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October 19, 1959

SUPPLEMENT C TO PRODUCTION TEST IP-250-A,
IRRADIATION OF ZIRCALOY-2 JACKETED TUBE AND TUBE ELEMENTS
IN THE KCR LOOPS

OBJECTIVE

The objective of this Supplement to PT-IP-250-A is to determine if enriched tube and tube elements will develop pitting corrosion on the Zircaloy-2 jackets when irradiated in pH 10 water. The measurement of dimensional changes in the fuel elements and the observation of the effect of irradiation on the uranium and bond area are also objectives of the test, but secondary in importance to identifying a pitting corrosion problem in NPR quality water, if one exists.

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SUMMARY

Three enriched tube-and-tube elements similar to those irradiated under PT-IP-250-A, Supplement B, except for more extensive autoclave testing, will be irradiated in pH 10 water in the KER loops to a goal of 2000 MWD/T.

BASIS AND JUSTIFICATION

A charge of three Zircaloy-2 jacketed enriched tube and tube elements irradiated in KER Loop 3 under PT-IP-250-A, Supplement B, (1,2,3) failed by pitting corrosion of the Zircaloy-2 jackets after 13 operating days in the reactor. The cause of the pitting corrosion is not known, but abnormally high jacket surface temperatures resulting from a heavy crud film associated with the pH 4.5 water in which the elements were irradiated may have been a necessary requirement for the corrosion to occur. This hypothesis is supported by the observation of similar pitting corrosion on a rod from a tubes-and-rod charge, 1,569 which was also irradiated in pH 4.5 water with the concomitant heavy crud film. These elements had been irradiated for 200 days at a coolant temperature 60°C lower than the tube-and-tube elements and were discharged at goal without failure.

- (1) Kratzer, W. E., "Production Test 250-A, Irradiation of Zircaloy-2 Jacketed Tubes-and-Tube Elements in the KER Loops", HW-60551, June 1, 1959. (SECRET).
- (2) Kratzer, W. E., "Supplement B to Production Test 250-A, Irradiation of Zircaloy-2 Jacketed Tubes-and-Tube Elements in the KER Loops", HW-61160, July 20, 1959. (SECRET).
- (3) Kratzer, W. E., "Revised Operating Conditions for Enriched Tubes-and-Tube Elements in the KER Loops Under 250-A, Supplement B", HW-62059, September 2, 1959. (SECRET).
- (4) Kratzer, W. E., "250-A, Irradiation of Zircaloy-2 Jacketed Rod-and-Tube Elements in the KER Loops", HW-57732, October 9, 1958. (SECRET).
- (5) Kratzer, W. E., "Operating Conditions for PT-IP-205-A, Irradiation of Zircaloy-2 Jacketed Rod-and-Tube Elements in the KER Loops", HW-58259, November 25, 1958. (SECRET).
- (6) Swanson, W. E., "KER Loop 4 (1268) Operating Report, Test Number K-4-6, Production Test IP-205-A, Irradiation of Zircaloy-2 Jacketed Rod and Tube Elements", HW-61783, September 1, 1959. (SECRET).

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BASIS AND JUSTIFICATION (cont'd)

Observation of Zircaloy-2 pitting corrosion in low pH water, where it was not expected, raises the immediate question of whether similar corrosion may also occur in pH 10 water with Li OH addition, which is the coolant planned for use in the NPR. This test authorizes the irradiation of three enriched tube-and-tube elements to a goal of 2000 MWD/T in pH 10 coolant to see if a pitting corrosion problem exists under irradiation conditions as near to NPR conditions as can be obtained in the KER Loops.

This test differs from the test that failed only in that the coolant pH is raised to 10 and the fuel elements were re-autoclaved under conditions intended to reveal any jacket surface contamination that might be conducive to corrosion. KER Loop operating experience has shown that crud film formation is considerably less in high pH coolant than in low pH coolant. The additional autoclave testing, in which the elements were autoclaved for fourteen days in 360°C water, may be a more severe test for jacket corrosion resistance than the seventy-two hour autoclave test in 400°C steam at 1500 psi previously applied to the elements.

TEST DETAILS

1. Fuel Elements

The three 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, 1.050 inch ID outer tube. Both tubes have 0.020 inch co-extruded Zircaloy-2 jackets. The tubes are 35-1/4 inches long with 1/2 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.

The elements have been autoclaved for 72 hours in 400°C steam at 1500 psi and re-autoclaved for 14 days in 360°C water.

2. Loading

The loading will consist of 21 eight-inch spacers down stream, 1 eight-inch stainless steel triangular perf, 3 enriched tubular elements, 1 eight-inch stainless steel triangular perf, and up to 15 eight-inch spacers upstream. The spacers may be carbon steel perfs, (7) normal stainless-steel triangular spacers, or coupon holders approved by Process and Reactor Development Operation and Coolant Testing Operation.

Replacement of the spacer material downstream of the fuel elements with a thermocouple train to measure flow channel temperatures is also authorized provided the thermocouple train meets the requirements specified in Supplement B to PT-IP-250-A.

3. Irradiation Facility

The test may be irradiated in KER high-temperature recirculating loops 2,3, or 4; however, present plans call for irradiating the test in KER Loop 4.

(7) Kratzer, W. K., "PT-IP-284-A, Evaluation of Carbon Steel Tubular Dummies in the KER Loops," HW-61938, September 17, 1959. (UNCLASSIFIED)

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4. Operating Conditions

The coolant will be pressurized water with the pH at 10.0 $\pm$ 0.5. The desired operating flow is 60 gpm with a low flow trip of 48 gpm. The low pressure trip will be set at 1500 psig. The desired operating outlet temperature, high outlet temperature trips and cooling point suppression trip are given in 2062059, reference 3.

If recirculation with system pressures less than 1500 psig is required, the outlet temperature will be reduced and maintained at least 100°C below the system saturation temperature.

5. Exposure

The goal exposure for the fuel elements is 2000 MWD/T.

6. Tests

Code: 2065320 • 206-09

5. The test charge:

	Elevator Time	Hours	Manhours
	Front	Rear	
Charging	1	2	30
Discharging	1	2	15
Total	2	4	25

• 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

There is a definite possibility that this test will result in a fuel element failure. If pitting corrosion should occur at the test conditions it would probably cause jacket failure before the elements have reached goal. In addition, there is always the possibility of failure occurring by some mechanism not associated with pitting corrosion. The four Zircaloy-2 jacketed fuel element failures that have occurred in the KER loops have demonstrated, however, that the delayed neutron monitor is capable of detecting failures and shutting down the reactor with a minimum distortion of the fuel element and without mechanical damage to the process tube. The worst credible result of a fuel element failure would be an unscheduled reactor outage and the possible replacement of the loop process tube if examination of the failure showed that the failed area touched the process tube in such a way as to promote zirconium hydriding.

8. Other Modifications of the Original Production Test

All provisions of PT-IP-250-A and Supplement B to PT-IP-250-A not specifically modified by this supplement will remain in effect.

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Hanford Laboratories Operation

Fuels Development Operation

Irradiation Processing Department

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

- a. Operation of the XER loops.
- b. Taking basic operating data.
- c. Scheduling the loop change with the concurrence of the Processing Operation.
- d. Reactor Safety and production continuity as they are affected by loop operation.

2. Termination of the production test and issuance of the final report.

E Processing Operation is responsible for:

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

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APPROVALS

J. H. Brown, Manager Process and Reactor Development IRRADIATION PROCESSING DEPARTMENT
J. F. Music, Manager Process Technology IRRADIATION PROCESSING DEPARTMENT
C. B. Lewis, Manager Testing Operation IRRADIATION PROCESSING DEPARTMENT
O. H. Greager, Manager Research and Engineering IRRADIATION PROCESSING DEPARTMENT
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