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PRODUCTION TEST IP-250-A
IRRADIATION OF ZIRCALOY-2 JACKETED
TUBE-AND-TUBE ELEMENTS IN THE KER LOOPS

OBJECTIVE

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The objective of this production test is to determine the in-reactor performance of co-extruded Zircaloy-2 jacketed tube-and-tube elements. The effect of power, surface temperature, and uranium alloying on dimensional stability and uranium swelling and cracking will be measured.

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SUMMARY

Three-foot Zircaloy-2 jacketed tube-and-tube elements with either natural or 1.6% enriched unalloyed or 2% zirconium alloyed uranium will be irradiated in any of the KER Loops to goals up to 5000 MWD/T. Downstream thermocouples to measure flow channel coolant temperatures will be included for charges of enriched elements. Special tray discharges to prevent the fall of the elements to the basin are required for all loadings.

BASIS AND JUSTIFICATION

The tube-and-tube geometry is being investigated for use in the NPR because of its large surface to volume ratio and low uranium temperature for a given specific power. A series of irradiations is planned to study the dimensional stability and uranium behavior of the tubular elements at jacket surface temperatures up to 315°C and exposures up to 5000 MWD/T.

Because of its lower reaction rate with high temperature water, the uranium-2 w/o zirconium alloy may be useful in a high temperature recirculating system. Consequently the behavior of this alloy will be compared to the behavior of unalloyed uranium.

TEST DETAILS

1. Fuel Elements

The tube-and-tube fuel elements consist of a 1.050 inch OD, 0.500 inch ID inner tube mounted concentrically in a 1.820 inch OD, 1.450 inch ID outer tube. Both tubes have 0.020 inch co-extruded Zircaloy-2 jackets. The tubes are 36-1/4 ± 1/4 inches long with 1/4 inch end caps. Both tubes are supported at the ends and at the midpoint by welded Zircaloy-2 semi-flexible supports. Details of the elements are shown in SK-2-8782, Revision 1.

Elements will contain either a uranium-2 w/o zirconium alloy or unalloyed uranium. Both fuel compositions will be available with 1.6% enriched and natural uranium. All elements will have been tested for bonding and jacket thickness and have been autoclaved at 400°C in 1250 psi steam.

2. Irradiation Facility

The elements may be irradiated in any of the high temperature recirculating KER Loops, tubes 2160 KE, 2864 KE, 3565 KE, and 4268 KE. The outer tube support sizes will be varied to conform to the different process tube diameters.

Operating Conditions

The purpose of this production test is to provide the basic authorization for the irradiation of specific tube-and-tube

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elements in the KER Loops. The detailed requirements for each loading, including operating conditions and limits, charge pattern, and exposure, will be provided by supplements to this production test. Authorization for the irradiation of other heat generating elements incidental to the main test or of non-heat generating samples, coupon holders, or thermocouple dummies will also be provided by the production test supplements.

4. Exposure

The fuel element exposure will not exceed 5000 MWD/T.

5. Special Procedures

The fuel elements from this production test will be discharged into a special tray to avoid damage resulting from their fall to the basin. A detailed discharge procedure approved by KE Processing Sub-Section and Coolant Testing Unit will be issued prior to discharge.

6. Priority

Additional downtime is authorized if charging or discharging cannot be accomplished during a normal outage.

7. Costs

- a. Cost Code - XXX.5320-XXX.09
- b. Time Per Charge

	<u>Elevator Time, Hours</u>		<u>Manhours</u>
	<u>Front</u>	<u>Rear</u>	
Charge	2	3	10
Discharge	1	4	10
	3	7	20

- 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.

8. Data Desired

Routine operating data, including coolant flow, inlet and outlet temperature and pressure, system pressure, and operating time at equilibrium, will be taken during irradiation.

9. Hazards

Failure of the tube-and-tube elements is improbable. The corrosion resistance of the Zircaloy-2 jackets, the high operating temperature, and the extended surface geometry should preclude either a jacket or a core failure. If a failure should occur, there is

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sufficient volume in the coolant channels to accommodate the uranium-water reaction products from a failure without process tube splitting.

10. Deviation From Process Standards

This production test authorizes deviation from Process Standard K-040, Section 40.01, which limits the maximum uranium temperature to 600°C. Uranium temperatures up to 660°C may occur at maximum tube power conditions and are authorized, although the anticipated maximum uranium temperature will be less than 600°C.

RESPONSIBILITIES

Hanford Laboratories Operation

Reactor and Fuels Research and Development Operation

Fuels Development Operation

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

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.
1. 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. Providing the tube loading pattern and designating the operating conditions and exposure for each charge.
- c. 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

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

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

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