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PRODUCTION TEST IP-324-C
UPSTREAM FLUX DEPRESSION CORRECTION
AT C REACTOR

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by J. A. Owsley

June 15, 1960

PRODUCTION TEST IP-324-C
UPSTREAM FLUX DEPRESSION CORRECTION AT C REACTOR

OBJECTIVES

The objective of this test is to correct the flux depression caused by 3X balls lodged in graphite by charging compensating enrichment in the depressed region.

BASIS AND JUSTIFICATION

Flux traverses at C Reactor indicate that about 20 per cent of the tubes in the pile operate with a rear peaking condition. In general, this peak is located three pieces downstream of center and is as high as 20 per cent above a normalized cosine peak. This peaking is the result of a flux depression located about six fuel element lengths from the front of the metal charge. The depression is probably caused by the large quantity of balls that have been lost in the cracks along VSR channels in this region of the reactor.

In the region where the depression is evident, up to 150 random tubes will contain four enriched fuel elements located in the normal 23, 24, and 25 fuel element positions. The principal advantage to be gained is a flattened flux distribution in the region bounded by tube rows 12 and 32, and tube columns 62 and 84; this improvement in flux distribution should lead directly to reduced rupture potential and thus increased production.

Presently the flux at the point of maximum depression (the sixth slug from the front) is about 50 per cent of the normal cosine distribution flux level, and the peak is about three slug lengths downstream of the center line. A simple one-group slab geometry calculation indicates that the flux should increase to at least 80 per cent of the normal cosine distribution at the point of maximum depression (Figure I) and that the

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peak should be moved about two slug lengths upstream by the loading of the 600 pieces. This calculation should over-estimate rather than under-estimate the effect of the E Metal.

TEST DETAILS

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1. The special charge make-up will be:
 - (a) Standard downstream dummy pattern:
1 - 8" perf, 1 - 5" perf, 8 - 8" perfs, 7 - 8" expendables
 - (b) 21 I & E natural uranium plus mixer. The mixer will be in the normal position.
 - (c) 4 I & E enriched pieces.
 - (d) 7 I & E natural uranium pieces.
2. The actual number of these natural-enriched-natural (R-E-R) columns will not exceed 150 or the minimum number required to return the flux distribution to normal, whichever is the lesser.
3. A limit of not more than 40 R-E-R charges will be added to the in-pile inventory during any one outage, and no more than two tubes will be charged at one time in any 3 x 3 tube array.
4. The location for the R-E-R columns will be specified by the C Pile Physicist.
5. The axial flux distribution will be monitored in at least three locations within the central region between each operating period. Graphite TC's will indicate the magnitude of a flux change the first of each operating period.
6. The test will continue until either:
 - (a) the cause of the depression is removed,
 - (b) experience indicates sufficient incentive exists to adopt this method of flux distribution correction columns as standard at C Reactor, or
 - (c) analysis shows that continued flux correction by this method is not economically feasible.
7. The goal exposure in MWD/ton for these columns will be the same as that of a normal I & E natural charge operating at the same power. The goal exposure may be changed through the normal channels of organization.
8. Axial flux monitoring for the test will make use of numbered or special pickup I & E natural columns weaseled less than 24 hours after shutdown and will be necessary only when a change in the R-E-R column inventory of ten changes or more has occurred since the previous set of three traverses. However, a minimum of three traverses will be required every two months to monitor any flux changes that may occur from boron burnout.

COSTS

Slightly greater U-235 burnup per unit product at higher cost per unit burnout of U-235 will result from this loading; however, some of the increased cost will be to

COSTS (Continued)

accelerate the boron burnout, a cost which would be incurred at a later date unless some method of removing the 3X balls is found. Losses due to charge-discharge and enrichment handling costs will be increased. However, the improved axial flux distribution should result in a lower rupture potential for a given tube power, thus giving a net economic gain.

TOTAL CONTROL

Since the purpose and extent of the enrichment is to compensate for permanent poison of the 3X balls in the lattice, total control requirements will not be affected.

PROCESS STANDARDS

Process Standard F-020, "Make-up of Tube Charges," will be relaxed, within limits specified above by this production test. All other Process Standards, including restrictions on handling of enriched uranium, shall apply.

RESPONSIBILITIES

Manufacturing Section

For operational safety and production continuity, and for the charging and discharging of the R-E-R columns in accordance with provisions of this test and applicable Process Standards: C Processing.

For scheduling the test columns for discharge: Production Planning and Scheduling Operation.

Research and Engineering Section

For specifying placement of all R-E-R columns and monitor columns, for analysis and evaluation of the test results, and for issuing a final report: Operational Physics, the assigned C Reactor Physicist.

For specifying operating limits for the R-E-R columns: Process Technology.

R. A. Chitwood

Operational Physics Sub-Section
Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

RA Chitwood:mwe

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Figure I

Flux Level Increase as a Function
of Enrichment Invested

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