COST, RISK, BENEFIT STUDY FOR SELECTION OF RADIOACTIVE WASTE VOLUME REDUCTION SYSTEMS AT TVA NUCLEAR POWER PLANTS

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ABSTRACT

Due to recent changes in the burial ground pricing structure, advances in radwaste technology, and the enactment of the Low-Level Waste Policy Act, TVA saw a need to reevaluate its goal of seeking self-sufficiency through onsite storage and volume reduction (VR). Using a computer code developed by EPRA, TVA performed a comprehensive cost-benefit study to evaluate all available alternatives. Based on TVA's current perception that the near term risk at the burial ground is minimal, a radwaste management plan has been recommended that provides significant VR, requires minimal capital expenditures, and has a positive cost benefit. The projects include liquid radwaste treatment system improvements, dry active waste (DAW) compaction improvements, and volume reducing solidification systems at all plants.

INTRODUCTION

VR plans for TVA's Browns Ferry, Sequoyah, and Watts Bar nuclear plants were initiated in January 1980 because of a severe curtailment of available offsite disposal sapce. The apparent uncertainity in future availability of disposal space at that time prompted TVA to seek self-sufficiency through onsite storage and incineration. A number of changes have occurred since then which have significantly altered the need and cost justification for the comprehensive VR systems orginally planned. Listed below are some of the changes which have occurred in the past three years and an explanation of the effect they have had on VR economics.

A. Changes in the pricing structure at Barnwell over the last several years have resulted in large increases in the dose rate and activity surcharges. Since VR concentrates the radioactivity, the change in price structure results in less reduction in overall disposal charges.

B. It has been determined that TVA can modify the existing liquid radwaste systems at Sequoyah, Watts Bar, and Browns Ferry to significantly reduce the radwaste output.

C. The emerging technology of supercompaction now provides an alternative to incineration which has much lower capital costs and reduces environmental impacts.

D. The emerging technology of mobile incinerators and volume reducing solidification systems provides maximum VR capability with much lower captial costs than permanent systems requiring a new building.

E. The enactment of the Low-Level Waste Policy Act and the ensuing establishment of regional compacts for low-level waste disposal led TVA in June 1982 to change its onsite storage policy and support the States in their waste management efforts.

The combination of these changes led TVA in February 1983 to question the continuing cost effectiveness of the planned VR systems for Sequoyah and Watts Bar. Therefore, a study was performed to determine the most cost effective approach. The study for Sequoyah Nuclear Plant is presented in detail.

SCOPE

The scope of the study was to evaluate the capital and operating costs, the environmental risks, and the VR benefits of state of the art VR technologies as they would apply to TVA's nuclear plants. VR technologies evaluated include compaction, incineration, liquid drying and solidification, resin solidification, dewatering, chemical oxidation, and drying.

Capital costs were order of magnitude (+30%) estimates performed by the TVA staff. VR ststem performance was determined by TVA working in conjunction with Burns and Roe, Incorporated, and the Analytical Science Corporation (TASC). Burns and Roe performed an independent review of all perforamnce data used in the evaluation. The actual calculations were performed by TASC using a computer code VRTECH that was recently developed for EPRI.

Due to the potential impact on decision making, the scope of the study included sensitivity studies on the economic scenario used. The economic scenarios evaluated are as follows:

Table I

Economic Scenario Elements

ESCALATION SCENARIOS			
ITEM	LOW	MEDIUM	HIGH
Burial (Until 1986)	10%	15%	25%
Burial (1986 Onwards)	6%	10%	15%
Transport	7%	8%	9%
Other	5.5%	6%	6.5%

COST OF MONEY	
SCENARIO	COST OF MONEY
Low	9%
Medium:	12%
High:	15%

Other sensitivity evaluations included in the scope of the study are PVC content of DAW, curie content of the waste streams, and performance of some of the VR alternatives.

STUDY BASIS

The study is based on plant specific waste volumes as follows:

TABLE II

Sequoyah Waste Streams

Waste Streams	Annual Volume
CVCS resins	600 ft^3 per year
Radwaste resins	600 ft^3 per year
Boric acid: 25 wt%	3,800 ft^3 per year
Sodium sulfate: 50 wt%	4,600 ft^3 per year
DAW (7^3 lbs/ft -12,000 Btu-hr/lb)	26,000 ft^3 per year
Noncompactible trash (32 lbs/ft^3)	
(a) Combustible (9,000 Btu-hr/lb)	2,813 ft^3 per year
(b) Noncombustible	4,687 ft^3 per year

SEQUOYAH NUCLEAR PLANT EVALUATION

Current plant radwaste operations are relatively simple. Compactible DAW is compacted using a standard drum compactor. Nomcompatible DAW is packaged in 103 ft^3 metal boxes. These operations are performed in an exisitng building that was originally designed for solidification operations using a vermiculite absorption process. The building is approximately 78' long by 40' wide. It contains a shielded drum storage area, a 6 ton crane, and has access to the truck bay. Thus, it is ideal for retrofitting a colume reducing solidification system. Current solidification operations are performed by a service contractor using cement and large liners for evaporator concentrates. Resins are dewatered in high integrity containers (HICs).

The basis of comparison for the VR alternatives is the present value of operating costs using current plant operations less the operating costs using proposed VR technologies. This number is considered the maximum justifiable cash expenditure for the technology as it represents the "break even" point for like of plant oepration. An example of the computer output for the Sequoyah evaluation is shown on Table III.

The format shoun in Table III allows us to determine the relative cost-benefit of each technology by waste stream. This is very important when evaluating systems that utilize combinations of equipment. Using this approach, an optimum combination of equipment can be identified.

Life of plant operation cost sensitivity to the economic scenario used is illustrated on Table IV for the shredder-compactor/extruder-evaporator system. This shows how the economic scenario used affects the final costs. TVA decisions are based on a 15 percent discount rate and the medium escalation rates.

Figure 1 provides a summary of the evaluate capital costs, life of plant operating costs, and annual waste volumes produced for each alternative studied. It should be noted that in cases 5, 6, 8, and 9, the waste streams not handled by that alternative remains the same as in the base case.

CONCLUSIONS

1. An incinerator or supercompactor installed in a new building is not justified due to the high cost of the building.

2. VR can be provided that requires a minimal capital investment and has a positive cost benefit. This can be accomplished as follows:

   (a) Volume reducing solididfication system retrofit (in waste packaging building).

   Capital cost = \$5.4 M per plant (purchased), \$2.4 M per plant (leased)

   *Net cost savings = \$7.3 M per plant

   VR = \$14,654 ft^3 per year

   (b) Shredder - Compactor

   Capital cost = \$ 0.1 M per plant

   Net cost savings = \$0.8 M per plant

   VR = 3,600 ft^3 per year

Similar recommendations apply to Watts Bar and Bellefonte nuclear plants due to their similarity in waste generated and availability of exisitng building space.

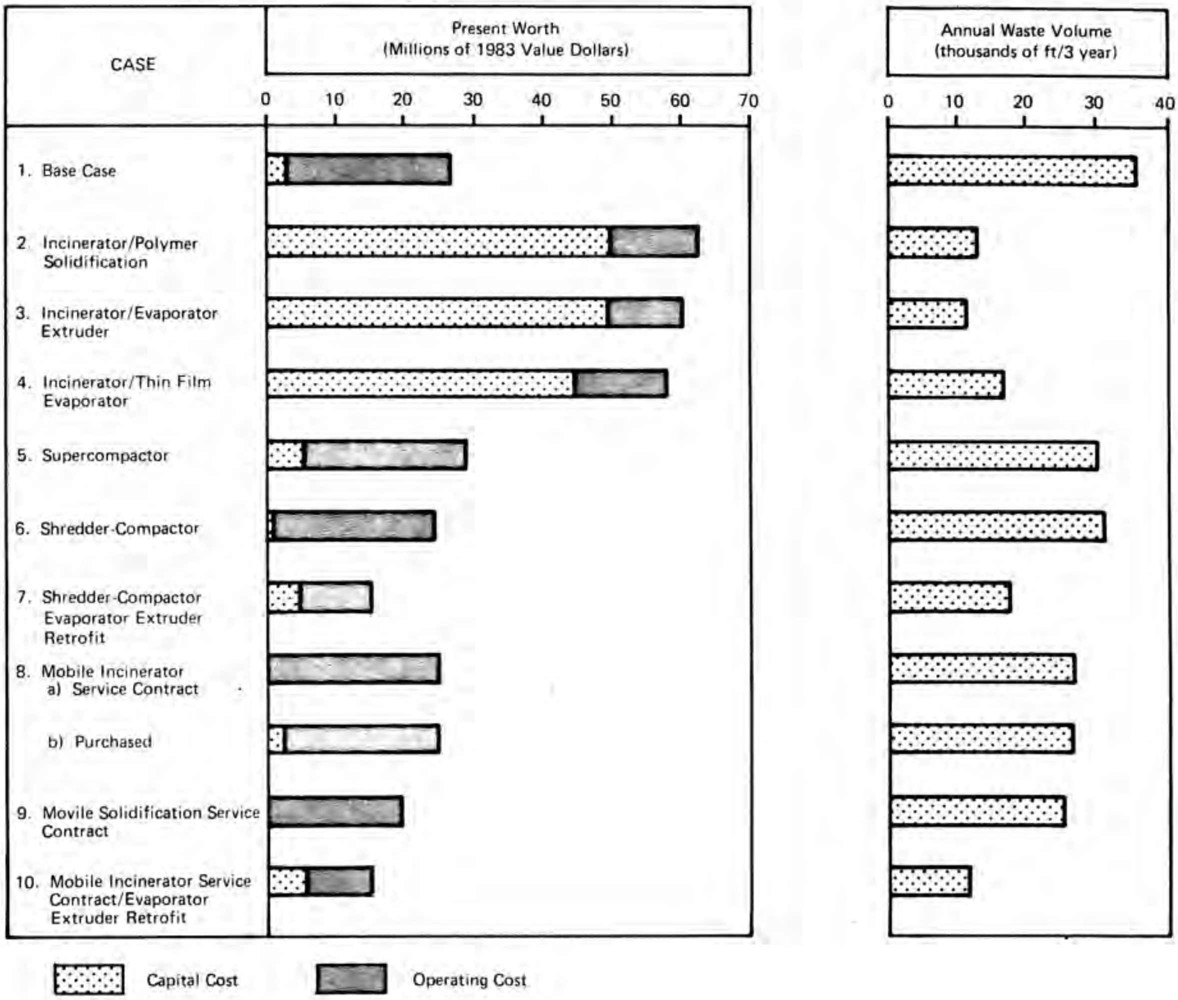

FIG. 1 Sequoyah VR Cost Benefit

TABLE III

Shredder-Compactor/Extruder-Evaporator System

AVE. ESCALATION RATES - BOOK LIFE = 25 YEARS
COST OF MONEY = 15%
PRESENT-VALUE COSTS IN 1983 DOLLARS - 25 OPERATIONAL YEAR(S)

ESCALATION FOR VR/SOLIDIFICTION = 0.060
ESCALATION FOR STORAGE = 0.000
ESCALATION FOR TRANSPORATION = 0.080
ESCALATION FOR BURIAL BEFORE 1986 = 0.150
ESCALATION FOR BURIAL AFTER 1986 = 0.100

OPERATION	COTRASH	CVCSRESIN	SULFATE	BORIC	RAD RESIN	NCTR/CMB	NCTR/NCMB	SUBTOTALS
Chemical additives	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Containers	1.17E+05	6.85E+03	7.16E+04	3.09E+04	6.85E+03	5.79E+04	1.86E+05	4.77E+05
Solidifying Agents	0.00E+00	8.16E+03	8.54E+04	3.68E+04	8.16E+03	0.00E+00	0.00E+00	1.38E+05
Utilities	1.11E+03	6.50E+02	6.81E+03	2.93E+03	6.50E+02	5.50E+02	0.00E+00	1.27E+04
Transportation	2.40E+04	5.75E+05	3.68E+04	6.24E+04	4.09E+03	1.44E+04	2.40E+04	7.40E+05
Burial	1.06E+06	9.87E+05	1.10E+06	4.83E+05	1.06E+05	5.27E+05	1.56E+06	5.82E+06
Miscellaneous	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Operation Labor	********	********	********	********	********	********	********	7.89E+05
Maintenance	********	********	********	********	********	********	********	2.88E+06
SUBTOTALS	1.21E+06	1.58E+06	1.30E+06	6.16E+05	1.26E+05	6.00E+05	1.77E+06	1.08E+07
SAVINGS	6.11E+05	5.13E+05	6.62E+06	5.30E+06	3.44E+05	4.74E+05	0.00E+00	1.39E+07
VOLUME (FT**3)	4.56E+03	3.23E+02	3.38E+03	1.46E+03	3.23E+02	2.26E+03	5.77E+03	1.81E+04

TABLE IV

Shredder-Compactor/Extruder-Evaporator Sensitivty

		Discount Rate		
		9%	12%	15%
Escalation Rate	Low	$\$1.74 \times 10^7$	$\$1.17 \times 10^7$	$\$8.13 \times 10^6$
	Medium	$\$2.44 \times 10^7$	$\$1.59 \times 10^7$	$\$1.08 \times 10^7$
	High	$\$4.56 \times 10^7$	$\$2.83 \times 10^7$	$\$1.83 \times 10^7$

3. The recommendations for Browns Ferry (a 3-unit General Electric BWR) are different from the other plants die to differences in waste volume and the lack of existing building space for a solidification system. Browns Ferry recommendations are are follows:

   (a) Etched disc filter retrofit

   Capital cost = $1.3 M

   Net cost savings = $62.6 M

   Volume reduction + 14,310 ft^3 per year

   (b) Supercompactor retrofit (in evaporator building)

   Capital cost = $3.65 M

   Net cost savings = $0.75 M

   Volume reduction = 17,950 ft^3 per year

   (c) Mobile volume reducing solidification system

   Capital cost = $4.5 M (purchased), $1.0 M (leased)

   Net cost savings = $21.6 M

   Volume reduction = 11,920 ft^3 per year

4. With all projects implemented, the following costs and benefits would be realized:

   Total capital cost = $26.3 M (all solidification systems purchased), $13.8 M (all leased)

   Total net cost savings =$137 M

   Total volume reduction = 100,000 ft^3 per year

   Total plant waste shipped = 94,000 ft^3 per year