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August 13, 1959

SUPPLEMENT B TO PRODUCTION TEST IP-226-A:

IRRADIATION OF ENRICHED SEVEN-ROD CLUSTER ELEMENTS WITH TWENTY AND THIRTY-
MIL ZIRCALOY-2 JACKETS

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RLO - CG 4, DS Lewis, 1-10-94.

By Debbie Mally, 4-21-94.

Verified By DK Hansen, 4-24-94

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OBJECTIVE

The objective of this Supplement to PT-IP-226-A^(1,2) is to authorize the substitution of improved cluster element supports for the triangular supports originally used on the seven-rod cluster elements and to authorize irradiation of a Pu-Al cluster element in the charge.

SUMMARY

Six 1.6% enriched Zircaloy-2 jacketed seven-rod cluster elements with modified end supports and one Zircaloy-2 jacketed Pu-Al seven-rod cluster element will be irradiated in KER Loop 1 to an exposure of about 4500 MWD/T.

BASIS AND JUSTIFICATION

Production Test IP-226-A originally authorized the irradiation of 1.6% enriched seven-rod cluster elements with twenty and thirty mil Zircaloy-2 jackets to an exposure of 4500 MWD/T in KER Loop 1. The test was discharged at an exposure of about 1300 MWD/T, however, because of a variable pressure drop across the tube caused by partial plugging of the strainer in the inlet nozzle. This difficulty has been corrected and the present test is intended to achieve the objective of the original loading--the comparison of the behavior of rods with twenty and thirty mil Zircaloy-2 jackets.

A Zircaloy-2 jacketed Pu-Al seven-rod cluster element is included in the charge to provide information about the behavior of the fuel rods and cluster assembly during irradiation. This information is needed in the development of fuel elements for the PRTR.

TEST DETAILS

.. Fuel Elements

The individual rods in the six Zircaloy-2 jacketed 1.6% enriched seven-rod cluster element are 0.593 inches in diameter and 13 inches long. Each rod contains 11.4 inches of uranium. Rods in four of the elements have a 0.553 inch uranium diameter and 0.020 inch thick jackets; rods in the other two elements have a 0.533 inch uranium diameter and 0.030 inch jackets. The individual rods are held in the form of a seven-rod cluster by circular end fittings with flexible supports as shown in SK-3-8010. The fuel elements have been visually examined, ultrasonically tested for jacket-uranium bonding, and autoclaved at 270°C and 2250 psig.

- 1) Kratzer, W. K., "Production Test IP-226-A, Irradiation of Enriched Seven-Rod Cluster Elements with Twenty and Thirty Mil Zircaloy-2 Jackets", HW-58781, January 8, 1959. (Secret)
- 2) Kratzer, W. K., "Supplement A to Production Test IP-226-A, Irradiation of Enriched Seven-Rod Cluster Elements with Twenty and Thirty Mil Zircaloy-2 Jackets", HW-60112, April 21, 1959. (Secret)

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Fuel Elements (cont'd)

The Pu-Al cluster element consists of seven Zircaloy-2 jacketed 0.570 inch O.D. rods containing an Al-1.8 w/o Pu alloy. The individual rods have a 0.030 inch wall. Clearance is maintained between the rods by 0.072 inch diameter Zircaloy-2 wire spirally wrapped around each rod. The overall length of the complete cluster assembly is 27.7 inches and the length of the Pu-Al fuel is 18 inches. Details of the clusters are given in SK-3-8021-Rev. 2, SK-3-8022-Rev. 4, SK-3-8023-Rev. 1, and H-3-13302. The cluster has been modified by replacing part 3, SK-3-8021-Rev. 2, by a welded pin. The fuel rods have been radiographically inspected, helium leak tested, and autoclaved for 72 hours at 400°C and 1300 psig.

2. Loading

The tube loading pattern is given in Table 1. If changes are made in the tube loading, the loop will be operated at low temperature until a revised set of operating conditions is provided.

TABLE 1

Tube Loading Pattern for KER Loop 1

<u>Position*</u>	<u>Element</u>
1-24	Eight inch coupon holders, perfs, or spacers.
25	Eight inch modified perf
26	Pu-Al cluster element
27	Eight inch modified perf
28	Eight inch perf
29	Seven-rod cluster, 20 mil jacket
30	Seven-rod cluster, 30 mil jacket
31	Seven-rod cluster, 20 mil jacket
32	Seven-rod cluster, 30 mil jacket
33,34	Seven-rod cluster, 20 mil jacket
35	Eight inch perf

*All elements are listed from the downstream end of the process tube.

3. Irradiation Facility

The fuel elements will be irradiated in KER Loop 1, Tube 2160-KK. The loop consists of a 2.089 inch Zircaloy-2 process tube through which coolant of controlled composition, pressure, and temperature is recirculated.

4. Operating Conditions

The coolant will be pressurized water with the pH adjusted to 9.0 to 11.0 by the addition of LiOH. The operating conditions are:

- a. Desired operating flow - 50 GPM.
- b. Low flow trip - 40 GPM.
- c. Low pressure trip - 1250 psig.
- d. High outlet temperature trip - as shown in Figure 1.
- e. Desired operating outlet temperature - as shown in Figure 1.
- f. Boiling point suppression trip - as shown in Figure 1.

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Operating Conditions (cont'd)

If recirculation with system pressures less than 1250 psig is required, the outlet temperature should be reduced and maintained at least 100°C below the system saturation temperature.

5. Exposure

The desired exposure is about 4500 MWD/T. The maximum exposure will not exceed 5000 MWD/T.

6. Costs

a. Cost Code: XXXX-5320 - XXX.09.

b. Time per charge:

	<u>Elevator Time hours</u>		<u>Manhours</u>
	<u>Front</u>	<u>Rear</u>	
Charging	1	1	5
Discharging	1	4	15

c. Reactivity Change: The test loading will have a reactivity intermediate between that of a dummy charge and a standard charge of normal fuel elements.

7. Hazards

The hazards associated with the cluster elements are covered in the original production test. Although irradiation of the Pu-Al cluster will introduce no appreciable swelling hazard in the event of a failure, there is a definite radiological hazard associated with the failure of the Pu-Al alloy element before the fuel element has been irradiated long enough to produce appreciable quantities of fission products. After this time, failure of the Pu-Al element would create hazards no greater than those associated with any irradiated uranium fuel element failure in the loops.⁽²⁾ Before appreciable fission products have accumulated, however, an undetected failure of the Pu-Al element could contaminate the loop coolant with Pu and produce a radiological control problem wherever the coolant escaped from the system. Because of this hazard, for the first forty-eight hours of reactor operation coolant samples will be taken twice a shift for analysis for plutonium and loop will be operated at low temperature to minimize corrosion of the Pu-Al alloy if a failure should occur.

8. Other Modifications of the Original Production Test

All provisions of the original production test not specifically modified by this supplement will remain in effect.

RESPONSIBILITIES

Hanford Laboratories Operation

Reactor and Fuels Research and Development Operation

Fuels Development Operation

Fuels Design is responsible for the fabrication of the cluster elements, analysis of data, and issuance of technical reports.

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RESPONSIBILITIES (cont'd)

Irradiation Processing Department

Research and Engineering Section

Component Testing Unit is responsible for post-irradiation examination and testing of components in the test charge.

Coolant Testing Unit is responsible for:

- a. Operation of the KER Loops.
- b. Taking basic operating data.
- c. Scheduling the loop charge with the concurrence of KE Processing Sub-Section.
- d. Reactor safety and production continuity as they are affected by loop operation.

Process and Reactor Development Sub-Section is responsible for:

- a. Technical aspects of the fuel element irradiation.
- b. Termination of the production test and issuance of the final report.

KE-KW Reactor Section

KE Processing Sub-Section is responsible for:

- a. Operational safety.
- b. Production continuity, except where inconsistent with the provisions of this test.
- c. Special discharges.

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

WK Kratzer:gb

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FIGURE 1

Operating temperatures and trip settings
as a function of the observed Tube ΔT .

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