HANFORD DEFENSE WASTE CLEANUP OPTIONS

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ABSTRACT

The 570 square mile Hanford Reservation in southeastern Washington State has been used to produce plutonium for national defense programs since 1943. Operations have resulted in very large amounts of high-level, low-level, chemical, radioactive mixed wastes, and transuranic wastes. Some of the wastes have been stored in tanks, capsules, drums, and boxes on site, while others have been disposed of in the soil column. This paper briefly reviews the history of the site, describes the wastes, and lists technical and policy issues which impact cost schedule.

BACKGROUND

In 1942, during the early stages of World War II, Enrico Fermi created the world's first nuclear reactor on the campus of the University of Chicago. Spurred on by enemy efforts to develop nuclear weapons, the United States established the Manhattan Project which led to the production of the atomic bomb. In March of 1943 the government, using the War Powers Act, acquired nearly 600 square miles of private and public land for what was to become the Hanford Engineer Works. Three towns were evacuated and a work force of 50,000 was mobilized. Housing, roads, power lines and productions facilities were built in record time and under a strict security blanket. It only took 14 months to design and construct the world's first nuclear plant, the B-Reactor. From beginning of design to operation took only 18 months.

Over the years, a total of nine reactors and three reprocessing facilities were built at Hanford for defense programs. Eight shutdown production reactors are currently being considered for decommissioning. Today the Hanford mission is shifting toward waste management and advanced technologies. Only a few chemical processing facilities are operating and N-Reactor is in standby status.

During World War II, the government directed all of its efforts to production and assumed that future governments would solve the waste problem. While looking for the optimum solution, the approach was to temporarily store highly radioactive wastes in single shell tanks. When these tanks began to leak in the 60s the decision was to build improved double wall tanks. It is ironic that in this same time frame, the French Atomic Energy Commission (CEA) decided against tank storage and quickly identified solidification as borosilicate glass as the optimum solution. The French now have over 30 years of research and development plus 10 years of production to demonstrate the safety and reliability of the vitrification process.(1)

REGULATORY PROCESS

In June of 1983, the United States Department of Energy (USDOE) issued the Defense Waste Management Plan(2) which called for the first U.S. defense waste vitrification plant to be constructed at the Savannah River Plant in South Carolina, the second plant at Hanford, and the third Plant in Idaho. Costs for long-term high-level waste management at Hanford were estimated to be about 1.5 billion dollars.

In March of 1986, the Draft Hanford Defense Waste Environmental Impact Statement, (HDW-EIS)(3) examined the potential impacts calculated for the disposal of defense wastes stored at Hanford since 1943. On May 1, 1987, USDOE clarified its Resource Conservation and Recovery Act (RCRA) obligations by issuing a rule which stated all USDOE radioactive waste which is also hazardous under RCRA will be subject to regulation under RCRA and the Atomic Energy Act of 1954 (AEA).

The December 1987 final HDW-EIS(4) described Hanford wastes, examined impacts and recommended a preferred alternative. Table I shows the total activity of Hanford wastes and the percentage of activity in each waste category.

TABLE I
Radioactivity of Hanford Defense Waste

Total Activity 570 million curies	
Cesium and Strontium Capsules	37.0%
Double Shell Tank Waste	31.8
Single Shell Tank Waste	30.0
Low-level Waste	1.2
Stored Transuranic Waste	0.009
Pre-1970 Buried Transuranic Waste	0.006
Surplus Production Reactors	0.005
Transuranic Contaminated Soil Sites	0.003

Per 1987 integrated base(5)

The final Defense Waste EIS also documented large amounts of chemical components associated with Hanford wastes. Single and double shell tanks contain over 50 million gallons of waste including 200,000 tons of sodium nitrate, 100 tons of chromium, 4 tons of cadmium, 180 tons of nickel, hazardous organic wastes and complexants. The resultant waste is a very complex mixture which exceeds the corrosive, EP-toxic, and toxic hazardous waste criteria. As a result these wastes are subject to state and federal hazardous waste laws.

The Resource Conservation and Recovery Act of 1976 (RCRA) as amended by the Hazardous and Solid Wastes Amendments of 1984 (HSWA) together with the Washington State Toxics Control Act, Chapter 70.105(b) RCW provide for protection of public health and environment from activities associated with management and disposal of solid and hazardous wastes. All radioactive waste which is also hazardous is subject to regulation under both the AEA and RCRA. New and existing facilities which treat, store or dispose of hazardous waste must obtain a RCRA operating permit. USDOE, as owner of the Hanford site, has applied for over 50 operating permits.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) provides for liability, compensation, cleanup and emergency response for hazardous substances released into the environment and the cleanup of releases of hazardous substances. SARA confirmed and re-emphasizes that CERCLA is applicable to federal facilities such as Hanford and defines the process by which federal agencies are required to undertake remedial actions at their facilities. Funding for CERCLA activities at federal sites is provided through normal Congressional appropriation process rather than from the private sector Superfund.

COST ESTIMATES

Cost estimates for Hanford cleanup have sharply increased over time. Table II compares cost estimates from the March 1986 Draft HDW-EIS with the December 1987 final HDW-EIS. The wide range of costs for the preferred alternative is due to uncertainties associated with deferred decisions. Escalating repository costs resulted in a sharp increase in geologic disposal costs.

TABLE II
Cost Comparison Between Draft and Final HDW-EIS Millions of $ 1987

	DEIS(1)	FEIS(2)
Geologic Disposal	$11,300	$17,500
In-Place Stablization	1,900	2,400
Reference Alternative	2,600	3,900
Preferred Alternative		3900 to 16,400

1. 3/86 Draft HDW- EIS

2. 12/87 Final HDW-EIS

On July 1, 1988, USDOE issued the Environment, Safety and Health Report for the Department of Energy Defense Complex.(6) This "Glenn Report" indicated costs for clean up of single-shell tanks and inactive sites would range between a low estimate of about $5 billion to a high estimate of $46 billion with an expected cost of $27 billion. The assumptions used in the "Glenn Report" for single-shell tank remediation are presented in Table III and cost assumptions for remediation of inactive sites are presented in Table IV.

TABLE III
Cost Assumptions Single Shell Tank Remediation
$ In Millions Per Tank

Stabilize in Place	$7.4
Remove Contents	$74
Remediation Costs	
Low Case (149 stabilized)	$1,100
Expected Case (1/2 removed)	$7,000
High Case (149 removed)	$11,000

TABLE IV
Cost Assumptions Remediation of Inactive Sites
$ in Millions per Site

Characterization	$3
Excavation	$100
In Place Treatment	$60
Cap or Barrier	$3
Assume Remediation at 500 Sites $ Millions	
Low Case (all excavated)	$4,000
Expected Case	$20,000
Upper Case (all excavated)	$35,000

The Glenn Report assumed characterization of about 700 of the more than 1200 inactive waste sites. This report assumed remediation would be needed on about 500 of these 700 sites, with removal and treatment of some wastes, in-place treatment of others, and/or capping of the sites. A summary of HDW-EIS, Glenn Report, Vitrification Plant and decommissioning costs are presented in Table V.

The large difference between the "expected" total cost and the "high" cost for Hanford cleanup strongly indicates a high degree of uncertainty regarding specific disposal options. Resolution of key technical and policy issues is a prerequisite to the deceptively difficult task of selecting appropriate options.

One of the major technical challenges is to understand the waste characteristics. For example, USDOE estimates a cost of about $100,000 to collect a drill string from a single-shell tank and to complete the analysis for radioactive and hazardous components on one composite sample. Such a high cost for sample collection and analysis forces decision makers to use extreme care in selecting where and when to sample. Current cost assumptions are based on only 2 samples from each of the 149 single shell tanks. Although this very minimal characterization of tank wastes may be adequate for the retrieval for geologic disposal option, this level of sampling is not adequate for leave in place options

TABLE V
Summary Cleanup Cost

ACTIVITY	HDW-EIS(1)	GLENN REPORT(2)	SUMMARY(3)
Existing Double-Shell Tank Wastes	1,300		1,300
Future Double-Shell Tank Wastes	1,300		1,300
Strontium and Cesium Capsules	210		210
Retrievably Stored and New TRU Wastes	190		190
Single-Shell Tank Wastes	700/11,300	7,000/11,000	7,000/11,000
Transuranic Contaminated Soil Sites	68/470	(4)	
Pre-1970 Buried TRU Wastes	170/1,600	(4)	
Inactive Site Characterization and Remediation		20,000/35,000(4)	20,000/35,000
Safety and Health		30/130	30/130
Facility decommissioning		(5)	1,000
TOTAL (rounded)	$3,900/12,000	$27,000/46,0030	$32,000/52,000

(1) HDW-EIS COSTS (LOW/HIGH) ARE IN MILLIONS OF 1987 DOLLARS. VALUES ARE ROUNDED

(2) GLENN REPORT REMEDIAL ACTION AND HEALTH AND SAFETY COSTS ARE IN (EXPECTED/HIGH) MILLIONS OF 1990 DOLLARS. VALUES ARE ROUNDED.

(3) SUMMARY COSTS (EXPECTED/HIGH) ARE CURRENT BEST ESTIMATES.

(4) GLENN REPORT INACTIVE SITE CHARACTERIZATION AND REMEDIATION COSTS INCLUDE PRE-1970 BURIED SUSPECT TRU-CONTAMINATED SOLID WASTES. THE REPORT DID NOT ADDRESS INTERIM OPERATIONAL COSTS.

(5) DECONTAMINATION AND DECOMMISSIONING COSTS FOR CURRENT AND FUTURE RETIRED FACILITIES WERE NOT INCLUDED IN THE GLENN REPORT. THIS COST IS EXPECTED TO EXCEED $1 BILLION.

such as in place stabilization. Leave in place options will require a very detailed data base for performance analysis calculations.

About the time waste characteristics are defined, the technical feasibility of a manageable number of options should receive a fair share of research attention. Pacific Northwest citizens will not accept leave in-place options unless the retrieval options have been thoroughly researched. If retrieval is not viable, options, such as in-place immobilization or vitrification must be fully researched. In all cases, there will be a need for research on subsidence control, barriers and markers.

Policy issues are fully as challenging as the technical issues. Policy decisions such as selecting appropriate standards and criteria, establishing priorities, approving funding levels, and setting schedules are inextricably entwined with the technical issues mentioned earlier. A clear understanding of which agencies have oversight and enforcement responsibilities is needed to ensure timely permits and approvals. Public information programs must be an integral part of the cleanup program. Pacific Northwest citizens are aware of the problems and have expressed a willingness to support cleanup efforts. They will support the efforts if they are kept informed at each step of the program and if they are assured that the decisions are safe, cost effective, and equitable with private sector cleanups.

Such a wide range of technical and policy issues reinforces the preliminary nature of current cost estimates. Stabilization of single-shell tanks will not be completed until the mid 1990s. Small scale model testing of waste retrieval technologies will begin in that same time frame. A laboratory designed to analyze low level radioactive mixed waste is scheduled for completion in early 1992 but new laboratory hot cells for analyzing high level radioactive mixed waste will not be available until 1993. The laboratory delay will delay chemical and radionuclide characterization of single-shell tanks until the late 1990s.

CONCLUSION

Hanford cleanup costs range from about $32 to $52 billion. Clearly a massive infusion of funds is needed to clean up the 40 year accumulation of wastes. If we assume the expected 32 billion dollar cleanup cost and if cleanup is expected to be completed in 30 years, Hanford alone will need at least a billion dollars a year. Currently, the Hanford cleanup budget is much less than half that amount.

The Hanford Nuclear Reservation has played a key role in this nations defense efforts, but Washington State and the federal government are now faced with a massive nuclear waste legacy. Washington State citizens insist that the federal government and the Department of Energy take prompt, aggressive action to assure a timely and adequate cleanup. In 1986, Governor Gardner and the Washington State Nuclear Waste Board developed general criteria the Department of Energy should use to make cleanup decisions. They are still valid. The number one criterion must be the protection of public health and the environment. To meet this all important criterion, USDOE must:

- use state-of-the-art technologies;
- comply with appropriate laws by leaving the shadow of the 1954 Atomic Energy Act exclusions and moving into the sunshine of current federal legislation;
- consider economics, but not allow economics to drive decisions;
- minimize future releases; and
- make sure science, not politics, prevail in the decision making process.

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