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PRODUCTION TEST IP-582-D, IRRADIATION OF
DEPLETED URANIUM IN THE KW SNOUT FACILITY
HAPO-275

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PRODUCTION TEST IP-582-D

IRRADIATION OF DEPLETED URANIUM

IN THE KW SMCUT FACILITY - HAP0-275

J. H. Cox

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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PRODUCTION TEST IP-582-D
IRRADIATION OF DEPLETED URANIUM
IN THE KW SNOUT FACILITY - HAPO-275

OBJECTIVE

The objective of this test is to produce 50 milligrams of neptunium 239 for a process stream study in the Purex plant.

BASIS AND JUSTIFICATION

The efficient recovery of neptunium 237 as an alternate product produced at HAPO is presently impaired by the lack of knowledge of the distribution of neptunium 237 in the several Purex process streams. Present methods of following the neptunium 237 through the process streams involves inadequate alpha counting techniques. However, neptunium 239, because of its discrete gamma decay energy, can be readily identified in the process stream. As a result, the neptunium 239 produced by this irradiation will serve as a gamma-emitting tracer for the neptunium 237 in the Purex process stream.

REACTOR AND FACILITIES REQUIRED

KW Reactor, 4 B Snout Facility

DESCRIPTION OF CAPSULE

Two depleted I&E pieces (C11D-type) are centered in an aluminum basket. Each depleted piece contains 2000 grams of uranium with 0.19 per cent U-235. A one-inch aluminum tube attached to the basket carries coolant to the fuel elements; also, the one-inch tube serves as a handle for charge-discharge. Figure 1 shows a drawing of the sample and basket. This basket assembly will be charged into the 4B Snout bore tube which has an ID of 2.86 inches.

DETAILS OF IRRADIATION

Instrumentation - On capsule - none

Inlet annulus flow:	X-2 level and control room alarm on high and low pressure
Inlet bore flow:	X-2 level low pressure alarm and X-1 level flow recorder
Outlet bore flow: (1)	X-2 level and control room alarm on low flow. Reactor scram on low-low flow.
Outlet bore temperature:	Control room alarm on high temperature.
Outlet bore gamma activity:	X-2 level and control room alarm on high and low activity.

Special Features

Prior to test insertion, all valves in the X-levels process water supply system downstream from the B-C crosstie (source of the X-level water supply) which could have a decreasing affect on the Snout bore flow will be locked closed, capped or plugged. A schedule of all valves and their positions is given in Figure 2.

(1) Design Change 684, 4B Snout Facility Coolant Safety Circuit, PE Lindstrom

FIGURE-1
SAMPLE AND BASKET

FIGURE-2

X-LEVEL VALVE SCHEDULE

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The two depleted uranium samples were re-run through all the standard post-canning examinations and tests to ensure cladding integrity.

Special piping was installed from the X-1 level process water header to the 4B Snout annulus inlet connector. The normal X-2 level annulus water supply was blanked off. This division of water supplies to the annulus and bore will ensure that the backup flow would not be interrupted by the extremely remote incident of an X-2 level header failure. The bore flow during the test is supplied from the X-2 level header at the 4C test hole; a hydraulic hose (working pressure 1000 psig) carries the water from the X-2 level header to the end of the 20 foot one-inch tube feeding the capsule. All connecting fittings are of the standard 37 degree flare type used on process tube flexible connectors. Figure 3 shows the special piping change. Special piping changes will exist only for this production test.

A special rear nozzle cap was fabricated with a thermocouple well to monitor the effluent bore temperature. The temperature is printed out on a recorder located on the X-1 level and will alarm in the control room should the effluent temperature increase 7 C above the normal bore temperature. The cap alteration and a schematic drawing of the thermocouple circuitry is shown on Figure 4.

Other than Irradiation Testing people, any personnel entering the confines of the Snout facility (roped off area around casks on X-2 level) or personnel operating equipment anywhere on the X-2 level will first obtain permission from the reactor manager.

Method

The Snout Facility is a tube-in-tube arrangement. It has independent water flows in the annulus and bore; the annulus flow remains on at all times. The capsule is inserted into the water lock, and the ball valve connecting the water lock and the bore tube is opened. The water supply from 4C test hole (through the hydraulic hose and one-inch tube) is valved in and the normal 4B bore water is valved off. Bore flow (approximately 20 gpm) is verified by the flow recorder on the bore inlet and by the low flow light being clear in the control room. The low flow warning light is actuated by a signal from the outlet flow monitor in case of insufficient flow. The bore flow is then placed in the safety circuit. The capsule may then be pushed into the flat flux zone of the reactor. After the capsule has received the required exposure (less than 48 hours), it is withdrawn into the biological shield and then into the water lock. The bore flow is then removed from the safety circuit. At this time the 4B bore flow is valved in. The water supply from the 4C header will also remain on during the subsequent cooling period. A cooling period of six hours will be completed before the 4C water supply is turned off and the ball valve is closed.

The capsule is then withdrawn into the cask train located on the X-2 level in front of the Snout facility. The capsule and basket are cut from the aluminum tube, using the Snout guillotine, and pushed into the transfer cask. The sample will then be transferred to a normal fuel shipping bucket in the KW basin and delivered to the Purex plant.

Reactivity Loss - Three nominal cmk.

Number of Samples and Length of Exposure - This production test authorizes the irradiation of two depleted fuel elements for an exposure period of up to 48 hours.

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NOTE:

ALL FITTINGS USED IN THE MODIFICATIONS
WILL BE STANDARD PIPE OR 37° FLARE
CONNECTORS

FIGURE-3
WATER SUPPLY MODIFICATIONS

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FIGURE-4
THERMOCOUPLE INSTALLATION
FOR PT-IP-582-D

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Reactor Shutdown Time Required - None

Operating Conditions

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4B Bore tube:

Normal flow	= 20 gpm
Low flow alarm	= 14 gpm
Scram flow	= 10.5 gpm
High gamma monitor alarm	= 1.8 x normal preinsertion reading
Low gamma monitor alarm	= .5 x normal preinsertion reading
High temperature alarm	= Normal outlet temperature + 7 C

Conditions for Reactor Shutdown

The activity level of the Snout effluent water is continuously monitored on the 18' level. The relative activity level is recorded on the X-2 level; also, there are activity alarms in the reactor control room and on the X-2 level. These alarms will actuate on either high or low activity. If a high alarm is given, the tube (4B test hole) will be sampled at the 18' level sample manifold to verify a cladding failure. Should there be evidence of fresh fission products, the reactor will be shut down. A schematic drawing of the gamma monitor system is given on Figure 5.

The annulus flow is monitored by a Panellit gauge located on the X-1 level. Gauge trip points will be set at dial readings of 20 and 80 and will alarm on the test hole high pressure annunciator in the control room. Upon receipt of a pressure alarm the actual pressure to the facility will be checked. If the pressure is 20 psig (or lower) or 100 psig (or higher), the reactor will be manually shut down and the test discharged. Header pressure available on the X-1 level is 125 psig.

The signal from the bore effluent flow will be in the safety circuit during the test. If the flow rate drops to 10.5 gpm or less, the reactor will automatically be scrammed.

Thermal Hydraulics

Scram flow

Total flow	= 10.5 gpm
Fuel element annulus	= 6 gpm
Fuel element bore	= 4.5 gpm

Maximum power

Total	= 25 KW/ft
	= 85,000 BTU/hr ft
Fuel element annulus	= 57,200 BTU/hr ft
Fuel element bore	= 28,100 BTU/hr ft

Maximum heat flux

Fuel element annulus	= 150,000 BTU/hr ft ²
Fuel element bore	= 300,000 BTU/hr ft ²

Surface temperature at scram flow

Fuel element annulus	= 143 F
Fuel element bore	= 154 F

Film heat transfer coefficient

Fuel element annulus	= 2620 BTU/hr ft ² F
Fuel element bore	= 4130 BTU/hr ft ² F

FIGURE-5
4-B TEST HOLE GAMMA MONITOR

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After heat

One minute after irradiation	=	560 watt/ft
Six hours after irradiation	=	64 watt/ft

HAZARDS

The worst credible condition for this test would be the instantaneous loss of flow and pressure to the Snout bore tube. An investigation has been made; in summary, the investigation shows that the sample will not melt.

With the annulus flow at the high or low pressure alarm point (approximately 7 gpm) there is adequate backup cooling available to prevent damage to the bore tube following loss of bore flow.

Removal of the test assembly from the flux to the water lock in the hypothetical time of one second would not result in film boiling. However, removal of the test assembly from the flux to the water lock will be done slowly, requiring approximately two minutes. One minute of this time will be when the assembly is essentially out of the flux region. Removal of the test assembly to the dry discharge cask six hours after leaving the flux will result in a maximum equilibrium cladding surface temperature of less than 300 C.

RESPONSIBILITY

Irradiation Processing Department

KW Processing

Perform high gamma activity and annulus flow alarm steps as described in Conditions for Reactor Shutdown, page 8.
Control of personnel and equipment allowed on the X-2 level.

Irradiation Testing

Charge and discharge the capsule.
Ensure capsule integrity.
Maintain reactor safety and production continuity as determined by the conditions of this test.

J H Cox

Irradiation Testing

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