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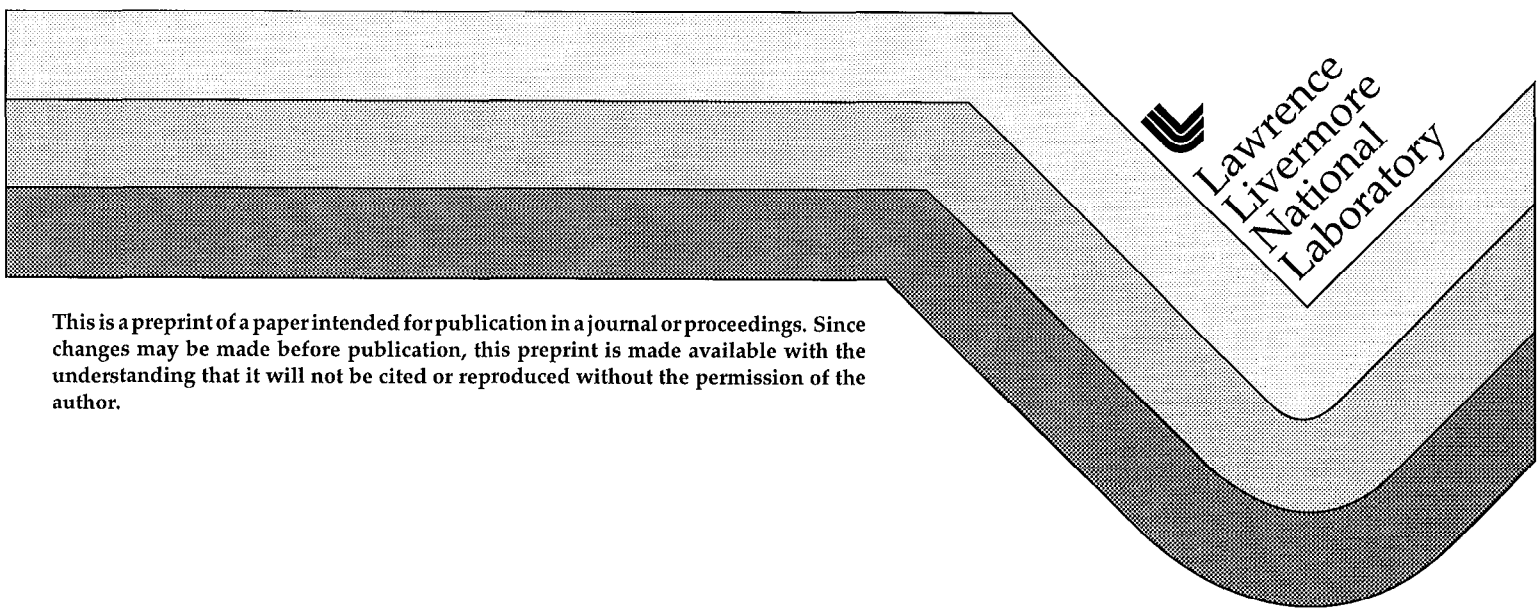

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The Cost Consideration in Closing the Nuclear Fuel Cycle

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Introduction

This study evaluates the economic aspect of closing the nuclear fuel cycle. It compares the fuel cycle costs of the direct disposal and the "self-generated recycle[1]" fuel cycles to determine the justifiable fuel-reprocessing costs. Previous fuel cycle cost studies[2] cited the low natural uranium prices, due to soft demand, as the reason for low incentive of fuel reprocessing. This study calculated fuel-reprocessing costs as functions of the spent-fuel disposal costs and the natural uranium prices to illustrate that spent-fuel disposal economics could also play an important role in fuel reprocessing and the closing of the nuclear fuel cycle.

Evaluation

We calculated the break-even cost of fuel reprocessing, defined as the cost which results in zero benefit (or penalty) from reprocessing, i.e., the cost of the reprocessing/recycling fuel cycle becomes identical to the cost of the direct-disposal fuel cycle. The calculated break-even fuel reprocessing costs as functions of spent-fuel disposal costs (in mill/kWh) and varying natural uranium (yellow-cake) prices (in US$/lb.) are shown in Figure 1. The calculations assumed a utility financing structure of a 50/50 debt-to-equity ratio, with a real interest on debt of 4% and a real after-tax return on equity of 8%. Unit costs for other fuel-cycle expenditures are assumed fix to those values indicated in Figure 1. For a spot yellow-cake price of US$12 per pound and a spent-fuel disposal fee of 1 mill/kWh, Figure 1 shows a break-even fuel reprocessing cost of US$200 per kgHM, a cost many times lower than what is perceived to be paid by the Japanese utilities for reprocessing their spent fuel abroad. For a fuel reprocessing cost of US$2000 per kgHM[3] and a yellow-cake price of US$12 per pound, the cost of spent-fuel disposal in a geologic repository would have to be as high as 6.1 mills/kWh, a fee much more than the 1 mill/kWh now paid by the US utilities to the USDOE for disposing their spent LWR fuel.

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Despite the high cost of fuel reprocessing, Japan and other European countries maintain the closure of the nuclear fuel cycle with fuel reprocessing as their national nuclear energy policies. Because the total fuel cost is relatively small for nuclear electricity generation, a doubling in fuel reprocessing cost would only result in a small percentage of increase in the overall bus-bar cost of electricity. In addition, the fuel reprocessing costs could be assigned as part of the environmental abatement cost, since by fuel reprocessing, the long-term environmental impacts exerted by spent fuel disposal could be lessened. However, in the United States, the incentive for spent-fuel reprocessing is much less, due not only to the low yellow-cake prices, but also to the low spent-fuel disposal fee currently charged to the US utilities. This fee, at 1 mill/kWh as authorized by the Nuclear Waste Policy Act (NWPA) of 1982, is so low that fuel reprocessing cost would have to be in the range of US$200 per kgHM (at yellow-cake of US$12 per pound) before the reprocessing fuel cycle could break-even with the direct-disposal fuel cycle. Although one may argue whether the total waste fund collected by the 1 mill/kWh fee could ultimately be sufficient to pay for spent-fuel disposal, it is still one of the main reason why fuel reprocessing is not economically viable in the United States.

We also examined the cost trends in fuel reprocessing as the costs of other fuel-cycle expenditures varied. We found that the costs of MOx fuel fabrication and disposal of the high-level reprocessed wastes are very important in the consideration of spent-fuel reprocessing.

Conclusion

The break-even fuel reprocessing costs estimated here are subject to considerable uncertainties. These include future uranium supply, regulation and licensing uncertainties, the maturity of the fuel-reprocessing and MOx fuel fabrication technologies, and constraints from domestic and international safeguards. Any one of these uncertainties could affect the economics of fuel reprocessing.

This study indicates that the incentive for spent-fuel reprocessing depends strongly on the costs of spent-fuel disposal. Fuel reprocessing would not be justifiable if 'spent-fuel disposal cost is kept low (as in the US). Also, to close the nuclear fuel cycle with fuel reprocessing, the costs of MOx fuel fabrication would have to be less, or the uranium price more, than those currently anticipated.

References

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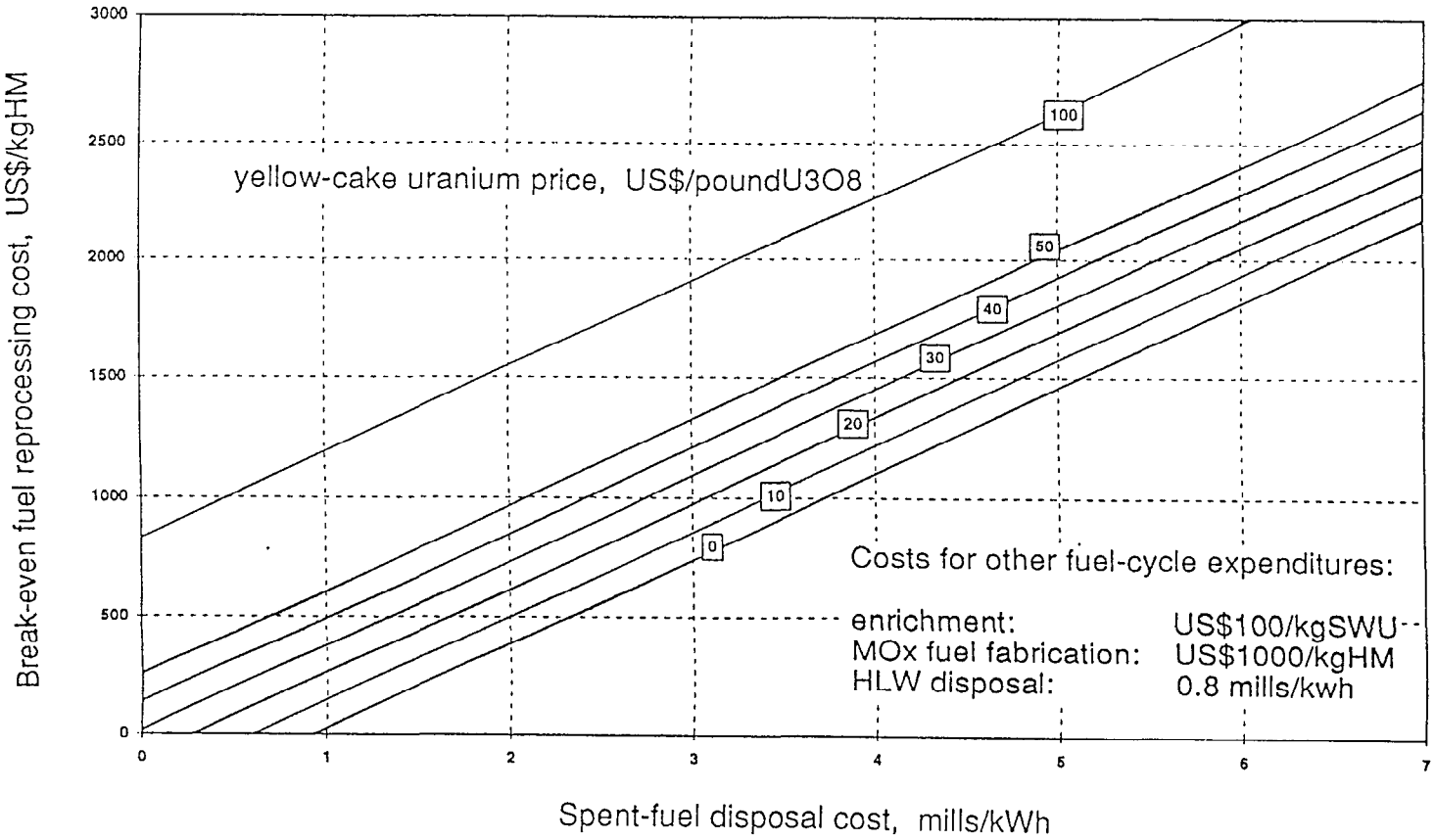

Figure 1 Break-even fuel reprocessing costs as functions of spent-fuel disposal cost and yellow-cake uranium proces (Calculated by equating the direct-disposal fuel cycle and the self-generated U-Pu recycle)

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