MEETING PERFORMANCE OBJECTIVES FOR A LOW-LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY AT THE SAVANNAH RIVER SITE

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ABSTRACT

A new Low-Level Radioactive Waste (LLW) disposal facility at the Savannah River Site is presently being constructed. The facility was designed to meet specific performance objectives (derived from DOE Order 5820.2A and proposed EPA Regulation 40CFR193) in the disposal of containerized Class A and B wastes. The disposal units have been designed as below-grade concrete vaults. These vaults will be constructed using uniquely designed blast furnace slag + fly as concrete mix, surrounded by a highly permeable drainage layer, and covered with an engineered clay cap to provide the necessary environmental isolation of the waste form to meet the stated performance objectives. The concrete mix used in this facility, is the first such application in the United States. These vaults become operational in December, 1992, and will become the first active facility of its kind, several years ahead of those planned in the commercial theater. This paper will discuss the selection of the performance objectives and conceptual design.

HISTORICAL OVERVIEW

The Savannah River Site (SRS) has been storing and disposing of solid radioactive waste since 1953. The disposal site now known as the Solid Waste Disposal Facility (SWDF) is centrally located on the 780,000 km^2 (300 square mile) site and has disposed of more than twenty million cubic feet of solid radioactive waste. It is located between the "F" and "H" Separations facilities, in an area recently designated as "E" area. (Fig. 1) The current operating disposal area is a 254 m^2 (63 acre) tract, that is expected to be filled to capacity in September, 1992. Within E-Area, a contiguous 404.7 m^2 (100 acres) has been selected as the site for the new low-level radioactive disposal facility.

In 1984, the operating contractor initiated a project to develop the selected site for the expansion of the existing burial ground facility. The intent was to begin a combination of shallow land burial (SLB) and Greater Confinement Disposal (GCD). This new methodology was in response to the issuance of DOE Order 5820.2 and its intent to provide a greater degree of isolation for the waste forms disposed.

At the SRS, low-level waste is segregated into a high activity fraction ($>$200 mr/hr at contact) and a low activity fraction ($>$200 mr/hr at contact). The existing SLB operation consisted of placing the higher activity disposal shipments in slit trenches 6.1m (h) x 6.1m (w) [20 ft (h) x 20 ft (w)]. The lower activity shipments that could be contact handled were placed in larger "engineered low-level" trenches, (ELLT's). All waste to be disposed of in this facility is considered as "low level" (LLW) per NRC 10CFR61 classification.

The gross volume of waste generated at the SRS is approximately 1.4 million cubic feet per year of which 1.2 million is classified as "low activity". After some segregation and processing, the final disposal volume to the Low Activity Waste (LAW) unit is approximately nine hundred thousand cubic feet of waste for disposal. With trench disposal, the 100 acre site would have an expected capacity of at least twenty years.

The primary objective of this capitally funded project was: to ensure continuous disposal capacity, to prevent the possible disruption of waste producing activities, while providing maximum environmental protection. Project cost estimates were developed establishing a $14.5 million price tag. In 1987, guidance was issued stating that, "...for the Department's humid sites, including Savannah River and Oak Ridge, eliminating contact of untreated solid fission product and tritium waste with the soil environment will be necessary to ensure protection of the groundwater..." and "...the necessary degree of protection for a humid site can be provided by packaging solid LLW in durable concrete containers that provide a diffusion barrier for soluble radionuclides or emplacing the waste in concrete vaults." This new guidance initiated a design change eliminating all trench disposal. This redesign effort had to be performed on an expedited schedule in order to meet the expected need date as determined from the capacity of the existing facility. Considering the state of flux that the groundwater standards were in at the time, a best-guess estimate as to where the final standards would be set had to be made.

PERFORMANCE OBJECTIVES

The primary objective for this new facility is to: provide continuous waste disposal capacity for the SRS, to provide a disposal methodology that adheres to the guidance of the DOE and the associated applicable regulations (local, state, federal), and minimize the quantity of tritium and long-lived ($>$30 years) radionuclides disposed. Minimizing operational changes became an important and limiting factor due to time constraints. It is important to note that there are no local or state regulations for DOE operated radioactive waste disposal facilities.

The specific performance criteria, listed below, were taken from an Environmental Information Document (1) published in 1987:

"**Radioactivity in Groundwater** - The concentration of radionuclides in groundwater at the storage/disposal site boundary must not exceed those established in the EPA National Interim Primary Drinking Water Standard Regulations, 40CFR141 (1977).

Radiation Dose to Persons - The radiation dose to any member of the public due to releases of radioactivity in the groundwater, surface water, air, soil plants, etc., as given in DOE Order 5480.1A, must not be exceeded.

Minimum Depth Between Waste and Water Table - The minimum distance between the waste and the groundwater table shall be at least 10 feet. Knowledge of variations in water table level should be based on water table data for the site.

Distance Between Root Zone and Waste - The waste should be emplaced below the root zones of plants which are indigenous to the area. At SRS this criterion can be met by placement of waste at a minimum depth of 5 meters (16 feet). The intent of the criterion might also be achieved by other means (for example, root barriers), but such barriers would be subject to breaching at flaws.

Subsidence - Subsidence of waste and backfilled soil should be minimized to avoid undue maintenance of surface topography and to avoid enhanced water infiltration and potential unacceptable migration of radionuclides. To achieve this, wastes (or waste packages) must be physically stable and spaces between packages must be minimized or filled with compacted soil or other fill material.

Post Closure Control - It is assumed for the purpose of projecting radionuclide movement that institutional control shall be maintained for 100 years following site closure. During this period, it is assumed that the site will be well maintained to prevent surface erosion, intruder entry, etc."

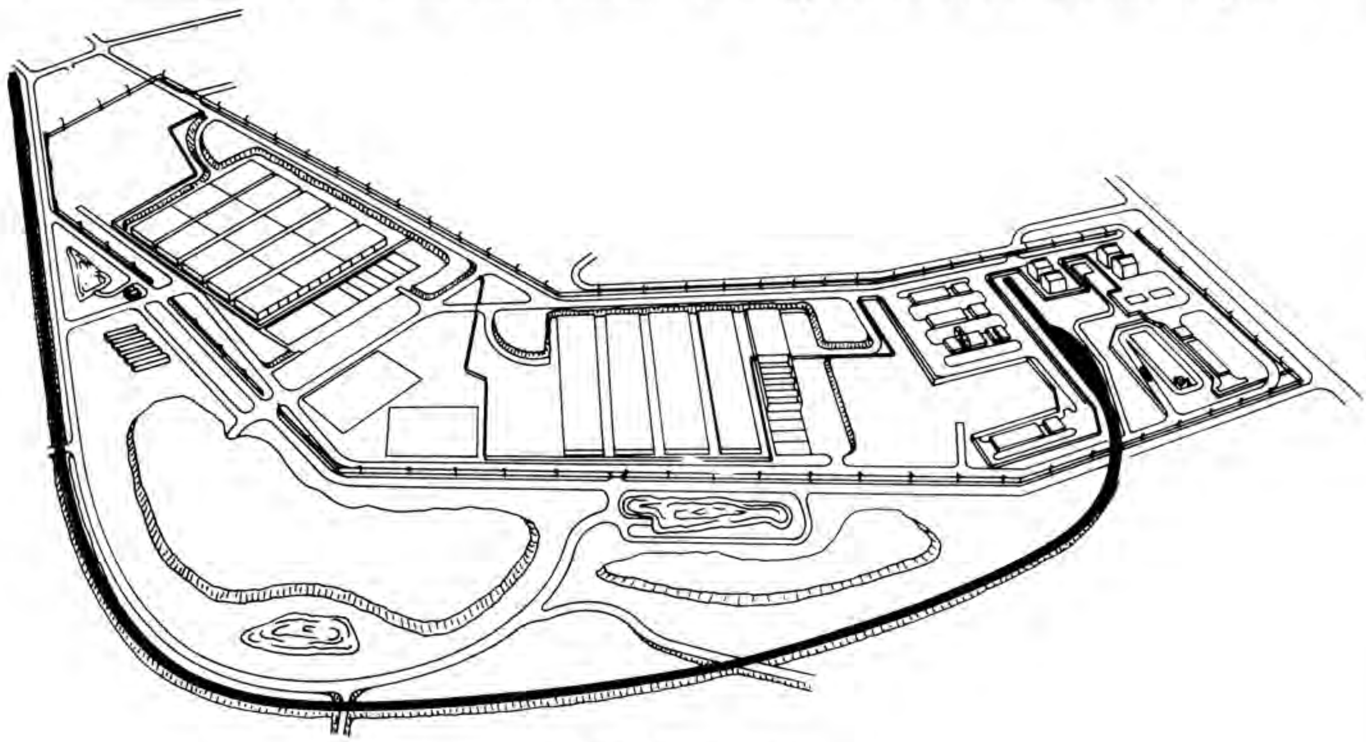

Fig. 1. Site layout.

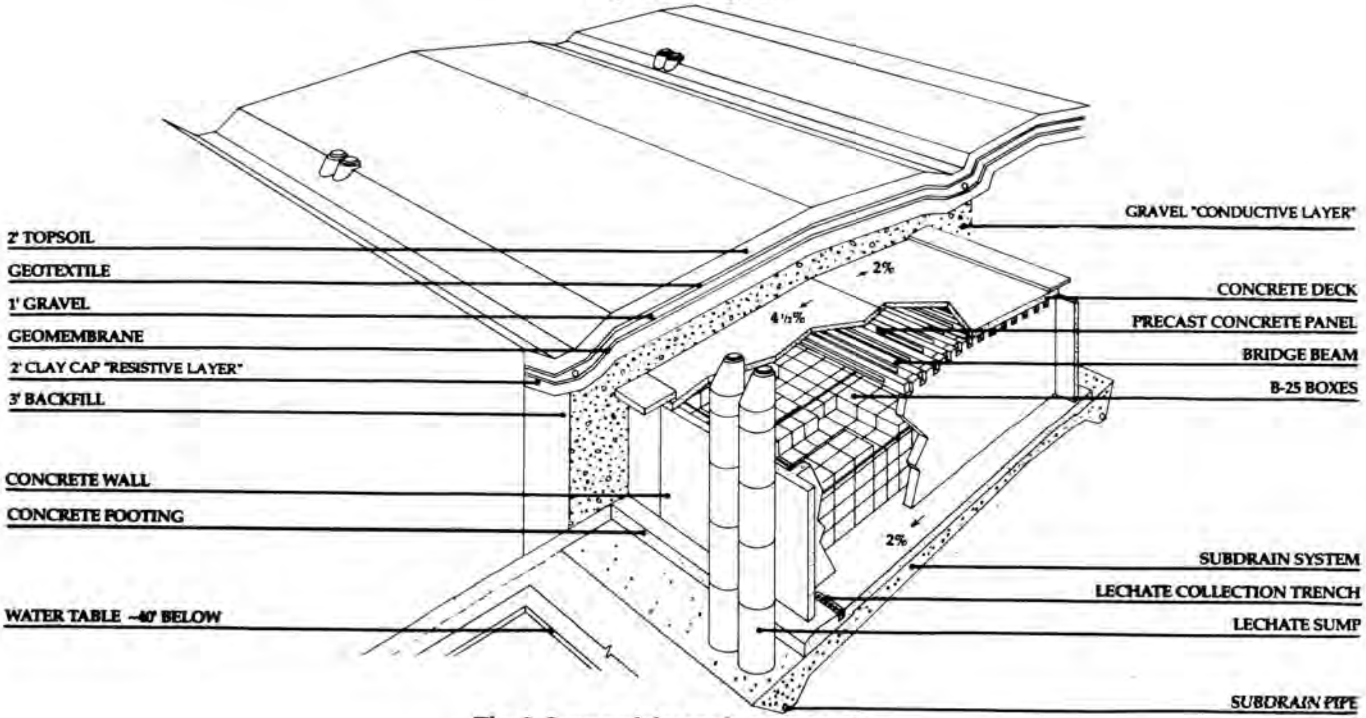

Fig. 2. Low activity vault cross section.

Several sites and various disposal alternatives were evaluated using this criteria as weighing factors. The disposal alternatives under consideration were combinations of above and below grade, engineered structures with and without concrete barriers, and also engineered modular containers. The disposal alternative chosen was below-grade concrete vaults with a combination of 'resistive and conductive layer barriers' (3) as will be described in detail. Figure 2 shows the typical features at final closure.

GENERAL FACILITY DESCRIPTIONS

Waste Classification

The classification system at SRS categorizes waste according to type and activity level shown in Table I. The disposal unit designs are based on the method of handling.

TABLE I

Waste Classification Descriptions

Waste Class	Dose Rate/Activity	Handling Method
Intermediate Activity (Tritium & Non)	>200 mrem/hr 10-100 nCi/gr α	Remote
Low Activity	<200 mrem/hr <10 nCi/gr α	Contact
Long-lived	Half life >30 yrs <100 nCi/gr α	Remote

Disposal Unit Design

For this project, there are three separate disposal units and one storage unit designed to correspond with the classification system. Those wasteforms containing long-lived radionuclides are not suitable for disposal at the SRS. These wasteforms are stored for later disposal at an appropriate repository. Further discussion of the storage facility will be excluded from this paper.

Specific design requirements for the concrete were to maximize durability and to minimize uncontrolled cracking. To meet this requirement, the units were designed with a specially formulated concrete mix with a unique blend of cement, blast furnace slag and pozzolan. This mix was selected from a series of mixes tested in a full-scale demonstration of workability, constructability, and early crack resistance. Descriptions of the individual units are as follows:

INTERMEDIATE LEVEL NONTRITIUM UNIT (ILNT) FIG. 3

The ILNT disposal unit is a below-grade concrete vault with dimensions: 57.6 m (189 ft) long by 14.8 m (48.5 ft) wide by 8.9 m (29.5 ft) high. The vault is divided into seven cells 7.6 m (25 ft) by 13.6 m (44.5 ft) separated by .5 m (1.5 ft) thick walls. Each cell is covered with steel raincovers to prevent the infiltration of rainwater. These units are designed with .5m (1.5 ft) thick concrete tees for shielding during operations. The exterior end walls are .7 m (2.5 ft) thick with side walls .6 m (2.0 ft). Total volume of the vault is approximately 5662 m^3 (200,000 ft^3) providing two years disposal capacity. This unit is top loaded using a gantry crane. There are fabric nets on the interior walls of each cell to 'wick' any infiltrating water towards a conductive gravel layer under to waste packages. This gravel layer drains the leachate collection system that will be monitored during operation and after closure. The unit is to be closed with a 1.2 m (4 ft) thick concrete cap for overburden support and intruder protection.

INTERMEDIATE LEVEL TRITIUM UNIT (ILT) FIG. 3

The design is very similar to the design of the ILNT vault with like raincovers, shielding tees, and leachate collection. The below-grade vault has dimensions 17.2 m (56.5 ft) long by 14.8 m (48.5 ft) wide by 8.9 m (29.5 ft) high. The vault is divided into two cells. One cell is grouted full with cylindrical

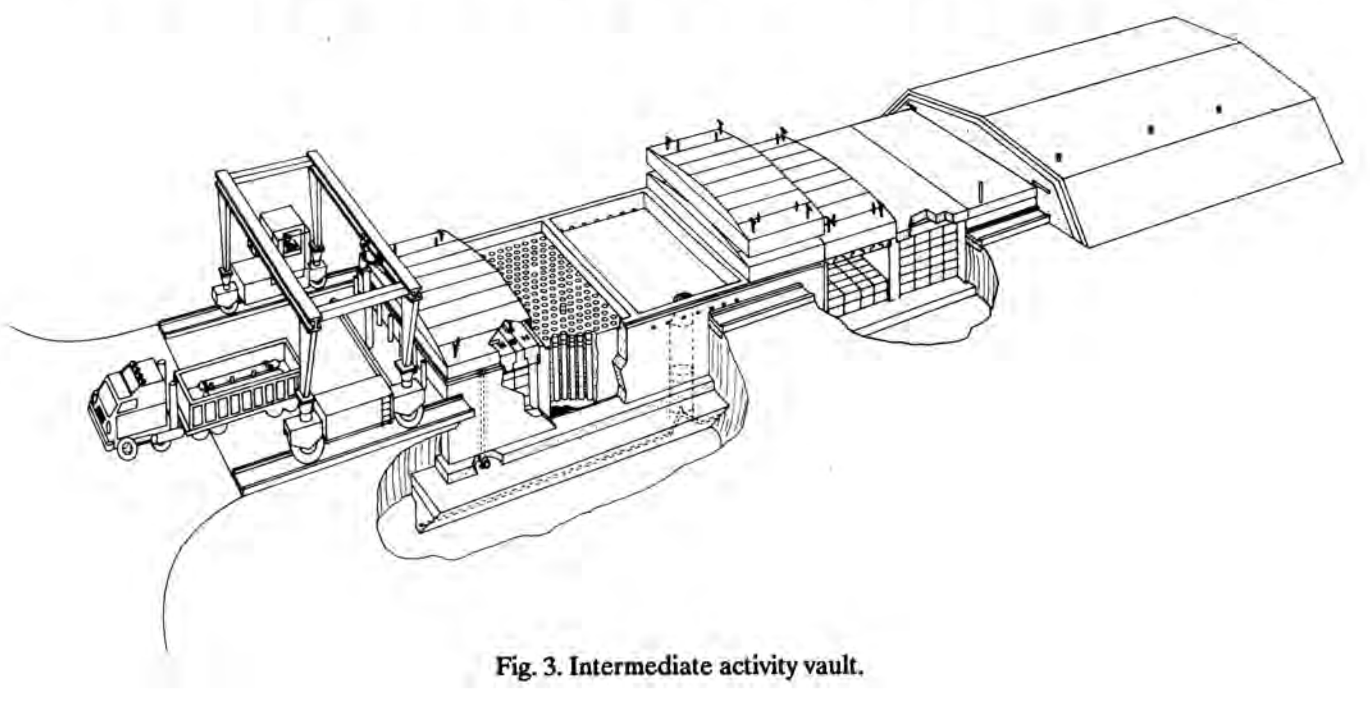

Fig. 3. Intermediate activity vault.

silo-type' void spaces for the disposal of tritium crucibles; the other cell is open. There is an upper layer of shielding concrete with cylindrical plugs for closure after the crucible emplacement. The ILT disposal vault is constructed in close proximity of the ILNT vault to facilitate the use of the same gantry. The total volume of the open cell is approximately 990.8 m^3 (35,000 ft^3); the waste packages are various sized steel boxes. The silo cell is designed to accommodate a fixed number of crucibles. The unit is to be closed with a 1.2 m (4 ft) thick concrete cap for overburden support and intruder protection.

LOW ACTIVITY WASTE UNIT (LAW) FIG. 4

The LAW disposal unit is operated as a partially subgrade vault that is side loaded using forklift trucks. The unit is constructed in three modules of four cells each. The overall structure is 196 m (643 ft) wide by 44.1 m (145 ft) long. There is approximately 7.6 m (25 ft) clear stacking height. Each cell is approximately 16.1 m (53 ft) clear span, supported by prestressed AASHTO highway bridge beams. The floor of each cell is sloped to a drainage trench that leads to a collection sump. There is one collection sump per two cells that will be monitored and sampled during operation and after closure. Expected general-use containers for this facility are: a 2.5 m^3 and, 1.3 m^3 steel boxes, and 208 liter (55 gallon) drums. Each cell is equipped with ventilation fans and overhead lighting that will be removed at closure. It has been concluded that the inclusion of fire suppression equipment is in direct conflict with the intent of these facilities - preventing the contact of waste and water. There has been no official DOE concurrence with this conclusion.

All units have an exterior surrounding 'conductive' layer (Fig. 4) of drainage gravel to 'wick' perched water to a non-monitored collection sump. All units are designed as 'strong' vaults, that is, the vault structure itself must provide the capability of supporting the overburden cover. This decision was made to provide long-term assurance of subsidence control. Subsidence has been found to increase the failure potential of conventional cover systems used in typical shallow land burial facilities without wasteform stabilization.

CONCLUSION

There is considerable evidence that shows this combination of a 'resistive' (compacted clay) layer along with a 'conductive' (capillary break) layer will significantly increase the transport times for those short half-life radionuclides usually associated with LLW. Performance assessments for the final design have not been completed. Prior to construction of subsequent disposal units studies will be initiated to investigate conditioning of the exterior environment immediately surrounding the structure as discussed by O'Donnell, OTT, et.al. (2) in a recent technical exchange. Other studies will be initiated to optimize performance capabilities as a result of the assessment and operational experiences.

ACKNOWLEDGEMENTS

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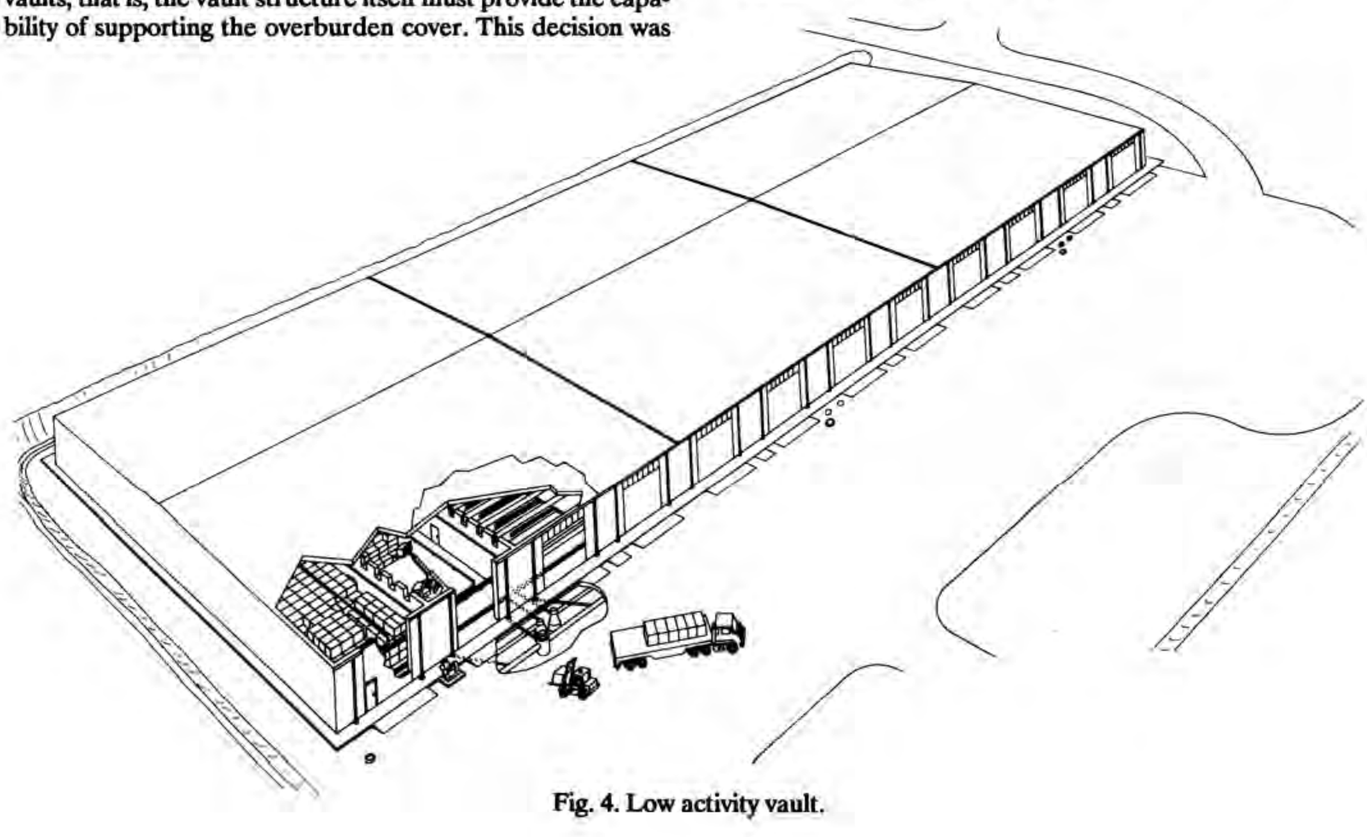

Fig. 4. Low activity vault.

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