0049142

TWRS

Phase I Project

A New Direction For DOE

Report To Congress

Treatment and Immobilization of Hanford Radioactive Tank Waste

July 1998

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EXECUTIVE SUMMARY

Summary

This report to Congress on the Tank Waste Remediation System (TWRS) Phase I privatization project describes the U.S. Department of Energy's (DOE's) plan for taking the next steps to assure treatment of Hanford tank waste. The report also fulfills the notification requirements of Section 3132 of the National Defense Authorization Act for Fiscal Year 1998, initiating the 30-day waiting period for the Secretary to enter into a defense environmental management privatization contract.

DOE has decided to authorize one contractor team led by BNFL, Inc. to proceed to the next phase of the TWRS privatization project. The next phase is a 24-month design period that will result in sufficient engineering and financial maturity to establish fixed-unit prices and to finalize project financing terms. At the conclusion of the design phase, DOE will make a decision whether to proceed with BNFL into a construction and operations phase. If authorized to proceed to the construction and operations phase, BNFL would provide both high-level and low-activity waste treatment and immobilization services. During the 10-year minimum-order-quantity period, the BNFL facility is expected to process approximately 10% of the Hanford tank waste by mass and 20% to 25% by radioactivity.

The Challenge

Approximately 54 million gallons of highly radioactive wastes are stored in 177 underground tanks, including 149 older single-shell tanks, at the Hanford Site in Washington State. That waste, which was derived from production of plutonium for the nation's nuclear defense program, has been accumulating at Hanford since 1944. The waste poses a serious safety concern to the public and to the environment. Since most of the single-shell tanks have exceeded their design life, that risk is growing. Sixty-seven of the single-shell tanks are known to have leaked, and several additional tanks are being investigated for potential leaks. Nearly a million gallons of the tank waste has spilled into the soil of the vadose zone below the tanks since the first leak occurred. Recent information has indicated that tank waste radionuclides have moved through the vadose zone and now have reached the groundwater that flows under the Hanford Site and connects with the Columbia River.

DOE is taking active measures to reduce the chance of additional tank leaks. However, it is not possible to predict when the next tank will leak, and with passage of time, even the newer, safer double-shell tanks are approaching the end of their design lives. Removal of the waste from the tanks, treatment, and immobilization as an inert waste form will constitute a lasting solution to the problem. DOE,

the U.S. Environmental Protection Agency, and the Washington State Department of Ecology have entered into an enforceable compliance agreement setting forth milestones for cleanup of the tank waste. DOE, State regulatory agencies, and stakeholders view the tank waste cleanup as one of their top priorities.

Tank Waste Remediation System Program

In view of the importance of the Hanford tank waste issue, DOE established the TWRS program in 1992 to ensure that the tank wastes would be stored, treated, and immobilized in a safe, environmentally sound, and cost-effective manner. In 1994, DOE embarked on a privatization demonstration strategy to purchase waste processing services from best-in-class companies instead of building its own facilities. One goal of that demonstration strategy was to make greater use of the technologies, demonstrated efficiencies, and management discipline of private industry to provide effective solutions to the tank waste challenge. However, at the same time, it was determined that several major TWRS functions (e.g., waste retrieval, and waste characterization) were not appropriate for fixed-price contracting. These functions are being carried out by the Management and Integrating contractor for the Hanford Site, which is currently Fluor Daniel Hanford.

In September 1996, DOE entered into contracts with two contractor teams—one led by BNFL, Inc. (BNFL) and another led by Lockheed Martin Advanced Environmental Systems (LMAES)—for Phase I of the TWRS privatization project. At the time of contract award, the contracts for TWRS Phase I were structured into two parts, a 20-month Part A, ending in mid-1998 and an optional Part B, planned for approximately 10 to 14 years. The purpose of Part A was to evaluate the technical, operational, regulatory, business, and financial elements required by privatized facilities that would provide treatment and immobilization services on a fixed-unit-price basis. Under the original TWRS Phase I contracts, Part B was a period, scheduled to begin in mid-1998, in which the authorized contractor(s) would fully finance, design, construct, operate, and deactivate waste treatment plants on a fixed-price basis.

Based on a detailed review of the work products prepared by both contractors (as required by Part A of the contract), DOE has decided to restructure Part B of the contract and to authorize only one contractor, BNFL, to proceed to the design phase of Phase I. DOE has concluded that the BNFL proposal contained a viable conceptual facility design with robust technologies that have been effectively demonstrated at other sites. DOE concluded that BNFL would be able to meet contractual requirements for design, construction, and operations in the balance of Phase I.

In comparison, DOE determined that the Part A work products provided by LMAES set forth an approach with an unacceptably high technical risk in attaining DOE's cleanup goals. The LMAES conceptual facility design was deemed to be unrealistic without additional development, and its proposed technologies, while novel in some cases, were largely unproven. The LMAES proposal did not provide DOE with evidence to conclude with a sufficient level of confidence that LMAES would be able to meet the contract requirements for the balance of Phase I. As a result, DOE decided not to authorize LMAES to proceed to the design phase.

In light of the importance and sensitivity of the authorization-to-proceed decisions for BNFL and LMAES, DOE used nearly 100 independent experts to participate in the decision-making process in advisory, contributor, and review capacities. DOE expects to continue to use an independent review process to assist in program decisions as Part B of the contract progresses.

Scope and Structure of the BNFL Contract

The contract with BNFL reflects an evolution of the original TWRS privatization approach. The original approach envisioned that the Department would make a final, multi-billion dollar decision whether to proceed with the TWRS Phase I project at the end of the 20-month Part A developmental period with completion of conceptual design. The revised approach will allow DOE to move forward on design without delay, but defers a final decision until the project is further refined with respect to its design and technical approach, regulatory requirements, and financial and incentive structure. This approach incorporates the changes necessary for the downselect to a single performer and the division of Part B of the contract into two parts. Specific contract provisions are included to: 1) develop the necessary technical, operational, regulatory, and business elements to reduce uncertainties and provide performance assurance, and 2) refine the contract management processes required for the life of the contract early during the design phase.

During the design phase, BNFL will take its current enhanced conceptual design to one in which final design approaches have been selected for all major process and facility systems (approximately 30% design). This more detailed design and improved understanding of regulatory requirements are expected to enable BNFL to obtain project financing and to propose fixed-unit prices for waste processing services. Based on the current scope of work, the estimated cost of the design phase would be $350 million.

The current BNFL target price for the 10-year minimum-order quantity of treated waste under the contract is $6.9 billion (FY1997 dollars). This price is significantly higher than the original DOE estimates for Phase I. This is, in part, because the hazards presented by the operations to be performed under the contract necessitated more robust facilities for processing and confinement of the waste. These facilities will have a 30-year design life rather than the original concept of a 5- to 9-year demonstration facility. As a by-product of the longer design life, the plant has the potential to treat waste for a much longer period, can treat waste with a broader range of composition, and could treat more than half of the tank waste (by mass) and approximately 95% of the long-lived radionuclides with a limited additional investment.

Although the contract developed represents a positive business arrangement for the Department, there are key implementation steps which must be taken in the early stages of the contract to assure project success. DOE will review the project throughout the design phase to ensure that downward pressure is maintained on the target prices and that necessary progress is maintained by BNFL in developing its technical and safety design, and in securing necessary financing and permits. This will include an important review after six months to reach agreement with BNFL on the terms and methodology that will be used to establish the fixed-unit prices submitted at the end of the design phase.

At the end of the 24-month design phase, DOE will decide whether to proceed with the subsequent construction and operations portion of Phase I or to pursue one of several other approaches to complete Phase I. BNFL's authorization to proceed will depend on DOE receiving acceptable fixed-unit prices, acceptance for review of their design for nuclear and chemical process safety, a substantial equity commitment by BNFL, and other significant financing arranged by BNFL. A key element of this financing will be BNFL equity, which represents BNFL's investment in the success of the project.

In combination with BNFL's.activities during the design phase, DOE will be carrying out a number of other activities to ensure that an optimum contract results at the end of that phase. Those activities will include value engineering studies to refine technical specifications for the most cost-effective waste processing approach, and defining the optimum financing approach with BNFL to be used in the construction and operations phase.

If BNFL is authorized to proceed beyond the design phase, it will move forward to the completion of the design, construction, startup, testing, and operation of the facility to provide waste treatment services at the fixed-unit prices established at the end of the design phase. Under the contract negotiated with BNFL, DOE currently forecasts that waste treatment will begin in 2005 to 2006 and will continue for at least 10 years. During that period, DOE expects the contractor to immobilize approximately 10% of Hanford's waste by mass. That waste processing will include both high-level and low-activity waste treatment and immobilization. The waste processed during operations will be retrieved from 11 tanks and will free up valuable double-shell tank space to enable transfer of waste from high-risk single-shell tanks. The waste to be processed constitutes between 20% and 25% of the total radioactivity in the Hanford tanks and includes some of the highest safety-risk tanks at the site. BNFL's facility design provides for the ability to expand the capacity of the plant at a later date. This could allow a significant amount of the waste currently planned for TWRS Phase II to be processed in the expanded facility.

DOE also recognizes that the successful execution of the TWRS Phase I project requires effective management by the Department. The approach to managing this contract involves a less directive role than DOE normally has in a cost-reimbursement contract to take advantage of the incentives and efficiencies of private industry. To carry out this role effectively, the DOE has developed, or is developing, a number of important management tools, including a detailed project management and integration system. Work also is underway to assure that staffing needs are met in a timely manner by a dedicated, specialized team. The management plan includes extensive input from external reviewers, including participants with broad experience in fixed-price contracting with other federal agencies, and the plan takes into account key lessons learned during Part A of TWRS, as well as significant lessons from other recent projects in the DOE complex.

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List of Acronyms and Abbreviations

ATP	Authorization to proceed
BA	Budget authority
Bechtel	Bechtel National, Inc.
BNFL	BNFL Inc., a United States subsidiary of British Nuclear Fuels plc
BO	Budget outlay
CFR	Code of Federal Regulations
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
DST	Double-shell tank
Ecology	Washington State Department of Ecology
EIS	Environmental impact statement
EPA	U.S. Environmental Protection Agency
FY	Fiscal year
HLW	high-level waste
LAW	Low-activity waste
LMAES	Lockheed Martin Advanced Environmental Systems
M&I	Management and integration
M&O	Management and operating
MOU	Memorandum of Understanding
NRC	U.S. Nuclear Regulatory Commission
NTP	Notice to Proceed
OSHA	Occupational Safety and Health Administration
RCRA	*Resource Conservation and Recovery Act*
Regulatory Unit	DOE Office of Radiological, Nuclear, and Process Safety for TWRS Privatization
RFP	Request for proposal
RTP	Readiness to proceed
SAIC	Science Applications International Corporation
SST	single-shell tank
TPA	Tri-Party Agreement (*Hanford Federal Facility Agreement and Consent Order)*
TWRS	Tank Waste Remediation System

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1 Introduction

The Hanford Site Tank Waste Remediation System (TWRS) program is at a critical juncture. Two contracts were awarded in September 1996 for Phase I of a "privatization" initiative for waste treatment services. The contracts were awarded to teams led by BNFL Inc. (BNFL), a United States subsidiary of British Nuclear Fuels plc, and Lockheed Martin Advanced Environmental Systems (LMAES). At the time of the Phase I awards, the contracts were structured into two parts: a 20-month Part A, scheduled to end in mid-1998; and an optional Part B, planned for approximately 14 years. The purpose of Part A was to establish the technical, operational, regulatory, business, and financial elements required by privatized facilities for provision of tank waste treatment and immobilization services on a fixed-unit-price basis. If authorized to proceed to Part B, contractor(s) would then design, build, permit, operate, and deactivate privately financed, low-activity waste (LAW) and (optionally) high-level waste (HLW) treatment plants. They would be paid for treated waste when it was delivered back to the U.S. Department of Energy (DOE) for storage and disposal. Of the 20-month Part A period, 16 months were provided for the contractors to complete deliverables for submittal to DOE, and 4 months were provided for DOE to review and evaluate the deliverables and decide whether to authorize initiation of Part B by zero, one, or both contractors.

TWRS Phase I was designed to treat and immobilize between 6% and 13% of Hanford's tank waste and serve as a demonstration of the elements that would be required in continuing this new contracting approach with the production-scale Phase II. In Phase II, DOE envisioned that the balance of the tank waste would be processed, the immobilized HLW sent to a geologic repository, the tanks closed, and the processing facilities decontaminated and decommissioned.

The two contractors submitted their Phase I, Part A deliverables as scheduled on January 26, 1998. DOE has evaluated those deliverables and completed its authorization-to-proceed decision process. This report describes DOE's decision and provides information to support that decision.

1.1 Purpose of the Report

This report describes DOE's first major decision on the privatization of the waste treatment and immobilization services under the Hanford Site TWRS Project Phase I. The report is also intended to satisfy the Congressional requirement for a 30-day notification period for privatization contract actions contained in Section 3132 of the *National Defense Authorization Act for Fiscal Year 1998*.

DOE has carried out a detailed analysis to arrive at the Phase I, Part B decision described in this report. Moreover, in view of the importance of this Part B decision, DOE has involved more than 100 experts from outside the Department in the review of the decision process and the decision itself. As a result, DOE believes that the Part B decision is sound, represents good value and a flexible path forward, and will ultimately result in significant progress toward DOE's cleanup mission.

1.2 Contents and Organization of the Report

This report is intended to provide the reader with a clear picture of the urgency and the technical challenges associated with initiating tank waste treatment at the Hanford Site. The report describes in detail the contracting approach that DOE has selected for TWRS Phase I as the solution for these challenges, and the reasons for selecting that approach compared to other options. The report is organized along the lines of the following key questions:

- What is the technical nature of the tank waste problem? (Section 2)
- Why did DOE select privatization for TWRS? How has the contracting approach evolved over time? (Section 3)
- What was the basis of DOE's authorization-to-proceed decisions with respect to BNFL and LMAES? (Section 4)
- What are the contract structure and technical and financial features that DOE negotiated with BNFL for Part B? (Section 5)
- How will DOE manage the project? (Section 6)

Appendices A and B are included to provide the reader with additional information on the TWRS Phase I decision process and external review of the decision. The current Construction Project Data Sheet for the project is set forth in Appendix C.

1.3 Mapping of Report to Congressional Reporting Requirements

DOE has compiled pertinent information in this report to clearly present the decision and its justification to the Congress. DOE has addressed the matters required in the *National Defense Authorization Act for Fiscal Year 1998.* Table 1-1 maps these issues to corresponding sections of the report.

Table 1-1. Congressional Reporting Requirements Mapping

Section 3132(b)*	Reporting Requirement	Associated Section(s)
2A	The anticipated costs and fees of the Department under the contract, including the anticipated maximum amount of such costs and fees	5.6 and 5.7
2B	Any performance specifications in the contract	5.2 and 5.3
2C	The anticipated dates of commencement and completion of the provision of goods or services under the contract	5.4
2D	The allocation between the Department and the contractor of any financial, regulatory or environmental obligations under the contract	5.2 and 5.5
2E	Any activities planned or anticipated to be required with respect to the project after completion of the contract	5.8
2F	The site services or other support to be provided the contractor by the Department under the contract	5.5
2G	The goods or services to be provided by the Department or contractor under the contract, including any additional obligations to be borne by the Department or contractor with respect to such goods or services	5.5
2H	If the contract provides for financing of the project by an entity or entities other than the United States, a detailed comparison of the costs of financing the project through such entity or entities with the costs of financing the project by the United States	5.6
2I	The schedule for the contract	5.4
2J	The costs the Department would otherwise have incurred in obtaining the goods or services covered by the contract if the Department had not proposed to obtain the goods or services under this section	5.6
2K	An estimate and justification of the cost savings, if any, to be realized through the contract, including the assumptions underlying the estimate	5.6
2L	The effect of the contract on any ancillary schedules applicable to the facility concerned, including milestones in site compliance agreements	5.4
2M	The plans for maintaining financial and programmatic accountability for activities under the contract	6
3B	In the case of a contract under subsection (a) at the Hanford reservation, the report under paragraph (1) shall set forth—(A) the matters specified in paragraph (2); and (B) if the contract contemplates two pilot vitrification plants—(i) an analysis of the basis for the selection of each of the plants in lieu of a single pilot vitrification plant; and (ii) a detailed comparison of the costs to the United States of two pilot plants with the costs to the United States of a single pilot plant	N/A

*Section 3132(b) of the *National Defense Authorization Act for Fiscal Year 1998.*

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2 Background—The Importance of Tank Waste Treatment

The Hanford Site in the southeastern part of the state of Washington is the location of one of the greatest concentrations of radioactive waste in the world. That waste is the legacy of nearly 50 years of chemical processing to produce plutonium for nuclear weapons, which began with the Manhattan Project in the 1940s and continued through most of the Cold War. The 54 million gallons of tank waste at Hanford exist in three forms—sludge, salt cake, and liquid supernatant—and are stored in 177 underground, steel-lined, concrete tanks (see Figure 2-1), most with capacity of a half-million to a million gallons.

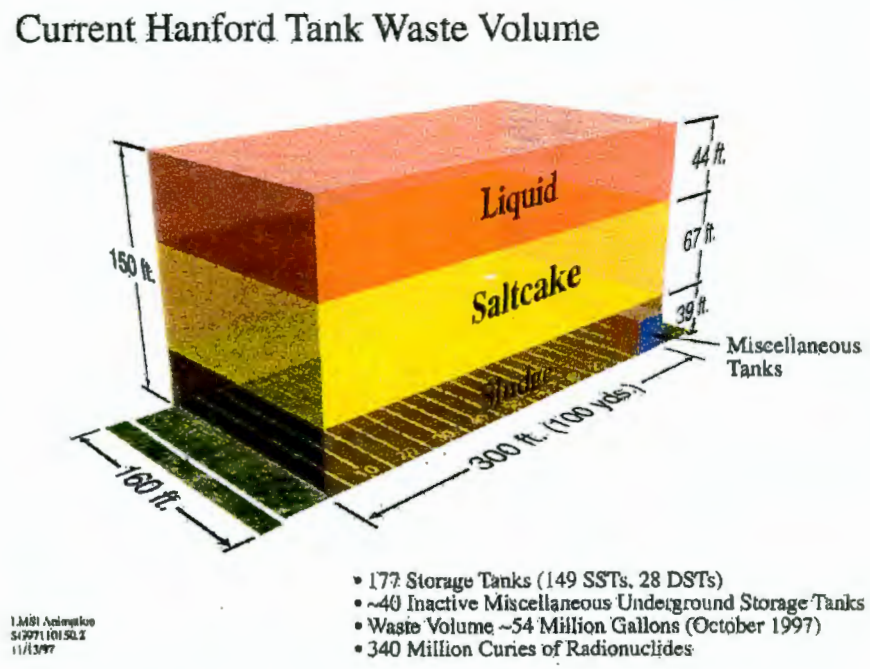


Figure 2-1. Current Hanford Tank Waste Volume

Of the 177 tanks, 149 are older, single-shell tanks (SSTs), the last one being placed in service in 1964. Figure 2-2 illustrates that all of the SSTs have exceeded their 20-year design life. Sixty-seven of these SSTs are known to have leaked high-level radioactive waste into the ground. DOE is currently investigating several additional tanks to assess the liquid levels and determine the potential for leaks. DOE operates an ongoing process of pumping liquids out of SSTs to minimize chances of additional leaks.

The remainder of the waste is contained in 28 newer double-shell tanks (DSTs), which were placed in service from 1971 to 1986. Although none of these DSTs has leaked, a number will reach the end of their design life prior to waste being retrieved and treated, as shown also in Figure 2-2.

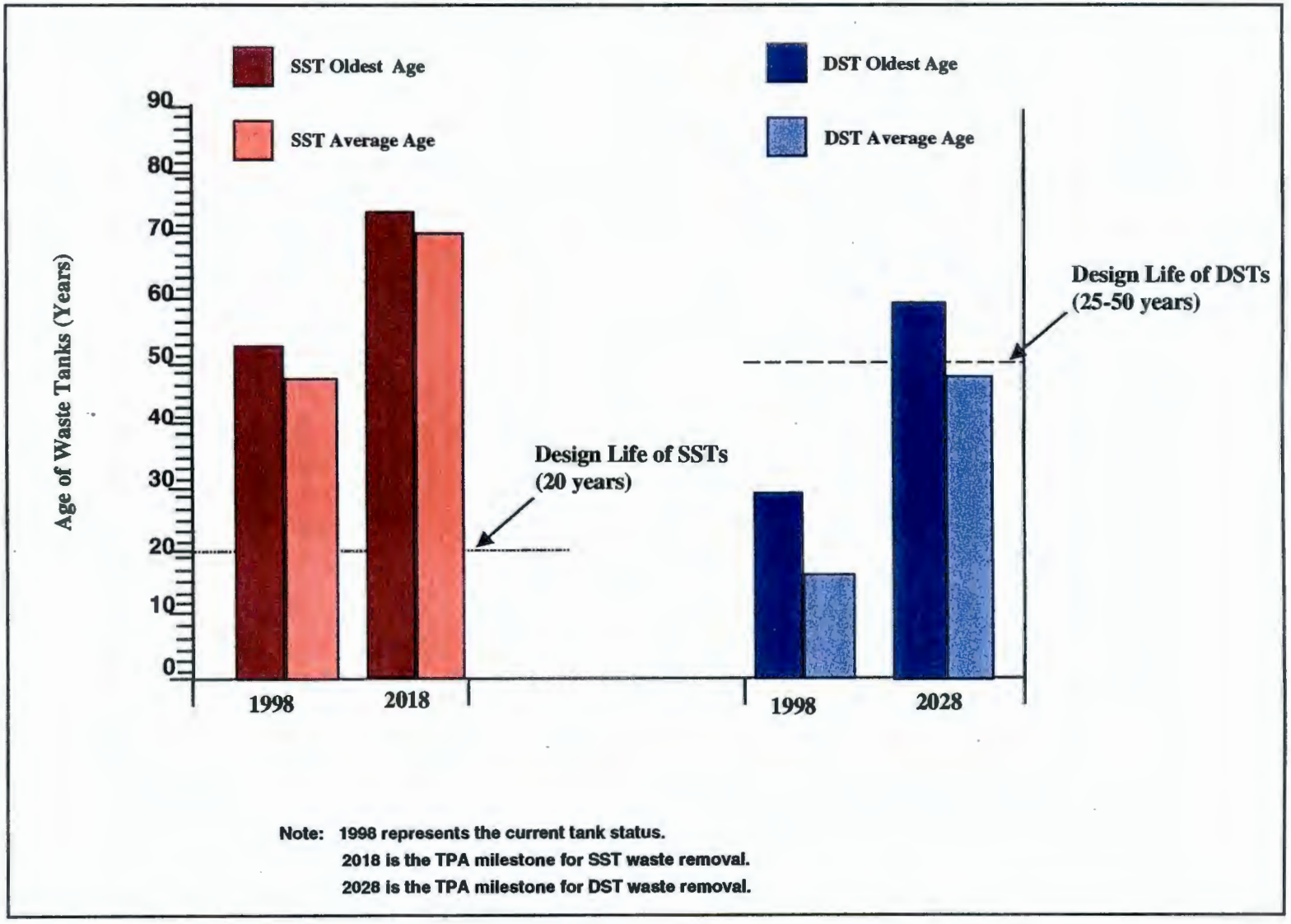


Figure 2-2. Delay of Tank Waste Disposal Poses Risk of Tank Failures

Cleanup of the Hanford tank waste is of major importance for Hanford regulatory agencies and regional stakeholders. The Hanford Advisory Board, representing a cross section of stakeholders, has made tank cleanup, and specifically the privatization project, one of its top priorities.

2.1 Description of the Problem

Hanford's tank wastes present a serious safety concern to the environment, specifically the Columbia River, and, at the same time, to public and worker health and safety. These concerns exist because the tanks were intended for interim storage when they were constructed and were not designed to be permanent disposal facilities for the waste. To date, tank leaks already have resulted in nearly a million gallons of HLW entering the soil at the Hanford Site, and there is a constant threat of new leaks.

The Washington State Department of Ecology (Ecology) and other stakeholders have emphasized the need to address the threat to the environment caused by contamination of the groundwater and the need to protect the Columbia River. In November 1997, DOE confirmed that contaminants from past tank leaks have moved further into the vadose zone toward the groundwater than previously believed and have undoubtedly reached the groundwater. The vadose zone is the soil and rock that lies between the Hanford tank farms and the groundwater. The vadose zone itself is heavily contaminated by previous disposal of low-level radioactive and hazardous liquid chemicals from plutonium processing, which were discharged into cribs, ditches, and ponds, as well as the leaks from SSTs. This contamination is illustrated in Figure 2-3.

The leaking of these SSTs and the aging of all of the tanks represent problems that compound with time until actions are carried out to eliminate the source of the problems. Even though no DSTs are known to have leaked as yet, they also will be soon exceeding their design life. DSTs represent the last available safe storage location for Hanford's tank waste, particularly for the liquid supernatant. Under current regulatory milestones, all waste, solid and liquid, is scheduled to be transferred from SSTs to DSTs by 2018. To achieve this schedule, some waste in the DSTs must be processed to provide space for SST waste. If DSTs begin to develop leaks, the urgency and magnitude of Hanford's tank waste management problem increase dramatically.

To prevent further releases to the soil, Hanford is currently carrying out a process of removing pumpable liquids from the SSTs. To date, 119 of 149 SSTs have had the pumpable liquids removed and transferred to safer DSTs. However, this pumping does not remove all of the liquid waste from the tanks, nor does it remove the waste solids from the SSTs. It will take several more years to pump the remaining 30 tanks, at which time all will be several decades beyond their design lives.

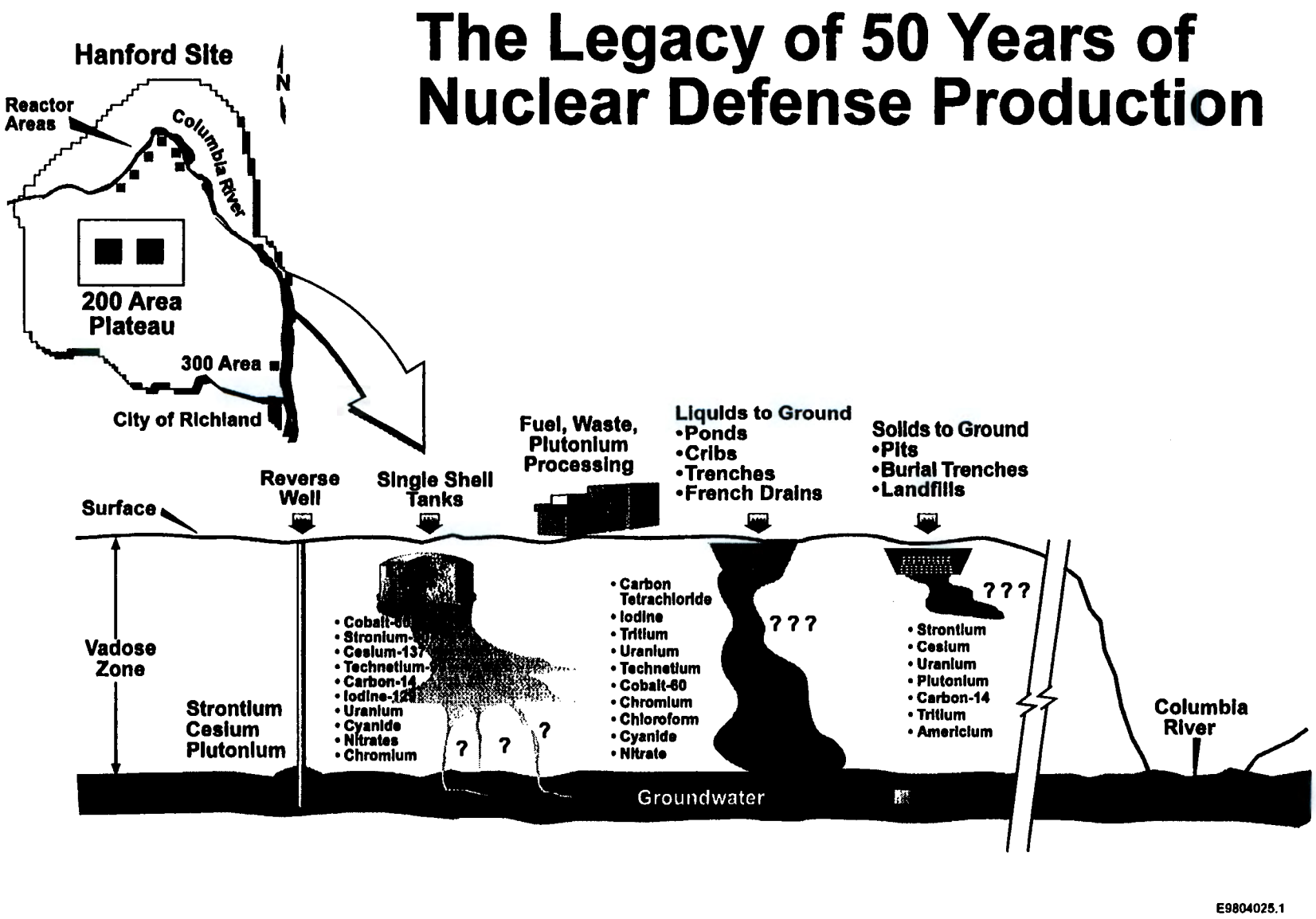


Figure 2-3. Tank Waste as a Source of Vadose Zone and Groundwater Contamination

The highly radioactive tank waste is viewed regionally as a long-term threat that requires near-term actions to be initiated to provide a permanent solution. The preferred solution is to remove the source of the problem by retrieving and immobilizing the waste, as currently planned in TWRS Phase I. Phase I has been designed to retrieve, treat, and immobilize approximately 10% by mass (and as much as 25% by radioactivity) of the tank waste, which will free up valuable tank space to transfer SST waste to DSTs.

2.2 Compliance Agreements

With regard to environmental and public safety issues, there are specific legal requirements that DOE must satisfy, as well as compliance agreements that DOE has signed, concerning the Hanford tanks. DOE, the U.S. Environmental Protection Agency (EPA), and Ecology have entered into the *Hanford Federal Facility Agreement and Consent Order* (also called the Tri-Party Agreement [TPA]). This agreement is intended to ensure compliance with the *Resource Conservation and Recovery Act* (RCRA) and the *Comprehensive Environmental Response, Compensation, and Liability Act*, as amended. The TPA sets forth certain requirements and milestones for cleanup activities at the Hanford Site, including cleanup of the tank waste. The major project milestones and their respective completion dates will be discussed in Section 5.4.

In providing waste treatment and immobilization services in Phase I, the contractors also are required to assure that treated HLW meets *Nuclear Waste Policy Act* requirements for deep geologic disposal. Additional requirements for LAW require that the treated LAW meets RCRA requirements for near surface land disposal. Treatment facilities also must meet state and federal requirements for public and worker health and safety.

2.3 Regulatory Context

The regulatory framework for the TWRS Phase I project requires compliance with existing laws and regulations and relies on, to the extent possible, established external regulatory authorities. The regulatory framework for execution of Phase I addresses a variety of objectives, including the following:

- Compliance with the TPA;
- The need for regulatory stability and consistency; and
- The need to achieve improved effectiveness and efficiency in execution of regulatory requirements.

Except where regulatory authority is specifically reserved for DOE, or where regulatory compliance responsibility is established for DOE, DOE will not serve as the regulator or enforce regulatory compliance requirements. Where an external regulator assigns joint responsibility for regulatory compliance to DOE and the contractor, the contractor has primary responsibility and accountability to the external regulator. Where joint responsibility does not exist, the contractor has full responsibility and accountability to the external regulator. Based on the scope of work

and the applicable regulatory authorities, the planned regulators for this project include Ecology, the Washington State Department of Health, and the U.S. Department of Transportation, the EPA, as well as DOE. Continued participation by the U.S. Nuclear Regulatory Commission (NRC) is planned, and involvement of the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) is currently being addressed. The regulatory framework is outlined below.

2.3.1 External Regulation

For environmental protection, federal and state agencies will regulate the contractor in a manner similar to other facilities on the Hanford Site.

The external regulatory agencies and their specific roles are described below.

- EPA and Ecology will regulate and administer all permits for treatment and storage operations under the RCRA and the State of Washington *Hazardous Waste Management Act.*

- EPA, Ecology, and the Washington State Department of Health will regulate radioactive and non-radioactive air emissions.

- Ecology, the Washington State Department of Health, and/or local health agencies will regulate liquid effluents. Most contractor liquid effluents will receive final treatment at other, permitted Hanford Site facilities.

- Ecology and the U.S. Department of Transportation will regulate offsite transport of radioactive and non-radioactive dangerous wastes.

The OSHA, or DOE under its authority, will be responsible for regulating non-radiological safety and health concerns. If OSHA does not assume regulatory authority (per letter of May 13, 1998 from the OSHA Administrator to DOE), oversight of the contractor's non-radiological safety and health will be provided by DOE.

2.3.2 Regulation by DOE

DOE will regulate the radiological, nuclear, and process safety of the TWRS Phase I facilities through the DOE Office of Radiological, Nuclear, and Process Safety for TWRS Privatization (Regulatory Unit). This is a DOE organization that reports directly to the DOE Richland Operations Office (DOE-RL) manager with DOE Headquarters oversight. As such, the Regulatory Unit is independent of the TWRS program and is essentially autonomous within its range of regulatory authority.

Pursuant to the *Atomic Energy Act*, either DOE or the NRC serves as regulator for all radiological and nuclear safety regulation in the United States. External regulation by the NRC was desired by prospective Phase I private contractors and stakeholders as it was viewed as capable of providing more certainty and more predictable regulation than the traditional DOE order-based approach to safety. However, discussions with NRC confirmed that the Commission

could not provide independent regulation as quickly as needed under the DOE privatization planning. Furthermore, it appeared that NRC regulation required legislative action to confirm NRC authority to regulate the Hanford tank waste treatment.

To allow the project to proceed under a stable regulatory regime for nuclear and process safety, DOE established the Regulatory Unit; a staff of 17 full-time federal employees at Hanford. Additional support for the Unit is provided by DOE Headquarters and, in an advisory role, the Nuclear Regulatory Commission (NRC). This support is formalized by Memoranda of Agreement and Understanding between the cognizant DOE and NRC officers, specifically, the DOE Assistant Secretaries for Environment, Safety and Health; and Environmental Management; and the Director of Nuclear Materials Safety and Safeguards of the NRC.

Pursuant to the Memorandum of Understanding (MOU) between DOE and NRC (62 FR 12861), the NRC's participation during Phase I is primarily of a cooperative nature for the purposes of information transfer and assisting DOE in establishing a regulatory program that is consistent with the NRC's regulatory approach for protecting the workers, the general public, and the environment. To further this goal, NRC has formally assigned staff to coordinate with the Regulatory Unit of TWRS.

Accordingly, DOE arrived at a radiological, nuclear, and process safety oversight program to ensure maximum NRC involvement in accordance with the cited MOU. Under this approach:

- DOE will regulate radiological, nuclear, and process safety through a dedicated, independent Regulatory Unit whose sole focus and authority is the regulation of the design, construction, and operational safety regulation of the privatized TWRS contractor;
- Regulation will be consistent with the NRC's *Principles of Good Regulation* (NRC 1991);
- Regulation will not rely on the DOE order-based system unless specifically invoked through the contracts;
- Oversight of process safety will be conducted in a manner consistent with OSHA authorities;
- Regulation will be consistent with DOE nuclear safety rules; and
- Regulation will apply the concept of "tailoring" of controls to the work to be performed and associated hazards consistent with established standards.

To facilitate the regulatory transition to Phase II, the Memorandum of Understanding between NRC and DOE for Phase I calls for prompt identification and elevation of issues that could impact the design, construction, or operation of the Phase II plants. In addition, during this period, NRC is expected to issue its new draft 10 CFR 70 Rule, that would ultimately apply to the TWRS facilities, if NRC assumed regulatory oversight. DOE and its contractors will comment on this draft rule. The comment resolution process is expected to settle many areas of potential disagreement. The lead time for Phase II will allow the NRC to have the necessary legislative and regulatory framework to assume regulatory oversight.

Other DOE regulation will be for the protection of government assets (including waste to be processed) from theft or sabotage, and for the protection of classified information. Oversight of the contractor's safeguards and security program will be provided by the DOE-RL Safeguards and Security Division. The scope of the safeguards and security program includes physical protection, nuclear material control and accountability, information and personnel security, and government property protection.

2.4 TWRS Environmental Impact Statement

DOE issued an Environmental Impact Statement (EIS) (DOE 1996a) for the TWRS program and a subsequent Record of Decision (62 FR 8693) under the *National Environmental Policy Act*. In view of the complexity and remaining uncertainties of the TWRS program as a whole, DOE decided on a path of "phased implementation," whereby forward movement on the program would be in well-defined phases. This incremental approach allows for learning in each increment and for development of new information and new technologies. It also allows for refining program plans as new information is incorporated.

The phased approach being used to define the TWRS Phase I project, as well as subsequent work on TWRS, is consistent with the TWRS EIS and Record of Decision. Details on the implementation of this approach are provided in Section 5.

3 Privatization Concept for Hanford Tank Waste Treatment and Immobilization

In 1992, DOE formally established the TWRS program to ensure that highly radioactive tank wastes at Hanford would be stored, treated, and immobilized in a safe, environmentally sound, and cost-effective manner. Beginning in 1994, DOE embarked on a strategy to procure the services of private companies to treat and immobilize these tank wastes.

The contracts signed in September 1996 for TWRS Phase I with BNFL and LMAES reflected a DOE contracting strategy to purchase tank waste processing services at fixed-unit prices from contractor-owned and contractor-operated facilities at the Hanford Site on a demonstration basis. Under this privatization approach, DOE sought to achieve greater accountability and risk-sharing with the contractor(s) than under traditional DOE cost-reimbursement contracts. DOE also expected to achieve improved performance and fewer delays with this approach and to realize savings for American taxpayers over the life cycle of the TWRS Phase I project.

DOE's contracting approach on TWRS Phase I has evolved with time in order to adjust the realities of the vendor and financial markets, incorporate lessons learned on other projects, and consider feedback from stakeholders. A review of these changes in DOE's approach and the underlying reasons is important for the reader to understand the context of DOE's Part B decision. This section tracks the evolution of the approach.

3.1 Selection of Privatization for TWRS

The privatization contracting strategy for TWRS Phase I began as a concept in 1994 for a more efficient way to carry out the Hanford tank waste remediation mission. The idea was to make greater use of the technologies, demonstrated efficiencies, and management discipline of private industry to provide solutions to the Hanford tank waste cleanup challenge. Fundamentally, this approach sought to identify a portion of the total TWRS work scope (i.e., Phase I) that could be defined with sufficient certainty to enable fixed-price contracts to be signed and attract best-in-class contractors to bid competitively for that fixed-price work. This approach represented a new way of doing business for DOE, which had relied for decades on management contractors to conduct broad scopes of work under cost-reimbursement contracts. However, privatization in one form or another had been used successfully in other federal agencies, in state and local governments, and in other countries.

An analysis of TWRS, documented in *A Systematic Look at Tank Waste Remediation System Privatization* (Holbrook et al. 1996), was carried out in 1994 to 1995 to examine the feasibility of privatizing a portion of the TWRS work scope. That analysis suggested that a number of features would be advantageous in the contracting strategy. Among these features were:

- Phasing of the work—procuring only that portion of work for which a clear statement of work and input and output specifications could be written, and for which there were reasonably mature technologies to carry out the work;

- Competition to help ensure fair prices; and
- Well-defined interfaces with the site contractor.

A scope for Phase I was identified and approved by the Secretary of Energy in September 1995. That scope consisted of the TWRS functions of pretreatment, LAW immobilization, and HLW immobilization for a specified portion of the TWRS waste that was well-characterized and retrievable. DOE planned that two contractors would operate treatment plants in the proof-of-concept "demonstration" Phase I in order to preserve competition and provide additional opportunities for learning, which would be beneficial in Phase II. Phase II was left largely unspecified, but was understood to be the "production" phase, which would benefit by learning in Phase I, and again would have competing plants, which would be sized to complete the TWRS mission within TPA milestones.

The TWRS programmatic functions chosen for privatization in Phase I are shown in Figure 3-1. That figure also illustrates that several TWRS functions are not privatized, and those functions interface directly with the privatized scope. These non-privatized functions—tank farm operations, waste characterization, safety issue mitigation and resolution, waste retrieval, and waste product storage and disposal—were deemed not feasible for privatization, at least during Phase I, for reasons described in the TWRS feasibility report (Holbrook et al. 1996). These functions will be carried out by the Hanford Management and Integration (M&I) Contractor during Phase I. Fluor Daniel Hanford is currently the Hanford M&I Contractor.

DOE's goal was to issue a draft request for proposal (RFP) for comment by late in 1995, issue a final RFP early in 1996, and award contract(s) by the end of fiscal year (FY) 1996. During this time, DOE was refining its concepts for privatization, and in particular TWRS privatization, and establishing principles on which it would base the TWRS Phase I RFP. These principles expanded on the ideas identified in the earlier TWRS feasibility study and became an essential checklist as the TWRS privatization contracting strategy was further developed. These principles indicated that the solution should:

- Fulfill TPA requirements;
- Shift significant responsibility, accountability, and liability to private contractor(s);
- Make the private contractor(s) responsible and accountable for cost and technical performance;
- Provide for contractor-owned, contractor-operated plant;
- Assign responsibility for environmental protection and compliance to the contractor(s);
- Ensure worker and general public safety and health protection;

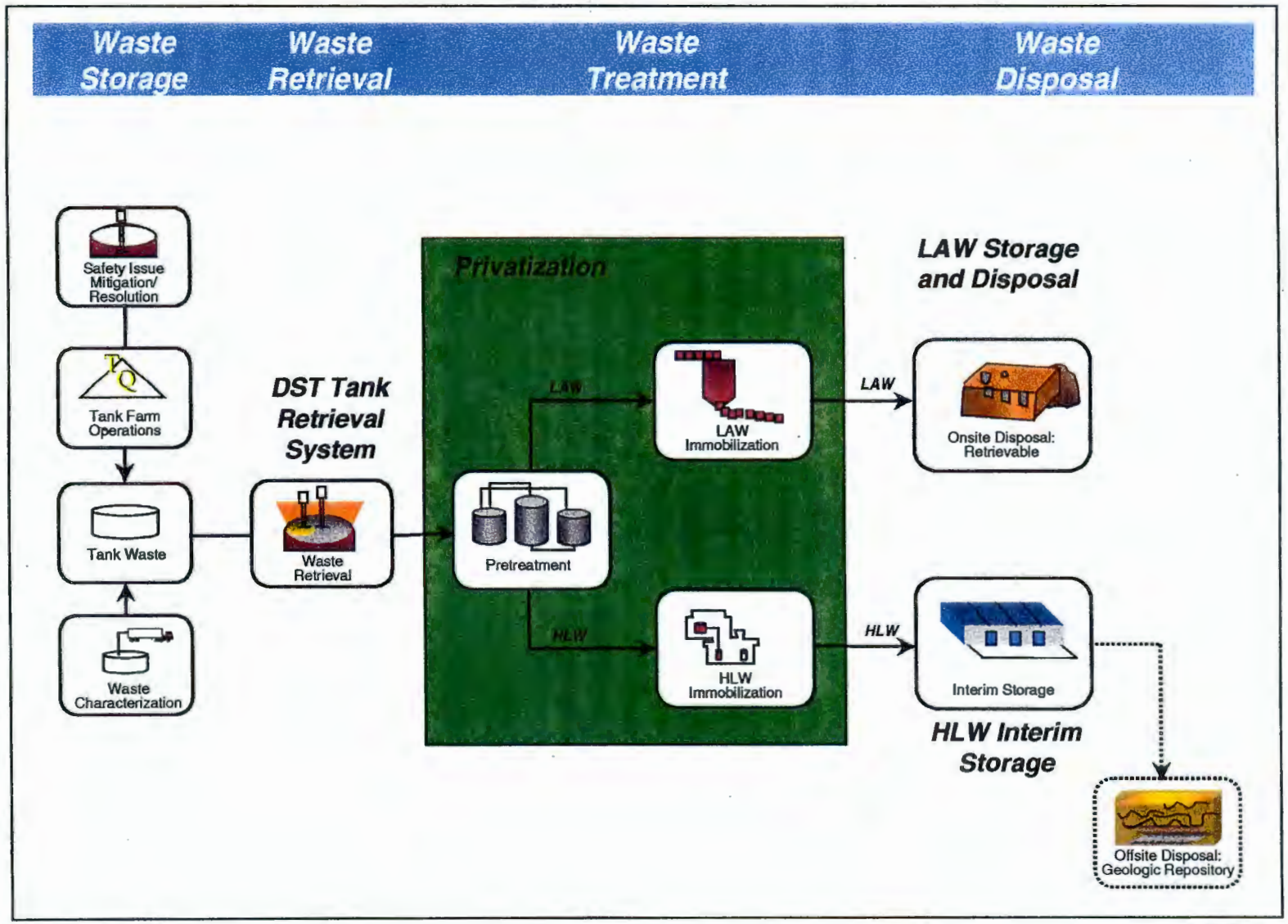


Figure 3-1. Division of Contractor Responsibilities for Tank Waste Remediation System

- Ensure government-purchased products and services meet performance specifications;
- Acquire products and services under fixed-price contract(s) after initial development period;
- Establish competitive framework for cost control;
- Reduce life cycle costs compared to traditional contracting approaches;
- Initiate phased learning and continuous improvements starting with demonstration plants; and
- Ensure contractor(s) possess sufficient technology to carry out work, while DOE focuses on high-risk, high-payoff technology development.

These principles are still embodied, in whole or in part, in the TWRS contracting approach. DOE is not treating these principles as a rigid framework, but is using them as a guide in adjusting for lessons learned, and to tailor the contracting approach to arrive at the best contract vehicle for TWRS Phase I.

3.2 Evolution of the TWRS Privatization Approach—Part A Contracts

The TWRS Phase I draft RFP was issued in November 1995 (DOE 1995), and DOE actively solicited comments in writing and at vendor and public meetings on that draft. In addition, DOE made extensive use of private sector financial advisors during this time frame. Some of that input and feedback resulted in significant refinements in DOE's contracting approach. Among these refinements were the following changes.

- *Clarification by DOE of the regulatory environment in which the private contractors would function.* This led to the formation of the TWRS Regulatory Unit, a separate DOE-Richland Operations Office (DOE-RL) organization independent of TWRS, to regulate the Phase I contractors for radiological, nuclear, and process safety (see Section 2.3). The Regulatory Unit has sought to adopt applicable NRC concepts and principles and have NRC staff assigned to coordinate with the Regulatory Unit pursuant to an MOU between DOE and NRC.

- *Introduction of the concept of waste feed envelopes.* This approach provided the contractor increased assurance that the waste feeds they would be required to treat and immobilize would fall within predetermined and agreed-upon compositional and radionuclide limits. This approach also gave DOE enhanced flexibility in how it might choose to deliver waste to the contractors. Prior to the proposals for Phase I, DOE defined three LAW feed envelopes (Envelopes A, B, and C) of supernatant waste that would demonstrate different waste processing capabilities of the contractors' facilities, and the Department developed one high-level waste feed envelope (Envelope D) to demonstrate vitrification of a slurry feed. These were refined during Part A contract negotiations.

- *Increased emphasis on defining clearly the interfaces that the private contractor would have with DOE or with the Hanford M&I Contractor.* This led to the development of Interface Control Documents, which defined the roles and responsibilities of all parties at interface points (see Section 5.3).

- *Managing without meddling.* Feedback from the vendor marketplace indicated that DOE would have to modify its traditional management approach to reap the benefits of a privatization strategy. It became clear that DOE would have to play a less directive role than it normally used in cost-reimbursement-type, DOE-financed projects (e.g., Management and Operating [M&O] contracts) to take advantage of the incentives and efficiencies of private industry. An additional concern would be that performance risks would be shifted in part back to DOE. To achieve the needed balance in this area, DOE borrowed the concept of Integrated Product/Process Teams from the defense and aerospace industry to provide for non-intrusive monitoring of progress by DOE and a mechanism for contractors to obtain needed information from the Department.

- *Split of TWRS Phase I into two parts, Part A and Part B.* Feedback from potential bidders to the draft RFP emphasized that it would not be possible to establish fixed-unit prices or to secure private financing until at least after a design phase. A 20-month Part A period was developed in response to this feedback. Each contractor would be paid a fixed price of $27 million for submittal of acceptable Part A deliverables. Contractors would be evaluated to determine whether they should be authorized to proceed to Part B based on viability and best-value assessments performed by DOE upon receipt of the contractors' Part A deliverables. (See Appendix A for additional detail on these assessments.)

The final RFP for TWRS Phase I, which included these and numerous other changes in response to comments on a draft version, was issued in February 1996 (DOE 1996b). DOE had intended to select two or more contractor teams for Part A and down-select to zero, one, or two contractors to proceed to Part B. Two bids were received from teams led by BNFL and LMAES in May 1996. Contracts with both contractor teams were signed in September 1996.

Key lessons learned from the bids and negotiations on the Part A contracts are listed below.

- *Need for an equitable risk allocation.* In the early stages of developing the Phase I contracting approach, DOE recognized that privatization is effective in shifting significant performance risk to the contractor, but some risks would have to remain with DOE. For example, DOE recognized that the private sector would not accept the risk of potential fluctuations in yearly budget appropriations. In addition, DOE recognized the need to absorb the risks associated with its own performance in areas such as waste characterization and preexisting conditions.

- *Nuclear waste processing plants are not likely to be temporary plants.* Another major lesson that DOE learned in negotiating the Part A contracts is that safety and financing considerations limited the possibility of having contractors build "temporary" plants (those with useful lives consistent with the Phase I schedule, approximately 10 years) to process high-level tank waste. Based on the need for a conservative, seismic-resistant design, and

with input from the financial communities, both Part A contractors proposed more robust, capital-intensive facility designs than originally envisioned by DOE, with plants having a useful life of nominally 30 years. This required a change in philosophy from the original "throw-away" demonstration nature of the plants. The capital funding requirements for these plants increased substantially as a result of this change (see Section 5.6).

3.3 Evolution of the Privatization Approach—Part B Proposals and Implications

The Part A contracts authorized the contractors to propose "enhancements" in technical, business and finance approaches to benefit the contractors as well as the government. The Part A deliverables, which included the proposed enhancements for Part B, were received in January 1998, and provided DOE with additional insight on the type of agreement that the government could expect to negotiate with private industry for TWRS Phase I.

Overall, the January 1998 proposals for Part B indicated that the private sector was not yet in a position to guarantee fixed-unit prices for Part B services. Both contractors maintained that better definition and quantification of project risks were required before they could make the corporate commitments necessary to put their financial resources at risk and attract third-party financing. Issues needing clarification by one or both contractors fell into the following four areas:

- The need to delay the establishment of fixed-unit prices and corporate financial commitments until a later point in the design process;
- The need to minimize concurrent design and construction;
- The need for a combination of public and private financing; and
- The opportunity for Phase I expansion.

Both contractors contended that the regulatory framework for radiological, nuclear, and process safety, permitting requirements, and project design needed additional development to reduce project uncertainties. Although the original concept of TWRS privatization assumed that fixed prices and private financing could be secured at the end of the conceptual design phase (Phase I, Part A), this assumption proved incorrect. Neither contractor was willing to commit to firm fixed prices at the end of Part A without adding significant contingency to their prices. Both contractors recommended subdividing the next phase of the project (Part B) into two or more parts, and one contractor indicated that the division of Part B into two parts—(1) a continuation of the design phase lasting 24 months and (2) a construction and operations phase—would substantially reduce the risk premiums and contingencies required to commit to fixed-unit prices. This approach was also viewed as enhancing the contractor's ability to secure private financing. DOE determined that this two-phase approach to Part B would strengthen the feasibility and economics of the TWRS project.

Both contractors indicated that concurrent design and construction needed to be minimized so that Phase I plants could be financed and built. Accordingly, both contractors proposed less aggressive schedules than originally requested.

The contractors indicated that the feasibility of the project's financing and the overall economics of the transaction would be improved by establishing an appropriate mixture of private and public financing instead of the original concept of 100% private financing. For example, the government could effect a decrease in the interest rate charged by project lenders or could favorably influence the prospects for project financing by the private sector, by providing a credit enhancement in the form of a backstop or support for the debt portion of the project's financing.

One proposal also suggested that the 30-year facilities could be expanded for a limited additional investment to process a significantly greater portion of the Hanford waste than originally anticipated in Phase I of TWRS. The expansion capabilities and additional processing capabilities of the Phase I facilities offer potential new opportunities for achievement of the total TWRS mission.

3.4 Development of an Optimal Contracting Approach for TWRS Phase I

DOE's approach for TWRS privatization, both technically and contractually, has evolved considerably to accommodate information gained during and after the first two years of the project. These modifications in approach have been made in coordination with DOE's Contract Reform and Privatization Project Office, which is using the experience on TWRS to refine its overall approach to privatization of cleanup projects.

In designing and implementing the path forward for TWRS, DOE is establishing a contract structure that provides strong incentives to achieve project schedule, cost, and performance goals while minimizing total project cost to the government. Thus, DOE is seeking to structure an optimal contracting approach for TWRS Phase I that will:

- Allocate risks to the party best able and motivated to manage them;
- Obtain the best mix of private and public financing; and
- Maintain appropriate decision points to adjust project direction in response to new information and to bring competitive pressure to bear on project costs and approaches.

Each of these principles is discussed below. Together, these principles have guided DOE's negotiation for TWRS privatization services and will continue to guide refinements as that strategy is implemented.

3.4.1 Risk Allocation

Privatization contracts differ significantly from traditional cost-reimbursement contracts in their allocation of risks between the government and the contractor. Under privatization, the

contractor assumes a far greater share of risks, particularly those under the contractor's control such as technology performance and operating efficiency. Under the TWRS contract, DOE has sought to allocate specific risks to the party that is most able to manage the risk.

DOE has evaluated a broad spectrum of risks that are potentially relevant to risk allocation decisions in privatization contracts. These risks are depicted in Figure 3-2. In general, any specific risk will be assigned to a party or it will be shared.

The allocation of risks has a direct bearing on the incentives the contractor faces and ultimately on the total cost of the project. The assignment of all risks to the government (a cost-reimbursement approach) leads to a very high total cost to DOE because of ineffective performance incentives for the contractor. This is in part because the scope and schedule are not defined in adequate detail when the project is planned. In addition, in this type of arrangement, the contractor has little incentive to control costs and schedule. As a result, substantial cost growth has occurred in past projects of this type as documented in GAO (1997) and a draft Pacific Northwest National Laboratory report, *DOE Cost Savings from Private Contracting?*

However, a complete assignment of risks to the private contractor would lead to very high total cost to DOE because of the risk premium that the contractor would charge for taking on risks that it was not equipped to control. At this extreme, the allocation of risk would lead to an infeasible solution where private financing could not be obtained. A middle ground will lead to savings in total cost to DOE. This concept is illustrated in Figure 3-3.

3.4.2 Benefits of a Mix of Private and Public Financing in the TWRS Case

Based on contractor responses and other market indicators in the past two years, DOE determined that full private financing of Phase I, Part B may be difficult to achieve at affordable levels and began an analysis of options for mixing private financing with government financing. This section examines the tradeoffs associated with the government assuming a greater role in the project's financing and describes the intent of the financing optimization process planned in the next phase of the TWRS contract. The specific financing approach embodied in the proposed BNFL contract is discussed in Section 5.2.1

The TWRS privatization approach was spurred by the concern that DOE's traditional cost-reimbursement contracting approach would likely result in cost overruns and schedule slippage. Since the source of financing is a critical ingredient to making privatization effective, DOE is exploring a number of options that the government can take to mitigate the risks of the project and effect savings in the financing costs. In its analysis, DOE has recognized that even though the government's interest rate is significantly lower than the cost of raising capital in the private sector, the potential for cost growth and schedule delays (as demonstrated by past DOE projects) in the government's traditional financing of cost-reimbursement contracts outweighs the private sector's higher cost of capital. On the other hand, the risks associated with 100% private financing may increase the financing costs so much as to make the project unaffordable or infeasible. Between these two financing extremes may be a balance of risks such that the project is both affordable and financially feasible.

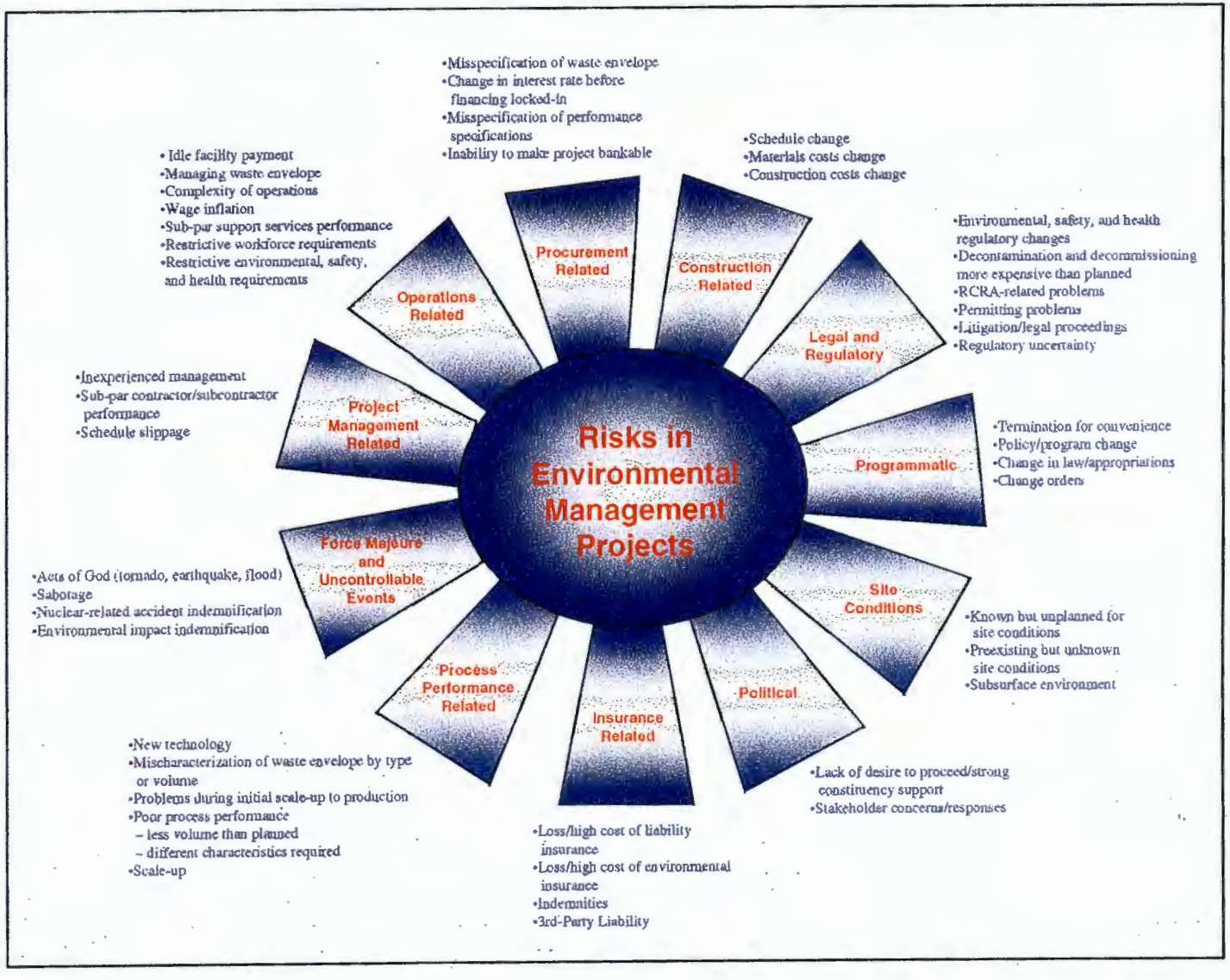


Figure 3-2. Risks in Environmental Management Projects

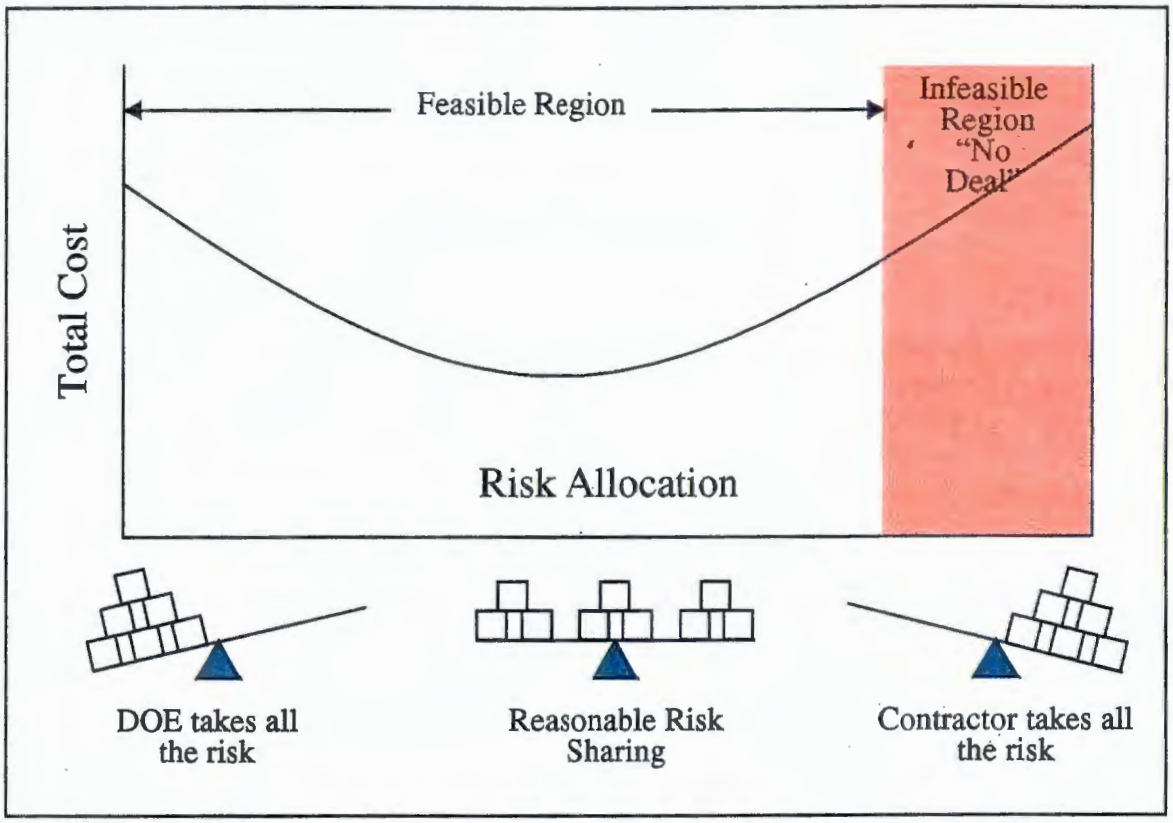


Figure 3-3. Risk Sharing Leads to Optimal Contracting Approach

In determining the appropriate allocation of public and private financing, it must be recognized that focusing on interest rate comparisons of government debt versus private debt oversimplifies the process of allocating risks and responsibilities between the government and its contractor. Since the source of financing is an integral part of the overall project risk allocation, the allocation process needs to preserve the key benefits associated with private financing, including the inherent performance incentives and the requirements of third-party lending sources. These benefits are discussed below.

- *Incentives Associated with Private Financing.* Under traditional government cost-reimbursement contracting approaches, the government assumes a significant degree of the risks of project completion and performance. Proponents of private financing point to the built-in incentives associated with having a contractor's money at risk. In these structures, the team members' participation, as equity providers, is a critical tool in allocating risk because, if the project were to fail, the team would lose its equity investment. This factor is a strong incentive for the team to bring the project to completion on time and under budget in accordance with performance specifications.

- *Requirements of Third-Party Financing Sources*: The presence of third-party financing imposes added structure into the project's planning, construction and operations, thereby ensuring a higher probability of success within budget. Lenders often require very specific terms and conditions in contract documents and introduce additional project oversight. For

example, lenders monitor project performance closely, ensuring that, among other things, construction is proceeding on time and within budget specifications.

Participation by the government in a project's financing has a direct bearing on the nature and impact of the benefits described above. Full public financing using traditional cost reimbursement shifts the risks for project performance to the government and results in relatively weak performance incentives. Accounting for these risks complicates the direct comparison of public and private financing options. The true cost of government financing is not reflected in the government's interest rate and budget authorization estimates and often will not show up at all in economic analyses of the project. However, just as an insurance company experiences claims on risks it covers, the government will experience the cost of absorbing the contingent liabilities associated with project cost overruns and schedule delays. As noted above, traditional government financing approaches lack many of the built-in incentives and controls of the private financing approach, increasing the likelihood of problems.

Government financial participation can occur in many ways besides direct financing. As a general rule, the method and magnitude of this participation should depend on the unique requirements of the project and should serve to enhance the project's ability to raise private financing. A range of options exists for government involvement between the extremes of totally private or totally government financing as described in the Pacific Northwest National Laboratory draft report, *Privatization Financing Alternatives: Blending Private Capital & Public Resources for a Successful Project.*

Some options can build government participation on commercially available financing to improve the project's attractiveness to private lenders. In some cases, incorporating one or more of these alternatives is necessary simply to make the privatization project feasible.

3.4.3 Decision Points for Project Optimization

The TWRS privatization project is novel and complex and still has uncertainties to resolve. DOE firmly believes that the best approach is to proceed with the project but move forward using discrete steps and explicit decision points. The intent of this approach is to:

- Make iterative refinements in project requirements and directions to accommodate new information (both technical and financial); and

- Maintain competitive pressure on the privatization contractor(s) to ensure peak performance and reasonable prices.

The TWRS EIS and Record of Decision identified the need to proceed with a phased approach. The Record of Decision made specific commitments to conduct formal evaluations of new data and information under DOE NEPA regulations at three key points during the course of Phase I, with an appropriate level of public involvement, and after seeking the advice of independent experts from the financial and scientific community. These evaluations will occur prior to:

- Proceeding to Phase I, Part B;

- Start of hot operations in Phase I, Part B; and
- Proceeding to Phase II.

DOE also concluded that the level of uncertainty with respect to design, financing, and regulation at the end of Part A was such that fixing prices would require an excessive price to compensate for the risk faced by the contractor. Thus, a design phase (referred to as Part B-1 in the contract and introduced in Section 5 of this report) was defined to reduce this uncertainty and to provide DOE with various reviews and decision points prior to proceeding with construction and operations. The design phase will allow time to verify technology performance on Hanford-specific wastes and to optimize debt and equity arrangements and technical requirements. Uncertainties about permits and the regulatory environment also would be greatly reduced.

4 The Decision to Proceed

DOE's review of the contractor deliverables for Part A led to the following decisions.

- The LMAES proposal was judged to be non-viable because the technical approach had an unacceptably high technical risk in attaining DOE's cleanup goals. DOE did not extend the LMAES contract, which expired on May 25, 1998.

- BNFL's proposal was judged viable because the technical approach was sound and the regulatory approach was reasonable. The business and financial terms were not acceptable as originally proposed and were addressed in subsequent negotiations.

- DOE negotiated with BNFL to seek services for both LAW and HLW immobilization. The technical scope of work was generally consistent with an "enhanced proposal" offered by BNFL.

This section summarizes the distinct decisions that support DOE's authorization to proceed with Part B of the TWRS Phase I project. First, the contractors' January 1998 proposals are summarized along with the changes in the original 1996 contracts that were proposed and selected for further evaluation. Next, the evaluation and selection of the BNFL proposal is described. Then, the decision to include HLW services as well as LAW services is addressed. The details of the final negotiated agreement with BNFL are provided in Section 5.

To ensure that the path forward for treatment and immobilization of tank waste was the best possible, DOE developed and implemented a systematic decision process to evaluate contractor deliverables. (See Appendix A for a detailed description of the decision process.) This process focused on the three criteria defined in the original RFP:

- Meet Phase I, Part B contract requirements;
- Perform Part B services for a reasonable price; and
- Provide best value to the government.

In addition, the decision process included a determination of the readiness-to-proceed of key supporting organizations (i.e., DOE-RL, the TWRS DOE Regulatory Unit, and the Hanford M&I Contractor) and whether the impact of the contractor approaches remained bounded by the TWRS EIS under the *National Environmental Policy Act*. Review teams, including numerous experts from private industry, academia, national laboratories, and DOE contractors, also reviewed the basis for the decision and the decision itself (see Appendix B). Individuals with specific expertise in nuclear waste management, nuclear engineering, nuclear safety, project finance, cost estimating, complex construction management, privatization contracting, glass and vitrification technology, chemical and process engineering, radiochemical process design, decision modeling, economics and public policy, and systems management were included on the review teams. These reviews examined the decision at multiple levels of detail (e.g., from overall decision to specific details of readiness-to-proceed assessments and specific financial modeling).

4.1 Description of Contractor Approaches

The following sections describe the contractors' proposals contained in their January 1998 Part A deliverables. In preparing the Part A submittals, the contractors were encouraged to propose enhancements to the contract that they believed would provide a better overall value to the government. BNFL proposed a series of enhancements as an alternate proposal, as described below in Section 4.1.2. LMAES did not propose technical enhancements to the contract. Instead, LMAES proposed an "alternative pricing approach" that would use a cost-reimbursement contract for much of the proposed work.

4.1.1 LMAES' Approach

LMAES proposed an approach with several innovative, but untested technologies. Those technologies and their previous applications are shown in Table 4-1. The LMAES technical approach proposed to use a liquid-fed, high-temperature, ceramic melter for LAW immobilization; cold crucible melter for HLW immobilization; and ion-exchange, ozonation, and electrochemical processing for radionuclide removal. LMAES also proposed use of a contact maintenance approach for its LAW vitrification process. Contact maintenance can reduce facility costs (because of reduced shielding requirements), but would require additional separation processes to limit radiation exposure to workers. The additional separation processes proposed by LMAES were generally unproven for application with Hanford waste.

The LMAES business approach included numerous companies providing basic services to a Limited Liability Corporation. No member, including the Project Manager, LMAES, would have a controlling vote. The Project Manager would not be liable for the actions of first-tier subcontractors. The Limited Liability Corporation would have an executive management council comprised of Lockheed Martin Corporation (chair), Fluor Daniel Inc., COGEMA, and AEA Technology. LMAES proposed to provide the project management and systems integration elements as a subcontractor to the Limited Liability Corporation.

LMAES divided the work into 13 job lots and proposed to conduct work on a fixed-price basis for only three of those job lots. The remaining work would be performed on a cost-reimbursement basis. For example, under the LMAES proposal, fixed-unit prices for treated waste would not be set until at least one year after the hot start of the facility. LMAES proposed to recover project costs for design, construction, and startup whether or not their facility successfully processed waste.

4.1.2 BNFL's Approach

BNFL proposed mature technologies for treatment and vitrification of the wastes, including use of a liquid-fed, low-temperature, ceramic melter based on the same technology used for HLW vitrification at the West Valley Demonstration Project in New York and the Defense Waste Processing Facility at the Savannah River Site in South Carolina. The proposed pretreatment technologies, including ion exchange, precipitation, and isotopic dilution, also have been applied at other facilities in the United Kingdom, Belgium, France, and Japan. Table 4-1 shows BNFL'S proposed technologies for key treatment functions and their previous applications.

The BNFL team, as described in its Part A deliverables, is composed of BNFL Inc., BNFL Engineering Ltd., Bechtel National Inc. (Bechtel), GTS Duratek, and Science Applications International Corporation (SAIC). BNFL will be the prime contractor and majority owner of the special purpose corporation proposed for Part B. In addition, BNFL will be responsible for project management and integration, regulatory and nuclear safety management, and operations management.

BNFL submitted a proposal incorporating fixed-unit prices and also prepared a series of enhancements as an alternate proposal. The separate elements of BNFL's alternate proposal along with a summary of their merits are described below.

- *Design Phase.* BNFL indicated that a design phase was needed to achieve an adequate basis for setting reasonable fixed prices. Establishing fixed prices earlier would result in substantially higher prices because of the risk involved. The design phase was needed to obtain private financing and BNFL equity commitment. This phase does not represent a delay in the project; rather it delays the point at which fixed-unit prices are set until the end of the design phase. DOE determined that waiting to set fixed prices until completion of the design phase would substantially lower prices.

- *Capacity Expansion/Extension.* BNFL proposed several features in its design that would support future capacity expansion and/or extension of operations. Those features would potentially allow the facility to process a large percentage of the Hanford waste over the useful life of the facility. BNFL's pretreatment facilities were sized to accommodate a capacity increase of 100% at little, if any, additional cost. The HLW vitrification facility was designed with sufficient space for two melters. Only one melter was required for the minimum-order quantity specified in the BNFL contract. A second, larger melter could be added to increase the initial Phase I capacity (by greater than a factor of four). The LAW vitrification facility was designed with the connections and flexibility in common support systems to add a second LAW facility with capacity similar to that of the Phase I facility.

  BNFL estimates that those capacity expansions would cost an additional $800 million in construction funds (in FY1997 values) and start expansion of the facility around 2011 to be completed in time for extended processing. If implemented, BNFL contends the expanded facility could enable immobilizing the waste in the 85 highest risk tanks by 2028. The waste in those tanks would account for 55% to 65% (by mass) of the total tank waste and approximately 95% of the long-lived radionuclides that would be mobile in the soil in case of a leak.

Table 4-1. Major Applications of Treatment Technology Proposed by BNFL and LMAES

Treatment Function	BNFL		LMAES	
	Technology Proposed	Application History	Technology Proposed	Application History
LAW Concentration	Evaporation	Evaporation of alkaline supernatant at Hanford since the 1950s and at Savannah River since the 1960s	No Evaporation Proposed	Not applicable
Solid/Liquid Separation	Ultrafiltration/ Cross-Flow Filtration	Ultrafiltration/cross-flow filtration used at Enhanced Actinide Removal Plant at Sellefield, United Kingdom	Centrifuge, High Shear Rotary Filter	Centrifuges used for gross separation at Hanford's AR Vault facility and in France for uranium processing No known applications of high shear rotary filter used in nuclear production industry
Cesium Removal	Elutable Ion Exchange SL-644	Elutable ion exchange used at Hanford's B Plant in 1970s Non-elutable ion exchange used at Hanford's B Plant in the 1970s and West Valley in the 1980-90s on chemically similar wastes	Elutable Ion Exchange Electro-Ion Exchange Membrane Ion Exchange	Elutable ion exchangers used in nuclear waste processing Electro-ion exchange in initial development stage for cesium removal No known applications of membrane ion exchange used in nuclear waste processing
Strontium/ Transuranic Removal	Strontium-Nitrate Isotopic Dilution	Used in Hanford's B Plant to enhance recovery of strontium-90 from retrieved Hanford tank wastes	Ozonation	Ozonation tested on radioactive laboratory-scale at Hanford for organic de-complexation, but inefficient
	Iron-Nitrate Precipitation (Ferric Floc Precipitation)	Used at Enhanced Actinide Removal Plant for transuranic recovery from liquid wastes. Similar physical process at Hanford and Savannah River for the settling of transuranic in alkaline Plutonium-Uranium Extraction Facility wastes	High Shear Rotary Filter	No known applications of high shear rotary filter used in nuclear production industry
Technetium Removal	Elutable Ion Exchange SL-639	30,000 gallons of Hanford tank waste treated in 1960. Continued research on use of anion exchange to recover technetium from Hanford wastes	Electro-Reduction for Technetium Recovery Electrodialysis for technetium purification	Technology tested on radioactive laboratory-scale only–results unclear

Table 4-1. Major Applications of Treatment Technology Proposed by BNFL and LMAES (continued)

Treatment Function	BNFL		LMAES	
	Technology Proposed	Application History	Technology Proposed	Application History
Cobalt and Europium Removal	Not Needed	Not applicable	Not Identified	Limited studies for wastes similar to tank wastes, but unknown if relevant to LMAES technology
LAW Vitrification	Liquid-Fed Ceramic Melter–Low Temperature, 1,100 to 1,200 °C	Technology used for HLW vitrification at West Valley Demonstration Project and Defense Waste Processing Facility. Also demonstrated at Pamela Facility in Mol, Belgium; Radioactive Liquid-Fed Ceramic Melter at Hanford; and a demonstration melter in Tokai Reprocessing Plant, Japan Some LAW processing has been completed by Duratek at Savannah River, M-Area	Liquid-Fed Ceramic Melter–High Temperature, 1,250 to 1,350 °C	Transportable vitrification system with small-scale melter incorporating some design features of proposed melter has been tested at Oak Ridge National Laboratory. Some innovative features are undemonstrated
LAW Maintenance Approach	Remote Operations Using Manipulators	Used at West Valley Demonstration Project, Defense Waste Processing Facility, United Kingdom, and France	Contact Maintenance	Not used in radioactive applications with highly volatile processes
HLW Concentration	Cross-Flow Filter for Supernatant Separation	Cross-flow filtration used at Enhanced Actinide Removal Plant at Sellefield, United Kingdom	Centrifuge	Centrifuges used for gross separation at Hanford's AR Vault facility and in France for uranium processing
Feed Preparation	Blending/ Evaporation	Process similar to that used in the West Valley and Defense Waste Processing Facility Projects for feed concentration	Acidification/ Blending	AVH Calciner used in the French R-7 and T-7 vitrification plants, with acidified feeds; some simulation work on Hanford-type wastes
HLW Vitrification	Liquid-Fed Ceramic Melter	Technology used for HLW vitrification at West Valley Demonstration Project and the Defense Waste Processing Facility. Also demonstrated at Pamela Facility in Mol, Belgium; Radioactive Liquid-Fed Ceramic Melter at Hanford; and a demonstration melter in Tokai Reprocessing Plant, Japan	Cold Crucible Melter	70% scale melter tests performed with simulated HLW. Small-scale cold crucible melter used in LAW vitrification in Russia

- *Treatment of Entrained Solids.* BNFL proposed to process entrained solids (along with separated strontium and transuranic waste) rather than return them to DOE, on a case-by-case basis. DOE benefits from this enhancement by not having to receive and store this intermediate waste product in a separate DST, thus keeping that DST available for other storage needs. DOE retains the option to receive the entrained solids if it determines it does not want to pay additional costs.

- *Sludge Wash in Pretreatment.* BNFL proposed to use an ultrafiltration system (part of its base facility design) to separate suspended solids from HLW feed streams. This step would eliminate the need for DOE to provide a less efficient in-tank sludge washing step. The primary benefits to DOE are: (1) elimination of the approximately 924,000 gallons of LAW volume that would be produced by in-tank sludge washing and the need to store this waste (approximately equivalent to the capacity of one DST); (2) reduction of the cost of the Hanford M&I Contractor performing in-tank sludge washing, estimated to be up to approximately $6 million; (3) reduced risk to DOE of meeting feed specifications for certain waste streams; and (4) availability of sludge washing capability for treatment beyond the current contract term.

- *Phased Construction and Startup.* BNFL indicated that by phasing the construction and startup of pretreatment, HLW vitrification, and LAW vitrification, earlier hot start can be achieved, compared to its base proposal. Compared to BNFL's base proposal, this enhancement proposed early dates for hot start of pretreatment, hot start for HLW vitrification, and hot start for LAW vitrification. The primary benefits of this enhancement to DOE are: (1) earlier pretreatment reduces DST storage requirements for the initial years of operation; (2) earlier payment reduces private contractor financing costs and prices to DOE; and (3) sequential testing and startup reduce technical risk.

- *Extended Base Operating Period.* BNFL also proposed an increased minimum-order quantity that would extend the base operating period from 5 years to 10 years. BNFL indicated that this change would lower treatment costs by reducing performance risk (i.e., a longer base operating period would provide more recovery time if problems occur in the first few years of processing).

BNFL's alternate proposal was evaluated to be superior to its base proposal. Based on the above results, all elements of BNFL's alternate proposal were accepted for comparison with other possible programmatic approaches and as a basis for negotiations.

4.2 Evaluation of the Contractors' Approaches

To support its decision to proceed with Part B, DOE conducted a systematic review of all deliverables from Part A. The evaluation of those products led to an initial determination of the viability of each contractor to meet Part B requirements and identified issues to be addressed during negotiations. The review also identified areas of concern for both teams. Therefore, in considering the viability of the two contractors, consideration was given to the features of the proposed approaches that could be refined through negotiations.

The technical viability assessment considered whether proposed technologies are likely to work. The primary consideration in assessing technical viability was the demonstrated maturity of the technologies, process flowsheets, and facility designs. The findings from this review are summarized below.

LMAES was judged to not be viable because the technical approach had an unacceptably high technical risk in attaining the DOE's cleanup goals. The LMAES contract deliverables did not provide sufficient evidence that the contractor could, with a high degree of confidence, successfully treat Hanford tank waste using the proposed technical approach in a timely manner. The LMAES approach uses numerous technologies that are research and development in nature. The approach was judged by DOE (and a group of external experts who assisted DOE with its review of the proposed waste treatment technology of both contractors) to be too risky and require substantial, additional development work. In DOE's judgment, the LMAES facility configuration and technical approach would likely undergo substantial change prior to the time that a waste treatment facility would be operational.

This determination by DOE was subjected to two outside reviews: one chartered by DOE-RL, and the second chartered by DOE Headquarters. (The review process and expertise of these reviewers are described in Appendix B.) Those reviews, while finding minor differences with the DOE determination, agreed on the central issue that the LMAES approach had an unacceptably high technical risk.

BNFL was judged viable because the technical approach was sound and the regulatory approach was reasonable. The business and financial terms were not acceptable as proposed and were addressed in subsequent negotiations. In general, the technologies chosen by BNFL for treatment and immobilization are mature, robust, and reliable and have resulted in a conservative process approach. In addition, the development requirements for the selected technologies were understood and identified, and a development program addressing those risks was clearly defined.

The independent review (see Appendix B) led to some refinements in the assessment of BNFL technologies and concurred with the determination that BNFL is viable for Part B. The independent review expressed some concern with the technology for technetium separation and suggested DOE should undertake a development program in parallel to that of BNFL.

DOE entered into negotiations with BNFL for both LAW and HLW treatment services. The Part A contracts provided for DOE to decide to contract for only LAW treatment services or for both LAW and HLW treatment services. DOE evaluated the alternative of including only LAW processing services during Phase I. This evaluation showed that proceeding with combined HLW and LAW processing services was preferred for several reasons.

- High-level services do not substantially raise the total project cost and do not impose significant additional requirements on the Hanford Site infrastructure.

- HLW processing treats some of the highest risk tanks and therefore provides earlier benefit and faster progress.

- Including HLW treatment and immobilization in Phase I will provide a valuable demonstration of the capability needed during Phase II to complete the entire TWRS waste-processing mission.

- The HLW plant will immobilize the waste products from the pretreatment and LAW immobilization process, which means that DOE will avoid additional handling and cost associated with intermediate waste products.

- Sufficient technical basis exists for the HLW processing.

The decision to proceed with BNFL satisfies the fundamental principles originally established for the contracting of privatized TWRS waste processing services.

- *Mature and Demonstrated Technology, Process Flowsheets, and Facility Designs.* BNFL has proposed a robust facility design based on mature and demonstrated technologies.

- *Significant Equity Commitment.* BNFL will seek to maximize its equity commitment such that it falls within a range of $200 million to $500 million.

- *Contractor Responsible and Accountable for Cost and Technical Performance.* BNFL is responsible for proper management of the project and the associated business entity.

- *Private Financing.* Construction and operations will have significant private financing with the specific approach to be determined during the design phase.

- *Responsibility for Environmental Protection and Compliance Assigned to the Contractor.* BNFL is responsible for meeting all associated regulatory and environmental requirements of the contract.

- *Protection of Worker and General Public Safety/Health.* A dedicated nuclear, regulatory, and process safety organization is responsible for oversight of BNFL.

- *Government-Purchased Products and Services Meet Performance Specifications.* BNFL must meet detailed product specifications in order to be paid for the product.

- *Fixed Prices.* The fixed prices will be finalized at the end of a design phase.

- *Cost Control.* DOE will apply requirements for receipt of certified cost and pricing data.

- *Life Cycle Cost Reduced Compared to Traditional Contracting Approach.* Analyses performed by DOE suggest that there are reduced life cycle costs in pursuing privatization.

5 Description of the BNFL Contract

DOE has negotiated a contract with BNFL for Phase I of TWRS that builds on BNFL's very promising technical approach and includes future options for expanding facility capacity to complete most or all of the TWRS mission. The contract places strong incentives on BNFL's performance and provides for only limited payment to BNFL until waste is successfully processed. DOE's path forward includes a series of explicit decision points that will allow optimization of the approach and will maintain a level of competitive pressure on BNFL by allowing DOE to consider alternative approaches at each decision point. The contract provides for the first major decision point after a 24-month period during which the design, permitting, and financing approach will be taken to a point where fixed-unit prices will be established. This contract places DOE on a firm path toward beginning treatment of Hanford's highly radioactive tank waste.

This section describes the key features of this contract. Section 5.1 provides an overview of the structure (i.e., phases and decision points) of the negotiated BNFL contract. Section 5.2 describes the design phase, including its scope of work, the products that are required to be completed, and the approach to securing project financing. Section 5.3 describes DOE's current expectations regarding the construction and operations phase (referred to as Part B-2 in the contract). Subsequent sections describe the schedule for Phase I (5.4), the allocation of project risks between the government and the contractor (Section 5.5), expected project costs (Section 5.6), funding requirements (Section 5.7), and planning for completion of the TWRS mission (i.e., Phase II) (Section 5.8).

5.1 Structure of Part B

Figure 5-1 shows the overall project structure with its two parts: a design phase and a construction and operations phase. Key decision points are depicted for moving forward with Phase I and initiating Phase II. The BNFL contract includes two distinct parts that together will complete Phase I.

- *Design Phase.* During this period (projected to be 24 months), DOE and BNFL will refine the technical requirements, further clarify the regulatory requirements, and finalize the project's financial and incentive structure. BNFL will further develop its project design and technical approach, secure project financing, establish firm fixed-unit prices for Phase I waste treatment services, and enhance its approach to regulatory compliance by submitting necessary permit applications. DOE will review the project throughout this phase to ensure that necessary progress is maintained. At the end of the design phase, DOE will decide whether to proceed with the subsequent construction and operations portion of Phase I or to pursue one of several other approaches to complete Phase I. Details of the design phase are provided in Section 5.2.

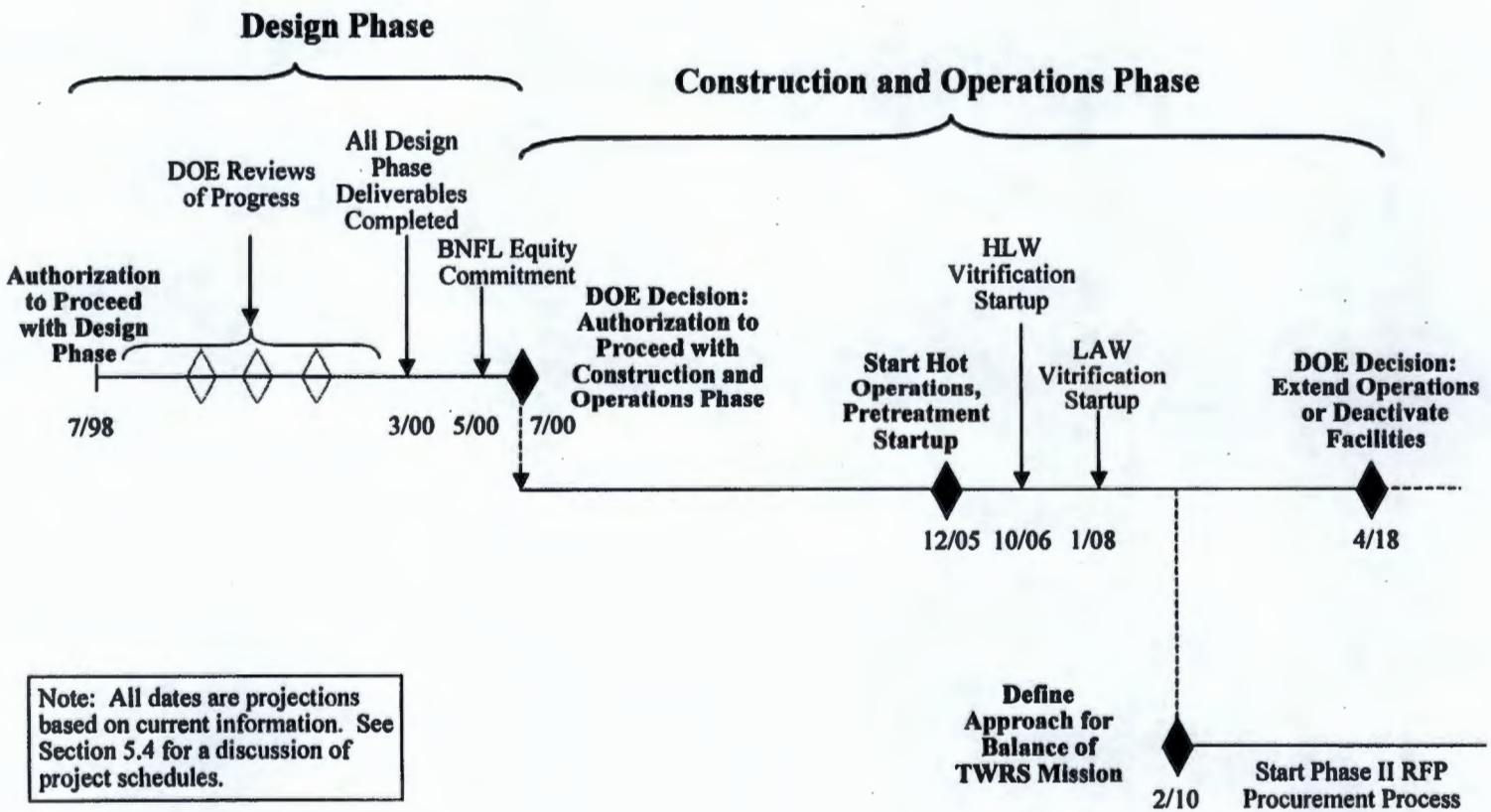


Figure 5-1. Part B Project Structure

- *Construction and Operations Phase.* This part of Phase I will include the completion of design, construction, startup, testing, and operation of the facility to provide waste treatment services at the fixed-unit prices established at the end of the design phase. DOE currently forecasts that waste treatment will begin in 2005 to 2006 and will continue for about 10 years. During that period, the contractor will immobilize approximately 10% of Hanford's tank waste volume and 20% to 25% of the inventory of radioactivity. Details of the construction and operations phase are provided in Section 5.3.

As shown in Figure 5-1, DOE will maintain a series of decision points throughout Phase I. These decision points will enable DOE to further optimize the project and realize potential cost savings based on lessons learned and new information. Also, these decision points provide opportunities for DOE to move to alternative approaches and exert competitive pressure on BNFL, particularly with the decision at the end of the design phase.

5.2 Design Phase

DOE's approach to TWRS has been to use an iterative strategy with explicit decision points so that the approach is enhanced as new information becomes available. The current decision on how to proceed with Part B continues this strategy with the specification of the design phase. At the end of this phase, DOE expects that BNFL's fixed-unit prices will be set, private financing will be secured, and a decision will be made about proceeding with the construction of the BNFL facility. Independent reviewers of DOE's approach strongly supported this strategy (see Appendix B), particularly the use of a period of approximately two years to optimize the approach. The key building blocks of DOE's overall strategy are shown in Figure 5-2.

The design phase constitutes the first 24 months of Part B and will allow BNFL to:

- Advance the design from the conceptual design stage to approximately the 30% level, which is required for start of construction and to obtain private financing;

- Ensure that testing and demonstration (i.e., scale-up) of the proposed waste melter technology yield acceptable results;

- Conduct process testing on radiological and non-radiological materials and submit plans and qualification reports for waste products to be returned to DOE during the construction and operations phase;

- Complete regulatory permitting applications;

- Finalize project financing by committing BNFL's corporate equity and securing private, third-party financing;

- Provide fixed prices for treatment services during the constructions and operations phase; and
- Complete a revised standards approval package based on a more mature hazards analysis, a Limited Construction Authorization Request, and a complete Construction Authorization Request including a Preliminary Safety Analysis Report.

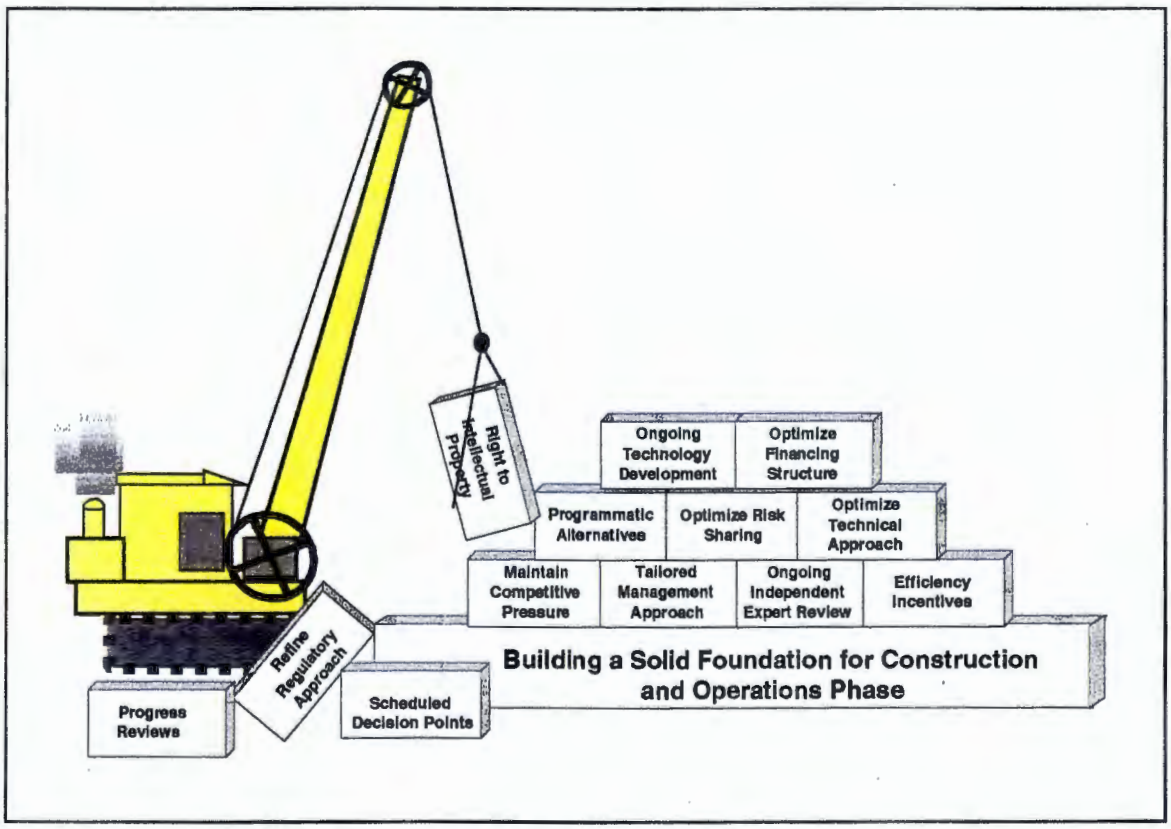


Figure 5-2. Design Phase Strategy

The design phase also will include efforts by DOE and BNFL to optimize the technical specifications and financing approach. These efforts will reduce uncertainty about the costs of waste treatment. By the end of this phase, BNFL and DOE should have a higher level of confidence in the basis of the prices, which should yield lower fixed-unit prices than the targets set at the end of Part A because of the optimization efforts and reductions in contingency costs. The fixed-unit price after the design phase will be based on certified cost and pricing data provided by BNFL. At the end of the design phase, BNFL and its joint venture partners will invest equity in the construction of the facility. At financial closing, BNFL also will obtain commitments from private lenders to finance project construction costs.

As shown in Figure 5-1, DOE will review BNFL's progress throughout the design phase. DOE has the right to terminate the contract for convenience at any time, with an option to obtain technical data and intellectual property needed to continue with another contractor or a different acquisition strategy. DOE's review of the contractor's progress during the design phase will:

- Assess the method that BNFL will use to establish final fixed-unit prices;
- Confirm that BNFL is still viable for the construction and operations phase based on the quality and timeliness of work products and a refined technical approach; and
- Determine whether the final fixed price at the end of the design phase is likely to be significantly different (i.e., greater than ~10%) from the current target price.

The design phase will conclude with a DOE decision—authorization to proceed with the subsequent construction and operations phase. This decision has the following two parts.

- *Evaluation of Design Phase Deliverables and Payment Determination.* By the end of this phase, BNFL will complete a series of technical, regulatory, and financial deliverables, and will commit its own equity to the project, which will be augmented with additional financial backing to pay for facility construction. The negotiated contract provides an incentive fee to be paid for successful completion of these steps and for reducing project construction and operating costs.
- *Proceed with Construction and Operations.* At the end of the 24-month design phase, DOE will decide whether to proceed with the subsequent construction and operations portion of Phase I or to pursue one of several other approaches to complete Phase I. BNFL's authorization to proceed will depend on DOE receiving acceptable fixed-unit prices, a substantial equity commitment by BNFL, other significant financing arranged by BNFL, and acceptance for review of their design for nuclear and chemical process safety. A key element of this financing will be BNFL equity, which represents BNFL's investment in the success of the project. If DOE decides not to proceed with BNFL, other approaches to consider include: (1) obtaining the treatment services under another contracting process or (2) proceeding with a modified work scope that would be developed through optimization efforts during the design phase.

During the design phase, DOE will continue to use independent reviews by outside experts. These reviews will bring independent perspectives to strengthen the approach taken and will ensure that a decision by DOE to proceed is the best possible approach.

The following sections summarize the approach to finalizing the project's financing structure, (Section 5.2.1), the optimization efforts that will seek to improve the cost-effectiveness of Phase I (Section 5.2.2), and the expected advancements in the project's regulatory approach (Section 5.2.3).

5.2.1 Completion of Project Financing Approach

During the contract negotiations with BNFL, DOE's objective was to assign substantial levels of technical, performance, and financing risk to BNFL to retain strong performance incentives. At the same time, DOE sought an appropriate balance between the allocation of risks to the contractor and the ultimate cost of the project to the government as discussed in Section 3.4. The negotiated contract with BNFL contains a framework for the private financing structure. During the 24-month design period following the contract authorization to proceed, DOE and BNFL plan to finalize that financing structure and establish final fixed-unit prices that are commensurate with the risks faced by each party. The financing structure is organized around the two separate parts of Phase I, Part B: financing for the design phase and financing for the construction and operations phase. Figure 5-3 presents an overview of these elements.

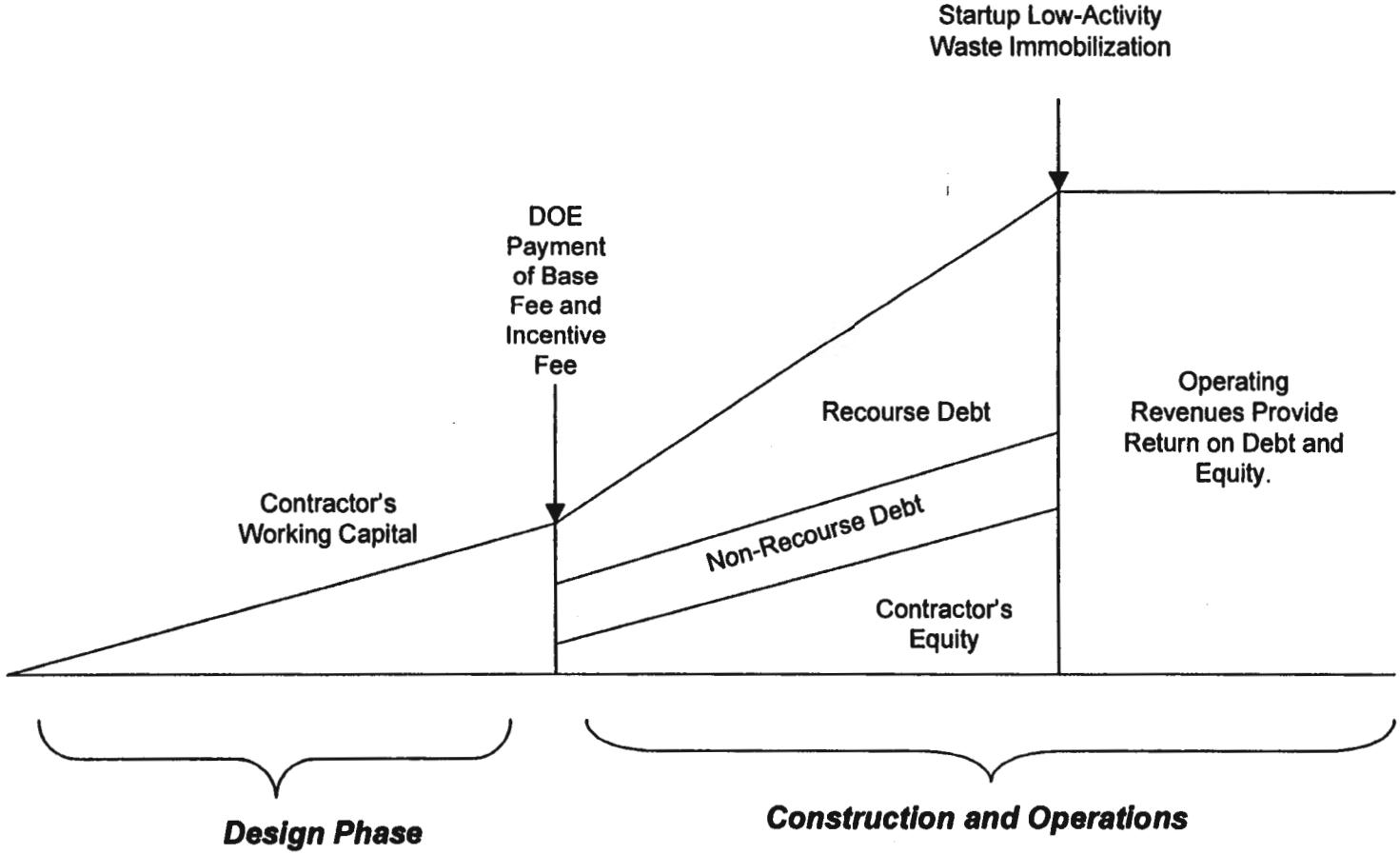
Financing for the Design Phase. Based on the current scope of work, the estimated cost for the design phase is approximately $350 million.[1] BNFL will finance this work with its working capital. No government involvement in financing project costs is contemplated during this 24-month period.

With successful completion of the design phase, the contractor has the opportunity to receive immediate payment of $50 million of the estimated $350 million. This payment involves a base fee payment of approximately $20 million and an incentive fee payment of up to $30 million. Both fee payments are dependent upon BNFL reaching financial closure. In addition, the amount of the incentive fee is dependent on BNFL's success in reducing the project's construction and operations costs. BNFL's costs during the design phase are not paid by DOE at financial closing and will be carried into the construction and operations phase. They will be paid out as treated waste is delivered to DOE. In effect, the majority of BNFL's investment during the 24-month period would not be recovered until waste is successfully processed. BNFL's working capital is at risk during the design phase in the event that DOE terminates the contract for default. If DOE terminates the contract for convenience, then DOE would compensate BNFL for its negotiated settlement costs.

Financing for the Construction and Operations Phase. If authorized by DOE, the construction and operations phase of the project will begin immediately after BNFL secures adequate project financing and provides acceptable fixed-unit prices. In addition to equity funding, the financing structure for this contract phase may involve two other sources of funds:

- Non-Recourse Debt; and
- Recourse Debt.

[1] Unless otherwise noted, all dollar amounts in nominal dollars. Nominal dollars are actual year outlays, e.g., escalated for expected inflation.



* Financing proportions not to scale

Figure 5-3. Financing Strategy for TWRS Project

The definition and the use of each of these types of funds are described below.

- *Equity.* Equity represents BNFL's direct corporate investment in the success of the project. BNFL's equity investment would be at risk if the project should fail because of its inadequate performance. This money would be placed at risk by BNFL and is in a "first-loss position," i.e., if the project generates lower than expected revenues, BNFL may not recover its equity or earn a return on that equity. Therefore, this project financing requires a commensurate financial return. The return BNFL actually realizes will depend directly on the contractor's ability to design, construct, and operate the facility in an efficient, cost-effective manner.

  Increasing the equity commitment by BNFL will strengthen the incentive to perform, but will lead to higher fixed-unit prices. DOE and BNFL will seek an appropriate balance between equity commitment and fixed prices. If the equity commitment is insignificant, it will provide limited motivation to the contractor for successful project completion because the contractor has little to lose as a result of non-performance. However, if DOE requires an inordinately high level of equity commitment, this financing approach unnecessarily increases the price of the project. This occurs because the contractor return requirements for equity financing are much higher than debt interest rates. BNFL equity can be supplied by the BNFL parent company, other contractor team members (Bechtel, GTS Duratek), and third-party investors.

  The BNFL equity would include direct funding of project costs and "firm and irrevocable undertakings" (e.g., letters of credit) to pay project costs and fund company obligations, such as performance warranty payments.

- *Non-Recourse Debt.* Non-recourse debt is lent to a project by banks and other lending institutions. Payment of this debt is secured solely by the revenues of the project, liquidated damages, contingency reserves, process warranties, and other funds. The payment is non-recourse to BNFL as a corporation and receives no support under the contract in the event of non-payment because of contractor fault. That is, lenders will focus solely on the cash flows of the project and the project's ability to meet debt service requirements. Lenders of this type of debt are first to receive project cash flows but do not have additional assurances for repayment of principal and interest (see Recourse Debt below). This debt is in a "second-loss" position because, to the extent that revenues do not cover costs, its principal and interest will not be paid.

  Non-recourse debt commands a higher interest rate in the market than recourse debt but is substantially less expensive than the equity funds. Prior to lending funds, the non-recourse lender would conduct independent oversight of the project for construction and operations of the facility. This independent third-party review will give DOE additional assurances that the team and technology selected have a high probability of success in the construction and operations phase of the contract. DOE recognizes that lenders perceive "nuclear" waste remediation projects as having a high-risk profile. Accordingly, DOE is working with non-recourse lenders to help potential lenders understand the technical

risks. This will increase the likelihood of obtaining non-resource financing and help to achieve an acceptable balance of risk.

- *Recourse Debt.* As with non-recourse debt, recourse debt is lent to a project by banks and other lending institutions. Also, as with non-recourse debt, in the event the contractor has performance problems that increase the internal project costs, available sources of project funds (not money from the lender or DOE) would be accessed to fund necessary modifications to the project. Those sources normally would include liquidated damages, equipment and process warranties, contingency, and the contractor's standby equity. However, recourse debt relies, in part, on the government's commitment to support and/or take over ownership of the project after all contractor resources have been depleted. If DOE determines that the contract should be terminated, the termination settlement would include, as an allowable cost for the contractor, the amount of the outstanding recourse debt. The provision of recourse debt will substantially reduce the interest costs associated with the project, and without this provision, the contractor is unlikely to be able to arrange project financing with any private lender.

  The anticipated structure places significant levels of private equity and debt at risk prior to DOE being adversely impacted. By placing the equity and non-recourse debt commitments in "first-loss" and "second-loss" positions, respectively, the financing package ensures that the contractor is motivated to successfully complete the project.

The design phase of the contract will be used to structure a financing package that balances the use of equity, non-recourse debt, and recourse debt. The contract establishes a minimum level of equity that BNFL will invest in the project, and BNFL must use its best efforts to attract non-recourse debt. In addition, DOE will evaluate the tradeoffs between government and private debt to determine the best overall mix of equity, non-recourse, and recourse debt, as well as the amount of any other government participation.

5.2.2 Optimization of the Technical Approach

During the first six months of the design phase, DOE and BNFL will address selected technical specifications to seek improvements in cost and technical performance, and BNFL will submit their design safety approach. A value engineering process will be used to assess the impacts of engineering changes on cost. This process also will determine tradeoffs among the changes and will find lowest-cost solutions. DOE and BNFL will work together to identify beneficial changes, and selected changes will be implemented early in the design process to minimize the impacts on project schedule.

BNFL's Part A deliverables provided some insights regarding the potential cost impacts of some project specifications. For example, project specifications led to a LAW treatment service that was more expensive than estimated previously, and both DOE and independent reviewers

concluded that opportunities to lower costs without reducing quality should be sought. Detailed analysis of BNFL costs indicated two areas of cost savings that will be a particular focus of attention are:

- *LAW Container Specifications.* The contract specifications require BNFL to produce an immobilized LAW that fits in a metal box suitable for handling and storage. This specification was established in response to public concerns over uncertainties in final waste form performance and the desire to ensure that wastes could be retrieved in the future. Retrievability is not a legal or regulatory requirement and is not applied at other DOE sites. Based on BNFL's Part A cost estimates, independent reviewers determined that this specification may be a significant driver on overall LAW treatment costs and should be assessed during the design phase.

- *Immobilized LAW Product Specifications*: The BNFL approach produces a glass monolith within the container. Other waste forms—either non-monolithic glass or non-glass—could be acceptable if they can be demonstrated to meet performance requirements. Also, prior studies at Hanford have indicated that the total cost of immobilization with glass would not be significantly different from the cost for alternative waste forms. Cost information from the BNFL Part A deliverables, however, suggests that this issue should be re-examined.

Optimization is planned to continue beyond the design phase and will include additional technology development by DOE in preparation for future Phase II requirements. Such technology development can provide upgrades (e.g., more cost-effective technology than the current technology planned for use by BNFL). In addition, technology development will help to maintain competitive pressure on BNFL because the technology will be available to competitors. DOE will pursue using technology development funds (possibly cost-sharing with private companies) for further development of current technologies or to further demonstrate high-potential, but still unproven, technologies. This approach will benefit future DOE national needs (including Phase II of TWRS waste treatment) by making a broader range of technical solutions available for bidders.

5.2.3 Regulatory Activities During the Design Phase

During Part A and subsequent negotiations, the approach to regulatory compliance has been defined and agreed upon by DOE and BNFL. However, uncertainty remains in the details, and the design phase will further refine the approach.

During this design phase, BNFL will submit a number of deliverables and draft compliance documents for DOE review and/or concurrence where joint responsibility exists for environmental compliance. These deliverables are a vehicle for BNFL to propose the details of its approach to meet the environmental requirements under the Phase I contract and will, after DOE review and/or concurrence, provide assignment of the BNFL and DOE responsibilities for the achievement of these key environmental, safety, and health accomplishments. These deliverables and draft compliance documents include those listed below.

- *Revised Environmental Plan.* This plan identifies BNFL's approach for environmental protection, compliance, and permitting, including: (1) all planned environmental permitting and compliance activities for Part B, (2) a detailed permitting and compliance schedule, and (3) environmental monitoring and reporting requirements.

- *RCRA Permitting.* BNFL will prepare a RCRA permit application for its facility and will also prepare a permit modification for its operation of the DST provided as a feed tank. BNFL's permit conditions will be incorporated into the Hanford Site's overall RCRA permit (Ecology 1994), which will then be co-signed by BNFL.

- *Risk Assessment Work Product.* The Risk Assessment Work Product will be the document developed as a result of BNFL's negotiated agreement with the regulators to demonstrate that the treatment facility will meet required environmental performance standards for a thermal treatment facility under RCRA.

- *Approach for Immobilized HLW Delisting.* BNFL will document for DOE review and concurrence an approach to obtain an exclusion and/or exemption (delisting) for the removal of the immobilized HLW product from RCRA and *Hazardous Waste Management Act* regulation.

- *Approach to Land Disposal Restriction Compliance for Immobilized LAW*: BNFL will develop and document the approach for demonstrating compliance with the RCRA land disposal restrictions for LAW and collect characterization and demonstration-scale treated waste product data to support the compliance demonstration.

During the design phase, BNFL also must submit several nuclear-safety-related deliverables to the Regulatory Unit as part of a comprehensive regulatory process. These deliverables must demonstrate that BNFL will achieve adequate radiological, nuclear, and process safety through requirements that are properly defined, implemented, and maintained. The required deliverables include the following.

- *Revised Standards Approval Package.* This submittal will include BNFL's revised set of recommended radiological, nuclear, and process safety standards and requirements. It also will describe BNFL's approach to standards-based integrated safety management. Regulatory approval of this submittal will provide assurance to BNFL that its safety basis (safety technical approach and safety management practices) for the balance of design and for projected construction, operation, and deactivation activities is adequate and acceptable.

- *Construction Authorization Request.* BNFL will formally request authorization to commence construction activities. The Regulatory Unit will issue a construction authorization upon determination that

  - BNFL's safety-related activities and design are being conducted in accordance with its approved Standards Approval Package;

- BNFL's design properly accounts for the natural and man-made external events associated with the designated site;

- BNFL is qualified, by reason of experience and training, to perform the proposed construction;

- BNFL's construction procedures are adequate to ensure that the construction-related aspects of safety standards and requirements will be properly implemented;

- BNFL's quality assurance plan is adequate and has been implemented such that the intended quality will be assured in the safety-related portions of the design, construction, and pre-operational testing and that the quality assurance records will attest thereto;

- The radiological, nuclear, and process hazards associated with facility operation, including those from postulated accidents, have been adequately by assessed, sufficiently controlled or mitigated, and adequately documented in a formally controlled Preliminary Safety Analysis Report submitted by BNFL and formally approved by the Regulatory Unit, to establish a basis for safe operation and an unambiguous definition of the safe-operating envelope;

- The deactivation plan is acceptable;

- The drafts of plans and programs to be finalized as elements of the operating authorization request and implemented during operation are adequate and acceptable; and

- BNFL has made a commitment to comply with the conditions of the authorization agreement associated with the construction authorization.

As part of the overall Construction Authorization Request, BNFL intends to submit a Limited Construction Authorization Request for site preparation and excavation. Approval of this request by the Regulatory Unit will permit early construction activities with little or no potential to impact adversely the radiological, nuclear, or process safety aspects of the facility. BNFL must provide sufficient detail for the Regulatory Unit to review the request and reach an approval decision.

The fundamental regulatory requirements were established in the initial contract for Phase I. During the design phase, the design will be developed consistent with standards committed to by the contractor during Phase I. As the design develops, the contract calls for technical exchanges between DOE and the contractor regarding the implementation of the requirements. This will help avoid situations where the contractor's design or facility fail to be adopted by DOE because of failure to communicate regulatory requirements.

5.3 Construction and Operations Phase

This part of Phase I will include the completion of detailed design, construction, startup, testing, and operation of the facility to provide waste treatment services at the fixed-unit prices

established at the end of the design phase. DOE will provide tank waste and will order at least a minimum quantity of waste treatment services from BNFL during construction and operations. As an option, DOE may order additional treatment services if feed is available and BNFL has the processing capability.

The negotiated contract sets a minimum-order quantity of 6,000 "units" of LAW feed processed, and 600 (4.5-meter-long) canisters of immobilized HLW. Units of LAW are defined as 1 unit per metric ton of sodium for Envelope A, 2.5 units per metric ton of sodium for Envelope B, and 1.15 units per metric ton of sodium for Envelope C. The difference among feed envelopes reflects the difference in difficulty of processing because of the feed composition. The HLW canisters will contain optimally loaded, immobilized waste, where the optimal loading is defined in the contract based on the limiting constituents of the specific feed batch. These minimum order quantities are approximately equivalent to those expressed previously for two contractors in the 1996 contracts in metric tons of sodium processed for LAW and metric tons of oxides for HLW.

During construction and operations, BNFL will initiate an HLW vitrification service that will be capable of treating the minimum-order quantity (i.e., producing 600 canisters of optimally loaded, immobilized HLW) during Phase I. BNFL also will include LAW vitrification services capable of immobilizing a minimum of 6,000 units of LAW during Phase I. BNFL will operate DST AP-106 as a waste feed receipt tank. This minimum-order quantity will treat approximately 10% of the Hanford tank waste and 20% to 25% of the radioactivity.

The Phase I waste processing will immobilize some of the most dangerous wastes stored at the Hanford Site and will significantly reduce risks associated with tank waste storage. The candidate wastes for the Phase I service are currently stored in 9 DSTs and 2 SSTs. Because of waste transfers among tanks, processing of those wastes will free up valuable DST space to enable transfer of waste from high-risk SSTs. The 11 tanks are detailed below.

- Two tanks (AZ-101 and AZ-102) contain 12% of the radioactivity in the Hanford tanks (40% of the radioactivity in the DSTs).

- Two tanks (AN-102 and AN-107) have high levels of complexed strontium-90, plutonium, and americium. Should these tanks leak, these complexed radionuclides are believed to be mobile in the vadose zone.

- Four tanks (AN-103, AN-104, AN-105, and AW-101) are among the six DSTs that generate flammable gases and are on the Hanford Tank Watch List.

- One SST (C-106) contains a relatively large fraction of insoluble solids. This tank is the only high-heat tank on the Hanford Tank Watch List.

- One SST (C-104) contains a relatively large fraction of insoluble solids.

- One DST (AY-102) will accept the waste retrieved from tanks C-106 and C-104. The liquid from tanks AY-102 will be used for sluicing tanks C-106 and C-104 to assist in retrieval.

If DOE exercises the option for additional waste treatment and immobilization beyond the stated minimum-order quantities, BNFL will provide waste treatment services at fixed-unit prices to be negotiated. LAW and HLW feed envelopes, the quantity to be processed, and the price for treatment will be defined and agreed upon at the time the option is exercised.

5.3.1 Project Interfaces

The Phase I project identified all interfaces between BNFL and DOE, as shown in Figure 5-4. The details of these interfaces are specified in Interface Control Documents (BNFL 1998a), which are contractual documents that describe the BNFL and DOE requirements at each interface. The ICDs specify all physical interfaces (i.e., what item is transferred, who is responsible for each action, and where the item is transferred), interface schedule (i.e., when a specific item is transferred), and administrative interface (i.e., procedural details of how items are transferred).

Figure 5-4 shows that DOE is responsible for providing utilities, services, facilities, equipment, land, and roads at no cost to BNFL. BNFL will produce the immobilized products, which will be provided to the DOE. DOE also is responsible for taking certain wastes (e.g., radioactive solid waste), while BNFL remains responsible for some of their waste (e.g., liquid sanitary waste).

The Interface Control Documents have been developed over the course of Part A and have been reviewed by DOE, BNFL, and the Hanford M&I Contractor in meetings of the Integrated Product/Process Teams. Section 6 contains additional detail on the Integrated Product/Process Teams. The Integrated Product/Process Teams interactions have been extremely valuable in defining the details of integration that must occur if the waste is to be retrieved, transferred, immobilized, and stored successfully. Section 5.5 discusses specific obligations incurred by the DOE for these interfaces.

5.3.2 Waste Feed Specifications

A critical success factor for Phase I waste treatment and immobilization will be DOE's ability to reliably deliver waste feed to BNFL with a well-characterized chemical and radiological composition. The waste feed characteristics have a direct impact on the facility design and in particular the waste separations steps that are required. DOE's strategy for tank waste feed specification has been to define waste feed envelopes, rather than to specify actual tank contents. These envelopes define the maximum chemical and radionuclide concentrations to be sent to BNFL for three LAW envelopes and one HLW envelope.

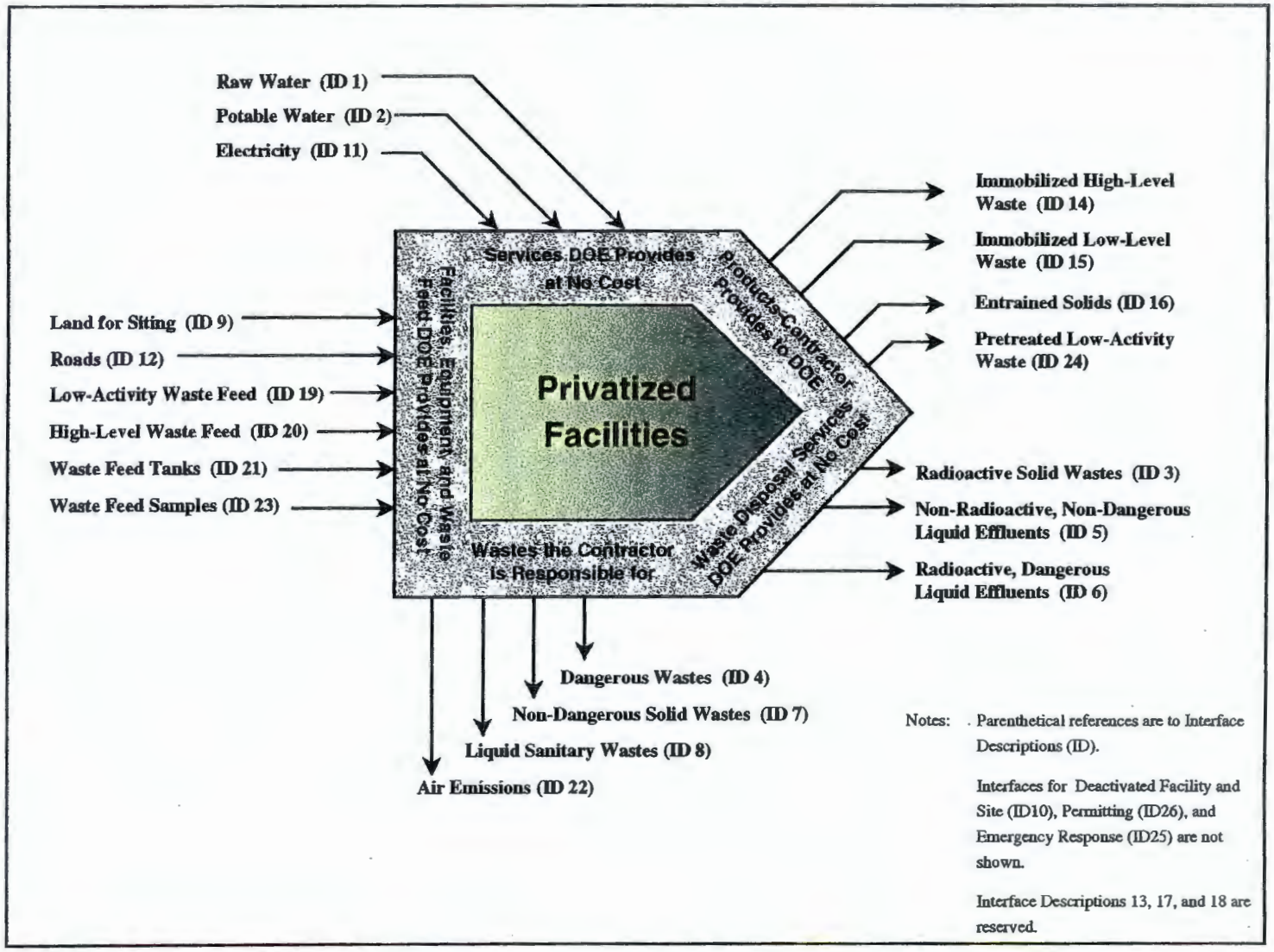


Figure 5-4. TWRS Phase I Project Interfaces

DOE has defined feed characteristics that it can meet with high assurance, yet are specific enough to enable cost-effective facility design and operation. DOE used available characterization data and has focused additional characterization activities on the specific needs for Phase I waste processing. Waste feed conforming to the defined waste feed envelopes will undergo the following specific treatment prior to immobilization in BNFL's facility.

- Envelope A (LAW) feed requires the removal of radioactive cesium-137 and technetium-99.
- Envelope B (LAW) feed requires the removal of radioactive cesium-137, technetium-99, and may contain constituents, such as sulfate, that limit the quantity of waste that can be immobilized in a fixed quantity of glass.
- Envelope C (LAW) feed requires the removal of radioactive cesium-137, technetium-99, strontium-90, and transuranic elements.
- Envelope D (HLW) feed requires removal of soluble components.

The specifications for the waste envelopes were developed for the 1996 RFP and are based on existing characterization data and estimated waste process limits. To refine these waste envelopes during Part A, both contractors provided input to DOE's waste characterization objectives. Subsequent characterization efforts have sought to provide better information on those waste constituents that have the greatest impact on waste processing limits (both pretreatment and vitrification). Since the waste envelopes were first established, several changes have been made to optimize them in an effort to increase DOE's ability to deliver feed and to reduce project cost.

Based on projections and historical data, DOE expects that approximately 90% of the total TWRS waste inventory will fall within the waste envelopes. For waste that does not fall within the specified envelopes during Phase I, DOE can reserve that waste for Phase II, blend it with other wastes to bring it within specification, or process it at a negotiated price with BNFL, provided that BNFL's facility is capable of treating the out-of-specification waste.

DOE will retrieve Phase I LAW feed from several DSTs. The identified tanks contain 50% more feed than the contract requires, which provides DOE with additional assurance that sufficient Phase I feed can be provided. The candidate HLW feed is currently located in a small number of DSTs and SSTs. All candidate source tanks for LAW and HLW feed have been placed under configuration control to ensure that the compositions are not unknowingly altered.

All waste in candidate source tanks was characterized for chemical composition and radionuclide content prior to the definition of waste feed envelopes. More than half of the tanks with LAW feed have been recharacterized since that time and were found to be within the waste feed envelope specifications. DOE also has recharacterized one of the potential HLW source SSTs, and this tank waste also was found to be within specifications. The remaining source tanks for both LAW and HLW will be fully characterized early in the design phase.

Small-quantity waste feed samples from all four envelopes were supplied to both BNFL and LMAES during Part A. The analysis of all of those samples indicated that the compositions fell within the waste feed envelopes. DOE will supply BNFL with additional samples during the design phase, which will provide further confidence in the feed characterization.

During operation of BNFL's Phase I facility, DOE will certify that the waste is within specifications, and BNFL will concur with this certification prior to receiving the feed. Prior to transferring the feed to BNFL, DOE will provide the contractor with samples to confirm the analysis. Characterization for processing will occur within BNFL's facility to ensure that each unit operation is functioning properly and that the final product will meet requirements.

DOE recognizes that robust feed delivery systems and procedures are keys to the success of the TWRS Phase I project. The Hanford M&I Contractor's plans for feed delivery were subjected to extensive review during the readiness-to-proceed assessment (see Appendix B). DOE already has begun to establish binding and financially significant performance agreements with the Hanford M&I Contractor to help ensure that DOE meets its commitments for timely delivery of feed meeting required specifications.

5.3.3 Waste Product Specifications

The requirements for the immobilized waste products are described below.

- *Immobilized LAW.* Under current specifications, BNFL will produce an immobilized LAW glass encased in a stainless steel box. The requirements of the immobilized LAW are based on nationally recognized standards (10 CFR Part 61, i.e., "Licensing Requirements for Land Disposal of Radioactive Waste") for LAW and specific requirements for the disposal of LAW at the Hanford Site as developed with regulators and stakeholders over several years.

- *Immobilized HLW*: Under current specifications, BNFL will produce an immobilized HLW form—borosilicate glass encased in a stainless steel canister. The waste form requirements are defined by the Office of Civilian Radioactive Waste Management for acceptance of treated HLW at the proposed national repository. The requirements are very similar to those required of the Defense Waste Processing Facility at the Savannah River Site and the West Valley Demonstration Project in New York State for their immobilized HLW.

Changes in the product specifications could result from optimization work in the design phase and/or changes in external requirements (e.g., repository waste acceptance criteria). Such changes would be implemented through contract modification.

DOE will make payment after BNFL demonstrates that products and secondary wastes resulting from waste processing meet specifications. The basis for payment is the defined units for the LAW and the number of HLW canisters produced. BNFL is not compensated for the secondary waste produced in process operations, but will have incentives for waste minimization.

5.4 Phase I Schedule

Table 5-1 shows the current schedule for the BNFL contract, including the major project milestones. This schedule may be refined as a result of work in the design phase. As shown in Figure 5-5, BNFL has provided two sets of milestone dates that differ depending on BNFL's estimate of their likelihood of achievement (i.e., either 50% confidence or 90% confidence). For consideration of potential impacts on TPA milestones, the 90% confidence dates, which are set forth as targets in the contract, are assumed.

The Phase I contract, with fixed-unit pricing and private financing, provides a strong incentive for the contractor to improve upon the schedule estimates shown in Table 5-1. BNFL has a strong financial motivation to successfully and efficiently process waste. The longer it takes to process waste, the greater the finance costs, which will then erode BNFL's return on its investment. BNFL's profit also will be at risk if there are schedule delays.

Table 5-1. Major Project Milestones

Milestone	50% Confidence Date	90% Confidence Date
Authorization to proceed	-	July 1998
DOE project review—6 months	-	January 1999
DOE receive final design phase deliverables	-	March 2000
Complete design phase	-	July 2000
BNFL start pretreatment facility construction	May 2001	July 2001
BNFL start HLW vitrification facility construction	May 2001	July 2001
BNFL start LAW vitrification facility construction	November 2001	January 2002
BNFL complete pretreatment facility construction	July 2003	March 2005
BNFL complete HLW vitrification facility construction	March 2005	January 2006
BNFL complete LAW vitrification facility construction	February 2006	November 2006
BNFL complete pretreatment cold start	June 2005	February 2006
BNFL complete HLW vitrification cold start	December 2005	November 2006
BNFL complete LAW vitrification cold start	January 2007	February 2008
BNFL start pretreatment hot start	August 2005	April 2006
BNFL start HLW vitrification hot start	February 2006	February 2007
BNFL start LAW vitrification hot start	January 2007	January 2008
BNFL complete Phase I, Part B, HLW processing	February 2017	February 2018
BNFL complete Phase I, Part B, LAW processing	February 2017	February 2018
BNFL Phase I facility deactivation	February 2018	February 2019

The schedule shows that the BNFL HLW facility can be brought on-line earlier than the LAW facility. This is largely because of HLW experience gained at the Defense Waste Processing Facility at Savannah River, South Carolina, and the West Valley Demonstration Project at West Valley, New York. HLW vitrification has been ongoing for several years now, and the operations and design requirements are better understood. With LAW vitrification, the melter size needs to be significantly larger than for HLW (approximately a factor of 10 times the size). This larger melter requires a pilot melter demonstration to establish melter design prior to finalizing the facility design and results in a longer design period for LAW vitrification than for HLW vitrification.

The TPA includes two sets of milestones that directly apply to the Phase I project. The first set, known as the Primary Path, applies to the previous plan where two contractors would process waste during Phase I. This path would have required start of hot operations for LAW processing

by December 2002. The second set of milestones, known as the Alternate Path, applies to situations where DOE does not authorize two contractors to proceed. The Alternate Path requires start of hot operations for LAW processing by December 2003.

The BNFL target schedule will put DOE on a path to closure of SSTs and DSTs and completing the vitrification of HLW and LAW. The schedule will not be finalized, however, until completion of the design phase. The start of HLW pretreatment and vitrification with BNFL's target schedule would occur more than two to three years early (between February 2006 and February 2007) under the BNFL contract. The BNFL target schedule would, however, require some changes in near-term TPA milestones. The targeted start of LAW vitrification (TPA milestone date of December 2003) would occur about three to four years later (between January 2007 and January 2008).

These schedule changes result from the reduction of concurrent design and construction. BNFL developed its schedule assuming that design would be largely completed before initiation of construction. This revised scheduling assumption leads to greater confidence that the facilities will come on-line as scheduled, and once on-line, will operate successfully and safely. The inclusion of the design phase as a separate phase in the contract does not delay BNFL's waste processing schedule; it simply delays the point in the schedule at which fixed prices are established.

In general, BNFL's schedules for some Phase I hot operations will favorably affect the confidence levels assigned to schedules for several TWRS projects that are necessary to support BNFL's operations (e.g., infrastructure support and interim storage).

The proposed schedule for Phase I will require approval by the state of Washington and EPA through the renegotiation of applicable TPA milestones. Figure 5-5 compares the current Phase I schedule with the current TPA milestones. The Department is currently conducting a detailed review of potential impacts of the BNFL schedule on the out-year TPA milestones. DOE has requested the Hanford M&I Contractor to determine the effect of the revised contract schedule on the TWRS baseline, particularly on SST retrieval and associated TPA milestones. As schedules are finalized through the end of the design phase, DOE will further refine the schedule and will propose and negotiate any necessary changes to the TPA milestones with the state of Washington and EPA.

5.5 Allocation of Project Risks and Obligations

A key consideration in building this contract is the allocation of risks and other obligations (e.g., financial, regulatory, and environmental) between DOE and the contractor. As discussed in Section 3, the DOE strategy for allocating risks has evolved. The design phase has been developed to reduce project risks and to arrive at the best allocation of the remaining risks. Section 5.2.1 addresses the allocation of financial obligations under this contract.

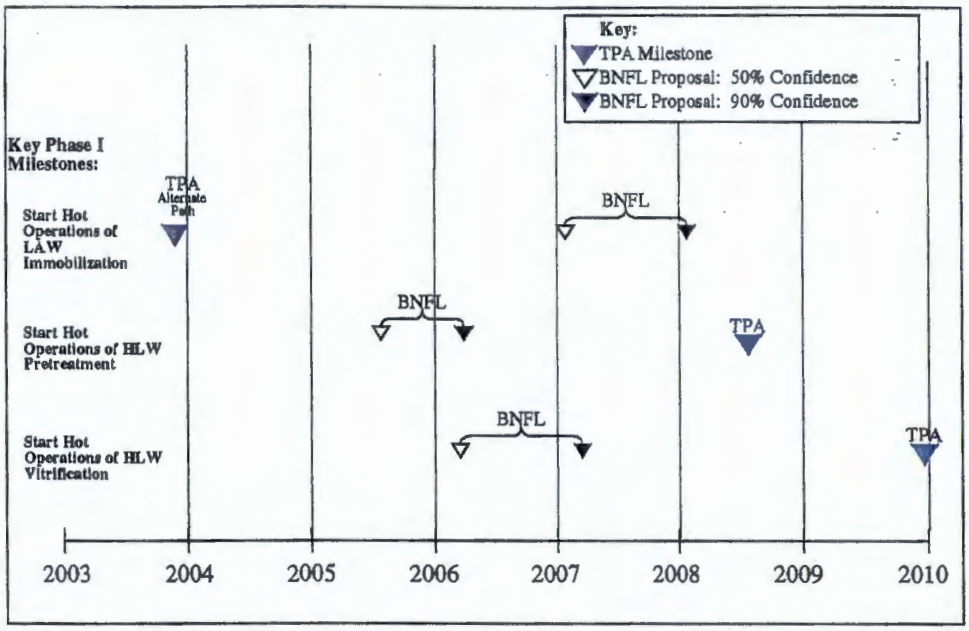


Figure 5-5. Comparison of Tri-Party Agreement and BNFL Milestones

5.5.1 Allocation of Project Risks

Figure 5-6 illustrates the allocation of risks under this contract. Understanding the risks allocated to either party or shared by both parties is particularly important to understanding the agreement for the two phases of this contract.

During the negotiations for Part B of the contract, the 1996 contract with BNFL was modified to reduce significant risks to the contractor, particularly financing risks. These changes were motivated by a desire to lower the ultimate unit price for waste treatment services.

Under this contract, BNFL is ultimately accountable for the successful design, construction, and efficient operation of its facility. Among the principal risks allocated to BNFL are those detailed below.

- *Performance During the Construction and Operations Phase.* BNFL is responsible for constructing and operating the waste treatment plants and for producing acceptable immobilized waste products. DOE will verify that the immobilized products meet storage and disposal specifications. BNFL's investment in construction and operations will only be recovered by successful treatment and delivery of waste products. If those operations do not meet expectations because of poor technical performance, shortcomings in design, or other reasons, BNFL's revenues will suffer.

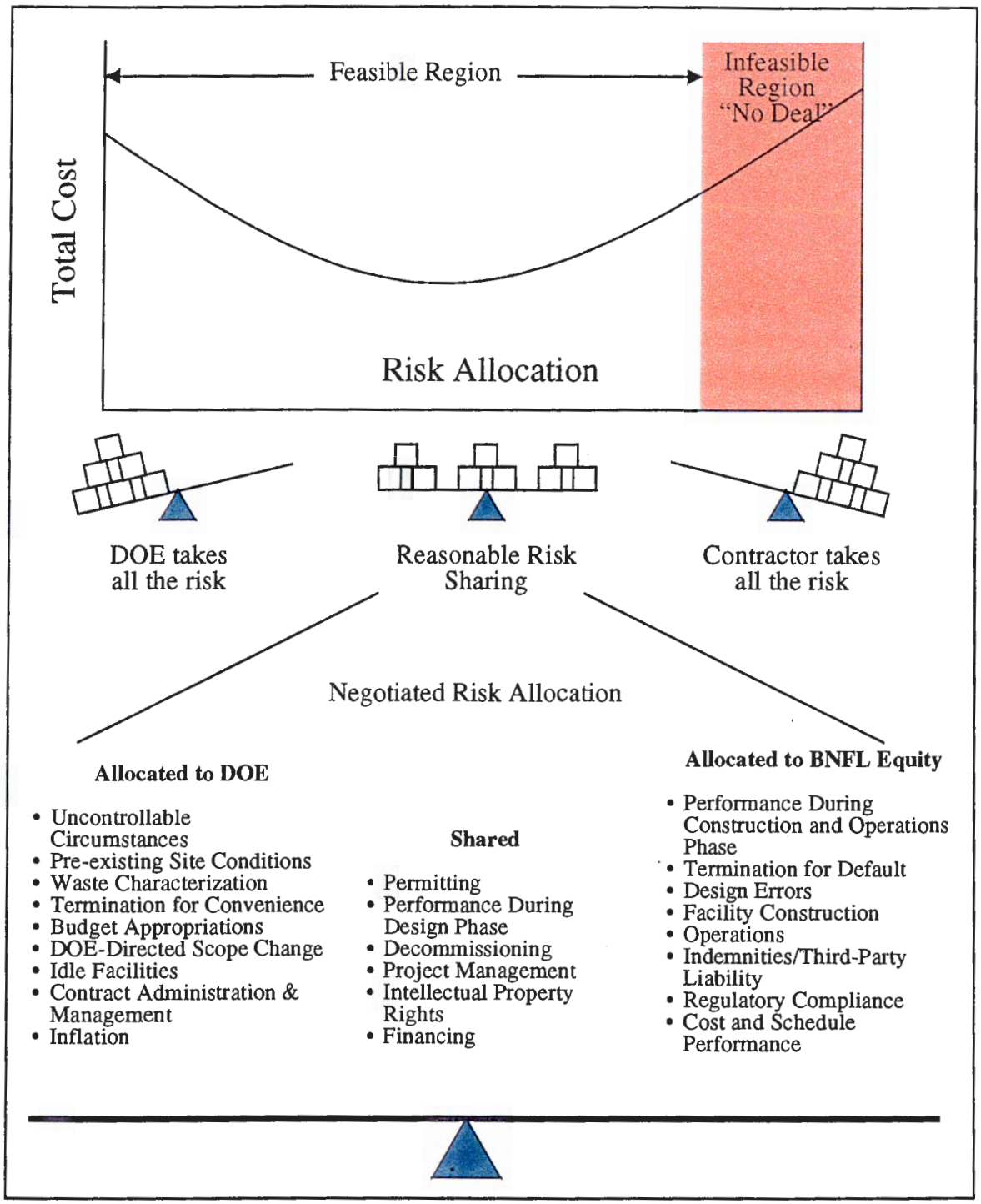


Figure 5-6. Risk Allocation

- *Termination for Default.* During the design phase, if DOE terminates the contract for default, BNFL risks losing its investment in the project including up to $25 million of internal research and developments funds invested in a pilot melter needed to test and demonstrate its design. During the construction and operations phase, BNFL equity will be at risk (BNFL will seek to maximize its equity commitment such that it falls within a range of $200 million to $500 million).

- *Regulatory Compliance.* Once environmental permits are in place, BNFL will be responsible for operating its facility in compliance with those permits. Failure to do so will directly affect BNFL's operating schedule and costs and erode potential profits. In addition, BNFL will be required to reimburse DOE for the amount of fines and other associated costs for violations caused by contractor activities that are not in accord with the contract.

Under this contract, many risks, including the following, are shared by DOE and BNFL.

- *Permitting Risks.* After the Draft Permit and Notices of Construction for Operations of a Dangerous Waste Treatment Facility are issued, DOE and BNFL work together to secure the final permits from regulatory agencies. Issues will be handled by the most appropriate party, or both, on a good-faith basis. BNFL may be reimbursed for costs if permits are denied following a good faith effort and if the problems are not the fault of BNFL.

- *Performance During the Design Phase.* BNFL has incentives that increase payment for the design phase based on reducing target prices and reaching financial closure. DOE retains some risks because, if it chooses to terminate the contract, it must pay BNFL termination costs. These costs would approach $275 to $350 million towards the design phase, depending on the circumstances surrounding the termination.

- *Financing.* Financing risks are shared through equity and private financing by BNFL and termination payment commitments by DOE. The exact mix of financing for the construction and operations phase will be determined in the first 20 months of Part B. In addition, BNFL faces the risk associated with private financing interest rates, and DOE faces the inflation rate risk.

- *Decommissioning.* A specific amount of BNFL's payments will be set aside for deactivation. If deactivation costs exceed budgeted funds, BNFL is responsible for the additional cost. DOE is responsible for decommissioning facilities after deactivation by BNFL.

- *Intellectual Property Rights.* To ensure that the project can proceed on another basis, if that becomes necessary, DOE has the right to obtain BNFL's intellectual property (design and technical information) if the contract is terminated for convenience. DOE, however, faces the risk under this circumstance that transferring this information to another contractor could cause a delay in the overall project.

The risks that are allocated to DOE through this contract include the following.

- *Pre-existing Site Conditions*. DOE agrees to reimburse BNFL for any expense that may be incurred by the contractor arising out of any pre-existing site condition, such as radiological contamination.

- *Termination for Convenience*. DOE has the right to terminate the contact for convenience of the government. However, such termination will result in obligations and costs under the terms and conditions of the contract, including those relating to reimbursement of financing costs.

- *Uncontrollable Circumstances*. DOE will assume the risk, for certain acts, events, or conditions uncontrollable by the contractor that have a material and adverse effect, including cost or schedule, on the contractor to perform its obligations.

- *Idle Facilities*. DOE may incur idle facilities payments if the Department does not provide waste feed according to terms of the contract for schedule, quantity, and type.

5.5.2 Project Obligations of BNFL and DOE

DOE provides certain utilities and services to BNFL under the contract. For the most part, DOE carries out its obligations through the Hanford M&I Contractor and does so at no cost to BNFL.

The most significant of these obligations are described in a separate set of documents called Interface Control Documents, as shown in Figure 5.4 and discussed in Section 5.3.1. Specific obligations of the DOE include the following.

- *Raw and Potable Water*. DOE is required to provide adequate water for waste processing operations and fire control.

- *Electricity*. DOE will provide 33 MW of electricity.

- *Land and Roads*. DOE will provide BNFL land for siting its plants, parking lots, and road access to that land.

- *Waste Treatability Samples*. DOE will provide BNFL samples of the waste for the contractor's use in testing its treatment and immobilization processes.

- *Waste Feed Tank*. DOE will provide to BNFL a feed tank for its use. The tank will be warranted by DOE for use on the project. BNFL will prepare all permit changes and carry out all modifications and upgrades.

- *Waste Feed.* DOE will provide BNFL with LAW and HLW in the amounts and type specified in the contract. Through the Hanford M&I Contractor, DOE will retrieve the waste from SSTs and DSTs, transfer it to a staging tank, test the waste to ensure it meets the chemical specifications, and deliver the waste feed to BNFL.

- *Returned Pretreated LAW and Entrained Solids.* DOE will accept and store pretreated waste during the first two years of operation and entrained solids for the duration of the contract from the pretreatment process.

- *Liquid Effluents and Solid Waste.* DOE will accept liquid effluents and solid wastes meeting acceptance criteria that are generated in the course of waste treatment and will dispose of them on the Hanford Site.

- *Immobilized Products.* DOE will verify that immobilized LAW and immobilized HLW products meet specifications and then accept these products for storage and disposal, as appropriate.

DOE and the contractor have allocated regulatory and environmental obligations on the basis that: (1) where DOE and the contractor have joint obligations, the contractor is required to take lead responsibility; and (2) where DOE has no obligation, the contractor has sole responsibility. Given the current project maturity and the responsibilities that DOE could delegate, the following allocations have been made for operations.

- The contractor is responsible for occupational safety and health under regulatory oversight.

- The contractor is responsible for radiological, nuclear, and process safety under regulatory oversight.

- DOE is responsible for regulating radiological, nuclear, and process safety (through the independent TWRS Regulatory Unit).

- The contractor is responsible for assuring its treatment facilities are permitted and operated within Hanford's environmental compliance framework and applicable laws and regulations.

The following allocations have been made for waste management.

- The contractor is responsible, with DOE concurrence, for identifying and implementing a technical and regulatory path for producing RCRA-compliant HLW and LAW waste forms.

- DOE is responsible for obtaining RCRA delisting for HLW (using contractor data and technical support).

Further definition of responsibilities is needed and provided for in the contract. The contract has provisions that will drive both parties toward increasingly well-defined roles and responsibilities

as the project matures. In effect, the contractor is accountable for its environmental, safety, and health program with respect to both safe operations and production of treated defense nuclear waste. DOE assumes responsibility for its roles as regulator for radiological, nuclear, and process safety; land owner; and customer for waste treatment services.

5.6 Project Costs and Cost Savings

This section addresses project costs and estimated cost savings that are expected over the duration of the contract with BNFL. These assessments are based on conceptual design work and other information developed by BNFL during the first 20 months of the TWRS Phase I contract as well as data developed by DOE. The estimates will be updated during the next phase of the contract as the BNFL design becomes more mature, the technical approach is optimized, the specific mix of private and public financing is determined, and final fixed-unit prices are set. Specifically, this section addresses the following questions.

- What are the expected costs for the design phase and the construction and operations phase? (Section 5.6.1)
  - What incentives will be used to contain costs?
  - How and why do these costs differ from previous estimates?
  - What is the cost of private versus government financing?
- Do the expected project costs represent savings relative to other possible contracting approaches? (Section 5.6.2)
- How do these costs compare to other DOE vitrification projects? (Section 5.6.3)

5.6.1 Project Costs

This section addresses project costs that are expected over the two phases of the BNFL contract—the 24-month design phase and the construction and operations phase. For each phase, DOE has defined incentives to contain future cost growth.

Design Phase Costs. Based on the contract scope of work, the estimated cost for the design phase is approximately $350 million. BNFL will finance this work with its working capital. No government involvement in financing project costs is contemplated during this 24-month period.

With successful completion of the design phase, the contractor has the opportunity to receive immediate payment of $50 million of the estimated $350 million. This payment involves a base payment of approximately $20 million and an incentive fee payment of up to $30 million. Both fee payments are dependent upon BNFL reaching financial closure. In addition, the amount of incentive fee is determined by BNFL's success in reducing the project's construction and operations costs.

BNFL's remaining costs of approximately $300 million for the design phase are not paid by DOE at financial closing and will be carried into the construction and operations phase.

BNFL's working capital is at risk during the design phase in the event that DOE terminates the contract for default. If DOE terminates the contract for convenience, then DOE would compensate BNFL for its negotiated settlement costs.

To ensure that design phase costs are reasonable, BNFL's costs will be subject to certified cost and pricing requirements. DOE will only allow actual costs consistent with the contract to be included in the waste processing fixed-unit prices. Early in the design phase, BNFL will implement a cost accounting system that will provide certified cost and pricing data for both the design phase and the construction and operations phase. This system will help DOE ensure that only appropriate costs are included in the final fixed-unit prices.

Construction and Operations Phase Costs. The BNFL contract contains target prices for treatment and immobilization services during the construction and operations phase. These target prices will be refined during the design phase as new information becomes available. The agreement negotiated with BNFL establishes a $6.9 billion target price (constant FY1997 dollars) for a 10-year, minimum-order quantity of treatment and immobilization services. (This price includes allowable design phase costs.) This minimum-order quantity will treat 10% of the Hanford tank waste (by mass) and 20% to 25% of the radioactivity (see Section 5.3).

This target price is significantly higher than the original DOE estimate for Phase I. The current Construction Project Data Sheet, included as Appendix C, shows an estimated cost of $3.95 billion ($3.2 billion in constant FY1997 dollars). The higher price is, in part, because the hazards presented by the operations to be performed under the contract necessitated robust facilities for processing and confinement of the waste. These facilities will have a 30-year design life rather than the original concept of a 5- to 9-year demonstration facility. As a by-product of the longer design life, the plant has the potential to treat waste for a longer period, to treat waste with a broader range of composition, and to treat more than half of the tank waste by mass and approximately 95% of the long-lived radionuclides if the plant is expanded with limited additional investment (see Section 4.1.2).

Table 5-2 shows the separate cost elements that comprise BNFL's target total price for the minimum order quantity. DOE compared the individual cost elements of BNFL's target price to a separate government estimate of the target prices to ensure that the negotiated target prices were appropriate given the current level of certainty in facility design and financing. This initial comparison identified approximately $1.9 billion in differences between the government's price estimate and BNFL's target price. The construction and operations cost in both were similar. The main differences were in fee/profit, general and administrative expenses, insurance, and research and technology costs. Many of these issues were resolved during contract negotiations and led to roughly a $700 million reduction in BNFL's target prices compared to those offered in its January 1998 submittal. The remainder of the cost issues will be resolved during the first 20 to 22 months of Part B. A final price-reasonableness determination will be completed when fixed-unit prices are finalized at 20 to 22 months after the start of Part B. If prices are too high, BNFL will not be authorized to proceed beyond the 24-month design phase.

Mechanisms to Contain Costs. Prior to the construction and operations phase, DOE will consider the merits of potential changes in the target prices that may be proposed in the context of BNFL's cost elements and the contract-specified bounds. BNFL will have to supply certified cost and pricing information and must track and explicitly justify the basis for each change from the current cost baseline. Regular reviews are planned during the design phase, including an important review at six months, which will focus on terms and methodology that BNFL will use to establish fixed-unit prices and the mechanism by which cost savings during the construction and operations phase will be shared with DOE.

Table 5-2. BNFL Target Price Summary (Minimum-Order Quantity)

Element	Target Price (Constant FY1997 Values in millions)	Major Cost Drivers
Basic Component Costs		
Facility Construction[a]	$1,651	Safety features, waste form acceptance criteria
Facility Operations	$1,046	Safety, successful startup of facility, period of operations, operating efficiency
Deactivation	$ 94	Facility design, facility contamination level at the end of operations
Contingency and Risk	$ 439	Maturity of technology and design, and regulatory uncertainties
Subtotal	$3,230	
Additional Costs		
Insurance, General and Administration, Property Tax, Business and Occupation Tax	$ 424	Amount of insurance required by the contract, tax rates established by Benton County and Washington State Department of Revenue
Subtotal	$ 424	
Financing/Incentive/Profit		
Financing[b], [c]	$1,304	Amount of private financing and debt type (recourse and non-recourse)
Income Tax	$ 680	Tax estimated by BNFL. Actual tax rate will be determined by the U.S. Internal Revenue Service
BNFL Fee/Profit	$1,287	Internal rate of return; amount of equity committed; fees for service
Subtotal	$3,271	
Total	**$6,925**	**Nominal Dollars - $10,483**

(a) Includes design phase costs rolled forward into construction and operations phase.
(b) Includes financing of design phase costs rolled forward into construction and operations phase.
(c) Based on BNFL's assumed constant rate of 4.3% equal to the assumed nominal interest rate (6.8%) minus the assumed inflation rate (2.5%).

During the construction and operations phase, DOE will apply several mechanisms to contain project costs.

- The fixed-unit prices established at the end of the design phase will be subjected to price adjustments that are intended to reduce contingencies in BNFL's fixed-unit price. The precise adjustment mechanisms will be defined during the first six months of the design phase.

- DOE will retain the right to acquire BNFL's facility design and rights to intellectual property if the contract is terminated for convenience. In addition, DOE may obtain the facility at the end of the construction and operations phase if BNFL's prices for processing in excess of the minimum order quantity are deemed unreasonable.

- DOE and BNFL also will negotiate waste minimization incentives during the design phase. These incentives are intended to reduce the total lifecycle cost for the project.

Private versus Government Financing. It might appear that substituting the project's private financing sources with public funding (as in a cost-reimbursement contract) would enable tapping of the government's relatively lower cost of capital (typically two to four percent lower) and effect cost reductions in the project. Although this argument might appear logical, it oversimplifies the process of allocating risks and costs between the government and its contractor. Often, the debate over private financing assumes the project being financed will achieve the same degree of success regardless of its financing source. Indeed, under this assumption, the interest rate premium attached to private financing is difficult to justify. However, the incentives to contain costs and to ensure project success must be considered in determining the merits of private versus government financing. For example, in a recent report on alternative financing strategies for cleanup projects (GAO 1998), the General Accounting Office concluded:

> "While government financing of construction costs would appear to be the most attractive option, under this approach the government is assuming a much greater level of performance risk than it would face under a private financing option. This risk includes the risk that the facility the government finances will not be completed successfully or that the facility will experience significant cost growth. The potential costs associated with these risks could offset – or more than offset – any potential benefits of lower-cost government financing."

Financing costs (i.e., return on equity and interest on debt) account for a significant portion of BNFL's total target price. The target price also assumes that the project is financed with both equity and debt capital, including between $200 million and $500 million of equity. The remaining portion is financed by debt. The target price also assumes that the pre-tax internal rate of return for the equity portion would be approximately 35% to 40%, while the real interest rate for the debt portion (assuming government credit support) would be 6.8%. Given these assumptions, the finance costs (including the financing, income tax and BNFL fee/profit categories shown in Table 5.2) would be $3.27 billion (constant FY1997 dollars). This results in a weighted average cost of capital of approximately 9% (with rate of inflation removed), assuming the capital is spent over 7 years and repaid over the next 9 years.

By comparison, if the project was financed by the United States instead of by private sector commercial lenders, a real interest rate of 3.8% (comparable to the 9% weighted average cost of capital) would apply (per January 1998 guidance from the Office of Management and Budget) and the interest charge would be approximately $1.1 billion (constant FY1997 dollars).

It should be emphasized that the contractor will not be guaranteed any specific equity return and will only earn the assumed equity return if the project is successful. If the project fails, the contractor's entire equity is at risk.

During the design phase, DOE and BNFL will finalize the project financing approach, including the specific rates for equity and debt financing, and seek to optimize the relative amounts of public and private financing. The goal of the Department is to develop a final balanced approach in which the higher cost of private financing (compared to government financing) should be offset by the strong incentives to contain cost growth (compared to a cost-reimbursement contract).

The following section addresses the potential for cost savings that could result from this contract.

5.6.2 Potential for Cost Savings

The negotiated contract terms and target prices provide a potential for cost savings to the government compared to traditional contracting methods. However, it is premature to reach a definitive assessment of cost savings until the end of the design phase, when final fixed-unit prices are set and the project financing approach is finalized. In developing preliminary estimates of cost savings, DOE considered the current target prices, including estimates of construction, operation, finance, and other costs, and compared these to the costs expected from a cost-reimbursement contracting approach. Table 5-3 summarizes DOE's cost comparison of the BNFL contract with potential cost-reimbursement contracting. As the table shows, these comparisons led to a range of estimated cost savings for the BNFL contract.[2]

As shown in Table 5-3, DOE prepared two separate estimates of the costs that could be incurred under a cost-reimburseable contract. The range of these estimates is typical of the cost estimates prepared at this stage in design development (such estimates typically have a range of ± 40%). This range of estimates reflects uncertainties in various assumptions underlying the cost estimates (e.g., the amount of cost growth) and assumptions used to place privately financed and government-financed projects on comparable terms. These cost estimates provide a range of costs that DOE could incur if TWRS privatization was not pursued.

The first cost estimate, shown in column C, used past Hanford Management and Operations contractor cost data and assumed that a cost-reimbursement contractor was requested to proceed with the treatment and immobilization of the tank waste. This estimate was intended to show the costs that would be incurred if the Hanford M&O contractor was asked to perform the Phase I work scope. This cost estimate assumed that there were no lessons learned from the privatization contractors and that the M&O contractor proceeded with the design, construction, permitting and operation of a facility in a manner comparable to historical practices.

[2] Prior to the beginning of Part A, DOE estimated that the two-phased privatization approach would result in approximately 25% to 30% cost savings (Holbrook et al 1996). This savings estimate was based on the past experience with privatization (where market forces drive efficiencies) and preliminary expectations about responses to the Part A contracts.

Table 5-3. Summary of Potential Cost Savings from the Phase I Contract (Constant 1997 Dollars, Billions)

A	B	C	D
	BNFL Contract	**DOE-RL M&O Estimate**	**BNFL Under a Cost Reimbursement Contract**
Base Cost Estimate	6.9[a]	8.2[b]	3.9[c]
Potential Cost Growth	0.0	0.0[d]	2.6[e]
Adjustment for Government Cost of Capital[f]	0.0	1.6	2.0
Credit for Federal Taxes	(0.7)[g]	(0.07)[h]	(0.06)[h]
Net Cost to the Government	6.2	9.7	8.4
Potential Cost Savings for Phase I Contract	–	3.5 (36%)	2.1 (26%)

Notes:
(a) BNFL's target price including design phase costs.
(b) Estimate derived from previous Hanford TWRS studies.
(c) BNFL's costs excluding financing costs and profit.
(d) No additional cost growth was assumed for this case.
(e) The 68% cost growth represents the type of cost growth that DOE has historically experienced with an M&O contractor. This cost growth factor is based on an independent cost estimate study performed for DOE by Burns and Roe (Burns and Roe, June 1998). Even if this cost growth factor were reduced by half, cost savings may still be realized.
(f) The adjustment for the Government cost of capital is an imputed charge on the Government's investment in capital assets necessary for the treatment and immobilization of tank waste.
(g) Tax payments are BNFL's projected taxes. Actual tax payments could differ depending on the tax treatment BNFL receives from the U.S. Internal Revenue Service regarding appropriate rules for depreciation.
(h) Estimated based on the fee paid to M&O contractors. The tax calculation assumes that the M&O contractor pays at a marginal tax rate of 30%.

The second estimate, shown in column D of Table 5-3, was developed by updating an estimate provided by BNFL prior to delivery of their Part B proposal in January 1998. This estimate assumes that the current technologies proposed by BNFL, as well as their proposed construction, operation and deactivation processes, would be used by BNFL under a traditional DOE cost-reimburseable contract. DOE developed factors that estimate the differences between a privatized fixed price contracting approach and a traditional DOE cost-reimburseable contracting approach.

The estimates in columns C and D were compared with the cost of the BNFL contract, assuming the currently negotiated target price (shown in column B of Table 5-3). It should be noted that various mechanisms in the contract provide the potential to reduce this target price, including technical optimization and incentives to drive down costs. To determine the net cost to the government of the BNFL contract, BNFL's target prices were adjusted for federal taxes paid back to the government.

As shown in Table 5-3, before comparisons of the costs to the government could be made, adjustments were made to account for three key differences: (1) the Government cost of capital under the cost-reimbursement approach; (2) the amount of federal taxes paid; and (3) estimates of potential cost growth. These adjustments are discussed below.

Government Cost of Capital. The price paid for services under the BNFL contract includes the cost of capital for both equity and debt capital requirements. However, the cost of capital is not included in DOE's payments to the cost-reimbursement contractor, even though the government has a cost of capital. In effect, there is a cost of money associated with paying a cost-reimbursement contractor as the costs are incurred compared to a fixed-price contractor, which is, for the most part, not paid until waste is processed. To allow for a fair cost comparison, the government's cost of capital should be added to DOE's cost of performing the work under the cost-reimbursement contract. This approach is consistent with both public and private financial analysis practices used to place competing investments on common terms.[3]

Credit for Federal Taxes Paid. The fixed-priced contractor pays considerably more federal taxes than would be paid by a cost-reimbursement contractor. BNFL's potential profit will likely be substantially larger than the typical 2% to 3% fee earned under a cost-reimbursement contract to compensate for higher risks. Thus, BNFL will pay more in federal taxes than would be paid under a cost-reimbursement contract.

Expected Cost Growth. The last adjustment is made to account for the difference in the potential cost growth under the BNFL contract compared with the potential cost growth under a cost-reimbursement contract. The BNFL contract contains several factors not present in typical cost-reimbursement contracts, which are expected to minimize the potential for cost growth. These factors include:

- The fixed-price nature of the BNFL contract should improve technical and schedule performance relative to a cost-reimbursement approach. BNFL must stay within budget or potentially suffer a reduction in profit. This will lead BNFL to minimize costs in order to maximize profits. On the other hand, cost-reimbursement contracts generally have schedule slippage that leads to cost growth. The added costs result from the same quantity of staff taking longer to do the same job.

- The BNFL contract shifts substantial performance risk for construction and operations (including processing technology) to the contractor, thereby creating incentives for the contractor to ensure the success of their approach. This risk sharing for the overall performance of the facility and technology is not present in cost-reimbursement contracts. BNFL's equity and the desire to recover it, plus an equitable rate of return, drives performance.

[3] For example, the Office of Management and Budget uses a similar approach to account for the implicit government cost of funds in its guidance on how to perform discounting in cost-effectiveness analysis of alternative government programs. The discounting is accomplished by using the real (i.e., adjusted for inflation) cost of government borrowing. In its January 1998 guidance, the Office of Management and Budget prescribed a real interest rate of 3.8% as the government cost of finance (OMB 1998).

- Additionally, private lenders will add a further layer of oversight to the project. The lending community will want assurances that they will recover their principal and interest. To ensure that recovery, they will employ independent engineers and other consultants to study BNFL's approach, validate the technical approach and the cost estimates, and monitor progress of the project throughout.

5.6.3 Comparison with other DOE Vitrification Projects

DOE has initiated a preliminary analysis to compare the BNFL HLW target prices to the cost of making HLW glass at the Defense Waste Processing Facility (Savannah River, South Carolina) and the West Valley Demonstration Project (West Valley, New York).

The BNFL estimated price for HLW treatment services is approximately $300,000 per metric ton of glass produced for the minimum order quantity. Actual fixed-unit prices will be established at the end of the design phase.

A fair and accurate comparison of this price with the costs of treatment at the South Carolina and New York facilities is made difficult due to differences in the processing configurations, design-life of plants, and designed and realized throughput. In addition, the scope of work to be performed at the facilities differs. The BNFL facility will be used to produce both high-level and low-activity waste glass, whereas the Savannah River and West Valley facilities produce high-level waste glass and cementitious low-level waste forms.

The following comparisons represent an initial assessment that will be refined as the design phase moves forward. Although the comparisons are complex to perform, all three facilities use similar technology and must meet similar requirements for their HLW products.

All three facilities use a joule-heated, liquid-fed, ceramic melter and pour molten glass into stainless-steel canisters to produce glass "logs." The canisterized borosilicate HLW glass from all three facilities must meet specifications and quality assurance requirements prescribed by the Office of Civilian Radioactive Waste Management and the Office of Environmental Management. With appropriate adjustments, cost comparisons with these two existing facilities can provide a reasonable benchmark for BNFL's estimated price. The following adjustments were made to provide a basis for comparison:

- BNFL's estimated price for HLW processing (price per metric ton of HLW oxides) was converted to a price per metric ton of immobilized HLW glass.

- West Valley's costs were adjusted to exclude those costs not associated with HLW vitrification, such as some storage costs, tank farm operations and closure, and waste retrieval.

- Savannah River's costs were similarly adjusted to exclude costs not associated with HLW vitrification, such as waste water treatment, construction and operation of LAW disposal (saltstone facility), waste retrieval, and tank farm operations and closure.

The adjusted average unit cost for the Defense Waste Processing Facility is $670,000 per metric ton, which assumes a 22-year operating life. The adjusted average unit cost for the West Valley Demonstration Project is $1,228,000 per metric ton for its planned 2.5-year operating life.

In comparison, BNFL's estimated unit price is approximately $300,000 per metric ton of glass for the minimum-order quantity (assumed to be the first 10 years of operations). BNFL's facility, however, is expected to have a useful life of 30 years or more. Because the capital cost of the contractor's facility will be recovered during the processing of the minimum-order quantity, DOE expects to negotiate a substantially lower price on treatment of any waste in excess of the minimum-order quantity. These "post-minimum-order quantity" prices will be established at the end of the design phase.

5.7 Phase I Funding Requirements

Proceeding with the design phase will require that sufficient funds are appropriated to DOE for both the BNFL contract and for the various support projects, which must be completed by the Hanford M&I Contractor. The funding requirements are described in Section 5.7.1 for the BNFL contract and in Section 5.7.2 for the various Hanford M&I Contractor projects required to accomplish Phase I Part B.

5.7.1 TWRS Phase I Funding Requirements

Annual budget appropriations will be required through FY2017 to allow DOE to pay for the treatment, immobilization, and deactivation services to be provided by BNFL during Phase I of the TWRS program, if BNFL is authorized to proceed to the construction and operations phase of the contract.

When DOE pays for waste treatment services under the contract with BNFL, these payments will have two components: a capital portion that pays for amortization of the BNFL waste treatment and immobilization facility and an operating portion that pays for the labor, materials, and other costs associated with providing waste treatment and immobilization services. Since 1997, Congress has appropriated budget authority (BA), totaling $285 million, for the capital portion ("capital BA") through the Environmental Management privatization account. When waste treatment is initiated, the capital BA accumulated in this account will be the source of funds for budget outlays (BO) for the capital portion of the payments for waste treatment services. BA for the operating portion of the payments for waste treatment services ("operating BA") is outlayed in the same year that it is appropriated.

Table 5-4 provides current estimates of BA and BO profiles for Phase I. The operating BA and BO profiles are based on the current BNFL target prices and schedule and will be adjusted during the 24-month design phase. As a result, they do not represent precise budget estimates.

Table 5-4. Potential Budget Authority/Budget Outlay Profiles for 90% Confidence Schedules for Phase I, Part B Waste Processing Services (Nominal Dollars, Millions)

A	B	C	D	E	F	G
Fiscal Year	BNFL's Estimated Outlays	Estimated Budget Authority		Estimated Budget Outlays		
		Capital	Operating	Capital	Operating	Total
1997	0	170	0	0	0	0
1998	20	115	0	0	0[a]	0[a]
1999	155	113	0	0	0	0
2000	291	474	0	50	0	50
2001	631	675	0	0	0	0
2002	659	675	0	0	0	0
2003	633	610	0	0	0	0
2004	594	600	0	0	0	0
2005	598	573	0	0	0	0
2006	563	529	0	58	0	58
2007	518	530	0	188	0	188
2008	804	403	0	401	0	401
2009	712	0	711	197	711	908
2010	691	0	691	382	691	1,073
2011	705	0	705	397	705	1,102
2012	661	0	661	436	661	1,097
2013	669	0	669	442	669	1,111
2014	599	0	599	766	599	1,365
2015	498	0	498	939	498	1,437
2016	354	0	354	876	354	1,230
2017	128	0	128	335	128	463
Total	**10,483**	**5,467**	**5,016**	**5,467**	**5,016[a]**	**10,483[a]**

(a) Excludes payment made to BNFL and LMAES for Part A.

Notes:

(1) Funding is in fiscal year dollars.

(2) These numbers reflect BNFL's current financial model and will be updated during the design phase. The estimate provides an example of potential spending streams rather than a precise budget estimate.

A number of additional factors were considered in developing the capital BA profile, including the following:

- Coverage will be provided for termination liability in accordance with the *Anti-Deficiency Act.*

- Sufficient funding will be provided to allow BNFL to accelerate the design, construction, and permitting of its facility or to continue design, construction, and permitting in the event of a continuing resolution. The ability to accelerate the project could lead to cost reductions for DOE as a result of the reduced financing costs of the project.

- A level budget request is desirable to avoid the need for unsustainable out-year funding increases.

- Assurance needs to be provided to the private financial community that DOE and the Congress are committed to TWRS privatization; thereby, providing downward pressure on the cost of capital.

- Funds will be provided for the capital portion of the payment to BNFL for services provided.

The capital BA profile will result in instances where there will be unobligated funds and uncosted balances. In the event that BNFL finds a means of accelerating the construction schedule by doing work faster or by ordering material sooner, the unobligated funds serve as a reserve to allow DOE to meet its contractual obligations and cover the additional costs for the accelerated performance. By allowing acceleration of the construction schedule, BNFL should be able to start the facility sooner, reduce the interest costs, and decrease the total cost to DOE. The capital BA profile shown in Table 5-4 would allow an acceleration estimated to be approximately 6-9 months. Since the capital BA provided to DOE is assigned to the BNFL contract, there will be strict accountability of these funds.

The operating BA will be used to pay for the operations costs of the facility when it is treating and immobilizing tank waste. Capital BA has been requested since FY1997 through the privatization account and will continue to be requested through FY2008. Operating BA will be requested from FY2008 through FY2017. As shown in Table 5-5, an overlap in the construction and operation of the BNFL facilities will require DOE to request both capital and operating dollars in some years.

Table 5-4 is based on the assumption that BNFL will be authorized to proceed to the construction and operations phase. If not, a termination settlement would be negotiated with BNFL. The estimated costs of a termination for convenience settlement at the end of the 24-month design phase range from approximately $275 to $350 million, depending on the circumstances surrounding the termination.

If the project moves forward to the construction and operations phase, DOE does not plan to provide a payment in FY2000 equal to the BNFL costs for the 24-month design phase. A maximum payment of $50 million is planned in FY2000, consisting of a base fee of $20 million and an incentive payment of no more than $30 million. The incentive payment is based on BNFL's ability to minimize the construction and operating costs of the facility. An incentive based on reductions in construction and operations costs was selected because BNFL has the greatest control over these costs. These costs are also the elements that drive the financing costs of the facility. The payment will be outlayed from the funds currently appropriated in the TWRS privatization account.

If DOE authorizes BNFL to proceed to the construction and operations phase, payments to BNFL for delivery of acceptable product starting in FY2005 to FY2006 will provide the mechanism for repaying that portion of the BNFL costs for the design phase which are not covered by the DOE payment in FY2000.

Table 5-5. Estimated Budget Profile for M&I Contractor Costs (Direct and Indirect) To Support Privatization (Nominal Dollars, Millions)

A	B	C	D	E
Fiscal Year	Estimate for TWRS Base Operations by M&I ($M)	Estimate for BNFL Direct Support by M&I ($M)	Estimate for Total TWRS M&I Requirements ($M)	Baseline M&I Funding Profile ($M)
1999	210	112	322[a]	302
2000	202	133	335	346
2001	154	184	338	335
2002	124	216	340	326
2003	121	245	366	388
2004	128	209	337	392
2005	114	160	274	298
2006	114	127	241	348
2007	85	135	220	[b]
2008	85	81	166	[b]
2009	87	60	147	[b]
2010	88	55	143	[b]
2011	87	29	116	[b]
2012	87	21	108	[b]
2013	84	17	101	[b]
2014	86	15	101	[b]
2015	86	15	101	[b]
2016	86	15	101	[b]
2017	86	15	101	[b]
Total	2,114	1,844	3,958	

(a) The planned work scope for FY1999 exceeds the anticipated funding levels. DOE will adjust the planned work scope to meet the anticipated funding. BNFL support activities will be funded at their required level.
(b) The Environmental Management "Paths to Closure" planning horizon currently extends to FY2006, and baseline funding profiles have not been prepared for the period after FY2006.

5.7.2 Hanford M&I Contractor Funding Requirements for Support of Privatization

There are three components of the TWRS program: TWRS base operations, TWRS support to BNFL, and the work to be performed by BNFL. The Hanford M&I Contractor will perform the work associated with TWRS base operations and TWRS support to BNFL. All costs for these two components of the TWRS program are shown on Table 5-5. Costs associated with work to be performed by BNFL were shown on Table 5-4.

The work associated with TWRS base operations shown in Column B must be performed whether or not DOE authorizes BNFL to proceed to the construction and operations phase. These activities include routine surveillance and maintenance of the tanks, receipt of liquid wastes from other site cleanup efforts, continued characterization of the tank wastes, and resolution of safety issues associated with continued storage of the waste in the tanks.

The work associated with TWRS support to BNFL, shown in Column C, includes retrieving wastes from the tanks, delivering feed to BNFL, accepting and storing the low-activity and high-level vitrified waste products, and providing other services to BNFL, such as roads, water, and electricity.

The total cost of TWRS base operations and TWRS support to BNFL (Column D) through the year 2018 is estimated to be approximately $4 billion. This estimate is based on a preliminary analysis that will be refined and verified in FY1999. Although this refinement and verification is likely to result in some changes, DOE is confident that the costs shown are realistic and the Department does not expect any major changes.

Column E of Table 5-5 provides the baseline funding profile for TWRS base operations plus TWRS support to BNFL. This funding profile was developed prior to the time that the decision was made to not consider LMAES for Part B work and before the current agreement was negotiated with BNFL. The treatment and immobilization of tank wastes according to the terms of the agreement with BNFL will necessitate only minimal changes to the baseline funding profile.

5.8 Planning for Phase II

Following completion of the BNFL contract, either after the minimum-order quantity or after possible contract extension(s), DOE will be responsible for decommissioning the Phase I facilities after deactivation by the contractor. DOE will also be responsible for continued safe storage of any returned intermediate waste products (e.g., entrained solids), disposal of all immobilized LAW, and interim storage and eventual transfer to the geologic repository of the immobilized HLW produced by the contractor.

Completion of the TWRS mission will require waste processing beyond that provided under the BNFL Phase I contract. A TWRS Phase II will be required to complete the TWRS program mission by implementing systems to retrieve, treat, and immobilize the remaining inventory of tank waste. Phase II activities will also need to dispose of all immobilized LAW, store immobilized HLW pending shipment to the repository, close all waste tanks, decontaminate and decommission all TWRS facilities, and conduct post-closure monitoring of closed tanks and facilities.

Processing by BNFL of the Phase I minimum-order quantity will result in treatment and immobilization of approximately 10% of the Hanford tank waste by mass and 20% to 25% of the radionuclide content. The BNFL contract does provide DOE with some flexibility in how it approaches Phase II and completion of the tank waste cleanup. If the BNFL facility operates efficiently and effectively, DOE may request BNFL to process additional quantities of waste in Phase I, thus reducing Phase II requirements. BNFL's design also includes the capability to expand capacity and extend operations beyond Phase I. This expansion capability could be used to process most of the remaining tank waste during the expanded plant's remaining operating life.

The TPA requires that DOE complete all tank waste immobilization by 2028. To meet this milestone, DOE would need to add Phase II capacity that is greater than the expansion option currently envisioned. BNFL's pretreatment facilities were sized to accommodate a capacity increase of 100%. The HLW vitrification facility was designed with sufficient space for two melters; only one melter was required for the minimum-order quantity specified in the BNFL contract. A second, larger HLW melter could be added to increase the initial Phase I capacity

(by greater than a factor of four). The LAW vitrification facility was designed with the connections and flexibility in common support systems to add a second LAW facility with capacity similar to that of the Phase I facility. BNFL estimates that these capacity expansions could be accomplished for a limited additional investment. (See Section 4.1.2.)

If those changes are authorized by DOE, the modifications would effectively double the LAW capacity of the BNFL facility and quadruple the HLW capacity. If the expansion were completed in approximately 2012, BNFL estimates that the capacity expansions could enable this facility to immobilize 55% to 65% of the total tank waste (by mass) by 2028. The balance of the waste requiring treatment by 2028 would require additional capacity. Preliminary estimates by DOE indicate that the addition of a separate facility operating in parallel with the BNFL expanded facility, with HLW and LAW capacities approximately equal to the expanded BNFL facility, could complete the TWRS cleanup mission by 2028 if brought on-line by 2016.

DOE will initiate planning for Phase II during the Phase I design phase, and decisions regarding how best to deploy Phase II services will occur during Phase I construction and operations. These decisions will occur some time after hot start of the Phase I facility, thus allowing some Phase I operating experience to be incorporated into the Phase II plan. This schedule represents a change to the Phase II planning activities contained in the current official TWRS baseline schedule and will require a change in the baseline. The current TWRS baseline shows Phase II planning starting in FY2002 and continuing through initiation of Phase II contract award in FY2005. Given the BNFL schedule for a Phase I hot start, the TWRS baseline dates for Phase II planning and execution need to be updated. The costs for Phase II planning are not shown in Table 5-4 and are expected to be approximately $10 million per year above the spending shown in Table 5-4. In addition, there will be requests for capital BA to cover the anticipated termination-for-convenience costs for the Phase II contractors, as there were for Phase I.

6 Management of the TWRS Phase I Project

The successful execution of the TWRS Phase I project requires effective management by DOE. Accordingly, DOE is establishing separate project management teams with expertise in technical, financial, legal, and contract administration areas. The privatization project team will be responsible for the successful administration of the BNFL contract. The operations contractor project team will manage the activities of the Hanford Site contractor performed in support of the BNFL contract. This section describes the elements DOE has incorporated into its management plan for the TWRS Phase I project. This management approach has been adopted due to the size, complexity and unique nature of both contracts and the overriding necessity to ensure integration across all TWRS and Hanford activities.

6.1 Overview of DOE's Management Approach

With TWRS Phase I, DOE is taking on a new management role—one that requires the integration of activities of two prime contractors to execute the entire TWRS Phase I work scope. BNFL will be responsible for design, construction, waste treatment and immobilization. The Hanford M&I Contractor will be responsible for retrieving the waste from the tanks and providing it to BNFL for treatment and immobilization. The Hanford M&I Contractor will also be responsible for accepting, receiving, and storing or disposing of the treated waste and byproducts.

Under the TWRS management approach, DOE primarily defines the requirements (i.e., specifies *what* it wants accomplished) and the performance incentives, and the details of implementation (i.e., the *how*) are left largely to the performing contractors. This approach is designed to allow the contractors freedom to determine the best way to carry out the work and to be rewarded for a good job. To carry out this role effectively, DOE is taking a project-oriented approach. The Phase I project includes features to assure effective management and integration of the work, including incentives and tools to ensure and monitor contractor performance. Key features include assembling experienced, dedicated contract management teams and implementing disciplined project management systems that contain approved scope, schedule, and cost baselines and enable performance to be measured and changes to be formally controlled. The project management systems will be tailored to TWRS Phase I.

The management approach is based on project management, performance-based, fixed-price-, and incentive based contract administration principles and best practices from the private sector and other government agencies, as well as lessons learned captured in DOE Order 430.1, *Life Cycle Asset Management*, and the DOE Headquarters *Environmental Management Privatization Program Management Plan* (DOE 1997a). The TWRS Phase I Management Plan will describe DOE's management approach.

6.2 Special Elements for Management

Special elements have been incorporated into DOE's management approach. These elements focus on: (1) managing the risk that DOE is assuming for the pretreatment and immobilization of the waste by BNFL under the BNFL contract and (2) incorporating lessons learned from other DOE privatization projects. Table 6-1 highlights these elements and their use.

Table 6-1. Special Elements of DOE Management Approach

Element	Function
Direct contracting between DOE and BNFL	Provides contract management and control to DOE rather than to the Hanford M&I Contractor
Performance incentives in the BNFL contract	Equity, third-party financing, and incentive fees provide incentives for BNFL's to perform on schedule and within cost parameters
BNFL Integrated Master Plan (BNFL 1998b)	Establishes well-defined cost and schedule baselines and objective, verifiable interim and completion milestones from which to monitor performance and detect non-performance early in the process Identifies the critical programmatic risks for monitoring and management of these risks
BNFL project management plan	Establishes a management plan for the execution, integration, and control of the BNFL work Establishes monthly reporting against the Integrated Master Plan for monitoring of BNFL performance and early detection of performance problems
A Contract Administration Plan for the BNFL Contract	Ensures DOE monitoring and administration consistent with contract type, terms, and conditions
Performance agreements with the Hanford M&I Contractor	Provides incentive for the M&I Contractor to meet its obligations under the project
Integrated TWRS Phase I project baselines	Provides for monitoring of overall project performance and early detection of impacts on performance resulting from contractor performance problems
Integrated Product/Process Teams	Provide for frequent exchange of information, informal monitoring of contractor performance, early detection and timely resolution of issues and problems, and teaming of the parties including regulators
Interface Control Documents	Specify contractor interface requirements and activities to meet the requirements, to clarify and communicate the parties and their obligations
Interface Memoranda of Understanding	Specify DOE organizational interface requirements and activities to meet the requirements, to clarify and communicate the parties and their obligations
Teams of management and technical experts	Augment DOE capabilities in the technical, business and finance, regulatory, and project management areas
Ongoing non-proponent review	Provide guidance and lessons learned from private industry and other government agencies

6.3 Establish TWRS Phase I as a Separate Project

TWRS Phase I includes four major functions. These functions are performed by the Hanford M&I Contractor and BNFL as described below.

Hanford M&I Contractor

- *Waste Retrieval* involves retrieval of waste from DSTs, retrieval of waste from SSTs, and delivery of four envelopes of characterized waste feed to BNFL for processing. Waste retrieval also includes all activities necessary to install retrieval systems, retrieve waste, and test retrieval technology.

- *Waste Disposal* involves receipt and storage of immobilized HLW and receipt and disposal of immobilized LAW and interface with the national geologic repository.

- *Infrastructure* involves physical interfaces with the BNFL facility, including land, roads, utilities, effluent treatment systems, feed tanks, and radioactive solid waste systems.

BNFL

- *Waste Processing* involves treatment and immobilization of LAW and HLW, including all pretreatment, separation into high-level and low-activity fractions, separation of byproducts, operation of waste processing plants, and production of immobilized waste forms.

The contract management teams and the necessary components of the project management systems are being implemented on a schedule that assures the elements are aligned with TWRS Phase I activities and will be in place when needed.

6.4 TWRS Phase I Project Management

The DOE Phase I project teams will be located in close proximity to the BNFL and Hanford Operating Contractor managers at the Hanford Site.

The DOE teams will possess the requisite qualifications, experience, and mix of capabilities to manage Phase I. The core positions for the DOE privatization project team are as follows:

- Project Manager;

- Deputy Project Manager;

- Baseline Integration Manager;

- Quality Assurance Manager;

- Contracting Officer;

- General Counsel;

- Contract Specialist;
- Financial analyst experienced in commercial financial markets;
- Engineers with experience in radioactive facility design, constuction, and operation;
- Cost estimator with experience in large, construction and operating projects;
- Contracting Officer's Representative;
- Stakeholder Involvement Specialist; and
- Management, regulatory, and technical experts.

DOE will fill these key positions with skilled and experienced staff from within and outside DOE. DOE-RL is currently below its Strategic Alignment Initiative staffing ceiling, providing opportunity for hiring specialists to fill critical staff positions. When needed, excepted service positions are being used to acquire these special skills. In addition, DOE's teams will include an established group of management, technical, and financial experts from national laboratories and the private sector, which has been supporting DOE on the TWRS project for the past several years.

Project staffing and training plans are being prepared. The TWRS Phase I Project Staffing Plan will identify the project management functions that need to be performed by DOE, the staff required to perform these functions, and the staff assigned to fulfill the functions. The TWRS Phase I project training plan will identify the TWRS Phase I project-specific training requirements for project staff and staff interfacing with the projects.

In addition to managing TWRS Phase I DOE will build the capability to provide direction to a new contractor in the event that BNFL must be terminated for convenience at the end of the design phase.

6.5 Project Management System

The Project Management System is being revised to meet specific requirements of the TWRS Phase I Project in Part B. The revised DOE Project Management Systems of TWRS Phase I will include:

- Work Breakdown Structures defining all of the work to be performed, including work to be performed by DOE to manage Phase I;
- Organizational Breakdown Structures describing how Phase I is organized, key DOE and contractor organizations, their relationships, and lines of authority;
- Descriptions of the organizational and key personnel roles and responsibilities;

- Specific management plans and procedures for project management, stakeholder and public involvement, quality assurance, risk and decision management, staffing, and training;

- Interface Control Documents to manage the interfaces between the contractors and interface MOUs to manage interfaces within and outside of DOE;

- Project Baselines containing project scope, schedule, and cost baselines and monthly baseline status reviews used to manage and control project scope, schedule, and cost performance and to monitor the contractors;

- Project controls appropriate for fixed-price and incentive-fee contracts that include change control, configuration control, funds control, baseline variance threshold monitoring and evaluation, and monthly project reports and review meetings to review contractor and overall project baseline performance against the approved baseline;

- Critical Risk Management Lists and Decision Tracking Lists to ensure critical risks are identified and managed and key decisions are made when needed;

- Annual Budget Authority and Budget Outlay profiles, containing life cycle funding profiles for each of the projects to ensure the necessary funding is planned and provided as scheduled to meet DOE commitments;

- Non-proponent project reviews at key project milestones and decisions.

The Project Management Plans will describe how DOE will manage TWRS Phase I. These plans will emphasize DOE's management role and will describe the mission, strategy, objectives, scope, schedule, and cost baselines of Phase I; work and organizational breakdown structures; roles and responsibilities; and project management and contract administration functions and reporting relationships.

6.6 Management Elements for Maintaining Financial Accountability and Reporting Cost Variances

During the design phase, the Hanford M&I Contractor and BNFL will evaluate and report their progress and performance to DOE monthly. For BNFL, this reporting will be against the Integrated Master Plan. For the Hanford M&I Contractor, this reporting will be against the annually updated Multi-Year Work Plan. Written reports submitted to DOE will contain:

- A narrative assessment by the Project Manager;

- The significant accomplishments and progress towards completion of project goals, objectives, and milestones;

- A comparison of the amount of work completed against the approved contract baseline;

- Potential problems, impacts, and alternative courses of action using a schedule-based method to identify potential schedule deviations and needed corrective actions before they affect the baseline;

- A critical path analysis to monitor the completion of important activities in the correct sequence;

- Identification of cost and schedule variances exceeding 10% and plans for addressing the variances;

- Critical risks and actions planned to address those risks;

- Status of decisions and information requirements for those decisions; and

- A 90-day preview of major activities and milestones.

This information will be integrated by DOE and used to assess the contractors' performance and the performance of the project overall, using performance and variance analyses. Through these analyses, significant variances will be identified and evaluated further by DOE to determine:

- *Cause:* The specific reasons why the variance occurred;

- *Impact*: The specific impacts on remaining work scope, including impacts to the estimate of fixed prices at completion of the design phase; and

- *Corrective Actions*: The specific plans developed by the contractors to mitigate variances.

The information resulting from these analyses will be presented by DOE in regularly scheduled Project Management Integrated Product/Process Team meetings to review and discuss contractor and overall project performance with contractor project management staff. Topics expected to be addressed during these meetings include performance accomplishments; technical, schedule, and cost variances; risks; impacts; and corrective actions associated with each of the contracts and the overall project. In addition, the Critical Risk Management Lists and Decision Tracking Lists will be reviewed and discussed to ensure critical risks are being managed and key decisions are occurring when needed. Proposed corrective actions resulting from discussions will be recorded and tracked to completion.

The information and results of the performance evaluations and project reviews will then be summarized and reported to DOE Headquarters. Significant technical/schedule/cost variances and increases in the BNFL contract cost estimate will be reported as required in Section 3132 of the *National Defense Authorization Act for Fiscal Year 1998*. Specifically, any increases in the cost estimate of the BNFL contract that equal or exceed the estimates provided to Congress by 10% will be reported to Congress by DOE Headquarters.

6.7 BNFL and Hanford M&I Contractor Management Approaches

The Hanford M&I Contractor and BNFL, like DOE, are taking a project-oriented approach to managing their efforts in support of TWRS Phase I. Each contractor is implementing its effort as a project and establishing the necessary project management elements. The most important elements include a project office; project team/organization; work and organizational breakdown structures; a project management plan; a project baseline containing scope, schedule, and cost baselines; and monthly reports and reviews of status against baselines. The Hanford M&I Contractor's project management approach and ability to manage was independently evaluated, as well as evaluated by DOE, as part of the Hanford M&I Contractor readiness-to-proceed assessment.

Lockheed Martin Hanford Corporation is the subcontractor, under Fluor Daniel Hanford (the Hanford M&I Contractor), responsible for day-to-day operation of Hanford's tank farms and will ensure all activities in support of the privatization contractor will be carried out successfully. Both Fluor Daniel Hanford and Lockheed Martin Hanford Corporation are staffed by individuals with extensive experience in defense waste cleanup activities, and who have a thorough understanding of the tank waste challenge at Hanford. Key performance measures have been built into the Hanford M&I contract that provide substantial incentives for strong performance.

BNFL's project management approach and ability to manage was evaluated prior to the award of its contract for Part A, and again for authorization to proceed, based upon its Part A deliverables. The BNFL team has successfully demonstrated extensive, relevant technical and management experience. BNFL has 40 years of experience in the financing, development, design, construction, and operation of complex nuclear waste management facilities. For TWRS Phase I, they have established a best-in-class project management team with a combined experience base totaling more than one hundred years, and recent experience (within the past 5 years) managing 15 major projects, each with an overall cost in excess of $100 million.

The team is comprised of BNFL Inc., BNFL Engineering Ltd., Bechtel, GTS Duratek, and SAIC. BNFL will serve as the project manager providing the project management, integration, and operations expertise; with Bechtel providing design and construction management services; GTS Duratek providing waste treatment and vitrification services; and SAIC providing regulatory compliance services. BNFL's Project Manager has 35 years of project management and engineering experience with complex radiochemical processing projects, with 13 of the last 16 years managing the successful design, construction, commissioning, and operation of BNFL's Thermal Oxide Reprocessing Plant and associated operating plants in Sellefield, England. This plant is of similar size and has many facility features that will be implemented in BNFL's proposed facilities. It was recently commissioned, and therefore, the Project Manager has very recent experience in the engineering and construction of a radiochemical processing facility.

6.8 Management of Interfaces

Successful management of the TWRS Phase I project requires management of the interfaces between different organizations and functions. Interfaces in the TWRS Phase I project are

managed and documented primarily through the Interface Control Documents, Integrated Product/Process Teams, and interface MOUs.

- *Interface Control Documents* are agreements that are actively managed and become part of the work requirements of the project. For each interface, they define the scope, responsibilities, applicable documents, physical description, functional/procedural description, and major interface product delivery dates. The Interface Control Documents have been co-prepared and agreed upon by BNFL, the Hanford M&I Contractor, and DOE.

- *Integrated Product/Process Teams* have been established to promote contractor innovation and accountability for deliverables and services; minimize formal reporting and other administrative requirements; integrate contractors (both BNFL and the Hanford M&I Contractor) activities by linking interfaces; and provide contractors with focused, timely access to information. Integrated Product/Process Teams take a cooperative, partnering approach without compromising the contractors' responsibility for contract performance. Four Integrated Product/Process Teams have been established for: (1) Project Management; (2) Contract and Business/Finance; (3) Environment, Safety, and Health; and (4) Interfaces.

- *Memoranda of Understanding and Agreement* are written agreements between the TWRS Phase I project and other Hanford Site organizations with a key interface. These agreements define the necessary working relationships, obligations and commitments, roles and responsibilities, and authorities and accountabilities of each DOE organization supporting the TWRS Phase I project. Points of contact for the project and the interface organization and regularly scheduled meetings of the points of contact are being established. Interfaces for which memoranda are planned include:

  - DOE-RL Site Infrastructure Division;

  - DOE-RL Waste Management Division (including the Spent Nuclear Fuel Project);

  - Regulatory Unit; and

  - DOE Headquarters Office of Civilian Radioactive Waste Management.

6.9 Issue Identification and Resolution Process

There are several forums for early detection and resolution of issues: Integrated Product/Process Teams and Interface Control Document working groups. These forums provide for frequent, regular meetings in which the early identification and resolution of issues are key meeting objectives. As an example, during the regularly scheduled Project Management Integrated Product/Process Team meetings, contractor and overall project progress is evaluated against approved scope, schedule, and cost baselines. In addition, performance issues and risks (i.e., schedule slippage, cost growth) are discussed and corrective actions identified and tracked. Issues that cannot be resolved within these forums or that require a change to the project baseline and/or privatization contract are referred to the Project Management Integrated Product/Process Team.

The intent of these forums is to identify and resolve issues before they evolve to the point where they require contract change order or dispute resolution processes and adversely affect progress. However, in the event such processes are needed, provisions for handling disputes are provided in the BNFL contract. In addition, guidance for handling disputes is provided in the BNFL contract administration plan.

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7 Conclusions

The Hanford tank wastes present a serious safety concern to the environment, and proceeding toward treatment and immobilization of the wastes is the preferred course of action for the TWRS program. Further delays in initiating tank waste processing could lead to additional tank leaks and the potential for contamination of the Columbia River.

DOE has developed a prudent approach for moving toward tank waste processing. That approach not only serves the needs of the TWRS program, but also the taxpayer, the public, and the environment. DOE is now looking to Congress to acknowledge the crucial nature of this cleanup work and provide funding for DOE to carry out this strategy.

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APPENDIX A

TWRS Phase I Authorization-To-Proceed Decision and Decision Methodology

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Appendix A

TWRS Phase I Authorization-To-Proceed Decision and Decision Methodology

The Tank Waste Remediation System (TWRS) Part B authorization-to-proceed (ATP) decision described in this report was made using a systematic decision process, which was based on the application of the *Cost and Operational Effectiveness Analysis* (DoD 1991) decision approach used by other federal agencies. In addition, the process involved extensive independent reviews of both the decision process and the results. The ATP decision and the process for making the decision are summarized here.

The ATP decision process is illustrated in Figure A-1 and included two major parts. The first part consisted of readiness-to-proceed (RTP) reviews for the Hanford Management and Integration (M&I) Contractor, the U.S. Department of Energy (DOE) itself, and the DOE Office of Radiological, Nuclear, and Process Safety for TWRS Privatization (Regulatory Unit); and a review of the "Record of Decision for the Tank Waste Remediation System" (62 FR 8693). Those RTP assessments are discussed in Section A.1.

The second part addressed selection of the best arrangement with private contractor(s) for Part B. Assessments were made of the contractors' Part A deliverables against each of the three, contract-specified decision criteria:

- Ability to meet Phase I, Part B contract requirements;
- Ability to perform Part B services for a reasonable price; and
- Ability to provide best value to the government.

Using these prime criteria, the decision methodology for contractor selection was constructed to make several key decisions answering the following questions:

- Should zero, one, or two contractors be selected?
- Should high-level waste (HLW) processing be included or not, and with which contractor?
- If one contractor is selected, should it be BNFL Inc. (BNFL) or Lockheed Martin Advanced Environmental Systems (LMAES)?
- Is this cost-effective for the government versus other options (e.g., the M&I, cost-reimbursement approach)?

The decision process was capable of handling the situation where either one or both contractors passed the initial Part B viability screen. However, DOE determined in the process of evaluating LMAES' Part A deliverables that there was too much risk associated with its technical approach, and LMAES was eliminated from further consideration. This outcome has the result of directly answering some of these fundamental questions. The rest of the ATP process is one of ensuring price reasonableness in the BNFL bid and, through contract negotiation, ensuring that the best deal for the government was achieved with BNFL. The contractor selection process is described further in Section A.2.

A.1 Readiness-to-Proceed (RTP) Assessments

The RTP reviews were performed to ensure that all organizations required to support the Part B contractor would be able to perform their functions.

- *Hanford M&I Contractor Readiness-to-Proceed.* This RTP assessment consisted of the review of the Hanford M&I Contractor's TWRS Phase I plans to carry out feed delivery, immobilized product and secondary waste acceptance, and infrastructure improvements in support of the TWRS Phase I project. In its role of carrying out the non-privatized portions of the TWRS scope, the Hanford M&I Contractor will need to provide all services necessary to ensure the privatized contractor can be successful.

- *DOE Readiness-to-Proceed.* Another crucial element for the success of TWRS Part B is to ensure that DOE be prepared to manage BNFL and the Hanford M&I Contractor during Part B. Since the TWRS Phase I project is a different contract arrangement than DOE has negotiated in the past, DOE has to manage an integrated TWRS that includes both the Hanford M&I and BNFL contracts.

- *DOE Regulatory Unit Readiness-to-Proceed.* The Regulatory Unit is the independent regulatory body that will oversee the nuclear, radiological, and process safety of BNFL in TWRS Phase I, Part B. It has been crucial to the ATP decision that the Regulatory Unit be prepared to carry out its regulatory duties and have those plans clearly understood by the privatized contractor. The Regulatory Unit RTP consisted of an assisted self-assessment carried out in February 1998 and an independent review, completed in April 1998, by the DOE Office of Environmental Safety and Health.

- *Environmental Impact Statement—Record of Decision Review.* The TWRS Environmental Impact Statement (DOE 1996) Record of Decision (62 FR 8693) committed DOE to complete a review of the TWRS Phase I project prior to initiating Part B. The review was designed to ensure that DOE did not proceed with Part B unless the governing strategy for TWRS was adequately covered by the Environmental Impact Statement and Record of Decision pursuant to the *National Environmental Policy Act.*

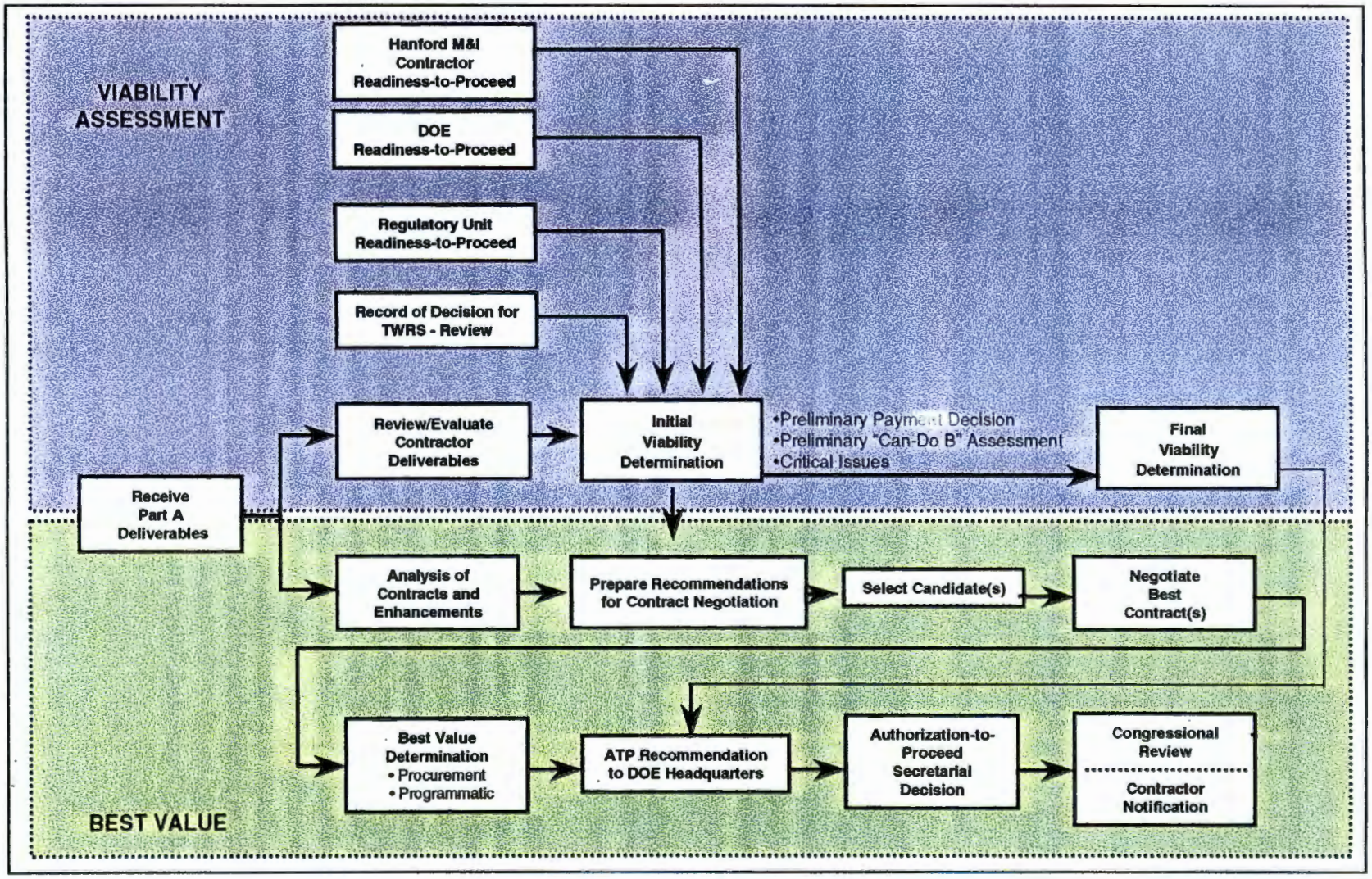

Figure A-1. Authorization-To-Proceed Decision Process

A.2 Contractor Selection Process

The selection process, which was based on the contractor's ability to: (1) meet Part B requirements, (2) provide Part B services for a reasonable price, and (3) provide best value to the government, is discussed in the following sections.

A.2.1 Ability to Meet Part B Requirements

Based on a review of each contractor's deliverables, two determinations were made:

- Whether the contractor sufficiently met the Part A requirements to qualify for payment for Part A; and
- Whether the contractor is able to meet Part B contract requirements.

DOE evaluated the contractor's ability to meet Part B contract requirements based on the following questions.

- Does the contractor have a viable technical, regulatory, and business approach?
- Has the contractor provided sufficient information to assess its ability to implement its processes at full scale?
- Are the skills and experience reflected in the contractor's management and technical teams adequate to demonstrate a reasonable certainty that the contractor's project will be successful?

This evaluation was conducted by a team of DOE, external experts, and national laboratory staff. The evaluation was based on a set of 13 evaluation plans—one for each of 12 deliverables, plus one for overall viability. As described in Appendix B, two outside reviews also were conducted.

A.2.1.1 Viability Evaluation Results for BNFL

Based on its evaluation of Part A deliverables, DOE determined that the BNFL team demonstrated that its proposed technical and regulatory approaches were viable. Its business and financial approach required negotiations to achieve acceptable conditions and better value for the government. There was a strong indication that BNFL would be successful in the Phase I, Part B work. DOE also judged that BNFL's proposed technologies and conceptual facility design were robust and mature, based on the demonstrated use in operating plants in the United States, the United Kingdom, Japan, and France (see Table 4-1).

A.2.1.2 Viability Evaluation Results for LMAES

Based on an analogous evaluation, DOE determined that the deliverables provided by LMAES set forth an approach with an unacceptably high technical risk in attaining DOE's cleanup goals. LMAES' approach proposed numerous technologies that would require research and

development. The approach was judged by DOE (and two groups of external experts who assisted DOE with its review of the proposed waste treatment technology of both contractors) to be too risky and require substantial, additional development work. In DOE's judgment, the LMAES facility configuration and technical approach would likely undergo substantial change prior to the time that a waste treatment facility would be operational. LMAES Part A deliverables placed the risk associated with these changes on DOE through cost-reimbursement contracting and would not provide a fixed price for treatment services until at least one year after the start of hot operations. The LMAES approach was deemed not viable for Part B of the TWRS Phase I project.

A.2.2 Price-Reasonableness Determination

Price-reasonableness was determined by considering the following questions.

- How do the proposed prices compare with the "should cost" (government fair cost) estimates?
- How do the proposed prices compare with a conventional Management and Operating approach for a comparable plant capacity and useful life?
- Does the price of waste processed per unit of measure represent a good value compared with other applicable estimates of the price for this work?
- Has a sufficient degree of competition been maintained during the pricing process?

This assessment was only carried out for BNFL.

A.2.2.1 Best Value to the Government

The objective of the best-value assessment was to identify contract terms that represent the best deal for the American taxpayer in carrying out TWRS Phase I work scope and to compare the negotiated arrangement with other programmatic alternatives.

The sub-criteria for evaluating best value to the government were constructed to mirror the fundamental objectives of the TWRS Phase I project. These sub-criteria, and further levels of detail, were used both to evaluate contractor-proposed enhancements and to make the final best value determination about which contract(s) should be the basis for proceeding with Part B. These best-value sub-criteria were:

- Minimize programmatic risk for Phase I;
- Minimize environment, safety, and health risk;

- Position DOE to complete the balance of the TWRS mission after Phase I; and

- Minimize costs.

These sub-criteria were developed to encompass values and concerns expressed by Hanford regulators, affected Tribal Nations, and stakeholders. They also recognized that the quality of the contractors' project plans and the experience of the contractors' management teams are key factors in DOE's assessment of programmatic risk for a successful TWRS outcome. Accordingly, these aspects of the contractors' proposals have been included as an input during the best-value assessment.

The best-value assessment included two elements:

- Determination of the best path forward for Part B (privatization best value) based on
  - Assessment of possible enhancements and changes to contractor proposals;
  - Procurement best-value assessment, comparing contractors for similar work scope;
  - Privatization deployment best-value assessment, considering one versus two contractors and the inclusion of high-level waste vitrification services; and

- Programmatic best-value determination comparing the contract negotiated with BNFL with other programmatic alternatives.

The best-value assessment was based on a decision framework previously used in major DOE and Department of Defense decisions and adapted for use on the TWRS Phase I project. The Department of Defense Cost and Operational Effectiveness Analysis decision framework was adopted to ensure that the basis for the ATP decisions could be clearly articulated and documented. The best-value decision analysis was based on the criteria defined earlier, with further definition, including specific metrics for each sub-criterion.

To ensure that the best approach to proceed with tank waste processing and disposal was selected, other alternatives were defined and compared to proceeding with BNFL. This comparison was part of an iterative process to evaluate specific tank waste processing and disposal approaches.

The best-value assessment of the BNFL enhanced proposal, which included an initial design period, referred to as Part B-1 in the contract, determined that structuring Part B with this initial period and subsequent decision point was of benefit to DOE.

A broad range of alternatives with differing levels of detail was considered as part of the ATP decision process. The range included:

- Having BNFL proceed with scope other than combined HLW and low-activity waste (LAW) processing services;

- Considering alternatives to privatization (e.g., government-owned, contractor-operated) for accomplishing the TWRS mission; and

- Considering alternatives to the current TWRS strategy.

This assessment and comparison, as summarized below, confirmed that proceeding with BNFL is in the government's best interest.

DOE also evaluated the alternative of proceeding with BNFL as the contractor for LAW processing services only. This alternative was considered to be inferior to the decision to proceed with BNFL providing both LAW and HLW immobilization services.

Combined HLW and LAW processing services were preferred for several reasons.

- DOE cost and management of intermediate waste product are avoided.

- HLW processing service in Phase I provides a technical basis for timely completion of the TWRS mission.

- There is a sufficient technical basis for the HLW processing.

- Including HLW services does not substantially raise the Phase I cost, and does not impose significant additional requirements on the Hanford Site infrastructure, while treating the highest risk waste.

- Including the HLW processing service permits treating some of the highest risk tanks early in Phase I.

Three non-privatization alternatives were developed in the ATP decision process prior to receipt of contractor deliverables. The purpose of these alternatives was to provide benchmarks against which implementing the Part B decision could be compared. The three alternatives developed were:

- Delayed implementation of the TWRS strategy pending available funding;

- Single-phased, full-scale, government-owned, contractor-operated facility; and

- Government-owned, contractor-operated facility executing the Phase I work scope.

DOE wanted to ensure that a comprehensive range of alternatives was considered in making its decision whether to authorize BNFL to proceed with Part B. Each of these alternatives had major disadvantages including long delays in initiation of waste processing and disposal, incurring delay in retrieval of single-shell tanks or building of new double-shell tanks, higher cost, inability to support feed schedule, and/or higher programmatic risk. This led to a consideration of additional alternatives to: (1) determine if any alternatives with lower near-term

costs were plausible and attractive to DOE; and (2) have some fallback position should negotiations with BNFL not produce an acceptable agreement.

An analysis of these alternatives was performed. The conclusions are discussed below.

- None of these alternatives are clearly superior to authorizing BNFL to proceed into the next contract phase.

- A few alternatives reduce near-term costs by performing the current work scope in a different sequence or at a slower pace. However, all of these alternatives require a redesign phase and would delay startup. All would be strongly opposed by regulators and stakeholders. These alternatives are also less cost effective from a life cycle perspective.

- Other alternatives would reduce near-term cost by performing very different scopes of work but would be inconsistent with the Record of Decision for TWRS (62 FR 8693) and the *Hanford Federal Facility Agreement and Consent Order* (also known as the Tri-Party Agreement). Extensive delays would result.

Each alternative was assessed for schedule impact, near-term cost, life cycle cost, environmental safety and health impacts, TWRS system impacts, compliance, and stakeholder support.

A.3 References

62 FR 8693, February 26, 1997, "Record of Decision for the Tank Waste Remediation System," *Federal Register*.

DoD, 1991, *Cost and Operational Effectiveness Analysis*, DOD 5000.2-M, Part 8, U.S. Department of Defense, Washington, D.C.

DOE, 1996, *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*, DOE/EIS-0189, U.S. Department of Energy and Washington State Department of Ecology, Richland, Washington.

Hanford Federal Facility Agreement and Consent Order, 89-10, as amended, Washington State Department of Ecology, Olympia, Washington; U.S. Environmental Protection Agency, Seattle, Washington; and U.S. Department of Energy, Richland, Washington.

National Environmental Policy Act of 1969, Public Law 91-190, 42 United States Code 4321 et seq.

APPENDIX B

Expert and Non-Proponent Reviews

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Appendix B

Expert and Non-Proponent Reviews

B.1 Introduction

Throughout the authorization-to-proceed decision process, the U.S. Department of Energy (DOE) had many different reviews of their work performed by expert reviewers chartered by the DOE Richland Operations Office (DOE-RL) and non-proponent reviewers chartered by DOE Headquarters. These reviews were designed to help assure DOE that it had a program that was well positioned for successful implementation. In addition to the experts brought in to assist in developing specific portions of the process, more than 100 expert reviewers from the following were asked to evaluate the work done for the authorization to proceed:

- academia,
- private industry,
- national laboratories,
- other DOE high-level waste facilities, and
- other federal agencies.

These reviewers had expertise in a variety of key areas relating to the Tank Waste Remediation System (TWRS) program, such as:

- glass production,
- nuclear facility management,
- cost-estimating,
- management of large complex projects,
- fixed-price contracting, and
- decision analysis.

The reviewers were tasked to evaluate the overall decision process as well as specific portions of the contract decision-making process. Extensive expert reviews were conducted for each of the key steps in the process and for the process as a whole, plus the final decision. These expert reviews are shown in Figure B-1.

Overall Authorization-To-Proceed Process

- Five Reviewers with specialized expertise from:
  - Academia
  - Private Industry
  - Former DoD Manager
  - National Laboratory

Evaluation of Private Contractors

Part A Deliverable Reviews

13 Reviewers from:

- Academia
- Private Industry
- Other DOE HLW Sites
- Supporting DOE & National Laboratory

Price Reasonableness & Cost Savings

9 Reviewers from:

- Academia
- Private Industry

Best-Value Determination

1 Reviewer from:

- Academia

Contract Negotiations

4 Reviewers from:

- Privatization Contracting
- Project Finance
- Government Contracting
- Large Construction Contracts

Readiness-to-Proceed Process

Hanford M&I Contractors

19 Reviewers Assembled by Hanford M&I Contractor:

- DOE Complex
- HAB
- Former Regulators
- Former DOE Contractor

30 Reviewers Assembled by Hanford M&I Contractor:

- National Laboratory
- DoD
- Other DOE Complex
- Private Industry

Department of Energy

2 Reviewers from:

- Former DOE Site Manager
- Former DoD Manager

Record of Decision Re-Evaluation

5 Reviewers from:

- Former DOE Disposal Manager
- NAS Member
- Tank Advisory Panel
- National Laboratory
- Former Westinghouse Hanford - TWRS Program Integration

Figure B-1. Expert Reviews

As a result of the issuance of a report by the National Research Council during the course of this work, *Assessing the Need for Independent Project Reviews in the Department of Energy* (Duscha 1998), DOE Headquarters also chartered non-proponent reviews of the authorization-to-proceed process, involving outside experts and DOE personnel with no vested interest in Hanford or the outcome of this decision. These non-proponent reviews are shown in Figure B-2. Each of the expert reviews and non-proponent reviews developed an evaluation plan and criteria to evaluate the work, produced a report that identified key concerns or findings, and provided recommendations to address the problems identified.

B.2 Process

In the early stages of this activity, an expert review was conducted specifically for the authorization-to-proceed decision logic, as discussed in Appendix A and shown in Figure A-1, to determine if there were any gaps present, if the process was logical, and whether the ultimate decision would be defensible. Based on the results of this early review, expert reviews were then performed on many of the key steps in the process:

- Hanford Management and Integration (M&I) Contractor Readiness to Proceed,
- DOE Readiness to Proceed,
- TWRS Environmental Impact Statement Readiness to Proceed,
- Contract Negotiations Strategy,
- Best-Value Determination,
- Cost Savings and Price Reasonableness, and
- Part A Deliverable Review.

A non-proponent review was performed to evaluate the entire expert review process and all of the key steps listed above. A non-proponent review of the DOE Office of Radiological, Nuclear, and Process Safety for TWRS Privatization (Regulatory Unit) was performed by the Office of Environment, Safety and Health at DOE Headquarters. Finally, a non-proponent review team was asked to evaluate the final decision and to determine if DOE had followed the decision logic it had prepared and whether the decision had been adequately documented in this Report to Congress.

B.3 Review Teams and Results

Each of the review teams varied in its number of personnel, the backgrounds of its personnel, the type of review it performed, and at what time in the process its evaluations were performed. The scope of the readiness-to-proceed reviews is summarized in greater detail in Appendix A.1.

Overall Authorization-To-Proceed Process Decision

- Five Reviewers with specialized expertise from:
  - Academia
  - Private Industry
  - Former DoD Manager

Overall Authorization-to-Proceed Process

- Two Reviewers with specialized expertise from:
  - Private Industry
  - Former DoD Manager

Evaluation of Private Contractors

Part A Deliverable Reviews	Price Reasonableness & Cost Savings	Best-Value Determination	Contract Negotiations
11 Reviewers from: • Academia • Other DOE Sites • DOE Headquarters • Private Industry	5 Reviewers from: • Private Industry 7 Office of Field Management Headquarters Reviewers from: • Private Industry	2 Reviewers from: • Private Industry	• Office of Procurement Headquarters • General Counsel Headquarters • Contract Reform and Privatization Project Office

Readiness-to-Proceed Process

Hanford M&I Contractors	Department of Energy	Regulatory Unit	Record of Decision Re-Evaluation
3 Reviewers from: • Academia • Private Industry	3 Reviewers from: • Academia • Private Industry	9 Reviewers from: • Former NRC Office Directors • Other Federal Agencies • Private Industry	3 Reviewers from: • Academia • Private Industry

Figure B-2. Non-Proponent Reviews

Overall Authorization-to-Proceed Decision Process. Five individuals from academia, the U.S. Department of Defense, and private industry participated in this expert team early in the review process. Its findings indicated that the decision process "is logically sound and the staff has made an effort to ensure that all technical, cost, and risk concerns are covered in the best-value judgment." Recommendations were provided to strengthen the process, and these recommendations were accepted and incorporated.

Hanford M&I Contractor Readiness-to-Proceed. As part of the process of developing its readiness-to-proceed plan, the Hanford M&I Contractor brought in a team of 19 outside subject matter experts to evaluate its plan. The team concluded, "there is reasonable assurance that the M&I contractor will be able to deliver feed to the privatization contractor." A total of 30 people, split equally between DOE and national laboratory personnel, then performed an evaluation of the Hanford M&I Contractor plan. The results of their review confirmed that the Hanford M&I Contractor was ready to proceed provided certain risks were addressed in the privatization contracts. These risks included adequacy of funding to meet the existing schedule and adequacy of float in the schedule for receipt of the final waste forms. It appears these risks will be reduced substantially by changes proposed by BNFL in the original schedule for construction and operations. The Hanford M&I Contractor plans will be refined during the design phase to assure DOE that the Hanford M&I Contractor is prepared to deliver feed and to store and dispose of the final waste products according to the new schedule proposed by BNFL.

The non-proponent review team determined that the conclusions of the external review team were supportable and adequately documented. The non-proponent review team recommended that DOE expand the self-assessment to fully evaluate any additional interfaces as a result of the contract negotiations. This recommendation was accepted and will be completed through the use of Interface Control Documents and Integrated Product/Process Teams.

DOE Readiness-to-Proceed. The expert review team assembled to conduct this assessment consisted of a former DOE Ohio Field Office Manager and a former U.S. Department of Defense senior manager with expertise in fixed-price contracting. The team concluded that the management assessment performed by DOE-RL was conducted in a structured manner and was credible, and it agreed with the results, observations, and path forward. However, the team expressed concern that additional staffing was needed on the project team to ensure a successful execution of the privatization contract. They also suggested additional training in fixed-price contracting for all staff directly or indirectly involved with the project. As described in Section 6.4, actions are underway to address these concerns.

The non-proponent review supported the conclusions and recommendations of the expert review of the readiness-to-proceed review, particularly those related to staffing limitations. The non-proponent review team determined the expert review "was comprehensive and no significant gaps were identified in the overall methodology." Recommendations provided by the non-proponent review team included developing a time-dependent internal staffing plan, augmenting the DOE staff, and refining the interface review process after Part B is started. These recommendations were accepted, matrixed staff was brought in from other offices within DOE-RL, and the staffing plan is currently being developed. The non-proponent review team also recommended that the Headquarters elements perform a readiness-to-proceed evaluation to

ensure that there is a recognition and understanding of the unique interface requirements of this fixed-price contract. This Headquarters readiness-to-proceed evaluation is presently under development. Additional information on the management approach is provided in Section 6, "Management of the TWRS Phase I Project."

DOE Regulatory Unit Readiness-to-Proceed. The Office of Environment, Safety, and Health performed a non-proponent review of the Regulatory Unit. Based on evaluation criteria established by the review team, the team concluded that the Regulatory Unit met the criteria and is ready to regulate in Part B provided identified weaknesses are corrected. These weaknesses are categorized as those requiring completion of corrective actions prior to regulating in the design phase and those that could be addressed during the design phase.

The areas to be addressed prior to regulating in the design phase include the following:

- Identify and train individuals to serve as Safety Concerns/Allegations Program Coordinator and Enforcement Lead Coordinator,
- Identify the additional qualification requirements for Regulatory Unit staff and complete applicable requirements,
- Fully implement the commitment tracking system,
- Improve controls on proprietary and competition-sensitive information and upgrade guidance in this area, and
- Complete a planned reorganization.

The issues to be addressed early in the design phase include the following:

- Fill open federal staff positions with personnel having expertise in the areas of process safety management and vitrification,
- Develop a directive and handbook on its backfit process, and
- Elevate the priority of the development of pre-construction inspection procedures.

The Acting Assistant Secretary for Environmental Management issued the EH report, "*Independent Assessment of the Tank Waste Remediation System Privatization Regulatory Unit – Readiness for Phase B*" on May 1, 1998. Corrective actions are under way, and several of the weaknesses already have been partially or completely resolved.

Environmental Impact Statement-Record of Decision (62 FR 8693) Review: Because of the diverse nature of the three environmental documents that were reviewed for this report, this five-member team had a wide range of backgrounds in waste management, scientific, and technical fields. The objective of this review was to ensure compliance with the *National Environmental*

and Policy Act regulation. The results of its reviews indicated there was no need for a Supplemental Environmental Impact Statement or other *National Environmental Policy Act* documentation prior to proceeding with Phase I, Part B.

Evaluation Reports of Privatized Contractor Deliverables. The expert review of the privatized contractor deliverables chartered by DOE-RL was comprised of a multi-disciplined team of 13 outside reviewers from academia, private industry, DOE high-level waste sites, and other federal agencies. The reviewers were organized into specific teams, based on individual expertise, to conduct the evaluations for all except the health and safety deliverables, which were reviewed by the Regulatory Unit. The input from these teams was used as the basis for DOE acceptance for payment of deliverables and assessments of technical viability of the contractors. The evaluation concluded that the BNFL team demonstrated that its proposed technical and regulatory approach were viable. The review also indicated that the LMAES technology approach, facility concept, and regulatory strategy had significant risks for both the contractor and DOE, and were determined not to be viable. More detailed results of this review are discussed in Section 4 and Appendix A of this report.

The non-proponent review of this evaluation agreed with the viability determinations and concluded that "omissions, uncertainties, and lack of integration within the LMAES deliverables were systemic and undermined confidence in their successful implementation." It further recommended several specific steps to minimize technical risk to DOE in proceeding with the BNFL proposal. These steps included:

- Undertaking a parallel effort to evaluate technologies for separation of technetium,
- Providing more consideration of waste minimization,
- Resolving waste disposability issues, and
- Determining the need to maintain the operation of a testing facility throughout the operating life of the production facility.

DOE-RL plans to have a symposium during the design phase to evaluate the technical issues relating to technetium separation, and the other issues were addressed during the negotiation process.

Price Reasonableness and Cost Savings. The objectives of the Price Reasonableness and Cost Savings Evaluation were to determine whether the contractor's price could be determined to be fair and reasonable to the government and whether the private contractor's approach saved money in comparison to a traditional Management and Operations (M&O) contractor approach. The reviewers evaluated (1) the methods used to determine the costs, (2) the methods used to determine whether the contractor's price was fair and reasonable, (3) the methods used to determine whether a more equitable risk allocation was possible between DOE and the contractors, and (4) the evaluation of the contractor's prices on the TWRS life cycle costs. The

expert review team that evaluated the financial model consisted of four members from private industry and five from academia.

The non-proponent reviews were chartered by two independent offices at DOE Headquarters. Specifically, the Government Fair Cost Estimate and M&O Cost Estimate were evaluated by two separate teams chartered by the Office of Field Management. These reviews, as well as the review of the financial model, were then evaluated by another non-proponent team chartered by DOE Headquarters. The results of this final review stated each of the areas was reviewed adequately and the teams performing the reviews were qualified. The non-proponent team identified several areas that had not been addressed in the review, including reconciling the M&O cost estimate prepared by the Office of Field Management team with the DOE-RL estimate to harmonize the two cost estimates to support the fixed-unit price determination.

Best-Value Determination: The expert reviewer for this determination noted "the hierarchical structure of the alternatives, their specifications, and the sequence of the decisions are well formulated." The main recommendation was to restructure the list of criteria.

The non-proponent review team that looked at this determination noted that some portions of this evaluation had been subjected to an expert review and some portions had not. However, the non-proponent review team also noted this was a result in part of the fact that negotiations were ongoing at the time of the non-proponent review. The non-proponent review team recommended that the final non-proponent review team evaluating the final ATP decision evaluate the portions that had not been reviewed as part of its analysis, and this was completed by that group. Another recommendation was to perform another Best Programmatic Value Determination at the end of the two-year design phase. The Best Programmatic Value Determination will be continued as part of the optimization steps described in the overall recommendations. (See also Section 5.2.2.)

Contract Negotiation. Three expert reviewers evaluated the DOE's negotiation position and approach and provided private sector perspectives to the DOE negotiating team, particularly on legal and financial issues. Because of the sensitive nature of this information, the non-proponent evaluation was limited to key DOE officials at Heaquarters, particularly the Office of Procurement and Assistance Management, the Contract Reform and Privatization Project Office, and the Office of General Counsel.

Non-Proponent Review of Overall Authorization-to-Proceed Process. In addition to the specific recommendations provided in the sections listed above, the non-proponent review team identified several overall recommendations. The primary recommendation was to include optimization studies to (1) evaluate alternative financing concepts to ensure that the Phase I, Part B contract has the flexibility to accommodate changes that would benefit the DOE, (2) evaluate the cost and time savings as a result of changes to technical requirements, and (3) complete a programmatic re-evaluation to assure that no better programmatic solution exists. In addition, the team recommended that an "open item tracking list" system should be put in place to assure that all commitments to responses and commitments to actions are completed. The review team concluded that "authorization to proceed to Phase IB should be given" provided

the commitments to all expert review recommendations were resolved and the optimization studies were included in the contract.

The optimization studies are either underway or are now included in the contract requirements for completion early in the design phase. The open tracking system has been developed and is close to completion.

Final Authorization-to-Proceed Decision. The role of this five-member team was to determine whether this Report to Congress "clearly and adequately presents the DOE decision and the rationale used to arrive at that decision" and whether "the deal presented represents the best deal for the government compared to other options" evaluated. The team was an expert review team chartered by DOE Headquarters. The results indicated "the fixed price approach should be a better deal for the government both from the standpoint of lower cost and improved performance (higher likelihood of success). However, the magnitude of the financial savings will not be quantified until Phase IB-1 [design phase]." The team supported and endorsed the 24-month period to move from a 5% to a 30% design in the resulting plant. It was stated this period was of great benefit to the government because it tremendously reduced the risk and uncertainties of this project.

B.4 Conclusion

DOE had many different reviews of its work performed by experts and non-proponent reviewers throughout the process of developing the authorization-to-proceed decision in order to assure itself it had a well-positioned program ready for successful implementation. The findings and recommendations strengthened the process. Although not all of the findings will be resolved prior to the design phase, the review teams supported DOE's plan to proceed with this phase. Outstanding issues are being resolved as part of the design phase.

B.5 References

62 FR 8693, February 26, 1997, "Record of Decision for the Tank Waste Remediation System," *Federal Register.*

Duscha, L. A., 1998, *Assessing the Need for Independent Project Reviews in the Department of Energy*, National Research Council, Washington, D.C.

National Environmental Policy Act of 1969, Public Law 91-190, 42 United States Code 4321 et seq.

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APPENDIX C

TWRS Phase I Construction Project Data Sheet

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DEPARTMENT OF ENERGY
FY 1999 CONSTRUCTION PROJECT DATA SHEET
DEFENSE ENVIRONMENTAL MANAGEMENT PRIVATIZATION
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and Location of Project: Tank Waste Remediation System Privatization Phase 1; Hanford, Washington

2a. Project No: 97 PVT 1
2b. Operating Expense Funded

3a. Date A-E Work Initiated, (Title I Design Start Scheduled): **June 1998**
3b. A-E Work (Titles I & II) Duration: **18 Months (June 1998 to December 1999)**
3c. Request for Proposal Issue Date: February 1996
3d. Contract Award: September 1996 (Phase I Part A); May 1998 (Phase I Part B)

5. Previous Cost Estimate:
Total Estimated Cost (TEC) -- **$1,450,000**
Total Project Cost (TPC) -- **$3,954,000**

4a. Date Physical Construction Starts: FY 2000
4b. Date Construction Ends: FY 2002
4c. First Schedule Delivery: FY 2003
4d. Projected End Date: Phase I for 13% of waste - FY 2010

6. Current Cost Estimate: a/
TEC -- **$1,450,000** b/
TPC -- $5,144,000 c/

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation d/	Contract Commitments e/	Capital Outlays f/
Prior Years	$ 0 g/	$ 0	$ 0
1997	170,000 h/	0	0
1998	**115,000**	200,000	0
1999	**330,000**	**415,000**	0
2000	**474,000**	**474,000**	0
2001	**296,000**	**296,000**	0
2002	**65,000**	**65,000**	0
2003	0	0	290,000
2004	0	0	290,000
2005	0	0	290,000
2006	0	0	290,000
Outyears	0	0	290,000

7. Financial Schedule (Federal Funds): (contd.)

a/ These estimates are preliminary. Conceptual designs have not been completed and may affect the final estimates.

b/ The Total Estimated Cost as defined here is the value DOE has established for the capital investment by the private sector. It is the basis for the Privatization B/A Request.

c/ The Total Project Cost as defined here is the combined value DOE believes will be necessary to pay for the products or services contractually agreed upon. It includes B/A requests for Privatization (TEC); EM Base Program requests for direct payment to the vendor, including $54.0 million obligated in FY 1996 for Phase I, Part A.

d/ For multi-year funded projects, appropriation is needed a year ahead of contract commitments to preclude Anti-Deficiencies. M&I support costs for Phase I minimum order quantity of $1.190 billion.

e/ Includes current contractor investment plus funds to maintain current project schedules (including allowances for items such as long-lead procurements).

f/ Reflects latest known outlay projection and may be different from the outlays used in developing the FY 1998 Congressional Budget.

g/ **Office of Environmental Management Base Program appropriation of $54.0 million was obligated in FY 1996 for Phase 1, Part A. These funds are part of "Other Project Costs", and are reflected in Section 11 of this data sheet.**

8. Project Description, Justification and Scope

Radioactive waste has been stored in large underground storage tanks at the Hanford Site since 1944. Approximately 56 million gallons of waste containing approximately 240,000 metric tons of processed chemicals and 250 mega-curies of radio nuclides are currently being stored in 177 tanks. These caustic wastes are in the form of liquids, slurries, saltcakes, and sludge. In 1992, the Tank Waste Remediation System (TWRS) Program was established to manage, retrieve, treat, immobilize, and dispose of these wastes in a safe, environmentally sound, and cost-effective manner. **The integrated TWRS program was designed to include efforts to resolve a number of safety concerns and technical issues, and to address past leakage from some of the underground storage tanks which has contaminated the vadose zone and, recent reports indicate, could have contributed to contamination of the ground water. Storage in the current tanks is very costly and, as the tanks age, potential for radioactive and chemical release increases, although the short-term risks are low. The TWRS program will substantially decrease the long-term costs and provide long-term protection of public health and safety and the environment, by removing the wastes from the tanks and providing a waste form suitable for long term disposal.**

The TWRS pathway for cleanup is formally documented in the Hanford Federal Facility Agreement and Consent Order, commonly known as the Tri-Party Agreement (TPA). Under the TPA, DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology have agreed to a 30-year timetable for cleanup of the Hanford Site. Key dates related to the privatization found in the TPA are selection of contractor(s) for Phase 1 Part B by July 1998 (TPA-M 60-10), **initiate definitive design of HLW pretreatment facility by November 1998 (TPA M 50-04-T01), start construction of HLW pretreatment facility by June 2001 (TPA M-50-04-T01),** start hot operations of Phase 1 Pretreatment and Immobilization Facilities by December 2002 (TPA M-60-12), and completion of Pretreatment and Immobilization of all Hanford low activity waste by December 2024 (TPA M-0-00).

The Hanford Site processed more than 100,000 metric tons (110,000 tons) of uranium and generated several hundred thousand metric tons of wastes. The waste include: high-level wastes (i.e., cesium-137 and strontium-90), low-level wastes, and hazardous waste, which may exhibit dangerous characteristics of ignitability, corrosivity, reactivity, or toxicity. All of the waste is stored at Hanford and is being addressed in the TWRS Program.

1. Title and Location of Project: Tank Waste Remediation System Privatization Phase 1; Hanford, Washington	2a. Project No: 97 PVT 1 2b. Operating Expense Funded

8. Project Description, Justification and Scope

The TWRS privatization program is divided into two phases. Phase I is a commercial demonstration effort whose objectives are to: demonstrate the technical and business viability of using privatized facilities to treat Hanford tank waste; define and maintain required levels of nuclear, radiological, and occupational safety; maintain environmental protection and compliance; and substantially reduce life-cycle costs and time required to treat Hanford tank waste. Phase I consists of two parts. Part A is a 20-month period to establish the technical, operational, regulatory, business, and financial elements required by privatized facilities that will provide tank waste treatment services on a fixed-unit-price basis. Based on Part A performance, one or more of the contractors who successfully perform Part A will be authorized to perform waste-treatment services for DOE in Part B. Part B is a period of 10 to 14 years, during which the authorized contractor(s) will finance, design, construct, operate, and deactivate the waste-treatment facilities. During Part B, fixed unit prices will be paid only for completion and acceptance of waste-treatment services meeting contract specifications. If Phase I efforts are successful, DOE plans a second competitive procurement for Phase II activities. Phase II would be the full-scale production phase, and it is currently expected to begin in 2005 (contract award). The current Phase II plan involves two competitively selected fixed-price contractors who will finance, design, construct, operate, and deactivate waste-treatment facilities. The objectives of Phase II include implementing the lessons learned from Phase I, processing all tank waste into forms suitable for final disposal, and meeting or exceeding regulatory performance milestones.

The wastes will be retrieved from the tanks and separated into low activity and high activity fractions, which will be immobilized for safe permanent storage meeting government specification and in accordance with all Federal and State regulations.

The Department's regulatory approach is to utilize, to the extent possible, established and functioning external regulatory authorities, such as the Nuclear Regulatory Commission and the Occupational Safety and Health Administration. The Department will retain oversight responsibility for radiological and nuclear safety, and certain aspects of environmental compliance.

8. Project Description, Justification and Scope (contd.)

The contractor shall be responsible for the protection of human health and the environment from radioactive materials, hazardous materials, and dangerous waste contamination, and non-radiological worker safety and health from conventional industrial and occupational hazards.

The FY 1997 appropriation of $170.0 million and the FY 1998 **appropriation of $115.0 million** are for the purpose of authorizing contractor(s) to proceed with part B of the contract for treatment of 6-13 percent of the Tanks Waste. The contractor(s) will initiate Detailed Design, prepare equipment procurement specifications, identify and order long lead materials and equipment, and establish radiological Nuclear Safety Requirements. These funds also cover the remote possibility of termination of the contract. They will eventually be used to reimburse capital expenditures after services commence. **It is anticipated that there will be two primary work scopes accomplished in FY 1999 by TWRS privatization contractor(s): 1)the completion of detailed design; and 2)the ordering of long-lead time material.**

The contractor(s) will be required to reach financial closure(obtaining private sector financing for the construction of their facility) prior to start of construction. In order to obtain financing the contractor(s) will have to complete all their design work. Detail design work involves the development of all structural detail drawings, mechanical systems design and detail drawings, electrical design and detail drawings, and all radiological, nuclear and process safety analyses required to support the design work. During the development and completion of the detail drawings, the contractor(s) will identify the long-lead time material, typically those items that require several years to obtain once the order is submitted.

During the development of the detail drawings the contractor(s) will start to order the long-lead time materials required to support the construction of the facility. Structural long-lead time material would include any special structural members (unusual forms or sizes). Mechanical long-lead time materials include the cesium ion exchangers, Hastalloy tanks, Hastalloy piping, Hastalloy fittings, the low activity waste and high level waste melters, and their respective control systems. Special distributive control systems will be ordered downstream to be completed prior to installation.

8. Project Description, Justification and Scope (contd.)

Fiscal year 1996 funding of $54.0 million from within the Defense Environmental Restoration and Waste Management Appropriation, Waste Management Program, was used to award Phase 1, Part A of the contract, and is expected to be costed in FY 1998.

9. Details of Cost Estimate

As shown in section 11, the total project cost for Phase I is $5.144 million. **This estimate includes $54.0 million for Part A that was funded in FY 1996 from the Office of Environmental Management Base Program.**

Total capital cost during Part B has been estimated to be $1.450 million. In addition, future budget requests for an estimated $2.450 million will be made within the Defense Environmental Restoration and Waste Management Appropriation, for the purpose of making payments to the vendor for the contractually required services. These estimates were prepared before Part A of the contracts was initiated. It is expected that these estimates will change in January to May 1998 after receipt of the Contractor Part A deliverables, contract negotiations, and the completion of the Authorization to Proceed decision process. The estimated capital and expense requirements are expected to change because the contractors have both proposed the use of facilities with a 30-year plant life (which may result in higher capital costs) but which also have lower operating costs. These facilities will be used in Phase I and could be used to execute a significant portion of the Phase II TWRS mission and thus reduce total-life-cycle costs.

10. Method of Performance

In September 1996 DOE awarded contracts to two teams led by the BNFL, Inc. and Lockheed Martin Advanced Environmental Services. The contracts were for the Phase 1, Part A of this project. The contractors will demonstrate the technical and business viability of using privatized facilities to treat and immobilize Hanford tank wastes; define and maintain

10. Method of Performance(contd.):

required levels of nuclear, radiological and occupational safety; maintain environmental protection and compliance; and reduce life-cycle costs and remediation time. The Department will then select one or both of the contractors to proceed with Phase I, Part B. In Part B, the two contractor(s) will finance, design, construct, operate, and deactivate their own facilities during Phase I, Part B of the privatization. Site infrastructure support to include Tank Retrieval systems, roads, utilities, etc. will be provided by the government utilizing the existing Management and Integration contractor on site. Phase I is expected to last from 12 to 16 years and process between 6 and 13 percent of the tank waste.

The contractor must finance the project; design the equipment and facility; apply for and receive required permits and licenses; construct the facility and bring it on-line; operate the facility to treat waste; and deactivate the facility. The contractor can recover the resources it has invested only through the delivery of acceptable services paid for by DOE on a fixed-unit-price basis. The underlying intent is to transfer the primary share of the financial, performance, and operational responsibility for the treatment effort from the Government to the contractor.

1. Title and Location of Project: Tank Waste Remediation System Privatization Phase 1; Hanford, Washington	2a. Project No: 97 PVT 1 2b. Operating Expense Funded

11. Schedule of Project Funding and Other Related Funding Requirements

	PriorYears	FY1997	FY1998	FY1999	Outyears	Total
Total facility costs - payments to vendor	$ 0	$ 0	$ 0	$ 0	$1,450,000	$1,450,000
Other project costs:						
Facility Operations - payments to vendor	54,000*	0	0	0	2,450,000	2,504,000
Facility Support - M&O support/Other	0	0	110,000	150,000	930,000	1,190,000
Subtotal Other project costs	54,000	0	110,000	150,000	3,380,000	3,694,000
TOTAL	$ 54,000	$ 0	$110,000	$150,000	$4,830,000	$5,144,000

* Represents payment to competing vendors for demonstration under Phase 1a.

12. Management and Operations Approach:

The privatization approach of $3,954 million ($1,450 million capital and $2,450 million operating) is expected to lead to cost savings/avoidance of $1,496.0 million (27 percent) compared to the cost estimate for the traditional M&O approach of $5,450,000,000. **The estimated funding requirements for the privatization contractors to do the work are based on privatization bids, with assumptions for post negotiation adjustments.** The estimate also excludes M&O support costs, which is comparable to costs to support the Privatization contractors. **These estimates were developed by DOE in November 1996.**