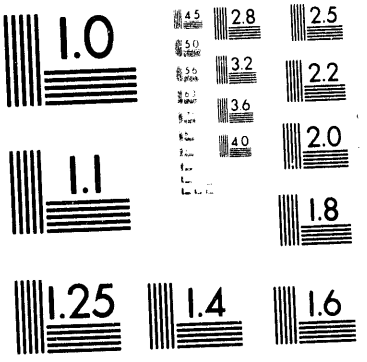
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TITLE

PRODUCTION TEST IP-401-A; IRRADIATION OF ZIRCALOY-2 JACKETED UO_2 TUBULAR ELEMENTS IN THE KER LOOPS

AUTHOR

W. K. Kratzer

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IRRADIATION PROCESSING DEPARTMENT

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PRODUCTION TEST IP-401-A: IRRADIATION OF ZIRCALOY-2 JACKETED UO_2 TUBULAR ELEMENTS IN THE KER LOOPS

OBJECTIVE

The objective of this production test is to evaluate the behavior of large diameter tubular UO_2 fuel elements during high temperature irradiation.

SUMMARY

Eighteen inch long tubular UO_2 fuel elements 1.804 inch OD, 0.544 inch ID, in 0.060 inch Zircaloy-2 jackets will be irradiated in the KER loops either alone or in conjunction with other tests to exposures up to 3500 MWD/T of contained uranium.

BASIS AND JUSTIFICATION

Zircaloy-2 jacketed UO_2 fuel elements have potential application in N Reactor for phase III (power only) operation. Appreciable irradiation experience has been obtained from UO_2 elements in rod form and from tubular elements with thin fuel cross-sections irradiated in the vertical position. No experience, however, is available for tubular elements with 1/2 inch thick fuel cross-sections or for tubular elements irradiated in the horizontal position. Since a phase III tubular UO_2 fuel element would probably require thick fuel sections and would obviously be irradiated in the horizontal position, irradiation of the fuel elements authorized by this production test will provide information otherwise not available for evaluating UO_2 fuel element behavior.

TEST DETAILS

1. Fuel Elements

The fuel element dimensions are:

OD	-	1.804 inches
ID	-	0.544 inch
Length	-	18 inches
Zr-2 Jacket Thickness	-	0.060 inch
End Cap Thickness	-	3/16 inch

The fuel consists of sintered UO_2 prepared from natural uranium. After fusion welding one cap to the jacket in a helium atmosphere, powdered UO_2 was compacted in the jacket by vibration to 88% theoretical density for UO_2. The other cap was then fusion welded in place. The assembled elements have been helium leak tested, X-rayed for weld soundness, and autoclaved in steam for seventy-two hours at 400°C and 1500 psig.

Semi-flexible Zr-2 supports were spot welded to the jacket at each end. Fuel element details are shown in Figure 1.

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.

3. Irradiation Facility

The fuel elements may be irradiated in any KER high temperature recirculating loop with a nominal 2.028 inch process tube ID.

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 loops 2, 3, or 4, 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 subcooled 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 jacket-fuel interface temperature will not exceed 450°C. The maximum UO_2 temperature, although not precisely known, will probably not exceed 2500°C.

6. Exposure

The maximum exposure authorized by this production test is 3500 MWD/T of contained uranium.

7. Special Procedures

The fuel elements from this production test may be discharged into a special tray according to procedures developed by the KE Maintenance Operation, depending upon the discharge requirements for the fuel irradiated in conjunction with this test.

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.75

b. Time for each loading:

	Elevator Time, Hours		Manhours
	Front	Rear	
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.

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

The risk of process tube or reactor damage in the event of a fuel element failure is negligible with the UO_2 element since, with the sensitivity of the KER loop failure detection system and the rapidity of shutdown following detection, there should be no fuel element swelling or distortion as the result of failure.

RESPONSIBILITIES

Hanford Laboratories Operation

Reactor and Fuel Research and Development Operation

Fuels Development Operation

Ceramic Fuels Development Operation is responsible for fuel element fabrication, 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.

[redacted]

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 the 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 Subsection
RESEARCH AND ENGINEERING SECTION

WKK: kmn

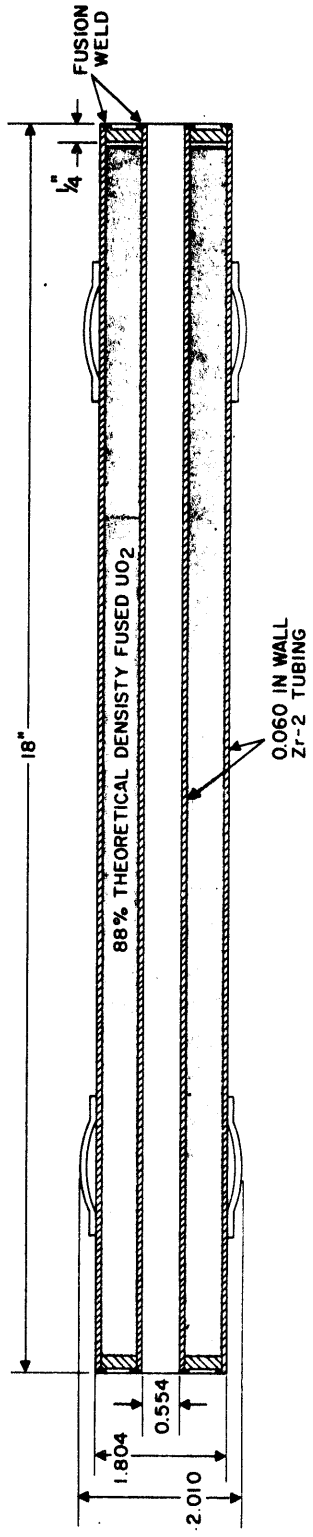

FIGURE I
Zircaloy-2 Jacketed Tubular UO_2 Element

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