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HW-80409

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January 20, 1964

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TITLE

PRODUCTION TEST IP-653-D, IRRADIATION SERVICE
REQUEST HAP0 300, IRRADIATION OF A TUNGSTEN
MATRIX UO₂ CERMET PLATE IN THE KW SNOUT
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PRODUCTION TEST IP-653-DIRRADIATION SERVICE REQUEST HAPO 300IRRADIATION OF A TUNGSTEN MATRIX UO₂ CERMET PLATE IN THE KW SNOUT FACILITY

Classification Cancelled and Changed To

J. H. Cox

January 20, 1964

DECLASSIFIEDBy Authority of RM. Olen4-5-94, CG PR-2By J. E. Sawley 4-17-94Verified By Jessie Maley 4-18-94

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRODUCTION TEST IP-653-D
IRRADIATION SERVICE REQUEST HAPO 300
IRRADIATION OF A TUNGSTEN MATRIX UO₂ CERMET PLATE IN THE KW SNOUT FACILITY

OBJECTIVE

The objective of this production test is to continue an irradiation program started under Production Test IP-608-D. (HW-78725).

BASIS AND JUSTIFICATION

Cermets are attractive as fuel for nuclear reactors because of their relatively high thermal conductivity and their apparent ability to withstand very high temperatures for prolonged periods of time. A number of cermet fuel specimens have been successfully irradiated at temperatures greater than 2000 C for periods of up to six weeks. Two cermet fuel plates described herein have successfully operated, in the snout facility, at ~3000 C for four hours each. This continuation of the program for twelve more capsules is to investigate the diffusion characteristics of UO₂ and fission products from the tungsten matrix and to study the dimensional stability of the system. The in-reactor test, in conjunction with extensive out-of-reactor studies, will provide a firm basis for building cermet fuel technology.

REACTOR AND FACILITIES REQUIRED

KW Reactor; Snout Facility

DESCRIPTION OF CAPSULE AND SPECIMENS

A drawing of the capsule is shown in Figure I. The fuel is 93 per cent enriched UO₂ in a tungsten matrix. The specimen is 1" x 0.875" x 0.030", containing 1.08 grams of UO₂. The sides of the specimens are clad with two to three mils of tungsten; the edges are bare cermet. The specimen is centered, using tungsten rods, in a 304L stainless steel capsule 1.75" OD x 1.63" ID by 5" long. Specimen support is maintained by resting the tungsten rods in zirconia end blocks. A 125 mil clearance in the zirconia allows for expansion of the tungsten during irradiation. Capsule atmosphere will be 1) a 10⁻⁵ mm mercury vacuum, 2) a 100 per cent hydrogen atmosphere with a 1.0 atmosphere pressure. The above pressures are at room temperature. An aluminum sleeve 1.750" ID x 2.700" OD is placed around the stainless steel capsule with a shrink fit.

The capsule is attached to a twenty-foot aluminum tube using a 37° flare Parker fitting. This tube is used as a "handle" for charge-discharge.

DETAILS OF IRRADIATION

Capsule Instrumentation

None

Method

The snout facility is a tube-in-tube arrangement. Each tube has independent coolant flow from the X-level crossheader. The capsule is inserted into the bore water lock; the ball valve connecting the water lock and the bore tube is opened and bore

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QTY.	QTY.	DESCRIPTION	MAT'L OR CAT
1	1	ASSEMBLY	
1	2	TUBE	
1	3	SUPPORT ROD	
2	4	SPACER	
1	5	END CAP	
1	6	END CAP	
1	7	FUEL PIECE	
1	8	HOUSING	
1	9	PLUG	
1	11	MALE CONNECTOR,	PARKEE PART-5

GENERAL NOTES:
(UNLESS OTHERWISE SPECIFIED)

1. TOLERANCES: FRACTIONAL $\pm \frac{1}{64}$, DECIMAL $\pm .005$, ANGULAR $\pm 0^\circ 30'$
2. ALL MACHINED SURFACES $\sqrt{63}$ (ASAB A66.1 1962)
3. BREAK ALL SHARP CORNERS & REMOVE ALL BURRS.
4. ALL MATERIAL TO BE AS SPECIFIED OR APPROVED EQUAL QUALITY.

H-3-19962 1/1

NO.	DESCRIPTION	REV.	DATE	APP'D	FOR	DATE
3	ADDED PART 10, ZONE 69 PART 10B11 TO ASSY 1 & M/L 6) DELETED PART 9 & ADDED 9) EX. DIM. PART 8, ZONE 67	JNJ	7/17/65	FTM	FTM	7/17/65
2	C) CHGD DIM PART #4, ZONE D) CHGD PART #7, ZONE 68 A) CHGD DIM PART #5, ZONE 67	JNJ	7/14/65	FTM	FTM	7/14/65
1	EN CO 258 253, C) HAS .002-.005 A) CHGD DIMS OF PARTS # DMS & MAT'L LIST ADDED PARTS # 4, 5 & 7	JNJ	7/14/65	FTM	FTM	7/14/65

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NEXT USED ON		NEXT USED ON	
H-3-19962		H-3-19962	

DETAILS OF IRRADIATION (continued)

flow is verified. Next, the bore flow is placed in the reactor safety circuit and the capsule is slowly pushed into the flat flux zone of the reactor.

After the capsule has received the required exposure, it is withdrawn to the water lock. The bore tube is removed from the safety circuit and the ball valve is closed. After a 24-hour decay period, the capsule and aluminum tube are withdrawn from the water lock into a cask train located in front of the snout facility. The capsule is cut from the aluminum tube and pushed into a shipping cask. The aluminum tube is then cut up and buried.

Number of Capsules to be Irradiated and Length of Exposure

This production test authorizes the irradiation of twelve (12) capsules for exposure periods of four (4) hours each.

Reactivity Loss

Two effective cmk

Reactor Outage Time Required

None

Special Considerations

The reactor control room will be notified before each test is started. The Panellit trips, which are based on laboratory flow tests, and gamma monitor trips are verified before each test.

Processing will be furnished with a charge letter giving normal, maximum high, and minimum low Panellit pressures for this production test.

Conditions for Reactor Shutdown

The Snout bore tube has a standard Panellit gauge in the reactor safety circuit. During this test, it will be placed on a 60-second delay scram.

Operating Conditions

Normal Bore Flow	$\approx$ 20 gpm
Scram Flow	= 5 gpm

Heat Transfer

Maximum Power From Sample	= 2.04 kw
Heat Flux on Cermet	= 3.15×10^5 BTU/hr ft ²
Maximum Surface Temperature of Cermet	= 5560 F
Heat Flux on Stainless Steel Capsule	= 6.28×10^4 BTU/hr ft ²
Surface Temperature of SST capsule at 5 gpm	= 209 F
Heat Flux in Aluminum Sleeve	= 4.53×10^4 BTU/hr ft ²
Surface Temperature of Aluminum Sleeve at 5 gpm	= 128 F

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TEST MONITORING

The Snout bore tube has a Panellit gauge in the reactor safety circuit. For the duration of this test, the safety circuit will be set on a 60-second delay. A flow of five gpm will scram the reactor after 60 seconds.

The Snout effluent is continuously monitored for radioactivity level. If a high alarm is given, a water sample will be taken from the test hole sample header on the 18-foot level. Should fission products be present in the sample, the capsule will be removed from the flux, allowed to cool, and discharged.

The Snout annulus coolant flow is continuously monitored with a Panellit gauge. Loss of annulus coolant flow will give an alarm which requires that the capsule be removed from the flux as soon as possible.

HAZARDS

A conservative hazards analysis has been made based on the following assumptions:

1. The tungsten rails fail and the sample falls to the stainless steel wall.
2. Of the heat generated, one-half is absorbed in the lower one-third of the capsule.
3. The capsule is operating on the scram flow rate (5 gpm).
4. There is an instantaneous loss of bore flow. Annulus coolant flow is unaffected.
5. All bore water is instantaneously drained from the bore tube.

This investigation has shown that, if the reactor is scrammed on a 60-second delay scram, the aluminum sleeve should not fail from loss of bore flow.

The reactivity loss (~2 effective cmk) caused by the capsule should cause no unusual reactor control problem.

At the temperatures listed in the heat transfer section, no stainless steel aluminum corrosion problems are foreseen.

A hydrogen-oxygen reaction, assuming 50 per cent of the O_2 available in the UO_2 specimen is instantaneously burned, should not cause an excessive pressure in the capsule (~226 psig).

If the aluminum wall and stainless steel wall were to fail, the cermet would come in contact with process water. The metallic matrix of the cermet will allow only a very low corrosion rate. However, should a rupture become evident, the test will be pulled from the flux, allowed to cool, and then discharged.

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RESPONSIBILITY

Irradiation Processing Department

Irradiation Testing

Irradiation Testing will be responsible for capsule integrity, charge-discharge, and shipment of the capsule to 300 Area.

J H Cox

Engineer
Irradiation Testing

JH Cox:mkc

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