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CF-55-6-152

Subject Category: PHYSICS

UNITED STATES ATOMIC ENERGY COMMISSION

ECONOMIC REQUIREMENTS FOR RADIOACTIVE
WASTE DISPOSAL IN A NUCLEAR POWER
ECONOMY

By
H. R. Zeitlin

June 9, 1955

Oak Ridge National Laboratory
Oak Ridge, Tennessee

Technical Information Extension, Oak Ridge, Tennessee

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Printed in USA, Price 15 cents. Available from the Office of Technical Services, Department of Commerce, Washington 25, D. C.

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ECONOMIC REQUIREMENTS FOR RADIOACTIVE WASTE DISPOSAL IN A
NUCLEAR POWER ECONOMY

By H. R. Zeitlin

June 9, 1955

Work performed under Contract No. W-7405-Eng-26

OAK RIDGE NATIONAL LABORATORY
Operated by
Carbide and Carbon Chemicals Company
Post Office Box P
Oak Ridge, Tennessee

1.0 ABSTRACT AND SUMMARY

1/ An attempt has been made to define the limits on the tolerable cost per initial gallon of liquid radiochemical process waste as a function of 1) reactor operating and design characteristics, 2) the radiochemical separations process employed and 3) the fraction of 8 mill/kwhr power which is allocated to the disposal of wastes. The allowable cost of waste disposal for the case in which the reactor burnup is 5,000 MWD (heat)/ton, the processing waste volume 1200 gals/ton, and the allocated cost for waste disposal 2% (or 0.16 mills/kwhr_e) is \$4/gallon. $\frac{1}{1}$ ∞ 8

2.0 PURPOSE AND RESULTS OF STUDY

Ultimate disposal of radioactive liquid wastes, particularly those resulting from the processing of spent reactor fuels, has in the past appeared to be a problem, the solution of which would place a significant economic burden on a future nuclear power economy. Waste disposal costs of the order of one dollar per initial gallon of liquid wastes resulting from the standard solvent extraction separations processes seemed to be an upper limit to what can be allowed for the ultimate disposal of these wastes. These cost limits do hold for certain reactor-processing complexes, but are for the most part not in accord with the characteristics of the contemplated nuclear power economy.

It is the purpose of this memo to indicate what the allowable cost limits are in the more general case, the one in which the pertinent reactor-processing-cost variables are taken into consideration.

In Figures 1 through 6 is plotted the allowable disposal cost per initial gallon of waste as a function of the burnup of the spent reactor fuel that is being processed, the parameters being the gallons of radioactive waste resulting from the process per ton of spent reactor fuel and the fraction of the cost of 8 mill/kwhr_e allocated to disposal of these liquid wastes. (See Table I for the range of the variables employed.)

It should be noted that these six curves were derived using values of the variables which are representative of the reactor and processing characteristics now being proposed for an economic (low enrichment) nuclear power economy. A similar curve (for only one value of fraction of power cost allocated to waste disposal) using values of the variables representative of a premium power (high enrichment) economy is plotted in Figure 7.

It can be seen that allowable costs for waste disposal can vary from \$0.80 to \$80.00 per gallon for a low enrichment economic nuclear power economy and from \$.08 to \$4.80 for a high enrichment power economy, depending on the reactor and process characteristics and on the fraction of the total cost of power allocated to waste disposal.

It should be noted that although both high and low activity wastes result from processing of reactor fuels, and low activity wastes will presumably be cheaper to dispose of, no differentiation was made in Figures 1 through 6. Therefore, on the assumption that one-fourth of the allocated portion of the total power cost went for low activity disposal, another series of curves shown in Figure 8, was determined to indicate the allowable cost of disposing of low activity wastes.

3.0 CONCLUSIONS

The areas shown shaded in Figures 1 through 6 probably well represent an average of the operating characteristics of reactors and chemical processes that will exist in a low enrichment economic nuclear power economy. From these areas, it can be seen that as the allocated portion of the total power cost varies from 1% to 10% (i.e., 0.08 $\frac{\text{mills}}{\text{kwhr}_e}$ to 0.80 $\frac{\text{mills}}{\text{kwhr}_e}$) the allowable cost for waste disposal will vary between \$1.60 and \$64.00.

Since there are many areas in the economic picture of nuclear power which may be in error to three or more percent, an allocated cost for waste disposal of three percent does not appear unreasonable. Therefore, a cost range of \$5.00 to \$20.00 per gallon of initial high activity waste may be a better basis to use in determining the direction which waste disposal research and development should follow.

In conclusion it is obvious that to reduce the stringent economic requirements dictated to the disposers of radioactive wastes (i.e. geologists, biologists, oceanographers, sanitary engineers, designers of tanks, pits, and fancy gadgets for treatment of wastes, etc.) it is necessary to design reactors with ever increasing processing cycle times and design chemical processes with ever decreasing volumes of wastes per unit weight of reactor fuel processed.

Table 1
Range of Variables

<u>Variable</u>	<u>Range</u>
Burnup: Low enrichment (economic power)	1000 to 10000 MWD/ton
High enrichment (premium power)	0.20 to 0.50 MWD/gm U ²³⁵ *
Processing Waste Volumes:	
Low enrichment: High activity	600 to 2400 gals/ton
Low activity	300 to 1200 gals/ton
High enrichment: High activity	
Al elements	0.05 to 0.30 gals/gm U ²³⁵ *
Zr elements	0.5 to 1.5 gals/gm U ²³⁵
S.S. elements	0.05 to 0.30 gals/gm U ²³⁵
Low activity	0.2 to 0.6 gals/gm U ²³⁵
Fraction of Power Cost Allocated to Waste Disposal	1% to 10% (0.08 to 0.8 $\frac{\text{mills}}{\text{kwhr}_e}$) ⁺
Reactor Thermal Efficiency = 25%	

*Grams of U²³⁵ as charged to the reactor.

⁺Based on a total power cost of 8 $\frac{\text{mills}}{\text{kwhr}_e}$.

Fig. 1 Allowable Waste Disposal Cost As A
Function of Burnup and Process Waste Volume

Fig. 2 Allowable Waste Disposal Cost As A
Function of Burnup and Process Waste Volume

Fig. 3 Allowable Waste Disposal Cost As A
Function of Burnup and Process Waste Volume

Fig. 4 Allowable Waste Disposal Cost As A
Function of Burnup and Process Waste Volume

Fig. 5 Allowable Waste Disposal Cost As A
Function of Burnup and Process Waste Volume

Fig. 6 Allowable Waste Disposal Cost As A Function of Burnup and Process Waste Volume

Burnup, MWD (Heat)/gm U as Charged to Reactor

Fig. 7. Allowable Waste Disposal Cost for,
Highly Enriched (Premium Power) Reactors

Fig. 8 Allowable Low Activity Waste Disposal Cost
As A Function of Burnup and Process Waste Volume