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TITLE

SUPPLEMENT B, PRODUCTION TEST IP-377-A,
IRRADIATION OF N-REACTOR INNER FUEL TUBES
IN THE KER LOOPS

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October 6, 1961

SUPPLEMENT B, PRODUCTION TEST IP-377-A, IRRADIATION OF N-REACTOR INNER FUEL TUBES IN THE KER LOOPS

OBJECTIVE

The objective of this supplement to Production Test IP-377-A⁽¹⁾ is to evaluate the behavior of N Reactor inner fuel tubes with modified end closures during irradiation in the KER Loops.

- (1) Kratzer, W.K., Production Test IP-377-A, Irradiation of N Reactor Inner Fuel Tubes In the KER Loops, HW-67756, December 13, 1960. ()

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HW-71267

Page 2

SUMMARY

Natural and 0.947% enriched N Reactor inner fuel tubes (NIN1 and NIE1 elements) with contoured end closures are authorized for irradiation in the KER Loops to exposures no greater than 2500 MWD/T. The modification consists of machining a V groove in the uranium after counterboring and using an end cap shaped to fit the groove. Both brazed and unbonded closures will be evaluated.

BASIS AND JUSTIFICATION

The current N Reactor fuel closure design using a flat-bottomed end cap brazed to the fuel core and jacket has performed satisfactorily during irradiation testing in the KER Loops. Because the volume of testing is limited by available loop space, satisfactory fuel performance during loop testing does not necessarily mean that this closure concept is completely trouble free. As a safeguard against unexpected difficulties occurring in the flat-bottomed brazed closures, it appears prudent to develop and evaluate, on a limited scale, promising alternate closure designs. The irradiation testing of the modified closures is intended to evaluate uranium and jacket distortion in the end cap region. Because of limited test space, the superiority of either the standard or the modified closures cannot be demonstrated; however, enough information can be gained about the irradiation behavior of the modified closures to determine the desirability of continued evaluation.

The contoured end design, Figure 1, is intended to reduce the effects of the differential thermal expansion between the uranium core and the Zr-2 cap. The flat-bottomed design tends to localize shear strains in the jacket at the cap-uranium interface. By providing a tapered uranium section from the base of the recess to the cap, the contoured closure should spread the jacket strain over a larger area, thus reducing potential for failure in this region. Both bonded and unbonded contoured end caps will be tested to determine the effect of the restraint imposed by bonding on fuel and jacket deformation.

TEST DETAILS

1. Fuel Elements

The fuel elements shall consist of standard NIN1 or NIE1 elements authorized by PT-IP-377-A modified by contouring the uranium and cap as shown in Figure 1. The bonded elements will be prepared by standard brazing and welding procedures. The unbonded elements will be prepared by assembling the cap and fuel and electron beam welding the cap in place. All fabrication and inspection procedures, with the exception of those steps related to the modified closures, will be in accordance with the Coextrusion Process Standards. ⁽²⁾

2. Loading

The tube loading will be given in a document approved by Process Technology Operation and Process and Reactor Development Operation prior to charging. Coupon holders of a design approved by Coolant Testing Operation and Process and Reactor Development Operation may be included in the charge, in positions not affecting the fuel element test.

(2) Coextrusion Process Specifications, HW-69941, August, 1961 ()

DECLASSIFIED

HW-71267
Page 3

3. Irradiation Facility

The fuel elements may be irradiated in KER high temperature recirculating loops 1 or 2.

4. Operating Conditions

The coolant will be pressurized water with the pH adjusted to 10.0 ± 0.5 by the addition of LiOH. The low pressure trip will be set at 1500 psig. For a charge in loop 2, the desired operating flow is 60 gpm with a low flow trip of 48 gpm. For a charge in loop 1, the desired operating flow is 50 gpm with a low flow trip of 40 gpm. The high outlet temperature trip, maximum operating outlet temperature, desired operating outlet temperature (which can be varied at the discretion of the test author as long as it does not exceed the maximum operating outlet temperature), and boiling point suppression trip will be given for each loading in a document approved by Process Technology Operation and Process and Reactor Development Operation prior to charging.

If recirculation with system pressures less than 1500 psig is required, the outlet temperature will be reduced and maintained at a temperature such that fuel surface temperatures will be less than the coolant saturation temperature and local channeled coolant temperatures are sufficiently below the coolant saturation temperature to preclude sub-cooled burnout.

5. Power and Temperature Limits

The operating conditions will be chosen so that surface boiling will not occur on the fuel elements during normal operation, burnout will not occur at the limiting trip conditions, and the maximum uranium temperature will not exceed 600°C.

6. Exposure

The maximum exposure authorized by this supplement is 2500 MWD/T.

7. Special Procedures

The fuel elements from this production test will be discharged into a special tray according to procedures developed by the KE Maintenance Operation.

8. Priority

Additional down-time is authorized if charging or discharging cannot be accomplished during a normal outage.

9. Costs

a. Cost Code: XXX-5R24-XXX.73

b. Time for each loading:

	<u>Elevator Time, Hours</u>		<u>Manhours</u>
	<u>Front</u>	<u>Rear</u>	
Charge	1	1	4
Discharge	2	4	10
	3	5	14

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.

DECLASSIFIED

HW-71267

Page 4

10. Data Desired

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

11. Hazards

There is little likelihood of poorer performance from the elements with modified closures than from normal NIN1 or NIE1 fuel elements. In fuel with unbonded end caps, the contoured end should be beneficial in alleviating the type of jacket straining that caused a failure in a KSN1⁽³⁾ element at 1700 MWD/T under PT-IP-309-A⁽⁴⁾.

If a failure should occur, the Zr-2 flow distributing sleeve around the elements should preclude hydriding damage to the process tubes.

RESPONSIBILITIES

Fuels Preparation Department

Engineering Section

Coextruded Product Engineering is responsible for preparing the fuel elements.

Hanford Laboratories Operation

Reactor and Fuels Research and Development Operation

Fuels Development Operation

Fuels Fabrication Development Operation is responsible for fuel evaluation, analysis of data, and issuance of technical reports.

Irradiation Processing Department

Research and Engineering Operation

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

(3) Kusler, L.E. and W.K. Kratzer, Method for Designating Experimental Coextruded Zircaloy-2 Jacketed Fuel Elements, HW-67225, October 26, 1960 ().

(4) Kratzer, W.K., Production Test IP-309-A, Irradiation of Heavy Walled Tubular Elements in the KER Loops, HW-64183, March 7, 1960 ().

DECLASSIFIED

HW-71267
Page 5

Coolant Testing Operation 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 Operation.
- d. Reactor safety and production continuity as they are affected by loop operation.

Process and Reactor Development Operation is responsible for:

- a. Technical aspects of the fuel element irradiation, including effect of fuel elements on reactor safety.
- b. Termination of the production test and issuance of the final report.

KE-KW Reactor Operation

KE Processing Operation is responsible for:

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

W. K. Kratzer
Process and Reactor Development
Research and Engineering
IRRADIATION PROCESSING DEPARTMENT

WKK:gb

FIGURE 1

FUEL CLOSURE MODIFICATION

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