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HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

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December 2, 1963

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MONTHLY TECHNICAL REPORT
NOVEMBER, 1963

Reactor Physics

AUTHOR

Paul F. Nichols
and
Reactor Physics Staff

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6 pages.

MONTHLY TECHNICAL REPORT
NOVEMBER, 1963

Reactor Physics
Research and Engineering
N-REACTOR DEPARTMENT

Classification Cancelled and Changed To

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By Authority of CA-PR-2
DS Lewis, 4-4-94.
By Jessie Mally, 4-7-94.
Verified By J.E. Savely, 4-8-94

Paul F. Nichols
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Reactor Physics Staff

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MONTHLY TECHNICAL REPORT
NOVEMBER, 1963

Reactor Physics

I. FISSION PRODUCTS IN FUEL DISCHARGED FROM ZERO POWER STARTUP

A small portion of the initial critical fuel loading will be discharged after some "zero power" physics tests. Some fuel elements may be recoverable. Rejected elements are to be reprocessed either through normal spent fuel processing or directly through the original supplier (National Lead). The decision depends upon fission product content. The fission product content and radiation intensity has been estimated for various fuels as requested by the Chemistry and Metallurgy Subsection.

II. PRIMARY WATER FLOW CONTROL (ORIFICING)

Calculations of flux flattening with a cylindrical model are being used to obtain preliminary values of relative tube power for purposes of establishing possible orificing patterns. It has been proposed that slab calculation be used for this purpose instead since significant errors can occur at large "radii" in cylindrical calculations. It is of course recognized that the corner effects are not entirely adequately covered in the slab method either. Slab flux curves are being generated for the Reactor Engineering Subsection.

III. LATTICE PARAMETER AND SPECTRAL INDEX EXPERIMENTS

A document has been published (HW-79237) which describes in detail the lattice parameter and spectral index experiments which have been planned for the N-Reactor startup program.

The status of hardware and progress of Hanford Laboratories personnel is summarized in Table I.

A supplementary work order for \$2,500 has been written for additional assembly work. Unexpected difficulties were encountered in attaching support hardware to the aluminum cladding. Some specially sized tubing was destroyed in fuel element assembly tests and must be replaced.

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TABLE I

SPECIAL FUEL ELEMENT FABRICATION PROGRESS

<u>Item</u>	<u>Cost Estimate</u>	<u>Work Orders To Date</u>	<u>Percent Completion</u>	<u>Completion Date (Actual or Estimated)</u>
<u>COLD TEST</u>	\$8960-Total	\$8510-Total		December 1, 1963
Design			99%	December 1, 1963
Fuel Machining	4500	4500	95%	November 22, 1963
Canning	2000	3250	50%	December 1, 1963
Clad - outside vendor	1500	Not required - local supply		
Radio Activant Procurement	(HL)	-	90%	November 21, 1963
Graphite	(300)			
Nickel F.P. Catchers	(0)	~760	100%	
Water Pin Holders	(660)	Cancelled	-	
<u>HOT TEST</u>	\$7840-Total	\$7750-Total		
Design	-	-	99%	December 7, 1963
Fuel Drilling)	(5500)	5500	89%	November 22, 1963
Fuel Machining)	(1000)	2250	50%	December 7, 1963
Canning				
Radio Activant Procurement	(HL)	-	90%	November 21, 1963
Water Pin Holders	(1340)	Cancelled	-	-
Miscellaneous	-	-	-	-
<u>TOTALS</u>	\$16,800	\$16,260		

[REDACTED]

A special irradiation of radioactivants to be used in N startup experiments has been made in the PCTR by Hanford Laboratories personnel. Radiation measurements on the sample fuel elements verify earlier predictions of the irradiation levels estimated for the startup experiments. The required total exposure at startup can now be set precisely.

IV. TECHNICAL BASES

Every effort is being made to complete a rough draft of the first issue of technical bases for total control and speed-of-control by the end of November. Heat transfer coefficients are being calculated with FLEX 2 for the conditions of normal startup, hot startup after scram, and equilibrium operation.

V. STARTUP REVIEW

1. Migration Area Determinations

The migration area of N-Reactor is a function of the shape of the system and the directional void content or directional migration areas. Differences in the directional values are expected due to differences in directional void content and will be approximately 5 to 10% according to Behren's theory. The anticipated uncertainty in bucklings inferred from flux traverses is $\sim \pm 5\mu b$ or $\sim \pm 10\%$ in the transverse directions. This value in turn induces approximately a $\pm 15\%$ uncertainty in the transverse migration areas. Hence it is not expected that differences in directional migration area will be distinguishable. Since these "rough" results are not encouraging a more precise error estimate is being obtained. This work employs IBM 7090 codes GLEX, COFIT, and HFN. Familiarity with these codes has been achieved, necessary programming has been completed (GLEX) and initial runs are in progress.

2. Corner Reflectors

It has been proposed (R. E. Heineman, Hanford Laboratories) that the reflector savings of corner reflectors be inferred from reactivity experiments in which the corners were poisoned. Reactivities would be inferred from period measurements before and after poisoning. This experiment was excluded from initial plans on the basis that a satisfactory poisoning method was not feasible. It is possible to obtain some measure of the worth of the corner reflectors by using the water in non-fueled columns

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as a statistical weight probe. The worth of the loss of one column of water in a side reflector of the small critical would yield a reactivity increase of approximately 0.06 mk (0.1 μ b); a readily measureable quantity. Similarly, the worth of water in one or all corners could be measured. These two worth measurements can then be related to the total worth of the side reflector and hence the corner reflector. One group calculations indicate the worth of water in all columns of a side reflector is 10% of the total reflector worth.

As a result of this preliminary analysis, a corner reflector measurement has been proposed to Process Physics personnel. We understand that this request will be included in detailed plans.

VI. SINGLE TUBE FUEL ELEMENT STUDY

The single tube survey study has been completed and a rough draft of a report on the results has been prepared. The results of the study indicate that probably the most restrictive parameter of the single tube fuel is its high fuel temperature. For a single tube without flow spacer, this parameter limits the fuel weight to about 11 lb/ft even if a maximum uranium temperature of 550°C is assumed tolerable. Introduction of a canned void flow spacer into the single tube improves the conditions considerably, and fuel weights of 19-20 lb/ft may be attained before the maximum uranium temperature of 550°C is exceeded in a central tube. However, the Pu production rate is still lower than in the present standard tube-in-tube fuel element.

Indications are that one would achieve the goal of higher Pu production and still remain below 550°C in fuel temperature with a single fuel tube surrounding a depleted uranium target rod. This was the only type of arrangement found in the study which satisfied both criteria.

VII. Re¹⁸⁷ PRODUCTION STUDY

Estimates were made of the fractional conversion of W (tungsten) to Re¹⁸⁷ (rhenium) upon irradiation under N-Reactor conditions. It was assumed that the only significant contribution to Re¹⁸⁷ formation is from neutron capture by W¹⁸⁶.

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Thermal cross sections of 32b and 66b were used for W^{186} and Re^{187} respectively. The equations for the decay scheme were solved for Re^{187} and Os^{188} concentrations as a function of exposure, ϕt . The Re^{187} yield is fairly small; at a ϕt corresponding to one year's irradiation in N-Reactor at normal flux, the amount of Re^{187} present is about 3% of the initial W^{186} . The Os^{188} content at that time is $\sim 0.75\%$ of the initial W^{186} . Assuming a flux trap with flux higher by a factor of 3, these numbers become $\sim 7.0\%$ for the Re^{187} and $\sim 1.5\%$ for the Os^{188} .

VIII. COMPUTER CODE DEVELOPMENT

There are some indications now that FLEX 3 will be available in about one month. The higher plutonium isotopes are incorporated in FLEX 3 and will make possible calculations of fuel cycles utilizing Pu with the FLEX code.

Cases involving heavy water cooling and moderation are giving some difficulty. There is apparently trouble with convergence because of the apparent extreme interdependence of D_2O physical temperature and the spatial distribution of the Maxwellian flux.

IX. CONSULTATION SERVICES

Arrangements have been completed for the visit of P. R. Pluta to Hanford from November 18 - 22, 1963. Dr. Pluta is employed at APED in San Jose, and will supply us with consultation services concerning the utility of noise measurements and/or rod oscillator measurements to obtain such reactor characteristics as transfer function, ratio of neutron lifetime to delayed fraction, etc.

X. REPORTS

- HW-79525, "Kinetics Studies in Support of N-Reactor Startup Hazards Analysis," R. V. Poe, October 30, 1963.
- HW-79526, "Monthly Technical Report - October, 1963 - Reactor Physics," P. F. Nichols and Reactor Physics Staff, November 1, 1963.
- HW-79237, "N-Reactor Startup Lattice Parameter and Spectral Index Experiments," R. A. Bennett, November 1, 1963.
- HW-79680, "Fuel Element Design for Co-product Pilot Load," R. J. Shields, November 11, 1963.

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