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by

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DISPOSAL OF SAVANNAH RIVER PLANT WASTE SALT

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INTRODUCTION

Approximately 25-million gallons of soluble low-level waste salts will be produced during solidification of 6-million gallons of high-level defense waste in the proposed Defense Waste Processing Facility (DWPF) at the Savannah River Plant (SRP). A flowsheet of the DWPF is shown in Fig. 1. Present plans call for insoluble waste (primarily Fe, Mn, and Al hydroxides) now being stored in waste tanks on the plantsite to be vitrified and shipped to a federal repository. Soluble wastes (primarily $NaNO_3$, $NaNO_2$, and NaOH) also stored in the waste tanks will be decontaminated by ion exchange and solidified in concrete. The resulting salt-concrete mixture, "saltcrete", will be placed in a landfill on the plantsite such that all applicable federal and state disposal criteria are met.

Proposed NRC guidelines for the disposal of waste with the radionuclide content of SRP salt would permit shallow land burial.[1] Federal and state rules[2] require that potentially hazardous chemical wastes (mainly nitrate-nitrite salts in the saltcrete) be contained to the degree necessary to meet drinking water standards in the ground water beneath the landfill boundary. This paper describes the proposed saltcrete landfill and tests under way to ensure that the landfill will meet these criteria. The work includes laboratory and field tests of the saltcrete itself, a field test of a one-tenth linear scale model of the entire landfill system, and a numerical model of the system.

SALT DESCRIPTION

The estimated 25-million gallons of soluble salts currently in SRP waste tanks is largely $NaNO_3$, $NaNO_2$, and NaOH. Table I lists the major components of the salt. The components which are of most concern are the mercury and the nitrate-nitrite, because they present the greatest potential hazard to the ground water.

The salt solution will be decontaminated by ion exchange in the DWPF canyon facility. The decontaminated salt will be low-level waste. Table II lists the estimated radionuclide content of this salt.

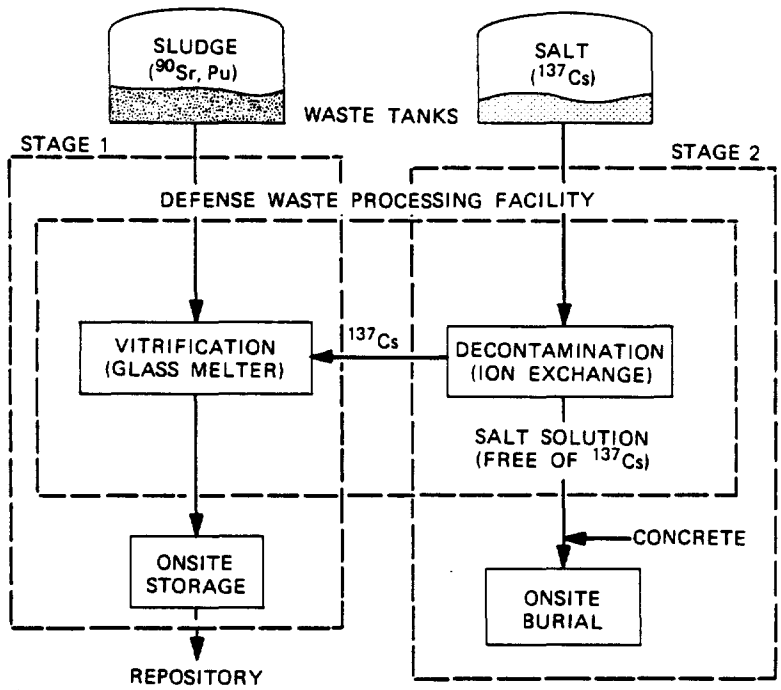

FIGURE 1. Process for Waste Immobilization - Staged Project

TABLE I

Radionuclide Content of DWPF Salt

Radionuclide	nCi/g
^{60}Co	0.2
^{90}Sr	1.5
^{99}Tc	98
^{106}Ru	81
^{125}Sb	35
^{129}I	(0.4)[a]
^{137}Cs	78
^{147}Pm	8.4
^{151}Sm	114
^{238}Pu	0.4
^{239}Pu	0.004
^{240}Pu	0.002
^{241}Pu	0.3
^{241}Am	1.1

a. Nuclide calculated to be present, but not chemically detected.

TABLE II

Chemical Composition of DWPF Salt (Dry Basis)

Compound	Amount, wt %
$NaNO_3$	40
NaOH	19
$NaNO_2$	14
$NaAlO_2$	9
Na_2CO_3	9
Na_2SO_4	8
$Na_2C_2O_4$	0.1
NaCl	0.2
Hg	0.05
Miscellaneous	0.65

SALTCRETE BATCH PLANT

A block diagram of the conceptual saltcrete process is shown in Fig. 2. The decontaminated salt solution will be taken as it comes from the ion exchange columns, concentrated to a near saturated salt solution, mixed with cement, and pumped into trenches which are part of an intermediate depth landfill. To match the production rate of salt by the DWPF, the saltcrete batch plant will produce 20,000 ft^3 of saltcrete per week.

SALTCRETE LANDFILL

The saltcrete disposal system will be an engineered, intermediate-depth landfill (Fig. 3). The system will be divided into 20 identical grids covering a total of 28 acres. Each grid will consist of eight saltcrete slabs measuring 20 ft x 20 ft x 250 ft, surrounded by a 5-ft-thick vault of clay having low permeability (10^{-7} cm/sec). The surface of the landfill will be 33 ft (10 m) beneath the surface to prevent intrusion by deep-rooted vegetation and burrowing animals. The bottom of the landfill will be 5 ft above the historic high-water mark of the water table.

Each grid of the saltcrete landfill will be laid down separately. The soil will be excavated and a 5-ft-thick clay liner will be placed on the bottom of the excavated area. The soil will be replaced partially and trenched so that a 5-ft-thick wall of clay can be placed around the grid. Trenches will then be dug and filled with saltcrete. Each grid of the landfill can hold the saltcrete made during about one year of DWPF operation. After all eight saltcrete blocks are poured, the grid will be covered with a 5-ft-thick clay cap. The entire grid will be protected from the weather by an inflatable building, while the filling and capping operations take place.

Disposal requirements for waste stored on the Department of Energy (DOE) controlled sites have not yet been established. We believe, however, that the intent of DOE requirements will match those of current NRC,[1] EPA,[2] and DHEC[3] guidelines. The goal of the saltcrete landfill, based on these guidelines, is to maintain drinking water standards at the boundary of the landfill. An evaluation program is under way to ensure that this goal is met.

SALTCRETE LEACHING AND LANDFILL EVALUATION

Laboratory Leach Testing

Saltcrete samples have been leached in the laboratory according to accepted leach-testing protocols.[4] Tests using distilled water that is replaced and analyzed on a regular basis have continued through nine months. The cumulative fraction of nitrate leached from the saltcrete samples is plotted vs. time in Fig. 4. The saltcrete leach rate has decreased from 10^{-1} to 10^{-5} g/cm^2-day during the leaching period. This is the type of leach rate decrease expected for diffusion-controlled leaching.[3]

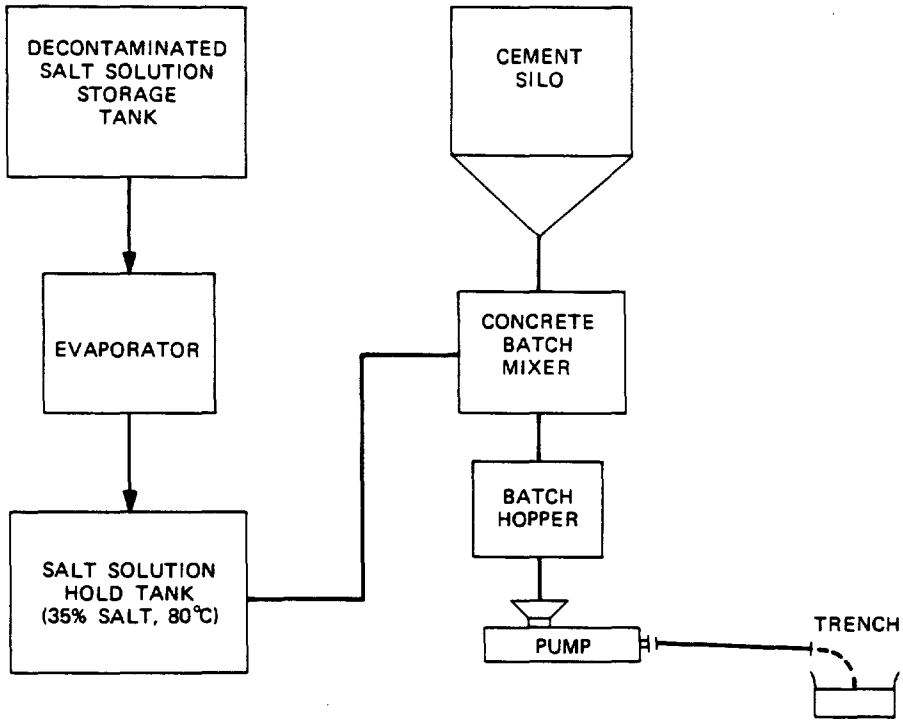

FIGURE 2. Salt Solidification Flowsheet

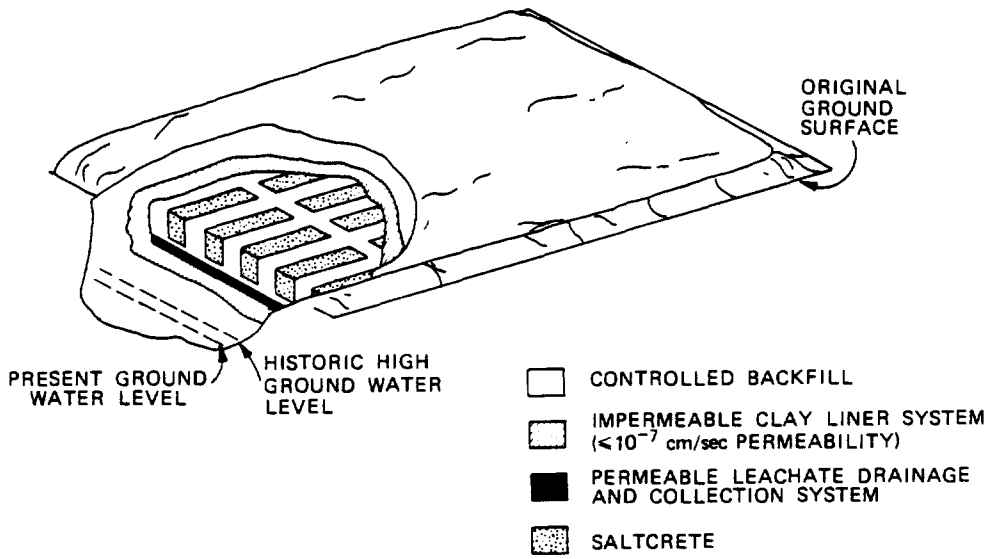

FIGURE 3. Salt Disposal System

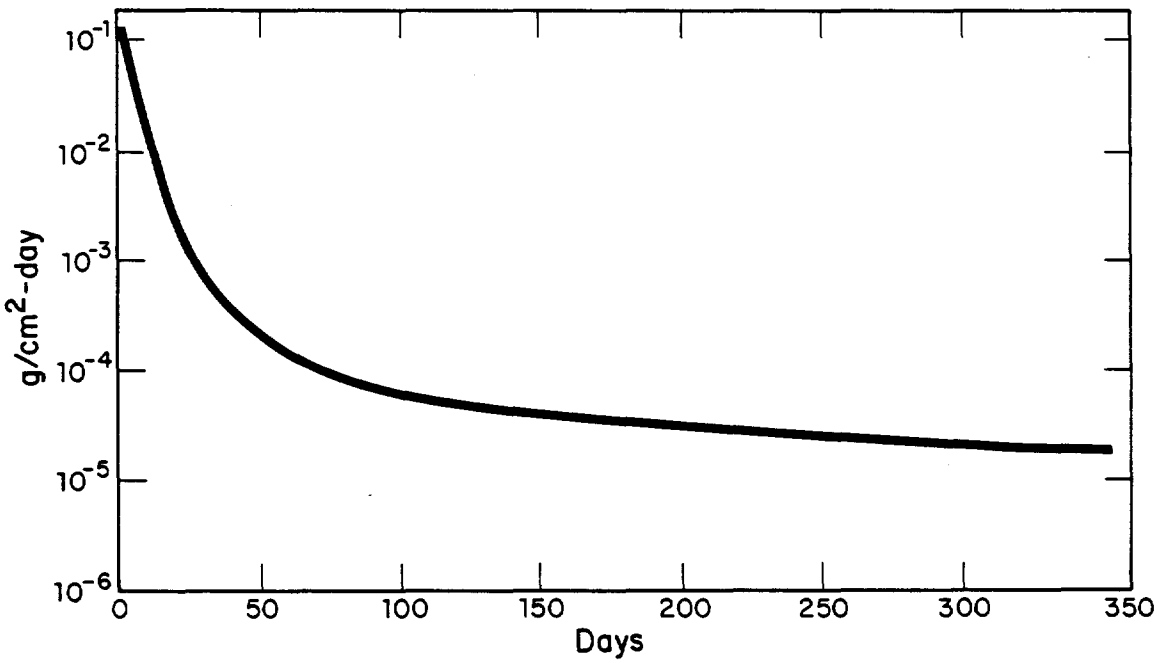

FIGURE 4. Saltcrete Leach Rates Based on Nitrate

Saltcrete was also leached using the EPA leach test for waste classification.[2] Based on this test, the mercury content in saltcrete does not place saltcrete in the hazardous waste category as defined by the Resource Conservation and Recovery Act (RCRA).[5] In leaching tests with saltcrete containing simulated and actual SRP waste salts, the maximum mercury content of the leachate was 1.4 ppb. This is well below the hazardous threshold of 20 ppb.

Field Testing

Two field leaching tests of saltcrete are under way at the Savannah River Laboratory (SRL) in lysimeters. In these experiments, blocks of saltcrete are located near the center of 6-ft-diameter by 10-ft-deep lysimeters, which are filled with typical SRP soil (Fig. 5). These lysimeters are equipped with gravel drains and sump pumps to pump percolate rainwater back to the surface for analysis.

One of these lysimeters contains a 450-kg-cylinder of saltcrete made from simulated DWPF waste salt. This lysimeter has been in the ground since July 1980. The concentration of nitrate found in water collected from the saltcrete lysimeter is plotted vs. time in Fig. 6. The cumulative fraction of nitrate released from the concrete to date is quite low, 0.38 wt %; however, the concentration of nitrate in the lysimeter water has gone above drinking water standards (44 ppm for NO_3^-). This shows us that saltcrete alone does not provide an adequate barrier against migration of the nitrate salts. Clay liners are needed to reduce infiltration by rainwater, as described in the previous sections.

The second saltcrete lysimeter experiment under way is one with a 25-kg-block of saltcrete containing actual decontaminated SRP waste salt. This lysimeter has been in the field since September 1981, but little data has been collected due to limited rainfall. This test will determine the rate radionuclides and mercury, as well as nitrate-nitrite, will leach in a "worst-case" situation (no engineered barrier). Monitoring of these lysimeters will continue for several years.

Saltcrete Landfill Lysimeter

To help predict performance of the entire landfill system, including clay barriers, a one-tenth linear scale model of the landfill has been built in a 30-ft x 30-ft lysimeter (Fig. 1). The model landfill contains eight 2-ft x 2-ft x 25-ft blocks of saltcrete surrounded by a 6-in. layer of clay. The vault of saltcrete blocks and clay is underlain by a gravel drain. Beneath the gravel drain is a liner of Hypalon® synthetic rubber that will collect any water and salt solution which eventually permeates through the model landfill. Solutions collected on the Hypalon liner will drain to a sump. This will be pumped to the surface for analysis.

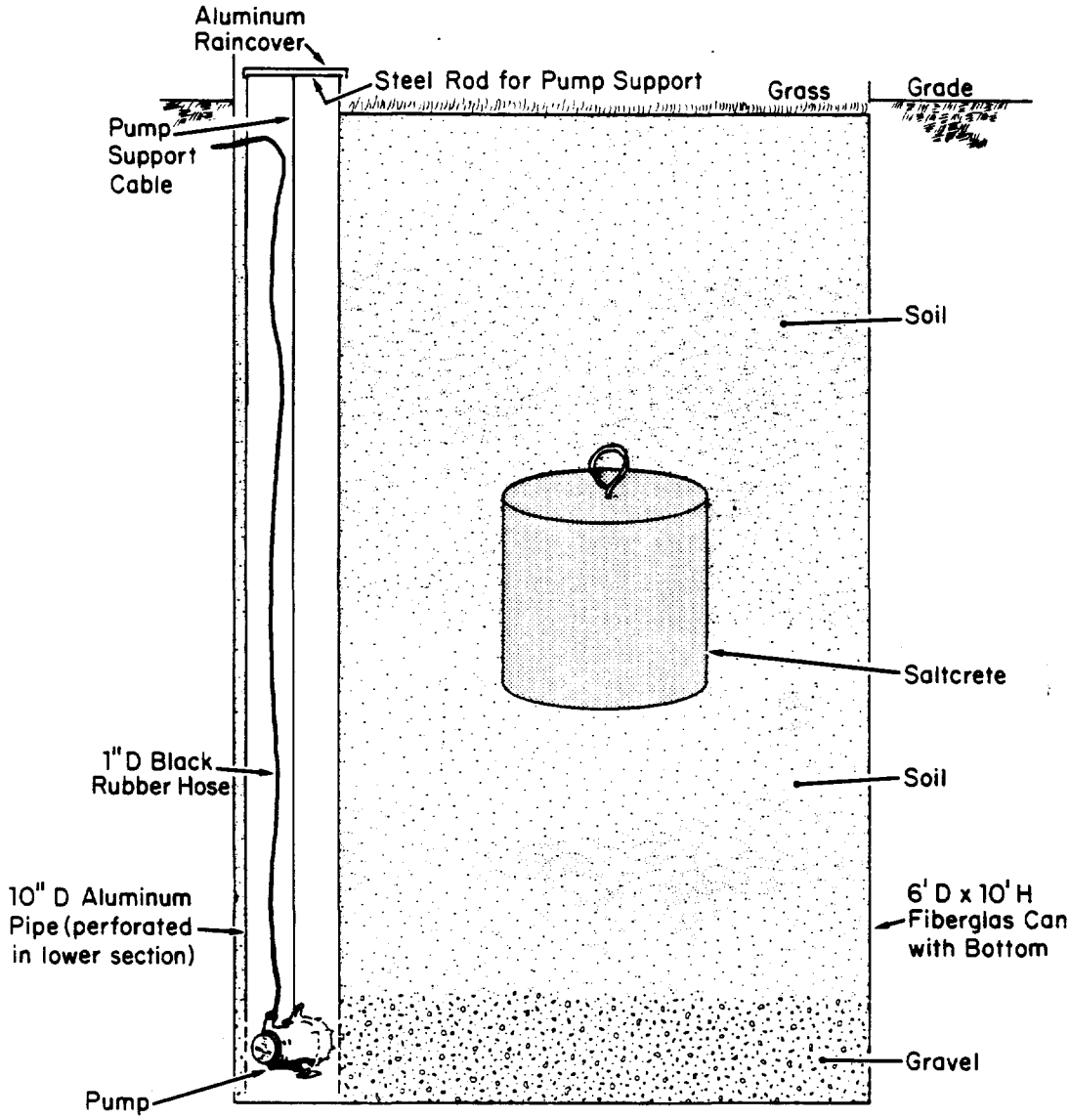

FIGURE 5. Saltcrete Lysimeter

In addition to the collection of solutions passing through the saltcrete landfill, devices have been placed throughout the lysimeter to monitor water and contaminant migration. Two types of monitoring devices are being used, soil moisture detectors and soil moisture samplers. The moisture detectors allow measurement of soil moisture content thoughout and above the lysimeter. The soil moisture samplers allow small samples of soil moisture to be pulled to the surface and analyzed for salt content.

Construction on the saltcrete landfill lysimeter has just been completed. It may take one to two years for moisture flow through the landfill to reach steady state where moisture inflow though the clay cap equals the moisture outflow through the clay liner. Some initial indications of saltcrete leachabilities in this environment should be available during the next few months from the monitoring devices placed within the landfill lysimeter.

The information collected from the landfill lysimeter will allow prediction of the effectiveness of the landfill in protecting the ground water from significant contamination.

COMPUTER MODELING STUDIES OF THE SALTCRETE LANDFILL

A contract has been let with Interra, Inc. of Houston, Texas to perform a computer modeling study of water and contaminant flow through the saltcrete landfill. This modeling will be done for the reference landfill (Fig. 3) and minor variations of this design to optimize the performance.

The data from this study and the saltcrete landfill lysimeter will be compared as cross checks. These combined studies will provide information to predict the release rates of salts from an actual saltcrete landfill. This will allow us to ensure the quality of the ground water in the vicinity of a saltcrete landfill.

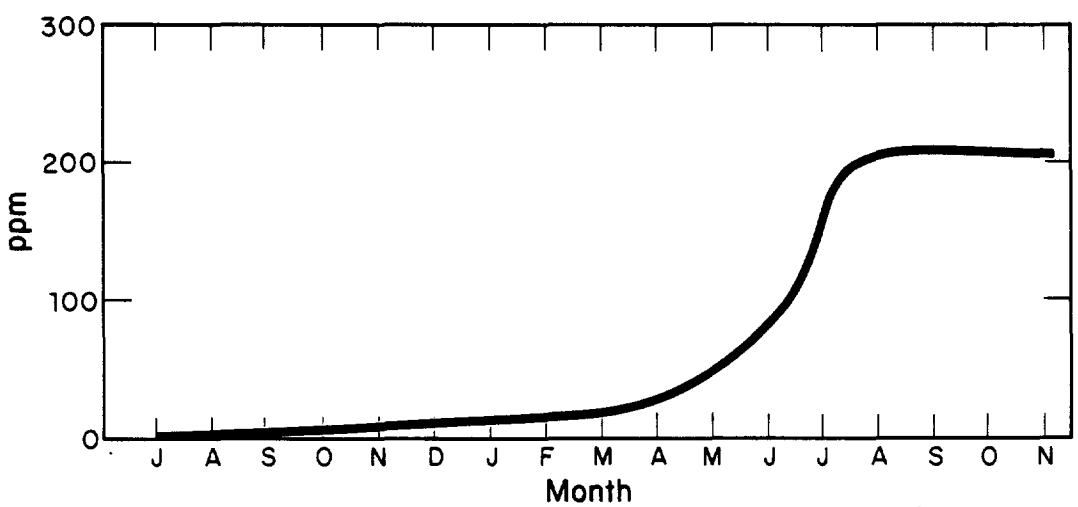

FIGURE 6. Nitrate Concentrations Found in Lysimeter Leach Solutions

ACKNOWLEDGEMENT

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REFERENCES

1. U.S. Nuclear Regulatory Commission Proposed 10 CFR Part 61. **Licensing Requirements for Land Disposal of Radioactive Waste.** Federal Register 46 No. 142, pp. 38029-38400 (1981).

2. Environmental Protection Agency 40 CFR Part 257. **Criteria for Classification of Solid Waste Disposal Facilities and Practices.** Federal Register 44 No. 169, p. 53438 (1979).

3. South Carolina Department of Health and Environmental Control, **Hazardous Waste Management Regulations,** March 31 1981, amended January 19, 1981.

4. P. Columbo, R. M. Nielson, Jr., and B. Vegas. **Properties of Radioactive Wastes and Waste Containers.** BNL-NUREG-50921 (1978).

5. **Rules and Regulations.** Federal Register 45 No. 98, p. 33127 (1980).