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RL-REA-2249 J
Hanford Code C-65

September 3, 1965

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

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MONTHLY RESEARCH AND DEVELOPMENT REPORT
AUGUST 1965
IRRADIATION PROCESSING DEPARTMENT

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MONTHLY RESEARCH AND DEVELOPMENT REPORT
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By

T. W. Ambrose

AUGUST 1965

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RESEARCH AND DEVELOPMENTRESEARCH AND ENGINEERINGUranium Oxide Fuel Program

Fabrication of oxide elements is now under way. One fuel column (20 elements) of the vibration compacted elements has been completed. About ten of the higher-density, sintered pellet elements have been assembled. Up to four fuel columns of 20 elements each are scheduled to be charged into the KW Reactor during the mid-September outage.

Welding of the compacted elements is still a problem. Some steps have been taken to prevent contamination of the closure region. Completion of the elements is not expected to be delayed as a result of closure trouble. All of the elements produced have been helium leak checked and the welds radiographed.

Bismuth Test

The mixed charge of bismuth elements alternated with uranium pieces was discharged from C Reactor on July 30 without difficulty. This completes the irradiation phase of polonium production test in overbore geometry.

Ribbed Zircaloy Tubes

The three full-length ribbed K-size Zircaloy process tubes being fabricated by electron beam techniques have been completed.

High Graphite Temperature Test

Data from the high graphite temperature test at F Reactor are presently being analyzed. Preliminary conclusions indicate that a temperature limit increase in the order of 50C is technically feasible; however, a different philosophy of oxidation limit administration would probably be necessary.

Physics Code Development

Adaption of GEM (Monte Carlo) and EXTERMINATOR (two-dimensional diffusion) codes to local facilities is progressing. An additional Monte Carlo program, which was developed at Oak Ridge called the O5R, is being considered for use. This code is being adapted to local facilities by Battelle-Northwest.

Pu-Thoria Physics Testing

Dry reactivity and flux distribution measurements of 6 w/o Pu in aluminum and thoria in a 1:1 supercell arrangement have been completed in the PCTR; the data are being analyzed. The wet tests have been scheduled for September.

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Reactor Characteristics of Hot-Die-Sized Fuel

Physics calculations of the reactor improvements in the use of hot-die-sized fuel have been made. The differences given below are based on the present AlSi fuel.

	<u>Small Reactors</u>	<u>K Reactors</u>
Positive Void Coefficient	10% reduction	30% reduction
Positive Graphite Temperature Coefficient	no change	no change
Negative Doppler Coefficient	2% more negative	3.6% more negative
Cold, Clean k	no change	no change
Gratuitous Np production	3.5% gain	5% gain
Weight Per Foot	6.6% heavier	8.6% heavier
Pu Conversion	1% gain	1% gain

The 30 per cent reduction in the void coefficient in the K Reactors is significant as it will make it easier to obtain future goals in increasing specific fuel powers and thus strengthen the K-Reactors' flexibility for non-defense products.

Irradiated IPD Fuel Examination, 105-C Facility

Examinations were completed on fuel elements from 39 tubes requiring 4543 individual examinations.

Production Test Material

<u>No. of Tubes</u>	<u>Production Test</u>	<u>Title</u>
4	IP-216	Evaluation of Performance of Normal Production I&E Fuel Elements
1	IP-449	Effluent Activity Studies in the 1706-KE In-Reactor Facility
4	IP-476	Irradiation of Dummy Fuel Elements in Tube 2952-KE
4	IP-520	In-Reactor Testing with Coolant Prepared in the Water Treatment Pilot Plant
8	IP-604	Alternate Inhibitor Studies
3	IP-669	Depleted Uranium Irradiation, Smaller Reactors
3	IP-694	Depleted Uranium Irradiation, K Reactors
1	IP-746	Polonium Production in the C Overbore Facility
2	IP-32 (PITA)	Use of Small Production Quantities of Hot-Die-Sized Fuel Elements

Other MaterialPurpose of Examination

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Visual examination of randomly-discharged fuel elements for end-unbond, B Reactor

Photographs were taken of two ruptured fuel elements from C Reactor.

Single-Pass Tube Facility Operation - 1706-KE

<u>Tube</u>	<u>PT</u>	<u>Water Supplied</u>	<u>Corrosion Inhibitors & Chemical Additions</u>	<u>pH</u>
SP-1 (2952)	604	Service	2.0 ppm dichromate	7.0*
SP-2 (3050)	604	Service	2.0 ppm dichromate	7.0*
SP-3 (4355)	520	WTTPP**	1.8 ppm dichromate	6.6**
SP-4 (4456)	520	WTTPP**	1.8 ppm dichromate	6.6**
SP-5 (4557)	604	Service	2.0 ppm sodium sulfite	6.6
SP-6 (4863)	604	Service	2.0 ppm sodium sulfite	6.6
SP-7 (4963)	449	Process	10.0 ppm activated silica	6.6
SP-8 (5063)	449	Process	10.0 ppm activated silica	6.6

* pH controlled with sodium hydroxide.

** Water Treatment Pilot Plant product. The flocculating agent is aluminum nitrate and is supplied in sufficient quantity to maintain the zeta potential near zero. The pH control is maintained with nitric acid addition.

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FACILITIES ENGINEERING

Dose Rate Telemetry

Operating and maintenance manuals, certified test data, and reliability data were received July 21. The system, which was received on-plant in early July, has run approximately 648 hours in the laboratory. To date we have noted one failure chargeable to Tracerlab. All the detector transmitter units were returned to Tracerlab because of the marginal performance of the pulse-shaping equipment. These units have been repaired and returned to HAP0 for further testing. Preparations are being made to install the prototype equipment in KE Reactor during September.

In-Core Flux Monitor

The gamma-sensitive, stainless steel, in-core chamber assembly removed from 105-KW was shipped to Battelle-Northwest, Radiometallurgy Laboratory, on July 16 for examination and evaluation. Preparation of the development report has been initiated.

Uncooled Horizontal Control Rods

A full-size simulated uncooled HCR fabricated from stainless steel has been tested in a channel mockup to demonstrate the mechanical action of the rod in a grossly distorted channel, check stress levels, and measure drive force requirements. Testing was under the direction of personnel from GE's Nuclear Materials and Propulsion Operation (NMPO), Cincinnati, Ohio, who designed the rod. A blocked channel test demonstrated that the rod would not "jackknife" in the channel within the process tube pattern even with a drive force of 660 pounds applied. The maximum bending stress which was at the entrance to the step plug was about 3300 psi and the test was considered a success.

A full-size rod segment made up of the poison cermet clad in Inconel 600 has been co-extruded and is being fitted with hinge-joint ends in order that the assembly may be tested. It is planned to measure the control strength of this assembly in the 305 test reactor at Hanford.

PRODUCTION FUELS SECTION

Thoria

Three hundred (300) pounds of thoria produced by extrusion, calcination, and crushing were received from GE-NMPO for evaluation. An analysis of the thoria particles shows the following characteristics:

	1/8" Pellets	Mesh Size		
		6/10	60/100	200/323
Dissolution (%)	98.6	98.2	99.4	98.6
Surface Area (m ² /g)	0.78	0.41	0.44	0.66
Offgas Volume (cc/g) 1200 C	0.029	0.099	0.093	0.156
Loss-on-Ignition	0.01	--	--	--

This material has approximately a 20 per cent void volume. The voids range from 0.3 to 0.6 microns in diameter, resulting in an effective particle density of 80 per cent. Although the ternary particle size mix was expected to compact to a target density of 8.7 g/cc, the compacted density using standard mechanical vibration equipment was 7.2 g/cc. The fine fractions of the thoria were heavily contaminated with iron.

An experiment was conducted to determine the effect of calcining on thoria particle properties at 1200 C for four hours. Samples were calcined from ten Mallinckrodt lots with the following results:

	<u>Before Firing</u>	<u>After Firing</u>
Ave. Surface Area (m ² /g)	4.38	0.67
Ave. Particle Density (cc/g)	8.81	9.60
Dissolution	All samples passed	Three samples failed

Anticipating a continuing thoria target element production program, fabrication parameters are being optimized for 45 mil cladding components. Two end-cap wafers are being used to provide insulation between the thoria and the end-closure weld zone, and to provide a heat sink to minimize weld blowouts. Some welding improvement has resulted from the use of a chill block around the target elements during welding to prevent overheating.

Analytical Laboratory measurements are being made to determine the amount of moisture absorbed by thoria during target element assembly. Complete data are not yet available, but preliminary measurements indicate humidity control may be required for future production runs to control moisture adsorption.

Calculations to determine helium concentration for target element leak detection indicate that testing has not been conducted at the desired level of confidence. Engineering specifications are being revised to specify both helium concentration and helium leak rate.

Alternate Process

The preparation of five columns each of 1.25 per cent enriched hot-die-sized and AlSi bonded fuel elements is essentially complete for a K Reactor irradiation test. This test is designed to compare the corrosion resistance of the two types of fuel elements at high tube power and exposure. In order to minimize the effects of uranium core fabrication, the test and control pieces were assembled with cores taken from alternate positions in the as-rolled uranium rod. Difficulty experienced in the sizing step of the hot-die-size process with galling and wrinkling of the cladding was eliminated by adjusting the fuel assembly preheat temperature to compensate for the smaller dimensions of the enriched cores.

Two nickel-plated uranium specimens were tested at 170 C for periods of 130 minutes to determine the resistance of nickel-plated uranium to attack by hot water or steam. Specimen variables included surface roughness and nickel-plate thickness. Differences in surface roughness were achieved by electrolytic etching in (1) phosphoric-hydrochloric acid, as used in present plating process, and (2) sulfuric-hydrochloric acid, which produces a smoother surface. The phosphoric-hydrochloric acid etched sample exhibited gross detachment of the plate, while the sulfuric-hydrochloric etched sample failed only along one sharp edge where highly stressed or possibly cracked plate might be expected.

Development was continued on a "Hall Effect" probe to nondestructively measure the nickel-plate thickness of finished hot-die-sized fuel elements.

Two natural self-supported hot-die-sized overbore fuel elements failed in the C Reactor test facility during August. One failure occurred at about 25 per cent of goal exposure and was caused by a defective inner weld closure. The other was a side corrosion failure at 69 per cent of goal exposure. In this case, the cladding failed near a support rail tab, and several of the supports were collapsed. Both failures and selected companion pieces are scheduled for a detailed examination in the Radiometallurgy Laboratory. Process innovations made to improve closure integrity, and conversion from the collapsible-bridge rail to a stronger arch support rail, are expected to minimize the probability of these types of failures in the future.

Manager, Research and Engineering

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