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PT-IP-325-AC - INCREASED GRAPHITE LIMITS
DURING DR REACTIVITY MINIMUM

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AUTHOR

D. G. Montague
and
R. W. Benoliel

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May 26, 1960

PT-IP-325-AC - INCREASED GRAPHITE LIMITS DURING DR REACTIVITY MINIMUM

OBJECTIVE

The objective of this test authorization is to increase reactivity and thus reduce short term enrichment requirements by increasing graphite temperature limits during low exposure operation following full central zone discharge.

BASIS AND JUSTIFICATION

Sixty to seventy-five E-columns are necessary in addition to normal enrichment requirements to compensate for the low reactivity status immediately following a central block discharge. /1/ After about three weeks of equilibrium operation Pu gains compensate samarium build-up, so the additional reactivity supplied by these columns is no longer needed. The reactivity provided by sixty additional E-charges could be achieved with an increase in maximum graphite temperature of up to 100°C over the operating temperatures specified in Standard C-040 (about 550°C at 20 per cent helium) for the initial 35,000 MWD of production (approximately 21 days).

- /1/ Process Improvement Transition Authorization No. 294-C - "Evaluation of Unit Flattened Zone Discharge at DR Reactor," R. D. Carter, and D. I. Monnie, December 7, 1959.

BASIS AND JUSTIFICATION (Continued)

At an E-metal cost of \$400/c-mk-year /2/ the direct savings would be \$144,000 to \$190,000 per year. In addition, elimination of these columns would reduce the reactor rupture potential and decrease the special discharge and pick-up time for enriched material.

A method of operation has been devised which will permit graphite temperatures to exceed normal limits sufficiently during the samarium transient to reduce enrichment requirements significantly, yet within an integrated burnup rate over the 90-day irradiation cycle which will not exceed two per cent graphite burnup per thousand operating days. This method has been devised on the basis of information presented in Reference /3/.

Provisions for gas composition limitations consistent with fringe poison loadings stated in this test are expected to maintain biological shield temperatures within process standards.

PROCEDURE

1. Graphite Temperature Limits (Allowed under this test at helium concentrations lower than specified in process standards but in no case lower than 20 per cent.)
 - a. Integrated burnup rate over the 90-day irradiation cycle is not to exceed two per cent per thousand operating days.
 - b. Burnup rates at 650°C are approximately four times those at 600°C, and burnup rates at 625°C are approximately double those at 600°C. This production test allows up to a maximum of 50 days per cycle equivalent burnup to that obtained in the 550 to 600° range. For example, five days in the 625 to 650° range plus five days in the 600 to 625° range would be equivalent to 30 days operation in the 550 to 600° range and would thus permit up to 20 days in the operation in the lower range.
 - c. For purposes of this production test the following definitions are given as a day's operation in a particular temperature range:
 - (1) A temperature at any time(s) in excess of 575° would be counted as a day's operation in the 550 to 600° range. If one or more graphite temperatures are observed in excess of 550° during twelve or more hours of any 24-hour period, a day in the 550 to 600° temperature range will be counted.
 - (2) Similarly a temperature in excess of 615° at any time(s) will be counted as a day's operation in the 600 to 625° range, and one or more graphite temperatures in excess of 600° during twelve or more hours of any 24-hour period will be counted as a day in the 600 to 625° range. One day in the 600 to 625° range will be counted as two "equivalent" 550 to 600° days.
 - (3) Likewise, a day will be counted for the 625 to 650° range if any graphite temperatures exceed 640° at any time(s) or if one or more graphite temperatures in excess of 625° are observed during twelve hours out of any 24-hour period. One day in the 625 to 650° range will be counted as four "equivalent" 550 to 600° days.

/2/ This value supplied by R. D. Carter.

/3/ Figure XV, HW-62273, Rev. - "Graphite Burnout Monitoring Interim Report 3 on PT-IP-25-A," by B. A. Ryan, October 9, 1959.

PROCEDURE (Continued)

2. Shield Temperature Limits

Gas composition should be adjusted to bring the biological shield temperature to $\leq 160^{\circ}\text{C}$ within one day should it exceed that temperature. Shield temperatures should not be permitted to exceed 170°C at any time.

3. Fresh burnout monitors will be installed during the central zone discharge scheduled for June 6, 1960. These graphite samples in tube number 2577 will be replaced after two high graphite temperature cycles and again after four cycles (about six months and twelve months respectively).
4. As during normal operation it is desirable that oxygen content be maintained as low as possible, certainly not to exceed standards.
5. This production test will terminate if any one of the following occurs:
 - a. Graphite burnout monitors indicate an integrated graphite burnout rate over the first two cycles in excess of two per cent per thousand operating days.
 - b. The block discharge procedure is terminated.
 - c. The Process Standards are revised to permit this method of operation.

In any event, this authorization will terminate not later than completion of four central zone discharge cycles.

PROCESS STANDARDS

Process Standard C-040 will be relaxed as authorized during this test; this relaxation does not include exceeding uncooled process tube limits. No other standards are affected.

HAZARDS

No safety hazards are involved; actually the reduction of the number of E-columns decreases total control requirements.

Accelerated burnout and contraction of the graphite or the deterioration of the masonite in the biological shield could reduce reactor life. However, these effects are believed to be very small for the short time periods involved; the integrated graphite burnup rate is calculated to be less than two per cent per thousand operating days. Adequate monitoring is provided to guard against excessive shield temperature or deterioration.

REACTIVITY

A moderator reactivity coefficient of $3.5 \frac{\text{c-mk}}{^{\circ}\text{C}}$ (based on the maximum graphite temperature) was observed following the initial full central zone discharge in February, 1960. Since an E-column has an effective reactivity of about six c-mk, an increase in temperature of 100°C is equivalent to 60 E-columns.

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SHIELD PROTECTION

Standard A-070 advises temperature limits for the masonite shield. Since these temperatures are strongly dependent on helium concentration, the following limits are set: /4/

1. A minimum of 40 per cent helium with the present fringe poison loading of 30 mint columns plus 10 additional columns of fringe poison in the top.
2. A minimum of 20 per cent helium with six more poison charges on the far side in addition to the amount specified in item 1 above.

RESPONSIBILITY

Manufacturing Section

For reactor safety and continuity of operation, with special emphasis on monitoring of graphite temperatures, oxygen concentration; and shield temperatures to assure that the provisions of this test are complied with: DR Processing Operation.

Research and Engineering Section

For analysis of burnout samples and for issuing recommendations based on these analyses: Process and Reactor Development Sub-Section, R. W. Benoliel.

For arranging for installation by HLO of graphite monitor samples, for loading recommendations designed to permit efficient operation within the limits authorized by this test, and for following shield temperatures and issuing appropriate recommendations: Operational Physics Sub-Section, D. G. Montague and W. L. Smalley, respectively.

D. G. Montague
Operational Physics Sub-Section
Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

R. W. Benoliel
Process and Reactor Development
Sub-Section
Research and Engineering Section
IRRADIATION PROCESSING DEPARTMENT

R
DG Montague:RW Benoliel:mwe

/4/ Private communication with W. L. Smalley

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FIGURE 1

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