
6. No additional LAB costs are included.
7. BoF facilities required to support the second LAW facility include:
   a. Common Scope – required but scoped smaller to account for the reduced BoF facilities.
   b. Site Work – a 25 percent factor is applied to account for the reduced BoF facilities.
   c. Administration Building – the existing facility is assumed to be sufficient.
   d. Cooling Tower Facility – although the existing facility may be large enough but a 15 percent allowance for modifications is provided.
   e. Fire Water Pump House Facility – the existing facility is assumed to be large enough.
   f. Fuel Oil Facility – the existing facility is assumed to be large enough.
   g. Diesel Generator – to meet the Uninterruptible Power Supplies loads for the second LAW facility an additional 750 kVA generator will need to be added. A 25 percent factor is added for the diesel generator work.
   h. Glass-Former Storage Facility – another facility is included in the estimate.

---

[9] Based on the TC&WM EIS analyses, public comments, and the final agency decisions published in a ROD, these assumptions and associated cost analyses are subject to modification.

i. Guard House – the existing facility is assumed to be large enough.
j. Melter Assembly Building – the existing facility can meet the needs of the second LAW Facility.
k. Chiller Compressor Plant –
   - An additional 1500 ton chiller is required to support the second LAW facility. A 25 percent cost factory has been included for the procurement and installation of an additional chiller.
   - An additional 8,600 scfm is required to support the second LAW facility. A 25 percent cost factory has been included for the procurement and installation of an additional compressor.
l. Steam Plant Facility – An additional boiler is required to support the second LAW facility. A 25 percent cost factor has been included for the procurement and installation of an additional boiler.
m. Wet Chemical Storage Facility – the existing facility is assumed to be large enough.
n. Water Treatment Building – the existing facility is assumed to be large enough but a 15 percent allowance for modifications is provided.
o. Non-Dangerous, Non-Radioactive Effluent Facility – the existing facility is assumed to be large enough.
p. Switchgear Building – another facility sized to be one-third of the existing facility is included in the estimate. Engineering estimate is the same as the existing building.
q. ITS Switchgear Building – the existing facility is assumed to be large enough.
r. Central Waste Stored – no facility changes are required.
s. Erected Tanks – Process/Portable - no facility changes are required.
t. Failed Melter Storage - another facility sized equivalent to the existing facility is included in the estimate.
u. BoF Switchgear Building – another facility sized to be one-third of the existing facility is included in the estimate.
v. Spent Melter Staging Facility - no facility changes are required.
w. Simulator Facility – the existing facility is assumed to be large enough.
x. Anhydrous Ammonia– another facility identical to the existing facility is included in the estimate.

8. Commissioning preparation and start-up work for the first LAW facility is completely applicable to the second LAW facility. This has resulted in commissioning preparation for only the one-year prior to startup and actual facility operations.
9. Commissioning and start-up costs for BoF facilities are the same fraction of the Plant Equipment costs as in the December 2005 EAC.
10. There is no R&T required for the second LAW facility.
11. There is no BoF process engineering required.
12. Site work Civil/Structural is 25 percent of the initial estimate.
13. Management of BoF Construction is assumed to be 20 percent of the WTP estimate.

Bulk Vitrification Assumptions

Cost estimates for the bulk vitrification supplemental treatment facility are based on the RPP life-cycle baseline estimate for two 4-line bulk vitrification facilities as described in BCR RPP-06-003. The baseline estimates accounted for the similar design and startup efforts needed to support the two bulk vitrification facilities and it has been assumed that equivalent economies of scale would apply to one 8-line bulk vitrification facility. Key assumptions from the baseline bulk vitrification cost estimates include[10]:

- After CD-4 (Hot Startup) approval is received, assumed Time Operated Efficiency (TOE) for the first 8 months is expected to be ~ 35 percent to ramp-up.
- TOE for the operational life-cycle of bulk vitrification facilities will average 75 percent.
- Facilities will be Hazard Category 3, PC2.
- No secondary containment system is required.
- Liquid effluent waste from the bulk vitrification facilities will be treated at Effluent Treatment Facility (ETF) at no cost to the Tank Farm Project.
- Liquid effluents from Supplemental Treatment are currently assumed to be transferred to the Effluent Treatment Facility for further treatment prior to disposal without any recycle. If during testing of the DBVS it is found that recycle of a portion of the liquid effluent is required this capability will be designed into the production Supplemental Treatment system.
- Transport of In Container Vitrification from the bulk vitrification facilities to Integrated Disposal Facility will be performed by Solid Waste Management using their 200-ton trailer (driver is paid for by bulk vitrification operations).
- Project Management, Permitting and Project Support Costs (and scope) end upon obtaining CD4. These costs are then included in Operations.
- Costs for developing and obtaining approval on the RCRA Part B Operating Permit, for an 8-line system is assumed to be 150 percent of the cost for a 4-line system.
- Conceptual, Preliminary and Final Design for an 8-line system is 50 percent of the cost for a 4-line system.
- Procurement, Fabrication, and Site Preparation are 8 times DBVS estimated cost times 0.90 (10 percent reduction due to economy of scale).
- Construction is 8 times DBVS estimated cost times 0.95 (5 percent reduction due to economy of scale).
- Startup and Testing is 8 times the DBVS estimate.
- Operation costs are the annualized operating costs based on DBVS, and includes all materials, power, supplies, maintenance and management/oversight.

---

[10] Based on the TC&WM EIS analyses, public comments, and the final agency decisions published in a ROD, these assumptions and associated cost analyses are subject to modification.

Appendix – A, Cost Estimate Assumptions

- No box sampling will be required after DBVS ($214,600 per box cost avoidance), therefore no analytical costs are planned.
- An efficiency of 25 percent is assumed in operational costs by running 8-lines in a co-located area.
- D&D cost is assumed at 8 times DBVS times 0.5 (economy of scale savings for mobilization & physical demolition).
- Hanford Atomic Metal Trades Council will supply operators, Health Physics Technicians and Industrial Hygiene Technicians.

Batch: Document Separator

isbat-DOCSEP

Hanford's ISEARCH Kodak Scanner Sheet (10.2 bar resolution)

(Feed top edge into scanner transport first.)

Batch: Document Separator

isbat-DOCSEP