1 of 1

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MONTHLY RESEARCH AND DEVELOPMENT REPORT
OCTOBER 1965

IRRADIATION PROCESSING DEPARTMENT

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MONTHLY RESEARCH AND DEVELOPMENT REPORT

IRRADIATION PROCESSING DEPARTMENT

By

T. W Ambrose

OCTOBER 1965

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7 pages.

Distribution

1. Battelle-Northwest/Attn: FW Albaugh	22. AR Maguire
2. Battelle-Northwest/Attn: ER Irish	23. WM Mathis
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7. WA Blanton	28. GF Owsley
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10. JR Carrell	31. LH Rice
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12. JH Ferguson	33. HF Tew
13. SM Graves	34. OA Towler, DuPont Co.,
Savannah River
14. CN Gross	35. AP Vinther
15. HW Heacock	36. LD Weislogel
16. GA Huff	37. 700 Files
17. PC Jerman	38. Records Center
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RESEARCH AND DEVELOPMENT

RESEARCH AND ENGINEERING

Ribbed Zircaloy Process Tubes

The three ribbed Zircaloy process tubes, fabricated by Electron Beam Techniques, were inspected in the tube shop at White Bluffs. It was found that the welds which attach the ribs to the tube wall did not meet specifications in all cases, and the tubes had warped as a result of rib welding operations. The warp was partially removed by roll straightening. These problems are not considered serious enough to prevent testing these tubes in reactor service.

Uranium Oxide Program

Fabrication of three columns of uranium oxide fuel elements for irradiation in KW Reactor has been completed by Battelle. The irradiation test is expected to begin in late November.

Plutonium Fuel Tests

Phase I of the Pu-Al tests was completed. The purpose of the first testing phase was to determine the increase in graphite temperature next to the low-density Pu-Al fuel. The graphite temperatures were found to increase 30 C above normal, less than expected and no serious limitation to Pu-Al irradiations. The second phase of the Pu fuel program consists of two test columns (of six pieces each) which will be used to develop isotope buildup data. After 20 days of irradiation, no change in fuel power has been observed; the initial powers were 20 per cent lower than predicted.

Neptunium Irradiation Tests

It is planned to irradiate twelve NpO_2 - aluminum target elements in the KW Reactor beginning in late November. Fabrication of the target elements will be completed near the end of October.

To predict dose rates which will be encountered in handling Np-237 elements being prepared, a set of measurements were made with a Cutie Pie on the NpO_2 prior to canning. The dose rate at contact with the oxide was 4.7 R/hr. The Np had been separated nine days before, putting it at 25 per cent of equilibrium with its first daughter Pa-233 which is the main dose contributor.

Five-inch long target elements consisting of a matrix of aluminum powder and NpO_2 compacted and canned in aluminum are predicted to have the following dose rates.

<u>NpO₂</u> (g/element)	<u>Dose Rate at 1' in mR/hr</u>			
	10 days	20 days	60 days	over 120 days
16	5	8	14	18
63	20	32	55	70

A dose rate reduction of 50 was noted for 3/8 inch of lead.

Polonium-210

Calorimetric measurements to determine the polonium content in the overbore bismuth elements have been completed. Values obtained correspond to theoretical calculations used in past production studies. The measured peak Wescott flux in the process channel containing all bismuth was 1.35×10^{14} and 1.20×10^{14} in the process channel containing a striped loading of bismuth and fuel elements. Polonium values obtained for these flux values were 12 grams polonium per ton of bismuth for 92 days' irradiation at a flux of 1.35×10^{14} and 7 grams polonium per ton of bismuth for 56 days at a flux of 1.20×10^{14} . These values are 30 days after reactor discharge.

Columbia River Studies

The half-plant test at D Reactor to determine the effects of adding 20 ppm SiO₂ to process coolant continued. During September, the silicate reduced the concentrations of P-32 and As-76 by factors of 3 and 5, respectively. This is the best improvement seen to date.

In early August, the alum feed rate at KW Reactor was reduced to 6 ppm on a test basis. By month-end, the feed rate had been reduced to 3 ppm and operation continued at that feed rate through September and early October. The concentrations of P-32 and As-76 increased by factors of 2 and 8, respectively, as compared to KE Reactor (16-18 ppm alum). The alum feed rate at KE Reactor was increased to 6 ppm on October 15.

Computer Code Development

Program MOFDA was converted and checked out for use on the CSC UNIVAC 1107 in addition to the IBM 7090. Reactor core loadings can now be studied by use of either of the two computers. Some features of MOFDA which had previously been stripped due to limited core storage in the 7090 have been restored in the 1107 version.

An enlarged version of RIBD was generated for use on the 1107 in processing grids composed of complex long chain neutron transmutations combined with simultaneous beta and/or isomeric transitions which produce multiple paths and side chain reactions.

It is estimated that the single tube hydraulic portion of the proposed CLUMSY kinetics code modifications will be completed within the next two months. This portion of the full program will be utilized to evaluate the protection provided by the individual tube pressure monitor system to reactivity insertion incidents.

Exploration of the validity and the application of EXTERMINATOR (two dimensional - diffusion theory code) to various reactor physics problems is continued. It appears that EXTERMINATOR is considerably faster than 9 ANGIE and converges more rapidly. In addition, the R-O geometry feature of EXTERMINATOR (9 ANGIE is limited to x-y and r-z geometries) is being explored. With EXTERMINATOR, it is also possible to submit several different problems stacked one behind the other, thus saving read-in time.

Irradiated IPD Fuel Examination, 105-C Facility

Examinations were completed on fuel elements from 60 tubes requiring 7116 individual examinations.

Production Test Material

<u>No. of Tubes</u>	<u>Production Test</u>	<u>Title</u>
20	IP-216	Evaluation of Performance of Normal Production I&E Fuel Elements
18	IP-728	Half-Plant Sodium Silicate Test

Other Material

<u>No. of Tubes</u>	<u>Purpose of Examination</u>
7	Visual examination of normal production fuel elements from KE Reactor to determine amount and severity of groove and ledge type corrosion.
8	Visual examination of not-die-sized canned fuel elements from KW Reactor to determine amount and severity of groove and ledge type corrosion.
7	Visual examination of normal production fuel elements from KW Reactor to determine amount and severity of groove and ledge type corrosion.
1 piece	Visual examination of one enriched fuel element from B Reactor to determine nature of bore obstruction.

Photographs were taken of one ruptured fuel element from B Reactor and one from C Reactor.

Water Treatment Test Facility Operation - 1706-KE

<u>Tube</u>	<u>PT</u>	<u>Water Supplied</u>	<u>Corrosion Inhibitors & Chemical Additions</u>	<u>pH</u>
WT-1 (2952)	604	Service	2.0 ppm dichromate	7.0*
WT-2 (3050)	604	Service	2.0 ppm dichromate	7.0*
WT-3 (4355)	786	WTTP**	1.8 ppm dichromate	6.6**
WT-4 (4456)	786	WTTP**	1.8 ppm dichromate	6.6**
WT-5 (4557)	604	Service	20.0 ppm sodium sulfite	6.6
WT-6 (4863)	604	Service	20.0 ppm sodium sulfite	6.6
WT-7 (4963)	449	Process	10.0 ppm activated silica	6.6
WT-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 ENGINEERINGUncooled Horizontal Control Rods

The uncooled HCR development program at GE's Nuclear Materials and Propulsion Operation is scheduled for completion by November 1. This will close out the Assistance to Hanford authorization for the program in accordance with the GE-DUN transfer timetable. The long term materials environmental tests will not be completed by November 1, however; they will continue uninterrupted as Division of Reactor Development funds are being utilized for the support of this phase of the program. The environmental testing of cladding material coupons and composites of cermet core and cladding has reached 7,500 hours and 6,600 hours, respectively, with both tests planned to extend to 10,000 hours.

Two full length (40-inches) control rod sections have been extruded and are now being finished and fitted with hinge joint ends. These will be utilized for mechanical and nuclear control strength. A composite sample consisting of a dysprosium oxide-nickel cermet clad in 19-9DL stainless steel has been removed from the 105-KW Reactor after seven months' residence in a high flux region of the reactor. The sample is being examined at the Radiometallurgy Laboratory, Battelle-Northwest, for any evidence of metallurgical and/or dimensional changes and to measure induced radioactivity and self-heating. A similar composite sample with Inconel 600 cladding is still under test in the reactor with plans to accumulate twelve months' exposure before removal.

Dose Rate Telemetry

Additional laboratory testing and evaluation have been performed upon the dose rate telemetry system following initial on-reactor testing. This additional work has established that the latest set of circuit revisions by Tracerlab, Inc., has brought the equipment within specification requirements. The procurement contract has accordingly been closed out. These latest circuit modifications brought the system dose integration accuracy to within plus or minus 10 percent over the entire monitoring range. However, additional development work is still required to provide the equipment with greater channel isolation and dose rate integration accuracy. This will be performed during the planned on-reactor testing period. Arrangements are under-way to install this equipment at 105-KE Reactor at the next outage for a six-month on-reactor test and evaluation period.

In-Core Flux Monitoring

The basic development work upon the in-core flux monitoring chambers has been successfully completed, and the final report is in preparation. The remaining phase of this program is a correlation of the N Reactor in-core flux monitoring system basic performance and sensitivity with respect to monitoring chamber burnout. Data is currently being collected for this phase of the program.

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PRODUCTION FUELSAlternate Process

Preliminary laboratory testing indicates that nickel-plated uranium having improved resistance to water (steam) penetration can be produced employing a H_2SO_4 -HCl electrolytic etch rather than the conventional H_3PO_4 -HCl electrolytic etch. A single sample prepared with the H_2SO_4 -HCl etch with approximately a two mil thick plate survived a 25 hour test in saturated steam at 170 C without evidence of failure.

Exploratory tests on pulse-current plating produced nickel plate up to 2.5 mils thick that was satisfactory in appearance, and with clean nickel-uranium interfaces. Current densities up to about 780 ASF (amperes per square foot) were employed during "on" periods of 100 to 200 micro seconds, followed by off periods of 800 to 900 micro seconds.

An evaluation of four different techniques to nondestructively measure the thickness of nickel plate in finished hot-die-sized fuel elements has led to the selection of a "Hall Effect" device for testing in the pilot plant. This device has an estimated accuracy of about ± 0.1 mil for a nickel plate thickness range of 0.3 to 1.0 mils through a 30 mil thick aluminum can. It is also capable of measuring the thickness of nickel plate on the as-plated uranium cores, and can be adapted readily for continuous scanning.

A production test (PT-781) to compare the rupture resistance of 0.947 per cent enriched hot-die-sized and AlSi-bonded fuel elements was discharged from D Reactor after sustaining three hot-die-sized fuel failures and one confirmed AlSi fuel failure. The hot-die-sized fuel failures occurred at exposures ranging from 420 to 870 MWD/T, and the AlSi failure at 870 MWD/T. All of the failures were attributed to ledge and groove corrosion of the external cladding. Both types of fuel show evidence of severe corrosion attack.

Laboratory studies of the 8001 cladding on hot-die-sized and AlSi-bonded fuel elements were continued to assess differences in grain size, hardness, chemical composition, or other characteristics that may influence resistance to ledge and groove corrosion. Metallographic examination of hot-die-size fuel cladding shows large grain (up to 0.050 inch diameter) areas extending in varying patterns from the cap toward the base end, as compared to relatively uniform small grains in the AlSi fuel cladding. Cladding hardness on a hot-die-sized fuel element varied considerably, and qualitatively the hardness varied inversely to grain size. The carbon content of the cladding on four hot-die-sized fuel samples ranged from 200 to 1600 ppm, indicating significant amounts of carbon pick-up from the die-sizing lubricant. Further analyses are underway. A laboratory-scale accelerated corrosion device has been designed and fabricated which will produce corrosion grooves in hot-die-sized fuel cladding up to 15 mils deep in 16 hours using high velocity tap water (80 feet/sec.) at 104 C. Comparative tests are scheduled on both hot-die-sized and AlSi-bonded fuel cladding.

D. Wilson for
Manager, Research and Engineering

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