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GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

March 11, 1963

TITLE

THE EFFECT OF HIGH EXPOSURE ON PROMETHEAN EFFICIENCY

AUTHOR

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IRRADIATION PROCESSING DEPARTMENT

March 11, 1963

L. W. Lang, Principal Engineer
Reactor Process
MANUFACTURING SECTION

THE EFFECT OF HIGH EXPOSURE ON PRODUCTION EFFICIENCY

At your request, we have estimated the effects on production efficiency of raising the plutonium product specification. As you specified in your request, the various cases have been considered using a pH of 6.6 at all reactors. In addition to this, the following estimates and assumptions have been used:

1. Failure rates will vary with the fifth power of exposure and directly with fuel throughput. This assumption is based on the types of failures that have been observed over the years and not on groove corrosion-induced failures. This model is not applicable to the latter failures. However, it is believed that with the lower pH, a negligible number of these groove corrosion failures is expected; viz, recent K reactor experience at low pH. The low pH is also estimated to reduce by a factor of two the frequency of failures caused by temperature-dependent aluminum removal; i.e., hot-spot failures etc.
2. Charge-discharge losses will be proportional to throughput.
3. Throughput will vary inversely with exposure.
4. The failure rates of the K5 self-support fuel are unknown, but are assumed equal to present K4 rates.

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5. Exposure for various specifications are shown below:

Per Cent Pu-240	MWD/T	
	Natural	Enriched
6.0	625	800
7.0	725	965
7.5	820	1050
8.0	890	1140

6. Product specification changes will have no other effect on production efficiency.

The effect of these assumptions on reactor production efficiency is given in Table 1.

TABLE 1

THE EFFECT OF PRODUCT SPECIFICATION CHANGES
ON PRODUCTION EFFICIENCY

Per Cent Pu-240	Reactor	pH	Relative Loss		P.E. Cost			P.E. Charge
			Ruptures	C-D	Ruptures	C-D	Total	
6.0	Old	7.0	1.00	1.00	.024	.064	.088	(.010)
	K	6.6	1.00	1.00	.004	.077	.081	.000
6.0	Old	6.6	.50	1.00	.012	.064	.078	Base
	K	6.6	1.00	1.00	.004	.077	.081	Base
7.0	Old	6.6	1.07	.83	.025	.053	.078	.000
	K	6.6	2.13	.83	.009	.064	.073	.008
7.5	Old	6.6	1.48	.76	.035	.049	.084	(.006)
	K	6.6	2.96	.76	.012	.059	.071	.010
8.0	Old	6.6	2.06	.70	.049	.045	.094	(.016)
	K	6.6	4.13	.70	.017	.054	.071	.010

Lowering the pH at the old reactors will improve their efficiency, neglecting tube losses, about one per cent. Changing the product specification at the low pH will probably increase the production efficiency at the K reactors by about one per cent. Changing the product specification will not affect the efficiency of the old reactors unless the specification is raised above seven per cent, in which case a reduction in efficiency of up to one-and-a-half per cent might be expected.

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Power levels, even with the eight per cent specification, will probably not be failure limited. The rupture loss of 4.9 per cent predicted for old reactors at the eight per cent specification is very nearly limiting, and indeed might be considered unacceptably high by Manufacturing. This problem could be alleviated by the following: (1) exposure adjustment to more nearly balance losses between reactor types and (2) use of more bumper fuel in old reactors. The latter would not be profitable unless bumper charge-discharge rates are considerably improved.

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