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PRODUCTION TEST IP-255-A-9-FP
E-N DEMONSTRATION TEST

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May 8, 1959

PRODUCTION TEST IP-255-A-9-FP
E-N DEMONSTRATION TEST

OBJECTIVE

The objectives of this test are: a) to evaluate the integrity of I & E MINT fuel elements canned by the "C" process, b) to determine the conversion ratio of I & E geometry E-N "striped loadings", and c) to provide a demonstration loading for a full reactor loading incorporating a "striped"* center loading and a fringe "blanket"* loading.

TEST SUMMARY

This test will involve two portions: a) a 26 tube block loading of I & E enriched uranium and MINT fuel elements arranged in a striped array, and b) a 10 tube fringe blanket loading of MINT fuel elements supported by the required enriched uranium fuel columns, and accompanied by controls. Either portion may be charged independently.

BASIS AND JUSTIFICATION

Production gains in excess of those attainable with natural uranium loadings operating on coolant outlet temperature limits are possible through use of enriched uranium compensated by a productive poison such as lithium. If fuel element failure rates are not limiting, conversion ratio increases of about 12% are possible⁽¹⁾ due to the increased initial atom/atom conversion ratio and decreased product burnout at equivalent power levels. Incentives for this program are outlined in references (2)(3) and (4). Incentives for this testing schedule are further discussed in reference (4).

-
- * Striped Load - Balanced charges of 0.94% enriched uranium poisoned with 3.5% enriched lithium-aluminum.
  - * Blanket Load - Fringe columns fully loaded with 3.5% enriched lithium-aluminum alloy elements supported by adjacent columns of 0.947% enriched uranium.
- (1) HW-58917, "Final Report - Production Test IP-2-A, Enriched Uranium Conversion and Stability Test", L. W. Lang, October 10, 1959.
  - (2) Confidential-Undocumented, "Incentives for Enriched Uranium Usage", L. W. Lang, August 5, 1959.
  - (3) HW-6148 RD - "Production Economics Associated With A Supported Blank Load," L. W. Lang, April 30, 1959.
  - (4) HW-60309 - "Proposed E-N Demonstration Load," L. W. Lang, to be issued.

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AEC approval has been obtained to determine the process for fabrication of the elements which would be utilized for a full reactor E-N loading. The process chosen is the cold-canning process previously utilized for canning "C" metal. Test elements have been prepared and AEC approval has been obtained to irradiate the demonstration portion of the load to confirm the ability of the cold canned elements to withstand irradiation to the desired goal exposure, to confirm conversion ratio calculations, and to determine the optimum configuration for the "striped" loading. It is the purpose of this test, therefore, to authorize the demonstration loading, and to specify the data required for its execution.

TEST DETAILS

1. Fuel Elements

A. MINT - 740 pieces of solid lithium-aluminum alloy, (38.5 a/o Li⁶) shall be required for the blanket loading; 240 pieces of I & E geometry MINT of the same type shall be required for the striped loading. These elements shall be canned by the "C" process previously utilized in MINT and DOE production except that the I & E elements shall be electron beam welded to minimize weld porosity.

B. Enriched uranium - approximately twelve tons of normal production I & E OIIE, (1.440 x 0.310, 0.947% enriched uranium) elements will be required to support the loading.

C. Natural uranium - eight columns of OIIN (1.445" x 0.310" - natural uranium I & E) fuel elements will be required as controls for the blanket loading.

2. Fuel Identification and Pre-Exposure Measurement

All fuel elements utilized in the striped loading shall be weighed and numbered and shall have pre-exposure weights, dimensions and warp recorded. The MINT pieces utilized in the blanket loading shall be assembled in columns of 70 pieces per column and numbered with a piece and column number. The control columns of OIIN and twenty columns of OIIE shall also be numbered.

3. Column Assembly

A. Blanket: The columns for use in the blanket shall be full length MINT, 70 pieces long.

B. Striped Load: The columns in the striped loading shall be charged alternately in 4 patterns to decrease peaking effects. Reactivity of these columns shall be balanced so as to coincide with that of natural uranium columns. The columns shall be charged as follows: (A B C D indicate fuel arrangement in each tube which is being determined experimentally.)

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A B
A B C D C
C (D) (A) (B) A B
A (B) (C) (D) C D
C D A B A
C D

The circled columns are those chosen for conversion ratio determination and alternates.

C. Fringe Enrichment: Fringe supporting enrichment columns shall be 43 pieces long, in the second and third lattices, 34 in the remainder.

D. Natural Uranium: The 18 fringe loaded control columns shall be 32 pieces in length, loaded normally.

4. Charging

Early discharge of all fuel columns in the specified block for the striped load is authorized in order that this loading may be made during a single outage to maintain the flux balance. All columns shall be charged into the designated tubes in order, with piece #1 downstream. The charge machine may be utilized for this loading.

The blanket load shall be charged likewise during one outage; however, this need not be during the same outage as the striped loading. Supporting enrichment will require early discharge of the surrounding natural fuel but this is authorized by this test. The controls shall be charged into the designated columns during the same outage the blanket columns are charged.

All charging shall be observed by a representative of Research & Engineering Operation to assure proper charge data assembly and to make necessary decisions regarding tube loading changes. This test may be charged either in its entirety or in sections depending upon fuel availability. Approximate locations and arrangements are shown in the appendix. The final location of the loadings shall be adjusted to be mutually satisfactory to the H-Reactor Processing Operation and the authors.

5. Irradiation

During irradiation the following data will be required:

A. Striped Loading: Shiftwise temperature and daily panellit data will be required for all tubes in the central striped loading since these columns will be subsequently analyzed for production to verify conversion ratio calculations.

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B. Blanket Loading: Daily temperature and panellit data will be required for MINT columns and their supporting enrichment columns in the blanket loading. Daily temperatures and panellit data shall also be recorded for the control material.

6. Goal Exposure

All columns in the striped loading to be used for conversion ratio determination shall be irradiated to 800 MWD/T of R metal. The remainder until one failure is sustained, or until equivalent performance with a natural loading has been demonstrated. The enrichment supporting the fringe blanket loading shall be exposed to the normal variable goal for OIIE fuel in effect at the time of discharge except for columns reserved for conversion ratio determination which shall be discharged when the first column reaches goal exposure. The blanket loaded fringe MINT columns shall be irradiated for two years from the date they are charged, except for two MINT columns and supporting enrichment and the control columns which shall be all discharged approximately three months after charging.

7. Reactor Modifications

Specially calibrated venturi shall be required on those columns scheduled for conversion ratio determination. This will be approximately 25 columns (depending upon blanket compensated enrichment requirements).

All columns involved in this test, except the fringe enrichment (blanket support) columns, and the natural control columns, shall have special cap locks to prevent inadvertent discharge. Keys for these locks shall be retained in the control room safe, appropriately labeled.

8. Discharge

All columns shall be discharged, picked up, and stored separately except for those fringe enrichment columns not required for conversion ratio determination. These charges may be combined into buckets containing other columns from this test consistent with 0.947% enrichment criticality requirements.

9. Post Exposure Measurements

All columns subject to special pickup shall be examined in the 105-C Metal Examination Facility to evaluate dimensional stability. Selected columns shall be dissolved specially for product and conversion ratio determinations.

10. Reactor

H Reactor has been chosen for this demonstration loading since it will probably be the reactor utilized for the full scale loading (when authorized).

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11. Hazards

Since the sum total of the enrichment columns in H Reactor will be increased by this test, the total reactor rupture probability may be slightly increased; however, since fringe columns will all operate at lower specific powers than other enrichment, this increase should be slight. Rupture probabilities for the MINT are unknown.

12. Costs

Incremental costs incurred as a direct result of this test may be charged to XXXX-5320-XXX.54. Outage time and manpower requirements are provided below for scheduling purposes:

<u>JOB</u>	<u>Manpower</u>	<u>Elevator Time</u>	<u>Outage Time*</u>
A. Striped Load			
1. Install calibrated venturi on conversion ratio tubes	1/2 mh/tube	1/4 hr/tube	1-1/2 hours
2. Charge the block loading of E-N columns - 1 machine	2/3 mh/tube	1/6 hr/tube	5 hours
3. Discharge for special pickup the columns at goal	2 mh/tube	1/3 hr/tube	10 hours
B. Blanket Load			
1. Charge the blanket columns	2/3 mh/tube	1/6 hr/tube	2 hours
2. Discharge for special pickup	2 mh/tube	1/3 hr/tube	4 hours
3. Charge supporting enrichment columns for blanket	1 mh/tube	1/4 hr/tube	10 hours
4. Discharge the enrichment for special pickup	2 mh/tube	1/3 hr/tube	13 hours
5. Install calibrated venturi - 21 tubes	1/2 mh/tube	1/4 hr/tube	5 hours

* These outage hours are approximate, and can be considerably reduced by scheduling. It is estimated that the entire test could be charged during one shift and discharged during a total of two additional shifts by overlapping work schedules. Additional costs will include early discharge of approximately 80 columns at an average of no less than 50% of normal goal exposure to accommodate the loading of the test.

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13. Ruptures

The striped loading shall be discharged if two failures are sustained before the loading achieves 800 MWD/T exposure, at the discretion of the Manager, H Processing Operation.

14. Conversion Ratio Determinations

Selected columns of those having calibrated venturi will be individually separated for analytical determination of conversion ratio and isotopic concentration. These columns will be chosen prior to discharge depending upon relative power and exposures.

In addition a control group of fringe natural uranium shall also be extracted for use as controls in evaluating relative production

15. Limits

A. Higher individual tube powers encountered in this loading may require operation above the TOA corrosion limit specified in Process Standard A-022. Since this limit is arbitrary, and since no pile life or safety problems are associated with it, the tubes charged under this test are authorized to exceed this limit, provided the goal exposure is modified to maintain a constant failure probability in all enriched material except the striped loading.

B. Due to the increased thermal flux level in the region of the demonstration striped loading, graphite temperatures in excess of normal may result. Since this loading will only be in-reactor for between four months and eight months, permanent graphite damage should be slight; however, temperatures above 700°C could cause permanent graphite thermocouple damage. It is, therefore, authorized that the graphite limit specified in Process Standard C-040 be relaxed to permit graphite temperatures 50°C in excess of those authorized provided the helium concentration is above 60%. In a reactor fully charged with E and N material this problem would be non-existent since the flux level would be decreased at a given power level, and in any event sufficient helium could be introduced to reduce these temperatures. An uncooled tube in the test region invalidates this relaxation.

RESPONSIBILITIES

Fuels Preparation Department

Manufacturing Operation

The Manufacturing Operation shall be responsible for canning all MINT pieces by the "C" Process, for normal quality control, and for preirradiation measurements and marking.

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Engineering Operation

The Engineering Operation shall be responsible for liaison in the 300 Area portion of this test and for providing technical assistance.

Irradiation Processing Department

Research and Engineering Operation

Process Technology Operation shall be responsible for assistance in scheduling, assistance in charging of the test, and for forwarding of operating data to the author.

Process and Reactor Development Operation shall be responsible for coordination of the test, data analysis, and reporting of irradiation experience.

Component Testing Operation shall be responsible for obtaining post-irradiation examination data.

H-Reactor Operation

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

H-Maintenance Operation will be responsible for all maintenance work required by this test.

Reactor Fuels Operation
Process & Reactor Development Operation
IRRADIATION PROCESSING DEPARTMENT

Reactor Physics Operation
Process and Reactor Development Operation
IRRADIATION PROCESSING DEPARTMENT

RE Hall:WS Nechodom:dgm

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FIGURE 1 - SAMPLE LOADING DIAGRAM

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10/11/94

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