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GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

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TITLE

PT-IP-385-C
E-N REACTIVITY MATCHING MEASUREMENT

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PT-IP-385-C
E-N REACTIVITY MATCHING MEASUREMENT

By

R. D. Carter
IRRADIATION PROCESSING DEPARTMENT

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PT-IP-385-C
E-N REACTIVITY MATCHING MEASUREMENT

OBJECTIVE

The objective of this test is to determine as closely as possible the reactivity of the proposed E-N charge relative to the known natural uranium charge reactivity.

BASIS AND JUSTIFICATION

The projected E-N load at H Reactor will require a complete change in the type of charge placed in most flattened zone process tubes. In general, the new loading will consist of enriched uranium pieces with a small number of lithium-aluminum ("N" or "Boll") pieces added. These charges are planned to produce the same pile reactivity effect at equilibrium operating conditions as the present loading in order to obtain proper flattening and control. In order to minimize the possibility that the E-N load will have insufficient or excessive reactivity, a fine reactivity measure of a block representative of the proposed load should be made in a production reactor to confirm the calculated loading reactivity characteristics. H Reactor offers an excellent opportunity to perform such a test for two reasons: 1) the full E-N load will later be charged into H Reactor, and 2) the flattened zone is being discharged as a unit, thus providing an extended transient-free outage and a uniform loading over a wide area of the reactor. This test is to take place during the block discharge tentatively scheduled for January, 1961, since the full E-N load is scheduled for the following block discharge date which will occur about April, 1961.

TEST DESCRIPTION

A. E-N Load Requirements and Charge Make-up

The charge make-up for the present test is chosen to duplicate the effect of the full scale load E-N charge make-up with respect to the reactivity effect and the effect on axial flux distribution. The limitations of the test demand that there be a minimum number of different charges commensurate with the above requirements. This can be accomplished with the use of a minimum of five different types of charges. These charges are identified by a number and will be referred to by these numbers. All charges are assumed to have the standard downstream dummy pattern specified for 32-piece natural uranium charges. All charge make-ups read starting with the downstream piece. E represents enriched uranium and N represents lithium-aluminum.

Charge Code

Charge Make-up

I	2-E; 1-N; 12-E; 1-N; 12-E; 1-N; 12-E; 1-N; 2-E
II	4-E; 1-N; 13-E; 1-N; 13-E; 1-N; 11-E
III	7-E; 1-N; 13-E; 1-N; 13-E; 1-N; 8-E
IV	9-E; 1-N; 13-E; 1-N; 13-E; 1-N; 6-E
V	12-E; 1-N; 13-E; 1-N; 13-E; 1-N; 3-E

B. General Description of Test

The size of the test block, 30 columns, has been planned such that differences in the reactivity of the reactor will be measurable by reactor rising periods and be significant relative to absolute core reactivity, but small enough that these rising periods will be measured with as nearly identical HCR patterns as possible. A comparison will be made between the reactivity effects of ripe natural uranium, a local spline, an E-N loading, and green natural uranium. The E-N block will be loaded in several steps to note any change in the reactivity per column charged. Since full pile comparisons between green and ripe natural uranium exist, it should then be possible to estimate the relative change for the E-N load for the cold pile without absolute knowledge of the relative reactivity weighting of this block under test conditions. Corrections for hot pile reactivity will be made on the basis of theoretical calculations.

The various steps in charging the E-N columns will be in multiples of five tubes since there are five different charges, each with a slightly different reactivity effect. It is hoped that the test can be concluded with the first fifteen charges, but fifteen additional high exposure columns will be available (as will 15 extra E-N charges) if the data is not conclusive after charging fifteen tubes.

C. Procedure

The flattened zone of the reactor will be discharged normally as directed by Production Scheduling except that a group of thirty tubes will be left charged with ripe uranium for the test. The exact number and location of these tubes are shown in Figure I and are compatible with scheduled outage work.

The following conditions will prevail for the test.

1. Poison columns required for normal startup will be charged prior to the test.
2. The gas composition in the reactor unit will be brought to startup standards. During the two hours prior to the start of the test no purging will be done, and the gas makeup system will be set to hold the reactor atmosphere composition constant.
3. Process Standards governing total control will apply at all times.
4. The subcritical monitors must be in operating condition. A scaler will be provided and will be connected into one SCM circuit to provide more detailed period data.
5. Reactor flow will be reduced to shutdown conditions and the panellit system bypassed; a minimum of 75 psi, TORP, is to be maintained on reactor flow except that full flow will be maintained on the initial approach to critical and the Panellit cleared to be certain of normal water flow on each process tube.

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6. VSR use during the test will be as follows:

During the first approach to critical, VSR's and HCR's will be withdrawn according to Process Standards; subsequently, only six VSR's will be used for terminating and initiating reactor periods. All six may be withdrawn simultaneously to obtain a period if no loading changes have been made since the latest prior period. No HCR withdrawals are to be made prior to VSR withdrawal. If a loading change has been made, 4 of the 6 VSR's may be withdrawn, then after a five minute wait the other two may be withdrawn.

7. In order to permit the best possible test results, the three PCCF tubes immediately adjacent to the test block, 2788-H, 3282-H and 3288-H will be charged with reject I&E natural uranium columns from prior to the test until after the conclusion of the test. Process Standard F-050.02 will be temporarily waived for this production test since only operation below one megawatt will be involved.

The test will proceed in the following sequence:

1. Initial approach to critical will be made in the normal manner according to Process Standards. Following attainment of critical, the SN relay will be bypassed and the Beckman trips set to scram the reactor at 1-5 MW. The reactor power will then be allowed to rise on a free period until the reactor is scrambled by Beckman trip of the #1 safety circuit.
2. The LP and VLP trips will be bypassed and water pressure lowered to 75 psi.
3. After a 30 minute wait all the VSR's may be withdrawn simultaneously, the HCR's remaining at the same configuration obtained before the scram and the rising period again measured. (NOTE: In this and all following phases of the test, all HCR movements just prior to obtaining a desired rising period should be in the outward direction to reduce the effect of mechanical play in the control rod drive mechanism. This will aid in obtaining the same rod tip placement and corresponding rising period with a given position shown on the control rod position indicator.)
4. After this pile period measurement has been made, HCR's selected by the physicist in charge of the test will be used to obtain other rising periods of approximately 150, 50 and 25 seconds and the rod positions recorded. Rod(s) selected for use should not be close to the test block, and preferably a single rod should be used for final reactivity adjustment. The six VSR's will be inserted (leaving the HCR's positioned) to reduce the background sufficiently between periods.
5. After obtaining the above periods the HCR's may be adjusted to one of the configurations established in Step 4, for use as the probable fixed configuration for the remainder of the test. However, this may be changed to one of the other previously measured configurations if the physicist in charge of the test decides that the rising period is either too slow or too fast. A second rising period will be taken, the period checked and the six VSR's again inserted.

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6. If the observed period in Step 3 differs inexplicably from the earlier period (Step 1) with the same HCR configuration, then there should be a thirty minute wait and another period measurement since this probably means that the reactor atmosphere is changing. If necessary to insure stable conditions have been attained, another thirty minute wait and period measurement should be made.
7. After satisfactorily completing Step 6, the six VSR's should be inserted and a spline inserted into one of the tubes in the center of the block. The VSR's will then be withdrawn and the rising period measured. After determining the rising period the six VSR's should once again be inserted. When the background is reduced sufficiently the VSR's should be withdrawn and a second period measurement should be taken to confirm the first.
8. When the above period measurements are completed the six VSR's are to be inserted and the first part of the E-N loading will be charged. Two successive rising periods are to be measured. The first three parts of the E-N loading will be charged in groups of five tubes (see Figure II). If these three parts do not give sufficiently consistent reactivity data, the fourth step of fifteen tubes will be charged. Each of the parts of the E-N block loading will have period measurements similar to the above. The reactor power level will be held to a minimum to reduce exposure on the E and N pieces.
9. After measurement of the above rising periods, the E-N material is to be discharged into containers on the rear elevator (the number of charges allowed on the rear elevator at any one time will be specified by H Processing). The enriched uranium pieces are to be picked up and placed in containers for storage until they can be returned to Manufacturing Operation, FPD, for recanning. The N pieces may be stored for later use in the E-N loading. Any remaining ripe uranium charges in the block will also be discharged (into the basin) at this time.
10. Green natural uranium is to be charged into the entire test block and again two successive rising periods will be measured with a thirty minute wait between periods.
11. On completion of the test the reject uranium pieces in tubes 2788-H, 3282-H and 3288-H may either be discharged onto the rear elevator for special pickup and storage until they can be returned to Manufacturing Operation, FPD, for recanning, or flushed into the basin at the option of Processing Operation. Following this, the SN relay, panellit, LP and VLP circuits will be unbypassed with the reactor held at low level critical. Beckman trips may then be raised to normal settings and operation resumed according to Process Standards.

COSTS

Recanning costs of enriched uranium used in E-N charges and natural uranium charged in tubes 2788-H, 3282-H, and 3288-H should be negligible since reject material will be used if available. Additional 300 Area handling costs for the enriched material will be charged to Code 5R40.71.

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MANPOWER REQUIREMENTS

In addition to the control room operating crew there will be manpower required for picking up the E-N charges on the rear elevator during the test.

SHUTDOWN TIME REQUIRED

Initial preparation and rising period determinations - 4 hours.

Charge-discharge of special charges and spline - 5 hours. (Total 9 hours)

REACTOR

The test will take place at H Reactor.

REACTOR SAFETY

All normal startup procedures will be observed except that following the initial critical determination it will be permissible to withdraw all VSR's simultaneously. Although up to 30 tubes will be recharged the reactivity changes are not expected to be more than 30 c-mk which would result in a period of about 40 seconds if the preceding period were as much as 60 seconds. Bypassing of the LP and VLP trips require that Standard C-110.02 be temporarily waived. (The Beckman flux monitors will be in the safety circuit set at 1-5 MW; process water pressure will be continuously monitored during the test and the Ball 3X System tripped manually if flow loss occurs.)

RADIATION HAZARDS

The pick-up of the E-N and reject natural uranium charges on the rear face will result in some personnel exposure. Every effort will be made to reduce the irradiation time of the E-N load but some contamination will probably be picked up from the tubes. Radiation from surface contamination is expected to be greater than that induced in slugs during test. Enriched uranium pieces should be picked up and stored for shipment back to Manufacturing Operation, FPD, for recanning. Pick-up of E-N charges on the rear face and temporary storage in GI cans will not violate the intent of Process Standard H-010.01 providing cans contain no more than two tube charges and are not stacked. The cans may contain water if desired. Before shipment of the enriched uranium pieces, surface contamination should be reduced to the point that Radiation Standard No. 7.5 is met. N pieces should be picked up and stored for future use. The charging of reject uranium with PCCF tubes 2788-H, 3282-H, and 3288-H requires the temporary waiving of Standard F-050.02 but operation will be below 1 MW and of short duration.

RESPONSIBILITIES

Research and Engineering Section

Operational Physics Operation - for determination of the E-N charge make-up, procurement of special instrumentation, direct supervision of test procedure, evaluation of safety and total control aspects, and evaluation and reporting of data R. D. Carter.

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Manufacturing Section

H Processing Operation - for reactor safety and continuity of operation, for supervision of startup procedures and direct operation of the reactor during the test, for charge-discharge of the tubes in the test block and for special pickup, and for storage and reshipment of the E-N charges.

Production Operation - for securing reject enriched uranium fuel elements for the test.

R.D. Carter

Operational Physics Subsection
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FIGURE I
LOCATION OF TEST

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FIGURE II
E-N CHARGING SEQUENCE

		Column						
		82	83	84	85	86	87	88
Row	32		4-I	4-II	4-III	4-II		X
	31		4-V	2-II	1-V	2-I	2-III	4-I
	30	4-IV	4-I	2-IV	1-III	1-IV	4-V	4-IV
	29	4-V	4-II	2-V	1-I	1-II	3-I	4-III
	28		4-III	3-II	3-V	3-III	3-IV	4-II
	27							X

X Represents PCCF Tubes

Arabic numbers represent steps in E-N loading

Roman Numerals represent types of charges

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