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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
JUNE, 1959

72946

Compiled by
Operation Managers

July 15, 1959

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

PRELIMINARY REPORT

This report was prepared only for use within General Electric Company in the course of work under Atomic Energy Commission Contract AT(45-1)-1350. 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 June 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	133	98	231	126	95	221	8	4	1	1
Reactor & Fuels Research & Development	193	158	351	191	138	329	7	21	5	1
Physics & Instrument Research & Development	72	36	108	65	33	98	7	3	0	0
Biology Operation	37	47	84	35	42	77	2	5	0	0
Operation Res. & Synthesis	17	3	20	15	2	17	2	1	0	0
Radiation Protection	33	101	134	33	101	134	1	0	1	0
Laboratory Auxiliaries	48	187	235	47	189	236	2	8	1	10
Financial	14	12	26	14	26	40	0	0	0	14
Prof. Plcmt.& Rel. Pract.	92	30	122	39	22	61	58	10	5	2
Programming	16	4	20	14	4	18	3	0	1	0
General	1	2	3	1	2	3	0	0	0	0
Totals	656	678	1334	580	654	1234	90	52	14	28
Totals excluding Internal Transfers	656	678	1334	580	654	1234	89	46	12	22

Composite Separation Rate	3.1250
Separation Rate (based on separations leaving G. E.	.5997
Controllable Separations Rate	.1499

BUDGETS AND COSTS

Costs for June were $2,579,000 an increase of $736,000 from the month of May. Total operating costs for Fiscal year 1959 were $20,424,000 or 97% of the operating budget of $21,044,000. Operating costs for Research and Development were 99% of the budget. The major underruns occurred in general overhead, direct service HLO performs for other HAPO departments, and Washington Designated Programs.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

PRTR Phase I and II contracts are complete. Final inspections have been made.

PFPP Phase II construction is estimated to be 99.5 percent complete. Completion is expected July 15. PFPP Phase III is estimated at 62 percent complete vs 70 percent scheduled. The PFPP service wing has been accepted and a partial force of operations personnel will move into the building during the week of July 6.

In heat transfer experiments with the Mark II (concentric tubular) fuel element, boiling burnout was experienced at a heat flux of 1,568,000 BTU/hr/ft^2 at an outlet temperature just below saturation. This compares favorably with the design value for maximum heat flux of 400,000 BTU/hr/ft^2.

Fabrication of the PRTR Zircaloy-2 process tubes has been completed, with 95 tubes having been inspected and accepted at the vendor's plant. Eight-eight of these tubes are already on site.

Zyglo fluorescent dye penetrant testing of the outside surfaces of 2700 thin-wall Zircaloy-2 PRTR jacket tubes showed 38 percent of the nominal 3/4-in tubes and 48 percent of the 1/2-in. tubes to be free of outside-surface cracks and flaws, and about 10 percent of each group to be unuseable. Further tests are in progress to determine the acceptability of the remaining, intermediate quality tubes.

Irradiation of evaporated uranium dioxide films and subsequent examination by electron microscopy has revealed straight line tracks. Taking into account the accumulated exposure of 2 x 10^{16}nvt, and calculating the number of fissions per micron^2, the density of tracks correlates well with the number which should be observed if the tracks were the results of fission events.

The prototype mechanical seal pump and PRTR spare pump were operated nearly full time during June with seal leakage of less than half the design value.

Zircaloy clad, aluminum core elements have withstood thermal cycling under PRTR conditions for the required number of cycles. When cycled at twelve times the PRTR heating and cooling rates and over 60 times the required number of cycles similar elements failed by swelling of the core and rupture of the cladding. Tests are continuing to define the conditions under which thermal ratcheting causes excessive deformation of this type of element.

Large scale reduction of plutonium oxide by aluminum in a cryolite bath has produced extrusion billets of plutonium-aluminum alloy of the desired composition and quality.

Various aluminum alloys modified to improve their corrosion resistance have been injection cast in Zircaloy and thin wall stainless steel with good bond formation and low porosity.

Alumina powder packed into flattened stainless steel tubes and rolled has been compacted to 90 percent of theoretical powder density. This technique may be useful for fabrication of PuO_2-inert diluent spike elements.

Following the irradiation of 0.630 inch diameter enriched coextruded, Zircaloy-2 clad uranium rods to 2200 MWD/T, cracking of the uranium metal and average diameter increases of 0.010 inch were reported. Enriched coextruded rods of 0.593 inch diameter irradiated to 1500 MWD/T are now being examined. These rods, operating at the same maximum temperatures as the prior irradiation showed only 0.002 inch average diameter increases, and no cracking of the uranium metal has been observed.

The end closure process developed for use on coextruded fuel rods has been applied in the closure of 112 rods. Three were defective. With improved instrumentation, reject rates should be sharply diminished.

In defected element rupture testing, a fuel rod specimen that had been beta treated, water quenched, and aged at 475 C for 350 hours performed better than unaged specimens. Further tests will be performed to verify this behavior.

Irradiation testing of NPR candidate graphites at temperatures up to 1000 C will be initiated in the GETR, beginning in August, in order to supplement experiments already under way in the MTR and ETR. The second graphite irradiation experiment in the L-48 shim rod of the MTR was inserted the week of June 29.

2. Chemical Research and Development

Characterization of the cerium - rare earth sulfate precipitate from the Purex 1WW waste (synthetic) established likely mean particle sizes and

general filtration behavior. Self-heating may cause the actual precipitate to reach 300 - 500 C during recovery and shipment; simulated heating to 500 C indicated property changes may occur which would impede nitric acid dissolution for subsequent processing. A trace of fluoride in the nitric acid relieved this problem.

The first processing run was completed to convert cesium zinc ferrocyanide slurry to cesium chloride in the Fission Product Isolation and Packaging Prototype. General behavior was satisfactory, but numerous process adjustments were indicated. The mechanical packaging component remains to be completed.

Extraction of neptunium from synthetic 1WW Purex waste was demonstrated in the miniature mixer-settler using di-n-butyl n-butylphosphonate (DBBP) as the extractant. Yields were good.

Calcined products from synthetic high level waste solutions were produced by the radiant heat spray calciner, by batch calcination, and at ANL in a fluid bed unit. A wide range of product bulk density and thermal conductivity resulted, depending on the composition of feed waste solution and the process used. Added materials affected both process behavior and product properties. Dense glassy solids were produced by firing typical high aluminum waste powders with borate additives.

Gamma radiation measurement as a function of depth in 200 East Area monitoring wells showed an expected downward migration of radioactive waste emitters in the soil near active crib sites over the period of a year since the last measurements. Several wells near heavily utilized cribs showed activity all the way to ground water. Measurements near inactive disposal sites near the T-Plant in 200 West Area showed a maximum soil penetration of 120 feet which is well above ground water. No detectable migration occurred at sites at which no wastes have been charged for the last two or three years.

Twelve hundred simulated startups and shutdowns were successfully completed on bench tests of the UO_3 Calciner Control Programmer. Plans to automate the UO_3 Plant will follow from this development.

As much as three percent of the UO_2 was dispersed as small suspended particles (10 to 20 microns) when stainless steel clad swaged UO_2 fuel rods were sheared under water. The prototype shear (30 tons nominal) has cut an equivalent of two tons of power fuel elements (10, 000 square inches). Wear data indicated that for each ton of rods processed an incremental ton of force was necessary to operate the shear blades.

Nitrate ion was shown to affect adversely the dissolution of stainless steel

clad fuel in a Sulfex system (sulfuric acid). Stainless steel dissolution rates decreased and uranium dioxide rates increased when nitrate ion was present in amounts greater than about 0.01 M. Continuing work on the dissolution of irradiated UO_2 in boiling sulfuric acid showed 3000 MWD/T material dissolves very slowly (0.0006 percent per hour) in the presence of stainless steel constituents in the acid. The presence of air was shown to affect room temperature reaction rates for Sulfex systems.

Test runs were initiated in a Sulfex pilot plant dissolver. Passivation of the stainless steel charge was observed when acid addition rates were low or interrupted. The presence of mild steel in the charge was shown to start dissolution of the stainless steel after passivation had occurred.

Laboratory tests indicated that plutonium losses during the Zirflex decladding of Pu-Al rods can be significantly reduced by pretreating the Pu-Al rods with a nitric acid etch.

Both UO_3 and U_3O_8 were converted to soluble UO_2Cl_2 when chlorine was added to a fused salt mixture of the oxides. Previous work showed UO_2 also forms the uranyl chloride. Zinc reduction of the UO_2Cl_2 to form crystalline UO_2 was shown to be quantitative. Some characterization of the path of fission products in this system resulted from cycling an irradiated UO_2 specimen.

Enrichment of mercury-202 in natural mercury by photoactivation was demonstrated.

Phosphorus-32 in reactor effluent water was shown to be primarily in the form of orthophosphate as an equilibrium mixture of $H_2PO_4^-$ and $HPO_4^=$ ions.

3. Physics and Instrument Research and Development

The first two full-scale experiments in the AEC-Air Force atmospheric physics program were run. All portions of the experimental system operated in a satisfactory manner. Lack of favorable weather conditions prevented additional runs during the month.

For the IPR program, exponential experiments with concentric tube fuel elements continued, and measurements were made in the PCTR on seven-rod, slightly enriched cluster elements.

Experimental work continued in the field of nuclear safety of 3% enriched Non-Production Fuels in both dissolving and subsequent processing.

In the Shielded Personnel Monitoring Station, calibration work continued, assisted by the acquisition of a phantom. Counting equipment was calibrated for emergency use in the Van de Graaff laboratory in event of personnel exposure during a criticality accident.

All radiotelemetering data stations south of the Columbia River are now calibrated and operating.

In the basic data field, analysis of the recently completed experiments on the slowing down of neutrons in water and an organic liquid revealed agreement between the results and calculations from basic principles.

An improved neutron "temperature" detector was conceived for use in lattice experiments and exploratory work to test its feasibility was begun.

4. Biology

The proportion of Sr^{90} present in the blood of miniature pigs was lower following relatively higher dose than following a lower dose, suggesting that radiation damage may lead to a decreased rate of removal of Sr^{90} from the skeleton, possibly as a result of vascular damage.

Absorption of glucose from the irradiated (1500 r) rat intestine was normal at one-day post irradiation, inhibited 60 percent at 3 and 6 days, and back to normal levels by 10 days, indicating that the absorption defect parallels pathologic damage to the intestine.

Additional studies of the radiation protective effect of erioglaucine on a different strain of mouse (CF_1) are considerably less impressive than previous results. Fifteen days following 800 r x-irradiation, 10 of 15 control mice were dead, while 7 of 15 mice protected with 960 mg erioglaucine/kg were dead. At lower levels of erioglaucine administration, mortality was higher than in controls. These results will require confirmation.

5. Programming

A survey was completed on the nuclear safety aspects of Plutonium Metallurgy Operation laboratories.

A revised schedule for fueling the PRTR based on more accurate fuel burnup estimates was transmitted to the Commission.

The meeting of the Program Directors of the Division of Biology and Medicine was held at Hanford on June 8 and 9.

TECHNICAL AND OTHER SERVICES

A report on the development work in the area of model building using multivariate statistical techniques was presented to OR personnel from other General Electric components on June 8 and 9, and to members of the Office of Operations Analysis and Forecasting, AEC, on June 10.

Further analysis designed to locate the optimum combination of preheat and submerge times in the canning cycle confirmed previous results, and a three month trial run on one canning line at the estimated optimum cycle will be started in the near future.

Work in connection with in-reactor corrosion data has developed in a continuing program of analysis jointly sponsored by HLO and IPD.

Work on the input-output simulation study and ten operations analysis programs continued during the month. One new operations analysis program was defined based on previous statistical work. In addition, statistical and mathematical analysis on 15 problems was given within HLO and to other departments and operations.

There were 22 authorized projects at month's end with total authorized funds of $8,515,500. The total estimated cost of these projects is $8,646,500. No projects were completed during the month. Two new projects are awaiting AEC approval. Six project proposals are in preparation with an additional four completed and awaiting transmittal to AEC.

Project work is proceeding generally as scheduled and within the limits of the authorized funds. Project CA-744 for the construction of the 306 Building Addition is ahead of the total project schedule but the Contractor is behind his schedule which could affect the building ready-for-use date. Current progress is about at the scheduled rate. The Contractor on the High Level Radiochemistry Facility, Project CA-749, is slightly behind schedule. Gunite placement of the heavy aggregate concrete was slower than anticipated due to equipment limitations caused by the weight of the aggregate and the density control of the placed material.

Activity for the Radiographic Testing Operation this month reached a record level reflecting the output of increased manpower and the results of the tube testing program. Eighteen thousand, two hundred and forty-three tests were made.

Two significant classification developments occurred during the month:
(1) Hanford production data for periods subsequent to June 30, 1958 were

downgraded from Top Secret to Secret. (2) The NPR was downgraded from Secret to Confidential. Actual plutonium output from the NPR will remain classified Secret. Essentially all other information on the NPR will be classified no higher than Confidential.

No new cases of plutonium deposition were confirmed during the month. The total number of deposition cases which have occurred at Hanford remained at 229. There are 161 employees currently employed who have a measurable deposition of plutonium.

An operator at the 234-5 Building, with a previous small plutonium deposition suffered a contaminated injury to the left index finger. Examination of the wound, caused by a piece of plutonium metal, in the Shielded Personnel Monitoring Station showed approximately 0.058 μc Pu. After surgical removal of a small portion of flesh from the wound area, 0.002 μc Pu remained. Preliminary bioassay results plus the remaining radioactivity in the wound indicate a total maximum body deposition of less than 10 percent.

Four recently installed high-level radiation alarms in the 231 Building were tested and accepted.

SUPPORTING FUNCTIONS

A summary report of findings in connection with the FY 1959 physical inventory of uninstalled cataloged equipment in the custody of Hanford Laboratories was prepared. A comparison of the inventory balance $9,642,342 (9,717 items) disclosed a shortage of only 24 items valued at $5,633 or six-tenths of one percent of missing equipment to the book balance. This indicates a significant improvement over the findings in the last inventory.

Estimated needs during FY 1960 for attendance at professional societies and off-site courses have been submitted to Contract and Accounting. Authorization is expected in July.

To give effect to the consolidation of clerical functions, 18 Financial Operation employees were transferred to Contract and Accounting effective June 29, however, they are remaining in HLO until about July 20 in order to close out the fiscal year at which time they will take over new assignments in the 700 Area.

As of June 30th, the staff of the Hanford Laboratories totalled 1334 employees, including 656 exempt and 678 nonexempt. There were 580 exempt employees possessing technical degrees, including 349 B.S., 119 M.S., and 112 Ph.D.

Laboratories personnel worked a total of 207,682 man-hours during the month with no disabling injuries. Since September 1, 1956, a total of 6,482,041 man-hours have been completed with no disabling injuries.

The medical treatment frequency for June was 2.02 compared with 1.59 last month.

There were 6 security violations in the Laboratories in the month of June, bringing the total for the year to date to 22.

Nine Ph. D. 's visited HAPO for interviews during June. Eight offers were extended for HAPO with 2 acceptances during the month and 7 offers continuing open. One new Ph. D. chemist reported on the roll. For the recruiting year to date, there have been 12 Ph. D. acceptances for HAPO.

Four additional acceptances were received from Technical Graduates during the month, bringing the total for the recruiting year to 75. Nine acceptances were received from experienced BS/MS candidates and 17 experienced BS/MS employees were placed on the roll.

There were 66 additions to the Training Program rolls during June, including 42 Technical Graduates, 11 members of the Western Circuit - Engineering Training Program, 8 college Juniors, and 5 high school teachers. Four Technical Graduates were permanently placed in HAPO Departments, leaving 77 Technical Graduates on the Program at month's end. Total force on the Training Program, including summer employees, is now 101.

Thirty-nine requisitions were filled during the month. With the receipt of 33 new requisitions and 5 cancellations, there are currently 33 nonexempt openings, for which 21 candidates are in process and 5 transfers are pending, with 7 candidates yet to be procured.

H M Parker

Manager,
Hanford Laboratories

HM Parker:kss

REACTOR AND FUELS RESEARCH AND DEVELOPMENT OPERATION

TECHNICAL ACTIVITIES

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. METALLURGY PROGRAM

Corrosion Studies

Nickel Plated Fuel Elements. Flaking and blistering of the nickel plate on aluminum-clad fuel elements, which has been observed on such fuel elements after irradiation under IP-207-A, has been simulated out-of-reactor under laboratory conditions. This was accomplished by making the nickel plated aluminum piece the cathode in an electrolytic cell, using a pH 7 buffer as the electrolyte. After generating atomic hydrogen on the nickel plate for 16 hours, blistering and cracking occurred. The extent of blistering seemed to increase with the amount of hydrogen evolved. There was a pronounced tendency for the blisters to form along edges, cracks, and pinholes in the nickel plate. This blistering was more severe on chemically plated samples than on the electroplated samples. Thermal cycling of the plates prior to testing increased the subsequent tendency to blister in the electrolytic test. The blistered, flaked laboratory specimens were remarkably similar to one area of reactor-exposed nickel plated fuel element which has been examined in the Radiometallurgy Laboratory.

Hence, hydrogen blistering in-reactor, caused by atomic hydrogen produced by corrosion, or by radiation-induced decomposition of water, is considered a prime suspect as a cause for the observed flaking of the nickel plate. The electrolytic test will be further developed to gain fundamental understanding of the problem and as a quality control test for improved plating techniques.

Loop Test in 300 C Deionized Water. Aluminum samples of four alloys have been examined after five weeks exposure to evaluate the effectiveness of several autoclave pretreatments. The first exposure period suggests that two weeks of autoclave treatment at 300 C is better than one week, and also that increasing the autoclave temperature to 350 C is of little or no value. Examining the corrosion data from this test of four alloys (viz., X-5001, C-810, C-823, and Alcoa-192270) with a variety of autoclave pretreatments and three different flow rates has shown the amount of oxide retained on the sample is dependent on all of these factors. The association with alloy composition was surprising since in general the most highly alloyed material more effectively retained the corrosion product. While there was a tendency for corrosion rates to be slightly lower where the oxide is best retained, the benefit of the additional corrosion product is minor. This is a further example of the non-protective character of the bulk aluminum corrosion product formed in dynamic systems.

Loop Test in 250 C Deionized Water. In view of the importance of refreshment rates on aluminum corrosion in the stirred autoclave, the current test in the dynamic autoclave involves refreshment at the rate of 9.4 gph instead of the usual 2 gph. The test results after one month involving-pre-autoclaved samples show about a 30% increase in rate over those exposed at low refreshment rates. A much greater percentage effect from refreshment rate would be expected with samples having no pretreatment.

Reactor Decontamination Studies. The Turco 4501 process, a proprietary process of the Turco Products Company, is of interest in reactor decontamination. This process has been used with reasonable success on several in-reactor loops. The chemistry of the process is obscure because the vendor has not made public the composition of his solutions. In order to understand the chemistry of the process, the analysis of 4501 solutions has been started.

The process consists of three steps starting with Turco 4501, followed by Turco 4502, and then nitric acid. Turco 4501 solution is said to contain potassium hydroxide, phenolic bodies, organic acid salts, and aliphatic amines. The 4502 solution contains sodium hydroxide, sodium carbonate, potassium permanganate and inhibitors.

Turco 4501 has been separated into four fractions by steam distillation and extraction at controlled pH's. The solution was first made strongly (pH 2) acid, and steam distilled. This distillate was neutralized to pH 6, and again steam distilled. The fraction volatile in steam at both pH 2 and pH 6 was identified as phenol by boiling point (177-8 C) and melting point of the bromine derivative (94-5 C). Phenol constitutes about 4% of the Turco 4501. The fraction volatile in steam at pH 2 but not at pH 6 is an acid with equivalent weight of about 95. It has a typical carboxylic titration curve with a break at pH 6. The free acid is very soluble in water and has a very faint acetic acid odor, suggesting lactic acid. This acid constitutes about 6% of the Turco 4501 solution.

The residue from the original steam distillation was made alkaline and extracted with chloroform. An amine was recovered, tentatively identified as triethanol amine by its extreme solubility in water and the melting point of the hydrochloride (177 C). This extracted amine fraction constituted 2-3% of the Turco 4501.

The remaining fraction, which is not volatile with steam at any pH, contains potassium salts and may contain other ingredients.

Radiometallurgy Laboratory Studies

Density, metallography, and burnup analyses samples were obtained from a peripheral and center rod of a 1.6% enriched uranium 7-rod cluster element with 0.020-inch thick Zr-2 cladding (RM-279). Four, 13" long, 1.6% enriched U, Zr-2 clad, 7-rod clusters, that were irradiated according to PT-IP-214-A, were received. No evidence of rupture was found in the first

element (RM-295). The results and conclusions from these examinations will be reported in connection with the respective development programs of Fuel Design and Physical Metallurgy Operations.

Basic Metallurgy Studies

Radiation Effects in Structural Materials. A series of metals representing the common crystal types was irradiated at Brookhaven, Hanford, and the MTR under various exposure conditions. These metals include copper, nickel, titanium, zirconium, iron, molybdenum, and type 347 stainless steel. Post-irradiation measurements were initiated at KAPL and will be completed at HAPO to advance the theory of neutron damage to metals. Metallographic studies of irradiated zirconium, titanium, and molybdenum were completed during the month. No changes in microstructure due to neutron radiation have been observed at magnifications to 1000X. X-ray line broadening and lattice parameter studies were completed for the unirradiated control specimens and for molybdenum irradiated to 4.4×10^{8} and 1.5×10^{20} nvt. The lattice parameter for molybdenum was 0.025 percent higher than the unirradiated value after an exposure to 4.4×10^{18} nvt. These results are in excellent agreement with those of prior investigations at HAPO. Although the line broadening increased continuously with exposure, the extent of broadening was substantially less than that measured in prior studies. The materials under investigation were analyzed spectrographically during the month. The purity of the metals is 99.9 percent or better except for titanium and "A" nickel which are approximately 99% pure.

These values are considered approximate and will be improved upon by wet chemical analysis. A Zircaloy-2 tube which has been exposed to radiation over a 25-month period and a similar unirradiated tube were removed from the KER facility. These tubes will be mechanically tested and examined metallographically to determine the effects of high neutron exposures at elevated temperatures on Zircaloy-2 and to establish testing methods for monitoring NPR tubing. The test pieces cut from the irradiated tube were transferred to the Radiometallurgy facility for further sectioning. One test piece which received half of the maximum exposure was given a cursory examination at 10X magnification. The outer surface was smooth and had a dark brass luster. The inner surface was smooth and had a dull born appearance.

Mechanical and Physical Properties of Materials. The textures of extruded and drawn Zircaloy-2 tubing are being determined by x-ray diffraction. Preferred orientations are being correlated with results of tube burst tests to determine the relationship of texture to mechanical properties.

Preliminary investigations of extruded Zircaloy-2 (39:1 extrusion ratio) have been made. Pole figures of (0002), $(10\bar{1}1)$, $(10\bar{1}0)$, and $(10\bar{1}2)$ planes of both cold drawn and annealed tubing have been determined. Highly preferred orientations of primary (0002) and secondary $(10\bar{1}1)$ slip planes are present. A texture consisting of (0002) planes with the $[10\bar{1}0]$ direction parallel to the extrusion axis was found. Burst test failures due to hoop stresses occurred at 45° to the radius which correlated with the high

density of basal planes observed at this orientation. Inverse pole figure data have been gathered for the cold drawn and annealed (1 hr - 700 C) Zircaloy-2 tubing also. A randomly oriented Zircaloy-2 specimen is being prepared at the U. S. Bureau of Mines to supplement this work. Specimens have also been prepared with an anneal in the alpha plus beta range to study this effect on texture. Annealing of Zircaloy-2 tube at 1050 C for one hour and furnace cooling, produced excessive grain size. Beta annealing followed by oil quenching produced a fine grained structure suitable for x-ray diffraction analysis.

The creep properties of Zircaloy-2 are considerably improved by small amounts of residual work. The extent to which increasing amounts of cold work improve creep properties and the effect of recovery occurring in the test temperature range is not known. These effects are being determined in order that Zircaloy-2 fabrication procedures can be specified for process tubing. A portion of the Zircaloy-2 stock supplied to BMI for the HAPO Assistance Program Creep Testing was further cold worked to 15, 25, and 45 percent, and flat specimens of the 25 and 45 percent material are now being tested in the vacuum creep units at stress levels of 21,000, 18,000, and 13,000 psi and 400 C (752 F). Results of 2000-hour tests show higher creep rates for the 45 percent cold worked specimens than for the 25 percent material, with initial elongations being lower for the 45 percent samples than for the 25 percent. In addition to the creep tests in the vacuum units, advantage is being taken of the availability of four atmosphere creep units to determine the effect of CO_2 contamination in the helium atmosphere on the creep properties of Zircaloy-2. Similar conditions are being used on the atmosphere machines to those in the vacuum units except for the carbon dioxide content of the atmosphere.

Notch-bend and impact tests have been performed on Zircaloy-2 to correlate these two types of tests and to determine if one is a more sensitive measure of texture and notch sensitivity than the other. The effects of cold work, temperature, specimen orientation, and additions of 100 and 500 ppm H_2 are being investigated. All test work has been completed, and the results are being analyzed. No obvious correlation between the two types of test has been observed. However, an "analysis of variance" test is being performed to see whether a statistical correlation can be found.

Electron and Optical Microscopy. The study of the microstructure of cladding and fuel materials is a direct way of detecting radiation damage in these materials. As previously reported, thin evaporated films of uranium dioxide show straight line tracks after irradiation to an exposure of only 2×10^{16} nvt. These irradiations have been repeated, and the results have been verified. Film thicknesses were 100 Å rather than the 13 Å previously reported. With a film thickness of 100 Å, an exposure of 2×10^{16} nvt results in approximately 24 fissions/micron^2. In the electron microscope the number of tracks greater than 500 Å in length per micron^2 were four. From a purely geometrical consideration of the length of tracks in the 100 Å thick film, only 20 percent of the tracks should be greater than 500 Å. Consequently, the total number of tracks or fission events determined from microscopic examination becomes 20/micron^2. This figure is in good agreement with the predicted value.

Thin foils of aluminum and Zircaloy-2 have been prepared by mechanical and chemical thinning techniques to permit transmission electron microscope examination of the microstructure. Extinction contours and dislocation movements in the aluminum foils have been observed directly with the electron microscope. Satisfactory foils of zirconium have not as yet been prepared. Such foils are to be irradiated and then re-examined to determine the pinning effect of defects caused by irradiation. Similar foils will also be coated with fissionable material, irradiated, stripped of the fissionable materials, and then examined in the microscope for fission fragment damage.

In-Reactor Measurements. A knowledge of the errors in temperature measurement using thermocouples in a neutron flux is essential for the quantitative evaluation of the effects of neutron irradiation on materials. Because such knowledge is lacking, a program of in-reactor thermocouple stability testing is in progress.

The 300 C thermocouple stability capsule, containing a chromel-alumel, an iron-constantan, and a copper-constantan thermocouple has received 3073 hours of exposure in a "gettered" helium atmosphere. Electrical resistance between the copper-constantan couple and the metal thermocouple well in the capsule has increased to approximately 130,000 ohms. This couple now registers a temperature approximately six degrees lower than the other two during steady state operation. This change is probably due to a separation of the thermocouple bead from the bottom of the well. It could also have been caused by excessive oxidation of the couple, which will lead to early failure. The gas atmosphere in the capsule has been changed to a 75 percent helium, 25 percent carbon dioxide mixture.

The creep capsule that has been received from Technical Industries Corporation for the purpose of providing continuous creep measurement of a Zircaloy-2 specimen during irradiation is now awaiting a reactor shutdown for charging. The capsule and its instrumentation have been tested in the laboratory. The monitoring equipment for strain and load measurements was provided by Technical Industries. Temperature control has been maintained to within 1 F with a one degree temperature distribution over the length of the sample in laboratory tests. Tests on a strain transducer and monitoring system similar to the one in the creep capsule has shown that the transducer performs well within the sensitivity and accuracy range claimed by the supplier. Heat transfer calculations based on gamma heating for the capsule indicate that the specimen will attain a temperature of 800 C when the capsule is in the peak flux zone of the reactor; consequently, the capsule will be inserted only as far as the center of the graphite reflector where the indicated specimen temperature is 267 C (512 F). Supplementary power will then be supplied to the electrical heaters to maintain temperature control.

Metallic Fuel Development

Cluster Fuel Elements. Seven 7-rod cluster fuel elements, fabricated from 1.6 percent enriched uranium coextruded in Zircaloy-2 cladding, are operating satisfactorily at 125 kw/ft in the KER Loop 2 facility. Calculated core temperature for the rods is 510 C. Clad thickness on six elements was 0.020-inch, the seventh element contained a 0.030-inch cladding. These elements are being irradiated to compare the performance of rods with variable clad thickness and have a goal exposure of 5000 MWD/T.

In-reactor corrosion data for uranium coextruded in Zircaloy-2 is to be obtained by purposely defecting, at temperature, fuel elements at various levels of exposure in the ETR 3x3 loop facility. Exposure levels of 0, 1000, and 2000 MWD/T are to be investigated. Two 7-rod cluster fuel elements have reached an exposure of 900 MWD/T in the KW Reactor through-hole. Two other 7-rod cluster fuel elements have reached an exposure of 300 MWD/T in a similar facility. Rods for seven 7-rod cluster fuel elements have been fabricated and will be assembled into elements. These elements will serve as the zero exposure elements as well as for heater elements throughout this series of tests.

Post-irradiation examination of 7-rod cluster fuel elements irradiated in the KER Loop 2 facility in 200 C coolant to an exposure of 1500 MWD/T was undertaken this month. Calculated core temperature of these elements was 510 C. Diameter measurements taken show a 0.003-inch maximum increase or a calculated volume increase of 1.1 percent (R = 10). The average diameter increase was 0.002 inch or a volume increase of 0.8 percent. Metallographic examination revealed no macro- or micro-cracking as was found in similar material irradiated to 2200 MWD/T. Although grain boundaries were still visible, no evidence of recrystallization was found.

Radiometallurgy examination of a 7-rod cluster element with variable interrod spacing is complete. This test was designed to measure differences in irradiation stability for rods with spacings of 0.025 to 0.055. All rods were coextruded Zircaloy-2 clad uranium. The most closely spaced rod had the biggest diameter increase of any rod. The density of this rod, however, was no lower than others. No correlation was found between core density and diameter increase. The diameter of the closely spaced rod corresponded to "R" values of 3-10. Other rods had "R" values near zero. All rods were free of scaly crud and showed no signs of uneven heat transfer. The exposure at KER Loop 2 was 1250 MWD/T average with water temperature at 275 maximum.

The assembly of natural uranium fuel into 7-rod clusters for an irradiation test in the KER facility is nearly complete. The Zircaloy-2 clad rods were coextruded at NMI by FPD personnel, and the closure, heat treatment, straightening, and assembly techniques used were those developed by Fuels Fabrication Development personnel, as described elsewhere in this report. Initially, suitcase handle type supports were used which were attached by resistance spot welding to the heat generating

surface of the individual rods. However, due to the small clearance between the support and rod surface, there was a possibility for generating hot spots under the supports. To remedy this, the supports were changed to a solid design attached to the spider in such a manner that they do not shield any heat generating surface.

Tubular Fuel Elements. Tubular fuel elements can combine high surface area to mass ratios with symmetrical coolant channels. A tube-tube element of coextruded uranium has received Reactor Safeguard approval at the ETR. It will begin operation at high power level (60 watts/gm) in July. Eight tubular elements of tube-tube geometry and KER dimensions were completed at the first of the month. Four are alloy (2% Zr) core, and four are uranium core. All have electron beam welded end closures and recessed end rings to allow for swelling. Vacuum beta heat treatment was used. End grooves were made by acid machinery with HGl. Four of these elements are scheduled to run in KER Loop 1. Power there would be about 12 watts/gm or 65 kw/ft. Work on NPR size tube-tube elements began. About 40 feet of tube is now available.

Component Fabrication. Two dingot uranium billets, 3-3/4 inches in diameter and seven inches in length, have been monitored through the salt bath heating and quenching cycle to determine required heating times and quenching rates by water quenching and air cooling. Heating in chloride salt required approximately nine minutes to reach the alpha-beta transformation, and an average of 15 minutes to reach 730 C. The first billet quenched directly in water had a center cooling rate of 11.66 C/sec at the beta-alpha transformation. The second billet was air cooled, and the center quenching rate was 0.65 C/sec in the beta prior to transformation. Grain sizes are being compared for these two treatments and the initial condition.

A total of nine coextruded uranium rods, 0.620 inch initial OD, 0.022 inch Zircaloy-2 wall, and approximately 20 feet long have been used in preparing 7-rod cluster elements for KER irradiation. The material was prepared from ingot uranium castings, triple beta heat treated before machining to billet size, and coextruded by FPD personnel at NMI. The rods were extruded with a 39:1 extrusion ratio at approximately 1160 F. The partial chemistry of the billets was as follows: C, ppm-325 min-451 max; N_2-ppm, 31 min-53 max; Fe, ppm-49 min-108 max. The density ranged from 18.93 to 18.98 gm/cc. Metallographic specimens were taken from the front, center, and rear of each extrusion after swaging from 0.620 inch OD to 0.593 inch OD. Numerous core defects were observed in each rod. These were small voids, cracks, networks of cracks and voids extending in a stringer, and clusters of oxide and carbide inclusions forming stringers. From their appearance it is believed that most of these defects originated in the cast billet as shrinkage cracks and voids and agglomeration of inclusions. It is not unlikely that these were aggravated by the severe quenching during beta heat treatment of the billets. The fuel rods were screened for the more serious of these defects and rejected as described later. Beta heat treatment of individual fuel rods was performed following the heading step, described in another section of this report, without removing the copper plate or lubricant from the surface of the element. The treatment consisted of

hanging the rod vertically from the extrusion stem formed in heading, heating in chloride salt for five minutes at 730 C, transferring to 600 C chloride salt for five minutes, and air cooling while rolling the rod on concrete. The crystallographic orientation is being determined for a number of these rods in the following conditions: as-extruded, after sizing by swaging, after upsetting the heading die, and after beta heat treatment. After beta heat treatment, the fuel rods were bowed, ranging from a few thousandths to a maximum of approximately 0.050 inch total indicated runout (TIR). They were straightened to 0.003 TIR after cleaning by supporting between U-blocks and tapping with a wooden mallet. Each fuel rod was tested for core or bond defects following beta heat treatment using an ultrasonic test. Several sections showing indications of defects were examined metallographically. Several severe core defects were identified in this manner so all elements having indications on this test were rejected. A total of six elements of 112 were rejected on this basis. A rupture occurred during autoclaving of one group of 36 rods to determine the projection weld integrity and subsequent metallographic examination of the Zircaloy-2 clad of one of the elements indicated that the hydrogen content of the clad had been increased to approximately 100 ppm. The remaining rods were outgassed 18.5 hours in vacuum at 600 C. Metallographic sections of the test sample indicated that the hydrogen had been reduced to approximately 50 ppm. The cladding of at least one rod was examined for each group in which an autoclave rupture occurred. From these examinations it appears that each rod making up the cluster elements contains approximately 50 ppm hydrogen in the Zircaloy-2 clad.

An extrusion press for use in coextrusion studies has been set up by adapting one of the 400-ton hydraulic presses in the 306 Bldg. Two composite Zircaloy-2 uranium billets have been satisfactorily extruded with the press with extrusion reduction ratios of 13.5 to 1. This press is designed to back extrude rod vertically up into a steel tube guide. The extrusion is then hung from an overhead crane while cooling to aid in straightening the extrusion.

Zircaloy-2 clad uranium rods 0.593 inch in diameter have been drawn successfully on the seven-ton draw bench. The procedure consisted of vapor-blasting, plating with half a mil of copper, and lubricating with "Steel Skin" (sodium stearate and molybdenum disulfide) during the drawing operations. No seizing occurred. The rod had a very smooth surface and was round to within 0.25 mil. Spring back on the final draw was 1.25 mils. This appears to be an excellent rod sizing technique and one that may hold promise for tube sizing.

Closing and Joining. Additional pressure testing of end closures on 0.625 inch diameter, 0.030 inch wall fuel rods in the as-coextruded condition produced the following tentative conclusions:

1. The internal pressure necessary 300 C to burst the cladding at the end cap in a short time generally exceeds 3000 psi.

2. The longitudinal engineering stress in the jacket at failure in these 300 C tests generally exceeds 40,000 psi.

3. In none of seven closures in which the jacket was nosed over an end cap by swaging prior to welding did the bond between the uranium and Zircaloy-2 fail.

4. Two of the seven closures produced by welding the jacket to the end cap without swaging failed as a result of breaking the bond between the uranium and the Zircaloy-2. In such cases the tangential (hoop) stress, equal to twice the longitudinal stress, becomes effective and reduces the rupture pressure.

5. Failure of the U-Zr-2 bond probably is a result of heating the bond during welding and could, therefore, be corrected by deeper counterboring of the uranium thus making the weld a greater distance from the Zr-2-U bond.

The end closure process developed by Fuels Fabrication Development was applied to 112 one-foot long natural uranium fuel rods clad with 0.020 inch thick Zircaloy-2. This process consists of semi-extrusion of each rod end to form the cladding over most of the end of the rod. Following this step a resistance ring type projection weld is made between the rod end and the cap. After projection welding the closure is autoclave tested, then a second fusion weld is placed in series with the first weld. The double closure tests greater than 10,000 pounds under tensile load. There were three weld failures in the ring type resistance welds in 224 welds for a failure rate of 1.34 percent. With improved instrumentation more reliable results are expected. A higher reject rate was encountered in fusion welding due to difficulty in bridging at the start of the weld. Twenty-seven percent of the fusion welds were rejected due to excessive penetration. A modified welding procedure is being developed which is expected to reduce the reject rate through the fusion welding station to less than three percent.

Equipment has been developed which will satisfactorily hot head 0.593 inch diameter coextruded fuel rods clad with 0.020 inch of Zircaloy-2. Twelve-inch lengths have been hot headed at a rate of approximately eight rods per hour. To date 115 rods have been successfully hot headed with this equipment. The hot heading provides a thicker Zircaloy-2 section at the ends of the rod. This is required for one form of welded end closure. The hot heading equipment is resistance heated and operated at an average temperature of 550 C. Both ends of the fuel rods are formed simultaneously with a forming die in each end of the container. The rods are prepared for hot heading by swaging to approximately 0.010 inch under the desired finished size. This permits the rods to be inserted into the container with ease and the rods are upset to the desired size in the forming operation. After swaging the rods are cut to length, cleaned, and 0.0005 inch of copper is plated over the entire rod. The copper plate prevents the rods from seizing to the steel container and

protects the Zircaloy clad from the atmosphere while at elevated temperatures. Prior to hot heading the rods are coated with a thin layer of lubricant. The rods are preheated to 620 C and inserted in the container for forming. Equipment for hot heading rods with lengths up to three feet is being fabricated and should be completed and ready for use within two weeks.

Allied Fuel Studies. In fuel elements with bonded jackets and unbonded end caps, large displacement incompatibilities are encountered during reactor operation. These incompatibilities can cause localized strain cycling in the jacket near the end cap. An ex-reactor test for duplicating these mechanical conditions is being developed. A material with a large coefficient of thermal expansion was required, and a suitable 75 w/o Mn-25 w/o Ni alloy has been found. Bonding tests on coupons have obtained bonds between Mn-Ni alloy and Zircaloy-2, Mn-Ni alloy and copper, Mn-Ni alloy and nickel plated Zircaloy-2, and copper to Zircaloy-2. Copper plated Zircaloy-2 was also bonded to 410 stainless steel. All bonds were obtained at 715 C, under 5000 psi pressure, in vacuum and with 15 minutes holding times.

Two alloy fuel samples of Th-98 w/o fully enriched uranium are being examined in the Radiometallurgy facility after attaining calculated exposures of 2 and 2-1/2 a/o B.U. at the MTR. The cursory examination to date indicates that this fuel material is still dimensionally stable under the conditions at which it attained these high burnups.

A mockup of the planned 7-rod cluster fuel element failure experiments in the ETR 3x3 fuel testing facility has been operated successfully in ELMO #4 ex-reactor logs at 300 C and 1450 psi. The fuel corrosion and rod damage followed the pattern as established in autoclave tests of control pieces, but the hydraulic rupturing mechanism did not work as well as desired. The test will be run again with an improved hydraulic rupturing mechanism.

Corrosion rate determination of defected fuel rod specimens is continuing. In a recent test a fuel rod specimen that had been beta treated, water quenched, and aged at 475 C for 350 hours produced a corrosion rate drastically reduced from that of unaged specimen. The corrosion rate was also less than that of beta treated and isothermally treated specimen (quenched to 600 C from beta and held ten minutes). This observation gives a clue to some anomalous behaviors noted with beta treated water quenched specimens in ELMO #1 loop testing and may show the way to a heat treatment which is simpler and more effective than the isothermal treatment, which to date has given the best results.

The failure of a defected coextruded fuel rod specimen was observed in a windowed autoclave at BMI this month. This test, and others which are being filmed, reveals that rupturing at intentional defects does not occur with explosive violence as many have feared but is rather very time dependent and occurs at a slow, steady rate.

In support of Hanford's fuel element development work, a series of experiments to obtain data on the dependence of clad uranium swelling upon cladding and uranium temperatures, cladding thickness, and exposure is being conducted. Four experimental assemblies, containing Zircaloy-2 clad uranium fuel rods and irradiated in the MTR and ETR as a cursory investigation of the effect of the above parameters on swelling, have been returned to Hanford for examination in July. Ten more assemblies to extend the coverage of the temperature, exposure, and cladding restraint parameters are 90 percent fabricated. These assemblies, being prepared for irradiation in the MTR, are similar to those just returned to Hanford. To attempt a statistical analysis of the effect of temperature, exposure, and cladding upon fuel rod swelling, a series of NaK capsule experiments have been designed for irradiation in process tubes of Hanford reactors. Assembly of the capsules is 25 percent complete. It is planned to begin irradiations in July or August.

A new metal forming machine, the Dynapak, was installed in the 326 Building for experimental extrusion and forging of fuel element components. The machine has a static capacity of 100 tons and a dynamic capacity of nearly 2,000,000 ft lbs. The few extrusions and coextrusions made indicate the metal flow under the high forming rates is essentially streamlined and coextrusion is possible. Closed die forging of UO_2 powder in aluminum and stainless steel sheaths showed densification of the green oxide up to 85 percent of theoretical density, a value considerably greater than obtainable by other compacting methods.

A design, development, and research contract for the induction heat treating of uranium is being prepared. This will be a three-phase contract to cover basic heat treating studies on short specimens of coextruded Zircaloy-2 clad uranium tube, methods of heat treating full length fuel element tubes, and the design and construction of equipment capable of heat treating and stretch straightening full length tubular fuel elements. A cooperative heat treating program with FPD is under way at the Ajax-Magnethermic Corporation. This program involves the induction heat treatment of coextruded Zircaloy-2 clad uranium rod sections. Various conditions of time at temperature, delay time between the temperature peak and quenching, and cooling rates have been investigated. Four conditions of water spray quench and three conditions of air quench were investigated. Water spray quench conditions involved pressures of 10 and 80 psig and temperatures of 28 and 80 C. The air cool conditions involved compressed air at pressures of 10 and 70 psig and a normal air cool at 28 C. This process provides a relatively simple method of heat treating long uranium rod and is readily adaptable to automation. Texture data are not yet available.

Metallurgical Development. Nine Zircaloy-2 clad uranium tubular cores were taken to BMI for pressure bonding in Battelle's high pressure gas autoclave. The specimens consisted of three cast bonded fuel geometries, two elements with the uranium core in the as-cast condition, two elements with NMI extruded uranium cores, and two elements with as-cast cores which had been subjected to a single beta treatment at 730 C, followed

by a water quench and an alpha anneal at 640 C, followed by an air cool. Cores were bright etched and electron beam closures were made. The specimens were pressure bonded in two batches, each at 10,000 psig helium pressure and 840 C (1550 F) for four hours. No leaks appeared when the elements were pressure checked after the bonding cycle. Metallographic examination of these samples has not been completed.

Facilities and Equipment. Remote measurement of irradiated fuel rods is required in reactor basin facilities and radiometallurgy facilities. Special problems arise in measuring the diameters of irradiated fuel elements which are to be recharged in-reactor. A clip gage using SR-4 strain gages has been developed which will measure the diameters of the outer rods of cluster fuel elements without having to disassemble the cluster element. The gage has an accuracy of 0.1 mil and a range of 20 mils. Higher ranges of measurement could be obtained if special hardened steels were used in the gage fabrication. Two gages are now being machined for use in the Radiometallurgy facility and the ETR basin.

The effect of irradiation upon the accuracy of strain measurement will be determined by making measurements on irradiated swelling samples in a Radiometallurgy cell.

Gamma heating in HAPO's 6x9 ETR fuel testing facility has been measured as the first experiment in the facility. An instrumented stainless steel slug was operated in the 6x9 (reactor core), and a gamma heating value of about 20 watts/gram at full ETR power was obtained.

The relocation of testing facilities in 303-J Building is now nearly complete. A few minor items remain to be done, such as laying a driveway, lagging the steam lines, and installing some electrical outlets. When completed, this testing center will include facilities for performing the following routine tests: sonic orientation test, leak vulnerability (water autoclave) tests, OD and ID frost test, ultrasonic bond test, vectorscope test, dimension checks, Dy-check test, autoradiographs, macro- and micro-visual surface examination, destructive removal of jacket by chisel test and/or lathe turning, and weld and end cap radiography.

2. REACTOR PROGRAM

Coolant Systems Development

Nickel-Plated Fuel Elements. Out-of-reactor testing of nickel-plated fuel element cans at 165 C and 120 C in process water is continuing. Examination of the pieces at 120 C after 12 weeks exposure indicates excellent corrosion resistance. No evidence of local attack at defected spots was noted. The test at 165 C after four weeks exposure showed very good corrosion resistance with very little penetration at the defected spots. However, boiler type scale formation was very evident on the surfaces of several of the test pieces.

Temperature Variation in Flow Channels. The charge in KER-2 includes thermocouples to measure water temperatures in the different flow channels after passing over seven aligned non-wire-wrapped, 1.6% enriched 7-rod clusters. These indicate a spread of water temperatures of about 20 C; the inner flow channels average 10 C hotter than the outer. During a week of operation at low temperature (outlet below 100 C, necessitated by a pinhole weld leak in the piping), this temperature spread was the same as at 260 C outlet.

In-Reactor Corrosion of Aluminum. KER-3 was charged May 23 with 20 aluminum-clad Doe-alloy slugs. Five were clad in X-8001 and 15 with C-810 alloy (X-8001 with 0.1% Ti added). The principal purpose of this charge is to condition the loop for a few weeks at high temperature following decontamination and tube replacement. The next charge will be a four-month corrosion test of aluminum clad elements for which it is essential that the water quality be under careful control. Several instances of high loop activity have occurred, apparently the result of sloughing off of radioactive crud. This charge is also the first in-reactor exposure of slugs clad in C-810. Out-of-reactor tests have indicated that this new alloy is more resistant to intergranular attack than X-8001. Operation is at about 210 C, pH 4.5 H_3PO_4.

Out-of-Reactor Corrosion of Aluminum. The C-810 alloy clad Doe slugs and X-8001 alloy clad Doe slugs charged into ELMO-6 were discharged after four weeks operation at 300 C, pH 4.5. Both the X-8001 and C-810 alloys were in good condition. No abnormal corrosion was noted on the weld areas or surfaces of the slugs. These slugs will be defected and exposed to 400 C steam to duplicate the rupture conditions which could exist in the next KER-3 test. In this test the aluminum metal temperature will be operating at 400 C. This rupture test will help predict the severity of a KER-3 rupture. Coupons of X-8001 were removed from ELMO-6 and will also be exposed to 400 C steam to determine the protective nature of the corrosion product formed at 300 C.

Fretting Corrosion of Zr-2. Two fretting tests were performed in ELMO-7 during the month. One test consisted of a Zircaloy-2 tube spirally wound with Zircaloy-2 wire fixed at one end but free to move at the other end. The assembly was exposed to 300 C pH 6 to 7 water for two weeks at about 25 fps. No pre-treatment except etching had been performed on the Zr-2. The components were etched prior to assembly. Upon discharge, four areas of wear in the form of grooves were noted in the tube. Estimation of the depth of these grooves was one to five mils. Some white oxide was present at these grooves. The groove areas were directly below the wire wrapping and wear on the Zr-2 wire was also one to five mils at this point. Where the Zr-2 wire contacted the type 304 stainless steel test section, the wire was worn down about 20 mils. Metallographic examination is being made on the tube. Another assembly was exposed in ELMO-7 and consisted of a 1/2 inch Zr-2 process tube with Zr-2 wires used for ribs and 1/4 inch Zr-2 rods used for slugs. All pieces again were etched prior to assembly. The specimens were exposed to 300 C pH 6 to 7 water for six days at ~50 fps. On examination it was noted that the wires

were missing and probably had fretted away at the contact points. The tube and "slugs" had fretted from 5 to 50 mils wherever contact had been made with each other and with the wires. The 50-mil penetration occurred where the slugs had vibrated against the process tube. The tube had been positioned in the test section with 304 stainless steel spacers to cause all of the flow to pass over the "slugs". Where the 304 stainless steel and the Zr-2 tube made contact, fretting occurred on both materials. In addition, cracking was observed in the tube in this region. Both the tube and one "slug" are undergoing metallographic examination.

Rupture Testing. A fourth half-hour run, making a total of two hours exposure, was made with a coextruded uranium and Zircaloy-2 fuel rod in the as-extruded condition. Test conditions were 300 C, 1650 psi, power rate 30 kw/ft, and 20 fps velocity. The general conclusion from this series of tests is that very little difference exists between the rupture rate of heated (internally) and unheated rods. The uranium oxide release rate during the last exposure was 0.72 gram/minute per defect. The maximum diameter of the rod was increased to 0.79 inch from an original 0.59 inch.

The projection element for ETR rupture testing was exposed for an additional hour, for a total exposure of 2-1/2 hours at 300 C. Rupturing at the end-cap had caused considerable swelling, with the maximum diameter increased to 0.87 inch from an original 0.59 inch. After a total of three hours exposure at 300 C, two coextruded rods beta-heat-treated followed by isothermal treatment exhibited almost negligible swelling along the initial 0.030 inch slit defect.

Long-Term Effects of Decontamination. A six-month operating test has been started in CEP-1 at simulated NPR operating conditions. Long-term corrosion effects from repeated decontaminations of this all-stainless steel loop with Turco-4501, Turco-4502, and HNO_3 are being evaluated. The loop was also charged with 304 stainless steel coupons stressed to 100% of yield and Zr-2 coupons stressed to 50% of yield, to determine the effect of these repeated decontaminations on stress corrosion.

CEP-4 loop installation incorporating mixed carbon and stainless steel is expected to be completed by July 15, 1959. This loop will be operated under simulated NPR conditions for six months to study the long-term corrosion effects from repeated decontaminations of a mixed carbon steel-stainless steel system with Turco-4501, Turco-4502, and Turco-4512.

Corrosion Evaluation of Decontaminants. A coupon holder containing C-810 aluminum alloy coupons was charged into KER Loop 3 to determine whether there is a significant change in corrosion rate following a loop decontamination. The holder is located at the downstream end of the fuel element charge. Five coupon holders containing A-212 carbon steel and Zr-2 coupons pre-treated in Turco-4512 decontamination solution and non-treated control coupons were charged into KER Loop 2. This test is to determine whether large corrosion product film build-up will occur on carbon steel after Turco-4512 treatment during in-reactor exposure. Out-

of-reactor tests indicate that film build-up is 1.7 times larger on coupons treated with the Turco-4512 (inhibited H_3PO_4) solution than on non-treated coupons.

Film weights and uniform corrosion of carbon steel coupons pre-treated in Turco-4512 decontamination solution and exposed in 300 C, pH 10 water agree with previous tests. The film weights of the pre-treated coupons were 1.7 times heavier than values measured for polished coupons. Initial penetrations are 0.05 mil for the polished coupons and 0.08 mil for the pre-treated coupons. Also included in this test are etched and non-etched Zr-2 coupons which were processed in the Turco-4512 decontamination solutions. No differences in weight gains or surface appearance were found between the etched and non-etched coupons. These coupons are showing decreasing weights with increased exposure. At discharges after 325, 650, and 805 hours the weight gains were 15.5, 12.4, and 10.8 mg/dm^2, respectively.

Structural Materials Development

Zircalcy Pressure Tubing. Zircaloy-2 pressure tubing is being tested to failure with internal pressure at elevated temperatures, as part of a program to study the tensile properties and failure mechanisms of this tubing. An NPR type process tube with 20 percent cold work was burst at 350 C and 10,000 psig internal pressure. The unit hoop stress was calculated to be 57,300 psi, with 3.8% uniform elongation and 8.8% localized elongation of the diameter. The tube failed in a longitudinal split which continued for about six inches, then turned both right and left, transverse to the axis of the tube, and continued about half way around the circumference at both ends of the original crack. The failure mechanism appeared to be shear since the fractured surfaces were inclined approximately 45 degrees to the direction of principal stress. The parallelogram pattern discussed in the May 1959 monthly report was observed on the inside surface of the tube both before and after testing, suggesting that the failure had a mechanical rather than a crystallographic origin.

Creep Testing of Zircaloy-2. A new lot of annealed Zircaloy-2 material has been shipped to Battelle Memorial Institute, and testing is under way.

Strain gage modifications have been completed for an in-reactor creep capsule. Shop difficulties are still being encountered in fabricating a reliable capsule heater. One of the modified bellows for the in-reactor creep capsule has been received and tested. Although not to specifications, the bellows is acceptable. It is expected that this creep capsule will be shaken down and ready to start in-reactor creep tests early in FY-1960.

Nonmetallic Materials Development

Irradiation of Candidate NPR Graphites. Recent revisions in the schedule for off-site irradiation of candidate NPR graphites have been made to include the following factors:

1. Exposure accumulation in the ETR facilities will not be at the rates originally predicted due to low power levels and operating efficiencies. Consequently, the time for each ETR irradiation has been extended. Also, the sample arrangement has been redesigned to accommodate more samples.

2. Processing variables which might improve the dimensional stability of graphites under irradiation were selected during recent discussions with carbon manufacturers. Samples which represent reduced grain sizes and increased graphitization temperatures were prepared by the manufacturers and are incorporated in the revised irradiation schedule.

3. Irradiations of NPR candidate graphite samples are being scheduled into the GETR by August 3, in order to compensate for lost space and irradiation time in the MTR (e.g., L-42) and the ETR.

Compression Set in Graphite. An annealing of a compression set introduced by sample preparation has been noted on 1/4" diameter samples of KC, CSF, TSGBF, and Continental graphite after 45 minutes at 650 C. The expansions obtained from five samples of each graphite were:

KC	0.046 ± 0.003%
CSF	0.033 ± 0.002%
TSGBF	0.027 ± 0.002%
Continental	0.047 ± 0.001%

where the statistical errors of the mean value were computed from the sample variance. These data tend to support the hypothesis that the initial expansion which has been noted upon high temperature irradiation of graphite arises from a thermal annealing of a compression set.

IP-22A Intermediate Temperature Graphite Irradiation. The graphite test assembly located in 1573-DR has not functioned properly since it was installed on April 27, and so far the cause of the failure has not been found.

A new assembly containing CSF graphite is to replace the defective one during the next shutdown period as authorized by PT-IP-22A, Supplement D, HW-60453.

Stored Energy Apparatus. A test of the stored energy calorimeter with its new shield heater showed satisfactory manual operation to about 1200 C. About 75 cal/min of power to the unirradiated graphite specimen was needed to hold this temperature. Much of this heat loss is believed to be through the ends of the calorimeter. Calibration of the apparatus is in progress with materials of known heat capacity, such as copper and beta-brass.

Thermocouple Development. A survey is being made of the performance of the iron-constantan, porcelain insulated reactor thermocouple stringers. This is being conducted to provide a basis for comparison with thermocouples of Driver-Harris alloys 242/33 (Geminols) which are currently installed or scheduled for installation in most reactor stringers.

Thermal Hydraulics Studies

Equipment Projects. The silicon rectifying equipment (Project CG-661) which was installed in 189-D to provide additional heat generating capacity in the Heat Transfer Laboratory was operated at powers up to 2700 kw during startup tests. Various minor adjustments of the controls and instruments were found to be necessary before the acceptance tests can be completed.

The project to modify the High Pressure Heat Transfer Apparatus for higher flow and heat generating capacities and to allow transient type experiments (Project CGH-834) continued on schedule. The 250 gpm pump was installed and run successfully during startup tests. The electrical bus work was modified to increase its capacity to 32,000 amperes. A bus intertie was finished that provided for operation of the apparatus with

either the motor-generators or the silicon rectifiers as an electrical source for heat generation. These modifications are sufficient to allow experimentation with short test sections simulating NPR fuel elements under prototypical reactor operating conditions.

Hydraulic Studies. Flow experiments were conducted to determine the pressure drop and flow split characteristics of C-II size self-supported I & E fuel elements in a ribless BDF process tube. (The designation C-II is a fuel element model having specified dimensions as shown on HAPO drawing H-3-7350, "Canned Virgin Uranium Fuel Elements." The nominal canned dimensions are 1.460 inch OD by 0.375 inch ID.) These fuel elements exhibit a pressure drop characteristic only about five percent greater than for the same nominal size fuel element (not self-support) in a ribbed BDF tube. The annulus-to-hole flow ratio was 1.33 for the self-supported fuel elements. The data and results of these experiments are presented in HW-60566.

Data were recorded which show the pressure drop across a 7-rod bundle of 0.704 inch OD rods for two cases: 1) with no wire wrapping, and 2) wire wrapping of the six peripheral rods on a two-inch pitch. These data show that the pressure drop is about 12.5 times as great for the two-inch pitch wrapped case as for the non-wrapped bundle. This compares with a pressure drop ratio (i.e., Δ P wrapped/Δ P non-wrapped) of about 8.5 for the 0.780 inch OD rod bundle and the two-inch pitch wrapping as reported in HW-59333.

The mockup of the KER process tube in the hydraulics laboratory was modified with the replacement of the M-257 aluminum tube with one of equal dimensions composed of Type 316 stainless steel.

Miscellaneous. Modification of the low pressure apparatus to allow use of short test sections for special heat transfer studies of present Hanford reactor fuel elements was 75 percent complete. Test sections were constructed to determine heat generation rates associated with subcooled burnout and to study effects of eccentric placement of the fuel element in the process tube. These studies will be aided with the use of a glass process tube.

Bids were reviewed and orders placed to procure materials for a 20-foot electrically heated mockup of the NPR 7-rod fuel element. Appropriate materials were found that would allow the simulation of cosine heat generation within the test section. Fabrication of the process tube and hydraulic heads was initiated in on-site facilities.

Mechanical Equipment Development

Organic Cooling System Components. The MOTS-1 facility operated for 276 hours during the month at temperatures between 275 and 300 C and pressures between 250 and 300 psig. The main pump developed a leak in the coolant side stream which resulted in the organic leaking out through the cooling water system. The pump bearings, which are organic lubricated, were

inspected and found to be in good working order after approximately 5000 hours of operation.

The pressurized fire test using monoisopropylated terphenyl indicates that a small leak will not support combustion although a large leak will. The fluid is less combustible than MIPB and is extinguished easily with a small amount of water.

Reactor Technology Development

Attenuation Measurements. A summary report on the shielding properties of ferrophosphorus concrete and ordinary concrete is in progress. The second test on the neutron attenuation through iron is being analyzed.

Two new sets of test slabs were fabricated: 1) using a barite mixture and 2) using a serpentine mixture. The serpentine concrete is scheduled to be placed in the test well atop the DR Reactor for the first irradiation at month-end. The neutron collimator for the DR wells is under construction.

Foil counting has been completed on the first foil loading of the NPR boron steel thermal shield test. Analysis of the results is under way.

Shielding Instruments. The 100-channel analyzer is again running correctly. The primary difficulty originated in the binary-to-decimal conversion blocking oscillator which was firing in the wrong time sequence or not firing at all.

3. FABRICATION DEVELOPMENT - SPECIAL ALUMINUM-PLUTONIUM FUEL ELEMENTS

An additional 69 billets have been cast for the experimental fabrication of fuel elements for SRP irradiation. All analyses on the entire fuel fabrication have been within five percent of the nominal fuel composition. The boron pickup (10 - 100 ppm) on these alloys, which was reported last month, continued to occur in the alloys cast this month. Since the boron pickup coincided with the use of clay-graphite induction melting crucibles, samples of the raw materials used in the crucibles have been obtained from the manufacturer in order to determine the source of the boron. These samples have not been analyzed to date.

An average of 12 billets per day have been extruded. Billet soak time and billet furnace capacities are limiting factors in this extrusion rate. Surface condition of extrusions has been improved by minimizing the amount of oil-dag on the die. This causes noticeable die pickup, and cleaning in a caustic solution is required after extrusion. Two hundred twenty-eight transplutonic elements have been extruded to date.

Final inspection of the fuel rods showed inclusions of a foreign alloy material in the 8001 alloy jacket. This material was analyzed to be high in tin and lead, and was picked up from rod straightener guides. A nitric, hydrofluoric and chromic acid etch was used to selectively remove the inclusions. Even with the chromic acid inhibitor present, the base metal was

[redacted]

etched at a rate of four mil per hour. The maximum etch time for acceptable rods is 15 minutes.

Eighty-one good elements were shipped during the month for a total of 114 to date. Thirty-six additional elements are required to complete this work.

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 distributions lists appropriate to weapons development work.

C. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Fuels Development

Basic Studies. Sinterability experiments in the system UO_2-PuO_2 have continued, and data are available at one hour hold times across the UO_2-PuO_2 composition limits. Sintered densities appear to be markedly dependent on pressed densities with densification occurring very rapidly at higher pressing pressures. The following table illustrates the effect of one hour at temperature on final density for pure plutonium dioxide pressed to both 40 and 60 percent of theoretical density.

Temp.	40% TD	60% TD
1100	73.6	--
1200	78.4	--
1300	81.8	96.9
1400	86.3	95.7
1500	87.6	89.7
1600	92.9	--

Metallographic examination of UO_2 compacts bearing up to 10 w/o PuO_2 and sintered at temperatures up to 1600 C revealed the porosity pattern and densification occurring at elevated temperatures. Etching indicated a large amount of porosity to be along grain boundaries and a decrease in the total number of pores at higher temperatures. It was attempted, both metallographically and by x-ray diffraction, to obtain information on the time and temperature dependence of solid solution formation during sintering. At magnifications up to 500X, a second phase on samples sintered at low temperatures could not be detected because of the extreme porosity. On the other hand, those samples sintered at the higher temperatures show a minimum of porosity; however, the single phase formation is complete. Diffraction patterns of UO_2-2 w/o PuO_2 and UO_2-10 w/o PuO_2 heated for eight hours at 1200 C gave very sharp peaks with no evidence of two phases at low angle refelctions. Lattice parameter calculations may, however, show solid sclution formation to be incomplete.

The first results of a sintering study in which as-received ceramic grade Spencer UO_2 was compared to PWR grade MCW UO_2 ball milled 48 hours show the former to have a higher sinterability. When both powders are pressed at 25 tsi and sintered in helium, the Spencer material shows a higher density at each temperature and time. A comparison of the sintered densities of these oxides show the Spencer material to be higher at shorter sintering times and lower temperatures. They both have equivalent densities (93% TD) when sintered five hours at 1500 C in helium.

The preliminary hydrogen sintering data show Spencer UO_2 to have a higher density at all sintering times and temperatures. An ultimate density of 98% theoretical was achieved by sintering the Spencer material 6.7 hours at 1600 C.

Fabrication Studies. Examination is in progress on the full length Zircaloy clad and wire wrapped dummy element that had been fabricated by swage sizing and thermally cycled 1650 times in the Elmo loop at a pressure of 1530 psig and a heating and cooling rate of 50 F per minute. The cladding split longitudinally from core swelling, and the element was badly distorted. The element took a permanent set following the contour of the wire wrap which was still intact. An over-all length measurement of the element was made, and it had increased about 3/4 of an inch. A one-inch gap was provided between the end of the core and can to accommodate the differential thermal expansion of the core. After thermal cycling, there was a four-inch gap on one end and an 8-1/2 inch gap on the other end of the element indicating that gross thermal ratcheting had occurred. The diameter of the aluminum rod had increased considerably in some areas; however, the density of the rod in these expanded regions did not change from the theoretical. An examination of the Zircaloy showed that the fractures in progress are emanating from the inside surface of the tube. It is difficult to hypothesize a mechanism which fully explains what occurred; however, it appears that the Zircaloy tube is gripping the rod and preventing differential slippage between the two upon heating. The tube plastically deforms and lengthens with the rod, and at the same time, the rod is upset by the restraint of the tubing. This occurs because the gripping action of the tubing is probably intermittent, and upsetting occurs between points of seizure. On cooling, the core contracts more than the tubing, and this is repeated on subsequent cycles. The wire wrap and the pressure of the coolant may further complicate the ratcheting effect.

It is felt that the rate of heating and cooling plays an important part in this mechanism. Heating and cooling rates of the coolant stream in the PRTR will be of the order of 4 F per minute, so from this point of view, the thermal cycling test of the element which failed was much too severe and perhaps unrealistic from an evaluation standpoint. Elements fabricated by the same process which are two and three feet long are being thermally cycled in an autoclave under conditions which more closely duplicant anticipated PRTR conditions, i.e., heating and cooling rates of the order of 4 F per minute and a pressure of 1300 psig. No discernable changes have occurred in these elements after being subjected to 20 cycles. These tests will be continued. It is estimated that an Al-Pu element will receive about 15-20 complete thermal cycles during its residence time in the PRTR. Additional tests on full length elements will be conducted under PRTR conditions in the Elmo loop.

A Mark I-B 19-rod dummy cluster with 1200 hours in the Elmo-7 hydraulic test loop has just been received. This cluster was made up of 17 stainless steel clad and two Zircaloy clad aluminum cored rods. It contained the first two Zircaloy-2 tubes received by PMO.

The test conditions were:

261 hrs, steady state at 580 F 1900 psi 120 gpm,
277 hrs, 45 thermal cycles 300-580 F 1900 psi 120 gpm flow,
470 hrs, 50 thermal cycles 300-527 F 1530 psi 120 gpm flow,
139 hrs, steady state at 527 F 1530 psi 120 gpm flow,
52 hrs, steady state at 572 F 1900 psi 120 gpm flow.

A preliminary examination of the cluster showed it held up well under the conditions with the exception of a slight 1/8" bow over the full length of the cluster. This was caused by the lengthening of the Zircaloy rod on one side which, being restrained between the two end brackets, caused the element to bow. Heating and cooling rates for this test were approximately 6-10 F/min, which may account for its better performance under thermal cycling.

Fourteen Al-1.8 w/o Pu billets were made for the PRTR fuel fabrication using the plutonium oxide-aluminum-cryolite reduction process. The results of the first reduction showed the alloy to contain 1.7 w/o Pu and the flux to contain 0.12 w/o Pu. The Pu loss to the flux was one percent of the total Pu charge; the flux to alloy ratio was 1:5. In two subsequent reductions the ratio was reduced to 1:13 and 1:20.

Three different core materials were used for injection casting studies: 1) Al-5 w/o Zr injection cast into Zr, 2) Al-3 w/o Zr, 2 w/o Fe injection cast into 0.008 inch wall 304 stainless, and 3) Al-1 w/o Ni in 0.008 inch stainless. Fifty pounds of Zr-16 w/o Fe were requested for injection casting capability studies.

Aluminum 12 w/o Si was injection cast into a 0.030 inch wall Zr tube which had 1/8 inch wide reductions in the tube. The reductions were "necked into" the tube with a modified tube cutter before the casting was made. The outside diameter of the tube was reduced 0.040 to 0.060 inch at six-inch intervals along the length of the tube. The radiograph of this casting revealed that the core was broken apart near one of the restrictions leaving a 1/4 inch long void 12 inches from one end. Thermal cycling tests are planned for this prototypic element to determine if the design has merit for alleviating the problem of differential thermal expansion.

Another design which will be thermal cycled in Al-1 w/o Ni alloy injection cast into 0.008 inch wall 304 SS tubing. As reported in November 1958, a similar combination was furnace cycled five times to 450 C with no apparent longitudinal separation of the core and clad. These tests were conducted on short lengths (9 and 12 inches) with no end caps in the tubing so the results were not conclusive. Additional

thermal cyclic autoclave tests are planned for full size (89-inch long) elements with end caps. The bond formed when aluminum is cast into 0.008 inch stainless tubing is thin (0.00015 inch) and is broken on the stainless side during cooling; however, the thin reaction layer remaining on the periphery of the simulated aluminum fuel rod is hard, very smooth, and more corrosion resistant than the core alloy. It is believed that such fuel elements with no end clearance at the end caps may be superior to Zr clad elements in withstanding the stresses imposed by differential expansion during reactor thermal cycling. Development of welding procedures has begun for end cap closures on 0.005 and 0.008 stainless steel tubing.

Two unsuccessful attempts were made to injection cast 1100 alloy aluminum into 89-inch long 8001 alloy aluminum tubing (0.030 inch wall). The problems presented in making 89-inch long injection cast fuel elements in which the melting point of the core alloy is near that of the cladding are not insurmountable, but more time will be required to solve the problems, which become more serious when plutonium is added to the alloy. Al-12 w/o Si was injection cast into 8001 aluminum tubing (0.030 inch wall) with a resultant density of 97% in an 87-inch length. The AlSi core was not bonded to the aluminum tubing; however, the core was apparently in intimate contact.

An aluminum-5 w/o Zr alloy was injection cast into an etched 0.020 inch wall Zr tube, and the bonding layer was examined at 500X. A somewhat thicker Al-Zr reaction layer resulted, but the layer was cracked and separated from the tube in some of the transverse sections which were examined. It appears that thin bonds, as obtained full length with 1100 alloy aluminum cast into 89-inch long Zr tubing, are stronger at room temperature than the thicker bond obtained with this one experiment with an Al-Zr alloy.

An aluminum-1 w/o Ni alloy was cast into a 0.030 inch wall Zr tube that had been vacuum outgassed for six hours at 800 C and 0.5 micron. This injection casting, which was made with 35 microns pre-evacuation of the tube, 690 C aluminum and 75 psig, was 95% of theoretical density, as determined by weight and length measurements. Previous castings in as-received tubing resulted in 93% maximum density. Hydrogen extraction analyses of the tubing before and after furnace annealing will be requested when a group of five tubes has been tested.

Steel tubes have been loaded with Al_2O_3 and swaged in the rotary two-die machine. Since this machine must be fed by hand, a reduction in diameter of 22% was the greatest effected. This resulted in a calculated density of 80% theoretical density. An investigation is continuing on possible methods of closing swaged UO_2-PuO_2 rods without undue decontamination procedures. The swage feeding mechanism has been completed and will be installed as soon as the swaging facility in the Pilot Plant is accepted. The wedge adjusting mechanism is also ready for installation.

Flattened tubes were loaded with fused alumina. These were evacuated for 16 hours at 250 C and pinched off. The plates were given a 25% reduction in two passes. After annealing for one hour at 790 C, the plates were given another 25% reduction. The final measured density was in excess of 90%. Most of the plate failures have been found at the trailing end of the plate. To alleviate this problem, the can and end closure design is being modified.

Study of plutonium-bearing fuel elements for future loadings in the PRTR is continuing. Emphasis is being given to cost, geometry, fabrication, and fuel and cladding materials. Several 7-rod cluster designs have been explored. Other work is being done on cheaper 19-rod end bracket designs.

Five Al-5 w/o Pu billets were cast and extruded to 0.505-inch diameter rod to complete the critical mass experimental fuel elements for Physics and Instrument Research. The last of the 220 Zircaloy clad elements required will be shipped the first week in July.

Dies and a cold weld press have been fabricated for canning Pu-containing foils. The equipment is being installed for the fabrication of PCTR test foils as well as for off-site foil requests. Pu-Al rod is being extruded and Zircaloy tubes are being prepared for loading of the 240 PCTR test elements.

Fuel Evaluation. Two, high-density, UO_2-PuO_2 capsules (GEH-14-19, 20) were charged in the MTR on June 8, 1959, for irradiation during MTR Cycles 123 and 124, and will be discharged about July 27, 1959.

Sixteen Al-5 to 20 w/o Pu alloy capsules (GEH-14-5 through 12 and GEH-14-42 through 49) have been approved for MTR irradiation and are scheduled for charging in MTR Cycle 124 on July 6, 1959.

Four irradiated, high-burnup Al-Pu and Al-Si-Pu alloy capsules (GEH-14-23, 24, 25, 26) have been dejacketed and are being examined in the Radiometallurgy Laboratory.

Radiometallurgical examination of the unbonded, four-rod, Al-Pu alloy cluster (IP-186A) irradiated in the KER-3 Loop is continuing. Replicas of fractured fuel rod surfaces have been prepared and submitted for examinations. Samples of the two fuel rod alloys are currently being studied by x-ray techniques.

The 7-rod, Al-Pu alloy cluster for irradiation in the KER-1 Loop during the next scheduled charge (IP-250A) has been completed and is currently being shipped to the reactor facility. The prototype cluster is about 28 inches long and was assembled with quick-disconnect type end fittings.

The three-foot long nineteen-rod Zircaloy clad Al-Pu cluster has been completed and sent to the ETR for irradiation. An exact duplicate cluster to be tested in the ETR critical facility was also sent at the same time. This element contains an Al-0.5 w/o Pu alloy fuel material which, when

exposed in the 6x9 loop facility, will generate the maximum specific power expected in a 19-rod cluster operating in the PRTR. Maximum core temperatures of 450 C and surface heat fluxes up to 302,000 BTU/hr-ft^2 are expected. This cluster was fabricated by the anticipated PRTR fuel fabrication process, which is to insert undersized rods into as-received Zircaloy tubing and sizing the sealed tube onto the core by swaging.

Six PuO_2 impregnated graphite capsules clad in Zircaloy have been sent to the MTR for irradiation. The two-inch long graphite cores will operate with maximum calculated core temperatures of 345, 525, and 780 C. They will be irradiated to 25 and 50 percent burnup of the plutonium atoms and returned to HAPO for examination.

UO_2 Fuel Development

PRTR Fuel Elements. Nine hundred pounds of UO_2 for swaging PRTR fuel rods were prepared this month by ball milling, pressing with the 300-ton press, sintering, crushing, screening, and outgassing.

The first off-site order of PRTR 19-rod cluster end caps, enough for forty fuel elements, has been received. This order was fabricated from approximately 430 feet of 0.60 diameter Zircaloy-2 rod for $4,895.88.

Design of a segmented nested tubular fuel element is in progress. This design will separate the Mark II-C element into four separate fuel sections. If necessary, a fuel element may be discharged, a section replaced remotely, and be recharged into reactor. On final discharge, the element can be easily disassembled for ease of transportation and chemical processing.

Fabrication Development. The preliminary Zircaloy-2 clad fuel element weld samples made by magnetic force butt welding have been evaluated by helium leak test, hydrostatic testing, tensile testing, autoclaving, and microsection examination. The test results were encouraging, demonstrating the excellent quality of this type of weld. Micro-examination showed the narrow heat affected zone with the weld metal consisting of a fine fragmented grain structure. The heated weld area collapses under pressure during the weld cycle producing upset material both internally and externally. The internal upset metal reinforces the weld area and provides a transitional increase in cross section from the thin tube wall to the thick cap. The external upset metal must be removed by a subsequent machining operation. Magnetic-force resistance butt welding will produce high integrity Zircaloy-2 clad fuel element closures. Complete welded joints can be produced without a protective atmosphere in 1/60 second of weld time.

The Genisco-Savage vibration system was received and put into operation. Sintered and fused UO_2 powders were compacted in eight-foot tubes to 84 and 86 percent, respectively, of the theoretical UO_2 density. Particle size compositions available were not those which compact to the highest

densities. The sintered material consisted of 60 percent of -3 +8 mesh particles and 40 percent of -20 +100, with no fines. Fused UO_2 composition was:

60%	-6 +10
15%	-35 +65
25%	-100 +200.

Sintered UO_2 normally used for swaging (-20 +100 mesh) was compacted to 70% TD in 0.750" OD x 0.035" wall tubes and then swaged to 0.563" OD. Final swaged densities are being determined with the gamma absorptometer.

The particle size distribution of swaged UO_2 rods was measured to determine what percentage of the UO_2 in reject rods could be reused provided a satisfactory method of recovery is devised. Particle size specifications for UO_2 powder before swaging are presently -20 +100 as defined by Tyler mesh screen sizes. After swaging, only one percent of the UO_2 powder fell outside this range, indicating that nearly all of the swaged powder was acceptable, as far as particle size was concerned, for reswaging.

The effect of swaging on various types of cladding is being evaluated. During the past month 70 percent cross sectional area reductions were satisfactorily achieved when swaging 0.700 OD x 0.015 wall Inconel X and 0.678 x 0.020 wall M-257-F aluminum tubing (SAP). These experiments indicate that these materials can be used as cladding for swaged UO_2 fuel elements.

Zyglo-Pentrex testing of Zircaloy-2 tubes prior to swaging has proven capable of detecting defects as small as 0.001 inch in depth. Metallographic examination of cross sections of those defects has shown that all Zyglo indications are definite cracks in the metal surface.

Defects present in the as-received tubing may be propagated during the subsequent swaging and straightening operations, and it is, therefore, desirable to swage only tubes free from Zyglo indications. Therefore, the 1676 tubes on-site, but not yet consigned to CFDO, were Zyglo-Pentrex tested on the external surface. Approximately 62 percent of these tubes showed Zyglo defect indications. The indications were categorized as either "pit" indications or "line" indications. It is felt that, in general, the line indications are more serious defects than the pit indications. Those tubes containing only pit indications are to be surface conditioned by centerless grinding with the expectation that the majority of them can be reclaimed. The tubes containing line indications will also be centerless ground, but the reclamation rate is expected to be quite small.

Methods of inspecting the internal surface of the Zircaloy-2 tubes are being investigated by the Testing Methods Operation.

Fuel Evaluation. The three-foot long UO_2 rod and tube element, which ruptured after reinsertion in the ETR was examined in the MTR hot cell. A longitudinal failure in the outer cladding wall of the fuel tube was the obvious rupture. This failure may have been caused by restriction of the outer cladding coolant annulus by one or more thermocouples. The restriction caused high local temperatures and resulted in cladding burn-through. There were no other evident defects on the fuel element.

The post-irradiation examination of a cored and sintered UO_2 fuel element revealed a failure in the Zircaloy-2 end cap. The fuel element, 1.44" OD and 8" long contained natural UO_2 sintered compacts with a 0.250" hole in the center. The following observations have been made:

1. Failure occurred at end cap nearest peak thermal flux. The end cap was distorted, with a brittle fracture, causing the failure.

2. The 0.25" hole which ran the full length of the UO_2 was partially filled.

3. Extremely large radially oriented columnar grains run to within 0.25" of Zircaloy-2 cladding.

A series of swaged UO_2 capsules continued to accumulate exposure in the MTR and ETR. The maximum exposure to date is approximately 8700 MWD/T.

A four-rod cluster containing arc-fused natural UO_2, vibratory compacted to 78 percent of the theoretical density was discharged after a successful irradiation of three cycles in the MTR to approximately 900 MWD/T.

A sintered UO_2 fuel element containing 2.35 w/o U-235 enriched UO_2 failed during startup of the MTR. The cause has not been determined. The stainless steel clad fuel element, 1.44" OD and 9" long, contained high density sintered UO_2 cylinders with a 1/4" hole in the center. The element was to be irradiated with surface heat fluxes near 1,000,000 BTU/hr/ft^2.

Two, eighteen-inch long, 7-rod cluster elements of UO_2 swaged in Zircaloy-2 cladding, discharged from a KER loop as being possible ruptures, were tested for fission gas release. The elements were individually tested in the Radiometallurgy Building basin in a special container. After an element was sealed in the container, water was forced out by CO_2 gas which was then allowed to occupy the chamber with the self-heating element for a suitable time. The test chamber was then evacuated to less than atmospheric pressure and the collected gas analyzed for fission gases. No fission gases were found which indicates that neither fuel element was ruptured.

Facilities. A hammermill was placed in operation for pulverizing sintered UO_2. By using three-inch diameter, one-inch thick tablets pressed in the 300-ton press, the jaw crushing operation has been eliminated, as the hammermill is capable of pulverizing tablets of this geometry.

A rotating screener with automatic feeder was placed in operation for screening pulverized UO_2 from the hammermill. The screener has a capacity of approximately 200 pounds of feed per hour.

A sound-controlled feeding device for the continuous ball mill was provided by Chemical Research Operation. The device automatically maintains a constant UO_2 charge in the ball mill, thus making possible optimum operation and eliminating excessive aluminum oxide contamination of the UO_2 caused by operating the mill in an underloaded condition.

Two more pieces of equipment were put in service this month for fabrication of PRTR fuel elements. The first is a turret lathe which was [redacted] to welding. The second piece of equipment is a Van-o-lite finisher (a belt sander) which is being used to buff the surface of swaged rods. The Van-o-lite finisher reduces the time required for buffing by about two-thirds and further time saving will be made when a motorized drive is fabricated.

A Sutton No. 35 (stationary spindle) swaging machine has been received and is being installed in the basement of the 325 Building. This machine is equipped with a slow rotating head so that the work may be fed without rotating and still not produce fins. This swager is also equipped with separate sets of adjusting cams for controlling the stroke of the dies and the stroke of the hammer blocks. The machine will provide adequate capacity to swage at least one inch diameter fuel rods. The machine will be used for R&D studies, particularly hot swaging, and will also serve as a backup machine for swaging PRTR fuel rods in case of malfunctioning of present equipment.

Corrosion Studies

Allowable Zirconium Concentration in HNO_3-HF Etch Bath. Recent data showed that an excess of zirconium in the etch bath caused staining of autoclaved Zircaloy surfaces, and hence, a test was initiated to determine the allowable zirconium concentration in the etch bath. Preliminary results show that a zirconium concentration of 11.75 g/l will cause staining of PRTR fuel elements if transfer times between the etch bath and the aluminum nitrate "stop bath" approach 30 seconds. No staining was detected on rods processed with transfer times less than 10 seconds, or on rods processed through an etch bath containing 9 g/l zirconium and 30-

Zircaloy. A Vanton Pump was tested for use in the HNO_3-HF etch bath recirculation system. Under nominal operating conditions, the pump should operate satisfactorily and should require no replacement of parts for a period of 9 to 12 months. The only detectable wear after 300 hours of operation (100 hours with water and 200 hours with a standard HNO_3-HF etch solution) was a crack in the Kel-F liner which did not affect the pump's operation.

Rupture Testing of Simulated Al-Pu Fuel Elements. Two pre-defected, solid 2S type aluminum core rods with swaged-on Zircaloy-2 cladding were operated at 300 C in pH 9.0 water for 30 hours. Post-inspection revealed that no significant swelling or aluminum oxide deposit had built up.

Structural Materials Development

PRTR Jacket Tubing. All fuel jacket Zircaloy tubing on-site has been examined on the outside surface by the Zyglo fluorescent dye penetrant test for cracks or surface flaws. Of the 2707 tubes on hand, 38% of the 3/4-inch OD tubing for swaged oxide elements and 48% of the 1/2-inch OD Pu fuel tubing revealed no outside-surface flaws under Zyglo examination. The tubes wherein flaw indications were observed will be etched and/or surface conditioned and retested to determine whether the flaws are real or attributable to surface scratches, grinding marks or galling. A few tubes have been split open for internal surface examination, and a statistical sampling of the total lot is under way. Samples of tubes in which flaws were indicated by dye penetrant are to be examined metallographically.

PRTR Process Tubes. Ninety-five Zircaloy-2 process tubes, meeting all contract specifications, have been received. This completes the current process tube order with Tube Reducing Corporation, and a topical report covering the fabrication of these tubes is in preparation.

Burst Testing PRTR Process Tubes. An analysis of the Zircaloy pressure tube burst test data accumulated to date has suggested that a substantial systematic error may be present. Since the diameter of an annealed tube may increase by as much as 60% during a test, a considerable amount of cool water used to pressurize the test specimen is pumped into the system prior to actual fracture of the specimen. In an effort to assess the magnitude of the error introduced in this manner a PRTR process tube was tested with a thermocouple placed inside at the center of the tube. The results of this test revealed that the water temperature dropped 80 C before fracture occurred after the diameter had increased by 60%. The water temperature drop in the last 30 seconds of the test was 60 C which indicates that most of the temperature drop occurs just prior to failure.

A preheat-chamber was fabricated to provide a reservoir of hot water between the pump and the specimen. A test was run on a PRTR tube (which had been extruded, tube reduced about 40%, and vacuum annealed) using the preheater and an internal thermocouple. The water temperature rose from 300 C to 308 C during the first two minutes of the test, then dropped to

285 C during the next 5-1/2 minutes at which time the tube fractured. The total internal pressure for this tube section which had a 0.135 inch minimum wall went to 3500 psig then dropped to 3300 psig just prior to fracture. The latter figure calculated to 3600 psig for a tube which meets the specified minimum wall thickness of 0.146 inch. The unit hoop stress was calculated to be 42,600. An average hoop stress of three other similar tubes burst without the preheater was 50,000 psi. Several more tubes with the same fabrication history will be tested to verify this result.

A tapered section of a PRTR process tube was tested at 300 C. The diameter of the tube increased 49.5% before it failed at a total pressure of 4600 psi and a unit stress of 49,500 psi. The failure occurred in the annealed thinner wall section of the tube adjacent to the tapered section.

New Fuel Cladding and Process Tubing Materials

An experimental heat of an "optimized" Fe-Al-U base alloy is being prepared by the Metallurgical Products Department, General Electric Company, for use in exploratory HAPO tests of its suitability as a fuel cladding material.

Available information on nickel-base super alloys for use in high temperature loops is being assembled.

Radiometallurgy Laboratory Studies

Two eighteen-inch long, 7-rod clusters, Zr-2 clad, swaged, natural UO_2 that were suspected of failing in the KER Loop facility were examined for failure by placing them in a vacuum chamber, evacuating to approximately 100 microns pressure and sampling the gas. No evidence of a fission leak was found. Replicas of the fractured surfaces of Pu-Al and Pu-Si-Al alloy samples were obtained for electron microscopy. A uranium sample which had received an exposure of 2600 MWD/T as part of the uranium swelling program and had been annealed at 880 C for 100 hours, was replicated to study the observed deposition of some material at the grain boundaries. The results and conclusions from these radiometallurgy studies will be reported in connection with the respective development programs of Ceramic Fuels, Plutonium Metallurgy, and Physical Metallurgy Operations.

Thermal Hydraulics Studies

Thermal Hudraulic Studies Associated with the PRTR. Heat transfer experiments were performed to define the heat flux at which boiling burnout could be expected for the Mark II (concentric tubular) fuel element. In an electrically heated test section run at pressures and flow velocities typical of reactor design conditions, boiling burnout was experienced with a heat flux of 1,568,000 BTU/hr-ft^2 at an outlet temperature just slightly less than saturation. This compares favorably with the design value for maximum heat flux of 400,000 BTU/hr-ft^2.

The test section consisted of two concentric Hastelloy C tubes with water flowing in the 0.150 inch annulus between the tubes. Both tubes were subjected to resistance heating with the inside surface of the outer tube having a heat flux 1.75 times that of the outside surface of the inner tube. Thermocouples were attached to the outside surface of the outer tube, and their readings were used to calculate the surface temperature of the inside surface.

Boiling burnout conditions were approached by holding the pressure, velocity, and outlet water temperature constant while increasing the power input to the two heated surfaces. The temperature of the outside surface of the outer tube was at a steady state temperature of 1780 F before burnout was reached and then experienced a large excursion as film boiling began. The test section physically failed at burnout when a small hole was formed as the outer element melted from the outside inward over a small area. A second identical test section was installed in the apparatus for further experimentation.

Fabrication of the full scale electrically heated mockup of the Mark I 19-rod cluster fuel element was completed. Plans were made to install the test section in the high pressure heat transfer apparatus as soon as work with the Mark II test section was finished.

Mechanical Equipment Development

Design Test PR-1 - Discharge Operation Mockup. Drawings for installation of the PRTR Fueling Vehicle in the 314 Building were completed. Fabrication of test components continued during the month.

Design Test PR-10 - Primary Loop Mockup. The PRTR primary process pump was operated for 405 hours (328 hours at operating conditions) during the month. The seal leakage at the end of the month was approximately 0.05 gallon per day. Total leakage collected from the 14-inch gate valve during the above operation was 0.26 gallon.

The Single Tube Prototype Mockup was operated for 487 hours with the rented constant speed motor. Seal leakage at the end of the month was less than 0.04 gallon per day.

PR-20 - Calandria Characteristics. The calandria mockup was pulsed at various frequencies using a displacement bellows of approximately 300 cubic inches acting on the atmosphere of the storage tank. The maximum deviation of the moderator level recorded was ±0.10 inches, with a 1-1/4 inch valve at the top of the calandria open to simulate the gasometer connection. With the top of the calandria open to atmosphere, the maximum deviation was ±0.37 inch, and with the top of the calandria completely closed, the deviation was barely perceptible. Under the above stated conditions, the measured deviations were maximum between 40 and 60 cycles per minute.

Further tests are planned to find the most desirable size gasometer connection and to determine the influence of water level in the storage tank on the critical frequency of the moderator.

PR-40 - Shim Control Mockup. The shim control bid package, consisting of 20 drawings and one specification, has been approved and transmitted to the AEC for procurement. The first prototype shim control motor-planetary gear assembly has failed from lack of lubrication. The components are being cleaned and repacked with a special nuclear radiation resistant grease for high speed application. Another assembly was sent out for a baked molybdenum disulfide treatment as recommended by the Plant Lubrication specialist.

The second prototype shim control is 75 percent complete. The procurement of additional motor assemblies, scheduled for delivery July 13, will determine the completion date of this prototype.

The proposed ball bearings for the shim assemblies were operated without lubricant at 400 rpm in a 600 F moist nitrogen atmosphere for 540 hours without failure. Tests will continue on several alternate types to determine acceptability.

PR-50 - Reactor Piping Seal Testing. A Zircaloy-2 PRTR process tube was installed in the single tube mockup. Prototype water and gas seals are being provided with high integrity shroud closures to determine minute leaks. The process tube to ring flange gas seal was changed to a solid copper gasket after tests showed that the temperature plus the bolt-up forces extruded the asbestos filler.

PR-51 - Reactor Piping Structure Integrity. The flexure cycling facility was modified to permit flexing an outlet nozzle while operating at 535 F and 1250 psi. New hold-down devices are being evaluated. Two dog-leg type hold-downs using 3/8 inch bolts were cycled 8200 cycles without significant seal leakage.

PR-52 - Process Tube Thermocycling and Pressure Testing. The PRTR prototype Zircaloy-2 process tube is installed. A prototype UO_2, 19-rod fuel element will be installed about July 1. Tests on pressure drop, vibration, corrosion, and orifice sizing will commence thereafter.

Special Tools. A study of possible tools for the outlet jumper piping is being conducted. Several promising styles are being designed and fabricated to achieve the necessary high torque in the limited space available.

PR-60 RTD Test. The test loop has been completed and installed in the prototype loop. The calibration instrumentation has arrived and is being checked out.

PR-70 - Helium Compressor Test. The Corblin low pressure compressor is operating on air. The oil temperature was too high following startup until water cooling of the cylinder heads was started; information available

indicated water cooling was optional and probably unnecessary. The Hofer high pressure compressor was started but will not be run extensively until oil leaks and the belt guard supports are corrected.

PR-80 - Air Cooling Duct Test. The installation of the air cooling duct is complete, and flow tests have started. The "zipper" type sheet seal is working well.

Inconel "X" Life Test. The stress relieved Inconel "X" loop (stress relieved at 1650 F for 24 hours followed by aging at 1300 F for 20 hours) operated for 230 hours at 1150 F and 4500 psi without incident. It was then operated for 340 hours at 1150 F and 5500 to 6000 psi before it failed. Replacement loops will be fully heat treated.

Gas Loop Jumper. A furnace for testing the 2-1/2 inch braded jumper with convoluted core was built, and electric heaters are being installed. The jumper will be cycled 2.5 inches, to simulate the reactor process tube expansion, at 1500 F and 500 psi.

Reactor Technology Development

PRTR Instrumentation. Resistance temperature detectors from Charles Engelhard appeared satisfactory on all tests completed to date. Additional problems developed at the cable connector after vibration checks were completed on these units. An acceptable connector of different design is probable for this detector without additional development time. Detectors from Arthur Ruge have arrived for final evaluation.

The first prototype of the thermistor temperature probe for the Fuel Examination Facility shows instability due to circulating air currents around the thermistor. A second design prototype is being fabricated in the optical shop.

Reactor Safeguards. Battelle Memorial Institute has completed the analysis of possible loss-of-coolant incidents. The final report of these analyses is in preparation and will be issued in July. In all of the cases studied it was found that automatic injection of light water into the primary coolant system when the pressure has decayed to 100 psi would prevent fuel element melting.

Control of Tests in the PRTR. A procedure was written for the control of tests in the PRTR. This procedure provides for analysis of test proposals to insure that the tests are safe, compatible with reactor facilities, and efficiently scheduled. It is now under management review.

Reactor Analogue Study. Final compilation of data and charts of input reactivity for the various transient cases to be studied on the analogue computer were prepared. The generator cases to be studied are:

(a) Starting subcritical with all shim controls cut, the moderator level is increased at the maximum possible rate.

(b) Starting subcritical, the moderator level is increased at maximum possible rate and shim controls removed at maximum possible rate.

(c) Starting at about 10 MW, the moderator level is increased at maximum possible rate and shim controls removed at maximum possible rate.

(d) Starting at about 70 MW, the moderator level is increased at the maximum possible rate and the shim controls are removed at maximum possible rate.

(e) Introduce various arbitrarily selected ramp reactivity changes.

Each case will include runs with no scram, scram at varying power level, and scram at varying reactor period. Reactor enrichment level, UO_2 thermal conductivity, and UO_2 Doppler coefficient will also be varied. It is expected that the computer runs will begin about July 1, 1959.

Final PRTR Hazards Report. An outline of the final report was prepared, and updating of the descriptive sections of the report is in progress. Requests for written material from other cooperating components were issued. Analyses of various mechanical failures of the primary and secondary coolant system were performed.

Hazard Studies for Various Mechanical Failures in the PRTR. (1) The pressure build-up in the space between the top biological and floating shields following a complete rupture of the 14" header was calculated. Due to the 42 sq-ft vent line made available, the maximum pressure build-up will not exceed 13.7 psig. This value is based on a maximum flow of 4700 lb/sec discharged from the 14" line after a rupture. Since the system is able to withstand 18 psig without serious damage to the reactor, the vent provided appears adequate.

(2) The maximum pressure experienced by the shroud tube was calculated after a process tube rupture. The break was assumed to occur at the base of the fuel element in order to estimate the maximum pressure build-up. The leaking steam-water mixture must then pass through the maximum length of process tube-shroud tube annulus before entering the one-inch space between the tube sheet and top biological shield and finally venting to atmosphere. The maximum pressure at the break is calculated to be 700 psia, and the flow is 100 lb/sec. The hole size must be equal to or greater than 1.32" diameter in order to produce this worst case. Since the shroud tube will not be able to withstand pressures greater than 180 psia, it will burst. To maintain shroud tube annulus pressures below 180 psia the critical hole size is 0.806" diameter. The maximum flow is 18.75 lb/sec.

After the shroud tube bursts, the steam-water mixture will exhaust into the calandria and out the two 10" vent lines provided. The maximum permissible pressure in the calandria to avoid rupture was taken as

21.7 psia. The maximum flow possible without failure was calculated as 22.5 lb/sec per vent line. Therefore with the two vent lines, the maximum flow from the calandria is 45 lb/sec without exceeding 21.7 psia. However, if two additional gas lines were equipped with pop-off valves the maximum flow would be increased to 90 lb/sec. This flow corresponds to a process tube rupture of area equivalent to a 2.10" diameter hole.

These results indicate that for process tube ruptures less than about 2.10" diameter, the calandria will not fail provided four gas lines are vented.

(3) The flow decay and equilibrium conditions following complete loss of one of the two primary coolant pumps were determined. Assuming the impaired pump is brought to a complete stop instantly, the flow will decay to the new steady-state flow 78.5 percent of the original in about 0.20 second. Although total bulk boiling will not occur, bulk boiling in the hottest channels will occur over about 1.13 feet of the active fuel length. The latter result assumes the reactor is not scrammed. The exit quality is less than 0.2 percent, and the flow is not reduced below 75 percent of the normal flow with two pumps in line as a result of two-phase flow. Since the heat flux at the point of boiling is about 157,000 B/hr-ft^2, danger of burnout is nearly non-existent. The results thus indicate that at no time after a pump seizure is the reactor placed in jeopardy. Some bulk and considerable subcooled boiling will occur, but the estimated heat fluxes will be well below calculated burnout limits.

Steam Loop Fuel Element. A fuel element for use in the proposed steam loop of the PRTR has been designed. The fuel will have a core of UO_2 in the form of a 8-leaf clover with nine internal coolant channels. The coolant will enter through eight tubes arranged in a circle and return through a single central tube.

The fuel element operating at 600 KW per tube and at nominal 1000 F coolant temperature will experience UO_2 temperatures ranging from 4250 F to 1630 F. The calculated maximum heat flux is 624,000 B/hr ft^2 while the over-all average is 464,000 B/hr ft^2. Heat losses to the moderator will not exceed 6.0% of the total heat generated.

PRTR Physics Evaluation. Two separate attempts were made to recompile the FORTRAN version of the SNG reactor code on the IBM-709. The first compilation was carried out with the program partitioned in five parts. This has the advantage that the memory requirements are minimal, allowing an increase in problem dimensions if desired. A second compilation was completed with the program in a single block. To eliminate difficulties resulting from this approach, the input-output, SAP subroutines which were with the original version are being replaced by equivalent FORTRAN statements.

Preparation of graphs of the radial neutron flux and power distributions obtained from previous three-group PRTR calculations is now under way. Correlation of this information with reactor loading patterns will complete

the one-dimensional analysis of the reactor.

A complete analysis of the reactivity effect of shim rods in various positions in the PRTR core has been initiated. Analytic methods for treating gray rod systems are now being studied.

Report HW-60845, Gamma Heating in PRTR Gas Loop, has been completed and distributed. Heating from direct and capture gammas in the high temperature alloy liners was found to be one watt per gram.

Design Development

Phase I PRTR Construction Status. The Phase I contract is 100% complete. Final inspection was made on June 29, 1959.

Phase II PRTR Construction Status. The Phase II contract is 100% complete. Final inspection was made on June 24, 1959.

The Phase II-A PRTR contract is approximately 84% complete versus 100% scheduled. The pump site remained flooded during the month. Partial backfilling was complete by bulldozing material into the flooded area.

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

The prime coat for the chemical resistant paint is about 25% completed in Cells A and B, and surface preparation for priming is approximately 75% completed. A design change was issued to include a chemical resistant coating for B cell. Erection of structural steel was started in A cell and the gasometer and deaerator have been set in position.

Design Analysis. A contract for performing piping stress analyses for the PRTR primary cooling system is being prepared. This contract is to be submitted to the Blaw-Knox Company, the M. W. Kellogg Company, and the Electric Boat Division of General Dynamics Corporation for proposals.

Flow, pressure, and temperature relationships were developed for a 709 computer program for calculation of transients following various excursions and failure of components in the PRTR. Programming of the problem is in progress.

Preliminary results from moderator level oscillation tests being performed on the calandria mockup in 189-D Building appear to confirm predictions of low system damping and associated high sensitivity to exciting forces imposed at the system's natural frequency. An input pressure oscillation of about 0.07 inch in terms of moderator level produced an actual moderator level oscillation of about 0.7 inch at the natural frequency. However, changing the input force frequency by as little as 10 percent virtually eliminated all moderator oscillation. No changes in the PRTR level control system are required as a result of these experiments, unless, however, reactor operation shows that there are exciting forces present which have

the same oscillation frequency as the gas balance system. If such occurred, it would be necessary to change the natural frequency of either the gas balance system or the source of the excitation.

Reactor and Process Piping. Thirteen sets of design data and information for Phase III moderator, reflector, and boiler feed pumps, miscellaneous valves and strainers, pressurizer, steam generator accessories and small heat exchanger expansion joints were reviewed.

A second sample of steam generator tube-to-tube sheet welding received from Yuba Heat Transfer Division was sectioned and examined for defects. Metallographic examination showed good coverage of the joints with no shrinkage holes or porosity. The tube rolling process on this sample gave three percent expansion vice two percent specified and the vendor was notified of the departure from the specification. However, even with the three percent expansion, there was no apparent difference between microstructure in rolled and unrolled sections of the tube. A fluorescent dye check of the face of one-half the sample (12 tubes) showed four pinholes and micro-cracks in and near the welded joints of three tubes.

Core Components. The bottom shield gas seal has been received on site. With the receipt of this item, all GE procured material necessary to allow the Phase III contractor to proceed with the installation of the side biological shield has been received. Fabrication of the calandria and shields has fallen approximately three weeks behind schedule so that, even assuming no strike in the Consolidated Western Steel plant, the fabricator will not meet the July 24 delivery date. A late August delivery appears quite likely at this time.

Shielding. A number of the thermal shield blocks have been cast short of the specified length by a small fraction of an inch. Acceptance and/or rework of these items is under consideration.

A proposal from the Phase III contractor to install a permanent 1/4-inch steel outer shell on the side biological shield for a sum of $2700 has been accepted.

D_2O Recovery. Tests of the inflatable seals for the thermal barrier have disclosed that an internal pressure of 15 psig is required to effect a seal. The effects of this seal pressure (which is much greater than was anticipated) on the thermal barrier structure are being investigated.

Fuel Handler. Fabrication work on the fuel handler is progressing on major sub-assemblies, including the cask sections and the bridge and carriage structures. Transformer capacity was increased for the variable speed drive motors. Final approved prints have been received from the Willamette Iron and Steel Company.

Instrumentation and Control. A design change encompassing a general revision of the PRTR safety and containment systems is being processed. The change includes the institution of three-channel coincident trip systems

for a number of the more critical variables in these systems and the elimination of several non-essential trip variables. The changes bring the reactor safety and containment system into conformance with recommendations of ACRS, the GE-APED technical audit group, and the Reactor Technology Development Operation.

The PRTR dump valves have been received. Opening time of the valves during acceptance tests (time from cutting of solenoid current until valves were completely open) was consistently less than 5.0 milliseconds. Also, tests of Allen Bradley Bulletin 200 relays of the type used in the safety circuit gave an average opening time, on DC actuation, of one cycle AC current (0.015 sec). The opening time of both valves and the relays is considerably shorter than the design requirements, and response time of the system will be correspondingly shortened.

The bid assembly for the reactor dry gas moisture detection system was approved and placed for bid.

The PRTR automatic controller design was reviewed in considerable detail with Minneapolis-Honeywell engineers from the viewpoint of what would happen if various components of the system failed. The general conclusion was that, while it is possible to postulate some failures which could call for an increase in reactor power level, the probability of these failures should be quite low and the reactor is well protected from damage by an adequate number of high level safety trip circuits. It is planned to have a similar review made by ANP in the near future.

Fuel Element Examination Facility. A check made of the critical wall dimensions of the fuel examination facility pit showed that the openings for the cast iron wall blocks are within specifications. The openings for the filler blocks and the location of the bolt holes for attaching the wall blocks were not within specifications, however, and require that drawings be changed to agree with the as-built concrete dimensions.

The contract for construction of the cast iron and steel shielding was awarded to the Mosler Safe Company with a bid of $124,000.

A prototype of the movable duct to be used with the primary manipulator has been completed. Preliminary tests have confirmed the feasibility of the design.

Work orders were issued to complete the fabrication and testing of the profilometer and 5X viewer to be installed in the examination facility.

The preliminary design of the primary manipulator has been completed. The detailed design is scheduled for approval in approximately two months.

Load-Out Equipment and Transport Mechanism. The design criteria for the Load-Out Criteria and Transport Mechanism has been approved and issued.

PRTR Steam Loop (Project CAH-841). The scope description was distributed for comment. Drafts of three sections of the design criteria have been prepared and reviewed.

A "reference" internally cooled fuel element has been scoped. This element is based on scaling down the element in the supercritical pressure power reactor study to a size compatible with the loop test section. The element has approximately the same UO_2 temperature (4000 F), heat flux (600,000 BTU/hr-ft^2), and tube size (3/8-inch OD) as the fuel element in the reactor study. This element should operate at about 600 KW power in the loop test section.

Estimates of heat loss to the test section sleeve show that independent coolant circulation will be required to handle the heat load. A reservoir and percolater type cooling system was devised for cooling fuel elements during discharge.

Plutonium Fabrication Pilot Plant

Phase II Construction. Completion of work under Phase II is estimated at 99.5%. Preliminary punch lists have been prepared for about half the building, and the contractor has prosecuted work on the punch list fairly energetically. It is believed that this phase of the work will be complete before July 15 - about 60 days late.

During the preliminary inspection of the exhaust filter rooms, it was found that, owing to deficiencies in both design and construction, the structural steel grilles on which the building exhaust filter banks rest are not sealed to their seats in the building construction, and thus a large leak by-passing the filters exists. Field studies to rectify this condition are in progress.

Severe cracking of the joint between exterior wall concrete block panels and the poured concrete building frame has been observed. It has been determined that this joint was not made in accordance with the plans and specifications. Sealing the joint with vinyl tape is presently considered to be the only feasible way out of this difficulty, with project schedules in mind.

Phase III Construction. Completion of work under the Phase III contract is estimated at 62%, compared with 70% scheduled. The painters' strike was settled and the men returned to work June 1, but interference between trades resulted from the upset in schedule caused by the strike. Competition for painters between the Phase II and Phase III contractors and between 308 and 309 Building was keen during the month also, with some adverse effect on schedules. Delayed delivery of the hood fire alarm sensing elements has prevented testing and acceptance of several hoods otherwise practically completed.

The 30 kw vacuum melting furnace assembly is nearly complete; a factory representative has been scheduled to assist with testing the equipment July 7. The billet lathe assembly is complete and ready for testing. The swage assembly is to be accepted, with minor exceptions, July 2, and installation of feed mechanisms by plant forces will start at once. Little progress has been made on the drawbench installation since it is not high on the priority list. The autoclave installation is nearly complete; correction of several minor vendor errors has caused some loss of time on this unit. Installation of the utility hoods and the degrease-decontamination system is nearly complete. Modifications to the x-ray rooms to enable installation of the equipment have been completed, the equipment has been conditioned by the vendor's representative, and is ready for installation of the tube crane, shipped from Los Angeles on June 30.

This report in detail will serve to indicate that the Phase III contractor is at present making good progress on all parts of his construction job.

Negotiations with the Phase III contractor to attempt to recover some of the time lost by the Phase II contractor, through the use of evening shifts, premium time, and the like, were terminated unsuccessfully.

Procurement. The 200-ton compacting press for the oxide line, being constructed by Clearing Machine Company, is slipping behind schedule. Purchasing liaison is obtaining the facts on which to base a decision whether to accept a late July delivery from Clearing or to order the press shipped at once for completion by Minor Construction. The Phase III contractor can set the press at once when it arrives on site.

The oxide line finishing hoods, scheduled for shipment the week of June 22 from Van Vetter Company, were not shipped. The reason has still not been advanced. These hoods cannot be set in their final position until the sintering furnaces arrive, so the Phase III contractor is not being held up by this vendor. The internal grinder has been shipped. It will be set up and tested using uranium oxide sintered shapes prior to its installation in the oxide line hood.

Work is progressing on schedule on the sintering furnaces. The remaining procurement on the project is on schedule.

Project Schedules. Room 132 will be accepted from the Phase II contractor, and the swage and hood accepted from the Phase III contractor, with the exception of the hood leakage test, July 2. Work by GE forces will commence July 6 on installation of feed mechanisms and the like. The Phase III contractor will return at a mutually convenient later date for the hood leakage test.

The service wing has been accepted from the Phase II contractor, the floors have been cleaned and waxed by maintenance personnel, and a part of the office furniture is to be moved in July 2. Some of the operating staff will move to the building the week of July 6.

The beneficial use date for the building, as defined in February 1958, has been rescheduled for about August 15.

PRTR Operations Planning

PRTR Technical Manual. Chapter 18, Shield Coolant Systems, was revised to include a description of the modified top and bottom shield coolant system design. Copies of the revised chapter will be issued to Technical Manual copyholders this week.

Pre-Startup Activities. Major activities during the month include preparation of the reactor operation section of the final PRTR hazards report, preparation of a list of operating procedures for the reactor and standardization of the form for the procedures. Discussions were held with interested groups concerning the functional tests to be performed following the contractor's acceptance testing. Preparation of the test outlines is under way.

A survey of each PRTR component was completed on June 15. The purpose of this study was to determine the areas where high level radiation fields may be expected. As a result of this analysis, a number of minor design changes and special operating and maintenance procedures were recommended.

Preparation of the PRTR Engineering Assistant training program is essentially complete. All lecture outlines, tests, and other training material will be ready July 15.

An identification system for PRTR valves was selected and reviewed with FPD maintenance personnel. All valves will have metal tags attached. Appropriate numbers will identify valves on PRTR As-Built drawings.

Design information received during the month was reviewed for acceptability from the operations point of view.

PRTR Operations Handbook. The initial rough draft of the PRTR Operations Handbook was finished and is being reviewed for completeness and accuracy of information. This pocket-size handbook is a compilation of the more important PRTR construction and operating data.

Construction and Procurement Liaison. BPF data are being compiled for all equipment supplied by the Phase I and II contractors. A complete Blue Print File will be maintained in the 309 Building.

Shop equipment requisitions have been forwarded for processing. At present, purchase of $14,000 worth of equipment is proposed, with additional items costing $3500 to be purchased later.

Discussions were held with manufacturer's representatives to resolve problems concerned with lubricating and cooling the shaft seals of the boiler feed pumps, moderator pumps, and reflector pumps. A satisfactory solution was obtained.

Acceptance tests of the diesel-powered deep well pump, the diesel-generator set and associated switchgear were witnessed. Also, tests of the water chillers, air compressors, service area heating and ventilating system, and hold-up tank pumps were completed.

Plans to receive the first heavy water shipment, including temporary storage in Central Stores, were formulated. The plans are being reviewed with GE Security.

PRTR Staffing. Fifty percent of the non-exempt Technicians and Engineering Assistants have been chosen. It is tentatively planned to have the Technicians report to PRTR on September 1, 1959.

PRTR Data Processing. The general scope requirements for a data processing system suitable for the PRTR have been outlined, including the recommendation that a general purpose digital computer and associated data acquisition system be obtained. This computer would be used in conjunction with the automatic reactor control system.

2. BASIC SWELLING STUDIES

Irradiation Program

A capsule design has been completed for the irradiation of metallographic specimens in the ETR at constant temperature. The capsule is designed to accommodate 50 percent unrestrained swelling of the specimen. The heating element is installed in the NaK close to the specimen so that good heat transfer between the heater and the specimen is achieved. The heat losses to the cooling water are low with a design of this type thus reducing the power requirement placed on the heaters. A temperature controlled capsule has been assembled utilizing one centimeter natural uranium spheres, and spheres of enriched uranium are being machined for the assembly of another capsule to determine the effect of burnup rate on unrestrained swelling. Instrumentation for the temperature monitored capsule has been assembled and tested and found to operate satisfactorily under the laboratory conditions. About five pounds of enriched uranium have been sent to Tamescal Metallurgical Corporation where they are presently remelting the material in an attempt to improve its purity by their electron beam melting process.

Simulated Swelling Experiments

A knowledge of the mobilities of rare gas fission products through uranium is important in understanding the mechanisms of pore formation. Diffusion of rare gases in uranium is, therefore, being studied. In these studies rare gases are introduced into the uranium surface by means of electrical glow discharge (sputtering). The amount of rare gas that is deposited in the uranium surface under various experimental conditions is being determined. Heating the uranium to a sufficiently high temperature causes most of the gas deposited in the surface to be evolved. Large quantities of helium were shown to be deposited in the uranium surface by a glow discharge. A mass spectrometer type helium leak detector was used to measure

the rate of helium evolution.

Similar experiments were performed using xenon. As no continuously recording xenon detector was available, the evolved gas was collected in gas sampling tubes and submitted to the mass spectrometer laboratory for analysis. Results of this analysis indicated that some xenon had been deposited and released on heating. The several experimental difficulties that contributed to inconsistencies in the apparent gas analysis have been corrected, and the experiment is being repeated. In an effort to determine whether or not rare gas deposited in a uranium surface will diffuse into the volume, the gas is to be deposited on the inner surface of uranium cylinders at various temperatures. After a diffusion anneal, the surface layers will be removed, and the remaining material will be heated to a high enough temperature to cause evolution of contained gases. These gases will then be analyzed to determine the rare gas content. Uranium cylinders for this study are being fabricated.

Mechanisms and Theory

Optical and electron microscopy are being used as a direct means for determining the size and distribution of pores in irradiated uranium. Statistical analysis by operations research personnel has revealed that a distortion of pores must arise during the specimen preparation steps, in that the number of pores on the specimen surface with given depth to diameter ratios does not agree with the number calculated on the basis of a random section through spherical pores of various diameters. A specimen of irradiated uranium having extensive gas porosity has been polished, and replicas are being prepared of the specimen surface in the as-polished, lightly etched, and heavily etched states. Statistical analysis of the observed pore diameter to depth ratios should disclose the extent and nature of pore distortion associated with etching. The distortion associated with the replication of pores sectioned at various positions above and below their centers is being studied in pseudo specimens. Polystyrene spheres 0.4 micron in diameter were dispersed in an epoxy resin. After solidification these dispersions were polished. The polystyrene spheres on the polished surface were dissolved in acetone, and the surface of the pseudo specimen was replicated. Electron micrographs of these replicas are being analyzed statistically.

Although the microscopic measurements of pore volume fraction would appear to be in error due to the above mentioned distortions, an estimate of pore volume fraction has been made for uranium irradiated to 0.25 a/o burnup. On the assumption that the pores are spherical and that no distortion of the actual pores has occurred, the pore volume fraction is given by the relationship $\frac{2\pi \Sigma r_i^2}{3A}$, where A is the area of the specimen surface on which the pores are measured, and r_i is the calculated radius of the i^{th} pore. The calculated radius is determined from the maximum apparent diameter of the pore if it is sectioned above its center and is determined from the apparent diameter and its depth if it is sectioned below its center. For a specimen which exhibited a 7.8 percent decrease in density

after irradiation and annealing, the equation predicts a 7.0 percent change in density for a small region near the specimen periphery (low temperature of irradiation, high burnup), whereas a 4.7 percent decrease in density is predicted for a region in the center of the specimen (high temperature of irradiation, lower burnup). It should be emphasized that the density change observed is obtained by water displacement and includes the effect of cracks as well as the pores. If the void fraction is calculated from the apparent radii by an alternate relationship $\frac{5\pi\Sigma r_i^2}{6A}$, the predicted density changes are 8.7 and 5.7 percent, respectively. Since the two estimates give essentially the same results and similar precision estimates, ± 2 = 40%, the latter method which is considerably simpler, may prove advantageous.

These methods will be tested on wider ranges of experimental conditions afforded by two specimens, irradiated to burnups of 0.25 and 0.40%, which have been annealed at 700 C for 100 hours.

3. GAS COOLED POWER REACTOR PROGRAM

Graphite Studies

PRTR Pressurized Gas-Cooled Loop Facility (CAH-822). An addendum to the gas loop design criteria was issued in June prior to bid opening. The addendum changed the loop in-reactor section location from channel 1946 to 1542, redefined materials for use in the loop, and revised requirements for the loop in accordance with more refined calculations of pressure drop and thermal analyses completed since issuance of the original criteria.

A pre-bid conference was held June 4, for the convenience of interested bidders on the design and fabrication of the "Phase A" (out-of-reactor) portions of the loop equipment. Bids for the Phase A work were opened June 15, and are currently being evaluated. The apparent low bidder is Struthers Wells Company, with a bid of $385,000. The fair cost estimate was approximately $400,000.

An order for the three main blowers in the gas loop was placed June 8 with Bristol-Siddeley Engines, Ltd., Coventry, England. Each blower features gas-lubricated bearings and will deliver 7500 lb/hr of CO_2 at 500 psi.

Graphite Oxidation Studies. Two solid cylinders of CSF graphite were oxidized by a flowing stream of carbon dioxide in graphite-weight-loss equipment. The graphite cylinders were two inches long and 0.42 inch in diameter, with major axes parallel to the whole bar extrusion direction. During 576 hours of oxidation to a total weight loss of 1.8 percent, the following weight loss rates were observed: 4.82×10^{-6} gm/gm hr at 750 C, 2.05×10^{-5} gm/gm hr at 800 C, and 7.90×10^{-5} gm/gm hr at 850 C. The second sample was oxidized for 256 hours to a total weight loss of 0.53 percent. The weight loss rates observed were: 2.28×10^{-5} gm/gm hr at 800 C and 6.71×10^{-5} gm/gm hr at 850 C. Surface to volume ratio as a

variable in graphite oxidation is being investigated. Hollow CSF graphite cylinders which have approximately three times the surface to volume ratio of solid cylinders were prepared and are being oxidized.

Permeability of Graphite. Equipment for measuring the permeability of various graphites has been designed and is being fabricated. A modification of the Poiseuille equation for the flow of gases in porous media developed by Eatherly will give a measure of permeability as an admittance factor that has the dimensions of ml $cm^{-1}min^{-1}$. The equation to be used is: $F_o = \frac{LV_o}{At} \ln \frac{\Delta P_o}{\Delta P}$. F_o is the admittance factor for slip flow, L is the length of the sample, V_o is the volume of the system, A is the area of the exposed face, t is the time, ΔP_o is the differential pressure at time zero, and ΔP is the differential pressure at time t. Once flow has been established in the fixed-volume system, the pressure will be read at various time intervals. This method will be applied to impermeable graphites that are being produced both here and in the United Kingdom.

Surface Area Studies. The inverse relationship between rate of oxidation and density of graphite is probably due to surface phenomena, i.e., surface area and pore size distribution. An experiment has been prepared to determine changes in surface area resulting from in-reactor oxidation. Two control samples were encapsulated in quartz containers filled with helium. Two similar KC-graphite samples will be exposed to an atmosphere containing carbon dioxide. The experiment will be charged into the reactor during July.

Gamma Irradiation Facility. Construction work on a cobalt-60 gamma irradiation facility has been completed, and a 15,000 curie source of cobalt-60 has been received from Oak Ridge National Laboratory. The cobalt rods will be placed on a three-inch radius in an underwater source holder. After the source has been calibrated with ferrous sulfate and ceric sulfate chemical dosimeters, the facility will be employed initially to evaluate the effect of gamma radiation on the carbon dioxide-graphite reaction.

D. CUSTOMER WORK

Radiometallurgical Examinations

Examination of M-388 Failure 5148 KE (RM-299). A piece of canwall from a suspected hot spot area was examined. The bonding at this spot was good, and no evidence of intergranular corrosion was found.

Model III Manipulators. Modification of the Model III master slave manipulators has been completed. Three manipulators have been installed, and the fourth (spare) manipulator will be disassembled for preparation of "As Built" drawings. A new set of manipulator jaws was fabricated and tested successfully. With the new jaws one manipulator was used to lift an 80-pound, four-foot long rod.

Metallography Laboratories

The sample prepared for x-ray examination last month containing the most brittle layer formed between uranium and AlSi has proven to be a solid solution of two or more compounds, both with simple cubic structure. It is known that under different conditions of heat and time USi_3 and UAl_3 would have been formed from the same constituents. It is probable that the brittle layer under study is a mutual solid solution of USi_3 and UAl_3; however, identification cannot yet be considered positive.

All equipment has arrived and the necessary arrangements have been made for the installation of a new electron microscope in the 326 Building Metallography Laboratory.

Samples Processed During the Month

Total samples processed: 314

Photographs

Micrographs	341
Macrographs	57
	398

FW Albaugh

Manager, Reactor and Fuels Research and Development

FW Albaugh:kb

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
FW Albaugh	6/29-30	GE - ANPD, Cincinnati, O.	Discuss ceramic fuels technology.	HC Towle	Yes
ID Thomas	"				
EA Evans	" & 6/11				
WS Kelly	6/22-25	W.F. & John Barnes Co., Rockford, Ill.	Consult on Fuel Exam. Fac. manipulator design.	J Ross	No
MR Kreiter	6/1-30	Consolidated Western Steel, Los Angeles, Calif.	Consult on PRTR calandria & shield fabrication.	DC Coates	No
H Harty	6/21-24	"	"	VP Cline	"
DJ Foley	6/8-12	"	"	DC Coates	"
		Western Pipe & Eng. Co., San Francisco, Calif.	Piping fabrication.	Mr. Zimmerman	"
HK Nelson	6/18-19	Minneapolis-Honeywell, Philadelphia, Pa.	Liaison on PRTR automatic controller contract.	EB Dahlin	"
EG Peterson	6/18	ORNL, Oak Ridge, Tenn.	Discuss shielding.	EP Blizard	Yes
		Gatlinburg, Tenn.	Attend ANS meeting.	--	No
JE Hammond	6-13-19	"	"	--	"
		U.S. Stoneware Co., Akron, O.	Discuss fabrication of ceramic electrical insulators.	H Frahme	"
RG Clark	6/25	GE-ANPD, Idaho Falls, Ida.	Discuss data handling instrumentation & attend ISA Nuclear Instrumentation Symposium.	KK Dedrick	Yes
ED Waters	6/14-21	St. Louis, Mo.	Attend ASME meeting.	--	No
DE Fitzsimmons		Armour Res. Foundation, Chicago, Ill.	Discuss fluid dynamics.	HB Karplus	No
SH Bush	6/1-6	US-AEC, Washington, D.C.	Member of Reactor Development Fuels Task Force.	FK Pittman	Yes

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JC Tverberg	6/1-3	New York University, New York, N.Y.	Short Course on Vacuum Metallurgy.	--	No
KR Merckx	6/8-9	NMI, Concord, Mass.	Meeting re dimensional changes in-reactor fuel elements.	AR Kaufmann	Yes
JW Goffard	6/10	BMI, Columbus, O.	Observe windowed autoclave tests.	FR Shober	Yes
	6/11	ANL, Lemont, Ill.	Discuss fuel element defect testing.	Mr. Draley	Yes
EA Evans WE Roake	6/15-18	Harwell Atomic Res. Estab., Harwell, England.	Fundamental studies of UO_2.	Drs. Roberts & Murray	Yes
	6/22-23	Swedish Atomic Energy Comm., Stockholm, Sweden.	Discuss Swedish UO_2 work.	Dr. Kiessling	Yes
EA Evans	6/24-25	Atomic Energy Res. Estab., Saclay & Le Bouchet, Paris, France.	Fundamental studies of UO_2.	J Quinn	Yes
WL Wyman	6/15	GE-Flight Propulsion Lab., Cincinnati, O.	Discuss welding applications.	Mr. Eisonlohr	No
	6/16-17	Aeroprojects, Inc., West Chester, Pa.		Mr. Jones	"
	6/18	GE-Large Steam Turbine Div., Schenectady, N.Y.		Mr. Potter	"
MK Millhollen	6/16-19	AEC-IOO & Phillips Pet. Co., Idaho Falls, Ida.	Examine UO_2 fuel element in hot cell.	R Neidner	Yes
TT Claudson	6/17	Buckner Weatherby Co., Seattle, Wn.	Observe fabrication of fuel element supports.	JE McCullough	No
DL Gray	6/18	GE Research Lab., Schenectady, N.Y.	Discuss swelling & irradiation damage work.	WE Tragert	No
	6/21-26	Gordon Res. Conference, Meriden, N.H.	Attendance only.	--	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
GT Geering	6/23	Res. Welding & Engr. Co., Compton, Calif.	Discuss welding contract.	G Garfield	No
	6/24	GE-APED, Vallecitos, Pleasanton, Calif.	Witness coextruded tube removal from GETR.	L Welsh	No
DC Kaulitz	6/23-24	Res. Welding & Engr. Co., Compton, Calif.	Discuss welding contract.	G Garfield	No
OJ Wick RW Stewart	6/1-5	ANL, Lemont, Ill.	Attend US-UK meeting on plutonium technology.		Yes
TC Nelson	6/3-5	LRL, Livermore, Calif.	Discuss Gorton machine tooling; consult on calculation schemes.	M Harris	No
JH Rector	6/19-23	Gorton Machine Co., Racine, Wisc.	Discuss special Gorton Lathe.	A Gunderson	No
WB Weihermiller	6/8-11	Monarch Mach. Tool Co., Sidney, O.	Investigate redesign of equipment purchased.	--	No
		Sheffield Corp., Dayton, O.	Check new equipment.	H Boppel	No
CH Bloomster	6/14-19	General Motors, Detroit, Mich.	Discuss investment casting and crucible manufacture.	DG McCullough	No
		Dixon Crucible, New York, N.Y.		Mr. Rathyen	No
		Investment Casting, New York, N.Y.		Mr. Parris	No
WJ Gruber	6/1-6	Philips Electronics School, Chicago, Ill.	Attend instrumentation school; course on x-ray diffraction.		No
LA Hartcorn	6/22-25	Atlantic City, N.J.	Attend ASTM Convention	--	No
	6/29	Bausch & Lomb Co., Rochester, N.Y.	Check metallographic equipment.	RL Grau	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
LD Perrigo RD Weed	6/22	Phillips Petroleum Co., Idaho Falls, Ida.	Assist in determining procedures & processes for decontaminating 3x3 ETR Loop.	LH Jones R Neidner	Yes
RB Lobsinger	6/20-27	MIT, Cambridge, Mass.	Attend short course in corrosion.	HH Uhlig	No
HH Yoshikawa	6/15-19	U. of Buffalo, Buffalo, N.Y.	Present paper at 4th Bienniel Carbon Conf.	S Mrozowsky	No
RE Nightingale			Attendance only.		
EM Woodruff			Attednance only.		
RE Nightingale EM Woodruff	6/22-23	Speer Carbon Co., St. Maries, Pa. Niagara Falls, N.Y.	Discuss graphite production technology.	W Elston	No
EM Woodruff	6/24-30	National Carbon Co., Clarksburg, W.Va. Cleveland, O.		P Hastings	"
		Great Lakes Carbon Co., Morgantown, N.C. Mortongrove, Ill.		B Bailey	
TJ Clark RC Giberson	6/17-20	U. of Washington, Seattle, Wn.	Attend NW Regional ACS Mtg. Present paper.		No
RE Dahl	6/14-22	U. of California, Seattle, Wn.	Attend gas chromatography class.		No
JM Davidson JW Helm	6/24-26	Vallecitos Atomic Lab., Pleasanton, Calif.	Discuss pending HAPO irradiations in GETR.	W Prince	No
JM Davidson JW Helm	6/29-30	Phillips Petroleum Co., Idaho Falls, Ida.	Installation of GEH-19 experiment.	RB Johns	Yes

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JW Riches	6/22-23	Atlantic City, N.J.	Meeting of ASTM Committee B-2	--	No
	6/24	Allegheny Ludlum, Watervliet, N.Y.	Zr fabrication.	J Preston	"
	6/25	Budd Company (Allegheny Ludlum Sponsor)	"		
RC Aungst	6/23	New Rochelle Tool Co., New Rochelle, N.Y.	"	CA Tudbury	No
	6/24	Allegheny Ludlum, Watervliet, N.Y.	"	J Preston	"
	6/25	Budd Co., (Allegheny Ludlum Sponsor)			
	6/26	Chase Brass & Copper Co., Waterbury, Conn.	Zr Fabrication.	DK Crampton	"

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
JC Danko	6/25	Westinghouse, Bettis, Pittsburgh, Pa.	Tour PRTR & PFPP Discuss administrative arrangements for assignment of metallurgist to HAPO.	HE Hanthorn FW Albaugh	No "	PRTR Site 300, 3760
JR Reavis	6/11-12	Westinghouse, Bettis, Pittsburgh, Pa.	Discuss seal development.	LT Pedersen PM Jackson	No	300, 314
G Forrest	6/25	Marman Div. of Aeroquip, Los Angeles, Calif.	Study seal assembly.	PM Jackson	No	300, 314
GS Hoppin	6/1	GE-Flight Propulsion, Cincinnati, O.	Discuss electron beam welding.	JJ Cadwell WL Wyman	No	300, 326-303
WV Johnston	6/16	GE-KAPL, Schenectady	Fuel Element discussions.	JC Tobin	Yes	300, 326-306

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas & Bldgs. Visited
MC Pebbles	6/18-21	GE X-Ray Corp., San Francisco, Calif.	Install x-ray equipment.	WV Cummings	No	300, 326
JD Rogers	6/29-30	Philips Electronics, Mt. Vernon, N.Y.	Electron microscope installation & maintenance.	TK Bierlein	No	300, 326
MJ Sinnott	6/22-26	U. of Michigan, Ann Arbor, Mich.	Consultant Agreement #199.	FW Albaugh OJ Wick et al JJ Cadwell et al	Yes " "	300, 326-325-303 200-W, 231, 2704-Z
CG Currin	6/17	Dow Corning Corp., Midland, Mich.	Discuss plastics.	R Harrington	No	300, 326
H Hering	6/25-26	French AEC	Discuss graphite research.	RE Nightingale	No	300, 3760-305
PL Walker,Jr.	6/29-30	Pennsylvania State U., University Park, Pa.	Discuss carbon & graphite research.	RE Nightingale et al	Yes	300, 326
DM Newell	6/29	Convair, Ft. Worth, Texas.	Discuss radiation damage to plastics & elastomers.	RC Giberson	No	300, 326-3730
WC Ulrich HL Yakel, Jr. RJ Gray	6/29-7/2	ORNL, Oak Ridge, Tenn.	Discuss x-ray diffraction equipment.	LD Turner	Yes	300, 327

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

JUNE 1959

FISSIONABLE MATERIALS - 2000 PROGRAM

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION REACTORS

Lattice Neutron Temperature Study

The ratio of the fission product activity of Pu^{239} to that of U^{235} is a sensitive indicator of the effective neutron temperature in the region between 400°K and 1000°K. At temperatures below 400°K, the ratio is a slowly varying function of the temperature. Therefore, at low temperatures a more sensitive "thermometer" would be of great value. The neutron temperature in this low temperature range is of interest in the determination of the cross section for the rethermalization of neutrons which have migrated between two temperature zones.

The cross section for the lutecium isotope of mass 176, as reported in BNL-325, makes this isotope ideally suited for this purpose. Several resonances are reported for Lu^{176}. Among them is one at 0.14 ev which has an isotopic peak cross section of $\sim$ 14,000 barns.

Preliminary calculations show that the radioactivity of Lu^{177} which is produced by neutron irradiation of Lu^{176} should be very sensitive to a Maxwellian distribution of neutron energies. Moreover, there are only two natural occurring isotopes of lutecium, both of which can be made radioactive by neutron irradiation. If the other isotope (Lu^{175}) has a cross section which varies approximately as "1/v" it would be possible to obtain, with a single foil, a ratio similar to the one obtained in the Pu^{239} and U^{235} experiments, i.e., $A_{Lu^{177}}/A_{Lu^{176m}}$. To further investigate this possibility a quantity of lutecium oxide was obtained.

For the preliminary experiments, foils were made by packaging the Lu_2O_3 in aluminum containers. Experiments were conducted which determined a) the half life of Lu^{176m}, b) the half life of Lu^{177}, c) whether any impurities were present in sufficient quantities to hamper the analysis, and d) the amount of lutecium that could be contained in a foil before observable self-shielding would occur.

The half lives are found to be 6.77 ± 0.07 days and 3.75 ± 0.02 hours for Lu^{177} and Lu^{176m}, respectively. The 6.77 day half life was determined by following the decay of the 208 kev gamma ray which is known to occur in the decay of Lu^{177}. The gamma rays in the energy region between 10 and 165 kev decayed with a half life of 6.53 ± 0.04 days. (Errors quoted are for 70 percent confidence interval.) These facts indicate that a contaminant might be present. In order to be sure, the low energy region must be analyzed in more

detail. The 3.75 hour decay was determined by following the decay of gamma rays of energy between 10 and 165 kev.

To determine the effects caused by self-shielding, foils containing various quantities of Lu_2O_3 were irradiated on the foil rotator in the PCTR. The gamma-ray activity of each isotope and the ratio of the 3.75 hour to 6.77 day activity was determined for a time t = 0 which was arbitrarily chosen to be at the end of the irradiation. Tentative results are listed in Table I.

TABLE I

Wt. of Lu_2O_3 (Mg in 1/2" Dia. Foil)	Ratio $\frac{A_{Lu}^{176m}}{A_{Lu}^{177}}$
1.23	3.01
2.70	2.77
5.45	2.77
8.0	2.73
9.2	2.76
11.1	2.78
15.9	2.62
20.8	2.69
41.8	2.51
190.5	1.77

The A_{Lu}^{177} part of the $A_{Lu}^{176m}/A_{Lu}^{177}$ ratio remained constant while A_{Lu}^{176m} varied to cause the changes in the ratio listed in Table I. If one assumes that the decay schemes of the Lu isotopes are assigned to the proper masses, it is apparent that Lu^{175} is causing "self-shielding" instead of Lu^{176}. This poses the following: Either a) the 0.14 ev resonances in the Lu cross section has been assigned incorrectly or b) the Lu^{175} cross section has resonances which are shielding the foils more effectively than those of the Lu^{176} cross section, or c) the original assumption is wrong and the decay schemes of Lu are incorrectly assigned. The alternatives have not been completely evaluated but at this time alternative c) seems the least probable and a) the most probable.

Instrumentation

The stack effluent gas monitor, used for investigation of stack gas gamma energies, is back in operation at 100-F. The instrument was out of service for about one week because of air flow problems. Several gamma energy spectrums have been obtained with no clearly discernible photopeaks resulting. In general use, the equipment is adjusted to count the I^{131} 364 Kev photopeak. It is hoped that data concerning I^{131} increase can be obtained in the event of a slug rupture.

Thermal Neutron Flux Spectrum Near a Temperature Discontinuity

A. Theory

The manuscript for a paper to be submitted to Nuclear Science and Engineering has been completed.

The analytical solution for the generalized problem including a net neutron flow across the interface has been obtained. A modification of the SYZYGY program has been written and is now being debugged.

B. Experiment

The analysis of data has been completed on the experimental investigation of neutron exchange across a temperature discontinuity in graphite. The tests of the applicability of the plane diffusion model described last month were successful within the errors of the measurements. The final values of the relaxation length for neutron exchange are tabulated in the table below. The uncertainties quoted are based upon maximum estimates of the uncertainties in experimentally observed quantities used in the analysis.

TABLE OF RELAXATION LENGTHS

Temperatures Region One °K	Region Two °K	Relaxation Length (cm.)	Uncertainty in Relaxation Length
108	285	21	± 2.5
491	320	11.4	± 1.3
666	350	7.5	± 0.8

A complete report of this work will appear in the April-May-June Nuclear Physics Quarterly Report.

STUDIES RELATED TO FUTURE PRODUCTION REACTORS

Lattice Measurements for Large Diameter Fuel Elements

The following material buckling measurements for 2.5-inch tube and tube and 1.92-inch solid fuel elements have been completed this month.

TABLE II

Fuel Element	Lattice Spacing	Buckling (10^{-6} cm^{-2})	Volume Ratios Al/U	H_2O/U	C/U
1.92	10 3/8 Dry	+ 123	0.264	--	35.60
2.5 x 2.0 with 1.66 x 1.1	12 3/8 Wet	- 72	0.487	1.089	48.70
2.5 x 2.0 with 1.66 x 1.1	12 3/8 Dry	+ 116*	0.487	--	48.70

* To be taken again because of bad fit.

The series of buckling measurements for 1.92-inch solid fuel elements is complete. Analysis of horizontal traverses is still in progress.

The buckling values quoted in Table II are tentative based on an estimated side extrapolation length, λ, of 1.66 inches and a front-to-rear extrapolation length of 1.03 inches. Final bucklings will be reported after completing the analysis of horizontal traverses.

An analysis of ten front-to-rear horizontal traverses has been made. The traverses were taken in exponential piles with various fuel elements and lattice spacings. The average front-to-rear extrapolation as determined from the analysis is 1.03 inches with an average deviation of 0.05 inches. It appears that the front-to-rear extrapolation distance is constant so that 1.03 inches can be used for all of the piles.

PCTR Measurements of k_∞ and f in the PCTR has been completed for an enriched uranium cluster in a 7-inch graphite lattice. The lattice was water-cooled. Each of the seven rods in the cluster were 0.925 inch in diameter. The enrichment was 1.007% by weight U-235.

Preliminary values of the lattice parameters have been calculated from the experimental data. They are:

$$k_\infty = 1.064$$

$$f_{fuel} = 0.921 \qquad f_{graphite} = 0.013$$

$$f_{Al} = 0.016 \qquad f_{H_2O} = 0.050$$

The volume ratios of graphite, aluminum, and water-to-uranium were 8.47, 0.351, and 0.665, respectively.

Error analyses have not yet been made. However, it is estimated that the error in k_∞ will be about 3 or 4 mk (1 mk = 10^{-3} in k).

An additional feature of the experiment was an investigation of the effect of properly poisoning the buffer cells surrounding the test cell. In one case, the buffers did not have any copper poison. In the second case, each buffer cell was poisoned sufficiently with copper wrapped around the process tube to reduce its multiplication to unity. The resultant difference in the inferred value of k_∞ was found to be only one mk. Within the ordinary experimental errors of about 2 mk for each determination, no dependence of k_∞ was therefore observed upon the poisoned or unpoisoned condition of the buffers, even for a lattice of this large k_{excess}.

Coordinated Theoretical-Experimental Program

A comparison of methods for calculating D and L^2 for the homogenized equivalent of a heterogeneous lattice cell has been made for the simple system of a solid rod of natural uranium embedded in a graphite moderator. Four lattice-rod combinations were considered. These were for 0.925-inch and 1.66-inch rods in both maximum and minimum lattice spacings for which exponential

measurements have been made.

In the D calculations, a comparison was made between the method proposed by Selengut (Nuclear Physics Research Quarterly Report, January-March 1959, to be issued) and the formulations: (1) $D = 1/3\ \bar{\Sigma}_{tr}$ and (2) $D = 1/3\ (\bar{\Sigma}_{tr} + \bar{\Sigma}_a)$. $\bar{\Sigma}_{tr}$ and $\bar{\Sigma}_a$ are the flux and volume weighted transport and absorption cross sections, respectively. Simple diffusion theory was assumed. Relative to (1), the values obtained by Selengut's formula were as much as 14% low. Relative to (2), the Selengut formula values were about 0.2% high for the small rod and about 0.7% low for the large rod.

In the L^2 calculations, a comparison was made of the following formulas:

(1) $L^2 = \Sigma_i\ f_i\ L_i^2$, (2) $L^2 = 1/3\ \bar{\Sigma}_{tr}\ \bar{\Sigma}_a$, (3) $L^2 = 1/3\ (\bar{\Sigma}_{tr} + \bar{\Sigma}_a)\ \bar{\Sigma}_a$,

and (4) $L^2 = D_{eff}/\Sigma_{a\ eff}$. In the fourth formula, D_{eff} is calculated by Selengut's formula and $\Sigma_{a\ eff}$ is found from the reaction rate and the calculated flux at the boundary of the heterogeneous cell. The values calculated by (4) were consistently low for all cases when compared with each of the other methods, the respective greatest percentage differences being 3.1, 4.5, and 1.9. These differences occurred in each instance for the case of a 1.66 inch rod in a 6 3/16 inch lattice spacing.

Full Scale PCTR

Physics planning for the Full Scale PCTR has continued during the past month. A tentative layout of the reactor itself is partially completed.

It is not clear at the present time whether or not small source theory can be employed successfully in interpreting Full Scale PCTR experiments designed to obtain moderator temperature coefficients. The capacity to perform such experiments will be designed into the reactor if this proves to be compatible with other requirements.

Improved Methods of Reactor Parameter Calculations

As a preliminary to a combined theoretical and experimental attack on the problem of temperature coefficients, coding has begun on a program to generate a nuclear data tape. This tape will be a compilation of both microscopic and macroscopic cross sections in a form which can be readily used by reactor codes.

Multi-thermal-neutron-group-diffusion Program

The unmodified version of F_3, a three-group (one thermal group) code, was compiled and a test case was run. The FORTRAN deck, received in May from ANPD, was used.

The FORTRAN modifications of F_3 to handle two thermal groups are essentially complete, but some checking must be done before compilation is attempted.

Information was received from ANPD about F_n. A listing of the program was included and a source deck is in the mail. F_n will have to be modified before it can be used at Hanford, because it uses special subroutines which are avail-

able only on the IBM 704.

Scintillation Counter with Uniform Efficiency

Measurements of flux distributions for lattice parameter determinations can be simplified by using foils which cover the fuel cross section rather than taking point-to-point traverses with small foils or pins. This requires the scintillation counter to detect all of the foil activity with uniform efficiency, which is not usually the case for fairly large foils (1" to 2") on reasonable size crystals (3" to 5" diameter).

An empirical approach has been taken to the problem of producing a scintillation counter with uniform efficiency over the central region (1" to 2" diameter) of the crystal. A large crystal (2" x 5") was borrowed for preliminary studies in order to provide good resolution. Then the crystal was "scanned" along a radius with cesium, cobalt, and americium sources to determine the unperturbed variation in sensitivity. Aluminum absorber disks of various radii were then added between the source and crystal to depress the response in the center of the crystal. Amplifier bias was always set just below the photopeak so that all interaction in the aluminum effectively prevent the interacting photon from being detected. This approach has resulted in the empirical selection of a different set of absorber disks for each source which provide flat response (to ± 1% or better) over at least 1 1/2" diameter and up to 2" in one case. The method is then successful for the large 2" x 5" crystal and the studies are being extended to our own 1/2" x 5" crystal.

Automatic PCTR Data Recording System

Information concerning an automatic data recording system for the present PCTR is being gathered preparatory to submitting an appropriation request. Present thoughts call for a package proposal. The basic experimental data will be recorded on a typewritten page and on punched tape.

Computational Programs and Services

The cofit program to obtain extrapolation distances from exponential pile traverse data is now ready for operation. At the request of users, some revisions are being made in the output format of both the Exponential Data and Cofit programs. A report on the P-3 program has been written. A program for calculating incomplete gamma functions has been written and is being compiled.

Effect of Absorbing Cylinder on Thermal Neutron Flux

The effect of an absorbing rod on the neutron flux in an infinite, moderating, nonabsorbing medium is now being investigated. It is assumed that a Maxwellian flux source at infinity produces neutrons at a rate equal to the neutron absorption of the rod. The effect of the absorption is expressed through the energy dependence of the boundary conditions at the rod surface. Several methods of evaluating the coefficients in the infinite series solution are now being tried.

Automatic Counter - Mechanical Components

The preliminary design sketches of the sample changer for the automatic counter have been reviewed and accepted. The sketches have been reviewed by Technical Shops to determine fabrication time and cost estimates. The work may be subcontracted to an outside vendor. The estimated time of completion is 5 months after receipt of the working drawings. The 5-month figure includes a month for assembling and debugging the equipment.

Instrumentation

Tests were made in the near infra-red using a lead-sulfide detector for the purpose of measuring the color temperature of a tungsten filament. Some of the experimental arrangements tried were sensitive to temperatures well below the point where the filament was visible. No attempt was made to measure the temperature accurately although it is estimated that it was below 500°C. The test will be repeated when the Barnes' Black Body Radiation Reference Source is received. This source will provide a radiator of known spectral energy distribution for temperatures controllable between 200°C and 1000°C. Promised shipping date is July 15.

Mechanism of Graphite Damage

A piece of KC graphite at liquid nitrogen temperature was irradiated with 2 Mev electrons to test the feasibility of low temperature irradiation. During the irradiation no hot spots were detected that would have resulted in thermal annealing. There was no length change greater than 50 micro inches as a result of the irradiation or of the low temperature. It appears that low temperature irradiations can be made successfully.

String Cherenkov radiation was noted in the ice on the graphite. This will be a help in future experiments in determining beam size and location.

It was shown that the calibration of the calorimetric system is a function of the change in room temperature during a measurement. Additional heat shielding is being provided to eliminate this difficulty.

STUDIES RELATED TO SEPARATIONS PLANTS

Critical Hazard Specifications

Nuclear Safety in Hanford Laboratories

A meeting was held with members of the Radiation Protection Operation regarding the locations of criticality alarms within HLO operations. All buildings used by HLO in which appreciable quantities of fissile materials are now being used or in which future operations presently indicate the use of appreciable quantities of fissile materials were reviewed. The Radiation Protection Operation will follow through on the installation of the alarms where potential criticality is indicated.

At the request of the Plutonium Metallurgy Operation, nuclear safety in shipping Pu-Al alloy rods (7.35% Pu) together with enriched uranium (1.25% - 1.725% U^{235}), a small quantity (185 grams) of highly enriched uranium turnings, and irradiated bismuth and cobalt was reviewed. Previous shipments of slightly enriched fuels together with irradiated cobalt and bismuth have been made from HAPO. The AEC-HOO desired to ship the Pu-Al alloy rods (4.0 Kg Pu) together with the other materials to save shipping costs. Nuclear safety in the shipment of this type Pu-Al fuel by itself was previously reviewed in April and reported in HW-60233 B. It was determined that this shipment would be safe provided each type material was packaged and arranged in an array safe by itself and that the Pu-Al fuel was stored in the opposite end of the car from the uranium, with the irradiated cobalt and bismuth in the middle. The slightly enriched fuel was packaged and stored in an array safe for the 1.725% U^{235} enriched fuel. The highly enriched fuel was to be stored at a distance $\geq$ 3.0 feet from the slightly enriched uranium.

Plutonium Critical Mass Facility

Construction of the Plutonium Critical Mass Facility was begun during the first week of June.

Design is proceeding on the in-hood equipment for the reactor vessels, including the safety rod, control rod, source drive, and dump valve mechanisms.

Criticality Studies in Support of Processing Power Reactor Fuels

Experiments with Heterogeneous Systems

A critical approach measurement was made with the 0.300-inch-diameter rods of 3.063% enrichment for the purpose of evaluating the relative worth of water and lucite as moderators. The center-to-center spacing of fuel elements was 0.8 inches. Lucite plates 1/4-inch thick were placed between the fuel columns in the lattice; the total amount of lucite contained in the lattice, including that of the lucite tubes, displaced 48% of the water moderator by volume. The lucite tubes encasing the fuel elements occupied 6% of the moderator volume. This experiment indicated the lucite to be a slightly better moderator than water; this is in agreement with calculations which show the moderating ratio of lucite to be slightly higher than that of water. The extrapolated critical mass for the loading without the lucite plates inserted was 312.4 pounds and with the lucite plates, 308.6 pounds. Extrapolating these measurements to the case of 0% lucite in the lattice makes only about a 0.2% increase in the critical mass from the normal loading of lucite fuel tubes for this lattice.

Exponential measurements were started with the 0.600-inch-diameter rods to evaluate extrapolation lengths by equating the bucklings from the critical approach data and the exponential measurements. The fuel rods were 32 inches long encased in 1/32-inch wall lucite tubes. The uranium was 3.063% enriched. The preliminary results are as follows:

Lattice Spacing (Inches)	H_2O/U (by volume)	λ (cm)
1.0	2.06	6.17
1.1	2.71	6.46

The 0.300-inch-diameter fuel elements are currently being swaged down to a diameter of 0.17 inch. Critical approach measurements will be made with these elements in order to determine the minimum critical mass for this diameter and to better evaluate minimal critical mass for the 3.063% enriched uranium as well as to establish the maximum buckling.

Exponential pile measurements were made in lattices with various fuel loading radii in order to examine the variation in extrapolation length with pile size. The lattice spacing was 0.600 inch. The fuel rods were 0.300 inch in diameter and 32 inches in length encased in 1/32-inch wall lucite tubing. The following table shows the results of the measurements which were made at the different loading radii together with the values of the extrapolation lengths used:

BUCKLING OF 3.063% ENRICHED URANIUM
(0.600 inch lattice spacing, 0.300 inch diameter fuel)

H_2O/U (by volume)	No. Rods	Eff. Radius (cm)	b_{11} (cm) (Relaxation Length)	Buckling at λ (cm) (10^{-6} cm^{-2})	Buckling at λ (cm) (10^{-6} cm^{-2})
3.41	253	12.73	43.78	14,928 at 6.62	15,124 at 6.50
3.41	199	11.29	18.51	15,096 at 6.62	15,124 at 6.61
3.41	151	9.83	12.94	15,393 at 6.62	15,124 at 6.72
3.41	121	8.80	10.72	15,617 at 6.62	15,124 at 6.78

By decreasing the value of extrapolation length as the radius increases the value of the buckling can be maintained. This change is in the same direction as predicted by theory. Calculations by J. Chernick at BNL have indicated the reflector savings to decrease with loading radius (about -0.02 cm/cm) in the range of R between 15-30 cm. The above data give a decrease of about -0.07 cm/cm for the range of 9-13 cm.

Experiments with Homogeneous Systems

A measurement of K_∞ has been performed in the PCTR for a homogeneous mixture of 1.006%-enriched UO_3 and H_2O with an H/U atomic ratio of 5.1. The purposes of the experiment were:

1. To determine the magnitude of a systematic error in the measured value of k_∞ due to the presence of the aluminum walls of the cans used for containing the mixture,

2. To determine the ratio of the fast and slow adjoint fluxes in the mixture as a function of reactor loading,

3. To obtain the maximum value of k_∞ for the enrichment of this mixture. (The maximum k_∞ occurs at an $H/U \simeq 5$.)

The data for calculating the desired parameters have been obtained, and their analysis is in progress.

Consultation

At the request of the Programming Operation (HLO) the nuclear safety of a slab-type dissolver was evaluated for processing fuels with a U^{235} enrichment $\leq 5.0\%$. This dissolver consists of a number of rectangular-cross section compartments in a single layer. Nuclear safety criteria as a function of compartment cross section and spacing between compartments were given so that the feasibility of this type dissolver could be evaluated.

Neutron Age Measurements

The final experimental values for the ages of 0.966 Mev neutrons in water and kerosene have been derived. In the following table these values are compared with the results of moments-methods calculations of the age which were received from Goldstein. The calculated values have been corrected where necessary.

Moderator	Water	Kerosene
Measured Age	14.17 ± 0.22 cm^2	14.18 ± 0.21 cm^2
Calculated Age	13.90 ± 0.14	$13.94 \pm (0.08)$
Difference	0.27 ± 0.26	$0.24 \pm (0.22)$

The standard deviation of the calculation in kerosene is a lower limit.

A paper reporting the experiment has been written.

Mass Spectrometer for Plutonium Analyses

Work has been resumed toward correcting difficulties previously encountered in the operation of the ion source vacuum lock of the mass spectrometer for this program. Modifications made in the pumping leads of the vacuum lock have resulted in smooth operation of the lock, but final evaluation of its performance cannot be made until the entire source is assembled and operated over a period of time. Assembly of the ion source awaits the successful fabrication of a kovar-to-glass seal.

Critical Mass Theory

The program written to integrate the reactor kinetics equations with N groups of delayed neutrons and time dependent reactivity has been compiled and run for two different cases. The preliminary results indicate that an unreasonably large number of time steps are required in order to obtain satisfactory

accuracy. An improved method of approximation which greatly decreases the number of time increments necessary has been found and the program is being modified to use this method.

NEUTRON CROSS SECTION PROGRAM

Pu^{241} Fission Cross Section

Cross-section measurements in the 0.1-20 ev region are essentially complete. Irregularities in the fission foils have prevented an accurate shape analysis to determine if the asymmetries in the 0.26 ev resonance observed in earlier Hanford measurements are real. When corrections for nonuniformity in the foils and in the diffracted spectrometer beam are made, the magnitude of the observed cross section is about 6.6 percent lower than the earlier measurement.

The three resonances reported earlier in the 1-3 ev region were apparently due to second order contamination of the diffracted beam obtained from the Be $11\bar{2}0$ plane. Runs with the $10\bar{1}3$ plane and the $11\bar{2}0$ plane with an indium filter show an essentially flat cross section with the exception of a 30-barn resonance at 1.6 ev. The existence of this resonance could explain the unexpectedly large cross section observed in this region and the asymmetry in the 0.26 ev resonance.

Seven resonances were observed in the 4-20 ev region using the be $11\bar{2}4$ plane. The preliminary values of E_r and $\sigma_o \Gamma$ along with the resolution function width are given in the table below. All the resonances except those marked with (*) were observed to be as wide as the resolution function and hence no shape analysis could be made. Those resonances marked (*) are apparently unresolved multiple resonances.

RESONANCE PARAMETERS

E_r	$\sigma_o \Gamma$	% Resolution
4.30	1186	3.78
4.65	561	
6.00*	181	
6.90	210	4.82
8.60	129	5.44
9.60*	151	
15.00*	78.9	7.08

Slow Neutron Scattering Cross Sections

Measurements of the energy distribution of 0.22 ev neutrons scattered from room temperature water made with the three axis spectrometer have been temporarily discontinued. A study of the calibration of the efficiency of the third axis neutron energy analyzing system is in progress.

Fast Neutron Cross Sections

A test was made to determine the ultimate resolution of the new model vernier chronotron, preamplifier and multiplier phototube (as used in a time-of-flight

arrangement). In this test a light flasher similar to one built at the Radiation Laboratory at Berkeley was used. It was found that for a light level change of a factor of eight the resolution was about 0.6 mμsec; the 0.6 mμsec spread being entirely due to the multiplier phototube.

Review of Pu^{239} Cross Sections

A critical review of all measurements made on the low energy neutron cross sections of Pu^{239} has been completed. This paper has been submitted for evaluation to the Neutron Cross Section Advisory Group of the Atomic Energy Commission.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Low Exposure Plutonium Lattices

Samples of the alloy used in fabrication of the 1.8 w/o Pu-Al monitor foils have been received from Pu-Metallurgy. These samples will be analyzed for Pu isotopic composition by the Mass Spectrometer Laboratory of Nuclear Physics Research.

PCTR Experiments

Analysis of the P_3 calculations on clusters of small diameter, highly self-shielded rods of Pu indicated that the 0.0625-inch-diameter rods would not yield the required power output per tube. Since this result is based primarily on thermal reactions, and probably underestimates the reaction rate, another approach is being considered which will use a three-group diffusion theory code, F_3.

Planning for PRTR Startup

A preliminary list of startup experiments which are of interest to Nuclear Physics Research has been prepared. The list includes also those general experiments which are basic to the use of the PRTR for any measurements. The list has therefore been compared with ones prepared by other Sections in HLO. From such comparisons a proposal will be made for the full scale testing of the PRTR.

The Reactivity Measurement Facility (RMF)

A sum of $250,000 has been allowed for the construction of an RMF in the basin of the PRTR. This facility will greatly enhance the usefulness of the PRTR to the Plutonium Recycle Program.

Several meetings with the people responsible for the scope design have been held. The schedule for the initial planning is the following: By July 31, 1959, a Scope Description is to be prepared. This is to be a preliminary description of the types of experiments which are to be done and the general physical specifications necessary for these experiments. A Project Proposal is to be completed by September 1, 1959, with the final Scope Design prepared by September 15, 1959.

Instrumentation

An analysis of errors due to the effects of nonlinearity in the diameter unit of the Profilometer is being carried out. The analysis is not complete but results show that these errors can be kept to within ±0.001" by proper adjustment of lever arm lengths. One important discovery resulted from this analysis. This involved the angular positioning of the screw. The original design placed the screw -1° 23' off of perpendicular to the lever arm whereas the analysis shows that +3° (approximately) gives the least departure from linearity. A similar analysis is planned for the warp measurement unit. The Electronics Shop has been provided with sufficient details about the print-out system to permit them to estimate the cost of building one on site. Offsite bids appear to be about twice as high as anticipated.

An investigation has begun to develop a method for testing the quality of single lenses and groups of lenses. The method has been used by Eastman Kodak in recent years. It is particularly useful in predicting the response of an optical system when the response of the individual elements is known and will thus be useful in designing and testing periscope systems such as the two viewers for PRTR.

GAS COOLED REACTOR PROGRAM

The third experiment on the Allis Chalmers-Kaiser Engineers lattice is the measurement of the fuel temperature coefficient of reactivity. The PCTR central cell has been fabricated with thermal insulation, heating wires and electrical insulation, and thermocouples. The fuel was easily heated to 550°C in a test run prior to insertion in the PCTR core. The core is now loaded in the reactor.

Theoretical PCTR Studies

Efforts to explain the discrepancy between the experimentally measured f of the GCR lattice with control rod and the value predicted by small source theory have continued. The angular variation of the flux over the surface of an absorbing element, as exhibited by sums of K_0 functions only, has been removed by averaging. This resulted in essentially no change in the values calculated. An attempt to introduce a more accurate variation through inclusion of lattice sums of higher order Bessel functions has been delayed because of difficulty in evaluating coefficients.

A major deficiency in the present formulation is the exclusion of a proper treatment of epithermal effects. The possibility of extending the present small source theory formulation to include two energy groups is being examined and appears feasible.

TEST REACTOR OPERATIONS

Operation of the PCTR continued routinely during the month except for a one-week scheduled maintenance outage. There was one unscheduled shutdown due to an electronic failure. The 1.007 percent enriched, 7-rod cluster element experiment and the k_∞ measurements on the 1 percent enriched $UO_3 \cdot H_2O$ system were completed during the month.

The one-week outage was scheduled to reinforce the floor under the moving face. The floor and the earth under it were removed to a total depth of 26 inches. The excavation was extended under the fixed face approximately one foot so that the new concrete could be tied to the base of the reactor. Three 8 x 8 inch H beams were imbedded in the concrete to hold the tracks and the rack. Poor reproducibility caused by bending of the tracks and settling of the floor appears to have been successfully corrected.

Following the work review recommendations, a work order to Plant Maintenance was issued to put a charging port through the moving face plus a safety railing around the top of the PCTR. The new port will allow insertion of a central test cell without moving the face and thereby improve the techniques of measuring temperature coefficients of reactivity.

Critical mass experiments were conducted in the TTR reactor room during the first two weeks of the month. One week was spent modifying the control circuit connections between the TTR and the critical mass experimental equipment, or in the opposite direction, in a few minutes by operating personnel. Experiments to find the optimum arrangement of H to U^{235} ratio for the TTR fuel disks were conducted during the remainder of the month.

There were seven unscheduled shutdowns during the month caused by noise in channel three of the Safety Circuit.

BIOLOGY AND MEDICINE - 6000 PROGRAM

ENVIRONMENTAL SCIENCES

Atmospheric Physics

Assembly and installation of all of the field equipment required for this summer's joint AEC-AF dispersion experiments were completed on June 10, 1959, and the first partial experiment was run on June 12, 1959. This experiment was designed to test all equipment on the ground and tower sampling network on the first four sampling arcs, familiarize all personnel with the operation of this equipment and communication procedures under nighttime conditions, and collect air samples for the final calibration of the automatic counters. These objectives were achieved.

On June 19, the first full-scale experiment was conducted successfully. All air sampling and meteorological gear was operated and the first definitive measurements of atmospheric dispersion under stable temperature stratification and to a distance of 25.6 km from the source were obtained. Two major operational problems were encountered, 1) the gasoline engines on Arc 6 could not operate for five hours without refueling despite the manufacturer's specifications and 2) the cross-wind distribution measurement was truncated near the source due to inadequate sampling on the north end. Procedures for refueling were worked out to overcome the first problem and extension of the first four arcs 20 degrees to the north was begun in order to avoid the latter problem.

Difficulties in drawing representative samples from the formulation mixture of the tracer pigment, due to violent agitation by the mechanical mixer, caused

difficulties in the final calibration of the source strength. A return to a less violent stirring by bilge pumps, a procedure we have used previously, was indicated and the necessary equipment was put into service.

Computational procedures for the basic reduction of individual air sample measurements were completed. These computations include the preparation of uncertainties for each measurement, based on variabilities in flow rate, filter permeability, and counter calibration.

A second experiment was completed on June 27, 1959, but has not been analyzed sufficiently for assessment of worth. Despite readiness of field equipment and personnel, further experimental work has been delayed by persistently adverse meteorological conditions.

DOSIMETRY

Assembly of the large scintillation counter for the shielded Personnel Monitoring Station was completed. The ten-inch EMI tube was received after the counter was assembled. A similar tube was tested by Analytical Chemistry Operation and gave poorer resolution than the tubes now in use on the large counter. Our tube will be tested later, although it seems to have too high a K^{40} content.

A new chair was obtained for the counter. Alterations are being made in the counter mounting in preparation for the final calibration work. A phantom was obtained that consists of a plastic shell the size and shape of a man and containing a natural skeleton and dummy lungs, liver, kidneys, spleen, thyroid and gonads that can be filled with radioactive solutions for calibration purposes. A K^{42} source was obtained for calibration work and is being checked for radioactive purity.

The filters on the cell air supply were replaced after five months' use. Zr^{90}-Nb^{95} and Ru^{106}-Rh^{106} were detected on the filters.

During the month, eleven people were counted either for routine sampling or as suspected contamination cases. One of these had 58 mμc of plutonium in a finger wound. After surgery this was reduced to 2.2 mμc.

Two pigs were counted for the Biology Section. One had about 200 mμc of Sr^{85} (a gamma emitter) and the other had about 1 mc of Sr^{90} (a beta emitter).

The positive ion Van de Graaff was not operated during the month. An aluminum grating floor was installed in the laboratory. Work is continuing on the installation of a circular track for the instrument jig and on additional control room space for the building. The pressure tank of the accelerator was given a third-party inspection and was approved. Annual maintenance of the Van de Graaff is now in progress.

A successful spherical BF_3 proportional counter was finally obtained from the shop. After several days use it failed, apparently due to a leak.

Measurements with the double moderator neutron dosimeter were made to measure the neutron dose rate due to cosmic rays. For this purpose two counters that were identical except for the amount of BF_3 gas were used so that correction

could be made for natural alpha activity in the counters and for star production in the counter walls. The result was 0.074 microrad per hour. This is to be compared with a total natural background rate of approximately 10 microrads per hour. A few more measurements are required to correct for the possible effect of neutron sources in the building and to make sure that the natural alpha contamination is about the same in the two counters.

The vacuum system for preparing accelerator targets were used to evaporate titanium on stainless steel and load the titanium with deuterium.

A new 3" x 3" NaI crystal was obtained for use in the Van de Graaff laboratory. Its gain, stability and resolution were checked. The resolution was 8.6%. The crystal was calibrated for use in measuring Na^{24} in the event of a criticality accident. It should be capable of detecting about one rad of neutron dose.

In studies of the use of pencil ion chambers for low dose measurements it was confirmed that a standard variable condenser in parallel with the feedback condenser of the vibrating reed electrometer would either increase the range of the instrument or permit each measurement to be made as a full scale reading.

The gamma ray calorimeter was reassembled to make some more Co^{60} measurements. A Liston-Becker amplifier was employed in a resistance bridge for use with the thermistors of the calorimeter. An increase in sensitivity of about 100 times was achieved in this way.

Some very short range tracks found by the Biology Section in NTB-3 emulsions used for radioautographing cells containing Zn^{65} were interpreted as Auger electrons. An experiment with Fe^{55}, where there is no competing gamma ray, was suggested to confirm this interpretation. The phenomenon is of considerable interest because it permits determining exactly where the radioisotope [redacted]

rate meter work and other applications requiring direct current amplification. Both germanium and silicon transistors and various temperature compensating circuits are being investigated. Two d-c circuits were developed giving current gains, with about one microampere input, of 10 and 40, respectively. The outputs with temperature compensation decreased by half for an approximate 40°F increase in temperature. A chopper input transistorized amplifier using a transistorized chopper one-kc oscillator, an a-c amplifier, a demodulator and meter was developed. The minimum input current is about 5×10^{-8} amperes (limited by chopper noise). With a d-c input of one microampere, the output current is 300 microamperes. The equivalent current gain is thus 300. Using a scintillation gamma dose-rate detector, the circuit can stably measure gamma dose rates in the order of one or more mr/hr. The one-kc amplifier has a feedback voltage gain of 1000. The system has shown excellent stability thus far.

The application of the standardized transistor printed circuits to the High-Level Alpha Air Monitor was started and tests indicate good results. A less expensive detector head configuration was developed which gives improved efficiency of background collection for experimental purposes.

Design-development work is completed and fabrication has started on an experimental completely transistorized, aurally indicating alpha-beta-gamma instrument. The alpha-caused pulses are indicated by loudspeaker "pops" and beta-gamma-caused pulses are indicated by a distinct one-kc note or "chirp." Discrimination and gating circuits are used to separate and indicate the alpha-caused pulses from the beta-gamma-caused pulses. A single scintillation probe using a combination zinc-sulfide and terphenyl-in-polyvinyltoluene detector is used with the instrument.

A study of background conditions at various plant locations has been started with the arrival of a 200-channel analyzer. This analyzer will be used in the study. It is hoped to determine levels, energy peaks, and any other information which may be useful to development work.

The gamma dose-rate analysis of the background in Purex is being continued. The background is being checked for over a week in each area. The background has already been checked in the Machine Shop and inside Room 7 just off the laboratory corridor. The backgrounds are being checked where the nuclear incident alarm systems will be placed.

All radictelemetering data stations south of the Columbia River are calibrated and in operation. It was found that the Bendix "Aerovanes" at six stations were faulty and required readjustment of the wind speed contactor switch. These six stations have been repaired.

Some investigation work was started concerning several transistor pulse amplifier and count-rate circuits at low temperatures. It has been noted that some ceramic and tantalytic low-voltage capacitors change values markedly at low temperatures especially during long periods of exposure. Since such capacitors are used as emitter by-pass and range capacitors, the associated transistor circuits are sometimes adversely affected. No trouble is noted at elevated (125°F to 130°F) temperatures, but gain and readout is affected at low (below 30°F) temperatures after long-time soakage. Low-voltage paper and mylar capacitors do not cause trouble; however, the larger physical size of these types tends to preclude their use in miniaturized circuits.

WASHINGTON DESIGNATED PROGRAM

Because the urgent local need for analytical service to this program was temporarily relaxed, full effort is being directed toward (1) placing the ion counting detection system of the mass spectrometer into operation and (2) studying the behavior of the individual components which affect the accuracy and precision of isotopic ratio measurements.

CUSTOMER WORK

Analog Computing

A solution of the PRTR Primary Coolant Transient problem is now being obtained. A shortage of equipment has caused considerable delay in putting this problem on the computer.

A report was issued this month, HW-60370, "Simulation of NPR Pump Coastdown Curves on an Analog Computer."

Several loading configurations for both the old reactors and the K reactors were analyzed. These analyses determine the location and amount of enrichment and/or poison tubes required for a critical loading. A concentric ring pattern (at the reactor face) was considered using the diffusion equation in cylindrical coordinate form.

A study was made comparing the efficiency of a one-tank versus two-tank dissolver system considering a number of different design parameters.

The Waste Tank Temperature Distribution Study is to consist of analog computer runs to determine the steady state distribution of temperatures within the waste solution for various rates of internal heat generation. The analog solution will be uni-dimensional.

Another phase of this study will be to determine the approximate amount of error involved by assuming one-dimensional heat flow. Since it is not practical to attempt a two-dimensional analysis on the analog computer, an effort is being made to set up a digital program for the IBM 709. The program will consist of a two-dimensional resistive network composed of approximately 300 nodes.

Work has been initiated on both phases of this study.

A study is being made to obtain the best method to simulate transport lags. Specifications will be written for four such units in the near future.

The digital differential analyzer is back in operating condition after replacement of the bad rectifier.

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	90	85.4
24-Hour General	60	83.8
Special	116	89.7

Temperatures for June averaged one degree below normal while precipitation totaled only about a third of normal. Thunderstorms on the afternoon of the 28th started several grass fires in the area.

Instrumentation

Fabrication of the analytical calculator was delayed. The calculator should be finished the last week in June.

The experimental radiation warning device is completed, tested, calibrated, and ready for delivery to the Facilities Engineering Operation, Hanford Laboratories Operation. The scintillation unit has a minimum alarm sensitivity setpoint of about five mr/hr. It will be used as an alarming monitor above a water-filled tank containing a 15,000-curie Co^{60} source. The alarm point is settable from five mr/hr up to 100 mr/hr via meter setting and high voltage adjustment.

The class in electronics for instrument maintenance personnel has been progressing smoothly.

Fabrication has started in the 328 Building Electronics Shop on a simple G-M tube type count-rate beta-gamma alarming monitor using transistorized circuitry. A meter relay is incorporated in the count rate meter circuit to give alarm point settings adjustable from about 200 c/m to 10,000 c/m corresponding, very approximately, to gamma dose rates of 0.1 to 5 mr/hr. The units, three of which are being fabricated, are for use at Redox. By changing count-rate range capacitors, the units alarm-point range may be anywhere from 200 c/m to 100,000 c/m as desired. A simple rugged 1B85 G-M tube will be used as a detector.

Fabrication has started in the 328 Building Electronics Shop on a loudspeaker count-rate meter alpha-transistorized semiportable monitor designed for use with either a scintillation or an air-proportional alpha detecting probe. The prototype experimental unit is being fabricated for the Calibrations Operation, Hanford Laboratories Operation. The unit will use 110 VAC 60-cycle power.

At the request of Reactor Lattice Physics Operation, a study was made of the application of digital measuring and recording to the readout of PCTR experimental data. One company was found to be interested in assembling a system meeting, with some exceptions, the requirements specified by RLPO. A meeting is to be scheduled with representatives of that company during July.

Mr. H. E. Carter of Office Procedures Service in Schenectady has, at our request, talked to Western Union regarding their reactivation of a project for processing information by means of magnetic discs. Such a system may be found to have extensive application in the storage and transmission of financial and process data at HAPO. A meeting is planned for the first week in July to discuss detailed system requirements with members of Financial and Data Processing Operations management.

The design for the gross count instrument for the HLO Materials Development Operation has been given to Tech Shops for fabrication. With no delays in component procurement, the unit should be ready about the middle of July.

The dual beta-gamma probe for the Fission Product Chemistry Operation has been completed except for the high-voltage supply which has not been received from the manufacturer. The instrument, at present, is being calibrated and should be finished about the first week of July.

Evaluation was completed on the Tracerlab and Riggs Remote Area Monitoring Systems. Evaluation continued on the scintillation transistorized neutron and alpha-beta-gamma detectors.

Optical

Work has begun to adapt the scratch depth measurement method of HW-59410 to the variable-power underwater microscope at 105-C.

The routine Optical Shop work during this period included 480 manhours. H. P. Fricke had the first week of his vacation during this period. The period also includes one holiday (24 manhours). A total of 416 manhours work was done of which 3% was for Spare Parts (ultimate customer is CPD), 35% for IPD, 42% for CPD and 20% for HLO. The work included:

1. Aluminizing 10 mirrors.
2. Fabrication of six glass bearings.
3. Repair of one large Lenox Borescope.
4. Repair of a crane periscope head for Redox and two heads for Purex.
5. Polishing three thallium bromide windows.
6. Fabrication of one double solenoid periscope head for Redox.
7. Fabrication of parts for the Wide-Angle Viewer (PRTR).
8. Fabrication of a temperature probe.

Paul F. Gast

Manager
Physics and Instrument Research
and Development
HANFORD LABORATORIES OPERATION

PF Gast:mcs

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
John K. Fox	6/1-2	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Discuss experimental physics measurements including recent Oak Ridge work in critical mass area.	JE Faulkner RB Smith	Yes	300: 326 100-K 105-KE
J. L. Symonds	6/3-5	Australian Government Australia	Discuss PCTR and TTR.	RE Heineman HL Henry JE Faulkner RA Bennett PF Nichols LC Schmid DE Wood VI Neeley HE Handler WP Stinson BR Leonard HA Fowler	No	300: 305-B 326
Dr. Livermore	6/3	Reed College Portland, Oreg.	Discuss whole body counting and radiochemistry.	WC Roesch RC McCall JM Nielsen	No	300: 329 325 700: 747-A
Dr. Thorpe	6/3	Good Samaritan Hospital Portland, Oreg.	" "	WC Roesch RC McCall JM Nielsen	No	300: 329 325
Martin Jachter	6/4	Army Nucleonics Branch, Evans Signal Corps Laboratory Belmar, N. J.	Discuss instrumentation.	LV Zuerner	No	300: 329 3745
E. R. Wagner	6/9-10	Allis Chalmers Washington, D. C.	Gas-cooled reactor experiments.	TJ Oakes RE Heineman	No	300: 326 305-B

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. L. Powell	6/15-19	Univ. of Oregon Eugene, Oreg.	Consulting.	JE Faulkner	Yes	300: 326
D. K. Holmes	6/18-19	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Discuss solid state physics problems.	JL Carter DA Kottwitz	Yes	300: 326 305-B 3745-B 100-K 105-KE
J. R. Cameron	6/22	Univ. of Wisconsin Madison, Wis.	Discuss cross section measurement techniques using Van de Graaff	JE Faulkner	No	300: 326 305-B 3745-B
J. B. Sampson Fred Timberley Roddey Walton	6/22	General Atomic San Diego, Calif.	Discuss gas-cooled reactor experiments.	RE Heineman HL Henry	No	300: 326 305-B
Martin Stearns	6/24-26	General Atomic San Diego, Calif.	Discuss unclassified work in experimental physics.	JE Faulkner	No	300: 326
W. J. Ozeroff C. G. Andre	6/25-26	General Electric Vallecitos Atomic Laboratory Pleasanton, Calif.	Discuss PCTR technique.	JE Faulkner RE Heineman	No	300: 326
H. Hering	6/25-26	Saclay, France	Discuss graphite cross-section measurements.	PF Nichols	No	300: 305 305-B
J. A. Berberet	6/29-30	TEMPO Santa Barbara, Calif.	Discuss cross-section and critical mass experiments.	JE Faulkner	No	300: 326

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
E. D. Clayton	5/28-6/2	Eurochemic, Mol, Belgium	Consulting on critical mass problems.	E. L. Nicholson	No
	6/22-23	Saclay and Chatillon France (Commissariat a l Energie Atomique)	Discuss Pu critical mass experiments and criticality problems.	Robert Descours	No
W. C. Roesch	6/4-5	Univ. of Washington Seattle, Wash.	Teach AEC Fellowship class.	Faculty and Students	No
R. A. Harvey	6/4-5	Univ. of Washington Seattle, Wash.q	Assist in teaching EE 510.	Prof. Eastman	No
H. V. Larson	6/8	Univ. of Washington Seattle, Wash.	Teach AEC Fellowship class.	Faculty and Students	No
D. S. Selengut	6/10-12	Aircraft Nuclear Propulsion Dept. Cincinnati, Ohio	Consultation.	John Krase	Yes
	6/15-17	American Nuclear Society Meeting Gatlinburg, Tenn.	Attend Meeting.	--	No
	6/18	Knolls Atomic Power Laboratory Schenectady, N. Y.	Discuss reactor physics and variation methods.	Jack Smith	Yes
A. L. Ruiz	6/10	General Engineering Lab. Schenectady, N. Y.	Attend Meeting of Control Systems Steering Group.	H. Chestnut	No
	6/11	Knolls Atomic Power Laboratory Schenectady, N. Y.	Discuss automatic controls of reactors.	E. H. Bancker B. F. Cassidy J. E. Barnes E. Boerner I. W. Underwood	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
M. O. Rankin	6/11	Univ. of Calif. Radiation Laboratory Berkeley, Calif.	Observe and discuss instrumentation trends.	R. Walker	No
	6/11	U.S. Naval Electronics Laboratory San Francisco, Calif.	" "	K. Miller	No
	6/12	G-E Atomic Power Equipment Department San Jose, Calif.	" "	L. Test	No
	6/15	Lockheed Aircraft Sunnyvale, Calif.	" "	C. Erwin	No
	6/16-17	American Meteorological Conference San Diego, Calif.	Present Paper.	Members	No
I. T. Myers	6/15-19	Univ. of Buffalo Buffalo, N. Y.	Attend a carbon conference.	--	No
H. L. Henry R. B. Smith R. C. Lloyd V. I. Neeley	6/15-17	Gatlinburg, Tenn.	Attend American Nuclear Society Meeting. Present talk at ANS Mtg. " " " "	--	No
H. L. Henry R. C. Lloyd V. I. Neeley R. B. Smith	6/18	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Discuss critical mass experiments at Oak Ridge.	A. D. Callihan	Yes
B. R. Leonard	6/22-23	Brookhaven Nat'l Lab. Upton, N. Y.	Attend Neutron Cross Section Advisory Group Meeting.	V. L. Sailor	Yes
	6/24	Columbia University New York, N. Y.	Discuss cross section report.	--	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
W. D. Cameron	6/29-30	Boeing Aircraft Seattle, Wash.	Inspect Analog Computer Equipment.	George Wallman	No
		Ampex Corporation Seattle, Wash.	" " "	Lynn Watson	No
G. R. Hilst	6/29-30	Univ. of California Santa Barbara, Calif.	Chairman of Interdisciplinary Conference on Atmospheric Pollution.	R. D. Elliott S. Frank K. C. Spengler	No
		North American Weather consultants Santa Barbara, Calif.	Discuss diffusion experiments.	--	No

Chemical Research & Development

RESEARCH AND ENGINEERING

FISSIONABLE MATERIAL - 2000 PROGRAM

IRRADIATION PROCESSES

Decontamination of Reactor Components

Decontamination runs were made to determine the effect of higher temperatures attainable in an autoclave. The INCA pretreatment (Aircraft Gas Turbine Department process) was more effective at 130 to 140 C than in previous tests at 110 C, but still less effective by a factor of two than the Turco 4501 process at 110 C. When the INCA process was used at 190 C, decomposition of the reagents occurred and surface deposits formed; decontamination was relatively poor. The APACE process was not improved by operating the first step at 130 to 140 C.

Decontamination was shown to depend on the level of radioactive constituents in the cleaning solutions. When solution activity levels comparable to those present during the 100 Area rupture loop tests were used, over-all decontamination factors ranging from 14 to 40 were obtained with modified Turco procedures. These decontamination factors correspond more closely to those obtained in the rupture loop tests than to those obtained in laboratory tests at lower solution activity.

Four grades of Graphitar, G-14 (currently used), G-16, G-39, and G-85, are being tested for corrosion resistance to solutions used in the APACE process. Preliminary results indicate the four grades are equally subject to pitting attack by the solutions. The attack appears to occur mainly in the Step II (ammonium citrate) solution. General corrosion rates (obtained by weight loss measurements) are difficult to measure due to the porous nature of Graphitar. Values obtained after baking out absorbed liquid ranged from 0.12 to 0.15 mil/hr. for the four grades of Graphitar in ammonium citrate at 90 C.

Uranium Oxidation and Fission Product Volatilization

A decision to dissolve the high exposure specimen residue after a run resulted in significant changes in the furnace requirement. Furnace designs were studied which would permit readily dissolving the residue contained in the heating crucible and obtaining a known aliquot of the solution for analysis.

Two additional experiments were performed on fission product release from low level irradiated uranium heated in air. The purpose of these tests was to compare release during dynamic temperature conditions with that estimated from the isothermal test data gathered previously. The results show that integrated isothermal tests agree with dynamic tests within the limit of analytical error involved.

Five additional steam atmosphere fission product release experiments were completed. Analytical data show a much lower release from the metal of the volatile fission products I, Te, Ru and Xe than was achieved in an air atmosphere under otherwise similar experimental conditions.

Reactor Effluent

The reactor effluent disposal and radiological exposure problems associated with navigation in the Columbia River through the Hanford reservation were reviewed. The opinions and comments of concerned HLO Operations were composited and transmitted to IPD for inclusion in a document.

Fuels Preparation's aluminum scrap which was immersed in the 100-H retention basin appear to have a maximum equilibrium surface area of about one-fourth that of the machined turnings used by Chemical Research in earlier laboratory work. Since decontamination effectiveness depends on surface area, utilization of scrap from Fuels Preparation will require more massive beds to achieve the same clean-up efficiencies than would specified machined turnings; however, the life of the scrap beds would be longer.

Analytical Services

Activation analysis was used to measure 11 impurities in aluminum metal. Following irradiation the radioactive products were measured using standard radiochemical techniques. Impurity concentrations varied from 0.01 ppm to 1000 ppm.

Foils were prepared supporting more than a milligram of uranium on one cm^2 discs. Quality of the deposit was suitable for cross section studies. Minor modification of Cohen's ammonium oxalate deposition method was used; in fact, its application to discs as large as ten cm^2 is progressing. Because of the area to be plated and the large quantity to be deposited, metal vaporization techniques were abandoned.

An emission spectrographic method for the determination of 0.001 per cent silicon in aluminum was found to be insufficiently sensitive.

SEPARATION PROCESSES

Neptunium Recovery from Purex 1WW

A neptunium recovery scheme which could be used with solvent extraction equipment in any future fission product recovery facility has been demonstrated with the miniature mixer-settler. Synthetic 1WW and 30 per cent di-n-butyl n-butylphosphonate were employed as the feed and extractant, respectively. Neptunium was reduced in the feed by adding 0.03 M ferrous sulfamate. The scrub stream was 0.5 M HNO_3 and the stripping stream was 0.25 M HNO_3, 0.03 M Fe(III) nitrate. The flow ratios, aqueous/organic, in the extraction, scrub, and stripping sections were 1.5, 0.5, and 0.5, respectively. The temperature was 50 C throughout. The neptunium losses were 0.1 per cent and 0.4 per cent in the aqueous and organic wastes, respectively. Decontamination factors for neptunium were 2 from plutonium, 12 from thorium, 95 from zirconium, and 100 from ruthenium. Complete decontamination could be achieved by total reflux while replacing the 1WW with fresh nitric acid.

Neptunium Recovery from Purex 1BU

Consideration is being given to the recovery of neptunium from the 1BU stream by oxidizing neptunium(IV) to neptunium(V) and subsequently stripping the neptunium(V) into an aqueous phase. Ferric ion as the oxidant and a one stage contactor have been considered to effect neptunium recovery. The entrainment of ferrous ion from the 1BX column, however, prevents high recovery yields. Upon addition of nitrous acid, high recovery yields are again obtained as long as the nitrous acid concentration in the 1BU stream leaving the contactor is maintained in the 0.01 M range.

Determination of Neptunium(IV) Complexing Constants

The first and second successive formation constants of the neptunium(IV) oxalate complexes have now been measured by the TTA solvent extraction technique. The values for k_1 and k_2 were 5.2×10^3 and 200, respectively. These contain the hydrogen ion activity, i.e., involve reaction of neptunium with undissociated oxalic acid.

Plutonium Recovery from Slag and Crucible

Sixty per cent of the plutonium contained in a slag and crucible sample was solubilized by treatment with HCl gas in molten LiCl-KCl eutectic. Further exploration will be made of this approach which offers the possibility of relaxed criticality control on batch size as compared with aqueous processes.

Nitrate Complexes of Plutonium

Study of the nitrate complexes of plutonium(IV) have continued with determination of the spectra in solutions of different nitrate concentration. With aqueous nitric acid no change in the plutonium spectra is seen as the concentration changes from 11 to 15.4 M HNO_3. The spectra is the same as for $[(C_2H_5)_4N]_2 Pu(NO_3)_6$ in acetone and, hence, is probably that of the hexa-nitrato complex. The solubility of the tetraethyl amine complex in nitric acid changes very markedly over this acid range and may be due to increased formation of $H_2Pu(NO_3)_6$ at the higher ionic activities at 15.4 M.

The spectra of plutonium(IV) in a calcium nitrate solution (5.75 M $Ca(NO_3)_2$, 0.5 M HNO_3) was found to be similar to that in 8 M HNO_3 as reported by Hindman (ANL), but in 9 M $Ca(NO_3)_2$, 0.26 M HNO_3 (18.3 M total nitrate) the spectra was that of the hexa-nitrato complex. This suggests that the nitrate activity in concentrated calcium nitrate solutions is relatively low.

Tritium Processes

Linde Molecular Sieve 5-A (30-100 mesh) is being examined for use in concentrating the light isotope of the hydrogen rich mixtures which constitute the "tails" of chromatographic separation runs. The most successful of initial experiments resulted in a raffinate which contained only 0.01 per cent deuterium. Operation of the column was absorption at liquid nitrogen temperature with very rapid desorption occurring upon removal of the coolant. A very rapid flow has been found to be most satisfactory in achieving a clean hydrogen separation.

Dissolution of Nickel Cladding

Several procedures for dissolving the nickel coating, proposed for aluminum clad production fuel elements to increase corrosion resistance are being tested. The nickel coating is applied to the fuels by an electroless process involving chemical deposition from a sodium hypophosphite bath. Neither the conventional aluminum jacket removal solution (10 per cent NaOH - 20 per cent $NaNO_3$) nor a 10 per cent NH_4OH - 20 per cent $NaNO_3$ solution attacked the nickel. Nitric acid, ferric nitrate, and combinations of these reagents do attack the nickel coating. Boiling nitric acid dissolved the coating at penetration rates (assuming a density of 7.9 g/cu.cm. for the coating) which increased exponentially from ca. 0.05 mil/hr. at 0.05 M to ca. 35 mils/hr. at 3 M. Combinations of ferric nitrate and nitric acid do not appear practical because of relatively high uranium dissolution rates at low acid. The data for nitric acid, together with previously known data for the dissolution of uranium in nitric acid, are being used to determine optimum conditions for removing the coating either in a separate vessel or in the present dissolvers. These calculations are being made in cooperation with CPD, Research and Engineering personnel.

Slug Distribution in a Multi-Purpose Dissolver Mockup

The proposed annular multi-purpose dissolver for the Redox plant incorporates guides within the slug crib to support NPR fuel elements. Studies were made with a full-scale mockup and mild steel slugs to determine the effect of the guides on slugs distribution. Results indicate that equal charging on both sides of the distributor is necessary to assure coverage of a 12-ton charge of 8-inch solid slugs with a normal solution volume. A 56 per cent void volume was obtained when the equivalent of a 6-ton charge was made from one side only, and no slugs were found opposite the dump point.

Analytical Services

A flame photometric aluminum procedure was adapted to analyze aluminum ranging from 0.02 g/l to 0.22 g/l at a precision of ± 20 per cent at the 95 per cent confidence level. Interference (probably F^-) was removed by fuming to near dryness with sulfuric acid.

Gas chromatographic equipment and techniques were used to prepare 2 ml of ultra pure n-heptane for research use. Best available commercial n-heptane was injected into a 12 foot column of di-n-butylmaleate at 50 C. Carrier was helium at 30 psig. Lower mass impurities were vented to atmosphere and upon indication of n-heptane coming off the column, a liquid nitrogen cooled trap collected only n-heptane by condensation. Several 0.02 ml injections of stock were required to collect 2 ml of pure n-heptane.

Aluminum analysis was simplified through revival of an early Hanford method (S. A. Hays) based upon titration of hydroxyl ion released by adding potassium fluoride at pH 10.5. Accuracy and precision of 0.6 per cent were indicated. The method was both less tricky and at least five times faster than the oxine method for aluminum. The Hays method was sharpened through use of a more sensitive pH meter (full scale = 1 pH unit) and a Meniscc-matic® buret.

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The addition of 2.5 g/l nickel gave a four-fold reduction in time required for hydrochloric acid dissolution of high purity plutonium-aluminum alloy. Subsequent coulometric titration of plutonium was not affected.

WASTE TREATMENT

Semiworks Waste Calciner Prototype

Fabrication and installation of equipment for the calciner prototype is complete, except for the pre-heater which has not arrived on site. Process piping is 80 per cent complete. Instrument and electrical installations are 25 and 50 per cent complete, respectively. The over-all job is approximately 75 per cent complete.

Fixation of Purex Waste by Batch Calcination

Additional scouting runs using unagitated batch calcination techniques have been made. Formaldehyde-killed, three fold-concentrated waste was neutralized with 50 per cent sodium hydroxide to a pH of 9-10 and calcined. The resulting calcine (which melted at 625 C) had a volume of about 2.8 gal/ton U compared with about 1.8 gal/ton U for unneutralized waste.

Thermal Conductivity of Simulated Wastes

Thermal conductivity measurements have been made on three different types of simulated waste. Summary data from these measurement studies are tabulated below:

	Bulk Density, g/cc.	Thermal Conductivity, Btu/(hr)(ft)(°F)
Batch Calcined IWW - A solid mass of salt calcined to 930 F with no agitation	1.85	0.36
Radiant Heat Spray Calcined IWW	0.6	0.05
Radiant Heat Spray Calcined Coating Waste	0.09	0.03

Fission Product Fixation

Some very promising results have been obtained on the production of glassy melts from Redox (high aluminum) waste. Addition of borate or of borate plus silicate to synthetic Redox first cycle waste followed by firing at 900 to 1000 C resulted in fluid melts which solidified to dense glassy solids. Chemical cost of the minimum amount of borate required for a fluid melt is about $46/ton U. This may be compared to $110 for caustic to neutralize the same quantity of waste (present disposal process). Further experiments are planned with active solutions to determine fission product leachability from the solids.

Special Geological Studies

"Ground Vibration Tests in the HAPO Area in April, 1959" (GEH-24390) was received, reporting the evaluation by Frank Neumann, CPD seismologist-consultant, of natural earth vibrations. Three dominant periods of vibration were detected, the longest lying in the range of those generated by earthquakes. Waves of this period (about 0.2 sec.) are not readily transmitted far from the source, hence, local earth shocks are of greatest concern. A local earthquake generating waves of this period could have those waves greatly amplified as they passed through the fluviatile sediments. Additionally, structures that vibrate with that period would similarly amplify those waves by resonance. Tentative data indicated that the Ringold sediments vibrate with different periods than the fluviatile sediments. If this be so, building structures crossing the Ringold-fluvialite sediments contact would be subjected to shearing at that contact in the event of an earthquake.

Observation Wells

Groundwater monitoring wells in 200 East Area were examined with the gamma scintillation probe and the results compared with those of a previous survey conducted approximately a year ago. Gamma emitting waste components were found to have penetrated to the water table beneath the 216-A-8, 216-A-24, and 216-BY cribs. Gamma emitters were also detected all the way to the water table in well 299-E13-20, monitoring the 216-BC cribs; this may indicate the imminent breakthrough of radioactive contamination beneath this site. A downward movement of detectable gamma emitters totaling 65 feet was measured in a well monitoring the 216-A-24 crib. The downward movement of radioisotopes detected by this survey was less than 15 feet in all other wells probed at the same site.

Groundwater monitoring wells near inactive T-Plant disposal sites in 200 West Area were also surveyed with the scintillation probe. The maximum penetration detected near the 241-T crib was 85 feet and that near the 241-T-361 reverse well was 120 feet. No deeper penetration of residual gamma emitters was detected in any T-Plant monitoring wells.

Disposal to Ground

Geological, well probe, groundwater sampling and waste disposal data were utilized as bases for determining twenty-four well-drilling locations that will yield maximum information on radioisotope distribution and concentrations under five 200 Area ground disposal sites. These wells represent about fifty per cent of the anticipated drilling footage requirements for the proposed program to investigate the distribution of radioactive materials in the vadose zone under 200 Area ground disposal facilities.

Soil column experiments were conducted to evaluate the behavior of UO_3 Plant condensate waste in soils from near the 216-TY crib site. Columns were run with influents of pH 6, 9, 11, and 12. The columns receiving condensate at pH 6 and 9 showed a 2 per cent strontium breakthrough after about 3 column volumes and 50 per cent breakthrough after 20 column volumes. The columns receiving condensate at pH 11 and 12 showed no significant breakthrough after passage of 136 column volumes. Apparently the life of the condensate crib can be significantly extended by adjusting the waste to a high pH.

A better evaluation of the fate of plutonium discharged to the 216-A-9 crib is planned on the basis of current research. Exchange capacity measurements were performed on drilled samples from nearby monitoring wells. The average cation exchange capacity was found to be 6.8 meq/100g, with a maximum of 10.3 meq/100g. This low exchange capacity might indicate that the present crib capacity limitation based on criticality considerations may be unduly conservative. The possibility of plutonium being incorporated in precipitates in the soils near the crib requires further study.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Cerium Recovery from the Purex Plant

The proposal to ship cerium to Oak Ridge as dried cerium-rare earth sulfate precipitate in a shielded filter cartridge shipping cask has raised the question of whether the precipitate, which will have experienced temperatures of 300 to 500 C, can be readily dissolved out of the cask. Preliminary experiments indicated that heating the precipitate to these temperatures caused some change (probably either dehydration or formation of refractory CeO_2) which resulted in incomplete dissolution in nitric acid. Further experiments were undertaken to resolve the problem. Precipitate was dried at 500 C and the solubility determined in 15.7, 12, 10, 8, 6, 4, 1, and 0.5 M HNO_3. The concentration range from six to eight molar HNO_3 was most effective. Except for a one to five per cent residue, one gram of the 500 C-fired precipitate will dissolve in 40 ml of six to ten molar HNO_3 at 100 C in about four minutes.

Addition of a trace (0.005 to 0.1 M) of fluoride resulted in complete solution under the same conditions. Within the indicated concentration range, the concentration of fluoride did not appear to be important. Thus, if a trace of fluoride can be tolerated in subsequent processing, dissolving the precipitate from the filter cask does not appear to be a major problem.

Studies are being made to develop basic design criterion for the filter element which will be incorporated in the Purex Plant recovery equipment. Using simulated plant precipitation conditions a rare-earth sulfate slurry was prepared from synthetic IWW. Approximately 21 grams of rare-earth sulfate precipitated from each liter. The precipitate readily settled to 6.8 per cent of the solution volume. Greater than 99 per cent of the precipitate was recovered when a 40-micron pore size ceramic filter was used. Low filtration efficiency (less than 60 per cent recovery) was obtained when a 100 micron filter tube was used. The mean particle diameter of the rare-earth precipitate is roughly 15 microns as observed under a microscope.

Strontium Extraction

N-Dodecylbenzyldiethylene-triamine tetracetic acid was investigated as an extractant for strontium. It was thought that this organic-soluble substituted versene should extract strontium readily into an aqueous-immiscible organic solvent. Such was not found to be the case. Using four per cent reagent in chloroform, little or no strontium was extracted from sodium nitrate solutions in the pH range 1 to 11. The yttrium daughter was strongly extracted, however, in the pH range three to nine.

Promethium Recovery

An ion exchange run was completed similar to the high pH-H-Cu mixed bed run reported last month except for operation at 60 C rather than 25 C. As expected, better separation was achieved at the higher temperature. Seventy-five per cent of the neodymium was recovered at a purity of 96 per cent and 95 per cent was isolated at a purity of 92 per cent. This is considered very adequate for a proposed first cycle. The elution rate was such that a plant-scale seven-foot bed could be eluted in about 24 hours. This should be very adequate from the standpoint of the radiation stability of the resin.

Fission Product Isolation and Packaging Prototype

All equipment components except the Capper have been installed in the fission product isolation and packaging prototype. Operational "cold" testing has begun on the equipment required to convert the feed slurry of cesium zinc ferrocyanide to dried cesium chloride powder and to permit controlled discharge of this product to suitable containers for off-site shipment.

Operational tests on the receiver tank and the concentrator showed the need to slightly acidify the $Cs_2ZnFe(CN)_6$ slurry in order to prevent excessive foaming and carry over to the condenser and waste catch tank. Operational tests on the hydrolyzer showed the need for metering the feed in small

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increments (approximately 100 milliliter) rather than the 500 milliliter increments dictated by the original design. The pneumatic feed mechanism was modified to satisfy this requirement.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

Neutron Counting of Plutonium

The rate of emission of neutrons from plutonium in aqueous solutions is due principally to α, n reactions. The rate of emission of a specific amount of plutonium nitrate is greatly enhanced by converting it to plutonium fluoride because of the greater α, n cross section of fluorine over oxygen. A slight enhancement can also be obtained by promoting contact with the fluoride in certain organic polymers such as Teflon and Fluorothene. It was demonstrated that the specific neutron count rate of 10 ml of 20 g/l plutonium nitrate solution was increased about 30 per cent by putting it in a column packed with fine Teflon shavings. The same amount of plutonium precipitated as fluoride in the same volume of solution gave a 15-fold greater neutron counting rate. The Teflon packed column, therefore, only slightly increases the sensitivity for plutonium by neutron counting methods.

EQUIPMENT AND MATERIALS

234-5 Miniature Cyclone Powder Trap

Studies have been continued on the miniature cyclones being evaluated for possible use in removing particulate from 234-5 reactor off-gases. Recent studies have been made to determine whether vibration would eliminate the serious powder "bridging" previously encountered.

A miniature cyclone, with a 3/8-inch diameter apex, was vibrated at a frequency of 15,000 cycles/min. and an amplitude of 0.025 inch. Efficiencies of 98 per cent and 94 per cent were obtained for three hour and eight hour runs, respectively, using five micron silica powder. Bridging across the apex was not observed in the three hour run, but was initiating during the latter part of the eight hour run. Previous runs, without vibration, experienced bridging in 30 to 60 minutes.

HAPO Canned Motor Screw Pump

Document HW-60661 entitled, "Design and Evaluation of HAPO Canned Motor Screw Pump" was issued.

Corrosion of 1020 and 304-L in Sodium Dichromate

Corrosion rates for 1020 steel and 304-L stainless steel in 60 weight per cent sodium dichromate solutions were determined at 40, 70, 85 C and boiling at the request of 100-F Area personnel. Both materials corroded at less than 0.01 mil/month under all conditions tested with the exception of 1020 steel at the boiling point. During one exposure period this material corroded at 0.05 mil/mo.

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Materials of Construction for Purex Waste Calcination

In exploratory tests on materials of construction for calcination of Purex process wastes, samples of tantalum, Hastelloy B, and 347 stainless steel were exposed to synthetic calcined Purex waste at 900 C. The exposures were made in open quartz vials in the normal furnace atmosphere; samples were partially submerged in the molten salt. Tantalum and Hastelloy B corroded at about one inch per month and 347 stainless at about 14 mils/mo.

Failure of a Purex Steam-Waste Condensate Line

Failure of a Purex Plant stainless steel line, which initially carried steam and, later carried low level waste condensate, occurred where the line entered a concrete junction box through a mild steel liner. The pipe was severely corroded and cracked in the portion within the mild steel liner. The cracks appear to be progressing inward from the outer surface. An adherent black carbonaceous material present along the corroded portion indicates the pipe had been wrapped with a plastic tape. It is believed this failure is similar to those previously observed in Redox imbedded steam pipes and is due to stress cracking induced by chloride derived from thermal breakdown of polyvinyl chloride tape.

PROCESS CONTROL DEVELOPMENT

UO_3 Plant Automation

Bench tests of the Calciner Control Programmer were completed this month. All sections of the Programmer have operated satisfactorily during some 1200 simulated startups and shutdowns. The necessary wiring to connect the Control Programmer into the main panel board in the 224-U Building is presently being installed, which when completed will allow the immediate installation of the Programmer.

The necessary drawings for off-site construction of additional Programmers are being drafted and are about 60 per cent completed. An outline of the operation and maintenance manual for the Programmer has been written.

The "O" ring seal which failed on the magnetic flowmeter at the UO_3 Plant was found to be the specified Viton-A and not Buna-N as was suspected. This failure and a second which occurred this month precludes further use of this type of Fischer & Porter flowmeter. However, Fischer and Porter recently informed us of a new glass lined magnetic flowmeter with fused platinum electrodes for the 0 to 1 gpm range which they are starting to produce. Use of this latter meter should completely eliminate seal failure due to dissolution.

Polyvinyltoluene Scintillators

A terphenyl-in-polyvinyltoluene phosphor (Nuclear Enterprises Ltd. - NE 102 phosphor) exposed to flowing 144 gm/l uranium solution gave alpha count rates between 3000 and 4000 CPM. Decontamination after flow tests was excellent.

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A water wash reduced the background count to essentially its original value. All tests to date indicate the phosphor will probably have a long service life when applied to aqueous nitric acid streams.

Purex E-3 pH Probe

The remote pH probe in the Purex E-3 tank has been in operation for one month. Performance in general has been good, although intermittent periods of no response are observed. Potential sources of this difficulty are being investigated.

C-Column Instrumentation Studies

The C-Column instrument test facility is in operation after several major changes. The first scan of the in-column aqueous uranium concentration has been made using the phase separating photometer. Sampling rates of 10 ml/min were used which represent 1 per cent of the total flow. The sampling system provides a 30 second time lag between the column conditions and the photometer measurements. Satisfactory phase separation was obtained in the photometer even with quite tight emulsions.

Precision of Tank Level Measurements

Three calibrations, two with water and one with 12 lb./gal. uranium solution were conducted on 321 Building tank T-4. The water and uranium were weighed into the vessel in approximately sixty increments of 44 gallons each. Level readings from two precision manometers and the electronic gaging rod system were recorded. Temperatures of the vessel, vessel contents, outside air, and the manometer fluids were also recorded. Specific gravity readings were recorded from a standard manometer system. Preliminary analysis of the first water run, by Operations Research, indicates that at the 2000 gallon level the volume in the 3000 gallon vessel may be predicted within ± 0.5 per cent at the 95 per cent confidence level.

Boron-10 Monitor

Mechanical construction of the boron monitor is now complete. The counting instrumentation is assembled for testing. The moderator unit is presently being filled with paraffin. Upon receipt of the neutron source, the instrument will undergo final testing and laboratory calibration.

NON-PRODUCTION FUELS REPROCESSING

Mechanical Head-End Studies

Preliminary Equipment Specifications. Document HW-60760, entitled, "Preliminary Specifications for Mechanical Head-End Processing Equipment - Non-Production Fuels Reprocessing Program," is currently being issued. It presents preliminary specifications for the saw and the shear to be included in the mechanical processing cell. In addition, preliminary specifications are included for saw and shear auxiliaries required to control particulate and gases generated during saw and shear operations.

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Shearing of Stainless Steel Clad Swaged UO_2 Rods. Additional underwater shearing studies have been conducted using stainless steel clad swaged UO_2 fuels to determine the characteristics of the UO_2-water suspension formed during shearing. Semi-quantitative measurements indicate that as much as 3 per cent of the uranium may be suspended during normal shear operation. Microscopic examination indicated that the suspended particles are mainly in the 10 to 20 micron range, although settling rates (0.04 mm/sec) indicate the presence of some 3 to 5 micron particles.

Shear Blade Life Testing. The 40 ton 321-A Building shear, using a modified S-4 toolsteel shear moving blade and a 420 stainless steel stationary shear blade, has completed several thousand cuts, totalling 10,000 sq.in. cross-sectional area of cut material. This service is equivalent to the shearing of approximately two tons of power reactor fuel elements. When extrapolated to production shears, the blade deterioration data indicate that shear cutting force requirements will be increased at the rate of a ton for each ton of uranium chopped. For example, if a 150-ton force is initially required for a new blade, a force of 170 tons would be required for the same fuel when the blade had chopped 20 tons.

"Cold" Saw Testing. A Motch and Merryweather Model 3 coldsaw which will be evaluated for use in hardware removal operations in the Non-Production Fuels Reprocessing Program has been installed in the 321-A Building. Acceptance and run-in tests with company representatives in attendance are scheduled for the first week in July.

Feed Preparation

Sulfex Process Studies. The effect of nitrate ion on the dissolution of 304-L stainless steel and of uranium dioxide in sulfuric acid was examined to determine the required cleanout of the dissolver from batch to batch. Stainless steel dissolution rates in boiling 3.5 M H_2SO_4 dropped markedly at nitrate ion concentrations above 0.02 M (ca. 10 mils/hr. at 0 and 0.01 M NO_3^-; ca. 5 mils/hr. at 0.02 M; and 0.2 mil/hr. at 0.04 M). Uranium dioxide dissolution rates increased gradually from 1.2 mg/(sq.cm.)(hr.) at 0.0 M NO_3^- to ca. 75 mg/(sq.cm.)(hr.) at 0.1 M NO_3^-. It appears desirable to keep nitrate concentration to 0.01 M or less during Sulfex decladding.

Irradiated UO_2 which had received a (calculated) exposure of 3000 MWD/T dissolved in boiling 4 M H_2SO_4 at a rate of 0.0006 per cent per hour in the presence of dissolving stainless steel after the concentration of stainless steel in solution had reached a value of ca. 0.1 M. The rate of dissolution in boiling 4 M H_2SO_4 alone (0.02 per cent per hour) was found to be independent of whether or not air was present in the system. At room temperature, however, the rate of dissolution was found to be at least three times lower in the absence of air than when air was present (0.0006 per cent per hour). In the presence of air at room temperature, the rate of dissolution was found to be the same with water as with 4 M H_2SO_4. Thus, air-oxidation to uranium(VI) appears to be responsible for most of the reaction occurring at room temperature.

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Techniques for recovery of uranium and plutonium from off-standard Sulfex decladding solutions are under study. A literature survey on amine extraction of uranium has been made. From an equipment standpoint, a precipitation process would be preferable to solvent extraction. Preliminary experiments on the precipitation of uranium as the peroxide have been made. At low sulfate concentrations reduction of uranium content to concentrations representing less than 0.5 per cent loss was obtained. However, at sulfate concentrations expected in Sulfex decladding solutions, recoveries were erratic.

U-Mo Process Studies. The nitric acid - ferric nitrate solutions proposed for dissolution of U-Mo alloy fuel cores are relatively corrosive particularly at high concentrations. A survey of dissolving rates and solution stability at ferric nitrate concentrations of less than one molar is being made to assist in choosing a dissolving schedule which will minimize corrosion. Ferric nitrate concentrations of 0.5 and 0.75 M are under study. As expected, lower terminal uranium and higher terminal acidities are required to maintain solution stability. Samples of the terminal solutions are set aside for observation of long term stability.

The applicability of the Darex process for the dissolution of U-Mo alloys was reexamined since a better understanding of the role of ferric ion in preventing molybdenum precipitation now exists. Using U-3 w/o Mo alloy, solutions stable to precipitation following chloride removal have been prepared. A mole ratio of stainless steel to uranium of approximately 1.2 was used. Small amounts of solids were formed during the dissolution. During chloride removal larger amounts of solids were formed. These redissolved in the final concentration step following chloride removal and a solid-free solution was obtained by diluting to volume at about 0.7 M acid. Attempts to avoid solids formation by eliminating the concentration step prior to chloride removal was not successful. No conditions for preparing solid-free terminal solutions using U-9 w/o Mo alloy have been found as yet. Chloride removal in the presence of molybdenum appeared to proceed about the same as in its absence. Extraction of molybdenum from feeds prepared from U-3 weight per cent Mo under simulated Redox first cycle conditions was too low for detection.

Zirflex Process. Spectrophotometric studies on uranium in ammonium fluoride solutions indicate that the solubility of uranium(IV) in such solutions at room temperature is considerably lower at low free fluoride concentrations than was previously reported. These studies demonstrated that the rate of oxidation of uranium(IV) to uranium(VI) varies inversely with the free fluoride concentration, becoming sufficiently rapid at low free fluoride concentrations to make the more highly soluble uranium(VI) the predominant oxidation state in solution at the completion of solubility experiments of the type performed earlier.

Work has been initiated on the reduction of uranium(VI) to uranium(IV) in order to find means of assuring that all the uranium in solution at the completion of the decladding step will be uranium(IV). The zirconium dissolution process (and presumably the dissolution of other metals) results in the formation of uranium(IV) from uranium(VI) present. It was also observed that hyposulfite ion ($S_2O_4^=$) rapidly reduced uranium(VI) to uranium(IV) in ammonium fluoride solutions at room temperature. Studies on these and other reducing agents are continuing.

Darex Pilot Plant. Dissolution of stainless steel clad, metallic uranium core fuel elements was continued. The dissolution rate of uranium varied inversely with the nitrate-to-chloride ratio in acid concentrations greater than two molar. Rates increased from 18 to 169 mils per hour as the nitrate-to-chloride mole ratio decreased from 6.0 to 3.0.

The dissolution of type 304 stainless steel pipe in Darex-UNH solutions was attempted. The stainless steel would not dissolve in a 1.2 M UNH, 3.3 M total acid, 1.3 M HCl solution in which the nitrate-to-chloride mole ratio was 4.2. Stainless steel dissolved readily at about 30 mils per hour after an initial contact with an activator when the hydrochloric acid was increased to 1.9 M (nitrate-to-chloride mole ratio of 2.9). Previously reported data for the dissolution of stainless steel in the absence of UNH show a maximum nitrate-to-chloride ratio of about 8 for dissolution of stainless steel. Increased anion concentrations in Darex solutions apparently drop the threshold nitrate-to-chloride ratios necessary for dissolution of stainless steel.

Sulfex Pilot Plant. Pilot plant studies of the dissolution of 304-L stainless steel by the Sulfex process were begun. Dissolution techniques involved the controlled addition of cold concentrated H_2SO_4 to boiling water containing the stainless steel. Mild steel in contact with the stainless steel was used as an activator for the dissolution. Dissolution of the stainless steel began at rates ranging from 14 to 21 mils per hour when the sulfuric acid concentration reached approximately three molar. The reaction was initiated with acid addition rates of 0.55 to 0.70 cu.ft./(hr.)(sq.ft. of stainless steel surface).

In two runs, passivation of the stainless steel charge was experienced. In one case the passivation is attributed to a low acid addition rate (0.13 cu.ft./(hr.)(sq.ft. of stainless steel)). Acid addition continued until the solution reached 6.4 M H_2SO_4 with no dissolution taking place. The other case of passivation occurred when the acid addition was stopped at 2.9 M H_2SO_4 before the reaction had started. Both charges of passivated stainless steel were subsequently dissolved in 4 M H_2SO_4 using higher acid addition rates and mild steel to start the reactions.

Dissolution was deliberately stopped in one run and the solution was allowed to cool to room temperature. Upon reheating, the reaction resumed with no addition of mild steel and no change in the dissolver solution.

Charge mole ratios of acid to stainless steel were varied from 3.5 to 13.3; however, these changes had no noticeable effect on the dissolution rates.

Recirculating Dissolver. An "outrigger" dissolver barrel is being added to the present Hastelloy F dissolver to permit study of recirculation techniques, foaming, and sedimentation problems in proposed recirculation dissolver concepts. Fabrication of the barrel assembly (from Ni-o-nel welded Hastelloy F) is 95 per cent complete. Material has been ordered to allow addition of a second dissolver barrel at a later date.

[redacted]

Calculations were made to estimate the time required to declad a typical non-production fuel element in a recirculating dissolver with a separated dissolution crib and dissolvent reservoir. The additional time required over the conventional batch decladding process (within ±20 per cent) was about twice the solution hold-up time in the reservoir and was nearly independent of the assumed first-order dissolution rate constant. For example, a dissolver complex having a 1200 gallon reservoir and circulating dissolvent at 20 gallons per minute would require an additional 2 hours dissolution time over that required for a batch system. Such increases are considered small in relation to the contemplated over-all dissolution cycle time.

Materials of Construction. The corrosion of 304-L stainless steel, Hastelloy F, and Ni-o-nel by Zirflex and Sulfex decladding solutions under recirculating dissolver conditions is under study. The laboratory-scale recirculating dissolver consisted of one-inch diameter Haynes 25 tubes, slotted both top and bottom and placed in a Hastelloy F pot. Corrosion specimens were located both inside and outside the tubes. Zircaloy or stainless steel was dissolved inside the tubes and dissolvent circulated from inside to outside the tubes. An air sparge was used in Zirflex dissolvings but not in Sulfex runs. Corrosion data obtained to date show little difference between samples located inside and outside the tubes.

Corrosion rates for 304-L stainless steel during dichromate oxidation of solutions prepared by dissolution of U-Mo alloys in HNO_3-$Fe(NO_3)_3$ solutions are under study. At 0.04 M HNO_3, the attack is slight (less than 1 mil/mo) and non-preferential while at 0.5 and 1.0 M HNO_3 the attack is severe (ca. 5 mils/mo.) and intergranular.

Further examination of the corrosion of Hastelloy F and 304-L stainless in HNO_3-$Fe(NO_3)_3$ systems (dissolution of U-Mo alloy) indicates that the ferric nitrate concentration should be limited to 0.8 M in Hastelloy F and 0.6 M in 304-L to avoid intergranular attack.

REACTOR DEVELOPMENT - 4000 PROGRAM

PLUTONIUM RECYCLE PROGRAM

Plutonium Loss During Decladding of Plutonium-Aluminum Alloy Elements

Studies on the dissolution of plutonium-aluminum alloy by Zirflex decladding solution (6 M NH_4F + 0.5 M NH_4NO_3) indicate that the alloy reacts quite rapidly with the boiling solution until an insoluble coating (presumably AlF_3) is formed on the surface of the alloy. This coating greatly hinders further dissolution, the concentration of plutonium in the solution showing no further increase on continued exposure. In experiments employing as-prepared 1.5 weight per cent plutonium alloy, the plutonium concentrations in the solutions were found to be ca. 2 mg/l. It has not yet been determined what effect changes in free fluoride concentration will have on the concentration of plutonium in solution.

Exposure of plutonium-aluminum alloys to nitric acid was found to result in the more rapid dissolution of plutonium than of aluminum. When alloy specimens

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which had been treated with nitric acid were exposed to boiling 6 M NH_4F + 0.5 M NH_4NO_3, much lower (ca. 0.1 mg/l) concentrations of plutonium were found in solution than when as-prepared alloy specimens were employed. This can be explained on the basis that the surface of the alloy after nitric acid treatment is depleted in plutonium so that, on subsequent exposure of the alloy to ammonium fluoride solution, less plutonium enters the solution before the insoluble coating is formed on the surface. It thus appears that loss of plutonium to the decladding solution would be significantly reduced by treating the alloy core with nitric acid before the core is encased in its cladding.

Molten Salt Cycling of UO_2

Further cold scoping studies have shown that both UO_3 and U_3O_8 in a molten chloride melt are converted to UO_2Cl_2 by the action of chlorine and that the reaction rate is much greater at 800 C than at 650 C.

Uranium dioxide obtained by zinc reduction of the dissolved UO_2Cl_2 has been preliminarily characterized. It appears crystalline with a particle size falling within a 30-200 mesh range. A typical tap density is 4.3 g/cm^3 and the aggregate density (by carbon tetrachloride displacement) is 9.7 to 10.1 g/cm^3. Ignition of one product sample disclosed a O/U mole ratio of 2.065, and the X-ray diffraction pattern was typical of UO_2. Contaminants, as determined spectrographically, were Na and K, 1000 ppm; Zn, 100 ppm; and Si, 16 ppm.

Analysis of salt samples taken before and after zinc addition demonstrate the completeness of the reduction reaction. Whereas the oxidized phase contained 17 weight per cent uranium, after reduction it contained only 0.08 weight per cent, representing a "loss" of uranium of less than 0.5 per cent. The zinc phase contained less than 0.001 weight per cent uranium.

The experiment with the 900 MWD/T uranium dioxide wafer mentioned last month was inconclusive with respect to fission product behavior since all of the UO_2 failed to dissolve, thus leading to a product contaminated with unreacted UO_2. Comparison of the oxidized and reduced salt phases, however, was quite informative. Fission product concentrations of Ru-Rh, Cs-Br, Zr-Nb, and Sr in the salt phase were essentially unchanged by the reduction treatment. The cerium activity, however, was significantly lowered by the zinc treatment, in accordance with the large reduction of the cerium (thermodynamic) activity coefficient as determined by personnel at the Argonne Laboratories.

The plutonium to uranium ratio in the dissolution step was less than one-fiftieth of that of the solid as estimated from the radiation history of the element - in reasonably good agreement with cold runs on UO_2-PuO_2 solid solution material.

High Temperature Spectrophotometry

There is indication that UCl_3 in KCl at 800 C exhibits fluorescence in the 280 - 240 mμ region when the tungsten lamp is used as the illuminating source, but not when the hydrogen source is used. This implies the presence of an excited state which upon absorption of visible radiation is further excited to a state which is capable of producing the energetic fluorescent radiation noted.

Mercury Isotope Separation

Using essentially the technique of Gunning, four experiments were performed wherein mixtures of mercury vapor, hydrogen chloride, and butadiene were irradiated with a microwave excited electrodeless mercury-202 vapor lamp. Enrichments of the mercury 202 isotope were found in every case, the greatest concentration being 37.2 per cent as compared with 29.6 per cent of natural mercury. Although far smaller enrichments than reported by Gunning, these represent a successful start towards establishment of the necessary techniques.

Automatic Ball Mill Feed Controller

An automatic feed controller for a continuous ball mil used to grind UO_2 powder has been developed and is operating successfully with a significantly more effective and uniform control than possible by manual or time-programmer methods. The controller is based upon sonic principles, using a directional microphone at the focus of a parabolic reflector to pick up the sound of the balls striking each other in the mill. The transistorized pre-amplifier, which is tuned to exclude unwanted low frequency noise, feeds a count rate meter which in turn activates an on-off relay through a time delay to control a vibratory powder feeder. A low powder level in the ball mill results in an increased rate of collision of the balls and, conversely, a high powder level, which causes insufficient grinding, results in a lowered rate of collision. The optimum rate is easily determined by experimentation. The system is very resistant to interference from the noise and vibration of other operating machinery in the immediate vicinity.

PRTR Fuels Reprocessing

Information concerning PRTR charge-discharge schedules and fuels reprocessing schedules was compiled and transmitted to representatives of ORNL in meetings held at HAPO on June 16 and 17. Problems associated with handling and transporting the fuel elements to ORNL for processing were also discussed.

The material to be used in the gas dryer of the Redox off-gas analysis system has been selected on the basis of laboratory tests. Basic materials, such as sodium hydroxide or potassium hydroxide, will absorb water without absorbing ammonia. The new system is required during Redox processing of PRTR fuels by the Zirflex process.

A drawing, SK-2-7235, "Redox Combustible Dissolver Off-Gas Analysis System Interconnection Diagram," has been issued for use in installing the Redox off-gas analyzer system.

Fluid Bed Ion Exchange Studies

Twenty-three breakthrough runs were made using Cs-134 tracer to determine the reason for the excessive throughput volumes required for initial breakthrough in the earlier runs and to investigate further the effect of resin bed fluidization on fluid channeling. The runs were made in a 4-inch diameter glass

column, with resin bed heights of approximately 2.5 and 4.5 feet (corresponding to fluidized heights of 4 and 6 feet, respectively). The belated breakthrough was apparently due to absorption of some tracer by the solution within the resin particle. The nitric acid concentration of the feed solution was reduced to 0.001 M and, after sufficient washing and equilibration of the resin, the initial breakthrough occurred as predicted by theory.

With a packed height of 4.5 feet, the values for hold back (measure of the deviation from piston flow) at upflow rates of 0.6, 1.1, 1.5, and 2.9 gal./(min.)(sq.ft.) were higher than for the corresponding downflow rates by factors of 1.4, 1.8, 2.8, and 4.4, respectively. With the 2.5 feet packed height, the values for hold back at upflow rates of 0.6, 1.5, and 2.9 gal./(min.)(sq.ft.) were higher than for the corresponding downflow rates by factors 1.0, 1.9, and 2.7, respectively. The effect of increasing the bed height was generally to increase slightly the values of hold back for upflow and decrease them for downflow operation.

Boiling Metal Characteristics

The objective of this work is to investigate the boiling and circulating characteristics of a column of uniformly heated fluid metal. The knowledge gained will establish the engineering feasibility of using such techniques for high temperature heat transfer in nuclear and chemical reactors.

Currently, the boiling characteristics of mercury dissolved in the lead-bismuth eutectic are being studied. A column of liquid amalgam one inch in diameter and two feet long is heated uniformly by induction heating in a vertical quartz tube. An insulated liquid loop is provided, through which the liquid may circulate by thermosyphon action. The mercury vapor from the top of the column is refluxed by heat losses to the surroundings.

So far, the column has been operated only with mercury. With the thermosyphon closed, the maximum power level was limited to one kw by violent surging originating throughout the length of the column. With the thermosyphon open a power level of three kw was reached with less surging. Bubbles originated only in the top third of the column, while the lower part of the column was cooler due to heat losses in the thermosyphon.

Analysis of cooling curves for the lead-bismuth eutectic-mercury amalgam gives freezing points of 126, 101, 79, 57, and 38.5 C for 0, 11.1, 22.2, 32.9, 42.9 per cent mercury, respectively.

WASTE FIXATION

Mineral Reactions

Laboratory experiments were conducted to investigate the effect of insoluble material on the mineral bed decontamination of a typical condensate waste. Redox D-2 solution was used in these experiments. Filtered and unfiltered solutions at pH 1.8 were passed through beds of clinoptilolite. In this

acidified waste 28 per cent of the radiostrontium and 80 per cent of the radioruthenium were present in the solids. There was little evidence of non-ionic radioisotopes passing through the clinoptilolite beds. The clinoptilolite did not remove radiostrontium well at this low pH.

An experiment was performed to measure the strontium scavenging effect of the precipitate formed when diluted solutions of synthetic Redox high-salt waste (D-9) are neutralized to pH 10 at 65°. It was found that greater than 95 per cent of the strontium was scavenged from solutions at Al^{+3} concentrations >0.01 M.

Availability and cost information on calcite and clinoptilolite are being obtained. Both minerals appear readily obtainable and at reasonable costs.

A study of facilities in the 200 Areas in which a pilot test facility could be installed, indicated that the CR tank farm would be suitable. Easy access to Purex tank farm condensates along with existing facilities makes this location desirable. A request for utilization of this facility for mineral reaction development work is being prepared.

Radiant Heat Spray Calcination

Several runs were made during the month in an effort to calcine a TBP-25 (high aluminum) type waste. Using conditions that were optimum for Purex waste (650 C top temperature, 825 C center temperature), operation was very smooth and there was singularly little tendency for any material to hold up on the walls, but the density of the product was extremely low. The product density was only 0.11 gms/cc, and the fine particles agglomerated to form a fluffy material which seemed more suitable for a thermal insulating material than for ultimate waste disposal purposes. It was thought that this difficulty may be related to the low decomposition temperature of aluminum nitrate (134 C). Prior conversion of the aluminum nitrate to the sulfate (decomposition temperature ca. 770 C) was accordingly tried in another run. Decomposition of the sulfate was incomplete, and the bulk density was only increased to 0.18 gms/cc.

BIOLOGY AND MEDICINE - 6000 PROGRAM

Geology and Hydrology

"The Rate of Land Usage at Hanford for Waste Disposal, A Guide for Future Disposal Plans," (HW-60450) was completed in rough draft form. About 64 acres of land have been used per year, on the average, for cribs, trenches, tank farms, ditches, swamps, piping and similar facilities, including the contaminated ground underlying these facilities. About one-fifth of this total was required for cribs, trenches, caverns and necessary piping for radioactive liquids discharged to ground.

More than 200 years of disposal, at the rate of 64 acres per year, are indicated readily possible in view of available land. Geologic and hydrologic studies, combined with empirical data and laboratory studies, indicate that a 2000-acre

tract immediately southwest of 200 West Area possesses the best qualities of readily available land. If this tract be reserved, developed and efficiently used for crib structures only, more than 200 years of disposal are still indicated possible with as great or greater radiological safety and probably over-all lower costs than exist with the present disposal practices.

A new basalt surface contour map was constructed incorporating the latest stratigraphy information. The most significant changes are in the basalt ridge north of 200 East Area. This ridge has a significant influence on the movement of groundwater beneath the 200 East Area. Previously, this ridge was thought to be continuous and to rise above the water table in an unbroken barrier; actually it is broken in several places either through folding or erosion. This information assists in formulating logical explanations for cation groundwater movements observed in this region.

Two possible mathematical techniques for estimating the flow of water downward from a crib were developed. Attempts were made to obtain moisture distribution beneath a model crib in the field to test these solutions and permit their evaluation. The results were distorted by surface moisture from spring rains and no conclusions could be drawn; the experiment will be repeated under more favorable conditions. It was possible to determine a relationship between moisture content and effective moisture content for unsaturated flow by means of laboratory experiments with soils from the Gable Mountain test crib site.

Soil Chemistry and Geochemistry

A reaction was studied that permits the removal of cesium from wastes through the addition of potassium cobalticyanide and passing the solution through a bed of metallic zinc. A cesium reduction of 10^3 was obtained from solution containing 1 M sodium and 0.005 M $K_3 Co(CN)_6$. The reaction is favored by low pH and increased temperature. The decontamination reaction seemed to be insensitive to flow rate up to 3.5 gal/ft^2 per minute.

Further work showed depressed clinoptilolite capacity for cesium at pH 7 with increased temperature. This temperature effect was previously described for very high and very low pH systems. The depression of clinoptilolite capacity for cesium is ascribed to the sodium ion present in these experiments.

Studies of the phosphate-calcite reaction for removing strontium from solution showed a linear relationship between C/C_o and column length for short lengths, with essentially no additional decontamination afforded by calcite beds beyond a critical thickness. This effect is ascribed to phosphate depletion in the system. It was found that the C/C_o obtained at 60 C is six times that obtained at 25 C for a calcite column operating at about 2 gal/ft^2 per minute. This same improvement in the decontamination factor can be obtained by reducing the flow to about 1.2 gal/ft^2 per minute.

Studies continued on the soil chemistry of cerium. Equilibrium experiments indicated that the carbonate ion has little or no effect on cerium-soil reactions. However, the large excess of calcium ions in calcareous soils acts

competitively with the cerium for exchange sites at low pH and tends to partially flocculate the peptized cerium hydroxide coloid at high pH.

Experiments with cerium in solution at an added concentration of 4×10^{-11} M show good removal by centrifugation between pH 5 and 8, but removal decreasing to zero at lower and higher pH.

Ground Waste Investigations

Soil column and equilibrium experiments with coarse (>0.105 mm) and fine (< 0.105 mm) fractions of a local subsoil were compared. The best strontium uptake was obtained with the coarse soil fraction although this material had a cation exchange capacity (sodium acetate method) only about 25 per cent of that of the fine fraction. These data tend to indicate some non-exchange reaction responsible for the strontium removal. Some specific mineral reaction similar to the phosphate-calcite reaction will be sought.

The flow of radiostrontium-spiked solution to the field test crib near Gable Mountain was terminated after 9000 gallons had been discharged to the site. A 50 per cent nitrate breakthrough beneath the crib was detected after passage of 1100 gallons of the calcium nitrate solution. The depth to ground water beneath the 2-foot x 2-foot crib is 112 inches. The nitrate breakthrough data indicated an "effective soil column diameter" beneath the crib of 14.3 feet. Analytical work on the Sr^{85} breakthrough is not complete. A calcium solution is now being discharged to the site to displace the adsorbed radiostrontium; the displacement appears to take place with greater difficulty than was originally anticipated. The displacement is being followed by means of a G-M probe survey in 2-inch driven wells around the crib site.

Field Apparatus Development

A remotely controlled rotatable mirror for use with the in-well TV camera was assembled and tested. Satisfactory performance was achieved. With the equipment it was possible to clearly observe a break in a well casing which had parted during attempts to withdraw the casing from around a well screen.

A commercial (Beckman) moisture-sensing element was tested and found to be inadequate for the required application in laboratory measurements in soil. The element had limited sensitivity at higher water content of local soils. It also exhibited a slow response time.

Arrangements were made to discuss forthcoming aerial magnetic surveys to be performed by U. S. Geological Survey and to observe their equipment.

Rupture Monitoring and Rupture Debris Characterization

Water containing fission products released from irradiated uranium pieces under simulated NPR operating temperatures was studied to identify constituents removable by filtration and those not so removable. Results showed that a small fraction (less than 0.5 per cent) of the Sr^{89} in the water would pass through a

filter, suggesting that a large part of the fission Sr was associated with particulates. Cs^{137} was present in true solution as anticipated. Characterization of rupture debris is necessary to design properly and evaluate any rupture monitor system.

Micromeritics

The wool-felt combination filter recommended for removing uranium particles from cutting irradiated uranium was tested by Radiometallurgy. Results were promising, suggesting that the filter would be effective without excessive pressure drop upon loading.

It was again demonstrated in an independent way that the iron oxide particles appearing in 234-5 Building exhaust air samples are not related to the alpha-active particles in the air discharged from the stack. A large fraction (about 90 per cent) of the oxide was impacted on stages of an impactor which collected less than 5 per cent of the alpha-emitting particles. Over 200 g. of oxide are released each day based on the findings of these tests and the assumption that particles do not originate in the sampling line proper.

Low-Level Radioisotope Detection

A 9-1/4-inch diameter sodium iodide scintillation crystal with a 3-inch diameter well was put into operation. By careful adjustment of the dynode voltages of the seven type 6363 photomultiplier tubes attached to this crystal, a resolution of 11 per cent was achieved for Cs^{137}, a value satisfactory for gamma spectrometry. The increased sensitivity and counting efficiency of this detector are sufficient to allow analyses of the radioisotopes in the Columbia River directly on a 500 ml sample placed in the well. Increased precision and accuracy and shorter analyses times are obtained over the present method which involves concentrating and plating gallon samples prior to counting. A further advantage of well crystal counting is the ability to determine As^{76}, Sc^{46} and Cu^{64} directly without the separate beta absorption and coincidence counting techniques required in the present counting methods. A factor of 20 to 25 increase in sensitivity for gamma emitting radioisotopes is obtained in vegetation analyses using a 500 ml plastic bottle full of the vegetation in this large well crystal rather than the standard nine ounce jar of vegetation counted on a three-inch diameter crystal. This increased efficiency also makes this apparatus more suitable for counting crop samples.

Radioisotopes in Reactor Effluents

Measurements of the electrophorectic mobility of the P^{32} containing ions in a reactor effluent water sample showed them to be present as an equilibrium mixture of $H_2PO_4^-$ and $HPO_4^=$ ions. These results support the ion exchange column findings of the main chemical form to be orthophosphate.

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The loss of Sr^{89}, Cs^{137} and Cs^{138} to the atmosphere from the reactor coolant water was determined by collecting the noble gas parents and measuring the daughter products after sufficient decay. The rate of discharge to the atmosphere from an eight inch vent near a retention basin is 11 uc/min for Sr^{89}; 5.2×10^{-2} uc/min for Cs^{137}; and 6.8×10^{4} uc/min for Cs^{138}. The Sr^{89} value is 10 to 20 per cent of the value found in the water and should represent the minimum which is lost. The ratio of these isotopes indicate that the time lapsed since fission is approximately four minutes.

L. P. Bupp

Manager,
Chemical Research & Development

LP Bupp:bp

[redacted]

R. L. Braun, Chemist II, was hired as a summer employee and assigned to the Chemical Research Operation.

G. R. Fowles, Senior Scientist, was hired as a summer employee and assigned to the Chemical Research Operation.

H. Freund, Senior Scientist, was hired as a summer employee and assigned to the Chemical Research Operation.

J. W. George, Chemist I - H, was hired as a summer employee and assigned to the Chemical Research Operation.

T. Harris, Junior Scientist, was hired as a summer employee and assigned to the Chemical Effluents Technology Operation.

W. Meyer, Engineer I, was hired as a summer employee and assigned to the Chemical Development Operation.

V. K. Schlatter, Chemist II, terminated to return to school.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
RK Browning	6/2/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss dense concrete placement by the Guniting technique in the High Level Radiochemistry Facility.	KH Hammill	No
Dr. Livermore Dr. Thorpe	6/3/	Reed College-Portland, Ore. Good Samaritan Hospital Portland, Oregon	Discuss low level counting instrumentation and techniques.	JM Nielsen WB Silker	No
SD Schwarz	6/4/	Geo-Recon Inc. Seattle, Washington	Discuss geological and geophysical studies.	RE Brown JR Raymond	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
Akio Iizami Yahei Asada Toratoro Uchikoga	6/5/	Japanese Visitors	Discuss power fuels separation.	LP Bupp	No
HE Stone	6/12/	Knolls Atomic Power Lab. Schenectady, New York	Discuss fission product release.	CE Linderoth RK Hilliard	No
DE Ferguson	6/15-18/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss fuel element processing and fuel cycles.	LP Bupp RL Moore AM Platt	Yes
E Lamb JH Gillette	6/16/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss fission product recovery research. Fission product recovery.	RL Moore HH Van Tuyl EJ Wheelwright GB Barton RJ Sloat	Yes
CM Slansky	6/17/	ICPP Idaho Falls, Idaho	Discuss chemical processing and Non-Production Fuels Program.	LP Bupp EE Voiland WH Reas AM Platt RJ Sloat	Yes
RG Hart	6/17/	Chalk River Plant Ontario, Canada	Discuss analytical methods, TBP processing of Pu-Th-U; Ion exchange processing of irradiated fuels; De-sheathing of Zr-2 fuels.	RJ Brouns AM Platt	No
WT McDuffee JL Matherne WR Whitson	6/17/	Oak Ridge National Lab. Oak Ridge, Tennessee	Solvent extraction.	AM Platt	Yes
Lt. A. Weinhold U.S.A.F.	6/30/	Rome A.F.B. New York	Discuss waste contamination problems.	JM Nielsen	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
J Rasmussen	6/19/	Soil Conservation Service Prosser, Washington	Discuss geologic and groundwater problems of mutual interest in region.	DJ Brown RE Brown	No
ER Tinney	6/17/	Washington State College Pullman, Washington	Seminar presentation	LC Schwendiman	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
OF Hill	6/1-12/	Eurochemic Mol, Belgium	To assist Eurochemic on criticality problems.	EL Nicholson & Eurochemic personnel.	No
	6/22-23/	Saclay & Chatillon France	Visit French Research & Development Facilities		No
LC Schwendiman	6/4-5/	American Standards Assoc. New York, New York	Participate in Committee work. Report on Poland Trip.	Committee Members	No
RJ Brouns	6/9-10/	AEC Washington, D.C.	Committee meeting on Washington Designated Programs.	DR Miller	Yes
	6/11-12/	ACS Symposium Urbana, Illinois	Attend 12th Annual Summer Symposium, Division of Analytical Chemistry.		No
CE Linderoth	6/17-18/	Oak Ridge National Lab. Oak Ridge, Tennessee	Discuss fission product volatilization; sulfex process.	GW Parker GE Creek JM Flannary	Yes
	6/19/	Argonne National Lab. Lemont, Illinois	Discuss high temperature fuel oxidation.	RC Vogel	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JF Honstead	6/15-19/	Oak Ridge National Lab. Oak Ridge, Tennessee Gatlinburg, Tennessee	Discuss waste disposal research. Attend Health Physics Society Annual Meeting.	EG Struxness	No
JL Nelson	6/18-19/	Western Soil Science Soc. San Diego, Calif.	Discuss soil chemistry problems.		No
		Atomic Energy Project University of Calif. Los Angeles, Calif.		EM Romney	No
AK Postma	6/22-26/	Air Pollution Control Ass'tn. Los Angeles, California	Attend national meeting.		No
HJ Anderson	6/18/	General Atomic San Diego, California	Discuss gas-cooled reactor analyses of common interest.	AW Mosen G Buzzelli	No
	6/19/	Dow Chemical Company Rocky Flats Boulder, Colorado	Discuss analyses of common interest.	H Anderson RH Roberts	Yes
	6/15-17/	University of California Los Angeles, California	Attend Gas Chromatography Course given at UCLA.		No
DL Reid	6/21-22/	Argonne National Lab. Lemont, Illinois	Discuss hot laboratory facilities.	RP Larsen	Yes
	6/24-26/	Atlantic City, New Jersey	Attend ASTM #D-19 Committee Meeting		No
RE Connally	6/25/	Phillips Petroleum Co. Idaho Falls, Idaho	Discuss counting instrumentation and control potential coulometry.	EH Turk	Yes
	6/24-26/	Instrument Society of America Idaho Falls, Idaho	Attend Second National Nuclear Instrumentation Symposium		No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
WR DeHollander	6/11-12/	APED - GE San Jose, California	Technical discussions.	RB Richards	No
RW Wirta	6/29/	General Mills Corp. Minneapolis, Minn.	Inspection of the General Mills manipulator being completed for HLO.		No
LL Burger	6/17/	University of Washington Seattle, Washington	Discuss solvent extraction.	AL Babb	No
DR Kalkwarf	6/17/	University of Washington Seattle, Washington	Attend Organic Symposium		No
LL Burger	6/18-19/	University of Washington Seattle, Washington	Attend Regional ACS Meeting		No
RE Ewing			Also presented paper		
RW Henkens			Also presented paper		
DR Kalkwarf					
WE Keder					
MC Lambert			Also presented paper		
FP Roberts			Also presented paper		
FM Smith			Also presented paper		
UL Upson			Also presented paper		
EJ Wheelwright					
AS Wilson					
GJ Alkire			Also presented paper		
RE Burns					
JE Mendel					
EW Christopherson					
LR Duncan					
FE Holt					
PO Jackson			Also presented paper		
R Ko					
HA Treibs			Also presented paper		

BIOLOGY OPERATION

A. ORGANIZATION AND PERSONNEL

Dr. Wendell E. Ham, Associate Professor of Biochemistry, Washington State College, Pullman, Washington, joined the Biology Operation as a Summer Professor, now on assignment with the Biological Analyses Operation.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Radioiodine Contamination

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

Location	μc/g wet thyroid Average	μc/g wet thyroid Maximum	Trend Factor
Wahluke Slope	4×10^{-4}	9×10^{-4}	-
4 Miles SW of Redox	3×10^{-4}	6×10^{-4}	-
Prosser Barricade	2×10^{-4}	5×10^{-4}	-

Columbia River Contamination

Concentrations of gross beta emitters in Columbia River organisms collected at Hanford were slightly lower than one year ago. Values of indicator organisms follow:

Sample Type	μc/g Wet Wt. Average	μc/g Wet Wt. Maximum	Trend Factor
Minnows (entire)	1×10^{-3}	1×10^{-3}	-

Salmon fingerlings were exposed to a concentration of 250 C. columnaris organisms per ml of water for 25 minutes at varying temperatures. The time to cause death was 6.5 hours at 22° C and 18 hours at 10° C. The intermediate temperatures gave killing times to approximate a linear relation between these extremes. It appears that virulent organisms will kill fish even at temperatures well below those required to produce extensive killing under natural conditions.

A virulent C. columnaris strain was transferred on tryptone-yeast extract plates through 10 successive transfers with no decrease in virulence as compared with the initial data and with lyophilized cultures.

Fallout Contamination

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

Sample Type	µc/g Wet Material Average	Trend Factor
Bone	3×10^{-5}	- 2
Feces	3×10^{-5}	-
Muscle	9×10^{-6}	-
Liver	6×10^{-6}	-

Effect of Reactor Effluent on Aquatic Organisms

Monitoring of effluent from the 100-KE reactor was resumed with small rainbow trout at the first of the month. Effluent concentrations being tested are 1%, 2%, and 3%. At the end of the month there was no effect on the size of the fish at any of the levels; however, some increase in mortality had occurred in both the 2% and 3% concentrations.

Population Dynamics

One hundred and eleven Canada geese from the Hanford Reservation were banded in cooperation with the Washington Department of Game.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Strontium

Three groups of yearling rainbow trout have received intramuscular injections of Sr^{90}-Y^{90} twice each week in an attempt to relate damage to body burden. The doses administered at each injection were 6×10^{-4}, 3×10^{-3}, or 1.5×10^{-2} µc/gram of fish. No effect on the growth of the fish has been observed after six weeks.

Litters farrowed by two miniature swine fed 1 µc/day of Sr^{90} for 115 days seemed normal in size and appearance.

Blood concentrations of swine fed 25 µc/day of Sr^{90} for one month were $2\text{-}3 \times 10^{-6}$ µc/ml.

Analyses for the skeletal concentration of Sr^{90} in three miniature swine administered Sr^{90} intravenously (270 µc/kg of body weight) for two to four months before expiration showed that skeletal burdens were 30 to 45 per cent of the administered dose. The Sr^{90} blood concentration in these swine indicated that 4 per cent of the body burden was in the circulatory system at 25 hours after administration while only 0.1 per cent was present 400 hours after Sr^{90} injection. Comparison of these values with the 5 per cent and 1 per cent for similar time periods in swine fed lower amounts of Sr^{90} suggests that in the group intravenously dosed with high levels damage occurred, leading to a decreased rate of removal of Sr^{90} from the skeleton. A decreased removal could result from serious vascular damage in the skeleton.

Bone retention data are available through the first 32 days of the study on retention and excretion of Sr^{90} and Ca^{45} in young growing rats as influenced by the calcium level of the diet. While Sr^{90} appears to be lost at a more rapid rate than Ca^{45}, particularly on the lowest calcium diet, this difference is not as clear-cut as it was in the case of mature animals.

Experiments involving competition between a synthetic resin and bentonite clay gave a relative dissociation constant of 4 for the strontium-clay binding. The constant for calcium-clay was erratic but indicated a probable range of 25 to 30. Thus, it appears that strontium is several times more firmly bound to clay than is calcium.

Iodine

No significant changes have appeared during the period in the sheep and swine fed varying levels of I^{131} daily.

Cesium

Aquatic communities were established in aquaria supplied with dried mud from the Cs^{137}-spiked pond that was studied last summer. Approximately 5 per cent of the Cs^{137} originally in the mud was recycled into the water and biota. Tadpoles which browsed directly upon the surface of the mud contained 2×10^{-4} μc/g in flesh.

Bean plants grown in nutrient solution containing Rb^{86} during early growth phases and no radioisotope during later growth showed translocation of the Rb^{86} to new growth formed after removal from substrate containing the radioisotope.

Over 4 liters of .01 N HCl were passed through 100 gram columns of Cinebar and Ephrata soil which was contaminated on the surface with Cs^{137}. No significant amounts of Cs^{137} were identified in the eluate from either soil.

Plutonium

DTPA chelates of calcium, magnesium and zinc were tested in rats for their effectiveness in preventing plutonium deposition. Results are not yet available, however, the magnesium chelate appeared to be distinctly more toxic.

Radioactive Particles

Examination of mice after inhalation of $Pu^{239}O_2$ was continued. Observations included enlarged lymphatic tissue in several mice and low white cell counts in about 25 per cent of the 40 mice examined.

Weekly scans of dogs showed continued retention in lungs nine weeks after inhalation of $Pu^{239}O_2$. The pulmonary clearance of Pu^{239} was proceeding with a half time of about ten weeks.

Dogs are being trained for inhalation exposures and pre-exposure clinical data are being accumulated in preparation for further $Pu^{239}O_2$ experiments.

Gastrointestinal Radiation Injury

The effect of x-irradiation of the exteriorized rat intestine on the ability of the intestine to absorb glucose was confirmed in additional experiments extending from one to 10 days after radiation of 1500 r. Impairment of glucose absorption is not evident at one-day post irradiation, is inhibited 60 per cent at 3 and 6 days and has recovered to normal levels by 10 days, indicating that the absorption defect parallels pathologic damage to the intestine.

Rats exposed for 60 days to oral doses of .5 mc Y^{90}/day have survived as long as 300 days without apparent late effects.

Gonad Dose Studies

The first phase of the gonad dose study is under way. The dosage regimen of Cs^{137} is as follows, with one adult ram at each level:

Level	5 mc	500 µc/day		
Number of feedings	Single	20	10	5

The body burden of 5 mc will be sufficient to allow direct measurement of the radiation dose to the different body tissues within a reasonable length of time. The body burden of a ram fed Cs^{137} daily will be within 90 per cent of maximum after 20 days. The animal will receive an estimated average tissue dose of 50 rads during the 20-day feeding period.

Pencil dosimeters and a miniature GM tube will be used to measure the tissue doses. The distribution of the Cs^{137} in the ram's tissues will be determined by radio-analysis. Fecal and urine excretion, blood levels and blood cell uptake will also be followed.

Radiation Protective Agents

Preliminary studies of the radioprotective effect of erioglaucine on a different strain of mouse (CF_1) are considerably less impressive than earlier data. Fifteen days following 800 r x-irradiation 10 of 15 control mice were dead while 7 of 15 mice protected with 960 mg erioglaucine/kg were dead. At lower levels of erioglaucine administration mortality was higher than in controls. These results will require confirmation.

Microbiological Studies

Initial autoradiograms of yeast exposed to tritiated thymidine did not show definite localization of tritium within the cell. Work is continuing in as much as a problem of working under a safe-light with these ultra thin sections caused much loss of material.

Potassium and phosphorus movement in control and irradiated cells was studied under aerobic and anaerobic conditions. Initial uptake of P^{32} by both types of irradiated cells was greater than by control cells although the total uptake after 1 hour was less than in control cells. This rapid initial uptake of P^{32} by irradiated cells may be due to an increase in cell volume, the P^{32} being carried along with water going to the cell.

R. Thompson

Acting Manager
BIOLOGY OPERATION

RC Thompson:es

[redacted]

Personnel Contacted	Access to Restricted Data	Areas and Bldgs.	
Biology staff	No	100-F,	Biology
" "	"	"	"
DG Watson	"	"	"
FP Hungate	No	"	"
Clarke, Bair, Schiffman	"	"	"
" " "	"	"	"
Biology staff.	"	"	"
JN Wolfe, AEC	"	-	
-	"	-	
WJ Lotz	"	-	
-	"	-	
-	"	-	
-	"	-	
VW Bacon	"	-	
RE Kerr	"	-	
Romney, Bonner, Overstreet	"	-	

D. Lectures

a. Papers presented at Meetings

H. A. Kornberg, 6/15/59, "Biological Implications of Radioactive Wastes," Sixth International Congress on Nuclear Energy, Rome, Italy.

W. J. Bair, 6/15/59, Summary of inhalation toxicity studies, AEC Conference on Problems of Pulmonary Toxicology, Washington, D.C.

b. Off-Site Seminars

R. F. Foster, 6/12/59, "Biological Research at Hanford," State Advisory Council on Atomic Energy Meeting - held at HAPO.

W. J. Bair, 6/29/59, "Radioactive Particle Inhalation," (AEC Radiological Physics Fellowship Program at HAPO).

c. Biology Seminars

J. E. Ballou, 6/17/59, "Buildup of Zinc-65 in the Rat Following Chronic Feeding."

J. Olivard, 6/17/59, "Formation Constants of Calcium, Strontium, and Yttrium with Anions of Biological Significance."

E. Publications

a. HW Publications (external distribution)

J. E. Ballou, "Metabolism of Zn^{65} in the Rat," HW-60062, Unclassified, 4/17/59.

b. HW Publications (internal distribution)

None

c. Open Literature

Dockum, N. L., "Applications of Autoradiography in Biological Research," Journal of Biological Photographic Association 27, January 1959.

OPERATIONS RESEARCH AND SYNTHESIS OPERATION MONTHLY REPORT

June, 1959

ORGANIZATION AND PERSONNEL

Ray L. Buschbom joined the Operation as a Statistician effective June 15.

OPERATIONS RESEARCH ACTIVITIES

Input-Output Simulation Model

Further difficulties were encountered with the computing program during the month due to the inability of the compiler to handle the complete program in the way in which it had been formulated. A different approach has been taken and it is now expected that the work will be completed early in August. In the meantime some computational work on presently developed models is being done using an earlier version of the program.

A report on the development work in this area was presented to Operations Research personnel from other GE components and to members of the Office of Operations Analysis and Forecasting, AEC, on June 8, 9, and 10 at Philadelphia, Pennsylvania and Washington, D. C. respectively.

OPERATIONS ANALYSIS STUDIES

Redox Dissolver Study

The time-consuming job of data collection for this study has been completed, and work on the preliminary treatment necessary to put the data in a form for testing is progressing. In particular, the relationship between specific gravity and time for each dissolution is being expressed in terms of the two parameters of an empirical function describing the relationship.

Z Plant Information Study

Orientation discussions with data processing personnel were held during the month. Arrangements for preparing the computer program have been made, but full time effort in this connection will not be possible until the 702 to 709 conversion work is completed.

FPD Process Control and Experimentation

Further analyses were performed on data from the 3^3 experiment conducted in the pilot plant in order to locate the optimum combination of preheat and submerge times. Silicon content is the third variable involved. Characteristics investigated in these analyses were tendency to wet, total bond count

(external and internal), and residual can wall thickness. Reject data from the 11% silicon run have yet to be analyzed. Results of these analyses are consistent with those found previously, and a three month trial run on one canning line at the estimated optimum cycle will start in the immediate future. It is tentatively planned to install evolutionary operation methods of process improvement to further define the optimum upon the successful completion of this three months experimental run.

Two additional experiments were planned and conducted during June in connection with the duplex bath process. The first was a preliminary experiment involving displacement position, lead time, and cycle time. A 1/4 replicate of 4^3 experiment was used. Since three of the sixteen experimental conditions specified could not be attained, slight changes in the cycle time were introduced which resulted in a non-orthogonal analysis. Results from this experiment were helpful in designing a subsequent experiment, since it was possible to delete one of the variables and redefine the region of experimentation. The second experiment investigated the effects of bath temperature. Five levels were considered and the experiments replicated three times. Significant cubic curvature was detected in the external bond count response.

Preliminary pilot plant data were analyzed to estimate the effect of welding on total bond count. Based on these data, a second experiment was designed in which other effects will be investigated, such as single-pass vs. double-pass weld. Counter reproducibility will also be considered.

An undercutting test designed to measure reaction to water is currently in the development stage. Analysis of test data from two groups of fuel elements having different histories indicates that there may be a potential use for this test as another measure of fuel element integrity.

Horizontal agitation of the fuel element during the canning process has been offered as a means of reducing porosity. An in-line test was conducted on one canning line during May in which horizontal agitation was used on alternate days. Strongly significant interactions clouded the interpretation of the results.

Quality Certification Program

The analysis of data resulting from the accelerated testing program conducted during May was completed. A joint report, co-authored with personnel from FPD and IPD, was prepared giving the results of this study. Included in this report were specific recommendations indicating areas where immediate answers would be required before monitor charges could be put in the reactor. Of immediate concern is an evaluation of the difference between bond testers. It is anticipated that the first monitor charge can be placed in the reactors early in July. Also, based on these data, process control charts have been prepared by line for two characteristics, total external bond count and residual can wall thickness. Further development work is being done on the destructive test phase of this program.

Fuel Element Failures

An experiment is being planned to evaluate the effects of charging machine damage on fuel element integrity, primarily with respect to breaks in the bonding layer and physical deformation which might restrict water flow. Of broader interest is the possible damage inflicted by lack of care in the handling of fuel elements. As a preliminary to a full scale test involving actual charging in process tubes under different conditions, it was suggested that a mock-up system be utilized to determine if these effects are important enough to require further effort.

Process Tube Leaks

Discussions have been held with others interested in the reactor tube leak problem in order to outline a specific approach, particularly at F reactor. The next step in this problem is to estimate the discriminant function which will best assist in scheduling tubes for probelogging. Contacts have also been made with personnel involved in the economics of this general problem, since the economic factor will be important in determining what schedule of probelogging and tube replacement should obtain.

Aluminum Corrosion

Work in this area has been developed into a continuing program of analysis jointly sponsored by IPD and HLO. A report has been issued presenting the results of an analysis of in-pile corrosion data in which estimates of the parameters in a specific model were found. In the course of the analysis, it was determined that the error distribution was non-random. Deletion of data of less practical importance corrected this situation. The data have now been put on IBM cards so that different corrosion models can be compared. The first of these models is currently under investigation.

Reactor Calculations

Work is continuing on the study concerned with determining the accuracy of the reactor power level calculations, plus the related problem concerned with the accuracy of individual tube exposure. This study is being made in the context of SS Accountability requirements. It is becoming apparent that a major consideration in connection with this problem is tied in with the information dissemination system. Preliminary investigation has pointed out that inadequacies exist in this system which are potentially of considerable importance in assessing the over-all accuracy of the power figures. It is anticipated that a thorough investigation will be made of this information system as a parallel study to the original request by IPD to assess the accuracy of the system's sensing devices.

CPD Control

A mathematical model has been developed to assist in obtaining a better understanding of the variability in recoveries for individual batches in the Recuplex dissolvers. An apparent decrease in dissolving efficiency

[redacted]

with increased heels exists, which accounts for the increased heel build-ups. The existing recovery data are quite consistent with the model hypothesized. This model will be useful in formulating optimum operating procedures with respect to batch size and frequency of clean outs.

Radiation Protection Studies

The experiment to test the validity of the inverse square law during the radium gamma calibration of film continued this month. The exposed film was developed and read on the densitometer, and the analysis of data is in progress.

Assistance was provided on the design of an experiment to test the effect of exposure angle on dose estimation. The experiment will consist of exposing film to the radium gamma source where the film will be mounted in a circle about the source such that the angle of the badge with reference to the source will vary from 0° to 90° in each of the four quadrants. The design will enable the resolution of the non-isotropic harmonic effect previously observed in the source and the angular dependence in the film.

Discussions were held with Radiation Protection Operation personnel in regard to their evaluation of the neutron track detection program. A sequential procedure was suggested for evaluating NTA films which would reduce the average number of fields read per film over the current program and still maintain nominal error rates, the frequency of incorrect film evaluations. Based on current data confidence intervals were provided on the probability of obtaining a positive fast neutron-negative gamma exposure to a film badge.

Systems Reliability

Work continued on a systems reliability study of the K reactors. Current efforts are centered about a final check of the correctness of the logical statement of failure conditions preparatory to a digital computer calculation of the system reliability. A more general program concerned with appropriate criteria for the measurement of reactor reliability is being formulated.

STATISTICAL AND MATHEMATICAL ACTIVITIES WITHIN HLO

2000 Program - Metallurgy

A discussion was held with personnel of Coating and Corrosion Operation concerning the design of an experiment to investigate corrosion of Zircaloy as a function of several independent variables including alloy type, etching, storage, and autoclave time. Prior to a full scale experimental program to determine the interrelationships of these variables, a pilot study is to be run to investigate the uniformity of flow rate within the experimental apparatus. An experimental design was suggested for the estimation of flow rate characteristics which in addition should provide information on storage and autoclave time as independent variables.

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2000 Program - X-ray Defraction

A meeting was held with personnel of Physical Metallurgy Operation and Fuels Design Operation concerning the mathematical resolution of X-ray diffraction patterns for annealed zircaloy samples. The status of a previously derived non-parametric technique assuming a symmetric peak was explained as well as the difficulties which arise in the asymmetric case.

4000 Program - Swelling Studies

A technique was devised for constructing void fraction estimates based only on apparent pore radii as seen on micrographs. Empirical comparisons with a method based on estimating true pore radii using shadow length indicates agreement to within experimental error. The new technique was used to estimate void fraction on pre- and post-anneal UO_2 samples.

4000 Program - Plutonium Recycle

Statistical analysis to determine the precision of leak rate estimates based on data from the recent PRTR containment vessel test was continued.

6000 Program - Biology and Medicine

Work continued on the statistical treatment of mortality data from miscellaneous fish tests, and on the problem of uptake and retention of radioactive isotopes by biological systems.

General

Work continued on the problem of quantitative resolution of several isotopes from multi-channel analysis data. Data from standard scans are being used to estimate the precision of a resolution method based on weighted least squares analysis.

A least squares procedure for quantitative resolution of a mixture of SR-89 and SR-90 isotopes based on counting the beta emission from the Sr-90 and Y-90 daughter product mixture after absorption of the Sr-90 soft beta was devised and conveyed to interested persons.

A discussion was held with personnel of Nuclear Physics Research Operation concerning the simultaneous least squares estimation of axial flux and buckling parameters for irradiated UO_2 rods.

The time and spatial behavior of the temperature to be expected in an underground waste storage tank was developed for members of the Process Demonstration and Analysis Operation. A further study was made of the relationship between the maximum temperature to be expected as a function of tank size.

Assistance was provided in designing an experiment to determine the errors associated with volume measurements of dissolved non-production fuel elements. To date, three test calibration runs have been made on a process vessel in the 321 Tank Farm. Two of these runs were water calibrations and one was a UNH calibration. Solution increments were accurately weighed into the vessel and liquid levels were observed by rod as well as with a high precision manometer. Two more calibration runs with water are planned. Analysis of the data obtained on the first three runs is in progress. An IBM 709 program was prepared to facilitate the data analysis.

STATISTICAL AND MATHEMATICAL ACTIVITIES FOR OTHER HAPO COMPONENTS

Irradiation Processing Department

One problem in connection with the use of the DR Gas Loop for development work for nuclear propelled ships is the prediction of heat generation in the loop. A knowledge of the uncertainties associated with this prediction is essential to insure safe operation. Estimated uncertainties associated with the quantities entering into the calculation of this heat output were combined to obtain the over-all uncertainty. A discussion of the types of variation involved (constant but unknown vs. variable during operation) was included in the report on this problem.

The reliability of a proposed coincidence scram system for a given reactor was estimated and was compared with the present scram system.

Chemical Processing Department

Work was completed on the preparation of nomographs for use in the inventory control problem. Specifically, they can be used to determine safety factors for stock-out risks, re-order points, and the economic order quantities. These nomographs were included in a document prepared by CPD personnel concerned with spare parts inventory control.

The detailed series of investigations on the possibility of designing and fabricating cams for Gorton lathes necessary to machine plutonium components continued. After a complete scoping of the problem with interested personnel, two preliminary designs have been calculated.

Construction Engineering & Utilities Operation

Work continued on obtaining more realistic estimates of the variability associated with fair cost estimates for the Estimating Operation, CE&UO, and the means to objectively compare these estimates with actual bids. It is now known that the present method of comparing the estimates with actual bids is biased. Another method which will tend to eliminate this bias will be suggested to responsible personnel.

Carl A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted D Data
None					

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. Y. Dean	6-3 to 6-5-59	Lawrence Rad. Lab. Livermore, Calif.	Consultation	Max Harris	Yes
R. L. Basmann	6-3 to 6-5-59	TIMS Meeting Chicago, Illinois	Invited paper	-	No.
"	6-8,9-59	GE Symposium Philadelphia, Pa.	Discussion of model building.	WH Bloodworth	No
"	6-10-59	AEC, Div. of Oper. Anal. & Forec., Wash.DC	Discussion of model building.	PC Fine	Yes
L. G. Waters	6-8,9-59	GE Symposium Philadelphia, Pa.	Discussion of model building.	WH Bloodworth	No
"	6-10-59	AEC, Div. of Oper. Anal. & Forec., Washington, D. C.	Discussion of model building.	PC Fine	Yes
A. D. Wiggins	6-15,16-59	Joint mtg. Amer. Assoc. of Advance. Sci. & Biometric Soc. San Diego, Calif.	Invited paper.	WT Taylor	No

1248309

PROGRAMMING OPERATION
JUNE 1959

A. FISSIONABLE MATERIALS - 2000 PROGRAM

A survey was completed on nuclear safety aspects of Plutonium Metallurgy Operation laboratories. The information obtained has been summarized in a rough draft form.

The potential use of the radioisotope family, U-232 - Th-228, as power source material continued to be studied. As previously reported these isotopes may be prepared by irradiation of Th-230. In order to assess the potential for Th-230 recovery from uranium ore processing waste streams, preliminary inquiries were sent to three uranium mills representing over forty per cent of today's U.S. milling capacity.

B. REACTOR DEVELOPMENT - 4000 PROGRAM

1. Plutonium Recycle Program

RBU Computer Code

The isotope list for the RBU basic cross-section library was written during the month. Debugging of the pre-Monte Carlo and burnup sections of the code are now essentially complete. Old VALPROD cases were repeated with the RBU diffusion code, resulting in detection of a few trivial errors. Cases were prepared for comparison of the Monte Carlo and the new FORTRAN-SNG code which is nearly ready for operation. Further progress was made in the coding of the RBU input program, and in the training of Numerical Analysis personnel to assist in RBU and other code development work using the SCAT language.

Meleager Fuel Cycle Analysis Code

The Meleager code was further modified during the month to provide for automatic adjustment of the time step. This will improve accuracy and running time on problems involving radioactive decay chains. The code is being used to analyze the U-232 - Th-228 system.

PRTR Planning

A letter presenting the latest PRTR fuel processing schedule and the needs for high Pu-240 plutonium was submitted to the Commission. The new schedule is based on more accurate estimates of fuel burnup rate. Slight downward revision in high Pu-240 plutonium needs from 54 Kg to 49.6 Kg was made possible by the new schedule, even after including other-than-PRTR needs.

A list of PRTR physics experiments has been prepared. Estimates of time and facilities requirements are now being made in cooperation with research and development personnel in order that a schedule may be drawn up.

Plutonium Value Study

Compilation of information is under way to facilitate reporting a years study of the apparent value of plutonium to reactor operators using self-sustaining plutonium recycle and an uranium enrichment cascade. Concurrently, the IBM-650 codes used for this work have been rewritten and integrated into a single 709 machine code. This code will be used to fill in obscure data points which may arise during the compilation. In addition, the high speeds available with the 709 format of the codes usefulness to other plutonium recycle systems.

C. BIOLOGY AND MEDICINE - 6000 PROGRAM

Radiological Consultation

Proposed new Radiation Protection Standards were reviewed and detailed comments transmitted to Radiation Protection Operation.

Numerous additional manuscripts and documents were reviewed and commented upon, including: a proposed article for publication in Health Physics, a document on the release of fission products from ruptures and the calibration of the rupture detectors, a chapter of CFR Part 1 proposed by the AEC, and a draft of a letter to the AEC on the subject of a proposed new road through the Cold Creek Valley. Consultation was provided on the proposed participation of Hanford in the forthcoming burning tests by the Air Force.

The proposal for the Rattlesnake Springs Radioecology project was reviewed and returned to the Radioecology group with a number of unresolved questions.

Committee Actions

A meeting of the Risk Subcouncil of the General Electric Reactor Safeguards Council was attended at Gatlinburg, Tennessee. From this meeting a proposal for a new formula for calculating the release of fission products from reactor accidents was proposed.

A meeting of the Subcommittee 2 of the NCRP was attended at Gatlinburg. Since only three members were present, no official business could be conducted. Future work of the Committee was the main topic of discussion.

The revision of National Bureau of Standards Handbook 42, "Safe Handling of Radioactive Isotopes", which has been in progress for some months was completed during this month. Copies of the revised handbook will be sent to the Committee members and members of the Executive Committee of the NCRP next month.

The meeting of the Program Directors of the Division of Biology and Medicine was held at Hanford on June 8 and 9. A comprehensive review of their research and development programs was presented by HLO representatives. Plant tours were arranged for interested parties.

The Task Force on Radiological Evaluation met and approved the Quarterly Report. This report, delayed by the demands of the Biology and Medicine meeting, was issued.

D. OTHER ACTIVITIES

HW-60564, "Reactor Heat Transfer by Boiling Mercury-204 (HW-56161 Revised)", by C. A. Rohrmann was issued.

The 1959 Summer Institute on Nuclear Energy - Chemical Processing was begun on June 22, with eight participants representing institutions in eight states. This is the third year for this program at Hanford. Arrangements were completed for presentation of lectures by speakers from Idaho Falls, Argonne, and Savannah River. Efforts were continued to obtain other contributions from ORNL. The inclusion of off-site speakers at the expense of the time devoted to the problem assignments is a new feature of the Hanford SINE program. Seventeen scheduled lectures and three tours were completed.

Talks were given to the Junior Engineers and Scientists Summer Institute students at Washington State College, Linfield College, and Oregon State College. A talk on Radiation Dosimetry and Measurements was given to the Summer Institute of Radiation Biology at the University of Washington.

Arrangements were made for numerous visitors to HLO including three representatives of the Japanese atomic energy industry. Arrangements were also made to provide two lecturers to the Chemical and Nuclear Engineering Seminar at the University of Washington.

Milton Lewis

for Manager, Programming

M Lewis:dl

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
Bio-Medical Program Directors (40 visitors)	6/7 & 6/8/59	AEC - Division of Biology & Medicine Washington, D.C.	Attend Bio-Medical Program Directors' meeting.	J.W. Healy	Yes, except for 5 persons	100-F, 108-F, 146-FR, 141-M, 1701-F 300, 325, 329, 3760, Purex, 200-W, 222-U 100-K, 105-KE
Henry Stone	6/11 & 6/12/59	GE - KAPL Schenectady, N.Y.	Discuss disaster calculations.	J.W. Healy	Yes	300, 328,325
E.J. Leshan J.R. Burr M.A. Temme	6/4 - 6/30/59	Advanced Technology Laboratories, Mountain View, Calif.	Work on the RBU computer code.	J.R. Triplett	No	700, 713
Dr. Yakei Asada Torataro Uchikoga Akio Iizumi	6/8/59	Chief, Planning Div. of Atomic Fuel Public Corp. Managing Director, Nippon Atomic Industry Group Co., Ltd. (Interpreter) Tokyo, Japan	To discuss power reactor fuel processing.	C.A. Rohrmann	No	3760, 300
J. A. Berberet	6/30/59	Tempo (Division of GE) Santa Barbara, Calif.	To discuss PRTR.	J.R. Triplett	No	300, 328

VISIT TO OTHER INSTALLATIONS:

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
S. Goldsmith	6/9/59	Washington State College Pullman, Washington	Participate as speaker in "Junior Engineers and Scientists Summer Institute".	Dr. H. Batey	No
M. Lewis	6/15/59 6/16/59	Linfield College McMinnville, Oregon Oregon State College Corvallis, Oregon	Participate as speaker in JESSI program.	S.H. Shirk	No
S. Goldsmith D. P. Granquist	6/18 & 6/19/59	American Chemical Society, University of Washington, Seattle, Washington	Attend Regional ACS meeting.	-----	No
J. W. Healy	6/15-6/18/59	Gatlinburg, Tennessee	Attend GE Reactor Safeguards Subcouncil Meeting and attend NCRP Subcommittee Meeting.	Dr. K. Cohen	Yes
J. W. Healy	6/26/59	University of Washington Seattle, Washington	Oral presentation at Institute of Radiation Biology.	Dr. L. Donaldson and class	No

RADIATION PROTECTION OPERATION MONTHLY REPORT - JUNE 1959

A. ORGANIZATION AND PERSONNEL

H. V. Clukey transferred to APED on June 12, 1959. J. F. Evans and P. E. Bramson were added to the staff of Radiological Development Operation. The force of the Radiation Protection Operation now totals 133.

B. ACTIVITIES

No new cases of plutonium deposition were confirmed during the month. The total number of deposition cases which have occurred at Hanford remained at 229. There are 161 employees currently employed who have a measurable deposition of plutonium.

An operator at the 234-5 Building, with a previous plutonium deposition of about five per cent, suffered a contaminated injury on June 24 to the left index finger. Examination of the wound, caused by a piece of plutonium metal, in the Shielded Personnel Monitoring Station showed approximately 0.058 μc Pu. After surgical removal of a small portion of flesh from the wound area, 0.002 μc Pu remained. Preliminary bioassay results plus the remaining radioactivity in the wound indicate a total maximum body deposition of less than 10 per cent.

Air filters for the Shielded Personnel Monitoring Station cell were changed following five months of operation and one filter was counted in the cell. Values obtained were 1.4×10^5 d/m each of Zr^{95} and Nb^{95} and 2.5×10^5 d/m each of Ru^{106} and Rh^{106}. Photopeaks of these elements were obtained on background measurements of the cell. Leakage past the filter was apparent upon visual inspection and a work order was issued to modify the filter box to the cell to circumvent the leakage.

Temperature control in the monitoring cell building has not met design criteria. Wet and dry bulb and temperature measurements were made and installation of two refrigerated 2 hp air conditioners are planned to be installed by the landlord. Although many warm days have not been experienced to date, the main room temperature was 89° F. while outside temperature was 94° F. Previous data showed that the electronic equipment operation is more stable at lower room temperatures.

Four recently installed high-level radiation alarms in the 231 Building were tested and accepted. These four alarms, activating five sirens, provide adequate coverage of the entire building with the exception of an area near an air compressor over the power house. An additional siren will be positioned at this location.

The Protective Clothing Standards Study Group met to discuss controversial issues related to the proposed procurement guide. The guide was approved and issued as a formal HAPO standard.

The first prototype of a portable battery-powered pencil reader has been constructed and indicated appropriate performance. A volume reduction of about 10 has been realized.

Development activities associated with the prototype eye dosimeters have continued. Chambers of about 3 to 4 cubic centimeters in volume are being studied. The prototypes have passed preliminary leak tests and Co^{60} source calibrations. Their range is about 10 to 500 mr. The light transmission properties are still unacceptable for field applications.

The radiation level of the Calibrations film storage cave was examined. The equipment used to make the radiation survey consisted of three Victoreen stray radiation chambers and an ionization chamber pulse reader. Two exposures in the film storage cave were made, one over a three-day week end and the second during a normal work week. No radiation above background was measured.

The Harris refrigeration system installed on the Van de Graaff accelerator was put into operation. The use of dry ice was eliminated and also the need for week end overtime to service the dry ice traps.

The emission rate of radioactive effluents from separations stacks was within the suggested control limits.

An increase was observed in gross beta activity at the Redox Swamp inlet to ~1.5 x 10^{-5} μc/cc, which then decreased through June to 2.6 x 10^{-6} μc/cc. Persistent operation of swamps at the 10^{-5} μc gross beta/cc level has required corrective action in previous instances.

The usual seasonal decrease in isotopic concentrations and GI tract exposure estimates were observed with the increased flow of the Columbia River. The average river flow for June, 1959, was 331,000 cfs against 208,000 cfs for May, 1959.

Studies for correlation of air-borne scintillation equipment with USGS equipment were begun. Flights were scheduled for operation of HAPO equipment simultaneously with the USGS device in their aircraft.

C. EMPLOYEE RELATIONS

The 1959 Radiological Physics Fellowship program was initiated and 21 of the students began the course on June 22.

A lecture, "Radiological Defense", was presented to about 60 officers and men of the 104th QM Co., U. S. Army Reserve on June 3.

A lecture, "Police Problems in the Transportation of Fissionable and Radioactive Materials," was presented to about 25 police officers at a conference of the Northwestern University Traffic Institute in Spokane on June 25.

There were five medical treatment injuries for a frequency of 2.25. No security violations occurred during the month.

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

D. SIGNIFICANT REPORTS

"An Automatic Film Badge Processing Machine" by L. F. Kocher was presented orally at the Health Physics Society Meeting in Gatlinburg, Tennessee.

"Monitoring for Air-borne Radioactive Materials at Hanford Atomic Products Operation" by J. K. Soldat was presented orally at the Air Pollution Control Association Meeting in Los Angeles, California.

Con. Undoc - "Inventory of Radioactive Liquid Wastes to Active Disposal Sites - April 1959" by K. F. Baldridge.

HW-60914 - "Monthly Report - June 1959, Radiation Monitoring Operation" by A. J. Stevens.

HW-60642 - "Analysis of Radiological Data for the Month of May, 1959" by R. L. Junkins.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings
B. W. Shumway	5/27/59	Navy Radiological Defense Laboratory, San Francisco, Calif.	To discuss pencil reader.	F.L. Rising	No	3706:300
Betsy Stover Karl Herde G. L. Voltz R. W. Johnston I. E. Wallen	6/10/59	Division of Biology and Medicine, AEC, Washington, D. C.	Tour Hanford. Discuss radiation protection.	J.W. Vanderbeek A.R. Keene & Staff	Yes	202-S:200-W 105-KE:100-K 327; 3745-B, 309, 3705, 3746;300

VISITS TO OTHER INSTALLATIONS

L.F. Kocher G.D. Brown R.L. Junkins	6/17 - 6/20/59	Health Physics Society Meeting, Gatlinburg, Tennessee	To present a paper To attend the meeting.	K. Z. Morgan - -	No
L. F. Kocher	6/22 - 6/23/59	Union Carbide Nuclear Co., Oak Ridge, Tennessee	To confer on radiation protection practices.	J. C. Hart J. C. Ledbetter H. H. Abee D. M. Davis E. D. Gupton	No
J. K. Soldat	6/23 - 6/29/59	Air Pollution Control Assoc. meeting, Los Angeles, California	To present a paper.	J. A. Maga	No
G. D. Brown	6/15/59	Argonne National Lab., Lemont, Illinois	Discussions relative to whole-body gamma counting.	Dr. C. E. Miller H. May	No
A. R. Keene	6/28 - 7/1/59	Dow Chemical Company, Rocky Flats, Colorado	Discuss plutonium processing.	T. S. Chapman	Yes
R. L. Junkins	6/14 - 6/16/59	Savannah River Plant, Aiken, South Carolina	Review environmental monitoring program.	C. M. Patterson	Yes

VISITS TO OTHER INSTALLATIONS (Continued)

R. L. Junkins	6/24/59	Northwest Pulp and Paper Association, Portland, Oregon	Attend Industrial Wastes committee meeting.	V. W. Bacon	No
B. G. Lindberg	6/25/59	Northwestern Univ. Traffic Institute, Spokane, Washington	Lecture.	T. J. Loveless	No

ENVIRONMENTAL MONITORING - RESULTS (May 25, 1959 - June 21, 1959)

Sample Type and Location	Activity Type	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	0.4	% MPC_{GI}	--
Separations Areas	Gross Beta	3.7×10^{-7}	µc/cc	-3
Pasco	Isotopic	0.2	% MPC_{GI}	--
Kennewick	Isotopic	0.1	% MPC_{GI}	--
Richland	Gross Beta	$< 3.0 \times 10^{-8}$	µc/cc	--
Columbia River Water				
Above 100-B Area	Gross Beta	2.0×10^{-8}	µc/cc	+3
100-F Area	Isotopic	1.8	% MPC_{GI}	-2
Hanford Ferry	Gross Beta	1.5×10^{-5}	µc/cc	-2
Pasco	Isotopic	0.7	% MPC_{GI}	--
McNary Dam	Gross Beta	1.0×10^{-6}	µc/cc	--
Vancouver, Washington	Gross Beta	3.7×10^{-7}	µc/cc	--
Waste Water				
Outlying Test Wells	Gross Beta	4.3×10^{-6} (Max)	µc/cc	--
Reactor Effluent Retention Basins to River	Gross Beta	24,000	curies/day	--
Atmosphere				
Gross Dose Rate -				
Project	Gamma	0.9	mrad/day	--
Environs	Gamma	0.5	mrad/day	--
I-131 Separations Areas	I-131	2.9×10^{-13}	µc/cc	--
I-131 Separations Stacks	I-131	3.1	curies/week	-2
Active Particles - Project	--	6.0	ptle/100 m^3	-3
Active Particles - Environs	--	10	ptle/100 m^3	-3
Vegetation				
Separations	I-131	1.5×10^{-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	2.8×10^{-5}	µc/gm	-2

* 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 RECORDS

Exposure Incidents Above Permissible Limits

	Whole Body	Localized
June	0	0
1959 to Date	6	6

Gamma Pencils

	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
June	24,140	150	7	2
1959 to Date	174,252	590	23	8

Beta-Gamma Film Badges

	Badges Processed	Readings 100-300 mrads	Readings 300-500 mrads	Readings Over 500 mrads	Lost Readings	Average Dose Per Film Packet mrad(ow)	mr(s)
June	13,476	1,057	123	34	44	9.67	16.93
1959 to Date	65,516	5,425	574	104	292	6.05	18.10

Neutron Film Badges

	Film Processed	Readings 50-100 mrem	Readings 100-300 mrem	Readings Over 300 mrem	Lost Readings
Slow Neutron					
June	1,242	0	0	0	11
1959 to Date	7,495	19	2	0	38
Fast Neutron					
June	76	0	0	0	11
1959 to Date	467	3	13	0	37

Bioassay

	June	1959 to Date
Plutonium: Samples Assayed	735	4,703
Results above 2.2×10^{-8} μc/sample	28	208
Fission Products: Samples Assayed	744	4,557
Results above 3.1×10^{-5} μc FP/sample	7	24
Uranium: Samples Assayed	259	1,660
Confirmed Plutonium Deposition Cases	0	5*

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

Uranium Analyses

Sample Description	Following Exposure Units of 10^{-9} µc U/cc Maximum	Average	Number Samples	Following Period of No Exposure Units of 10^{-9} µc U/cc Maximum	Average	Number Samples
Fuels Preparation	95	3.4	45	14	2.7	47
Hanford Laboratories	78	7.1	19	14	2.9	17
Chemical Processing	29	10	40	21	4.1	59
Chemical Processing*	14	7.9	4	0	0	0
Special Incidents	2.7	1.6	5	0	0	0
Random	1.8	1.4	2	0	0	0

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

Thyroid Checks	June	1959 to Date
Checks Taken	0	0
Checks Above Detection Limit	0	0

Hand Checks		
Checks Taken - Alpha	37,249	214,640
- Beta-gamma	26,347	143,913

Skin Contamination		
Plutonium	29	118
Fission Products	45	267
Uranium	7	64

CALIBRATIONS

Portable Instruments	Number of Units Calibrated June	1959 to Date
CP Meter	972	5,760
Juno	313	1,785
GM	1,413	8,190
Other	191	1,207
Total	2,889	16,942
Personnel Meters		
Badge Film	684	5,299
Pencils	-	5,248
Other	492	2,652
Total	1,176	13,199
Miscellaneous Special Services	1,074	2,687
Total Number of Calibrations	5,139	32,828

A. J. Stevens
for the Manager,
Radiation Protection

AR Keene:AJS:kc

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - JUNE 1959

GENERAL

Safety performance of the operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 4.50 which is considered above average experience.

There were no security violations charged to the Operation.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 21,565 hours. This includes 14,274 hours performed in the Technical Shops, 3,235 hours assigned to Minor Construction, 9 hours to other project shops, and 4,047 hours to off-site vendors. The total shop work backlog is 30,508 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 6.5% (1236 hours) of the total available hours.

Distribution of time was as follows:

	Man-hours	% of Total
Fuels Preparation Department	6179	28.6
Irradiation Processing Department	878	4.1
Chemical Processing Department	655	3.0
Hanford Laboratories Operation	13621	63.2
Construction Engineering & Utilities	170	.8
Miscellaneous	62	.3

Overtime ratio remained at a higher than normal level (6.5%) caused by the large number of customer requests for emergency service. Other project shops were utilized to capacity in providing assistance to the Technical Shops.

Two machinists were added to the Technical Shops' roll during the month with two more scheduled to report on July 15. One welder was transferred from the Chemical Processing Department as a replacement for a welder who was promoted to a higher rated position.

New equipment received included a Cincinnati Milling Machine, a DeWalt Saw, and an Oliver Band Saw, and Cincinnati Lathe. This equipment is to replace other equipment which has been on loan from the 2101 Building.

Security performance was considered satisfactory with no violations. Safety performance was considered satisfactory with no major injuries; however, the number of medical treatment injuries (15) was higher than normal. Absenteeism decreased from the previous month to a normal level for this period.

RADIOGRAPHIC TESTING OPERATION

Activity for the Radiographic Testing Operation this month reached a record level reflecting the output of increase manpower and the results of the tube testing program. A total of 18,243 tests were made, of which 793 were radiographic (including x-ray and gamma-ray) and 17,450 were supplementary tests. Out of a total of 1,392 man-hours, 655 (47.1%) were used in connection with radiographic tests and 737 (52.9%) were used on supplementary tests. The supplementary test work included; borescope, eddy current, penetrant, and ultrasonic (flaw detection and thickness measurements) tests.

The number of pieces handled this month amounted to some 2,755 items. Reflecting the greater number of tests and also evidenced by the large increase in supplementary tests (automated ultrasonic tests) the footage of material examined reached an all time high of 19,773 ft. Work was done for 17 different organizational components representing most of the operating departments and service organizations. A total of 25 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted in 24 different occasions for advice and information relating to general testing theory and applications for other than the jobs tabulated in Part II - Testing Statistics.

Major construction work was completed on the PRTR process tube testing and treatment facility at White Bluffs. Construction of this facility was completed in a remarkably short time. Start-up work is in progress and appears to be proceeding satisfactorily. Leaks were discovered in the plastic lining of the acid tank. Repairs have been made to seal the liner.

A fairly large temperature gradient was found to exist at the ends of the autoclave. The temperature will be leveled out by balancing the heat input at both ends. Other start-up deficiencies have delayed pickling and autoclaving of the first PRTR tubes. The Reactor tubes will not be treated until the process has been proven using available test pieces.

Testing of the PRTR tubes is proceeding slowly. Quality requirements are as yet undefined, resulting in some re-testing. It would appear that a 100% wall thickness measurement is required to evaluate inside diameter conditioning of the tube wall done at the vendor's plant. Pickling could result in areas below minimum tolerance. Originally, no dimensional measurements at HAPO were thought to be necessary; this additional necessary requirement now is causing some delay in selecting tubes for initial pickling.

An emergency testing program of zircaloy fuel element cladding tubes (UO_2 & PU) for the PRTR initial loading has been successfully completed. Fluorescent penetrant testing was found to be highly selective in sorting defective material. Results of testing to-date indicated a fairly high percentage of reject material and since considerable procurement lead time is necessary for the fabrication

of new tubes, it was necessary to know the exact amount of usable tubing. Utilizing the facilities at White Bluffs, over 2700 tubes were examined in an eight day period. This record output on an extremely short notice was accomplished with the help of personnel loaned from Reactor and Fuels Research and Development, and Plutonium Metallurgy.

Preliminary discussions with Irradiation Processing Department have established the possibility of Hanford Laboratories Operation providing testing services on the NPR process tubes. The existing White Bluffs facility would be supplemented by material handling equipment.

Testing Statistics

Component	No.of Tests	Ft.of Weld or Material	No.of Pieces	Description
CPD	90	110	25	Concentrator (Purex Facility) TH-3 H.S. col; Chain links.
CEO	10	1/2	1	Tubes to tube sheet welds.
FPD	14	12-1/2	15	Ceramic fuels; enriched doe slug.
HLO	18014	19545	2698	PRTR Process tubes; Titanium tube; Spool piece; S.S. housing; PRTR ceramic fuel rods; Fuel elements; Trans-Pu Fab; 2nd Palm Fab; 3rd Palm Fab; BF-3 tube; PRTR process tubes; Ceramic fuel rods; PRTR tubes; Swaged zr-2; 680" I.D. tubes; PRTR ceramic fuels; Zirc - 2 tubes; PRTR process tubes; Meas. on hot water heater.
IPD	115	104-1/2	16	AEC loop; Gas storage vessel; Counter tube positioner; Zirc - 3 tube.
Totals	18243	19773	2755	

FACILITIES ENGINEERING OPERATION

Projects

There were 22 authorized projects at month's end with total authorized funds of $8,515,500. The total estimated cost of these projects is $8,646,500.

Six new project proposals are being prepared and an additional four proposals are awaiting transmittal to AEC. One new project, Sheet Metal Shop - 328 Building, was authorized by AEC during the month and one new project proposal, Shielded Animal Monitoring Station, was submitted to AEC for approval.

The attached projects report details the status of individual projects.

Contracts were awarded during the month on three FY-1959 General Plant Projects as follows:

CAH-828	Central Storage Facility - 300 Area	- $ 29,740
CAH-837	Animal Pens, Etc. - 100-F	- $ 51,560
CAH-827	Auto. Columbia River Monitoring Station	- $ 15,675

Engineering Services

Title	Status
Removable Target Pit Grating 3745-B Building	Complete.
Clean Air Ducts - 326 Building	Work started on June 23, 1959.
Design & Install Fire Alarm System - 314 Building	Informal Request is being prepared for this work.
Air Balance - 108-F Building	Field work is in progress.
Gamma Irradiation Facility - 3730 Building	Radiation warning system is complete and ready for installation. Manipulator is being fabricated. Other work complete.
Isolate Crane Conductors 314 Building	Work in progress to isolate crane conductors. This will decrease hazardous condition in building. Field work to start about 7-15-59.
Dog Isolation Facility - 141-FS Bldg.	Work essentially complete.
326 Building Retention Waste Sump Modifications	Engineering work in progress.
Temperature Control for Fish Troughs - Biology Operation	Material on order. Installation is to start during July.
Air Balance & Control 328 Building	Work is essentially complete. Improved cooling resulted.
Graphite Storage Building	Foundation work nearing completion. Building is at site. Floor slab preparation work underway. Beneficial use estimated abut July 27, 1959.

DEL

Title	Status
HLO Plan	Preliminary work is progressing on development of plant layout of HLO structures, utilities and grounds including future plant additions.
Improve Process Ventilation, Laboratories 204 & 206 - 3706 Building	The work involves additional air flow and equipment to provide a high degree of clean air to the laboratories.
Hood Ventilation in 183-KE Building	Engineering work complete. Work orders have been issued for installation.
Sound Proof Enclosure for Sonic & Vibratory Compacting Equipment 325 Building Basement	Preliminary design work has been prepared.
Graphite Storage Racks - 326 Building	Design work complete.
Accelerator Target Area Temperature Control - 3745-A Building	Preliminary design with suggested solution to problem has been presented to customer; awaiting approval to proceed with formal drawings.
Increased 440 Volt Electrical Service - 325 Building Basement	Construction Operation is preparing an estimate.
Unfired Pressure Vessel Survey	Records on vessel inspection in 300 Area are up to date; calculations to determine reliability are underway.

Drafting and Design Services

Design and drafting work in progress includes the following:

In-Reactor Creep Measurement capsule.
Mechanism for removal and containment of ruptured irradiated fuel - 3x3 and 6x9 loops - ETR.
Modifications to 14 ton shipping cask.
Equipment for High Level Radiochemistry Facility - 325-A Building
a. Manipulator tongs.
b. Three ton liquid sample cask.
Monorail feed mechanism for swage - 325 Building basement.
PRTR prototype loop - "AS-Built" - 314 Building.
Mechanism for moving samples through Gamma recording instrumentation.
Cobalt-60 source holder and tong mechanism - 3730 Building.
Hand feed for swage - 325 Building basement.
Fuel element X-ray photometer.
Test set-up design - fuel, fuel and foil holders, and graphite - 305-B Building.

Mofify existing PRTR shim control drawings.
"As-Built" - Metallograph Assembly and Details - 327 Building
Modifications to vacuum welding box - 325 Building Basement.
Calciner Control Programmer - 224-U Building.

Also, work is being performed for layout and details on projects CGH-834, Modifications and Additions to High Pressure Loop - 189-D Building, AEC-167, Job 0084, Pickling & Autoclaving Facility for Zirconium Material, and CGH-838, Fission Product Volatilization Studies Test Facility - 292-T Building.

Maintenance & Building Engineering - Landlord Functions

Costs - May - $ 112,211
April - $ 108,446

Fiscal year to date expenditures are $1,129,459 which is 91% of budget. Expenditure forecast was $1,144,200 or 92% of budget.

Analysis for Month of May: Steam costs to date are up $18,000, or 8% above forecast and the annual steam budget of $235,000 is overexpended by $8,700. June costs are estimated to be $9,600. The Unusual Maintenance budget ($182,000) on the other hand, is only 55% expended to date as compared to the forecast of 97%.

At month's end, the 7390 account was $14,741, or 1.18%, underexpended, as related to the forecast expenditure pattern. With the usual anticipated year-end charges from other departments, it is expected that the budget will balance within ± 1%.

Unusual Maintenance

Engineering investigation of the heating and ventilating problem in 329 Building is complete. Detail design and procurement will be initiated during July.

Work of renovating of 3702 Building is as follows: partitioning complete, painting 65% complete.

Alterations for instrument development lab., 3707-C - Design and procurement in progress.

Dry waste housing and oil storage building, 321-Z - Work order issued for construction.

Construction of a women's lounge, men's restroom, and office in the 3745 Building - this work is 30% complete.

Status of HLO Furniture

Fifteen 3-section, open-face, metal bookcases were delivered to HLO components. No replacement gray metal furniture was received. Routine relocation and excessing of items was unusually active during the month, owing largely to the relocation of E&PR Recruiting Operation.

The"As-Built" program for HLO structures was reactivated.

The uninstalled equipment inventory (landlord account) increased in value from $133,585 to $242,713, due primarily to the transfer of laboratory hoods in the 325 and 329 Buildings from the custodian accounts to the landlord account.

Miscellaneous

Approximately 194 drawings including sketches, work sheets, and formal drawings were completed by the Drafting Component during the month.

Approximately 17,000 square feet of prints were reproduced during the month.

The total estimated value of the 24 requisitions issued during the month was $50,000. Material procurement and control is being performed for a greater number of HLO projects.

TECHNICAL INFORMATION OPERATION

Staff turnover increased markedly during the month, with seven employees leaving the Operation and five new employees coming in. The Supervisor, Reference and Publication went on leave of absence June 30, and a Specialist, Reference II, took a nine-week leave of absence to go to library school in Oklahoma.

Arrangements were completed during the month to transfer to Technical Information the responsibility for handling clearance of papers and speeches for HAPO. At month's end an announcement covering the transfer appeared in Department newsletters. A revision of the HAPO OPG covering this responsibility had been prepared earlier and is going the rounds for approvals.

Two memoranda on classification were distributed to the field during the month. They are:

HW-60679 "Classification: Hanford Production Data"
HW-60795 "Classification: Krypton"

A third memorandum, HW-60872 "Classification Policy: Production Reactor Technology and Photographs" was being readied for distribution at month's end.

Two significant classification developments occurred during the month: (1) Hanford production data for periods subsequent to June 30, 1958 were downgraded from Top Secret to Secret. (2) The NPR was downgraded from Secret to Confidential. Actual plutonium output from the NPR will remain classified Secret. Essentially all other information on the NPR will be classified no higher than Confidential.

Work was begun on the extensive revision to the Hanford Classification Guide which is required by the above changes.

A Specialist, Reference I has been devoting half time to a special assignment with the Programming Operation. This has consisted of three activities - editing of four reports, attendance at discussions on advanced reactor concepts, and exhaustive literature searches in partial support of some of these concepts.

A second Diebold file has been procured to house the File Record Cards in the Classified Files. In addition, three new IBM tub files have been installed for the IBM route cards. Unfortunately, this does not provide enough space for all the cards. Since additional floor space is not available for more tub files, consideration will have to be given next to the use of double-deck Rol-Dex files which will permit greater storage capacity in the same space.

The special summer programs sponsored by the local AEC and handled by the Laboratory (the Summer Institute of Nuclear Energy and the Radiological Physics Fellows) have necessitated some added work and staff training. The Manager, Technical Information and the Specialist, Classification and Declassification contributed orientation talks to the SINE program.

The job of simplifying and streamlining the ordering and receiving of periodicals is progressing steadily. This has two aspects:

A. Utilization of IBM equipment for maintenance of subscription and receiving records. - The keypunching of subscription data has been completed with the exception of the file of vendor information, which will be completed during July. New and renewal subscriptions, and changes in subscription information are being keypunched daily to keep the file up to date. A systematic followup on all subscription orders is maintained by tabbing the appropriate card in the subscription file.

B. Elimination of excessive paperwork. - Accounts Payable has agreed to accept the Library's receiving records in lieu of the receiving reports now being routinely sent to them for periodical subscriptions. In the case of assigned copies mailed directly, a form will be signed by the customer and returned in the Library as a receiving record. Elimination of receiving reports for periodical subscriptions will save a great deal of clerical time.

The first summer school session at the University of Washington Center for Graduate Study at Hanford has made it necessary to staff the W-10 Library in the evenings this summer, a situation not anticipated when budgets were being prepared. The same schedule as that used during the remainder of the year is being used.

The annual report on purchase of reprints and payment of page costs for HAPO authored articles was submitted to HOO. A new waiver number assigned by the AEC for FY-1960 purchases has been received.

Work Volume Statistics

	May	June
Document Distribution and Files		
Documents routed and discharged (copies)	14,437	18,720
Documents issued (copies)	10,570	10,012
Documents sent offsite (copies)	6,444	5,207
Document reserves filled (copies)	931	903
Documents picked up and delivered	19,573	20,328

	May	June
Document Accountability		
Holders of classified documents whose files were inventoried	324	499
Documents inventoried in Files (copies)	25,210	18,494
Documents destroyed or retired (copies)	4,842	4,961
Documents revised (copies)	1,723	574
Documents pulled and documents filed (copies)	10,421	9,781
Documents reclassified	189	230
Accountable copies of SECRET and DOCUMENTED CONFIDENTIAL documents onsite	205,508	204,443
Reference and Publication		
Books cataloged (new titles)	45	181
Books added to the collection (volumes)	219	348
Ready reference questions answered by professional staff	119	130
Literature searches by professional staff	116	74
Reports abstracted (titles)	249	166
Formal reports prepared (titles)	7	12
Offsite requests for HAPO reports (copies)	235	245
Reports released to CAP (titles)	28	30
Library Acquisitions and Circulation		
Books ordered (volumes)	401	398
Periodicals ordered	117	269
Books circulated (volumes)	1,760	1,711
Periodicals circulated (issues)	2,573	2,765
Inter-Library loans	62	79
Films borrowed or rented	9	4
Industrial film showings	92	46
Bound periodicals added to the collection	194	134

Library collection:

	Main Library	W-10 Library	108-F Library	Ind. Med.	Total
No. of books	26,665	8,208	1,442	1,954	38,269
No. of bound periodicals	12,118	1	1,431	96	13,646
	38,783	8,209	2,873	2,050	51,915

DEL

Classification and Declassification

	May	June
Documents, including drawings and photographs reviewed for downgrading or declassification	53	98
Documents and papers (intended for oral presentation or publication) reviewed for appropriate classification	31	33
Documents submitted to Declassification Branch, Oak Ridge	16	9

Manager
LABORATORY AUXILIARIES

JL Boyd:jcw

BUDGET CLASSIFICATION Improvements to Production and Supporting Facilities - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60846
MONTH June, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CG-731	Critical Mass Laboratory	$1,000,000	$1,000,000 3-23-59	100 100	2 * 2.6 *	5-22-58 6-3-59	- - - 6-30-60	2-24-59 6-1-60
		USING COMPONENT: Physics & Instruments R & D				FEO ENGINEER: D. S. Jackson		

REMARKS:

The Fixed Price Contractor poured the footings for the control building and is placing forms for service building footings. Excavations for the crib sanitary sewer and cooling water drain system were completed. The contractor is currently placing rock in the crib and assembling sanitary sewer components. Partial payment to the contractor for the month of June, 1959 will be about $15,500.

* Total Project Schedule; fixed price portion is 4% complete.

CA-744	Metallurgical Development Facility - 306 Building	$2,623,000	$2,685,000 11-5-58	90 90	5.2 6.5	6-30-58 3-30-59	- - - 9-1-60	9-1-59 9-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. T. Lloyd		

REMARKS:

The contractor is behind on his own schedule. The firewall construction has not been started and this is considered a key item. The contractor has requested an extension of approximately 30 days on his contract because of the changes to the x-ray room and the chemical processing facility. The AEC has requested a determination of the importance of maintaining the current schedule. Procurement is progressing on schedule.

CA-749	High Level Radiochemistry Facility	$960,000	$960,000 10-31-58	100 100	76 71	6-15-58 8-14-58	- - - 1-1-60	11-21-58 9-30-59
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: R. W. Dascenzo		

REMARKS:

The following construction was performed and material received this month: (1) Approximately 90% of the high density concrete for the cell structure has been placed; only grouting around the cell door frames remains. (2) The 3'-8" normal concrete roof slab was formed and placed. (3) Instrumentation tubing was completed. (4) The vertical rising doors for between cells are on the job site. (5) The fire protection system is 95% installed. (6) Clean-up of the pneumatically placed concrete is in progress. (7) Piping and tubing are being tested.

Fixed Price Contractor is 89% complete compared to 92% scheduled.

AM-7900-67 5-58)

BUDGET CLASSIFICATION Improvements to Production and Supporting Installations - 58-b-4

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60846
MONTH June, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE (Cf. Actual) DESIGN / CONST.
CGH-790	High Level Radioactive Receiving and Storage Addition - 327 Building	$350,000	$345,000 4-23-59	100 100	45 45	6-23-58 10-9-58	- - - 2-1-60	12-31-58 2-1-60
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: J. J. Peterson		

REMARKS:

All structural steel had been received by June 19, 1959; erection is proceeding with minor delays because of errors in fabricators steel drawings. Fortunately the steel was cut too long and corrections were made by cutting in the field. The electrical contractor is installing conduit, in the existing building, for the crane alarm system. CPFF forces have installed "V" trough in the decontamination pit; however, it is not complete. The revised construction schedule has been approved by the Commission.

CGH-819	Increased Laboratory Waste Facilities - 300 Area	$300,000	$ 30,000 11-24-58	63 55	0 0	3-30-59 11-1-59	- - - - - -	9-1-59 12-30-60
		USING COMPONENT: Chemical Research & Development				FEO ENGINEER: J. J. Peterson		

REMARKS:

Design work is progressing on all phases. Six comment drawings have been issued. Drafting manpower is reason for delay in schedule.

General Plant Projects - FY 1959

CAH-827	Automatic Columbia River Monitoring Station	$ 30,000	$ 27,000 3-17-59	100 100	0 0	4-3-59 7-15-59	- - - 12-31-59	6-18-59 12-31-59
		USING COMPONENT: Radiation Protection				FEO ENGINEER: D. S. Jackson		

REMARKS:

Bids on the fixed price portion of the work were opened June 29, 1959. There were three bids ranging from a low by Frank Lohse of $15,675 to a high of $21,183. The government fair cost was estimated at $11,350. The contract was awarded to Frank Lohse, however, Notice to Proceed has not yet been issued. Bids were received for several equipment pieces; these are being reviewed.

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60846

MONTH: June, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CAH-828	Central Storage Facility - 300 Area		$ 37,400	N.S.	0	3-30-59	- - -	6-8-59
		$ 37,400	2-18-59	100	0	7-15-59	12-31-59	11-15-59
		USING COMPONENT: Finance				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

Detail design was completed June 8, 1959. Invitations for bids were issued June 18, 1959; bids were opened June 29, 1959. The bids ranged from a low of $29,740 by Raymond Britton to a high of $34,800 by Frank Lohse, the fair cost estimate was for $27,710.

CGH-829	Building 325 Basement Improvements		$ 70,000	100	82	2-13-59	- - -	4-14-59
		$ 70,000	2-13-59	100	80	3-2-59	9-30-59	9-30-59
		USING COMPONENT: Reactor & Fuels R & D				FEO ENGINEER: R. C. Ingersoll		

REMARKS:

The truck ramp and retaining wall are complete. Installation of the roll-up door is proceeding. A revised project proposal to include the mezzanine partition work is being prepared.

CAH-837	Animal Pens, Isolation and Examination Facilities		$ 80,000	100	N.S.	3-30-59	- - -	6-3-59
		$ 80,000	3-17-59	100	0	N.S.	4-1-60	12-1-59
		USING COMPONENT: Biology				FEO ENGINEER: J. T. Lloyd		

REMARKS:

The Architect-Engineers, Carson, Kesterson and Moe, completed detail design and specifications June 3, 1959. The AEC issued invitations for bids June 12, 1959; bids were opened June 24, 1959. The low bid of $51,560 was submitted by Ray Ashcraft; the fair cost estimate was $54,283.

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60840
MONTH: June, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PERCENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PERCENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CGH-840	Sheet Metal Shop Addition - 328 Building	$ 40,000	$ 40,000 / 6-18-59	0 / 0	0 / 3	6-22-59 / 6-25-59	- - / 5-1-60	9-1-59 / 12-1-59

USING COMPONENT: Laboratory Auxiliaries

FEO ENGINEER: J. J. Peterson

REMARKS:

AEC Directive No. HW-488, dated April 30, 1959 was accepted June 18, 1959. A work order for $25,000 was written to Construction Operation after signing a Fixed Price Agreement June 18, 1959 for performance of the work. Construction work started June 25, 1959.

* Directive dated April 30, 1959, accepted June 18, 1959.

CAH-848	Geological and Hydrological Wells - FY 1959	$ 56,600	$ 56,600 / 6-24-59	N.S. / 4	0 / 0	5-30-59 / 7-30-59	- - - / 5-31-60	6-30-59 / 3-30-60

USING COMPONENT: Chemical Research & Development

FEO ENGINEER: H. E. Ralph

REMARKS:

Bids were opened June 25, 1959; there were four bids from a low of $40,945 submitted by the Bach Drilling of Coulee City, Washington to a high of $93,088.75. The Fair Cost Estimate was for $46,060. The drilling contract was awarded to Bach Drilling and Notice to Proceed was issued June 26, 1959.

CGH-860	Access for PRTR Fuel Elements - 327 Building	$ 81,000	None / None	0 / 0	0 / 0	1/2 * / 2 1/2 *	- - - / - - -	3 * / 10 *

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: H. Radow

REMARKS:

The project proposal is awaiting final General Electric Company approval and transmittal to the Commission.

AM-7300-019 (5-58)

1248336

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60846

MONTH: June, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
CGH-864	Shielded Animal Monitoring Station - 100-F	$ 46,000	None	None	0	0	0	0	1 *	2 *	- - -	- - -	3 *	7 *

USING COMPONENT: Biology

FEO ENGINEER: J. T. Lloyd

REMARKS:

The project proposal was submitted to Contract Accounting June 18, 1959 and transmitted to the AEC June 22, 1959.

* Months after authorization.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
IR-243	Relocation of the 200-E Testing Equipment	$ 18,000	$ 18,000	3-11-59	100	100	100	99	3-12-59	3-16-59	- - -	4-22-59	5-22-59	7-15-59

USING COMPONENT: Laboratory Auxiliaries

FEO ENGINEER: H. Radow

REMARKS:

All work is complete except rehabilitation of 221-B and 224-B Buildings and installation of the heating plant. Work on the rehabilitation will start as soon as an estimate is received from the CPFF Contractor so that a work order can be issued. Work on the heating plant installation has been held up pending delivery of the heating unit which has just been received.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED.	PROJECT PROGRESS IN PER CENT CONST. ACTUAL	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
IR-246	Alterations to the Positive Ion Accelerator Facility - 3745-B Building	$ 19,000	$ 19,000	4-20-59	N.S.	100	30	50	4-21-59	5-7-59	- - -	10-20-59	5-1-59	10-20-59

USING COMPONENT: Physics & Instruments R & D

FEO ENGINEER: R. C. Ingersoll

REMARKS:

The structural work is essentially complete. The air conditioning equipment ordered by Construction Operation has not arrived; promised on site delivery date was June 19, 1959. This shipment is being traced.

AM-7300-019 (5-58)

BUDGET CLASSIFICATION: General Plant Projects - FY 1959

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60846 DEL

MONTH: June, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT	AUTHORIZATION INFORMATION DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED.	PROJECT PROGRESS IN PER CENT CONST. SCHED.	STARTING DATE DESIGN	STARTING DATE CONST.	DIRECTIVE COMP. DATE DESIGN	DIRECTIVE COMP. DATE CONST.	ESTIMATED COMP. DATE DESIGN	ESTIMATED COMP. DATE CONST.
1R-247	Normal Electrical Service - Experimental Animal Farm - 100-F	$ 12,500	$ 12,500	4-28-59	N.S.	20	4-29-59	- - -	- - -	9-28-59	5-12-59	8-15-59
					100	35	6-5-59					

USING COMPONENT: Biology

FEO ENGINEER: R. C. Ingersoll

REMARKS:

The poles have been framed and set for the distribution line work. Plant Forces will start modification work inside the 141-H and 141-F Buildings about July 1, 1959.

IR-	Uranium Scrap Burning Facility	$ 17,500	None		0	0	*	- - -			1 **	
			None		0	0	*	- - -			5 **	

USING COMPONENT: Reactor & Fuels R & D

FEO ENGINEER: R. K. Waldman

REMARKS:

The Informal Request has been prepared and is being circulated for signatures.

* Immediately after authorization.
** Months after authorization.

0084 (AEC-167)	Pickling and Autoclaving Facility for Zirconium Tubes - C-25 Building, White Bluffs	$120,000	$120,000		100	100	3-2-59	- - -			5-15-59	
			5-25-59		100	99	3-19-59	- - -			7-1-59	

USING COMPONENT: Laboratory Auxiliaries

FEO ENGINEER: H. Radow

REMARKS:

Test runs with water have been made and preparations for initial pickling are underway. A number of start-up modifications will be incorporated to the extent that available funds permit.

BUDGET CLASSIFICATION Improvements to Production and Supporting Facilities - 60-a-1

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60840
MONTH June, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED OR ACTUAL COMP. DATE DESIGN / CONST.
CGH-832	Full Scale Physical Constants Testing Reactor	$915,000	None / None	0 / 0	0 / 0	- - - / - - -	- - - / - - -	- - - / - - -

USING COMPONENT: Physics & Instruments R & D
FEO ENGINEER: R. W. Dascenzo

REMARKS:

To date the project proposal requesting $30,000 preliminary design money has not been approved by the AEC-Washington.

CGH-859	327 Building Modifications	$350,000	None / None	0 / 0	0 / 0	1 * / - - -	- - - / - - -	- - - / - - -

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: J. J. Peterson

REMARKS:

The project proposal is awaiting approval by the General Manager.

Equipment Not Included in Construction Projects - Program Class 2900

CG-661	Additional Heat Generation Facility - 189-D Building	$419,000	$664,000 / 9-18-57	100 / 100	99 / 96	12-6-56 / 12-3-58	- - - / 8-31-59	10-15-58 / 8-31-59

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: J. J. Peterson

REMARKS:

The Lump Sum Contract is complete with minor exceptions, such as, placing protective screens around concurrent heaters and some grating to be installed. The requisition for an additional heat exchanger has gone to purchasing. CPFF work is approximately 50% complete on clean-up items. ATP testing has started again after about 2 weeks delay because of Project CGH-834 inter-tie work.

AM-7300-01 5-58)

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BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60840
MONTH June 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CA-681	Hanford Equipment in the ETR	$1,140,000	$1,140,000 4-1-59	96 96	87 * 87 *	9-17-56 4-1-58	- - - 3-1-60	7-15-59 3-1-60

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: H. Radow

REMARKS:

Hanford progress has been curtailed because of lack of manpower due to higher priority held by other experimenters. However, with some manpower now becoming available work is still being held up because the promised delivery of the Powell Operators has slipped to the week of July 13, 1959. At the request of the most promising vendor the bid deadline for the underwater inspection equipment was extended to July 6, 1959. Design of the NPR modifications is progressing favorably.

* Based on field completion only. The figures shown on previous report were in error.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CA-695	Radio Telemetering Network	$109,078	$109,078 9-23-58	100 100	100 100	2-22-57 7-25-57	4-15-57 2-1-59	5-27-57 2-27-59

USING COMPONENT: Physics & Instruments R & D
FEO ENGINEER: J. T. Lloyd

REMARKS:

The Physical Completion Notice for the General Electric Company portion of the work is being prepared.

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED. / ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED. / ACTUAL	STARTING DATE DESIGN / CONST.	DIRECTIVE COMP. DATE DESIGN / CONST.	ESTIMATED COMP. DATE DESIGN / CONST.
CG-785	In-Reactor Studies Equipment - 105-KW Building	$276,000	$276,000 12-8-58	50 45	0 0	1-5-59 N.S.	- - - 12-31-60	- - - 12-31-60

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: H. Radow

REMARKS:

Design of the capsule removal facility is underway. Some test capsules have been taken to 100-DR to obtain desirable data using existing cut-off equipment.

AM-7300-019 (5-58)

BUDGET CLASSIFICATION Equipment Not Included in Construction Projects - Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 60346
MONTH June, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
				DESIGN SCHED.	CONST. SCHED.	DESIGN	DESIGN	DESIGN
			AMOUNT					
			DATE	ACTUAL	ACTUAL	CONST.	CONST.	CONST.
CGH-801	X-Ray Diffraction Cell - 327 Building	$170,000	$ 10,000	N.S.	0	6-[illegible]-58	- - -	[illegible]
			6-[illegible]-58	-0-	0	N.S.	- - -	[illegible]

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: R. W. Dascenzo

REMARKS:

Approval of the project proposal for the remainder of design and total construction funds, submitted to the AEC-HOO November 19, 1958, has not been received.

CGH-805	High Temperature Tensile Testing Cell - 327 Building	$150,000	$150,000	100	0	8-26-58	- - -	6-15-59
			2-25-59	100	0	1-1-60	3-31-60	3-31-60

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: R. W. Dascenzo

REMARKS:

Design was completed this month on schedule. A test cell assembly procurement package has been issued for procurement of this long term delivery item. A similiar package is being prepared for the viewing windows and will be issued early in July. A rough draft of the M & E List has been prepared for this project.

CGH-834	Modifications and Additions to High Pressure Heat Transfer Apparatus - 189-D Building	$700,000	$700,000	12	10	4-20-59	- - -	2-9-60
			4-8-59	12	10	4-22-59	10-15-60	10-15-60

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: H. Radow

REMARKS:

The pump installation is complete and work on the bus modifications is progressing favorably.

AM-7300-019 (5-58)

Classification Equipment Not Included in Program Class 2900

MONTHLY PROJECT REPORT
HANFORD LABORATORIES OPERATION

HW - 6088
MONTH June, 1959

PROJECT NUMBER	TITLE	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION	PROJECT PROGRESS IN PER CENT		STARTING DATE	DIRECTIVE COMP. DATE	ESTIMATED COMP. DATE
			AMOUNT / DATE	DESIGN SCHED. / ACTUAL	CONST. SCHED. / ACTUAL	DESIGN / CONST.	DESIGN / CONST.	DESIGN / CONST.
CGH-	Fission Product Volatilization Studies Test Facility - 292-T Building	$ 75,000	$ 75,000 3-26-59	80 65	20	4-16-	11-30-59	8-1-

USING COMPONENT: Chemical Research & Development
FEO ENGINEER: O. M. Lyso

REMARKS:
The low bidder on the induction heating equipment did not comply fully with the specifications as to temperature control; a clarification on this point is being obtained prior to placement of the order. All equipment specifications have been submitted. Design of the junior cave sample train is in progress. A portion of the electronic counting equipment has arrived on the plant.

CGH-857	Physical and Mechanical Properties Testing Cell - 327 Building	$400,000	None None	0 0	0 0	1 * - - -	- - - - - -	14 * - - -

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: R. W. Dascenzo

REMARKS:
The project proposal requesting design funds in the amount of $75,000 is awaiting final General Electric Company approval.

CGH-858	High Level Utility Cell - 327 Building	$500,000	None None	0 0	0 0	1 * - - -	- - - - - -	12 * - - -

USING COMPONENT: Reactor & Fuels R & D
FEO ENGINEER: R. W. Dascenzo

REMARKS:
The project proposal requesting design funds in the amount of $70,000 is awaiting final General Electric Company approval.

AM-7300-019 (5-58)

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 and Buildings Visited
R. Browning	6-2-59	Union Carbide & Carbon Chem. Corp. Oak Ridge, Tenn.	Visit Radiochemistry facility	R.W. Dascenzo	No	325-A, 300
D. R. Hubbard	6-9-59	General Electric Co. San Francisco, Calif.	Ind. Representative for GE X-ray	R.B. Sooky	No	325, 300
Mr. Landers & Mr. Stevenson	6-11-59	GE Atomic Nuclear Pro. Cincinnati, Ohio	Discuss document Accountability	A.F. McConiga M. Puckett B. Borgmier	No	3760, 300
Dorothy Joyce	6-22-59	Kaiser Engr. Richland, Wash.	Learn about document accountability	M. McHale	No	3760, 300
Professors	6-22-59	Various Universities	" "	C.G. Stevenson B. Borgmier	No	3760, 300

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access To Restricted Data
C. G. Stevenson	5-30 thru 6-15	Mallinckrodt Chem.Co. St. Louis, Mo.	Tech.Info. Panel Meeting	Dr.C.O. Harrington	No
"		Atlantic City, N.J.	Special libraries association meeting	H. E. Loftus	No
		Schenectady, N.Y.	Attend Company Information Meeting		No
C. O. Finney	6-24,25, & 26	General Electric Idaho Falls, Idaho	Attend Nuclear Instrumentation Symposium	R. C. Mann & C. H. Weichel	No
J. W. Sadler	6-25-59	Spokane Trade School Spokane, Wash.	Recruiting		No

PROFESSIONAL PLACEMENT AND RELATIONS PRACTICES OPERATION MONTHLY REPORT

GENERAL

As of June 30th, the staff of the Hanford Laboratories totalled 1334 employees, including 656 exempt and 678 nonexempt. There were 580 exempt employees possessing technical degrees, including 349 B.S., 119 M.S., and 122 Ph.D.

COMMUNICATIONS

A tour of the Hanford Laboratories was conducted for the Commanding Officer of Camp Hanford and the members of his staff. A GE News story on the first PRTR fuel element to be tested was prepared and published. Assistance was provided in the arrangements for meetings of the Program Directors of the A.E.C. Division of Biology and Medicine and the A.E.C. - A.S.E.E. Summer Institute of Nuclear Energy.

HEALTH & SAFETY

Laboratories personnel worked a total of 212,500 man-hours during the month with no disabling injuries. Since September 1, 1956, a total of 6,486,859 man-hours have been completed with no disabling injuries.

The medical treatment frequency for June was 1.97 compared with 1.59 last month.

There were 6 security violations in the Laboratories in the month of June, bringing the total for the year to date to 22.

PROFESSIONAL PLACEMENT

Nine Ph.D.'s visited HAPO for interviews during June. Eight offers were extended for HAPO with 2 acceptances during the month and 7 offers continuing open. One new Ph.D. chemist reported on the roll. For the recruiting year to date, there have been 12 Ph.D. acceptances for HAPO.

Four additional acceptances were received from Technical Graduates during the month, bringing the total for the recruiting year to 75. Nine acceptances were received from experienced BS/MS candidates and 17 experienced BS/MS employees were placed on the roll.

There were 66 additions to the Training Program rolls during June, including 42 Technical Graduates, 11 members of the Western Circuit - Engineering Training Program, 8 College Juniors, and 5 High School Teachers. Four Technical Graduates were permanently placed in HAPO Departments, leaving 77 Technical Graduates on the Program at month's end. Total force on the Training Program, including summer employees, is now 101.

EMPLOYMENT

Thirty-nine requisitions were filled during the month. With the receipt of 33 new requisitions and 5 cancellations, there are currently 33 nonexempt openings, for which 21 candidates are in process and 5 transfers are pending, with 7 candidates yet to be procured.

Manager,
Professional Placement
and Relations Practices

1240344

TG Marshall:tr

VISITS TO OTHER INSTALLATIONS

Name	Date of Visit	Company Visited	Reason for Visit	Personnel Contacted	Access to Restricted Data
E.P. Galbraith	6/18-19	G.E. - Eng'g.Serv.	Discuss Technical Recruiting	W.S. Hill	None
E.P. Galbraith	6/18-19	G.E. - Eng'g.Serv.	Discuss Eng'g Register	T.E. Zebley	None
E.P. Galbraith	6/18-19	G.E. - Eng'g.Serv.	Discuss Recruiting Brochure	G.B. Cooper	None
E.P. Galbraith	6/18-19	G.E. - Eng'g.Serv.	Discuss college recruiting	M.B. Tracy	None
E.P. Galbraith	6/18-19	G.E.L.	Attend seminar on professional personnel		None
L.J. Kirby	6/29	G.E. - Eng'g.Serv.	Attend PhD coordinators' meeting	J.K. Wolf	None
L.J. Kirby	6/39	G.E. - Eng'g.Serv.	Attend direct placement review	D.E. Irwin	None
R.S. Himmelright	6/1	Research Lab	Discuss attitude survey of technical people	Lowell Steel	None
R.S. Himmelright	6/1-2	G.E.L.	Discuss placement and records procedure	Lou Barrington Ken Pringle	None
R.S. Himmelright	6/3-4	G.E. - Eng'g.Serv.	Attend training seminar	R.B. Hook	None

VISITORS TO HAPO

Name	Date of Visit	Company Represented	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
Frank Nuelle	6/18	G.E. - Eng'g.Serv.	Discuss problems in connection with the Eng'g Personnel Register	E.P.Galbraith	None	3760 -300
				L.P.Henderson		328 -300
				L.J. Kirby		325 -300
				T.G. Marshall		326 -300
						321A-300

TABLE III. PROFESSIONAL PERSONNEL PLACEMENT

A - Technical Recruiting Activity - HAPO - September 1, 1958 to Date

	Cases Considered	Visits to Richland			Offers*			
		Invited	Visited	To Visit	Extended	Accepted	Open	On the Roll
Ph.D.	656	194	85	28	55	12	7	10
Exp. BS/MS	480	100	74	1	99	66	4	60
Prog. BS/MS	392	--	--	--	207	75	11	56

*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 Considered	Visits to Richland			Offers**			
		Invited	Visited	To Visit	Extended	Accepted	Open	On the Roll
Ph.D.	656	194	85	28	41	8	5	7
Exp. BS/MS	391	73	48	1	44	26	1	24

**Offer totals include offers open on 9/1/58

Exp. BS/MS	2
Ph.D.	2

In addition to the above activity, 22 exempt employees have transferred into HLO from other HAPO departments and 23 technical graduates have accepted off-Program placement in HLO to date.

C - Technical Graduate and Technician Training Program
Month ending June 30, 1959

	TG Program	TT Program
Number Personnel on assignment	77	10
(HAPO Tech Grad Program.....62		
(West. District E.P.....15		
Summer Juniors	9	
High School Teachers	5	
	91	10
Distribution of assignments by Depts.		
HLO	39	4
CE&UO	3	0
FPD	9	0
IPD	28	6
CPD	12	0
Distribution of assignments by function		
R&D or Engineering	65	10
Other	26	0

TABLE II NONEXEMPT EMPLOYMENT

Nonexempt Employment Status	May	June
Requisitions		
At end of month	44	33
Cancelled	1	5
Received during month	17	33
Filled during month	19	39
Candidates Considered		
Total Applications	82	73

Nonexempt Transfer Request	May	June
Transfer Request		
Active cases at end of mo.	77	77
Cancelled	1	5
New	11	9
Transfers effected	1	4

FINANCIAL OPERATION MONTHLY REPORT
JUNE 1959

Perscnnel

Transfers required to give effect to the consolidation of clerical functions in Contract and Accounting were made effective June 29. The total force of HLO Financial Operation is forecasted to be 25 (23 presently on roll) as compared to 50 prior to the recent reorganization.

Activities

GENERAL ACCOUNTING OPERATION

Travel during the month of June was heavy and travel expense reports totaled 400. Travel orders processed each year in June generally exceed the average of those processed during the other months of the year due to year-end clean-up activities.

A special report was prepared and distributed to HLO management covering requirements for approval of foreign travel.

At the request of Contract and Accounting a letter was forwarded outlining HLO's fund requirements for Professional and Trade Society Meetings and for Off-Site Courses in Fiscal Year 1960. Preliminary reports indicate that in FY 1959 total costs incurred in attending off-site meetings will be approximately $1,300 less than the amount allocated HLO for this purpose. On the other hand, expenditures for off-site courses and seminars will exceed the amount allocated HLO by approximately $16.

In connection with the Assistance to Hanford Program a renewal of one 1959 authorization and two new authorizations are in process. A proposal to renew consultation services by Dr. Poritsky and to expand them to include the services of Dr. Meier has been prepared but not approved as yet. Letters are in the process of preparation requesting Commission approval of authorizing a heat transfer corrosion test by APED for $24,000 and graphite and contraction studies by GERL in the amount of $47,000. In connection with year-end closing, letters were written to GE components working on Assistance to Hanford Programs requesting information which would allow us to accrue for work completed but not billed at June 30. Replies were received from all components contacted and appropriate accruals were made.

A draft of a Manual covering Official Travel in HLO was completed and has been circulated to other HAPO Financial components for comment. After comments are received and appropriate modifications made to the proposed Manual, it will be issued to HLO management.

It currently appears that we will accrue approximately one quarter of a million dollars for equipment at fiscal year-end which will still leave an underrun of approximately $400,000 for all Programs.

We have revised page one of our Ozalid Master Request for Appropriation form to more closely conform with recent changes in the form used by the other HAPO components. In order to obtain better reproductions of our AR's, our new forms have been printed on a new ozalid paper with an orange carbon backing.

Transfers from our Work in Progress Accounts to Plant Records during the month of June exceeded one-half million dollars.

A summary report of findings in connection with the FY 1959 physical inventory of uninstalled cataloged equipment in the custody of Hanford Laboratories was prepared and distributed. A comparison of the inventory balance $9,636,709 (9,693 items) with the adjusted book balance $9,642,342 (9,717 items) disclosed a shortage of 24 items valued at $5,633 or .6% of missing equipment to adjusted book balance. Unrecorded items added to record during the fiscal year inventory totaled 32 items valued at $8,118. This indicates a significant improvement over the last inventory, however, the last inventory was the first inventory taken since 1953. Additional controls established during the past fiscal year were (1) preparation of a custodial card for each piece of equipment, (2) a signed card by the control custodian acknowledging receipt of each item, (3) quarterly IBM runs of equipment furnished each custodian, and (4) identification tags affixed by Property Accounting personnel to insure the equipment being properly and securely tagged.

Responsibility for maintaining 1,675 custodial equipment control cards in the custody of Reactor and Fuels Research and Development Operation was transferred to 10 Unit Operations. This was the result of a recommendation in our physical inventory report that custodial cards were too far removed from personnel actually responsible for equipment. The job of segregating the cards by Unit Operations was completed by custodial personnel and new property representatives appointed. Only one major component in HLO still operates with one control card custodian.

A Fiscal Year 1960 physical inventory schedule covering uninstalled cataloged equipment was prepared and forwarded to HLO personnel concerned. The first inventory of the new fiscal year is equipment in the custody of Radiation Protection scheduled for July 20, 1959.

Arrangements were completed for the regular quarterly inventory of other special materials of June 30, 1959 to be conducted by custodial personnel. Financial personnel will not witness the count but will reconcile the results to Property Accounting records. A report of results will be issued upon completion of the reconciliation.

Information requested by SS Accountability Operation regarding HOO-AEC Survey 16, Part 4 relative to inventory of HLO plutonium was consolidated and forwarded to them. The information submitted is for use in preparing a detailed inventory schedule for the AEC.

Project CAH-794, Geological and Hydrological Wells - FY 1958 and CGH-809, Electrical Modifications, 328 Building were physically inventory, unitized, and reports issued.

COST ACCOUNTING OPERATION

The following adjustments were made in the Hanford Laboratories control budget for FY 1959 and will be reflected in June financial statements:

Increase in Swelling Studies through a transfer of funds from the Maritime Gas Loop	$25,000
Increase in Off-Site Special Requests for:	
Request to fabricate 500 Plutonium samples for Oak Ridge	20,000
Request from AEC to perform Pyrophoricity Studies	40,000

With the receipt of the above funds, Hanford Laboratories operating budget for FY 1959 totals $21,044,000 and is summarized by program below:

	(In Thousands)
Research and Development	
2000 Program	
HL Sponsored Programs	$ 683
Product Departments Sponsored Programs	5 054
Sub-total	5 737
3000 Program	185
4000 Program	5 675
6000 Program	1 993
Total Research and Development	13 590
Process Technology	681
Services to Other HAPO Components	1 902
Service Assessments	2 873
Project Whitney	669
Washington Designated Programs	419
Off-Site Services and Other Accounts	910
Total	$21 044

In order to apply appropriate items of cost against FY 1959 funds, certain accruals were billed to operating cost accounts during June. A summary of these accruals by type and amount follows:

Materials received by June 30 but not booked	$120 679
Materials shipped FOB Shipping Point by June 30 but not booked	23 299
Services performed by off-site vendors by June 30 but not booked	63 805
Exempt Overtime and Shift Premium for June but not paid	6 130
Expense portion of Project CGH-829 applicable to month of June	3 000
Freight billed in June but not paid	622
Total	$217 535

In connection with the transfer of accounting clerical functions to Contract and Accounting Operation, transfer papers were processed for nine non-exempt people in Cost Accounting, effective June 29, 1959. The physical transfer, however, will not take place until July 20, 1959, immediately after completing FY 1959 accounting business.

PERSONNEL ACCOUNTING OPERATION

Report of 1959 Annual Meetings of General Electric share owners were delivered to all participants of the Savings and Security Plan, week ending June 8, 1959.

During the month 58 Tech Grads including 5 on a temporary basis, 19 other exempt temporary employees and 22 salaried temporary employees were added to the HLO payroll; a total of 101 employees.

Absenteeism and Overtime Reports for the calendar month of May were not forwarded to management until the week ending June 28, 1959. This was due to inexperience in preparing these reports by the payroll group in the 700 Area.

During the week of June 8th through the 12th Paul Burnside acted as Specialist-Personnel Accounting due to P. B. Lamphere being on vacation.

Stock price used to determine the number of shares of General Electric Company stock to be credited to participants of the Savings and Security Plan account was $80.216 per share.

W. Sale
Manager - Finance

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.

INVENTOR	TITLE OF INVENTION OR DISCOVERY
J. J. Shefcik	Depassivation of Stainless Steel in Dilute Aqua Regia
J. J. Shefcik	Removal of Chloride from Uranyl Nitrate Solutions by Nitrogen Tetroxide Addition
C. E. Huck	The Application of a Plastic Scintillator (Terphenyl-in-Polyvinyltoluene) for Counting Alpha Particles in Solution.
C. L. Pleasance	A Flow-type Sample Cell That Does Not Become Significantly Contaminated with Radioactivity for Use in Gamma Monitoring of Radioactive Liquids
W. L. Lyon	The Preparation of Uranium Dioxide by Fused Salt Electrolysis. (HW-60886)