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HANFORD LABORATORIES OPERATION MONTHLY ACTIVITIES REPORT

APRIL, 1959

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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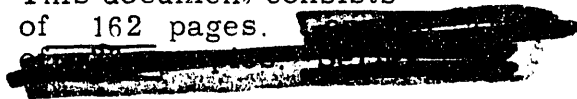
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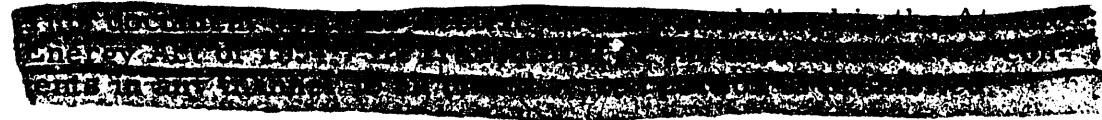
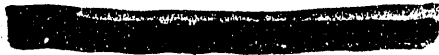
APRIL, 1959

Compiled by
Operation Managers

May 15, 1959

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HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON



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This report was prepared only for use within General Electric Company in the course of work under Atomic Energy Commission Contract W-31-109-Eng-52. Any views or opinions expressed in the report are those of the authors only.

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TABLE I. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

DATE April 30, 1959

	At close of month		At beginning of month		Additions		Separations			
	Exempt	NonExempt Total	Exempt	NonExempt Total	Exempt	NonExempt	Exempt	NonExempt		
Chemical Research and development	126	94	220	123	93	216	3	2	0	1
Reactor & Fuels Research & development	187	135	322	187	133	320	1	2	1	0
Physics & Instrument Research & development	66	32	98	66	32	98	0	0	0	0
Biology Operation	35	44	79	36	44	80	0	1	1	1
Operation Res. & Syn.	15	3	18	14	3	17	1	0	0	0
Radiation Protection	33	100	133	33	100	133	0	1	0	1
Laboratory Auxiliaries	47	185	232	46	180	226	1	8	0	3
Financial	15	27	42	16	33	49	0	0	1	6
Employee Relations	40	23	63	40	25	65	3	0	3	2
Programming	14	4	18	14	4	18	0	0	0	0
General Totals	$\frac{1}{579}$	$\frac{2}{649}$	$\frac{3}{1228}$	$\frac{1}{576}$	$\frac{2}{649}$	$\frac{3}{1225}$	$\frac{0}{9}$	$\frac{0}{14}$	$\frac{0}{6}$	$\frac{0}{14}$
Totals excluding Internal Transfers	579	649	1228	576	649	1225	7	12	4	12
Composite Separation Rate	----- 1.6286									
Separation Rate (based on separations leaving G. E.)	----- ,4071									
Controllable Separations Rate	----- .2472									

BUDGETS AND COSTS

Costs for April were \$1, 832, 000, a decrease of \$54, 000 from the month of March. Fiscal year-to-date costs are \$16, 001, 000 or 78% of the operating budget of \$20, 510, 000. A request is being made to HOO-AEC to provide the additional funds required for the Plutonium Recycle and Swelling Studies programs which were forecasted in our Midyear Budget Review.

RESEARCH AND DEVELOPMENT1. Reactor and Fuels

Phase I PRTR construction is 93% completed versus 99% scheduled.
Phase II PRTR construction is 90% completed versus 97% scheduled.
Phase II-A PRTR construction is 63% completed versus 88% scheduled.

PFPP Phase II construction is 97% completed versus 99% scheduled. The extended contract completion date is May 10. PFPP Phase III construction is 15% completed versus 13% scheduled.

A scope revision to add a gamma-neutron burst detector system to the PFPP has been submitted.

A 100-hour hot loop test of the PRTR shaft-seal primary pump has been completed with performance, including leakage, well within specifications.

Project CAH-822 (gas-cooled loop in the PRTR) design criteria and scope drawings have been completed. Procurement has started.

Project CGH-834 (high pressure heat transfer apparatus modification) has been approved, and design and procurement have been started. Beneficial use on NPR design testing is expected within four months.

Out-of-reactor creep tests of Zircaloy-2 run at 18, 000 psi and 400 C show the creep rate for 45 percent cold worked specimens to be approximately 30 percent greater than that for 25 percent cold worked material.

Three pilot-order contracts, each for 70 Zircaloy-2 NPR process tubes, are being awarded to three different vendors on the basis of demonstrated fabrication competence and bids submitted. Fabrication work on these orders is expected to be started in May.

The first 20 Zircaloy-2 PRTR process tubes have arrived at Hanford, and 30 more have been inspected at the vendor's plant and are ready for shipment. The balance of the 100-tube order is expected by the end of June.

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TSGBF graphite irradiated in the MTR at 1050 C exhibited 0.42 percent contraction for a Hanford equivalent exposure of approximately 7000 MWD/AT. This confirms the bulk of the previous data with the exception of one high value of 1.0 percent. New high temperature graphite irradiation experiments have been installed in the MTR and the ETR.

The degradation of pre-defected, coextruded uranium-zirconium clad fuel elements in water at 200 to 300 C has been studied by measuring the volume of hydrogen gas evolved as a function of exposure time at temperature. Typical tests at 300 C show a 50-minute induction period with essentially no hydrogen evolution, followed by hydrogen evolution equivalent to a corrosion rate of 0.2 g of uranium per minute, increasing to 1.1 g per minute after two hours. Standard ex-reactor rupture tests of pre-defected, coextruded U-Zr clad fuel elements continue to show a quite tolerable time-deformation behavior.

Two NPR tubular fuel elements have attained an exposure of 1350 MWD/T in KER-4.

A tubular element has been shipped to the ETR for irradiation at a specific power about three times the maximum expected in NPR.

Light swaging reductions of NPR fuel rod induce variable cold work in the jacket that leads to spotty and excessive grain growth during subsequent heat treatment. If the reduction of area is greater than about 12 percent, uniform grain size results in the jacketing.

A simple method for providing intermediate supports on rod cluster elements has been developed.

Examination of a cored coaxial fuel element has been completed in Radio-metallurgy. The entire inner tube was found to have operated in the beta phase and increased in volume about seven percent. However, it did not crack.

Formal approval has been received from Washington to install the 6x9 loop in the ETR. The first experiment, scheduled for mid-May, will be a test with stainless steel elements to determine the gamma heating.

Feasibility of large diameter UO₂ elements was indicated by an uneventful irradiation of 3/4" diameter capsules at heat fluxes of ca. 600,000 BTU/hr/sq. ft. A central void and radially oriented grains were formed.

The final shipment of enriched UO₂ rings to Atomics International was made. These rings will be irradiated in SRE in two fuel assemblies.

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Slight additions of PuO_2 to UO_2 markedly decrease the sintered density of the UO_2 . Additions of mixed crystal oxide to UO_2 decrease its sintered density for small additions, but at 10 w/o PuO_2 the sintered density is slightly greater than for UO_2 alone.

A UO_2 - PuO_2 solid solution obtained by sintering a mechanical mixture of the oxides was found to dissolve in acidic solution at nearly the same rate as mixed crystal oxide obtained by chemical co-precipitation.

PuO_2 and graphite heated to 1100 C in vacuo produced a mixture of Pu_2C_3 , Pu_2C_3 , PuO_2 and PuO or PuC .

2. Chemical Research and Development

Laboratory experiments and Purex "Mini" runs were continued to confirm and extend the useful range of a reducing environment during the removal of neptunium in the 2A - 2B Purex columns from 3WB backcycled waste. Increasing the system temperature was investigated as well as varying the concentrations of reductants and nitric acid. Solids in the 3WB stream were investigated and found to be primarily aluminum, iron, and silicon.

Laboratory experiments on Purex aqueous waste of current composition showed the cerium and promethium can be readily precipitated as sulfate salt with good yields. Preliminary tests on the use of ion exchange techniques for recovery of americium were also encouraging. The Fission Product Isolation and Packaging Prototype is nearing completion.

On Non-Production Reactor Fuels Processing technical studies, simulated cutting of NaK containing fuels continued to explore methods to minimize hazards. Cold sawing methods received more attention because less small particulate matter resulted from their use. Modifications were made to the Hastelloy-F pilot plant to permit dissolution of stainless steel using the Sulfex process. Bench scale preliminary runs were initiated to pilot the larger scale studies. Niflex pilot runs continued to show small undissolved residues of stainless steel from stainless clad uranium rods. The use of ferric ion to stabilize U-Mo dissolver solutions continues to look encouraging.

Preliminary batch calcination studies on simulated formaldehyde treated Purex 1WW waste appear encouraging with residue volumes of less than two gallons per ton of uranium feed. A cooperative effort was continued to determine the behavior of similar synthetic Purex waste during calcination in a fluid bed facility at the Argonne National Laboratory. Product powder fusion was observed as low as 600 to 680 C and may establish an upper limit on operating temperature.

Arsenic, gallium, and copper were measured in the parts-per-billion range in aluminum using neutron activation analysis.

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Laboratory study of volatile fission product evolution from small uranium cylinders having low irradiation histories have been extended to include the effects of aluminum jackets in a flowing air atmosphere. Near 1000 C aluminum oxide particles were dissipated throughout the downstream regions of the system, a behavior not observed at a system temperature of 1200 C. For bare uranium heated in a flowing helium atmosphere far less iodine, tellurium and xenon were evolved than was the case for air whereas more cesium was released. This behavior in a helium environment followed expected patterns.

Further work on molten salt cycling of UO_2 by oxidation-reduction in molten alkali chloride included an experiment using a 5/1 mole ratio UO_2 - PuO_2 mixed oxide. A uranium-plutonium separation factor of about 60 was obtained by filtering dissolved UO_2Cl_2 from the remaining residue after phosgene was bubbled through the melt for two hours at 800 C.

The UF_6 mass spectrometer was modified to analyze for mercury isotopes. Five to ten milligram samples of natural mercury gave relative isotope distributions within ± 1 percent of accepted values.

Plans were established for the drilling of ten closely-spaced hydrological wells north of Gable Mountain to provide a ground water sampling complex to determine as quantitatively as possible the dispersal of solutes in the ground water domain.

A laboratory model representing a two-dimensional slice through a crib was used to obtain data to test a mathematical representation of the flow pattern beneath a crib. Moisture content and tension measurements were made at 32 positions over the face of the model. The data, when applied in the previously derived unsaturated flow formula, will permit estimates of the flow pattern beneath the crib.

A field test facility was installed at a site southwest of Gable Mountain. The site chosen consists of a 15-foot profile of uniform soil above the water table. Small-scale crib experiments will be performed here to demonstrate the application of laboratory column data to the prediction of the break-through curve for a crib.

3. Physics and Instrument Research and Development

The exponential pile program for the NPR has been accelerated so that two experiments can now be run concurrently. Tubular fuel elements have been received and the first lattice with a tube-in-tube element was constructed.

In the critical mass field experiments continued on 3% enriched uranium in both heterogeneous and homogeneous situations. Also, a series of water-moderated exponential experiments were completed with 1.25% enriched

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I and E type fuels.

Invitations for bids for construction of Phase I of the Critical Mass Laboratory were issued by the AEC. Bid openings are now scheduled for May 20.

The acquisition and assembly of materials and equipment for this summer's atmospheric dispersion experiments was on or ahead of schedule. The erection of poles and towers proceeded satisfactorily except for an accident on April 22 when an 18-foot section of a tower under construction fell and seriously injured an offsite contractor's employee.

The order for the new analog computer was placed with delivery in October estimated by the vendor. Meanwhile, the backlog of problems for NPR, PRTR, and from other sources continues high.

Orderly progress was made on the many projects in the instrument field, among which the installation of a continuous flow stack gas monitor at 100-D, and the check-out of the central station equipment for the Radio-telemetry Network were notable.

In the basic data field, information was obtained on the rate of energy exchange between thermalized neutrons and graphite at various temperatures, cross sections for neutron scattering in water were obtained at near-thermal energies, and final values of the age of 950 kev neutrons in water and kerosene were derived from previously obtained data.

4. Biology

I-131 in rodent thyroids dropped to about two per cent of what it was one year ago.

After 4-1/2 years of receiving 1.5 μc I-131/day (since in utero), one ewe seems to be developing a thyroid tumor. Thyroid dose is estimated between 5,000 and 10,000 rads.

Assaulting animals with both plutonium and X-irradiation does not appear to harm the animals more than the sum of the separate effects caused by each.

Further work on attempting to remove $\text{Pu}^{239}\text{O}_2$ from lungs with NaCl aerosols did not show as much promise as a therapeutic tool as earlier work indicated.

5. Programming

A study was completed for the Chemical Processing Department covering the costs of degradation resulting from the blending of various enrichments of decontaminated uranium derived from NPF, NPR and E metal fuels.

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Agreement was reached on the plutonium needs of various laboratory components in support of the Plutonium Recycle Program.

Instructors were obtained for the University of Washington Graduate Center at Hanford to teach courses in Solid State Chemistry, Nuclear Chemistry, Radiochemistry, Analytical Chemistry and the Nuclear Engineering Series.

TECHNICAL AND OTHER SERVICES

Statistical consultation is being provided in connection with the development of a mathematical model of a pulse column.

Further development work on the optical comparator method for the non-destructive measuring of can and spire wall thicknesses has resulted in a measurement technique of acceptable precision and accuracy for use in the Quality Certification Program.

Work on two operations research studies and seven operations analysis programs continued during the month, and work on one new operations analysis program was initiated. In addition, statistical and mathematical assistance on 19 problems was given within HLO and to other departments and operations.

At the request of the AEC-HOO a comprehensive study was started to determine the feasibility of a State Highway Department proposal to construct a public highway up the Cold Creek Valley from Horn Rapids to the Yakima Barricade. Analysis of the possibility of releasing certain lands south and west of this proposed public highway is also to be included in this study.

One case of minor plutonium deposition was confirmed in April. The total number of deposition cases which have occurred at Hanford is 229. There are 162 employees currently employed who have a measurable deposition of plutonium. More extensive bioassay analyses of employees involved in the explosion in Plutonium Metallurgy facilities in the 234-5 Building on March 31 continued to indicate that plutonium deposition in the employee who was injured is only a small percentage of the maximum permissible limit.

The Technical Defense Section participated in the over-all Hanford district Civil Defense participation in Operation Alert 1959 on April 17-18. The test consisted of state directed operations involving nine near simultaneous nuclear hits in the State of Washington--none of which would have had serious effect on Hanford operations.

In response to requests from AEC-HOO considerable assistance was furnished on a priority basis on details of Hanford's over-all radiation protection effort and expenditures. These requests stemmed from the joint study being conducted by the Secretary of Health, Education, and Welfare; Chairman of the AEC; and the Director of the Bureau of the Budget.

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Preliminary routine use of the Shielded Personnel Monitoring Station was initiated in April. Measurements on a group of about 50 HAPO employees were started. The objective of this preliminary set of measurements is to establish useful criteria in establishing backgrounds of different groups of people at Hanford.

There were 20 authorized projects at month's end with total authorized funds of \$8,398,900. The total estimated cost of these projects is \$8,526,900. One project was completed during the month. Three new projects are awaiting AEC approval. Project Proposals for ten new projects are in preparation.

More normal activity for Radiographic Testing Operation was recorded this month with termination of the PRTR containment vessel work. A total of 5,257 tests were made, of which 985 were radiographic (including X-ray and gamma-ray) and 4,266 were supplementary tests. Of the total man hours, 53.6% were used in connection with radiographic tests and the remainder were used on supplementary tests.

The Technical Shops overtime rate continued high due to heavy work load and emergency requests. Other on-site shops were used to capacity in providing assistance to the Technical Shops. Off-site shops are also providing assistance via the purchase requisition procedure.

SUPPORTING FUNCTIONS

A follow-up was made of the Traveling Auditors' 1958 audit recommendations. Except for the conversion of the Physics and Instruments accelerator refrigeration system, which has been delayed for budget reasons, action on all recommendations is essentially complete.

A proposal has been presented to applicable HLO Section Managers setting forth the tentative approach to be taken in accounting for the various segments of the Plutonium Recycle Program and for pricing various fuel elements. Studies have also been started to develop cost data with respect to various components and processes involved in fabrication of the 19-rod cluster, swaged UO₂ element.

A report of results was issued for the physical inventory of uninstalled cataloged equipment in the custody of Reactor and Fuels Research and Development Operation. Significant statistics are: counted were 4,928 items valued at \$4,594,222; missing were 12 items valued at \$2,278.

HAPO General Overhead was reviewed during April to determine amounts applicable to HLO programs. It was determined that 16.3% of direct cost will be sufficient to provide for general overhead. This compares with the 18% previously estimated as needed for these costs.

At month's end, the staff of the Hanford Laboratories Operation totalled 1228 employees, including 579 exempt and 649 nonexempt employees. There were 491 exempt employees possessing technical degrees, including 279 B. S. , 110 M. S. and 102 Ph. D.

The first four sessions of the second program of the Information and Orientation Series were conducted with excellent attendance and interest.

Arrangements have been completed for the Laboratories to supply radiation protection display material for Armed Forces Day Open House at Larson Air Force Base and Umatilla Army Ordnance Depot on May 16.

Tours were provided in April for 36 East Wenatchee High School students, 50 Gonzaga University engineering students, 40 Chief Joseph Junior High School advanced science students and 50 Richland school teachers.

Laboratories personnel worked a total of 205,500 man-hours during the month with no disabling injuries. Since September 1, 1956 a total of 6,084,236 man-hours have been completed with no disabling injuries.

The medical treatment frequency for April was 1.50 as compared with 1.60 during March.

There were two security violations during the month of April, bringing the total for the year to 16.

Two Ph. D. candidates accepted HAPO offers during the month. For the recruiting year to date, there have been nine Ph. D. acceptances, including two in chemical engineering, two mechanical engineering, two chemistry, and one in physics.

We are continuing to encounter difficulty in attracting Ph. D. physicists and during the month visits were made to California Institute of Technology, UCLA, Stanford and University of California to meet with candidates in this field.

Four experienced BS/MS candidates accepted offers during the month. Sixty-three acceptances for technical graduate assignments have been received and it appears that an additional five to twelve acceptances may be expected. Distribution by academic field appears to be good with fourteen physicists and thirteen mechanical engineers having accepted.

Four Technical Graduates were added to the Program and three permanent placements were effected with 26 remaining on the Program at month's end. Seventeen of these are presently available for off-program placement with six having accepted assignments and to be placed by July 1.

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Fourteen nonexempt requisitions were filled during the month. With the receipt of 27 new requisitions, there are currently 49 nonexempt openings, for which 28 candidates are in process and 5 transfers are pending, with 13 candidates yet to be procured.

Paul F. Gast
for
Manager,
HANFORD LABORATORIES

PF Gast:kss

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REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATIONTECHNICAL ACTIVITIESA. FISSIONABLE MATERIALS - 2000 PROGRAM1. METALLURGY PROGRAMCorrosion Studies

Autoclave Testing of Aluminum Alloys. After six months testing in 300 C refreshed water, two alloys obtained from Alcoa are of decided interest. One of these alloys, GMB, (1% Ni, 0.1% Ti) appeared to fail in ten days, but thereafter the penetration did not significantly increase. The other alloy, KAB, (2.1% Fe, 0.6% Ni, 0.1% Ti) shows a very low penetration at the end of six months. It was reported in March and further confirmed by inspection of the 300 C loop samples this month, that alloy KAB is also more resistant to corrosion at high flow rates.

Jet Impingement Studies. Tests are continuing to determine the relative susceptibility of several aluminum alloys to attack by impingement of a jet of hot distilled water. Tests are conducted at 100 C with a jet produced by a 0.009-inch orifice. Penetrations were up to 20 percent higher on samples of annealed 1245 and X-8001 than on samples in the as-received condition. However, no consistent correlation between hardness measurements and penetration was obtained. Tests in which the period of exposure was varied showed that penetration was a linear function of time.

Fuel Element Rupture Rates. An autoclaving technique has been developed for continuously measuring the rate of a rupturing fuel element. Samples of coextruded Zircaloy-clad uranium core fuel elements, which have been defected with a 25-mil hole drilled through the cladding into the core, have been exposed at 200 and 300 C in water. The hydrogen, which is generated as a result of the uranium water reaction, is collected, and its volume is continuously recorded. Since five grams of uranium react to form one liter of hydrogen, the hydrogen generation curve can be interpreted as a uranium corrosion curve, or rupture rate curve. It has been found that all of the uranium oxide corrosion product is easily flushed from the ruptured fuel element, and consequently the rupture rate curve can be interpreted directly in terms of the release of core material to a coolant stream. Most of the data to date has been obtained at 300 C. In general, it can be described by a curve which has an induction time of 50 minutes, during which there is no release of corrosion product or hydrogen. This is followed by an initial rupture rate of 0.18 gram of uranium per minute. After two hours the rate increases rapidly to 1.14 grams of uranium per minute. Individual rupture rate curves are not smooth but consist of periods of high rate and periods of low rate. Rupture rates as high as 3.5 grams of uranium per minute have been observed for short periods of time. At 200 C the observed induction time was 17-1/2 hours, the initial rate was about 0.12 gram of uranium per minute, and the final rate about 0.4 gram per minute.

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Radiometallurgy Laboratory Studies

Hardness measurements and a burn-up sample were obtained from one rod of a high-exposure stainless steel jacketed 7-rod cluster (282), and metallography was completed on one rod of a Zircaloy-2 clad 7-rod cluster (287). Metallographic examination was completed on three rods from a Zircaloy-2 clad 7-rod cluster, and replicas of as-polished and etched surfaces were prepared for electron microscopy (277). Metallography, replication, and density results were obtained from samples of a 4-rod cluster element (254).

Two samples of irradiated uranium were broken, one at -195 C and the other at -80 C, and replicas were obtained for fractographic studies (108). Three irradiated Zircaloy-2 tensile specimens were tested at room temperature, demonstrating greater yield strength, less elongation, and similar ultimate strength values compared with unirradiated samples (260). Five thorium tensile samples were tested at room temperature (213).

The results and conclusions from this work will be reported in connection with the respective development programs of Fuel Design and Physical Metallurgy Operations.

Basic Metallurgy Studies

Radiation Effects in Fissionable Materials. Thorium tensile specimens irradiated to relatively high burnups were tested during the month. This work is part of a study to determine the effects of irradiation on a fissionable material with a cubic structure. Specimens irradiated to 0.08, 0.1, and 1.60 a/o burnup exhibited elongations of 32.6, 13.2, and 7.2 percent, respectively. The corresponding yield strengths were 50,000, 50,000, and 69,000 psi. The average elongation and yield strength for unirradiated specimens were 42 percent and 15,500 psi. Two other specimens irradiated to approximately one a/o burnup were also tested, and these specimens failed outside of the gage marks at less than 0.2 percent elongation. The fractures occurred at cracks which appeared to be oxidized, indicating that the cracks were produced during irradiation. A large decrease in ductility and increase in yield strength occurs for thorium at about 0.1 percent burnup; similar changes have been observed for uranium irradiated to only 0.03 percent burnup.

Radiation Effects in Structural Materials. A series of metals representing the common metal crystal types was irradiated at Brookhaven, Hanford, and the MTR under various exposure conditions. Some of the metals exhibited second phases indicating impurity contents unaccounted for by the chemical compositions reported by KAPL. The "high-purity" nickel contained a second phase which formed a continuous network at the grain boundaries. This phase probably accounts for the extreme brittleness of this material noted by KAPL. Massive hydrides were observed in the zirconium, and small, dispersed inclusions were observed in the titanium. A program to chemically analyze these metals has been initiated.

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Information is currently needed concerning property changes in high strength materials which may occur under combined high temperature and high flux environments. Room temperature tensile tests of Zircaloy-2 irradiated at an average temperature of 280 C to an estimated exposure of 10^{20} nvt have been completed by Radiometallurgy Operation. Preliminary results of these tests are as follows:

1. Unirradiated Zircaloy-2, elongation 30 percent, yield strength 40,000 psi, ultimate tensile strength 55,000-70,000 psi.
2. Irradiated Zircaloy-2, elongation 26 percent, yield strength 55,000 psi, ultimate tensile strength 55,000-70,000 psi.

These data show little change in strength and ductility. No definite conclusions are possible until examination of actual stress-strain data are made.

Mechanical and Physical Properties of Materials. Specimens of Zircaloy-2 with 25 percent and 45 percent cold work are being tested in creep units at 400 C under an applied stress of 18,000 psi. Both tests have accumulated a total of 680 hours to date. Initial elongations of 0.2 percent and 0.02 percent were observed for the 25 percent and 45 percent cold worked specimens, respectively. Elongations at the end of 680 hours are 0.9 percent for the 25 percent cold worked material, and 0.8 percent for the 45 percent cold worked material. The creep rate of the 45 percent cold worked specimen at the end of 680 hours testing was approximately 30 percent greater than that of the 25 percent cold worked specimen.

Electron and Optical Microscopy. Thin films of UO_2 prepared by vacuum evaporation of uranium metal and also films of evaporated aluminum have been irradiated to various exposures in the range 1.4×10^{16} to 2.5×10^{19} nvt. Analysis of the diffraction patterns and transmission properties of these films are being made. An article, "An Improved Method of Etching by Ion Bombardment," describing the use of VHF excitation has been written for publication in a technical journal.

X-Ray Diffraction Studies. A post-irradiation study of preferred orientation in molybdenum has shown that a disorientation of the crystallites is occurring during neutron irradiation. This observation, coupled with previous findings of crystallite fragmentation and a perceptible change in microstructure, contributes to the determination of the fundamental nature of radiation damage in this metal. Pole figures for the (110), (100), and (210) planes of rolled and annealed molybdenum sheet were obtained both before and after irradiation. The maximum pole densities decreased due to irradiation, and the symmetry of the figure was disrupted. The observed crystallite fragmentation cannot, then, be attributed only to the creation of small angle or incoherent boundaries such as would occur with the introduction of dislocations or agglomeration of defects.

At the request of the Industrial Hygiene Operation, x-ray diffraction was used to determine the amount of silica (hexagonal SiO_2) present in dust samplings taken from various working locations in the 300 Area powerhouse.

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SiO₂ exists in several forms, both crystalline and amorphous, but only that type with a hexagonal structure is considered to be a health hazard. Standard chemical analysis does not determine the crystal structure. Following a special preparation of the samples to eliminate preferred orientation effects, the diffracted intensities of the peaks from the hexagonal structure were compared with those obtained from a pure silica standard. The silica content of the samples as determined by this procedure ranged from 3.8 percent to 18.6 percent.

Solid State Reactions. The kinetics of recrystallization and recovery in zirconium, Zircaloy-2, and Zircaloy-3 are being determined to establish the optimum conditions of heat treatment during fabrication operations. During the month, electrical resistivity measurements were made on zirconium cold worked to 10, 25, and 50 percent after annealing in air, helium, and vacuum. Resistivity has been measured for these specimens as a function of temperature from liquid nitrogen temperature to 100 C. Resistivity coefficients are being determined from these data to determine the effect of annealing atmosphere contamination of zirconium. It is felt that the temperature coefficient of resistivity should be quite sensitive to such contamination and may prove to be a valuable tool in its study.

In-Reactor Measurements. The 300 C thermocouple stability capsule charged in KW Reactor has received 2476 hours of exposure in a gettered helium atmosphere. The chromel-alumel, iron-constantan and copper-constantan thermocouples under irradiation are operating satisfactorily, and they have shown no marked deviation from their out-of-reactor calibration at the melting point of lead. The gas atmosphere in the thermocouple well has been changed from "gettered" helium to a 75 percent helium-25 percent carbon dioxide mixture. Exposure of the thermocouples to this gas atmosphere will continue for a three-month period.

Metallic Fuel Development

Cluster Fuel Elements. Three 7-rod cluster fuel elements recharged into the ETR 3x3 loop facility are presently operating at 114 kw/ft. These elements, fabricated from natural uranium rod coextruded in 0.030" of Zircaloy-2 have reached an exposure of 900 MWD/T while operating in 280 C coolant. The calculated core temperature of this material is 530 C.

Seven 7-rod cluster fuel elements fabricated from 1.6 percent enriched uranium coextruded in Zircaloy-2 cladding were completed during the past month. Six elements contained fuel rods with 0.020" cladding, the remaining element contained rods with 0.030" cladding. This irradiation test will be charged into the new KER Loop 2 process tube (2.029" ID) to compare the effect of irradiation exposure on fuel rods with differing clad thicknesses. Goal exposure for this test is 5000 MWD/T.

Due to an unexplained rise in pressure differential across the KER Loop 1 facility, seven 7-rod cluster fuel elements were discharged. This test was designed to compare fuel elements with differing clad thicknesses and contained coextruded 1.6 percent enriched elements with 0.020" and 0.030"

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of cladding. The elements had operated satisfactorily in 230 C coolant with a calculated core temperature of 500 C to an exposure of 1100 MWD/T. Goal exposure for the test was 4500 MWD/T. Information gained from post-irradiation examination will be useful in the determination of the possible reasons for macro-cracking observed in similar fuel material as well as provide irradiation data on the swelling of restrained uranium operating under these prescribed irradiation conditions.

A total of four 7-rod cluster fuel elements have been prepared for charging into a KE through-hole facility to gain exposure prior to purposely defecting the element at temperature in the ETR 3x3 loop facility. Two of these elements were charged into the KW Reactor facility on April 22, 1959. These elements will obtain 2000 MWD/T before discharge and subsequent shipment to the ETR.

The variable spacing 7-rod cluster test was run at KER with water temperature of 270 C. One of the closely spaced rods had a diameter increase. The widely spaced rods did not. The end gaps of the closely spaced rod were more nearly filled with uranium. The volume expansion of the closely spaced rod (2.3%) is not out of line with that of Zircaloy-2 clad coextruded rod tested at other sites. However, the widely spaced rods are evidently much more resistant to swelling (0.1% volume increase after 0.14% burnup with core temperature of 400 C). Density measurements and examination of additional rods are under way at Radiometallurgy.

Tubular Fuel Elements. Three natural uranium tubes, 1.780" OD, 1.440" ID, and 19" in length, and associated aluminum end caps were nickel plated using a modified Thompson plating bath. Vertical rocking and air agitation were utilized to accomplish an acceptable plate (one mil nominal). The tubes were plated and are to be canned at BMI using a helium pressure bonding technique. Subsequent irradiation testing is scheduled in the KER loops.

Tubular fuel elements can, according to calculations, be operated at NPR specific powers without incurring beta phase temperatures in the fuel. Two tube and rod elements have operated at KER Loop 4 to an exposure of 1350 MWD/T with surface temperatures of 270 C. The elements are scheduled to be discharged at 2000 MWD/T.

A KER size tube-tube natural uranium element has been shipped to the ETR for a first fuel irradiation in the 6x9 Hanford loop. This element has U-2% zirconium cores with 0.020" Zircaloy-2 cladding. In the high thermal flux of the ETR core these unenriched elements will operate at 69 watts/gram of uranium as compared to the 20 watts/gram required in the NPR. The elements will operate at 300 kw/ft with a maximum surface heat flux of 1,250,000 BTU/hr/ft².

In an additional KER test, one tube-and-tube element and one rod-and-tube element will be charged in Loop 1 immediately after the long outage. The anticipated power in this test is 12 watts/gram or roughly one-fifth the power of the ETR test.

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Fuel for Present Reactors. The first element of the third MTR irradiation test of the coaxial fuel element concept has been examined at the Radio-metallurgy facility. Thermocouple data and heat transfer calculations indicate that the inner uranium tube operated completely within the beta phase during the last two-thirds of its irradiation. The inner tube increased in volume about seven percent but did not crack. The clearance between the inner and outer uranium tubes did not change, but the diameters did. A coarse-grained structure developed in the inner tube, but it is not the familiar columnar structure associated with beta phase operation.

One of the Sonobond units formerly used in production has been acquired and reconditioned for use in pre-irradiation evaluation of experimental fuel elements. This unit differs from current production models only in certain features that facilitate large scale handling, and when used with a simple scanning mechanism developed especially for experimental purposes, makes a testing system ideally suited for experimental work. Reproducible results have been obtained with this instrument, and a study is now in progress to identify each observed instrument indication with the type of defect it represents.

Component Fabrication. The first NPR geometry 7-rod cluster spiders are being fabricated by the "Jaypax" spark machining process. The spiders are being cut from 0.200" thick Zircaloy-2 plate and will be used on 7-rod clusters for charge-discharge testing.

An order is now being negotiated with Cincinnati Milling Machine Company to fabricate eighty 7-rod cluster spiders for KER geometry. The spiders will be cut from 0.200" Zircaloy-2 plate by the "electrojet" spark machining process. These pieces will be used to prepare a 7-rod cluster charge for KER loops. Purchase of pieces from Cincinnati Milling provides the opportunity to evaluate the finished product of both processes with respect to cutting time, surface finish, dimensional accuracy, and operational ease.

A punch and die is now being fabricated to determine the feasibility of punching the spiders from Zircaloy-2 plate.

The spider outlines that were previously fabricated by the "Jaypax" method have been completed. To determine if the 1/16" webs connecting the rod bosses had the strength to withstand the subsequent burning operation, all "Jaypax" pieces were finish bored. All pieces, 0.100", 0.200", and 0.375" thick, exhibited adequate web strength.

Coextruded uranium rods, 0.610" OD with 0.030" Zircaloy-2 wall, were cold swaged to a variety of diameters to give area reductions ranging from three to 12 percent. Sections were studied in both the as-swaged and heat treated condition to observe effects in uranium structure, interface bond and Zircaloy-2 structure as a result of the variation in sizing conditions. The heat treatment used was salt bath heating for five minutes at 730°C followed by air cooling. No harmful effects of swaging were observed in either the bond or uranium structure after any of the reductions. The sizing of the rods did produce variable cold work in the Zircaloy-2 jacket,

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however, and during the treatment at 730 C the material was recrystallized. The variable cold work led to variations in recrystallized grain size that was most severe in the light sizing steps (3-6 percent). With reductions of 12 percent, the working was more uniform and the resulting Zircaloy grain size was uniform. It appears that light sizing reductions are undesirable because of the spotty and excessive grain growth during beta heat treatment.

Cluster type fuel elements longer than approximately one foot require some type of intermediate support system to assure accurate location of the fuel. A simple method of accomplishing this has been developed. A series of 0.030" thick by 3/16" wide strips are attached to the Zircaloy-2 fuel cladding by resistance welding. Following attachment, the cluster is assembled, and the strips are fusion welded together to tie the several rods together and generate a system which results in support for each of the rods in the cluster.

Closure and Joining. The useful range of electron beam vacuum welding can be extended when an electron gun is developed with variable focal length which can project a welding spot a greater distance from the gun body. An accelerating and magnetic focusing device has been assembled to demonstrate the feasibility of this project. By accelerating the beam with an accelerating plate through a magnetic coil, it was possible to obtain a 1/16" diameter welding spot at a distance of two inches beyond the end of the coil. It is felt that these results can be improved with a modified design and a new system is now being constructed.

Allied Fuel Studies. Results of ex-reactor studies of thermal contact conductance of joints between fuel element materials were summarized in a final report submitted to ASME for publication. Copies are available from the author.

Coextruded fuel tube sections in various heat treated conditions have been defect (0.025" hole to uranium on OD) tested in Elmo #4. The manner of heat treatment effects the corrosion range significantly. In all cases, however, there was no distortion produced on the tube ID even though the outside surface (defect side) was grossly damaged.

Knowledge of the dependence of clad uranium fuel element swelling upon cladding and uranium temperatures, cladding thickness, and exposure is of importance for Hanford's fuel element development. The second of five experimental assemblies containing Zircaloy-2 clad coextruded uranium fuel rods, being irradiated in the MTR and ETR to provide initial swelling data, was discharged from the MTR on April 6. Examination of this fuel rod, exposed to 3500 MWD/T, will begin in May. The remaining three fuel rods in the ETR are gathering exposure slowly because of frequent extended reactor shutdowns. To extend the coverage of the temperature, exposure, and cladding restrain parameters, twelve more assemblies, similar to those now in the ETR, are now being prepared for irradiation in the MTR.

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A method of cooling rods or discs of irradiated uranium, which duplicates the thermal conditions encountered by the central core of reactor fuel elements, is described in HW-59928. The controlled ex-reactor cooling of irradiated uranium will determine what rates of cooling create micro-stresses which can cause crack formation. Radiometallurgy personnel have designed, purchased or constructed, and started assembly on the necessary test equipment.

Metallurgical Development. An evaluation of coatings to prevent carbon contamination from graphite crucibles has been completed. Flame sprayed zirconium oxide coatings provided the least amount of carbon contamination, even at holding times up to 30 minutes at 1475 C. Average carbon content in the uranium cast from the flame sprayed crucible was only 49 ppm as compared to 29 ppm in the melting stock. A butyl-alcohol zirconium oxide wash provided little improvement over a bare graphite crucible, except at the longer holding times. Carbon content in these castings ranged from 700 ppm to 1100 ppm. Magnesium zirconate with a thorium oxide overcoat was fairly successful in reducing carbon pickup but was very sensitive to the method of application. Uranium melted in a crucible coated by brushing had a carbon content of 610 ppm, but when the method of application was changed to a spray technique, the carbon content was reduced to 157 ppm.

Facilities and Equipment. Mechanical devices have been designed and tested, out-of-reactor, that will permit controlled ruptures of fuel specimens that have been irradiated to 2000 MWD/T. The elements are currently being irradiated at Hanford and will be shipped to the ETR for subsequent rupture tests. These controlled rupture experiments will be conducted in the 3x3 loop to determine the rate of rupture product release and the detailed gamma spectrum from fission products and coolant activities. The instruments for this program are on order and will be installed at the ETR by August 1, 1959. Other mechanical revisions to the loop to withstand high levels of activity will be completed about July 15.

Formal approval has been received from Washington that will permit insertion of the 6x9 tube in the ETR with fissionable specimens. The actual tube insertion will be started May 1, 1959. The first experiment will be a test with a stainless steel sample to determine the gamma heating. A replacement tube for the 3x3 position has been redesigned and is out on bid for construction.

Request for appropriations to procure and install, in the existing 306 Building, three high pressure-high temperature autoclaves (3500 psi at 425 C) were approved. High temperature autoclaving is necessary in support of the extensive fuel development program utilizing Zircaloy-2 as the cladding material. The vessels are to be sized to handle assembled fuel elements up to four feet in length plus required support work on individual components. Approximate internal dimensions are: 12" ID x 50" deep, 8-9" ID x 40" deep, and 6" ID x 20" deep. Purchase requisitions have been sent to prospective vendors.

2. REACTOR PROGRAM

Coolant Systems Development

Evaluation of Nickel-Plated Aluminum Fuel Elements. In- and out-of-reactor tests have been started to evaluate nickel-plated fuel elements for present reactors. Out-of-reactor tests at 60 C and 120 C, after four weeks, have shown no adverse effects; tests have been started at 160 C. One tube of electroplated slugs and two tubes of chemplated slugs were discharged from C Reactor after 200 MWD/T. After cleaning, some flaking of the chemplated pieces was noticed. It has not been determined whether the flaking was due to the in-reactor exposure or to the handling after discharge. Contrary to the report of somewhat similar testing last month, no flaking or other visual imperfections were apparent on the electroplated pieces.

KER Testing. The extended outage at KE Reactor started April 15, and is scheduled for completion during May. Some changes to improve the KER loop facilities are scheduled during the outage. The tubes in Loops 2 and 3 were removed and replaced with new, stronger, Zircaloy-2 tubes, which will permit safe operation at higher temperatures (up to approximately 300 C outlet water temperatures). Loop 1 was discharged March 29, because an in-reactor flow blockage had increased the pressure drop and decreased the coolant flow rate.

The Doe thermocouple slug charged from the front face of Loop 3 was discharged. The three thermocouple leads were found to be broken at the nozzle cap, apparently caused by the influent water flexing the unprotected and unsupported wires in the nozzle resulting in eventual fatigue failure. Adequate supporting of the lead-wires will be provided in future tests of this type charged from the front face.

Two thermocouple trains are being prepared for charging in KER within the next month. To determine whether water mixing will be a problem in the new smaller inside diameter KER tubes, a 7-rod cluster mixing test with thermocouples in various flow channels is scheduled to be charged in KER-2 immediately following the 105-KE extended outage. To determine the cladding temperature increase as scale is built up, an X-8001 aluminum-clad Doe element with three thermocouples 120° apart in the cladding is scheduled for charging in KER-3 at the first shutdown after the extended outage.

Decontamination of KER Loops. The out-of-reactor portion of Loop 2 and both the in-reactor and out-of-reactor portions of Loop 3 have been decontaminated with the three-step Turco 4501 process. An average DF of six was obtained for Loop 3. The process used was: (a) 50% Turco 4501; (b) Turco 4502 (25 pounds per gallon); (c) 30% HNO₃. The Zircaloy process tubes of both these loops were removed and guillotined into eight-foot lengths.

Pilot Plant Decontamination Studies. Another test to evaluate decontamination efficiencies of Turco solutions in carbon steel systems was completed last month, employing the decontamination prototype located in the

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north corridor of 1706-KER. The procedure entailed contaminating the loop by exposure to hot recirculating water in contact with irradiated uranium and then decontaminating the system with the following solutions:

1. Turco 4501 at 135 C for one hour.
2. Turco 4502 (2 lb/gal) at 105 C for one hour.
3. Turco 4512 at 60 C for one hour.

An over-all decontamination factor of eight was obtained. The DF for the various portions of the carbon steel section ranged from three to 45, and for the stainless steel section, from one to 72.

Water Treatment Studies. Tests have been initiated to evaluate the effectiveness of magnetite as a filtration bed to remove crud from water systems at pH 4.5. Some dissolution of the magnetite has been observed, as determined from a five-fold higher than normal iron concentration in the Elmo-6 autoclave section effluent samples. The cleanup ion-exchange system is operating satisfactorily by reducing the iron concentration. The particle size of the magnetite samples is 15% smaller than when the studies began. It has also been observed that the magnetite is changing from Fe_3O_4 to Fe_2O_3 . The crud level across the magnetite samples has been decreased by a factor of approximately five.

A test was initiated and completed to determine the oxygen scavenging properties of hydrazine in low temperature systems (120-170 F). No hydrazine decomposition occurs at these temperatures in neutral or moderately high pH systems. Some oxygen scavenging occurs; however, the degree of completion of the reaction is dependent on the system temperature and the initial hydrazine to oxygen ratio. No pH effect was observed during this study.

Aluminum Corrosion Studies. A test in Elmo-6 at pH 4.5 and 300 C indicates no effect of replacing samples on X-8001 aluminum corrosion rates. A rate of 0.7 mil/year was observed for all samples, comparing favorably with rates obtained in a previous pH 4.5, 300 C test. Since the prior test was conducted without loop cleanup, the agreement in corrosion rates between the two tests suggests that the reason for low pH systems inhibiting aluminum corrosion is due to a lower solubility of aluminum oxide in these systems. Otherwise, the test with cleanup should have produced higher corrosion rates than the test without cleanup.

Structural Materials Development

NPR Zircaloy Process Tubing. A final report is ready for issuance covering the efforts of three contractors in development of a process for producing NPR process tubes from Zircaloy-2. The three contractors employed three different processes with varying degrees of success. While none of the fabricators produced a tube entirely meeting specifications, much was learned about handling and forming massive components of Zircaloy. None of the fabricators feel that the difficulties encountered are insurmountable.

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The above work was followed by a period of intensive development, primarily at the expense of the vendors. Two new vendors entered the field during this period. Four proposals were received for the fabrication of 70 NPR type process tubes. A technical evaluation of these proposals was prepared, contracts are tentatively being awarded to three vendors, and fabrication should begin during May.

Nonmetallic Materials Development

High Temperature Graphite Irradiations. Length changes of the TSGBF graphite irradiated in the GEH-9-7 experiments in the MTR have been measured. The results indicate that the contraction rate at 1000 C is in the range 0.03 percent to 0.07 percent per 1000 MWD/AT. The experimental uncertainty in making the length measurements is estimated as $\pm 0.02\%$. The apparent slight increase in length of one sample could possibly be explained as a measurement error. However, it is also possible, since the flux intensity was three times greater in the second sample than in the first, that the radiation damage mechanism causing expansion predominated in this case for the relatively low integrated exposure received by the sample. X-ray diffraction studies on these four samples are in progress.

Installation of the first high temperature graphite experiment in the ETR (GEH-13-1) was accomplished during the week of April 27.

Stored Energy Apparatus. Satisfactory operation of the stored energy apparatus up to 1000 C with an unirradiated graphite sample was obtained using a prototype heater as an adiabatic shield. The prototype heater consisted of a 3/4-inch ID internal winding of nichrome wire to radiantly heat the half-inch diameter platinum reflector tube that separates the shield heater from the sample. The shield thermocouple was welded to the outer diameter of the reflector tube and located in the radiantly heated annular space to form one leg of the differential couple between the shield and sample. Approximate power requirements observed for a 1.4 g graphite sample heated at about 10 C/min were 10 cal/min at 100 C, 13 cal/min at 200 C, and increasing to 60 cal/min in the 800 C region.

Coefficient of Friction of Irradiated Graphite. A method for partially eliminating the horizontal distortion of the 105-K reactors by applying pressure through inflatable bags inserted in the gaps between the side cast iron and graphite is being considered (HW-58739). The feasibility of this scheme is being studied by Facilities Engineering Operation, IPD, on a small graphite stack. In support of the above effort, static coefficient of friction determinations made on unirradiated and irradiated TSGBF graphite bars indicated that no highly significant change in this property results from irradiations up to 2000 MWD/AT at 500 C. The initial coefficients of friction and those after up to fifty tests were slightly higher for the unirradiated bars than they were for the irradiated bars. A small amount of oxidation which occurred during the irradiations may have altered the surface characteristics sufficiently to lower the coefficients for the irradiated samples.

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Irradiation Damage to Plastics and Elastomers. The effect of hot water (175 C) on silicone rubbers is to cause depolymerization rendering them soft, spongy, and weak. Radiation, on the other hand, crosslinks the silicones eventually causing them to become stiff and brittle. Preliminary results on the combined effects of hot water and radiation indicate that radiation at high dose rates (10^6 r/hr) is the predominant damaging agent. Properties of silicones irradiated over a range of exposures from 5×10^7 r to 3×10^8 r in water at 175 C changed in essentially the same way as those irradiated in vacuo or in air at 25 C. Experiments are in progress to determine the effects of lower dose rates in 175 C water.

Thermal Hydraulics Studies

Reactor Flow Hazard Studies. Design was completed of a short test section for use with studies of subcooled boiling burnout for Hanford reactors. Initial results will be obtained for K Reactor geometries at heat generation rates up to 350 kw/ft.

Equipment Projects. The project to provide additional heat generating capacity in 189-D through the use of silicon rectifiers (Project CG-661) was approximately 85 percent complete. All experimental activities with the 189-D heat transfer facilities were suspended during the month while modifications were made to the bus work and the heat exchanger system. Acceptance Test Procedures were written to provide a complete verification of the equipment to meet the specifications concerning steady state, overload, and transient operating conditions. The specifications call for steady state operation at 2700 kw, an overload of 120 V at 32,000 amps for a thirty minute period, and an overload of 48,000 amps at 50 V for a one minute period.

The project to modify the high pressure heat transfer apparatus for higher flow and heat dissipating capacities and to allow transient type experiments (Project CGH-834) was approved by the Washington, D.C. headquarters of AEC. Design and procurement were initiated, and it is estimated that beneficial use of the apparatus under flows and heat generation rates typical of an NPR process tube will be realized within four months.

Hydraulic Studies. Calculations were made to analyze the temperature unbalance between the inner flow channels and the outer flow channels of a 7-rod cluster fuel assembly irradiated in the KER facility. A temperature rise ratio of about 3.0 was determined when assuming absolutely no mixing between channels. This value was compared with thermocouple probe data from KER Loops 1 and 3 which showed temperature rise ratios of 1.2 or less. Although there were some inconsistencies in the thermocouple readings, it was concluded that the fuel element end supports provided significant mixing between the flow channels. The thermocouples, located just downstream of a triangular end support, indicated that the triangle apexes forced the outer channel flow into the inner channel, thus causing mixing.

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Heat Transfer Characteristics of NPR Type Fuel Elements. The design of the full scale heated mockup of a 7-rod cluster fuel element was completed, and materials for construction were ordered. This test section will simulate the downstream half of an NPR fuel charge and will have prototypical heat generation rates in both an axial and radial direction. Similarly, design was completed of a 20-foot test section simulating a tube and tube type NPR fuel element. The axial change in heat generation rates will be accomplished by various materials with different values of electrical resistivity.

Mechanical Equipment Development

Organic Cooling System Components. The MOTS-1 facility operated for 408 hours during the month, at temperatures between 300 and 350 C, using the terphenyl--MIPB eutectic mixture as a coolant. Three mechanical seals with Hycar rubber shaft gaskets operated without signs of difficulty.

Reactor Technology Development

Attenuation Measurements. The final irradiation of ferrophosphorus concrete baked at 320 C is in progress. The fast neutron relaxation length for this material after baking at 320 C is 8.2 cm based on the first set of measurements.

The perforated ferrophosphorus concrete slabs have been fabricated and will be placed in the DR test well during the next shutdown.

The boron-steel thermal shield test assembly was installed in the shield test facility at 105-C. This assembly simulates the NPR thermal shield design and is part of design test DT-1037. Water temperatures and flow rates and shield temperatures at various points in the assembly are being recorded satisfactorily. Preliminary analysis of the thermal data confirms the initial design calculations. The first foil loading was removed after a two-week irradiation period, and a second foil loading was charged.

Shielding Instruments. Additional gamma ion chambers have been fabricated for the Thermal Shield Testing Facility. Reduced neutron response is the goal of the new design with the new chambers using aluminum heads to reduce the response significantly.

B. WEAPONS - 3000 PROGRAM

Research and development in the field of plutonium metallurgy continued in support of the Hanford 234-5 Building Operations and weapons development programs of the University of California Radiation Laboratory (Project Whitney). Details of these activities are reported separately via distribution lists appropriate to weapons development work.

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C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels Development

Basic Studies. Experiments to determine the effect of increasing PuO₂ concentrations on the sinterability of UO₂ have continued. Plutonium dioxide has been added to as-received and to ball-milled PWR grade UO₂ powders in concentrations of 1/4, 1/2, 1, 2, 5 and 10 weight percent. When pellets of these mixtures were sintered in the temperature interval 1000-1600 C for one and eight hours, the densities were found to decrease markedly with very slight PuO₂ additions, especially at the lower times and temperatures. Plots of density versus composition had the same general form for both as-received and ball-milled UO₂; however, the absolute values for the ball-milled material were slightly higher. On the other hand, when PuO₂ was added to UO₂ in the form of the mixed crystal oxide, isothermal plots of density versus composition were parabolic, reaching a minimum at 2 w/o PuO₂ and gradually increasing until at 10 w/o PuO₂ the sintered density was slightly above that of UO₂. After eight hours at 1500 C, for example, the UO₂ bearing 10 w/o PuO₂ in the form of the mixed crystal oxide and the ball-milled UO₂ sintered to 98.1 and 95.1 percent of theoretical, respectively. Tests on Spencer hi-fired and ceramic grade UO₂ control powders have shown the latter to sinter to a high density without an activation treatment. After eight hours at 1300, 1400 and 1500 C, pellets of the ceramic grade powder sintered to densities of 89.6, 94.3 and 94.6% of theoretical.

Chemical dissolution tests performed by FPO Analytical Laboratory have shown that a UO₂-PuO₂ solid solution obtained by sintering will enter acidic solution at nearly the same rate as a solid solution obtained by chemical coprecipitation. Attempts to dissolve a UO₂-PuO₂ physical mixture of the same composition as the solid solutions were unsuccessful since only 20% of the PuO₂ went into solution.

Two near 100% burnup, Al-Pu alloy capsules being irradiated as part of the GEH-14-23, 24, 25, 26 experiment were discharged from the MTR. The capsules are scheduled for examination in the Radiometallurgy Laboratory.

The four-rod, Al-Pu alloy cluster (IP186A) which had an exposure of about 4×10^{20} nvt is currently being examined in the Radiometallurgy Laboratory. The alloy rods were easily slipped out of the cladding tubes when the end caps were removed. One element which contained two short core sections was found to have diffusion bonded to form a single core rod. Metallographic examination of the bond area has been initiated.

Fabrication Studies. Twenty-eight, full length, PRTR fuel rods containing 1.3 w/o Pu have been hot extruded to 0.5025 ± 0.001 " dia. Two rods approximately 100" long are obtained from each cast billet. The extrusion of relatively straight rods has been accomplished by using a graphite cylinder with a tapered hole bored into it. The cylinder is inserted in the platen opening causing the rods to be straightened as they emerge from the extrusion die.

Another group of ten full length elements consisting of aluminum cores clad in Zircaloy tubing has been fabricated to investigate the assembly, etching, wrapping and autoclaving problems. These elements were fabricated by inserting undersized rods into as-received Zircaloy tubing which had one end cap welded in place. The rods can be easily assembled into the tubes with a diametral clearance of 0.005" to 0.006". A one-inch end clearance is provided to accommodate differential thermal expansion. The second end cap was welded, and the elements were run through a swage sizing operation which reduced the outside diameter of the tubing by 0.003" to 0.004". The tubes elongated $0.2" \pm 0.06$ ". The maximum diametral gap along the length of the elements was not more than 0.004" in any location. Radiographic examination indicated that there was adequate end clearance after swaging and that the sizing operation did not work the aluminum rods appreciably. The end clearance was randomly distributed at both ends of the element; however, this apparently did not affect the performance of the element during autoclaving. These elements were then cleaned, etched, wire wrapped and autoclaved in that order. An examination of the elements, after autoclaving at 400 C and 1500 psig for 72 hours, showed them to be free of water spots; straight with no indication of warpage; the wires were tight; and there was no sign of corroded welds. Some of the elements, however, had a streaked gray appearance which was attributed to the etching procedure. Three of these elements, two of which were defected, are being thermally cycled in the high temperature Elmo loops.

Seven and nineteen-rod Al-Pu clusters of the PRTR design, but approximately half the length, are being fabricated for irradiation in the ETR high pressure loops. The fuel material (Al-1.3 w/o Pu) for the seven-rod cluster has been extruded, cut to length, and inspected. The inside diameter of the jacket tubing was honed to size in an effort to obtain a constant diameter. After the first end closure was made, core and tube pairs were selected for assembly which gave a maximum diametral clearance of 0.004". Eight out of ten elements were successfully assembled with some difficulty. The final end closures were made, and the elements were helium leak checked, wire etched, wire wrapped, and autoclaved.

Pu alloy rods (Al-0.5 w/o Pu) for the 19-rod clusters have been extruded and straightened in the rod straightener. These clusters will be assembled by inserting undersized rods into as-received Zircaloy tubing and controlling the diametral gap between the core and can by swage sizing.

Development of fabrication techniques offering economic advantages for Pu-Al spike clusters has continued. Evaluation of one of the prototypic aluminum fuel rods, pressure die cast into Zircaloy tubing during the

Kux development contract, has revealed extensive bonding between the aluminum casting and the Zircaloy can. The tubing was easily stripped from the aluminum core for 20 inches on the extreme end of the casting; however, the remaining 69 inches of the tube, adjacent to the injection orifice, was metallurgically bonded and could not be stripped from the core.

Fabrication of 220 special fuel rods in support of critical mass studies for the PRP program is under way. All the Pu-Al core material has been cast, extruded, and cut to length. Cladding components have been machined, and the first end closure has been made. To date, 23 rods have been completed.

UO₂ Fuel Development

PRTR Fuel Elements. A device employing opposed, skewed, feed rolls has been developed to feed fuel rods completely through the swaging machine without interruption. The use of steel rolls in conjunction with a lubricant produces a satisfactory rod surface finish. High speed motion pictures reveal that the rolls permit the necessary slippage to relieve torsional forces as the dies grasp the work piece. This device has reduced the time required for swaging PRTR fuel rods from approximately ten minutes per swaging pass to less than three minutes per pass. Experiments with rubber rolls are continuing. Rubber rolls may eliminate the need for a lubricant during cold swaging.

Roll bar straightening of Zircaloy clad swaged UO₂ fuel rods induces diametral growth. Ten PRTR fuel rods were given one, two, or three passes through the roll bar straightener with deflections of 0.100, 0.125, and 0.150 inch. One pass with 0.150 inch deflection produced the same amount of diametral growth (approximately 1.3 mils) as three passes at 0.100 inch deflection. The growth produced by the first pass with 0.150 inch deflection was nearly twice the growth produced by the first pass at 0.100 inch deflection. However, the growth experienced in subsequent passes appeared to be independent of the applied deflection. On the basis of these observations, 0.100 inch was selected as the maximum permissible deflection during roll bar straightening of PRTR fuel rods.

High density UO₂ powder for swaged PRTR fuel rods is currently being made by a sintering and crushing process. The introduction of an abnormally high concentration (0.7 w/o) of aluminum oxide by off-standard operation of the continuous ball mill was found to decrease the sintered density of the UO₂ by four percent. Normal aluminum oxide content of ball milled UO₂ is 0.1 w/o. A decrease in sintered UO₂ density occurs at approximately 0.3 w/o Al₂O₃. An automatic control was provided to de-energize the ball mill system in the event of a feed failure. A feed failure causes the ball mill to run dry and introduces excessive amounts of aluminum oxide by deterioration of the grinding media.

Fabrication Development. Vibratory packing of fissile ceramic fuel to moderate densities in cladding tubes offers possibility of a simple means of fuel element fabrication. Further, such a packing method used in conjunction with a subsequent swaging operation would permit substitution of a variety of fuel materials into an existing swaging schedule without the necessity of changing original clad tubing size. Ground fused UO_2 and PWR type UO_2 powders were compacted to 86 and 46.5 percent of the theoretical density, respectively, by vibratory compaction in 44.75" long 0.57" OD Zircaloy tubes. The test was performed at the vendor's laboratory on a 500-pound thrust, 5-5000 cps, Genisco-Savage vibrator driven by a one kw amplifier. The stated densities were achieved in less than one minute of vibration at 33 g at the resonant frequencies of the tubes, which varied from an initial 220 cps to 280 cps at maximum compaction. Further compaction can be obtained by varying the frequency of vibration near the resonant frequency and at various harmonics of the fundamental frequencies. Preliminary experiments reveal that fused oxide particles are oriented to fill available void spaces and are further compacted by expansion and contraction of the tube walls at the resonant frequency by a "self-swaging" action. Compaction of UO_2 by ultrasonic vibration was investigated. Fused oxide was compacted to 85 percent of the theoretical density in 15" long, 0.570" OD Zircaloy tubes, using an air-jet ultrasonic whistle.

A series of hot swaging experiments were conducted to evaluate heating techniques. These experiments were conducted in a two-die, No. 4 Torrington rotary swage. Excessive vibrational and torsional forces imparted to the fuel rod by this machine create a serious handling problem not ordinarily observed in use of a stationary spindle swage. Swaging results were improved by the installation of a four-die spindle in this machine. Tests reveal that hot swaging of UO_2 in Zircaloy-2 at 800 C is feasible. Induction heating was demonstrated to satisfactorily transfer high power densities to the swaged rod. Tests utilizing direct resistance heating of the cladding tube were successful.

Sample Zircaloy-2 closure welds were made on a Magnetic Force welding machine at Precision Welder and Flexopress Company in Cincinnati, Ohio. The short welding time for each closure, 1/60 of a second, eliminates the necessity for an extremely pure inert gas protective atmosphere. A very narrow layer of weld metal and a small heat affected zone are produced. The total heat introduced into the fuel element is considerably less than in the present tungsten arc fusion method. The UO_2 contained in the fuel rod receives no heat from the welding process and does not outgas, thus eliminating the necessity of an outgas hole.

Fuel Evaluation. Post-irradiation examination of a three-rod cluster containing two rods of 1.0 w/o PuO_2 enriched UO_2 has revealed that the element received an exposure of approximately 570 MWD/T of uranium at an average surface heat flux of 250,000 BTU/hr/ft². The fuel was redistributed to the top of the Zircaloy-2 tubes. A central core, ~ 0.19" diameter, was observed to extend two-thirds the length of one PuO_2 - UO_2 fuel rod and the entire length of the second PuO_2 - UO_2 fuel rod. A 0.31 diameter central core ran the entire length of the 2.44 w/o U-235 enriched UO_2 . The UO_2

was severely fractured. The PuO₂ enriched UO₂ was easily removed from the tube in single pieces. Columnar, radially oriented grains extended from the central core to the periphery of the fuel.

Post-irradiation examination of a three-rod cluster of swaged UO₂ (1.6 w/o U-235) revealed the following facts: The cluster operated at an average surface heat flux near 300,000 BTU/hr/ft² to an exposure of approximately 470 MWD/T. Extensive radial crystal growth occurred. A central void approximately 0.1" in diameter extended the entire length of two rods and one-half the length of the third. This difference is attributed to the non-uniform thermal neutron flux of the MTR test position. The inside surface of the void is regular and smooth. Sausage-shaped voids, ~0.0017" long, were formed in the columnar grains near the central void. Voids such as these have been shown to result from cross linking of dendrites grown by vapor phase deposition of UO₂.

A series of five capsules of swaged UO₂ continue to accumulate exposure in the MTR and ETR. The maximum exposure to date is approximately 7000 MWD/T. An additional capsule, 0.569" OD, of natural swaged UO₂ has been discharged with an approximate exposure of 3000 MWD/T.

The radiometallurgical examination of an enriched 3/4" OD UO₂ capsule has revealed a 0.150" diameter void which extends the entire length of the 3.375" fuel length. Small voids less than 0.0005" diameter were formed in the large, columnar, radially oriented grains, predominantly at the grain boundaries. A 0.0005" thick layer of unidentified corrosion product and a 0.003" thick recrystallized phase were formed at or near the UO₂-Zr-2 interface. Approximately 50 percent of the fission gases were released. The capsule was irradiated to an exposure near 3000 MWD/T at a surface heat flux near 600,000 BTU/hr/ft².

A four-rod cluster containing arc-fused, natural UO₂ powder vibratorily compacted to 78 percent of the theoretical density has completed one-half of a two cycle irradiation test in the MTR-GEH-4 facility.

The irradiation test of a naturally enriched, sintered UO₂ fuel element, 1.440" OD, was interrupted after twenty-five days in the MTR due to a fission break. The element was operating at ~31 kw/ft. The nature of the failure is as yet undetermined. The test was performed with purposely small core-clad clearance.

Two, four-inch long, 0.560" diameter capsules of natural UO₂, hot swaged in a 0.030" wall Zircaloy-2 cladding, were prepared for irradiation in the ETR. Exposures ranging from 3000 to 5000 MWD/T have been requested in order to study possible solid state reactions at the internal surfaces of hot swaged fuel rods.

The final shipment to Atomic International of eight percent enriched UO₂ fuel cores was made. These cores were fabricated for two, six-foot tubular elements to be irradiated in SRE in a joint HAPC-Atomic International test program.

Forty-seven swaged UO₂ rods, 0.563" in diameter and 8" long, were delivered to Process Equipment Development Operation for shearing tests supporting the nonproduction reactor fuel reprocessing studies.

Basic Studies. Three techniques are being used to study radiation damage in sintered UO₂: (1) metallographic examination of pre-characterized surfaces, (2) metallographic examination of polished and etched surfaces, and (3) fractographic studies. Examination of sintered UO₂ irradiated at approximately 100 C to a burnup of 0.015 a/o revealed small voids at grain boundaries similar to the voids previously observed at grain boundaries in similar UO₂ irradiated to 0.005 a/o. These voids were found at grain boundaries and within grains in a band 300 microns wide around the periphery of test specimen UO₂. Such a distribution of holes near the surface of the specimen was not observed in the lower burnup specimens.

Facilities. The pusher-type H₂ atmosphere sintering furnace was cooled to room temperature in order to replace a broken hearth plate in the pre-heat zone. During the shutdown the pusher mechanism was extended to permit an unattended, continuous pusher operation of thirty hours. Previous operation was limited to seven hours before service was required. Additional viewing ports were added at the entrance and exit ends of furnace.

Etching and Autoclaving Zircaloy Components

Etching Zircaloy-2. The final steps in the preparation of Zircaloy-2 clad fuels for reactor exposure consists of etching, rinsing, and autoclaving the fuel. The appearance of white oxide on the autoclaved Zircaloy may be indicative of poor corrosion resistance. However, the white oxide can be caused by improper rinsing of the etch solution from the surface. As reported previously, the final rinse can effectively be accomplished by starting the autoclave full of deionized water, blowing off the water at elevated temperature and continuing the normal autoclave cycle at 400 C and 1500 psi. This technique has been further evaluated.

Employment of the water-filled autoclave startup procedure has eliminated most of the surface spotting caused by tap water and dilute etch solution but not spots caused by dilute hydrofluoric acid or poorly rinsed crevices. The temperature at which the water is blown off the autoclave was not significant in two comparative tests, one blown off at 150 C and the other at 314 C. The extent of spotting on the two groups of samples was judged about the same.

Rinsing of PRTR Fuel Rods After Etching. The above method was tested on 14 rods in the 314 Building etching prototype. After five rods were etched, rinsed, and wiped dry, two rods were removed from a deionized water rinse and not dried, and two rods were removed from a tap water rinse and not dried. The other five rods were then etched, rinsed, and dried in the normal manner. After autoclave testing using the wet startup procedure, all 14 rods exhibited good, black, autoclave films. Although still tentative, these results indicate that the final deionized water rinse may be satisfactorily accomplished in the autoclave as part of the autoclave startup procedure.

Use of Aluminum Nitrate in Rinsing of Zircaloy. To illustrate the use of aluminum nitrate in preventing acid staining, a careful experiment was performed. The results show pure deionized water to be a satisfactory rinsing agent. However, it soon becomes contaminated, presumably with HF carried over from the etching bath. The addition of aluminum nitrate to the rinse water eliminated acid staining, presumably by complexing the HF carried over.

Other laboratory tests completed during the month have reconfirmed that one of the most effective rinsing solutions for Zircaloy following etching in HNO_3 -HF is 1 N HNO_3 -100 g/l $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ solution. Although deionized water is an adequate rinse for small Zircaloy coupons under aseptic laboratory conditions, the advantages of the acidified aluminum nitrate intermediate rinse become most pronounced in processing larger Zircaloy hardware shapes. The aluminum nitrate complexes the unwanted residual fluoride ion, and the function of the added HNO_3 is to hold the hydrous zirconium oxides in solution. The latter contribute to the formation of water spots if they are deposited and allowed to dry on the surface of the Zircaloy.

Structural Materials Development

PRTR Process Tubes. The first 20 Zircaloy-2 PRTR process tubes have arrived at Hanford, and approximately 30 more have been inspected at Tube Reducing and are ready for shipment. These tubes have been inspected at the vendor's plant for conformance with the purchase specifications, including dimensional measurements, Vidigage measurements of minimum wall thickness, straightness measurements, visual inspection of surfaces including boroscoping of the inside surface, and pressure testing. Corrosion tests on samples from the first 20 tubes indicate that two of the tubes may be of questionable corrosion quality. The samples, however, were not correctly prepared, and the tests are being re-run. Corrosion test results on the second lot of tubes that have passed all other acceptance tests are not yet available.

Over-all progress on the 100 PRTR Zircaloy-2 process tube order continues to be good. Tapering of all tubes is completed. Thirty-two tubes are being conditioned and inspected at Tube Reducing before shipment to Chase Brass for flanging. Twenty-three tubes are currently at Chase being flanged and six tubes are being given their final inspection at Tube Reducing. An estimated delivery at Hanford of 50 tubes in May and 30 tubes in June will complete the 100 PRTR process tube order.

Alcoa successfully developed fabricating techniques and produced 10 PRTR process tubes of C-94-T6 aluminum alloy. The tubes have arrived at Hanford.

PRTR Jacket Tubes. Nuclear Metals, Inc., is making good progress in producing the second generation of ribbed jacket tubing for the Mark II nested tubular fuel element. Extrusions were produced April 21 at the Detroit plant of Revere Copper and Brass Co. These were three of each of the large and medium diameter tubes. NMI had previously extruded three of the small tubes at their own plant. This new group of extrusions will produce tubing

with a wall thickness of 0.060". All extrusions are slightly oversize so that they may be finished by drawing down to final size. It appears likely that at least one set of tubes will be available by June 1.

A tentative contract has been sent to Aerojet General Corporation inviting them to submit a proposal for conducting a development program. The program would investigate the application of explosive forming to the sizing of Zircaloy components. This method has been suggested as a means of correcting the form and dimensions of tubing. If this application is successful, many other uses may develop, such as flaring of heavy walled tubing.

The new contract with New Rochelle Tool Company is now in effect. This contract provides for conversion of the rib-to-tube welding machine to allow attachment of a spiral rib to small diameter tubing. The longitudinal welding head has been disassembled, and parts are being fabricated for the spiral configuration. New Rochelle personnel expect to be ready to apply power to the new machine by the end of May.

Radiometallurgy Laboratory Studies

Metallographic studies of a 2.44 w/o U-235 UO₂, Zircaloy-2 clad capsule were made. Four UO₂ metallographic samples that were polished and etched before irradiation were replicated; two were not good enough for replication work (285). Six samples of UO₂ were shipped to Battelle Memorial Institute for thermal conductivity measurements, and one sample each of 95% density and 89.2% density were fractured and replicated for electron microscopic studies (289).

Length, diameter, and warp measurements were obtained on bare rods of 8 w/o Pu-Al alloy and 8 w/o Pu:12 w/o Si-Al alloy after easy removal from three of the four Zircaloy-2 clad jackets (270). Wafers from low exposure (5%) Al-Pu and AlSi-Pu were replicated for electron microscopy (278).

One wafer from test KER-3-2 was prepared for x-ray diffraction studies in connection with the swelling program (265).

The results and conclusions from the above work will be reported in connection with the respective development programs of Ceramic Fuels, Plutonium Metallurgy, and Physical Metallurgy Operations.

Thermal Hydraulics Studies

Air Cooling of PRTR Fuel Elements. Heat transfer experiments were performed to evaluate the requirements to cool the Mark II PRTR fuel element by air in the fuel examination facility. Temperature distributions were obtained from a full scale electrically heated mockup of the fuel element under a variety of air velocities and heat generation rates. It was found that the outside section of the Mark II tubular fuel element could be cooled sufficiently by blowing air against one side of the element.

Heat Transfer Characteristics of PRTR Fuel Elements. The fabrication of the full scale electrically heated mockup of the Mark I element was 75 percent complete. A total of 44 thermocouples were placed for measurement of surface temperature at various points in the 19 rods. Plans were also made to measure water temperatures at sixteen different spots between the various rods. A 50-point scanner was fabricated to feed the thermocouple signals into a single recorder.

Mechanical Equipment Development

Design Test PR-1 - Discharge Operation Mockup. The structural drawings for the installation of the fueling vehicle in the 314 Building were begun. Scoping of special tools for use during charging and discharging of the reactor continued.

Design Test PR-10 - Primary Loop Mockup. The first 100-hour hot loop test of a full size PRTR primary pump was completed at the Byron Jackson Pump Company's plant. Delivery of this pump is expected during the first week of May. The construction of Phase II of the Single Tube Mockup is essentially complete, except for the installation of the full size pump and its associated piping and wiring.

Design Test PR-11 - Air Operated Check Valve. The approval drawings from Atwood and Morrill Company were corrected and sent back to the vendor without approval due to the many clarifications needed and changes required.

Design Test PR-15 - Injection Pump Test. The second Aldrich Injection Pump has completed 518 hours of operation with acceptable performance. Type 44C-C stainless steel plunger and Hycar 1002 radiation resistant rubber packing are being installed in the original Aldrich pump and this pump installed for testing.

Design Test PR-20 - Calandria Characteristics. Tests by pulsing the moderator level to determine the effect of vibration frequencies will begin in early May.

Design Test PR-24 - Shroud Tube Bellows. The final report, HW-58801, was issued.

Design Test PR-40 - Shim Control Mockup. The initial design of the three-rod PRTR shim control was completed. All procured items for the prototype assembly have been received except the lead screws. This item will arrive during the first week of May. Fabrication of the prototype assembly was approximately 85 percent complete at the month's end.

Design Test PR-50 - Reactor Piping Seal Testing. The fully prototype Process Tube Assembly "C" has undergone approximately 2700 thermocycles from 250 to 500 F at a pressure of 1350 psi without signs of leaks. The nozzle cap seal in the full size process tube mounted in the Single Tube Prototype Mockup was removed several times during the month without

experiencing any difficulty. The nozzle-to-process-tube gasket was believed to be leaking and was replaced. All other water and gas seals on the full size process tube showed no signs of leaking. The rough draft of the final report of this design test is 75 percent complete.

Design Test PR-51 - Reactor Piping Structural Integrity. Flexure cycling of the shortest outlet jumper at a temperature of 500 F is currently in progress. Approximately 20,000 flexure cycles have been completed to date. No evidence of excessive stresses or failure of any jumper components have been noted during the testing period.

Purchase orders for jumpers having a wall thickness of 128 to 134 mils and for schedule 40 pipe for use as jumper headers have been placed. These thicker walled jumpers and jumper headers will be evaluated for possible reactor use.

Design Test PR-52 - Process Tube Thermocycling and Pressure Testing. Testing of the stainless steel simulated process tube under PRT conditions continued during the month. A total of 750 hours of operation at 500 F and 1100 psi have been completed to date. No excessive signs of leakage have been experienced. A Zircaloy process tube is being secured for installation in this facility.

Design Test PR-30 - Air Cooling Duct Test. Installation of the blowers for this test was approximately 60 percent complete. The fabrication of the duct was completed, and installation will begin shortly.

Single Tube Prototype Mockup. The primary seal of the Byron Jackson pump showed signs of failure on April 16, when the leak rate increased to a value of six gallons per hour. The pump was shut down and disassembled. Examination of the pump and the seals revealed that excessive corrosion particles in the water had settled in the main seal cooling recirculating system and in the secondary seal water chamber. These particles caused the failure of the seals. The total operating time on the seals was 713 hours.

During the time that the pump seals were being replaced, the loop was flushed and cleaned with duPont No. 7 Cooling System Cleaner. Sodium nitrite is being used as a corrosion inhibitor during low temperature operation and shutdown periods. A full flow, 10-micron filter was installed in the main seal cooling recirculating system.

Operation was resumed on April 27, but the second failure of the Dynamic Drive pilot bearing caused a shutdown. This bearing is being replaced and the drive repaired.

Inconel "X". A test piece of 3/8 inch ID, 20-mil wall Inconel "X" tubing failed after 160 hours of operation at 5000 psi and 1100 F. The cause of the failure is being determined by metallographic examination. Small test pieces of the tubing are being subjected to varying degrees of heat treatment to evaluate the strength developed by each method of heat treatment.

Reactor Technology Development

PRTR Physics Evaluation. A study of the effects of in-reactor test loops on PRTR operation and program has been completed. Although results are based on preliminary information, the following numerical conclusions were obtained:

1. Insertion of a loop could result in as much as a 5 milli-k loss in reactivity which must be countered by increased enrichment.
2. A simplified analysis of the PRTR operating with uniform enrichment under self-sustaining conditions showed a loss of 150-250 MWD/T from maximum attainable exposures in the range of 4000 to 5000 MWD/T due to a single loop.

A complete description of this work is given in HW-59691, now in preparation.

Further calculations of neutron and gamma ray heating in shield plugs below the shim drive mechanisms were completed in support of the shim system design. The heat developed in these plugs was found to be of the order of 200 watts.

Report HW-60101, "Shielding of PRTR Gas Loop and Filter," has been completed. Calculations were made to determine the shielding of the loop piping and filter necessary to contain the radiation from diffused gaseous fission products and particulate fuel deposited in the filter.

PRTR Instrumentation. Time of response tests were conducted on the remaining two of the three strap-on resistance temperature detectors originally supplied by Charles Engelhard Co. Measured response times on these two were 4.4 seconds and 12.8 seconds as compared to 4.8 seconds reported earlier for the third unit. The slower unit was assembled using somewhat different construction techniques. Equipment for a test loop for evaluating the response of RTD's at high temperatures was ordered.

The needs of several interested groups regarding a data handling system for PRTR have been solicited. A preliminary project proposal on this in conjunction with an 8 $\frac{1}{2}$ -tube power calculator is being prepared.

Preliminary work for the calandria dump rate tests is progressing. Four level detector units are being made by the optical shop, and the entry plate and capacitor plates are being fabricated by the machine shop for the final test and calibration at 189-D. A prototype optical unit was assembled, and initial tests were successful.

Containment Study. A final report of a study of possible alternates to containment, based on PRTR design, was completed. It was concluded that the PRTR containment system is an effective method of preventing fission product escape to the atmosphere. A possible alternate to containment is a gravity powered emergency coolant backup system. To make such a

system effective, it would be necessary to provide a means of converting the primary coolant recirculation loop to a single pass system in the event of certain failure sequences and to provide a means of removing the radioiodine from the steam-air mixture flowing from the reactor in the event of a single tube meltdown. An appropriate valve in the primary loop and a filter-silver reactor set could be added to perform these functions.

PRTR Hazards Analysis. Consideration of possible control, mechanical, and scram circuit failures led to a listing of multiple failures considered potentially hazardous. Detailed analyses of these multiple failures are being performed.

Process Specifications. The selection of parameters to be used in an analogue study of nuclear accidents is in progress. The results of this study will be used as bases for selecting reactor instrumentation scram trip points and will be included in the final PRTR safeguards analysis report.

Loss-of-Coolant Accident in PRTR. Battelle Memorial Institute has completed the calculation of the adiabatic fuel temperature excursion following the loss of primary coolant through a piping rupture caused by the complete parting of the top 14-inch header. Their analysis shows that the average temperature of the maximum power section in one of the rods of a 19-rod cluster element first decreases from about 1200 F to 500 F in 16 seconds. After this initial decrease, the temperature rises as a result of fission product decay heating, reaching the melting point of zirconium (3362 F) in about 1000 seconds. BMI expects to complete the remaining analyses of the loss-of-coolant study in about four weeks, using the IBM-650 program developed in the study of this first case.

Design Development

Phase I PRTR Construction Status. The Phase I PRTR contractor is approximately 93% complete versus 99% scheduled. The vessel was soap tested during the month. The vessel pressure test and leak rate test are scheduled to begin the week of May 11. Concrete placing within the containment vessel was essentially completed. A contract modification is being made to allow the Phase I contractor to turn the vessel portion over by May 24. The remaining work outside the vessel and in the storage basin and load-out facility areas will be completed by June 9.

Phase II PRTR Construction Status. The Phase II contractor is 90% completed versus 97% scheduled. Acceptance testing was not conducted during the month of April as the contractor originally indicated. It is now proposed to start acceptance testing of the process water pumps the first week of May by using temporary power.

Phase IIA PRTR Construction Status. The contractor is approximately 63% complete versus 88% scheduled. The contractor has encountered considerable difficulty in dewatering and excavating to the required depth for

the pump structure. The Commission questioned the soil bearing capacity under the pump structure. This problem was resolved by driving a test pile, the results of which indicated that the underlying strata was satisfactory to the Commission. The contractor has procured and is driving sheet piling in order to excavate for the pump structure foundation.

Phase III PRTR Construction Status. The contractor is submitting detailed approval information on equipment and fabricated items.

Process Piping. Negotiations are under way at month's end to speed fabrication and delivery of the steam generator, now delayed by delivery of tubes being radiographed at the rate of only 200 per week. A sample of the Yuba tube-to-tube sheet weld performed by use of the Revere Automatic Welding Gun was received for metallurgical examination. Analysis of the micro and macro structure is in process. Preliminary inspection shows the welding to be extremely uniform and without apparent defect. Tube expansion was within specifications.

An order for two gimballed bellows joints (one 8-inch and one 14-inch) was placed with Parts Engineering Company. These joints will be tested for use in primary coolant piping.

Both the blowdown flash tank and the deaerating feedwater heater were received on-site.

Core Components. Continuing fabrication difficulties at Consolidated Western Steel made it necessary to establish a nearly full time resident engineer at their plant to provide rapid decisions on weld acceptability, fabrication methods, and day-to-day minor problems which arise. Continuing difficulty has been experienced in achieving porosity-free welds. A visit to the Consolidated plant by a local General Electric welding specialist has benefited the problem, but weld distortion problems will continue to be encountered.

A drawing revision is in process to add 7 psig rupture disks on two of the top gas lines in the lower reactor room. These rupture disks will tend to protect the calandria from massive damage should a process tube rupture and penetrate a shroud tube, injecting large quantities of steam inside the calandria.

Shielding. A drawing revision is in process to add three 8-inch pipe relief passages from the core of the reactor through the side biological shield. These relief passages, blocked by 3-5 psig rupture disks, will protect the calandria from excessive external pressures should a process tube leak at rates up to 1000 gpm.

The drawing revisions necessary to convert the top and bottom primary shields to a recirculating cooling system are nearly completed, and the revision package should be issued to the Phase III contractor in the near future.

Helium Gas System. The low pressure and high pressure helium compressors are currently undergoing acceptance tests at the supplier's plants. Only minor difficulties have developed thus far.

Instrumentation and Control. Design changes are being developed to increase the reliability of the reactor safety and containment systems. The changes will include the addition of a second set of sensing devices to a number of process trips, with the sensors being in each case of a direct-sensing nature, i.e., pressure switches, operated directly by changes in pressure, level, etc., of the process fluids. In addition, the electrical components of the safety circuit will be arranged to provide a fully dual system. At the same time, the exhaust activity monitor and effluent activity monitor will be "beefed up" and more sensing channels added for increased reliability of the containment system.

The PRTR Building Radiation Monitor System has been increased in size from a 10-channel to a 20-channel system. The additional channels will provide monitoring facilities for the loops to be installed in "B" cell and will provide a small number of spare channels for future use.

Fuel Handler. Willamette Iron and Steel has completed engineering on the fuel handler except for certain details of the position indicator and additional guide actuator in lower cask section No. 1. Fabrication of cask sections has begun.

Process Tube Assembly. A new tie-down design for the outlet nozzles has been proposed for design and testing by MEDO.

Fuel Element Examination Facility. The as-built measurements on the block-out for the fuel examination facility shows that the anchor spacing for the cast iron shielding was out of specification and the two walls out of plumb in excess of tolerance.

The cast iron shielding drawings were found to require extensive dimensional changes to procure shielding which would fit the as-built concrete. The thickness of the shielding afforded by the filler blocks would have been significantly reduced. To correct these difficulties, the Phase I contractor will chip out the entire face of the two walls for a depth of about one foot and replace the walls according to specifications.

An operating mockup of the diameter measuring components of the combined 5x viewer and profilometer was successfully tested. This completes the testing of the individual components.

Helium Evolution Study. A study of helium evolution during cooling of the primary coolant, and the effects of such evolution on convection cooling in the event of complete loss of electric power, was initiated.

High Pressure Loop (CAH-841). The preliminary project proposal for the High Pressure Loop has been approved and \$50,000 authorized for scoping and preliminary design of the facility.

Scoping of the high pressure loop was begun. A scope flow sheet has been issued and a layout made of a test section for internally cooled fuel elements. A description of the system presently visualized has been prepared in rough draft form as a basis for writing the design criteria, establishing equipment sizes and specifications, and obtaining cost estimates. A conference with U.S. Air Force experts on high temperature metallurgy indicates that selection of pressure tubing for the fuel element will be difficult because of the limited number of materials suitable for in-reactor use.

B Cell Model. A model of B cell is under construction to utilize in layout of the gas loop, high pressure loop, and rupture facility.

Critical Reactivity Measuring Facility. The preliminary project proposal on the Critical Reactivity Measuring Facility has been approved by the AEC.

Plutonium Fabrication Pilot Plant

Phase II Construction. Completion of work under the Phase II contract is estimated at 97%, compared to 99% scheduled. The contractor was awarded a 14-day extension to his contract, bringing the official completion date to May 10.

None of the chemical-resistant coating has yet been accepted as complying with the specifications. No work on correction of defects has yet been done. A meeting preliminary to legal action between the painting subcontractor and the general contractor was held during the month. The GE-AEC position was presented to attorneys for both parties.

Phase III Construction. Completion of work under the Phase III contract is estimated to be 15% compared to 13% scheduled. Negotiations with the contractor for an accelerated schedule have not yet been concluded. Switchgear for the motor control centers is the main long delivery contractor-procured item at present.

Procurement. All phases of procurement are on schedule. The schedule for submission of the requisition for the extrusion press has been delayed about 60 days to permit settlement of differences with Lombard Corporation over purchasing procedures in connection with purchase of an extrusion press for FPD.

Purchase order for the hydrogen atmosphere sintering furnaces was not placed at the month's end. It is planned to commence negotiations with the successful bidder, as soon as the order is placed, to accelerate his fabrication schedule.

Scope. Scope revisions adding a gamma-neutron burst detector system and a zirconium etching facility were submitted during the month.

PRTR Operations

Technical Manual. The PRTR Technical Manual was issued in rough draft form on April 30, 1959. Three of the fifty-one chapters were not complete at the time the manual was assembled. These chapters will be issued when available. The manual, as issued, contains some information made obsolete by design changes. Periodic revisions are planned.

Training Program. The training program for PRTR engineering assistants has been scoped and is being prepared. The program, to be conducted by PRTR engineers, is designed to familiarize the engineering assistants with the objectives of the PRP and the various PRTR systems. In addition, a number of general subjects will be covered, including radiation hazards, blueprint reading, and a brief mathematics review. The course is scheduled to begin August 1, 1959, and will continue for eleven weeks.

Preliminary Procedure for Test Irradiation in PRTR. Tentative procedures have been prepared to indicate to prospective test sponsors the requirements for installation of testing facilities and test irradiations in the PRTR. The procedures were designed to cause minimum inconvenience to test sponsors consistent with safe operating practice. Copies will be sent to interested persons after further internal review.

2. BASIC SWELLING STUDIES PROGRAM

Irradiation Program

Thermocouples, heating elements, and temperature control equipment has been received for the swelling behavior capsules. The sheathed thermocouples and heating elements are being radiographed for evidence of discontinuities in sheaths and wires. Laboratory tests are now under way to determine the life expectancy and behavior of the heating elements. Previous tests on laboratory built sheathed heating elements indicated that they would not handle the power requirements of the capsule.

A new capsule design is being evaluated. A rolling cylinder is used to keep the NaK level above the feeder tube and prevent a gas bubble from entering the feeder tube when the capsule is either cooled down or rotated in the horizontal position.

During the month three ingots of high purity depleted uranium were received from Argonne National Laboratory. The total weight of the three ingots is 5860 gms. Sufficient Oralloys has been ordered to enrich this uranium to the three percent level for the swelling investigations. A remelt of the high purity uranium will be necessary for the enriching operation.

Mechanisms and Theory

Diffusion of rare gas fission products through uranium may be important in both the rate of formation and the rate of gas pressure increase in pores. Mobilities of these gases in uranium are, therefore, being investigated.

In the present studies, rare gases are introduced into the uranium lattice by means of an electrical glow discharge. This method of introduction was used successfully to study the diffusion of rare gases through silver. Equipment for the present studies is being tested by determining the mobility of helium in uranium. Helium is being utilized in initial tests since it may be conveniently detected with a portable helium leak detector. A uranium cylinder, having a 0.020" thick wall has been annealed at 725 C for 33 hours. An internal helium glow discharge was maintained at 25 milliamperes current during this time. No detectable amount of helium passed through the cylinder. However, the sensitivity of detection was reduced due to a minute leak which developed during the anneal. Methods of fabricating leak-free uranium cylinders with wall thicknesses of 0.005" to 0.010" are being investigated. During reheating a gas charged cylinder, the rate of helium evolution from the inner surface of the uranium cylinder increased markedly at approximately 920 C. Studies are now being made to determine whether such an effect exists for xenon and krypton. Such an effect could be extremely relevant to studies of swelling mechanisms.

Optical and electron microscopy is being used as a direct means to determining the size and distribution of pores in uranium. Theoretically, with a random cut through a sample there should be as many pores cut above their centers as there are pores cut below their centers. However, this is not the case. A statistical analysis of the electron micrographs reveals that as the center of the sample is approached pores appear to be cut above their centers. This would indicate that: (1) the assumption that the pores are spherical is incorrect and that in reality they assume elliptical shapes, (2) the pore shapes are influenced by the temperature during irradiation, or (3) the original pore shapes are distorted during the course of specimen preparation. These three possibilities for distortion of pore geometries are now being studied.

Metallographic examination has been completed on an annealed uranium rod. The rod specimen had been annealed for 100 hours after an irradiation at a core temperature of 450 C and a surface temperature of 340 C to a burnup of 0.25 a/o. In the as-irradiated state the pore sizes in the center of the rod are larger than in the periphery where the temperature was lower. The annealing treatment greatly enlarged the pores in the center of the rod. Density, hardness, and x-ray diffraction data before and after the annealing treatment is to be determined. Similar specimens will be annealed at lower temperatures.

The theories of formation mechanisms of fission gas pores require the solid surface tension values of uranium in the presence of inert gases at swelling temperatures. The surface tension values are to be obtained by experimentally balancing the forces pulling down on a series of fine uranium wires with the forces of surface tension pulling upward. The apparatus for this study has been completed and tested. A tubular furnace will hold the specimens protected by a double vacuum system. Temperatures are to be measured with a zirconium-sheathed thermocouple in the inner vacuum system.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

PRTR Pressurized Gas-Cooled Loop Facility (CAH-822). A revision to the Gas Loop Project Proposal, increasing the maximum temperature from 1100 to 1500 F, and requesting an additional \$175,000 required by the temperature increase, has received all required General Electric Company approvals and has been forwarded to the AEC for their approval.

The design criteria and scope drawings for the gas loop have been approved. A purchase requisition for the gas-lubricated primary blowers to be used in the loop was issued on April 9. The requisition for the design and fabrication of the bulk of the loop equipment was issued April 22. The ex-reactor portions of the loop are to be designed and fabricated by an off-site vendor under a fixed price contract.

Coated Graphites. Evaluation of the oxidation resistance was begun on silicon carbide coated samples from National Carbon, Minnesota Mining and Manufacturing, and Carborundum. All of the samples were subjected to air at 1000 C until the rate of weight loss was established.

Samples which showed small weight changes were all crack-free and continuous. The others exhibited hair-line cracks in the coating. It is likely that samples with an isotropic base and a thermal expansion coefficient very close to that of the silicon carbide coating will remain crack free and resistant to oxidation in air.

Air Oxidation of Graphite. An experimental program is being planned which is expected to give more complete data on the air oxidation of graphite, the mechanism, and controlling factors of the reaction. The purpose of this study is to provide data to evaluate the results of air leakage into a high temperature, gas cooled, graphite moderated reactor during operation. In the event of rupture of coolant piping, the reactor would scram and air would be blown over irradiated graphite in a high gamma field at an elevated temperature. It is necessary to know the ensuing effects if adequate reactor safeguards are to be designed and operating procedures written.

The rate of graphite oxidation is believed to be a function of a number of variables, both extrinsic and intrinsic to the graphite; however, for a specific reactor only the extrinsic factors which may affect the rate need be considered. In order to evaluate the influence of the important factors in the least number of experiments, a factorial experimental design has been planned to include the following variables: temperature, flow rate, exposure (MWD/AT), gamma field, and surface to volume ratio.

Graphite Outgassing. Incidental to the testing and preparation of samples for the evaluation of high temperature radiation effects, some data have been obtained on the quantity and composition of gases evolved when graphite is heated. The volume of desorbed gas ranged from 3.2 to 10.6 cc/100 cc graphite. Some compression set was put into the samples during machining

into cylinders 0.42" diameter by 3.48" long. This resulted in an increase in length of 0.008 to 0.075 percent when the compression set was annealed at 975 C. Loss in weight of 0.001 to 0.01 percent resulted from the heat treatment.

Microwave Glow Discharge Studies. The use of a microwave glow discharge appears to be a convenient way to simulate some of the effects of reactor radiations on gas-graphite reactions. A Raytheon CMD-4X microwave generator has been obtained and preliminary familiarization has been completed using stagnant gas-filled tubes (a mercury vapor germicidal lamp and an ordinary fluorescent bulb). A glow can be maintained at three to four inches from a type C dipole radiator with as little as 25 to 30 watts microwave power, if initiated at higher power (100 to 125 watts). It is necessary to ionize the gas with a Tesla coil to initiate the flow. A quartz system is being constructed for flowing CO₂ and a tank of NO₂ has been obtained for reacting with oxygen atoms which will be produced in the CO₂.

Gamma Irradiation Facility. The effect of gamma radiation on the rate of reaction of various gases with graphite will be investigated in a cobalt-60 irradiation facility now under construction. Excavation work is now completed and preparations for pouring a 12-inch thick concrete base are under way. An eight-foot diameter caisson was lowered in 18-inch sections into the excavation to a depth of 13-1/2 feet. A seven-foot diameter stainless steel tank will be placed inside the caisson.

Design of the underwater assembly to hold the cobalt-60 in the desired configuration was started. With a source strength of 15,000 curies, calculations indicate that a 10⁶ r/hr dose rate will be obtained with the cobalt rods positioned at 60 degree intervals on a six-inch diameter circle. The cobalt rods will be held in a rigid steel frame under 14 feet of water. This configuration will permit simultaneous irradiations in four 2-inch diameter tubes located within the six-inch ring of cobalt. The underwater assembly will be tested prior to receipt of the cobalt-60 which is expected about June 1.

D. CUSTOMER WORK

Radiometallurgical Examinations

PT IP-134-A Irradiation of Wafered U Fuel Element (RM-245). A 1.3 inch OD, A-2 aluminum alloy jacketed, hot press canned, 1.6% enriched, wafered I & E fuel element was irradiated to low exposure at high power. Measurements of the cross sectional dimensions show the area sectioned to be elliptical in shape. The spire, fuel element wafer, and can are all elliptical. Metallography of the cathodically etched wafer revealed very good bond integrity between the uranium element, the nickel coating, and the aluminum can. Microcracks as long as 0.005 inch were observed in the uranium.

Examination of a Natural Uranium I & E Fuel Element Internal Hole Failure From Tube 0471-KE (RM-274). The male end of a natural uranium I & E fuel element internal hole failure from Tube 0471-KE was ground and checked periodically for water channels and entry points. No water channels were found either on

the uranium side or on the aluminum side of the transverse section. A transverse section from the female side of the ruptured area was examined, and evidence of undercutting of the uranium by water was definitely established. The cap end of the fuel element was examined as a transverse section with water channels being found on the uranium side, but no evidence of water was found in the aluminum cap.

Carbon Analysis of Undissolved Core Samples from Redox Dissolver (RM-268). A 1.5 gm piece of uranium was sampled from one of the undissolved uranium pieces removed from a Redox Plant dissolver, and the sample was submitted to Analytical Operation to determine the carbon content. The request was initiated to determine whether the undissolved material was ingot or dingo metal. The request is one phase of a study to determine the effect of large grained material on the dissolving rates in the large production dissolvers.

Metallography Laboratories

Two diffusion couples of AlSi and uranium were obtained from the Physical Metallurgy Operation for etching studies of the products of diffusion between these metals. Previous examination of a duplicate sample by the X-ray Laboratory showed that the major product formed was UAl_3 . At the time of the original examination of these couples, a good etchant to differentiate the phases was not available. The present etching studies have shown how the diffusion products in the laboratory couple compare with those formed in standard production fuel elements. The predominate phase in the diffusion couple (UAl_3) differs from the corresponding phase in production pieces in only one characteristic. When both are etched electrolytically in the standard phosphoric acid bath, the compound produced in production pieces turns dark brown while that in the diffusion couple remains bright and is sharply outlined. This difference is attributed to impurities known to be present in the AlSi baths on the production line. (Impurities such as iron, nickel, lead, and chromium.) Because of this very strong similarity, it is now assumed that this compound in the production elements is UAl_3 with impurities.

An as-yet-unidentified compound was found to be present in both the laboratory diffusion couple and production pieces. This compound has identical etching characteristics in both instances. It is brightened or polished by electrolytic etching in the phosphoric acid bath and rapidly turns dark brown to black when swabbed with 0.5% HF. This compound is the most brittle of the compounds appearing in the braze layer of standard fuel elements.

Samples Processed During the Month.

Total samples processed: 278

Photographs

Micrographs	359
Macrographs	<u>77</u>
Total	436

J. J. Cadwell
 For Manager, Reactor and Fuels
 Research and Development

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VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JHM Miller	4/1-4	Vallecitos Atomic Lab., Pleasanton, Calif.	Discuss startup problems, procedures & operation of a test reactor.	HT Wells	Yes
FA Bowman	4/23-30	Autoclave Engr. Sales, Erie, Pa. American Instrument Co., Silver Springs, Md.	Witness performance tests of German-made and French-made compressors.	JF Allison AR Freeman	No No
RH Purcell	4/6-7 4/8 4/10	Canadian GE Ltd., Peterborough, Ont. Nuclear Congress, Cleveland, O. Ill. Water Treatment Co., Rockford, Ill.	Technical consultation on PRTR and NPD-2. Attend professional society meeting. Consult on water quality for PRTR loops.	HE Tilbe, et al -- JF Wantz, et al	No No No
WK Winegardner	4/8-9, 4/27	Willamette Iron & Steel, Portland, Ore.	Fabrication of PRTR fueling vehicle.	O Novak	No
H Harty	4/27-30	Yuba Heat Transfer Co., Honesdale, Pa.	Contact with vendor on	JN Randolph	No
DJ Foley MR Kreiter	4/1-3 4/12-24	Cons. West. Steel Div., Los Angeles, Calif.	Discuss PRTR calandria & shield fabrication.	DJ Bentley	No
JC Fox HJ Pessl	4/22	U.S. Air Force, Seattle, Wn.	Discuss high temperature metals.	I Perlmutter	No
JF Fletcher DP Shively	4/21 4/22 4/23	GE, ANP, Cincinnati, O. BMI, Columbus, O. Internat. Nickel Co., New York, N.Y.	Discuss high temp. metals.	VP Calkins FS Shober MA Cordovi KM Spicer JJ Mueller L Frank	No
HK Nelson	4/27-30	Glenn L. Martin Co., Baltimore, Md. Minn.-Honeywell, Philadelphia, Pa.	Discuss PRTR controller design.	EB Dahlin	No

VISITS TO OTHER INSTALLATIONS (CONT)				Access to
Name	Dates of Visit	Company Visited and Address	Reason for Visit	Restricted Data
KE Clark JL Bates RG Wheeler AL Bement	4/6-7	Nuclear Congress, Cleveland, O.	Attend Congress & present paper. Attendance only.	No
MG Wittenbrock TW Ambrose	4/23-24	BMI, Columbus, O.	Discuss R&D contract.	No
TW Ambrose JM Batch	4/10	U. of Washington, Seattle, Wn.	Discuss two-phase flow problems.	No
ME Shockley	4/27-30	Byron Jackson Co., Los Angeles, Calif.	Witness test on pump.	No
JL Bates	4/6-7	Deep Hole Specialist, Cleveland, O.	Discuss deep hole drill- ing of metals.	No
	4/9	Amer. Metal Products, Detroit, Mich.	Discuss feasibility of obtaining ceramic fuel materials.	No
	4/10	Minn. Mining & Mfg., St. Paul, Minn.	Discuss possibility of ceramic cladding for ceramic fuels.	No
AL Bement	4/10	BMI, Columbus, O.	Hanford in-reactor creep programs being conducted at BMI.	Yes
HW Newkirk	4/6	Linde Co., Indianapolis, Ind.	Discuss operation & witness demonstrations of hi temp. generating equipment.	No
	4/7	GE Research Lab., Schenectady	Discuss research re metal- lography & fractography of UO ₂ .	No
	4/8	KAPL, Schenectady	Metallography of UO ₂ .	No
	4/9	Arthur D. Little Co., New York, N.Y.	Discuss operation & witness hi temp. generating eqpt.	No
	4/9	Thermal Dynamic Prod., New York, N.Y.	Same as above.	No
	4/10	ACS, Boston, Mass.	Present paper.	No

VISITS TO OTHER INSTALLATIONS (CONT.)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JE Minor WE Roake	4/6-8	Atomic Power Dev. Assoc., Detroit, Mich.	Attend High Temp. Fuels meeting.	RR Hayward	Yes
MK Millhollen BF Hightower	4/7	Kach Machine Works, Portland, Ore.	Inspect PRTR 19-rod cluster end cap job & discuss machining problems on nested tubular fuel element end fittings.	G Kach	No
JJ Hauth	4/8-9	Genisco, Inc., Los Angeles, Calif.	Inspect & evaluate Genisco vibratory equipment.	R Savage	No
LJ Chockie	4/13	Technical Industries, Pasadena, Calif.	Inspect design & construc- tion details on in-reactor creep capsule. Inspect final assembly.	JC Kyle	No
JJ Cadwell HJ Pessl	4/13-14	GE Metallurgical Prod., Detroit, Mich.	Metallurgy & Ceramics Conf.	--	No
DR Stenquist	4/13	Mackintosh-Hemphill, Pittsburgh, Pa.	Inspect & evaluate Mack-Hemp straightener.	JE Pauline	No
	4/14	Sutton Engr. Co., Bellefonte, Pa.	Inspect & evaluate Sutton swage.	WR Heck	No
	4/15	Induction Heat. Corp., Brooklyn, N.Y.	Consult on induction heat- ing & vibrating eqpt.	Mr. Stanon	No
	4/16	Gulton Industries, Metuchen, N.J.	Same as above.	Mr. Fortman	No
DC Kaulitz	4/15-16	AEC-100 & Phillips, Idaho Falls, Ida.	Engineering details re ETR loops.	R Neidner	Yes
SH Bush	4/20-24	National Lead Co., Cincinnati, O.	Working Committee of FEDC.	CE Polsen	Yes
JW Weber	4/22	Evergreen Industries, Linnwood, Wn.	Check on material damaged on shipment.	Mr. Ugrin	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JE Minor	4/22-24	AEC-Chicago Oper. Office, Chicago, Ill.	Arrange agends for Sheath Mtg. among HAPO, Savannah River & Chalk River.	JC Woodhouse, et al	Yes
LJ Chockie RS Kemper	4/23-25	Northwest Chapter Officers Mtg., ASM, Victoria, B.C.	Attend and present paper.	--	No
FB Quinlan	4/23-25	C. R. & B. Co., Portland, O. Cascade Mfg. Co., Portland, O.	Locate new shops to take over flow work.	Mr. Baker J Page	No No
KR Merckx	4/27	ASME, Albany, N.Y.	Attend Low Cycle Fatigue Committee and Fracture Prevention Committee meetings.	--	No
	4/29	GEL, Schenectady KAPL, Schenectady	Discuss stress calculational program Discuss strain cycling work.	R Flegar H Poritsky DR Miller	No
SH Bush	4/27-30	US-AEC, Washington, D.C.	Member of Reactor Development Fuels Task Force.	FK Pittman	Yes
JH Johnson DC Kaulitz WC Roberts	4/29-30	AEC-100 & Phillips, Idaho Falls, Ida.	Inspect facilities.	R Weidner	Yes
LC Lemon	4/3-10	ANL, Lemont, Ill. Amer. Welding Soc., Chicago, Ill.	Discuss welding techniques. Attend meetings & AWS metal show.	K Smith	No
RE Sharp	4/5-8	Pratt & Whitney, Los Angeles, Calif.	New eqpt. for Pu fuels.	JE Burch	No
WB Weihermiller	4/13-18	Sheffield Co., Dayton, O. Pratt & Whitney, Hartford, Conn.	Inspect gages being fabricated at both places for Hanford.	H Boppel Sales Mgr.	No No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
LC Lemon	4/16-24	Consol. Western Steel Co., Los Angeles, Calif.	Consult on aluminum welding problems.	DJ Bentley	No
SH Woodcock	4/8-9	Van's Metal Spinning Co., Seattle, Wn.	Discuss research work.	F DeBore	No
ED McClanahan SH Woodcock	4/22-25	Lawrence Rad. Lab., Livermore, Calif.	Project Whitney.	WJ Ramsey	Yes
TC Nelson	4/19-23	Offutt Field, Omaha, Neb.	Inspect equipment.	Mr. Baye	No
JH Rector	4/24	Perry Institute, Yakima, Wn.	Sinter bronze powder.	--	No
	4/29	Amer. Soc. Tool Engrs., Portland, Oregon	Attend professional society meeting.	--	No
JW Helm	4/3-8	Phillips Pet. Co. (MTR) Idaho Falls, Ida.	Check installation of GEH-13-1.	R. Neidner	Yes
RE Nightingale	4/12-16	Div. of Reactor Dev., AEC, Washington, D.C.	Discuss materials problems for helium cooled graphite reactor.	JM Atwood	Yes
JM Davidson JW Helm	4/26- 5/1	Phillips Pet. Co. (MTR) Idaho Falls, Ida.	Installation of GEH-19.	RB Johns R VanSice	Yes
DE Baker LD Turner	4/5-10	Cleveland, O.	Attend 5th Nuclear Congress.	--	No
LD Perrigo	4/7- 4/10	ACS Meeting, Boston WAPD, Bettis Field, Pittsburgh, Pa.	Present paper. Obtain information concerning activity buildup and removal.	-- SL Williams B Schultz	No Yes
	4/28	Aircraft Gas Turbine, GE, Evandale, O.	Discuss decontamination.	KC Netzler	No

VISITS TO OTHER INSTALLATIONS (CONT)

<u>Name</u>	<u>Dates of Visit</u>	<u>Company Visited and Address</u>	<u>Reason for Visit</u>	<u>Personnel Contacted</u>	<u>Access to Restricted Data</u>
RJ Lobsinger	4/14	Aluminum Alloy Task Force Group, Washington, D.C.	Present data and attend meeting.	JM Simmons	No
LD Turner	4/10	GE Co., MTR, Idaho Falls, Ida.	Visit ETR-MTR.	R Neidner	Yes
JW Riches	4/2	Hunter Douglas, Riverside, Calif.	Consult on fabrication of zirconium.	RD Quadt	No
	4/3	Harvey Aluminum, Torrance, Calif.		GA Maudry	No
FJ Parkaskie	4/20	KAPL, Schenectady	Consult on fabrication	JD Dunbar	Yes
VE Kable	4/21	ORNL, Oak Ridge, Tenn.	of zirconium.	ML Picklesimer	Yes
	4/23	Mallory Sharon, Niles, O.		F Heinselmann	No
	4/24	U. of Calif., Berkeley, Calif.		JE Dorn	No
RC Aurgst	4/21	Revere Copper Co., Detroit, Mich.	Consult on fabrication of zirconium.	A Badaluccio	No
	4/22	New Rochelle Tool, New Rochelle, N.Y.		CA Tudbury	No
	4/23	Chase Brass & Copper, Waterbury, Conn.		DK Crampton	No
	4/24	Tube Reducing Corp., Wallington, N.J.		H Spittler	No
RI Dillon	4/13-17	Div. of Res. - AEC, Washington, D.C. ANL, Lemont, Ill.	Attend Aluminum Task Force Meeting. Consult on aluminum corrosion.	JM Simmons IE Draley	No No
RA Thiede	4/17-	ANL, Lemont, Ill. WAPD, Bettis Field, Pittsburgh, Pa. Autoclave Eng. Inc., Erie, Pa.	Discuss etching and autoclaving facilities for zirconium.	N Grant DA Wigton Mr. Fredericks	No No No

VISITS TO HANFORD WORKS

Name	Visit	Company and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
FH Trones ARF Day	4/20 " 4/23 4/29 4/30	Byron Jackson Co., Los Angeles, Cal.	Inspect mechanical seal components of PRTR pump.	PA Scott	No	300, 314
FH Trones H Thompson						
JD Rodgers	4/8	Phillips Electronics, San Francisco, Cal.	Routine servicing of electron microscope.	TK Bierlein	No	300, 326
EF Champaygne	4/8	Phillips Electronics, Mt. Vernon, N.Y.	Same as above.	"	"	"
RG Ulrech	4/16	Consol. Electrodynamic Corp., Rochester, N.Y.	Discuss vacuum problems.	DC Kaulitz LJ Chockie RS Kemper B Mastel	No	300, 326, 327
WD Buckley	4/17	J.M. Perry Inst., Yakima, Wn.	Discuss metallurgical lab. & metallographic lab. equipment.	LJ Chockie.	No	300, 326
AE Cozens	4/22-23	Instron Eng. Corp., Los Angeles, Cal.	Discuss furnace arrangement on Instron Testing Machine for hi temp. samples of KAPL program.	LJ Chockie AL Bement	No	300, 326
M NaKatta	4/27-28	Boeing Aircraft Co., Seattle, Wn.	Consult on welding eqpt.	LE Mills WL Wyman	No	300, 325, 326
MJ Sinnott	4/1-3	U. of Michigan, Ann Arbor, Mich.	Consultant Agreement #199	FW Albaugh JJ Cadwell et al OJ Wick et al	Yes	300, 306, 326, 328, 325 200-W, 231-Z, 2704-Z

VISITS TO HANFORD WORKS (CONT)

Name	Dates Visit	Company and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
WP Eatherly JR Johnstone RJ Hastings JT Meers	4/16- 17	National Carbon Co., Cleveland, O.	Discuss graphite research proposal.	RE Nightingale HH Yoshikawa	Yes, all except JT Meers	300, 326, 305, 3760
LM Liggett	4/21	Speer Carbon Co., Niagara Falls, N.Y.	Same as above	Same as above	Yes	300, 326, 3760
JH Biasingame WJ Roesener JP Finney	4/23- 24	Commonwealth Edison, Detroit, Mich.	Discuss grapnite applica- tions in a proposed power reactor.	FW Albaugh FW Woodfield RE Nightingale EM Woodruff WA Snyder	Yes	300, 328, 326

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

APRIL 1959

FISSIONABLE MATERIALS - 2000 PROGRAM

FUELS

Nuclear Safety in the Fuels Preparation Department

A meeting was held with members of the Fuels Preparation Department to discuss nuclear safety criteria for the design and operation of a co-extrusion plant for the manufacture of NPR fuel elements. The Fuels Preparation Department are now making a study of these criteria and will submit detailed processing requirements at a later date so that the nuclear safety of the process can be analyzed.

Nuclear safety in the co-extrusion of 1.6 percent U-235 enriched uranium was also discussed. Operating procedures have been submitted and will be analyzed for nuclear safety. The project involves the manufacture of 3.5-inch diameter billets at Fernald. These billets are then to be shipped to Hanford for cladding in Zircaloy-2 and copper tubing. They will then be shipped in wooden boxes to Nuclear Metals, Inc., where the billets will be coated with a graphite slurry, heated to 1150-1200°F and then extruded into long tubes of 0.580-inch diameter. The rods will then be cut to about 17-foot lengths, put in wooden boxes and shipped back to Hanford.

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Lattice Neutron Temperature Study

The first part of this study has been completed and is reported in the January, February, March Nuclear Physics Research Quarterly Report.

Thermal Neutron Flux Spectrum Near a Temperature Discontinuity

The IBM 709 FORTRAN program to obtain numerical results for the analytic solutions to the temperature discontinuity problem has been debugged and checked on two simple cases. This program will perform calculations in all three of the infinite geometries for which analytic solutions have been found--plane, slab, and cylindrical. Although the basic program operated satisfactorily on the check cases, the desirability of several changes, principally in input and output features, has been revealed.

Neutron Energy Spectrum Near a Temperature Discontinuity

The theoretical analysis of the experimental work has been completed on neutron exchange between equilibrium thermal neutron energy distributions near a temperature discontinuity in graphite. The results are at present only in graphic

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form and final evaluation of the precision of the results is not available yet.

Instrumentation

The input address logic and core drive units of the simple computer, using magnetic cores has been tested and debugged. This unit works satisfactorily and only few changes and improvements are foreseen. Work is continuing on the development of core readout register drives and arithmetic units along with inhibit drives for write-in.

The stack effluent gas monitor for the 100-D stack was installed and was operated for two weeks. The detector is a NaI crystal and phototube in a 10-inch diameter hollow aluminum sphere. Gas flow through the sphere is two to three CFM. Several satisfactory spectrum analyses (gamma energy) have been obtained. Viewing only the photopeak portion of I^{131} , the original count contribution was about 250 c/m. After two weeks of operation, this level is now up to about 375 c/m indicating slight contamination within the sphere. None of the gamma energy spectrum analysis data have shown any clearly discernible energy peaks to date. However, we are waiting for a slug rupture to occur to provide us with better data. Some 110 VAC line transient and stack house heat problems have occurred indicating that the counting equipment should be changed to another building if possible. The air temperature in the 105-D stack house was between 110°F and 120°F on April 22, 1959.

A complete five-probe scintillation monitoring and alarm system was designed for the 100 Areas for use on the elevators. The system incorporates five probes cable-connected to the main indicating and recording instrument. Any range can be covered, by high-voltage changes, from a first range of 0-10 mr/hr up to 0-10 r/hr. Two-inch by two-inch terphenyl-in-polyvinyltoluene detectors are used giving an approximately gamma energy independent system above 90 Kev. Each probe has an indicating meter and alarm light and the central station comprises five indicating alarming meter relays and a recorder. The remote probes are set up to be either bracket-mounted on the elevator or hand-held for close work. The incorporated probe meter continuously tells the individual holding the probe what the dose rate is. All range switching is done at the control or central station.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Lattice Measurements for Large Diameter Fuel Elements

The exponential pile program of measurements on lattices using 1.92-inch and 2.5-inch solid fuel elements is now nearing completion.

The material bucklings listed in Table I have been measured this month. Note should be taken that one lattice has a tube and tube fuel assembly. The program now involves the simultaneous measurement of bucklings in two exponential piles.

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TABLE I

Fuel Element	Lattice Spacing	Buckling (10^{-6} cm $^{-2}$)	Volume Ratios		
			Al/U	H ₂ O/U	C/U
2.50 inch solid	14 9/16 Dry	+ 92	0.185	--	41.58
1.92 inch solid	12 3/8 Dry	+ 108	0.264	--	51.31
2.5 x 2.0 with 1.66 x 1.1	14 9/16 Dry	+ 57	0.487	--	68.46

These buckling values are tentative using an estimated side extrapolation distance, λ , of 1.66 inches and a front-to-rear extrapolation distance of 1.03 inches. Horizontal traverses have been taken to determine the actual λ .

Analysis of several horizontal traverses involving 1.92-inch and 2.50-inch fuel elements has been completed. Final bucklings are shown in Table II. The same front-to-rear λ of 1.03 inches has been used for each lattice. The values of λ tabulated seem to have rather large deviations from pile to pile, although the measurements were made with care.

TABLE II

FINAL BUCKLING VALUES

Fuel Element	Lattice Spacing	Buckling (10^{-6} cm $^{-2}$)	Side to Side λ (inches)	Volume Ratios		
				Al/U	H ₂ O/U	C/U
1.92	6 3/16 Dry	-400	1.20	0.264	--	11.64
1.92	6 3/16 Wet	-186	1.34	0.264	0.288	11.64
1.92	8 3/8 Dry	+ 67	1.55	0.264	--	22.65
1.92	8 3/8 Wet	+ 65	1.55	0.264	0.288	22.65
2.50	8 3/8 Dry	-199	1.30	0.185	--	12.67
2.50	8 3/8 Wet	- 60	1.55	0.185	0.403	12.67
2.50	10 3/8 Dry	+ 88	1.59	0.185	--	20.31
2.50	10 3/8 Wet	+ 49	1.41	0.185	0.403	20.31
2.50	12 3/8 Dry	+108	1.68	0.185	--	29.58
2.50	12 3/8 Wet	+ 28	1.95	0.185	0.403	29.58
2.50	14 9/16 Wet	- 29	1.29	0.185	0.403	41.58

Coordinated Theoretical - Experimental Program

The direction of previous effort in correlating theory with exponential pile data has been toward using various approximations in microscopic lattice theory. This approach implicitly assumes that the experimental values, as determined by

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the conventional procedure, are correct. The validity of this assumption for heterogeneous lattices, particularly in small exponential assemblies, is being examined.

Experimental work on the effect of void channels on the diffusion area has recently been summarized in Power Reactor Technology 2 14 (1959), with the conclusion that measurements on graphite assemblies confirm the theory of D. J. Behrens. For the case of neutron streaming perpendicular to the channels, an alternative diffusion theory expression obtained previously (Monthly Report, May 1958) has been used to obtain the values of $(L/L_0)^2$ diffusion in the following table. The subscript o refers to the solid graphite; homogeneous refers to the case of void dimensions small compared to a mean free path in the graphite, so that a simple density correction is sufficient. In the expression due to Behrens, r/λ is the ratio of hydraulic diameter of the void to graphite mean free path, and $Q = 1.33$ for a circular cross section and 1.49 for a square.

<u>Experiment</u>	<u>A. P. Schmitt, et al, Second Geneva Conference, A/Conf. 15/P/1191</u>	<u>L. Seren ANS Meeting Dec. 1958 Paper 3.6</u>
Void Cross Section	Circular, 7 cm. diameter	Square, 11.38 cm. sides
$\phi = \frac{\text{void volume}}{\text{graphite volume}}$.106	.333
$(L/L_0)_{\text{homogeneous}}^2 = (1 + \phi)^2$	1.223	1.78
$(L/L_0)_{\text{diffusion}}^2 = (1 + \phi)(1 + 2\phi)$	1.340	2.22*
$(L/L_0)_{\text{Behrens}}^2 = 1 + 2\phi(1 + \frac{3}{8} \frac{Qr}{\lambda})$	1.353	2.33
$(L/L_0)_{\text{experimental}}^2$	1.393 \pm .045	2.26

* Calculated for a circular cross section; the actual square cross section should lead to a slightly higher value.

It should be emphasized that the agreement of the diffusion result with experiment is of questionable significance since the derivation does not apply to the case of a void region. However, it suggests that the diffusion expression may be valid over a wider range than its derivation would indicate.

NPR Lattice Measurements

Bids have been received on the graphite to be used in the exponential pile which will be loaded with NPR fuel elements.

Intercalibration of Graphite Purity

The moderating effect correction to the PCTR graphite absorption cross section measurement is still uncertain. Isotopic analyses of two samples of the D₂O

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used in determining the correction are now available, but the results of the analyses are confusing and appear to be in error in some manner. Another D₂O sample will be analyzed to eliminate this difficulty.

A document describing this program in some detail has been prepared for publication in the open literature and will be submitted after all the results are final.

Mechanism of Graphite Damage

The measurement of the energy loss in thin foils required measuring a small difference between two large numbers. The stability of the system required for this is being checked again. An attempt is being made to measure the heat increment of the foil directly so that the difference measurement may be avoided. The Wheatstone bridge used for temperature measurement was rearranged to improve the response time at the expense of some loss in sensitivity.

Computational Programs and Services

The Exponential Data program has now been checked out and is operational. The P-3 subroutine for the IPD lattice parameter calculation program is nearly complete, the most difficult part having been debugged.

a. Least Squares Program (Linear Regression Only)

The code will handle any regression problem which is reducible to linear form. For example, $y = a x^2 + b$ is linear if the variable x^2 is evaluated and entered as, say, z . Exponential regression analysis is handled with a single "statement" of "do take logarithms." In all cases the code will do a weighted regression analysis using specified weights only. The output gives constants of the linear expression and their errors. One case specifies the confidence level of the solution by stating the students "f" test parameter f_{n-2}, α .

b. EXPOG Program

This is a special code written specifically for evaluation of a thermal activity function in the graphite core of the FCTR. It does however have wide application. The general form of the calculated expression is

$$y = A e^{\alpha x} + B e^{\beta x} + C e^{\gamma x} + D e^{\delta x} + E x^2 + F x + G.$$

All constants A, B, . . . , α , β , . . . , etc. are to be specified and, of course, may be zero. The code evaluates the function y for integral values of x. The range of the independent variable x may be specified.

c. NEUTHERM Program

The code was written to solve the matrix of the coefficients of the solutions to a set of four simultaneous plane diffusion equations for a two region, two thermal group problem. It calculates the thermal activity of a 1/v detector in both regions, compares the calculated curve with a corresponding experimental curve point by point to obtain the residual sum of

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squares of the fit, and repeats the solution a specified number of times. The repeating of the solution is an iteration process on a coupling coefficient between the original differential equations. The interval of iteration is specified initially and thereafter is reduced by a factor of 10 as necessary to obtain the minimum residual sum of squares or until the specified number of iterations has been performed. The output is the input, the final iteration, and the flux curve or all iterations and flux curves, as specified. This code was written by R. A. Cahoon of IPD.

d. Multi-Thermal Neutron Group Diffusion Program

Attempts have been made to develop a program capable of dealing with one fast group and two thermal groups, using a three-group program, $F_3^{(1)}$, as a basis. The FORTRAN listing for F_3 is given in (1). Attempts to run test cases, using a deck as punched from the document listing have been unsuccessful, so this approach was dropped.

e. A Program for Analyzing PCTR Data

Descriptions of portions of the proposed program are being circulated to physicists using the PCTR. Subjects covered include:

1. Foil data analysis
2. Reactivity data analysis
3. Thermal absorption cross sections to be used in calculating k_{∞} and f .
4. Corrections for resonance absorption effects upon thermal traverses.
5. Computation of errors associated with all of the above.
6. Computation of the error in k_{∞} due to spectral mismatch.

The above have been written as individual subroutines. The input format in all cases has been kept as simple as possible. Remaining work involves figuring out a simple way of calculating average fluxes for the several regions in a cell and specifying the layout of the main program which ties all the subroutines together. Virtually no actual programming has been done.

STUDIES RELATED TO SEPARATIONS PLANTS

Critical Hazards Specifications

Nuclear Safety in Hanford Laboratories

A rough draft of general nuclear safety specifications was prepared.

Specifications have been issued for Critical Mass Physics governing the storage and handling of U²³⁵-Al alloy fuel elements, 1.44 percent and 1.6 percent U²³⁵ enriched I. and E. fuel elements, and 3.0 percent U²³⁵ enriched fuel elements.

(1) Keppler, J. G., and Orr, W. L., "Three Group Neutron Diffusion Calculation (Program F_3 -IBM 704)," XDC-58-7-18.

At the request of the Plutonium Metallurgy Operation, a study has been made of the nuclear safety in storage and shipping of 7 percent Pu (by weight) - Al alloy fuels. These elements are one-inch diameter rods, five feet-two inches long. Each rod contains about 90 grams Pu. These fuel elements are being sent by air express to Savannah River. It was determined that an array of boxes containing a total of 168 of these elements would be safe under the following conditions:

- (1) Each box would contain 12 rods spaced on four-inch centers in three rows of four rods each.
- (2) The 12 rods are centered in a box whose cross section is 24 inches by 36 inches.

It is believed that these storage and shipping criteria have a safety factor of at least two.

E-Metal Program

Two meetings were held with members of the AEC-HOO to discuss the E-Metal Program, particularly the analysis made by PIRDO of the random loading of the E-Metal dissolver.

AEC-HOO Nuclear Safety Consulting

A meeting was held with a member of the Separations Branch, AEC, regarding nuclear safety in the shipment of a proposed weapon model. When a firm production schedule is made, a formal request for a nuclear safety shipping specification will be made.

Plutonium Critical Mass Laboratory

Invitation for bids, No. AT (45-1) - 1446, for construction of the Critical Mass Laboratory Facilities, 200-East Area, was issued by the AEC on April 8; bid opening was scheduled for May 6.

At the request of the Commission a concrete block structure was substituted in lieu of the 40 x 80 ft. metal excess Army mess hall which was to have been used for the control building. An addendum to invitation to bid was issued asking interested bidders to bid on this basis and extending bid opening date to May 20.

Radiation Levels for a Potential Criticality Incident at the Hanford Critical Mass Laboratory

A detailed calculation of radiation levels at various points at the proposed Hanford Plutonium Critical Mass Facility has been performed based upon a maximum burst of 3×10^{18} fissions. The purpose of this calculation was to confirm the prediction contained in HW-57603, dated September 30, 1958, "Preliminary Hazards Study of the Hanford Plutonium Critical Mass Laboratory," that "the reactor room walls and ceiling are of such thickness that the radiation dose to personnel in areas outside the reactor room to which access is permitted will be less than 100 mrem for a burst as large as 3×10^{18} fissions."

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The γ radiation was divided into four energy groups. The direct doses calculated are tabulated below.

<u>Location</u>	<u>Distance From Center of Reactor Room</u>	<u>Dose in mr</u>				<u>Total</u>
		<u>Group I (1 Mev)</u>	<u>Group II (2 Mev)</u>	<u>Group III (4 Mev)</u>	<u>Group IV (6 Mev)</u>	
Mixing Room	33 ft.	0.000073	0.0382	0.866	1.103	2.007
Control Room	66	0.000016	0.00896	0.212	0.270	0.491

The skyshine contributions were also calculated and are tabulated below:

<u>Location</u>	<u>Distance From Center of Reactor Room</u>	<u>Dose in mr (γskyshine)</u>				<u>Total</u>
		<u>Group I (1 Mev)</u>	<u>Group II (2 Mev)</u>	<u>Group III (4 Mev)</u>	<u>Group IV (6 Mev)</u>	
Mixing Room	33 ft.	0.237	0.255	0.307	0.049	0.848
Control Room	66	0.248	0.268	0.332	0.051	0.899

<u>Location</u>	<u>Total γDose (mr)</u>
Mixing Room	2.86
Control Room	1.39

The neutron contribution to the total dose is less than 0.3 mrem, and hence is not presented with the foregoing. The calculations for both the neutron and gamma attenuation are based upon a multiple scattering calculation, and self-shielding by the source is neglected, thus lending a further degree of conservatism to the results.

Criticality Studies in Support of Processing Power Reactor Fuels

A series of experiments was initiated for the purpose of evaluating the extrapolation lengths of the water reflected heterogeneous lattices. These experiments were made with 3.063 percent enriched uranium rods of 0.300-inch diameter and 8 inches in length. Four of these elements placed in a lucite tube of 0.028-inch wall thickness constituted a fuel rod (32 inches in length).

Lattices of these rods in water were supported on a 3/4-inch thick aluminum plate. Four 1/2-gram RaBe sources were placed just below the aluminum plate so that sufficient flux would be available to irradiate 1/4-inch diameter, 0.005-inch thick gold foils. The loadings were taken to about 94 percent of critical. Horizontal neutron flux traverses were taken with both gold foils and BF₃ proportional counters. The flux traverse points were fitted by a least squares analysis to a J₀ function of the form J₀(αr), where α is the square root of the radial buckling and r is the true radial distance from the central axis of the lattice where the flux was measured. From this fit the extrapolated radius can be calculated. The difference between the extrapolated radius and the true radius is the extrapolation length. The preliminary results of these measure-

ments are given as follows:

<u>Lattice Spacing</u>	<u>H₂O/U Volume Ratio</u>	<u>Extrapolation Length</u>	
		<u>BF₃ Measurement</u>	<u>Au Foil Measurement</u>
0.700 inch	5.00	6.2 cm.	6.1 cm.
0.800 inch	6.84	6.5 cm.	6.3 cm.

The critical masses for these 32-inch high loadings were also determined and measured bucklings compared with earlier calculations from 16-inch high loadings. The results are given as follows:

<u>Lattice Spacing</u>	<u>H₂O/U (Volume Ratio)</u>	<u>Measured Critical Mass (32-inch High Cylinder)</u>	<u>Measured Buckling (32-inch High)</u>	<u>Calculated Buckling (16-inch High)</u>
		0.700 inch	5.00	355 lbs.
0.800 inch	6.84	312 lbs.	$13,262 \times 10^{-6} \text{ cm}^{-2}$	$13,383 \times 10^{-6} \text{ cm}^{-2}$

An extrapolation length of 6.5 cm was used in the buckling calculations.

Experiments were continued to determine reasons for the discrepancy between k_{∞} measurements involving polyethylene (CH₂) and water moderation for 3 percent U-235 enriched UO₃-moderator mixtures having the same effective H/U ratios. It was suspected that disagreement results either from improper care in the handling of the water moderated samples before analysis for water content or a possible difference in the resonance escape probability between the polyethylene and water-moderated systems at the low H/U ratios investigated.

The following experiments were performed to clear up this discrepancy.

- A measurement of k_{∞} for a polyethylene pellet (1/8-inch diameter sphere) moderated system at a nominal H/U = 4.
- A measurement of k_{∞} for a polyethylene powder moderated system at a nominal H/U = 4.
- A measurement of k_{∞} for a water moderated system at a nominal H/U = 4.
- A measurement of the resonance escape probability in the polyethylene pellet and water moderated systems.
- A measurement of k_{∞} for a water moderated system at a nominal H/U = 6.5.

The first three experiments (a-c) were conducted at an H/U = 4 since a large discrepancy between k_{∞} measurements of polyethylene- and water-moderated systems were found in earlier experiments. The experiment at an H/U = 6.5 was done to check a k_{∞} measurement near the maximum. The UO₃-H₂O mixture was prepared by adding a known weight of water to the UO₃ and mixing. Earlier mixtures were prepared by adding the H₂O to the oxide by means of steam. This mix-

ture is now being analyzed for water content.

Preliminary calculations indicate that the k_{00} measurements for polyethylene and water moderated fuels are in agreement. Further analyses of these data, as well as the resonance escape probability, are being carried out.

Criticality Calculations for Correlating Theory with Experimental Data

The study of the critical parameters for homogeneous systems of slightly enriched uranium fuel and moderator was continued. In the March Monthly Report theoretical calculations of k_{00} for slightly enriched U-235 fuels and water were reported that were in good agreement with experiment. Neutron ages for these homogeneous mixtures were calculated according to the following equation:

$$\tau = \frac{\tau_0}{\left[\frac{\rho_M}{\rho_{M_0}} + \frac{\sum_{Sl}^F}{\sum_{Sl}^M} \right] \left[\frac{\rho_M}{\rho_{M_0}} + \frac{\sum_{tr}^F}{\sum_{tr}^M} \right]}$$

where

τ_0 = neutron age of the pure moderator

τ = neutron age of the system

ρ_M = density of moderator in system

ρ_{M_0} = density of pure moderator.

The superscripts F and M represent fuel and moderator, respectively, while \sum_{Sl} and \sum_{tr} represent macroscopic slowing down and transport cross sections, respectively. The slowing down cross section is the sum of the inelastic scattering cross section and macroscopic slowing down power. The neutron age of pure light water was taken as 27 cm² as the use of this value for neutron age in a wide range of solution concentrations for highly enriched U-235 in light water resulted in critical mass calculations that were in good agreement with experiment.

Calculated critical parameters for homogeneous mixtures of UF₄ in paraffin were made and compared with experimental results. In these experiments the U-235 content was two percent of the total uranium. It was assumed that the neutron age of a pure moderator varied inversely as the product of the slowing down power and the transport cross section. Assuming water to have an age of 27 cm², paraffin would have an age of 17.6 cm². Had 32.29 cm² been assumed as the age of water, the corresponding age for paraffin would be 21.06 cm². This compares with 20.90 cm² using a modified age method and an IBM 704 multigroup program. The paraffin reflected extrapolation length was calculated to be 6.38 cm (assuming it to be inversely proportional to the transport cross section and that for a water reflector equal to 8 cm). Critical mass calculations using this method give results for paraffin reflected cylinders (diameters of 25-50 inches) that are 88-96 percent of experimental values at an H/U²³⁵

of 195. It is not clear from the report which cylinders were paraffin reflected and which were plexiglass. Critical mass calculations for homogeneous systems at an H/U²³⁵ of 294 in cylinders 25-50 inches in diameter were 106-112 percent of the experimental values if the experimental cylinders were paraffin reflected. If the experiments were conducted with plexiglass reflectors, the calculated critical masses are from 90-100 percent of experimental values.

It was not possible to make critical mass calculations for other H/U ratios for paraffin moderated systems as the relationship between H/U and uranium density is not available at this time. However, a study of homogeneous mixtures of UO₃ and water (two percent U-235 content) was made and critical masses evaluated. The minimum critical mass for water reflected systems of this material was calculated to be 5.9 kg U-235. This compares with an estimated experimental minimum critical mass for paraffin moderated and reflected systems of 4.0 kg U-235. It is reasonable to expect that the paraffin moderated systems will have smaller minimum critical masses, because the neutron age is so much smaller in paraffin than in water.

The theory was applied to homogeneous systems of 4.9 percent U-235 enriched uranium (U₃O₈) in glycerol tristearate and UO₂F₂ solutions in water. Good agreement between theory and experiment were obtained (within 5-10 percent of experimental values). It is interesting to note that for these systems the uranium concentrations were always less than 2.2 gm U/cc. Under these conditions the minimum critical mass was about 2.0 kg U-235 and the minimum critical cylinder diameter about 12 inches. However, the uranium concentration of interest in processing UO₃-water mixtures may be as high as 4.3 gm U/cc. Under these conditions the minimum critical mass is calculated to be 1.6 kg U-235 and the minimum critical cylinder diameter is calculated to be about 10 inches.

Miscellaneous Experiments for Nuclear Safety Specifications

1. Exponential Measurements with 1.25 Percent Enriched Uranium

The exponential experiments with the 1.25 percent U-235 enriched I. and E. fuel elements (1.336-inch O.D., 0.500-inch I.D.) were completed. The fuel rods consisted of six elements, each 7.5 inches in length, positioned in an aluminum tube of 1.402-inch O.D. with a 0.028-inch wall thickness. An aluminum tube filled with water was placed in the central hole for the wet core measurement. These tubes were 0.492-inch O.D. with a 0.020-inch wall thickness. The following buckling was determined this month:

<u>Lattice Spacing</u>	<u>H₂O/U (By Volume)</u>	<u>Buckling (Fuel Core Wet)</u>
1.85 inches	1.31	4650 x 10 ⁻⁶ cm ⁻²

A complete report on the 1.25 percent enriched fuel measurements is being made in the January, February, and March 1959, Nuclear Physics Research Quarterly Report, HW-60220.

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Neutron Age Measurements

Analysis of the monoenergetic age measurement is virtually complete. Most of the effort in the past month has been devoted to estimating the accuracy of the measured ages.

Two of the numbers reported last month have been changed. The age from a small source in kerosene contained an error in the position scale, and should read 14.15 cm^2 instead of 13.98 cm^2 . The lower limit quoted for the age from a small source in water has been judged to be unrealistic. The current value for this age is $14.29 \pm 0.23 \text{ cm}^2$.

The matrices used to determine the first-collision-approximation fits to the asymptotic flux distributions have been inverted, using an IBM 709 FORTRAN program. The inverse matrices have been used to determine the statistical precision of the asymptotic fits. It appears that the tails contribute about half of the overall variance in the ages. The balance of the variance comes principally from uncertainty in extrapolating to a point source. The extrapolation used is substantially larger than the largest value allowed theoretically. The final values of the age are $14.0 \pm 0.2 \text{ cm}^2$ in water and $14.1 \pm 0.2 \text{ cm}^2$ in kerosene.

The thermal migration areas have been computed as $22.0 \pm 0.4 \text{ cm}^2$ in water and $21.1 \pm 0.4 \text{ cm}^2$ in kerosene. The former gives a diffusion length $L = 2.79 \pm 0.07 \text{ cm}$ in water. The current "best" value from ANL-5800 is $2.75 \pm 0.02 \text{ cm}$, but the best Russian value is $2.69 \pm 0.02 \text{ cm}$.

Calculation of the source spectrum is still in progress.

Mass Spectrometer for Plutonium Analyses

Progress toward putting the mass spectrometer for this program into operation has been confined to altering the electronic instrumentation according to the final design of the components of the other mass spectrometer. Efforts to fabricate successfully a kovar-to-glass seal for the source vacuum interlock are awaiting the firing of the kovar metal according to a special firing schedule.

Theoretical Critical Mass Studies

A report, HW-60255, on the leakage of neutrons from subcritical plutonium solutions, has been written and is in the reproduction stage. Some of the results of this report were described qualitatively in the Monthly Report for February. In the linear time variation of reactivity problem, an analytical approximation has been made which neglects the prompt neutron lifetime. The solution of the resulting first order differential equation indicates that the effect of a geometrical buckling change accompanying the linear change in reactivity is small for values of parameters of current interest. An analog computer formulation of this problem is also being investigated. The principal defect in an earlier numerical integration by digital computer is now attributed to an improper formulation of the problem. The acquisition of information on computational methods in critical mass problems continues.

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Criticality Alarms

The two experimental nuclear incident alarm monitors or dose-rate indicating and alarming monitors have now been tested using the two-transistor amplifier for about two months continuously with a maximum error due to drift of 2.5%. All source checks (daily) have shown reading and alarm errors to be approximately the same (2.5%). The instrument can be used for metering and alarm work with stable operation from one mr/hr up to ten r/hr. The instruments are exceedingly simple and reliable.

A gamma dose-rate analysis of the background in Purex is being made. The backgrounds are being checked where the nuclear incident alarm systems will be placed.

NEUTRON CROSS SECTION PROGRAM

Absolute Fission Cross Section of U²³⁵

The study of experimental errors in the U²³⁵ absolute fission cross section measurement has been continued. The diameter of the uranium deposited area of the U²³⁵ fission foil used in the experiment was redetermined using a traveling microscope. The area of the foil obtained from these measurements was (0.85 ± 0.32) percent larger than the area previously assigned from the reported size of the mask used in preparing the foil at KAPL.

Slow Neutron Scattering Cross Sections

The energy spectra of neutrons scattered from water of incident energy 0.184 ev was measured for scattering angles of 5 and 45 degrees. No experimental data have been obtained since the middle of April because of the extended reactor outage.

The observed angular distributions of elastically scattered (bound atom) neutrons for the incident energies investigated of 0.095 ev, 0.141 ev, and 0.184 ev are apparently the same within experimental uncertainty. This is a theoretically unanticipated effect and might be a result of the method of analysis. The effect of the finite energy resolution of the analyzer has not been taken into account and the method of subtraction of the gas scattering background has not been carefully investigated.

A FORTRAN program has been initiated to calculate the theoretically expected hard sphere gas scattering energy spectra. The results of these calculations are being used to determine to what precision the gas scattering component of the observed neutron scattering from water can be approximated by this simple model.

Subthreshold Fission

No data have been taken on this program during the month. A sample of several milligrams of Pa²³¹ was received through the courtesy of the Phillips Petroleum Company, MTR, Neutron Cross Section group, for subthreshold fission measurements. This sample joins samples already on hand of U²³⁴, U²³⁶, and U²³⁸ awaiting preparation as deposited foils for fission cross-section measurements.

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Slow Neutron Fission Cross Section - Pu²⁴¹

The radiation problem which existed at 105-DR and caused the loss of at least two months operating time of the crystal spectrometer has now been ascribed to an improperly shielded test hole on the X-2 level operated by an IPD engineering group. The additional dose rate caused by the crystal spectrometer neutron beam on the X-1 level has been determined to be well below tolerance except within a few feet of the spectrometer shielding. No further efforts have been made to cause the spectrometer beam to be turned off with the exception of two days early in the month. Useful data were obtained on the Pu²⁴¹ fission cross section about 50 percent of the month. The lost time was caused by spectrometer instrumentation malfunction and reactor outage.

The fission resonance at about 0.26 ev in Pu²⁴¹ obtained with this supposedly high purity sample is observed to differ by as much as twenty percent in shape in the wings of the resonance from the variation deduced in earlier measurements with a sample of lower isotopic purity. The investigation of this energy region is not complete and further analysis of the data is necessary to determine if the shape difference is real.

The energy region from 1 to 20 ev has been measured with an energy resolution about three times better than previously used in the Hanford measurements of Pu²⁴¹ fission cross section but still not adequate to perform a shape analysis of resonances above about 3 ev. Slightly more structure was observed than is revealed in the latest BNL-325 cross section compilation in the region of 4 to 12 ev. In addition, two small apparent resonances were found at about 1.6 ev and 2.4 ev. The resonance at 1.6 ev is rather remarkably small with a peak cross section of about 10 barns.

Fast Neutron Spectra

The new model of the vernier chronotron has been tested in the laboratory and has been installed at the Van de Graaff. The testing of the resolution, sensitivity, etc. of the complete system for time-of-flight studies is in progress.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Correlation of Data on D₂O Moderated Cluster Lattices

This work is now complete. A report is to be issued.

Low Exposure Plutonium Lattices

Fabrication of the special graphite pieces for the 10 1/2-inch, 8 3/8-inch, and 6 1/2-inch lattices is about 75% complete. It is planned to assemble these lattices in a mockup (without fuel) to guarantee compatibility of components before assembly in the PC^{TR}.

Instrumentation designed to reduce PC^{TR} time required to level fluxes along the longitudinal axis has been fabricated. This consists of a dual channel BF₃

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traversing device; one channel uses an enriched BF_3 tube cadmium covered, the second channel uses a natural BF_3 tube bare. They are moved simultaneously, one above the central fuel column, the other below. Simultaneous measurements of total and epi-cadmium $1/v$ fluxes at a longitudinal position are made possible. The tubes are intercalibrated beforehand in the Sigma pile. This system should make possible optimum flux leveling in a strange lattice with the maximum expenditure of about one shift of PCTR time.

PCTR Experiments

Further work on the problem of highly self-shielded Pu fuel rods has consisted of making cell calculations on clusters consisting of 0.0625 inch dia. and 0.125 inch dia. Pu rods which are 65-90 w/o Pu. These are not yet complete.

Instrumentation

A variable wedge was fabricated for the diameter measurement unit of the profilometer. The unit has been assembled and tested. Preliminary tests indicated excessive spherical aberration, lens effect, and chromatic aberration. The addition of a film of oil between the spherical surfaces of the variable wedge to a large extent corrected all defects except chromatic aberration which has been eliminated by use of a filter. Tests of the unit with these changes indicated that diameters can be measured with a $\pm .001$ -inch accuracy. The unit was demonstrated. A correction of a small focusing effect is still required and will be made this month. Drawings and a description of the print-out system are being prepared for distribution to possible vendors for cost estimation.

Calculation of thermal conductivity values for samples of graphite and UO_2 gave values in agreement with data from National Carbon Company for graphite but the values for UO_2 are higher than data reported by BMI. The difference is due to the variation of thermal conductivity with temperature. A method of successive approximations which takes this variation into account is being used to calculate more correct values of UO_2 thermal conductivity.

GAS COOLED REACTOR PROGRAM

Lattice Parameter Measurements

Analysis of the data obtained in the PCTR to obtain k_{∞} and f is underway.

The additional fuel needed for a 16-column loading of the PCTR has been received and preparations are being made for the control rod experiment.

Variation in Doppler Coefficient with S/M Ratio

Fabrication of the mockup assembly is nearly complete. Testing will begin with arrival of the induction heater. Bids have been received on the heater, ranging from \$4400 to \$7500. No award has been made as yet.

It was found necessary to coat the stainless steel jackets of the thermocouples with molybdenum by flame spraying to prevent their failure due to forma-

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tion of an iron-uranium eutectic at elevated temperatures ($\sim 700^{\circ}\text{C}$).

A 12-point Brown recorder has been modified to have a full scale linear span of 5 millivolts and 15 overlapping ranges, to cover the range from 0 to 60 millivolts ($\sim 0-1000^{\circ}\text{C}$ for iron-constantan) with an estimated accuracy of 0.0125 millivolts ($\sim 0.2^{\circ}\text{C}$).

Theoretical PCTR Studies

The small source theory critical condition for an infinite array consisting of one control rod for each fuel rod has been found and has been related to the criticality condition for fuel rods only. The condition has been employed to predict the thermal utilization for a sample case. The result is $f = 0.38$ as compared to $f = 0.92$ for the same system with no control. Based on physical arguments regarding relative absorption rates in a cell, this result appears reasonable. The method is now being extended to the GCR lattice which consists of one control rod for each nine fuel rods and requires the solution of a 4×4 determinant. The elements of this determinant are now being evaluated numerically.

TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month. There was one unscheduled shutdown due to electronic failure. The initial experiment for the gas cooled reactor program was completed as was another series of runs to measure k_{∞} of 3 percent enriched $\text{UO}_3\text{-H}_2\text{O}$ mixtures.

Work orders were written for the fabrication of equipment needed for the k_{∞} measurements using 7 element clusters of 1.007 percent enriched uranium. As built drawings of the traverse device were prepared and a work order issued for fabrication of a second unit. This will allow simultaneous bare and cadmium traverses.

The reproducibility of positioning the moving face was checked by making five successive period measurements. After each one, the rods were dropped and the face opened one inch. The reproducibility was within the error due to the rod drop (std. deviation 0.007 cents).

PCTR

The preliminary Project Proposal for the Full Scale PCTR, CGH-832, has been forwarded to Washington AEC with local Commission approval. Preliminary work on the Reactor Hazards Study has been initiated.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

Essentially all of the R and D effort in this Operation was expended in the preparation and arrangement of physical equipment for the forthcoming dispersion experiments. These preparations are on or ahead of schedule.

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The erection of the towers for vertical air sampling was approximately 90 percent complete at month's end. The completion date for this work was scheduled for May 8, 1959. A major injury was sustained by a construction worker on April 22, when an 18-foot section of tower fell over as another six-foot section was being lifted into place.

The assembly of 487 gasoline-driven vacuum pumps was completed by Transportation employees, and the testing, adjustment, and installation of this equipment at the field locations were begun. Two of the four automatic pigment counters were completed and accepted. New sources for the other two are being fabricated. Delivery of disposable filter holders and filters was assured and 14 pulse-type drum samplers were received from the U. S. Army Chemical Corps on a loan basis.

The visible preparations for these experiments, such as the erection of towers, assembly of pumps, etc., were photographed by the Photography Operation as part of an overall documentation of the experiments. The Air Force has dubbed this project, "Operation Greenglow," an official Air Force nickname. We have not used this designation.

DOSIMETRY

The basic trouble with the live-timer of the 256-channel analyzer in the Shielded Personnel Monitoring Station was found and corrected. Minimum maintenance was required during the month.

Tests of the resolution obtained for the large NaI crystal with a uniform array of six 3" photomultiplier tubes or five such tubes in a circle gave definitely poorer results than a circular array of six tubes. One more photomultiplier, a 10" EMI tube, remains to be tested.

Tests were made of our ability to standardize gamma ray sources by using theoretical photofractions and efficiencies at known distances. Results were very good. The accuracy was certainly better than 5% and usually better than 2%. Tests by this method of six sources obtained on the plant uncovered errors in the values of three of them and cast doubt on a fourth.

It was found that a box made of lead-plywood sheets such as used in X-ray shielding was quite effective in reducing the background of low energy pulses on the big NaI crystal. Many of these low energy rays result from the slowing down of higher energy gamma rays in the iron of the shield. The shielding was effective even though there was some small radioactivity detectable in it; the radioactivity could very well have been in the adhesive used to bond the lead and the plywood. It seems desirable to line the interior of the iron room with a 1/8 inch thick sheet of lead that tests show to be low in radioactivity. This has been done at other whole body counters.

The large NaI crystal was calibrated by the one meter arc method for natural body Cs^{137} and K^{40} for three subjects. The accuracy was about 20%, which is sufficient for the present. A calibration for Zn^{65} was obtained through the cooperation of a visitor with a known body burden of the isotope.

A subject injured in a glove box explosion was studied for plutonium contamination. Both cuts and burns were involved. Surgery had been performed prior

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to our examination with the result that two cuts had been combined into a single wound. There was (1.0 ± 0.2) mpc of plutonium in the wound. The excised flesh contained (0.39 ± 0.06) mpc. An examination of the whole side of the face and neck with a 4-1/2 inch by 1 mm NaI crystal indicated less than 2 mpc present. A second man involved in the same incident was examined for plutonium in the lungs; none was detected.

The positive ion accelerator operated satisfactorily during the month. The use of the new stapled belt has improved the stability of the machine. Sparking has developed near 2 Mev. It may be due to small iron fragments released inside the accelerator from wearing of the staples. The X-ray warning device and interlock system were completed and put into use.

Advantage was taken of the new stability of the accelerator to restudy some characteristics of the Be(d,n) and D(d,n) reactions with the double moderator. For the latter reaction the results indicated that the angular distribution was not the same for two different targets and that the deuterium gas is probably not uniformly distributed in the titanium metal of the target.

The system for counting neutrons from radioactive sources was automated and further measurements made on plutonium oxalate, plutonium nitrate, and several RaBe sources to obtain statistically better data.

An automatic system for gamma ray counting was put into use. Na²⁴ in samples of effluent water was counted several times a week to calibrate the system and to test its stability. Stability was good.

In studies of the use of pencil ion chambers for low dose measurements it was found that electrical discharge of the chambers equivalent to 1 mr dose could be measured to better than 1% accuracy if the measurement was made immediately after discharge. If the chamber were exposed to 1 mr of gamma radiation, however, only 5% accuracy could be achieved. Only 5% accuracy could be achieved with the electrical discharge method if the chambers were allowed to sit for the same length of time required for the gamma ray exposure. It is suspected that slow drifts in the charging voltage cause the decrease in accuracy. Use of a stable 6 volt battery resulted in somewhat better accuracy.

INSTRUMENTATION

The scintillation, transistorized combined alpha-beta-gamma hand and shoe counter is still in satisfactory continuous operation in the 329 Building. The instrument has been source-checked twice a day for almost two months with no recalibration or maintenance work found to be necessary. Personnel acceptance of the instrument has been gratifying. The instrument indicates about twice background for a 500 d/m Pu²³⁹ source distributed over a four-inch by eight-inch area, and it indicates two to three times normal background for a similarly distributed 15 millimicrocurie Ra D-E-F source. The total individual counting time is 15 seconds since the probes simultaneously detect the indicated types of radiation. The alpha information is separated electronically from the beta-gamma information and the two are then separately indicated.

Two final model scintillation transistorized slow and fast neutron count-rate and dose-rate meters and two final model scintillation transistorized alpha-

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beta-gamma meters have been completed and tested satisfactorily. The neutron portable meter replaces, in one instrument, both the old BF₃ meters and the "Neuts." The alpha-beta-gamma meters, in one instrument, replaces the old scintillation alpha "poppies" and the standard GM's. In all cases, the performance of the new instruments is superior to the old types.

The composite transistor circuit board tester for all of our various plug-in type, modular construction transistor circuits has been completed and tested satisfactorily. This testing device will enable any technician to check the plug-in boards in a go, no-go type test. All of the transistor circuits for portable and fixed instruments which we have developed can be tested. Several new stable transistor oscillators of various pulse repetition rates were developed and tested. These will be used to drive the other circuits being checked in the transistor tester. The transistor plug-in circuits that can be tested include amplifiers, multivibrators, binaries, count-rate meters, and register-driving types.

The pinhole camera was evaluated this month. The best results were obtained by using Eastman-type kk X-ray film for the radiation picture and Royal Pan (ASA 200) film for the daylight picture. An exposure of 300 mr from a point source at the face of the camera was necessary to produce satisfactory results. The camera was demonstrated by placing a Co⁶⁰ bug inside of an aluminum tube and photographs made. After the film had been processed, the radiation film was laid on top of the photograph to locate the source. An attempt to improve the sensitivity by inserting a terphenyl crystal in the film holder and laying Royal Pan (ASA 800) on the crystal was not successful.

The Radiotelemetry Central Station equipment has now been tested and is ready for delivery to and installation at the 622 (Meteorology) Building. RCA engineers are changing receiving and transmitting antenna positions of equipment on Rattlesnake Mountain to attempt alleviation of interference problems. The Aerovane wind direction detector at the Yakima Barricade has ruined its bearings and will be replaced, in total, by the manufacturer. Some trouble has been experienced with the Benton City data station from cattle damaging the unit. The AEC is engaged in a study of methods to alleviate the condition.

The four zinc sulfide particle counters were assembled and tested this month. Two of the alpha sources received were not satisfactory because of the high background. The sources were prepared identically but at different times. The reason for this background on two of the sources is unexplainable. The two units which are satisfactory have been delivered to the field.

An instrument for automatically counting dust particles in air has been developed. The instrument consists of a vacuum source to draw air through a pipe which is used as an impactor, a lucite disc covered with a triboluminescent pigment (pigment 3336-U. S. Radium), a photomultiplier tube, amplifier, scaler or count-rate meter and a high-voltage supply. In operation, dust is impacted onto the pigment that is attached to the disc. The dust particles striking the pigment causes it to scintillate. The scintillations are viewed by the phototube which changes them into electrical pulses that are amplified and recorded. Size separation can be accomplished by adjusting the space between the impactor and the deposited pigment.

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The investigation of determining the efficiencies of various light pipes continued.

Consultation was rendered to the Process Control Development Operation concerning the use of terphenyl-in-polyvinyltoluene detectors for Pu²³⁹ alpha detection in acid-flowing process lines for Purex. The terphenyl type is to be tried as a replacement for a very thin Teflon-covered zinc-sulfide alpha detector which has not stood up to use in the acid fluid.

WASHINGTON DESIGNATED PROGRAM

The mass spectrometer for this program is now operated on a part-time basis (about 30 percent of available time) as an analytical service to the program. For this service the alternate ion detection system consisting of the electron multiplier, vibrating reed electrometer, and Brown recorder is being used. The remainder of the time is being used to study experimental effects of importance to the types of samples encountered in this program and toward putting the ion counting detection system into reliable operation.

CUSTOMER WORK

Analog Computing

The problem load for the Analog Computer is building up to the point where a considerable back-log has accumulated. The problems waiting for machine time are (1) Hazards re-runs for PRTR, (2) Frequency response for PRTR, (3) Primary loop frequency response for NPR, (4) Pump coast down for NPR, (5) Heat exchanger frequency response for NPR, (6) Primary loop plus heat exchanger for NPR, (7) Boilout curves for existing reactors, (8) Boilout with the effect of meltdown of lithium poison, (9) Flux distribution with various pile loading effects, and (10) Log simulator for reactor kinetics (theoretical physics).

The Goodyear Computer has been in operation almost steadily for the last month with a gradual loss in capacity due to loose connections, bad potentiometers, etc. It is estimated that the computer will have to go down for an overhaul before some of the larger of the above-mentioned problems can go on.

The new replacement coefficient potentiometers have been received and twenty-four have been installed. The remaining thirty-six will be installed during May.

Replacements for the intercept potentiometers on the diode function generators have been ordered. May 15 is the tentative delivery date.

Work has been started on the design of a better slope switch-potentiometer combination for the diode function generators and the components have been placed on order.

The order for the new computer was placed on April 20, 1959, with Beckman Instruments, Inc. The delivery date is six months, which would mean October 20 before the new computer arrives.

The new Brush 8-Channel Recorder has been received. All necessary wiring has been completed and the recorder is now in service. The Sanborn recorder is to

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be removed from service and completely overhauled at the earliest opportunity.

A study is being made into the feasibility of either building or purchasing a Magnetic Tape Type Transport Lag Simulator. Several vendors have been contacted and more will be contacted in the next couple of weeks.

A one-hour talk, followed by a demonstration and discussion period, was given to the Design groups in CEO on May 4. The talk covered the basis of analog computers and their applications.

The NPR Primary Loop (Four Section Temperature Model) Frequency Response runs are approximately 90% complete. A few runs are still to be made using a positive water temperature coefficient.

Pump coastdown curves for the NPR are now being studied on the computer.

Report No. HW-60026, "Multi-Region Simulation of Xenon Poisoning in the PRTR," has been issued.

Constants necessary to make a new hazards analysis on the PRTR have been received.

A request for Primary Coolant Transient Analysis for the PRTR was received April 24. Special equipment needed for this study has delayed its solution. Four transport lag simulators are needed to solve the problem. Arrangements are being made to obtain three of these from the Los Angeles Computer Center for a 30-day loan.

Curves depicting the response of a power rate meter after different power level ramps were recorded. The kinetics part of the problem included the constants from a natural uranium loading.

Using equations and constants from HW-32346, "Solutions of the Pile Kinetic Equations When the Reactivity is a Linear Function of Time: I," a solution was attempted on the analog computer. The computer overloaded before prompt critical was reached and, since the interest was in the shape of the curve just preceding prompt critical, a new approach seemed necessary. The log simulator which plots the log of the power level versus time has been programmed and is awaiting computer time.

Weather Forecasting and Meteorology Service

The first Columbia River crest forecast was issued on April 21, 1959. Expected crest heights are nearly equivalent to or slightly in excess of those observed in 1958. The forecasts for the 100 Areas and Richland are as follows (these forecasts will be amended as later information becomes available):

	<u>Peak Stage (Feet above MSL)</u>			
	<u>100-B</u>	<u>100-D</u>	<u>100-F</u>	<u>Richland</u>
1959 Forecast	405.5-408.5	394.0-397.0	381.0-384.0	348.5-352.5
1958 Observed	406.2	395.0	381.8	349.2

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The River is expected to crest in late May or early June, but probably before the 1938-1952 average crest date of June 7.

<u>Type of Forecast</u>	<u>Number Made</u>	<u>% Reliability</u>
8-Hour Production	90	88.4
24-Hour General	60	82.1
Special	136	87.5

April was the windiest month in more than 14 years of record at the Hanford Meteorology Station. The average speed of 11.1 mph compares with 10.7 mph in June of 1949, which previously was the windiest month of record.

Instrumentation

A count-rate system is being developed for checking the thickness of the zirconium cladding around the uranium fuel element for FPD. The probe is a scintillation type employed terphenyl in polyvinyltoluene for beta-gamma detection. The crystal, light pipe, and shield are being fabricated for evaluation.

A complete, fair-cost estimate was prepared concerning the alpha-only scintillation transistorized hand counter. The estimate was necessary because offsite fabrication bids are being obtained for the fabrication of twelve of the units. The fair-cost estimate, excluding the profit factor, was found to be \$2,300 each in lots of one only. In lots of twelve required, the estimate would be reduced by about 10% per unit.

Design and fabrication work was started for conversion of the vertical lead pig beta-gamma shelf counters from mica-window GM tube use to a scintillation detector using a phototube and terphenyl in polyvinyltoluene. The very fragile mica-window tubes which cost about \$200 for replacement will then be eliminated.

A radiation warning device design was completed for Facilities Engineering Operation, HLC. The instrument is to monitor above a water-filled tank containing 15,000 curies of Cobalt 60. The instrument has a minimum alarm sensitivity of five mr/hr, and the alarm point may be varied to 100 mr/hr or greater. The detector is a two-inch by one-inch NI(TL) crystal with a 6655A multiplier phototube. The alarm circuit is activated by a meter relay which measures the multiplier phototube anode current.

Acceptance tests were continued on eight Victoreen remote area monitoring systems with a total of 65 channels and a Riggs (one channel) remote area monitor. Acceptance tests were completed on 47 HAPO GM's.

Optical

Work was completed on the modified Slit Camera for 105-C Fuel Inspection Facility. The camera has been delivered and the customer is installing and testing the camera at 105-C.

Design drawings have been completed for a remotely operated TV scanning system to be used in the six-inch diameter access holes on the rear shield wall of the reactors. Fabrication of the unit is about 80% complete.

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The routine Optical Shop Work during this period includes 400 manhours work of which 35-3/4% was for Spare Parts (Stores), 19-1/2% was for IPD, 15% for CPD and 29-3/4% for HLO. During the month, O. K. Selle left to work in Technical Shops. Work performed included:

1. Completion of parts for PRTR profilometer components.
2. Polishing three lead glass bricks.
3. Fabrication of 20 glass bearings.
4. Fabrication of parts for TV scanner.
5. Service to 327 Building microscopes.
6. Fabrication of a second scratch depth microscope.
7. Evaporation plating of gold on wire loops.
8. Fabrication of a lamp projection and photocell detector mounting for R. C. Clark.
9. Fabrication of a pyroceram bearing.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
J. E. Sperry	4/16	Brush Instruments Seattle, Wash.	Discuss recorders.	HH Burley WD Cameron GR Taylor	No	300: 326
Lt.Col. B. Pusin	4/16-17	Air Force Tinker Field, Okla.	Install rawinsonde equipment.	GR Hilst	No	200-W:622F 200-E
W. B. Lewis	4/24	Phillips Petroleum Idaho Falls, Idaho	Discuss nuclear safety problems.	ED Clayton JE Faulkner	No	300: 326
A. C. Hughes	4/30	Hawker-Siddeley Nuclear Power Co., Limited Slough, England	Discuss application of PCTR techniques in Argonaut Type Reactors.	JE Faulkner RE Heineman	No	300: 326 305-B

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
C. R. Lagergren	4/1-2	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Mass spectrometer - consulting.	A. E. Cameron	Yes
A. L. Ruiz	4/1-2	Schenectady, N. Y.	Attend Symposium on Reliability.	--	No
W. C. Roesch	4/2-3	Univ. of Washington Seattle, Wash.	To teach AEC Fellowship Class.	Faculty and Students.	No
N. Ketzlach	4/5-9	Nuclear Congress Cleveland, Ohio	Present a paper at Nuclear Congress.	--	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. E. Wood	4/9	Univ. of Washington Seattle, Wash.	Present a talk.	--	No
I. T. Myers	4/9-10	Univ. of Washington Seattle, Wash.	To teach AEC Fellowship Class.	Faculty and Students.	No
N. Ketzlach	4/10	ANP Dept. (G.E.) Evendale, Ohio	Discuss critical mass experiments.	C. C. Gamerts- felder	Yes
L. V. Zuerner	4/10-11	Knolls Atomic Power Laboratories Schenectady, N. Y.	Discuss health instru- mentation.	L. Cherubin	No
	4/13	Brookhaven Nat'l Lab. Long Island, N. Y.	Discuss health instru- mentation.	F. P. Cowan	No
	4/16-17	Argonne Nat'l Labs. Lemont, Ill.	Discuss health instru- mentation.	J. R. Novak	No
R. A. Harvey	4/9-10 4/16-17	Univ. of Washington Seattle, Wash.	Assist in teaching EE 510.	Prof. Eastman	No
J. E. Faulkner	4/15	Univ. of California Los Angeles, Calif.	Recruiting.	--	No
	4/16-17	California Tech. Pasadena, Calif.	Recruiting.	--	No
W. C. Roesch	4/16-17 4/23-24 4/28-29	Univ. of Washington Seattle, Wash. U. S. Atomic Energy Commission Washington, D. C.	To teach AEC Fellowship Class. Project Tutor Meeting.	Faculty and Students D. Gale	No Yes
	4/30	Nat'l Bur. of Standards Washington, D. C.	ICRU Committee on Quan- tities and Units	H. O. Wycckoff L. S. Taylor	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
P. F. Gast	4/20-21	Univ. of California Berkeley, Calif.	Recruiting.	--	No
	4/22	Stanford Univ. Palo Alto, Calif.	Recruiting.	--	No
	4/23	G-E Vallecitos Lab. Pleasanton, Calif.	Discuss business of Standards Committee No. 6.	W. J. Ozeroff	No
R. A. Harvey	4/20-24	Chalk River Ontario, Canada	Attend Sixth Tripartite Instrumentation Conference.	Conf. Members	Yes
R. C. McCall	4/29-30	Am. Physical Society Washington, D. C.	Attend meeting.	--	No
C. R. Lagergren	4/29	Knolls Atomic Power Lab. Schenectady, N. Y.	Consulting on Wash. Designated Program.	T. L. Collins	Yes
	4/30	Am. Physical Society Washington, D. C.	Attend APS meeting.	--	No
D. G. Foster	4/30	Am. Physical Society	Attend APS meeting.	--	No
E. D. Clayton					
I. T. Myers	4/30	Univ. of Washington Seattle, Wash.	Teach AEC Fellowship Class.	Faculty and Students	No

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Chemical Research & Development

RESEARCH AND ENGINEERING

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATION PROCESSES

Flow Characteristics of an Aluminum Packed Bed

Studies of flow through a column packed with aluminum turnings were concluded. In addition to the "standard" packing described in the March report (2S aluminum turnings 0.005-inch thick by 0.13-inch wide), studies were made using "as-received" scrap aluminum turnings (spiral end turnings made from slug jackets, approximately 0.015-inch thick by 0.50-inch wide, and some thin ribbons and small chunks) and "sorted" scrap (only well-defined spiral turnings).

The highlights of the studies are discussed below:

1. The packing density increased with flow rate. The scrap turnings re-expanded to nearly their initial packed density when the flow ceased. The "standard" turnings remained compressed to 140 per cent of their initial density.
2. The pressure drop across the "sorted" scrap increased approximately as the 2.5 power of the flow rate. The pressure drop across the "unsorted" scrap and the "standard" turnings increased at a higher rate - presumably, because of greater packing compression at high flow rates.
3. Any increase in pressure drop, due to formation of an oxide film on the packing, was less than the deviation between runs.

The data are summarized in the following table:

<u>Packing Material</u>	<u>Packed Density, (lb/cu.ft.)</u>		<u>Flow Rate, (gpm/sq.ft.)</u>	<u>Pressure Drop, (lb/sq.in./ft of Bed)</u>	
	<u>Initial</u>	<u>Final</u>		<u>(1)</u>	<u>(2)</u>
"Standard" Turnings	3.62	5.05	430	1.20	
Sorted Scrap (3) (First Pack)	8.36	8.92	350	0.06	0.12
			680	0.45	0.54
			860	0.81	
Sorted Scrap (3) (Second Pack)	8.36	8.90	350	0.12	0.15
			680	0.58	
Unsorted Scrap	5.94		350	0.04	0.07
			680	0.43	
			860	1.04	

- Notes:
- (1) With flow increasing
 - (2) With flow decreasing
 - (3) The sorted turnings were packed and two runs were made, then the turnings were removed, separated, and repacked to the same initial density.

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Decontamination of Reactor Effluent with Aluminum Metal

Examination of the experimental data available on the use of aluminum turnings to decontaminate reactor effluent indicates that the surface area of the corroded aluminum is one of the most important measurements to be made for the selection of a bed packing. Consequently, an experimental study is being developed in which various types of aluminum turnings will be immersed in a retention basin and allowed to corrode. The measured surface area of these specimens, coupled with the above pressure drop data, will permit optimizing the design of a decontamination bed.

Decontamination of Reactor Components

Acetanilid and 8-hydroxyquinoline were tested as stabilizers for hydrogen peroxide in carbonate-bicarbonate solutions at 25 C and in contact with oxidized mild steel surfaces. Acetanilid at one g/l. had little effect on the hydrogen peroxide decomposition rate. The hydrogen peroxide half-life was increased from about 15 minutes without a stabilizer to about two hours when one g/l. of 8-hydroxyquinoline was present. Lower concentrations of 8-hydroxyquinoline produced the same degree of stabilization for short periods after which the peroxide decomposition rate approached that in the absence of a stabilizer. Destruction of the 8-hydroxyquinoline in the system is indicated.

When in contact with carbon or stainless steel, peroxide present in the Westinghouse Q.D.S. decontaminating solution (sulfamic acid, Versene, acetanilid, hexamethylenetetramine, and hydrogen peroxide) decomposed rapidly at 95 C and a heavy foam formed. In contact with glass, no gas evolution occurs.

Potassium permanganate-sodium carbonate solutions will dissolve uranium dioxide (prepared by exposure of metallic uranium to water at 200 C). In four hours exposure of excess UO_2 to a permanganate-carbonate solution at 95 C, the dissolved uranium concentration was 4.2 g/l. This compares favorably with results obtained with peroxide-carbonate solutions.

Further coupon decontamination tests with combinations of the Turco and APACE processes were made to define effects of solution concentrations, contact time and temperature, and order of application. The corrosion of carbon steel (A-246) by the APACE Step II solution (ammonium citrate-EDTA) is effectively inhibited by acridine. A large part of the radioactive content of alkaline permanganate solutions, after use as decontaminating agents, is carried on the small amount of solids present and can be removed by filtering or settling of the solids.

Uranium Oxidation and Fission Product Volatilization

Emphasis was placed on measuring the fission product release during thermocycling, investigating the effect of aluminum jackets on fission product release, and studying the release of fission products in an inert atmosphere. Thermocycling caused fluctuations in the fission product release rate. In this test, the furnace was held at constant temperature and the uranium specimen temperature allowed to fluctuate. Aluminum jackets were pressed over the bare uranium

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specimens in two tests. At 990 C in air atmosphere the aluminum oxidized rapidly and the aluminum oxide particles were deposited throughout the system, even penetrating the caustic and charcoal traps. At 1200 C no aluminum oxide particles were observed downstream of the furnace tube. The reasons for this difference in particle generation have not been resolved. In helium atmosphere the release of iodine, tellurium and xenon was greatly retarded, while cesium was more volatile than in air. The release of strontium, ruthenium and barium was about the same as in air.

Equipment assembly and procedures were completed for conducting oxidation studies of uranium at high temperatures in steam atmosphere. Three experiments with cold uranium using the modified apparatus were successfully completed. Oxidation rates of 1/4-inch x 3/4-inch cylindrical specimens at 1200 C for two runs were 12.9 and 13.9 mg per cm² per minute. This compares with a rate of 64.7 mg per cm² per min for the same conditions in air atmosphere.

Analytical Services

Atom per cent burn-up is being measured from Cs-137 fission yield and determining Cs-137 disintegration rates. Use of burn-up standards is no longer needed. While accuracy remains the same, the new method is about 20 per cent cheaper and is the method used by most other laboratories measuring burn-up. The advance came from using a local Cs-137 standard for calibrating a 256-channel energy analyzer with a 3-inch NaI(Tl) crystal.

A 0.002 mil coating of gold was removed from a 0.2 mil coating of silver on brass electrical connectors for Non-Metallic Materials Development. There was some concern about formation of mercury by beta decay of neutron activated gold. The gold was preferentially dissolved with cyanide-carbonate solution.

Activation Analysis. As, Ga, and Cu in the ppb range were measured in 0.1 g aluminum using standard radiochemical techniques after a 16 hour irradiation. Cs, Ni, Se, Zn, Sb, and P measurements are in process.

Analysis of carbon in plant irradiated metal was performed. The year old metal was handled in modified combustion-gasometry equipment regularly used for inactive samples.

SEPARATION PROCESSES

Anion Exchange

In order to further elucidate the mechanism of absorption of plutonium(IV) from nitric acid by anion exchangers, the solubilities of the tetra ethyl ammonium salt of the plutonium(IV) anion complex were determined as a function of nitrate concentration in both nitric acid and calcium nitrate - 0.5 M nitric acid. Plots of $-\log(\text{solubility})$ versus total nitrate gave curves which were very nearly identical in shape and slope to the anion exchange plots of $\log K_D$ versus total nitrate. The salt is being analyzed.

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Neptunium Recovery

Recovery of Neptunium from Purex 3WB. In the extraction of neptunium(IV) from 3WB in the 2A column using mixed ferrous sulfamate-hydrazine as the reductant the plutonium may leave in either the aqueous or organic streams or reflux internally depending on the acidity and concentrations of reductants. This is because the reductant reduces plutonium(IV) to plutonium(III) but increased nitric acid increases the oxidizing potential and thus increases the plutonium(IV)-to-plutonium(III) ratio. Plutonium distribution coefficients (E_a^0) were measured from synthetic 3WB of 5, 7, and 9 molar nitric acid before and after making the solutions 0.036 M ferrous sulfamate and 0.54 M hydrazine. The E_a^0 's were measured at various time intervals from one to twenty minutes after reductant addition, and virtually no effect of time was observed.

Equilibrium M HNO ₃	Plutonium E_a^0		
	5	7	9
No Reductant	8.9	16.2	19.3
Ten Minutes after Reductant Added	0.22	0.76	4.5

Thus, it can be seen that at low acid the plutonium will remain in the aqueous stream, and at high acid (≥ 9 molar) the plutonium will extract into the organic with the neptunium.

Another experiment demonstrated that it was feasible to reduce with ferrous sulfamate-hydrazine in 3WB of 10 M HNO₃, kill excess reductant by digesting at elevated temperature, and extract both plutonium and neptunium with 30 per cent TBP. Three extractions removed 97 per cent of the neptunium and 99.5 per cent of the plutonium from the aqueous phase.

3WB Neptunium Recovery Flowsheet. A variation of the reducing flowsheet used successfully in the March Purex plant neptunium recovery run was tested in the miniature mixer settler equipment. This varied from the March run in that the concentration of reductants in the feed was cut by a factor of two, and the 2A unit was operated at 52 C instead of 25 C. Increasing the 2A temperature increased the plutonium reflux only slightly. It was concluded from the results of this run that the Purex 2A-2B columns may be used to process 3WB under total recycle conditions at 50 to 55 C with one-half the ferrous sulfamate and hydrazine used in the March Purex recovery operation. The neptunium was stripped from the organic in the seven Mini stage 2B section with 0.05 M HNO₃ at an L/V of 0.25, giving 0.1 per cent 2BW loss. The Purex 2B column has unknown efficiency for this operation, and the L/V may have to be increased to achieve good neptunium stripping.

Solvent Extraction

Purex 2B Column Studies. Semiworks scale studies have been started to determine the capacity of the Purex 2B column at elevated temperature (~50 C) under a

simulated neptunium recovery flowsheet. A 3-inch-diameter glass pulse column equipped with a 9-foot long "standard" cartridge plate section was used.

Very little capacity improvement resulted from raising the column operating temperature from 35 C to 50 C. At a column temperature of 35 C and a pulse frequency of 30 cycles/min., the instability threshold was 900 to 1000 gal/hr/sq.ft. total flows and complete column flooding occurred at 1200 gal/hr/sq.ft. with a pulse frequency of 60 cycles/min.

At a column temperature of 50 C and a pulse frequency of 30 cycles/min., the instability threshold was 1000 to 1100 gal/hr/sq.ft. and complete column flooding occurred at 1200 gal/hr/sq.ft. with a pulse frequency of 70 cycles/min.

3WB Solids. A sample of solids was isolated from 3WB by centrifugation followed by three 6 M HNO_3 washes. An aliquot dissolved in HF-HNO_3 was analyzed by alpha total and showed 0.025 grams plutonium per liter of centrifuge cake. Other constituents are alumina, iron, and silicon.

Stability of Neptunium and Plutonium in DIBAN. DIBAN (dibasic aluminum nitrate) may be a potentially useful material for acid neutralization in certain Redox and Purex streams. Because of this the stability of plutonium(IV) and neptunium(IV) with respect to polymer formation and surface deposition was determined. Neptunium(IV) and plutonium(IV) at one to two grams per liter were found to be stable in 1.8 M DIBAN (ca. 3.2 M acid deficient) for periods of one week. Iron(III) was also found to be stable in this solution. Neptunium(IV) and plutonium(IV) E_a^0 's in 1.8 M DIBAN are low; 0.004 and 0.007, respectively. The E_a^0 's increase with increasing acidity.

Neptunium Chemistry. The formation of neptunium(IV) complexes is under study using the TTA extraction technique. The only neptunium(IV) complex for which quantitative data have been previously obtained was that with sulfate, which was measured by Hindman at the Argonne National Laboratory. To verify the method and techniques, the formation constants of the sulfate complexes were redetermined. Good agreement was obtained with Hindman's values. Data have also been obtained on the nitrate, oxalate, and fluoride complexes at 25 C; however, computation of the complexing constants is not yet complete. Qualitatively, the order of stability is found to be $\text{F}^- > \text{C}_2\text{O}_4^{2-} > \text{SO}_4^{2-} > \text{NO}_3^-$. Although complexing by nitrate is relatively weak, the average number of nitrates per neptunium ion was found to increase from 0.5 to 0.25 M nitrate to 2.9 at 2 M, implying the existence of even higher order complexing.

WASTE TREATMENT

Semiworks Waste Calciner Prototype

Final design of the calciner prototype is nearly complete. Over-all fabrication of equipment is about 60 per cent complete. Fabrication of the reactor fluidizing column chamber, the reactor de-entrainment section, the off-gas scrubber, and the spray condenser is complete. Installation of equipment has started.

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ANL Fluid Bed Calcination Studies

Exploratory studies at ANJ. on the fluid bed calcination of Purex acid wastes has continued. A shut-down of the calciner for repairs revealed a failed fluidizing distributor plate. It is believed that the failure occurred before starting the studies with synthetic Purex waste in February, and that the defective distributor plate was at least partially responsible for the formation of relatively large particles reported in March. The equipment has been repaired and a four-hour run, with simulated Purex "formaldehyde-killed" unneutralized waste has been completed. The quality of fluidization and appearance of the powdered product was considerably better than during any previous run.

Additional data on prior runs indicate the nitrate content of the product powder is less than one per cent by weight, and no sulfate is decomposed. Laboratory heating tests indicate significant fusion of the powder particles starts at temperatures as low as 600 to 680 C. Thus, these temperatures will be the approximate maximum for fluid-bed calciners operating with unneutralized Purex waste.

Fixation of Purex Waste by Batch Calcination

Additional preliminary scouting runs utilizing unagitated batch calcination techniques have been made, using simulated "formaldehyde-killed" three-fold concentrated Purex LWV.

A method of repeated filling, evaporating, drying, and calcining within the calciner vessel was tried along with the two methods reported in March (SW-59717 C, page 6). Results continue to be encouraging, as the two best runs (one of the methods reported last month and the method outlined above) obtained calcined volumes of about 1.8 gallons per ton of uranium feed.

Observation Wells

A project was initiated to provide a hydrological test site for performing ground water research. The site will be furnished with a pattern of ten closely-spaced wells, especially designed for optimum hydrologic measurements. Initial studies will be directed toward the quantitative evaluation of the rate of solute dispersion in the ground water. A location north of Sable Mountain was chosen for this facility because of the relatively shallow depth to ground water and its well defined homogeneous aquifer.

Relatively small change was evident in the pattern of ground water contamination as revealed by ground water analyses. Some indication of a slight eastward shift in the contaminated ground water beneath the 200 East Area cannot be deemed significant until it is confirmed by further observations.

Disposal to Ground

It was suggested that the Chemical Processing Department should consider the feasibility and advisability of discharging 300 Area Laboratory low-salt wastes

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to the self-concentrating tanks at Purex instead of to the Redox laboratory waste crib. Such a change would reduce the activity discharged to ground in the 200 Areas and increase the life of the 216-SL-1 and 2 cribs. Also, reductions in radiation exposure to truck operators and in transportation manpower charges will be realized from the shorter hauling distance.

A program to study the kinds and concentrations of radioisotopes stored in 200 Area soils above the ground water table was outlined. The proposed study relates to the effect a higher and fluctuating water table might have on past, present and future disposal of radioactive liquid wastes in the 200 Areas.

Laboratory study of anion exchange resins for recovery of plutonium from Recuplex CAW waste was centered on establishing elution curves. It was found that increasing the temperature of the eluting solution from 28 to 60 C speeded up plutonium desorption from all the resins tested but did not alter the relative order of elution efficiency of the resins. At 60 C, 95 per cent breakthrough was achieved at two column volumes for Permutit SK and five column volumes for Amberlite IRA 400 and 401 resins. Laboratory data regarding the ion exchange recovery of plutonium from CAW waste were reported in HW-59983, "Removal and Recovery of Plutonium from Recuplex Process Waste by Anion Exchange," by A. E. Reisenauer and J. L. Nelson.

Laboratory studies were initiated to determine the compatibility of ^{224}U condensate waste and waste decontamination solutions from the ^{271}U decontamination facility for disposal to a single crib. The influence of the detergents used for decontamination on the soil retention of radioisotopes will establish the feasibility of combining these streams.

TRANSURANIC ELEMENT & FISSION PRODUCT RECOVERY

Multicurie Cell Investigations

The fractionation of the solids in a recently received batch of Purex lww into fast-settling and slow-settling portions was described last month. Analytical data available to date show, surprisingly, that half or more of the plutonium, cerium, and rare earths (plus yttrium) were in the solids. However, these were easily leached out with a water wash. Precipitation of these elements may have been due to slight over concentration in the Purex plant and/or to a higher than normal salt content (0.62 M Fe, 1.5 M NaNO_3). The phenomena is being investigated further and may afford a way of obtaining a concentrated crude cerium-rare earth cut without the necessity of a sulfate precipitation step or of solvent extraction.

The centrifuged lww was butted with nitric acid from the as received 4.1 M to 7.5 M, oxidized with sodium nitrite, and an anion exchange recovery run made to demonstrate neptunium and plutonium recovery. Although the feed had been centrifuged for 15 minutes at 1200 G, some difficulty was encountered with plugging of the column by residual solids. However, it appeared that the solids probably passed through the resin and that the plugging was at the glass frit resin support. Thus, this experience may not necessarily imply similar trouble in the plant column but does, however, serve to indicate the importance of very thorough feed clarification.

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Cerium and Promethium Recovery

A series of runs have been made to define conditions for efficient precipitation of cerium and promethium double sulfates from LWW of current plant composition. Using samarium as a stand-in for promethium and tracing with promethium-147, recoveries of 96 to 97 per cent were routinely obtained with a procedure which involved diluting the LWW two-fold to reduce the iron concentration to 0.25 M, butting the sulfate to one molar, neutralization to pH 1 with caustic, and digestion at 90 C for at least an hour. The crystalline precipitate settled readily and centrifuged to a slurry volume of about one per cent. Exhaustive washing with 1 M sodium sulfate (adjusted to pH 1.7) dissolved very little of the rare earths (over-all recovery 91 per cent) and was shown to be a practical procedure for reducing contamination from other fission products. Reducing the concentration of rare earths in the feed to one-third to one-half current LWW levels (corresponding to loss of a substantial fraction to the LWW solids or to processing of low MWD/T uranium) still gave a satisfactory recovery of 92 per cent.

Americium Ion Exchange

Distribution coefficients of americium onto Dowex 1, X-4 (50 - 100 mesh) were measured from several aluminum and calcium nitrate solutions and from simulated Redox wastes. Log K_D was found to increase linearly with nitrate concentration from 4.0 to 8.0 M nitrate in ANN and in ANN made acid deficient with CaCO_3 or NH_4OH . Distribution coefficients were lower in acid deficient solutions and were higher at 25 C than at 70 C. K_D reaches 200 at 25 C and 70 at 70 C in 7.9 M nitrate in neutral ANN. Simulated Redox LWW in which the dichromate was destroyed by hydrazine nitrate gave a K_D of 160 at 25 C, and 70 at 70 C. Equilibrium appeared to be reached reasonably rapidly. These values of the K_D indicate that americium could be recovered from Redox LWW by anion exchange. It can be expected that total rare earths would load to about the same degree as americium and a rare earth americium concentrate would be obtained. The practicality of such a process depends on several incompletely explored factors such as radiation stability of the resin, removal of solids from the feed, etc.

Fission Product Isolation and Packaging Prototype

Installation of the prototype equipment has continued in the 321-A Building. All components, except the Hopper-Crystallization assembly and the Capper, have been installed and have undergone preliminary testing to determine operational characteristics. The tests have dictated minor modifications to some components.

The delivery of the General Mills manipulator has been indefinitely delayed because of a strike at the fabricator's site. However, this does not seriously hamper the initial phases of testing the prototype.

Xenon Isotope Separations

A scope design of two pilot coaxial thermal diffusion columns for separating xenon isotopes has been completed. The columns and the auxiliary equipment for controlling them could be installed and operated in the 321 Building.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

The UF₆ mass spectrometer continues to show promise for mercury. After a sample system was attached, five to ten miligram samples of natural mercury gave values with ± 1 per cent relative error for each isotope. A heated sampling system is expected to reduce a memory effect. A Rocky Flats plunger sample system is also being fabricated.

Liquid-Contact Scintillation Alpha Counter

A report, HW-49003, is being issued which describes the development, testing, and plant operating experience of the Hanford liquid-contact scintillation alpha counter. This alpha detector employs a ZnS phosphor alpha scintillation screen which is protected from chemical attack by a bonded Teflon film, 0.00025-inch thick. The film permits the passage of a sufficient fraction of the alpha particles from the solution for effective counting. A multiplier phototube is used to detect the light pulses produced in the phosphor by the alpha particles. Concentrations of plutonium ranging from 0.05 to 10.0 grams per liter can be measured with a precision of about ± 20 per cent. The detection limit is about 0.01 gram per liter. The monitor is virtually insensitive to beta and gamma radiation. A Cs-137 concentration of ten curies per liter (about 20 times that expected in most process streams under consideration) is equivalent to only 0.01 gram per liter plutonium when measured in a cell designed to minimize beta, gamma effects. The protective film over the phosphor is highly resistant to Purex and Redox process organic solutions and nitric acid up to 2.5 M. It is destroyed by 6.5 M nitric acid and is also easily damaged by abrasive material in flowing streams. One of the screens has been used continuously for over a year in the Purex plant (2BP stream) without failure and with very satisfactory results.

EQUIPMENT AND MATERIALSBearing Test Program

Interstitally hardened titanium was found to serve satisfactorily as a bearing material against boron carbide and Pyroceram*. Commercially pure titanium tends to gall readily when in sliding contact with many materials. However, heating the titanium in a flame to interstitially contaminate the surface, and thereby harden it, has been shown to reduce the tendency to gall. Such treated titanium test journals have been operated submerged in water against boron carbide at 1800 and 3600 rpm and loads up to 40 psi for over 40 hours with no evidence of surface damage. In comparison, untreated titanium seized almost immediately at about 10 psi load. Similar beneficial results were achieved in tests with Pyroceram when operated with loads up to 20 psi. However, surface damage did occur with Pyroceram when operated at 33 psi loading and 3600 rpm.

* The Corning Glass Works trademark for a crystalline glass.

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Corrosion of Ti-6Al-4V in Nitric Acid

Further tests on the corrosion of Ti-6Al-4V alloy in nitric acid solutions confirm the relatively high rates previously reported. Although heat treatment tends to reduce the attack in nitric acid of intermediate concentrations, the rates are still as high as those for stainless steels and much higher than those for A-55 titanium. A memorandum recommending that the alloy should not be used for product concentrators has been issued.

Evaluation of Air-Arc Cutting Technique

Corrosion tests were performed to evaluate the effect of air-arc cutting (metal cut with a carbon arc and molten metal blown out with an air jet) on subsequent welding of stainless steels. Concern in the air-arc process is over possible carbon pick-up at the cut edges. No differences in corrosion by boiling 65 per cent HNO₃ were observed for 304-L samples cut by hack saw and by the air-arc process and subsequently welded with 308-L welding rod.

Corrosion of 309 SCb Welded with 308-L Rod

It is proposed to make welding repairs on a failed 309 SCb Redox dissolver with 308-L rather than 309 SCb rod to reduce possibility of weld metal cracking and preferential weld metal attack. During 200 hours exposure to boiling 65 per cent HNO₃ there are no significant differences in the corrosion of test samples of 309 SCb welded with 308-L and 309 SCb rod.

PROCESS CONTROL DEVELOPMENT

UC₃ Plant Automation

The control programmer for the automation of the calciners has been redesigned and is considerably more flexible than originally conceived. Main features of the redesigned unit are summarized as follows:

1. Steam and main programmer are in one unit.
2. One servo is used to drive all three furnace rheostats.
3. The startup cycle is divided into three parts:
 - a. Continuous agitation with steam purge for the last 1/2 hour.
 - b. A single step corresponding to 10 divisions on the heater rheostats (100 divisions from shutdown to full load) is applied to the heater servo followed by 15 minutes of a continuously increasing input corresponding to a rate of about 160 divisions per hour.
 - c. At 50 divisions the rate of the heater servo changes to about 5 divisions per hour.

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4. The heater servo rate in both (b) and (c) above will be continuously adjustable from 1/4 to 4 times the above-mentioned rates. The programmer is presently under construction and will be completed and tested next month.

Studies on Uranium Transfer in Stripping Columns

To establish a basis for an analog of a solvent extraction column, studies are being performed to determine the instantaneous distribution of uranium in stripping columns.

A pH flowcell fitted with a glass electrode and a calomel reference electrode with a methanol-KCl salt bridge was installed in the LCF (organic feed) line. While the calibration of pH vs. acid and uranium concentration is not yet complete, the indicated pH is useful and has been used to control the blending of two solutions of differing acidity to give a blended solution with a constant intermediate acid concentration.

A phase-separating photometer with a quick disconnect fitting will be used to obtain uranium distribution data throughout the cartridge while the column is in operation. This will be achieved by moving the photometer sensing unit from one column outlet fitting to another and drawing a small sample directly from the column through the sensing unit.

Polyvinyltoluene Scintillators

Preliminary tests with polyvinyltoluene plastic scintillators for alpha counting techniques are encouraging. This type scintillator appears to have the following advantages: the scintillator can be exposed directly to the process stream, i.e., no protective coating is required, the material appears to be relatively stable in organic saturated nitric acid solutions, it is available as a shelf item at relatively low cost and can be easily machined. Additional samples have been ordered for prototype testing.

Gamma Monitor on Fluidized Ion Exchange Bed

A pulse counting gamma monitor system was installed on the product stream of a fluidized ion exchange bed in the 321 Building. The monitor will be used to measure the activity of a cesium-134 tracer in the product stream. It will detect the break-through of feed into the product stream at different capacities and degrees of fluidization.

NON-PRODUCTION FUELS REPROCESSING

Mechanical Head-End Studies

Sodium and Sodium-Potassium Alloy Reservoir Studies. Studies of mechanical techniques for safely processing the sodium or sodium-potassium alloy (NaK) reservoirs present in some non-production fuels have continued. Tests have included both high-speed friction sawing and hacksaw cutting of NaK-filled

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capsules in the presence of water. Friction-saw tests were made with the capsules at the surface of the water and under an inert-gas blanket. Up to four capsules (6 gm NaK/capsule) were exposed in a single blade pass without fires or explosions when the saw hood atmosphere contained less than five per cent oxygen. In the hacksaw tests, single capsules were opened six inches to two feet below an air-blanketed water surface. The quantity of burning NaK reaching the surface decreased with increasing submergence, but the severity of underwater explosions increased. Additional sodium and NaK studies are planned in two general areas: (1) some studies will be required to determine boundary conditions for safe cutting of sodium or NaK in water under inert gas atmospheres, (2) studies are required to specify the equipment and/or operating conditions required to handle the white fumes generated by the NaK - water reaction.

Friction blade sawing of zirconium tubing. The pyrophoric nature of finely-divided zirconium suggest a fire hazard. Dry sawing was accompanied by a shower of white sparks and ejection of glowing metal fragments. Wet sawing (slight tube submergence accompanied by a blade water spray) was considerably less spectacular. As was expected, the sawdust was principally zirconium oxide (about 90 per cent) and contained a significant quantity of particles in the one to two micron size range.

Cold saw Studies. Although high-speed friction-blade sawing has been demonstrated as an acceptable method for the removal of end fittings from non-production fuels, friction sawing requires cutting at relatively high temperatures and produces fine particles (1 to 2 micron) which must be safely separated from gas streams and stored. Consequently, "cold" sawing (i.e., low-speed multi-tooth blades which provide milling-cutter type operation) is currently being evaluated as an alternate method for end fitting removal. Initial cold-saw feasibility tests were conducted during April at the Motch and Merryweather Company in Cleveland, Ohio. During these tests simulated end fitting geometries (stainless steel tubing and pipe assemblies) were successfully cut using a 14-inch diameter blade (112 teeth, 0.39-inch tooth pitch) turning at 15 revolutions per minute (54 surface feet per minute). The "sawdust" produced during the test was considerably larger than that produced during friction sawing. Semi-quantitative analysis indicates that more than 99 per cent of the particulate produced is greater than 300 microns in diameter. On the basis of these attractive test results a "cold" saw is to be obtained to permit additional Hanford evaluation.

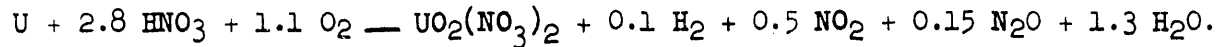
Feed Preparation

Darex Pilot Plant. Additional studies of metallic uranium dissolution in dilute aqua regia were made. The dissolution rate is primarily a function of the nitrate-to-chloride ratio, decreasing gradually as the ratio increases to 4.5, and decreasing markedly at higher ratios. The rate appears to be a direct function of the acidity and stainless steel concentration and an inverse function of the uranium concentration, although all three of these variables have second-order effects.

Analyses of off-gas from the downdraft condenser show H_2 , N_2O , NO , and NO_2 present. The maximum hydrogen gas concentration was 2.5 per cent, with typical

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values less than 2 per cent for an air sparge rate of 1.5 Scfm per square foot of initial uranium surface area. A typical, representative equation for the dissolution is:



Chloride was volatilized by sparging gaseous N_2O_4 - NO_2 mixed with an equal volume of air into a boiling 2.2 M U, 4.0 M H^+ , 2.8 M Cl^- solution. The off-gases passed through a downdraft condenser and a caustic scrubber for chloride removal. The condensate was refluxed. An average sparge rate of 0.6 gram mole NO_2 per liter of solution per hour produced 0.4 mole of acid and removed 0.25 mole chloride per mole of NO_2 added. No appreciable change in chloride removal rate was noted down to the terminal 0.2 M Cl^- concentration attained.

In another chloride removal study, a solution 2.2 M U, 4.0 M H^+ and 2.8 M Cl^- was concentrated by a factor of three, diluted to the original volume with 60 per cent HNO_3 and boiled under reflux for 2.5 hours. Excess HNO_3 was removed by concentration. A chloride decontamination factor of 10^4 was obtained.

Sulfex Studies

In dissolution of stainless steel cladding from UO_2 it was found that a more rapid initial UO_2 dissolution by sulfuric acid occurred if the UO_2 was exposed to the atmosphere. This more rapid UO_2 dissolution after exposure to the atmosphere is presumed to be due to surface oxidation of some UO_2 .

Data obtained with no significant exposure of the UO_2 to the atmosphere between experiments indicate that the rate of UO_2 dissolution in the presence of stainless steel is dependent on the rate of stainless steel dissolution. It was shown with unirradiated UO_2 that, whereas the simultaneous dissolution of stainless steel or carbon steel decreased the rate of UO_2 dissolution, the simultaneous dissolution of 99.99 per cent iron had no effect on the UO_2 dissolution rate. From this it is concluded that hydrogen evolution is not responsible for the lower UO_2 dissolution rate.

It was found that a black solid of unknown composition is present during and for a while after the dissolution of carbon steel or stainless steel in sulfuric acid. The inhibition of UO_2 dissolution by the presence of the black solid isolated from these solutions indicates that it is the black solid rather than the steel itself which results in the lower UO_2 dissolution rate in the presence of dissolving steel. The weight of the black solid isolated by the dissolution of 304-L in boiling 4 M H_2SO_4 was ca. 0.3 per cent of the weight of the steel dissolved. This black solid is about 90 per cent dissolved in one hour in boiling 4 M H_2SO_4 . The data obtained to date indicate that uranium waste losses of 0.1 per cent or less can be maintained in sulfuric acid dissolution of stainless steel cladding from UO_2 .

Sulfex Pilot Plant. The modifications of Hastelloy-F dissolver to permit the dissolution of stainless steel using the Sulfex process have been completed. An acid addition tank to permit the controlled and measured addition of acid to the dissolver, and a recorder to permit the continuous monitoring of the hydrogen concentration in the off-gas stream were installed.

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A proposal for operating the pilot plant Sulfex dissolver involves addition of 98 weight per cent sulfuric acid to dissolver previously charged with stainless steel and water. Annealed 304-L plate, annealed 304 tubing, and sensitized (one hour at 1250 C) 304-L plate were dissolved by this procedure. The 304-L samples started to dissolve at a sulfuric acid concentration of about one molar and the 304 tubing at about two molar.

Several other bench scale runs were made of the sulfuric acid dissolution of stainless steel with similar results. No serious passivation was experienced when the stainless steel in mild steel wool was placed in boiling water and sulfuric acid was added. The stainless steel began reacting when the solution became 0.8 M H_2SO_4 . With no mild steel present, the reaction with stainless steel began when the solution became about 5 M H_2SO_4 . Cooling the solution caused no noticeable passivation of the stainless steel.

Niflex Pilot Plant. Dissolution of 1/2-inch-diameter stainless-steel-clad uranium dioxide pellets and 3/4-inch-diameter stainless-steel-clad uranium rods was completed on 100-pound batches. Neither a fluoride-to-stainless steel mole charge ratio of 7 nor a ratio of 8 gave complete dissolution of the stainless steel cladding. The stainless steel cladding was 96 to 99 per cent dissolved after four hours of operation. As expected, the end plugs were left intact, except for a 10 mil surface removal. (End plugs were approximately 23 per cent of the total stainless steel charged.) Approximately two weight per cent of the uranium core and three weight per cent of the uranium dioxide core dissolved in the Niflex solution (2 M HNO_3 , 1 M NH_4HF_2 , and 0.4 M stainless steel) during the 4-hour decladding period. Uranium concentrations at this point in the dissolution steps were 5 to 13 grams per liter.

The uranium dioxide dissolved at average rates of 30 to 60 mils per hour when aluminum nitrate was added to complex the fluoride and the solution was adjusted to 1.5 — 2 M HNO_3 . Dissolution of the uranium dioxide cores was 75 to 99 per cent complete in eight hours, with a 1.5 and a 2 M HNO_3 concentration, respectively. The final solution of uranium dioxide contained approximately 0.4 to 0.5 M U, 4.8 M NO_3^- , 1 M Al, 1 M F^- , and 0.2 M stainless steel. In the metallic uranium dissolution, average rates of 15 to 30 mils per hour were obtained; although the acidity became quite low and an unstable solution formed at concentrations of about 0.94 M U, 0.2 M H^+ , 4.7 M NO_3^- , 0.16 M stainless steel, and 1.3 M Al. This "cut" dissolved 53 per cent of the total uranium present.

Dissolution of Uranium-Molybdenum Alloy. Further studies on the preparation of Redox-type feed solutions from uranium-molybdenum alloys by dissolution in nitric acid-ferric nitrate solutions may be summarized as follows:

1. Off-gases from the dissolution of uranium - 3 weight per cent molybdenum alloy in ferric nitrate - nitric acid solutions are primarily oxides of nitrogen. Only traces (less than 0.2 volume per cent) of hydrogen were found.

2. Sulfate ion at concentrations which might be present during core dissolution due to incomplete washing following Sulfex decladding had no significant effect on uranium-molybdenum alloy dissolution in ferric nitrate-nitric acid solutions.
3. A laboratory-scale recirculating dissolver has been used for dissolution of uranium-molybdenum alloys. This equipment was operated with storage-vessel-to-dissolver-volume ratios from 10 to 20. Solution was maintained at 85 C in the storage vessel and preheated before it entered the dissolver. Normal dissolution rates and solution stabilities (as compared to runs in pot-type dissolvers) were observed. Extensive (ca. 10 hours) recirculation of dissolver solution following dissolution to less than 0.2 M free acid caused precipitation of a brown solid, presumably ferric hydroxide.
4. Stability (toward precipitation) of the dissolver solutions, during long term storage at 25 and 50 C, as a function of acidity, ferric nitrate, and uranyl nitrate concentration is under study. The minimum acidity for stable solutions is governed by the ferric nitrate concentration. Lower temperature favors stability of the solutions.
5. Oxidation of plutonium by dichromate or other oxidizing agents will be necessary for Redox processing. Minimum acidity to prevent solids formation during the oxidation step appears to be about -0.4 M for solutions about one molar in uranium and in ferric nitrate. Such solutions have a pH less than zero.
6. Aqueous ferric nitrate for use in this process can be prepared readily by dissolving mild steel in nitric acid. In dissolution rate studies covering ferric nitrate concentrations from zero to one molar and nitric acid concentrations from two to 10 molar, dissolution rates for 1020 carbon steel ranged from two to 12 g/sq.cm-hr. Ferric nitrate prepared in this manner has been used to dissolve uranium-molybdenum alloys and the dissolver solutions have been used for plutonium oxidation and batch contact solvent extraction studies. No observable differences between these dissolver solutions and those prepared using reagent grade crystalline ferric nitrate were found.
7. Exploratory studies attempting to define the mechanism by which ferric salts prevent precipitation of uranyl molybdate are in progress. Preliminary evidence points toward formation of a soluble iron-molybdenum heteropoly acid.

Dissolution of Uranium and Uranium Dioxide. Further studies on the dissolution of ingot uranium and sintered uranium dioxide in nitric acid and nitric acid - ferric nitrate solutions confirm a previously reported acceleration in dissolution rate by ferric nitrate. The instantaneous dissolution rates for a sample of fused uranium dioxide in 9 M HNO₃ and in 9 M HNO₃ - 0.1 M Fe(NO₃)₃ were about two-fold lower than those for sintered uranium dioxide in the same reagents.

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Materials of Construction. Two more heats of modified Hastelloy-F have been obtained for testing as possible welding material for use with Hastelloy-F base metal. One of these contains nine per cent molybdenum and one per cent niobium. The other contains 12 per cent molybdenum and no niobium. Nominal composition of Hastelloy-F includes six per cent molybdenum and two per cent niobium. Both heats showed poor corrosion resistance to nitric acid - hydrofluoric acid and to sulfuric acid - stainless steel solutions. Both suffered severe attack by nitric acid - hydrofluoric acid when used as weld filler with Hastelloy-F base metal.

Hastelloy-F weldments welded with Ni-0-nel show average corrosion rates of 0.22 mil/mo. during 50 hours exposure to simulated Zirflex dissolver conditions.

Process Control Development

Chromatograph Installation on NPF Cut Off Saw Hood. A process chromatograph was calibrated for gas samples containing 0 to 100 per cent air and 0 to 10 per cent hydrogen. The unit was installed so as to sample the atmosphere in the hood surrounding the NPF cut off saw in order to determine the gas composition before and after a cut was made on NaK bonded fuel elements. The chromatographic data indicated rather quickly that the sputtering and flaming which had occurred while sawing bonded NaK elements was due to insufficient purging of the hood with inert gas. No evidence of reaction was noted with gas mixtures of 20 per cent air in helium.

Strain Gauge-Dissolver Weigher. A strain gauge weighing system for a continuous dissolver is now being readied for use on a prototype dissolver. The system has an accuracy of ± 0.25 per cent for loads from 40 to 200 pounds at temperatures between 15 F and 115 F. Tare weights (basket) up to 100 pounds may be suppressed.

Precision Level Measurements. Tank T-4 on the 321 tank farm is being prepared for precision level measurement experiments. All solution lines in and out of the tank are being blanked. An electronic level measurement system is under test in the laboratory for use as a standard. Operations Research and Synthesis Operation has reviewed the planned level measurement studies and will analyze the data from the tests. A four line dip tube system will be calibrated with water and a heavy metal solution. A calibration with water and a conventional dip tube system will also be carried out.

Criticality Studies - Feed Materials Preparation

A core material for the third PCMR criticality experiment (H/U atomic ratio of 8) using three per cent U-235 enriched uranium trioxide was prepared and delivered. The shipment consisted of approximately 40 pounds of polyethylene-moderated, boron-poisoned uranium trioxide and 50 pounds of hydrated, boron-poisoned uranium trioxide containing 16 weight per cent water.

SECRET

REACTOR DEVELOPMENT - 4000 PROGRAMPLUTONIUM RECYCLE PROGRAMMolten Salt Cycling of UO_2

It has been discovered that UO_2 will react with phosgene, $COCl_2$, dissolving in a chloride melt as UO_2Cl_2 , and further, that UO_2 may be reprecipitated upon the addition of a mild reductant such as Zn or Mg metal. On the other hand, PuO_2 reacts only extremely slowly with $COCl_2$ bubbled into molten alkali chloride. These facts afford a potential separation process for irradiated UO_2 fuel material.

A uranium-plutonium separation factor of 58 was obtained in an experiment wherein 500 milligrams UO_2 - PuO_2 mixed oxide with a uranium-plutonium mole ratio of 5/1 was added to 16 grams of molten NaCl - KCl eutectic at 800 C and treated with phosgene for two hours, as determined by uranium and plutonium assays of the filtered salt solution which gave a mole ratio uranium-plutonium of 290/1.

It is planned to study fission product behavior in this fused salt cycle.

Non-Aqueous Systems

Continued study of the liquid N_2O_4 system has disclosed a very slow rate of reaction of UO_2 with the substrate. In six experiments runs at 105 C, the maximum extent of reaction (61 per cent) was found after seven days. Although small glass beads were added to prevent packing, this still occurred and is believed to be the factor controlling the rate of reaction.

The solubility of $UO_2(NO_3)_2 \cdot 2NO_2$ in liquid N_2O_4 at 25 C was determined as 1×10^{-4} molar. Analysis of uranium, nitrate-nitrogen, and NO_2 -nitrogen were in accord with the above formula.

Tetraethylammonium nitrate was found to be soluble in liquid N_2O_4 , but forms a second phase at a (presently) unknown composition. $UO_2(NO_3)_2 \cdot 2NO_2$ appears to be soluble in this second phase.

Mercury Isotope Separation

A simple technique for making electrodeless mercury emission lamps starting from mercuric nitrate solution has been established. Particularly precautions must be taken to eliminate water vapor and more especially nitric oxide which has a very large fluorescence quenching cross-section. A successful lamp has been constructed containing Hg-202.

Analytical Services

Am-Cm was separated from aluminum metal and salt samples with hydroxide and Dowex-1. Details are the same as for the magnesium separation, mentioned two months ago. Over 98 per cent Am-Cm recovery was indicated.

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Dissolver Off-Gas Analysis System for PRTR Fuel Processing

The flow diagram for the Redox dissolver off-gas analysis system is complete. Installation of the equipment will begin as soon as instrument components are received. Delivery of all components is scheduled for completion by June 8, 1959.

Fluidized Bed Ion Exchange Studies

Five preliminary runs were made in a 4.0-inch ID glass column 6-foot long, using uranyl nitrate (20 g U/l.) in dilute nitric acid (0.5 M) solution as a tracer. Two down-flow runs at 0.5 and 2.4 gal/min/sq.ft. and three up-flow runs at 1.1, 1.5, and 2.4 gal/min/sq.ft. at bed expansions of 12.4, 20, and 30 per cent, respectively, were made. The holdback* obtained at up-flow rate of 2.4 gal/min/sq.ft. was 22 per cent higher than at the same down-flow rate.

Plutonium Oxide Chlorinator

Samples of nickel, chlorimet-2, Ni-o-nel, and Inco 804 corroded at 2.8, 4.7, 6.3, and 10 mils/mo. during a 76 hour exposure to a phosgen-air-water mixture at 600 C. All of these except Inco 804 appear as good as or better than Hastelloy B or C for this environment and temperature.

Waste Disposal

The broad similarity of the waste treatment and disposal work being sponsored by 2000 and 4000 Programs results in much of the experimental information reported herein on the Fissionable Material Program being applicable to the Reactor Development Program, but on a broader basis of application. For example, most of the information reported on experimental calcination techniques, heat transfer properties of calcined powders, isolation of specific fission products, and materials of construction can be beneficially applied to the Reactor Development Program. The reader is referred to prior sections of this and earlier reports for detailed information on these subjects.

WASTE FIXATION

Mineral Reactions

Decontamination factors for Sr⁹⁰ and Cs¹³⁷ of process D-2 waste solutions passed through columns of clinoptilolite were about 10⁻³ of those of synthetic D-2 solutions prepared in the laboratory. Investigation revealed the presence of radioactive insoluble material in the process D-2 samples which would not enter into decontaminating reactions. The amount of radioactive material associated with these suspended solids ranges up to 90 per cent of the total. The solids were identified as suspended silts introduced with raw water leaking from cooling coils in the Redox D-4 tank. The raw water normally contains

*The holdback is defined as the area under the breakthrough curve from 0 to 1 column volume; or, $H = \sqrt{DZ/\gamma}U$ where D = diffusivity, Z = bed height, and U = fluid velocity.

SECRET

about 22 ppm suspended solids during this season of the year. Such material greatly complicates the study of mineral bed decontamination of the D-2 stream. Synthetic waste samples have demonstrated decontamination factors of about 10^5 for one pass through a bed of the natural zeolite.

Studies were continued to determine the feasibility of using mineral reactions to decontaminate condensate streams which may originate from fuels reprocessing plants. A review of the laboratory data and available literature was essentially completed. Economic studies were initiated to estimate the incremental costs that would be sustained by waste disposal processes if mineral beds were used for this purpose.

Radiant Heat Spray Calcination

A series of runs were made during the month aimed at improving product quality, with elimination of dust and improvement in bulk density being particularly desired. Using a synthetic Purex feed containing added phosphate and sugar, best results were obtained by (1) maintaining the top of the column in the region near the nozzle at a relatively low temperature of about 325 C, (2) operating the center section at a high temperature, 840 C, and (3) employing a somewhat greater residence time (14 seconds) than had previously been assumed to be required. Shorter residence times have resulted in a high percentage of incompletely ignited particles which expanded into large hollow bubbles. Using the longer residence time, the incompletely ignited fraction ranged from only four to 24 per cent, and the remaining powder had a tap density ranging from 1.05 to 1.45 grams/cc.

Gas temperatures within the column were measured by means of a shielded thermocouple probe. Very little gradient was found to exist across a cross section of the column. This indicates that interchange of heat between radial zones of different temperatures is very rapid. Scale-up of this type of reactor therefore appears even more feasible than anticipated.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Radioisotopes in Reactor Cooling Water

The adsorption of 13 reactor effluent water radioisotopes on aluminum, stainless steel, and carbon steel was measured in continuing studies of the effect of this adsorption on the radiation dose from the reactor rear face piping materials. Of this incomplete group La¹⁴⁰, As⁷⁶, Sc⁴⁶, Cu⁶⁴, and Zn⁶⁵ contributed over 95 per cent of the gamma dose with relative importance in the order given. Other rare earth radioisotopes probably are important contributors and will be measured in future studies.

Application of more sensitive analytical methods has made possible studies of the paper electrophoretic behavior of five different radioisotopes in reactor effluent water without the necessity of concentrating the sample. This reduces the possibility of inducing changes in the chemical form before measurement. Under these conditions Cr⁵¹ moved in a single zone rather than

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the three previously observed and is probably present entirely as the chromate ion. As ⁷⁶ migrates as two distinct species, one of which moves very little. Confirmation of these and other chemical form assignments will require more ion mobility data which are being obtained.

Samples of the Kr⁸⁹ released through reactor effluent water piping vents and at the reactor effluent basins were collected and analyzed for the Sr⁸⁹ daughter after time was allowed for decay. These measurements showed that at least ten per cent and possibly much more of the Sr⁸⁹ is released to the atmosphere through escape of its noble gas parent instead of remaining in the reactor effluent water. Only a much smaller fraction of the Sr⁹⁰ would be expected to be lost by the noble gas escape mechanism since the half-life of the parent Kr⁹⁰ is 33 seconds which is only about one-sixth that of Kr⁸⁹ and, hence, would not have as long a time to escape. These results are important in studies where Sr⁸⁹:Sr⁹⁰ ratios are used to infer time since fission as well as in studies of waste disposal. Significant loss by this mechanism of other fission products, such as Cs¹³⁷, might be expected also to occur because of the long lives of their noble gas precursors.

Geology and Hydrology

Excavation for the river water intake structure at the PRTR site disclosed a Columbia River channel older than the current one, paralleling it, and similarly incised into the compact silts and sands of the lower Ringold formation. The channel is apparently about 2000 feet wide at this site. It constitutes a part of the extensive network of such river channels throughout the project area that significantly affects the flow of the ground waters. The channel is separated from the river by a ridge of compact silt of the lower Ringold formation and by a narrow ridge of middle Ringold conglomerates or compact gravels that rises locally above the ground water table. These compact gravels and the silts inhibit the movement of river water into the ground water system during high river stages and the movement of uranium-bearing ground waters into the river except through gaps in the ridge.

A laboratory model representing a two-dimensional slice through a crib was used to obtain data to test a mathematical representation of the flow pattern beneath a crib. Moisture content and tension measurements were made at 32 positions over the face of the model. The data, when applied in the previously derived unsaturated flow formula, will permit estimates of the flow pattern beneath the crib.

Results of an eight-hour pumping test on well 699-31-53 indicated a coefficient of transmissibility of 1.2×10^7 gpd/ft and an average aquifer permeability of about 1000 gpd/ft². Hydraulic evidence suggests that this well is on the edge of a buried glaciofluvial channel and that the aquifer is comprised of a thin layer of permeable glacial deposits and a thicker section of less permeable Ringold material. This well and a similar screened well nearby were constructed with the liberal use of bentonite drilling mud which has an unknown influence on the measured hydrologic coefficients. In the first of

these wells very little development was attempted before the pumping test was made, with a resulting well efficiency (effective perforation of casing) of only 27 per cent. A vigorous development of this second well, including chemical treatment, surging, and bailing, resulted in a measured well efficiency of 92 per cent.

Soil Chemistry and Geochemistry

The influence of temperature, flow rate, and pH on the removal of cesium by the natural zeolite clinoptilolite was studied. In general, the cesium capacity of this mineral is less at high temperatures, particularly in the upper pH range but the temperature effect is slight from solutions having a pH less than 10. Raising the pH above 10 also has an increasingly detrimental effect on the uptake of cesium by clinoptilolite, probably because of some dissolution of the high-silica mineral. Very little effect of flow rate was observed for flows up to 14.2 ml/cm²/min. The rate of the cesium removal reaction by clinoptilolite compares favorably with the rate of cation exchange of Dowex-50 resin. The cesium capacity of the resin in the absence of extraneous ions is only about 1.4 of that of the mineral under the same conditions. In the presence of significant concentrations of other ions, the selectivity of clinoptilolite for removing cesium from solution gives it a far greater cesium capacity than any exchange resin tested for comparison.

Mass action calculations of data on Sr⁺² sorption by soils at different strontium concentrations and in the presence of macro concentrations of other ions indicate an increasing retention energy for Sr⁺² with decreasing strontium concentration. The f-value, (relative "ease of release") of strontium in solutions containing 1000 ppm Mg⁺² was determined to be 0.97 at a strontium concentration of 0.1 ppm (the f-value of Ca⁺² arbitrarily = 1.0). At a concentration of 10 ppm the f-value for Sr⁺² was found to increase to 1.25. These data are in agreement with previously observed variations in strontium breakthrough curves with solutions having various strontium concentrations.

Equilibrium studies of the soil retention of cerium ion were performed with a composited sample of local calcareous soil and solutions of CeCl₃ ranging from concentrations of 10⁻⁴ S to 10S, where "S" represents the cation exchange capacity of the soil used. At a pH less than 5.5 cerium appears to be ionic and may be removed from solution by an ion exchange mechanism on soil. As the pH of these solutions is increased to 5.5 with the addition of NaOH the cerium is precipitated as Ce(OH)₃. In the pH range from 7.5 to 11.5 the soil-Ce(OH)₃ complex tends to peptize and disperse, providing equilibrium soil removal data that are difficult to interpret.

Ground Waste Investigations

A field test facility was installed at a site southwest of Gable Mountain. The site chosen consists of a 15-foot profile of uniform soil above the water table. Small-scale crib experiments will be performed here to demonstrate the application of laboratory column data to the prediction of the breakthrough curve for a crib. The facility consists of a two-foot square

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crib surrounded by a pattern of driven well points for monitoring the ground water. A solution spiked with Sr^{85} will be added to the crib at a constant rate to permit the determination of the strontium breakthrough curve.

Two 47-foot soil columns which have received a strontium-90 spiked solution for about six weeks exhibited the first signs of strontium breakthrough. The columns will continue to receive the solution for about another six weeks to define the shape of the breakthrough curve more completely. The initial breakthrough occurred very close to the time for which it was predicted on the basis of data from shorter columns.

Field Apparatus Development

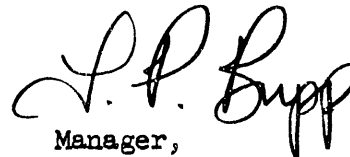
Parts for the rotatable mirror to be used with the closed circuit TV have been fabricated by Technical Shops.

Excellent results can be obtained with the refraction seismic method if high energy input to the ground is maintained. In one test, the depth to the water table calculated from seismic data was in close agreement to the actual measured depth of 37 feet.

Eight well points were installed at the Gable Mountain site by crane-operated pile driver. The wells were developed by water surge and the sand was removed by flotation.

Particle Studies

Autoradiographic examination of a Millipore filter sample of the 234-5 Buiding stack exhaust indicated that the activities of the particles are equivalent to spheres of plutonium up to 0.8 micron in diameter. Large particles, 200 to 300 microns in diameter, were not radioactive. Alpha energy analysis of the filters gave a typical curve for plant-produced plutonium. Fine resolution and an absence of alpha energy smear was observed. This appears to be a possible sampling technique where it is necessary to know the nature of the activity as well as the gross amount. The delay time required for decay of radon daughters on present filter samples would be eliminated.



Manager,
Chemical Research & Development

LP Bupp:bp

ORGANIZATION AND PERSONNEL

L. F. Lust, Chemist II, was transferred from Chemical Processing Department to the Analytical Laboratories Operation.

J. M. Skarpelos, Engineer I, was transferred from Reactor Fuels Research & Development Operation to the Chemical Effluents Technology Operation.

A. K. Postma, Junior Engineer, was transferred from Professional Personnel Placement to the Chemical Effluents Technology Operation.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
B. L. Schmalz	4/13/	Health & Safety Division AEC Idaho Falls, Idaho	Investigate waste disposal at Hanford	JF Honstead DW Pearce RE Brown	No
K. W. Newman F. Morris	4/14/	Turco Products, Inc. Los Angeles, Calif.	Discuss Turco (4501) composition and uses.	HJ Anderson	No
H. W. Chandler	4/16-17/	Radiation Application New York, New York	Discuss fission product recovery, waste disposal, and allied topics.	LP Bupp RL Moore RJ Sloot VP Kelly AM Platt RW Wirta	Yes
C. Pierce L. Slater J. Evans	4/27-28/	Brookhaven National Lab. Upton, Long Island, NY Savannah River Lab. Aiken, South Carolina	Discuss process chemistry, waste disposal, and fission product recovery, non-production fuels reprocessing.	RL Moore EE Voiland KH Hammill RJ Sloot OF Hill	Yes
T. P. Lenaban	4/20-22/	Halliburton Oil Well Cementing Co. Duncan, Oklahoma	Discuss waste disposal procedures and studies at Hanford	DW Pearce JF Honstead RE Brown	No

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW	
				Personnel Contacted	Access to Restricted Data
F. Neumann	4/22/	University of Washington Seattle, Washington	Perform preliminary tests relating to seismological study of Hanford project.	RE Brown JR Raymond	No
G. W. Watt	4/27-30/	University of Texas Austin, Texas	Technical Consultations	CE Linderoth WH Reas MT Walling RL Moore EE Voiland OF Hill RE Burns JE Mendel	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Access to Restricted Data	
				Personnel Contacted	Access to Restricted Data
F. P. Brauer	4/1-3/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss Washington Designated Programs	AE Cameron	Yes
O. F. Hill	4/1-3/	AEC Washington Division of International Affairs	Attend meeting on OEEC-Eurochemic Affairs; confer on US-UK Exchange	-----	Yes
R. F. Maness	4/1/	GE-Evandale Plant Cincinnati, Ohio	Discuss improvement of existing materials for power reactor fuel dissolver construction.	L Jahnke E Sayre	No
	4/2/	Union Carbide Metals Co. Niagara Falls,	"	"	No
	4/3/	Research Laboratory Schenectady, NY	"	"	No
	4/6-8/	National ACS Meeting Boston, Mass.	Presented paper.	JH Hollomon	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
W. A. Haney	4/2-3/	9th Pacific Northwest Industrial Waste Conference Seattle, Washington	Present Paper		No
C. R. Cooley	4/6-8/	5th Nuclear Congress Cleveland, Ohio	Attend Meeting		No
R. D. Dierks	4/9-10/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discussions on Non-Production Fuels Reprocessing	FL Culler	Yes
	4/6-7/	Research Laboratory Schenectady, New York	Discuss methods of alpha particle detection that may be suitable for development into process control instruments at HAPO. Presented paper	WW Piper	No
	4/8-10/	ACS National Meeting Boston, Mass.			No
R. J. Sloat	4/6/	Motch & Merryweather Co. Cleveland, Ohio	Mechanical sawing studies		No
	4/7-9/	7th Hot Laboratory Conf. Cleveland, Ohio	Attend Meeting		No
	4/10/	General Electric Co. Wiring Department Providence, Rhode Island	Discuss patent		No
	4/13/	Brookhaven National Lab. Upton, Long Island, NY	Waste Studies, Non-Production Fuel Reprocessing studies, liquid metal fuels reactor processing, rare gas recovery. Give talk to graduate students.	B Manowitz	No
D. W. Pearce	4/28/	Washington State College Pullman, Washington	Technical consultation	GH Dunstan	No
L. P. Bupp	4/27/	Research Laboratory Schenectady, New York	Attend Meeting	CH Linder	No
	4/28-30/	Engineer & Laboratory Manager's Meeting Schenectady, New York			No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. C. Schwendiman	4/15/ 4/16/ 4/17/ 4/21-22/	American Standards Assoc. Washington, D.C. Polish Legation Washington, D.C. American Standards Assoc. New York, New York Warsaw, Poland	Briefing for trip abroad to attend ISA Meeting Obtain visa for trip to Poland Briefing for trip abroad Attend ISA Meeting	HG Lamb Members of Committee	No No No No
R. W. Stromatt	4/16/ 4/13-13/	Brookhaven National Lab. Upton, Long Island, NY Conference on Molten Salt New York, New York	Discuss molten salt chemistry. Attend Conference	RH Wiswall	Yes No
R. H. Moore	4/6-10/ 4/13-16/	ACS National Meeting Boston, Mass. Conference on Molten Salt New York, New York	Presented paper Attend Conference		No No
K. H. Hammill	4/6-10/ 4/30/	7th Hot Laboratory Conf. Cleveland, Ohio Penberthy Instrument Co. Seattle, Wash.	Attend conference and present paper. Inspect glass slabs for shielding windows.	J Gifford	No No
A. S. Willson	4/21/	Washington State Univ. Pullman, Wash.	Present talk on Ruthenium Chemistry.		No
D. L. Reid	4/27/ 4/28/ 4/29/	Atomics International Canoga Park, Calif. UCIRL Livermore, Calif. Phillips Petroleum & Westinghouse Idaho Falls, Idaho	Discuss operation of hot laboratory and analytical cells Discuss hot lab operation at Pratt and Whitney Discuss high level analytical facility	BG Johnson RV Steele RC Shanks B Singer	No Yes Yes

BIOLOGY OPERATION

A. ORGANIZATION AND PERSONNEL

Dr. Rubin Borasky, of the Biological Analyses Operation, resigned to accept a position outside of the Company.

B. TECHNICAL ACTIVITIESFISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Radioiodine Contamination

Concentrations of I^{131} in thyroid glands of jack rabbits were approximately 60 times less than those of one year ago. Values follow:

<u>Location</u>	<u>µc/g wet thyroid</u>		<u>Trend Factor</u>
	<u>Average</u>	<u>Maximum</u>	
Wahluke Slope	2×10^{-4}	6×10^{-4}	-
4 Miles SW of Redox	2×10^{-4}	6×10^{-4}	- 2
Prosser Barricade	8×10^{-5}	2×10^{-4}	-10

Columbia River Contamination

Concentrations of gross beta emitters in Columbia River organisms collected at Hanford were about the same as one year ago. Values of indicator organisms follow:

<u>Sample Type</u>	<u>µc/g wet weight</u>		<u>Trend Factor</u>
	<u>Average</u>	<u>Maximum</u>	
Minnows (entire)	9×10^{-4}	2×10^{-3}	-

Previous reports have indicated an extremely rapid death of fingerling salmon following exposure of fish to water containing C. columnaris. The rapidity of the death has raised doubts whether this is a normal method of killing, particularly since injection of the organisms into the fish gave a slower death. These doubts appear to be dispelled by the observation that six health fish placed in circulating water containing a dead fingerling killed previously by C. columnaris were all dead within six to eight hours.

Fallout Contamination

Fission products occurred in rabbits from the Hanford Reservation in the following amounts:

<u>Sample Type</u>	<u>µc/g wet materials</u>	<u>Trend Factor</u>
	<u>Average</u>	
Feces	6 x 10 ⁻⁵	- 3
Bone	4 x 10 ⁻⁵	-
Liver	7 x 10 ⁻⁶	-
Muscle	5 x 10 ⁻⁶	-

Effect of Reactor Effluent on Aquatic Organisms

Routine monitoring of effluent from the 100-KE reactor was terminated at the time the reactor was shut down for an extended period. No additional mortality of consequence was experienced in any of the concentrations during the month. However, an effluent concentration of 2-1/2 per cent had previously caused a slight increase in mortality.

Population Dynamics

The annual survey of nesting Canada geese was initiated. The first hatched goslings were observed during the last week of April. Aerial counts indicate a slight reduction in the population as compared to previous years.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Strontium

Tests to demonstrate the effects of Sr⁹⁰-Y⁹⁰ radiation on rainbow trout were terminated. Although some samples are still undergoing aging to attain secular equilibrium, it appears that the new technique of drawing serial blood samples will demonstrate uptake rates and hematological changes during the course of the experiments.

A new group of six miniature pigs was started on a daily regimen of 25 µc of Sr⁹⁰. These animals are now being bred and will be sacrificed at 50, 70, and 90 days gestation in order to determine fetal uptake of Sr⁹⁰ and to define pathologic effects, if present.

X-ray plates (5 per animal) were made on all non-pregnant animals on the main chronic feeding study. (The total x-irradiation dose per animal was less than 0.5 r). These plates will be used as a basis for comparing changes that may occur in the skeletal system during the course of the study. Animals up to two years of age were X-rayed, and in none of them was epiphyseal closure evident.

The first phase of a study to determine the effect of 2x normal dietary calcium on Sr⁹⁰-Ca⁴⁵ uptake and retention in ewes and their suckling lambs was initiated.

An experiment to study the retention and excretion of Sr⁹⁰ and Ca⁴⁵ in young growing rats as influenced by the calcium level of the diet was initiated during the month.

Ephrata soil was surface contaminated with Sr^{85} and subsequently surface treated with solutions of K_3PO_4 in amounts equivalent to 100 and 5000 pounds phosphorus per acre. Variability was quite large, but there seemed to be a distinct depression of Sr^{85} uptake with increasing concentrations of phosphorus up to amounts which were toxic. The experiment will be repeated using Sr^{90} so that recropping will be possible.

Iodine

One ewe fed $1.5 \mu c$ of I^{131} for the past four and one-half years after being born to and weaned from a dam on the same regimen was sacrificed. One thyroid lobe was nodular in appearance, suggestive of a thyroid tumor. No thyroid tumors have been observed in this lower feeding level up to this time. The accumulated thyroid dose is estimated to be between 5,000 and 10,000 rads.

Three sows in various stages of gestation were given tracer doses of I^{131} at 48 and 24 hours before sacrifice in order to determine relative thyroid depositions of I^{131} . The following results were observed:

Days gestation	I^{131}/g thyroid	
	Dam	Fetus
58	1.9	1.2
86	1.7	1.6
114	0.5	1.5

Cesium

Leaching studies with Cinebar and Ephrata soils show little movement of Cs^{137} when distilled water is used as the leaching agent. Use of 0.1 N KCl caused movement of the Cs^{137} in both soils. The movement was much greater in the Cinebar soil with 53 per cent of the Cs^{137} appearing in the effluent after approximately 4 liters of KCl solution had passed through the column. Similar treatment of the Ephrata soil showed no Cs^{137} in the effluent. Since the Cinebar soil has a much greater exchange capacity, this result is surprising and, at present, no satisfactory explanation has been thought of.

Plutonium

An experiment was completed in which rats were sacrificed from 1 hour to 20 days following combined treatment with $6 \mu c$ plutonium and 500 r X-irradiation. Hematological and histological data are not yet available. Data on tissue distribution of plutonium indicates that this was not affected by the X-radiation. In another experiment, rats are receiving 100 r X-irradiation at weekly intervals following injection of approximately $1 \mu c$ plutonium. Eight weekly doses of X-irradiation have now been delivered, without marked evidence of effects different from controls receiving the X-ray treatment or plutonium alone.

Radioactive Particles

Twelve dogs were exposed to $\text{Pu}^{239}\text{O}_2$ aerosol and autopsied for study of deposition and distribution as a function of concentration and particle size. Five other dogs, following $\text{Pu}^{239}\text{O}_2$ exposure, were treated with NaCl aerosol to observe the effect on lung clearance of Pu^{239} . Although, in earlier studies with mice, the technique showed promise as a therapy regimen for lung-deposited radioactive particles, the results in these studies were less positive.

Gastrointestinal Radiation Injury

The nucleolytic enzyme DNase I is produced principally in the pancreas and secreted into the intestine for digestive purposes. After total body radiation the concentration of this enzyme in the blood plasma is increased and it has been suggested that this enzyme may be involved in the sensitivity of DNA to radiation. In preliminary experiments we have found that irradiation of the exteriorized intestine does not result in increased plasma DNase I. The effect of total body radiation in increasing plasma levels of DNase I is therefore not a simple matter of increasing absorption of the enzyme from the intestinal tract. Removal of pancreas prior to total body irradiation did not prevent the increase in plasma DNase I indicating that the pancreas is not the source of this radiation induced increase. None of these results seem to support the suggested relationship between DNase I and the early decrease in DNA seen following irradiation of the intestinal tract.

Gonad Dose Studies

Initial investigations will be in vitro studies, exposing various types of monitoring devices in solutions of Zn^{65} and Cs^{137} for calibration purposes prior to surgical fixation in rams. Instruments to be utilized initially are Sievert type ionization chambers and film packs. Other instruments undergoing investigation are miniature G-M tubes, scintillation detectors with light pipes, and glass dosimeters.


Manager
BIOLOGY OPERATION

HA Kornberg:es

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C. OFF-SITE VISITS AND HAPO VISITORS

Name	Dates of Visits		Company or Organization Represented/Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas & Bldgs.
VISITS TO HANFORD WORKS							
Dr. Jee	3/31		Univ. of Utah, Salt Lake	Seminar	HA Kornberg	No	100-F, Biology
Dr. White	4/14		WSC, Pullman	Seminar	HA Kornberg	No	" "
Dr. Woodbury	4/22		Univ. of Utah, Salt Lake	Tour	RC Pendleton	No	" "
AEC secretaries and new hires	4/16		AEC, Richland	Tour	VG Horstman	No	" , 141-M
A.T. Neale	4/22		Public Health, Olympia	Tour	HA Kornberg	No	100-F, Biology
E. Ordal	4/22		U of Wash., Seattle	Discuss research	FP Hungate	No	" "
Fathers Sweeney, Heneghan, Bishop Dougherty	4/22		Richland and Yakima	Tour	VG Horstman	No	100-F, 141-M
Dr. Daubenmire	4/21-22		WSC, Pullman, Wash.	Soil sampling	RC Pendleton	No	100-F
VISITS TO OTHER INSTALLATIONS							
RF Palmer	4/2-3		Medical Journal Club, Portland, Ore.	Present paper	Van Bruggen	No	-
RT O'Brien	4/2-3		U of Wash., Seattle	Attend meeting of anatomists and discuss research	Bennett, Luft	No	-
LA George, EJ Coleman, R Borasky							
JF Cline and VG Horstman	4/2-4		U. of Okla., Stillwater	Attend conference	Tillman	No	-
RF Foster	4/6-10		5th Nuclear Engineering Congress, Cleveland, Ohio	Present paper	-	No	-
WJ Clarke	4/7		State College of Washington, Pullman, Wash.	consult on research	Markowitz, Spencer, Klavano	No	-
VG Horstman	4/13		WSC, Pullman	Lecture,	Dr. Galgan	No	-
RH Schiffman	4/13		Argonne National Lab, Lemont	Tour	Dr. Brues	No	-
	4/14		Gull Lake, Michigan	Discuss research	Midwest Benthological Society	No	-
	4/20-24		Cincinnati, Ohio, USPHS	Attend seminar	-	No	-
	4/20-24		" "	Present paper	-	No	-
RF Foster	4/15		Greeley, Colo.	Present paper	Colorado State Coll.	No	-
FP Hungate	4/16		Naches High School	Present paper	-	No	-
JF Cline	4/15		Atlantic City, N.J.	Fed. Mtgs., present paper	Dr. Brodie	No	-
MF Sullivan	4/15		Bethesda, Md.	Discuss research.	-	No	-
WJ Clarke	4/30		WSC, Pullman	Address Toxicology class	Dr. Klavano	No	-

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D. Lectures

a. Papers presented at Meetings

- M. F. Sullivan, 4/15/59, "Effects of X-Irradiation on DNA and DNASE Metabolism of the Gastrointestinal Tract," Federated Societies for Experimental Biologists Meeting, Atlantic City, N.J.
- R. F. Foster, 4/8/59, "The Need for Biological Monitoring of Radioactive Waste Streams," Fifth Nuclear Engineering Congress, Cleveland, Ohio.

b. Off-Site Seminars

- R. F. Palmer, 4/2/59, "Strontium-Calcium Interrelationships in the Mature and Growing Rat," Medical Journal Club, Portland, Oregon.
- V. G. Horstman, 4/6/59, "Radiobiology at Hanford," FFA, Benton City.
- V. G. Horstman, 4/13/59, "Pitman-Moore Swine in Research," Animal Husbandry graduate class, WSC, Pullman, Washington.
- F. P. Hungate, 4/15/59, "Radiation and Isotopes in Biology and Agriculture," Lecture Series at Colorado State College, Greeley, Colorado (MEND Program).
- D. E. Warner, 4/16/59, "Radiation Biology at Hanford," Kiwanis Club, Dayton, Washington.
- J. F. Cline, 4/16/59, "Uses of Radioisotopes in Agriculture," Naches High School, Naches, Washington.
- R.F. Foster, 4/22/59, "The Significance of the Uptake of Radioisotopes by Fresh Water Fishes," Second Seminar on Biological Problems in Water Pollution, U.S. Public Health Service, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.
- W. J. Clarke, 4/30/59, "Radiotoxicology", Toxicology graduate class, WSC, Pullman, Washington.

c. Biology Seminars

- R. F. Palmer, 4/8/59, "Strontium-Calcium Interrelationships in the Mature and Growing Rat".
- W. J. Clarke, 4/8/59, "Bone Marrow Transplantation as a Therapeutic Agent Following Total Body Irradiation".
- A. I. White, 4/14/59, "The Importance of Structural Conformation in Biologically Active Compounds," (from Washington State College, Pullman.)
- L. K. Bustad, 4/22/59, "Ionic Movement Across Plasma Membrane as Detected by Radioactive Isotopes".

E. Publications

a. HW Publications (internal distribution)

- Foster, R. F. and P. A. Olson, "Water Temperatures for the Columbia River Above the Hanford Reactors, Sept. 1946 through December 1958", HW-60028 (UNCLASSIFIED) (April 15, 1959).

b. Open Literature

None.

OPERATIONS RESEARCH AND SYNTHESIS OPERATION
MONTHLY REPORT

April, 1959

ORGANIZATION AND PERSONNEL

Fred W. Plotke reported for work as a Junior Scientist on April 13.

OPERATIONS RESEARCH ACTIVITIES

Input-Output Simulation Model

Work was continued on the preparation of a general computing program for models of this type, and on the formulation of a highly aggregate model of HAPO operations. Work was also started on a paper describing the use of multivariate techniques in the investigation of causal and interdependent relationships for presentation at a General Electric symposium on model building to be held June 8-9 in Philadelphia, Pennsylvania.

Difficulty in obtaining data is causing delay in testing the specified models in connection with an operational problem in the Redox plant.

OPERATIONS ANALYSIS STUDIES

Z Plant Information Study

Negotiations with IBM representatives concerning the use of certain IBM equipment in connection with the test program were completed, and the study team is now provided with full information as to the capacity and limitations of the equipment to be used. The entire program and its relationship to normal operations are to be presented to the functional managers concerned at a meeting on May 6, 1959.

FPD Process Control and Experimentation

A report was issued in connection with an experiment conducted to determine the effects on fuel element dimensions of vacuum annealing. The effects of anneal temperature and time were also investigated, but these effects could not be clearly separated, since difficulties associated with running the experiment led to the confounding of certain important effects.

As anticipated in last month's report, a recommended pre-heat and submerge cycle combination was used in a four-day experiment conducted on two of the production canning lines to compare this cycle with the current cycle. Yield data consisted of reject rates for different kinds of rejects, total bond count data, and residual can wall and tube wall thicknesses. The independent variables were cycles, lines, crews, and days. Certain effects were again confounded with one another, largely due to the crew assignments, and in addition the cycle time was adjusted in the course of the experiment which

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complicated the analysis of the results. Further data from runs at the pilot plant are currently being analyzed.

A program for investigating the causes of excessive porosity in the tube walls has been outlined by Process Engineering personnel. One area of investigation centers about duplex bath variables. In a preliminary investigation of these variables, three are being considered, each at 4 levels. A 1/4 replicate of the 4³ experiment was designed in which one of the interaction effects was also confounded with the differences between the two days needed to run the experiment.

Further development work on the optical comparator method for non-destructively measuring can wall and spire wall thicknesses has resulted in a measurement technique of acceptable accuracy and precision for use in the Quality Certification Program. Recently collected data were analyzed to obtain regression lines showing residual can wall and tube wall thicknesses (determined by caustic penetration) as a function of comparator measurements.

Fuel Element Failures

A report on the analysis of rupture index data will be issued during May. Current efforts have been devoted to investigating the dependence of the rupture index on the corrosion index for the tube.

1958 rupture data for solid fuel elements were combined with 1957 data in order to firm up the rupture rate curve in current use. The agreement between the two sets of data was quite good.

Variable discharge plans incorporate metal quality as one of the pertinent variables which determine optimum discharge exposures for a given tube power. Over a given period of time, rupture experience may indicate that metal quality has shifted, resulting in a change in the variable discharge plan. However, it is recognized that some apparent changes in metal quality are only due to random variation rather than a real change. An investigation was made of the general problem of deciding when to call an observed change real, i.e., when to conclude that rupture experience is indicative of a real change in quality. A report was issued on this to interested personnel in which data requirements for determining a firm set of decision rules were outlined.

Production Tests

A report was issued in connection with the production test concerned with the evaluation of low hydrogen dingot I and E fuel elements.

Further data were submitted in connection with the determination of the warp and hot-spot angles associated with a given fuel element. A special set of fuel elements were measured in which chisel marks were used as reference points. This eliminated the uncertainties associated with the determination of the rib marks used as reference points in practice. Based on this analysis, further production test data were requested, restricting attention to the central portions of the tubes where they are more meaningful due to more clearly defined rib marks.

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Assistance was given in connection with the design of a production test which will be run to evaluate nickel plated fuel elements.

Reactor Calculations

Work is continuing in this area, and several discussions have been held with personnel familiar with the general problem. Certain sources of error have been mentioned which will be included in the study.

Process Tube Leaks

A request has been received to supply statistical services in connection with a program designed to investigate all phases of the tube leak problem. Initial efforts are being directed toward a better understanding of the variables related to the tube leaks caused by external corrosion at F reactor. Proboclog data for tubes probocloged during the first part of 1959 have been analyzed. A request has been made for similar data collected during 1958.

CPD Control

The examination of available data to determine the reliability of plutonium material control in the dissolvers of the Product Recovery Operation was continued. The significant underaccounting previously noted was largely corrected during the period October-December, 1958, the major improvement being due to the establishment of neutron counting for receipt measurements. This combined with neutron counter monitors on the dissolved material receiving tanks, has permitted a considerable increase in batch size. The problem of determining recovery of different material types, however, has become even more complex. An attempt is being made to locate the source(s) of the excessive variability in recovery from batch to batch.

The tolerance statement required to demonstrate conformity to specifications of the final product was calculated for parts shipped during the first quarter of calendar year 1959. In addition, variance components essential for control purposes were estimated from the data.

Radiation Protection Precision and Accuracy Study

Statistical analysis was performed on data from an experiment designed to determine the iso-tropic nature of the radium gamma source that is used to calibrate gamma dosimetry film. A report is being prepared which describes the analysis in detail and estimates the effect of the non-iso-tropic nature of the source on existing calibration techniques. An interim report describing previous activity with respect to the over-all goals of the study is in the final stages of preparation.

Several regression analyses were made on neutron film badge data in order to obtain a formula for estimating neutron and gamma dosage as a function of film density.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program - X-ray Diffraction

Work continued on the problem of analyzing X-ray diffraction patterns for annealed zircaloy-2 samples. A non-parametric technique assuming only a symmetric peak is being used to resolve multi-peak diffraction patterns into

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their component parts, particularly to estimate peak height and integrated breadth. To date no usable technique has been developed for the resolution of asymmetric peaks.

2000 Program - Separations Development

A discussion was held concerning a study of a pulse solvent extraction column from which a mathematical model might be derived which would describe the operation of the column. Statistical consultation is needed in laying out the design of the development program so that the effect on column operation of all independent variables can be ascertained with a minimum number of experimental runs.

4000 Program - Swelling Studies

Empirical distributions, based on metallographic data, of the relative position of inert gas bubble centers with respect to the interface of a cross-sectioned irradiated uranium cylinder are not in agreement with the assumption of a uniform distribution of centers and spherical bubbles. A more complex mathematical model allowing for distortion of spherical bubbles to ellipsoidal shapes of varying eccentricities is now under consideration with the hope of obtaining a tool for correcting distortions due to sample preparation prior to statistical analysis of bubble radii distributions and void fractions.

4000 Program - Waste Disposal

Work continued on a problem associated with the ground disposal of radioactive reactor effluents, with attempts being made to find an adequate mathematical form for the breakthrough ratio prediction curve for a laboratory soil column.

4000 Program - Reactor Graphite Studies

An experimental design was developed for a proposed experiment to investigate the reactivity of graphite as a function of five independent variables: temperature, water flow rate, exposure, gamma field, and surface to volume ratio. Experimental irradiations will take place in the Kaiser gas cooled reactor.

6000 Program - Biology and Medicine

Work continued on the construction of a model to explain phenomena associated with passage of element pairs through food chains. Current efforts include the derivation of a system of differential equations to describe in mathematical terms the uptake and retention of radioactive isotopes within various compartments of the biosystem and the discrimination which the system exhibits in favor of one element.

6000 Program - Atmospheric Diffusion Studies

Work continued on a formal report jointly authored with Atmospheric Physics Operation discussing the derivation and utilization of statistical techniques for analyzing data from the pending Air Force - AEC diffusion and deposition study. It is quite probable that the method of estimating air pollution as dependent on distance from the source; techniques were considered for

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estimating this dependence with preliminary experimental runs prior to the initiation of the diffusion study.

General

Further discussions were held concerning the estimation of the precision of radiochemical analyses based on low level counting statistics with appreciable background. A method has been developed and examples are being checked of quantitative resolution of several isotopes with a multichannel analyzer. Work continued on the problem of estimating multichannel analyzer zero shift and proportional drift from a standard energy spectrum scan.

A mathematical model was devised to attempt to explain the time and spatial oxidation of gamma-irradiated polyethylene slabs. Theoretical predictions based on the model are now being checked for agreement with experimental data.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Fuels Preparation Department

A discussion was held with personnel from FPD relative to the interpretation of minor injury statistics. It was suggested that the injuries be categorized roughly with respect to general causes (inattention, lack of proper equipment, lack of safety instruction, etc.) and control charts be maintained to indicate when the observed injury record is inconsistent with past behavior. Data since January, 1957, have been collected and forwarded for analysis.

Further tests were run in the test reactor in an attempt to better define the relationship between enrichment and reactivity. Results of these latest tests indicate that an unexplainable non-linear relationship exists.

Further theoretical work was carried out in connection with the program of the study of Lamb wave propagation in composite solids.

Irradiation Processing Department

Assistance was provided in assessing the reliability of several types of warning systems.

Chemical Processing Department

A report was prepared in connection with the corrosion of stainless steel as measured by Huey Test results. This report was a status report summarizing results found thus far and indicating what types of answers would be obtained by further processing the wealth of existing data with the aid of IBM machines.

An analysis is currently being made to determine whether the neutron emission rate of a particular material is related to either the weight or the volume of the batch in question.

A nomograph is being prepared for use in simplifying calculations associated with spare parts inventories.

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Work was begun on the theoretical design of a series of cams which are to be used to guide the controlling mechanism of certain machine tools. These tools are required to machine pre-determined shapes to a high degree of accuracy.

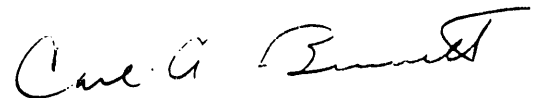
Construction Engineering & Utilities Operation

Work continued on a systems reliability study of the K reactors. Reliability in this case is defined in probability terms and appropriate expressions for computing the probability are currently being developed.

Assistance is being provided in developing a method which will facilitate the estimation of the variability associated with fair cost estimates.

Contract and Accounting Operation

The final draft was prepared of a paper, "Some Statistical Aspects of E-PID's and Ending Inventories," for presentation at the 1959 AEC Contractors SS Materials Management Meeting to be held in Germantown, Maryland, May 25-28, 1959.



Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

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VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HM Personnel Contacted	Access to Restricted Data
Don F. Musser	4-8-59	Nuclear Mat'l Mgmt. AEC - Washington, DC	Discussion of CPD Control Study	CA Bennett CG Hough	Yes
Milton E. Jenkins	4-22-59	AEC-Div. of Intell. Washington, D. C.	Consultation	CA Bennett	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. L. Jaech	4-2 to	Portland Section ASQC	Present paper	-	No
W. F. Stevenson	4-4-59	Portland, Oregon	"	"	"

PROGRAMMING OPERATION
APRIL 1959

A. FISSIONABLE MATERIALS - 2000 PROGRAM

A study was completed for the Chemical Processing Department covering the estimation of the costs of losses which may result from the blending of decontaminated uranium of different enrichments recovered in the processing of the various NPF, NPR, and E metal fuels. The report provides graphs and details of the simple calculations which can be used routinely by plant supervision to estimate the costs of degradation resulting from blending. The high value of enriched material justifies careful consideration of such losses so that economic decisions can be made for blending or for segregation of certain batches or classes of recovered materials.

B. REACTOR DEVELOPMENT - 4000 PROGRAM

1. Plutonium Recycle Program

Plutonium Requirements

With the completion of the study which established the needs for plutonium for operation of the Plutonium Recycle Test Reactor, attention was directed toward the integration of these requirements with the amounts of plutonium necessary for the conduct of related laboratory programs such as PCTR and Critical Mass Laboratory tests. Agreement was reached on the needs of each of the laboratory components involved. These needs were included in the over-all needs of the Plutonium Recycle Program.

Cycle Analysis

The Meleager cycle analysis code was modified during the month to decrease machine running time. Additional optional modifications to still further reduce running time for survey purposes are now being incorporated.

Organization of input lists for the RBU code was revised to facilitate data handling procedures. The debugging of the Monte Carlo and Diffusion portions of the code by the Advanced Technology Laboratories personnel (formerly called American Standard Atomic Energy Division) on the HAP0 IBM-709 computer progressed well during the month, and these sections of the code may now be considered essentially completed.

An attempt is under way to evaluate meaningfully the use of various iron base alloys in place of aluminum and zirconium jacketing materials in thermal reactors. Cost analysis type measurements do not show large incentives one way or the other, if enriched uranium at present pricing is available. Less specific analysis relating the various reactor

parameter values to achieve a given fuel exposure as a function of fuel jacket neutron absorption cross section indicates that iron base alloys can be applied to a wide range of reactor types if enrichment beyond natural is economically available. The real value of iron base alloys may well be that these alloys appear to be a reasonably satisfactory alternative to zirconium for all but natural uranium reactors, but can even be utilized in these, if the neutron economy is favorable, as in the HAP0 types.

C. 6000 PROGRAM

Radiological Consultation

Comments were made on papers and documents including the Report of the General Electric Task Force on Workmen's Compensation, proposed legislation formulated by the Atomic Energy Commission to permit states participation in control of atomic energy, and a Summary of the Waste Disposal Hearings prepared by the Joint Committee. Comments were also prepared on the proposed gas loop for the PRTR, drafts of papers by individuals in Biology and Radiation Protection, and a write-up on a Statistical Evaluation of Meteorological Data by Operations Research.

Recommendations were made for a survey of the ocean in the vicinity of Astoria. Comments on a proposed emergency standard for maximum permissible body burdens of Strontium-90 were given to the Radiation Protection Operation.

A draft of the preliminary report for Subcommittee 1 of the American Standards Association Sectional Committee N-6 "Reactor Safety Standards" was reviewed with comments returned to the Chairman. This report deals with the detailed calculations required in evaluating a site for reactor placement. A report of the Small Boiling Water Reactors Subcouncil was prepared and forwarded to the members for review.

A qualitative lung model for use in calculating the fate of radioactive materials in the respiratory tract was prepared and forwarded to the Chairman of the Subcommittee on Inhalation Hazards of the National Academy of Sciences Committee on Pathological Effects of Atomic Radiation.

The previous draft of the report of the NCRP Handbook on Safe Handling of Radioisotopes was further revised during the month.

Information on the Biology and Medicine development programs were forwarded to Radiation Protection Operation for incorporation in a letter to Washington describing the programs at Hanford.

The Division of Biology and Medicine has selected Hanford for the next meeting to be held on June 8 and 9. Preliminary efforts in planning the program and facilities to be used were started.

D. OTHER ACTIVITIES

Comments relating to the Hanford Laboratories portion of the HAPO Five Year Program Report were solicited, received, and incorporated into the final draft (HW-59633).

Information on HAPO research and development facilities was prepared for preparation at the quarterly GE-HOO, AEC Technical Review.

Potential candidates for instructors at the University of Washington Graduate Center were proposed. Specific courses for which instructors were obtained include: Solid State Chemistry series, Nuclear Chemistry and Radiochemistry, Analytical Methods series, and Nuclear Engineering series.

A breakdown of plutonium recycle budget information was prepared using a format requested by the Commission. This was transmitted to the Commission through appropriate channels.

Arrangements were made for exchanges of technical speakers with Washington State University and the University of Washington. Professor Harold Dodgen and Professor E. R. Tinney will visit Hanford and B. Mastel and J. DePangher will visit Washington State University. Professor J. I. Mueller from the University of Washington visited HLO. A group of speakers to address a high school science teacher's institute at Gonzaga was arranged for July.


Manager, Programming

LH McEwen:CAR:d1

VISITS TO HANFORD:

Name	Dates of Visit	Company or Organization Represented and Address	Reason for Visit	HAPO Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
Mark Temme James R. Burr	4/13 - 4/27	Advanced Technology Laboratories Mountain View, Calif.	Work on the RBU computer code.	J.R. Triplett	No	700 - 713
C. C. Gerhards	4/3	GE - ANP Idaho Falls, Idaho	Discuss remote manipulating equipment.	C.A. Rohrman	No	300 - 327, 328
J.A. Ranschoff (ACCESS PERMIT)	4/30	(Self-Employed Consultant) Washington, D.C.	Discuss fuel cycles. Discuss shipping cask design.	J.R. Triplett E.A. Eschbach C.A. Rohrman J.G. Bradley	No No	300 - 328

VISITS TO OTHER INSTALLATIONS:

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
L. H. McEwen	4/6-7	GE - Schenectady, N.Y.	Attended meeting of special Dresden Task Force.	P.H. Reinker	No
	4/8-9-10	Nuclear Congress Cleveland, Ohio	Attended Nuclear Congress meetings.	----	No
C. A. Rohrman	4/14	University of Colorado Boulder, Colo.	Campus recruiting.	----	No
J. W. Healy	4-7-9	Nuclear Congress Cleveland, Ohio	Attended Hot Lab. Conference.	----	No
		7E Reactor Safeguards Council	Attended Small Boiling Water Reactors Subcouncil and Risk Subcouncil	I.N. MacKay K. Cohen M. Leverett	No
J. W. Healy	4/21	Washington State University Pullman, Washington	Discussed MPL's with Radiological Class of the Sanitary Eng. Dept.	G. Dunstan	No

RADIATION PROTECTION OPERATION
MONTHLY REPORT - APRIL 1959

A. ORGANIZATION AND PERSONNEL

Helen K. Speer transferred into Radiation Protection Operation from Relations Operation on April 6, 1959. Robert K. Jones of the Bioassay Operation died in an auto accident on April 26, 1959. The force of the Radiation Protection Operation remained at a total of 132.

B. ACTIVITIES

One case of minor plutonium deposition was confirmed in April. The total number of deposition cases which have occurred at Hanford is 229. There are 162 employees currently employed who have a measurable deposition of plutonium. More extensive bioassay analyses of employees involved in the explosion in Plutonium Metallurgy facilities in the 234-5 Building on March 31 continued to indicate that plutonium deposition in the employee who was injured is only a small percentage of the maximum permissible limit. Substantial progress was made in decontaminating rooms and corridors adjoining Room 179-B where the explosion occurred.

Two cases of exposure to the skin in excess of permissible limits occurred. These involved an employee being sprayed with contaminated water in the discharge area at 100-D Reactor and an employee receiving coverall contamination in the 327 Building. The maximum dose to a small portion of the skin was 16.5 rads including 0.5 r.

The supplemental crews in IPD discontinued their use of multiple badges in the 100 Areas. This improvement removed a total of 512 badges from service.

Increased visual inspection of hood gloves in the Plutonium Metallurgy Operation, 231 Building, resulted in a sharp decrease in the number of hood glove ruptures in April--four as compared to 25 in March.

Initial experience with 2000 to 3000 watt minute irradiations of core loadings of UO₂ seven rod clusters in the PCTR revealed dose rates of 1.9 r/hr between the reactor faces upon entry two and one-half hours after the irradiation.

Work on the reduced electrodeposition area procedure was continued in the Bioassay laboratory. Some difficulty was encountered in maintaining acceptably low backgrounds. Comparative samples using the large area plating and the new reduced area plating are being analyzed to determine if the excessive background is due to the chemicals being used.

Preliminary routine use of the Shielded Personnel Monitoring Station was initiated in April. Measurements on a group of about 50 HAPO employees were started. The objective of this preliminary set of measurements is to establish useful criteria in establishing backgrounds of different groups of people at Hanford.

At the request of the AEC-HOO, a comprehensive study was started to determine the feasibility of a State Highway Department proposal to construct a public highway up the Cold Creek Valley from Horn Rapids to the Yakima Barricade. Analysis of the possibility of releasing certain lands south and west of this proposed public highway is also to be included in this study.

A spontaneous fire occurred on April 29 in a section of a process tube at the 100-KW reactor during the removal of the tube which was suspected to contain a damaged fuel element. Analysis of stack filter samples indicated that about 1.3 curies of combustion debris were released to the atmosphere. For the 10-second period, during which the damaged tube and fuel element were suspended in the air on the rear face of the reactor, the dose rate in the lunchroom and the adjacent corridor floor ranged from 5 to 50 mr/hr. No ground contamination was detected in the immediate vicinity of the 105-KW stack area.

A Bar-Ray Hills Automatic Film Processing System was ordered at an acquisition cost of \$25,380. Shipment was scheduled for June 30. This system is designed to perform automatically the chemical processing of personnel meter badge film while maintaining precise control of solution temperatures and composition. Fabrication of mechanical components for an automatic densitometer to be used for reading badge film was initiated.

Assistance was furnished to the Biology Operation in measurement of gonad dose to animals from irradiation by internally deposited isotopes. It was planned to use the Sievert chambers for implantation and small size stray radiation chambers for lower level doses to the male gonads.

Prototype devices capable of measuring radiation dose received by human eyes and still permitting unhampered vision and body motion were designed. An invention description, "A Dosimeter for Measuring Radiation Doses to the Human Eye," was filed.

Special analyses of nitrogen in Columbia River water at Hanford and Pasco were obtained for the Columbia River Advisory Group. Analysis showed about 0.015 ppm free NH_3 , 0.056 ppm organically-bound NH_3 , 0.015 ppm NO_2 and 0.38 ppm NO_3 . The nitrate ion concentration is about six times that observed in earlier analyses made in 1955. Additional analyses of nitrate ion were scheduled for the next six months to confirm the higher-than-previous concentration.

In response to requests from AEC-HOO, considerable assistance was furnished on a priority basis on details of Hanford's over-all radiation protection effort and expenditures. These requests stemmed from the joint study being conducted by the Secretary of Health, Education, and Welfare; the Chairman of the AEC; and the Director of the Bureau of the Budget.

The Technical Defense Section participated in the over-all Hanford District Civil Defense participation in Operation Alert 1959 on April 17-18. The test consisted of state-directed operations involving nine near simultaneous nuclear hits in the State of Washington--none of which would have had serious effect on Hanford operations.

C. EMPLOYEE RELATIONS

There were three medical treatment injuries for a frequency of 1.34. No security violations occurred during the month.

One suggestion was received for evaluation. Two suggestion evaluations were completed and none were adopted. One suggestion is pending in RPO for evaluation. No awards were made.

A lecture and demonstration, "Radiation and Radiation Protection" part of a series on "Introduction to Radiation" was presented to a meeting of Construction Building Trades Business Agents on April 30, 1959.

D. SIGNIFICANT REPORTS

HW-60225 "Monthly Report - April 1959, Radiation Monitoring Operation" by A. J. Stevens.

HW-60209 "Waste Disposal Monitoring Summary, April 1959" by K. F. Baldrige.

Con. Un. "Inventory of Radioactive Liquid Wastes to Active Disposal Sites - February 1959" by K. F. Baldrige.

Report of Invention - "A Dosimeter for Measuring Radiation Doses to the Human Eye" by Carl M. Unruh.

VISITS TO HANFORD WORKS

Name	Date of Visits	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Buildings
A. T. Neale	4/9-21/59	Washington State Pollution Control Commission, Olympia, Washington	To discuss evaluation of radioactivity in Columbia River	HV Clukey	No 3746:300
B. L. Schmalz	4/15/59	AEC Idaho Operations Health & Safety Dept. Idaho Falls, Idaho	Discuss aerial survey, waste program, vegetation monitoring, and stack monitoring	IC Nelson RC Dozer MM McConiga	No 329:300
R. A. Beall F. W. Wood	4/23/59	U.S. Bureau of Mines Albany, Oregon	Review thorium handling	HV Clukey	No 3746:300
J. L. Meuschke R. B. Guillou	4/29/59	U.S. Geological Survey, Washington, D.C.	Pending USGS aerial surveys in June	IC Nelson	No 703:700

VISITS TO OTHER INSTALLATIONS

A. R. Keene A. J. Stevens	4/3/59	Reed College Portland, Oregon	Attend AFSWP planning meeting	Dr. Oerlien and AFSWP training staff	No
A. J. Stevens	4/24/59	University of Washington, Seattle, Washington	Meet with AEC fellows	-	No

ENVIRONMENTAL MONITORING - RESULTS (March 23, 1959 - April 26, 1959)

<u>Sample Type and Location</u>	<u>Activity Type</u>	<u>Monthly Average</u>	<u>Units*</u>	<u>Trend** Factor</u>
<u>Drinking Water</u>				
100-F Area	Isotopic	1.1	% MPC _{GI}	--
Separations Areas	Total Beta	1.7×10^{-6}	μc/cc	--
Pasco	Isotopic	0.3	% MPC _{GI}	-2
Kennewick	Isotopic	0.2	% MPC _{GI}	--
Richland	Total Beta	$< 3.0 \times 10^{-8}$	μc/cc	--
<u>Columbia River Water</u>				
Above 100-B Area	Total Beta	2.5×10^{-8}	μc/cc	--
100-F Area	Isotopic	6.1	% MPC _{GI}	--
Hanford Ferry	Total Beta	7.2×10^{-5}	μc/cc	--
Pasco	Isotopic	1.2	% MPC _{GI}	--
McNary Dam	Total Beta	1.7×10^{-6}	μc/cc	--
Vancouver, Washington	Total Beta	4.6×10^{-7}	μc/cc	--
<u>Waste Water</u>				
Outlying Test Wells	Total Beta	3.7×10^{-6} (Max)	μc/cc	--
Reactor Effluent Retention Basins to River	Total Beta	30,000	curies/day	--
<u>Atmosphere</u>				
<u>Gross Dose Rate -</u>				
Project	Gamma	0.8	mrad/day	--
Environs	Gamma	0.6	mrad/day	--
I-131 Separations Areas	I-131	2.2×10^{-13}	μc/cc	--
I-131 Separations Stacks	I-131	7.3	curies/week	+2
Active Particles - Project	--	15	ptle/100 m ³	--
Active Particles - Environs	--	26	ptle/100 m ³	--
<u>Vegetation</u>				
Separations	I-131	$< 1.5 \times 10^{-6}$	μc/gm	--
Residential	I-131	$< 1.5 \times 10^{-6}$	μc/gm	--
Eastern Washington and Oregon	I-131	$< 1.5 \times 10^{-6}$	μc/gm	--
Fission Products less I-131 - Wash. and Ore.	Beta	1.0×10^{-4}	μc/gm	-5

* The % MPC_{GI} is the percent of the maximum permissible limit for continuous occupational exposure to the gastrointestinal tract calculated from drinking water limits.

** The trend factor shows the n-fold increase (+) or decrease (-) from last month, where values of n less than 2 will not be noted.

EXPOSURE EVALUATION AND RECORDSExposure Incidents Above Permissible Limits

	<u>Whole Body</u>	<u>Localized</u>
April	0	2
1959 to Date	4	5

Gamma Pencils

	<u>Pencils Processed</u>	<u>Paired Readings 100-280 mr</u>	<u>Paired Readings Over 280 mr</u>	<u>Lost Readings</u>
April	31,866	47	1	1
1959 to Date	128,572	197	8	4

Beta-Gamma Film Badges

	<u>Badges Processed</u>	<u>Readings 100-300 mrad</u>	<u>Readings 300-500 mrad</u>	<u>Readings Over 500 mrad</u>	<u>Lost Readings</u>	<u>Average Dose Per Film Packet</u>	
						<u>mrad(ow)</u>	<u>mr(s)</u>
April	11,816	794	56	14	23	6.84	15.46
1959 to Date	42,638	3,398	358	55	204	4.69	18.20

Neutron Film Badges

	<u>Film Processed</u>	<u>Readings 50-100 mrem</u>	<u>Readings 100-300 mrem</u>	<u>Readings Over 300 mrem</u>	<u>Lost Readings</u>
<u>Slow Neutron</u>					
April	1,317	1	0	0	7
1959 to Date	4,826	18	1	0	17
<u>Fast Neutron</u>					
April	80	2	2	0	5
1959 to Date	304	2	4	0	16

Bioassay

	<u>April</u>	<u>1959 to Date</u>
Plutonium: Samples Assayed	742	3,093
Results above 2.2×10^{-8} $\mu\text{c}/\text{sample}$	34	119
Fission Products: Samples Assayed	697	2,968
Results above 3.1×10^{-5} $\mu\text{c FP}/\text{sample}$	1	13
Uranium: Samples Assayed	281	1,158
Confirmed Plutonium Deposition Cases	1	5*

* This brings the total number of plutonium deposition cases which have occurred at Hanford to 229.

Uranium Analyses

<u>Sample Description</u>	<u>Following Exposure</u>			<u>Following Period of No Exposure</u>		
	<u>Units of 10^{-9} μc U/cc</u>			<u>Units of 10^{-9} μc U/cc</u>		
	<u>Maximum</u>	<u>Average</u>	<u>Number Samples</u>	<u>Maximum</u>	<u>Average</u>	<u>Number Samples</u>
Fuels Preparation	24	3.6	56	7.3	1.9	38
Hanford Laboratories	14	3.2	20	5.6	1.9	22
Chemical Processing	95	8.2	66	19	3.6	55
Chemical Processing*	29	11	11	6.3	3.0	5
Special Incidents	0	0	0	0	0	0
Random	1.5	0.9	5	0	0	0

*Samples taken prior to and after a specific job during work week.

Thyroid Checks

	<u>April</u>	<u>1959 to Date</u>
Checks Taken	0	0
Checks Above Detection Limit	0	0

Hand Checks

Checks Taken - Alpha	64,261	148,809
- Beta-Gamma	43,573	99,693

Skin Contamination

Plutonium	16	70
Fission Products	30	146
Uranium	14	49

CALIBRATIONS

<u>Portable Instruments</u>	<u>Number of Units Calibrated</u>	
	<u>April</u>	<u>1959 to Date</u>
TP Meter	1,061	3,850
Juno	315	1,194
GM	1,463	5,446
Other	204	818
Total	<u>3,043</u>	<u>11,308</u>
<u>Personnel Meters</u>		
Badge Film	935	3,699
Pencils	1,703	5,248
Other	520	1,778
Total	<u>3,158</u>	<u>10,725</u>
Miscellaneous Special Services	<u>121</u>	<u>1,154</u>
Total Number of Calibrations	<u>6,322</u>	<u>23,187</u>

AR Keene
 Manager
 Radiation Protection

AR Keene:kc

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LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - APRIL 1959

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 2.27, which is considered below average experience.

The absenteeism rate was 4.08 per cent, which is about average experience.

There were no security violations charged to the Operation.

TECHNICAL SHOPS OPERATION

Total time for the month was 23,636 hours. This includes 14,791 hours performed in the Technical Shops, 5,615 hours assigned to Minor Construction, 175 hours to other project shops, and 3,055 hours to off-site vendors. The total shop work backlog is 22,860 hours of which 50% is required in the current month, with the remainder distributed over a three month period. Overtime worked during the month was 6.4% (1155 hours) of the total available hours.

Distribution of time was as follows:

	<u>Man Hours</u>	<u>% of Total</u>
Fuels Preparation Department	2075	8.8
Irradiation Processing Department	2691	11.4
Chemical Processing Department	1092	4.6
Hanford Laboratories Operation	16987	71.9
Construction Engineering Operation	511	2.1
Miscellaneous	280	1.2

The number of requests from customers for emergency service remained at a high level, necessitating an overtime ratio of 6.4%. Other project shops were utilized to capacity in providing assistance to the Technical Shops. Off-site shops are also providing assistance via the purchase requisition procedure. In conjunction with the Purchasing Operation, procedures have been set up which permit the expeditious handling of this off-site work.

Five machinists and one welder were added to the Technical Shops roll during the month. Four machinists are in the process of obtaining security clearance and will be called in as soon as possible.

The Endothermic Gas Preparation Unit used in conjunction with the heat treating furnaces was received and installed. This unit permits the heat treating of high alloy steels by providing a neutral atmosphere in the furnace chamber.

Security performance was considered satisfactory with no violations. Safety performance was considered satisfactory with 8 medical treatment injuries and no major injuries. Absenteeism was considered normal for this period.

RADIOGRAPHIC TESTING OPERATION

More normal activity for Radiographic Testing Operation was recorded this month with termination of the PRTR containment vessel work. A total of 5,257 tests were made, of which 985 were radiographic (including X-ray and gamma ray) and 4,266 were supplementary tests. Out of a total of 1027 man hours, 551 (53.6%) were used in connection with radiographic tests and 476 (46.4%) were used on supplementary tests. The supplementary test work included dimensional measurements (micrometric and plug gage), eddy current, leak detection, penetrant, ultrasonic (flaw detection and thickness measurements), visual (borescope), and stress measurement (stress coat).

The number of pieces handled this month was about normal, totalling some 2,493 items. The feet of material represented by the foregoing remained at a substantial level, amounting to 18,673 feet. It is anticipated that this index will remain at this level for the duration of the tubular production test work. Work was done for 19 different organizational components, representing all of the operating departments and service organizations. A total of 36 reports were issued, detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 17 different occasions for advice and information regarding general testing theory for other than the jobs tabulated in Part II - Testing Statistics.

The construction schedule established for the White Bluffs tube testing facility is being fairly well maintained. It is still contemplated that pickling and autoclaving will be done the week of May 25th. Equipment relocation from the 200-East Area is essentially completed. Twenty PRTR process tubes have been received and are in place at White Bluffs. Immersed ultrasonic testing and penetrant testing of these tubes has been started. It is anticipated that all test work will be completed in time for pickling and autoclaving at the end of May.

Construction testing on the PRTR containment vessel has been completed. All repair welds have been tested and approved. Final leak testing around penetrations was also completed. It is understood that the pressure test of the vessel was successful, indicating satisfactory work.

Concurrent with the three-week shutdown of the KE reactor, Radiographic Testing Operation extended previous work done on stress evaluation. Primary concern continues to be the process water piping between the 190 Building and the 105 Building. It is desired to determine the location of the high stress points and the magnitude of such stress. To locate the high stress points, a "stress coat" system was employed, using brittle coat lacquers. Use of this system permitted large areas of the piping system to be covered and evaluated. In addition, electric wire resistance strain gages were used in a number of areas. Primary indications are that the stress levels are of very small magnitude.

<u>Component</u>	<u>No. of Tests</u>	<u>Ft. of Weld or Material</u>	<u>No. of Pieces</u>	<u>Description</u>
CPD	14	15	14	1/2" and 3/8" SS plate, Redox dissolver. 2" Sch. 80 SS pipe. 316 SS flanges, 10" sch. 10 SS pipe.
CEO	620	823	48	X-ray interpretation on PRTR containment vessel; halogen snifter test of PRTR containment vessel welds.
HLO	472	1388	302	Pig X-ray, sheated TC, high pressure autoclave, Zr-2 clad UO ₂ fuel rods, samples; Na K samples, SS piping, Pu Al billets, rods; co-extruded Pu Al extrusion die; Al welds.
	3495	15913	2046	.680" and .505" I.D. Zr.-2 tubes; Zr.-2 clad UO ₂ fuel rods; 3" O.D. x .270" wall Zr. tube.
IPD	630	508	81	10" sch. 10 SS pipe weld, 100K-190 water lines; 12" and 18" sch. 80 steel pipe; 2.4" O.D. Zr.-2, KER, ribless process tube.
R&UO	26	26	2	Hydraulic 20' boom.
TOTALS	5257	18673	2493	

FACILITIES ENGINEERING OPERATION

Projects

There were 20 authorized projects at month's end with total authorized funds of \$8,398,000. The total estimated cost of these projects is \$8,526,900.

The project for modification of 303-J Building for use as a fuel element test facility (IR-242) was completed during the month.

Four Project Proposals were submitted to HOO-AEC during the month. These are:

- | | | | |
|-------------|-----------------------------------|---|-----------|
| (1) CGH-840 | Sheet Metal Shop | - | \$ 36,500 |
| (2) CAH-848 | Geological and Hydrological Wells | - | 56,600 |
| (3) IR-246 | Additions to 3745-B Building | - | 19,000 |
| (4) IR-247 | Normal Electrical Service - 100-F | - | 12,500 |

Ten Project Proposals are being prepared. Four of these are for Radiometallurgy facilities and are essentially completed.

The attached project report details the status of individual projects.

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H-4

HW-60233

Engineering Service

Title

Status

Removable Grating - 3745-B Bldg.

Installation to start 5-15-59.

Clean Air Ducts - 326 Building

Bids to be received and work initiated during May.

Renovate Rm.30-C 326 Building

New equipment is being received for installation.

Improve Lighting - Rooms 11-1A & B - 325 Building

Fixtures on hand for installation.

Design and Install Fire Alarm System - 314 Building

Design work completed.

Air Balance - 108-F Building

Engineering work in progress.

Lighting Study, Bindery Room, 3760 Building

Work complete.

Gamma Irradiation Facility 3730 Building

Excavation complete. Tank and caisson in place.

Kitchenette Facility in 326 Bldg.

Work in progress.

Locker Room Modifications 321 Bldg.

Work complete.

Erection of Towers for Atmospheric Physics

Five each of 100 foot poles, 141 foot triangular and 204 foot rectangular towers have been erected. High winds have slowed progress. The base of one tower fell during erection and a construction workman was injured.

Study - Layout of Biology

A study and report is being prepared to show proposed facilities. Statistical information will compare costs, space, and occupancy.

Isolate crane conductors 314 Bldg.

Work in progress to isolate crane conductors. This will lessen hazardous condition in building.

Dog Isolation Facility 141-F3 Building

A concrete slab for a temporary building is being constructed. Trenches and sewer connection will be made.

326 Building Retention Waste Sump Modifications

Engineering work in progress.

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Design and Drafting ServiceTitleStatus

Creep Capsule

In-reactor creep measurement of zirconium. A capsule to monitor stress, elongation, and temperature while being irradiated. 20% complete.

Design and drafting work in progress includes the following:

Automation of feed mechanism of Kux Hydraulic Press - 325 Building.
 In-Reactor mechanism for rupture of irradiated fuel - 3x3 loop ETR.
 Redesign of portion of in-reactor loop - 3x3 loop ETR.
 Tools for handling discharged fuel elements - ETR.
 Modifications to 14 ton shipping cask.
 Modifications to vacuum welding box - 306 Building.
 Equipment for High Level Radiochemical Facility - 325-A Building.

- a. Manipulator dolly
- b. Underwater manipulator
- c. Underwater vacuum cleaner
- d. Transfer mechanism
- e. Mock-up wall
- f. Miscellaneous items, tongs, brush, plugs

Hand feed for swage - 325 Building basement.
 Fuel element X-ray photometer.
 Assembly jig for fuel rods.
 Test Set up design - fuel, fuel and fail holders, and graphite - 305-B Building.
 Transistorized circuits for counters.
 Fuel element leak detector.
 Scope drawing for thermal diffusion column.
 Traverse counter drive - 305 Building.

Also work is being performed for layout and details on projects CGH-834, Modifications and Additions to High Pressure Loop - 189-D Building, and Job 0084, Pickling and Autoclaving Facility for Zirconium Material.

Maintenance and Building Engineering - Landlord Functions

Costs - March - \$113,816
 February - 116,249

Fiscal year to date total expenditures are - \$908,802, which is 73% of budget. Our expenditure forecast is - \$936,600, which is 75.2% of budget.

Analysis for Month of March: Maintenance costs in all categories remained low. This is the result of maintenance backlogs, delays in releasing work, and a credit of \$1600 for costs assumed by a project. Steam costs did not decline as sharply as predicted and were \$5,000 above the forecast. Year to date steam costs are \$13,000 more than anticipated.

The lunch room relocation for 3760 Building is estimated 90% complete.

The proposed restroom and office addition to 3745 Building has been rescoped and is being considered for performance.

Steps are being taken to define the property lines around 747 Building, Bioassy Laboratory.

The AEC has approved our request for contingency maintenance to the 325 Building ventilating and exhaust fans. This work can provide the necessary air for the High Level Radiochemistry Facility and for the basement improvements of the heavy equipment laboratories, as well as for other required hood and cave additions.

Miscellaneous

Approximately 180 drawings including sketches, work sheets, and formal drawings were completed by the Drafting Component during the month.

Approximately 14,300 square feet of prints were reproduced during the month.

The total estimated cost of the 14 requisitions issued during the month plus associated bid reviews, EPF's, and alterations. Total estimated value of requisitions issued was \$2,500.

The next Third Party Inspection of HLO Pressure Vessels is scheduled for May.

TECHNICAL INFORMATION OPERATION

The following memoranda containing classification information were issued during the month:

- HW-59874 "Classification: Production Data" dated April 2, 1959.
- HW-59384 SUP1 "Classification: Depleted Uranium" dated April 7, 1959.
- Classification Information Bulletin: "Production Reactor Fuel Element Work" dated April 24, 1959.
- Classification Information Bulletin: "Water Mixer Fuel Element" dated April 24, 1959.

Seven pages of the Hanford Classification Guide were revised to incorporate new classification instructions and to change existing topics in the Guide.

As reported last month, a request was sent to HOO for review and declassification of development work on externally modified fuel elements for existing production reactors. As a result, Design, Development and Research Contract 54 between General Electric Company and AeroProjects, Inc., has been declassified. Contract DDR-54 is for the development of ultrasonic welding procedures for attaching supports to aluminum and Zircaloy-2 clad fuel materials.

Although the request to HOO was aimed at obtaining relief in the general area of externally modified fuel elements, the reply was limited to the work on projection fuel elements as covered by Contract DDR-54. This action did, however, declassify the concept of the projection fuel element. Subsequently, the water mixer fuel element design was declassified. Concurrent with the above actions HOO reaffirmed that present regulations require that research and development work carried out for production reactor fuel elements must be born classified.

Three more projects related to fuel element development were submitted for classification review during the month. They are:

- (1) Assistance to Hanford Project No. ATH-HLO-5-59 "Friction Welding of Fuel Rod Sections"
- (2) Design, Development and Research Contract DDR-57 "Welding Closure - Ends of Rods and Tubes" and
- (3) Nickel plating of standard canned I & E fuel elements by several firms who specialize in plating work.

The Atomic Energy Commission requested a crash review of all information created since 1947 relating to radioactive fallout and environmental contamination. A list of 87 pertinent Hanford originated documents was transmitted to the AEC through the Hanford Operations Office. This listing included 15 documents related to Washington designated sensitive programs. All but two of the Research and Development memos had previously been transmitted to the Technical Information Service Extension, Oak Ridge.

HAP0's justification for continuing to receive reports in category C-86, "Nuclear Rockets and Ramjet Engines" of M-3679 was submitted through the Hanford Operations Office to the AEC, Washington. After careful review of our "need to know," HOO submitted to Washington a supporting memorandum.

During the past three months several questions have been raised by TISE and HOO regarding the proper categorization of classified HAP0 Research and Development reports. The categorization of the Fuels Development Operation Quarterly (HW-58205) is currently being questioned. A letter was sent to HOO pointing out why we believe that the report does not disclose production information. HOO was not in agreement and the matter was discussed further at a meeting attended by representatives of HOO, Technical Information, Fuels Development Operation, and Nuclear Physics Research Operation. Additional information was supplied to the AEC for review and consideration.

A meeting was held with personnel from the Electronic Data Processing Operation, R&U, Operations Research and Synthesis, HLO, and Technical Information to explore the possibilities of utilizing machines for the storage and retrieval of information at Hanford. A limited project may be attempted, primarily to acquire know how in this rapidly growing field.

An IBM system for handling periodical ordering and receiving has been devised and the first steps taken in setting it up. Objective of the program is to simplify the record handling associated with this operation. All necessary renewal forms will be automatically printed by the machine as they become due; summary listings of all subscriptions can be prepared as needed; periodic reports to the Departments on the cost of assigned subscriptions can be made; and

the subscription information can be broken down into whatever categories are desired e.g. copies assigned to individuals, reference vs circulating copies; costs of assigned vs library copies, etc.

<u>Work Volume Statistics</u>	<u>March</u>	<u>April</u>
<u>Document Distribution and Files</u>		
Documents routed and discharged (copies)	15,913	16,970
Documents issued (copies)	9,197	13,435
Documents sent offsite (copies)	3,904	1,305
Document reserves filled (copies)	820	941
Documents picked up and delivered	23,015	18,684
<u>Document Accountability</u>		
Holders of classified documents whose files were inventoried	447	570
Documents inventoried in Files (copies)	9,220	6,347
Documents destroyed or retired (copies)	3,891	4,003
Documents revised (copies)	1,735	1,636
Documents pulled and documents filed (copies)	17,173	10,902
Documents reclassified	328	232
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents onsite	202,995	204,462
<u>Reference and Publication</u>		
Books cataloged (new titles)	191	96
Books added to the collection (volumes)	512	316
Ready reference questions answered by professional staff	186	142
Literature searches by professional staff	123	116
Reports abstracted (titles)	204	238
Formal reports prepared (titles)	5	15
Offsite requests for HAPO reports (copies)	217	312
Reports released to CAP (titles)	56	76
<u>Library Acquisitions and Circulation</u>		
Books ordered (volumes)	333	500
Periodicals ordered	225	81
Books circulated (volumes)	1,835	2,046
Periodicals circulated (issues)	3,225	2,911
Inter-Library loans	61	119
Films borrowed or rented	24	19
Industrial film showings	72	93
Bound periodicals added to the collection	29	202

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H-9

HW-60233

Library collection:

	<u>Main Library</u>	<u>W-10 Library</u>	<u>108-F Library</u>	<u>Ind. Med.</u>	<u>Totals</u>
No. of books	26,155	8,192	1,414	1,941	37,702
No. of bound periodicals	<u>11,790</u>	<u>1</u>	<u>1,431</u>	<u>96</u>	<u>13,318</u>
	37,945	8,193	2,845	2,037	51,020

Quantities Reviewed for Declassification

Documents, including drawings and photographs
reviewed for downgrading or declassification

March

April

93

106

Documents and papers (intended for oral
presentation or publication) reviewed
for appropriate classification

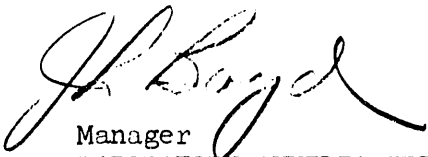
33

41

Documents submitted to Declassification
Board at Oak Ridge

9

12


Manager
LABORATORY AUXILIARIES

J. H. Boyd, gow

BUDGET CLASSIFICATION		MONTHLY PROJECT REPORT										NW - 60033	
Improvements to Production and Supporting Facilities 58.b-4		HANFORD LABORATORIES OPERATION										MONTH April, 1959	
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT			STARTING DATE		DIRECTIVE COMP. DATE		ESTIMATED DATE OF A CUREL COMP. DATE	
			AMOUNT	DATE	DESIGN SCHED.	CONST. SCHED.	ACTUAL	DESIGN	CONST.	DESIGN	CONST.	DESIGN	CONST.
CG 731	Critical Mass Laboratory	\$1,000,000	\$1,000,000	3-23-59	100	0	100	0	5-22-58	6-30-60	2-24-59	6-1-60	
REMARKS:		Physics & Instruments R & D The Company proposed submitting an addendum to the bid package; to include an alternate bid for a 40' x 80' concrete block control building in lieu of moving the metal army mess hall to the construction site. The Commission indicated a reluctance to include this an alternate; upon making a brief cost comparison of the two structures, the Company decided to forego the alternate. The Commission then requested the Company to submit a bid package alteration, substituting the concrete block structure for the metal building. The specifications and drawing for this change were transmitted to the AEC; as a result the bid opening will be extended to May 19, 1959.											
CA-744	Metallurgical Development Facility - 306 Building Addition	\$2,623,000	\$2,685,000	11-5-58	97	0	98	0	6-30-58	9-1-60	9-1-59	9-1-60	
REMARKS:		Reactor & Fuels R & D The contractor, Jensen-Rasmussen, started work April 9, 1959 on excavating for column line A footings. Pavers started the new roadway on the north side of the 306 Building. The electrical contractor is working on the 13.8 KV line poles and installing new street lighting circuit and 2400 Volt supply to 506-C Building. Equipment requisitions have been completed. Bid prices on 13 items of equipment totalled \$384,322 versus estimated cost of \$380,200. Some of these bids are subject to review and may result in selection of more expensive equipment in order to meet specifications.											
CA-749	High Level Radiochemistry Facility	\$960,000	\$960,000	10-31-58	100	58*	100	61	6-15-58	8-14-58	11-21-58	8-30-59	
REMARKS:		Chemical Research & Development The following construction work was performed during the reporting period: 1) The large door hinge supports were installed. 2) Cell wood formwork was completed. 3) Welding of cell liners and pipe conduit (except electrical) is complete. 4) Pipework for cells was completed but not tested. 5) Lead shielding and sample transfer ducts have been installed. 6) Installation of SS exhaust ducts in basement is continuing. 7) Manipulator sleeves and plug liners are installed. 8) The liquid storage vault is being Amercoated. 9) Overhead truck door has been installed. The 15-ton crane was received at the job site. B. D. Bohna Company initiated a design change to pneumatically place (Gunitite) the high density concrete cell shield. Excavation and fabrication of the 3" waste pipe connection outside the building has been started. *Bohna Co. submitted their second revised construction schedule. It was approved by the AEC. ** New Directive Completion Date.											

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BUDGET CLASSIFICATION Improvements to Production and Supporting Installations - 58-b-4		MONTHLY PROJECT REPORT HANFORD LABORATORIES OPERATION						HW - 60235 MONTH April, 1959			
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PERCENT			STARTING DATE	DIRECTIVE COMP. DATE		
			AMOUNT	DATE	DESIGN SCHED.	ACTUAL	CONST. SCHED.			ACTUAL	
CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building	\$350,000	\$345,000*	4-23-59	100	100	28	30	6-23-58	- - -	12-31-58
REMARKS		Reactor & Fuels R & D The contractor, Jensen-Rasmussen Company, started work on April 14, 1959. However, very little major work can start on the new addition until the structural steel arrives at the job site. The electrical sub-contractor plans to start his portion of the work in the existing building during the first week in May. The first radiation orientation meeting for contractor personnel will be held Monday, May 4, 1959. The contractor has indicated the structural steel drawings and progress schedule should be received the first week in May. The CPFF Construction Contractor has essentially completed the duct runs in the basement of the existing building. Work is progressing on the water door between the two basins and the 17" stainless steel portion of the decontamination chamber. *The Commission issued a directive authorizing \$345,000; this is \$5,000 less than was requested in the revised proj. prop.									
CGH-819	Increased Laboratory Waste Facilities - 300 Area	\$300,000	\$30,000	11-24-58	0	2	0	0	3-23-59	- - -	9-1-59
REMARKS		USING COMPONENT Chemical Research & Development A. W. Hervin									
REMARKS		Architectural and mechanical design work has been started. A design schedule is being prepared.									
General Plant Projects - FY 1959											
CAH-827	Automatic Columbia River Monitoring Station	\$27,000	\$27,000	3-17-59	5	5	0	0	4-3-59	- - -	6-13-59
REMARKS		USING COMPONENT Radiation Protection D. S. Jackson									
REMARKS		Carson, Kesterson and Moe, architects, are currently scoping the river pumping system and the monitoring structure. The General Electric Company is designing the monitoring equipment and layout. Construction of the pumping system must be closely coordinated with construction of the PRTR river pumping facilities. The work will probably be included in the same contract.									

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BUDGET CLASSIFICATION		MONTHLY PROJECT REPORT										HW - 1959	
General Plant Projects FY 1959		HANFORD LABORATORIES OPERATION		AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT		STARTING DATE		DIRECTIVE COMP. DATE		ESTIMATED COMP. DATE	
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AMOUNT	DATE	DESIGN SCHED.	ACTUAL	DESIGN SCHED.	CONST.	DATE	DESIGN	CONST.	DESIGN	CONST.
CAH-28	Central Storage Facility - 300 Area	\$37,400	\$37,400	2-18-59	25	N.S.	0	3-30-59	6-18-59	12-31-59	5-20-59	12-31-59	
REMARKS:		Property Accounting R. C. Ingersoll											

Carson, Kesterson and Moe, Architect-Engineers, started Title I work March 30, 1959. It is expected that their preliminary design will be complete the first week in May.

CGH-29	Building 325 Basements Improvements	\$70,000	\$70,000	2-13-59	100	96	30	2-13-59	3-2-59	9-30-59	5-13-59	9-30-59	
REMARKS:		Reactor & Fuels R & D R. C. Ingersoll											

The partition has been completed. The Work Release and drawings for installation of the electrical and ventilation work have been forwarded to Construction Operation. Apparent low bidder for the ramp and basement access was Frank Lohse, with a bid of \$12,400. The Fair Cost Estimate prepared by J. A. Jones was for \$13,800. The sprinkler system design has been forwarded to Construction Operation, and a bid package for lump sum installation was issued the last week in April. Bid opening is expected approximately May 15, 1959.

CAH-37	Animal Pens, Isolation and Examination Facilities	\$80,000	\$80,000	3-17-59	35	50	N.S.	3-30-59	N.S.	4-1-60	5-22-59	12-1-59	
REMARKS:		Biology J. T. Lloyd											

Carson, Kesterson and Moe, Architect-Engineers, were awarded the contract for Title I, II and III work. Preliminary arrangement drawings which were submitted are being altered in accordance with new proposal made by biology.

UNCLASSIFIED

BUDGET CLASSIFICATION		MONTHLY PROJECT REPORT										HW - MONTH April, 1959	
General Plant Projects - FY 1959		HANFORD LABORATORIES OPERATION											
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT			STARTING DATE	DIRECTIVE COMP. DATE	DESIGN	CONST.	ESTIMATED COMP. DATE	
			AMOUNT	DATE	DESIGN SCHED.	ACTUAL	CONST. SCHED.						ACTUAL
CCH-840	Sheet Metal Shop Addition - 328 Building	\$36,500*	None		0	0	0	1**				4**	
USING COMPONENT		None			0	0	0	4**				12**	
REMARKS:		Laboratory Auxiliaries A. W. Hervin											
<p>Verbal notification has been received that this project was approved for \$40,000 by the local AEC Review Board. This approval stipulates a concrete block structure in lieu of utilizing the surplus, metal army mess hall specified in the project proposal; to date a directive has not been received.</p> <p>* Funds requested in the project proposal for a structure utilizing a surplus, metal building. ** Months after authorization.</p>													
CAH-848	Geological and Hydrological Wells - FY 1959	\$56,600	None		0	0	0	5-30-59				6-30-59	
USING COMPONENT		None			0	0	0	7-30-59				3-30-60	
REMARKS:		Chemical Research & Development H. E. Ralph											
<p>Verbal notification has been received that this project was approved by the local AEC Review Board April 30, 1959; to date a directive has not been received.</p>													
0084 (AEC-167)	Pickling and Autoclaving Facility for Zirconium Tubes - C-25 Building, White Bluffs	\$100,000	\$100,000		90	55	3-2-59					5-15-59	
USING COMPONENT		2-27-59*			90	45	3-19-59					7-1-59**	
REMARKS:		Laboratory Auxiliaries H. Radow											
<p>All major items of equipment are on hand or on order with favorable promised delivery dates. Fabrication of the autoclave is underway and shop progress on all the other fabrication is progressing favorably.</p> <p>* Letter from J. M. Fryar to J. L. Boyd, dated February 27, 1959. ** Required beneficial use date is May 18, 1959.</p>													

UNCLASSIFIED

BUDGET CLASSIFICATION		MONTHLY PROJECT REPORT										MONTH April, 1959	
General Plant Projects - FY 1959		EST. TOTAL PROJECT COST		AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PERCENT				STARTING DATE	DIRECTIVE COMP. DATE		ESTIMATED COMP. DATE
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	AMOUNT	DATE	DESIGN SCHED.	ACTUAL	CONST. SCHED.	ACTUAL	CONST.	DESIGN	CONST.	ESTIMATED COMP. DATE
IR 242	Modify 303-J Building to Provide an Interim Test Facility for Fuel Elements	\$19,000	\$19,000	2-17-59		100	100	100	100	2-17-59	4-28-59	4-28-59	4-28-59
REMARKS:		Reactor & Fuels R & D Beneficial use of the facility was attained on April 24, 1959. The project was physically with two minor exceptions on April 28, 1959.											
IR-243	Relocation of the 200-E Testing Equipment	\$18,000	\$18,000	8-11-59		95	95	80	80	3-12-59	4-22-59	5-22-59	6-1-59*
REMARKS:		Laboratory Auxiliaries All of the testing equipment, except the dark room facility, has been removed from 221-B Building. The dark room equipment will be moved last as it must be kept in use as long as possible. Partitioning of the C-25 Building is nearly complete and installation of the sanitary facilities is nearing completion. The ultrasonic tank has been installed and installation of the other equipment is progressing favorably. *The directive completion date was not met because promised delivery date for the heating plant is now May 15, 1959.											
IR-246	Alterations to the Positive Ion Accelerator Facility - 3745-B Building	\$19,000	\$19,000	4-20-59		100	100	N.S.	N.S.	4-21-59	10-20-59	10-20-59	10-20-59
REMARKS:		Physics & Instruments R & D Work Order # A 1425 was issued April 29, 1959 to Construction Operation for the performance of the alterations. R. C. Ingersoll											

UNCLASSIFIED

BUDGET CLASSIFICATION	MONTHLY PROJECT REPORT	MONTH April, 1959	PROJECT PROGRESS IN PER CENT		ESTIMATED COMPLETED		
			DESIGN SCHED.	ACTUAL	DESIGN	CONST.	
General Plant Projects - FY 1959	HANFORD LABORATORIES OPERATION	STARTING DATE	DESIGN	CONST.	DIRECTIVE COMP. DATE	DESIGN	CONST.
PROJECT NUMBER	EST. TOTAL PROJECT COST	AUTHORIZATION AMOUNT	DATE	ACTUAL	DATE	DATE	DATE
IR-247	\$12,500	\$12,500	4-28-59	N.S.	4-29-59	9-28-59	9-28-59
	USING COMPONENT						
	Biology						

REMARKS:

A bid package for lump sum installation of the line work is being prepared by Construction Operation.

R. C. Ingersoll

IR-

Uranium Scrap Burning Facility

\$17,500
USING COMPONENT
Reactor & Fuels R & D

	None	0	0	*	-	-	1 **
	None	0	0	*	-	-	5 **

REMARKS:

The Informal Request has been prepared and is being circulated for signatures.

R. K. Waldman

- * Immediately after authorization.
- ** Months after authorization.

New Construction - FY 1960

CCH-832 Full Scale Physical Constants Testing Reactor

\$915,000
USING COMPONENT
Physics & Instruments R & D

	None	0	0	-	-	-	-
	None	0	0	-	-	-	-

REMARKS:

The preliminary project proposal requesting \$30,000 preliminary design money has not yet been approved by the AEC-Washington.

R. W. Dascenzo

UNCLASSIFIED

PROJECT NUMBER	TITLE	MONTHLY PROJECT REPORT				HANFORD LABORATORIES OPERATION		HW - 681		MONTH April, 1959		ESTIMATED COMP. DATE	
		EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	DESIGN	CONST.	DESIGN	CONST.	DESIGN	CONST.
CG-681	Additional Heat Generation Facility	\$419,000	\$664,000 9-18-57	100	82*	12-6-56	8 31-59	10-15-58	10-15-58	8 31-59	8 31-59	8 31-59	8 31-59
USING COMPONENT		Reactor & Fuels R & D											
REMARKS:		<p>The contractor should finish his portion of the work the first week in May; at this time the ATP will be run. The contractor was delayed in completing his portion of the work, because of the late arrival of the reworked bus from the vendor. The reworked bus arrived at the job site April 28, 1959. The mechanical sub-contractor should complete his work this month. The contractor's work was scheduled to be 100% complete, however, due to the bus work delay he was not able to complete his work as scheduled.</p> <p>* Does not include startup.</p>											
CA-681	Hanford Equipment in the ETR	\$1,140,000	\$1,140,000 4-1-59	90*	82**	9-17-56	3-1-60	7-15-59	7-15-59	3-1-60	3-1-60	3-1-60	3-1-60
USING COMPONENT		Reactor & Fuels R & D											
REMARKS:		<p>The 6 x 9 Loop is scheduled for insertion the week of May 4, 1959; although approval has not yet been received from the Hazards Survey Group.</p> <p>*Based on additional work included in revision to the project proposal. ** Based on field completion only.</p>											
CG-682	High Level Cut-Off and Examination Cell - 327 Building	\$415,275*	\$430,000 8-20-57	100	100	7-18-56	10-1-58	6-28-57*	6-28-57*	10-1-58	10-1-58	9-30-58*	9-30-58*
USING COMPONENT		Reactor & Fuels R & D											
REMARKS:		<p>Status of exceptions: The water baffling has corrected the excessive splashing of the saw wheel. The major item left on the saw is the cooling line, which is to be flexible and of stainless steel; finding a vendor for this item is becoming difficult. The exterior portion of the hood lifting mechanism is nearing completion. The third manipulator has been completed and the fourth manipulator is approximately 50% complete. The thickness measuring micrometer was calibrated, tested and completed. The cell exhaust alarm system parts and material have been received and fabrication has started. The pitot tube has been installed. Design of the photography stage for viewing and photographing elements is 75% complete.</p>											

AM-7500-019 (5-59)

UNCLASSIFIED

UNCLASSIFIED

0-17

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900		MONTHLY PROJECT REPORT HANFORD LABORATORIES OPERATION										HW - 1959 MONTH April, 1959		
PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION		PROJECT PROGRESS IN PER CENT				STARTING DATE		DIRECTIVE COMP. DATE		ESTIMATED COMPLETION DATE	
			AMOUNT	DATE	SCHED.	ACTUAL	CONST. SCHED.	ACTUAL	DESIGN	CONST.	DESIGN	CONST.	DESIGN	CONST.
CA-695	Radio Telemetering Network	\$109,078	\$109,078	9-23-58	100	100	100	100	2-22-57	4-15-57	2-27-57	2-27-57		
USING COMPONENT														
REMARKS:		Physics & Instruments R & D J. T. Lloyd												
<p>Eleven stations are operating and reporting data; the nine remaining stations are awaiting wind generator repair. A work order has been issued for repair and adjustment of the wind generators.</p> <p>* Project was complete with minor exceptions. Beneficial use was attained March 20, 1959.</p>														
CG-785	In-Reactor Studies Equipment - 105-KW Building	\$276,000	\$276,000	12-8-58	20	20	0	0	1-5-59					
USING COMPONENT														
REMARKS:		Reactor & Fuels R & D H. Radow												
<p>The R & D Capsule Development Contract has been placed with United Electrodynamics, Inc., Pasadena, California. Copies of the preliminary procurement specifications for the major instrumentation were sent to this vendor for comments; since some of these instruments will be loaned to him for use during development work. These comments have been received and the specifications in final form are being prepared for the start of procurement.</p>														
CGH-801	X-Ray Diffraction Cell - 327 Building	\$170,000	\$10,000	6-7-58	N.S.	40	0	0	6-10-58					
USING COMPONENT														
REMARKS:		Reactor & Fuels R & D R. W. Dascenzo												
<p>The revised project proposal for the remainder of design and total construction funds, submitted to the AEC-HOO November 19, 1958, has not been approved.</p>														

UNCLASSIFIED

PROJECT NUMBER	TITLE	MONTHLY PROJECT REPORT HANFORD LABORATORIES OPERATION										HW - MONTH	STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED STARTED COMP. DATE	
		EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT DATE	PROJECT PROGRESS IN PERCENT		DESIGN SCHED.	ACTUAL SCHED.	DESIGN	CONST.	DESIGN	CONST.					
CGH-806	High Temperature Tensile Testing Cell 327 Building	\$150,000	\$150,000 2-25-59	85	0	80	0	N.S.	3-31-60	3-31-60	6-15-59	3-31-60	3-31-60			
REMARKS:		Reactor & Fuels R & D R. W. Dasenzo														
The design schedule has been approved by the AEC. Design is behind schedule due to drafting bottleneck; other projects had a higher priority in the drafting room.																
CGH-834	Modifications and Additions to High Pressure Heat Transfer Apparatus 189-D Building	\$700,000	\$700,000 4-8-59	1	0	1	0		4-20-59	5-15-59	10-15-60	10-15-60	10-15-60			
REMARKS:		Reactor & Fuels R & D H. Radow														
Design and collecting material for early installation of bus extension and inter-ties has started.																
CGH-838	Fission Product Volatilization Studies Test Facility - 292-T Building	\$75,000	\$75,000 3-26-59	10	0	10	5		3-30-59	4-16-59	11-30-59	11-30-59	11-30-59			
REMARKS:		Chemical Research & Development O. M. Lyso														
Initial building clean-up and equipment removal has been completed. Design of shielded induction enclosure, furnace pot, exhaust system and transport cask are in progress. Building modification and equipment layout prints have been completed.																

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
J. R. Mohondro & Roger Eide	4-8 & 4-9-59	Halladie Mach. Co. Spokane, Wash.	To discuss machine tool equipment.	L. J. Lucas	No	300, 328
John N. Engelsted	"	O. S. Walker Co. Worcester, Mass.	"	L. J. Lucas	No	300, 328
D. B. Klikovits	4-8, 9, & 10-59	Monarch Mach. Tool Co. Sidney, Ohio	To check & adjust lathe	J. H. Kelly	No	300, 328
Gildo J. Martini	4-16 &	Pacific Scientific Co. Portland, Ore.	To inspect new gas converter.	J. H. Kelly	No	300, 328
Don Mendenhall	4-22, 23, & 24-59	Pacific Scientific Co. Seattle, Wash.	To inspect gas converter.	J. H. Kelly	No	300, 328
J. R. Mohondro & Paul Forsythe	4-29 & 4-30-59	Halladie Mach. Co. Spokane, Wash.	To discuss machine tools.	L. J. Lucas	No	300, 328
50 Gonzaga Univ. Students	4-10-59	Gonzaga Univ. Spokane, Wash.	Learn more about Tech. Infor.	C. G. Stevenson	No	300, 3760
48 Richland Teachers	4-25-59	Richland Public Sch.	"	C. G. Stevenson	No	300, 3760

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
P.F.X. Dunigan	4-6 - 4-9-59	Hot Lab. Meeting Cleveland, Ohio	Session Chairman	--	No
	4-10-59	Nela Park - GE Co. Cleveland, Ohio	Discuss laboratory maint. problems.	Mr. Troutman	No
R. W. Dascenzo	4-6 - 4-9-59	Hot Lab. Meeting Cleveland, Ohio	To present technical paper.	--	No
J. H. Kelly, C.W. Abbott & J. M. Jones	4-14-59	Perry Institute Yakima, Wash.	To observe heat treating facilities.	Bill Buckley	No
A. W. Fraser	4-16 & 4-17-59	Boeing Plant #2 Seattle, Wash.	To check fluorescent tanks & seeing eye scanning instrument; See about offsite courses for assts.	Robert Booth	No
		Magnaflux Corp. Seattle, Wash.		Mr. Haller	No

PROFESSIONAL PLACEMENT AND RELATIONS PRACTICES OPERATION
MONTHLY REPORT

GENERAL

At month's end, the staff of the Hanford Laboratories Operation totalled 1228 employees including 579 exempt and 649 nonexempt employees. There were 491 exempt employees possessing technical degrees, including 279 B.S., 110 M.S. and 102 Ph.D.

TRAINING

Four sessions of the second program of the Information and Orientation Series were presented with excellent attendance and interest on the part of HLO nonexempt employees.

COMMUNICATIONS

Arrangements have been completed for the Laboratories to supply radiation protection display material for the Armed Forces Day Open Houses at Larson Air Force Base, Spokane, and the Umatilla Army Ordnance Depot on May 16.

Tours were provided in April for 36 East Wenatchee High School students, 50 Gonzaga University engineering students, 40 Chief Joseph Junior High School advanced science students and 50 Richland School teachers.

HAFD secretaries were honored at an Open House held by the Manager, Hanford Laboratories in the 3760 Building Conference Room during National Secretaries Week.

EMPLOYEE COMPENSATION

Robert Keith Jones, a Bioassay Analyst with the Exposure Evaluation and Records Operation, died April 26th from injuries received in an off-the-job automobile accident.

One nonexempt job package was approved for assignment to the recently authorized Technician Grade 24 classification.

HEALTH AND SAFETY

Laboratories personnel worked a total of 205,500 man-hours during the month with no disabling injuries. Since September 1, 1956 a total of 6,084,236 man-hours have been completed with no disabling injuries.

The medical treatment frequency for April was 1.50 as compared with 1.60 during March.

There were two security violations during the month of April and one during March which was reported late, bringing the total to 16 for the year to date.

In addition to damages of \$200 reported during March as a result of a glove box explosion in Plutonium Metallurgy, a prototype monitoring instrument was contaminated beyond recovery, resulting in a replacement cost of \$1449.

PROFESSIONAL PLACEMENT

Two Ph.D. candidates accepted HAPO offers during the month. For the recruiting year to date, there have been nine Ph.D. acceptances, including two in chemical engineering, two in mechanical engineering, two in chemistry, and one in physics.

During April, HLO physics managers participated in Ph.D. recruiting at Cal Tech, U.C.L.A., Stanford and the University of California, and HAPO was represented at the American Physical Society Meeting in Washington, D.C. for physics recruiting.

Physics and metallurgy continue to be the critical disciplines in Ph.D. recruiting at HAPO and elsewhere in the Company.

Four experienced BS/MS candidates accepted offers during the month. Sixty-three acceptances for Technical Graduate assignments have been received and it appears that an additional five to twelve acceptances may be expected. Distribution by academic disciplines appears to be good with 14 physicists and 13 mechanical engineers having accepted.

Four Technical Graduates were added to the training program and three permanent placements were effected, with 26 remaining on the program at month's end. Seventeen of these are presently available for off-program placement with six having accepted assignments to be effective by July 1.

EMPLOYMENT

Fourteen nonexempt requisitions were filled during the month. With the receipt of 27 new requisitions, there are currently 49 nonexempt openings for which 28 candidates are in process and five transfers are pending with 13 candidates yet to be procured.



Manager,
Professional Placement
and Relations Practices

TG Marshall:tr

VISITS TO OTHER INSTALLATIONS

UNCLASSIFIED

Name	Date of Visit	Company Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data
R.H. Scott	4-8, 4-9	General Electric Co. Research Laboratories	Discuss NFPA committee assignment; exchange knowledge on research safety administration; submit article on laboratory hazard for publication in Chemical Section Newsletter (National Safety Council)	H.H.Fawcett	None
R.H. Scott	4-10	General Electric Co. Lamp Development Dept.	Discuss lighting standards and lighting applications with relation to safety. Discuss industrial hygiene.	S.K. Guth, M. Christensen, I. Metalsky	None

TABLE II. NONEXEMPT EMPLOYMENT

Nonexempt Employment Status Mar. Apr.

Requisitions

At end of month	40	49
Cancelled	4	4
Received during month	19	27
Filled during month	25	14

Candidates Considered

Total Applications	35	75
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Nonexempt Transfer Request Mar. Apr.

Transfer Request

Active cases at end of month	73	69
Cancelled	3	4
New	5	3
Transfers effected	3	3

TABLE III. PROFESSIONAL PERSONNEL PLACEMENT

A - Technical Recruiting Activity - HAPO - September 1, 1958 to Date

Cases	<u>Visits to Richland</u>			<u>Offers*</u>			<u>On the Roll</u>
	<u>Invited</u>	<u>Visited</u>	<u>To Visit</u>	<u>Accepted</u>	<u>Open</u>	<u>Roll</u>	
Ph.D.	179	72	36	9	12	5	
Exp. BS/MS	72	54	2	44	12	40	
Prog. BS/MS	--	--	--	63	55	13	

*Offer totals include offers open on 9/1/58

Ph.D. 3
Exp. BS/MS 3
Prog. BS/MS 3

B - Technical Recruiting Activity - HLO - September 1, 1958 to Date

Cases	<u>Visits to Richland</u>			<u>Offers**</u>			<u>On the Roll</u>
	<u>Invited</u>	<u>Visited</u>	<u>To Visit</u>	<u>Accepted</u>	<u>Open</u>	<u>Roll</u>	
Ph.D.	179	72	36	6	8	5	
Exp. BS/MS	53	37	2	19	7	17	

**Offer totals include offers open on 9/1/58

Exp. BS/MS 2
Ph.D. 2

In addition to the above activity, 20 exempt employees have transferred into HLO from other HAPO departments and 18 technical graduates have accepted off-Program placement in HLO to date.

C - Technical Graduate and Technician Training Program
Month ending April 30, 1959

	<u>TG Program</u>	<u>TT Program</u>
Number Personnel on assignment	26	10
(HAPO Tech Grad Program.....24		
(West. District E.P..... 2		
Distribution of assignments by Depts.		
HLO	9	4
CEO	0	0
R&UO	0	0
FPD	3	0
IPD	12	6
CPD	2	0
Distribution of assignments by functions		
R&D or Engineering	23	10
Other	3	0

FINANCIAL OPERATION MONTHLY REPORT
APRIL 1959

Personnel

One exempt employee in the Cost Accounting Operation resigned to take work with another company. Seven employees in Personnel Accounting were transferred to Contract and Accounting Operation as a part of the implementation of the decision to consolidate financial clerical functions.

Activities

GENERAL ACCOUNTING OPERATION

Current plans are to transfer all General Ledger functions to Contract and Accounting by May 18, 1959. In connection with the consolidation of General Ledger, second class invoice billings to other departments and all current accounts are being eliminated. All future billings affecting general ledger accounts will be made by journal entries only. This will place a temporary burden on all financial clerks to determine what general ledger accounts are affected by each entry. Originators of journal entries will have the option of distributing journal entry copies to all recipients or forwarding all copies to general ledger for distribution. To the extent that entries are distributed by the originator, possible bottlenecks in paper flow through general ledger will be minimized.

Output from General Ledger to each department's Manager - General Accounting will consist of two copies of the HAPO trial balance which will indicate appropriate department balances where desired and a detail listing of the department's account balances and current month activity.

The budget for attendance at professional and trade society meetings was increased from \$27,000 to \$28,000. Internal shifts of budgets by Sections were also made during April. Of allocated meeting funds 34%, amounting to \$8,321, was neither expended nor committed as of April 24, 1959.

A report of results was issued for the physical inventory of uninstalled cataloged equipment in the custody of Reactor and Fuels Research and Development Operation. Two thousand, nine hundred and twenty-eight items were physically counted valued at \$4,594,222. Twelve missing items (\$2,278) were not located during the inventory compared to 32 missing items (\$20,709) in the FY 1957 inventory. The percentage of missing equipment to total dollar value was 0.05% compared to 0.63% in FY 1957. Seven items valued at \$1,423 were added to record as compared to 403 items valued at \$228,117 in the FY 1957 inventory. Inventory results in general indicated good control over equipment and the use of proper procedures in transferring or retirement of equipment.

All field work in connection with the physical inventory of uninstalled cataloged equipment in the custody of Chemical Research and Development Operation is complete and the reconciliation is in progress. A listing of 23 unlocated items was forwarded to custodial personnel requesting that they either locate the items or prepare a missing property report.

The updating of our property unit records with IBM is complete. Ten-thousand two hundred and sixty-six input data sheets were prepared and submitted to Data Processing which included additional description, purchase order reference, rate of depreciation and reconciliation of all other information. The updating and reconciliation of our records with IBM was in connection with our mechanization program of property records. Effective with April business, we discontinued the practice of establishing manual property record files. Listings in HEW sequences provided by Data Processing will replace HLO manual records. The next step in our mechanization program is to add to record equipment received but not billed (charges not transferred from Equipment Work in Progress). This will provide the custodial personnel with a record as soon as a receiving report is received in Property Accounting and reduce our physical inventory reconciliation time. With the inclusion of depreciation rates in the Data Processing system composite depreciation rates can be computed automatically on the machine, thus eliminating the manual efforts previously necessary in this area.

Arrangements were completed and a procedure issued for the physical inventory of shop stock material in the custody of Technical Shop Operation. The inventory count will be taken June 6, 1959 and the physical count will be adjusted to reflect quantities on hand as of that date.

Work is continuing in connection with our program of updating fixed asset records to accurately reflect actual property holdings. All 300 Area buildings, installed equipment and other structures have been physically inventoried and the reconciliation is approximately three-fourths complete.

Projects CA-765, Additions to the 314 Building, and CA-778, Expansion of the 305-B Building, were physically inventoried, unitized, and reports issued.

A report of results of the quarterly inventory of Other Special Materials for quarter ending March 31, 1959 was issued. All reports were in agreement with Property Accounting records.

In response to a request of SS Accountability, material custodians were requested to submit forecasts for inside diversions of SS Materials covering the first and second quarters of FY 1960. Upon receipt, the information will be consolidated and forwarded to SS Accountability.

During the month of April \$154,000 of zirconium was transferred from the inventory; \$122,000 to HLO Cost; \$32,000 to other HAPO components. Material transferred to HLO Cost, for the most part, consisted of tubes, rods and wire ordered on production orders for fuel element jacketing. As these orders were not complete, billings were made on an estimated cost per tube or rod basis, with any variance to be transferred to cost upon completion of the order. Effective May 1, 1959, all production orders will be billed on an estimated basis to HLO cost in the month in which the material is consumed. Any variance between the actual and the estimated cost will be charged to HLO Cost upon completion of the order.

Section Managers were requested to submit estimates of their requirements for Assistance to Hanford work during FY 1960. These estimates will be used as a basis for requesting Commission approval for those jobs estimated to cost less than \$5,000 during the coming fiscal year.

COST ACCOUNTING OPERATION

Preparation and printing of the FY 1961 budget presentation to HLO management is complete. Assembly and distribution will be completed in a few days. The presentation covers all facets of Hanford Laboratories fiscal year budgeting for FY 1960 and FY 1961. Visual aids have been employed to highlight the growth and significant trends of Hanford Laboratories activities and investment in capital facilities over a five-year period, FY 1957 through FY 1961.

HAPO General Overhead was reviewed during April to determine amounts applicable to HLO programs so that funds previously reserved for general overhead could be released to Operating Components for direct costs. It was determined that 16.3% of direct costs will be sufficient to provide for general overhead costs. This compares to the 18% previously withheld from program budgets for general overhead. The reduction of 1.7% will provide an additional \$94,000 for use by the Research components. This adjustment will be reflected on April cost reports.

A proposal has been presented to applicable HLO Section Managers setting forth the tentative approach to be taken in accounting for the various segments of the Plutonium Recycle Program and for pricing various fuel elements. Studies have also been started to develop cost data with respect to various components and processes involved in fabrication of the 19-rod cluster, swaged UO₂ element.

New organizational cost codes were established during the month for the Professional Placement and Relations Practices Operation established April 1, 1959. The organizational codes for the previous Employee Relations Operation were cancelled. The new codes established are as follows:

<u>Code</u>	<u>Title</u>
7200	Professional Placement and Relations Practices - General (Includes functions pertaining to Employee Compensation, Employee Relations, Communications and Health and Safety)
7210	Professional Recruitment
7220	Advanced Degree Personnel
7230	Placement Programs
7231	Technical Graduates
7232	Technician Trainees

Cost code 7332 was established to identify the cost of off-site fabrication jobs contracted by purchase order by the Technical Shops Operation.

Two work identification codes were established to identify costs associated with the Trans-Plutonic Element work which will be funded from the HAPO 2000 Program.

- .13 Trans-Plutonic Elements - Development
(2000 Program - Research and Development)
- .14 Trans-Plutonic Elements - Fabrication
(2000 Program - Production)

PERSONNEL ACCOUNTING OPERATION

State Unemployment Taxes were paid to Washington and Idaho in the amount of \$59,772.90 and \$74.83, respectively.

State income taxes withheld from employees pay were transmitted to Oregon and Idaho in the amount of \$71.50 and \$46.55, respectively.

Quarterly Employees' Tax Returns and Summary of Tax Deposited for the first quarter of 1959 plus the 941-A Continuation Sheets were completed and mailed on April 13, 1959. Federal Income Tax withheld from employees' pay amounted to \$330,769. FICA taxes in the amount of \$56,680 was withheld from employees' pay and the same amount was paid as the employer's portion of this tax law.

Gross payroll for the first quarter amounted to \$2,308,654 of which \$917,840 was received by salaried employees and \$1,390,814 by exempt employees.

All other quarterly reports such as Employees & Payroll, Suggestion Awards, Annual Fringe Benefit Survey Reports, Geographical Location, etc. were completed and transmitted within due date.

PROCEDURES

Initial work has been started toward establishing a functional index for Hanford Laboratories forms.

As a result of the recommendation contained in the audit report on work orders the format of the work order form used by Hanford Laboratories will be altered by overprinting. Distribution will be about May 1, as unused forms are recalled.

MEASUREMENTS

The comparison of Technical Shops charges with those of FPD maintenance and shop organizations was completed. A summary of the information from the meeting at Schenectady in March was forwarded to interested management. The Specialist - Measurements was a visitor during the month to each of the current PBM classes.

AUDITING

The Work Order audit report was issued as of March 31st. Field work continues on the audit of General Accounts and Cash Controls.

A review was made of the Deductions from Employees' Pay Account balances at March 31, 1959 and the entries made to the account during the preceding months. No significant exceptions were found.

The final follow-up was made of the Traveling Auditors' 1958 audit recommendations. Except for the conversion of the Physics and Instruments accelerator refrigeration system, which has been delayed for budget reasons, action on all recommendations is essentially complete.

Payroll Statistics

<u>Number of HLO Employee</u> <u>Changes During Month</u>	<u>Total</u>	<u>Exempt</u>	<u>Non-Exempt</u>
Employees on Payroll at Beginning of Month	1 223	576	647
Additions and Transfers In	18	7	11
Removals and Transfers Out	(9)	(4)	(5)
Employees on Payroll at End of Month	<u>1 232</u>	<u>579</u>	<u>653</u>

<u>Overtime Payments During Month</u>	<u>April</u>	<u>March</u>
Exempt	4 428	4 088
Non-Exempt	<u>7 471</u>	<u>13 288</u>
Total	<u>\$11 899</u>	<u>\$17 376</u>

<u>Gross Payroll Paid During Month</u>		
Exempt	\$469 294	\$468 436
Non-Exempt	<u>261 077</u>	<u>289 814</u>
Total	<u>\$730 371</u>	<u>\$758 250</u>

<u>Participation in Employee</u> <u>Benefit Plans at Month End</u>	<u>April Participation</u>		<u>March Participation</u>	
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>
Pension Plan	1 177	99.0	1 165	99.0
Insurance Plan				
Personal Coverage	1 229	99.8	1 245	99.8
Dependent Coverage	845	-	834	-
U.S. Savings Bond				
Stock Bonus Plan	77	39.3	75	37.3
Savings Plan	90	7.3	91	7.4
Savings and Security Plan	1 026	94.0	1 024	93.7
<u>Good Neighbor Fund</u>	842	68.3	841	68.6

<u>Insurance Claims</u>	<u>April</u>		<u>March</u>	
	<u>Number</u>	<u>Amount</u>	<u>Number</u>	<u>Amount</u>
Employee Benefits				
Life Insurance	0	\$ 0	0	\$ 0
Weekly Sickness and Accident	8	745	12	1 163
Comprehensive Medical	73	8 291	64	5 057
Dependent Benefits				
Comprehensive Medical	<u>142</u>	<u>11 072</u>	<u>174</u>	<u>14 580</u>
Total	<u>223</u>	<u>\$20 108</u>	<u>250</u>	<u>\$20 800</u>

INVENTIONS OR DISCOVERIES

All persons engaged in work that might reasonably be expected to result in inventions or discoveries advise that, to the best of their knowledge and belief no inventions or discoveries were made in the course of their work during the period covered by this report except as listed below. Such persons further advise that, for the period therein covered by this report, notebook records, if any, kept in the course of their work have been examined for possible inventions or discoveries.

<u>INVENTOR</u>	<u>TITLE OF INVENTION OR DISCOVERY</u>
J. J. Hauth	Laboratory Compaction of UO ₂
C. M. Unruh	A Dosimeter for Measuring Radiation Doses to the Human Eye.
W. L. Lyon	A Pyrochemical Separations Process Applicable to Uranium Dioxide Reactor Fuels. (HW-60029)
W. B. Silker	The Use of Adsorbing Materials, in Particular the Water Corrosion Film Formed on Aluminum, for the Removal or Depletion of Radioisotopes from Aqueous Solutions, Such as, Reactor Effluent Water. (HW-59982 - Confidential)
E. M. Duke	Use of Ferric Nitrate to Prevent Precipitation of Molybdenum from Uranium-Molybdenum Solutions.
R. F. Maness	Use of Ferric Nitrate to Accelerate Dissolution of Uranium, Uranium Alloys, and Uranium Dioxide.
R. W. Wirta	The Use of Interstitially Hardened Titanium for Sliding Contact Service.



END

**DATE
FILMED**

4 / 29 / 93

