EVALUATION OF TECHNOLOGIES FOR REMEDIATION OF DISPOSED RADIOACTIVE AND HAZARDOUS WASTES IN A FACILITY AT THE IDAHO NATIONAL ENGINEERING LABORATORY*

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ABSTRACT

For the past twenty years the U.S. Department of Energy has been investigating and evaluating technologies for the long term management of disposed transuranic contaminated wastes at the Radioactive Waste Management Complex of the Idaho National Engineering Laboratory. More than fifty technologies have been investigated and evaluated and three technologies have been selected for feasibility study demonstration at the complex. This paper discusses the evaluation of those technologies and describes the three technologies selected for demonstration. The paper further suggests that future actions under the Comprehensive Environmental Response, Compensation, and Liability Act should build from previous evaluations completed heretofore.

INTRODUCTION

For the past two decades the U.S. Department of Energy and State of Idaho have been concerned about disposal and storage of radioactive and hazardous wastes at the Radioactive Waste Management Complex (RWMC) of the Idaho National Engineering Laboratory (INEL). Concerns have focused on long-lived radioisotopes and hazardous wastes being placed above the Snake River Plain Aquifer. This paper (a) identifies technologies evaluated for the long-term management of disposed wastes, (b) discusses how the remedial technologies being demonstrated were selected, and (c) briefly describes those technologies. The three demonstrations are the Vapor Vacuum Extraction (VVE), In Situ Vitrification (ISV), and Retrieval of Disposed Wastes From Pit 9.

HISTORICAL PERSPECTIVE

The Radioactive Waste Management Complex of the Idaho National Engineering Laboratory was established in 1952 as a disposal facility for solid low-level radioactive contaminated wastes generated at the Idaho National Engineering Laboratory [at that time called the National Reactor Testing Station (NRTS)]. The disposal Complex is situated above the Snake River Plain Aquifer, an important source of drinking and irrigation water for southeastern Idaho. In 1954, the Radioactive Waste Management Complex began receiving and disposing of solid wastes (contaminated with transuranic elements) generated at the Rocky Flats Plant in Colorado. The transuranic-contaminated waste from Rocky Flats also contained hazardous wastes, as defined by present regulations of the U. S. Environmental Protection Agency. From 1954 to 1970 the transuranic-contaminated wastes were disposed in shallow pits and trenches. Since 1970, wastes from Rocky Flats have been stored at the Complex above ground on asphalt pads. Low-level radioactive wastes still are being disposed of in the Complex.

Although transuranic-contaminated wastes have been received at the Complex since 1954, it was not until 1969 that public interest focused on the issue of placing long-lived radioisotopes over the aquifer. At that time large quantities of transuranic-contaminated wastes were being transported to INEL as part of a cleanup after a fire at the Rocky Flats Plant. Publicity about the fire caused officials of the State of Idaho to question the safety of those wastes being disposed at the Complex. The congressional delegation from the State of Idaho requested a joint, four agency study evaluating the safety of radioactive waste disposal activities at the Complex (1).

In 1970, the Atomic Energy commission made commitments to the Governor of and congressional delegation from the State of Idaho that transuranic-contaminated wastes would be removed from the Radioactive Waste Management Complex as soon as a federal facility was available for receipt and disposal of such wastes (2). Numerous documents were written during the 1970s and early 1980s that evaluated alternatives for the long-term management of transuranic-contaminated wastes at the Complex (3-9). Those documents identified and evaluated management alternatives for disposed and stored transuranic-contaminated wastes including retrieval, confinement, and immobilization in place.

In 1987, attention was again focused on transuranic-contaminated wastes when plutonium and volatile organic compounds were found in geologic formations beneath the Radioactive Waste Management Complex (10, 11). That led to the Complex being designated a hazardous waste storage facility under the Resource Conservation and Recovery Act of 1976. The findings caused the Department of Energy to accelerate formation of a long-term strategy for management of disposed transuranic-contaminated wastes. In 1989, Region 10 of the U.S. Environmental Protection

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Agency announced that the Idaho National Engineering Laboratory had been placed on the National Priority List. That listing specifically identified three facilities at the Laboratory needing immediate environmental attention, namely the Radioactive Waste Management Complex, the warm waste pond at the Test Reactor Area, and the Test Area North facility.

TECHNOLOGICAL PERSPECTIVE

In response to the finding of migration of hazardous constituents, the Idaho Operations Office of the Department of Energy and its contractor EG&G Idaho Inc. established the Buried Waste Program. The purpose of the program was to "...determine the sources of contamination, characterize the extent of contamination, mitigate further migration of TRU [transuranic] and nonradioactive hazardous materials from the Radioactive Waste Management Complex, and provide the mechanism for selecting a permanent solution to migration."(12) The Buried Waste Program recognized that new innovative remedial technologies would need to be identified, investigated, evaluated, and demonstrated as potential actions for remediation of the Subsurface Disposal Area.

In 1987, the Department of Energy authorized the National TRU-Waste Program to fund studies which would identify and evaluate remedial technologies potentially applicable to the Radioactive Waste Management Complex. The Idaho Operations Office of the Department of Energy and EG&G Idaho, Inc. convened a group of nationally recognized professionals to participate in a Waste Isolation Techniques Value Engineering Workshop. The objective of the workshop was to generate a list of technologies which could be used to manage the long-lived radioisotopes and volatile organic compounds disposed in the Complex. Results of the workshop were 22 summaries of high-rated remediation technologies and 27 lower-rated remedial technologies (13).

To further identify potential remedial technologies, the Buried Waste Program also initiated literature searches, surveys of other government agencies involved in remedial actions, and a Waste Innovative Ideas program. The purpose of the program was to identify new innovative technologies and evaluate those applicable to remediation at the Complex. As part of that program, brainstorming sessions were held during the months of November and December of 1987. The sessions yielded more than six hundred (600) ideas. Participants were invited to select one or more of the technologies and prepare a one page proposal for funding to further develop and qualitatively evaluate the technology. That resulted in 122 technology proposals being submitted for funding. A committee evaluated funding proposals. Forty three of those proposals were funded for further qualitative evaluation (14). Table I lists collections of technologies considered by the Buried Waste Program. The authors took the liberty to consolidate similar technologies into generic designations. For example, Infiltration, Erosion, and Drainage Control (first entry under Containment) includes technologies such as single-layer cap, multi-layered caps, synthetic membrane caps, dikes and berms, channels and waterways, grading, and revegetation.

VAPOR VACUUM EXTRACTION

Technologies gathered from literature searches, surveys of government agencies, Value Engineering Workshop, and brainstorming sessions were evaluated and rated by the Innovative Waste Technology Committee. The Vapor Vacuum Extraction was rated high and later selected as a remedial technology for feasibility study demonstration. The rationale for selecting the Vapor Vacuum Extraction (with a detailed description of the process) is presented in the RCRA Facility Workplan for the Radioactive Waste Management Complex (15).

The Vapor Vacuum Extraction system as planned consists of a borehole drilled into the geologic formations beneath the Radioactive Waste Management Complex. A vacuum then is applied to the borehole which draws air from the unsaturated portion of the geologic formation. Air then is processed through a filter system where volatile organic compounds are removed. Fig. 1 illustrates this process. The demonstration will evaluate whether the Vapor Vacuum Extraction system will perform in geologic formations found at the Radioactive Waste Management Complex.

IN SITU VITRIFICATION

The potential of In Situ Vitrification (ISV) as a remedial technology for TRU-Wastes had been demonstrated and investigated by the Department of Energy and its contractor Battelle Memorial Institute since 1980 at the Pacific Northwest Laboratory. However, there were concerns that the process might not work at INEL because of soil conditions and the high metal content of the disposed wastes. In 1988, the ISV process was tested at Pacific Northwest Laboratory using soils from INEL and simulating the high metal content of wastes at the Complex. The test demonstrated that potentially the system would work at INEL. Results became available about the same time as the Innovative Waste Technology Committee of the Buried Waste Program was completing its review of funded studies. The committee evaluated the results of the test and rated In Situ Vitrification high. In Situ Vitrification was funded in FY 89 as a feasibility study demonstration.

In Situ Vitrification is a thermal process that melts wastes and contaminated soil into a glass-like material similar in appearance to obsidian. This is accomplished by placing four electrodes in a square array in the soil above the waste. A small amount of powdered graphite and glass frit is used to connect electrodes and establish a conductive

TABLE I

Collections of Technologies Considered for Remediation of Disposed Wastes at the Radioactive Waste Management Complex at the Idaho National Engineering Laboratory

CONTROL MEASURES	RETRIEVAL	CONTAINMENT	STABILIZATION
Vapor Vacuum Extraction/Soil Venting	Remote Handling	Infiltration, Erosion and Drainage Control	In-Situ Vitrification
Negative Pressure Canopy	Macro Equipment	Microbic Products Utilized As Grout	In-Situ Coating With Inorganics/clays
	Cryogenic Excavation		In-Situ Sintering
Drying Of Vadose Zone	On Site Disposal	Grout Fissures And Pores	
			In-Situ Thermal Treatment
Change Groundwater Flow Direction	Off Site Disposal	Hydrogeologic Barriers	In-Situ Biodegradation
Freezing Of Vadose Zone	Excavation Of Contaminated Soils	Explosive Grouting	In-Situ Freezing
		Ground Penetrating Radar	
Bio-accumulation of Pu	Plasma Processing of Wastes	Subsurface Drainage	In-Situ Polymerization
Bio-remediation	Supercritical Fluid Extraction		In-Situ Silicate Based Solidification
Electro Osmotic Control			
			In-situ Grouting
Chleating Agents			
Bone Seeking Pu			In-situ Treatment Of Organics By Ozonation
Ozonation			
Plants To Attract Pu			
Accelerate Beta Decay			
Leach And Collect			
Pump Water From Aquifer and Treating			
Thermal Stripping Of Unsaturated Zone			
Soil Washing			

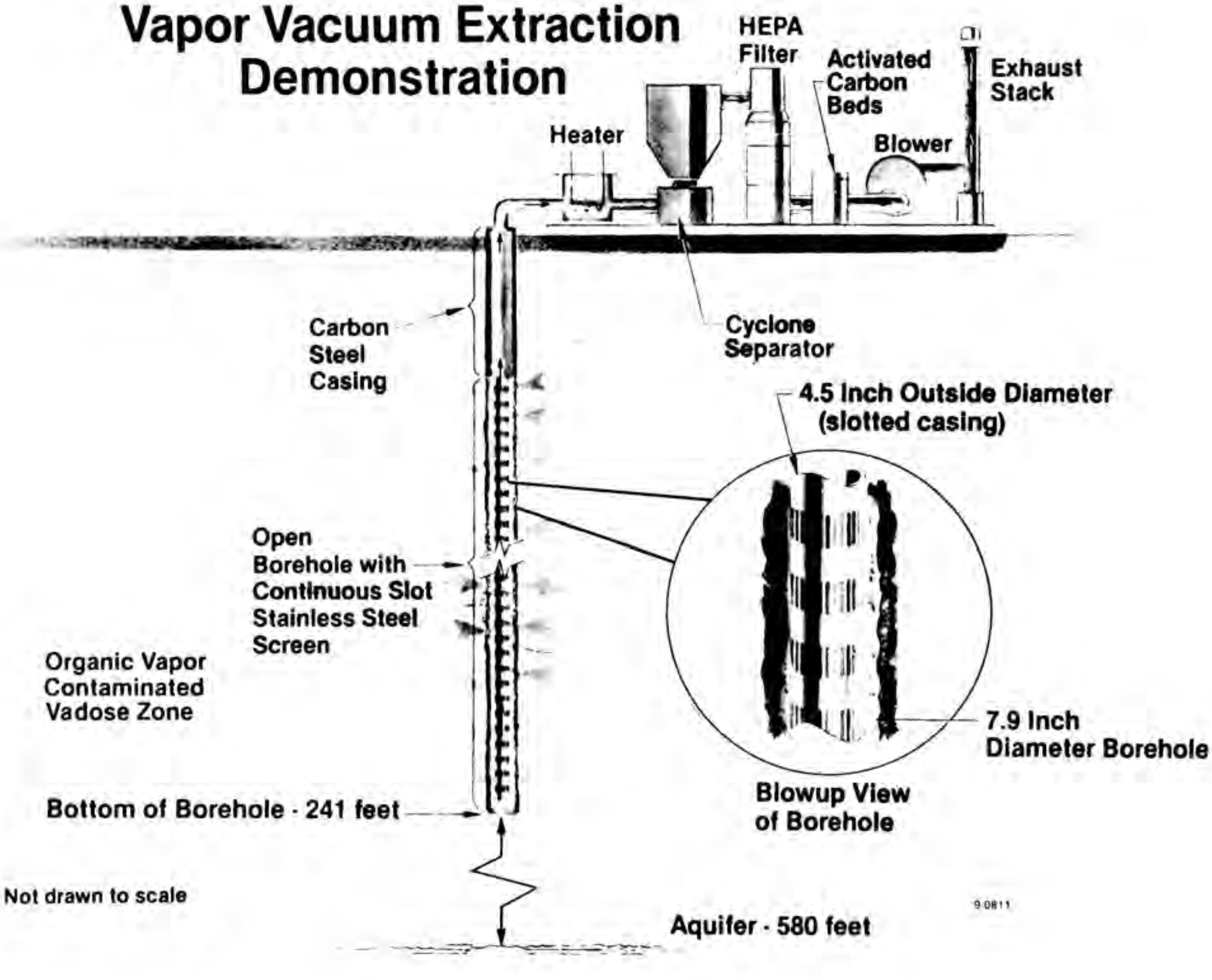

Fig. 1. Illustrates the components of the Vapor Vacuum Extraction system. Air from the geologic formation along with volatile organic compounds are extracted by vacuum. The air then is processed through the system where organic vapors are removed.

path. When an electric current is applied, resistance in the powdered graphite and glass frit is sufficient to cause the conductive path and the surrounding soil to melt. The electrodes are lowered into the melt as the process proceeds (Fig. 2).

RETRIEVAL

Two retrieval demonstrations, the Initial Drum Retrieval (16) (1974-1978), and the Early Waste Retrieval (17) (1976-1978) showed that disposed wastes could be retrieved, but at a slow and tedious rate similar to an archaeological dig. Those demonstrations and the planned Retrieval Demonstration of Pit 9 stem from commitments made by the Atomic Energy Commission in 1969 to move wastes in the Complex to a federal waste repository when available. The commitment was made in a letter from the Atomic Energy Commission to Senator Frank Church, which stated "... AEC plans to store not only currently generated alpha wastes but also to excavate, process and ship such wastes which are being temporarily stored at NRTS."(2) The Governor of and congressional delegation from the State of Idaho assumed that commitment meant both stored and disposed wastes at the Complex.

A National Academy of Sciences study in 1976 found that retrieval of disposed transuranic-contaminated wastes could be more hazardous than leaving them in place (18). Objectives of the Buried Waste Program at the Idaho National Engineering Laboratory are to develop retrieval alternatives that will reduce the hazards and costs, while at the same time accomplishing retrieval on a production scale [that is, 61 m^3(80 yd^3)/day]. The Retrieval Demonstration involves excavating Pit 9 in the Subsurface Disposal Area, retrieving, characterizing, segregating, and repackaging the wastes. The excavation will be performed inside a movable fabric building within a non-movable building (Fig. 3). Disposed wastes will be excavated and handled with remotely controlled equipment.

CONCLUSION

For 20 years, the Department of Energy has been investigating and evaluating technologies for the long-term management of radioactive and hazardous wastes disposed in the Radioactive Waste Management Complex. Knowledge gained from those investigations and evaluations should be used in planning remedial actions at the Radioactive Waste Management Complex under the Comprehensive Environmental Response, Compensation, and Liability Act as amended in 1986. Remedial actions accomplished under that Act require a formal evaluation process of alternative technologies and treatability demonstrations of innovative technologies. In many instances, that process has been or is being accomplished at the Complex, though perhaps not in the formal and rigorous manner as dictated by the Act. Nonetheless, this paper concludes that future actions under the Act should consider evaluations previously completed. Discounting past evaluations only to redo them later would prolong implementation of corrective actions at the Radioactive Management Complex.

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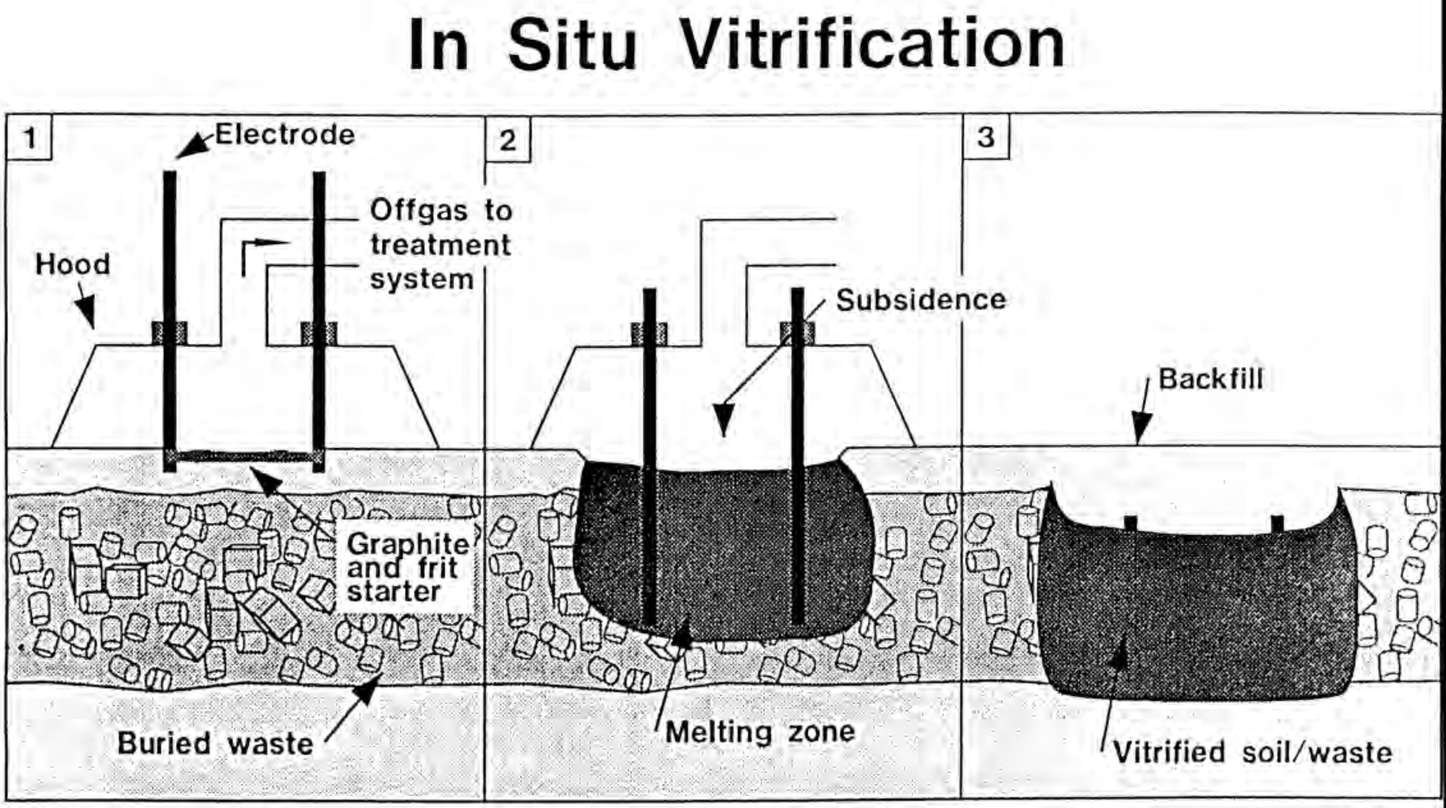

Fig. 2. Illustrates the 3 stages of In Situ Vitrification. Stage 1 depicts initial arrangement of equipment. Stage 2 depicts the melt proceeding and the electrodes being lowered into the melt. Stage 3 depicts the completed process with the vitrified block backfilled.

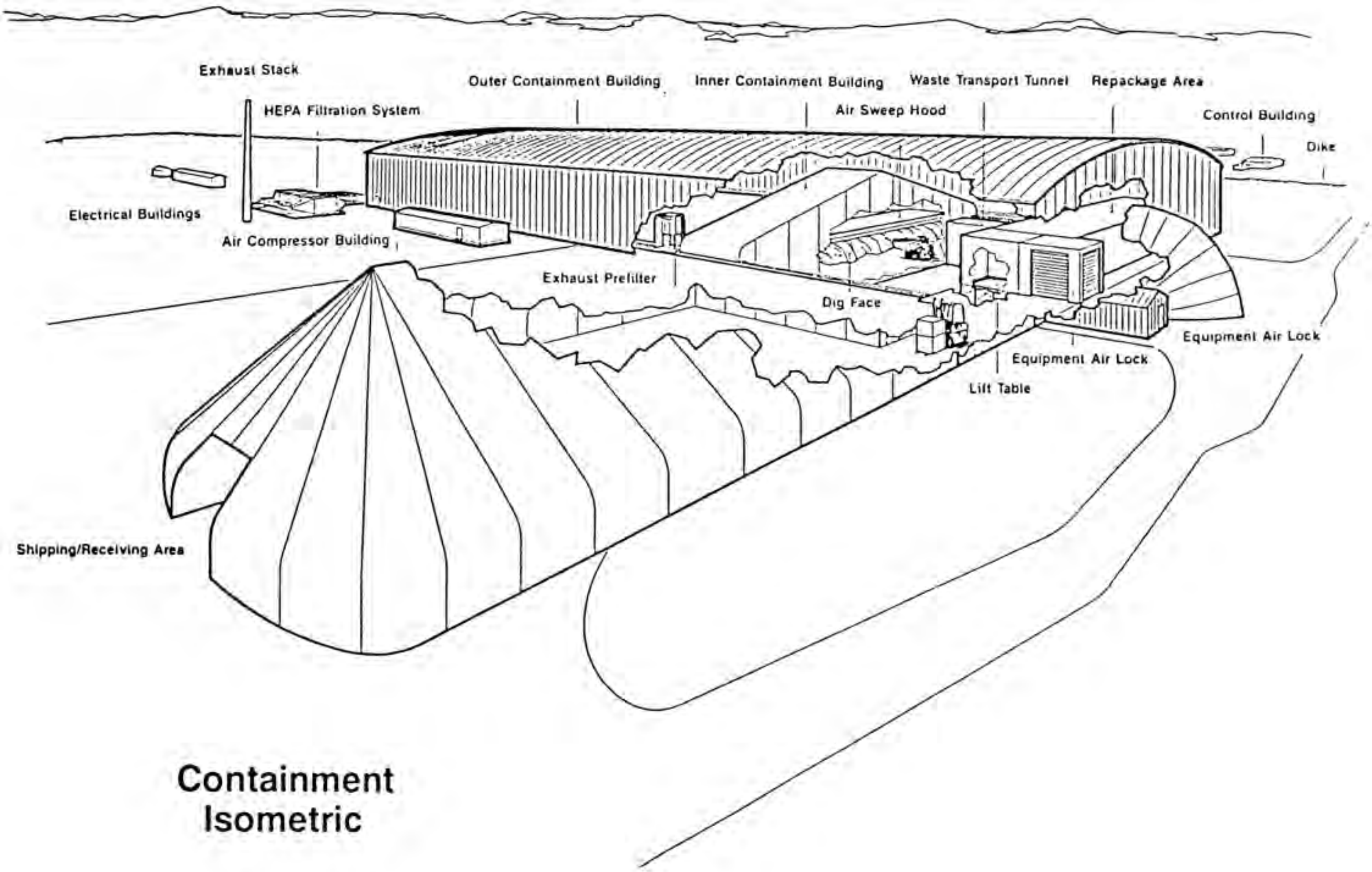

Fig. 3. Illustrates a cut away view of the building in which retrieval will occur. Note the inner and outer containment buildings in the illustration.

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