THE ECONOMIC IMPACT OF REGIONAL WASTE DISPOSAL ON ADVANCED VOLUME REDUCTION TECHNOLOGIES

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ABSTRACT

Waste volume reduction has received increased emphasis over the past decade as annual operating costs have risen from $250,000/year to $3,500,000 for 1983. Emphasis has been given to developing and designing into new nuclear plants process and DAW volume reduction technologies such as fluidized-bed dryers, incinerators, and evaporative-solidification systems. The basis for these systems was originally the correct perception that a crisis would be reached with the, then available, shallow land disposal sites which would increase costs substantially and possible jeopardize power plant operations. With the passage of the Low-Level Waste Policy Act of 1980 and increased emphasis on interim on-site storage of low-level waste, the "economics of volume reduction" are susceptible to increased uncertainties.

This paper reviews some previous volume reduction economic analyses and evaluates the revised economics based upon the development of regional waste disposal sites, improved waste generation and processing practices, and the increased use of interim on-site storage. Several case studies are presented.

INTRODUCTION AND BACKGROUND

Changes in Federal and State regulations, the current closing and restrictions at low-level radioactive waste burial sites, and large increases in radwaste disposal costs have significantly affected the processing, storage, and disposal of nuclear waste. This situation is not new but rather has been facing the nuclear industry for several years; many of the present problems were readily identifiable in the late 1970's.[1,2]

For the past decade, several equipment vendors and utilities have been in the forefront of improved waste treatment technologies, including the development of volume reduction technologies. Advances in volume reduction (VR) have involved modifications to existing systems and operations including:

- Increased management awareness
- Improved maintenance
- Segregation of waste inputs
- Improved operator training programs
- Improved filtration technologies
- High integrity containers

and the addition of new technologies and systems such as:

- Calcination/fluidized-bed drying
- Crystallization of concentrates
- Evaporation/solidification in asphalt
- Incineration of trash and resins
- Improved compaction of trash

The two major incentives for volume reduction are economics and regulatory criteria. These two incentives include a number of important considerations and are closely coupled. Because of changing regulatory criteria, the economics of previous practices or the use of previous practices may become economically regulatorily unattractive. With the increase in the number of nuclear plants, and consequently, the quantity of waste and the ever-increasing operating costs associated with waste management come under increased scrutiny and means of reducing these costs becomes more attractive.

In today's operations, the economics of waste disposal include:

- In-plant processing costs (includes maintenance)
  - Capital system cost
  - Personnel cost
  - Material cost
  - Energy cost
- Interim on-site storage costs
- Transportation cost (including cask charges)
- Disposal cost
  - Handling
  - Perpetual burial fees
  - Surcharges

In determining the potential role of VR in a radwaste management system, it is important to determine its cost/benefit ratio. In a 1976 study, the annual waste disposal costs for a PWR with deep bed condensate polishers indicated that the benefits of VR outweighed the costs by a factor of 2.5.[3]

Much of the benefit resulted from reduced transportation costs, and the fact that radiation surcharges only increased a factor of 2-3 for each factor of 10 increase in radiation level. Since 1976, disposal charges have increased by a factor of 8; transportation costs have doubled; and overall waste disposal costs have increased by a factor of about 5. Thus, it would appear prudent to explore volume reduction by not only reducing waste generation rates but also utilizing advanced treatment technologies, thus reducing overall costs and minimizing the impact of further disruptions at state burial sites.

Public Law 96-573, the Low-Level Radioactive Waste Policy Act of 1980, requires that states assume responsibility for the management of commercial low-level radioactive wastes generated within their borders and authorizes the formation of regional compacts among states to fulfill this responsibility in a cooperative manner. The Act encourages the future management of low-level waste on a regional basis, whether the regions that evolve consist of individual states acting independently or groups of states working together.

This regionalization has a number of effects on radwaste management practices. Among these, acceptable waste form, characterization, and classification, as well as transportation requirements and the ability to meet those requirements, are important considerations for states and regional compacts in the development of their waste management programs. Factors pertinent to the consideration of the effects of waste disposal include operational requirements and institutional issues.

It is against this backdrop that the uncertainties of waste disposal practices must be examined. In the 1970s, it appeared, and indeed has been proven, that disposal costs would skyrocket due to increases in transportation costs and decreases in disposal sites--both in number and in waste volume buried. Typical waste disposal costs have increased for a single unit PWR from $250,000 in 1976, to $510,000 in 1978, to nearly $3,500,000 for 1983. Thus, the potential for substantial VR retrofits appears to exist. However, a new question has surfaced--what happens if transportation distances are reduced from those required to reach Barnwell or Hanford to lesser distances for a state or regional compact disposal site. Further, the availability of disposal sites with no waste volume allocation program will reduce the continuing upward cost spiral increase from 40 percent annually to 5-10 percent.

VOLUME REDUCTION ECONOMICS

As indicated above, numerous items make up the cost equations for determining waste disposal costs. Based upon these factors, a VR system's performance, benefits, and economic analysis is determined by the following methodology:

- Evaluate process rates and VR factors
- Calculate annual waste disposal cost savings
- Evaluate impact of VR system on on-site storage building design
- Perform multi-year economic analysis
- Assess operating experience, economics, and licensing status

A critical element in this evaluation is the determination of the cost of the proposed VR system. Estimates are established which vary from a low value for an asphalt system retrofit at an operating BWR of $5.6 million (1982)[4] to tens of millions of dollars.

TVA, for its Brown's Ferry Station, expects to receive at least six bids on its RFP for an incinerator facility which is estimated to cost $48 million. Similarly, a fluidized-bed incinerator installation on the TVA Sequoia Nuclear Station is estimated to cost $40 million. This in in addition to an on-site low-level waste storage facility capable of waste storage for up to five years. The figures given are real costs which include cost of capital equipment, construction, and interest during construction. The question to be answered is whether or not expensive, advanced VR systems which have been evaluated on the conditions experienced before the passing of the Low-Level Radioactive Waste Policy Act can be justified when regional disposal facilities are available which will reduce transportation costs and possibly cause a leveling off or reduction in disposal costs.

RELATIVE COSTS OF TRANSPORTATION

Where low-level waste disposal sites are located directly affects transportation costs. The present status quo is three national disposal sites and no regional compacts among states. The alternative case investigated uses regions as they appeared to be aligning in late 1982.[5] We are usually very optimistic about how long it will take to license a facility. The licensing of the first regional compact disposal facility will tell us the real truth of how fast a facility can be licensed. In the status quo case, actual distances from a midwest utility to Barnwell and Hanford were utilized while the alternative case utilized a centroid estimate[6] with a disposal site located 300 miles from the plant.

Once disposal sites were evaluated, a number of estimates were made regarding shipment descriptions, volumes of waste shipped according to source type (Tables I and II), shipment patterns to existing disposal sites, and cost factors. These estimates were necessary because of the great variation in waste characteristics. Further complications in shipment descriptions were avoided by assuming that all shipments were made using exclusive-use trucks.

The cost factors used in the analysis are found in Table III. The factors can be grouped logically according to those shipments that require casks and those which do not. Costs vary according to distances shipped as well as days of travel since casks are generally leased on a per day basis. The combination of cask rental and trip distance costs yields the overall cost of transport.

TABLE I

Waste Generation Rate

Unsolidified Annual Volume
FT^3MWe/YR

	Liquid	Resin	Sludge	Trash	Total
BWR - Filter Demineralizer	0.4	0.9	9.6	7.2	18.1
BWR - Deep Bed	9.5	1.5	7.1	11.9	29.7
PWR	8.7	0.9	0.4	6.7	16.7

TABLE II

Solidified Waste Volume - BWR Deep Bed Plant

Agent	Annual Volume Ft^3/MWe/yr Liquid	Resin	Sludge	Total
Cement	15	2	10	27
Asphalt	5	1	4	10
Fluidized-bed dryer/Dow	4	0.5	2	6.5

Solidified Waste Volume - BWR Filter Demin. Plant

Agent	Annual Volume Ft^3/MWe/yr Liquid	Resin	Sludge	Total
Cement	0.5	1.5	13	15
Asphalt	0.05	0.5	5	5.6
Fluidized-bed dryer/Dow	0.04	0.3	2	2.3

Solidified Waste Volume - PWR

Agent	Annual Volume Ft^3/MWe/yr Liquid	Resin	Filters	Total
Cement	15	1.5	0.5	17
Asphalt	2	0.5	0.5	3
Fluidized-bed dryer/Dow	1.5	0.2	0.5	2.2

TABLE III

Cost Analysis Elements

Vehicle	Barnwell	Hanford	Regional
Unshielded van	$2,000	$5,300	$1,300
Shielded van	$3,000	$12,000	$2,200
Cask shipments	$40-$75 ft^3	$120-$250 ft^3	$30-$60 ft^3
Demurrage chgs.	$200/ shipment	$400/ shipment	-0-
Disposal Costs	$/$ft^3$	$/$ft^3$	$/$ft^3$
0-0.2 R/hr	$16.08	$17.00	--
12 R/hr	65.79	41.80	--
50 R/hr	104.31	71.27	--
1,000 R/hr	618.59	335.56	--

The results of the analysis cases in actual magnitude of each cost is less important than the relative magnitudes for each case. After reviewing the results and considering the uncertainties of estimates inherent in this evaluation, it is possible to state with confidence that the results of the alternative cases are significantly different from the status quo case.

It appears that almost any compact binding states into cooperating regions for waste disposal will reduce transportation costs markedly--a two to five fold reduction.

Demand for transportation services and equipment in going from present practices to the regional concept is expected to be reduced as a result of the shipping distance reduction. Reduced distances and shorter trip durations decrease the amount of transportation hardware required for a given quantity of material to be shipped. If the waste transportation systems were currently operating at full utilization, the shift from national to regional disposal sites could accommodate a significant increase in the number of shipments without development of a new capability. Since the industrial capacity in the U.S. for either manufacturing required casks or transport systems, or supplying the needed transport services far exceeds the requirements for transporting wastes, the shift from national to regional sites is not expected to reduce or improve the ability to complete these shipments even though cost pressure may decrease.

RELATIVE COST OF DISPOSAL

While disposal costs at existing disposal sites are readily available (data in Table III is effective January 17, 1983), reliable estimates for new regional or state facilities are minimal. Present Barnwell charges include a disposal charge of $13.20/ft^3; a radiation surcharge ranging from $5/ft^3 (50 mR) to $400/ft^3 (1,000+ R); a weight surcharge, a curie surcharge; a cask handling fee; a perpetuity charge; and 2.4 percent Barnwell County Business License Tax. At Hanford, a disposal charge, and a radiation and weight surcharge per liner is charged. Estimates in a recent EPRI study present disposal costs for a facility disposing of 14,000 m^3 (493,000 ft^3) of low-level waste per year at $7.57/ft^3 (1980).[7] If the facility would bury 2,830 m^3 (100,000 ft^3), costs approaching $30/ft^3 could be expected. These estimates are based upon the models developed in the EIS for 10CFR61 and do not directly address a charge system such as that which has evolved at Barnwell.

For a single state facility such as that proposed for Texas, cost estimates have ranged from $20-$105/ft^3 with an annual waste disposal of 2,830 M^3 (100,000 ft^3). It is apparent that the fixed operating costs, including:

- amortization of preoperating costs
- direct operating costs
- payments for post-operating costs
- return to investors
- income taxes

must be recovered regardless of the waste volume disposed. Thus, effective VR will reduce waste transportation costs but may only slightly decrease disposal costs since disposal rates must increase as waste volume decreases, especially if the disposal facility is operating below its rated capacity.

SUMMARY

If advanced waste volume reduction systems have costs in the tens of millions of dollars and regional disposal sites become available, previous analyses justifying these systems must be carefully reexamined to ensure the economic viability of the decision, especially when transportation costs are reduced by a factor of 2-5 and where disposal cost may rise as waste volume buried decreases.

This presumes that regulatory criteria do not require advanced, and expensive, VR systems. Indeed, a utility should emphasize waste reduction at the source, and simple, inexpensive VR systems such as improved drum and box compactors. It has always been our contention that significant VR can be obtained by "tightening up" the plant, developing an adequate water management program, and training personnel to implement the program. These are first steps. The purpose of this paper has been to make us all aware that regional compacts do change the waste transportation and disposal picture.

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