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DATE

April 4, 1963

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

TITLE

PITA IP-22, SUP I
E-N DEMONSTRATION LOAD

AUTHOR

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PITA IP 22, SUP I
E-N DEMONSTRATION LOAD

April 4, 1963

OBJECTIVE

The purpose of this supplement is to permit the charging of the fourth E-N demonstration loading at H Reactor; modifications in the charge makeup and the loading pattern, designed to improve the conversion ratio and to advantageously re-shape the longitudinal flux pattern, are recommended. These gains are available through utilization of the small surplus of excess reactivity, over operating requirements, in the present (third) core.

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BASIS AND JUSTIFICATION

Three cycles of the E-N demonstration program have been essentially completed with no deviation from the planned performance or detrimental effects on production efficiency.^{1,2/} The first two loads were authorized under a Production Test IP-22,^{3,4/} and the third load under a Process Improvement Transition Authorization.^{5/} It was expected that the E-N loading would assume the status of a normal loading pattern at the end of the third load; however, experience has indicated that over-all efficiency may be improved by productively utilizing the small surplus of excess reactivity available in the third core. Thus a further modification of the load appears feasible at this time, rather than an unqualified adoption of the present loading pattern. The changes in the charge makeup and loading pattern, as recommended in this supplement, are presented as the next step in optimizing the E-N program.

DISCUSSION

The production in the E-N loading consists of the Pu-239 formed in the uranium and the tritium formed in the lithium-aluminum(N) pieces. By placing the Li-Al closer to the center of the reactor two things may be accomplished; 1) the N pieces will be in a higher average flux and hence absorb a greater fraction of the pile neutrons, thus increasing the conversion ratio (in atom-equivalent grams per MWD), and 2) the front-to-rear flux distribution may be flattened or otherwise be shaped more efficiently. This increased average flux in the N pieces is accompanied by a decrease in pile reactivity; the third core load at H Reactor has proven to have sufficient excess reactivity to allow the proposed changes to be made.

The present (third) core loading consists of five different types of charges, with each group of five charges containing 197 I&E enrichment, 18 4-inch I&E lithium-aluminum and five natural uranium-mixers. This ratio of enrichment to lithium-aluminum results in an E to N length ratio of 17.28 as compared to ratios of 19.37 and 18.14 for the first and second core loadings, respectively; the reactivity loss between the first and second blocks was about four mk and between the second and third about three mk. During the reactivity minimum (the "samarium dip") approximately three milli-k of excess reactivity was compensated by poison splines; the addition of one N piece to the group of five tubes (as was done between each of the other loads), would consume most of this. Alternatively, moving the N pieces toward the center (as specified below) will reduce the pile reactivity by 1 to 1.5 mk^{6/} and flatten (or otherwise beneficially re-shape) the axial flux. This second alternative is recommended, since it is desirable to maintain at least one mk in splines at all times.

Table I

<u>Code No.</u>	<u>Charge Makeup, Rear-to-Front</u>	<u>Total</u>
4	SDDP, 2E, N, 5E, Mixer, 5E, N, 10E, N, 10E, N, 7E	39E, 4N
5	SDDP, 4E, N, 3E, Mixer, 7E, N, 10E, N, 11E, N, 4E	39E, 4N
1	SDDP, 6E, N, E, Mixer, 9E, N, 10E, N, 11E, N, 2E	39E, 4N
2	SDDP, 7E, Mixer, E, N, 11E, N, 9E, N, 12E	40E, 3N
3	SDDP, 8E, Mixer, 3E, N, 10E, N, 9E, N, 10E	40E, 3N

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The charges are positioned by the standard downstream dummy pattern (SDDP) of a 32-piece natural uranium column. The location of the N pieces is approximately the same as in the third load. Two types of charges are unchanged. In the other three charges, six N pieces were moved one slug toward the central high flux region. The code numbers were rotated as the simplest way to ensure that tubes with three N pieces in core three will contain four N pieces in this next E-N core loading. This is necessary to balance the tube corrosion in the E-N striped tubes since the charges containing three N pieces run at about one per cent higher tube power than those with four N pieces. Further modifications of the charge makeup in succeeding E-N blocks will be recommended as required to increase the conversion ratio by eliminating the excess pile reactivity.

The charge makeup of the fringe blanket should remain identical with the present loading.

Control Charges

Determination of the enriched uranium conversion ratio of the first two E-N blocks was accomplished by analyzing both the full block in the first core and selected groups of charges (special pickup groups) in both cores. Analysis to determine the improvement in the conversion ratio of the fourth block, if performed, will require the use of one or both of these methods. The use of a special pickup group would involve no more than 24 E-N charges. Selection of the method will depend upon the separations scheduling feasibility for obtaining meaningful data.

Upon discharge, the 4-inch N pieces will be separated from the enriched material and readied for shipment to Savannah River for processing.

Charging

In addition to the slight change in core charge distribution (see Table I), the E-ring is to be modified as follows: 41 34-piece enriched charges in the sixth lattice inward will be replaced with E-N charges (Figure 1). The supporting reactivity for these extra E-N charges is gained by replacing 189 tubes of 34-piece enrichment in the E-ring by full length (43-piece) enrichment.

Goal Exposure

Adjustments to the goal exposure of the various charges will be made through normal Manufacturing and Research and Engineering channels.

Reactor

The irradiation of the E-N load will be continued at H Reactor.

Tube Power Recommendations

Tube power limits will be recommended through normal Manufacturing and Research and Engineering channels based on operating conditions existing at the time.

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Hazards

No special considerations other than those already covered by Reactor Standards are necessary, but one cautionary note is perhaps advisable. Charge-discharge of the fringe poison column requires that appropriate compensating enrichment be out of the reactor when the fringe poison charges are out (in other words local combinations should not exceed the reactivity of a fringe zone consisting entirely of natural uranium).

Termination

This Process Improvement Transition Authorization will remain in effect until Reactor Process Standards authorize the E-N loading as a standard operational pattern. Until optimization of the E-N loading is complete the exact charge makeup and core loading pattern should be left flexible; a new supplement to the original PITA will be required for any charge makeup different from that specified in Table I of this document.

RESPONSIBILITIES

Research and Engineering

Process Technology Sub-Section will be responsible for determining operating limits, for interpreting fuel performance and tube corrosion data, for providing fuel exposure recommendations, and for providing mixer element recommendations.

Operational Physics Sub-Section will be responsible for the selection of the charge makeup and location and all modifications of same, for requesting and obtaining any product formation data from special tubes, for determining the reactivity parameters, for analysis and modification of the flux distribution and for publishing the final report.

Manufacturing Section

H Reactor Operation will be responsible for the operational safety and production continuity of the reactor, planning and scheduling of the program and collection of routine operating data.

Production Operation will be responsible for liaison with Production Fuels Section to fulfill material quality and quantity requirements, and for normal charge-discharge schedule recommendations.

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Fourth E-N Loading

P PCCF

G Graphite Stringers

F Fringe Poison

B B-Metal

Numbered Charges are E-N
Striped ChargesNOTE: The boundary between the enrichment and
E-N charges is subject to modification.

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