

Pre-Decisional Sodium Bearing Waste Technology Development Roadmap FY-01 Update

Gary McDannel

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*Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho, LLC*

**Pre-Decisional Sodium Bearing Waste Technology
Development Roadmap
FY-01 Update**

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**Idaho National Engineering and Environmental Laboratory
Idaho Falls, Idaho 83415**

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ABSTRACT

This report provides an update to the Sodium Bearing Waste (SBW) Technology Development Roadmap generated a year ago. It outlines progress made to date and near-term plans for the technology development work necessary to support processing SBW. In addition, it serves as a transition document to the Risk Management Plan (RMP) required by the Project per DOE Order 413.3, “Program and Project Management for the Acquisition of Capital Assets.” Technical uncertainties have been identified as design basis elements (DBEs) and captured in a technical baseline database. As the risks are discovered, assessed, and mitigated, the status of the DBEs in the database will be updated and tracked to closure.

SUMMARY

Dispositioning sodium-bearing waste (SBW) at the Idaho National Engineering and Environmental Laboratory (INEEL) remains a top priority for the State of Idaho and the Laboratory. This waste exists in liquid form and is contained in underground stainless steel tanks that do not comply with the Resource Conservation and Recovery Act (RCRA). Removing this waste from these tanks and treating it by the end of 2012 remains a commitment in the Settlement Agreement between the State of Idaho and the Department of Energy.

The previous version of the roadmap outlined key technology development activities necessary to support treatment of SBW. These are logically grouped into the following areas: (1) characterization of SBW and glass, (2) melter material balance and operation, (3) off-gas characterization and treatment, and (4) secondary waste generation and disposal.

Ideally, each of these areas would be addressed sequentially, since a change in SBW composition, for example, would alter melter and off-gas performance. However, due to the expedited schedule for treating SBW, the technology development efforts are being conducted in parallel. Development efforts in fiscal year 2001 concentrated on the first three areas, with the following major outcomes:

- Characterization of SBW in one of the four planned 300, 000-gallon storage tanks (WM-180) was completed.
- Compositional variation studies on 64 glass formulations were conducted to establish preliminary waste form qualification boundary conditions for feed mixtures.
- Pilot and bench-scale testing was completed during three separate test runs. Although physical properties of the glass produced have been within acceptable limits, a significant discovery resulted with formation of a sulfate layer in the melt. This anomaly was not predicted by the crucible tests being used for waste formulation development indicating a potential scale-up issue. Waste loading was reduced to 20% (for WM-180 SBW) and frit formulations adjusted in an attempt to compensate. Results are pending, but appear favorable.
- Off-gas speciation was evaluated from the pilot runs. Data from these tests has been collected but final analysis has not been completed. Cesium volatility appears higher than expected. In laboratory studies, removal efficiencies for both elemental and oxidized forms of mercury using granular activated carbon have exceeded 99%. However, the speciation of mercury throughout the off-gas treatment process remains largely undefined.

- Cold-crucible induction melter technology being utilized in France and Russia was studied with favorable preliminary indications.

Technology development activities funded by EM-40 and -50 for the next three years include (1) continued characterization of the remaining SBW tanks, (2) continued compositional variation studies for waste form qualification, (3) melt-rate studies with bench and pilot scale melters, (4) evaluation of cold crucible induction melter technology, (5) process modeling, and (6) improved waste loading. Funding levels are projected to increase, but lower-than-anticipated funding in FY-01 and FY-02, combined with the discoveries, contributes to increased uncertainty in finalizing the process flowsheet.

As the Project progresses through each critical decision (CD) point outlined by DOE Order 413.3, “Program and Project Management for the Acquisition of Capital Assets,” it will be imperative that the technical issues are sufficiently addressed. The first CD point (CD-0, Approve Mission Need) is scheduled to occur in the 1st quarter of FY-03. Based on uncertainties to date, continued focus is required to ensure that these risks are identified and mitigated before obtaining CD-0 approval.

In addition to the technology development activities completed to date, the pre-conceptual Project related activities included development of a risk management plan. In accordance with the requirements of DOE Order 413.3, risk assessment reports identify the technological risks and uncertainties, as well as other programmatic risks, that must be addressed to ensure successful Project completion. Similarly, a primary function of the SBW Technology Development Roadmap is identification of technical uncertainties and assurance that these uncertainties are properly managed (scheduled, prioritized, mitigated, etc.). Therefore, primarily to avoid redundancy, it was deemed appropriate to transition the database of technical uncertainties in the roadmap over to the risk management plan. This approach will improve integration of the technology development activities with the needs and priorities of the construction Project planned for dispositioning SBW. It is also consistent with the planned deployment of technologies in support of plant design, construction, and operation.

In summary, this Roadmap update is limited in scope to statusing activities outlined in last year’s Roadmap, identifying pending high-risk items, and establishing a transition to the risk management plan.

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Pre-Decisional Sodium Bearing Waste Technology Development Roadmap FY-01 Update

1. INTRODUCTION AND BACKGROUND

The INEEL has approximately one million gallons of sodium bearing waste (SBW) requiring treatment. Historically, SBW has been blended with high-level raffinate from nuclear fuel reprocessing and has been calcined. More recently, a revised high-temperature flowsheet was developed, and SBW was successfully calcined without blending. However, for a number of varied reasons, the Department of Energy (DOE) is re-evaluating this treatment methodology and has drafted an Environmental Impact Statement that has identified alternatives for treatment of SBW. One such alternative is direct vitrification. At the direction of DOE, the technology development efforts over the past year have concentrated on this technology.

To guide technology development for treatment of SBW, roadmapping was employed and a report issued a year ago (Olson, Murphy, and Perry 2000). The Roadmap was used during the last year to guide the technology development activities. Section 2.0 discusses the progress made to date and additional uncertainties identified.

As required by DOE Order 413.3, “Program and Project Management for the Acquisition of Capital Assets,” the Project has developed a risk management plan (RMP). The RMP serves essentially the same function as the roadmap by identifying the technological risks and management thereof. Consequently, this update to the roadmap is abbreviated and serves primarily as a transition document to the RMP.

DOE Order 413.3 outlines critical decision (CD) points for large capital projects. Achieving approval at each CD point is necessary for the project to remain viable. The “Office of Environmental Management Project Definition Rating Index Manual” (EM-PDRI) identifies those items considered important for each CD point and scores each project according to established criteria. Of particular importance to the SBW Vitrification Project is the upcoming approval at CD-0 (Approve Mission Need). The technical criteria, in order of priority, are alternative analysis, systems engineering, technology needs identified and demonstrated, functional requirements, design basis, and waste acceptance. The rating index requires a relative high maturity level and progression in the area of technologies being applied to the project.

2. ROADMAP PROGRESS REPORT

Last year's Roadmap was used as a guide to focus the technology development activities. It identified three possible paths for treating SBW: (1) direct vitrification, (2) solvent extraction, and (3) cesium ion exchange. At the beginning of FY-01, DOE directed that the technology development efforts focus on direct vitrification. Previous technology development efforts had primarily focused on cesium ion exchange with grouted waste to the Waste Isolation Pilot Plant (WIPP). This transition has forced a steep learning curve at INEEL regarding vitrification. This redirection has been supported significantly by other national and university laboratories and other DOE sites where vitrification technology is considerably advanced.

The FY-01 Roadmap identified several uncertainties (67) that have subsequently been prioritized. In addition, new uncertainties have been added based on knowledge gained (e.g. through discoveries) during the year. These uncertainties have been mapped to design basis elements (DBEs) and are contained in a technical baseline database for tracking purposes (Taylor, Barnes, and Lauerhass 2001).

The highest priority tasks, the progress made to date, and the plans for future resolution are summarized in Table 1 below. The Priority 1 items are those judged to impact process feasibility and the basic facility design and footprint. Out-year plans are contained in Detailed Work Plans (DWP) for the next three fiscal years. The Priority 1 DBEs are grouped according to the following categories:

- Characterization of SBW and glass
- Melter material balance and operation
- Off-gas characterization and treatment
- Secondary waste generation and disposal

Table 1. Listing of High Priority Design Basis Elements, Status and Plans.

Design Basis Element	Status – FY-01	Plans – DWP '02-'04
Characterization of SBW and glass		
Total volume and composite SBW feed composition	Sampled and completed analysis of WM-180 – one of four planned SBW tanks	Sample remaining tanks following evaporation
Representativeness of cold simulants in melter tests	Glass from simulants was compared to glass from hot waste (WM-180) to validate simulant composition and behavior. Off-gas consistency was not evaluated.	Develop cold simulants for remaining tanks
Composition envelope for acceptable glass feed	Preliminary Compositional Variation Studies (CVS) were completed.	Continue CVS analysis
Iodine-129 concentration in SBW feed	I-129 is expected to be sufficiently low, but if not, could cause secondary waste disposal issues. Further characterization of SBW tanks required.	Analyze remaining tanks for I-129

Design Basis Element	Status – FY-01	Plans – DWP ‘02-‘04
Characterization of SBW and glass (continued)		
Noble metals concentration in SBW feed	WM-180 characterized. Remaining SBW tanks require characterization.	Sample remaining tanks for noble metals following evaporation. Evaluate formulations and alternative melter technologies (e.g. bottom drain to avoid accumulation).
Waste loading in glass	Pilot studies generated unexpected sulfate layer in melt at original waste loading. Pilot scale tests at new waste loading (20%) not yet completed. Sulfate layer formation appears to be controlling factor for glass.	Evaluate alternative formulations and melter technologies to increase waste loading
Melter material balance and operation		
Speciation and partitioning of sulfate in melter	Pilot studies tested one glass formulation. May affect off-gas partitioning. Results being analyzed.	Conduct pilot tests
Partition factors for feed species in melter	One pilot study and some laboratory studies completed, but final analysis remains. Not all species of concern evaluated (e.g. Hg). Scale-up issues emerging.	Conduct additional laboratory and pilot tests.
Safe Handling of melter feed during abnormal shutdown	None in FY-01– previous fire/explosion concern raised with calcination from mixing sugar (reductant) and SBW – nitrated organics	Evaluate direct reductant feed to melter/alternative melter technology. Conduct preliminary safety analysis.
Disposition/Handling of noble metals in melter	Calculations indicate minimal accumulation with SBW	Analyze remaining tanks for noble metals
Off-gas characterization and treatment		
Solids scrubbing efficiency in acid venturi scrubber	ASPEN model completed but not validated during pilot runs.	Deferred to FY-03
Partitioning of acid gases and Hg during quench/scrubbing operations	Pilot test completed, but analysis remains to confirm ASPEN model. Hg partitioning only tested in laboratory with uncertain results.	Deferred to FY-03
Effects of other species on Hg polishing effectiveness of GAC	Hg partitioning evaluated in laboratory tests with uncertain results.	Deferred to FY-03
Will facility comply with MACT	Current baseline assumes MACT compliance.	None

Design Basis Element	Status – FY-01	Plans – DWP ‘02-‘04
	Secondary Waste generation and disposal	
GAC TCLP performance	Calculations indicate Hg (as HgCl ₂) may leach above TCLP.	Deferred to FY-04
Disposal requirements for mercury-containing secondary wastes	“Demonstration of equivalency waiver” may be required for disposal.	Deferred to FY-04
Should Sr-90 be extracted from the scrubber blowdown	Baseline assumption assumes no removal required.	None

Analysis of the above table reveals that the Priority 1 elements have increased during the past year, largely attributable to discoveries associated with sulfate and mercury. Resolution of these key issues is required before a process flowsheet can be finalized. Also note that a number of the priority 1 elements have been deferred beyond CD-0 (Approve Mission Need). Although this may be acceptable for obtaining CD-0 approval in FY-03, continued focus will be required to ensure these elements are addressed prior to Title 1 design in FY-05 (CD-1 – Approve Preliminary Baseline Range). Of the 17 Priority 1 DBEs identified above, 135 lower-priority DBEs are also contained in the technical baseline database. Each of these will go through the risk screening and mitigation process outlined in the RMP. Some of these will be accepted as is, but the majority will require some type of action to resolve.

Appendix A shows the detailed EM-40 or -50 funded activities contained in the DWP for FY-02 through FY-04. (Note: EM-50 tasks are only shown through FY-02.) Of particular concern is the limited number of bench and pilot plant studies planned before CD-0. To date, these studies, conducted at Clemson University and Pacific Northwest National Laboratory, have been instrumental in identifying potential issues. With only bench-scale testing currently scoped in FY-02, the potential for scale-up issues remains. Although these uncertainties are thought to be solvable through additional testing, resolution prior to CD-0 may not be supported. In the interim, the Project is typically forced to make conservative assumptions relative to equipment and process needs that tend to increase project cost estimates.

Although not clear from the schedule, the tasks associated with HM125, Pilot Melter Procurement and Testing, are for a cold-crucible induction melter (CCIM), not the baseline joule-heated melter. Increasing the INEEL (and DOE complex) knowledge base of this melter technology was deemed important relative to alternative analysis in preparation for CD-0. Furthermore, due to potential scale-up issues identified, deployment of a larger scale joule-heated melter either to the INEEL or in support of the INEEL is planned, but will not be on line for several years (about 2012).

As shown by Figure 1, the funding profile for technology development work is shown to increase throughout the DWP planning horizon. Not shown is the funding reduction in FY-01 from \$8.2M to \$6.4M. This reduction has been compensated by increased funding in FY-02 relative to last year’s roadmap estimate of \$2.8M. However, with the discoveries that occurred in FY-01, finalizing the process flowsheet prior to CD-0 remains uncertain. It is anticipated that the increased funding in FY-03/04, provided it is retained, will be essential to resolve key issues such as sulfate layer accumulation, scale-up issues, and mercury speciation prior to CD-1, which is estimated to occur in FY-05.

SBW Technology Development Projected Funding Profile

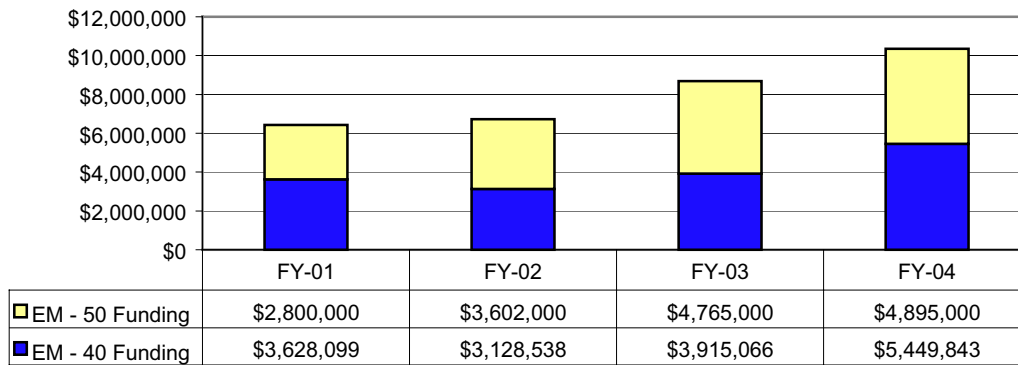
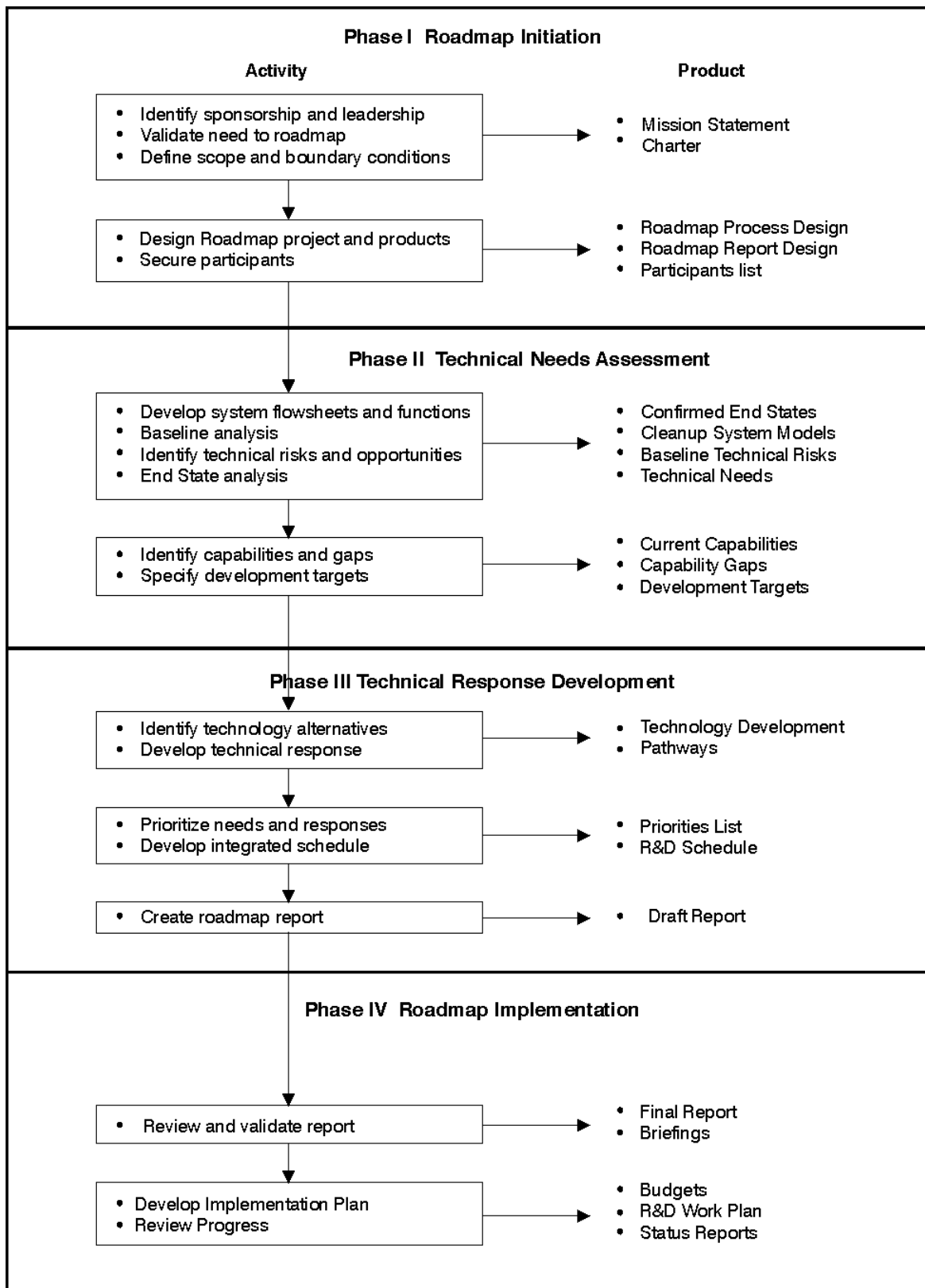


Figure 1. SBW Technology Development Projected Funding Profile.

Appendix B provides the planning schedule for the SBW Vitrification Project. The schedule illustrates, at a high-level, the technology development tasks funded by EM-40 to support the critical decision points in the Project. As mentioned above, currently scoped activities will not allow verification of the process flowsheets until CD-1. The Risk Assessment Reports, not shown specifically on the schedule, but included under the Pre-conceptual Project Management activity, will be completed prior to CD-0. This document will reflect the status of the technical uncertainties for the Project at that point in time. The various CD review teams and officials will then assess the viability to proceed based upon the perceived risks and mitigation plans. Also note that the schedule does not identify significant technology development activities in support of the project during the construction phase and beyond. Additional operating funds will be sought during these phases to ensure pilot plant operation can be used to support the project and subsequent operations.

3. TRANSITION TO RISK MANAGEMENT PLAN

A primary function of roadmapping is identification and management of technical risk. Likewise, the Risk Management Plan (RMP), although broader in scope, has the same function. The four major phases of roadmapping – (1) initiation, (2) needs assessment, (3) response development, and (4) implementation – are effectively addressed by the RMP. This is illustrated by comparing Figure 2, Roadmapping Process and Products Diagram, (EM S&T Roadmapping 2000) with Figure 3, Work Breakdown Structure for the RMP (Bryan 2001).



01-GA51025-01

Figure 2. Roadmapping Process and Products Diagram (as provided in the EM-50 Draft Guidance).

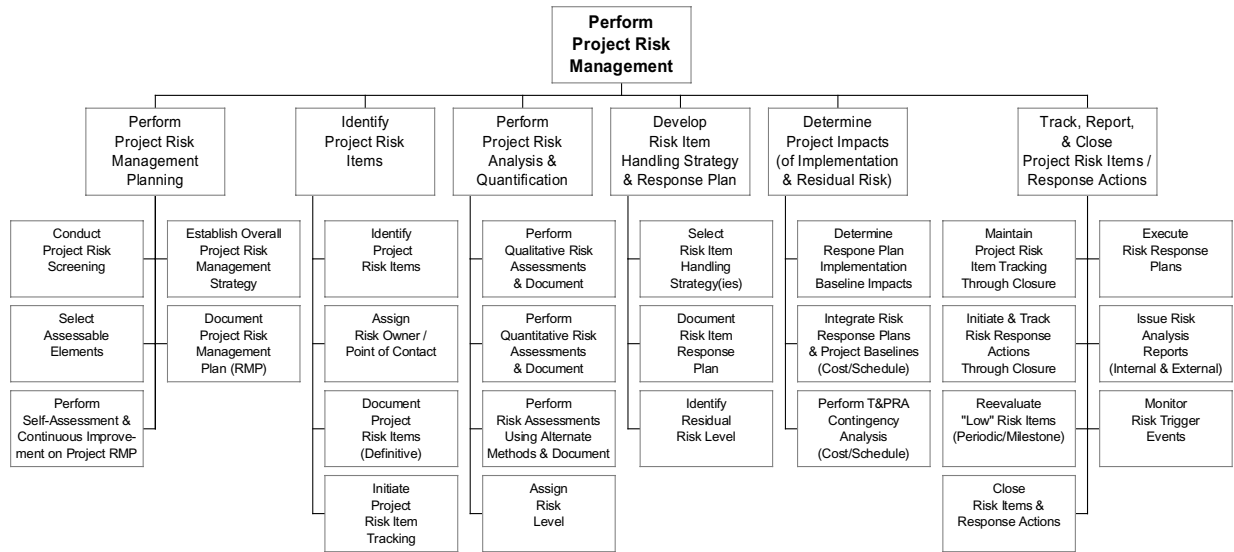


Figure 3. Risk Management Plan WBS.

It is clear from comparison of these two figures that following the outline of the RMP will ensure the intent of roadmapping is upheld.

To further illustrate this, it is important to understand how the RMP plan fits into the overall framework of the Construction Project. Figure 4 and 5 below illustrates how the RMP and associated documents will be addressed during each critical decision stage of the Project (Bryan 2001). The Project is currently in the pre-conceptual phase with CD-0 planned in FY-03.

Risk Management Documentation	Project-Specific Expectations for End of Project Phase				
	Pre-Conceptual (CD-0)	Conceptual Design (CD-1)	Preliminary Design (CD-2)	Final Design (CD-3)	As-Built (CD-4)
Risk Management Plan	Issued	Issued (updated if necessary)	Issued (updated if necessary)	Issued (updated if necessary)	Issued (updated if necessary)
Risk Screening Checklist	Complete	NA	NA	NA	NA
Risk Item Log	Established; populated with identified risks	Established; populated with identified risks	Established; populated with identified risks	Established; populated with identified risks	Established; populated with identified risks

Risk Management Documentation	Project-Specific Expectations for End of Project Phase				
	Pre-Conceptual (CD-0)	Conceptual Design (CD-1)	Preliminary Design (CD-2)	Final Design (CD-3)	As-Built (CD-4)
Risk Identification and Response Plan Forms	Complete for identified risks; quantified with conceptual response plan (i.e., mitigation strategy) defined; rough order of magnitude cost & schedule impacts (implementation & residual risk) identified	Complete and updated for identified risks; quantified with preliminary response plan (i.e., mitigation strategy) defined and integrated into project schedule; preliminary cost & schedule impacts (implementation & residual risk) estimated	Complete and updated for identified risks; quantified with detailed response plan (i.e., mitigation strategy) defined and integrated into project schedule; detailed cost & schedule impacts (implementation & residual risk) estimated	Complete and updated for identified risks; quantified with detailed response plan (i.e., mitigation strategy) defined and integrated into project schedule; detailed cost & schedule impacts (implementation & residual risk) estimated	Complete and updated for identified risks; quantified with detailed response plan (i.e., mitigation strategy) defined and integrated into project schedule; detailed cost & schedule impacts (implementation & residual risk) estimated
Risk Response Plan Action Tracking System	Concept defined	Established and populated with response plan actions	Established and populated with response plan actions (updated)	Established and populated with response plan actions (updated)	Established and populated with response plan actions (updated)
Risk Assessment Reports (RARs)	Conceptual RAR complete – risks address high-level functions & requirements, programmatic/cost/schedule issues. ROM T&PRA contingency calculated and added into project cost estimate.	Preliminary RAR complete – risks include previous risks (updated) plus new programmatic, cost, and schedule risks and technical risks to the facility (i.e., subproject) level. T&PRA contingency calculated and added into project cost estimate.	RAR complete – risks include previous risks (updated) plus new programmatic, cost, and schedule risks and technical risks to the system level. T&PRA contingency calculated and added into project cost estimate.	RAR complete – risks include previous risks (updated) plus new programmatic, cost, and schedule risks and technical risks to the component level. T&PRA contingency calculated and added into project cost estimate.	RAR complete – risks include previous risks (updated) plus new programmatic, cost, and schedule risks and all identified technical risks. T&PRA contingency calculated and added into project cost estimate.

Figure 4. Risk Management Plan Documents Relative to Project Phase.

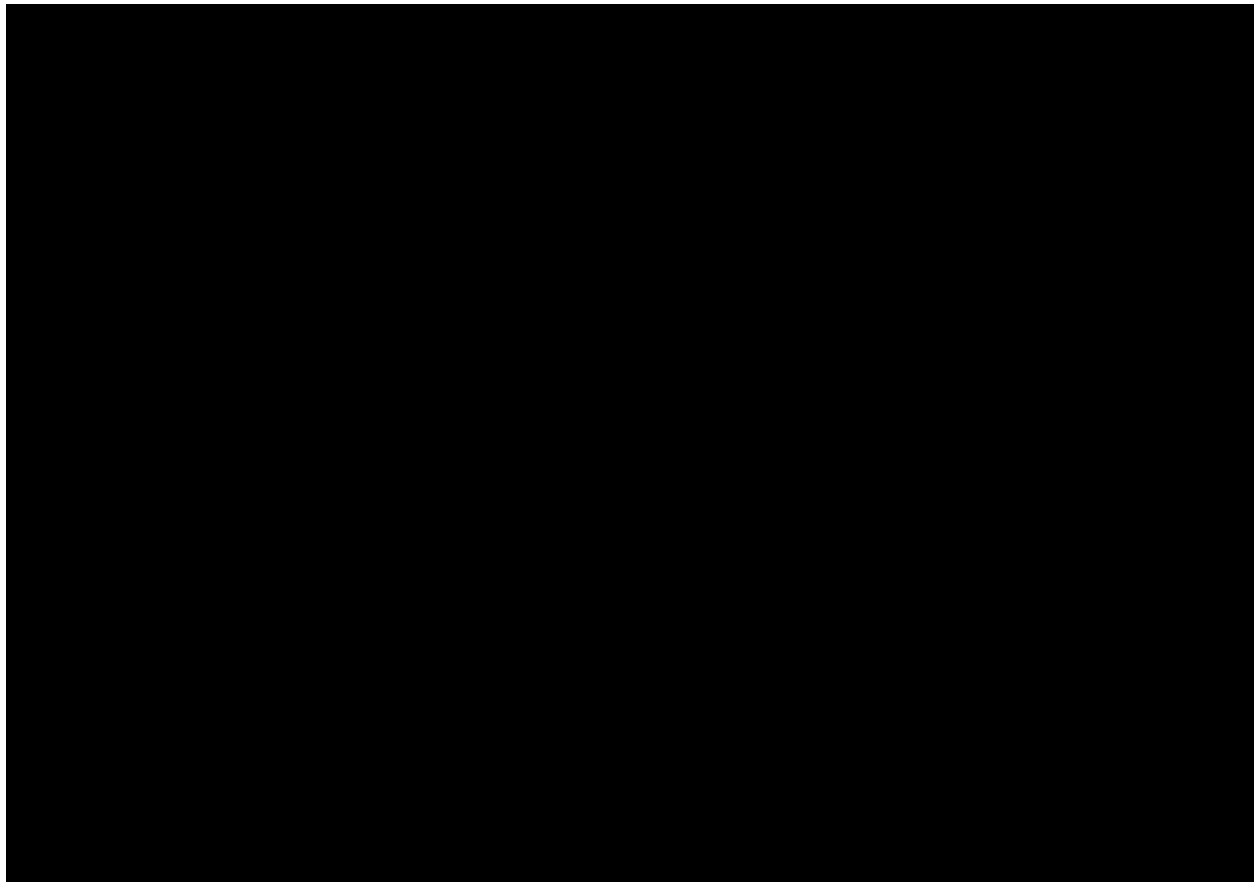


Figure 5. Risk Management Process Relative to Project Phase.

The charts above illustrate how the technical (as well as programmatic) risks of the Project will be addressed as the Project progresses through each critical decision point.

Pertinent to the technical risks will be generation of the Risk Assessment Reports just prior to CD-0. At CD-0, while it is known that technical risks will remain unresolved, the key to approval is identifying and developing mitigation plans for resolution.

A companion document to this roadmap update is the INEEL SBW Vittrification Process (Taylor, Barnes, and Lauerhass 2001). This key document provides the baseline flowsheet for SBW treatment. Furthermore, it contains a listing of the DBEs contained in the technical baseline database and therefore, these are not repeated in this document. Consistent with the roadmap, a transition to managing technical risks under the RMP is supported.

4. CONCLUSIONS

Based on analysis of the progress made in technology development and the progression toward design of a facility for processing SBW, the following conclusions relative to roadmapping are drawn:

- Considerable progress is being made in characterizing waste and resultant glass.
- Melter bench and pilot testing have effectively utilized expertise available. These tests and related studies have been effective at establishing a baseline flowsheet.
- Discoveries such as formation of a sulfate layer in the melt are forcing reduction in anticipated waste loadings and/or waste formulation changes.
- Further pilot testing to address identified issues remains paramount.
- Transition from the roadmap to the Risk Management Plan should ensure technical risks continue to be identified, tracked and resolved.
- Progressing to CD-0 with current uncertainties requires continued focus.
- Task identification prior to CD-1 currently appears adequate provided (1) identified funding is retained, and (2) additional discoveries are not uncovered during subsequent testing.
- Utilization of pilot melters across the complex is noteworthy. However, scale-up issues remain. Larger scale melters exist in the complex and redeployment either to INEEL or in support of INEEL should be pursued to address the unique SBW waste type.
- The potential advantages of cold-crucible induction melter technology warrant continued focus.

5. REFERENCES

- Bryan, Jeffrey D, September 6, 2001, "Risk Management Plan for the Idaho Waste Vitrification Facilities Project," PLN-909.
- DOE Order 413.3, October 13, 2000, "Program and Project Management for the Acquisition of Capital Assets," U.S. Department of Energy.
- EM-PDRI, February 2001, "Office of Environmental Management Project Definition Rating Index (EM-PDRI) Manual," U.S. Department of Energy, Office of Environmental Management.
- EM-S&T Roadmapping, Draft B, 2000, "Applying Science and Technology Roadmapping in Environmental Management," U.S. Department of Energy, Office of Environmental Management.
- Olson, Arlin, James Murphy, and Keith Perry, September 28, 2000, *Pre-Decisional Sodium Bearing Waste Technology Development Roadmap*, INEEL/EXT-2000-01299.
- Taylor, Dean, Charles Barnes, and Lance Lauerhass, September 2001, *INEEL SBW Vitrification Process*, INEEL/EXT-01-01139.

Appendix A

Bechtel BWXT Idaho, LLC PBS-102 Idaho Waste Vitrification Technology Development Work Package Schedules

Bechtel BWXT Idaho, LLC
PBS-102 IDAHO WASTE VITRIFICATION
Technology Development Work Package Schedules (EM-40)

Activity Description			Early Start	Early Finish	FY02			FY03			FY04			FY05		
V C.1.06.02.03.05 Conceptual Design Flow Sheets																
C.1.06.02.03.05.01 Applied Technology Management																
Coordination of TBA's (meetings, updating, c																
DWP change of scope (BC)																
Coordination of DWP's																
Control Account Monthly Reports																
Administrative Support																
Training Requirements																
Records Management																
Management and Tech Administration																
HLW SBW Roadmap Maintenance																
Planning the development of DWP's																
Development of DWP's																
Development of TBA's																
C.1.06.02.03.05.02 Characterization of SBW Liquid Suspended Solids																
HM150 Sample/Analyze SBW Tank (WM-188)																
Sample 3rd SBW tank (WM-188)																
Analyze 3rd SBW tank sample																
Review and model 3rd SBW tank data																
Prepare & evaluate 3rd SBW tank simulant																
Report for 3rd SBW tank																
Issue Final Report on SBW Tank (WM-188)																
HM152 Sample/Analyze SBW Tank (WM-189)																
Sample 4th SBW tank (WM-189)																
Analyze 4th SBW tank sample																
Prepare & evaluate 4th SBW tank simulant																
Review and model 4th SBW tank data																
Report for 4th SBW tank																
Scope and prepare other simulants																
Issue Final Report on SBW Tank (WM-189)																
HM154 Administration & Management																
Work Package Management																
Training																
Misc. Supplies and Materials																
Management and/or Tech Lead																
DWP Development																
C.1.06.02.03.05.04 Glass Formulation& Crucible Tests																
HM100 Melt Rate Redox																
Prepare Test Plans																
RSM3 - Prepare Test Plan																
RSM3 - Pre-run activities																
S04 Evaluation - Behavior Characterization																
S04 Evaluation - Detection																

Bechtel BWXT Idaho, LLC
PBS-102 IDAHO WASTE VITRIFICATION
Technology Development Work Package Schedules (EM-40)

Activity Description	Early Start	Early Finish	FY02	FY03	FY04	FY05
RSM3 - Perform Test (WM-180 & Recycle stream)	07JAN02	17JAN02	■ RSM3 - Perform Test (WM-180 & Recycle stream)			
Com RSM3 Test (WM-180 & Recycle Stream)		17JAN02	◆ Com RSM3 Test (WM-180 & Recycle Stream)			
RSM3 - Post-run activities	21JAN02	09MAY02	■ RSM3 - Post-run activities			
Develop Redox Curves for 188/189	04MAR02	09MAY02	■ Develop Redox Curves for 188/189			
RSM4 - Prepare Test Plan	18MAR02	08APR02	■ RSM4 - Prepare Test Plan			
RSM4 - Pre-run activities	18MAR02	12JUN02	■ RSM4 - Pre-run activities			
RSM4 - WM188/189 Melter Run	20JUN02	03JUL02	■ RSM4 - WM188/189 Melter Run			
Complete RSM4 Test - WM188/189 Melter Run		03JUL02	◆ Complete RSM4 Test - WM188/189 Melter Run			
RSM4 - Post-run Activities	08JUL02	26SEP02	■ RSM4 - Post-run Activities			
HM105 Glass Formulation Work						
Prepare Glass Formulation (1)	01OCT01	03JAN02	■ Prepare Glass Formulation (1)			
Prepare Troublesome Component Glass	01OCT01	01JUL02	■ Prepare Troublesome Component Glass			
Prepare Glass Formulation (2)	07JAN02	24JUN02	■ Prepare Glass Formulation (2)			
Analyze TC Glass	02JUL02	03SEP02	■ Analyze TC Glass			
HM110 Rad. Crucible Testing						
Maintain Furnace & Equipment	01OCT01	26SEP02	■ Maintain Furnace & Equipment			
Environmental Checklist	01OCT01	18OCT01	■ Environmental Checklist			
Misc. chemical, equipment, supplies	01OCT01	19NOV01	■ Misc. chemical, equipment, supplies			
IHR Mods	22OCT01	15NOV01	■ IHR Mods			
Crucibles	22OCT01	19NOV01	■ Crucibles			
Machine Shop Work	05NOV01	19NOV01	■ Machine Shop Work			
Treatability Study Approval	20NOV01	12DEC01	■ Treatability Study Approval			
Cold Tests 1	20NOV01	21JAN02	■ Cold Tests 1			
TF Transfers	13DEC01	07JAN02	■ TF Transfers			
Hot Test 1	08JAN02	25FEB02	■ Hot Test 1			
Cold Analytical 1	22JAN02	04MAR02	■ Cold Analytical 1			
Complete Hot Test 1		25FEB02	◆ Complete Hot Test 1			
Hot Analytical 1	26FEB02	22APR02	■ Hot Analytical 1			
Cold Tests 2	05MAR02	22APR02	■ Cold Tests 2			
Cold Analytical 2	23APR02	03JUN02	■ Cold Analytical 2			
Hot Test 2	07MAY02	25JUN02	■ Hot Test 2			
Complete Hot Test 2		25JUN02	◆ Complete Hot Test 2			
Hot Analytical 2	26JUN02	20AUG02	■ Hot Analytical 2			
RAL Waste Handling/Disposal	03JUL02	24SEP02	■ RAL Waste Handling/Disposal			
HM115 Administration Work						
WP Management	01OCT01	23SEP02	■ WP Management			
Training Requirements	01OCT01	23SEP02	■ Training Requirements			
Meetings - Conduct & Attend	01OCT01	23SEP02	■ Meetings - Conduct & Attend			
DWP Development	03JUN02*	31JUL02	■ DWP Development			
C.1.06.02.03.05.08 Melter Evaluation						
HM120 Support for TFA European Melter Testing						
Prepare TBA	01OCT01	01NOV01	■ Prepare TBA			
On-site technical support for off-gas monitorin	19NOV01	03SEP02	■ On-site technical support for off-gas monitorin			
Foreign travel for technical support	19NOV01	03SEP02	■ Foreign travel for technical support			
Test plan preparation (off-gas)	19NOV01	14JAN02	■ Test plan preparation (off-gas)			
Purchasing org. support for analytical subcontracta	13DEC01	12SEP02	■ Purchasing org. support for analytical subcontracta			

Bechtel BWXT Idaho, LLC
PBS-102 IDAHO WASTE VITRIFICATION
Technology Development Work Package Schedules (EM-40)

Activity Description	Early Start	Early Finish	FY02	FY03	FY04	FY05
Analytical subcontract for off-gas monitoring	17JAN02	28AUG02		Analytical subcontract for off-gas monitoring		
Final Report Input on Off-gas	30JUL02	12SEP02		Final Report Input on Off-gas		
HM125 Pilot Melter Procurement and Testing						
Prepare TBA	01OCT01	01NOV01		Prepare TBA		
Establish requirements for melter	01OCT01	22OCT01		Establish requirements for melter		
Design power supply and melter can	01OCT01	10DEC01		Design power supply and melter can		
Drawing sketches for power supply	01OCT01	10DEC01		Drawing sketches for power supply		
Drawings for melter can	01OCT01	10DEC01		Drawings for melter can		
Meetings	01OCT01	23SEP02		Meetings		
Travel to vendor site(s)	05NOV01	06FEB02		Travel to vendor site(s)		
Prepare Procurement specification for power supply	11DEC01	08JAN02		Prepare Procurement specification for power supply		
Purchasing org. support for power supply acquisition	11DEC01	25APR02		Purchasing org. support for power supply acquisition		
Complete Design & Procurement Spec of Power Supply		08JAN02		Complete Design & Procurement Spec of Power Supply		
Purchase materials for melter can	31JAN02*	21FEB02		Purchase materials for melter can		
Fabricate melter can	06MAR02	22APR02		Fabricate melter can		
Prepare Indep. Haz. Review for melter operation	06MAR02	14MAY02		Prepare Indep. Haz. Review for melter operation		
Prepare test plan for FY 02 operations	20MAR02	05JUN02		Prepare test plan for FY 02 operations		
Purchase power supply	15APR02*	09MAY02		Purchase power supply		
Purchase chemicals	06MAY02*	23MAY02		Purchase chemicals		
Install power supply and melter at INTEC	13MAY02	03JUN02		Install power supply and melter at INTEC		
Oversee power supply & melter installation	13MAY02	03JUN02		Oversee power supply & melter installation		
Complete Installation of Melter Power Supply		03JUN02		Complete Installation of Melter Power Supply		
Process development testing	04JUN02	27AUG02		Process development testing		
Write draft report on power supply testing	31JUL02	04SEP02		Write draft report on power supply testing		
Incorporate comments into power supply testing report	05SEP02	17SEP02		Incorporate comments into power supply testing report		
HM135 Lifecycle Cost Tradeoff Study						
Prepare TBA for CCIM Trade-off Study	04MAR02*	28MAR02		Prepare TBA for CCIM Trade-off Study		
Meetings	01APR02	26SEP02		Meetings		
Establish criteria, baseline assumptions	11APR02*	22APR02		Establish criteria, baseline assumptions		
Prepare drawings, sketches, calcs, EDF	23APR02	19AUG02		Prepare drawings, sketches, calcs, EDF		
Design review/ coordination with Applied Technol	23APR02	26SEP02		Design review/ coordination with Applied Technol		
50% Design review preparation	08JUL02*	22JUL02		50% Design review preparation		
Detailed cost estimate / Life-cycle	23JUL02	10SEP02		Detailed cost estimate / Life-cycle		
Provide input to final report	20AUG02	26SEP02		Provide input to final report		
Final Report Ready for Publication		26SEP02		Final Report Ready for Publication		
HM136 Flowsheet Development & Literature Review						
Prepare TBA	01OCT01	06NOV01		Prepare TBA		
Perform CCIM Literature Review	19NOV01*	25FEB02		Perform CCIM Literature Review		
Develop Process Flowsheets & M&E Balances	06MAY02*	09SEP02		Develop Process Flowsheets & M&E Balances		
Review Flowsheet, M&E Balances	22JUL02*	26SEP02		Review Flowsheet, M&E Balances		
HM138 Management/Administration Work						
Work Package Coordination	01OCT01	26SEP02		Work Package Coordination		
Management Support	01OCT01	26SEP02		Management Support		
Detailed Work Planning	01OCT01	25SEP02		Detailed Work Planning		
Training	01OCT01	26SEP02		Training		

**PBS-102 IDAHO WASTE VITRIFICATION
Technology Development Work Package Schedules (EM-40)**

Activity Description		Early Start	Early Finish	FY02			FY03			FY04			FY05		
W C.1.06.02.04.03.03 Verified Process Flow Sheet															
C.1.06.02.04.03.03 Verified Process Flow Sheet (Applied Technology)															
HM200 Applied Technology Management															
Coordination of TBA's (meetings, updating, c				01OCT02	25SEP03	Coordination of TBA's (meetings, updating, c									
Records Management				01OCT02	23SEP03										
HLW SBW Roadmap Maintenance				01OCT02	23SEP03										
DWP change of scope (BC)				01OCT02	30SEP03										
Coordination of DWP's				01OCT02	30SEP03										
Control Account Monthly Reports				01OCT02	30SEP03										
Secretarial Support for Applied Technology				01OCT02	30SEP03										
Training Requirements				01OCT02	30SEP03										
Planning the development of DWP's				01MAY03*	29MAY03										
Development of DWP's				02JUN03	30SEP03										
Development of TBA's				30JUN03	29SEP03										
Coordination of TBA's (meetings, updating, c				01OCT03	28SEP04	Coordination of TBA's (meetings, updating, c									
DWP change of scope (BC)				01OCT03	28SEP04										
Coordination of DWP's				01OCT03	28SEP04										
Control Account Monthly Reports				01OCT03	28SEP04										
Secretarial Support for Applied Technology				01OCT03	28SEP04										
Training Requirements				01OCT03	28SEP04										
Records Management				01OCT03	22SEP04										
HLW SBW Roadmap Maintenance				01OCT03	22SEP04										
Planning the development of DWP's				03MAY04*	27MAY04										
Development of DWP's				01JUN04	28SEP04										
Development of TBA's				29JUN04	28SEP04										
HM205 Characterization of SBW Liquid, Suspended Solids															
Work Package Management				01OCT02	25SEP03	Work Package Management									
Training				01OCT02	25SEP03										
Misc. Supplies and Materials				01OCT02	25SEP03										
Management Budget for home org 5%FTE				01OCT02	25SEP03										
Characterize 5rd SBW tank (WM-187)				01OCT02	01APR03										
Characterize 1st and 2nd tank heel solids				01OCT02	25SEP03										
Scope and prepare other simulants				01MAY03*	25SEP03										
DWP Development				15MAY03*	14AUG03										
Work Package Management				01OCT03	28SEP04										
Training				01OCT03	28SEP04										
Misc. Supplies and Materials				01OCT03	28SEP04										
Management Budget for home org 5%FTE				01OCT03	28SEP04										
Sample/Characterize NGLW				01OCT03	01APR04										
Characterize 3rd and 4th tank heel solids				05APR04	28SEP04										
Scope and prepare other simulants				03MAY04	29SEP04										
DWP Development				17MAY04*	29SEP04										
HM210 PFD Preparations Mass & Energy Balance Calcs															
Work Package Management				01OCT02	30SEP03	Work Package Management									
Training				01OCT02	30SEP03										
Misc. Supplies and Materials				01OCT02	30SEP03										

Bechtel BWXT Idaho, LLC
PBS-102 IDAHO WASTE VITRIFICATION
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Activity Description	Early Start	Early Finish			
			FY02	FY03	FY04
					FY05
Review on Site	12DEC02	17DEC02		Review on Site	
Review Clemson - 2	18DEC02	23DEC02		Review Clemson - 2	
Assist in Test Plan for FY02-1	09JAN03*	22JAN03		Assist in Test Plan for FY02-1	
QA Analysis of TP for FY02-1	23JAN03	29JAN03		QA Analysis of TP for FY02-1	
Assist in Run Plan for FY02-1	10FEB03	13FEB03		Assist in Run Plan for FY02-1	
QA Analysis of RP for FY02-1	17FEB03	18FEB03		QA Analysis of RP for FY02-1	
Perform Test	05MAR03	26MAR03		Perform Test	
Evaluate Melter Performance to Date	15APR03*	22APR03		Evaluate Melter Performance to Date	
Choose System (Meeting)	23APR03	23APR03		Choose System (Meeting)	
Document Decision Basis	24APR03	29APR03		Document Decision Basis	
Evaluate Data	08MAY03	22MAY03		Evaluate Data	
Incorporate new Char into Formulation	03JUN03*	08JUL03		Incorporate new Char into Formulation	
FY03 DWP	03JUN03*	31JUL03		FY03 DWP	
Review Report	12JUN03	18JUN03		Review Report	
Procure Chemicals	17JUN03	15JUL03		Procure Chemicals	
Test Plan Prep	09JUL03	29JUL03		Test Plan Prep	
Assist in Test Plan for FY02-2	14JUL03	24JUL03		Assist in Test Plan for FY02-2	
QA Analysis of TP for FY02-2	28JUL03	30JUL03		QA Analysis of TP for FY02-2	
Test Plan Review	30JUL03	12AUG03		Test Plan Review	
Assist in Run Plan for FY02-2	11AUG03	14AUG03		Assist in Run Plan for FY02-2	
Run Plan Prep	13AUG03	26AUG03		Run Plan Prep	
Set up for Test	13AUG03	02SEP03		Set up for Test	
QA Analysis of RP for FY02-2	18AUG03	20AUG03		QA Analysis of RP for FY02-2	
Run Plan Review	27AUG03	03SEP03		Run Plan Review	
Training	04SEP03	04SEP03		Training	
Perform Test (FY02)	08SEP03	30SEP03		Perform Test (FY02)	
Perform Test	08SEP03	29SEP03		Perform Test	
Perform 3 Melter Runs (2 Integrated)	01OCT03	29SEP04		Perform 3 Melter Runs (2 Integrated)	
HM250 Off Gas Treatment					
Baseline Flowsheet Config., Maint., & Cntrl	01OCT02	25SEP03		Baseline Flowsheet Config., Maint., & Cntrl	
Determination of Off-gas Treatment F&ORs	01OCT02	25SEP03		Determination of Off-gas Treatment F&ORs	
Oversight and Misc. Support	01OCT02	25SEP03		Oversight and Misc. Support	
Contract with Vendor	01OCT02	18NOV02		Contract with Vendor	
WESP Specification	01OCT02	11FEB03		WESP Specification	
WESP Design & Fabrication	01OCT02	14NOV02		WESP Design & Fabrication	
Contract with Melter Site	01OCT02	27NOV02		Contract with Melter Site	
Mercury Vapor-Liquid Equilibria	01OCT02	25SEP03		Mercury Vapor-Liquid Equilibria	
Scrubber Specification	01OCT02	18MAR03		Scrubber Specification	
Test Planning, Prep. & Oversight	01OCT02	07JAN03		Test Planning, Prep. & Oversight	
Performance Modeling w/ Chemkin	01OCT02	25SEP03		Performance Modeling w/ Chemkin	
Catalyst Specification & Procurement	01OCT02	11NOV02		Catalyst Specification & Procurement	
SCR Test Planning, Prep., & Oversight	01OCT02	22JAN03		SCR Test Planning, Prep., & Oversight	
Define Requirements for MACT Compliance	01OCT02	25SEP03		Define Requirements for MACT Compliance	
Mercury-Cesium Removal - Scrub	01OCT02	25SEP03		Mercury-Cesium Removal - Scrub	
Effects of NOx on GAC Performance	01OCT02	03JUN03		Effects of NOx on GAC Performance	
Test Planning, Preparation, & Oversight	08OCT02	24MAR03		Test Planning, Preparation, & Oversight	
Mercury Cont. Emission Monitor (CEM)	08OCT02	16DEC02		Mercury Cont. Emission Monitor (CEM)	

Bechtel BWXT Idaho, LLC
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Activity Description		Early Start	Early Finish	FY02	FY03	FY04	FY05
Test Execution		08JAN04	18FEB04			Test Execution	
Travel to test site (2x)		26JAN04	11MAR04			Travel to test site (2x)	
WESP Test Planning, Prep., & Oversight		12FEB04*	28SEP04		WESP Test Planning, Prep., & Oversight		
Corrosion Mitigation		12FEB04	27SEP04		Corrosion Mitigation		
Test Evaluation & Reporting		19FEB04	20APR04		Test Evaluation & Reporting		
WESP Test Execution		25FEB04	27APR04		WESP Test Execution		
Test Execution		15MAR04	12JUL04		Test Execution		
Contract with Melter Site		18MAR04	28APR04		Contract with Melter Site		
Equipment Design, Fabrication, & Mods		24MAR04*	27APR04		Equipment Design, Fabrication, & Mods		
Scrubber Test Planning, Prep., & Oversight		25MAR04	01SEP04		Scrubber Test Planning, Prep., & Oversight		
Test Evaluation & Reporting		29MAR04	26JUL04		Test Evaluation & Reporting		
Lab Scale Column Testing For GAC		05APR04*	16SEP04		Lab Scale Column Testing For GAC		
Kinetics of Mercury Vapor Oxidation in MO		05APR04	16SEP04		Kinetics of Mercury Vapor Oxidation in MO		
Scrubber Design and Procurement		08APR04	12MAY04		Scrubber Design and Procurement		
Test Evaluation & Reporting		28APR04	30JUN04		Test Evaluation & Reporting		
Travel to test site (2x)		10MAY04	10JUN04		Travel to test site (2x)		Test Execution
Test Execution		10MAY04	10JUN04				
Travel to test site (2x)		20MAY04	23JUN04		Travel to test site (2x)		
Scrubber Test Execution		20MAY04	23JUN04		Scrubber Test Execution		
Test Evaluation & Reporting		28JUN04	22SEP04		Test Evaluation & Reporting		
Test Evaluation & Reporting		01JUL04	27SEP04		Test Evaluation & Reporting		
HM255 Secondary Waste Treatment							
Alternative Treatment Testing		01OCT03	31MAR04		Alternative Treatment Testing		
NGLW Treatment		06JAN04	31MAR04		NGLW Treatment		
WAC for Alternative Treatments (Evap)		01APR04	30JUN04		WAC for Alternative Treatments (Evap)		
Gas Generation from Grout		01APR04	27SEP04		Gas Generation from Grout		
WAC for Mercury Disposal		01JUL04	27SEP04		WAC for Mercury Disposal		
HM260 Melter Evaluation							
Prepare TBA		01OCT02	31OCT02		Prepare TBA		
Work Package Management		01OCT02	29SEP03		Work Package Management		
Prepare IHR Modifications		07OCT02*	19DEC02		Prepare IHR Modifications		
Prepare Test Plan		15OCT02*	19DEC02		Prepare Test Plan		
Procure Chemicals		11NOV02*	24DEC02		Procure Chemicals		
Perform Testing		06JAN03*	04SEP03		Perform Testing		
Write Draft Report		16JUN03*	14AUG03		Write Draft Report		
Edit Final Report		08SEP03*	30SEP03		Edit Final Report		

Appendix B

Idaho Waste Vitrification Facilities Project Schedule

Idaho Waste Vitrification Facilities Project Schedule

PBS 1.06.02

9/25/01

