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Released 1994

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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This document consists of
6 pages,

November 2, 1959

PT-IP-269-A-FP, EVALUATION OF THE STABILITY
OF CORES FROM EXTRUDED TUBES

OBJECTIVE

The objective of this test is to monitor the performance and dimensional stability of I and E cores produced from extruded uranium tubing to be irradiated in quantities up to 60 tons per month.

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TEST SUMMARY

If material received under this program is deemed acceptable for reactor charging, this test will authorize irradiation of fourteen monitor columns which shall be discharged at 200, 400 and 800 MWD/T to observe the performance of this material. This test shall run concurrently with irradiation of quantities up to 60 tons/month to be authorized separately.

BASIS AND JUSTIFICATION

The AEC has requested that HAPO evaluate fuel elements fabricated from extruded tubing on as rapid a schedule as possible. Their justification for this request is threefold:

- a) At present, all uranium, regardless of reduction technique, is processed into the final fuel element core at FMPC. The bottleneck in the operation has been in the core-drilling step. Development of the extrusion process to successfully produce uranium tubing having the desired irradiation characteristics is a step to eliminate this bottleneck.
- b) Dependence upon one vendor for provision of a critical raw material is never good practice. Evaluation of this process may permit more rapid utilization of the Weldon Springs Plant, reducing the effects of work stoppages resulting from mechanical failures or labor difficulties at either Fernald or Weldon Springs.
- c) As part of the overall core fabrication development, it is desirable to evaluate savings, if present, through elimination of the core drilling step.

The preliminary evaluation⁽¹⁾ of fuel elements fabricated from solid rods extruded by Bridgeport Brass Company, indicated there was no significant difference between the dimensional stability of the extruded and the standard controls which were irradiated simultaneously. Since completion of that test, approximately 12 tons of I & E (extruded as solid rod) and 6 tons of solid extruded material have been irradiated to goal exposure with a single exception, an extruded solid failure which was possibly damaged prior to irradiation. As a supplemental step in the determination of the utility of extruded uranium cores at HAPO, it remains to be shown that extruded uranium tubing has the necessary characteristics for satisfactory use as reactor I & E fuel. It is probable that improved core stability will result because the core blanks will be heat treated as tubing. The heat treatment should be more uniform across the core diameter resulting in more uniform grain structure, and improved residual stress conditions. Inasmuch as cores produced from extruded tubing and transformed by the present core-blank heat treatment process have not been irradiated in HAPO reactors, the performance of this material cannot be accurately predicted. However, intensive laboratory testing of the original shipment by FPD is expected to reveal gross dimensional problems should they exist.

TEST DETAILS

A. Fuel Elements

1. Cores - All cores utilized in this test are to be either ingot or dinged

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Fuel Elements (cont'd)

blank form in chloride salt, and finish machined.

2. Cladding - These cores shall be clad in either X-8001 or C-64-F alloy cladding at HAP0, whichever is the normal cladding for B Reactor fuel at the time of this test.
3. Quality - All fuel elements utilized in this test shall meet all HAP0 standards and specifications for normal production OIIN fuel elements. In addition, destructive examination of a sample of canned elements to determine internal bonding integrity will be performed.

B. Lot Charged Fuel

This test will run concurrently with irradiation of up to 60 tons per month of this material, lot charged, to be authorized separately.

C. Monitor Columns

1. Fourteen monitor charges of alternated test and control (ingot, wrought blank, chloride heat treated cores) fuel elements will be utilized as monitor columns for this test.
2. Pre-Irradiation Testing and Measurements
 - a) All fuel elements for measured columns for this test will be categorized and tested as follows:
 - 1) Normal metallography, chemistry and reactivity measurements.
 - 2) X-ray diffraction.
 - 3) Number all bare cores for identity.
 - 4) Warp measurements.
 - 5) O.D. and I.D. measurements (each end and center) for all elements.
 - 6) SORT measurement of bare cores.
 - 7) Attenuation testing for grain size of bare cores.
 - 8) One hundred per cent total bond test count mapping, memoscope pictures or autoradiography with destructive examination of rejects including internal bond test rejects.
 - 9) Normal autoclave radiograph tests.
 - b) Measurement of warp and O.D. for each finished fuel element is required. Measurement of weight of pieces one through seventeen is required.
 - c) Fuel elements are to be made into charges containing 36 pieces per charge. Each fuel element will be stamped with a series and position number, and with an impression to mark the edge of the film or map of the porosity areas.

D. Charging

1. Fourteen charges shall be charged normally under the direction of a representative of Research and Engineering Section into central flow zone process tubes having tube factors in excess of 1.1. All columns shall be charged in order with piece number one downstream and the charge number-

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Charging (cont'd)

2. Since this test could be performed equally well in any of the older reactors, B Reactor was chosen to balance production test time requirements between the production reactors.

E. Irradiation

1. During irradiation, daily temperature and flow data shall be recorded on data sheets provided, and forwarded to the test author.
2. Goal exposure for the monitor charges utilized in this test shall be:

<u>Charge</u>	<u>Charge Makeup</u>	<u>Goal</u>
1 - 2	3 ¹ / ₄ piece alternated OIIN	200
3 - 6	" " " "	400
7 - 14	" " " "	800

F. Discharge

After irradiation all columns from this test shall be discharged in groups of six or less for special pickup and subsequent shipment to the 105-C metal examination facility.

G. Post Irradiation Examinations

1. All fuel elements will be measured for length, warp and diameter to determine tube filling capacity of each piece.
2. All fuel elements will be visually inspected for surface conditions.
3. All fuel elements will be weighed to determine specific exposure and specific power.
4. All fuel elements will be bend tested.
5. Those pieces exhibiting unusual surface conditions, i.e., hot-spots or groove pitting will be photographed to show the entire fuel element surface.
6. Fuel elements on which bare core dimensional measurements were taken will be chemically de-jacketed and measured.

H. Costs

All IPD incremental costs incurred as a direct result of this test may be charged to XXXX-5320-XXX-54. Outage time requirements for this test are outlined below for scheduling purposes:

<u>Job</u>	<u>Manpower</u>	<u>Outage Time</u>
1. Charge 14 columns in order with special fuel	3 ¹ / ₄ mh/tube	1 ¹ / ₄ hr/tube
2. Discharge and pickup special 14 charges	1 mh/tube	1 ¹ / ₃ hr/tube
Total	3 ¹ / ₄ mh	2 ¹ / ₂ hrs.

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HAZARDS

It is understood that this program entails some potential risk to production should the extruded cores not perform as well as current production. It is hoped that the possibility of this can be minimized through pre-irradiation core evaluation and by the early discharge of monitor columns. It is felt that the potential advantages outlined in the Basis and Justification for this test do justify this risk to IPD's production.

RESPONSIBILITIES

Fuels Preparation Department

Manufacturing Operation

The Manufacturing Operation shall be responsible for canning all pieces by the "F" Process, for normal quality control, and for pre-irradiation measurements and marking.

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, choice of test channels, 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.

B-C Reactor Operation

B 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.

Reactor Fuels Unit
Process and Reactor Development Sub-Section
IRRADIATION PROCESSING DEPARTMENT

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