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A Systematic Look at Tank Waste Remediation System Privatization

J. H. Holbrook
M. A. Duffy
D. L. Vieth
C. L. Sohn

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Pacific Northwest National Laboratory
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Summary

The U.S. Department of Energy (DOE) is considering a competitive, privatization approach to procure specific waste treatment products for one, or more, of the Hanford Site Tank Waste Remediation System (TWRS) functions. A determination of the viability of this concept will be based on two primary attributes: 1) technical credibility within the constraints of the required cost, schedule, and performance, and 2) privatization feasibility with regard to financing, liability, and contracting considerations.

This report describes efforts to assess the technical feasibility of privatizing all or part of the TWRS activities. The first approach considered breaking the TWRS scope up into discrete, and to some extent sequential, functions and systematically examining the credibility of privatizing these elements as stand-alone businesses. After taking into account the cost, schedule, regulatory, and performance constraints, it was concluded that a strategy of privatization by single system functions has a number of critical shortcomings, probably the largest being that DOE would have to retain the responsibility and risk of managing the interfaces between vendors.

In a second approach, which considered alternative privatization strategies, a two-phased approach was employed in investigating the technical credibility within the constraints of the current TWRS Program. During the first phase, nine potential alternatives for privatization were formulated and conceptually analyzed. The alternatives were created by combining a variety of features in different, logically consistent ways. Each alternative was evaluated with respect to cost, schedule, technical performance, regulatory complexity, contracting complexity, and programmatic risk. The following basic revelations were presented to a joint DOE Headquarters and DOE Richland Operations Office audience:

- Phasing is attractive because it allows learning to be incorporated, levelization of cost, new technologies to be inserted, and out-year uncertainties to be minimized.
- Head-to-head competition is attractive because it can reduce total cost.
- Meeting the Tri-Party Agreement (TPA) schedule will be difficult, but possible.
- Concurrent permitting, licensing, and construction may be required.
- Early DOE decisions will be needed, especially with regard to Low-Level Waste (LLW) glass specifications.

As a result of these insights, four additional cases were derived and analyzed during phase two. These preliminary analyses again suggested that phasing and head-to-head competition can lead to significant cost reductions and reduced program risk within the schedule mandated by the TPA. Additional benefits could be realized, however, by modifying some TPA milestones (viz., completion of Single-Shell Tank (SST) retrieval), while still achieving the overall completion date of 2028. The need to complete retrieval of all SSTs by 2018 effectively reduces the time available to complete the

entire remediation effort by ten years. This compressed time schedule reduces the opportunity to take full advantage of on-the-job learning and new technology advances, either of which could reduce the estimated total costs even more.

It is not presently possible to select an optimal privatization strategy, even from just a technical perspective. The results of this assessment, however, do support DOE's continued pursuit of an acceptable TWRS privatization concept. If investigations that are being conducted to evaluate privatization feasibility with regard to specific liability, financing, and contracting concerns, should consider potential strategies that include both phasing and head-to-head competition. Finally, a more rigorous technical analysis of the alternative approaches must be conducted prior to the issuance of a Request for Proposal (RFP).

The studies summarized in this report were conducted between July 1994 early November 1994. These analyses, carried out by a team of DOE and DOE-contractor staff, represent the earliest efforts to establish the feasibility of TWRS Privatization. Theses initial studies laid the foundation for subsequent TWRS Privatization strategies. Since November 1994, the fundamental technical approaches that were identified in the initial feasibility study have persistent and have evolved considerably.

Contents

Figures

Tables

1.0 Introduction

1.1 Background

The mission of the Tank Waste Remediation System (TWRS) Program is to store, treat, immobilize, and dispose, or prepare for disposal, the Hanford radioactive tank waste in an environmentally sound, safe, and cost effective manner. Highly radioactive Hanford waste includes current and future tank waste plus the cesium and strontium capsules.

The TWRS Program is pursuing a systems approach in defining what must be done to achieve this mission. Rather than thinking of a system in terms of a collection of facilities, the systems approach views a system in terms of the functions that must be accomplished. The functions to be performed by the physical system can be understood in terms of a functional flow block diagram (Figure 1.1). In conceiving alternative programs that might successfully contribute to the achievement of the TWRS mission, these functions and their requirements are assumed to be inviolate, as are the milestones of the Hanford Federal Facility Agreement and Consent Order (Table 1.1).

In the TWRS program, as in other Department of Energy (DOE) clean-up activities, there is an increasing gap between the estimated funding required to enable DOE to meet all of its clean-up commitments and level of funding that is perceived to be available. Since 1989, approximately $23 billion has been expended nationwide for clean-up and, using the current approach, $300 billion, or more, may be required over the next 30 years to satisfy regulatory commitments. Given the federal deficit and the demands imposed by other national priorities, such a sustained level of funding appears increasingly unrealistic. The DOE has recognized this problem and several mitigation strategies are at various stages of exploration or implementation. These include risk-based prioritization, technology development, and new contracting/management approaches. Revolutionary changes in approach may be required in order to bring the widening gap under control.

Privatization is one contracting/management approach being explored by DOE as a means to achieve cost reductions and as a means to achieve a more outcome-oriented program. Privatization introduces the element of competition, a proven means of establishing true cost as well as achieving significant cost reduction.

1.2 Purpose

A competitive privatization approach is being pursued under the President's Reinventing Government reforms and the related DOE Contract Reform Initiative. DOE is considering a competitive, fixed price award to procure waste treatment products for one or more of the TWRS functions. Each TWRS function has an identifiable waste product. Under this approach, a private vendor(s) would build and operate the necessary TWRS facility(ies) to satisfactorily accomplish each function. Subsequently, DOE would purchase treated waste products at a fixed price. DOE's interest in this approach is to substantially lower the costs of treating waste while meeting the regulatory milestones defined in the Hanford Tri-Party Agreement (TPA) and meeting all other environmental and safety requirements.

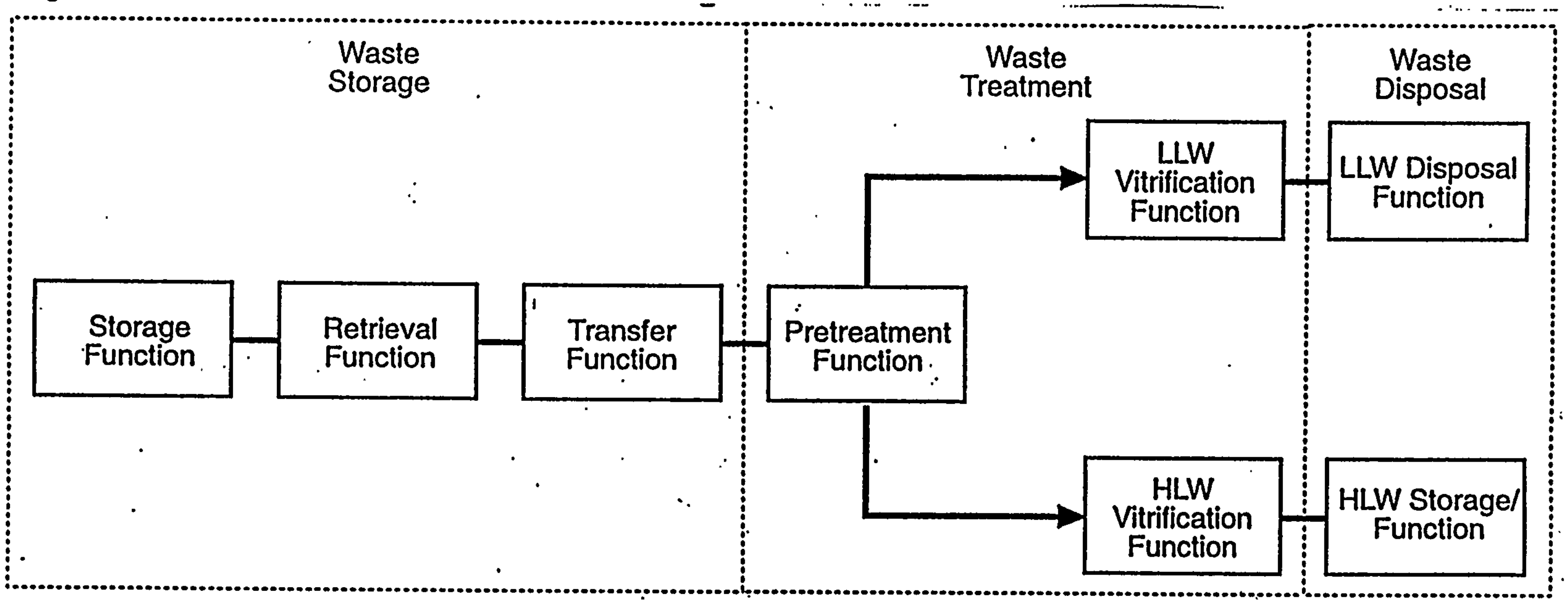

Figure 1.1. TWRS Functional Block Diagram

Table 1.1. Hanford Federal Facility Agreement and Consent Order Milestones

Major Milestones	Interim Milestones	Target Milestones	Description	Date	Storage	Retrieval	Transfer	Pretreatment	Low-Level Vitrification	High-Level Vitrification	Low-Level Disposal	High-Level Storage	High-Level Disposal
M-41-00			Complete SST interim stabilization	9/30/00	x	x	x						
	M-41-08		Start Interim stabilization of 1 non-watch list tank	7/31/95	x								
M-42-00			Provide additional DST capacity	12/31/98	x								
	M-42-01		Initiate "hot" operations of 200W tanks	2/28/98	x								
		M-42-01-T02	Initiate construction of 200W tanks	9/30/94	x								
	M-40-02		Complete construction of 200E tanks	9/30/98	x								
		M-42-02-T01	Initiate construction of 200E tanks	2/28/95	x								
	M-43-07		Complete replacement of cross-site transfer system	2/28/98			x						
	M-43-07A		Start construction of cross-site transfer system	11/30/95			x						
M-45-00			Complete closure of SST Farms	9/30/24	x	x	x						
	M-45-04A		Complete conceptual design for the initial SST retrieval systems	4/30/97		x							
	M-45-05		Retrieve waste from all SSTs	9/30/18	x	x	x						
		M-45-05-T01	Initiate tank waste retrieval from one SST	12/31/03		x							
	M-45-05		Complete closure of all SST Farms	9/30/24	x	x	x				x		x
M-50-00			Complete pretreatment processing of Hanford tank waste	12/31/28				x					
	M-50-01		Start construction of LLW pretreatment facility	11/30/98				x					
	M-50-02		Start hot operations of LLW pretreatment facility to remove Cs and Sr	12/31/04				x					
	M-50-03		Complete evaluation of enhanced sludge washing to determine whether advanced sludge separation processes are required	3/31/98				x					
	M-50-04		Start hot operations of HLW pretreatment facility	6/30/08				x					
M-51-00			Complete vitrification of HLW	12/31/28						x			
		M-51-03-T03	Initiate construction of the HLW vitrification facility	6/30/02						x			
	M-51-02		Complete melter tests and select reference melter	9/30/98						x			
	M-51-03		Initiate hot operations of the HLW vitrification facility	12/31/09						x			
M-60-00			Complete vitrification of LLW	12/31/28					x				
	M-60-02		Complete melter feasibility and system operability tests, select reference melter(s), and establish reference LLW glass formulation which meets complete system requirements	6/30/96					x				
	M-60-04		Initiate construction of the LLW vitrification facility	12/31/97					x				
	M-60-05		Initiate hot operations of the LLW vitrification facility	6/30/05					x				

This report addresses the feasibility of privatizing various portions of TWRS at Hanford. In the past there have been several false starts on remediation plans and, as a result, there are extensive and enforceable milestones which have been negotiated by DOE with the Environmental Protection Agency (EPA) and the State of Washington. The program established to meet these agreements is estimated to cost about $40 billion and to take 30 years to complete. It will be about 10 years before design and construction of the physical infrastructure are completed sufficiently to begin treatment of any of the wastes. No uncertainty analysis of the total cost is available. The uncertainty, however, is thought to be high, and unless there is a significant change in approach, the estimate is considered to be low. Although the TPA was renegotiated within the past year, it is estimated that a productivity improvement of about 20% will be needed to bring the available funds and the agreed-upon progress into alignment. Clearly this situation is an indication that major changes in approach need to be explored.

While privatization is a proven method of achieving cost reductions, it is usually applied in situations where the technology is fairly mature and the service well defined. TWRS, however, is a very complex project containing considerable uncertainty and with operations never before conducted. Given this situation, is privatization technically feasible?

This study considers the feasibility of privatization as an alternative approach for meeting regulatory milestones and other constraints involving safe operation and environmental impact, while improving the probability of success. Probability of success is defined by reduced costs, ability to meet regulatory schedules, reduced programmatic risk, and demonstrated early progress. Privatization, in this application, is defined as competitive, fixed-price, fee-for-service awards to procure waste treatment products for one or more of the TWRS functions.

The analysis carried out in this report have been focused on technical and programmatic issues. That is, the report attempts to address the question of "Can it be done with current technology" and "Can it be done safely, economically, and on schedule?"

Many details of licensing compliance, contractual, financing, and other major issues have only been touched upon in a cursory manner in this report. Of course, these are also critical topics that bear on feasibility and such questions must be addressed before issuance of a Request for Proposal (RFP).

1.3 Approach

The analyses conducted in investigating the feasibility of privatization were structured using the concepts of decision analysis. This concept involves carefully defining the decision(s) to be made (decision frame) and investigating the decision(s) with respect to:

- what is wanted (i.e., what are the values to be achieved)
- what can be done (i.e., what alternatives are available)
- what is known (i.e., the expected performance of the alternatives with respect to the values).

1.3.1 The Decision Frame

The issue of privatization of TWRS by DOE is framed as two sequential decisions: 1) Is privatization feasible, and 2) if privatization is feasible, what is the preferred privatization strategy?

These decisions are not independent, since clearly determining the feasibility of privatization must involve formulating some concepts of privatization strategy. But determining the preferred strategy is not necessary to determining the feasibility. If privatization is determined to be feasible, then a preferred strategy can be developed using insights gained while investigating feasibility.

The analyses performed and reported here address the first decision. In doing so, they also provide insight and guidance for developing a preferred privatization strategy, if DOE should decide to pursue privatization.

1.3.2 The Analysis Approach

The analysis approach involved three separate, but related efforts. The first effort (Section 2.0 of this report) investigated the feasibility of separately privatizing individual TWRS functional systems (e.g., Pretreatment, Retrieval, etc.). This approach has been labeled "Vertical Segmentation."

The second effort (Section 3.0 of this report) focused on a relatively top-level analysis of alternative privatization concepts in order to determine which features of a privatization strategy are desirable and to explore the privatization strategy space for regions of technical feasibility. The third effort was an in-depth analysis of a pair of closely related specific strategies for the purpose of uncovering potential issues or fatal flaws that might be missed in a top-level analysis and which would be revealed only by developing and examining a concept in more detail.

The body of this report describe privatization analysis by functional system and the top-level analysis of alternative privatization strategies. It also includes some summary material from the in-depth analysis and uses the in-depth analysis results in the findings and conclusions reached. The Appendix to this report describes the in-depth analysis in detail.

The studies summarized in this report were conducted between July 1994 early November 1994. These analyses, carried out by a team of DOE and DOE-contractor staff, represent the earliest efforts to establish the feasibility of TWRS Privatization. Theses initial studies laid the foundation for subsequent TWRS Privatization strategies. Since November 1994, the fundamental technical approaches that were identified in the initial feasibility study have persistent and have evolved considerably.

2.0 Privatization of Individual TWRS Functional Systems: Vertical Privatization

2.1 Method of Analysis

This section analyzes an approach to privatizing all or parts of TWRS involving segmentation by primary system function. Of all TWRS privatization strategies, this approach is perhaps the most straightforward and easiest to visualize because it consists of writing contracts for discrete functional elements of the TWRS flowsheet. The approach is illustrated in the block diagram in Figure 2.1. Because the boundaries between privatized functions in Figure 2.1 are identified by vertical dotted lines, this approach has been labeled the Vertical Segmentation approach.

2.1.1 Background

The treatment mission of TWRS includes three primary sources of waste. These are: tank waste from 149 single-shell and 28 double-shell tanks in the Hanford 200 Area; tank waste from approximately 50 miscellaneous underground storage tanks (MUSTs) also in the 200 Area; and 1,930 cesium and strontium capsules currently stored in the Waste Encapsulation Storage Facility (WESF). TPA milestones require start-up of hot operations in 1994 and completion of all waste treatment by 2028.

The **Waste Storage Function** involves safe storage of the tank waste and Cesium (Cs)/Strontium (Sr) capsules, management of the tank space and the inter-tank movement of wastes, and development of the necessary data on the physical and chemical characteristics of the waste.

The **Waste Retrieval Function** consists of the retrieval and conditioning of tank wastes to be placed in the transfer system for delivery to the pretreatment facilities, and ultimately delivering clean tanks [all 50 Miscellaneous Underground Storage Tanks(MUSTs) and 177 Underground Storage Tanks (USTs)]. Tank wastes exist in three fractions, a supernate, a saltcake, and a sludge. Not all tanks contain all three fractions and there is considerable variation in composition between tanks. The composition variation of the waste complicates the retrieval function. Supernates will be pumped while sludges and saltcakes will be sluiced using additional liquids or will be mechanically removed. The Cs and Sr capsules stored in WESF are reasonably well characterized and do not require any unique type of retrieval.

The **Waste Transfer Function** will include the transfer of the liquid and slurried waste via pipeline from the various tank farms to the pretreatment facility, return of treated sludges to the tanks, and transport of pretreated waste to the vitrification facilities; the transport via cask and truck of the 1,930 Cs and Sr capsules from the WESF to the treatment facilities and; providing a cross-site transfer route between 200 East and West Tank Farms (replacement of existing cross-site transfer system).

The **Pretreatment Function** will involve design, construction, and operation of the pretreatment processes, equipment, and the physical plant. The scope will consist of taking feed from Retrieval and Transfer and producing separated and treated High-Level Waster (HLW) (primarily sludge) and Low-Level Waste (LLW) (primarily sodium rich liquid). At this time, the input to the treatment processes

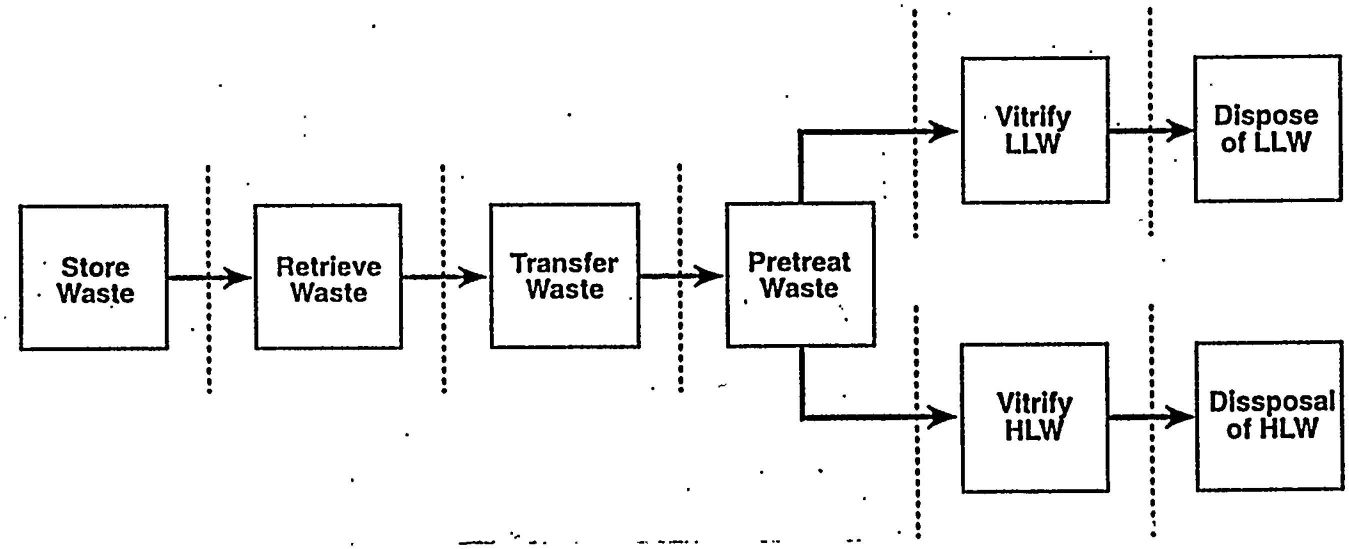

Figure 2.1. Vertical Segmentation of TWRS by System Function

cannot be accurately defined because waste characterization and retrieval operations are not sufficiently advanced to provide quantity and composition data. Given a tank waste feed with a specific range of chemical and physical characteristics, the two product streams provided by a company carrying out the Pretreatment Function must have the required chemical and physical characteristics for eventual LLW and HLW vitrification. Lag storage can be anticipated as a need in the Pretreatment Function for both the input and output streams: the retrieved waste before pretreatment and treated waste before vitrification.

The **Low-Level Waste Vitrification (LLWV) Function** processes a low-level radioactive feed from Pretreatment into a vitrified form that meets the specifications for Hanford LLW. The LLW form that will be stored on-site pending resolution of the disposal location, which is expected to be near-surface burial in the 200 Area at Hanford. Output specifications for the LLWV function have not been determined. Specifications for LLWV will depend on the desired class of waste, transportation and handling requirements, and the final disposal site. Until these issues are resolved, the process selected for vitrification must meet a broad range of product specifications.

The **High-Level Waste Vitrification (HLWV) Function** processes a high-level radioactive feed, principally washed sludge, from Pretreatment into a vitrified form that meets the specifications for Hanford HLW. Feed to the HLWV will be constrained primarily by the volumetric process rate and the composition of the waste stream from Pretreatment. The high-level waste form will likely be borosilicate glass in a container. The requirements for the amount of and composition of the HLW form are defined by the performance requirements and capacity of the repository. Various restrictions apply, including regulated quantities of radionuclide and heavy metals.

The **LLW Disposal Function** consists of transporting, providing interim storage for, and disposal of LLW forms generated from the LLWV Function. A company carrying out the LLW Disposal Function will undertake the design and construction of transportation equipment and the design, construction and selection, and operation of the physical disposal facility. Once all waste had been received, the disposal site will be closed. The private contractor will need to provide monitoring and surveillance at the disposal site while operating and post closure.

The **HLW Interim Storage Function** scope includes transporting HLW forms from the high-level vitrification facility to the interim storage facility and subsequent storage. The immobilized waste form will be received at the storage site and placed into a storage configuration, and eventually retrieved and removed from the facility. In the event of a failed container, the facility must provide the capability to repackage canisters. The storage facility must have a loading area designated for transfer of the canistered waste forms to the HLW Disposal Function. Once all waste had been removed, the storage site will be closed. The private contractor will need to provide monitoring and surveillance at the storage site while operating, and if required post-closure monitoring.

Currently, there are no plans to privatize the **HLW Disposal Function**. However, it will be considered here in order to better understand how this function will affect the privatization of other parts of TWRS. This function will consist of the transportation and disposal service for all of the canistered HLWV. The immobilized waste form will be received at the HLW interim storage facility and transported to the HLW disposal site, expected to be a mined geologic repository. The HLW Disposal Function is responsible for emplacement of the HLW in the disposal site and for back-filling the area.

Upon receipt of all waste, the disposal site will be closed. The organization carrying out this function will need to provide monitoring and surveillance at the disposal site while operating and post closure.

2.1.2 Procedure

A systematic analysis was performed on each of the system functions to assess the technical feasibility of privatization of the function as a stand-alone entity, or in combination with other functions. An assessment of each function input and output requirements, as well as constraints on particular functional operations, was also included.

The subsystem analysis consisted of addressing a number of questions to each function and examining for issues or complexities which would act as roadblocks to privatizing the individual functions. The specific fifteen questions asked were:

1. What is the Description of the System (Are the boundaries clear)?
2. What Constitutes Privatization?
3. What will be the Service/Product Purchased?
4. Can the Product Specifications be defined?
5. Are the Technology Requirements satisfied?
6. What are the key Constraints?
7. What are some Specific Risks and their impact?
8. What are the Function-Specific Regulatory Requirements?
9. What is the estimated Cost of The Equivalent TWRS Baseline System?
10. What is the Current TWRS Schedule of Operations?
11. Can the Connectivity/Interfaces with other functions be well defined?
12. Can the Basis for Fee be well defined?
13. Are there major Decommissioning Requirements?
14. Are there any Significant Other Issues?
15. Can the Inputs and Outputs be clearly specified?

The cost figures included under Question 9 are taken from the TWRS Baseline. There was no attempt to estimate the cost for the same element under a privatized scenario.

It is important to note that the present analysis dealt almost exclusively with technical and programmatic issues. No assessment of contracting or financing issues was made. The TWRS remediation schedule laid out in the TPA was assumed. Licensing and regulatory issues were identified, but not dealt with in any detail.

2.2 Waste Storage Function

2.2.1 Waste Storage - Description of The System

The Waste Storage Function consists of two major storage modes. The first is the high-level radioactive waste stored in the 149 Single-Shell Tanks (SSTs) (160 MCi) and in the 28 Double-Shell Tanks (DSTs) (90 Mci). These tanks are located in 17 tank farms in the 200 East (S, SY, T, TX, TY, and U) and 200 West (A, AN, AP, AW, AX, AY, AZ, B, BX, BY, and C) Areas. The second major storage mode involves the storage of 1,930 (150 Mci) capsules containing highly radioactive (Cs) and (Sr) in a water filled pool at the WESF.

There are significant technical and engineering activities associated with this effort. These include the management of the space in the tanks to ensure that the character of the waste is maintained in the appropriate physical condition (proper density, chemical composition, and water content) and to accommodate emergency transfer of waste should it be required. This involves the operation of the evaporator to reduce the water content of the waste. Because of their age, the tanks are in continuous need of physical maintenance and upgrades to ensure their operational capabilities and safety. Also, required is the capability to authoritatively measure and document the physical and chemical characteristics of the waste (supernatants, saltcake, and sludge) contained in the tanks. The condition of the waste in the tanks needs to be continuously monitored and documented. In view of the uncertain conditions of the waste, technically knowledgeable teams must be available to respond to conditions or situations that occur in the tanks to ensure that they are analyzed, understood on a technical basis, and the appropriate mitigative actions are prepared for and subsequently taken as required. With regard to the capsules in WESF, the pool and the handling facilities must be maintained for the removal, repair, and shipment of the capsules.

2.2.2 Waste Storage - What Constitutes Privatization

The tank farms and WESF are an established set of physical facilities. While some additional DSTs will be necessary in the future to facilitate operations, no massive development or construction effort to create the facilities is required. Privatization of this operation would occur through the turnover of these facilities to the contractor that would take responsibility for them. This could be accomplished in several ways. It could take place with no immediate financial investment by the contractor and the waste managed for a fee. It is also possible that the tanks could be transferred to the contractor under a "lease for use" agreement and the waste managed for a fee or the tanks and WESF could be purchased from the government and the waste in the tanks managed for a fee.

The actual process of privatization and the specifics of the service to be provided for the storage function with regard to privatization are the most uncertain of all the system elements in the TWRS.

2.2.3 Waste Storage - Service/Product Purchased

For privatization of Storage, multiple services would have to be purchased:

- safe storage of the waste
- management of the tank space and the inter-tank movement of wastes
- maintenance of a specific volume of tank space to accommodate emergencies
- monitoring and documentation of the condition of the waste in the tank
- development of the detailed knowledge of the physical and chemical characteristics of the waste stored in each tank and formally documenting the information and data
- response to and mitigation of off-normal or emergency conditions related to the tanks to ensure that they are analyzed and that determination is made regarding potentially threatening conditions to the environment, human health, or safety
- maintaining and upgrading the physical conditions of the tanks.

2.2.4 Waste Storage - Product Specifications

The product specifications for the above services would include the following:

- For safe storage, the product specifications would define the mass or volume of waste stored within the boundary of the tank without a condition of risk or loss of material outside of the tank.
- For inter-tank movement, the product specifications would establish the optimum volume of waste to be moved from one tank to another. Movement of larger or smaller volumes of waste could be penalized. The specification could be written against the amount of water evaporated to maintain the optimum volume and safe condition of mobile liquid waste.
- For the maintenance of tank space for emergency situations, the volume of serviceable space (cubic meters in designated DSTs) would be a product specification.
- For monitoring conditions in the tanks, a schedule for measurements and visual observations would have to be developed, and validated records would have to be provided.
- Product specifications would be chemical analyses and physical property measurement data in appropriate documented form delivered on a schedule tied to the sequencing of the tanks for processing and validated for accuracy.

- For technical response and analysis to off-normal and emergency conditions in the tank would have to be tied to the nature and quality of the response to the situation. This would be extremely difficult to do as a before-the-fact defined basis.

- For the maintenance and upgrade, a long-term schedule of improvements would have to be defined and specific performance test for the upgrades would have to be defined.

In the above list of product specifications, it will be extremely difficult to develop and properly quantify many items on a before-the-fact basis. It will be difficult to establish an objective basis for pay-for-performance fee-schedule for such items and they will be difficult to judge with regard to quality.

2.2.5 Waste Storage - Technology Requirements

Because the technology for building and maintaining carbon steel tanks for the storage of high-level radioactive waste is reasonably well established, and in view of the intent to minimize the construction of new tank space, the need for improved technology for the storage of liquid waste would not be a significant factor. Technology for obtaining samples of the waste and for accurately and precisely determining the physical and chemical characteristics of the waste is desirable. Technology to enable visual observation and to monitor critical parameters of the condition of the waste in those tanks on the "Watch List" would be extremely desirable. Additionally, technology with which to measure the physical condition of the tanks and their containment integrity along with the ability to find leaks would be desirable.

2.2.6 Waste Storage - Constraints

The most important constraint placed on privatization of the waste storage effort will be the requirement to know the content of the tank before developing a plan to move the content. It will be essential to know the sequence in which the waste in the tanks will be removed for processing. Five factors have been defined as important in establishing this sequence. The importance of these factors in establishing the sequence have not been prioritized at this point.

After safety of the tank operation, the second most important consideration affecting sequencing will be the need to ensure that the quality of the product exiting the final system within TWRS is such that it will make the transition into the disposal facility without problems. Therefore, the knowledge and understanding of the characteristics of the waste that will affect the quality of the high-level and LLW will be imperative in specifying the sequencing of the tanks for processing.

The five factors influencing retrieval sequences are:

- tank is a recognized safety concern requiring expeditious action

- tank space needed for emergency storage or operational processing

- chemical or physical properties of the waste as related to the pretreatment processing

- chemical or radionuclides composition of the low-level vitrified waste

- chemical composition of the vitrified high-level radioactive waste.

2.2.7 Waste Storage - Specific Risks

Among the major risks associated with the tanks farms are:

- licensing the tank farms by a private company

- continuity of operations during transition to privatization

- experience in response to emergency situations

- interfacing with DOE supplied services and infrastructure of other firms or government controlled sites

- scheduling

- responsibility for financial liability from environmental insult

- safety risks include worker occupational safety and public exposure.

2.2.8 Waste Storage - Function-Specific Regulatory Requirements

Specific regulatory requirements include both environmental and radiological issues. Because of the nature of the waste forms, direct handling is not an option. Sampling and monitoring must be installed and operated remotely with radiation-hardened apparatus. Characterization of waste must be conducted either in-situ or in hot-cells, possibly requiring special transportation and manipulators to maneuver equipment. Worker exposure must be carefully monitored and must meet Code of Federal Regulation (CFR) standards for neutron and gamma exposure limits.

Specific environmental regulations that would apply include Washington State Administrative Codes (WACs), potential Nuclear Regulatory Commission (NRC) regulations, DOE Orders, Ground Water Discharge and Air Quality regulations, in addition to many TPA milestones. Key TPA milestones associated with the storage operations include:

01/31/97	M-40-10	Complete Vapor Space monitoring for all flammable gas generating tanks
09/30/97	M-32-02	Complete 219-S Tank Interim Status Actions
02/28/98	M-43-07	Complete replacement of Cross-Site transfer system
09/30/98	M-40-09	Close all Unreviewed Safety Questions for DSTs and SSTs
12/31/98	M-42-00	Provide additional DST capacity (new tank farms)
09/30/99	M-32-00	Complete identified dangerous waste tank corrective actions
09/30/99	M-40-12	Resolve nuclear criticality safety issue
09/30/99	M-44-00	Issue tank characterization reports for 177 HLW tanks
09/30/00	M-41-00	Complete SST interim stabilization

09/30/01	M-40-00	Mitigate/resolve tank safety issues for high priority watch list tanks
06/30/05	M-43-00	Complete Tank Farm Upgrades
09/30/24	M-45-00	Complete Closure of all SST Farms
TBD	M-32-05	Complete 242-A Evaporator Interim Status Tank Actions

In addition, DOE has committed to the Defense Nuclear Facilities Safety Board an implementation plan specifically dealing with the characterization of the HLW tanks.

2.2.9 Waste Storage - Cost of The Baseline System

The work breakdown structure for the TWRS Program subdivides the cost of operating the tank farms into Tank Farm Operations and Maintenance, Waste Tank Safety, Tank Farm Upgrades, and Waste Characterization. The FY 1994 budget for this set of activities is $412 M. The total estimated cost for these activities through year 2029 is estimated to be $8.8 B.

2.2.10 Waste Storage - Current Schedule of Operations

The critical milestone for the operation of the tank farms is to complete the removal of the waste from the SSTs by 2018. The DSTs, while not specifically spelled out, will be cleaned out by 2028, the time when the vitrification of the HLW is completed. All SSTs must be closed by 2024. Characterization of all tanks must occur by 1999. The tank upgrades program must be completed by 2005.

Note that the MUSTs are relatively new within the TWRS Program scope and no definitive schedule for their clean-up has been outlined. The chemical characteristics of the contents of many of these smaller tanks are, however, similar to the SSTs and DSTs and would utilize the same facilities, which complete operations in 2028.

2.2.11 Waste Storage - Connectivity/Interfaces

The storage function interfaces primarily with retrieval, transfer and the treatment functions. Stored waste will be retrieved and transferred. Sludges from pretreatment will be transferred back for intermediate storage in DSTs. Some treatment technologies can be done in-tank. Characterization of the waste stream impacts retrieval, treatment technologies and processes. The sequence for retrieving waste from the tanks is dependent upon various requirements (tank safety, chemical or physical properties associated with ease of retrieval, and chemical or physical availability). The storage function is dependent upon the availability of site services such as power, road, cross-site transfer system, etc. If multiple vendors were to be selected to perform various functions, the nonavailability of site services would negatively impact effective and safe operations of the storage function.

2.2.12 Waste Storage - Basis for Fee

The basis for determining the fee for the storage function is difficult to define because of the lack of quantifiable aspects of the product specifications. Many of the items do not provide an objective basis for pay-for-performance fee schedule. In addition, the quality of the products or services is difficult to measure objectively. These characteristics make privatization of the storage function not feasible.

2.2.13 Waste Storage - Decommissioning Requirements

Decommissioning requirements would include the clean-up of spills from the storage of the waste and the clean-up of releases during operations. Both may require removal of the supporting infrastructure (piping, evaporators, etc.) and impact retrieval and transfer functions.

2.2.14 Waste Storage - Other Issues

The reliability of the infrastructure system is unknown. Drawings describing routings between generators, tanks and the evaporator have not been kept current although modifications have occurred. Other than current operating experience, the infrastructure system must be "walked down and tested" prior to transfers. Much of the equipment exceeds the intended design life because of a lack of capital reinvestment.

To date, DOE has not determined whether some wastes will be treated in-tank versus a separate facility. This complicates ownership and maintenance of the storage function if different vendors were to be involved.

2.2.15 Waste Storage - Inputs and Outputs

	Waste Storage Function	Interface with Function
Inputs:	Tank Waste	Operations, Treatment, Transfer (inter-site between East and West Areas)
	Cs and Sr Capsules	Operations
	Tanks (structure)	Operations
	Infrastructure (Evaporators, piping, pumps, etc.)	Operations
	Surveillance & Monitoring Equipment	Operations
	Chemical Additions (pH adjustments, sluicing fluids)	Operations, Retrieval, Treatment
	Technology	Operations
	Specifications, Dollars, Information	Operations
Constraints:	Tank Space for Emergency Situations	Retrieval, Treatment
	Lack of Chemical and Physical Characterization Information	Retrieval, Transfer, Treatment
	Lack of Characterization Facilities	Retrieval, Transfer
	Regulatory	External
	Design Life of Tanks	Retrieval, Transfer, Treatment
	Undefined Infrastructure System	Retrieval, Transfer, Treatment
	Form of Waste	Retrieval, Transfer, Treatment

	Waste Storage Function	Interface with Function
Outputs:	Characterized Tank Wastes	Retrieval, Transfer
	Cs and Sr Capsules	Transfer, Treatment
	Tanks	Retrieval and Decon
	Infrastructure	Transport and Decon
	Surveillance & Monitoring Equipment	Transport and Decon
	Spent Equipment	Retrieval, Transport, and Decon
	Operations Related Waste	Transport, Decon
	Air Emissions, Contamination, Certification of Product	Retrieval, Treatment

2.3 Waste Retrieval Function

2.3.1 Waste Retrieval - Description of The System

Retrieval operations consist of removing tank wastes from SSTs, DSTs, and MUSTs for the purpose of pretreatment. This involves specific technical and operational activities such as: 1) preparation (includes design, procurement, and construction) of the tank for waste retrieval and conditioning of the DST system or processing and disposal facilities, 2) provision for retrieval and conditioning systems which would include tank leak detection and subsurface barriers, as required, 3) operation of retrieval, conditioning, leak detection, and barrier systems, and 4) decontamination, removal, and disposal of retrieval and conditioning systems as required. DST retrieval would require that all activities accommodate mobilization systems in the DSTs to support tank reuse and utilization of any other retrieval subsystem to provide for tank closure.

Waste material contained in a total of 177 USTs would have to be retrieved, with retrieval limited to waste within the tank wall for the SSTs and MUSTs, and including the annulus (up to the exterior wall) for the DSTs. Retrieval would not include recovering radioactive waste associated with previous tank leaks outside of the tank's confinement barrier.

2.3.2 Waste Retrieval - What Constitutes Privatization

Privatization of the Retrieval Function would occur with the turnover of the responsibility for the design, procurement, construction, and operation of retrieval equipment and supporting facilities. This will likely include independent operating equipment. Note that no significant retrieval capability exists at the present time. The contractor would be required to finance, license, and permit this function. The contractor would be responsible for retrieving the waste to be fed to the pretreatment process. The retrieval operation should not be confused with the normal inter-tank transfers for the purpose of normal storage operations.

2.3.3 Waste Retrieval - Service/Product Purchased

Privatization of the Retrieval Function would consist of purchasing two basic services. The first would involve the retrieval and conditioning of tank wastes to be placed in the transfer system for delivery to the pretreatment facilities. The rate of retrieval would be determined by the processing requirements and any limits by the interconnecting transfer system. The second service purchased would involve the delivery of clean tanks (50 MUSTs and 177 USTs) that would have had 99% of the waste volume removed (Note: the 99% criteria is not established for MUSTs and may follow under TPA criteria for USTs). Specific bounds on the amount of radionuclide material to be left in the tank will be specified.

The products of retrieval will include the chemical wastes that will become feed to the waste treatment facilities, and solid wastes that will require decontamination and packaging for disposal. The chemical wastes will be conditioned, as necessary, to meet requirements for transport and acceptance criteria of the receiving facility. These conditioning steps may include both physical and chemical modifications, such as size reduction and pH adjustment. Solid waste products will be packaged as they are removed from the tanks so that they can be transported to another facility for decontamination and disposal functions.

There are at least three options for retrieval privatization that involve ranges of completion and concomitant risk.

Option 1: Retrieve 99% of waste volume. This option would achieve the TPA requirements, but may not meet the site source term requirements. Additional retrieval operations might have to be supplemented or contracted separately in the future.

Option 2: Retrieve sufficient waste to close the tanks. This option may be significantly more rigorous than TPA goals specified, due to allowable site source term, prompting >99% waste retrieval. The source term is also heavily influenced by the amount of LLW disposed of on-site.

Option 3: Retrieve all wastes and close the operable unit. This option is outside the scope of TWRS as defined for retrieval privatization, but should be considered. The importance of this option is that some retrieval approaches that rely on hydraulic methods may significantly increase the difficulty and cost for soil remediation and operable unit closure. This option allows the contractor to make tradeoffs on these considerations and will reduce total costs.

2.3.4 Waste Retrieval - Product Specifications

A primary service specification for retrieval of a waste stream (liquid plus solids [dissolved and suspended]) would be the flow rate with which it would be delivered to the transfer system. The waste stream to be delivered will have to meet criteria concerning the maximum solids content. There may also be a range in the solid/liquid ratio to control the use of water in the removal and transfer of the waste.

For clean tanks delivered to DOE, a specification on the amount of waste mass (kg of residual solids) and radioactivity (Ci) would be specified.

2.3.5 Waste Retrieval - Technology Requirements

Wastes in the tanks are generally classified in three categories; 1) supernatants [water containing dissolved solids (both radioactive and non-radioactive chemical constituents)], 2) saltcake (chemical residues capable of being dissolved in water), and 3) sludges (chemical species that are insoluble in water). In some cases supernatants have very high dissolved solid content (specific gravity up to 1.5) in addition to cases where suspended solids result in the supernatant being a slurry.

The physical conditions of the saltcake and sludges will vary significantly. In tanks that have been stabilized (liquids removed to prevent leakage), the saltcake and sludges have formed coherent solid formations. In some cases, sludges have underground mineralization processes.

The technology required to remove the contents of the tanks will vary with specific conditions. Pumps are clearly required, pumps capable of handling liquids, and pumps capable of handling two-phase flow with widely varying solid particle size. For water soluble saltcake, high volume sluicing equipment will be required to break up the saltcakes and create the slurries necessary to remove the waste from the tanks. For sludges that have been mineralized and have the characteristics of concrete or caliche, a technology for breaking down the formations (chemical, mechanical, hydraulic, pneumatic) into particles of size capable of being pumped as a slurry will be required.

For tanks of suspected containment integrity, adding water to the tanks or utilizing forces to disrupt the physical condition of the waste will raise questions about leakage of waste from the tanks. Technology to monitor the integrity of the tanks and leak detection technology will be important.

Technology to measure and monitor the condition of the waste stream as it is being retrieved and delivered to the transfer function will be important. Technology to verify the cleanliness of the tank at the time of turnover will be required.

2.3.6 Waste Retrieval - Constraints

The primary constraints affecting the operation of the retrieval systems will be the factors affecting the loss of containment, primarily within the tanks, of the radioactive waste. This will be of primary concern for tanks of questionable integrity (known leakers, suspected leakers, and fragile containment conditions).

A second constraint will be the commitment outlined in the TPA requiring closure of tank farms beginning in March of 2002. By September 2018, the waste will have been retrieved from all SSTs and by September 2024 all SST farms will have completed the formal regulatory closure process.

A third constraint will be related to the conditions for closure of the SSTs (as defined in TPA Milestone M-45-00). Cleanup to 360 ft^3 in 100 series tanks and 30 ft^3 in 200 Series tanks is required. The closure requirements are outlined in WAC 173-303-610 and Resource Conservation and Recovery Act (RCRA) Section 3004 (U).

A fourth constraint involves the retrieval of the waste according to the sequence established by DOE. Operating the retrieval system will require frequent and significant entry into the tanks and exposure to radioactive materials and radiation fields during retrieval operation and during equipment decontamination and decommissioning. Radiation exposure of workers for this function could be the most significant of all activities. The application of As Low As Reasonably Achievalbe (ALARA) for workers may become a constraining factor.

2.3.7 Waste Retrieval - Specific Risks

The privatization of waste retrieval carries several technology, programmatic, environmental, and safety risks. Numerous risks can be specified:

- New technology is required; e.g., new retrieval technologies need to be developed for the SSTs that are beyond sluicing, as well as for leak detection and subsurface barriers.

- There is a schedule risk associated with legislation, the application of regulations and licensing requirements, and interfacing with the services and infrastructure of other firms or government-controlled sites; examples would include roads, pipelines, and power supply, transmission lines.

- Risk in the interface and liability for solid waste disposal including the distinction between the disposal of solid wastes and "product" generated waste is unclear.

- The availability and delivery of specified products (supernatant, sludge, etc.) to the next stage in the processing sequence involves schedule risks.

- Operational risks include unknown waste inventories, tank conditions, waste minimization (dilution rates), equipment reliability, and plugging of equipment and transfer lines. The tendency for transfer line plugging and the integrity of the transfer system are not known.

- The initial capital investment for a complex retrieval system of this sort would be large, as would be the risk for default.

- The current Environmental Impact Statement (EIS) addresses only the DSTs. An Environmental Assessment (EA) is needed for the retrieval of wastes in Tank C-106 and a new TWRS EIS will be needed to address environmental issues for the SSTs.

- There is no legal precedence for the long-term liability of government and industry for this project.

- Examples of environmental risks include the lack of definition for acceptable limits of containment and the responsibility for any financial liability from environmental insult.

- Safety risks include worker occupational safety and public exposure.

2.3.8 Waste Retrieval - Function-Specific Regulatory Requirements

Regulatory oversight comes from many sources. DOE Orders, Dangerous Waste Permits, potential NRC regulation, Ground Water Discharge and Air Quality regulations, the Defense Nuclear Facility Safety Board (DNFSB), Occupational Safety and Health Administration (OSHA), and the EPA all regulate often overlapping aspects of waste retrieval and conditioning. Perhaps the most specific and legally binding regulation derives from the TPA, which has the following specific milestones:

09/30/94	M-45-01	Develop SST Retrieval Technology
09/30/94	M-45-07A	Complete evaluation of subsurface barrier feasibility
01/31/95	M-45-07B	Reach decision on whether to proceed with demo
03/31/95	M-45-07T01	Establish performance criteria and test specifications
10/31/95	M-45-07T02	Initiate demo testing of selected subsurface barriers
03/31/97	M-45-07T03	Complete evaluation of subsurface barrier demo test results
04/30/97	M-45-04A	Complete conceptual design for initial SST retrieval system
06/30/97	M-45-07T04	Reach decision on whether to proceed with subsurface barrier program
09/30/97	M-45-07	Complete evaluation and demo test of small subsurface barriers
09/30/97	M-45-07C	Establish new milestones
10/31/97	M-45-03A	Initiate sluicing retrieval of C-106
06/30/02	M-45-03T02	Initial final retrieval demo of C-106
12/31/02	M-45-04T02	Complete design for initial SST retrieval system
06/30/03	M-45-04T03	Complete construction for SST retrieval system
09/30/03	M-45-03T01	Complete SST Waste Retrieval Demonstration
11/30/03	M-45-04T01	Provide initial SST retrieval steps
09/34/17	M-45-02	Submit annual updates to SST retrieval sequencing document (A-V through 2017)
09/30/18	M-45-05	Retrieve waste for all remaining SSTs

Waste retrieval milestones for the DSTs have not been specified. The milestones associated with the completion of the high- and low-level vitrification functions (2028) and the completion of pretreatment processing (2028) do relate indirectly to waste retrieval of the DSTs. Therefore, we are assuming that DST retrieval has to be completed prior to 2028.

2.3.9 Waste Retrieval - Cost of The Baseline System

Current cost estimates for waste retrieval for both the SSTs and the DSTs is approximately $5.5 B over the life of the program. This figure includes barrier feasibility studies and leak-detection technology development, but does not include costs for deployment of barriers. A more specific breakdown of costs follows:

- retrieval costs would average $30 M per Tank
- conditioning costs may be significant, and have not been estimated
- feasibility costs for barriers to prevent leaking (unknown how many leakers would require this) would be small, but deployment would be potentially very expensive ($200 M per Tank Farm Barrier); technology development for barriers is not entirely covered by the current funding
- leak detection technology development would be at minimal cost, but deployment is not funded (Note: the cost would become significant if barriers must be verified; technology gaps exist)

Cost estimates for the retrieval of MUSTs have not been estimated and are not included, but are considered significant.

2.3.10 Waste Retrieval - Current Schedule of Operations

The schedule for the waste retrieval part of the TWRS project is given in the TPA milestones listing above. The schedule for MUSTs and DSTs retrieval have not been dictated by the TPA. Double-Shell Tank retrieval will be needed early in order to provide the receiving vessels for the SST wastes.

2.3.11 Waste Retrieval - Connectivity/Interfaces

The Retrieval Function interfaces with waste storage, transfer, and pretreatment. Retrieval and conditioning will require copious quantities of water or dilute wastes. Sources for the carrier dilute wastes include the existing DST wastes, pretreatment process secondary streams, evaporator condensate, and condensates from the vitrification plants. Since there will be a significant cost associated with treatment of unnecessary dilution, the logistics of storing and scheduling the transport of these process fluids back to retrieval will be vital. Retrieval will need to accomplish some of the initial pretreatment steps, including in-tank sludge washing and waste blending. As such, the equipment designed for retrieval must carry out additional functions, and the scheduling of these functions will be driven by other downstream processes. The efficiency of the pretreatment processes may be influenced by the methods used for retrieval and conditioning. For example, solid-liquid separation may be degraded if size reduction equipment produces extremely fine material. If the product stream changes significantly due to additives in the sluicing solution, retrieval could affect LLWV and HLWV performance characteristics. Final retrieval schedule will need to be coordinated such that closure activities are efficient, particularly if these are being conducted under another contract.

2.3.12 Waste Retrieval - Basis for Fee

The fee could be based on any or combinations of any of the following:

- A 99% waste volume removal from the tanks (excluding sluicing additive) with the fee per tank based upon a degree of difficulty. Excess sluicing solution could act as a penalty against the fee to ensure waste minimization.
- The amount of waste which leaks from the tanks during retrieval operations could act as a penalty to the fee (if there exists technology for determining that volume).
- Credit for complying with specifications for the physical and chemical characteristics of retrieved wastes.
- Number of tanks retrieved over a specified time frame.
- Delivery of waste products within prescribed rates.
- Credit for minimization of follow-on work required for solid waste disposal.
- Credit from achieving a higher-level of tank cleanliness.
- Sequence of tank retrieval specified is maintained.

2.3.13 Waste Retrieval - Decommissioning Requirements

There are significant requirements for the decontamination and decommissioning of equipment that may need to be removed prior to the start of retrieval operations. The same requirements exist for the retrieval equipment itself after completion of the waste transfer operation. The TWRS flowsheet does not address equipment removal, cleaning and/or rinsing, dismantling, and disposal or recycling. Preliminary cost estimates on robotic arms mandates their reuse. These decommissioning operations need to be part of the retrieval function. The issue is open over Environmental Restoration (ER) responsibility for the tank structure (they assume responsibility), which includes possible contaminated soil from leakage plumes.

2.3.14 Waste Retrieval - Other Issues

The most significant difficulty in sufficiently defining the work in order for a contractor to bid, relates to the lack of detailed information on waste characteristics, waste inventory, and tank integrity. These uncertainties must be accommodated in the contractor's bid through some kind of contingency, or some kind of contractual caveat. Each of these issues have very strong cost and schedule implications. For example, if a contractor assumes that a tank will leak, a barrier may be included in the proposal with a potentially unnecessary cost of $200 M. Other issues involve the availability and liability to participating parties for using the existing infrastructure, which is a possible risk to the private company. A secondary concern is, who defines infrastructure upgrade needs? For example, sluicing could impact ventilation requirements, or mixer pump technologies could impact power requirements for the project. Does the operations function stop when retrieval starts? DOE would argue that monitoring and maintaining the safety envelope is part of the retrieval responsibility. How is in-tank hardware going to be removed, treated, and disposed? How is the output stream going to be certified to ensure the specifications of the material feed for treatment? Subcontracting this monitoring function may be applicable. Who homogenizes the retrieved waste? This is not currently included as a function in the retrieval system, but it is a necessary function that may be required for some or all of the DSTs. Another issue is stakeholder consensus on the inherent risks for additional but limited leaks to the soil during retrieval operations. Overall, there is a lack of detailed characterization data for the USTs, and waste tank safety issues would have to be resolved.

2.3.15 Waste Retrieval - Inputs and Outputs

	Waste Retrieval Function	Interface with Function
Inputs:	Tank Waste	Storage
	Equipment	Operations
	Barriers, Leak Detection, Technology, Infrastructure	Operations
	Chemical Additions	Storage, Transfer, Treatment
	Specifications, Dollars, Information	Operations, Characterization
	Fluid and Chemical Retrieval, Services, Tank Maintenance	Operations
Constraints:	Time	Transfer, Treatment, Storage
	Percent Cleanup	External
	Form of Waste	Treatment and Transfer
	Regulatory	External, Treatment, Transfer
	Rate of Delivery	Treatment and Transfer
	Availability Requirements	Treatment, Transfer, Storage
	Sequencing	Treatment, Transfer, Storage
	Schedule	External
Outputs:	Tank Garbage	Transport and Decon
	In-tank Hardware	Transport and Decon
	Operations Related Wastes Including HEPAs, etc.	Transport and Decon
	Waste	Transfer and Treatment
	Spent Equipment	Transport and Decon
	Reusable Equipment	Transport, Decon, Retrieval
	Air Emissions, Contamination, Certification of Product	Transfer, Treatment

2.4 Waste Transfer Function

2.4.1 Waste Transfer - Description of The System

The Transfer Function will consist of three fundamentally different operations. The first will include the transfer of the liquid and slurried waste from the SSTs, DSTs, and the MUSTs via pipeline from the various tank farms to the pretreatment facility, and on to the vitrification facilities (this includes the return of treated sludges from treatment to the tanks). The second will involve the transport via cask and truck of the 1,930 Cs and Sr capsules from the WESF to the pretreatment facilities or other potential location for the purpose of dismantling the capsules and injecting the radionuclides into the waste stream from the tank farms. The third transfer operation will be in providing a cross-site transfer route between East and West Tank Farms (replacement of existing cross-site transfer system).

Transfer function activities for the tank wastes will include 1) development, fabrication and/or installation of the equipment and infrastructure of the pipeline system, 2) development of the procedure and conditions necessary to assure that the variety of waste could be transferred without significant problems, 3) operation of the pipeline, and 4) decontamination, removal, and disposal of the system. Tank waste materials and sluicing fluids from 50 MUSTs and 177 USTs would have to be transferred to the pretreatment facilities and on to the vitrification facilities.

Transfer function activities for Cs and Sr capsules will consist of loading the capsules into an NRC licensed transport cask at the WESF and moving the cask over the road to the pretreatment facility and on to the vitrification facilities.

2.4.2 Waste Transfer - What Constitutes Privatization

Privatization of the transfer subfunction would occur with the turnover of the responsibility for the design, procurement, construction and operations of the transfer equipment and facilities. This will include independent operating equipment. The contractor would then be responsible for receiving retrieved waste at the tanks and transferring it to the pretreatment facilities, and after pretreatment, accepting the waste and transferring those to the HLWV and LLWV facilities. This also includes receiving the treated sludges from the treatment facilities and transferring those to intermediate tank storage. It will include accepting the responsibility for receiving the Cs and Sr capsules in the cask at WESF and moving those to the treatment facilities. A final responsibility of the contractor will be to provide a transfer capability between the East and West Tank Farms.

2.4.3 Waste Transfer - Service/Product Purchased

Three distinctly different services would be purchased. The first involves the receipt of liquid /slurried waste from the retrieval subfunction for delivery to the pretreatment facilities, and from the pretreatment facilities for delivery to the low-level and high-level vitrification plants. This also includes receipt of treated waste (washed sludge) from the treatment facilities and returning that waste to the DSTs for intermediate storage.

The second service would involve the receipt of 1,930 Cs and Sr capsules from the WESF for delivery to the treatment facilities.

The third service involves the receipt of liquid/slurried waste from storage for delivery from to either East or West Tank Farms.

2.4.4 Waste Transfer - Product Specifications

With regard to transfer of liquid/slurried waste, the transfer performance specification would define the nominal and maximum flow rate of liquid/slurries along with nominal and maximum/minimum solids concentration to be delivered. These would be established based on the requirement that all waste must be removed from the SSTs by 2018 and all pretreatment must be completed by the end of 2028.

With regard to the transfer of the 1,930 Cs and Sr capsules, the specification is that they would have to be transferred in a cask and transporter approved by the U.S. Department of Transportation (DOT) and fulfill all of the requirements of the NRC for radiological protection. The delivery schedule for the capsules would be defined based on the availability of the specific facility within the pretreatment subfunction.

2.4.5 Waste Transfer - Technology Requirements

The regulatory requirements will require that double-containment piping be used for the transfer of the liquid/slurried radioactive waste. It will be essential that the size of the piping and the materials of construction be consistent with the pressure requirements of the pumping conditions and the abrasive nature of the suspended solids in the waste stream.

With regard to the transfer of the capsules, the technology for transport casks is well established. Purchase of transport casks built to specifications should not be a problem.

Shielded tank trucks have been utilized to transport HLW solutions in French nuclear facilities. Most are designed for volumes less than 1500 gal, requiring a large number of trucks to perform the transfer function for TWRS. In addition, tank truck transfers introduce the potential for worker exposure to radiation sources.

2.4.6 Waste Transfer - Constraints

The primary constraint is the need to fulfill the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) criteria for preventing releases to the environment with the use of double containment on the piping system. The use of double- containment piping will have with it a requirement to detect leaks within the piping and the capability to repair the piping if significant leakage occurs. There will also be a constraint on the design of the transfer system to allow for its decontamination and removal when the operation is complete.

With regard to the 1,930 capsules, the constraint is the use of the NRC approved Type B shipping casks for transport.

2.4.7 Waste Transfer - Specific Risks

Only modest risks are associated with the privatized operation of the transfer function. The most significant risks involve:

- Successful completion of the licensing process by the NRC, since no project of this nature has been licensed before.
- Obtaining the environmental permits under CERCLA for pipelines.
- Operation of the pipelines will be tied directly to the retrieval, pretreatment and storage sub-systems; it will be essential that the cross-site transfer system provide timely capability to meet storage limitations.

2.4.8 Waste Transfer - Function-Specific Regulatory Requirements

Regulatory oversight comes from many sources. DOE Orders, Dangerous Waste Permits, potential NRC regulation, Ground Water Discharge and Air Quality regulations, OSHA, the DNFSB, and the EPA all regulate often overlapping aspects of waste retrieval and transfer. Perhaps the most specific and legally binding regulation derives from the TPA, which has the following specific milestones regarding waste transfer:

02/28/98	M-43-07	Complete Replacement of Cross-Site Transfer System

The milestones listed below define the necessary availability of the transfer system to support the retrieval and treatment functions and include:

06/30/02	M-45-03T2	Initial Final Retrieval Demo of C-106
09/30/03	M-45-03T1	Complete SST Waste Retrieval Demonstration
12/31/04	M-50-02	Start Hot Operations of LLW Pretreatment Facility
12/31/09	M-50-03	Start Hot Operations of HLW Vitrification Facility
09/30/18	M-45-05	Retrieve Waste from all Remaining SSTs
12/31/28	M-50-00	Complete Pretreatment Processing of Hanford Tank Waste

2.4.9 Waste Transfer - Cost of The Baseline System

The work breakdown structure for the TWRS Program does not clearly define the cost of the transfer activity since it is included in both operations and upgrades. An estimate of this activity was made using 20% of the Tank Farm Operations budget and 10% of the Tank Farm upgrades budget. The FY 1994 budget for this set of activities is $10 M (Tank Farm Upgrades portion only). The total estimated cost for these activities through year 2029 is estimated to be $1.2 B.

The total estimated cost associated with Project W-058 (Replacement of the cross-site Transfer Function) is approximately $49.4 M.

2.4.10 Waste Transfer - Current Schedule of Operations

The schedule for the transfer function is given in the TPA milestones listing above. It is highly dependent upon the availability of the waste from retrieval and need of feed by treatment.

2.4.11 Waste Transfer - Connectivity/Interfaces

The operation of the cross-site transfer line is tied directly to the operation of retrieval and storage. In addition, treated sludges which must be returned to storage will be subject to availability of DST space. If a transfer system is used to manage tank space and transfer waste to/from treatment, the storage function may become very dependent upon the effective operation of the transfer system and may subsequently impact safety.

2.4.12 Waste Transfer - Basis for Fee

The basis to determine the fee for the transfer subfunction might include the delivery schedule for tank wastes and capsules, the volume or quantity of wastes transferred, and the volume or quantity of pretreated sludges transferred.

2.4.13 Waste Transfer - Decommissioning Requirements

Decommissioning requirements would include the clean-up of spills and releases from the transfer of the wastes. Both may require removal of the supporting infrastructure (piping) and impact the storage function.

2.4.14 Waste Transfer - Other Issues

The existing transfer system consists of six pipelines, each six miles in length, that connect the East and West Areas. This system does not provide double containment as required. Four of the existing lines are plugged and the remaining two are only used for emergency transfers. The existing system is not a feasible option for waste transfer use in the interim, requiring the vendor to construct a new system.

Location of the treatment facilities and tank selections determine when and where transfer systems must be available. A cross-site transfer system must be constructed to support management of tank space unless new tank storage facilities are built in the West Area.

2.4.15 Waste Transfer - Inputs and Outputs

	Waste Transfer Function	Interface with Function
Input:	Retrieved Waste/Waste	Retrieval, Storage
	Waste Sludges (treated)	Treatment
	Cs/Sr Capsules	Operations (WESF)
	Equipment	Operations
	Specifications,	

	Waste Transfer Function	Interface with Function
Constraints:	Sequencing	Storage, Treatment
	Tank Space Management	Storage
	Rate of Delivery	Treatment, Storage
	Regulatory	External
	Waste Form	Treatment, Storage
	Schedule	External, Storage, Treatment
Outputs:	Waste	Treatment, Storage
	Cs/Sr Capsules	Treatment
	Waste Sludges	Storage
	Spent Equipment	Transport and Decon
	Reusable Equipment	Transfer, Transport, and Decon
	Air Emissions,	Treatment, Storage
	Operations	Transport and Decon or Treatment

2.5 Waste Pretreatment Function

2.5.1 Pretreatment - Description of The System

Pretreatment prepares the waste from the tanks for vitrification. The current TWRS approach assumes that simple physical separation techniques coupled with cesium ion removal, which uses conventional ion exchange, will be sufficient for pretreatment. Additional separation techniques may, however, be required to meet feed specifications for vitrification processes. Pretreatment depends on the retrieval and transfer functions for input. Lag storage can be anticipated for both the input and output portions of this system element: the retrieved waste before pretreatment and treated waste before vitrification.

2.5.2 Pretreatment - What Constitutes Privatization

Privatization of the Pretreatment Function would involve design, construction, and operation of the pretreatment facilities, including process-plant type structures and equipment.

2.5.3 Pretreatment - Service/Product Purchased

Privatization of the Pretreatment Function would consist of purchasing from a private vendor the separated and treated HLW (primarily sludge) and LLW (primarily sodium rich liquid). Given a tank waste feed with a specific range of chemical and physical characteristics, the two product streams provided by the private company must have the required chemical and physical characteristics for eventual LLWV and HLWV.

2.5.4 Pretreatment - Product Specifications

Product specifications are difficult to provide at this time because they depend on the requirements for HLWV and LLWV. The range of chemical and physical characteristics of the treated and separated LLW and HLW feeds would have to be carefully specified to meet vitrification requirements.

2.5.5 Pretreatment - Technology Requirements

The necessary separations technology exists. Substantial technology development is underway, and this development could affect the performance of the pretreatment function. Technology transfer from the government and between private companies is also an issue.

2.5.6 Pretreatment - Constraints

Constraints include the storage capacity for high-level vitrified waste in the geologic waste repository and low-level vitrified waste on site. The rate at which waste is processed by vitrification facilities is a constraint on pretreatment output. Another constraint on pretreatment input is the rate of the retrieval and transfer of waste from the Tank Farms.

2.5.7 Pretreatment -Specific Risks

The risks to the government that might be incurred in the privatization of the Pretreatment Function element were considered. An attempt was made to establish and analyze those internal risks to the private company which would have potentially significant cost impacts. Risks specific to the pretreatment function are expressed below as issues, discussed briefly, with each qualitatively ranked as either high, medium, or low.

Issue	Discussion	Risk H/M/L
Lack of data on actual wastes	Maximum risk exists due to lack of demonstrated processing of actual wastes at pilot scale.	H
Who is responsible for necessary pre-testing (contractor or government)	Recommend government pays but contractor be responsible	L
Lack of feed specifications for vitrification	The vitrification feed specifications dictate the product specification for pretreatment. Without these specifications an optimum system cannot be designed. Cost impacts can be multi-billion dollar.	H
Lack of performance data to evaluate contractor proposals	Same as lack of data on actual wastes	M

Uncertainty on need for additional treatment	Will organic complexants cause a problem with ion exchange? Will strontium or technetium need to be removed?	M
Secondary	Has all secondary waste treatment been defined and costed?	M
Technology Development	Needs to be funded and fenced	M
Degree of solid/liquid separation	Undefined at this point	M

2.5.8 Pretreatment - Function-Specific Regulatory Requirements

Specific Regulatory Requirements include both environmental and radiological issues. Because of the nature of the waste forms, direct handling is not an option. Remote facilities will probably be utilized to limit worker exposure and meet CFR standards for neutron and gamma exposure.

Specific environmental regulations that would apply include Washington State Administrative Codes (WACs), potential NRC regulations, DOE Orders, Ground Water Discharge and Air Quality regulations, in addition to many TPA milestones.. Among the key TPA milestones associated with the pretreatment operations are:

12/96	M-50-01T2	Submit Conceptual Design and Begin Definitive Design of Pretreatment Facility
03/98	M-50-03	Complete Evaluation of Enhanced Sludge Washing to Determine Requirements
11/98	M-50-01	Start Construction of LLW Pretreatment Facility
06/01	M-50-04T3	Start Construction of HLW Pretreatment Facility
12/03	M-50-02T1	Complete Construction of LLW Pretreatment Facility
12/04	M-50-02	Start Hot Operations of LLW Petreatment Facility
06/08	M-50-04	Start Hot Operations of HLW Pretreatment Facility
12/28	M-50-00	Complete Pretreatment Processing

2.5.9 Pretreatment - Cost of The Baseline System

The current cost estimate for waste pretreatment is approximately \$3.8 B over the life of the program. Cost estimates for the treatment of MUSTs have not been estimated and are not included, but are considered significant.

2.5.10 Pretreatment - Current Schedule of Operations

The current schedule of operations for pretreatment is given in the milestones above and runs from 2004 to 2028.

2.5.11 Pretreatment - Connectivity/Interfaces

The Pretreatment Function interfaces with the Retrieval, Storage and Transfer Functions at the input end and with LLWV and HLWV at the output end. Characterization data obtained either in storage or retrieval will determine pretreatment processes. The efficiency of the pretreatment processes may be influenced by the methods used for retrieval and conditioning. For example, solid-liquid separation may be degraded if size reduction equipment in retrieval produces extremely fine material. Also, the addition of sluicing fluids could affect efficiency and performance characteristics in pretreatment. Interfaces with the Storage Function are based upon return of the treated sludge for interim storage in the DSTs. It has not been determined if any treatment will be performed in-tank in addition to a LLW pretreatment facility.

2.5.12 Pretreatment - Basis for Fee

The privatization basis for fee could use quantity of waste processed, which is common for private waste treatment facilities. In the case of the TWRS, the unit of measure would likely be a combination of straight volume, radionuclide content, and physical form. It would be desirable to place separation requirements on the process to optimize the HLW and LLW feeds to the vitrification facilities.

2.5.13 Pretreatment - Decommissioning Requirements

The government would likely be required to accept responsibility for decommissioning the facilities at the end of the project.

2.5.14 Pretreatment - Other Issues

In the baseline technology, the saltcake fraction of the waste is dissolved and cesium is removed by ion exchange using CS-100 resin. The liquid fraction is fed into the treatment stream for LLWV. Multiple evaporation steps are used throughout the process to concentrate the dilute treatment streams. This process is used for both the supernate and saltcake fractions of the retrieved tank waste. The baseline technology for sludge pretreatment is to use a water wash of the sludge followed by physical separation of solids by filtration. Effluent liquid will be processed using CS-100 resin to remove the cesium for LLWV. Ion exchange resin, as well as filtered solids, will be sent to HLWV. This process has a medium probability of success in terms of the feasibility of the operating processes. The economics of the process have not been determined, but this is probably not an optimum solution. Currently, the only known constraint is that the final LLW form not exceed a class C rating.

There are also technical risks associated with the baseline pretreatment approach which principally arise from the requirements for removal of radioisotopes. In addition to Cesium, there are a number of other soluble radioisotopes present in the Hanford wastes. Their quantity and the efficiency with which they must be removed are yet to be determined. In addition to the radioisotopes, small quantities of organic materials are also found in Hanford wastes. The effect of these organics on the separation process (both physical separation and ion exchange) is unknown. The operating experience with the processes used to reprocess fuel is being applied to the baseline pretreatment system. This experience may not be directly applicable to the waste treatment systems discussed here because of differences in the process feeds as well as inherent differences in the product.

2.5.15 Pretreatment - Inputs and Outputs

Privatization of the Pretreatment Function requires close coordination between the Waste Retrieval Functions and the low-level and high-level vitrification functions of the TWRS program.

	Waste Pretreatment Function	Interface with Function
Inputs:	Retrieved Tank Waste	Retrieval and Transfer
	Cs/Sr Capsules	Transfer
	Chemical Additions	Retrieval and Transfer
	Waste Sludges	Retrieval and Transfer
	Specifications, Dollars, Information	Operations
Constraints:	Rate of Delivery	Treatment and Storage
	Regulatory (includes LLW ≤ Class C)	External
	Waste Form	Treatment, Retrieval and Transfer
	Schedule	External, Storage, Retrieval, Transfer and Vitrification
	Storage capacity at Repository	External
	Vitrification Processing Rate	Vitrification
Outputs:	Treated Sludges	Transfer, Storage and HLWV
	Treated LLW	LLWV
	Operations Related Wastes (Resins, Solvents, HEPAs, etc.)	Treatment
	Air Emissions, Contamination, Certification of Product	Treatment, Vitrification
	Spent Equipment	Transport and Decontaminate

2.6 Low-Level Waste Vitrification Function

2.6.1 LLW Vitrification - Description of The System.

The LLWV Function processes a low-level radioactive feed from Pretreatment into a vitrified form that meets the specifications for Hanford LLW. The principal constraint for the input to LLWV is the volumetric feed rate from the Pretreatment Function. Output specifications for the LLWV function have not been determined. Specifications for LLWV will depend on the desired class of waste, transportation and handling requirements, and the final disposal site. Until these issues are resolved, the process selected for vitrification must meet a broad range of product specifications. The uncertainty is compounded because a bounding requirement for the pretreatment function is the input requirement for LLWV. Various glass-making technologies are available from private industrial sources. Selection of one vitrification technology over another will require feasibility testing with actual retrieved and pretreated tank farm wastes. It is uncertain whether any of the commercially available technologies are capable of meeting the broad requirements for LLWV.

2.6.2 LLW Vitrification - What Constitutes Privatization

Privatization of the LLWV function would involve the design, construction, and operation of the LLWV facilities. This will likely include process-plant type structures and equipment.

2.6.3 LLW Vitrification - Service/Product Purchased

The service purchased would be the transformation of pretreated LLW feed into an acceptable glass form.

2.6.4 LLW Vitrification - Product Specifications

The specifications for the LLW glass form are not yet finalized and would likely be based on two aspects of performance: a technical aspect that would provide performance specifications for leachability, radioactivity, etc.; and a specification for quantity that would minimize the amount of waste glass produced.

2.6.5 LLW Vitrification - Technology Requirements

Glass-forming technology exists but is untested for this application.

2.6.6 LLW Vitrification - Constraints

The constraints associated with LLWV are primarily driven by the TPA. In addition to the external regulatory drivers, availability of the LLW Disposal site and treated LLW from pretreatment may determine the operating schedule of the LLWV facility.

2.6.7 LLW Vitrification - Specific Risks

The risks to government requirements for support of the privatization option from pretreatment input, through processing, to the final product were considered. An attempt was made to establish and analyze the internal risks to the private company which would have potentially significant cost impacts. Risks specific to the LLWV function are expressed below as issues, discussed briefly, with each qualitatively ranked as either high, medium, or low.

Issue	Discussion	Risk H/M/L
As a new function, significant program unknowns exist	No demonstrated glass production, even with simulants.	H
Waste Class Level A or C? Impact of class of waste on cost of facility and process unknown	Affects shielding, maintenance requirements, and associated costs.	M
Waste Form Requirements	Needs to be defined ASAP	H

Lack of performance data to evaluate contractor proposals	No demonstrated glass production, even with simulants.	H
Technology Development	Need to pursue with fenced funding.	M
Off-gas issues.	Specific gas emissions from the melter and off-gas treatment requirements have not been identified.	M

2.6.8 LLW Vitrification - Function-Specific Regulatory Requirements

Specific regulatory requirements include both environmental and radiological. Because of the nature of the waste forms, direct handling may not be an option. Worker exposure must be carefully monitored if contact facilities are utilized and meet CFR standards for neutron and gamma exposure limits.

Specific environmental regulations that would apply include WACs, potential NRC regulations, DOE Orders, Ground Water Discharge and Air Quality Regulations, in addition to many TPA milestones. Among the key TPA milestones associated with the storage operations are:

06/96	M-60-02	Complete Melter Feasibility and System Operability Tests, Select Reference Melter(s), and Establish Reference Glass Formulation
11/96	M-60-03	Submit Conceptual Design and Initiate Definitive Design of LLWV Facility
12/97	M-60-04	Initiate Construction of the LLWV Facility
06/05	M-60-05	Initiate Hot Operations of the LLWV Facility
12/28	M-60-00	Complete Vitrification of Hanford Low-Level Tank Waste

2.6.9 LLW Vitrification - Cost of The Baseline System

Current cost estimate for LLWV are approximately $7.8 B over the life of the program.

2.6.10 LLW Vitrification - Current Schedule of Operations

The schedule for the LLWV part of the TWRS project is given in the milestones listing above. The current schedule of operations for LLWV is from 2005 to 2028.

2.6.11 LLW Vitrification - Connectivity/Interfaces

The LLWV connects directly to the pretreatment function. An implied interface exists between low-level and HLWV because the radionuclides and waste volume not processed through the HLWV facility must, by mass balance, be processed by LLWV.

2.6.12 LLW Vitrification - Basis for Fee

The privatization basis for fee could use the quantity of LLW processed, which is a common basis for private waste treatment facilities. In the case of the TWRS, the unit of measure would likely be a combination of the volume of the vitrified product, the radionuclide content, and the physical form. Minimizing the amount of vitrified waste produced from a given quantity of waste feed by restricting quantity would be desirable. Difficulties would be associated with such a restriction because waste feed would have to be carefully monitored and analyzed to enforce the product specifications.

2.6.13 LLW Vitrification - Decommissioning Requirements

The government would likely be required to accept responsibility for decommissioning the facilities at the end of the project.

2.6.14 LLW Vitrification - Other Issues

Presently, one clear constraint is that the vitrified LLW not exceed a class C rating. In addition, this glass must have physical and chemical durability properties that will ensure that a formal disposal performance assessment can be performed that meets DOE Order 5820.2A.

2.6.15 LLW Vitrification - Inputs and Outputs

Privatization of the LLWV function requires that the waste feed input from the pretreatment function be considered. Constraints on the quantity of LLWV output have not been established, but minimizing the quantity of LLWV waste seems desirable.

	LLWV Function	Interface with Function
Inputs:	Treated LLW	Treatment
	Chemical Additions	Treatment, Storage, Retrieval and Transfer
	Specifications, Dollars, Information	Disposal and External
Constraints:	Rate of Delivery	Treatment and Storage
	Regulatory (includes LLW ≤ Class C)	Treatment and External
	Schedule	External, Storage, Retrieval, Transfer and Treatment
	Storage Capacity at Disposal Site	External
Outputs:	Vitrified LLW form	LLW Disposal
	Operations Related Wastes (HEPA, etc.)	Treatment
	Air Emissions, Contamination, Certification of Product	LLW Disposal
	Spent Equipment	Transport and Decontaminate

2.7 High-Level Waste Vitrification Function

2.7.1 HLW Vitrification - Description of The System

The HLWV Function processes a high-level radioactive feed from pretreatment into a vitrified form that meets the specifications for Hanford HLW. Input to the HLWV is constrained primarily by the output volumetric feed rate and the composition of the waste stream from the pretreatment function. The output specifications for the HLWV function are strongly dependent on the repository requirements for HLW, requirements which have not been determined. Issues for HLW disposal include transportation and handling regulations, the allowed concentrations of heavy metals, and the formulation of the glass. Until these issues are resolved, the process selected for vitrification must meet a broad range of product specifications. As with LLWV, the uncertainty is compounded because a bounding requirement for the performance of the Pretreatment Function is the input requirement for HLWV.

Glass making technologies for HLWV are in the development and implementation stages as part of DOE remediation research. Committing to a particular technology will require feasibility testing with actual retrieved and pretreated tank farm wastes. It is uncertain whether any of the developing vitrification technologies are capable of meeting the yet-to-be defined requirements for Hanford HLWV.

2.7.2 HLW Vitrification - What Constitutes Privatization

Privatization of the HLWV function would involve the design and construction of the HLWV facilities. This will likely include process-plant type structures and equipment. This requires an immediate financial investment in facilities by the contractor.

2.7.3 HLW Vitrification - Service/Product Purchased

The service purchased would be the transformation of pretreated HLW feed into a repository acceptable glass form.

2.7.4 HLW Vitrification - Product Specifications

The specifications for high-level glass form are not yet finalized and would likely be centered on the performance of the glass. We currently expect a 10,000-year leachability standard for the vitrified waste. An accepted test that demonstrates this type of performance is not yet available. Product specifications would likely be based on two aspects of performance: a technical aspect that would provide performance specifications for leachability, radioactivity, and other characteristics of the waste form; and a specification for quantity that would minimize the amount of waste glass produced.

2.7.5 HLW Vitrification - Technology Requirements

Various glass forming technologies exist but few have been demonstrated on a large scale for HLWV, and there is no know technology that currently meets the requirements for a geologic repository. The West Valley Demonstration Facility and the Defense Waste Processing Facility both will demonstrate the use of vitrification in the near future. The French currently use a glass-forming technology to immobilize their high-level radioactive wastes. An adaptation of this technology could conceivably be used for the Hanford tank wastes.

2.7.6 HLW Vitrification - Constraints

The constraints on HLWV are primarily externally driven regarding the performance specifications for the product and the volume of glass which is allocated to Hanford HLW. In addition, there are a considerable number of TPA milestones which dictate the schedule for design construction and operations of the HLWV facility. Other constraints include the amount of vitrified waste that can be produced and stored. The HLWV processing rate is constrained by the output rate of the pretreatment facilities.

2.7.7 HLW Vitrification - Specific Risks

The risks to government requirements for support of the privatization option from pretreatment input, through processing, to the final product were considered. An attempt was made to establish and analyze the internal risks to the private company which would have potentially significant cost impacts. Risks specific to the HLWV function are expressed below as issues, discussed briefly, with each qualitatively ranked as either high, medium, or low.

Issue	Discussion	Risk H/M/L
HLW Accelerated Schedule is not Feasible Cost/Technology Wise	Privatized opportunities only exist in near term while HLWV in baseline doesn't start until 2007 because of budgetary constraints.	H
Glass Performance Criteria/Test Methods Do Not Exist	Needs to be defined prior to start of design.	H
Recipe for Glass Undefined	Needs to be defined prior to start of design.	H
Off-Gas Requirements	Specific gas emissions and off-gas treatment requirements have not been identified.	M

2.7.8 HLW Vitrification - Function-Specific Regulatory Requirements

Specific regulatory requirements include both environmental and radiological. Because of the nature of the waste forms, direct handling is not an option. Worker exposure must be carefully monitored to assure the CFR standards for neutron and gamma exposure limits are met.

Specific environmental regulations that would apply include WACs, potential NRC regulations, DOE Orders, Ground Water Discharge and Air Quality Regulations, in addition to many TPA milestones. The key TPA milestones associated with HLWV storage operations are:

06/98	M-51-02	Complete Melter Tests and Select Reference Melter
09/98	M-51-03T1	Submit HLWV Facility Conceptual Design
12/98	M-51-03T2	Initiate Definitive Design of the HLWV Facility
06/02	M-51-03T3	Initiate Construction of the HLWV Facility
12/07	M-51-03T4	Complete Construction of the HLWV Facility
12/09	M-51-03	Initiate Hot Operations of the HLWV Facility
12/28	M-51-00	Complete Vitrification of Hanford High-Level Tank Waste

2.7.9 HLW Vitrification - Cost of The Baseline System

Current cost estimate for HLWV are approximately $8.2 B over the life of the program. This estimate was based upon the segregation of the HLW storage and disposal functions from the HLWV operations.

2.7.10 HLW Vitrification - Current Schedule of Operations

The current schedule of operations is 2004 to 2028.

2.7.11 HLW Vitrification - Connectivity/Interfaces

The HLWV Function interfaces with the Pretreatment Function. The mass balance for radioisotopes and other waste components also require an interface with LLWV because the waste not processed through HLWV has to be processed by LLWV. An optimum configuration between these two vitrification functions has to be determined. The product specification is subject to HLW disposal requirements.

2.7.12 HLW Vitrification - Basis for Fee

The privatization basis for fee could use the quantity of HLW processed, which is a common basis for private waste treatment facilities. In the case of the TWRS, the unit of measure would likely be a combination of the volume of the vitrified product, the radionuclide content, and the physical form. Minimizing the amount of vitrified waste produced from a given quantity of waste feed by restricting quantity would be desirable. Difficulties would be associated with such a restriction because waste feed would have to be carefully monitored and analyzed to enforce the product specifications..

2.7.13 HLW Vitrification - Decommissioning Requirements

The government would likely be required to accept responsibility for decommissioning the facilities at the end of the project.

2.7.14 HLW Vitrification - Other Issues

Transportation and handling of the vitrified HLW could impact the processing requirements for HLWV.

According to the TPA schedule, the HLWV function does not begin until 2009. Such a long-term schedule could impact the economics of a privatization effort. This schedule was developed based on TWRS baseline budget profiles and the fact that the LLWV effort has to start in concert with pretreatment unless significant additional storage capacity is provided for pretreated wastes.

2.7.15 HLW Vitrification - Inputs and Outputs

Privatization of the HLWV function requires that the waste feed input from the pretreatment function be considered. Constraints on the quantity of HLWV output have been established but are based on cost. It is unlikely that allocation of radionuclide to the Federal repository based on current projections would be a problem.

	HLWV Function	Interface with Function
Inputs:	Treated High-Level Waste	Treatment
	Chemical Additions	Treatment, Storage, Retrieval and Transfer
	Specifications, Dollars, Information	Disposal and External
Constraints:	Rate of Delivery	Treatment and Storage
	Regulatory	Treatment and External
	Schedule	External, Storage, Retrieval, Transfer, Treatment, HLW Storage and HLW Disposal
	Storage Capacity at Disposal Site	External
Outputs:	Vitrified HLW Form	High-level Waste Storage and HLW Disposal
	Operations Related Wastes (HEPA etc.)	Treatment
	Air Emissions, Contamination, Certification of Product	HLW Storage and HLW Disposal
	Spent Equipment	Transport and Decontaminate

2.8 Low-Level Waste Disposal Function

2.8.1 LLW Disposal - Description of The System

The services that would be purchased include the transporting, interim storage and disposal of LLW forms generated from the LLWV Function. The following specific services would be required: 1) preparation (includes design, procurement, and construction) of waste transportation and disposal subsystems as well as for any interim storage facilities that might be required, 2) provision for transportation and disposal subsystems which would include waste transfer systems, container and packaging design, surveillance and monitoring, and subsurface barriers transfer systems, 3) operation of the transportation system and disposal site, 4) decontamination, removal, and disposal of transportation and disposal site equipment as required, and 5) closure of the disposal site.

2.8.2 LLW Disposal - What Constitutes Privatization

Privatization of the LLW disposal would involve the design and construction of transportation equipment and the design, construction and selection, and operation of the physical disposal facility. This will likely include facility structures and equipment.

2.8.3 LLW Disposal - Service/Product Purchased

The privatized LLW disposal services would consist of purchasing the service of transportation of the LLW product from the vitrification facility to the LLW disposal site. The immobilized waste form would be received at the disposal site, emplaced in a shallow burial facility and then covered. Some interim storage may also be necessary prior to disposal. Once all waste had been received, the disposal site would be closed. The private contractor would need to provide monitoring and surveillance at the disposal site while operating and post closure.

2.8.4 LLW Disposal - Product Specifications

The immobilized waste form is to be transported in an NRC/DOE certified package and may not exceed the limits for commercial LLW as defined in 10 CFR 61 Class C Waste. The disposal site must meet the following criteria:

1. provide capacity for an as yet undetermined volume of vitrified radioactive waste; the final volume will depend on waste loading

2. meet performance objectives for radionuclide releases to the environment and public

3. minimize leaching production and provide contingency to detect and collect leachate

4. provide groundwater protection prior to and after installation of the final closure cover

5. minimize the land area required and the impact on the environment

6. employ a double liner system which satisfies RCRA requirements

7. meet regulatory requirements including DOE Order 5820.2A and 10 CFR 61

8. not exceed the EDE 25mr/year from all pathways

9. waste form must be retrievable for at least 50 years beginning in 2028 (Retrievability has to be achievable, not necessarily easy)

10. LLW shall be placed in an on-site, shallow burial site (the top of the disposal system shall be a minimum of five meters below grade).

2.8.5 LLW Disposal - Technology Requirements

The privatization contractor is expected to have expertise in: 1) transportation, 2) disposal site selection, 3) disposal facility design criteria and system configuration, 4) LLW geometry, 5) container design and packaging, 6) design and testing of engineered barriers, 7) waste handling and emplacement systems, 8) implementing and complying with waste form specifications, and 9) monitoring and inspection techniques.

The baseline TWRS technologies are a quenched glass cullet, combined with a sulfur polymer cement matrix, placed in shallow burial (5 meters below the surface) on-site. There are no baseline technologies for transportation, engineered barrier, container design, monitoring, and waste handling systems.

Technologies that could be used in configuring the disposal system are listed below in seven categories:

- Transportation
    - shipment by truck
    - shipment by rail
    - matrix material, pumpable in pipes
- Waste Matrix
    - alternate glasses,
    - cements and polymer modified cements
    - polymers
    - resin sands
    - bitumen
    - low-melting point metals
    - ceramics
- Waste Geometry
    - cullet/marbles
    - sheet glass
    - monolith

- Container Design/Packaging

  - no container (monolithic block or pumpable matrix)
  - coating with no container
  - hot pour into container
  - cold fit into container
  - container filled (marbles, cullet)
  - vault filled (marbles, cullet)

- Engineered Barriers

  - water diversion by semi-impermeable barriers (asphalt and bitumen, sulfur polymer cement)
  - water advection through capillary action (small fine grained material, bentonite type clays, concrete)

- Waste Handling Systems

  - cranes
  - hoists
  - manned vehicles
  - robotic vehicles

- Monitoring/Inspection Techniques

  - NDE inspection techniques to determine vault defects and moisture sensors

2.8.6 LLW Disposal - Constraints

The regulatory constraints which have been placed on the system include NRC, safety, EPA, TPA, DOE, and other legally binding orders, regulations, and mandates. In addition, the system performance shall not only meet regulatory constraints but also meet agreement with EPA, DOE, and the State of Washington. Other mandates (derived from the TWRS process flowsheet) include the schedule and rate of delivery, availability, and the initial state of the transportation function, none of which preclude or exacerbate the LLWV operations.

2.8.7 LLW Disposal - Specific Risks

The privatization of waste disposal carries several technical, programmatic, environmental, and safety risks. These are:

- There is a time risk associated with legislation, the application of regulations, and licensing requirements.

- The privatization firm may have difficulty in obtaining financing to support a project of this magnitude.

- Litigation associated with the waste form selection or sitting may impose a schedule risk.

- Operational risks include the undefined waste acceptance criteria and not-yet completed performance assessment which may result in stakeholder disagreement and delay operation of the disposal site.

- There is no legal precedence for the long-term liability of government and industry for this type of project.

- The record of decision has not yet been formalized allowing LLW disposal at the 200 Area plateau.

- There has not been a decision by NRC regarding the classification of SSTs as incidental wastes.

- It is not determined who will retrieve packages if there is a modification to the acceptance criteria.

- Examples of environmental risks are the responsibility of any financial liability from environmental insult.

- Safety risks include worker exposure, uncertain ALARA levels, and an "acceptable" limit for increased cancer deaths due to exposure.

2.8.8 LLW Disposal - Function-Specific Regulatory Requirements

Regulatory oversight comes from many sources. DOE Orders, Dangerous Waste Permits, various or selected NRC regulation, Ground Water Discharge and Air Quality regulations, the DNFSB, DOT, and the EPA all regulate often overlapping aspects of waste transportation and disposal. While there are no specific milestones within the TPA, those relating to the LLWV operations, dictate availability of the disposal and transportation functions. Those specific milestones are:

06/30/05	M-60-05	Initiate Hot Operations of the LLWV Facility
02/31/28	M-60-00	Complete Vitrification of Hanford Low-Level Tank Waste

Key disposal requirements are defined in 10 CFR 61, 40 CFR 193, 40 CFR 265, and two DOE Orders 5820.2A and draft 5820.2B. Transportation requirements are defined in 10 CFR 71 and 49 CFR 173, 174, and 179. In addition, there are site requirements for transportation as well as hoisting and rigging.

2.8.9 LLW Disposal - Cost of Baseline System

The current baseline cost estimate for transportation and disposal of LLW is approximately $3.0 B over the life of the program.

2.8.10 LLW Disposal - Current Schedule of Operations

The schedule for LLW disposal and transportation within the TWRS project is not clearly defined within the TPA.

2.8.11 LLW Disposal - Connectivity/Interfaces

LLW disposal interfaces primarily with LLWV. Characterization of the waste stream impacts acceptance and performance characteristics for LLW disposal.

2.8.12 LLW Disposal - Basis for Fee

The privatization basis for fee could be based upon any or combinations of the:

- quantity of LLW shipped and stored
- facility availability and transportation availability
- safety record.

2.8.13 LLW Disposal - Decommissioning Requirements

The LLW disposal facility will be closed under the scope of this work. Transportation equipment will be decommissioned and decontaminated.

2.8.14 LLW Disposal - Other Issues

Other issues are lack of resolution to dispose of Class A versus Class C waste, subsequently affecting worker exposure of LLW disposal and the degree of separation technology for treatment. There has been no resolution of further segregation of LLW into a "below regulatory concern" category, possibly reducing waste generation totals. A specific capacity for the LLW disposal site has been defined, but is subject to the performance of the treatment function. It has not been determined who will perform leachate treatment for the LLW disposal site.

2.8.15 LLW Disposal - Inputs and Outputs

	Low-Level Waste Disposal Function	Interface with Function
Inputs:	Immobilized Waste Form	Treatment
	Barriers, Packaging, Leak Detection, Technology, Infrastructure	Operations
	Transportation Equipment	Operations
	Waste Handling and Emplacement Equipment	Operations
	Specifications, Funding, Information	Operations, Storage, Treatment
Constraints:	Time	Treatment, operations
	Retrievability	Treatment, Operations, External

	Low-Level Waste Disposal Function	Interface with Function
	Waste Form	Treatment, External
	Packaging Configuration	Treatment, External
	Availability	Treatment, Operations
	Rate of Delivery	Treatment, Operations
	Sequencing	Treatment, Operations
	Regulatory	External
Outputs:	Transportation Equipment	Transport and Decon
	Disposal Site Handling Systems	Transport and Decon
	Operations Related Wastes	Transport and Decon
	Buried, Immobilized Waste	Acceptable and Comparable Risks
	Waste Disposal Site	External?
	Leachate	Operations or Treatment

2.9 High-Level Waste Interim Storage Function

2.9.1 HLW Interim Storage - Description of The System

The services that would be purchased include the transporting (from the high-level vitrification facility to the interim storage facility) and storage of HLW forms. The following specific services would be required: 1) preparation (includes design, procurement, and construction) of waste transportation and storage systems, 2) provision for transportation and storage systems which would include waste transfer/handling systems including DOE RW transportation and loading interface, container and packaging design, surveillance and monitoring, and interim storage, 3) operation of the transportation system and storage facility (includes retrieving immobilized waste canisters from the storage site and preparing for transportation), 4) decontamination, removal, and disposal of transportation and storage site equipment as required, and 5) decontamination, decommissioning, and closure of the storage site.

2.9.2 HLW Interim Storage - What Constitutes Privatization

Privatization of the HLW Storage Function would involve the design, procurement, construction of transportation equipment and the physical storage facility, and serving as the DOE RL transportation and loading interface. This will likely include facility structures and equipment.

2.9.3 HLW Interim Storage - Service/Product Purchased

The privatized HLW Storage Function would consist of purchasing the service of transportation for an, as yet to be determined, quantity of canisters from the high-level vitrification facility to the HLW storage facility. The immobilized waste form would be received at the storage site and placed into a storage configuration, and eventually retrieved and removed from the facility. In the event of a failed container, the facility must provide the capability to repackage canisters to meet the Waste Acceptance

System Requirements Document (WA-SRD) criteria. The storage facility must have a loading area designated for transfer of the canistered waste forms to the HLW Disposal function. Once all waste had been removed, the storage site would be closed (includes decontamination and decommissioning). The private contractor would need to provide monitoring and surveillance at the storage site while operating, and if required post-closure monitoring..

2.9.4 HLW Interim Storage - Product Specifications

The immobilized waste form is to be transported in an NRC/DOE licensed package as defined in 10 CFR 71 and 49 CFR 173. Note that the applicability of NRC requirements for transportation within private facilities is unclear if the storage and vitrification facilities are adjacent. If an option is open for longer distance transportation, then the requirements must be defined by NRC. The uncertain regulatory aspects of transportation requirements introduce additional risk for the potential private contractor. Also the applicability of 49 CFR 173 is undetermined. NRC requirements for a private storage facility are unclear, but parts of 10 CFR 50 and 10 CFR 72 may apply. The uncertain regulatory aspects of storage introduces additional risk for the potential private contractor. Once received at the storage site, the canistered waste form must continue to meet the requirements of the Waste Acceptance System Requirements Document (DOE/RW-0351P, Rev 0).

The storage site must meet the following criteria: 1) monitor and control of physical conditions to maintain glass phase and container configuration, 2) provide adequate capacity to store all HLW canisters generated in the event that the HLW disposal site is not available immediately (HLW Logs will not have the highest acceptance priority when repository operations begin. As a result, the duration of storage cannot be specified at this time.), 3) minimize the land area required and the impact on the environment, 4) meet regulatory requirements as defined by the CFRs, DOE Orders, NRC, WAC, and site requirements, 5) waste form must be easily retrieved and removed from the storage facility for immediate transfer (based upon a final delivery schedule) to the HLW disposal site, and 6) transporting failed containers back to the vitrification facility for analysis. Experience and precedence from the WVDP and DWPF should be used as a guideline.

2.9.5 HLW Interim Storage - Technology Requirements

The privatization contractor is expected to have expertise in the following areas: 1) transportation, 2) facility site selection, 3) facility design criteria and system configuration, 4) HLW geometry, 5) container design and packaging, 6) HLW remote handling systems, and 7) monitoring and inspection techniques.

The baseline technology is the DWPF canistered borosilicate glass to be stored in a facility on-site. There are no baseline technologies for transportation, cooling system configuration, HLW geometry (stacking and layering), waste handling systems, and monitoring and inspection techniques.

Technology issues impacting the storage of HLW are listed below in seven categories:

- Transportation
  - shipment by truck
  - shipment by rail

- Storage Facility Site Selection

  - off-site location
  - adjacent-to-site location

- Facility Design Criteria and Configuration

  - Passive cooling systems (including underground storage)
  - Active cooling systems

- High-Level Waste Geometry

  - stacking
  - layers

- Container Design/Packaging

  - WVDP
  - DWPF
  - Larger container configuration ($10m^3$)
  - Alternate package configurations defined in WA-SRD (includes alternate waste forms applicability)

- Waste Handling Systems

  - cranes
  - hoists
  - manned vehicles
  - robotic vehicles

- Monitoring/Inspection Techniques

  - NDE inspection techniques to identify package defects

2.9.6 HLW Interim Storage - Constraints

The regulatory constraints which have been placed on the system include NRC, safety, EPA, TPA, DOE, and other legally binding orders, regulations, and mandates. In addition, the package description must address regulatory constraints as specified by EPA, DOE, DOT, the State of Washington and site requirements. Other mandates (derived from the TWRS process flowsheet) include the schedule and rate of delivery, availability, and the initial state of the transportation functions, none of which should preclude or exacerbate the HLWV operations.

2.9.7 HLW Interim Storage - Specific Risks

The privatization of HLW storage carries several technical, programmatic, environmental, and safety risks:

- Specific programmatic risk include the inherent risk of designing, sitting, operating and decommissioning a nuclear facility delaying the schedule or increasing the cost of the system.

- The private contractor may have difficulty in obtaining financing to support a project of this magnitude.

- The promulgation of the necessary legislation, regulations, and licensing requirements is uncertain, and may discourage potential bidders.

- Interim storage of the vitrified waste may be extended due to schedule slippage of the HLW repository.

- Operational risks include modifications to the WA-SRD which may modify packaging configuration.

- There is no legal precedence for the long-term liability of government and industry for this project.

- Examples of environmental risks are the responsibility of any financial liability from environmental insult.

- Safety risks include worker exposure, unpredictable ALARA levels, and an "acceptable" limit for increased cancer deaths due to exposure.

2.9.8 HLW Interim Storage - Function-Specific Regulatory Requirements

Regulatory oversight comes from many sources. DOE Orders, Dangerous Waste Permits, potential NRC regulation, Ground Water Discharge and Air Quality regulations, the DNFSB, DOT, and the EPA all regulate often overlapping aspects of waste and storage. While there are no specific milestones within the TPA, those relating to the HLWV operations, dictate availability of the storage and functions. Those specific milestones are:

12/31/09	M-51-03	Initiate Hot Operations of the HLWV Facility
12/31/28	M-51-00	Complete Vitrification of Hanford High-Level Tank Waste

Key storage requirements are defined in 10 CFR 50, 10 CFR 72, 40 CFR 191, and two DOE Orders 5820.2A and draft 5820.2B requirements are defined in 10 CFR 71 and 49 CFR 173. In addition, there are site requirements for as well as hoisting and rigging.

2.9.9 HLW Interim Storage - Cost of Baseline System

The current baseline cost estimate for storage of HLW is approximately $1.0 B over the life of the program.

2.9.10 HLW Interim Storage - Current Schedule of Operations

The schedule for TWRS HLW storage is not clearly defined within the TPA.

2.9.11 HLW Interim Storage - Connectivity/Interfaces

HLW storage interfaces with HLWV and HLW disposal. Characterization of the waste stream impacts acceptance and performance characteristics for HLW storage and disposal.

2.9.12 HLW Interim Storage - Basis for Fee

The privatization basis for fee could be based upon any or combinations of the:

- quantity of HLW shipped and stored and removed
- quantity of HLW repackaged for reasons other than damage incurred at the HLW storage facility
- facility availability and availability
- safety record
- penalty for number of damaged canisters and incentive for number of containers that meet WA-SRD criteria

2.9.13 HLW Interim Storage - Decommissioning Requirements

The HLW storage facility will be closed under the scope of this work. Equipment will be decommissioned and decontaminated.

2.9.14 HLW Interim Storage - Other Issues

The capacity of the HLW storage facility needs to be more specifically defined, to minimize total costs. Cesium and strontium capsules are assumed to be vitrified at the HLWV facility to meet WA-SRD criteria. There are no provisions in this scope of work to take the waste directly from other sources.

2.9.15 HLW Interim Storage - Inputs and Outputs

	High-Level Waste Storage Function	Interface with Function
Inputs:	Immobilized Waste Form	Treatment
	Packaging, Surveillance, Technology, Infrastructure	Operations
	Equipment	Operations
	Waste Handling Equipment	Operations
	Specifications, Dollars, Information	Operations, Storage, Treatment

	High-Level Waste Storage Function	Interface with Function
Constraints:	Retrievability	Treatment, Operations, External
	Waste Acceptance	Disposal, Treatment, External
	Packaging Configuration	Treatment, External
	Availability	Treatment, Operations
	Rate of Delivery	Treatment, Operations
	Sequencing	Treatment, Operations
	Regulatory	External
Outputs:	Equipment	Transport and Decon
	Disposal Site Handling Systems	Transport and Decon
	Operations Related Wastes	Transport and Decon
	Immobilized Waste Form	High-Level Waste Disposal

2.10 High-Level Waste Disposal Function

2.10.1 HLW Disposal - Description of The System

The services that would be purchased include the transporting and final disposition of HLW forms generated from TWRS. The following specific services would be required: 1) preparation (includes design, procurement, and construction) of waste system and HLW disposal site, 2) provision for and disposal system which would include waste transfer/handling systems, container and packaging design, surveillance and monitoring, interim storage/staging area, and disposal, 3) operation of the system and disposal facility, 4) decontamination, removal, and disposal of the and disposal site equipment as required, and 5) closure of the disposal site.

2.10.2 HLW Disposal - What Constitutes Privatization

The requirements and conditions covering the disposal of high-level radioactive waste will have a significant impact on the technical approach and strategy for privatizing the TWRS. The disposal of high-level radioactive waste is an activity that requires the institution or organization responsible have very long-term stability and continuity. These requirements far exceed historical experience for operating periods of private companies; the only institution with the long-term staying ability is government. The laws created by Congress establishing the government responsibility for the disposal of high-level radioactive waste were based on the recognition of the need for longevity and stability of the responsible organization. Congress assigned the responsibility to DOE. Consequently, there is no intention by DOE to privatize the HLW disposal function, only to understand how it will affect a privatization of TWRS.

2.10.3 HLW Disposal - Service/Product Purchased

As stated, there are no plans to privatize the HLW disposal function. However, if it were, a privatized HLW Disposal Function would consist of two principle parts, the first part is purchasing the service of for approximately 40,000 MT of canistered HLW. The immobilized waste form would be received at the HLW interim storage facility and transported to the HLW disposal site. The second part is purchasing the service of disposing of the approximately 40,000 MT. The immobilized waste form would be received and placed into a mined geologic disposal site. Once the waste had been emplaced the area would be back-filled. Upon receipt of all waste, the disposal site would be closed. The private contractor would need to provide monitoring and surveillance at the disposal site while operating and post closure.

2.10.4 HLW Disposal - Product Specifications

The immobilized waste form is received from the generator or designee only if it meets Waste Acceptance Specification Requirements Document (WA-SRD, DOE/RW-0351P, Rev 0). When it has been demonstrated that it meets that criteria, it is transported in an NRC/DOE licensed package as defined in 10 CFR 71 and 49 CFR 173. Once received at the disposal site, the canistered waste form must be verified that it continues to meet the requirements of the WA-SRD. Packages which do not meet the WA-SRD must be repackaged to conform to the WA-SRD.

The disposal site must meet the following criteria: 1) provide capacity for approximately 40,000 MT of vitrified radioactive waste and meet the requirements of the Nuclear Waste Policy Act and the Nuclear Waste Policy Amendments Act of 1987, in addition to NRC and other regulatory requirements, 2) meet performance objectives for radionuclide releases to the environment and public, 3) minimize the land area required and the impact on the environment, 4) monitor and control the disposal site to conform to regulatory requirements, 5) the disposal site must remain open for 50 years after the repository is filled.

2.10.5 HLW Disposal - Technology Requirements

The privatization contractor is expected to have expertise in the following areas: 1) , 2) facility site selection, 3) facility design criteria and system configuration, 4) HLW geometry, 5) container design and packaging, 6) HLW remote handling and emplacement systems, 7) engineered barriers, 8) waste form specifications, and 9) monitoring and inspection techniques.

The baseline technology is the DWPF canistered borosilicate glass to be transported by truck or rail to a mined geologic disposal site (Yucca Mountain) for emplacement.

2.10.6 HLW Disposal - Constraints

The regulatory constraints which have been placed on the system include NRC, safety, EPA, OSHA, TPA, DOE, and other legally binding orders, regulations, and mandates. Current regulations do not provide for the aspect of privatizing the disposal function. In addition, the package description shall not only meet regulatory constraints but also meet agreement with EPA, DOE, DOT, state, and Site Requirements. Other mandates include the schedule and rate of delivery, availability, and packaging configuration. Decontamination and disposal of the storage and systems should take place as required.

2.10.7 HLW Disposal - Specific Risks

The privatization of HLW disposal carries several technical, programmatic, environmental, and safety risks:

- The key programmatic risk is modifying existing laws (Nuclear Waste Policy Act and associated amendments) so this function can be privatized.
- There is a time risk associated with additional legislation, the application of regulations, and licensing requirements.
- The privatization firm may have difficulty in obtaining financing to support a project of this magnitude.
- Yucca Mountain site has not been selected as the disposal site at this time. In addition, it is undergoing site characterization. A disposal site must still be selected with adequate acceptance specifications.
- This project only examines one high level waste form for disposal.
- The current DOE strategy integrates TWRS disposal needs with those of other sites, and spent nuclear fuels into a common disposal site strategy.
- NRC has utilized waste package specifications in the past. It is believed that they will require performance based specifications for the waste form in the future.
- Because of the requirement to have the repository remain open for 50 years following the last waste input, the government would undertake an unprecedented contract is excess of 80 years.
- Operational risks include modifications to the WA-SRD which might modify packaging configuration.
- There is no legal precedence for the long-term liability of government and industry for this project.
- The quantity of HLW generated may vary as a function of the efficiency of the treatment operations, providing less specification for total waste volume.
- If a determination were made by OCRWM that a waste form was unacceptable post emplacement, retrieval and removal would not be included as a part of this effort.
- Environmental risks are the responsibility of any financial liability from environmental insult.
- Safety risks include worker exposure, unpredictable ALARA levels, and an "acceptable" limit for increased cancer deaths due to exposure.

2.10.8 HLW Disposal - Function-Specific Regulatory Requirements

Regulatory oversight comes from many sources. DOE Orders, Dangerous Waste Permits, NRC regulations, OSHA, OCRWM, potential NRC regulation, Ground Water Discharge and Air Quality regulations, the DNFSB, Department of , and the EPA all regulate often overlapping aspects of waste disposal and storage. The specific milestones described in the OCRWM Mission Plan follows:

OCRWM to begin accepting HLW for disposal at the MGDS in 2015.

There are no specific requirements within the TPA, other than those relating to the HLWV operations. Those requirements, dictate availability of the waste materials to disposal and functions. Those specific milestones are:

12/31/09	M-51-03	Initiate hot operations of the HLWV facility
12/31/28	M-51-00	Complete vitrification of Hanford high-level tank waste

Key disposal requirements are defined in the WA-SRD requirements are defined in 10 CFR 71 and 49 CFR 173.

2.10.9 HLW Disposal - Cost of Baseline System

Current cost estimate for disposal of HLW is approximately $3.4 B over the life of the program.

2.10.10 HLW Disposal - Current Schedule of Operations

The schedule for TWRS HLW disposal is not defined within the TPA. OCRWM discusses this schedule within their Mission Plan.

2.10.11 HLW Disposal - Connectivity/Interfaces

High-level waste disposal interfaces with HLWV and HLW interim storage. Characterization of the waste stream impacts acceptance and performance characteristics for HLW disposal.

2.10.12 HLW Disposal - Basis for Fee

The privatization basis for fee could be based upon any or combinations of the:

- quantity of HLW shipped and disposed
- quantity of HLW repackaged as requested for reasons other than damage incurred at the HLW disposal facility
- facility availability and availability
- safety record

- penalty for number of damaged canisters and incentive for number of containers that meet WA-SRD criteria.

2.10.13 HLW Disposal - Decommissioning Requirements

The HLW disposal facility will be closed, under the scope of this work, 50 years after the last waste is emplaced, and facility equipment will be decommissioned, decontaminated and disposed of or sent for disposal.

2.10.14 HLW Disposal - Other Issues

The capacity and requirements of the HLW disposal facility needs to be more specifically defined, to minimize total costs.

2.10.15 HLW Disposal - Inputs and Outputs

	High-Level Waste Disposal Function	Interface with Function
Inputs:	Immobilized Waste Form	High-Level Waste Interim Storage, Treatment
	Packaging, Surveillance, Technology, Infrastructure	Treatment, External
	Equipment	External
	Waste Handling Equipment	External
	Specifications, Dollars, Information	Treatment and Storage
Constraints:	Regulatory	External, Treatment, High-Level Waste Interim Storage
	Waste Acceptance	External, Treatment, High-Level Waste Interim Storage
	Packaging configuration	Treatment, External, High-Level Waste Interim Storage
	Availability	Treatment, External, High-Level Waste Interim Storage
	Rate of Delivery	Treatment, High-Level Waste Interim Storage, External
	Sequencing	Treatment, High-Level Waste Interim Storage, External
Outputs:	Equipment	External
	Disposal Site Handling Systems	External
	Operations Related Wastes	External
	Immobilized Waste Form	External

2.11 Findings

Table 2.1 attempts to summarize some of the key elements of the preceding analyses of TWRS vertical privatization by individual system functions. Six of the fifteen questions which were addressed for each function have been extracted for presentation. These six key questions were chosen because the feasibility of privatizing with this vertical segmentation strategy depend heavily on how well the answers to these questions are known:

- Can the Product Specifications be defined?
- Are the Technology Requirements satisfied?

Table 2.1. Summary of Vertical Segmentation Analysis

	TWRS Storage Function			TWRS Waste Treatment Function			TWRS Waste Disposal Function		
	Storage	Retrieval	Transfer	Pre-Treatment	LLW Vitrification	HLW Vitrification	LLW Disposal	HLW Storage	HLW Disposal
Product Specifications	●	◐	○	◐	◐	◐	◐	○	◐
Technology Required	○	◐	◐	◐	◐	◐	◐	◐	○
Specific Risks	◐	◐	◐	○	○	○	◐	◐	◐
Current Schedule of Operations	○	◐	◐	○	○	○	○	○	●
Connectivity/Interfaces	◐	◐	◐	●	●	●	○	◐	○
Basis for Fee	●	◐	○	◐	○	○	◐	◐	◐

Table Legend

○ Privatization Feasible ◐ Privatization Complex but Feasible ● Privatization Not Feasible

- What are some Specific Risks and their impact?
- What is the Current TWRS Schedule of Operations?
- Can the Connectivity/Interfaces with other functions be well defined?
- Can the Basis for Fee be well defined?

Based on the responses to each of these questions earlier, the summary in Table 2.1 has made an estimate of privatization feasibility of the individual TWRS functions. For each of the individual functions, simple rankings are assigned each of the key questions:

- Privatization Appears Feasible
- Privatization Appears Complex but Feasible
- Privatization Does Not Appear to be Feasible.

It should clear, for example, that the TWRS Storage Function would be very difficult to privatize (at least on a fixed-price, pay-for-product basis) because it is not at all clear how the "product" would be specified, and hence, on what basis a fee could be determined.

It is also clear that the HLW Disposal Function would be practically impossible to privatize in the current time frame because of the schedule uncertainties.

Less clear, perhaps, are the rankings of difficulty with individually privatizing the treatment functions--Pretreatment, LLWV, and HLWV. In these cases, the problems are with a perception of extreme complexity associated with connectivity and with management of interfaces. In a situation with individual contracts with treatment vendors, DOE would be in a position of having to monitor both the compliance of the feed and quality of the output in each processing function. This would put the primary burden of risk back on DOE and not on private vendors, which is not the desired outcome. Because of these difficulties, privatization of the separate functions of Pretreatment, LLWV, and HLWV is not considered feasible.

Different combinations of the treatment functions could be considered. The following three combinations have some attractive features:

1. Privatization of all three treatment waste treatment functions under one contract. This combination reduces governmental risks and requires the private firm to accept the tank waste from the government and produce vitrified high- and low-level waste. This option would require significant capital from the private sector. Financing under a phased treatment plan might be easier, where start-up facilities could be built to initiate waste treatment. Capital could then be generated to finance continued treatment.

2. Another option is to combine the pretreatment and low-level waste vitrification subsystems. Such a combination would reduce some interface specification risks to the government. A difficulty for this option would be determining how to specify the quantity and quality of HLW feed stock. The impetus for a private company would be to provide the separated, pretreated waste with specifications to their own advantage, which may not meet the government's requirements for HLWV feed stock.

3. A final option would be to privatize a combined HLW and LLW vitrification facility. This option could reduce capital outlays for a private firm and reduce risks to the government in terms of pretreatment feed specifications. The private firm would accept two separated, pretreated waste streams and process them according to their designation as HLW or LLW. They would be responsible for the interim storage of either stream.

It would appear then that the risk from privatization can be reduced by combining the individual treatment subsystems. Privatizing all of the treatment functions under a combined contract could substantially reduce governmental risk, but it would require massive capital outlays. It is possible that a phased approach could be used to help reduce the cost problem.

3.0 Analysis of Alternative TWRS Privatization Concepts

The analysis presented in the previous section illustrated numerous difficulties and uncertainties associated with the privatization of TWRS by discrete system functions. In particular, the number of contracts to be managed by DOE, the number of interfaces between contractors requiring regulation and coordination, and the number of regulatory issues to be addressed in the vertical privatization scenario would appear to make TWRS privatization by this approach unattractive, if not impossible. Thus, although TWRS privatization by system function may be the most straightforward approach from a systems point of view, the attendant complications, primarily with managing the interfaces has resulted in the consideration of other privatization strategies.

This section examines a number of other approaches to TWRS privatization. Fundamental to many of these approaches are the concepts of 1) time-phasing and 2) integration of functions. These concepts are illustrated in Figure 3.1 which introduces the concept of "Horizontal" privatization. Time-phasing refers to defining groups of tank wastes by chemical and/or processing similarity and undertaking the processing of these tank groups in a sequential manner. Integration of function is also illustrated in Figure 3.1 and refers to the situation where two or more TWRS functions are conducted by a single contractor, eliminating many of the interface complexities.

In the rest of this section, a number of alternative strategies for TWRS privatization are analyzed. The decision analysis approach used is depicted in Figure 3.2. Table 3.1 contains brief descriptions of each of these individual tasks. This top-level decision analysis was conducted in two stages. In the first stage, nine cases representing potential approaches to complete the TWRS remediation mission were developed and assessed. Then, in Stage 2, the information and insights from Stage 1 were used to develop four revised cases for additional assessment.

It should be noted that the analysis presented in this section focus entirely on the feasibility of private-contractor remediation of the 177 underground storage tanks in the Hanford 200 Area. Because of the major uncertainties and risks, the true test of a privatization strategy will be whether these tanks can be addressed. Treatment of the MUSTs and the Cs and Sr capsules appear to be considerably better defined and less of a technical challenge.

3.1 The Assessment Criteria

Assessment criteria were developed to reflect the values of DOE with respect to the privatization feasibility decision. These criteria define the standards by which the technical feasibility of privatization will be judged. These criteria were developed from interviews with DOE officials and from a review of values expressed by Hanford stakeholders. These criteria focus primarily on the cost, schedule, and technical performance of the potential strategies. In addition, regulatory complexity was assessed because of its critical importance to an overall privatization strategy. The application of these assessment criteria as they feed the overall assessment of technical feasibility is shown in Figure 3.3. The specific assessment criteria are defined in Table 3.2.

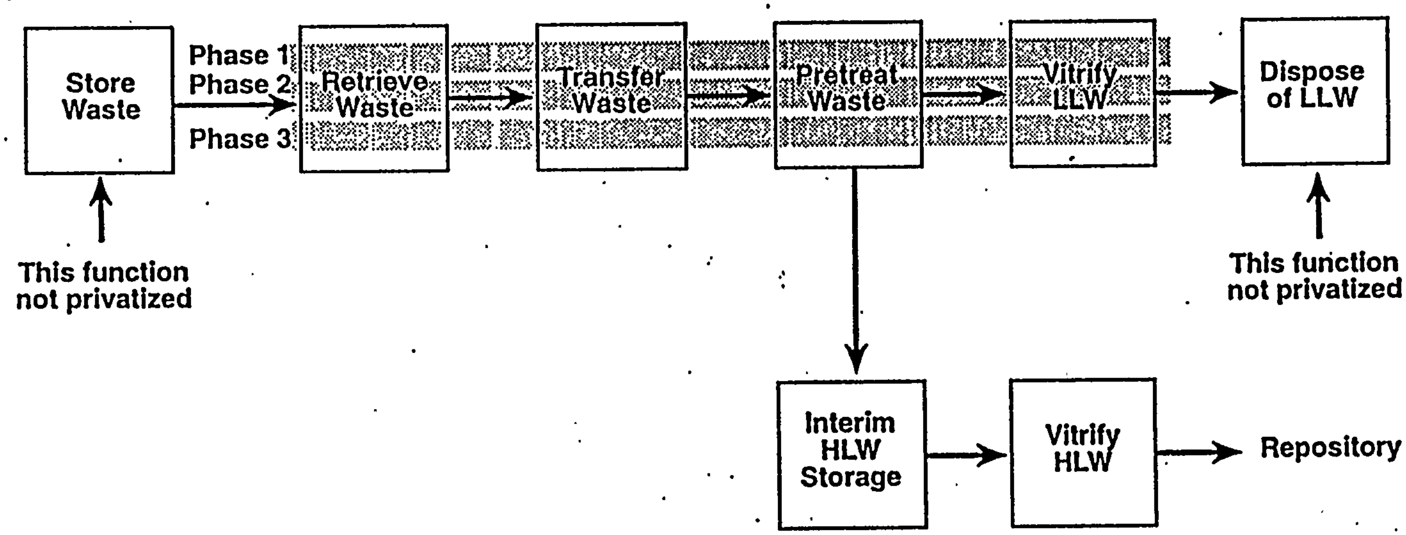

Figure 3.1. Horizontal Segmentation of TWRS by Waste Type and Quantity

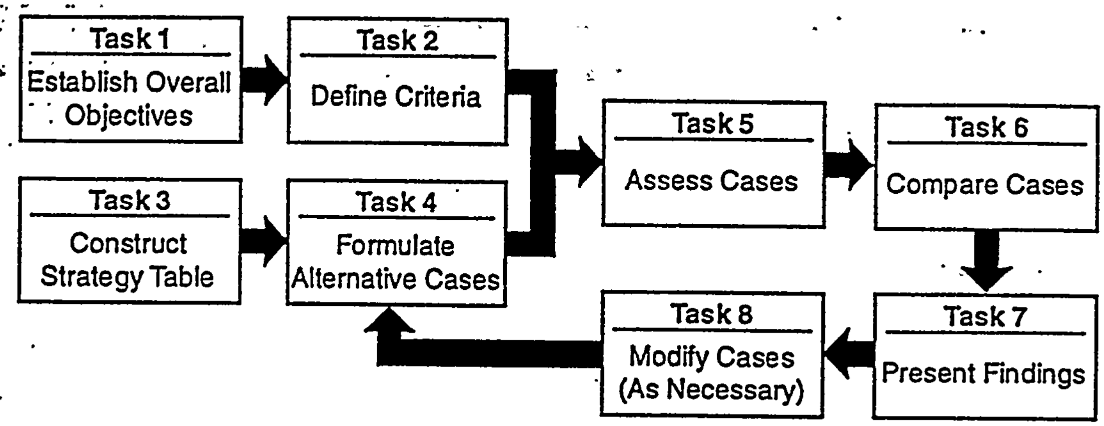

Figure 3.2. Approach for Determination of Technical Feasibility

3.1.1 Strategy Cases Development

Specific strategies were developed by initially defining a set of features that were thought to influence the feasibility of an overall strategy. These features involved the:

- number of phases in the TWRS program - operationalized as 1, 2, 3, 5, or 7
- number of contractors per phase - 1, 2, 5, or 15
- physical location of the processing facilities - distributed or centralized
- process set (how tanks are divided for remediation - by tank, waste type (supernate, saltcake, and sludge), by location (farm or quadrant), or all tanks
- modularity of processing facilities - all, mixed, or none
- mobility of processing facilities - fixed or transportable
- timing in phase (processing within the phase) - series, parallel, or both
- contract length - 5, 10, or 30 years
- processing timing (when majority of waste is processed) - front loaded, level loaded, end loaded
- maturity of technology - mature or not
- regulator - NRC or DOE.

Table 3.1. Task Descriptions for Determining Technical Feasibility

Step 1.	What Does the Department Want	Task 1 - Establish Overall Objectives • A list of objectives were developed based on inputs from DOE HQ and RL personnel plus the TWRS stakeholders. These objectives included minimize cost, demonstrate early progress, minimize program risk and comply with TPA milestones. Task 2 - Define Assessment Criteria • Assessment criteria were defined consistent with the objectives. The purpose of these criteria is to measure how well each of the objectives would be expected to be achieved.
Step 2.	What Can the Department Do	Task 3 - Construct Strategy Table • Individual strategies are created by combining a variety of features in different, logically consistent ways. The notion of a strategy table was used to display the various features of potential privatization strategies. Task 4 - Formulate Alternative Cases • Using the strategy table, nine alternative cases were created for further investigation. These nine cases were selected to cover the TWRS baseline strategy, to establish an envelope of potential feasibility, and to represent some realistic cases within that envelope.
Step 3.	What Does the Department Know	Task 5 - Assess Cases • Each case was evaluated with respect to how well it is expected to perform on each assessment criterion. Task 6 - Compare Cases • A composite matrix of all the assessment results for all nine cases was prepared. Any obvious conclusions that could be drawn by simple observational comparisons were made. However, the more difficult trade-off decisions that must eventually be made, must be made by the DOE.
Step 4.	Iterate	Task 7 - Present Findings • The interim results from this first phase of analysis were presented to DOE personnel and, based on the insights and understanding gained, new directions were obtained. Task 8 - Modify Cases, as Necessary • Based on a DOE assessment, four additional cases were formulated for further investigation. For the most part, these new cases represented only slight variations to one of the original nine cases.

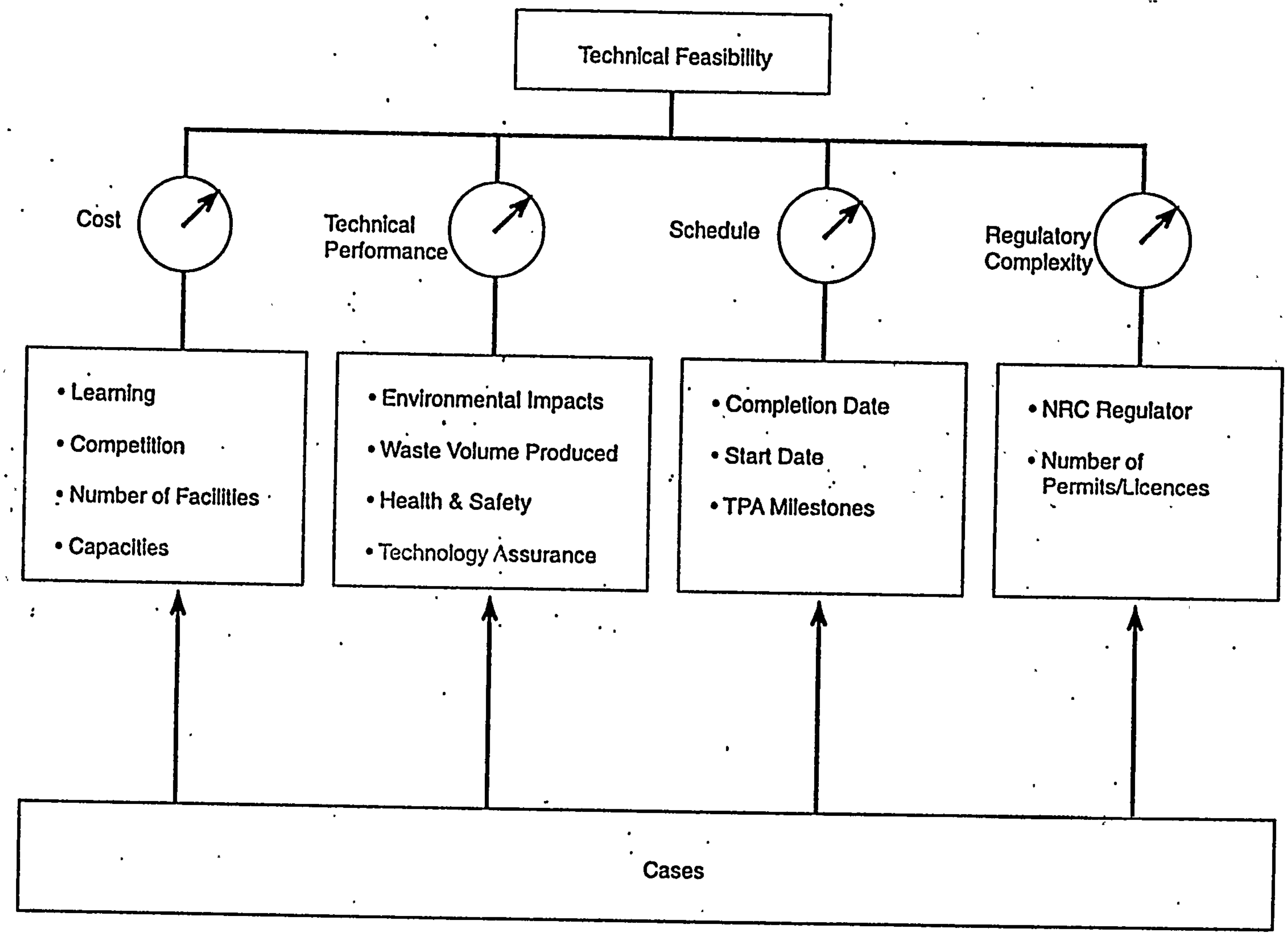

Figure 3.3. Technical Feasibility Assessment

Table 3.2. Technical Assessment Criteria

1.0 Cost

- 1.1 Total life-cycle cost - total cost for processing and disposal of all tank waste
- 1.2 Levelization of cost - extent to which costs are level from year to year, particularly avoiding sharp peaks and drops

2.0 Environmental Impact

- 2.1 Environmental contamination - the amount and extent of environmental damage occurring as a result of clean-up and final disposal of tank waste
- 2.2 High Level Waste (HLW) volume - the volume of HLW waste temporarily stored on-site and shipped off-site for disposal
- 2.3 Low Level Waste (LLW) volume - volume of LLW produced requiring on-site disposal
- 2.4 Other system generated waste - quantity of other waste generated by the processing

3.0 Health and Safety Risk

- 3.1 Public risk - health and safety risk to the off-site public during cleanup and after final disposal
- 3.2 Worker risk - health and safety risk to workers during cleanup and after final waste disposal

4.0 Technology Assurance

- 4.1 System operability, reliability, and maintainability
- 4.2 Expandability - ability of the system to expand production capacity
- 4.3 Process/technology maturity - the extent to which the process/technology has been successfully demonstrated and used in comparable circumstances
- 4.4 Flexibility - ability of the system to incorporate new technology

5.0 Regulatory requirements - extent to which the strategy can achieve regulatory requirements and ease of doing so

6.0 Schedule

- 6.1 Campaign duration - total time to complete clean-up of tank waste
- 6.2 Early disposal progress - time at which actual processing of waste is initiated and first final waste products are produced
- 6.3 TPA compliance - extent to which strategy achieves current TPA milestones

7.0 Contracting Complexity - extent to which contracting for strategy would be cumbersome or would require changes in usual procurement approaches and feasibility and difficulty of making required changes

Strategy cases for Stage 1 were then developed by combining these features into an overall system and building technical cases around these features. Figure 3.4 shows the features used in each of the nine cases developed while Table 3.3 summarizes the cases developed and assessed.

Stage 2 strategies were subsequently based on the insights gained from Stage 1 assessments.

3.2 Stage 1 Results

Nine cases were selected as being representative of the potential approaches to complete the TWRS remediation mission. They were used to assess the merits of different contracting strategies and to define a potential region of feasibility. Specifically, the cases highlighted how various technical, contractual, and strategic features influence the cost, schedule, technical performance, and program risk. These high-level features involve relationships among several key parameters. For example, the selection of the "best" technology involves an evaluation of how much is currently known about the waste and the candidate processes and how that selection would be influenced if remediation occurred in phases. Similarly, consideration of the types of contracts that could be awarded decomposes to an evaluation of how technologies should be grouped and the timing for their deployment. The strategy for remediation will define DOE's role, the funding profile, and the probability of being successful. Selecting a strategy involves understanding certain features of technologies and how their cost and risk are related to contracting approaches.

3.2.1 Case Descriptions

Case 1. TWRS Planning Case

Purpose. This TWRS Planning Case is based upon assumptions used to develop the Fourth Amendment (dated January 1994) of the Hanford Federal Facility Agreement and Consent Order (TPA) and on the current understanding of the ability of the technology to complete the TWRS mission. Managed by the M&O contractor, this case contains no privatization. It is the reference case against which all other alternatives will be compared.

Description. The TWRS Planning Case is completed in a single phase and using a single contractor; the contract has a length of 5-years that, in accordance with DOE-monitored performance, can be re-bid. Centralized, fixed facilities are used to treat and immobilize all tank wastes. Waste processing rates are level-loaded throughout the phase, with a mixture of series and parallel processing regimes. Existing technology is used as the technical baseline.

Mixer pumps and floating suction pumps are used for retrieval of DST wastes. Past practice sluicing is used for retrieval of SST wastes. No subsurface barriers are installed to contain tank leaks.

The pretreatment strategy is sludge washing using inhibited water, followed by caustic washing to reduce HLW volume. Ion-exchange is used to remove ^{137}Cs from the supernatants and wash solutions. The mass of sludge, on an oxide basis, resulting from pretreatment and requiring vitrification is 10,400 MT. Waste pretreatment for sludge washing is completed within existing DSTs.

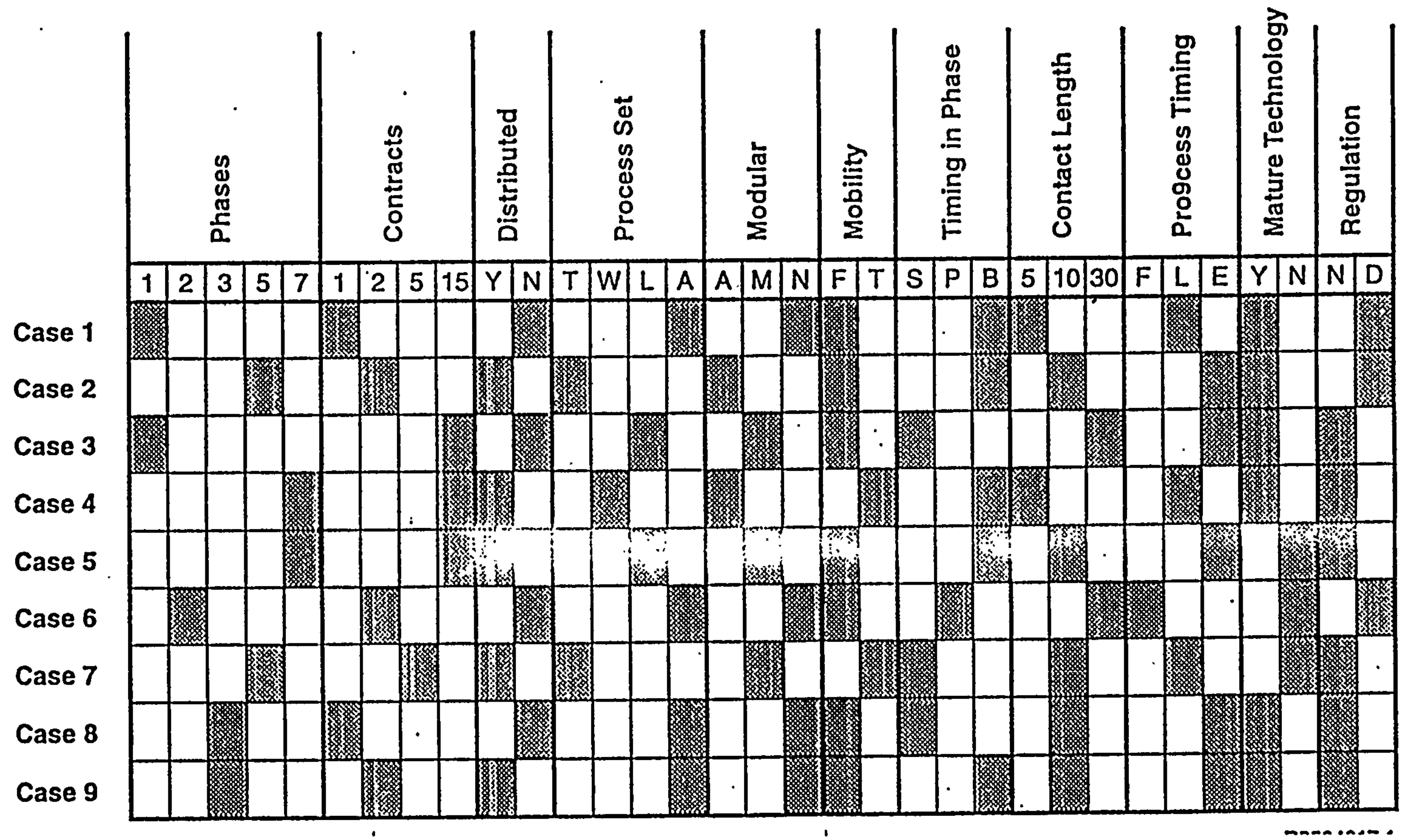

Figure 3.4. Identification of Alternative Technical Approaches for Remediation of the Hanford Tank Wastes

Table 3.3. "Case Concepts"

Case	Characteristics	Description	Purpose
1	Full-scale operation completed by one contractor	Existing TWRS Approach, one contractor (M&O), runs all parts of the icon	Baseline Case
2	Integrated, full-scale systems (not broken up by function) that easiest of 5 phases is processed initially	Segregating feed into five phases, run easiest feed first based upon processing and retrieval, gradually scale from small size operations to larger, total of 11 contracts.	Used to assess learning and competition.
3	Full-scale operation in which expertise is selected for each function, but work is segregated by location (east or west areas)	Physical separation of work (based upon location [East or West area]) and segregation of icon to utilize specialized expertise to run each function, total of 15 contracts. East and West work is done in parallel.	Used to assess intermediate distribution of work and competition.
4	Segregated, smallest-scale systems in which expertise is selected for each function and waste is done by easiest first (total of seven phases)	Further segregation of feed into seven phases based upon difficulty of processing and retrieval and segregation of the icon, plus one integrating contractor for a total of 105 contracts.	Used to assess greatest distribution of work.
5	Segregated, smallest-scale system in which expertise is selected for each function and waste is done by easiest first (total of seven phases) with use of new technologies rewarded.	Segregation of feed into seven phases based upon difficulty of processing and retrieval and segregation of the icon, plus one integrating contractor for a total of 105 contracts, but new technologies are encouraged on an incentive basis.	Used to assess competitive advantage through technology with greatest distribution of work.
6	Full-scale operations with expertise in two major areas and waste is segregated into two phases	Segregation of feed into two phases and splitting of the icon into two pieces (pretreatment/LLW vitrification and retrieval/storage/HLW vitrification), use existing technologies early and more advanced later, total of four contracts.	Used to assess combined effects of learning, competition, competitive advantage through technology, and limited distribution of work.
7	Segregated, small scale operations, with expertise for each function and waste is segregated into five phases with use of new technologies rewarded.	Segregation of feed into five phases (in series) and splitting of the icon into five pieces, plus one integrating contractor for a total of 20 contracts. Advanced technologies would be used for retrieval, pretreatment, and vitrification for more difficult wastes.	Used to assess combined effects of learning, competition, competitive advantage through technology, and distribution of work.
8	Integrated, full-scale operations that easiest of three phases is run first.	Segregate the feed into three phases, contractor runs icon throughout, total of three contracts, no integrating contractor, with existing technology.	Used to assess learning.
9	Integrated, full-scale operations that easiest of three phases is run first, but work is segregated by location.	Segregate the feed into three phases, separate physically by East and West areas, contractor runs the icon throughout, no integrating contractor, with existing technology, six total contracts.	Used to assess learning and competition.
Icon	Full-scale operation in which expertise is selected for each function.	Segregate icon into six functions, utilize specialized expertise to run each piece, 0-seven contracts dependent upon using an integrating contractor.	Used to address contracting by function.

The decontaminated supernatants and wash solutions are converted to glass in a large (140 MT/day) centralized plant. Total glass production, over a 14 year period, from 2004 to 2018, is 430,000 MT. The waste oxide loading is assumed to be limited by Na_2O at 25 wt%. Operation of the LLWV plant is consistent with the generation of supernatants.

The prepared high-level sludges are vitrified in a centralized facility which operates from 2009 to 2028. This plant converts 10,400 MT of oxides into 42,000 MT of glass contained into 25,400 Defense High Level Waste (DHLW) canisters. An overview of this case is illustrated in Figure 3.5.

Findings. As the TWRS baseline strategy with a single M&O contractor, this case provides for straightforward implementation with limited incentives for improvement beyond the technical baseline.

Case 2. Five-Phase Remediation

Purpose. This case involves investigating privatization of the entire TWRS icon by contracting for the remediation of segments of tanks on a sequential basis with competition only between phases. The contracts for each phase are horizontally integrated. This case provides an early start on 1) those waste types that are relatively well characterized, and 2) that require unit processes that are well understood and progressing to tanks requiring more difficult treatment.

Description. This case considers nine distinct contracts grouped into five time phases, plus two additional contracts for HLWV. Each of the contracts covers retrieval, pretreatment and LLWV of a pre-specified group of tanks, and assumes the use of distributed facilities which are modular in nature and are located to allow treatment of particular waste types. The timing of the phases is sequential, but overlapping. The contract length is approximately 10 years; the early contracts being somewhat shorter, the latter somewhat longer. The overall cost profile is end-loaded as the result of starting with small contracts. The use of existing technology and the DOE regulatory environment are assumed.

The inputs to the initial contractors are tanks containing waste, and their outputs are clean tanks, vitrified LLW, and pretreated sludge which is sent to storage. The contractor for each waste group invests in designing, constructing, and operating an integrated facility to perform the retrieval, pretreatment, and LLWV functions. The contractor is paid on the basis of mass of waste treated and the satisfactory final cleaning of the tanks. The first three time-phases each have multiple contracts with similar processing requirements whereas the last two phases have a single contract each. The capacity requirements and processing complexity generally increase with each phase. Two additional contracts are awarded for vitrification of HLW for all of the nine groups, for a total of eleven contracts and eleven facilities. An overview of this case is illustrated in Figure 3.6.

Findings. This five-phase concept provides for learning between phases, which reduces the overall programmatic risk, and allows for early remediation of well-characterized, relatively simple-to-process wastes. The re-bidding of the work in the phases is expected to lead to technical, operational, and cost improvements. The large number of phases, although allowing for greater learning and an early start, results in not meeting two TPA milestones, one major and one interim, associated with SST retrieval (2018) and SST closure (2024).

This case showed that a low technical risk approach to TWRS remediation could be cost competitive with the baseline if schedule constraints were relaxed.

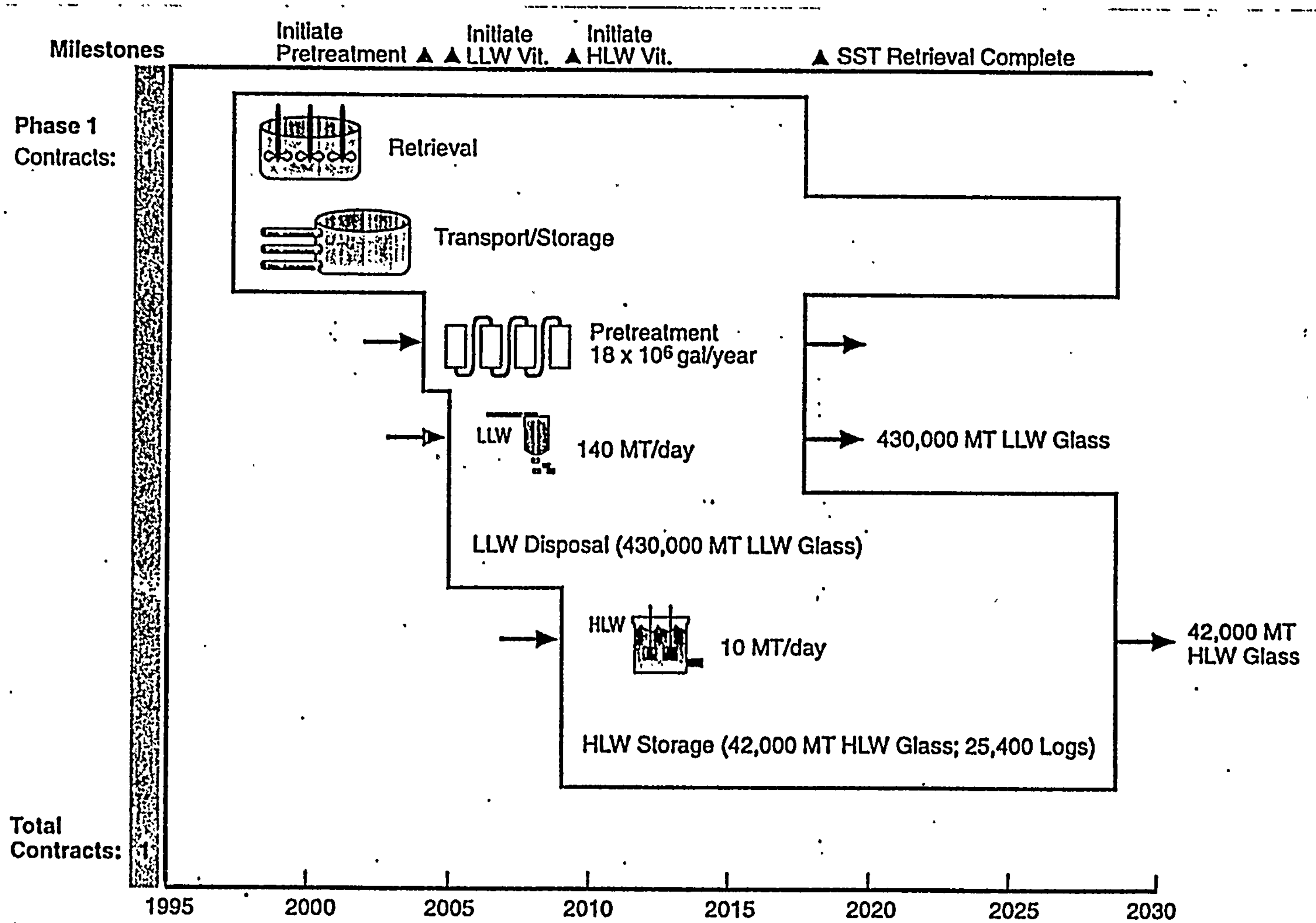

Figure 3.5. Case 1. TWRS Planning Case

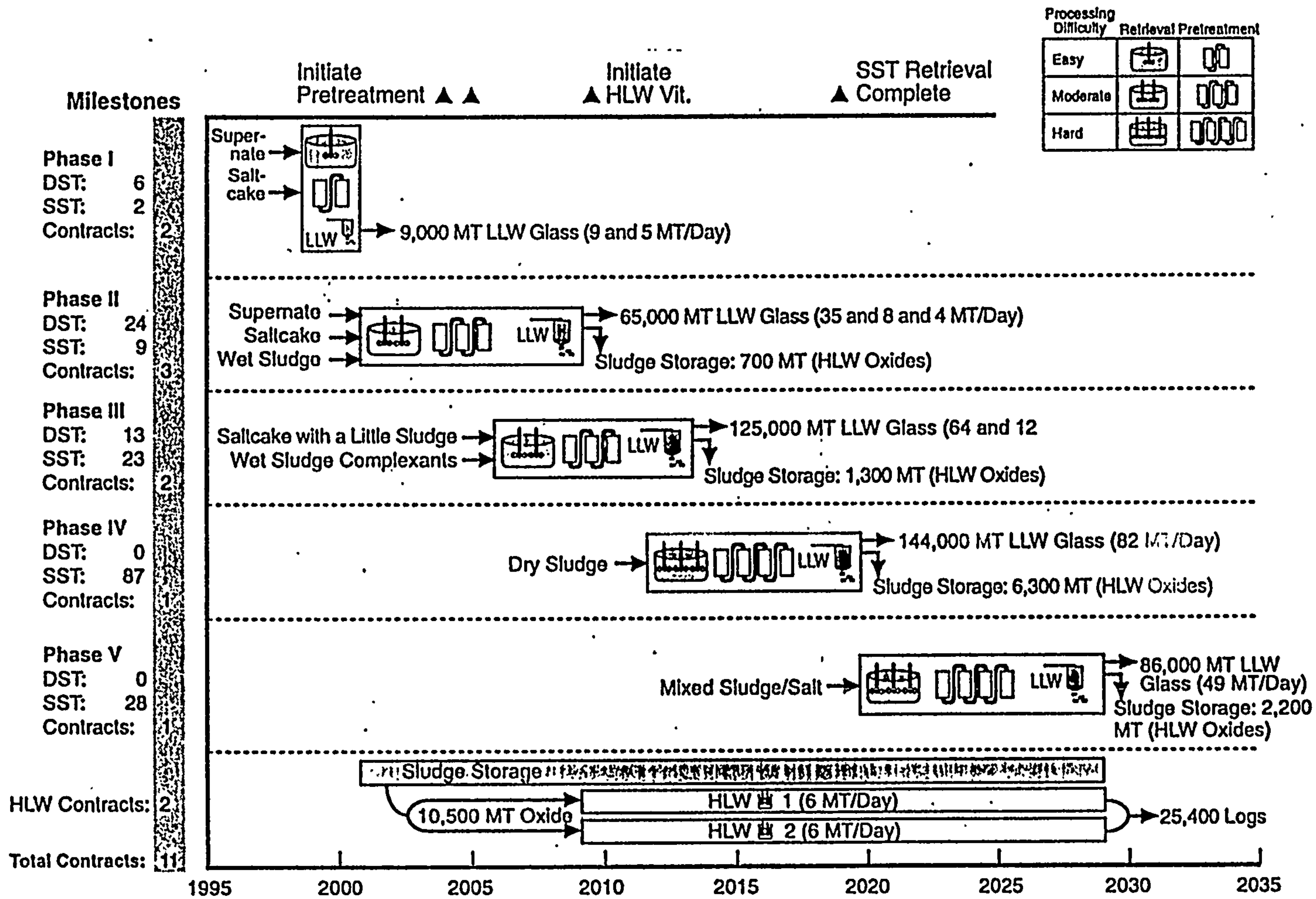

Figure 3.6. Case 2. Five-Phase Remediation

Case 3. Parallel Remediation in East and West Areas

Purpose. This case was investigated to see the effect of a gross geographic separation of the TWRS icon. This case divides the TWRS icon based on tank location (east versus west) by function and requires the use of integrating contractors to coordinate the separate functional contractors.

This illustrates the effect of multiple operations with minimal competition and no opportunity to tailor contracts based on previous experience. It demonstrates the merits of head-to-head competition created by parallel operations. The geographic separation in this case allows for a sensible segmentation for the TWRS mission.

Description. This case involves two independent efforts operating in parallel, one in the East Area and one in the West Area. Fifteen contracts are assigned by dividing the work into several sequential functions, seven in each area and one integrating contract. The operations in each area is run concurrently, with little planned exchange of waste between them. Process plants, however, are oversized to provide an opportunity for competition based on effective performance.

The volumes of high-level sludge, low-level saltcakes and supernatants in the East and West Area are similar. This situation leads to a processing option in which the waste processing and waste form processing can be done in facilities operating in parallel, during a single phase in each area.. Approximately 36% of the LLW and 55% of the HLW is in East Area. Conversely, 64% of the LLW and 45% of the HLW is in West Area.

This case has facility plant sizes that are 20% greater than the necessary capacity, assuming a plant operational efficiency of 60%. This is done to provide some contingency in the event that there is a need to either pretreat or vitrify waste from the other area. This case will require the construction of 5/10 new DST's in West Area to support retrieval, pretreatment and waste disposal operations. Figure 3.7 is a summary of this case.

Findings. This case shows that geographic separation of the waste results in two plants of approximately equal sizes allowing for competition in the initial bidding but not for the keen competition necessary to achieve the maximum benefit of competition. The implementation of this case may require significant infrastructure construction in the 200 West area to support the integration of the independent functional contractors.

Case 4. Multiple Remediation Contracts

Purpose. This case examined the effect of the widest possible geographic distribution of the TWRS functions. That is, a tank-farm-by-tank-farm integrated remediation of the TWRS waste.

Description. This case involves seven phases of operation. During each phase there are 15 contracts awarded, each for a particular waste type. Each contractor provides all remediation services for the designated tank farm; retrieval, pretreatment, LLWV, HLWV, and storage. There is a single integrating contractor that coordinates logistics within the tank farm. The facilities are assumed to be modular and transportable. The timing of the contracts is parallel within a phase and sequential (without overlap) from one phase to the next. Each phase is assumed to last approximately five years. The cost profile for this case is assumed to be flat. The use of existing technology and licensing under NRC are also assumed.

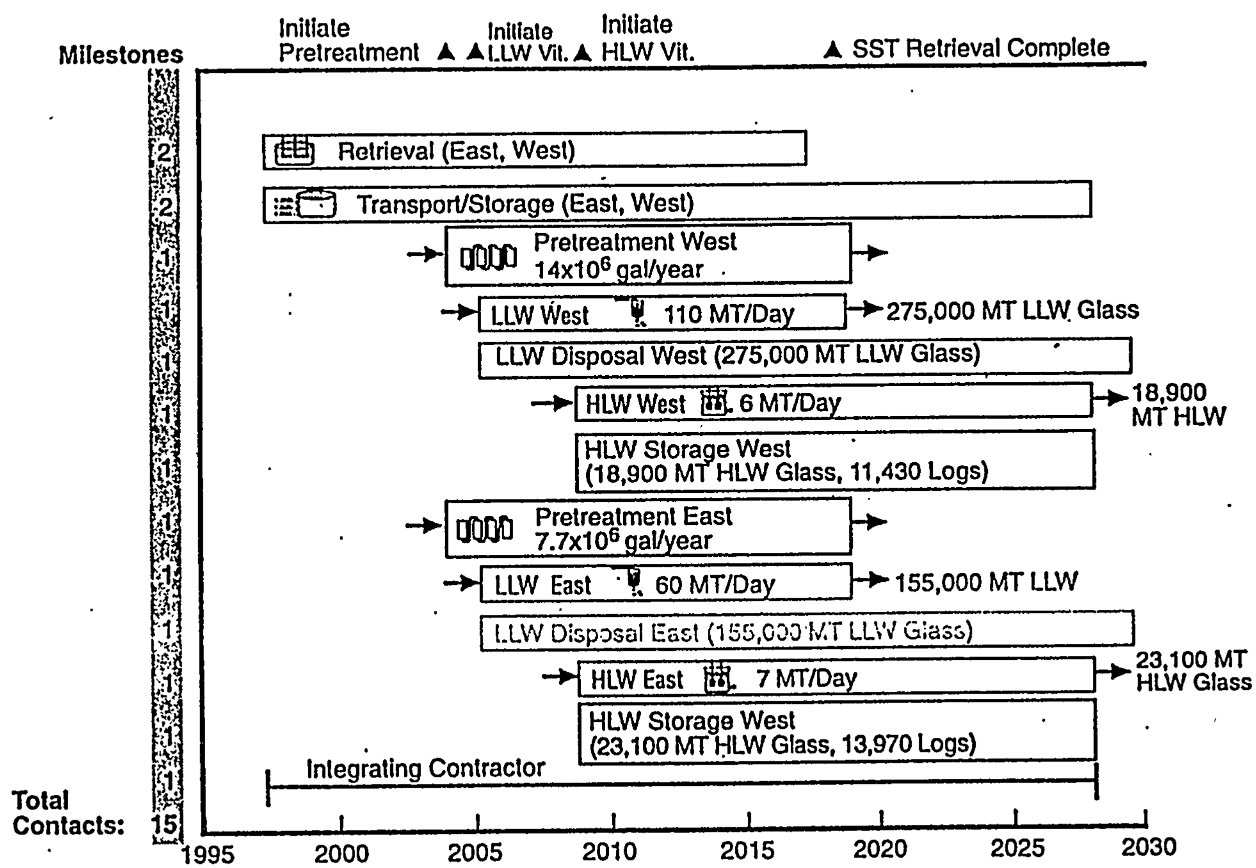

Figure 3.7. Case 3. Parallel Remediation in East and West Areas

With existing sludge washing and ion-exchange processing, the resultant wastes produced on a farm basis will yield limited chemical constituent removal. Further, it is assumed that wastes cannot be blended with wastes from other farms to reduce concentrations of problematic compounds. Because of these limitations on controlling concentrations of key chemical constituents (P, Al, Cr, etc.) and their impact on HLW glass manufacture, there will be approximately 63,000 equivalent DHLW canisters produced. Figure 3.8 presents a summary of this case.

Findings. With a relatively specific and limited scope, the contracts for this case can be tightly defined. By qualifying multiple contractors in the early phases a large pool of potential bidders will be available for the later phases, presumably resulting in lower bid costs. With 105 contracts, however, this case is a regulatory and procurement nightmare. The TPA milestones for SST retrieval (2018) and SST closure (2024) would not be met.

This case showed that, without the introduction of new technology, the cost of large HLW volume produced because of the lack of ability to blend waste makes this remediation approach economically expensive.

Case 5. Multiple Remediation Contracts (New Technology)

Purpose. This case was investigated to provide a best case analysis for the maximum distribution of the TWRS functions. That is, to assume that through new technology it would be possible to overcome the disadvantage of producing large volumes of HLW (as in case 4) because of the distribution of the TWRS icon.

Description. This case involves seven phases of operation. During each phase there are 15 contracts awarded, each for a particular waste type. Each contractor provides all remediation services for the designated tank farm: retrieval, pretreatment, LLWV, HLWV, and storage. There is a single integrating contractor that coordinates logistics within the tank farm. The facilities are assumed to be modular and transportable. The timing of the contracts is parallel within a phase and sequential from one phase to the next. Each phase is assumed to last approximately five years. The cost profile for this case is assumed to be flat. The use of significant technology improvements to reduce the amount of HLW and licensing under NRC are also assumed. Figure 3.9 illustrates this case.

Findings. With a relatively specific and limited scope, the contracts for this case can be tightly defined. By qualifying multiple contractors in the early phases, a large pool of potential bidders will be available for the later phases, presumably resulting in lower bid costs. With 105 contracts, however, this case is a regulatory and procurement nightmare. The TPA milestones for SST retrieval (2018) and SST closure (2024) would not be met.

This case showed that even with significant technology improvements that allow for reduction of HLW volume the tank-farm-by-tank-farm, total distribution of the TWRS ICON was not economically attractive.

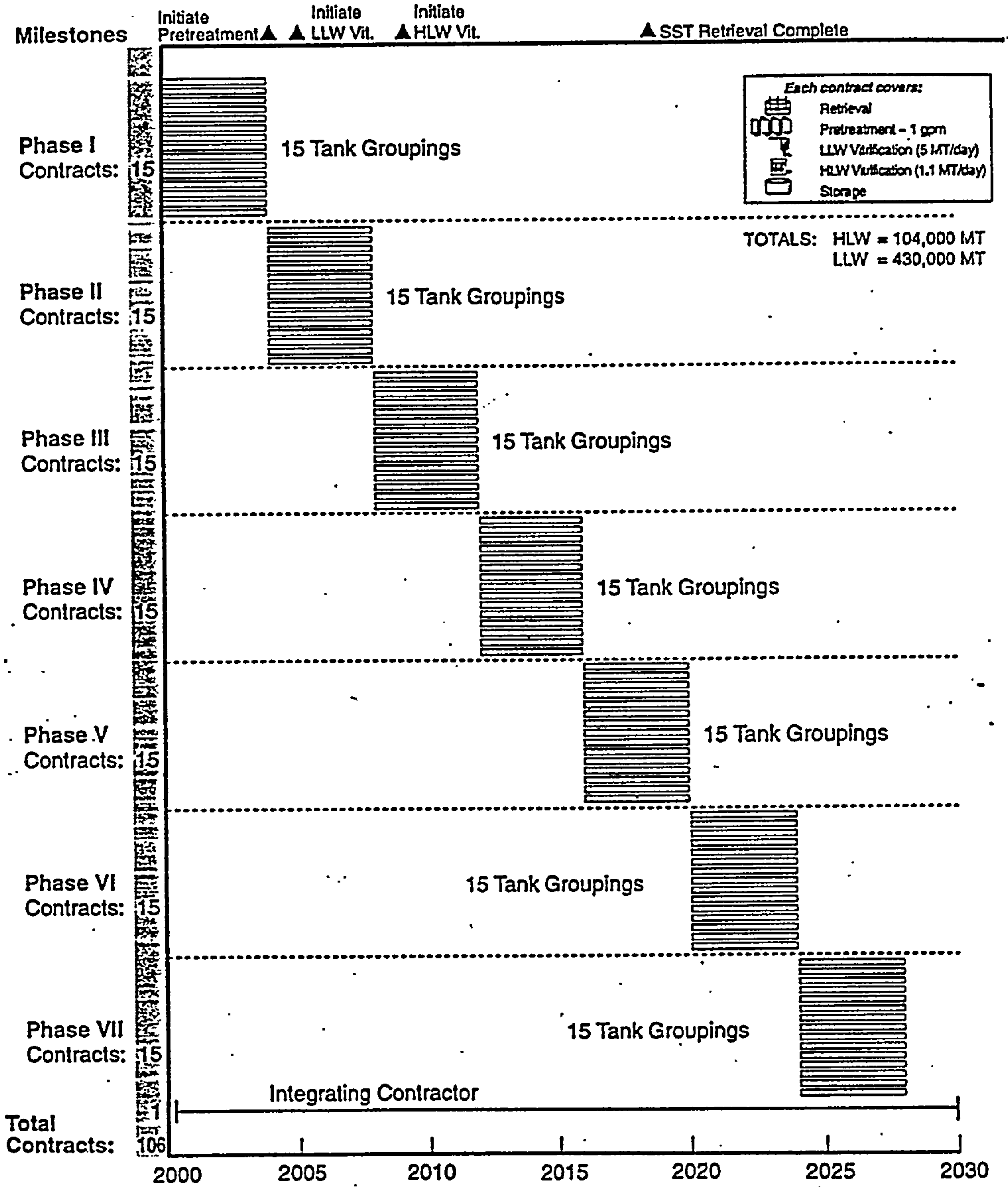

Figure 3.8. Case 4. Multiple Remediation Contracts

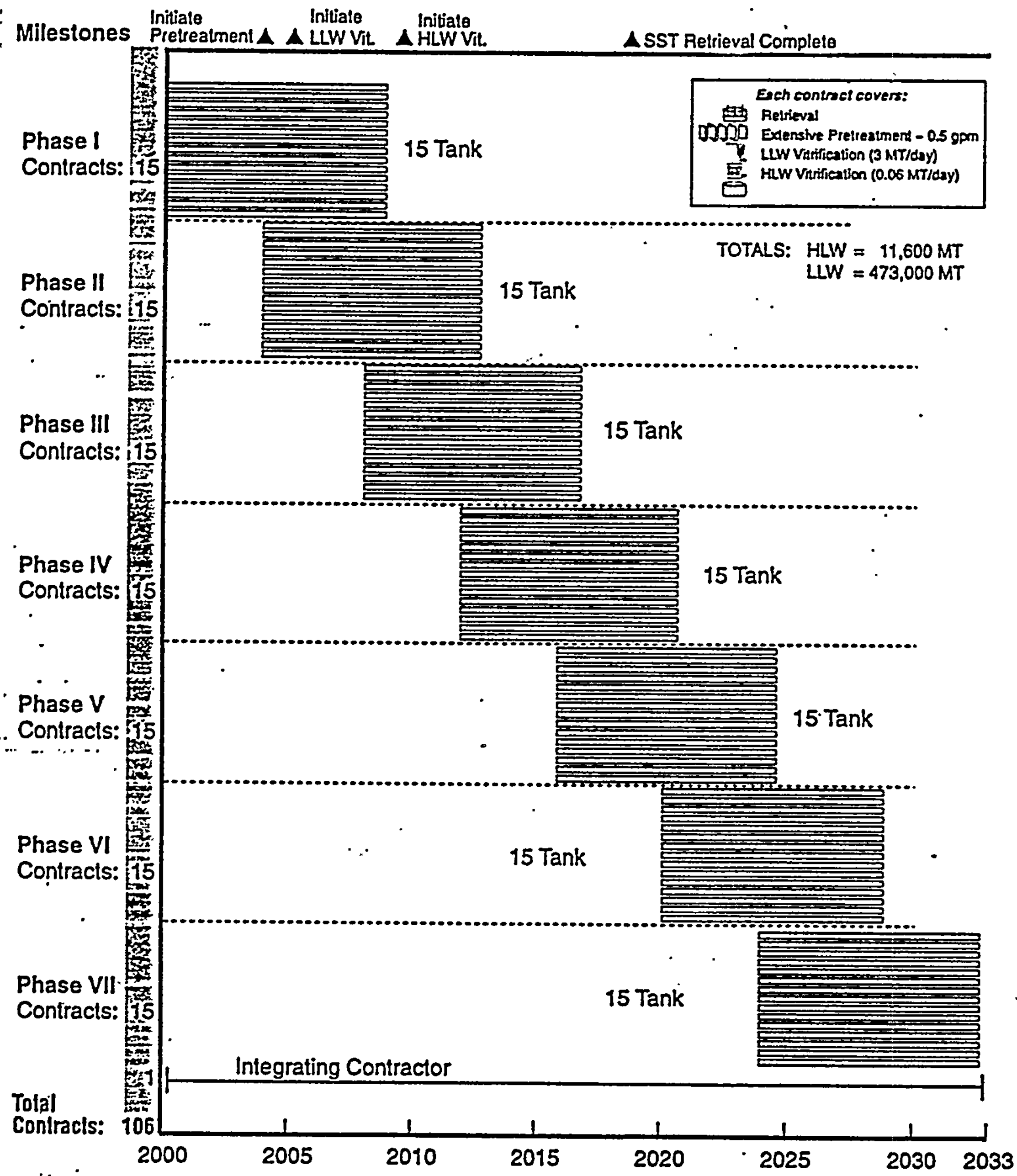

Figure 3.9. Case 5. Multiple Remediation Contracts (New Technology)

Case 6. Two-Phase Remediation (New Technology)

Purpose. This case investigates the phasing of the TWRS mission into two parts, one based on currently proven technology and a second based on technology requiring further development. This case illustrates features of large contracts and new technology. Phasing of the work shows how learning and limited competition influence cost profiles. The deployment of pretreatment technologies is staggered such that existing technologies are used early to begin the treatment of LLW and advanced technologies are deployed later, under a separate contract, to reduce the number of DHLW canisters. Some improvement in technology for the later work is expected as a result of the experience gained in the early plant. Further, by separating the LLW and HLW contracts, the later contracts can be more tightly defined. This should result in more competitive bidding, as the uncertainty of the work scope and the process chemistry will be reduced. Two large contracts will run concurrently throughout each of the two phases.

Description. In this case, two large contracts would be awarded within each of two phases. The contracts are divided by function, one being responsible for Pretreatment and LLW vitrification and the other for retrieval, waste storage, and HLW vitrification. This case will rely on large centralized facilities to process the waste. It allows an early start by limiting the early processing to the easier LLW stream and storing the HLW stream until later. The LLW pretreatment and vitrification contract is fairly specific in scope. The retrieval and HLW vitrification contract would include the balance of operations, including infrastructure management.

The first phase will focus on LLW treatment using existing technology, and will begin retrieval in 1997. Retrieval will rely on past practice sluicing in SSTs and mixer pumps in DSTs. The LLW pretreatment facility will use sludge washing and ion exchange only, and will have a capacity of 18 M gal per year. The LLW vitrification plant will produce 65000 metric tons per year of glass product. It will cease processing waste from the LLW pretreatment plant in 2018, having produced 430,000 metric tons of glass. From 2018 to 2028, this plant will receive LLW only as a stream from the advanced pretreatment plant. Figure 3.10 summarizes this case.

Findings. This case showed that segmentation with large facilities could be cost competitive with the baseline.

The use of large, centralized facilities (two pretreatment plants, one LLWV plant and one HLWV plant) will require substantial capital investment. Fewer potential bidders would probably be available for either combined pretreatment and LLWV capabilities or combined pretreatment and HLWV capabilities. The longer contract durations could encourage the development of improved technology.

Case 7. Five-Phase Remediation (New Technology)

Purpose. The purpose of this case was to investigate the phasing of TWRS with competition between phases but not within a phase.

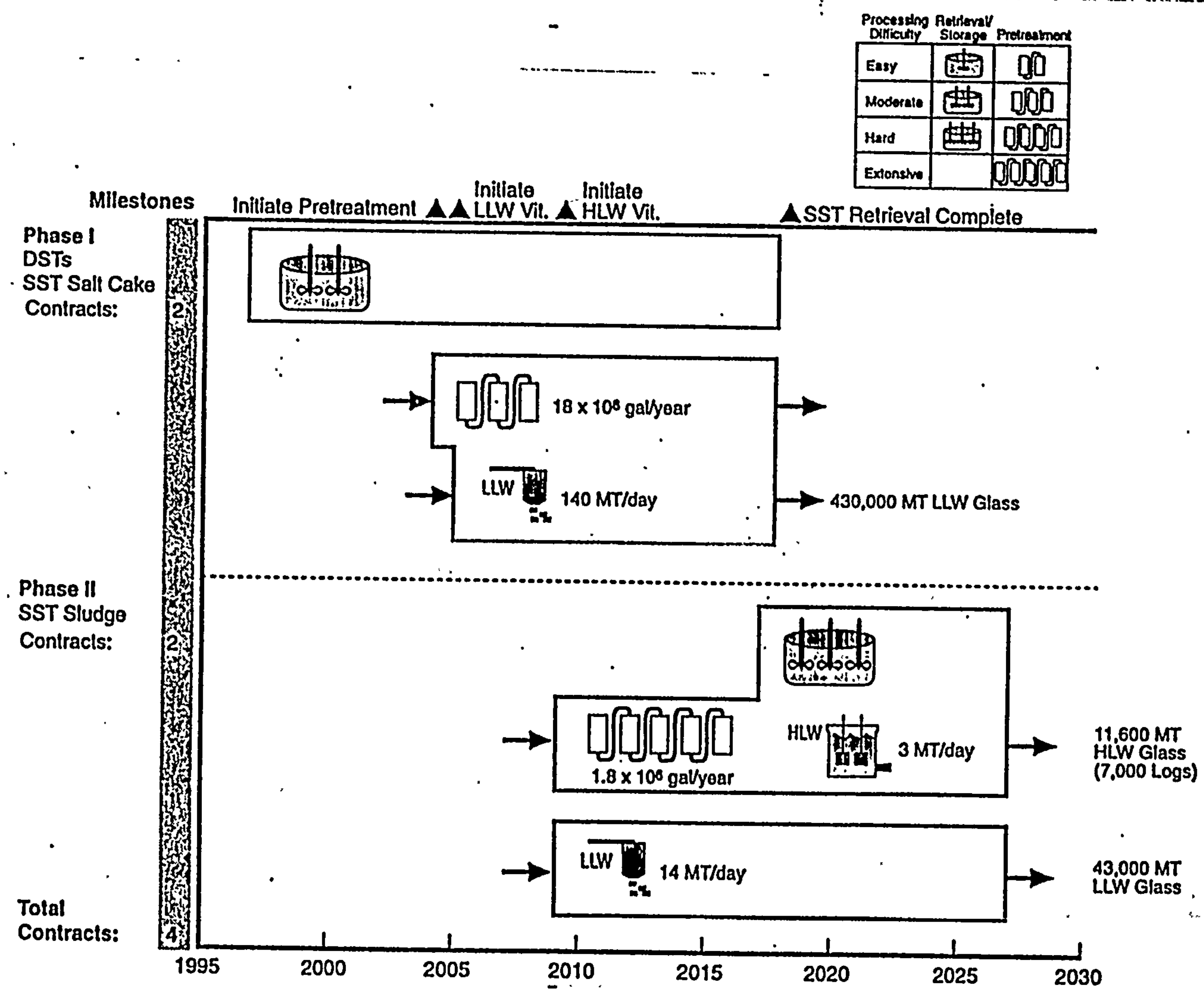

Figure 3.10. Case 6. Two-Phase Remediation (New Technology)

This case illustrates how short, tightly defined contracts for modular processes influence efficiency, competition, and technology development. With contracts defined by function and a reasonable contract length, a larger field of qualified bidders should be available. It also shows how contracts ofmoderate length influence the opportunity to improve processes. This is particularly true with a modular concept in which capital investments are distributed, but much less so in the case of a large central facility. The strategy for this contract arrangement is to divide the work into discrete functional areas of responsibility and to package the sequence of the work such that each succeeding phase benefits from the preceding experience. An integrating contractor will coordinate the interfaces among the contractors, and will have general responsibility for the site infrastructure. As such, the pipelines and tanks used to collect and store retrieved or pretreated wastes will be under the purview of the integrating contractor.

A generic dilemma in this case involves the lack of incentive for contractors to invest in new technology. The short contract duration (five years) offers very little time for recovery of development efforts, and will reduce the amount of risk that a contractor would be willing to take in developing innovative processes. These considerations suggest that actually achieving the 7000 canisters of DHLW glass may be unlikely, unless DOE cultivates advanced technologies independently.

Description. This case includes five sequential phases of five years each with no overlap. Each phase would be accomplished by five contractors, each performing one of the following functions: retrieval, pretreatment, LLWV, HLWV, or program integration. This case includes use of modules for processing, avoiding the large capital outlays inherent in large central facilities.

The facilities used in this case are distributed and transportable. It is assumed that these processing modules have a useful life equal to the contract period of five years. Advanced pretreatment technology would be employed for retrieval, pretreatment, and vitrification as the more difficult wastes are addressed in the later phases. Initial operations would include past practices sluicing for SST retrieval, and existing technology for pretreatment of saltcakes and supernatants. This case is illustrated in Figure 3.11.

Findings. This case suffers from the high cost of developing multiple facilities with relatively short lifetimes. The relatively short contract periods may not offer the contractor a sufficient opportunity for recovery of investment. Thus, the cost to DOE may be high and incentives to incorporate new technologies may not exist. Technical risk would be mitigated through development and deployment of small-scale facilities with low capital cost. All contracts operating on the same start/finish schedule would be disruptive during renewal/recompetition periods.

Case 8. Three-Phase, Enhanced Learning

Purpose. The purpose of this case was to investigate the impact of phasing based on a large scale-up between phases with competition existing only during the award of each phase contract and not within a phase. The volume of waste processed increased by 4 and 16 times, for Phases 2 and 3, respectively. This strategy would substantially limit technical and investment risk, even though the funding profile is heavily end-loaded.

Description. This case involves a three-phase approach using a single contract per phase in which the production capacity of each successive phase is increased. Each phase incorporates all TWRS functions: retrieval, pretreatment and LLWV and HLWV. This case uses centralized, non-modular

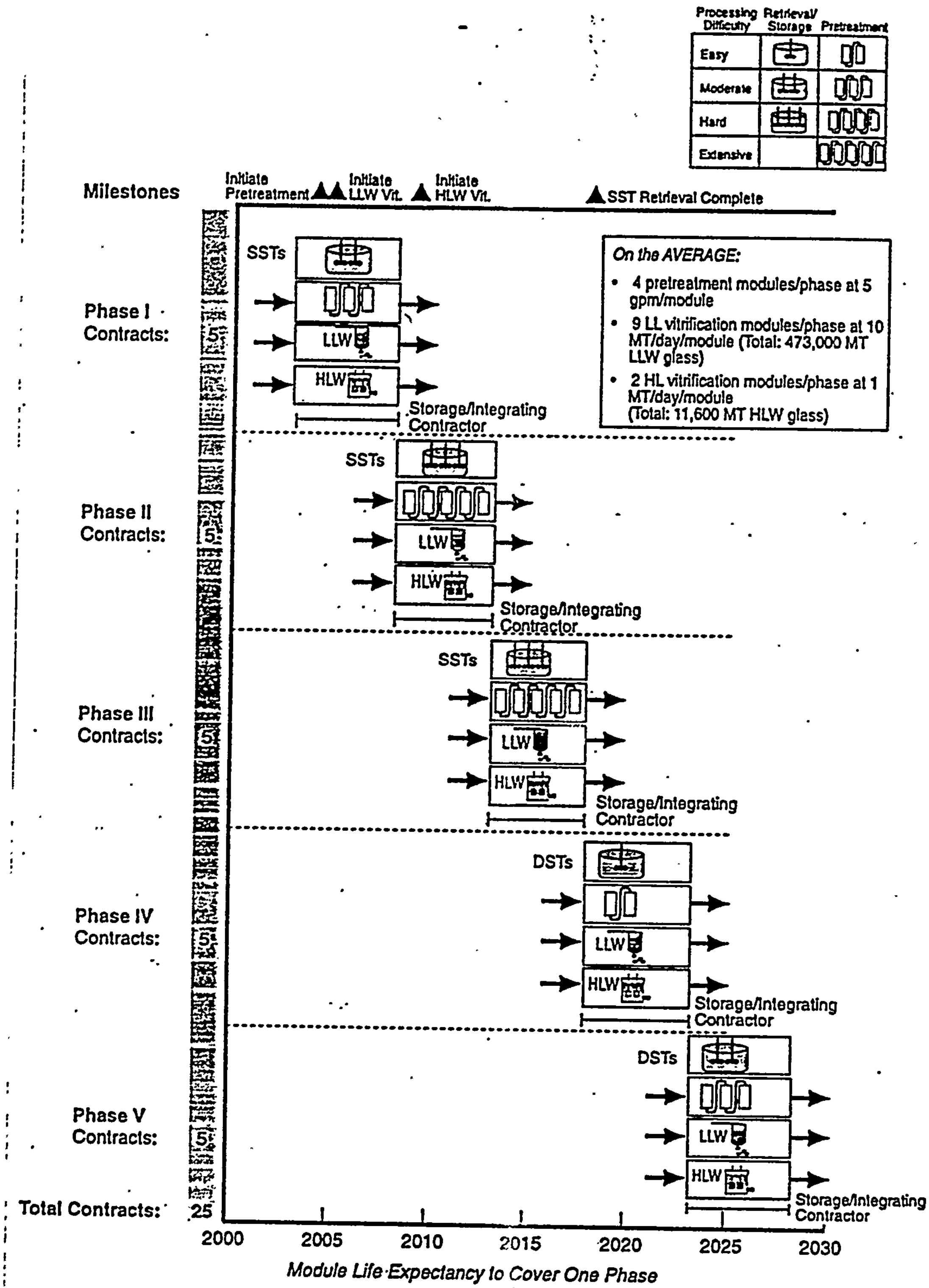

Figure 3.11. Case 7. Five-Phase Remediation (New Technology)

facilities which are fixed in place. All tank wastes are treated in the process set, with series processing in which the major production is completed toward the end of the mission. Existing technology is used. The average contract length is approximately 10 years, with DOE regulation. Figure 3.12 summarizes this case.

Findings. The use of phasing combined with scale-up is an effective way to complete the TWRS mission while reducing the cost and risk associated with mission completion. The relatively low capacity of the phase I operation would allow DOE to proceed with modest risk in terms of defining the project needs. Although there would be an early start in remediation of the tank waste, the TPA milestones for SST retrieval (2018) and SST closure (2024) would not be met.

Case 9. Phased Enhanced Learning and Competition

Purpose. This case was designed to investigate the effect of direct head-to-head continuous competition in all phases of the TWRS mission.

Description. This case is similar to Case 8 in which a three-phase approach is used to complete the remediation effort. The difference is that two head-to-head contracts are awarded, each completing one-half of the remediation effort. This case is summarized in Figure 3.13.

Findings. Case 9 demonstrated the benefits of head-to-head continuous competition.

3.2.2 Lessons Learned

Although none of these specific cases are being recommended for privatization, they did provide significant insights with regard to the interaction between various strategic features. The more significant insights are listed in Table 3.4. Each of these nine cases was evaluated with respect to the individual assessment criteria. The estimated values are contained in Table 3.5. Additional insight was gained via the direct DOE feedback provided in Table 3.6.

3.3 Stage 2 Results

As a result of the insights gained from the analyses of the preceding nine cases and the feedback received from DOE reviewers, four additional cases were developed to highlight major issues and their impacts upon privatization strategies. Table 3.7 contains a list of key assumptions that pertain to each of these new cases.

3.3.1 Case Descriptions

Case 10

Purpose. This case evolved from Case 2, in which phasing was determined to be a useful concept but in which five phases proved too many to achieve the current TPA milestones. The purpose of Case 10 is to investigate the feasibility of phasing the work, with a relatively small start-up phase incorporated to take advantage of learning, while still being able to comply with all TPA milestones.

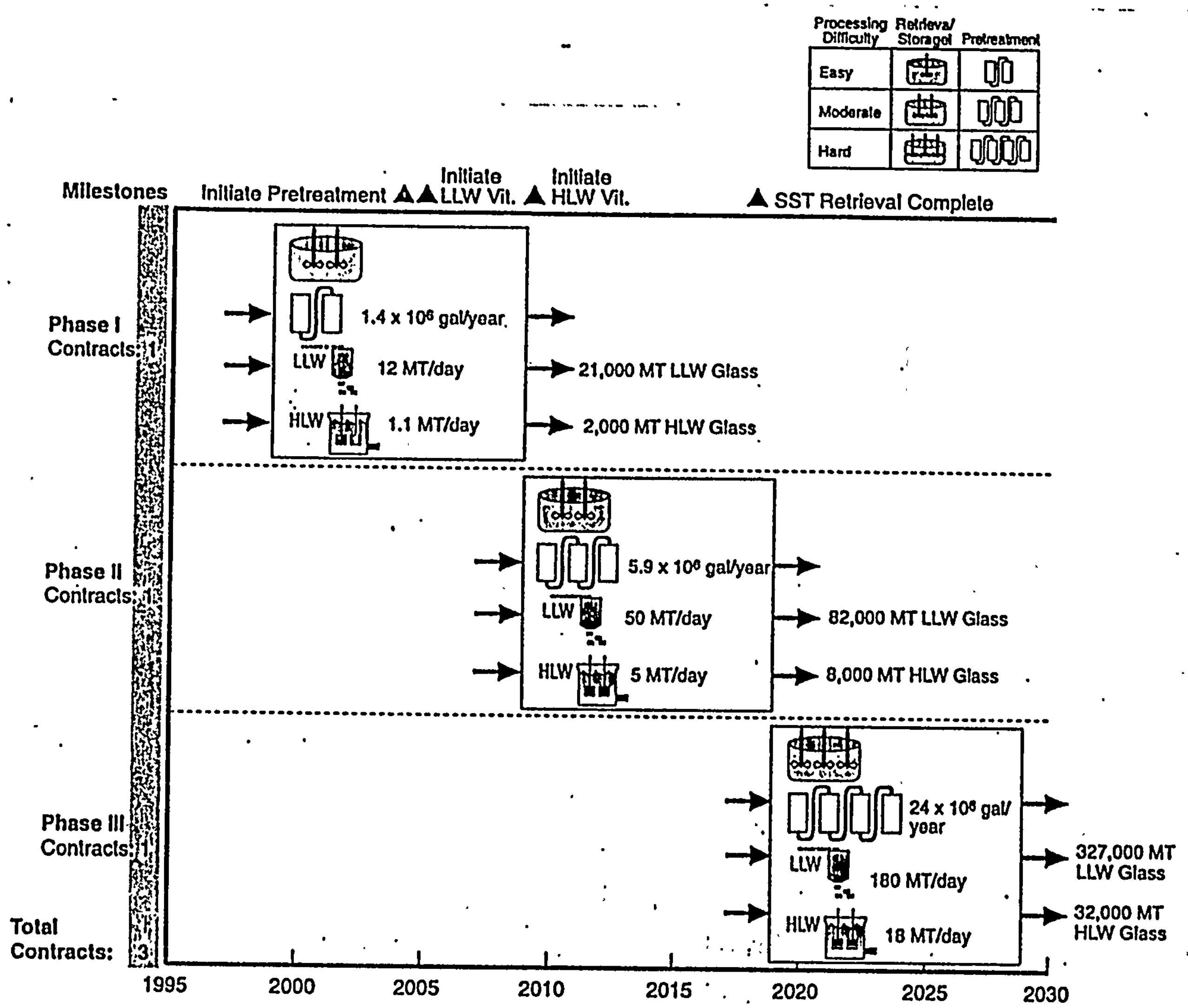

Figure 3.12. Case 8., Three-Phase, Enhanced Learning

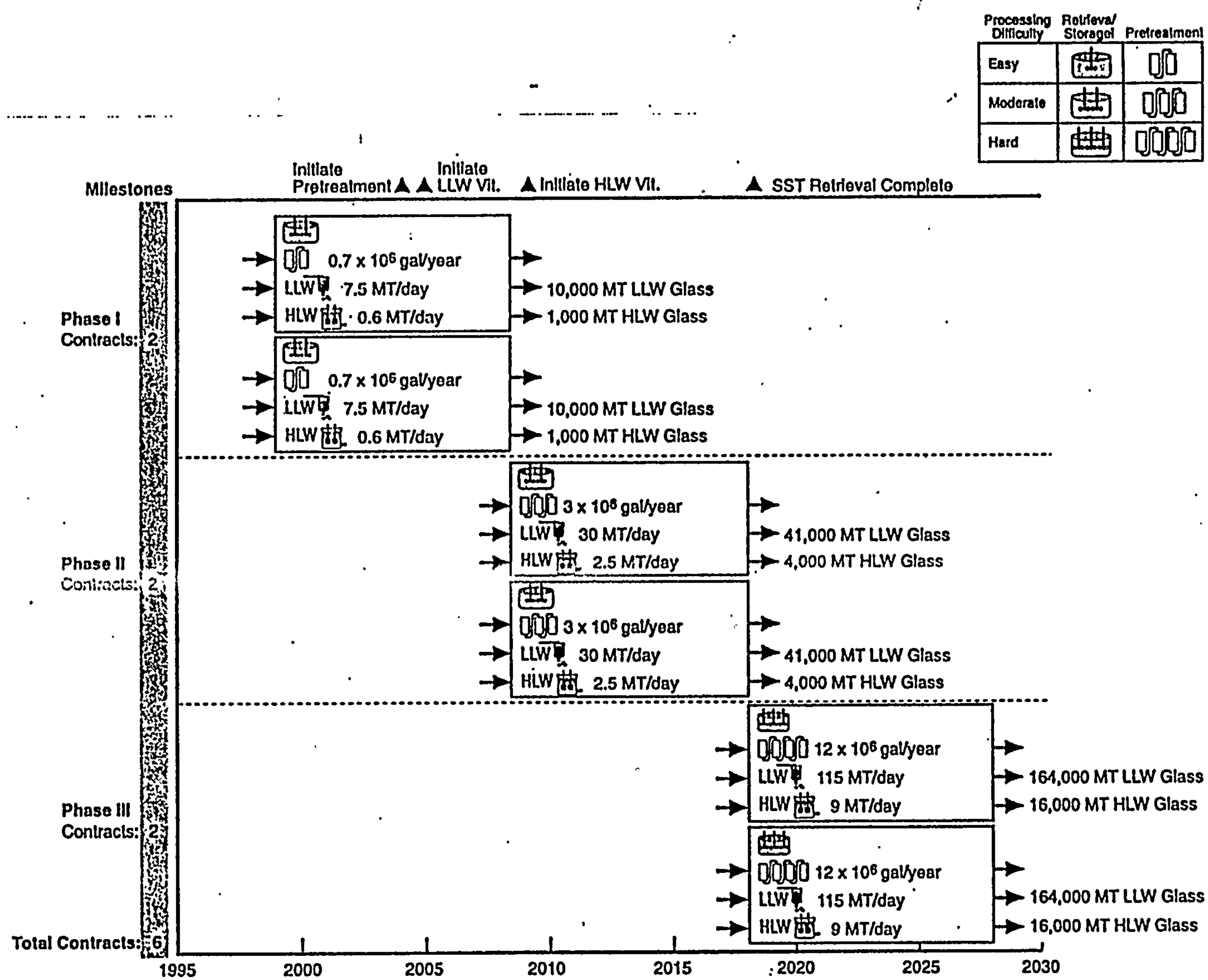

Figure 3.13. Case 9. Phased Enhanced Learning and Competition

Table 3.4. Significant Insights from Phase I Results

Phase	Advantages	Disadvantages
Multiple Phases	• Incorporates learning • lower cost • Reduced waste uncertainty • lower cost and program risk • Incorporates new technology • lower HLW glass volume • Accommodates pilot plant • early progress, operational experience	• More than 5 phases may be too unwieldy • May not be enough time for contractor to recover investment • Discourages technology development by contractors • New NRC license required for each new contractor
Multiple Contracts/ Function/Phase	• Head-to-head competition • lower cost • Smaller facilities • lower program risk, less capital investment per contractor	• Complexity of contract administration • Smaller scope • reduced incentive for potential bidders

Miscellaneous

- Meeting TPA schedule difficult, but manageable
- Early DOE decisions needed, especially on LLW specifications
- Concurrent permitting/ construction may be required

Table 3.5. Assessments of Nine Phase I Cases on Technical Criteria

Case	Cost	ENVIRONMENTAL				HEALTH/SAFETY	
	LLC ($B)	Other Impacts	IHLW (MT)	ILLW (MT)	Other SG Waste	Public Risk	Worker Risk
1	13.3	=	42,000	545,000	=	=	=
2	14.7	-	42,000	545,000	=	=	=
3	15.1	-	42,000	545,000	=	=	=
4	49.4	=	104,000	545,000	-	-	=
5	38.3	-	11,550	600,000	-	+	=
6	9.6	-	11,550	600,000	=	+	=
7	20.9	=	11,550	600,000	=	+	=
8	12.4	=	42,000	545,000	=	=	=
9	10.5	=	42,000	545,000	=	=	=

Case	TECHNOLOGY ASSURANCE				REGULATORY EASE	SCHEDULE			CONTRACTING COMPLEXITY	PROG RISK
	"ilities"	Expand	Tech. Maturity	Flexibility		End	Start	TPA		
1	=	=	=	=	=	2028	2003	Y	=	=
2	-	+	=	+	-	2028	1999	N*	-	+
3	-	+	=	=	- -	2028	2003	Y	-	=
4	-	=	-	+	-	2028	2000	N*	-	=
5	-	=	-	+	- -	2032	2000	N*^	- -	-
6	=	=	-	+	=	2028	2003	Y	-	-
7	-	=	-	+	-	2028	2003	Y	-	-
8	+	+	=	+	=	2028	1999	N*	-	+
9	+	+	=	+	-	2028	1999	N*	- -	+

= Equivalent to Case 1, TWRS Planning Case
\+ Better than Case 1
\- Worse than Case 1
\- - Substantially worse than Case 1

* : Retrieval operations do not support completion of SST retrieval by 2018.

^ : Does not achieve final waste processing by 2028.

Table 3.6. DOE Feedback on Phase I Results

Feedback
• Waste characterization could be more performance-based than it is now • Levelized cost should not be used as an assessment criterion (difficult to achieve) • New technology should be captured as a criterion • Pilot-scale operation would be an attractive option • Allow maximum competition (i.e., don't force or preclude consortia) • Potential deal-breaker - Total cost - Non-compliance with TPA milestones - Volume of HLW glass - Expandability of facilities is crucial - Public/worker risks must meet standards

Table 3.7. Key Assumptions for Cases 10 Through 13

Retrieval

1. Retrieval rates always match the rate needed to feed the processing (pretreatment and vitrification) plants.
2. No credits or penalties have been applied to differentiate between retrieval technologies that leak waste to the soil column versus those that do not.
3. New technologies (such as barriers or arm-based systems) were not addressed because they do not improve processing costs or rates (given the assumptions above). However, some of these systems will undoubtedly be necessary for many of the SSTs.
4. It is assumed that single systems will be capable of completing the retrieval required. Any final cleanout system to prepare for closure was not included.
5. Retrieval using existing technologies was assumed to produce acceptable waste concentrations. No provisions for additional evaporation capacity were included.
6. It is assumed that DSTs remain sound and reusable for the duration of the TWRS mission.

Pretreatment and Low-Level Waste Vitrification

1. Enhanced sludge washing[a] is assumed to be effective, and the logistics of washing, settling, and decanting are assumed to be the same regardless of contracting arrangements.
2. The reference pretreatment approach is to use enhanced sludge washing and ion-exchange for all sludges. Ion-exchange is used to remove Cs^{137} from alkaline supernatants and wash solutions. This pretreatment approach is assumed to reduce the sludge mass to 10,500 MT on an oxide basis.
3. The mass of pretreated supernatant results in an equivalent of 80,900 MT of Na requiring immobilization. Assuming a 25 wt% Na_2O oxide loading in the glass approximately 430,000 MT of LLW glass will be produced.

High-Level Waste Vitrification

1. It is assumed that the waste oxide from pretreatment can be incorporated into borosilicate glass at a waste loading of 25 wt%. This will result in the production of approximately 42,000 MT of HLW glass.
2. The reference DHLW canister is assumed to be used. It is assumed that the glass mass in the canister is 1650 kg. Thus, for the reference case approximately 25,400 canisters will be produced.

Schedule Development

The following assumptions were used to develop the case study schedules.

1. The RCRA Permit is assumed to be phased. Design and construction can be initiated on interim status. The Part B Permit is required before commissioning of the plant.
2. The design time for large-scale facilities is 4 years. The construction time for large-scale facilities is 4 years.
3. The design and construction time for small-scale modular facilities such as the pilot plant is 2 years.
4. The time required to bid and award a contract by the DOE is 1 year.
5. Operational times are based upon process need. A plant capacity factor of .60 is assumed for plant sizing.
6. The plant sizing and timing has been established to meet mission level TPA milestones.

(a) Enhanced sludge washing is assumed to remove at least 70% of the Al, Cr, P from the solids.

Description. Case 10 is an alternative employing a multiphased (Phase I, Phase II, and Phase III) remediation effort utilizing multiprocessing lines per phase. It is presented in schematic fashion in Figures 3.14 and 3.15. The basic objective of Case 10, executed under a fully privatized contractual relationship, is to utilize a learning curve and a competitive framework to promote a more effective means of completing the tank waste remediation process. The strategy is to undertake progressively tailored chemical processing campaigns using modular distributed units based on increasing levels of knowledge and technical understanding of the waste and utilizing improved processing technology. The tactical approach is to utilize multiprocessing lines in each time-phased campaign for processing waste of increasing throughput and processing difficulty. The vendors operating each processing line will be required to operate a fully integrated process to retrieve/transfer/pretreat/vitrify LLW and store on an interim basis the HLW produced. The Sr/Cs capsules will be retrieved and mixed with the tank waste prior to vitrification as HLW. The HLW will be vitrified in two HLW plants operating in parallel and operations in 2009 initiated to comply with the TPA schedule.

The waste processing lines in the three separate, phased campaigns will be based on different waste types; supernatants, saltcake and sludges. Grouping of tanks for providing feed for each of the processing lines will be based on chemical similarities.

The specific sequence of the groups of tank waste processed also reflects a concept of first processing the well-understood and easy-to-process waste, leaving the waste with greater uncertainties and process difficulties to later phases when understanding of the waste has improved, better processing methods have been developed, and technology to handle the waste is available.

In phase I of Case 10, the objective is to procure, through the competitive bid process under a fully privatized contract structure, services to put in place three different processing lines, operating in parallel but on different waste types. Three separate and competitive contractor organizations would be responsible for retrieving/transferring/pretreating/vitrifying LLW.

The plan for Phase I is to employ three pilot scale (2.5 gpm processing rate) modular distributed processing units. Each contractor organization selected will be responsible for designing and building the processing and required infrastructure facilities necessary to execute the scope of the effort. Operations of all three lines would be initiated at approximately the same time and operate for six years.

The privately-owned facilities handling high-level radioactive materials will require radiological safety oversight and an NRC license to operate. Based on the plan, with the RFP being issued in early 1995, contracts awarded in early 1996, the RCRA permitting (2 years) and NRC licensing (4 years) conducted in parallel with the design of the plant and allowing 2 years of construction, the three pilot plants in Phase I would be expected to be on line in 2002. Their processing campaigns would be completed in 2008. Under this scenario, both licensing and permitting are required to be complete before construction is begun.

Findings. In order to comply with TPA milestones, the bidding process for Phase II must begin prior to the start up of Phase I operations, and Phases II and III must overlap. RCRA permitting, NRC licensing, design and construction must also proceed in parallel. The full benefits of learning would only be available to Phase III and only from the relatively small first phase.

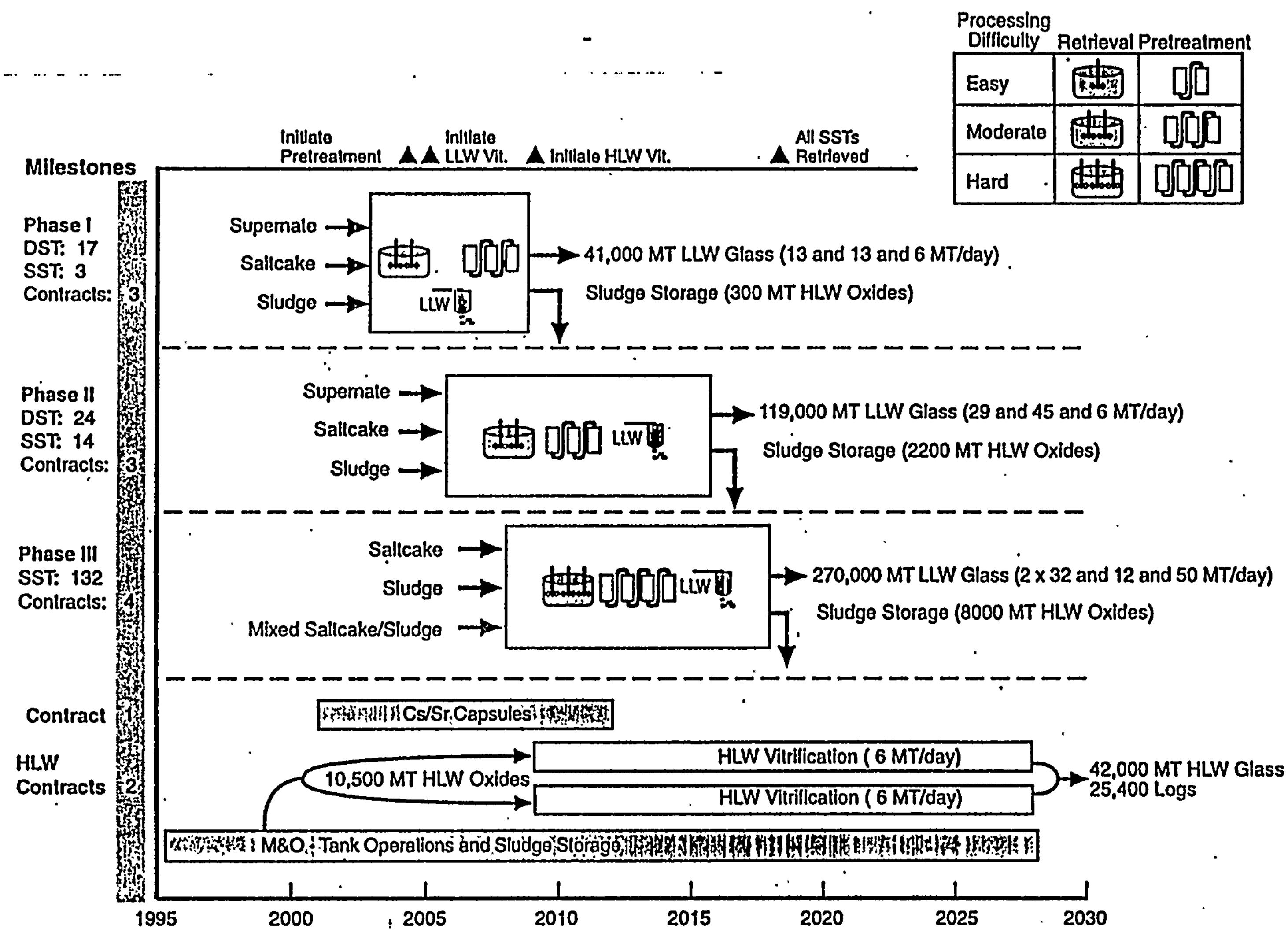

Figure 3.14. Case 10

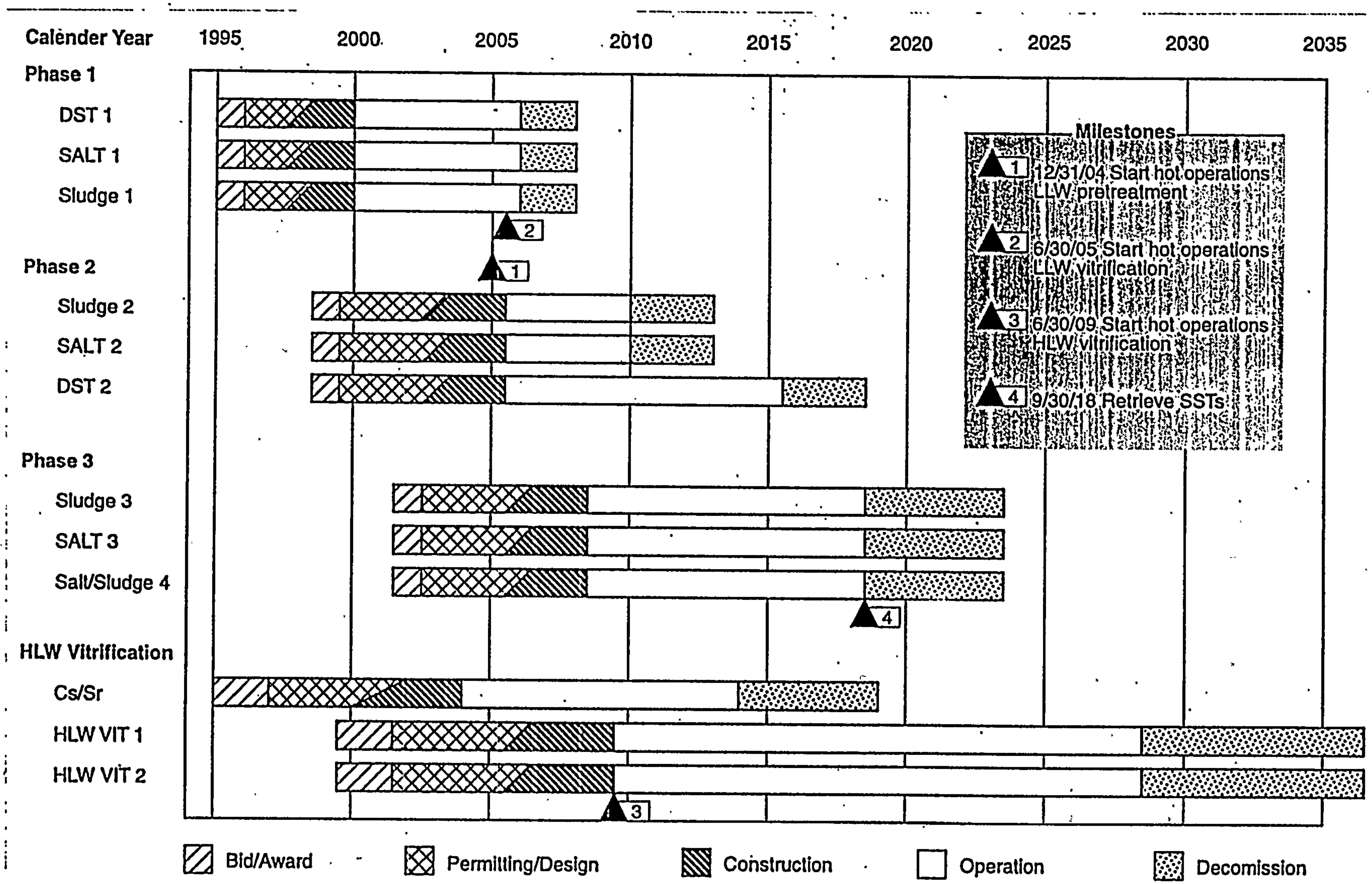

Figure 3.15. TWRS Privatization Schedules - Case 10

Case 11

Purpose. The purpose of Case 11 is to investigate slight modifications to Case 10, such that increased benefits of learning could be realized.

A cooperative, cost sharing, pseudo-privatization, contract framework during the "Phase I" pilot plant phase will establish a condition of modest vendor risk and performance-oriented motivation, while providing the environment and situation for learning the technical details of the Hanford waste situation and operational aspects of the business environment. The number of vendors involved in the operation of the waste processing plants is maximized by promoting the development of consortia of commercial vendors to form teams to bid on and contract for the creation and operation of the facilities of Phase I to process waste. Early contractor involvement is encouraged by using a cooperative, cost sharing, pseudo-privatization, contract framework to limit the dissemination of technical information and operation knowledge gained during the development and operation of the pilot plant to only those participating in the cost sharing effort. This will ensure that the organizations involved have a good information base on which to develop and submit cost competitive proposals for the fully-privatized, latter phases. The establishment of a government-owned, contractor-operated facility during Phase I will minimize the impact on TPA near-term milestones, by not having up-front delays associated with a 3 1/2 to 5 year licensing process with NRC.

A "Phase I" pilot plant will provide time to allow the TWRS Program to eliminate many of the basic technical uncertainties (performance assessment for low-level waste, completion of the waste characterization, performance standards for the vitrified waste) that would tend to drive up the cost of fixed price contracts in later phases. It will also provide the facilities and opportunity for testing new technology under minimum risk conditions.

Description. Case 11, an alternative that employs a multiphased (Phase I, Phase II, and Phase III) remediation effort utilizing multiprocessing lines in each phase is presented schematically in Figures 3.16 and 3.17. Case 11 is identical to Case 10 in terms of basic strategy but differs with regards to the tactics of implementation. The primary difference is in Phase I. In this case, Phase I would be executed under a pseudo-privatized effort, primarily cost/risk/experience sharing effort with vendors that are committed to support the remediation of the Hanford Site.

Case 10 shows significant delays in the initiation of the pilot plant efforts in Phase I due to the impacts of licensing, and this delay makes it difficult to meet commitments of the TPA. The time constraints imposed by licensing also significantly reduces the benefits to be gained from experience and learning that would come from operating the pilot plant, since the efforts to put Phase II in place would have to occur before the results of the pilot efforts could be adapted. In Case 11, the contractual relationship with the multiple vendors will be for a conventional government owned, contractor-operated facility managed under DOE self-regulation; NRC licensing would not be required. In the latter two phases of Case 11, the facilities would come under NRC licensing and radiological safety oversight.

In addition to improving the schedule with regard to meeting TPA commitments, this change to the pilot operations would increase the opportunities to address the learning, competitive, uncertainty and regulatory issues that will contribute to the cost of the remediation effort.

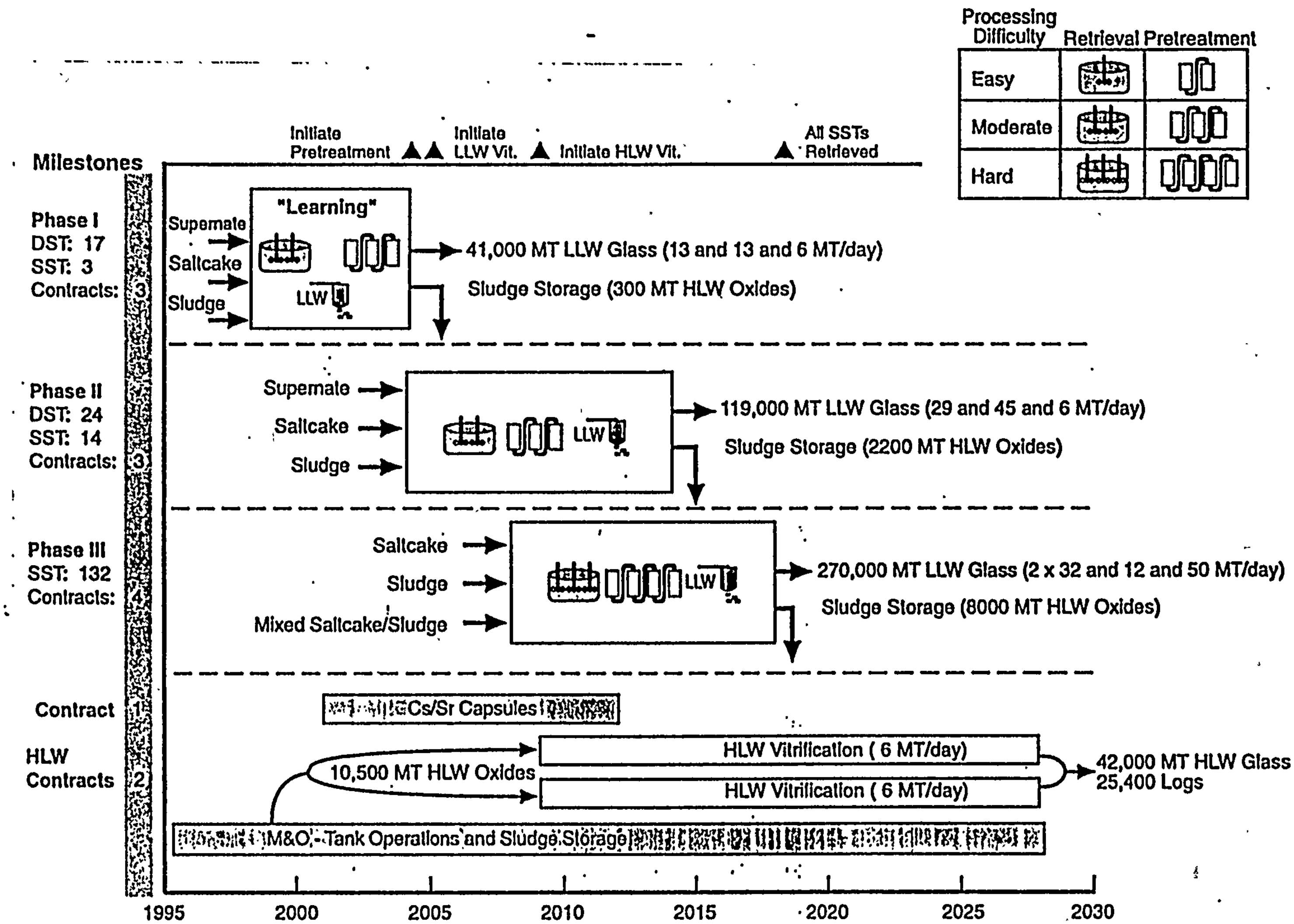

Figure 3.16. Case 11

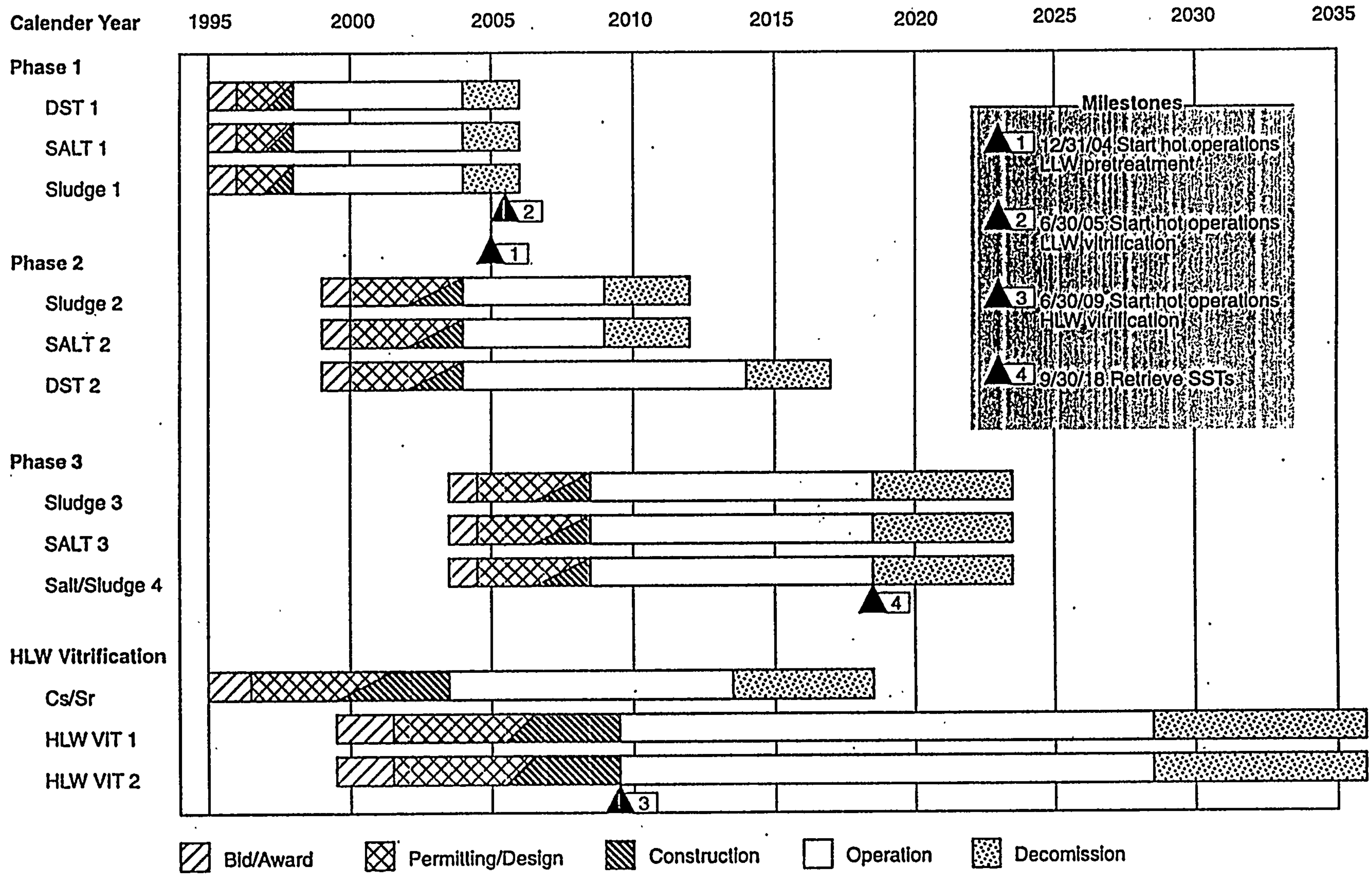

Figure 3.17. TWRS Privatization Schedules - Case 11

The tactical approach of utilizing multiprocessing lines will be retained; however, the emphasis will be on encouraging the creation of a consortia of private companies to be created to bid on the three pilot plant opportunities. The primary objective of this aspect of the tactical approach is to offer the greatest and most equitable (low vendor risk/performance oriented motivation) opportunity to educate potential vendors about the situation at Hanford, that is, reduce the level of uncertainty about the waste processing and operating conditions/business environment within which work must be executed. It also provides an opportunity for the maximum number of industrial organizations to participate in the actual waste remediation operations so that the actual problems will be known to all. The segmenting of process by waste types is designed to provided the maximum understanding of the different technical problems to all vendors involved. The information to come from the pilot-plant operation will be available only to those who shared the cost of the effort. An option can be developed to qualify vendors with regard to experience, knowledge, and demonstrated capability for operating on facilities processing highly radioactive materials. The idea is to ensure that industrial vendors have the best possible information base on which to develop and submit cost competitive proposals for the fully privatized latter phases.

The pilot-plant phase is also structured to offer a framework within which persistent issues can be addressed and resolved. During this period, the basic issue of NRC licensing regulations and process that would apply to a privatized operation at Hanford can be addressed in detail and this uncertainty minimized. The additional time also allows for resolution of known technical uncertainties regarding the waste, and for the details of problems of systems operation and integration to be studied and solutions developed before privatization is initiated. And it offers the opportunity to allow a modest level of market forces to be created so the competitive relationships necessary to improve quality of product and service, cost of operations, and impact on schedule can be examined.

Other issues that can be resolved in this time frame based on real operational experience, both technical and business, will include the development of the performance specification for the products and service, as well as the basis for fee to long-term privatized contract to be worked out.

Findings. A Phase I pilot plant would provide time for the TWRS Program to reduce many of the current uncertainties (such as waste characteristics and LLW glass specifications) that would tend to increase the cost of fixed price contracts during later phases. It would also provide the opportunity to test new technology under minimum risk conditions. DOE would be able to self regulate a pilot plant operation during Phase I, thereby postponing the potential complexity of an NRC licensing process until later, better understood phases.

Case 12. Vertical Segmentation of TWRS Baseline

Purpose. The concepts and issues of vertical privatization were explored in detail in Section 2.0 of this report. This approach is being revisited with Case 12 to highlight uncertainties and issues associated with managing five separate contracts to complete the TWRS disposal mission. The Case involving vertical segmentation of the TWRS baseline is based upon assumptions used to develop the Fourth Amendment (dated January 1994) of the Hanford Federal Facility Agreement and Consent Order (TPA), and current understanding of the ability of the technology to complete the tank mission.

Description. Case 12 involves vertical segmentation of the five TWRS functional areas; Waste Retrieval, Waste Storage and Transport, Waste Pretreatment, LLWV and HLWV. This large-scale case is completed in a single phase with five contracts. Centralized facilities are used to treat and immobilize all tank wastes. The processing is level-loaded throughout the phase with a mixture of series and parallel processing regimes. The operational schedule for completion of tank waste remediation is assumed identical to the TWRS planning case. Existing technology is used as the technical baseline. This case is illustrated in Figures 3.18 and 3.19.

Findings. Separation of the current TWRS M&O contract into five pieces would allow DOE to seek individual contractors with specific expertise in one of the functional areas. No additional benefits over the existing TWRS baseline strategy would be anticipated. The integration burden on the DOE or its integrating contractor would, however, be exacerbated.

Case 13. Two-Phase Competitive Horizontal Segmentation

Purpose. The objective of considering this case is two-fold. First, the impact that the pilot-plant will provide to reducing technical (programmatic) risk by providing early, small-scale operational information will be examined. Secondly, the two parallel (horizontal) contracts established to complete the TWRS mission will provide the opportunity to examine competition.

The objective of the Phase I contract is to obtain technical and operational information to support engineering development and operations of the Phase II capabilities of retrieval, pretreatment and LLWV. The objective of the Phase II contract is to complete the tank waste remediation mission through two contracts, each of which has the necessary capabilities to complete up to 60% of the remediation effort.

Description. This case is divided into 2 phases. In the first phase, a pilot-plant is operated to provide technical and operational information to support retrieval, pretreatment and LLWV design and operations. In the second phase, there are two contracts awarded. Each contract scope includes: waste storage and transport, waste retrieval, waste pretreatment, LLWV and HLWV. The contracts are specified such that the service provider would establish facilities capable of meeting 60% of the TWRS mission need.

The Phase I pilot plant will provide the following functional capabilities; ability to retrieve salt cakes and supernatants, pretreatment of the retrieved material and vitrification of the pretreated material into LLW glass. Pretreatment in the pilot-plant will involve filtration to remove solids and ion-exchange processing to remove ^{137}Cs from the supernatants. Solids and the ^{137}Cs are returned to a DST for storage. The conditioned and decontaminated salt solutions are vitrified as a LLW glass. The pilot plant is envisioned to operate between 1999 and 2004, at which time LLWV operations will commence in Phase II.

The Phase II contract is divided into two identical parts. The production plant capacities for pretreatment, LLWV and HLWV are sized such that each contract can complete 60% of the total mission need. The Phase II contract shall be implemented through large facilities in which the facilities for each contract set are centrally located. It is not known whether there are benefits in location of the facilities for each contract set in the same or different production area (East versus West). This case is illustrated in Figures 3.20 and 3.21.

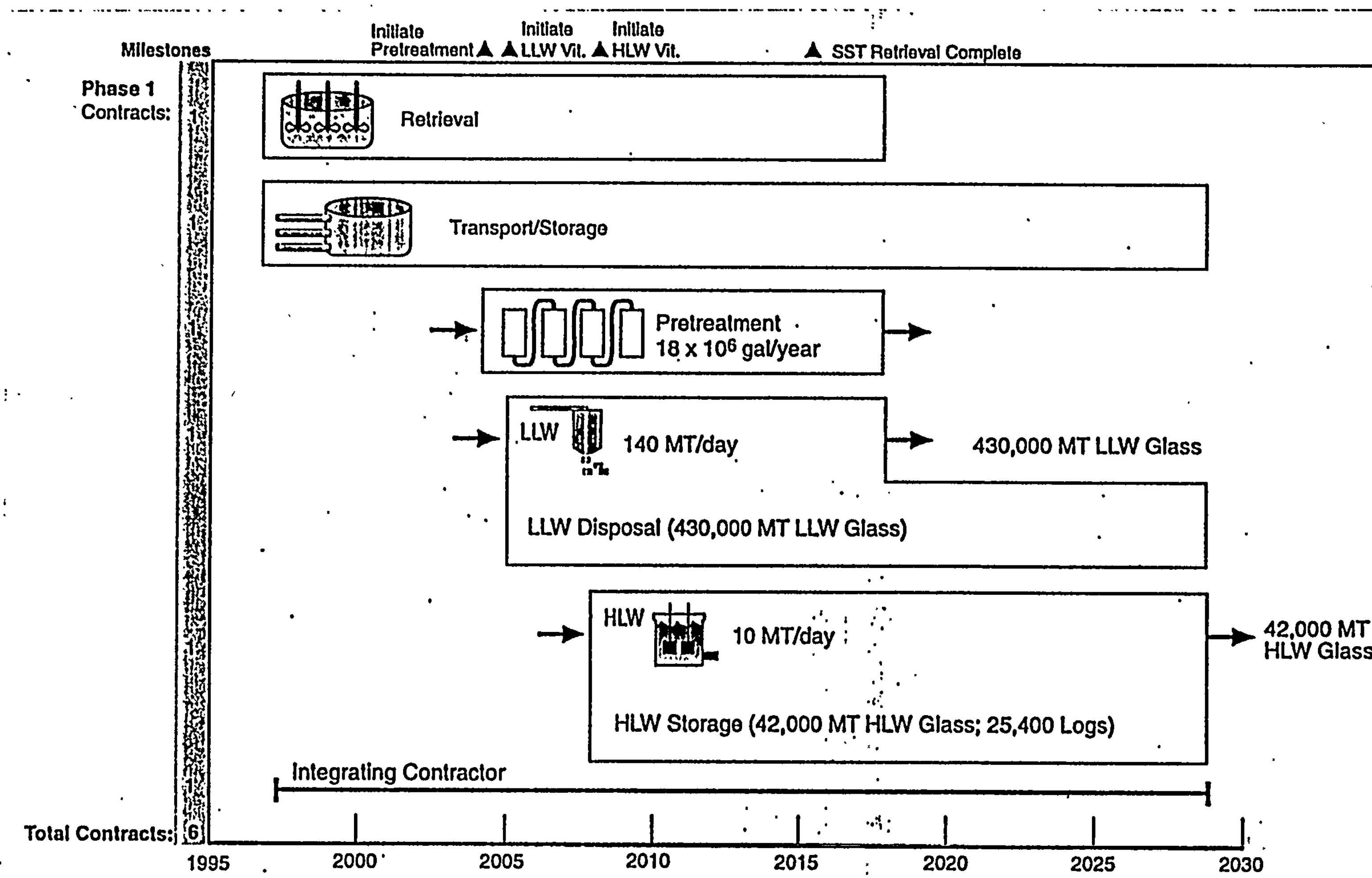

Figure 3.18. Case 12. Vertical Segmentation of TWRS Baseline

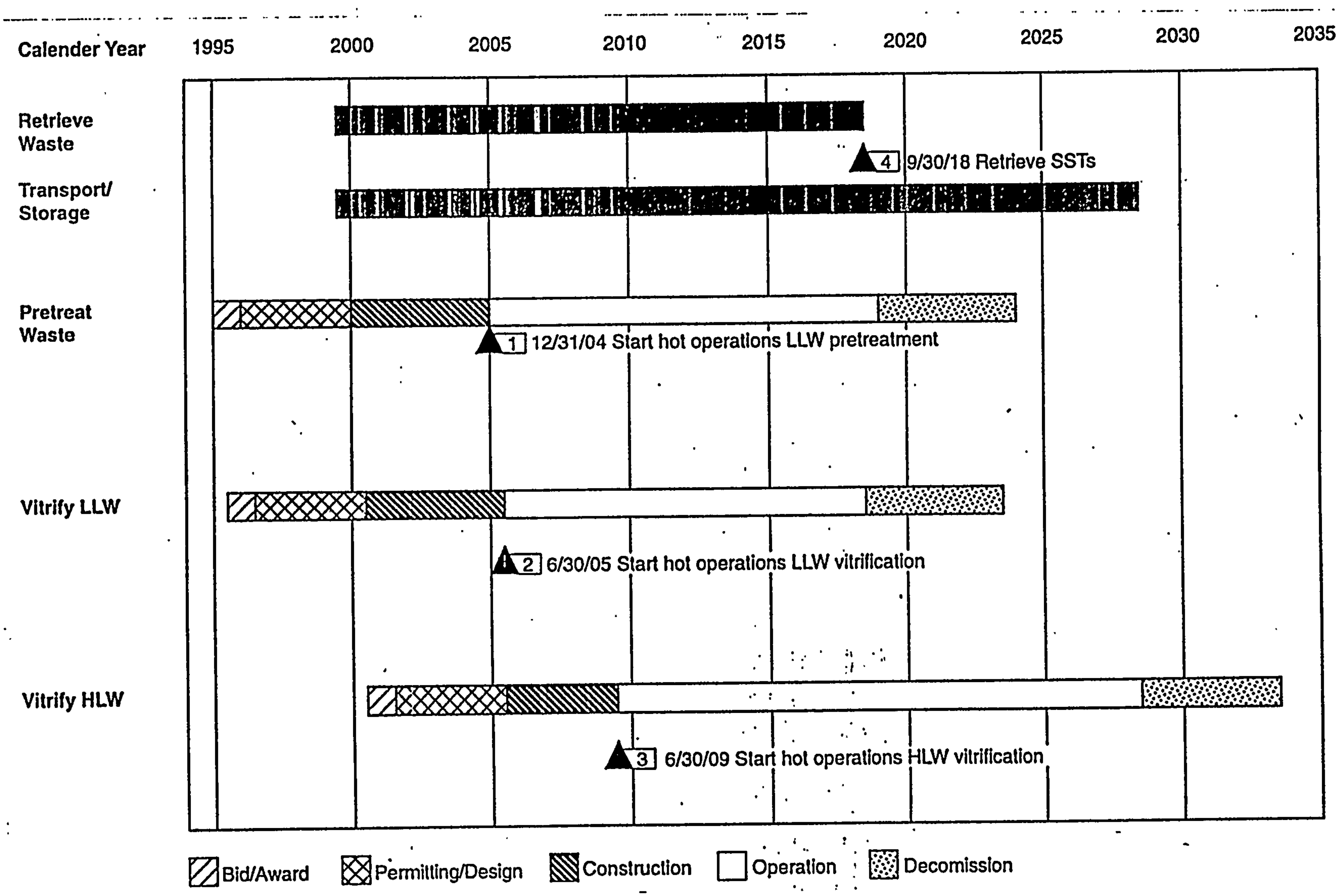

Figure 3.19. TWRS Privatization Schedules - Case 12

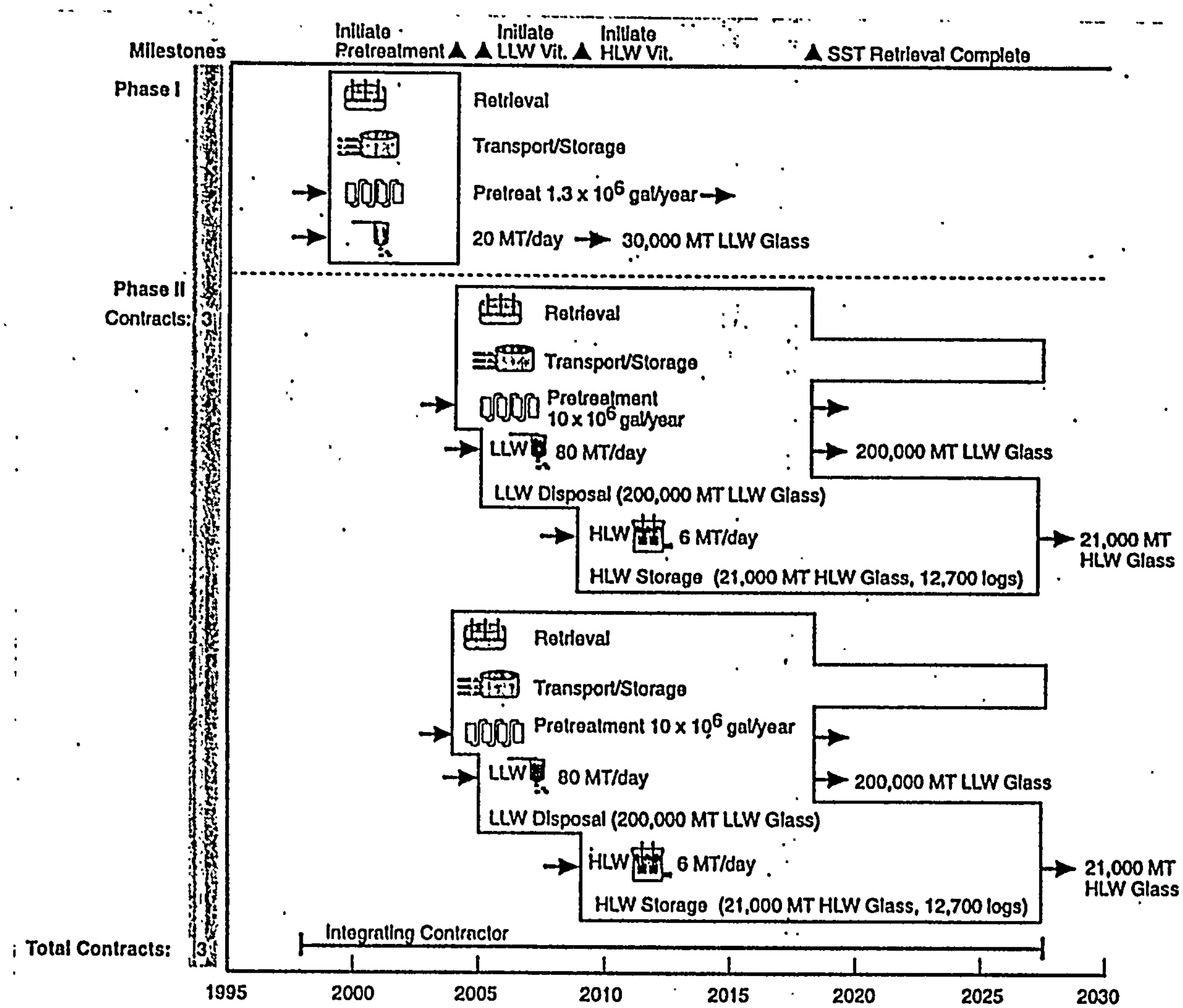

Figure 3.20. Case 13. Two-Phase Competitive Horizontal Segmentation

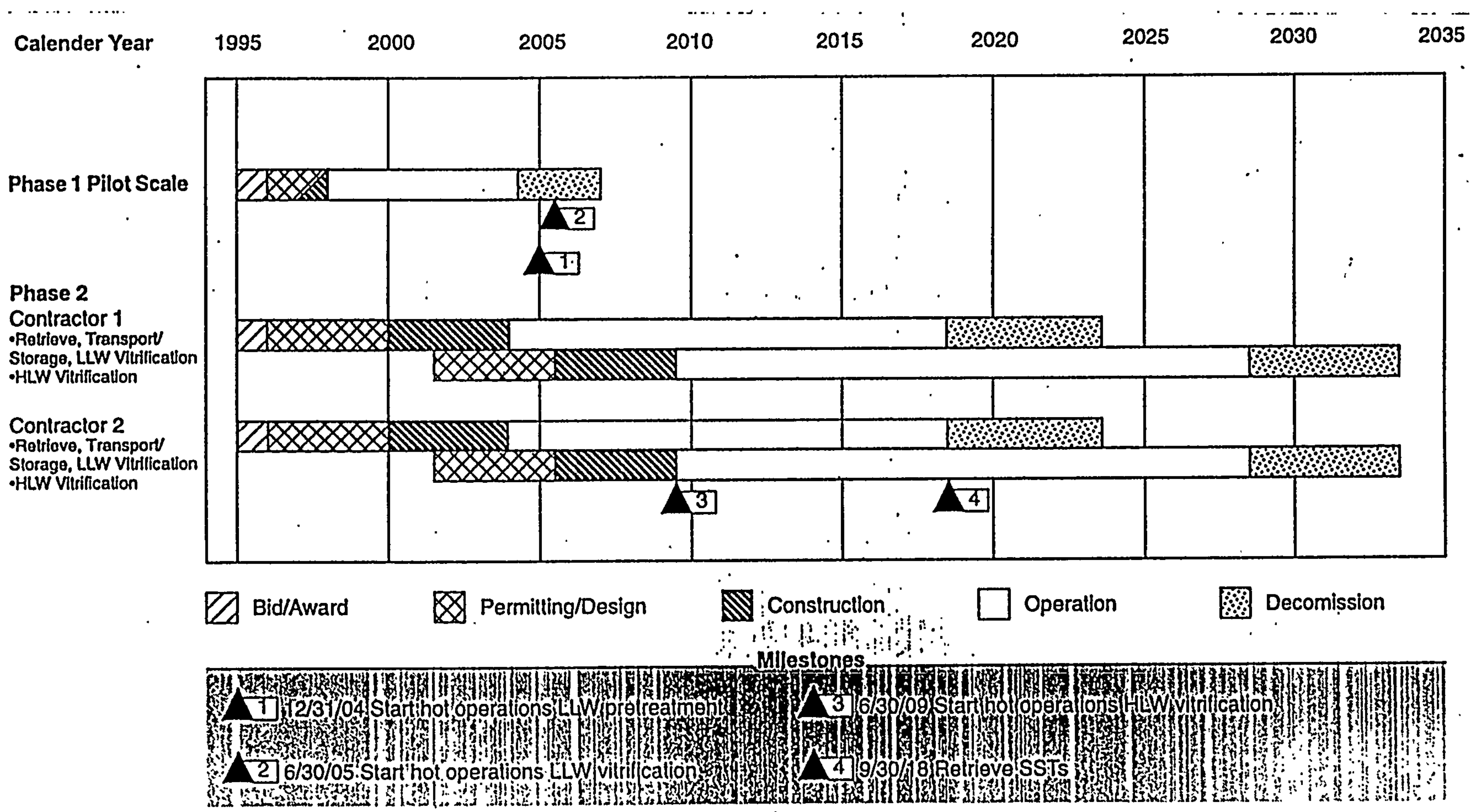

Figure 3.21. TWRS Privatization Schedules - Case 13

Findings. This case takes advantage of the benefits that can be realized from an early pilot plant demonstration, such as uncertainty reduction, learning, and new technology insertion. The relatively long contract duration of Phase II would provide the contractors sufficient opportunity to fully recover their capital investments. DOE would also benefit from the head-to-head competition that occurs during Phase II. As presently configured, this case can meet the TPA milestone, starting hot operations of the HLW vitrification plant by June 30, 2009, only by starting the design of the HLW plant in the year 2001.

3.3.2 Insights

Since Case 10 is privatized from inception, NRC licensing requirements encumber Phase I. This causes up-front delays and an attendant loss of learning and increased cost. The consortium approach in Case 11 contributes to a knowledgeable supply of vendors for later phases.

Case 13 reveals the need for careful structuring of a phased approach, with the initial phase being a pilot plant. In Case 13, design and construction requirements for Phase II are such that neither learning nor insight is available from Phase I at the time of the Phase II procurement. This is driven by the strategy requiring definition of the HLWV requirements by 2001 for Phase II. The vertical segmentation strategy (Case 12 avoids this difficulty, as potentially could a revised version of Case 13 having three phases and HLWV only in Phase III.

Other insights include:

- Phasing and head-to-head competition (e.g., cases 10 and 11) reduce programmatic risk.

- Case 12 illustrates the difficulty of vertical segmentation because of the requirement for the integrating contractor to manage a large number of interfaces with other contractors, and possibly to process waste received from one contractor before transferring it to another contractor.

- Use of multiple treatment facilities, through phasing and/or head-to-head competition, increases the ability to handle single point failures in the processing system.

4.0 Findings

These analyses have shown that certain phasing and head-to-head competition alternatives may lead to significant cost reductions and reduced program risk within the schedule mandated by the TPA. Phasing allows an early contract to process waste with characteristics sufficiently well-known to define contractual requirements. It also provides for significant cost reduction because of on-the-job learning and the potential to introduce new technology. The effect of head-to-head competition is shown directly by comparing Case 8 with Case 9. These cases are similar except for the competition that reduces the estimated life-cycle cost by nearly $2 B.

Additional significant benefits could, however, be achieved by revising some TPA milestones, i.e., completion of SST retrieval, while still achieving the overall completion date of 2028. The need to complete retrieval of all SSTs by 2018 effectively reduces the time available to complete the entire remediation effort by ten years. This time schedule reduces the opportunity to take full advantage of on-the-job learning and new technology advances, either of which could reduce the estimated total costs even more. The need to remediate the same waste volume over a shorter period of time also results in larger, more expensive, waste processing facilities.

5.0 Recommendations

On the basis of this preliminary technical feasibility assessment, it is recommended that DOE continue to pursue the overall approach of privatizing the TWRS program. At this time it is not possible to recommend an optimal privatization strategy, even from just a technical perspective. However, the additional investigations that are being conducted to evaluate privatization feasibility with regard to specific liability, financing, and contracting concerns, should consider potential strategies that include both phasing and head-to-head competition. Assuming that these additional investigations confirm the feasibility of privatization, a more rigorous technical analysis must be conducted prior to the issuance of an RFP.

Specific topics that must be addressed include:

- detailed definition of the initial contract(s), including specifications of products
- better understanding of programmatic risk and how privatization strategies compare with the current baseline, and how programmatic risk will translate into costs in fixed-price contracts
- revision and confirmation of cost estimates to provide additional comparison with anticipated budgets
- detailed planning to define the transition from the current M&O contract to a new strategy.

Appendix A

Concept Paper for Two Tank Waste Remediation System Privatization Options: Case 10 and Case 11

Appendix A

Concept Paper For Two Tank Waste Remediation System Privatization Options: Case 10 and Case 11

1.0 Introduction

This concept paper describes in detail a potentially feasible approach for privatizing the Hanford Tank Waste Remediation System (TWRS). The driving forces behind the privatization movement are the pressing needs to reduce cost, enhance quality of the effort and product, shorten the time required to complete the remediation process, and to reduce financial and programmatic risk.

The main concern involves making a major change in facility design and operation philosophy. Moving from an approach that, although costly, has been demonstrated historically to work (providing some flexibility to handle unknown situation), to an approach that is unproven (tailored chemical processing of the high-level radioactive waste in modular distributed units) but has high potential for achieving the increased performance objectives of privatization.

Deviation of the TWRS Program from the baseline action plan outlined for the implementation of the Tri-Party Agreement (TPA) under Case Beta has associated with it significant potential for seriously affecting the successful completion of milestones. The challenge is to outline an approach that will allow for the proper examination of the privatization concept without irrecoverably compromising the basic ability of the program to comply with the agreed-to requirements.

The approach described in this paper is based on a strategy of segmenting the waste tanks into distinct phases and starting remediation activities as early as possible, perhaps on a pilot scale, with tanks where the waste is well characterized and where waste retrieval is completely strtainghforward. Subsequent phases address tank groups with increasingly more difficult retrieval and processing challenges. Embodied in the overall strategy is the use of the modular time-phased approach of waste tank groupings to take advantage of head-to-head competition and learning in order to decrease cost and enable the use of new technologies. Fundamental to the strategy outlined here is the requirement to meet current TPA commitments and to minimize the risk and cost of successfully carrying out the TWRS mission.

2.0 Concept Definition

This section discusses drivers for TWRS privatization and, in particular, advantages of a time-phased modular approach for accomplishing the TWRS objectives. After a brief discussion of the rationale for privatization, two phased modular approaches, Case 10 and Case 11, will be defined in order to establish the framework for a more thorough analysis in the section entitled Concept Description. At the end of this section, some benefits and features associated with approaching the initial phase of TWRS privatization as a "learning" consortium will be presented.

2.1 General Discussion of the Rationale for Privatization

There are strong incentives for considering a phased, privatized concept, despite the fact that it is a new and unfamiliar approach to tank waste remediation. They center largely on getting started and learning as you proceed. These incentives are presented in the following discussion.

Get started early on phases that are well understood. Technical oversight groups have expressed considerable reservations about the ability of the program to design, at this time, a waste treatment complex that would be capable of remediating the total inventory of TWRS with an acceptable volume of high-level waste solids. If, however, the decision was made to proceed at this time, technology is in hand to design and operate a system to remediate segments of the Double Shell Tanks (DST) and Single Shell Tanks (SST) that contain wastes that are both well characterized and present relatively low programmatic risk. Based on stated criticisms of the TWRS program, it is believed that initiating a remediation project now, on a limited scope, would be endorsed by the technical oversight groups as well as state regulators, various stakeholder groups, and the local and national public. Moreover, with an aggressive schedule of regulatory permitting, design, and construction waste could be processed approximately six years earlier than the present TPA schedule.

Provide Hot Piloting for future phases. Considerable concern has been expressed by technical oversight groups about the present decision not to operate a radioactive pilot plant of the integrated baseline process before committing to the hot operation of the full pretreatment and vitrification facilities. Phase I of Case 11 would provide the equivalent of a radioactive pilot plant for the three principal types of waste: supernates, salt cakes, and sludges.

Learn from experience. The tanks remediated in Phase I are well characterized and require a minimal amount of pretreatment to vitrify the low-level waste (LLW) (after removal of Cs) and store the small amount of high-level waste (HLW) sludge for later solidification in the high-level vitrification facility. Other portions of Phase I will provide experience in retrieving salt cake from three SSTs and in the retrieval and treatment of a complex-concentrate waste, which will require some washing of the minor amount of sludge in the tank. The experience of these operations will provide "learning" in a host of areas, e.g., what are the complexities of retrieving waste from the tanks? What are the operating difficulties with undertaking pretreating in a field-remote modular pretreatment and low-level vitrification facility? In a similar manner, learning will be acquired with respect to contracting and the obtaining of regulatory permits. Initial experience will be obtained on small, relatively simple projects and facilities, which can then be applied to the later more complex phases of the program.

Reduce risks by incremental phased commitments. The risks of committing to a large central facility are reduced by committing one step at a time (for a total of five - counting the remediation of the Cs and Sr capsules and the high-level vitrification facilities as separate phases). At any one of these steps the strategy could be reevaluated and could revert to the current baseline strategy to complete the job. The risk associated with any one facility is initially moderate because there is little or no experience in building, operating, and performing D&D on these modular facilities. It is believed, however, that these risks will become progressively smaller as more experience is acquired during the earlier phases of the program.

Improve cash flow by phased commitment and private financing. Phasing reduces the need to obligate funds for the total project. Rather, funding would be obligated for the initial phase, and subsequently for Phase II. Confidence that the modular/phased approach was sound would have been gained before the funding for Phase III had to be obligated. If Phases II and III were privatized, the contracting for construction and operation of private plants to remediate groups of tanks would delay the required cash flow until treated waste is actually produced, and would then continue in proportion to the rate of waste treatment. This tends to further flatten the funding profile.

Facilitate the insertion of new technology. Specific technologies that are presently in the formative stages offer the prospects of significant cost reductions. Experience with phased procurement within the Department of Defense (DoD) has shown that reduction in unit costs from the insertion of new technology occurs in almost every situation. With the construction of a single central facility, however, inclusion of radical departures from the baseline are not easily accommodated in large facilities that must be remotely altered and maintained. Consequently, the cost of inserting new technology is sufficiently high that there is considerable inertia and resistance that must be overcome. With the phased approach, the potential for constructing new facilities at each phase of the project, plus the competition among bidders (and even between successful contractors) will stimulate the use of new technology in efforts to gain a competitive cost advantage.

Use private construction experience for more rapid deployment. Under a cost-plus contract, a combative management relationship develops between the government and the contractor because of the constant need to monitor the cost-effective use of funds. This relationship is heightened during construction because of the relatively poor record of cost control with this type of contract. The incentive for cost improvement is not present and so steps have been built into the construction activities for checking the design and holding up the next step at three points within the construction cycle. Work cannot proceed onto the next phase until these key decisions have been made with respect to progress as they perceive it. With a fixed-price, fee-for-service contract, the situation is very different. The contractor agrees to produce a product at a given price on the assumption that the end-states of the job are indeed as they were led to believe. DOE then has no reason to inspect except for those areas that impact legal obligations and cannot be completely transferred to the contractor. This situation then avoids the imposition of government practices on a job totally owned by the contractor. Consequently, the private contractor may be able to considerably shorten the design-construction cycle inherent in government construction projects.

Allow for competition to drive down the cost. For a project that is well risk-managed (i.e., with well defined interfaces, product requirements, and well known internal situations) a fixed-price, fee-for-service contract can be the most cost effective way to proceed. It can, however, also be a source of large project overruns if ambiguity exists at the interfaces, leading to numerous change requests. Such change requests can be demanded by the contractor since conditions are not as they were initially represented. Nevertheless, experience within DoD with large phased procurement of weapons systems has shown that, when competition is allowed in a well-structured environment, costs can drop dramatically. One must assume, however, that the savings by the government will be realized primarily at the time of recompetition, since the savings will likely arise out of efficiencies experienced by the contractor and hence a propriety asset.

2.2 Case 10 Description

Case 10, an alternative that employs a multiphased (Phases I,II, and III) remediation effort utilizing multiprocessing lines per phase, is presented in schematic fashion in Figure A.1. The basic objective of Case 10, executed under a fully privatized contractual relationship, is to utilize a learning curve and a competitive framework to promote a more effective means of completing the tank waste remediaton process. The strategy is to develop progressively more complex chemical processing campaigns using modular distributed units based on increasing levels of knowledge and technical understanding of the waste and utilizing improved processing technology. The tactical approach is to utilize multiprocessing lines in each time-phased campaign for processing waste of increasing throughput and processing difficulty. The vendors operating each processing line will be required to operate a fully integrated process to retrieve, transfer, pretreat, and vitrify LLW and to store, on an interim basis, the HLW produced. A separate contract will be let for remediation of the Sr/Cs capsules. The most probable option for treating these capsules is that they will be retrieved

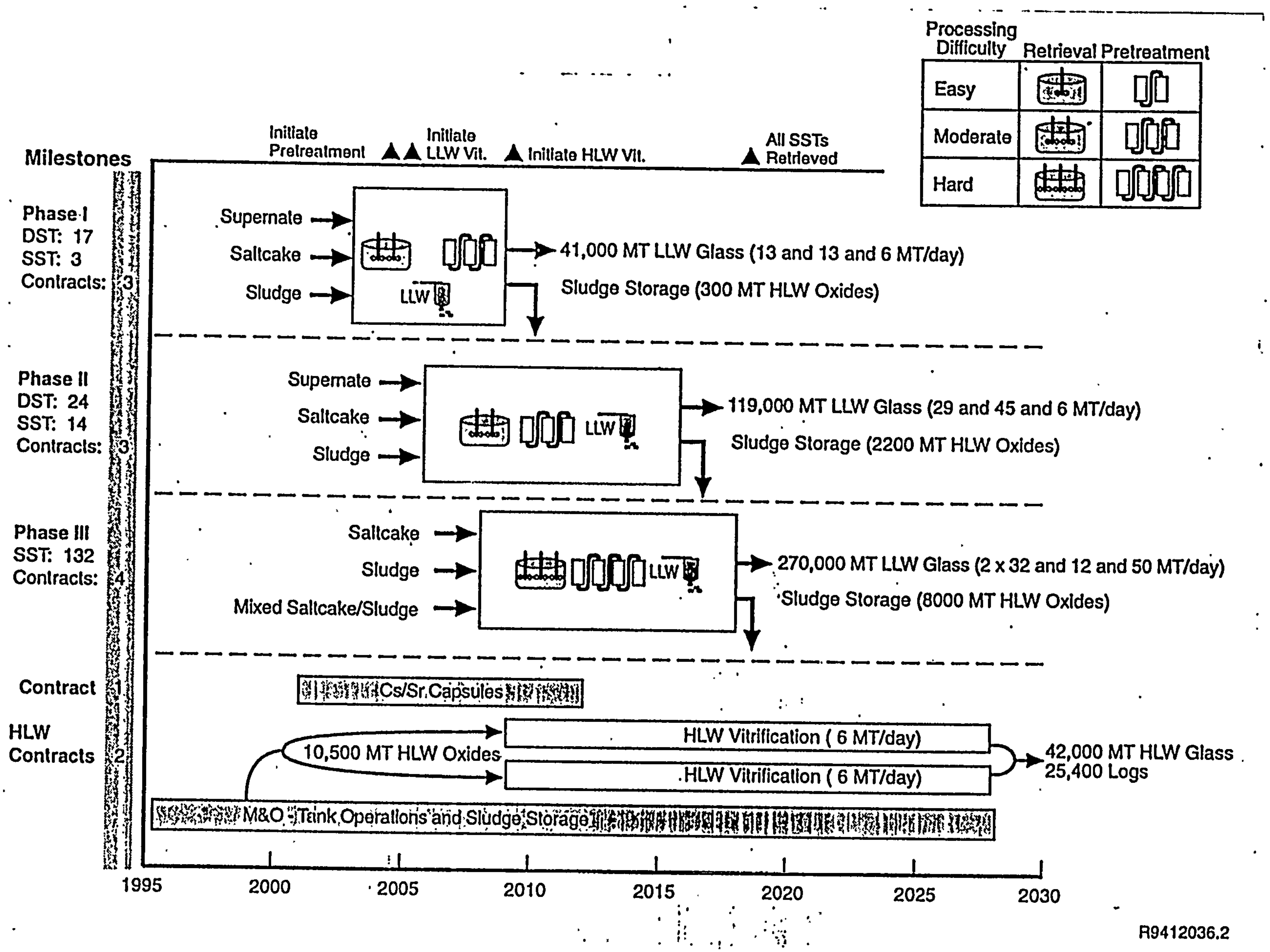

Figure A.1. Schematic of Operating Phases for Case 10 (Fully Privatized First Phase) and mixed with the tank waste for the process of vitrification as HLW. The HLW will be vitrified in two HLW plants, operating in parallel and beginning operation on the TPA schedule in 2009.

The waste processing lines in the three separate phased campaigns will be based on three different waste types; supernatants, salt cake and sludges. The grouping of tanks for providing feed for each of the processing lines will be based on chemical similarities. The specific structure and sequence of the groups of tank waste processed also reflects a concept for processing the well understood and easy-to-process waste first, leaving the waste with greater uncertainties and process difficulties to later phases when understanding of the waste has improved, processing methods developed, and technology to handle the waste is available.

In Case 10, Phase I, the objective is to procure, through the competitive bid process and under a fully privatized contract structure, services to put in place three different processing lines operating in parallel but on different waste types. Three separate and competitive contractor organization would be responsible for retrieving, transferring, pretreating, and vitrifying LLW.

The plan for Phase I is to employ three pilot scale (2.5 gpm processing rate) modular distributed processing units. Each contractor organization selected will be responsible for designing and building the processing and required infrastructure facilities necessary to execute the scope of the effort. Operations of all three lines would be initiated at approximately the same time and operate for six years.

The privately owned facilities handling high-level radioactive materials will require radiological safety oversight by and an NRC license to operate. Based on the plan, with the Request For Proposals (RFP) being issued in early 1995, contracts awarded in early 1996, the RCRA permitting (2 years) and NRC licensing (4 years) conducted in parallel with the design of the plant and allowing 2 years of construction, the three pilot plants in Phase I would be expected to be on line in 2002. Their processing campaigns would be completed in 2008. Under this scenario, both licensing and permitting are required to be complete before construction is allowed to be initiated.

2.3 Case 11 Description

Case 11 is an alternative that employs multiphased (Phases I,II, and III) remediation effort utilizing multiprocessing lines per phase. This is presented schematically in Figure A.2. Case 11 is identical to Case 10 in terms of basic strategy but differs with regards to the tactics of implementation. The primary difference lies in Phase I. In Case 11, Phase I would be executed under a pseudo-privatized effort, primarily cost/risk/experience sharing effort with vendors that are committed to support the remediation of the Hanford Site.

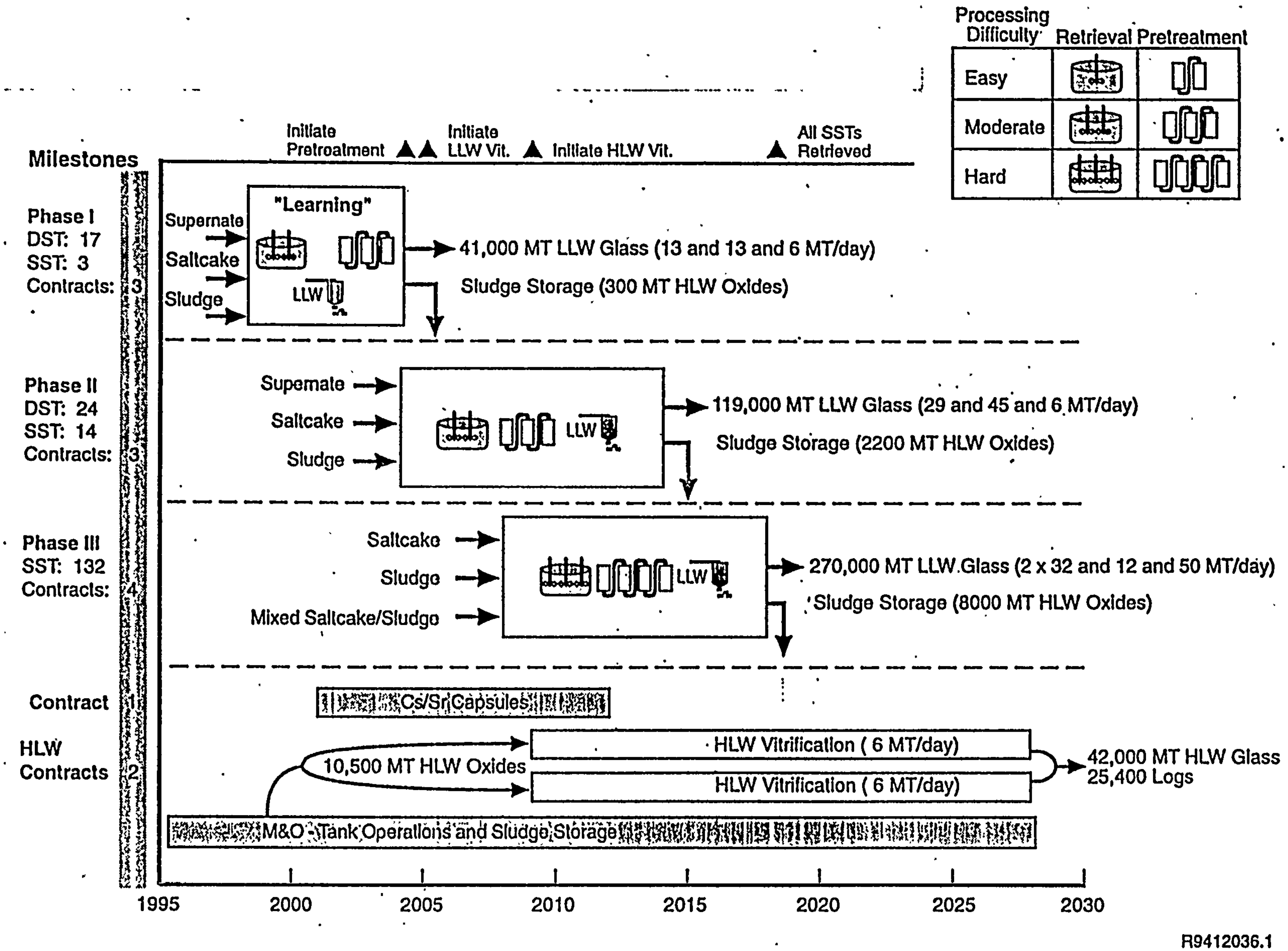

Figure A.2. Schematic of Operating Phases for Case 11 (DOE Regulated, Learning Consortium First Phase)

Case 10 contains significant delays in the initiation of the pilot plant efforts in Phase I because of the impacts of licensing. This delay makes it difficult to meet commitments of the Tri-Party Agreement. The time constraints imposed by licensing also significantly reduces the benefits to be gained from experience and learning that would come from operating the pilot plant since the efforts to put Phase II in place would have to occur before the results of the pilot efforts could be adapted. In Case 11, however, the contractual relationship with the multiple vendors will be for a conventional government owned, contractor operated facility managed under DOE self-regulation; NRC licensing would not be required. In the latter two phases of Case 11, the facilities would come under NRC licensing and radiological safety oversight.

In addition to improving the schedule with regard to meeting the TPA commitments, this change to the pilot operations would increase the opportunities to address the learning, competitive, uncertainty, and regulatory issues that would contribute to the cost of the remediation effort.

The tactical approach of utilizing multiprocessing lines will be retained. The emphasis, however, will be on encouraging the creation of a consortia of private companies to bid on the three pilot plant opportunities. The primary objective of this aspect of the tactical approach is to offer the greatest and most equitable (low vendor risk/performance oriented motivation) opportunity to educate potential vendors about the situation at Hanford, that is, reduce the level of uncertainty about the waste processing and operating conditions/business environment within which work must be executed. It also provides the opportunity for the maximum number of industrial organizations to participate in the actual waste remediation operations so that the actual problems will be known to all. The segmenting of process by waste types is designed to provided the maximum understanding of the different technical problems to all vendors involved. The information gained from the pilot plant operation will be available to only those who have shared in the cost of the effort.

The pilot plant phase is also structure to offer a framework within which persistent issues can be addressed and resolved. During this period, the basic issue of NRC licensing regulations and process that would apply to a privatized operation at Hanford can be addressed in detail the uncertainty minimized. The additional time for resolution of known technical uncertainties regarding the waste also allows for the details of problems of systems operation and integration to be studied and solutions developed before privatization is initiated. It offers an opportunity to allow a modest level of market forces to be created so the competitive relationships, necessary to improve quality of product and service, cost of operations, and impact on schedule, can be examined.

2.4 Features and Benefits of a Consortium-based Strategy for Phase I.

Application of a consortium-based implementation strategy with limited competitive characteristics, such as that envisioned for Case 11, embodies feasible and attractive implementation features for Phase I. Phase I can be implemented by promoting the development of a consortia of commercial vendors and individual companies to bid on and contract for creation and operation of multiple (2-3) pilot plants. Specific aspects of the consortium approach are described below.

- Use Phase I to focus on developing pilot plants, based on a "modular " concept, for waste processing and for use in either distributed or centralized plants during later cleanup phases. Utilize the pilot plants to test the real potential for and validity of a distributed system approach, based on actual operational experience and lessons learned during Phase I.

- Construct pilot plants that would involve the retrieval of wastes from tanks, transfer of wastes to processing sites, chemically processing the waste, vitrification of low-level waste, and storage of high-level waste until later cleanup phases. Create operational conditions that allow the vertical integration of processing operations to be fully examined under real operating conditions. Operation of the pilot plants will provide technical information and operational knowledge to develop and operate full-scale facilities for subsequent stages.

- Produce solid waste, through operation of the pilot plants, at the earliest possible date that meets the formal disposal criteria. Examine the strategy for building the high-level waste vitrification plants and resolve issues associated with the mass and volume of vitrified waste that can be accommodated by the repository.

- Establish a framework in which members of the consortia and individual companies may be qualified, with regard to equipment used and operational capability, for handling high-level radioactive material.

- Promote the development of a cooperative cost-sharing contractual relationship between DOE and contractors. One in which government-owned pilot plant facilities are built using cost reimbursement contracts with consortia and/or individual companies. Operation of the pilot plants would be accomplished through competitive fixed-price, fee-for-service contracts by the participating consortia and individual companies. Payment for operations would be made for final product (vitrified LLW and stored HLW) delivery meeting the formal disposal criteria specified by the DOE. As a result, the participating consortia and companies would effectively cost-share in the operation of pilot plants during Phase I.

Examine the interface between functional operations within the TWRS to ensure that the service or product to be purchased, and the nature and detail of the product/service specifications developed, provide a sound basis for DOE payments for final products and services.

- Involve financial underwriting organizations as part of the consortia to establish real understanding of the financial risks and uncertainties at the Hanford Site and within DOE to facilitate favorable conditions to obtain financial backing for fully privatized operations in later phases.

- Create a competitive situation involving multiple operations that allows for modest levels of market forces to work during the processing of wastes materials in Phase I.

- Stipulate in the Phase I RFP(s) that technical and operations information concerning constructing and operating the pilot plants developed by the consortia and individual companies will be placed in a common database maintained by DOE.

- Encourage early contractor involvement in Phase I by limiting the dissemination of technical information and operation knowledge gained during development and operation of the pilot plants to the consortia and companies participating in the Phase I cost sharing approach.

A consortia approach with limited dissemination of technical and operational information would maximize the number of contractors involved in Phase I, enhancing an extensive information base across several contractors. Use of a cost reimbursement approach during facility construction will encourage application of innovative technologies since the risk to vendors from applying new technologies is reduced. This limited competition approach with shared technical and operations information, developed throughout Phase I, promotes relatively rapid and wide-spread learning about the operational aspects of the cleanup activity and details of the Hanford waste situation. Contractor risk associated with the facilities can be minimized. In turn, contractors would take all operations risk, limiting DOE's risk exposure.

Limiting information dissemination to Phase I participants provides an incentive for consortia and individual companies to cost share with DOE and builds a broad information base among the several participants. Establishing a common information base for all participating consortia and individual companies promotes teaming flexibility to competitively bid in future cleanup phases, and gives DOE flexibility in selection of contracting strategies in subsequent stages.

Application of the consortium-based phase strategy provides time in which NRC licensing requirements can be clearly outlined before privatization of cleanup functions begins. Contractors and financial underwriters can become educated about licensing requirements, and the specific steps of the licensing processes, thereby reducing or minimizing the time required to obtain the licenses necessary to receive and possess the radioactive waste during processing operations. Information obtained from pilot plant operations provides the opportunity to analyze the operational requirements and define the requirements for the use of new technology in the subsequent phases of the cleanup operations.

This strategy also provides the TWRS program time to eliminate many of the basic technical uncertainties (performance assessment for LLW, completion of the waste characterization, performance standards for the vitrified waste products, etc.) that will tend to drive up the costs of fixed-price, fee-for-service contracts in the fully privatized phases. Elimination of technical uncertainties will provide a basis for the contractual framework to develop the specific terms and conditions of operations and final products and services under fully privatized operations.

3.0 Concept Description Overview

Both Case 10 and 11 scenarios separate the TWRS waste treatment functions into three phases of tank waste retrieval, pretreatment, and LLW immobilization; two competitive HLW vitrification facilities to immobilize the pretreated wastes; and a separate contract and plant for treatment of the cesium/strontium capsules. The three phases of tank waste pretreatment and low-level vitrification are separated into one cooperative learning phase and two competitive treatment phases. Each of these phases will require the construction of a pretreatment and low-level vitrification processing capability. The high-level solids generated and the cesium separated from the wastes by these operations will be transferred to the Integrating Contractor and stored for subsequent vitrification in the HLW vitrification facilities. The cesium/strontium capsule treatment is a separately competed phase for the treatment of these capsules and production of a vitrified product suitable for disposal in the HLW repository. The HLW vitrification phase is a separately competed phase that will receive blended washed HLW solids and cesium from storage and will vitrify these materials into a form suitable for disposal in the HLW repository. This scenario does not address the MUST tanks. The scope of the contracts used to implement Cases 10 and 11 are described below.

3.1 Retrieval, Pretreatment and Low-Level Vitrification Contracts

In Cases 10 and 11 the TWRS retrieval, pretreatment and low-level vitrification task is divided into nine campaigns (contracts) by waste type and treatment requirements grouped into three phases. The waste selected for treatment in each campaign is assigned to one or more contractors, responsible for the retrieval, pretreatment and LLW vitrification for that portion of the waste. The contracts for the retrieval, pretreatment and low-level vitrification of this waste will provide performance based specifications for the products of the waste treatment process and minimum requirements for the non-product based portions of the contract scope. The performance based specifications will be based on the performance of the

"Enhanced Sludge Washing Process" and the production of a low-level glass waste form with a cesium concentration of 1 Ci/m^3. The removal of other radionuclides or the use of advanced separations processes is not a part of the planning basis for Cases 10 and 11. The phased nature of Cases 10 and 11 would, however, make later incorporation of these process feasible. Incorporation of advanced processes could be encouraged through suitable incentives for improved performance (e.g., reduced HLW sludge)

The basic products of the retrieval, pretreatment and vitrification contracts of Cases 10 and 11 are:

- cleaned tanks
- a concentrated liquid stream, containing the cesium separated from the waste, neutralized and adjusted to meet the current tank farms waste acceptance criteria
- a washed-solids stream containing the insoluble solids separated from the treated waste
- containerized vitrified low-level waste glass.

The contractor will return these products to the M&O for reuse (DSTs), closure (SSTs), storage/disposal (vitrified LLW) or subsequent treatment (concentrated liquid eluent, Washed Solids). The vitrified LLW will be transported by truck from the contractors production facility to a storage area established by the Integrating Contractor. The concentrated cesium stream and the washed sludges will be transported using the French LR-56 truck (or equivalent) to a receipt point in the tank farms (204-AR facility) unloaded by the Integrating Contractor and placed into storage for subsequent blending and processing by the High-Level Vitrification contractor(s).

The contract terms will specify acceptance criteria for these products together with a reward penalty structure associated with not achieving or exceeding contract specifications. A preliminary assessment of the major specifications for these products is shown in Table A.1.

In addition to, or as part of, providing the four major products the vendor will also perform the following services during the course of the contract:

- Operate the tanks in a safe compliant manner.
- Update the safety documentation as required to address tank waste storage, retrieval and processing.

Table A.1. Specifications for Products from Retrieval, Pretreatment and Low-Level Vitrification Contracts

Item	Specification	Basis
Clean Tanks	99+% Waste Removal	TPA Requirement
Cesium Removal	maximum cesium concentration in feed to LLW glass plant of 4.6E-5 Ci Cs-137/mol Na	maximum LLW glass concentration of 1 Ci/m^3 cesium
Concentrated Liquid Cesium Stream volume	Maximum of 10% of IX Column feed at 5M Na	Place upper limit on truck shipments; technically achievable with regenerable IX process
Concentrated Cesium stream cesium content		LR-56 Shipping limit
Washed Sludge	70% or greater removal of Al, P, and Cr from the insoluble solids	removal efficiencies required to equal performance of "Enhanced Sludge Washing"
LLW Glass formulation/Overall Process Performance	6.30 MT glass/MT Na in tank	provide upper bound on glass volume; provide incentive to minimize glass volume/optimize processes
LLW Glass durability	TBD	TBD

- Retrieve the waste stored in the tanks.
- Treat the supernate in the tanks to remove cesium to levels that result in a LLW glass concentration of 1 Ci/m^3 or less.
- Vitrification of the low-level waste and packaging of the vitrified product in containers (e.g., 55 gallon drums).
- Documenting the inventory and quality of the products of the treatment process.
- Delivery of the containerized low-level waste to a point designated by the Integrating Contractor.

- Transfer to a tank truck a concentrated liquid cesium product for transport to the storage location by the Integrating Contractor.
- Return of the tank to the Integrating Contractor in a prescribed condition.
- D&D of facilities constructed to compete this mission.

3.2 High-Level Waste Vitrification Contracts

Cases 10 and 11 each have three contracts for the vitrification of HLW. One of these contracts is for the vitrification of the cesium and strontium capsules and the other two are for the vitrification of the cesium recovered from the tank waste and the washed sludges. These contracts will have a single product; vitrified waste meeting repository performance requirements. The waste processed under these contracts will be delivered by the Integrating Contractor to the site of the treatment plant. Cesium and strontium capsules will be transported by truck and the washed sludges and cesium will be transferred through a pipeline, constructed by the vitrification plant operator or by transfer of control of a DST containing the material to be vitrified to the HLW vitrification plant operator.

3.3 Physical Layout of Waste Processing Plants Under Cases 10 and 11

The underground storage tank farms in Areas 200 E and 200 W. contain the wastes are to be remediated by TWRS. The proposed series of contracts call for the construction, operation, and ultimate decontamination and demolition of thirteen facilities for retrieval of wastes from the tanks, transfer them to pretreatment systems, pretreat them, vitrify the residuals that can not be destroyed, and store the final HLW waste forms until an ultimate repository becomes available (the option exists that one of these facilities may be moved and reused in the Sludge 3 campaign, defined in Table A.2, which would result in twelve plants rather than thirteen). Included in the count of thirteen facilities is one plant planned for cesium/strontium capsule treatment. In addition to the processing facilities, two HLW-canister interim storage areas are designated. Preliminary suggested locations for these facilities are indicated on the scale map in Figure A.3. The suggested locations are based on the following considerations:

- no ES&H conflicts
- no physical interference with existing facilities, except where it makes sense to remove or modify them

Table A.2. Preliminary estimates of the total lengths of double-walled piping required to transfer liquid and slurried wastes from the USTs to each treatment facility for pretreatment.

Facility	Required Piping-System Capacity (GPM)	Total Piping-System Length (ft)
SUPERNATE-1	4	4,150
SALT-1	4	850
SLUDGE-1	4	500
SUPERNATE-2	8	1,650
SALT-2	8	1,800
SLUDGE-2	8	3,300
SALT 3 E	17	8,450
SALT-3 W	17	10,950
SLUDGE 3 E	17	10,400
SLUDGE 3 W	17	13,500
SALT/SLUDGE-4	17	5,250

- no use of transfer lines between Areas 200 E and 200 W and trucking of liquid/slurried wastes from only two tanks, i.e., B-105 and BX-111, for treatment in order to avoid the use of such transfer lines

- minimization of total transfer line lengths for each facility independently, with no credit for existing transfer lines, consistent with existing structures and services such as roads, railroads, power lines, etc.

- limited opportunity to examine each proposed site (actual siting would require designed-based assessment).

Any of the proposed sites may turn out, on closer examination, to have significant draw-backs, e.g., be congested with facilities, services, etc., not indicated on the available maps, have unfavorable topography, or involve unforeseen hazards. There appears, however, to be numerous attractive potential sites for most of the proposed facilities, so that there are apparently no insurmountable obstacles to their siting in favorable locations. It is projected that the foot prints of each of the proposed facilities, with the possible exception of the stored

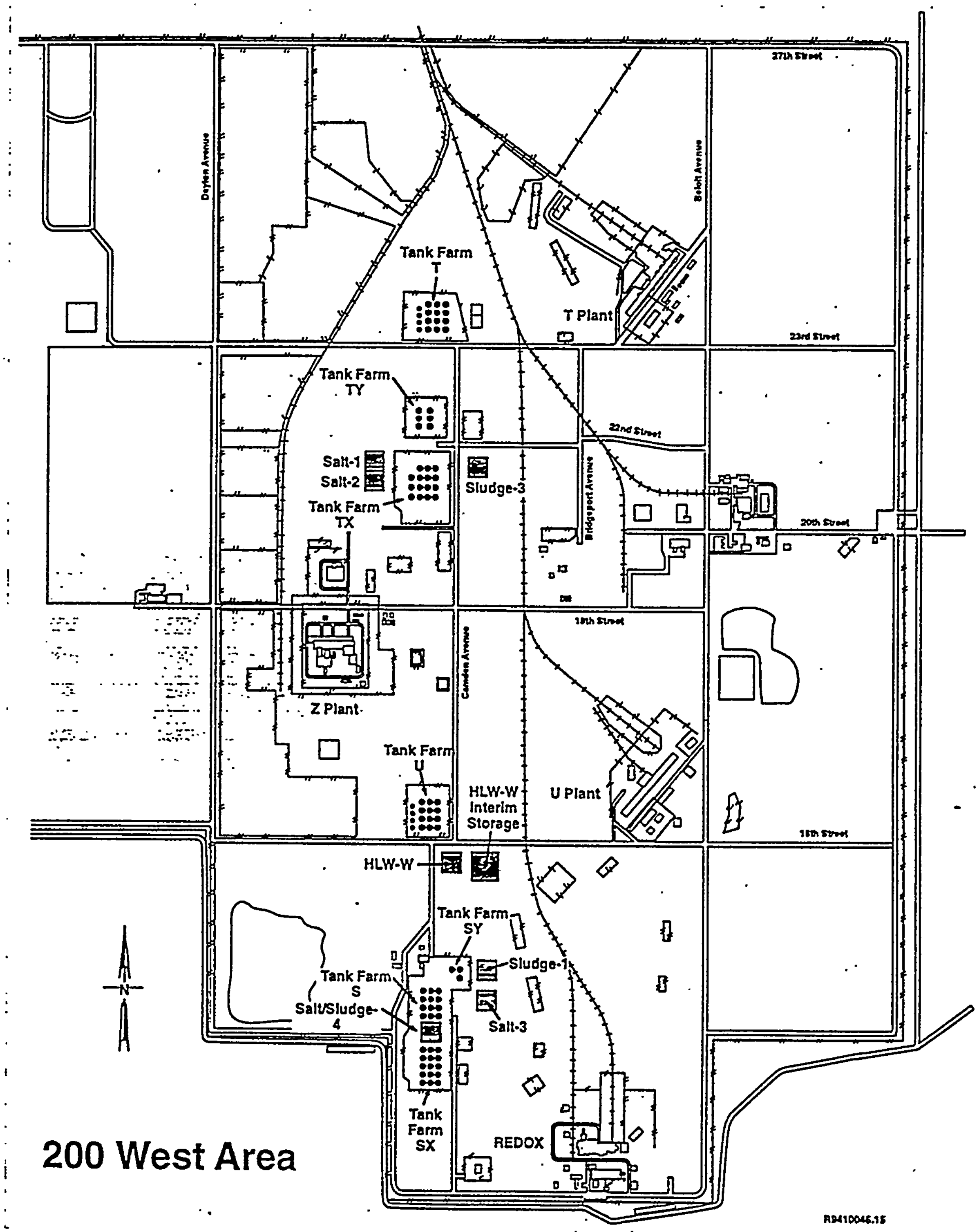

Figure A.3. Map (Scale: 1"=1440') of Area 200W Showing the Locations of the Tank Farms (Tanks Shown as Solid Black Circles) and the Suggested Sites for the Proposed Remediation Facilities (Shaded Squares)

ILHW canisters, will fit comfortably into a square, 200 ft on a side. Based on storage of 2-ft-diameter, 10-ft-tall HLW canisters one deep in a hexagonal-closest-packing array with a 1-ft clearance between canisters, all of the estimated ≅ 25,000 canisters produced during all three phases of the TWRS remediation of the Hanford USTs and the Cs capsules can be stored in a square area 441 ft on a side. We have assumed two such areas, one located in Area 200 E and the other in Area 200 W, each 400 ft square.

The issue of the lengths of transfer-line systems, with all pipe segments assumed to be double-walled for safety, was mentioned above. Preliminary estimates of the total lengths of the transfer piping associated with each of the proposed facilities are presented in Table A.2. The requirements for transfer piping for a single central facility would be much greater than the sum for the set of facilities for the phased approach described in this report.

3.4 Role of Integrating Contractor in Cases 10 and 11

The integration of the contractors conducting the treatment in the nine pretreatment campaigns and the three high-level waste vitrification campaigns will be the responsibility of a single Integrating Contractor. This contractor will be responsible for providing common services to the treatment contractors and assisting in the smooth operation of the TWRS. The principal services provided by this Integrating Contractor will be the operation of the tanks when they are not under the control of the treatment contractors, operation of a transfer system for washed sludge solids and cesium eluent, providing a transfer system for the cesium/strontium capsules, storage and blending of washed sludge solids and cesium eluent, receipt of products (vitrified LLW and HLW), and providing utilities and common services to the treatment contractors. These responsibilities are discussed below.

The Integrating Contractor will initially have responsibility for the safe operation of all of the tanks in the TWRS system. The operation of the tanks prior to transfer to the contractors will include providing analysis to support the preparation of bid specifications, concentration and transfer of the tank waste using existing facilities as required for implementation and, operation of tank farm support facilities to accept newly generated waste. When a treatment contract is awarded, the responsibility for the safe operation of these tanks will be transferred to the treatment contractors. The Integrating Contractor will be responsible for providing appropriate documentation and training to support the transfer of operational control of the tanks to the treatment system vendors, and developing the procedures for reassuming operational control of the tanks upon completion of the treatment of the tank contents or in the event of a default by the treatment contractor.

The Integrating Contractor is responsible for the operation of a waste transport system for the treated waste products (washed sludge, recovered cesium, vitrified low-level glass, vitrified high-level glass), for the transport of the cesium/strontium capsules to the cesium/strontium capsule vitrification vendor, and for transport of the cesium and washed solids to the high-level waste vitrification contractors.

The Integrating Contractor will operate a waste transfer system for the transfer of washed sludge solids and cesium removed from the waste from the point of treatment to an existing DST for storage prior to HLW vitrification. The Case 10 and 11 scenarios assume that this transfer system will be based on the use of a transport truck (e.g., LR-56) and the existing truck unloading facility (204-AR). This truck is now being purchased by the current Hanford M&O (Westinghouse Hanford Company) as part of meeting TPA milestone M-41-03A, "Issue request for proposal for a mobile high-level liquid waste transport cask. This cask must already be designed to meet applicable DOT and NRC licensing requirements."

In addressing this milestone the current M&O has determined that, at the present time, no domestic DOE or NRC Type B packages with the appropriate level of shielding are available for transport of radioactive liquids in bulk volumes (i.e., hundreds to thousands of gallons). Because of the expense and time involved in designing, fabricating, and approving a new Type B package, it was decided that the best way to meet the intent of this milestone was to select an existing Type B packaging, the LR-56 Cask System, used by the French as a part of their reprocessing program. The LR-56 is licensed for Type B liquids by a French Certificate of Compliance (COC) F/309/B(U)F. The LR-56 is presently designed and certified to carry 4000 L (1060 gal) volumes of liquid effluents between French reprocessing plants.

The use of this truck is dependent on the continuation of current DOE policies regarding transport of materials within the site that require an equivalent level of safety to DOT regulations but not full compliance with the regulations. The documentation of meeting this requirement is an approved on-site safety analysis report for packaging (SARP). Should this policy change to require full compliance with DOT regulations NRC licensure of the truck would be required. As previously stated the LR-56 truck is licensed for the proposed use under IAEA rules. Licensure for use in the US would, however, require NRC action. Although the IAEA licensure requirements are equivalent to the standards for licensure for this use in the US, prior to issuance of a license for use in the US the NRC may require that testing be repeated, additional testing performed, repetition of supporting calculations with NRC models/codes, or any other action the commission feels is necessary to convince the commission that the cask is suitable to be licensed for the proposed use in the US. Should NRC licensure of this cask be necessary it could be a lengthy process.

The minimization of the amount of high-level waste glass generated by the TWRS system requires that the solids generated from the pretreatment of the tank waste be blended. The Integrating Contractor will receive the washed solids form the pretreatment vendors, and store and blend these solids in order to minimize HLW glass volume.

The Integrating Contractor will transport the cesium and washed solids to the HLW vitrification contractors through a pipeline constructed by that contractor on an as requested basis, or by transferring control of the tank containing the solids to the HLW vitrification contractor.

The Integrating Contractor will arrange for transport of the cesium/strontium capsules to the vitrification facility for these capsules. This transport will be conducted using the existing transport cask and commercial transport contractors. This system is fully compliant with DOT regulations and licensed by the NRC.

The Integrating Contractor will receive and store the vitrified LLW and HLW from the vendors. This receipt will include verification that the product meets the applicable specifications prior to accepting the material for storage.

The Integrating Contractor will also provide common services to each of the vendors providing treatment services for the TWRS. These services will include provision of utilities (water, steam and electricity), maintaining common site facilities (existing roads, fences, etc.), providing emergency response services (fire, ambulance, security), storage and disposal of low-level and mixed wastes. The Integrating Contractor will provide these services on a cost recovery basis and any vendor, upon proving to the satisfaction of DOE, will have the option of seeking alternate provision of these services where appropriate.

4.0 Program Phases and Operations

The sequence of operations for the implementation of Cases 10 and 11 was illustrated in Figures A.1 and A.2. The details for the operations associated with each phase are discussed below.

4.1 Phase I — The Learning Phase

Phase I of Cases 10 and 11 is designed to demonstrate all of the basic technologies required for the complete implementation of the TWRS treatment mission with the exception of HLW vitrification. The major technologies required for Phase I are: retrieval of sludges and salt cakes in sound tanks, salt dissolution, washing of solids, ion-exchange treatment for cesium removal and, vitrification of LLW. The technologies for the retrieval of salt cakes and sludges have not been demonstrated, the technology and process for sludge washing and salt dissolution are known and have been demonstrated on a laboratory scale with actual tank waste samples. The technology for cesium ion-exchange is known and has been demonstrated on a laboratory scale with actual samples of Hanford DST waste and on a production scale with radioactive waste at Hanford and other DOE sites. The technology for the vitrification of LLW has been demonstrated on the pilot scale using simulated radioactive waste solutions.

The infrastructure for the implementation of Phase I is either in place, in the current TWRS planning basis, or will be provided by the waste treatment vendors. The primary infrastructure requirements for Phase I are: a tank waste transfer truck and associated unloading station, the ability to transfer waste within the existing DST transfer system in the 200 East area. Phase I does not require the use of the cross-site transfer line or any transfer lines associated with SSTs. The vendors will be required to provide as part of their Phase I scope, a truck loading station compatible with the transfer truck, any interconnecting piping between the tanks containing the waste and their treatment system, and a loading station for the vitrified LLW.

In this phase, cost reimbursement type contracts will be established with 1 - 3 firms with the scope of these contracts to design, build, permit, and operate 2.5 GPM process facilities for the retrieval and treatment of one of three waste types: DST Supernate, salt cake, and DST Sludge. The scope of these contracts is described above. The tanks currently containing the waste to be treated in this phase and the required treatments are summarized in Table A.3.

These contracts will be implemented as follows:

4.1.1 Double Shell Tank 1

The waste for the DST 1 contract will be concentrated, using the existing 242-A evaporator, by the Integrating Contractor and transferred into the AP tank farm. The solids currently present in these tanks will be left in their current location (AW, AN tanks) and will be consolidated and treated in a subsequent campaign (Sludge 2). Some of the current wastes in AP farm will have to be moved from this farm to accommodate this transfer. The waste will require 6 tanks for storage following transfer to the AP farm. These six tanks will be administratively segregated from the remainder of the DST system for the duration of this contract. The ion-exchange eluent from this process will be transferred for storage to a DST in the AY or AZ farm for subsequent HLW vitrification. The required tank space in the AY or AZ farm will be made available by the sludge washing demonstration currently being conducted by the existing M&O. The treated waste solutions from this process will be vitrified and the resulting vitrified LLW product containerized for transfer to the Integrating Contractor. At the completion of the contract the contractor will be required to return the tanks to the Integrating Contractor in a prescribed condition (clean, safe, compliant, and operable). The process equipment used for DST 1 is assumed to be decontaminated and disposed. It may, however, be desirable to consider the transfer of some or all of this equipment for reuse by the contractor for DST 2.

Table A.3. Phase I Scope and Treatment Summary

PHASE I	DST 1	Salt 1	Sludge 1
Waste Type	DST Supernate	Salt Cake in Sound SSTs	Sludge in DSTs
Tanks Currently Containing Waste	AN-102, 105 AP-101-108 AW-101, 103, 105, 106	TX-109, 111, 112	SY-101, 102, 103
Number of Tanks	14	3	3
Characterization Status	Sample Results Available for all tanks except AP-101,107,108 (dilute wastes characterized based on waste type)	Characterized based on comparison with similar waste types for which data was available	Sample Results Available
Stored Volume (Kgal)	10,438	1,403	2,567
Treatment Volume (Kgal)	5,890	6,314	7,437
LLW Glass Produced (MT)	16,000	17,000	8,000
HLW Oxides Processed (MT)	0	25	275
Treatment Required	Supernate Retrieval, IX, LLW Vit	Salt Retrieval, Salt Dissolution, IX, LLW Vit	DST Sludge Retrieval, Sludge Wash, Organic Destruction (?), IX, LLW Vit
Pretreatment Capacity (GPM)	4	4	4
LLW Vitrification Capacity (MT/day)	13	13	6

The operation of DST 1 will process approximately 6 million gallons of waste, produce 16,000 MT of LLW glass, and 590,000 gallons of cesium rich eluent requiring storage. The cesium rich eluent will be transferred by waste transport truck. If transferred by waste transport truck 590 shipments over a five year period, or approximately one every third day, would be required. The number of shipments could be reduced if a conventional recycle system were included in the vendor's system.

4.1.2 Salt 1

The waste for the Salt 1 contract is contained in three sound SSTs in the TX farm. These SSTs will be administratively isolated from the remainder of the tank farms for the duration of this contract. This contract will retrieve, dissolve and perform cesium ion-exchange on the salt cake. Insoluble solids will be stored and shipped by transport truck (e.g., the French Truck) to a DST for storage and treatment in future sludge campaigns (Sludge 2). The solids will be added to the tank where the solids remaining from the relocation of the DST waste in the AN and AW farm have been consolidated. The treated LLW generated from the treatment of the dissolved salts will be vitrified and the resulting vitrified LLW will be containerized for transfer to the Integrating Contractor. At the completion of the contract the contractor will be required to return the cleaned tanks to the Integrating Contractor for closure.

The operation of Salt 1 will process approximately 1.5 million gallons of salt cake, emptying 3 SST tanks; produce 17,000 MT of LLW glass; 630,000 gallons of cesium rich eluent requiring storage; and an estimated 70,000 gallons of insoluble washed solids. The cesium rich eluent and washed solids will be transported by waste transport truck. This transfer will require 70 shipments for the sludge and 630 shipments for the cesium rich eluent. This corresponds to 700 transfers over a 5 year period, or about 1 shipment every third day.

4.1.3 Sludge 1

The waste for Sludge 1 is contained in the SY tank farm. This tank farm will be administratively isolated from the remainder of the tank farms for the duration of this contract. The sludge in these tanks will be retrieved, washed, organic destroyed (if required) and returned to the SY tank farm for storage for future vitrification. The LLW generated from treatment of the supernate and sludge washing solutions will be vitrified and the resulting vitrified LLW will be containerized for transfer to the Integrating Contractor. At the completion of the contract the contractor will be required to return the tanks to the Integrating Contractor in a prescribed condition (safe, compliant, operable). The composition and characterization of the sludge remaining in the tanks will also be supplied to the Integrating Contractor at closure.

The operation of Sludge 1 will process approximately 2.6 million gallons of waste, produce 8,000 MT of LLW glass, and 743,700 gallons of cesium rich eluent requiring storage. The cesium rich eluent will be transferred by waste transport truck. This will require 750 shipments over a five year period, corresponding to one shipment every third day. The sludge generated by this campaign does not require transfer at this time and will remain in the SY tank farm until the separately competed HLW vitrification facility become operational.

4.2 Phase I Summary

Phase I will treat the waste contained in 20 tanks, generating a total of 41,000 MT of LLW glass, 300 equivalent metric tons of HLW oxides, and require 2040 truck shipments from the treatment vendors to the existing DST tanks. This will require approximately 1 shipment every third day from each vendor site and an average shipment rate of approximately 1 shipment per day. The details for the required shipments are shown in Table A.4. The completion of Phase I will represent completion of 9.5% of LLW treatment scope, 2.8% of the HLW pretreatment scope.

4.3 Phase II

Phase II of Cases 10 and 11 is designed to be a competitive implementation of the technologies demonstrated in Phase I. The same technologies used in Phase I are used in Phase II, the only new technology element introduced is the retrieval of salt cakes and sludges from leaking SSTs.

The infrastructure needs for the implementation of phase II are the same as those of Phase I except that the maximum number of truck shipments required per day increased from approximately 1 per day to approximately 3 per day. Phase II does not require the use of the cross-site transfer line or any transfer lines associated with SSTs. The vendors will be required to provide, as part of their Phase II scope, a truck loading station compatible with the transfer truck, any interconnecting piping between the tanks containing the waste and their treatment system and a loading station for the vitrified LLW.

Table A.4. Required Waste Truck Shipment — Phase I.

Phase I	Sludge	Cs Eluent	Total	Shipments/Day
DST 1	0	590	590	0.3
Salt 1	70	630	700	0.4
Sludge 1	0	750	750	0.4
Total	70	1970	2040	1.12

In this phase, incentivized fee-for-service-type contracts will be established with 3 or more firms with the scope of these contracts to design, build, permit, and operate process facilities for the retrieval and treatment of one of three waste types: DST supernate, salt cake, and DST sludge. The scope of the contracts will be the same as the scope of the corresponding contracts in Phase I. Table A.5 reflects those tanks currently containing the waste to be processed by each of these contracts, treatment required and corresponding estimated facility sizes.

The contracts for treatment of this waste will be implemented as follows:

Table A.5. Phase II Scope and Treatment Summary

PHASE II	DST 2	Salt 2	Sludge 2
Waste Type	DST Supernate	Salt Cake in SSTs	Sludge in DSTs & SSTs
Tanks Currently Containing Waste	AY-101-102, AN-102, 103, 104, 106, 107*	TX-102, 104, 105, 106, 107, 108, 110, 113, 118	AW-103, 105, 106, AN-102, 104, 106, 107, AW-101, 103,104, 105, 106, AY-101, 102, AZ-101, 102, A-103, 104, 105, 106, C-106**
Number of Tanks	7	9	22
Characterization Status	Sample Results Available	Characterization based on similar waste types no analytical data available	Analytical results available for A-106, A-103, AZ-101, 102, C-106, AN-102, 104, AW-101,103,104,105, AY-102. Balance Characterized based on similar waste types no analytical data available. Limited anion analysis for SSTs.

* Additional DST waste generated during the operation of Phase I may also be included in this campaign if available/desired.

** Sludge from these tanks will be consolidated and transferred to 3 - 4 double shell tanks prior to this contract being issued

Table A.5. (contd)

PHASE II	DST 2	Salt 2	Sludge 2
Waste Type	DST Supernate	Salt Cake in SSTs	Sludge in DSTs & SSTs
Stored Volume (Kgal)	8,736	2,930	2,655
Treatment Volume (Kgal)	25,709	13,185	11,392
LLW Glass Produced (MT)	63,000	50,000	6,000
HLW Oxides Processed (MT)	0	100	2,100
Treatment Required	Supernate Retrieval, IX, LLW Vit	Salt Retrieval, Salt Dissolution, IX, LLW Vit	DST & SST Sludge Retrieval, Sludge Wash, IX, LLW Vit
Pretreatment Capacity (GPM)	8	8	8
LLW Vitrification Capacity (MT/day)	29	45	6

4.3.1 Double Shell Tank 2

The waste for the DST 2 contract will be concentrated using the existing 242-A evaporator as necessary and transferred into the AP tank farm. This waste will be transferred into the tanks that have been emptied by the DST 1 contract. Initially all of the waste to be treated by this contract will not be present in the AP farm. The waste that is not present in the AP farm at the time the contract is let will be transferred into the AP farm as requested by the DST 2 contractor. The solids currently present in these tanks will be left in their current location (AN, AY tanks) and will be consolidated and treated in Sludge 2. The waste will be stored in 6 tanks in the AP farm. These six tanks will be administratively segregated from the remainder of the double shell tank system for the duration of this contract. This segregation will include provisions for accepting transfer of the waste included in this contract but not initially present in the tank farm. The ion-exchange eluent from this process will be transferred to a double shell tank in the AY or AZ farm for storage for subsequent HLW vitrification. The required tank space in the AY or AZ farm will be made available by the sludge washing demonstration currently being conducted by the M&O in these tanks. The treated waste solutions from this process will be vitrified and the resulting vitrified LLW product containerized for transfer to the Integrating Contractor. Upon completion of the contract the contractor will be required to return the tanks to the Integrating Contractor in a prescribed condition (clean, safe, compliant, and operable). The process equipment used for DST 2 is assumed to be decontaminated and disposed at the completion of the mission. It may, however, be desirable to consider the transfer of some or all of this equipment to a future contractor to provide a capability for continued treatment of system generated waste.

The operation of DST 2 will process approximately 9 million gallons of waste, produce 63,000 MT of LLW glass, and 2.6 million gallons of cesium rich eluent requiring storage. The cesium rich eluent will be transferred by waste transport truck. The transfer of this eluent will require 2,570 shipments over a ten year period, or approximately 1 shipment per day. The number of shipments per day could be reduced if the vendors system included a concentration/recycle system for the ion-exchange eluent.

4.3.2 Salt 2

The waste for the Salt 2 contract is contained in nine SSTs in TX farm. These SSTs will be administratively isolated from the remainder of the tank farms for the duration of this contract. This contract will retrieve, dissolve and perform cesium ion-exchange on the salt cake. Insoluble solids will be stored and shipped by transport truck (e.g., the French Truck) to a DST for storage and future vitrification. The treated LLW generated from the treatment of the dissolved salts will be vitrified and the resulting vitrified LLW will be containerized for transfer to the Integrating Contractor. At the completion of the contract the contractor will be required to return the cleaned tanks to the Integrating Contractor for closure.

The operation of Salt 2 will process approximately 2.9 million gallons of salt cake, emptying 9 SST tanks, produce 50,000 MT of LLW glass, 1.4 million gallons of cesium rich eluent requiring storage, and an estimated 147,000 gallons of insoluble washed solids. The cesium rich eluent and washed solids will be transported by waste transport truck. This transfer will require 147 shipments for the sludge and 1400 shipments for the cesium rich eluent over a 5 year period, or approximately 1 shipment per day. The number of shipments per day could be reduced if the vendors system included a concentration / recycle system for the ion-exchange eluent. The system and equipment used for Salt 2 is assumed to be decontaminated and disposed at the completion of the Salt 2 contract. It may be desirable, however, to transfer or reuse the equipment for treatment of other salt cakes located in the TX farm or relocate the equipment for the treatment of other salt cakes.

4.3.3 Sludge 2

The waste for Sludge 2 is currently contained in several DSTs and in five SSTs. The sludge in the DSTs will be consolidated and transferred to three tanks in the AW farm. The sludge contained in the SST (C-106) will have been retrieved into a DST and will be transferred into the tanks in the AW farm as required by the Sludge 2 contractor. The three AW farm tanks containing the sludge and one additional AW tank for containing the washed sludge will be administratively segregated from the remainder of the DST system for the duration of this contract. This segregation will include provisions for accepting transfer of the waste included in this contract but not initially present in the tank farm. The sludge in these tanks will be retrieved, washed, and returned to one of thanks in the AW tank farm for storage and for future vitrification. The LLW generated from treatment of the supernate and sludge washing solutions will be vitrified and the resulting vitrified LLW will be containerized for transfer to the Integrating Contractor. At the completion of the contract the contractor will required to return the tanks to the Integrating Contractor in a prescribed condition (safe, compliant, operable). The composition and characterization of the sludge remaining in the tanks will also be supplied to the Integrating Contractor at closure. The process equipment for Sludge 2 is assumed to be decontaminated and disposed at the completion of the Sludge 2 campaign. It may be desirable, however, to retain the Sludge 2 contractor or transfer the equipment from Sludge 2 to another contractor to retain a capability for the washing of sludges generated by future operations (e.g., D&D).

The operation of Sludge 2 will process approximately 2.6 million gallons of waste, produce 6,000 MT of LLW glass, 1.1 million gallons of cesium rich eluent requiring storage, and approximately 1 million gallons of washed solids. The cesium rich eluent will be transferred by waste transport truck. This will require 1,000 shipments for sludge and 1,100 for the cesium rich eluent over a five year period (approximately 1 shipment per day). The number of shipments per day could be reduced if the vendors system included a concentration/recycle system for the ion-exchange eluent. The washed sludge generated by this campaign does not require transfer and will remain in the AW tank farm.

4.4 Phase II Summary

Phase II will treat the waste contained in 38 tanks generating a total of 119,000 MT of low-level waste glass and 2200 equivalent metric tons of HLW oxides and require making 6247 truck shipments from the treatment vendors to the existing DST tanks. This will require making approximately 1 shipment from each vendor site per day and a maximum of 3 shipments per day total. The details for the required shipments are shown in Table A.6. Phase II includes 28% of LLW waste treatment scope, 21% of the high-level waste pretreatment scope. At the completion of Phase II the TWRS LLW pretreatment job will be 37% complete and the High-level waste pretreatment job will be 24% complete and 29 of the SSTs will have been emptied for closure.

4.5 Phase III

Phase III of Cases 10 and 11 is designed to complete the TWRS pretreatment and LLW vitrification mission. The same technologies will be used as were used in Phase II, only on a somewhat large scale. Two new technical problems are introduced in this phase. The technology for the treatment of mixed salt sludge waste and the technology for the retrieval and treatment of wastes that have been cemented or solidified in the tanks.

The infrastructure for the implementation of Phase III is the same as the infrastructure needs for Phase II except that the maximum number of truck shipments required per day increases from approximately 3 to approximately 6 per day. Phase II does not require the use of the cross-site transfer line or any transfer lines associated with SSTs. As part of their Phase II scope, vendors will be required to provide a truck loading station compatible with the transfer truck, interconnecting piping between the tanks containing the waste and their treatment system, and a loading station for the vitrified LLW.

In this phase, incentivized fee-for-service-type contracts will be established with four or more firms. The scope of these contracts will be to design, build, permit, and operate process facilities for the retrieval and treatment of one of three waste types: salt cake, SST sludge and mixed sludge/salt cake. The scope of the contracts will be the same as the scope of the

Table A.6. Required Waste Truck Shipment — Phase II.

Phase II	Sludge	Cs Eluent	Total	Shipments/Day
DST 2	0	2600	2600	0.7
Salt 2	147	1400	1547	0.8
Sludge 2	1000	1100	2100	1.15
TOTAL	1147	5100	6247	2.70

(a) First number for years 1-5; second number for years 5-10.

corresponding contracts in Phase I. Table A.7 reflects the identification of the tanks containing the waste to be processed by each of these contracts, treatment required, and corresponding estimated facility sizes.

The contracts for treatment of this waste will be implemented as follows:

4.5.1 Salt 3

The waste for the Salt 3 phase is contained in 30 SSTs located in the 200 East (16) and 200 West areas (14). The treatment of this waste will be let in a minimum of two contracts with one contractor being responsible for the treatment of the tanks in the east area tanks and one for the west area tanks. The contractor will be responsible for providing the facilities and equipment to retrieve and transport the waste to the point of treatment. These facilities may include shielded pipelines for the transport of slurries from sluicing, pneumatic conveying system for the transport of solids from mining operations, or transport trucks for solids or slurries. The SSTs covered by this contract will be administratively isolated from the remainder of the tank farms for the duration of this contract. This contract will retrieve, dissolve and perform cesium ion-exchange on the salt cake. Insoluble solids will be stored and shipped by transport truck (i.e., the French Truck) to a DST for storage and future vitrification. The treated LLW generated from the treatment of the dissolved salts will be vitrified and the resulting vitrified LLW will be containerized for transfer to the Integrating Contractor. Upon completion of the contract the contractor will be required to return the cleaned tanks to the Integrating Contractor for closure.

The operation of Salt 3 will process approximately 13.2 million gallons of salt cake emptying 30 SST tanks, produce 139,000 MT of LLW glass, 6 million gallons of cesium rich eluent requiring storage, and an estimated 400,000 gallons of insoluble washed solids. The cesium rich eluent and washed solids will be transported by waste transport truck. This transfer will require 400 shipments for the sludge and 6000 shipments for the cesium rich eluent over a 10 year period (approximately 2 shipments per day). The number of shipments per day could be reduced if the vendors system included a concentration / recycle system for the ion-exchange eluent. The systems and equipment used for Salt 3 are assumed to be decontaminated and disposed at the completion of the Salt 3 contract. It may, however, be desirable to transfer or reuse the equipment for treatment of other SSTs should the performance of the other contractors in Phase III prove unacceptable.

4.5.2 Sludge 3

The Waste for Sludge 3 is currently contained in 82 SSTs located in the 200 East (43) and 200 West areas (39). The treatment of this waste may be let to a single contractor responsible for the treatment of the tanks in both east and west areas or as 2 or more contracts dividing the waste by location (e.g., one for the east area tanks and one for the

Table A.7. Phase III Scope and Treatment Summary

PHASE III	SALT 3	SLUDGE 3	SALT/SLUDGE 4
Waste Type	Salt Cake	SST Sludge	Mixed Salt Cake & Sludge
Tanks Currently Containing Waste	A-101, AX-101, AX-102, AX-103, BY-101, BY-102, BY-103, BY-104, BY-105, BY-106, BY-107, BY-108, BY-109, BY-110, BY-111, BY-112, S-102, S-103, S-105, S-106, 1-108, S-109, S-112, SX-106, SX-109, TX-114, TX-115, TX-116, TX-117, TY-102	A-102, AX-104, B-101, B-102, B-103, B-104, B-106, B-107, B-108, B-109, B-110, B-111, B-112, B-201, B-202, B-203, B-204, BX-101, BX-102, BX-103, BX-104, BX-105, BX-106, BX-107, BX-108, BX-109, BX-110, BX-112, C-101, C-102, C-103, C-104, C-105, C-107, C-108, C-109, C-110, C-111, C-112, C-201, C-202, C-203, C-204, SX-107, SX-108, SX-110, SX-111, SX-112, SX-113, SX-114, SX-115, T-101, T-102, T-103, T-104, T-105, T-106, T-107, T-108, T-109, T-110, T-111, T-112, T-201, T-202, T-203, T-204, TX-101, TX-103, TY-101, TY-103, TY-104, TY-105, TY-106, U-101, U-104, U-110, U-112, U-201, U-202, U-203, U-204	B-105, BX-111, S-101, S-104, S-107, S-110, S-111, SX-101, SX-102, SX-103, SX-104, SX-105, U-102, U-103, U-105, U-106, U-107, U-108, U-109, U-111
Number of Tanks	30	81	20
Characterization Status	Characterization data available for S-105,109; TX-116, TY-102. All other tanks characterized based on similar waste types.	Characterization data available for B-110,111,201; BX-104,105,107; C-103,104,105,109,110,112; T-102,104,107,111;TY-101,103,104,105,106;U-110. All other tanks characterized based on similar waste types.	Characterization data available for B-105,S-104, S-110,SX-102,103. All other tanks characterized based on similar waste types.
Stored Volume (Kgal)	13,222	8,983	8,700

Table A.7. (contd)

PHASE III	SALT 3	SLUDGE 3	SALT/SLUDGE 4
Treatment Volume (Kgal)	60,075	44,915	3,966
LLW Glass Produced (MT)	134,000	109,000	27,000
HLW Oxides Processed (MT)	400	6,800	800
Treatment Required	Salt Retrieval, Salt Dissolution, IX, LLW Vit	SST Sludge Retrieval, Sludge Wash, IX, LLW Vit	Salt Retrieval,SST Sludge Retrieval, Sludge Wash, Salt Dissolution, IX, LLW Vit
Pretreatment Capacity (GPM)	17 (2)	17	17
LLW Vitrification Capacity (MT/d)	32 (2)	50	12

west area tanks, or by tank farm group). If this phase is let as one contract the contractor may choose to build one facility in the east and one facility in the west area, one facility that is relocatable between the east and west area or, one centralized facility with provisions to transport the wastes to that facility. In all cases it is the responsibility of the contractor to provide the facilities and equipment to retrieve and transport the waste to the point of treatment. These facilities may included shielded pipelines for the transport of slurries from sluicing, pneumatic conveying system for the transport of solids from mining operations, or transport trucks for solids or slurries. The SSTs covered by this contract will be administratively isolated from the remainder of the tank farms for the duration of this contract. This contract will retrieve, dissolve/wash and perform cesium ion-exchange on the sludges.

Insoluble solids will be stored and shipped by transport truck to a DST for storage and future vitrification. The treated LLW generated from the treatment of the dissolved salts and wash solutions will be vitrified and the resulting vitrified LLW will be containerized for transfer to the Integrating Contractor. Upon completion of the contract, the contractor will be required to return the cleaned tanks to the Integrating Contractor for closure.

The operation of Sludge 3 will process approximately 9 million gallons of sludge emptying 82 SST tanks, produce 109,000 MT of LLW glass, 4.5 million gallons of cesium rich eluent requiring storage, and an estimated 5.4 million gallons of insoluble washed solids. The cesium rich eluent and washed solids will be transported by waste transport truck. This transfer will require 5400 shipments for the sludge and 4500 shipments for the cesium rich eluent over a 10 year period (approximately 3 shipments per day). The number of shipments per day could be reduced if the vendors system included a concentration / recycle system for the ion-exchange eluent. The system and equipment used for Sludge 3 is assumed to be decontaminated and disposed at the completion of the Sludge 3 contract. It may, however, be desirable to transfer or reuse the equipment for the treatment of other SST wastes in the event that performance by the other contractors in Phase III is unacceptable.

4.5.3 Salt/Sludge 4

The waste for Salt/Sludge 4 is currently contained in 20 SSTs located in both the 200 East (2) and 200 West areas (18). The treatment of this waste may be let to a single contractor responsible for the treatment of the tanks in both areas or as 2 contracts, dividing the waste by location (e.g., one for the east and one for the west area tanks, or by tank farm group). If this phase is let as one contract the contractor may choose to build one facility in the east and one facility in the west area; one facility that is relocatable between the east and west area or; one centralized facility with provisions to transport the wastes to that facility. In all cases it is the responsibility of the contractor to provide the facilities and equipment to retrieve and transport the waste to the point of treatment. These facilities may included shielded pipelines for the transport of slurries from sluicing, pneumatic conveying system for the transport of solids from mining operations, or transport trucks for solids or slurries. The SSTs covered by this contract will be administratively isolated from the remainder of the tank farms for the duration of this contract. This contract will retrieve, dissolve/wash and perform cesium ion-exchange on the sludges. Insoluble solids will be stored and shipped by transport truck to a double shell tank for storage and future vitrification. The treated LLW generated from the treatment of the dissolved salts and wash solutions will be vitrified and the resulting vitrified LLW will be containerized for transfer to the Integrating Contractor. Upon completion of the contract the contractor will be required to return the cleaned tanks to the Integrating Contractor for closure.

The operation of Salt/Sludge 4 will process approximately 9 million gallons of mixed salt-sludges emptying 20 SST tanks, producing 27,000 MT of LLW glass, 400,000 gallons of cesium rich eluent requiring storage, and an estimated 1.2 million gallons of insoluble washed solids. The cesium rich eluent and washed solids will be transported by waste transport truck. This transfer will require 1200 shipments for the sludge and 400 shipments for the cesium rich eluent over a 10 year period (approximately 1 shipment every other day). The number of shipments would not be significantly reduced if the vendors system included a concentration / recycle system for the ion-exchange eluent. The system and equipment used for Salt/Sludge 4 is assumed to be decontaminated and disposed at the completion of the contract. It may, however, be desirable to transfer or reuse the equipment for the treatment of other SST wastes in the event that performance of the other contractors in phase 3 is unacceptable.

4.6 Phase III Summary

Phase III will treat the waste contained in 131 tanks, generate a total of 275,000 MT of LLW glass and 8000 equivalent metric tons of HLW oxides and will require 17,900 truck shipments from the treatment vendors to the existing DST tanks. This will require approximately 2 -3 shipments from each vendor site per day for a maximum of 6 shipments per day total. The details for the required shipments are shown in Table A.8. Phase III includes 64% of LLW waste treatment scope and 77% of the HLW pretreatment scope. At the completion of Phase III, the TWRS LLW pretreatment and HLW pretreatment will be completed and all of the SSTs will have been emptied for closure.

5.0 High-Level Waste Vitrification

The concept of operations of the HLW contractor(s) is shown in Figure A.4. The HLW vitrification phase of this case will convert the sludge solids into a vitrified HLW product and package and ship the product to the Integrating Contractor for storage and ultimate repository disposal. The treatment of the tank wastes will result in the generation of 10,500 MT of waste oxides and, upon conversion into glass, assuming a 25% waste oxide loading, 42,000 MT of HLW glass. This phase will be implemented by first segregating washed sludges that have been produced by the other phases in the DST system. It should be noted that the

Table A.8. Required Waste Truck Shipment — Phase III.

Phase III	Sludge	Cs Eluent	Total	Shipments/Day
Salt 3	400	6000	6400	1.75
Sludge 3	5400	4500	9900	2.7
Salt/Sludge 4	1200	400	1600	0.4
Total	7000	10900	17900	4.89

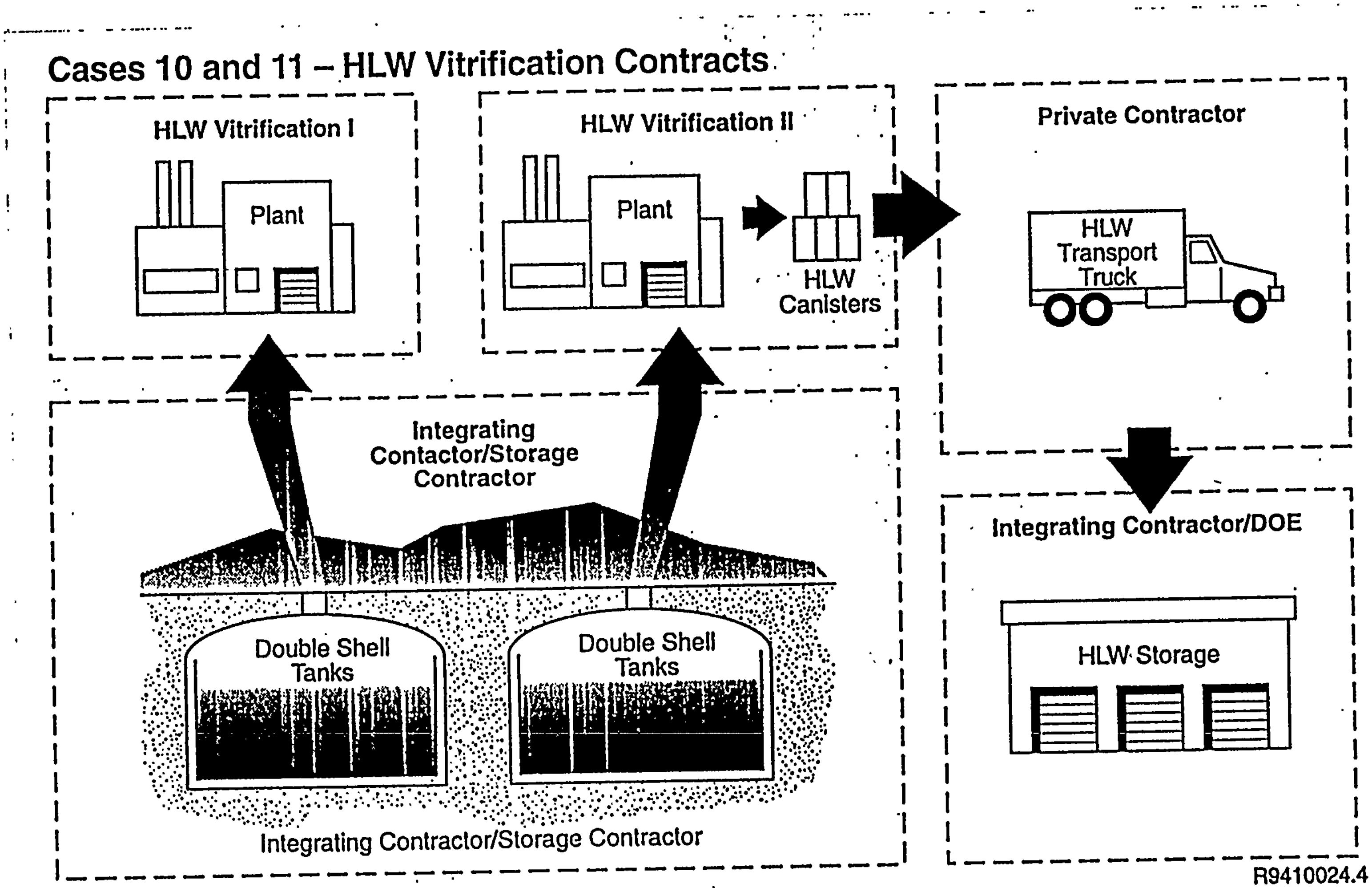

Figure A.4. Schematic of Operations for the HLW Contracts integrating or storage contractor is re[illegible]sible for blending the washed solids generated by the pretreatment contractors to mini[illegible] the glass volume by avoiding concentration spikes in the blended sludge. The Integrating [illegible]actor will transfer these sludges to the HLW vitrification contractor in one of two ways: [illegible] an as requested basis through a pipeline provided by the HLW treatment vendor, or by tr[illegible]rring control of the DST containing the sludges to the contractor for the duration of the [illegible]cessing of the material in that tank. The scope of the HLW vitrification contract will inclu[illegible] development and qualification of the waste glass formulation, construction of the vitri[illegible]tion facility, production of the vitrified HLW glass and delivery of the vitrified product with appropriate documentation to the Integrating Contractor for storage and ultimate shipment to the HLW repository. Three possible ways to implement the HLW vitrification process have been investigated:

- A phased capacity (1.8 MT/day - 7.6 MT/day) vitrification facility with a start up date of 2002 and an increase in plant capacity in 2010.
- A single large capacity (10 MT/day) vitrification plant starting in 2009.
- A pair of competing (6 MT/day) vitrification plants starting in 2009.

Each of these alternatives are discussed below.

5.1 Phased Capacity Plant

The phased capacity plant would start HLW vitrification in 2002 at a rate of 1.8 MT/day of glass at a 25% waste oxide loading and would increase production in 2010 to 7.6 MT/day of glass with a 35% waste oxide loading. These plants would have the capability of vitrifying 840 MT of HLW glass oxides in the 2002-2010 time frame and the capability of vitrifying 9,130 MT of waste oxides between 2[illegible] and 2028. The phasing scenario as described could treat sufficient HLW oxides to feed a [illegible]ant at this rate, however, the tanks selected for processing during this time period co[illegible] in high concentrations of glass limiting components (e.g., Cr). The tanks could be reorde[illegible] to better support an early start of the HLW vitrification process but in any case avoiding tanks with high concentrations of glass limiting components in the early years of treatment will be difficult as processing of some of the west area sludge tanks is required to allow for continued treatment of the SST waste in the west area. In addition early start of the HLW plant will probably generate greater volumes of HLW glass from the decreased opportunity to blend limiting components out of the washed sludges. If the HLW plant starts in 2002 under this scenario. only 8 tanks of waste will have been processed. Based on blending studies at PNL this will achieve on average only 70 % of the effect of a total blending and may only achieve 50% of the effect. Thus, early start of HLW vitrification will limit the benefits that can be achieved by blending and ultimately increase the volume of HLW generated, the exact impact on HLW glass volume from this limitation cannot be determined without further analysis. The estimated cost for vitrification, storage and disposal using a phased HLW vitrification plant is estimated to be $0.9 Billion for the first phase and $3.7 Billion for the second phase for a total of $4.6 Billion.

5.2 Single Large Capacity Plant

The single large capacity plant would begin operation in 2009 at a rate of 10MT/d of glass with a 25 wt% oxide loading. This plant would have the capability of vitrifying 10,500 MT of HLW oxides over its production life of 18 years. When the plant starts in 2009 approximately 39 tanks of waste will have been processed through the pretreatment process. This will allow essentially all of the effects of "infinite blending" to be realized even in the early years of vitrification operation. PNL blending studies have shown that if 20 tanks are blended together 77% - 95% of the effect of a total blend can be achieved and if 45 tanks are blended together 90 %- 99.7% of the effect of a total blend can be achieved. Thus delaying the start of high level vitrification will have the effect of reducing the ultimate volume of HLW glass that will require disposal by allowing for technology development and increased blending of the waste. The estimated cost for the vitrification, storage and disposal of the 10,500 MT of HLW oxides generated by this scenario using a single 10 MT/d plant is $5.3 Billion.

5.3 Two Competing Plants

The two competing plants would begin operation in the year 2009. Each plant would have a capacity of 6 MT/day. The two plants would compete on an annual basis for the right to provide vitrification services to DOE. Based on the relative costs of the two annual bids the waste available for vitrification would be allocated between the plants. The plant with the lower cost bid would be allocated a greater share of the waste (as much as 60%) and the plant with the high bid would be allocated less (as little as 40%) of the waste. This alternative has the same features of the single large plant alternative except that it provides the government with an excess of vitrification capacity which could allow an early completion of the HLW vitrification task and it reduces the risk to the government of a single failure eliminating all capability to vitrify waste for a protracted period of time. The estimated cost for the vitrification, storage and disposal of the 10,500 MT of HLW oxides generated by this scenario using two competing 6 MT/d plants is $3.6 Billion.

5.4 Cesium/Strontium Capsule Vitrification

The concept of operations for Cs/Sr capsule remediation is shown in Figure A.5. This phase of the TWRS mission consists of converting the cesium and strontium capsules (1,900 capsules; 170 MCi) currently in storage at B Plant/WESF into a form suitable for repository disposal. For the purposes of this analysis the capsules are assumed to be shipped from B Plant to a new dedicated plant (possibly a vitrification plant but it would depend on the

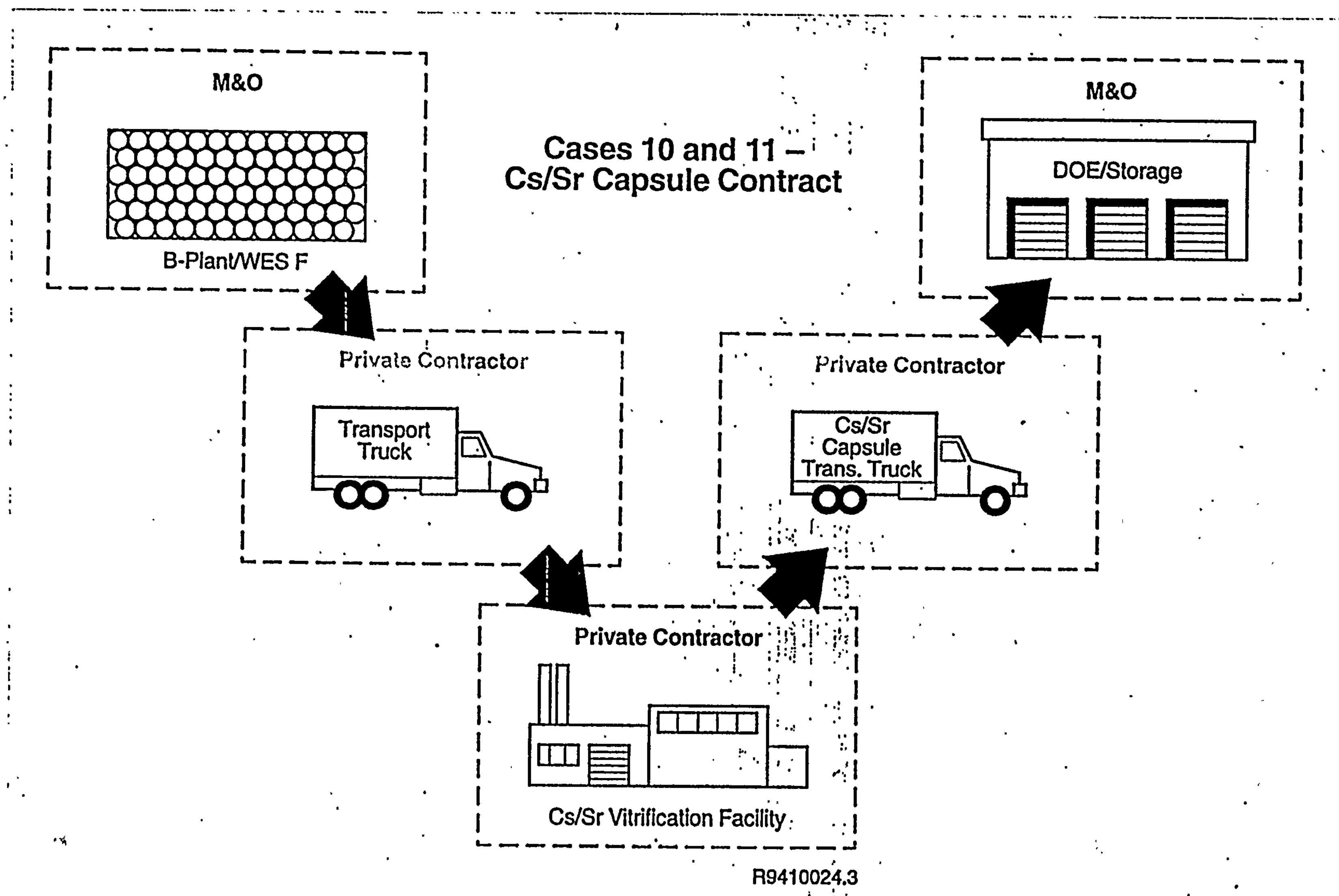

Figure A.5. Schematic,of Operations for the Cs/Cr Capsule Contract technical approach proposed by the contractors) constructed on-site using the existing capsule shipment system and the services of a private carrier. The capsules are received at the vitrification facility, opened and the cesium and strontium removed from the capsules. The Cesium and strontium are fed to a vitrification system that produces a vitrified glass product in canisters for repository disposal. The vitrified product is shipped to the Integrating Contractor for storage until repository disposal. The capsules will be decontaminated and if feasible released for reuse either as uncontaminated material or as lightly contaminated material for the fabrication of shielding blocks or radioactive waste shipping boxes by a commercial vendor (e.g., Scientific Ecology Group, Oak Ridge, TN.). The technology for completion of this job has been demonstrated and is available.

The operation of this facility will generate 495 MT of HLW glass requiring disposal at the HLW repository and has an estimated cost of $0.26 billion. Subsequent to the completion of this phase, this facility is decontaminated and decommissioned.

6.0 Transport / Infrastructure Issues

6.1 Infrastructure Requirements

The implementation of the TWRS treatment mission requires the following major infrastructure elements:

- infrastructure to transfer and evaporate waste within the existing tank farm system to optimize treatment processes and minimize waste storage requirements
- infrastructure to transfer the waste from the point of retrieval to the point of treatment
- infrastructure to receive, transfer, and store intermediate products from treatment to the location of the final treatment process (e.g., washed sludges, cesium eluent, Cs/Sr Capsules)
- infrastructure to receive and store final waste treatment products prior to ultimate disposal (e.g., vitrified LLW, vitrified HLW).

6.2 Status of Current Infrastructure

The current Hanford Site infrastructure that is available for use (meets current operating requirements and is permitted) consists of 28 DSTs, one operating evaporator (242-A), a rail car/tank truck unloading station (20[illegible] R) and a series of interconnecting piping. The interconnecting piping that is suitable for use connects all of the DSTs within either the 200 East or 200 West area but does not provide a connection between the 200 East and 200 West areas. The current TWRS baseline p[illegible] develops a cross-site transfer line which is scheduled to be available for use in 2/28/98. This line would be suitable for large volume transfers of waste from 200 East to 200 West area and vice versa. The current TWRS baseline plan also purchases a liquid high-level waste transfer cask. The ability of this infrastructure to meet the needs of a distributed phased deployment of the TWRS treatment system is discussed below.

1. Transfer and Manage Waste

This infrastructure will support the movement and management of waste to optimize treatment processes and minimize waste storage requirements as long as no transfers from 200 east to 200 west are required.

2. Transport Retrieved Waste

The current infrastructure will not support the retrieval of waste and transfer of retrieved waste to the point of treatment as essentially all of the SSTs are not connected to any usable transfer lines.

3. Receive, Transfer, and Store Intermediate Treatment Products

The treatment of the tank waste will generate two intermediate products requiring receipt, transfer and storage: washed sludges and cesium eluent. The current interconnecting piping infrastructure consists of 2" and 3" diameter lines and was designed to operate at flow rates of from 100 to 200 gallons per minute. The type of distributed treatment capacity envisioned for the implementation of Cases 10 or 11 cannot effectively utilize this system without the construction of large hold-up tanks for intermediate treatment products. In addition the use of the existing system requires that the line be flushed after each transfer. In many phases of Cases 10 or 11, the flush volume could be larger than the volume of material requiring transfer.

The existing infrastructure includes a truck unloading station located in the 200 East Area, however, the current infrastructure does not include a transfer truck suitable for the transfer of the intermediate treatment products.

The current M&O has the infrastructure in place to transport the cesium and strontium capsules from B-Plant WESF to any truck accessible location on or off-site using licensed casks and commercial vendors.

4. Receive and Store Final Treatment Products

No infrastructure is currently in place to receive and store final waste treatment products.

6.3 Selection of Methods to Provi̇ ̇ Required Infrastructure

The alternative methods considered and the recommended alternative for meeting each of the infrastructure requirements are discussed below.

1. Transfer and Manage Waste

The current infrastructure is sufficient to meet the need if the use of cross site (200E - 200W) transfers to manage the waste can be avoided. Cases 10 and 11 do not rely on cross site transfers of waste by pipeline.

2. Transport Retrieved Waste

The current infrastructure is insufficient to support the transport of the retrieved waste. Two options for transport of the retrieved waste were considered: construction of new pipelines and the use of transfer trucks. The use of transfer truck to transport the retrieved waste as even in the smallest capacity phase (Phase I) the receipt of 24 trucks per day (8 per facility) and in the large capacity phases receipt of 2 - 3 trucks per hour would be required. The number of simultaneous transfers and the required receipt rates were judged to be unmanageable and so the use of trucks to transfer the untreated waste was rejected. This left the alternative of constructing new transfer lines. The contractor for each phase has been assigned responsibility for the construction of the required transfer lines to support his operation.

3. Receive, Transfer, and Store Intermediate Treatment Products

The intermediate products generated from tank waste treatment will require storage awaiting further processing. The only locations currently suitable for storage of these wastes are the DSTs. The materials requiring storage, however, will be generated at locations that are not currently connected by pipeline with the DST system. Two alternatives for the transport of this material were considered: transfer lines or tank trucks. The use of transfer lines was rejected. Since most of the DSTs are located in the 200 East area, this option would require construction of a transfer line from 200 West area to 200 East area. The design of a transfer line to effectively transfer the small volumes of intermediate products from the 200 West area to the 200 East area is not feasible because of the distances involved. Therefore, this alternative was rejected. This left the alternative of truck transport of these materials. The number of truck transfers required to transfer all of the intermediate products from the point of generation to the intermediate storage point was evaluated. A maximum of six 1,000 gallon truck transfer per day was required. This was believed to be manageable using a fleet of 8 - 12 transfer trucks. A transfer truck suitable for this job has been developed by the French (LR-56 Transfer Truck). The existing tank car unloading station (204-AR) would be used and construction of an additional facility in the 200 West area would be required to facilitate receipt and transfer of waste in the 200 West area.

The transfer of the intermediate products (washed sludge, recovered cesium) to the HLW vitrification facility could be handled in two ways: staging of the waste to be vitrified in a DST and transferring the control of that tank to the HLW vitrification process operator or by the construction of a new pipeline from the existing DSTs to the vitrification plant. The vitrification vendors will be given the option of choosing either alternative at the time of proposal. If the use of a pipeline is chosen, construction of this pipeline is the responsibility of the vitrification service vendor.

The transfer of cesium and strontium capsules will be handled with the existing transfer system and infrastructure no upgrade is required.

4. Receive and store final treatment products

The receipt of final treatment products is assumed to be by truck transport. The integrating contractor will be responsible for developing this infrastructure system.

6.4 Issues With Selected Alternative

The selected alternative for providing the infrastructure required to support Case 10 or 11, relies on proven or existing infrastructure for all elements except the intermediate product transfer system. This transfer system uses the truck shipment of liquid radioactive waste. The truck shipment of type A quantities of liquid radioactive waste is possible and is in progress today. However, the truck shipment of 1,000 gallon quantities of liquid radioactive waste containing Type B quantities of radionuclides is not currently done in the United States. This type of shipment is required for the successful use of transfer trucks to meet the infrastructure need. The key issue involved in whether or not this is permissible is the NRC requirements for licensing of the shipment cask.

This issue, the use of this cask, is further clarified for analysis as follows:

> Would use of the LR-56 cask system for transportation of radioactive materials currently stored in the Hanford waste tanks be subject to NRC and/or DOT regulatory requirements if the transportation is limited to transit within or between the Hanford 200 East and 200 West areas?

Under current DOE orders and operating procedures at Hanford, licensure is not required. If the 200 areas were at some time open to public transit, the requirements could become applicable. The relevant regulations and DOE interpretations that support this conclusion are summarized in the following paragraphs.

The Nuclear Regulatory Commission's (NRC's) requirements for packaging and transportation of radioactive material are in 10 CFR Part 71. 10 CFR 71.0(c) provides that:

> The regulations in this part apply to any certificate holder and to any licensee authorized by specific license issued by NRC to receive, possess, use, or transfer licensed material if the licensee or certificate holder delivers that material to a common or contract carrier for transport or transports the material outside the confines of the licensee's or certificate holder's facility, plant, or other authorized place of use.

The contemplated use of the LR-56 system at Hanford would not involve the transfer of licensed material to common or contract carriers or transfer of the material off the Hanford Site. Consequently, the Part 71 regulations do not appear to be applicable unless DOE voluntarily chooses to make them applicable.

The Department of Transportation's (DOT) requirements for the transportation of hazardous materials are in 49 CFR Parts 171-180. These regulations were issued under the authority of the Hazardous Materials Transportation Act. The Act is applicable to "transportation in commerce" of hazardous materials. The issue of the potential applicability of DOT's hazardous materials regulations at DOE sites was addressed in an April 1991 letter from DOT to DOE.* The following quotation from the DOT letter is relevant to the issue under consideration:

> "Transportation on (across or along) roads outside of Government properties generally is transportation in commerce. Transportation on Government properties requires close analysis to determine whether it is in commerce. If a road is used by members of the general public (including dependents of Government employees) without their having to gain access through a controlled access point, transportation on (across or along) that road is in commerce. On the other hand, if access is controlled at all times through the use of gates and guards, transportation on that road is not in commerce."

All planned transportation within the scope of this analysis will be on roads where "access is controlled at all times through the use of gates and guards", hence the DOT hazardous materials regulations should not be applicable unless DOE chooses to make them so. Access to the 200 areas is controlled 24 hours a day at the Wye and Yakima barricades. The possibility of removing the guards at the Wye and Yakima barricades was recently examined

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* Letter from Judith S. Kaleta, Chief Counsel, U.S. Department of Transportation Research and Special Programs Administration, to Susan H. Denny, Director, Transportation Management Program, Office of Technology Development, U.S. Department of Energy, April 23, 1991.

by the DOE-RL Security Transition Program Office. The Office concluded that the Wye and Yakima barricades should continue to be manned by the Hanford Patrol, in part because of concerns that elimination of manned access control would subject shipments of hazardous materials on the Hanford Site to additional regulatory controls. An April 2, 1993 letter indicating that manned access control points at the Wye and Yakima barricades would be retained was sent to the Hanford contractors by Robert Rosselli, DOE-RL Assistant Manager for Administration.

Should the conditions described above change to require NRC licensing of the cask used for this transport, that is, DOE policy changes or access controls in the 200 area change, no licensed casks would be available for this use. The NRC licensure of the LR-56 casks or any other cask for the intended use could be a lengthy process and would delay the ability to implement the TWRS treatment mission by the time period required for licensure.

7.0 Waste Processing Summary

Table A.9 represents a summary of waste mass processed in each phase according to the Case 11 tank sequencing. These results are based upon the current TWRS process flowsheet (Orme, 1994), which assumes EIS chemical inventories.

8.0 Schedule Considerations

The issues involving technical and operations logic just discussed are virtually unaffected by the nature of the contracting vehicle. Thus, for all intents and purposes, those descriptions are applicable to both Cases 10 and 11.

Table A.9. Waste Processing Summary for Case 11 Schedule

	LLW Glass (MT)	HLW Oxides (MT)	HLW Canisters (0.62 m3)	Start Operations	Complete Operation
Phase I	41,000	300	700	1998	2004
Phase II	119,000	2,200	5,300	2004	2013
Phase III	275,000	8,000	19,400	2008	2018
Total	430,000	10,500	25,400		

A different conclusion about contracting strategy is reached, however, when one factors in the need for regulatory permitting of privatized waste processing plants. There are two key points in this regard:

- Serial versus Parallel Permitting
- Privatization of Phase I (Case 10) versus DOE cost/risk share contracting (Case 11)

8.1 Serial Versus Parallel Permitting — Impact on Privatization Objectives

Figure A.6 illustrates serial permitting under a fully privatized scenario (for example, this could be at start up of any phase in Case 10). Serial permitting in this case refers to a situation where construction on plants by the winning contractor is not started until the NRC license process is completed. Of course, the reasons for the delay in construction stem primarily from financial considerations--minimizing the risk of large capital investments by the contractor and/or his financial backers until some assurance is obtained that the plant can be operated. It can be seen from the figure that, with reasonable assumptions of one year for procurement, four years for the NRC license application/review process, and two years for plant construction, the contractor has approximately a 7-year delay between issuance of the RFP and hot operations. Parallel permitting, on the other hand, assumes that plant construction does not have to wait for NRC licensing and can begin as soon as the plant design is completed. The issues and procedures which would be involved with parallel permitting, such as the possibility of DOE self-regulation in one or more phases, are being identified and addressed.

Clearly the additional time lag associated with serial permitting is not appealing to the contractor from a business point of view, or to DOE and stakeholders interested in making significant progress at tank waste remediation. From the point of view of a time-phased modular remediation schedule, however, perhaps the biggest problem with serial permitting is its negative effect on learning and risk reduction, which would otherwise be strong advantages of a time-phased approach. This effect is illustrated in Figure A.7, where the specific time schedule of Case 11 has been used. In this example the end dates (E) of the phases have been pinned for both serial and parallel permitting cases in order to achieve TPA milestones. Thus, in this representation, the impact of the additional two years comes in the need to start the bid and procurement (B) two years earlier in an already demanding schedule which relies heavily on time overlap time for learning, technology advancements, and

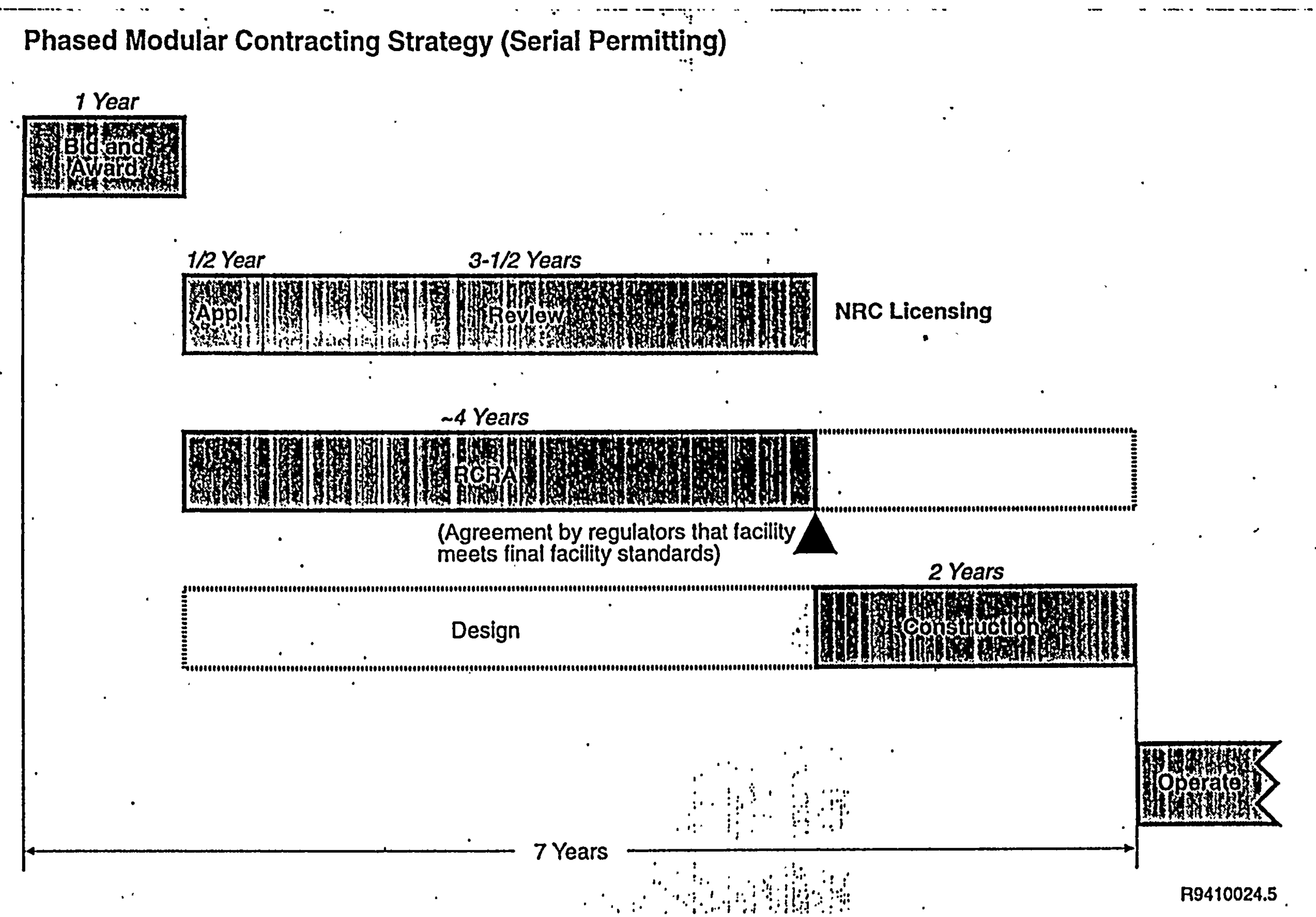

Figure A.6. Effect of Serial Permitting (Construction Must Wait for NRC License) on Schedule

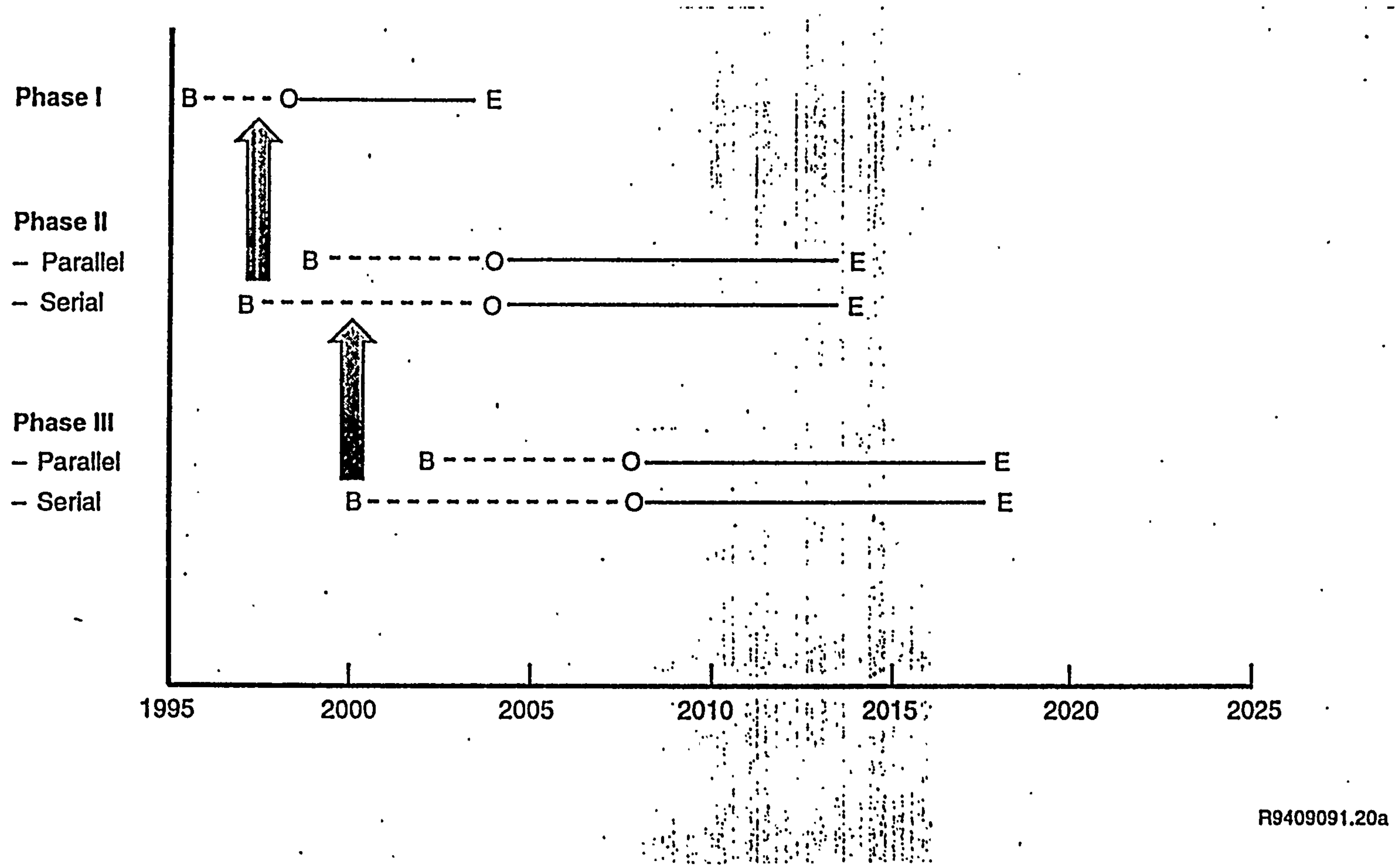

Figure A.7. Comparison of Parallel and Serial Permitting improve characterization information. Specifically, in the case shown, with serial permitting of Phase II the RFP for Phase II would have to be issued before the start of operations of the Phase I plants. If, in Figure A.8, Case 10's (privatization of Phase I) timeline for were used rather than Case 11's, the situation would be even worse.

Ways around the serial permitting issue include making bigger plants, having more plants operating at one time, or relaxing remediation milestones. All of these have some sort of associated cost increase. Another way is to assume parallel permitting, which will rely on close cooperation between DOE, NRC, and the privatization contractor from the date of award. In the cases studied in this paper, parallel permitting has been assumed and design and construction have been assumed to take 4 years for Phases I-III and 5 years for HLW vitrification plants.

8.2 Privatization of Phase I (Case 10 versus Case 11)

As suggested in the preceding paragraphs, requirements such as NRC licensing that add to the delay of plant operation impose serious constraints on operating campaigns either by compromising learning or by jeopardizing milestones. This is the primary conceptual difficulty with Case 10, and is the driving force behind the selection of a pseudo-privatization contracting approach for Case 11.

Figure A.9 illustrates the Case 11 schedule. It can be seen that the bid/award and design/construction in Phase I is very brief. This is because one of the fundamental Case 11 strategy assumptions is that the contracting and regulating would be carried out by DOE. Thus, design and construction times can be minimized and can begin immediately after the contractors have been selected. Full privatization of Phase I (Case 10) is estimated to delay the start of waste processing by a minimum of two years, from 1997 to 1999, because of the assumed need for formal NRC licensing. This effect is shown in the schedule for Case 10, shown in Figure A.8, where it has been assumed that serial permitting (7-year total time between bid and start of operations) is applicable. Again, this type of delay significantly compromises the learning available from Phase I when Phase II contracts, and places in jeopardy some TPA milestones.

For the foregoing reasons, only Case 11 is considered a viable option warranting more detailed cost and performance evaluation.

8.3 Cost Estimate for Case 11

Cost estimates, expressed in constant 1994 dollars, for the phases of Case 11 are listed in Table A.10. Assumptions used and cost estimating methodology are described in the Attachment to this Appendix. The cost estimate for the baseline case outlined in the Facilities Configuration Study is $15.1 Billion. As noted in the description of the cost estimating

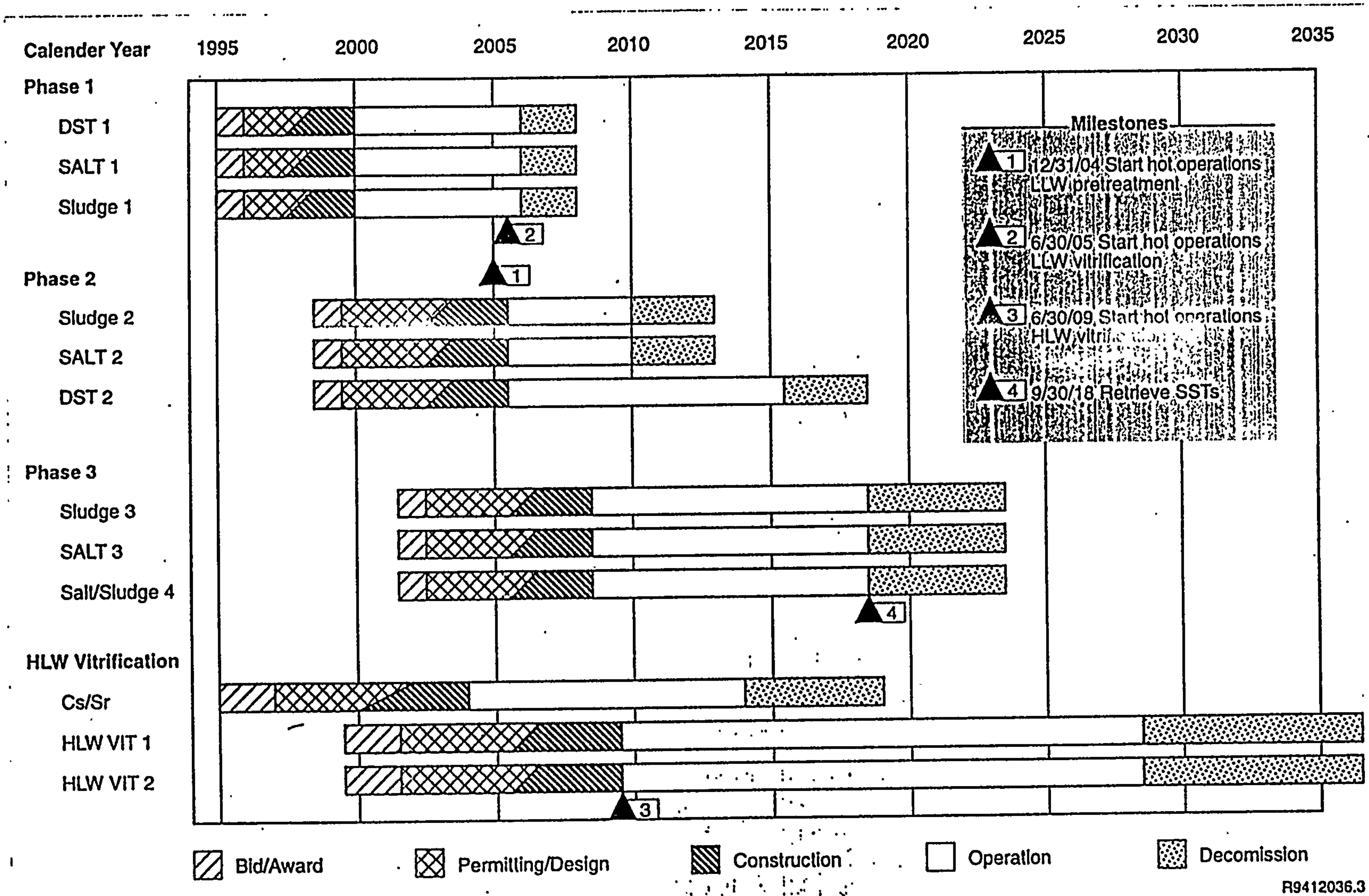

Figure A.8. Case 10 Time Line

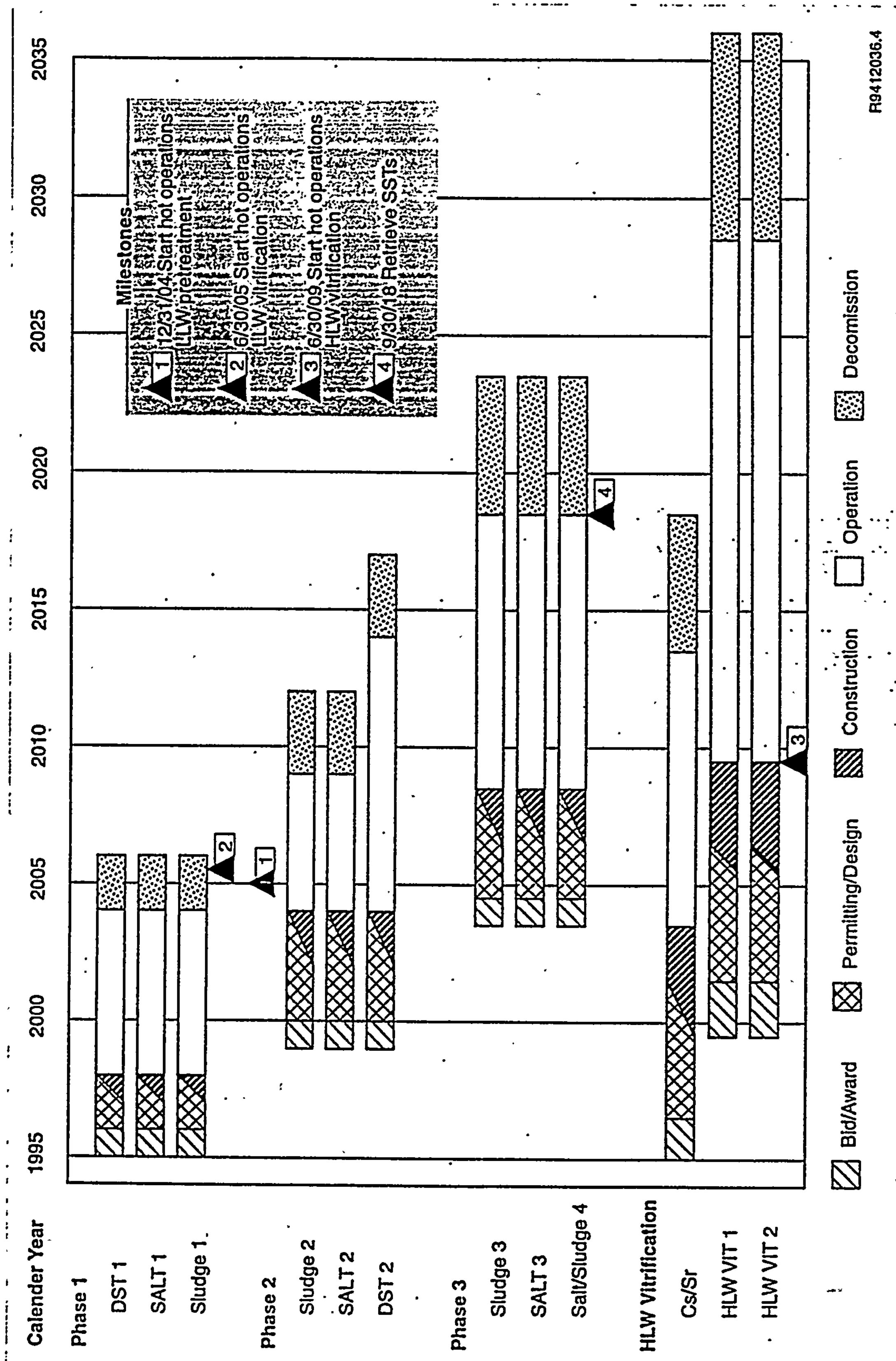

Figure A.9. Case 11 Time Line

Table A.10. Cost Breakdown of Case 11 versus a Baseline Non-Privatized Case

Item	Estimated Cost (Billions)	Comparative Non-Privatized Cost (Billions)
Phase I	3.3*	
Phase II	4.2	
Phase III	6.1	
Total Pretreatment Low-Level Waste Vitrification	13.6	9.50
Cs/Sr Capsule Vitrification	0.26	0.30
HLW Vitrification and Disposal	3.7	5.30
Comparative Total Program Cost	17.6	15.1

approach in the attachment, estimated costs for facilities and operation (except retrieval) were obtained by scaling costs found in the Facility Configuration Study. Retrieval costs were obtained from the TWRS baseline. Such scaling procedures will generally yield acceptable high-level (preliminary) cost estimates when the degree of required scaling is moderate, i.e., when the relative sizes of facilities and levels of operation do not differ markedly from the baseline case. The scale of operations for all of the facilities are, however, much smaller than operations in the baseline (a factor of 5 - 10 smaller), and will utilize a different design approach. For example, the baseline costs are based on the use of the Canyon design approach that has the potential for considerable flexibility but is costly because very large shielded areas are inherent in the design. With the phased approach used in Case 11, cost savings are envisioned by starting with tanks which have the simplest pretreatment requirements and designing the early modules for just those requirements. This is done with loss of flexibility for future equipment changes, but at considerably less expense. The facilities configuration study has estimated the capital cost savings from adopting proven, less flexible, non-canyon remote design concepts in large facilities is 20% or more.

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* The cost of this phase based on scaling up from the Cesium Demonstration Unit Conceptual Design Unit is Estimated to be $1.5 Billion, similarly it is believed that the cost for phase 2 may also be overestimated by a similar procedures.

This difference in design philosophies and the large scale difference results in a "disconnect" between the projected cost of the pilot plant modules of the phased cleanup approach with the less flexible design, and the down-sizing of the costs for the facilities in the Facility Configuration Study. Further work to refine the cost estimating approach to eliminate the "disconnect" could result in cost estimates that are lower than those in Table A.10 Cost by a factors of 5 - 10. For example, the total capital cost estimate for the cesium demonstration unit was $58 Million, the estimate for this same unit scaling from the configuration study is $280 Million. Cost estimates for vitrification facilities designed and built by private entities (e.g., Fernald Vitrification System) are in the 15 - 50 Million dollar range compared with the estimate for these types of facilities based on scale from the FCS of 200 - 400 Million.

8.4 Transition to Case 11

The current baseline plan calls for the M&O to operate the tank farm facilities and design, build and operate the facilities for the remediation of the TWRS waste. Under any privatization scenario the scope of the M&O will be reduced. The change in the role of the M&O from the current scheme to that required for a privatized TWRS system must be carefully planned to ensure that the savings to be gained in privatization are not lost in a series of confusions regarding scope, roles and responsibilities. The phased implementation of the Case 11 scenario enables an orderly transition from the baseline M&O operated TWRS to a privatized TWRS system.

8.5 Management of Interfaces

Case 11 is designed to minimize the required interaction of the privatized vendors with the M&O. This interaction is minimized by having the M&O transfer the waste to a set of storage tanks and isolating these storage tanks from the remainder of the tank farm system. When the contract is awarded the responsibility for the safe management of the tanks will be transferred to the vendor. Once this transfer is complete the M&O's only interactions with the operating contractor will be the 1) provision of utilities (water, electric, etc.), 2) transfer of waste by truck from the vendor to the M&O, and 3) provision of fire, emergency response and, security services. There is considerable experience in managing interfaces of this type with the current M&O as it is much the same situation that existed when separate contractors operated the 100, 300 and 200 area facilities and wastes and fuels were transferred between the areas for processing or disposal. The current M&O also has experience in providing fire services to non-contractor as shown by their contract to provide fire protection services to the Washington Public Power Supply System. The only new portion of this interface is the transfer of physical structures from the M&Os control to those of a vendor. This transfer will be investigated from the aspects of operational transition, and the eight portions of the TWRS icon.

The operational transition of the tanks will require that the M&O develop and transfer a complete as-built set of drawings, operating procedures for the facilities to the vendor.

Correspondingly the vendor will be required to restore the tank farm to a prescribed condition prior to return to the M&O and provide a similar set of documents. The transfer of operational control of the tanks will require that the vendor operate within the bounds of existing safety analysis until such time as it is revised and approved by the relevant regulatory authority. The revision and updating of the safety analysis will be a key contract requirement. The vendor will assume responsibility for the safe storage of the waste. This will require that the M&O provide an accurate and complete characterization of the tanks contents and a definition of the bounding conditions for safe storage of the waste and the operating limits and basis for these limits to the vendor. The provision of this information for the SSTs could represent a difficult interface problem because of the lack of detailed design information for these tanks.

Characterization of the waste in the tanks after award is the vendors responsibility. The vendor will be responsible for the sampling and analysis of the waste. The M&O will be offered an opportunity to bid on providing these services to the contractor but the contractor will be under no obligation to accept the services of the M&O.

In Case 11, retrieval, pretreatment and low-level vitrification are all horizontally integrated under a single contract. The contractor is responsible for the integration of these three functions and the provision of any lag storage or characterization required to operate these processes after the contract award. The M&O may elect to provide laboratory services to the

The retrieval of the waste will be the responsibility of the vendor. The definition of the required retrieval and the methods for determining that these requirements are met are key areas of concern. In addition, the retrieval system proposed for use by the vendor must be shown not to damage the tanks in the case of DSTs that will be returned to the M&O for future use, or create excessive leakage to the soil in the case of SSTs.

The transfer of waste after retrieval is the responsibility of the vendor. The vendor will not be permitted to use any existing piping or lines that are not completely contained within his area of responsibility. Any transfer systems or piping constructed by the vendor will be offered to the M&O for use at the completion of the contract or, at the M&Os option, removed and disposed. The transfer of waste generated from the treatment process back to the M&O will be limited to washed sludges that meet acceptance criteria, and cesium eluent. The transfer of this waste will be handled by truck and each shipment must contain appropriate documentation of the shipment contents and a demonstration that it meets acceptance criteria before the M&O will accept the shipment. The contracts with the vendors will contain penalty clauses as well as incentives to minimize the qualities of waste return to the M&O for future storage. Should the M&O be unable to accept a waste shipment because of conditions outside of the vendors control, the vendors contract will provide for cost reimbursement for lost productivity. The M&Os contract will also include a penalty provision for lack of readiness to accept shipments when shipments are required.

The pretreatment of the waste is the vendors responsibility. The vendor will treat the waste and deliver washed sludges and cesium containing liquids to the M&O by truck for storage and ultimate disposal. These transfers will be handled as described above.

The low-level vitrification of the treated waste is the vendors responsibility. The vendor is responsible for the qualification of the waste form to the specification provided. The vendor is responsible for treating the waste and producing a containerized vitrified product for transfer by truck to the M&O. The vendors contract will specify the frequency of these transfers and the documentation that is required to accompany each transfer.

Low-level waste storage/disposal is the responsibility of the M&O. Once the drum of containerized waste has been accepted for transfer to the M&O the storage and disposal of this waste form is the M&Os responsibility.

High-level waste vitrification will be the responsibility of the vendor. The vendor will be responsible for qualifying the waste form to the specifications. The waste to be vitrified will be transferred to the vendor by pipeline or truck at the vendors choosing. If the vendor desires truck transfer then the vendor must provide the interface with the tank farm system and upgrade any procedures or safety documentation as required. The vitrified product will be transferred to the M&O by truck for storage and ultimate disposal. The vendors contract will detail the frequency and documentation required to accompany each transfer.

High level waste storage will be the responsibility of the M&O. The M&O will be required to accept shipments of vitrified HLW from the HLW vitrification plant vendor and store this waste and arrange for shipment to a repository for disposal.

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ATTACHMENT

COST ESTIMATING ASSUMPTIONS AND METHODOLOGY

Estimated costs for facilities and operation (except for retrieval) were obtained by scaling costs found in the Facility Configuration Study. Retrieval costs were obtained from the Tank Waste Remediation System (TWRS) baseline.

All cases were scaled, then factors for learning and/or competition were applied to reduce total cumulative costs.

ASSUMPTIONS

Assumptions on Competition and Learning

Where studies have been undertaken comparing the effects of competition, competition, in effect, steepens the learning curve and increases cumulative cost savings compared with no competition. (Berg et al., 1986; Cox and Gansler, 1985).

Cost improvement stems from changes in technology, economies of scale, better product, factory and labor efficiencies (Fallon, 1983; Ghenawat, 1985).

The empirical evidence supporting these the cost savings used in different cases comes from approximately 50 studies cited in Mueller's book on public choice.

- Forty of the studies showed strong savings to the government by providing for competition in its services procurement; 10 showed a relative wash in costs between the private and government provision of services; and 2 showed higher costs for private companies providing the same service as the government (Mueller, 1989).
- Evidence in the DoD arena is similar with studies showing -36 percent to +62 percent savings when competition is introduced in providing government procurement of defense systems. Of 55 systems studied, 47 systems showed positive savings over single source procurement, 5 systems showed mixed results, and 3 systems had higher costs under competition (Berg et al., 1986).

Head-to-Head Competition, Fixed-Price, Fee-For-Services Contracts

- For basic head-to-head continuous competition, the empirical evidence indicates that an average cumulative savings of 40 percent is achieved. We assumed that if weak forms of competition, e.g., the threat of competition was achieved that a lesser savings would occur, e.g., 20 percent. Fixed-price, fee-for-serviced contracts could fall in this category under long term contracts.

- Because some options offered greater learning potential, regardless of competition, they were given a higher cost improvement. Three phases without competition resulted in approximately 15 percent savings and two phases resulted in 10 percent savings just due to extra learning available.

COST ESTIMATE METHODOLOGY

The following methodology was used in costing all cases.

Retrieval: Retrieval costs were determined by dividing the TWRS baseline cost by the volume of LLW glass throughput assumed in the baseline to get a cost per metric ton (MT) of waste retrieved. The cost per MT cost was multiplied by the throughput of each facility to determine the retrieval costs for each phase.

Capital Costs: Development, engineering costs, buildings, special equipment, and laboratory equipment were included in capital costs and scaled using a standard scaling technique. The cost of new facilities equals the cost of original facilities times the ratio of the new facility divided original facility to the 0.6 power (Peters and Timmerhaus, 1980).

$$\text{New Cost} = \text{Original Cost} * (\text{new throughput size}/\text{original throughput})^{0.6}$$

Startup costs were also included in capital and scaled along with capital costs. The technique was used in scaling costs for new sizes of facilities for Pretreatment and Evaporation Facilities, Low Level Waste Vitrification Facilities and High Level Waste Vitrification facilities. Facilities were scaled based on throughput proportional to the original facility throughput.

Labor: Labor costs were scaled using the same scaling formula as capital, except the scaling factor was .25 instead of .6 (Peters and Timmerhaus, 1980).

Consumables: Consumables costs which could include FRIT, chemical, water, steam, electricity, spares and replacements, glass formers, kerosene, ammonia, sulfur were directly proportional to the throughput of the new facility divided by the original facility.

Low Level Waste Disposal: Low level waste cost was scaled proportional to the low level waste disposal cost in the FCS based on relative low level waste volumes.

High Level Waste Storage: High level waste storage cost was scaled proportional to the high level waste storage cost in the FCS based on relative high level waste volume.

High Level Waste Disposal: High level waste disposal cost was scaled proportional to the high level waste disposal cost in the FCS based relative high level waste volume.

Decontamination and Decommission Costs: Decontamination and Decommissioning (D&D) costs were calculated as 3 years of operational costs and 30 percent of capital costs minus the startup portion of capital over 5 years. The startup costs were removed from the D&D costs based on the relative proportion of startup cost to total capital costs. The D&D costs were adjusted by the ratio. D&D costs included the scaled costs of the common facilities.

Cost Reduction Due to Competition and Learning: To obtain the total savings due to both additional learning and competition, the potential savings from competition and from just additional learning were combined into a single factor. For example competition with 3 phases was calculated by multiplying .6 times .6 (40 percent saving for competition and 40 savings for learning) which resulted in a cumulative cost of .36 or about 65 percent savings. Numbers were rounded to the nearest 5 percent.

Table AA.1. Factors used for Competition and Learning

Preprocessing and LLVit	Potential Savings
3 phases and competition	50 Percent
3 phases and little potential competition	30
3 phases and no competition	15
2 phases and competition	45
2 phases and little potential competition	30
2 phases and no competition	10
1 phase and competition	40
1 phase and little potential competition	20
1 phase and no competition	0
High Level Vit Plant	
1 phase and competition	40
1 phase and little potential competition	20
1 phase and no competition	0