A COMPARISON OF LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT ALTERNATIVES

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ABSTRACT

Low-level radioactive waste disposal and storage facilities, existing and modeled, are compared on the basis of land utilization, occupational radiological hazard, and cost.

INTRODUCTION

The selection of a low-level radioactive waste management alternative by a state or regional compact will be based on the ability of the alternative to meet the required performance objectives of 10 CFR Part 61 within the constraints of political acceptability, economic feasibility, and site-specific characteristics such as geology and hydrology. This paper presents an effort to organize available information for comparison of land utilization, occupational radiological hazard, and cost between and among conventional shallow land disposal facilities, disposal facilities which stabilize waste with grout, and storage facilities using engineered structures.

BASIS FOR COMPARISON

Land Utilization Factor

The Land Utilization Factor (LUF) is one measure of efficiency of an alternative to store or dispose of waste. The LUF is defined as the waste volume capacity of the facility divided by the minimum surface area requirement for the facility. For most cases, the minimum surface area requirement is taken to be the fenced property. The LUF can be used as a rule-of-thumb for estimating land need as a function of volume for a given alternative.

Specific Occupational Radiological Hazard

The Specific Occupational Radiological Hazard (SORH) is defined as the total occupational dose divided by the total volume of waste received. The SORH is a measure of the efficiency of a disposal or storage method to minimize worker exposure during waste emplacement. For comparison of tabulated values, the SORH has been plotted in Fig. 1 as a function of volume for different staffing levels assuming a dose per person of 5 rem per year.

Cost

Cost comparisons are the most difficult to justify because of the differences in local and national economies, waste volumes, licensing procedures, and variations and uncertainties present in economic models. A range of costs including these differences for each of the alternatives considered can, however, provide a rough cost estimate.

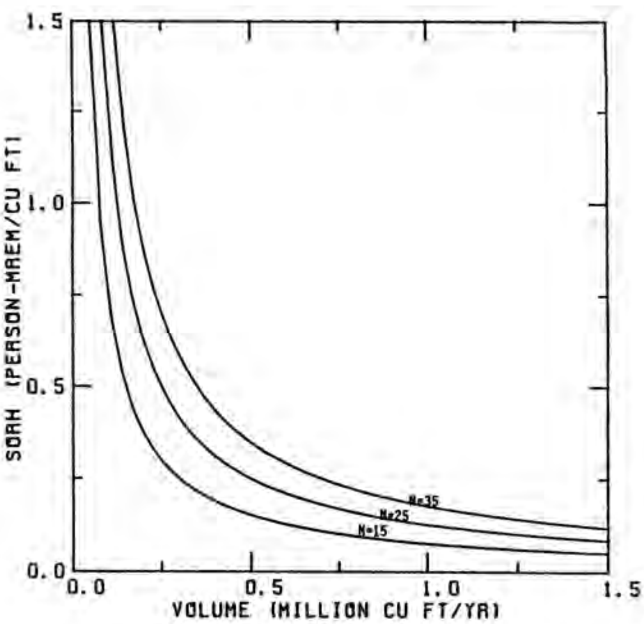

Fig. 1. SORH versus volume for N workers, each receiving 5 rem per year.

COMPARISONS AMONG ALTERNATIVES

Conventional Shallow Land Disposal

Conventional shallow land disposal is the permanent placement of both stable and unstable wastes in earth trenches up to 50 ft. deep. The existing and modeled facilities are assumed to operate within the limits of 10 CFR Part 61. TABLE I presents information on two existing and two modeled conventional shallow land disposal facilities, three of which are privately operated and handle large volumes. The higher LUF for the Richland site is due, in part, to the use of deeper trenches. The Richland facility also disposes of the largest volume of waste for the lowest SORH, although average occupational doses reported for the three sites were below 10 CFR Part 20 limits. The cost figures suggest a volume dependence and a significant tax contribution. The dramatic increases in disposal prices over the last 6 years (Fig. 2) by commercial shallow land burial facilities may imply that large volumes bring large expenses, or may just reflect the changing public awareness and regulatory climate.

TABLE I

A Comparison of Conventional Shallow Land Disposal Facilities

Facility	Annually Accepted Volume	LUF (ft^3/ft^2)	Number of Badged Workers	SORH (person-mrem/ft^3)	Pre-Tax Cost (1984 $/$ft^3$)	Total Cost (1984 $/$ft^3$)
Richland, Wash.	1,390,000[a]	7.0	23	0.015[b]	15.91[c]	21.76
Barnwell, S.C.	1,210,000[a]	3.8	35	0.036[b]	17.09[c]	21.50
NRC Part 61 Model[d]	1,150,000	3.8	50	0.093	19.70[e]	--
Texas Model[f]	133,000	1.3	12	--	31.83	--

(a) Based on a three-year (1982-1984) average.
(b) Ref. 1
(c) Base cost. Average cost to generators would be higher due to radiation and handling surcharges.
(d) Ref. 2
(e) Average cost is adjusted up from 1980 $ assuming a 5% annual inflation rate.
(f) Ref. 3 and 4.

Shallow Land Disposal Facilities Which Stabilize Waste With Grout

One improved shallow land disposal principle is to stabilize the waste in grout (or concrete), thus reducing subsidence and migration problems. Stabilization may be accomplished by first backfilling the waste container with grout and then placing the container in a trench, or by first placing the waste in the trench and then backfilling the trench with grout. Four models and one existing facility designed on this principle are compared in Table II. Of the five examples, the California model is considered to be an example of permanent, but not irreversible, waste disposal. The Texas and Maine models are state-operated facilities. At the Centre de la Manche site, stabilized waste is placed both below and above grade, resulting in the high LUF. The cost of the Centre de la Manche disposal activities, which appears low, is not calculated for the U.S. economy. If the cost data were scaled to include a 25% profit margin for the state-run sites, the figures would again suggest a volume dependence, especially in the case of the Maine model.

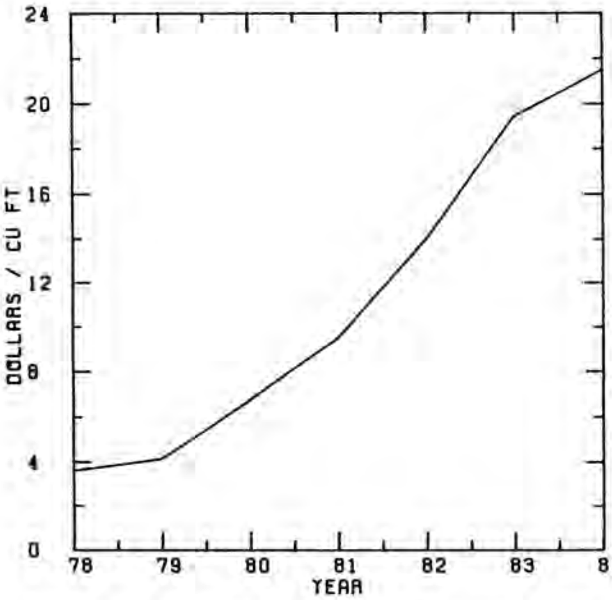

Fig. 2. Recent disposal price increases at a commercial low-level radioactive waste disposal facility.

Storage Facilities Which Use Engineered Structures

Storage of low-level radioactive waste in engineered structures is considered for three reasons: 1) it may be a necessary interim measure, 2) it may be politically acceptable, and 3) it may lead to a technically feasible disposal alternative. The storage facilities are compared in Table III. Both storage facilities are operated by a large electric power utility, and both are located on a nuclear power plant reservation. The BNPD Waste Operations has a relatively high LUF due to a net 3:1 volume reduction of accepted wastes and the use of above-ground concrete warehouses to hold lower-activity wastes. Again, the cost data indicates a volume dependence. If storage is an interim measure, the total occupational radiological hazard and total cost for one cubic foot of waste first stored and then disposed of may be several times the cost of direct disposal.

COMPARISON BETWEEN ALTERNATIVES

From the tables presented in this report, the following general comparisons between alternatives are made. First, among the three alternatives, conventional shallow land disposal is the least expensive means of waste management, but future concepts for stabilization of waste forms with grout do not appear to be substantially more expensive. Second, for smaller volume operations,the unit cost of disposal or storage increases . Third, the Centre de la Manche has the highest LUF, but the unit cost of achieving this in terms of the U.S. economy is unknown. Fourth, excluding transportation charges, storage appears to be as expensive as disposal. Should storage in engineered structures evolve into an acceptable disposal technology, additional cost factors such as siting and licensing would add to the unit costs presented here. Finally, although the Richland facility disposes of the greatest amount of waste at the lowest total occupational dose per cubic foot, reported and estimated average occupational doses are below the regulatory maximum.

TABLE II

A Comparison of Shallow Land Disposal Facilities Which Stabilize the Waste With Grout

Facility	Annually Accepted Volume (ft^3)	LUF (ft^3/ft^2)	Number of Badged Workers	SORH (person-mrem/ft^3)	Pre-Tax Cost (1984 $/$ft^3$)
NRC Concrete Trench Model[a]	1,140,000	2.9	120	0.15	27.68[b]
Centre de la Manche, France[c]	706,000	10	--	--	10-16
California Model[d]	441,000	1.7	--	--	36.42
Texas Model[e]	133,000	1.3	12	--	33.26
Maine 3-State Model[f]	30,000	0.95	12	--	53

(a) Ref. 2.
(b) Adjusted up from 1980 $ assuming a 5% annual inflation rate.
(c) Ref. 5.
(d) Ref. 6.
(e) Ref. 7.
(f) Ref. 8.

TABLE III

A Comparison of Storage Facilities Which Use Engineered Structures

Facility	Annually Accepted Volume (ft^3)	LUF (ft^3/ft^2)	Number of Badged Workers	SORH (person-mrem/ft^3)	Pre-Tax Cost (1984 $/$ft^3$)
BNPD Waste Operations, Canada[a]	150,000	5.7	40	0.080	16-32[b]
Sequoyah Waste Storage[c]	57,000	0.71	7	0.27	35+

(a) Ref. 9 and 10. Waste Volume Reduction Facility included in calculations.
(b) For storage in above-ground building and concrete trenches.
(c) Ref. 11.

FUTURE WORK

An organization of information on environmental radiological hazards and political attitudes for each of the alternatives is also underway. In addition, a final report will include mined caverns, hydrofracturing, and sea disposal as alternatives.

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