LETTERS TO THE EDITOR

COMMENTS ON "ECONOMIC ALTERNATIVES FOR THE LONG-TERM USE OF PLUTONIUM PRODUCED IN LIGHT WATER REACTORS"

With reference to the paper by Hnilica et al.,[1] I take a more pragmatic approach to the question of whether plutonium should be recycled in water reactors or held for possible use in fast breeder reactors (FBRs). First, one should note that the relative costs or values depend on the particular combination of unit prices assumed. The cost set shown in Table III is subject to considerable variation and appears already to be outdated in some respects as far as U.S. prices are concerned. Incidentally, I cannot speak intelligently about the situation in Europe and shall confine my remarks to the domestic U.S. reactor market.

I shall start with essentially the same premises, basically that

1. Plutonium is better used in FBRs than in light water reactors (LWRs).
2. There is an economic incentive for prompt recycle of self-generated plutonium in LWRs, rather than discard. I accept this as one of the conclusions of the reference article. If the cost of recovering spent uranium and plutonium proves to be more expensive than the value of the recovered material, then obviously the "throw-away" cycle seems indicated at the outset. I see no merit in the speculation that plutonium or other materials might be stored in hopes that potential inflation might enhance its value.
3. Plutonium can be assigned a value of zero.

If one accepts these premises, it seems obvious that new breeder reactors will obtain their initial fuel preferably from the current production of operating reactors, either excess bred fuel from older FBRs or from LWRs, and only to the extent that such sources are inadequate would it be necessary to draw on stored plutonium. I am inclined to believe that any reasonable growth pattern for the installation of FBRs can be accommodated by current production of plutonium from then existing reactors. If this is true, then one can justify prompt recycling of all plutonium until breeder reactors appear on the scene. To be sure, there may be some price negotiations for specific batches of plutonium, but this would not really change the relative amount of plutonium recycled, which would be much the same as if a single entity owned all reactors and fuel and material transfers were made internally to optimize performance but with no accompanying cash transfers.

To test my thesis, I have examined U.S. Energy Research and Development Administration (ERDA) data developed in February 1975 in connection with an unpublished update of WASH 1139 (74) (Ref. 2). ERDA considers four forecast cases with different growth rates. The pertinent data are summarized in Table I.

For each forecast the current year production of plutonium is more than adequate to supply the plutonium inventory requirement for new FBRs until beyond 2000. It must be acknowledged that this result is partly linked to the fact that the FBR component in the ERDA forecasts is constrained to about 10% of total installed nuclear capacity by 2000, but there is really little likelihood that the 10% figure will be exceeded by 2000. Furthermore, if plutonium is recycled in LWRs in accordance with the ERDA forecast schedules, the amount of fissile plutonium recovered from existing reactors would be even higher (by 13 to 16% for the year 2000 for the four ERDA projections).

Yes, perhaps sometime after 2000 one might want to expand the FBR population faster than would be possible if limited solely to the current year plutonium production from existing reactors, and storage for a few years might be justified. But, although the principles expounded in the paper[1] may be sound, an attempt to project economic factors—or even reactor characteristics—to that time period seems quite futile. For the

TABLE I
Plutonium Supply and Demand

Year	Total Installed Nuclear GW(e)	New FBR Additional GW(e)	Annual 10^3 kg Plutonium (f)	
			Recovered	Used in Breeder Fuel
High Growth Case (75% c.f.)				
1990	417	0.8	54.5	0.9
1995	790	6.3	96.6	34.1
2000	1250	39.0	196.2	187.2
Moderate Growth (high) (72% c.f.)				
1990	387	0.8	43.4	0.9
1995	642	4.6	75.1	25.3
2000	1002	31.0	153.1	143.3
Moderate Growth (low) (70% c.f.)				
1990	342	0.8	37.7	0.9
1995	547	4.0	64.0	22.9
2000	802	23.0	125.6	105.0
Low Growth Case (70% c.f.)				
1990	287	0.8	33.5	0.9
1995	447	3.0	53.3	19.1
2000	627	15.0	101.5	70.8

immediate future, there seem to be no reasons to consider storage of plutonium for later use in FBRs as an economic alternative to prompt recycle of plutonium in LWRs.

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REFERENCES

1. K. HNILICA, H. P. HOLLEY, K. LAHNER, and H. SCHMALE, "Economic Alternatives for the Long-Term Use of Plutonium Produced in Light Water Reactors," *Nucl. Technol.*, **31**, 53 (1976).

2. "Nuclear Power Growth 1974-2000," WASH 1139 (74), U.S. Atomic Energy Commission (Feb. 1974).

REPLY TO "COMMENTS ON 'ECONOMIC ALTERNATIVES FOR THE LONG-TERM USE OF PLUTONIUM PRODUCED IN LIGHT WATER REACTORS' "

My opinion about a possible limited stockpiling of plutonium is completely different from that of Ott.[1]

Ott starts in his conclusions from an "intact nuclear scene." Unfortunately, this intact scene exists neither in Western Europe nor in the U.S. It is a matter of fact that today and for the near future in all countries of the western world, the fuel cycles of light water reactors (LWRs) and fast breeder reactors (FBRs) are not closed. Having this in mind, every speculation based only on mass balances and growth rates seems rather academic. It might be, and probably everybody working in the nuclear field hopes, that in the mid-1990's the situation for utilizing plutonium will be as simple as Ott has outlined, but presently and probably also for the near future (1976 until the end of 1980), the situation is rather complex and uncertain. Any utility that has to decide what to do with the forthcoming plutonium has to understand the following facts besides the economic demands:

1. As a result of the worldwide and long-term lack of reprocessing capacity for irradiated LWR fuel in Western Europe, only a fraction of the continually predicted (in literature) quantities of plutonium will be ready for utilization. In Western Europe, for example, we expect by 1985 4000 tons of irradiated fuel, but less than half of that can be reprocessed in the existing and planned reprocessing plants of the United Reprocessors GmbH, and this prediction seems in the face of the activities of the different powerful environmental groups more than optimistic. In the U.S. the situation is similar, if not worse.

2. As a consequence of this development, the different utilities in Western Europe and the U.S. build compact storage racks in their LWRs to enlarge the capacity in the existing and planned spent fuel pools. Presently they intend to store the irradiated fuel until the mid-1980's. This means that until this point in time, there is no plutonium available from this stored LWR fuel. Considering the stockpiling of plutonium, the enlarged capacity of spent fuel pools brings a new aspect into the stockpiling scene, because in this case there are no additional charges for stockpiling the plutonium.

3. If utilities decide to recycle as much plutonium as they get (a) from the existing and working reprocessing plants and (b) from stores of partly unknown size, they are immediately faced with another problem. For instance, it is very difficult to get reprocessing agreements for the irradiated Pu/U fuel in the near future; the situation experienced in Europe so far is not very stimulating.

4. Utilities with FBRs have, because of reasons pointed out in items 1 and 2 above, difficulties in getting the necessary plutonium. [They need 2.6 tons Pu_{fis} for one 1000-MW(e) FBR.] In addition, the first FBRs do not have the expected high breeding factors, and the large-scale reprocessing of FBR fuel is still unresolved.

5. As far as I know, there still exists in the U.S. much confusion and uncertainty about the licensing of plutonium recycling in LWRs. The major U.S. activity on the plutonium recycling field is "waiting" for a decision by the U.S. Nuclear Regulatory Commission on commercial recycling, to be made hopefully in 1977.

6. The tremendous increasing charges for U_3O_8 and separation work in the last few years have allowed the practically "worthless" plutonium to become a more and more "valuable" fission material. This fact is one of the present contradictions in connection with the use of plutonium, but plutonium gets its "value" only in closed fuel cycles.

And now the conclusion: In front of this background, there exist for several utilities the following alternatives:

a. recycling the plutonium in LWRs and putting up with all the possible risks and uncertainties

b. stockpiling the plutonium over a limited period for the later use in FBRs or so-called plutonium burners.

It was one of the purposes of the published work[2] in *Nuclear Technology* to show that stockpiling of plutonium over limited periods can be economically attractive, contrary to the usual published meaning of other authors in the past. Certainly I agree with these authors that stockpiling of plutonium is not the general solution, avoiding all the problems; in particular, the contrary is true, because the less plutonium that is recycled, the less experience is gained for fabrication and handling. But on the other hand, as practice shows, there are several utilities that are, for different reasons (essentially presented in the foregoing points 1 through 6), seriously interested in stockpiling plutonium. For these utilities, the general statement that stockpiling is economically unattractive is wrong, because in every single case the special situation of the utility has to be considered.

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