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HANFORD LABORATORIES OPERATION
MONTHLY ACTIVITIES REPORT
APRIL, 1958

Compiled by
Operation Managers

May 15, 1958

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

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TABLE I. HLO FORCE REPORT AND PERSONNEL STATUS CHANGES

Date April 30, 1958

FORCE REPORT

	At close of month			At beginning of month			Additions		Separations	
	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Total	Exempt	Non-Exempt	Exempt	Non-Exempt
Chemical Research and Development	121	95	216	126	96	222	1	1	3	2
Reactor & Fuels Research & Development	147	98	245	153	100	253	3	0	13	2
Physics & Instrument Research & Development	59	25	84	57	25	82	2	0	0	0
Biology Operation	34	43	77	34	43	77	0	2	0	2
Operations Res. & Syn.	14	3	17	14	3	17	1	0	1	0
Radiation Protection	40*	120*	160	41	125	166	1*	0	2	5*
Laboratory Auxiliaries	44	180	224	45	181	226	0	4	1	5
Financial	16	34	50	16	34	50	0	0	0	0
Employee Relations	13	11	24	13	11	24	0	0	0	0
Programming	15	4	19	0	0	0	15	4	0	0
General	1	2	3	1	2	3	0	0	0	0
TOTALS	504	615	1119	500	620	1120	23	11	19	16
Totals excluding Internal Transfers	504	615	1119	500	620	1120	8	5	4	10

* 1 Reassignment from Non-exempt to Exempt

Composite Separation Rate -1.161
Separation Rate (based on separations leaving G. E.)- .983
Controllable Separation Rate- .446

SUMMARY

BUDGETS AND COSTS

Fiscal year to-date costs are $14,196,000 at the end of April or 78% of the FY 1958 Mid-Year Budget Review as adjusted to reflect changes received from the Product Departments and HOO-AEC. April costs of $1,516,000 were down slightly from the March level.

Cost-budget relationships for all programs are satisfactory at this time. Necessary adjustments of the level of effort on CPD-Separations Research and Development have been made to satisfy the budget requirements. Accelerated spending during the next two months is expected to reduce the indicated budget underrun on the Plutonium Recycle Research and Development Program.

RESEARCH AND DEVELOPMENT

1. Reactor and Fuels

Design of the Plutonium Recycle Test Reactor is 60% complete overall. The utilities portion of the construction effort was completed a week ahead of schedule, permitting the Phase I contractor early access to the site.

Design of the Plutonium Fabrication Pilot Plant is 38% complete.

PRTR calandria mock-up tests indicate a faster initial, but slower overall moderator dump rate than was anticipated. Although the measured rate is acceptable, development changes may succeed in increasing it.

Aluminum (as a stand-in for plutonium-aluminum) was mechanically injection cast at 1800 psi into a seven-foot long, one-half-inch diameter, stainless steel tube to attain 97% of the theoretical density.

Six, four-rod, UO_2 cluster fuel elements jacketed in stainless steel and fabricated by swaging were delivered to KER for irradiation in Loop 1. The densities produced by cold swaging varied from 83 to 89% of the theoretical.

Stainless steel, four-rod cluster fuel elements have been operating satisfactorily in KER Loop 3 since September 1957. The present exposure of the metal cores is 1800 MWD/T accumulated at an average power of 42 kw/ft.

To demonstrate the rupture behavior of an unbonded, insulated fuel element, one has been intentionally ruptured in the MTR. Radiometallurgy examination showed that the fuel element and the insulated uranium core had suffered negligible damage.

Metallographic studies of representative "brittle-bond" and "tough-bond" AlSi canned fuel elements have revealed a characteristic compound layer present only in the "tough-bond" elements. Its formation is promoted by reducing the silicon content of the AlSi bath. This study should lead to a ready solution of a current FPD problem.

Thermal hydraulics analog studies for uniformly-spaced cluster fuel elements indicate some positive provision for coolant mixing is desirable to promote uniform cooling. Without coolant mixing local boiling may occur around the center rod.

2. Chemical Research and Development

Very low concentrations of ammonium fluosilicate in nitric acid were found to increase the rate of dissolution of dingot uranium metal to rates equivalent to or in excess of those normally obtained for ingot metal in the absence of a catalyst.

Capacity tests on Permutit SK resin samples used for 41 days in Purex continuous anion exchange unit showed no significant degradation. Studies of the technical feasibility of replacing the 1BS, 2A, and 2B columns in Purex with a single cycle of anion exchange are encouraging.

Significant rates were achieved in the room temperature reduction of U(VI) to U(IV) by formaldehyde in an aqueous, nitric acid system catalyzed by light. These preliminary experiments included effects of temperatures, pH and reductant. U(IV) has application in the Purex process to potentially replace the ferrous plutonium reductant currently used. Concurrently, U(IV) production by the electrochemical Flurex process continues to be refined.

Only fair cesium yields have been obtained on cesium zinc ferrocyanide flow-sheet tests on intermediate amounts of Purex HAW "spike" feed to test equipment in the Multicurie cell. Next runs will be at ten per cent of full radiation level. Methods of recovering neptunium from Redox and Purex are being reviewed.

The U.S. Army Corps of Engineers has initiated sub-soil coring and water table studies with respect to the proposed Ben Franklin Dam. Laboratory specialists are cooperating with the Corps, IPD and CPD personnel studying the influence the Dam may have on HAPO.

Zirflex pilot dissolver testing continued. UO_2 core material dissolved ten times slower in Zirflex dissolver media than metallic uranium.

X-ray fluorescence was shown to be an effective non-destructive method to measure cladding thickness on MTR fuel plates.

Hydrated sodium ion occupies about the same volume as cesium ion. Minerals (particularly pollucite and other zeolites) having an exchangeable sodium ion in their structure were found to have high selectivity for removing cesium from aqueous media.

The Standard Oil Company test well on Rattlesnake Ridge was abandoned after penetrating 10,665 feet of basalt; more than twice the previously known basalt depth. Disposal of radioactive wastes beneath the basalt layer is almost certainly precluded.

3. Physics and Instruments

Progress was made in the program to obtain more information about the reactivity temperature coefficients of the production reactors when greater amounts of plutonium are present. A PCTR experiment was conducted with simulated 2000 MWD/T slugs; the accurate foil counting system, needed for the TTR experiment to determine the effects of water loss, was developed; and calculations needed for the interpretation of the results were programmed for the computer.

In the improved production reactor program, exponential experiments were started with fuel clusters of seven rods, each of 1/2-inch diameter.

Experimental nuclear safety work was carried out in two areas. Experiments in the PCTR to determine the maximum k obtainable in uranyl nitrate-water mixtures at 2% enrichment continued to lower hydrogen-to-uranium ratios. Exponential experiments with 1.6% I and E slugs continued.

Nuclear safety consultations and advisory service were provided on six problems, three for FPD, two for CPD, and one for HLO.

Work for the plutonium recycle program was directed toward interpretation of results obtained in PCTR experiments. Analysis of the experiments on spike plutonium fuel revealed an internal consistency between two methods of doing the experiments, increasing confidence in the correctness of the results.

Work on the Wahluke Slope problem was resumed with the return of suitable weather; five runs have been made to date under conditions expected to approximate the worst situation.

Two cases of plutonium contamination of wounds were examined in the temporary 329 Building facility. One was severe enough to require excision. Comparison of facility measurements with direct results on material removed from the wounds has indicated present calibration of the facility may be 50% high.

In the basic data field, measurements were made on the low energy fission cross sections of Np^{237} and Am^{241}. Attempts to clarify the 13% difference in the fission cross section of U^{235} between our values and those obtained at Harwell were unsuccessful. The new neutron spectrometer was accepted from Construction with some exceptions. Improvements were made in the neutron time-of-flight equipment at the Van de Graaff and designs drawn up for further improvements.

4. Biology

Concentrations of I^{131} in thyroids of rabbits were about five times higher than those observed a year ago. On the Wahluke slope, they were nearly 20 times higher than last month.

Concentrations of other fission products in rabbits were up to 25 times more than one year ago due presumably to the recent Russian nuclear tests.

Using newer analytical instrumentation, distribution of radioelements in laboratory animals fed concentrated reactor effluent was reinvestigated. Several isotopes, previously undetected in animals were found.

Several anions (sulfate, carbonate, phosphate and others) were found to depress Sr^{90} uptake into plants by a factor of about 20. The laboratory conditions for measuring this were purposely established to give maximum depression.

There is no longer any doubt, although experimentation is unfinished, that the "OR" or "observed ratio" (essentially the ratio of Sr^{90} to Ca deposited in the bone to the same ratio in the diet) markedly varies as a function of dietary constituents and time on the diets. The exact extent to which the Sunshine Unit can be in error is not yet known, but it is considerable.

5. Programming

An analysis of the reduction of the thermal portion of the neutron energy spectrum resulting from substitution of plutonium for U-235 in a given reactor indicated that the effect is large and will make difficult any self-consistent comparison between U-235 and plutonium performance in any reactor.

Arrangement of the computer program for calculating plutonium recycle fuel costs was completed and 200 reactor cases were analysed. Results are being interpreted.

An economic study was completed concerning a comparison of costs of PRTR fuels processing in the Redox and Hot Semiworks facilities.

Negotiations with the AEC, ORNL, Kaiser Engineers, and ACF Industries were carried on preparatory to arranging execution by HLO of research and development work, in FY 1958 and subsequent years, in the fields of lattice physics measurements in the PCTR and the chemical reactions between carbon dioxide and graphite. It appears probable that satisfactory arrangements can be made.

Technical and Other Services

Three cases of plutonium deposition were confirmed all resulting from special bioassay sampling following known radiation incidents.

A review of the trends of accumulated external exposures received by HAPO employees during the last 12 months indicates an upward trend in some areas. Extrapolation of the 1958 experience to the end of the year indicates that a substantial number of plant employees may exceed the Hanford working limit of 3 r per year, unless corrective measures are applied.

The average weekly emission of I^{131} from separations facilities was 9.2 curies. Substantial fallout from nuclear bomb tests continued to occur.

Statistical and mathematical assistance on 40 separate problems was given within HLO and to other departments and operations. Work in connection with bonding problems being encountered in the fuel element preparation process, and the nature of appropriate mathematical models for depicting the transfer of radioactive particles from region to region within a biological system, was of particular interest.

Work on the construction of an input-output response simulation model and on the CPD control study continued during the month.

Excluding the major PRP projects, there were 15 authorized projects at month end with total authorized funds of $4,415,000. The total estimated project cost of these authorized projects is $8,086,000. Two projects were completed during the month with a total close out cost of $210,000. Four new projects are awaiting AEC authorization; these have a total estimated project cost of $2,367,800. Proposals for four new projects are in preparation.

The bid invitation for design and construction of the High Level Radiochemistry Facility (Project CA-749) was issued on April 30. Bid opening is scheduled for June 12, and contract completion will be about June 15, 1959. Total project cost is $1,070,000.

Project CA-744, Metallurgical Development Facility, was authorized by AEC for design work in the amount of $60,000. The total project is limited by the directive to $2,600,000.

Supporting Functions

A new Financial Plan for FY 1958 was received and analyzed for comparison with the previous plan and with amounts currently included in the budget for HLO sponsored programs. Only one significant deviation. Separations Processes for Non-Production Fuels, is being considered by CPD and Chemical Research and Development.

The amount of underruns on appropriation requests continue to exceed the overruns, however, of the 86 completed requests since July 1, 1957, 54 (63%) have deviated (either over or under) by more than 10% from the original estimate.

All work in connection with the annual physical inventory of uninstalled cataloged equipment has been completed. Equipment consisting of over 8,000 pieces and valued at almost $8 million was involved.

The 1.77% cost-of-living increase, effective April 28, 1958, will increase the HLO annual payroll by about $45,000.

At month's end the staff of the Hanford Laboratories Operation totalled 1119, including 504 exempt and 615 nonexempt employees. Of the total exempt employees there were 438 with college degrees, including 420 technical degrees as follows: BS - 217, MS - 104, PhD - 99. There were 36 nonexempt employees with degrees.

Sixty-five HLO employees attended two sessions of Project Cost Estimates; 5 employees attended Engineering Data Processing; 12 commenced Understanding People and 8 started Conference Leading courses.

One hundred seventy-nine employees and guests attended the Biology Open House. Seventy-two science students from area colleges toured HLO facilities during April.

Since September 1, 1956, a total of 3,774,606 man-hours have been completed with no disabling injuries. The medical treatment frequency for April was 1.75 as compared with 1.52 during March.

There were 7 security violations during the month, bringing the 1958 total to 19.

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

M-257 Aluminum Alloy Process Tubing. A brief investigation has been conducted of the stability of M-257 aluminum alloy process tubing in high temperature water. The alloy was found to be inferior to 1245 alloy at 265 C. Samples of the tubing were completely destroyed in 141 hours at this temperature while control samples of 1245 alloy and regular process tubing were partially attacked or in good condition. Tests conducted at 215 C showed only slight differences in the alloys when examined after 174 hours. The alloys appeared similar (e.g., essentially the same weight gains) in a 170 C test for 341 hours. Testing in reactor process water is being started.

Organic Coolant Studies. Solid-liquid phase diagrams have been completed for three more ternary organic coolant systems. The results are given in the following table:

Ternary Eutectic Mixtures

Eutectic Composition (Mole Percent)	Eutectic Melting Point, °C
19% phenanthrene 49% o-terphenyl 32% biphenyl	23
20% phenanthrene 50% o-terphenyl 30% napthalene	24
19% m-terphenyl 42% biphenyl 39% napthalene	32

Liquid-vapor equilibria were measured in the system biphenyl: ortho-terphenyl. Activity coefficients were computed and found to be unity, as expected. If the activity coefficients are unity throughout the system, all the liquid-vapor equilibria can be calculated from existing vapor pressure data and Raoult's law.

Hydriding of Zirconium and Uranium. The hydriding studies of uranium, zirconium, and Zircaloy-2 in monoisopropyl biphenyl (MIPB) have continued. Exposures were for six days at 100 psi total pressure. Tests have covered

the temperature range of 150 C to 400 C and were run at 5 psi and 1 psi hydrogen partial pressure. In addition, a run was made with uranium in the absence of MIPB. The following table summarizes the results:

Hydriding of Zirconium and Zircaloy-2 in MIPB
In Six Days Under Controlled Hydrogen Pressure

Temp., °C	Initial H_2 in Metal	Final H_2 in Metal	
		5 psi H_2 Part. Press.	1 psi H_2 Part. Press.
400	3-12 ppm	700-8700 ppm	200-370
350	"	140-975	30-90
300	"	5-38	2-3
250	"	3-5	1
210	"	10-11	
150	"	10	

Hydriding of Uranium in MIPB in Six Days
Under Controlled Hydrogen Pressure

Temp., °C	Weight Loss During Exposure	
	5 psi H_2 Part. Press.	1 psi H_2 Part. Press.
400	5.0 mg/cm^2	0.25 mg/cm^2
350	11.5	1.5
300	93.0	0.93
250	285.	3.5
225	233.	
210	297.	
150	146.	
225 (No MIPB, e.g., dry H_2)	1790.	

The data indicate that the presence of MIPB reduces the rate of uranium hydride formation by about a factor of ten. Also, reducing the partial pressure of hydrogen from 5 psi to 1 psi results in a reduction of the rate of hydriding of uranium and zirconium by about a factor of ten.

Organic - Zircaloy Loop. A small, laboratory loop facility has been in operation recirculating MIPB through a Zircaloy-2 tube at about 370 C and 100 psi. The hydrogen pressure in the loop was kept very low by circulating the MIPB through a cooler and then into a storage tank where it was purged with a stream of CO_2 gas. After 1200 hours of operation the loop was shut down and the Zircaloy tube was sectioned for examination. There was no visible damage to the tube during exposure. The tube initially had a hardness of R_B 90. After exposure it had a hardness of R_B 81, indicating annealing during exposure. The hydrogen analysis of the tube after exposure was 200 ppm (preliminary value). The inside wall of the tube was covered by a thick film, apparently tar or coke from the organic material. During operation of the loop the tar content of the circulating fluid as observed in the feed tank increased when the

heaters were turned off and decreased when they were turned back on. This suggests that the tars were released from the heat transfer surfaces when cooling and redeposited on the heat transfer surfaces when heated.

Radiometallurgy Laboratory Studies

Production Test IP-32-A Irradiation of Insulated Fuel Elements (RM-176). Three, four-inch cored, insulated, natural uranium fuel elements were exposed to 600 MWD/T in KW Reactor. Examination of a fax film replica taken of an etched wafer of Element #2 revealed that the porous looking uranium structure, which resulted from the closure of the central hole, was a mass of gas bubbles, some bubbles being as small as 0.1 micron.

Examination of Elephant Slug (RM-223). A 1.800-inch OD I & E wafer fuel element (Elephant Slug) which had undergone irradiation in the KER Test Facility was examined. The fuel element consisted of forty-three 3/16 inch thick uranium wafers which were AlSi dip canned in M-388 I & E components.

The appearance of the element was good and no evidence of corrosion was observed on the surface of the can. After sectioning the central third of the element longitudinally, measurements of the thickness of the exposed wafer faces were made one tenth inch from the inner and outer edges and at the middle of the exposed face. The result of eight such sets of measurements indicates that there was no significant change from the original thickness of the wafers. There also appeared to be no trend toward uneven thickness across an exposed wafer face.

Uranium-AlSi interdiffusion occurred between wafers over most of the radius of the element. Maximum diffusion occurred over a 0.05-inch distance located about a quarter of an inch from the outside edge of the wafers. There was no evidence of distortion of the AlSi bonding layer or the can wall. A number of voids were observed in the AlSi. The uranium, although slightly cupped and distorted at the corners, had not experienced temperatures higher than 660 C since only alpha phase size grains were evident.

Basic Metallurgy Studies

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. Two techniques are being used: (1) metallographic examination of polished and etched surfaces, and (2) fractographic studies.

Specimens of dingot quality uranium are being characterized by x-ray diffraction prior to irradiation in the Materials Testing Reactor. Extensive x-ray diffraction analyses have been conducted on two specimens to determine optimum specimen preparation techniques. The width at half height of four low angle peaks, as well as two high angle peaks, has been determined at various stages in the polishing and electropolishing treatments. The absence of any sharpening of peaks with

additional electropolishing indicates the absence of cold work associated with the grinding and polishing operations. As a phase of the x-ray diffraction characterization, two specimens were heated to 610 C, and cooled at rates of 50 C/hr and 150 C/hr, respectively. The latter specimen showed marked line broadening. The relationship between cooling rate and x-ray line broadening in uranium will be investigated, since the determination of reactor induced line broadening will require knowledge of the thermal effects of start-ups and shut-downs.

Fractographic analysis of uranium irradiated at 200 C to burnups of 0.1 percent is continuing. Since the fracture surfaces and polished sections of irradiated impact specimens contain cracks, a non-irradiated specimen has been subjected to a similar fractographic analysis. No cracks have been detected by electron micrography. Additional fractographic analyses are being made on irradiated uranium specimens which have been broken at low and elevated temperatures, and after a post-irradiation anneal.

Recovery and Recrystallization of Zirconium and its Alloys. The kinetics of recrystallization and recovery in zirconium, Zircaloy-2, and Zircaloy-3 are being determined to establish the optimum conditions of heat treatment during fabrication operations. Percent cold work, temperature, time and heat treatment atmosphere were selected as variables.

Corrosion tests in 680 F water are being run on specimens of Zircaloy-2 and Zircaloy-3 at the Bureau of Mines, Albany, Oregon. The corrosion testing of vacuum melted Zircaloy-3, heat-treated in air and helium at 300 to 800 C for 10 to 1000 minutes has been concluded after 308 days in test. This material exhibits a "breakaway" after 224 hours, and the weight gains vary with heat treatment. The best corrosion resistance is produced by heat treating 1000 minutes at 600 C in air or 1000 minutes at 700 C in He. This corrosion resistance is quite possibly a function of the microstructure and, therefore, differences in optimum heat treat conditions could be ascribed to the effect of atmosphere on the rate of recrystallization.

The Zircaloy-2, argon melted Zircaloy-3, and vacuum melted Zircaloy-3 samples heat treated in vacuum at 300 to 800 C for times of 10 to 1000 minutes have been reported to 140 days exposure. To date, no marked change in corrosion rate has been noted.

Diffusion Studies. A knowledge of the interdiffusion of various uranium/barrier metal/clad metal combinations is essential in the design of fuel elements. Diffusion is being studied in U/Ni/Al, U/X-8001, U/Zr, and (U-Zr) alloy/Al couples. The effect of thermal cycling, during the diffusion anneal, on the U/AlSi diffusion rate is also being determined. Five U/Ni/Al diffusion couples were annealed seven days at 530 C. Metallographic analysis revealed that nickel had migrated to the surface of the 0.006" thick aluminum. However, no uranium could be found on the surface by means of autoradiographic analysis which has a lower detection limit of approximately 0.6 w/o uranium. Four U/Ni/Al couples were annealed fourteen days at 404 C. Aluminum diffused 0.0005" into the nickel from the original nickel/aluminum interface. The uranium did

not penetrate or adhere to the nickel in these couples. Four couples have been annealed fourteen days at 459 C. The nickel adhered to both the aluminum and the uranium. One of these couples has been mounted for cross sectioning and metallographic examination. Eight U/Ni/Al couples are being annealed at 450 C and eight are being annealed at 400 C. Observations on U/Ni/Al couples annealed at 570 C and 530 C indicate that the rate of diffusion of uranium outward into the aluminum greatly increases at some time after the Ni_2Al_3 phase boundary reaches the uranium.

Neutron Damage to Metals. The purpose of this program is to advance the theory of radiation damage to metals by neutrons. A series of metals representing the common metal crystal types was irradiated at Brookhaven, Hanford, and the MTR under various exposures and temperatures. These metals include copper, nickel, titanium, zirconium, iron molybdenum, and type-347 stainless steel. Post-irradiation measurements of mechanical and physical properties of these metals were initiated at KAPL and will be completed at HAPO. Segregation, cleaning, and recanning of the specimens were completed in Radiometallurgy during the month. The copper, titanium, zirconium, iron, and molybdenum specimens were transferred to the tube storage facility in the Physical Metallurgy Operation laboratory during the month. Wiring and assembly of the control panel for the annealing furnaces are about 30 percent complete.

Effects of Low Temperature Irradiation on the Properties of Uranium. The purpose of this test is to find the threshold of detectable neutron damage to uranium through a series of low temperature and short exposures. Specimens have been prepared from dingot uranium sheet and are being irradiated at the snout facility at 105-KW. Post-irradiation tensile and annealing tests will be performed to determine the amount of damage induced and the ease of removal. Four tensile assemblies, each containing two tensile specimens and one Al-Co flux monitor, were irradiated at a temperature below 35 C during the month. Three tensile assemblies were irradiated for 22 minutes, and the fourth was irradiated for six hours. The specimens were transferred from the reactor to the Radiometallurgy Laboratory in a lead cask fitted with a Dewar flask and filled with liquid nitrogen. The specimens are being stored below 0 C until they are tested.

X-Ray Diffraction Studies. The increasing awareness of the potential of x-ray diffraction studies both as an independent method and as a complement to other techniques of research has resulted in a sharp increase in the x-ray laboratory activities. During the current month the two x-ray units have been operated a total of 560 hours on various research and service-type problems. This represents 160 percent of the regular working hours and is accomplished by careful scheduling of the various problems and by using the automatic recording systems that have been developed.

The data for final reports on three radiation damage studies are close to complete. The final data concerning effects of radiation on the crystal lattice, hardness, and density of molybdenum have been obtained and the report is being written. A study of the kinetics of recovery during annealing of radiation damage in molybdenum also is close to completion. Determination of the types of crystalline defects in irradiated molybdenum by a Fourier analysis of the diffraction line shapes is complete and a report is being prepared.

New Fuel Element Development

Rod Cluster Fuel. Stainless steel clad cluster fuel elements have been operating in KER Loop 3 since September 1957. Experience from this irradiation test will guide an NPR fuel program using Zircaloy-2 clad co-extruded uranium. The KER Loop 3 fuel elements are four-rod clusters intended to test support methods, charge-discharge problems, operating temperatures, and core swelling in 240 C coolant. The present exposure is 1800 MWD/T, accumulated at an average power of 42 kw/ft (11.2 watts/gm).

For a succeeding loading, two seven-rod cluster fuel elements, completed in March, were autoclave tested, measured, and sent to 1706-KE. The fuel rods of these elements are co-extruded natural uranium clad with 0.030 inch of Zircaloy-2, with a nominal 0.050 inch clearance between rods. The uranium/water ratio for these fuel elements is equal to or greater than that proposed for the NPR cluster element. Due to a leak at KER Loop 1, these elements were not charged into the reactor as scheduled during April.

A test of co-extruded fuel rod in two- and three-foot lengths is being assembled. A two-foot element with no intermediate supports will be irradiated in the form of a three-rod cluster. A three-foot element with an intermediate support will be charged in the same process tube. An experimental determination of the amount of bowing suffered in long rods is critical to NPR design. This test will be charged in KER Loop 3 when the present stainless steel clad elements reach their goal of 2000 MWD/T exposure.

Four seven-rod cluster fuel elements are to be charged into the KE through-hole facility during the next shutdown of KE Reactor. The charging of these fuel elements was delayed from last January due to warpage of the process tube which prevented entrance of the basket assembly. Fabrication of new basket components was necessary. These fuel elements were fabricated from 1.3 percent enriched uranium rods and clad unbonded in 304 stainless steel tubing. An external ring spider was used to hold the rods in position. Two thermocouples were placed in separate rods in order to measure the central core temperature of the fuel. Two pairs of thermocouples were also placed upstream and downstream, respectively, of the basket assemblies to measure the specific power of the fuel rods. From these temperature data the uranium-jacket interface bond coefficient can also be determined. The goal exposure for the experiment is 2500 MWD/T.

Seven-rod cluster fuel elements are being made ready for the first loading of the ETR 3X3 facility. These fuel elements, made from 0.593 co-extruded natural uranium and Zircaloy-2 and supported by a modified triangular spider, will be irradiated during the first cycle of the ETR at 300 C coolant temperature. Based upon present physics flux calculations, the central core temperature of these rods should approximate 575 C. Data from the ETR critical facility experiment should enable refining these calculations and permit more accurate temperature estimates.

One problem in fabricating the cluster element is the attachment of supports to the jacket to permit accurate positioning of the element in the process tube. A method of attaching supports by resistance spot welding has been developed. With proper control of welding conditions there is no effect on the uranium or the Zircaloy-2 uranium bond, and consistently high quality welds can be made. The resistance to corrosion in 686 F water in and around the fusion zone is satisfactory when an inert gas shield is used to protect the weld area during the welding cycle.

Zircaloy-Clad Rod and Tube Element. A co-extruded Zircaloy-2 clad uranium tube was received from Nuclear Metals, Inc., as a result of a contract between Nuclear Metals and IPD. The nominal dimensions are: 1.785" OD, 1.375" ID, and the clad thickness is 0.030 inch. The tube is about ten feet long. The OD and ID are 0.040 inch eccentric in this first tube. A short section of tube was counterbored and successfully end closed with an electron beam weld. Bond, autoclave, and metallurgical tests will be performed to determine whether this tube is of irradiation quality.

Aluminum Clad Rod and Tube Fuel Elements. The fabrication of M-388 aluminum clad rod and tube fuel elements was started. These fuel elements will have the same dimensions as the prototypes made from cast uranium and described in HW-55498. Gun-reaming of five 20-inch long uranium tubes to final size was started. The alpha-extruded uranium tubes were straightened, beta-heat treated twice and checked metallographically for grain size. M-388 aluminum components to jacket the uranium tubes were on hand, but jackets for the rods had to be prepared from 1.44" OD M-388 cans swaged to 1.1" OD.

Co-axial Fuel Element. The co-axial tube fuel element is of interest because it may offer a better split failure resistance than a corresponding sized cored fuel element. Radiometallurgical examination has continued on the last two co-axial fuel elements irradiated at the MTR. Post-irradiation examination reveals that the erratic temperature behavior and failure of the thermocouple resulted from the formation of a low melting uranium alloy with the stainless steel thermocouple sheathing, and was due to thermocouple damage rather than the inherent characteristics of the fuel element. The inner co-axial tube in this element appears to have grown in length and is slightly loose in the outer uranium tube. When fabricated, the tube to tube fit was tight, having been assembled by shrink fit techniques. The second fuel element appears in good condition with the inner tube having maintained its original length. The original slip fit has become a tight fit as the result of the irradiation. Radiometallurgical examination is continuing. A second set of co-axial fuel elements has been prepared and shipped to the MTR for irradiation testing. One contains a tantalum sheathed thermocouple for temperature monitoring and determining the effect of operational history on the operating temperature. A goal of 1000 MWD/T is planned for the second fuel element for evaluation of its extended exposure behavior.

Insulated Fuel Elements. Insulated fuel elements are of interest as the increased uranium temperature during operation should enable the fuel element to perform with a decreased tendency to fail by thermal stress splitting. It has been previously reported that electron microscopy of a section of a cored, insulated fuel element operated in a K through-hole showed the presence of voids ranging in size from about 0.1 μ to 20 μ. It appeared that many of the voids were not spherical but had a longer dimension in the longitudinal direction of the uranium core. Optical microscopy of a longitudinal section of the uranium has been completed in the Radiometallurgy Laboratory to

determine if the voids display any directional preference during their formation or growth. No such preference was noted. Additional study of the longitudinal surface is to be made using the electron microscope.

A deterrent to the application of unbonded fuel elements in general and insulated (unbonded) fuel elements in particular is the possible manner or severity with which such a fuel element may rupture. To demonstrate the rupture behavior of an unbonded and insulated fuel element, one has been intentionally ruptured in the MTR. Radiometallurgical examination of this fuel element has been completed, and the fuel element and its insulated uranium core were found to have suffered negligible damage. The fuel element operated with a maximum temperature of 500 C but was maintained at power for only one minute following puncturing of the cladding.

Cold Closure Development. The investigation of the quality of the closures on elements which have been sized directly to 1.440" OD (finished dimension) has indicated that the closure is satisfactory. The surfaces of the elements so produced have been excellent and require only a minimum of finishing. The annular-ring-closure of an I & E element, which is currently being investigated, requires a pre-closure sizing to produce the concentric rings of heavy-walled jacket material from which the closure is extruded. The outside ring is obtained by the conventional method of sizing the thick-walled cup over the top of the core. Two methods for producing the inside ring are being considered. In one method a heavy-walled tube is extruded as part of the cup base and extends into the hole in the core. This tube is then sized to finished wall by shoving a pointed mandrel through the tube. As the tube extends out of the top of the slug, the mandrel forces the heavy wall out radially over the top of the slug. Preliminary attempts to size a thick-walled tube in this fashion indicate this method is feasible. The second method consists of extruding a thin-walled tube with a thick-walled top as part of the cup. This tube goes into the hole in the core and the thick-walled portion is expanded radially outward over the core top. The primary problem in this method seems to be in controlling the length of the tube extrusion.

Vacuum Closure of Elements. A method of fabricating aluminum jacketed tubular fuel elements by hydrostatic pressing is being developed by the Fuel Element Design group. These elements must be sealed so that the residual air pressure is less than one micron of Hg. At this pressure the element can be heated and bonded with no appreciable oxide formation on the bonding faces. Several such elements were assembled. To prevent oxidation of bonding surfaces, the elements were evacuated and sealed by welding the end closures at a pressure of 10^{-4} mm of Hg in the electron beam vacuum welder. To seal these elements without use of the electron beam vacuum welder would have required fabrication of end caps with attached evacuation tubes, welding the end caps to the jackets, evacuating the element and pinching off the tube. In addition to leaving a tube stub, this method has never produced results that could be guaranteed. When using the electron beam vacuum welding process, the seal is a fusion weld, the quality of which can be determined by inspection; there are no extra steps of evacuation after welding, and the finished

element does not have a tube stub requiring protection from mechanical damage. These factors indicate that the electron beam vacuum welding process is the best presently known method of closing containers evacuated to very low pressures.

Hot Pressed NPR Fuel Elements. In support of production test IP-134A, two groups of twelve fuel elements each, clad with the C-2 jacket alloy, have been completed. These fuel elements are 1.6 percent enriched uranium wafers, KER size and hot pressed to provide a diffusion bond. This completes the present requirements for the production test. Assembly procedure for these fuel elements was changed slightly to prevent the galling of the extremely hard aluminum cans. The present method is to assemble the nickel plated washers on the cap spire, and then to work the unannealed can over the washer column. The remainder of the process has remained unchanged.

Lead-Dip I & E Segmented (Washer) Fuel Elements. The fail-safe feature of the segmented core fuel element is a desirable reactor property. The mode of failure minimizes process tube damage. A four-tube "C" size I & E segmented core run-to-rupture production test is being fabricated. One hundred and eighty-five (185) fuel elements have been canned by the lead-dip process. Caustic etching of selected elements has revealed a minimum unpenetrated can wall of 0.012 inch. There is no adequate non-destructive AlSi penetration test for this type of fuel element. Lacking a detection method, research is being conducted on the canning variables to discover and correct the cause of penetration. If no adequate non-destructive test can be applied to the existing fuel elements, they will be rejected and the reclaimed cores will be jacketed under conditions modified by the results of the current investigation.

Restraint of Uranium Swelling by Zirconium Cladding. Swelling rates of unrestrained uranium irradiated in the 400-800 C temperature range have been measured, but to date no swelling data are available for unalloyed clad uranium with a 250-350 C cladding surface temperature and a maximum fuel temperature in the range 450-600 C. The above temperature conditions and restraint conditions are similar to those of proposed NPR fuel elements. To provide initial swelling data for the above temperature conditions, a NaK capsule irradiation GEH-3-31 was designed and charged in the MTR. The measured temperature of the uranium is 425 C or 175 C below that for which the capsule was designed. Flux measurements made during the last reactor shutdown showed the irradiation facility flux to be less than the value requested, but this does not completely account for the temperature difference. A second identical capsule, GEH-3-32, will be irradiated, at a higher flux than the first, as soon as space in the MTR is available.

A series of NaK capsule experiments is being designed for irradiation in Hanford reactors to obtain further information on the dependence of fuel element swelling upon cladding and uranium temperatures, cladding thickness, and exposure.

A double weld closure has been developed using the electron gun to weld an end plug to the inside well of the capsule and a solid end cap to the end of the capsule. Assuming the conditions of C Reactor, the ratios of power in the capsule assembly to the power in an adjacent process tube have been calculated to be 0.298 and 0.569 for natural and 1.6 percent enriched uranium, respectively. Work is now progressing on the final dimensional calculations for the capsules.

Brittle Bond-Bond Strength Determination. A concerted effort is being made to determine a relative bond strength for the brittle bond. To do this, 100 standard lead-dipped fuel elements, consisting of control samples and slugs canned by seven different methods, have been provided by FPD. Bond strengths are determined by flash welding a stud to the jacket, then isolating that portion of the jacket by machining around the stud. The stud is then placed in the grips of the tensile test machine and the fuel element held rigid. Three studs are pulled on each fuel element, one at the cap end, one at the center, and one at the base end. Present data are scattered, but with continued testing a pattern is beginning to form.

Fuel Element Testing and Evaluation. A series of tests is being conducted to aid FPD in remedying the "brittle bond" problem. This brittle bond condition is manifested in regular production as a zone usually near the cap end of lead-dip canned slugs in which the bond formed during canning has become broken and separated and may be non-destructively detected by the ultrasonic bond test or by the Frost test. Earlier studies of similar trouble had shown that bond frangibility is alleviated by decreasing (a) time of contact between uranium and AlSi, (b) temperature of uranium and AlSi while in contact, and (c) concentration of silicon in AlSi.

In connection with the recent brittle bond trouble, it appears that AlSi was being retained in contact with the upper ends of the slugs during agitation in the lead layer of the duplex bath, thus increasing both time and temperature of contact between uranium and AlSi. When the uranium cores were systematically submerged (by FPD) deeper into the lead bath during agitation to avoid turbulent entrainment of the AlSi layer into the lead near the upper end, there was a precipitous reduction of the incidence of brittle bonds, as measured by the ultrasonic bond test.

Tests were run cooperatively with FPD to confirm the correlation among ultrasonic test results, Frost test results, and the true condition of the bond as revealed by mechanical stripping. Further tests are in progress to determine the effect of long-term holding at temperatures somewhat in excess of pile operating temperatures with repeated thermal cycling, upon the bond of lead-dip slugs canned under various conditions of temperature, silicon concentration, depth of submergence in lead layer, heating time, rate of agitation, etc. Present indications are that continued heating at 275 C and repeated cycling to room temperature generally tend to induce bond fracture in slugs where the bond is weak and generally continue to increase the area of broken bond in slugs which had exhibited the defect to some degree prior to thermal testing.

Broken bonds appear to be almost non-existent among fuel elements canned by deep submergence in the lead bath.

Application of a vacuum-bubble-test "blister" to small holes drilled in the suspected broken bond zone permits semi-destructive verification of non-destructive bond quality checks. Thermal cycling may be resumed on slugs after application of this test (in contrast to other positive verification tests), which makes it preferable as a means for collecting data on thermal behavior. This test is a new application of an old principle.

Sylvania Corning Hot-Press I & E Slugs. The results of tests involving long-term baking, followed by drilling and water autoclaving (the Leak Vulnerability Test) were more favorable for the S-C slugs than most of the previous tests. The four specimens selected at random for this test were found to be much less vulnerable to both undercutting and interfacial channeling than either the Hanford hot-press or standard lead-dip-canned controls. Summing up the results of all the tests leads to the conclusion that the best S-C slugs are very good with respect to precharging tests, while many are very poor. Lack of consistency, presumably stemming from inadequate process control, appears to be the most unfavorable general characteristic of these fuel elements. The weak features are not amenable to grading by non-destructive means, so that it is not possible to separate acceptable from unacceptable slugs by available non-destructive inspection methods. Thus, the only apparent way of reducing the risk of in-reactor failure of slugs fabricated by S-C is a tightening up of fabrication process controls.

Aluminum Alloy Melting Point Determination. Four aluminum alloys, A-1, A-2, C-1, C-2, were developed as possible candidates for NPR jacketing material. These alloys have shown superior high temperature corrosion resistance as compared with other aluminum alloys. Several of the cladding methods require a knowledge of the jacket melting point to properly effect the diffusion bond between the jacket and the core. To determine the melting point, the freezing temperature method was employed. The melting point for the C-1 alloy, a 0.5 percent Ni, 0.5 percent Fe, 0.15 percent Ti, 0.05 percent Be, 0.2 percent Si-Al alloy has been found to be 660 C ± 1 C. The melting points of the other alloys are still being run.

Tru-Line Washers. One of the methods being developed for the fabrication of Tru-line washers is the upsetting of rod stock. The chief advantages of this method are: (1) scrapless production of washers with accompanying economy, and (2) built-in Tru-line feature eliminating additional fabrication. An experimental die set is being used to define the material and fabrication conditions required to upset 11/16-inch diameter rod to KER size washers (1.696-inch outer diameter). Several tests were made during the month using dingot uranium stock preheated to 550 and 600 C by first coating with $MoSi_2$ and then heating in powdered graphite. The die and punches were preheated to 360 C and presses were made with 200 tons. Oxidation was not severe with uranium heated to 550 C, and the die cavity was completely filled with no edge cracking except for a small section on

the corners. Metallographic, hardness, and x-ray examination was made of two washers showing the type of flow and crystallographic texture developed.

Thermal Contact Conductance of Fuel Element Materials. In the process of obtaining calibration data on the apparatus that measures conductance of contacts between parallel flat surfaces, the contact conductance of an aluminum-copper joint was obtained. At 1000 psi pressure on the joint, a mean joint temperature of 250 C and a thermal flux of 446,000 BTU/hr/ft^2, the contact conductance was 8500 BTU/hr/ft^2/^{o}F. At 160 C joint temperature, 1000 psi pressure and a thermal flux of 264,000 BTU/hr/ft^2 the contact conductance was 6600 BTU/hr/ft^2/^{o}F.

Combined Effects of Pressure and Thermally Induced Loadings. A proposal suggesting the study of pressure and thermally induced loadings has been submitted for the consideration of the A.S.M.E. Research Committee. Current problems in designing pressure piping for ETR testing facilities and tubing for the NPR have shown the need for investigation of this phenomena. Currently, methods of inducing prototype loadings in samples are being studied and the necessary equipment is being designed. These proposals will be submitted to various authorities for comment on the methods and equipment.

A method of determining pipe thicknesses which considers the plastic behavior of the material in pressure piping in a high flux reactor core is being developed. Initial calculations for the pressure piping for the ETR 9X9 Fuel Element Testing Facility showed that elastic calculations are inadequate if one considers the effects of gamma heating. A plastic method of calculation is being devised which will estimate the plastic strain per cycle for piping which cannot operate within the elastic range.

2. REACTOR PROGRAM

Coolant Systems Development

Operation of KER Loops. Loop KER-2 was charged with ten enriched hot-pressed Elephant slugs clad in A-2 aluminum alloy under Supplement A of PT-IP-134A. The test is designed to furnish data for determination of corrosion rates of aluminum under optimum operating conditions. The pH is adjusted to 4.5 with phosphoric acid; flow rates are 60 gpm; outlet temperature was initially 240 C but was changed to 180 C because of an abnormal flux distribution; and the ratio of aluminum surface area to volume of circulating water is 410 cm^2/gallon. This high ratio is obtained by means of a spiral sheet of X-8001 alloy placed in the mockup tube.

With the charging of KER-2, all four loops were operating at elevated temperatures (180 to 240 C). Tests described in previous reports are being continued in Loops 1, 3 and 4. An up-to-date program for the KER Loops has been published, HW-53619.

Since many new types of fuel elements are being proposed for testing in the KER Loops, calculations have been made of dimensions of fuel elements required for KER tests. It is always desirable and sometimes necessary to make preliminary out-of-reactor tests on prototypes to determine whether such fuel elements can actually be used. A letter outlining the requirements for KER fuels has been sent to all interested groups at Hanford.

A preliminary evaluation has been made of reconnecting the present two parallel KER pumps in series. This change would increase the coolant flow in each loop from the present 60 gpm to over 75 gpm, while at the same time permitting three times the current maximum pressure drop across the test section. The evaluation shows that in the event of single pump failure it would not be necessary to scram the reactor but only to reduce inlet temperature. This study will be continued by Thermal Hydraulics Operation and a letter on their conclusions will be issued soon. If the change-over is feasible, this modification will greatly relieve the limitations on KER testing until such time that new pumps are obtained.

Out-of-Reactor Recirculating Water Testing. The evaluation of dihydroxyanthraquinone as an inhibitor is continuing. This material is easily oxidized to phthalic acid by very low concentrations of oxygen, with a consequent lowering of pH. Under these conditions, the carbon steel samples corrode at a very high rate, and a thick film is deposited on both the carbon steel and the aluminum. If the system is kept free of oxygen, the inhibitor is fairly stable even at temperatures up to 360 C.

The improved rupture testing facility (ELMO-4) is being fabricated. Some difficulty in scheduling the work has delayed completion, but it is estimated that testing can start by May 15.

The corrosion testing of carbon steel in ELMO-5 is continuing. The pH is regulated at 10.0 with lithium hydroxide, and the coolant temperature is maintained at 290 C.

Testing of two fuel elements clad in A-2 and X-8001 aluminum alloys continued in ELMO-6 at 300 C, pH 4.5 H_3PO_4. After five weeks of operation at these conditions, only minor scattered pitting has been observed on the A-2 clad slug, and the X-8001 alloy continued to look good. Exposure of the two slugs will continue to evaluate the cladding integrity. The loop will be charged with several new aluminum cermet alloys as soon as coupons are available. The results are similar for tests in ELMO-7; A-1, A-2, C-1, C-2 and X-8001 aluminum alloy clad Elephant elements have shown no evidence of gross corrosion after running four weeks at 304 C, 1690 psi with 4.5 pH maintained by H_3PO_4 addition. Pitting was noted to varying degrees on all elements while blistering was noted primarily on C-2 and to a slight extent on A-2. The aluminum alloy cans were run for two weeks at 304 C with 4.5 pH. A-1 blistered inside with slight blistering and pitting outside; A-2 pitted and blistered slightly on the outside only; C-1 had several blisters about 10 mils across inside and a few pits and blisters outside;

and C-2 had numerous fairly large pits and some blisters inside with smaller pits outside. A-2 and C-2 alloy fuel element support rails blister at the rail attachment welds less severely than the other type alloys. Most of the blisters on all rails have formed after two weeks' operation.

Heat Exchanger Testing. A heat exchanger has been designed for installation on the Dowtherm unit in 1706-KE. This equipment will measure the scale build-up on carbon steel surfaces cooled by raw river water. The effects of temperature, time, and water composition will be determined. The Chempump recirculation pump on the raw-water cooled heat exchanger facility (ELMO-1) failed because of bearing wear and was replaced by a heavier duty Chempump of the same operating characteristics. The hotter exchanger still has less scale build-up on the baffles than the cooler exchanger. Microscopic examination of the scale showed no apparent difference in the scale on the two exchangers. The raw water cooled manifold heat exchangers on ELMO-7 showed about 1/32 inch scale build-up after one week's operation with the primary side cycling between 250 and 550 F. The scale had the appearance of regular boiler scale with some indication of rust.

Decontamination of Recirculating Reactor Systems. In last month's report, HW-55590-A1, it was reported that a proprietary compound, Turco 4008, appeared promising as a reagent for decontaminating stainless steel components in the KER Loops. During the past month stainless steel coupons and a coupon holder which had scale built up on them as a result of exposure to high-temperature high-purity water were immersed in the Turco 4008 chemicals. The scale was very effectively removed without excessive corrosion (0.05 mil), indicating that it may be possible to decontaminate stainless steel which has been exposed to high-temperature, high-purity water, assuming the contamination resides in the scale. The Coolant Testing Operation in IPD has also used this compound to decontaminate components of the KER Loops with marked success. For commercial reasons these compounds are sold by Turco under two sets of numbers (4008, 4338, 4104, 4501, 4502, and 4503).

The ELMO-10 loop has been extensively remodeled for use as a contaminated loop for decontaminating carbon steel coupons exposed in the KER loops. Changes include a new head tank, extensive repiping, and a new pump. Auxiliaries have been added which will enable the loop to operate as a contaminated facility. The loop should be ready to start on decontamination of KER-1 contaminated coupons within a month.

Organic Coolant Studies. Pyrolysis studies have been started on benzene and on an isopropylated ortho, metaterphenyl mixture (IOMT). The benzene is being studied to complete the data relating to mechanism studies on polyphenyl pyrolysis. Qualitatively, benzene is more stable than biphenyl, and IOMT is less stable than MIPB. The actual rates have not yet been established. A 50-gallon charge of IOMT is ready to go into in-reactor loop ORA-2. The loop is presently partially plugged from the last run several months ago, and an attempt will be made to clean the loop with steam at the next shutdown.

The ORA-1 loop operated without incident during the past month. This is the out-of-reactor loop operating at 700 F and 200 psi. The component testing loop, ORA-3, was out of service part of the month as a result of heater fouling and burnout. Several reports on organic coolants were issued during the month (HW-53718, HW-54994, HW-55245, and HW-55516).

Corrosion Tests in Process Water. A test was started last month to determine the extent of galvanic attack of zirconium connected to graphite in hot process water. After over a month's exposure at temperatures varying from 70 to 100 C, no attack has been detected.

Tests are continuing to compare corrosion behavior of different alloys of aluminum. Among the variables being tested are temperature, pressure, geometry, flow, undissolved solids, and inhibitor concentration. So far, it has not been possible to differentiate among the different alloys. Revisions are under way to continue these tests at higher temperatures in the mockup tubes.

Nonmetallic Materials Development

Graphite Development. Cooperative efforts in the development of improved reactor grade graphites are being conducted with the major carbon companies, Great Lakes Carbon Corporation, National Carbon Company, and Speer Carbon Company. Current interest is centered on the development of analytical methods capable of giving a reliable indication of the thermal neutron cross-section. Chemical analyses are being made on graphites whose purity has been determined in the Hanford Test Reactor. Two bars of graphite representative of GBF and AGOT processing with known dih purity have been shipped to Great Lakes Carbon Corporation for inclusion in a series of graphites undergoing chemical analysis. Results will be made available when this study is completed.

New manufacturing processes for the fabrication and purification of reactor graphites are being studied. Graphites recently received from the National Carbon Company for dih purity testing are representative of new fabrication processes. Bars which were processed in sizes up to 16-1/2" x 16-1/2" x 50" have been sectioned for purity measurements to determine the feasibility of producing AGOT material in large sizes.

A new purification process for reactor graphites which may be competitive with the "F" process is now available to the Speer Carbon Company. Graphite purified by this new process has been received, and the dih value has been measured. An average value for eight bars tested was 0.875. The density of this material was 1.64 g/cc. Material similarly processed with a density of 1.70 g/cc is being prepared for shipment. Speer Carbon Company has also developed a 1.1 g/cc graphite without the use of additives. Samples of this material are being prepared for testing.

A series of samples has been prepared by the National Carbon Company Research Laboratories for short term irradiation. Five types of new production graphite and natural flake samples are included. The results are expected to contribute to the fundamental understanding of radiation damage in graphite.

High Temperature Graphite Irradiations. The effect on graphite of irradiation at 700 to 1100 C must be determined for design support of the NPR and to assure that the life of the existing reactors will not be seriously shortened by the higher graphite temperatures expected in the future. The first results from the GEH-9 experiments in the L-42 position of the Materials Testing Reactor indicate that the contraction rate at 1000 C is fairly high - in the 0.5% to 1% range. Because the L-42 position is presently available for GEH-9 experiments only about one-fourth of the time, an effort is being made to obtain additional satisfactory irradiation space in the MTR and ETR. Discussions were held at the MTR with personnel of the Phillips Petroleum Company regarding the possibilities of converting the L-48 shim rod position to a graphite irradiation test hole. The L-48 position, which is a mirror image of the L-42 position, could be converted to a bottom entry facility and would have a very high fast flux similar to that found in L-42. The discussions indicated that any conversion to an irradiation facility preferably should retain the shim rod function for reasons of safety. Possible ways of accomplishing this are now being examined.

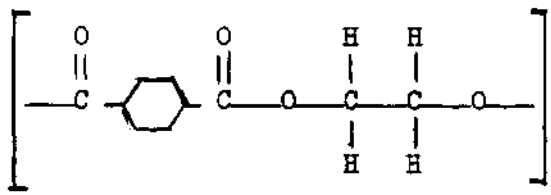
Thermal Conductivity of Graphite. The thermal conductivity of three unirradiated samples of TS-GBF graphite, density 1.65 g/cc, has been measured to 500 C. Data obtained by a radial heat flow method in hollow graphite cylinders indicate thermal conductivities of 0.12 cal/cm sec C at 200 C and 0.135 at 500 C for two samples. The conductivity of the third sample decreased from 0.21 to 0.15 cal/cm sec C over the temperature range of 200 to 500 C. The samples will be irradiated at about 500 C to determine the effect of irradiation on the thermal conductivity at 200 to 500 C.

Irradiation Annealing in Graphite. An hypothesis that irradiation annealing in graphite can be partially attributed to thermal neutrons of energy 0.1 ev or greater, is being considered as a basis for possible experiments. In the experiments the damage suffered by Cd-foil wrapped samples irradiated at high temperatures would be compared with the damage to accompanying unwrapped control samples. X-ray lattice measurements would be a convenient means of monitoring the damage since only a small amount of material would be necessary for such measurements.

A review of the experimental results on irradiation annealing and the increase in damage in the Argonne CP-3 reactor upon changing from water to gas moderator reveals no inconsistencies with the proposed hypothesis. Theoretical and experimental papers on inelastic scattering of thermal neutrons in solids do not yield sufficient pertinent information to corroborate or invalidate the hypothesis. Additional references are being consulted in an effort to establish the likelihood of the initiation of a sufficient number of annealing events to account for the observed irradiation annealing effects.

A large change in the flux of neutrons with energies greater than 0.1 ev would be anticipated when the temperature is raised from 25 to 325 C. A computation of the flux at the two temperatures, assuming Maxwellian distributions, indicates that the component of the thermal flux with energy greater than 0.1 ev is 10 times larger at the higher temperature than at the lower temperature. In addition, on the basis of the Cd ratio at 325 C, this component of the thermal flux is larger than the epithermal and fast flux components.

Irradiation Damage to Plastics. Vacuum irradiations in the gamma facilities at the MTR have been completed on Mylar and Irrathene to high doses (approx. 3×10^8 roentgens). The irrathene results are generally consistent with those reported earlier for lower doses. Mylar A is a polyester with a repeating unit of



Mass spectrometer analyses of the gases evolved from the Mylar samples show that some chain cleavage occurred with the evolution of carbon dioxide and carbon monoxide. Large changes in the mechanical properties were observed. The elongation decreased to zero after a dose of 3×10^8 r, and the tensile strength was reduced by 50% and 75% at 3 and 5×10^8 r, respectively. No changes were observed in the infrared spectra from 650 cm^{-1} to 4000 cm^{-1}. This is not inconsistent with the gas evolution results, since, of the C, H, and O atoms originally present, only 0.06%, 0.06%, and 0.29% respectively were lost as gases.

Two new plastics, which have become commercially available during the last few months, have been screened for their resistance to radiation. Delrin acetal resin (polymerized formaldehyde) was very severely damaged by moderate gamma exposures. At 5×10^6 r, it lost 100% of its elongation, 33% of its tensile strength, increased 12% in hardness, and broke when bent 180 degrees. At 1×10^7 r, it was so embrittled that the usual physical properties could not be measured. The decrease in tensile strength and the odor of formaldehyde suggest that this material was chain cleaved. The other plastic, polypropylene, behaved in an entirely different manner. The tensile strength of this material increased slightly at 5×10^6 r, after which it decreased. The material was quite brittle at 1×10^7 r, where it failed the bend test and lost all of its elongation. The hardness increased to 5×10^7 r, after which it decreased slightly. A small sample irradiated to 10^9 r was much more flexible than those taken to 1×10^7 r and was slightly tacky. The above suggest that this material undergoes both crosslinking and chain cleavage to approximately 5×10^7 r, after which chain cleavage predominates. Above 10^8 r, it appears that chain scission produces low molecular weight fractions which actually plasticize the material and

make it more flexible. Due to a limited number of specimens, only small pieces were irradiated above 1 x 10^8 r. Tensile specimens have since been procured and irradiations are being conducted to 1 x 10^9 r.

Thermocouple Development. Reactor testing of thermocouples for graphite temperature monitoring is proceeding. Five Geminol P-N thermocouples with porcelain insulators have been operating in B Reactor for four months at 400 to 560 C. The indicated temperatures are being compared with iron-constantan couples mounted at the same positions. The latter are insulated with porcelain and are of the type now being installed as replacements. The Geminol P-N thermocouples are continuing to read an average of 10 C higher. In a second test stringer at B Reactor the performance of thermocouples with swagged junctions is being compared with thermocouples with the usual silver weld junctions. After four months at 400 to 560 C two of the five thermocouples with silver weld junctions have failed and are electrically open. The remaining silver weld thermocouples are indicating approximately the same temperatures as the swagged thermocouples.

In laboratory tests two iron-constantan thermocouples with zirconia insulation and stainless steel sheaths began to fail after five weeks in 100% CO_2 at 800 C. The indicated temperature slowly decreased until at the end of eight weeks it was 150 C lower than the actual furnace temperature. One of the thermocouples will be removed from the furnace and examined for the cause of failure. A companion chromel-alumel couple with the same insulation and sheath is still operating satisfactorily.

Structural Materials Development

Zircaloy-2 NPR Prototype Tubing. Three short pilot NPR prototype tubes have been completed by Mallory Sharon. Process and tool design changes to counteract the effect of tool heating during tube reducing were made prior to starting on the full length tubes. The five extrusions for the final tubes have received their first tube reducing pass. The surfaces looked very good, but only two of the five will definitely make full length tubes. Because of difficulties during extrusion it is estimated that the final lengths of the other three tubes will range between 48 and 57 feet, although it is theoretically possible that all five could attain 57 feet. The second rock is to be made the week of April 28.

Chase Brass completed the extrusions for their NPR tubes on April 15. The extrusions are as fine in quality as any Chase has ever produced. Their initial drawing test on a composite tube containing nine butt welds failed when the phosphate coating broke down completely about halfway through the test. The weld metal does not take the chemical coating as readily as does the parent metal, a fact that appears to contribute to the failure. The coating-lubricant problem must be solved before the final tubes can be welded and drawn. The welds in the test piece were mechanically sound, since none of them failed under the severe stresses applied by the violent chattering in the drawing test.

The six KER-size tubes being fabricated by Allegheny Ludlum were successfully welded, and the radiographs were inspected and passed. However, on tube reducing, some cracks developed in a manner which suggests "shear failures" - a term used in the industry to describe this type of cracking which is believed to result from employing too high an extrusion temperature. As a result of the above failure, alternative means of rapidly procuring new KER tubes are being explored. The most likely alternative is that two NPR tubes will be cut in half, vacuum annealed, and carried through an additional tube-reducing step to produce four KER tubes.

Thermal Hydraulics

Flow Hazard Studies. Experimental heat transfer studies of the response of reactor process tube assemblies to imposed hazardous operating conditions were continued. Initial transient heat transfer experiments were run with a test section simulating C Reactor I & E fuel elements in a K process tube. Experiments were run at a tube power of 1250 KW and were aimed at investigating the degree of protection offered by the Panellit gage system to moderate flow reductions caused by plugging of the coolant stream upstream of the Panellit gage tap. During the sequence of events following a flow reduction, emphasis was placed on measuring the Panellit tap pressure at the throat of the venturi and also the movement of the dial of a Panellit gage as mocked up to represent a reactor installation.

The significant questions in these experiments were: (1) whether the Panellit pressure would drop as low as predicted following the flow reduction so as to effect a low trip, and (2) whether the subsequent increase in pressure due to steam formation in the process tube would be sufficient to cause a high trip in case the low trip was not actuated. In general, the measured minimum Panellit tap pressure was 5 to 25 psi higher than that theoretically predicted, the discrepancy increasing with increasing severity of plug. There is, however, enough conservatism in the instability limits as outlined in Specification A-020, HW-51659, that the minimum actual Panellit tap pressure dropped below the specified low trip pressure. Furthermore, at these experiments run at 1250 KW, the Panellit pressure increase following the start of steam formation was sufficient to cause a high trip.

During these runs recordings were also made of the dial of a Panellit gage connected to the Panellit tap. It was found that the Panellit dial oscillated widely immediately following the flow reduction. The oscillations had a frequency of 4 to 6 cycles per second, had a maximum peak to peak amplitude of approximately 50 psi and damped out within one second. In all cases the oscillations swung below the Panellit low trip point for times in excess of 0.2 second.

In extrapolating these experimental data to further cases of flow reduction caused by plugging upstream of the Panellit tap, the following qualitative conclusions may be made:

1. As the degree of flow reduction increases, the dependability of a high trip by the Panellit gage decreases and finally disappears. In such cases, however, the dependability of the low trip increases.

2. As the tube power is decreased, the dependability of the high Panellit trip decreases and finally disappears at approximately 750 KW. However, it is suspected that there is enough conservatism in Specification A-020 that a low trip is 100 percent dependable in such cases. Plans were made for further investigation, as these experiments were run with a heater rod which had no provisions to simulate inter-channel flow at the slug junctions.

Two steady state boiling curves were determined with a test section simulating C Reactor I & E fuel elements in a K process tube. Such information is of value in predicting reactor process variables, especially for cases of low flows and high temperatures. These experiments, run at tube powers of 500 and 1250 KW, were performed with a heater rod allowing inter-channel flow at the slug junctions. Each experiment consisted of obtaining data of coolant temperatures and pressures and of heated surface temperatures as the flow was reduced in a stepwise manner. Data were obtained until film boiling was encountered as indicated by a sudden and large increase in surface temperatures. Of interest was the difference in heated surface temperature between the top and bottom of the simulated fuel elements. Attributed to the eccentricity of the fuel element in the process tube, the temperature difference was 58 C at 50 gpm for the 1250 KW case and 38 C at 22 gpm for the 500 KW run. In both cases the temperature difference decreased toward zero as the flow was reduced to the film boiling condition.

Hydraulics Studies. Data were obtained in a study to determine the ability of the existing temperature detectors to measure the true end-of-fuel-column water temperatures for high outlet water temperatures for process tubes in C Reactor. It was found that, as was the case for K Reactor, the deviation between the true temperature and the measured temperature was not great. At 140 C true temperature the deviation was 1.5 C at 50 gpm and 10 C at 30.5 gpm. Critical flow conditions in the rear outlet fittings were found to be the controlling factor in these experiments.

Fabrication was started of a KER tube and a Lucite PRTR tube for addition to the hydraulics laboratory. Completion of both projects is expected by May 10.

Service work was conducted for IPD when vibration qualification tests were made for eleven Lewis type RTD (Resistance-Type Temperature Detector) elements for K Reactor. Vibration is set up in these elements by placing them just downstream of a venturi-to-pigtail adapter in the Y fitting. IPD personnel have determined that the cavitation and high velocity flow through this fitting causes vibrations such that running for five hours at 60 gpm is equivalent to 50 hours at a force of 100 times the acceleration of gravity in the vibration machine in 300 Area.

The first unit tested by this method failed after 1.5 hours. Sectioning of the unit revealed that the oxide packing material (packed around the resistance element in the well to prevent movement of the element during vibration) had not completely filled the well cavity.

High Pressure Heat Transfer Apparatus. The repair of the Ingersol-Rand recycle pump was halted when the company's field engineer recommended that the balancing drum sleeve be replaced. This was in spite of the fact that the part had been examined and declared sound by one of the company's sales engineers last fall.

Four new heater rods were designed as part of the program to study boiling burnout at high pressures. The purpose of these test sections will be to study the effect of boiling length and the effect of a step increase in heat flux along the length of the heated surface on boiling burnout.

Heat Transfer Coefficient Studies. Both analytical and experimental studies were continued of the heat transfer characteristics of rod cluster fuel elements. Heat transfer coefficients around the periphery and temperature distribution within each rod of the fuel element were calculated for cases of:

I. Seven-rod Bundle

1. Equal 0.050-inch spacing between adjacent rods and process tube wall.
2. Equal 0.050-inch spacing, except one rod is assumed to have swollen until in line contact with adjacent rods and wall.
3. All rods in contact with a 0.010-inch clearance between the outer rods and the process tube wall.
4. All rods in contact with the center rod removed.

II. Nineteen-rod Bundle

1. Equal 0.040-inch spacing between adjacent rods and process tube.
2. All rods in contact with a 0.010-inch clearance between the outer rods and the process tube wall.

In general it was found that although temperatures within the rods themselves would not be high, there could be considerable variation in the coolant temperatures such that local boiling and bulk boiling around the center rod could occur. It appeared that mixing promoters would be highly desirable in such fuel elements.

The experimental results run on a seven-rod cluster in a 42-inch test section also indicated that high temperatures could be expected around the center rod unless mixing was promoted. The heat transfer characteristics of the test section in these experiments were different than expected and are not yet totally explained. It was found that as the coolant flow was decreased at constant heat generation rates the difference in temperature between the surface of the rods and the coolant temperature also decreased. At a certain value of flow further decreases in flow caused an increase in this temperature difference, but after

still further decrease in flow the temperature difference once again decreased. Generally, maldistribution of flow within the bundle is presumed along with entrance effects and flow disturbances from the support pieces and rod separators.

Construction was started of several different designs of rod bundle test sections after the test section used in the experiments described above failed by electrical short circuiting.

Miscellaneous. A heat exchanger was designed to obtain the fouling characteristics of raw Columbia River water on carbon steel at water temperatures to 225 F with the temperature of the primary fluid as high as 580 F. The experiments dealing with this study will be administered by the Coolant Systems Development Operation. Design calculations were made for a four-section heat exchanger to be used in conjunction with a 300 KW Dowtherm boiler unit. It was recommended that the Wilson technique (Heat Transmission, McAdams, pp. 334) to be used to evaluate the degree of fouling.

More detailed information concerning the heat generating equipment included in CG-661 (Additional Heat Generation - 189-D) was obtained in a visit with the manufacturer at Schenectady. Calculations indicate that the equipment will be capable of the following capacities:

Steady state	- 2700 KW
One-half hour	- 3840 KW
One minute	- 4600 KW.

Calculations were performed to predict the characteristics of the KER Loops should the pumps be placed in series rather than the present parallel situation. Such a series arrangement would almost double the available pressure drop in the loops. Preliminary calculations indicate that operation with the pumps in series is entirely feasible and that failure of one of the pumps would not result in serious adverse conditions. For example, at a system pressure of 2000 psia, boiling would not be encountered in the loop upon loss of one pump for tube powers as high as 1200 KW, and an initial outlet temperature of 275 C.

Mechanical Equipment Development

Organic Cooling System Components. The organic facility (MOTS-1) operated

Shielding Studies

Neutron Spectrometer. A programmer and a remote operating position have been provided for the 100-channel analyzer. The equipment has been installed and is operating and is ready for extended tests and calibration of the associated spectrometer equipment.

Miniature Ionization Chamber. The small ion chamber for the C facility was recalibrated. A range of dose rates from 50 r/hour to 1.5×10^6 r/hour has been obtained from three different facilities. The calibration constant, expressed as response in micro-micro-amperes per r/hour, is essentially the same over these ranges.

The unit failed, however, after a few hours of complete immersion in the KE basin while monitoring a Co^{60} source. A waterproof coating was being evaluated. The cable and probe have been recovered and are being examined.

Ordinary Concrete (heated to 100 C). One ordinary concrete experiment was run last month, and the foils are being counted. The gamma dose rate through 47.5 inches of ordinary concrete is 6.8×10^{-1} r/hr/1000 MW. If the dose rate at the bottom of the well is known from previous experiments, the gamma relaxation length is estimated to be 13 cm.

Ferrophosphorus Concrete (as-cured condition). The second ferrophosphorus concrete experiment was run last month, and the foils are being counted. The counting data from experiment number one were sent to IBM, and the relaxation length has been determined to be 7.3 cm.

NPR Physics Calculations. NPR reflector optimization was completed, both radial and axial, and issued as HW-55658, "NPR Reflector Thicknesses". Flattening was not included since an attempted IBM solution of the flattened case failed. Although the flattening does not affect the optimization (which is primarily dependent upon effects in the fringe region, reflector and thermal shield), the theoretical prediction of relative power is unavailable. It has been found that the power distribution depends too much on other factors in addition to the thermal neutron distribution. Thus, even a good flux traverse would not necessarily yield a good power distribution. The problem appears to be a much larger job than expected and involves such things as initial loading, possible use of depleted uranium, Pu production by epithermal neutrons, and long term reactivity changes. A solution to the problem of optimizing the reactor power distribution will not be attempted as part of the present study.

A modification of the two-group treatment was made to provide accurate values of the thermal neutron flux at the reflector thermal shield interface. This involved correcting the extrapolation distance to properly account for the presence of a thermal shield. Then, the neutron current was derived from the flux using diffusion theory (and checked by IPD Process Design using blackness theory) and the heat input to the thermal shield was computed. A comparison was made for K Reactor to afford a rough check on the method. The predictions for

the nuclear heat load on the thermal shields are: 1000 Btu/ft2-hr for K; 400 Btu/ft^2-hr for NPR radially assuming a borated concrete thermal shield; and 750 Btu/ft^2-hr for NPR axially assuming an iron block thermal shield. The value for K is low compared to the present best estimate based on operating measurements, so it is probable that a significant radiant heat load exists. Personnel in IPD Process Design are working out upper and lower limits to the radiant heat load on the K thermal shield to firm up the validity of the theoretical nuclear heat load and the measurements of the total heat load. If NPR uses an iron radial thermal shield, the calculated nuclear heat load is 1200 Btu/ft^2-hr, about the same as K Reactor. This is reasonable since the specific power of NPR is higher, but the reflector is thicker, reducing the leakage from the reflector. These two factors apparently compensate to produce comparable heat loads.

B. WEAPONS - 3000 PROGRAM

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

C. CUSTOMER WORK

Corrosion Studies

Decontaminating Solution. Because of the proposed use of Turco 4306-B, a proprietary cleaner, to clean the K Reactor of radioactive contamination, corrosion tests were conducted in the laboratory on the various materials of construction with which the cleaner will come in contact. Static experiments at 46 C for a five-minute period in 3 oz/gal solutions of Turco 4306-B yielded the following corrosion data:

	mg/cm^2	Aver. Mils Penetration, Calcd. From Weight Loss
304 Stainless Steel	0.008	0.0004
Copper	0.01	0.0004
S.A.E. 1020 steel	0.03	0.001
1245 Aluminum Alloy	0.4	0.06
X-8001 Aluminum Alloy	0.4	0.06
6061 Aluminum Alloy	0.6	0.09
7072 Aluminum Alloy	0.7	0.1

The uniform corrosion in five minutes on all of the materials was small. However, at higher temperature (100 C) the stainless steel showed pitting after several hours. The vapors above the solution were also found to be corrosive to stainless steel, mild steel and copper. One sample of 304 stainless steel hung over the solution at 50 C for 20 days showed some deep pits as well as rusting. Preliminary experiments with galvanically coupled pieces showed increased rates. The galvanic effects and the corrosion rate of samples after treatment in Turco 4306-B are being

investigated. Although no stress corrosion has been attributed to this cleaner to date, more stringent stress-corrosion tests are now in progress.

Radiometallurgical Examinations

Production Tests IP-44-A and IP-81-A. Post-irradiation ultrasonic bond testing in the 105-C Basin Examination Facility indicated unbonded areas in several slugs from Production Tests IP-44-A and IP-81-A. Two of these slugs - 229 A and B - were selected for radiometallurgical examination to determine whether the areas detected by the bond tests were actually unbonded.

Transverse sections through the suspected unbonded areas of each slug were cut for metallographic examination. Unbonded areas were found in the locations detected by the bond tester in both slugs. Actually, two unbonded areas were found in the vacuum canned I & E slug (229-A); one between the uranium and external jacket had a maximum separation of four mils which covered about 60 degrees, and one between the internal jacket and uranium which covered about 120 degrees with a maximum separation of 11 mils. It was observed that in both unbonded areas the AlSi was quite thin, being nine mils at the external jacket and three mils at the inside jacket wall.

The AlSi canned BNTL slug (229-B) was selected because the bond tester detected an unbonded area approximately three inches long, located beneath a hot spot. The hot spot was located near the male end and opposite the tube rib marks. Metallographic examination of a transverse section taken through the hot spot revealed a maximum separation of 10 mils at the center of the hot spot area. No AlSi could be detected in this area, and some evidence of U-Al diffusion was observed. Etching of the wafer revealed a large elliptical shaped area which was heated above the beta phase transformation temperature. This area was offset toward the hot spot. A macrocrack was also observed in the center of the transformed area.

Examination of KE M-388 Rupture From IP-80-A (RM-224). HAPO failure #976, a regular M-388 jacketed, eight-inch slug, was transferred to the Radiometallurgy Laboratory on April 2 for examination to determine the cause of failure. Visual examination showed a tear-drop hot spot on the slug jacket, which was approximately five inches long and a maximum of one inch in width. A blister, located at the leading edge of the hot spot (caused by the formation of uranium corrosion product under the can) partially restricted the water flow and created the hot spot. Two pits were seen in the hot spot area and one at the tail of the hot spot. Sectioning of the slug revealed that the AlSi bond was broken under the hot spot and revealed penetration of the can at the blister and in one of the pits. Metallographic examination of the pit at the tail end of the hot spot showed no penetration but indicated that the pit was caused by pre-irradiation mechanical damage, probably a blow which dented the can.

Metallography Service

An examination of the second-stage impeller from one of the pumps installed on Project CG-558 was carried out by the Materials Testing and Metallography Laboratories to determine the cause of the fatigue-type failure encountered in service. The tensile properties and the hardness values of the specimens tested met ASTM specifications for the Grade CA-15 material, covered by ASTM-A-296-55. However, metallographic examination of the material near the origin of failure disclosed numerous pockets of slag and oxide stringers. It is concluded that these stringers acting as initiating stress risers caused the impeller to fail. A report has been issued covering the examination in detail.

A considerable amount of work was done on AlSi-uranium compound layers for the Fuels Preparation Department. The purpose of the work was to try to determine the cause for the brittle bond which sometimes occurs in the normal canning process. The Fuels Preparation Department provided samples in which variables were introduced into the duplex (or preheating) bath while the canning bath and canning conditions were maintained constant. The toughness of the bond was then determined for comparative purposes. Representative samples were submitted for metallography from each group of tests. In each case of reported greater-than-normal toughness, metallographic examination revealed the presence of a compound formation not previously recognized as being associated with a tough bond. This compound formation occurs immediately adjacent to the uranium. In each case of a reported brittle-bond, or one of very low toughness, metallographic examination revealed a thick layer of those compounds most generally associated with the AlSi-uranium interface. Further, it was observed that the compound formation associated with toughness does not replace all of those layers that are associated with a brittle bond, but only affects the layer adjacent to the uranium. The replacement of the original layer is partially completed when the two compounds occur in block fashion side by side, with a small line of the original compound continuing behind the new compound. When replacement is complete, the original compound appears to have been greatly reduced in thickness and separated from the uranium by the new compound. Apparently any process variable which will enhance the formation of the new compound will also make a tougher bond. The more desirable compound from the standpoint of bond strength can be made to form by reducing the silicon content in the duplex bath. (However, this appears to be only one of seven variables which may affect the formation of this compound.) The compound has the appearance of aluminum-uranium diffusion product, and may well be, but as yet has not been identified. It is observed to be more brittle than the AlSi braze layer, the aluminum, or the uranium; however, it does definitely appear to be less brittle than the compound layer which it displaces. This compound is identical in appearance with that formed by diffusion of aluminum through a very thin nickel barrier. Additional metallographic work is being carried out to provide a more thorough knowledge of the compound layer formations resulting from the canning operation.

Samples Processed During the Month

Total samples processed: 208

Photographs:

Micrographs	303
Macrographs	50
Total	353

The following Trips and Visits Reports apply to activities on 2000, 3000, and 4000 programs. Technical activities on the 4000 Program are reported separately in HW-55905 A2.

F. W. Albaugh

Manager, Reactor and Fuels Research
and Development Operation

FWA:FWW:kb

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
DC Kaulitz	4/1-4	Peet Mfg. Co., Los Angeles, Calif.	See pressure die casting of 2S aluminum	Mr. Peet	No
		Sciaky Bros., Los Angeles, Calif.	Witness seam-welding of aluminum cans	CA Carlson	"
HJ Pessl	4/7-8	Natl. Mach. Exchange, Chicago, Ill.	Inspect extrusion presses	--	"
	4/9	Sutton Engr. Co., Pittsburgh, Pa.	" " "	W Larson	"
	4/10-11	Tippins Mach. Co., Pittsburgh, Pa.	" " "	G Tippins	"
	4/14-15	Watson Stillman Co., Rochester, N. Y.	" " "	ST Bowden	"
EA Evans	4/9	WAPD, Pittsburgh, Pa.	Exchange of information re ceramic fuel elements	Dr. McGeary	Yes
	4/10-14	ANL, Lemont, Ill.	High Temperature Fuels Conference	JH Kittel	"
	4/14	Fellows Gear Shaper Co., Springfield, Vt.	Discuss UO_2 fabrication	F Jones	No
JE Minor	4/9	WAPD, Pittsburgh, Pa.	Exchange of information re ceramic fuel elements	Dr. McGeary	Yes
	4/10-14	ANL, Lemont, Ill.	High Temperature Fuels Conference	JH Kittel	"
WL Wyman	4/14	GE X-Ray Dept., Milwaukee, Wisc.	Discuss electron beam vacuum welding	M Zunick	No
	4/15-18	American Welding Soc., 1958 Natl. Spring Mtg., St. Louis, Mo.	Attend meeting	--	No
KR Merckx	4/16	Stanford University, Stanford, Calif.	Present talk	--	No

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
AC Cooper	4/15-17	AEC-IOO, Idaho Falls, Ida. Phillips Petroleum Co., Idaho Falls, Ida.	Discuss duties of new assignment at this site	R Neidner (GE liaison man)	Yes
HW Newkirk	4/16-17	ACS Meeting, San Francisco, Calif.	Attend symposium on nuclear technology	--	No
	4/18	Stanford Research Institute, Menlo Park, Calif.	Discuss high temp. research problems	NK Hiester	No
RG Wheeler	4/18	AIME Pacific NW Regional Conf., Spokane, Wn.	Present paper	--	No
SH Bush	4/21	Kux Press Co., Chicago, Ill.	Discuss extrusion presses	J Kux	No
	4/22-25	Mallinckrodt Chem. Wks., St. Louis, Mo.	Attend meeting of Working Comm. of Fuel Element Dev. Comm.	JA Fellows	Yes
	4/28-30	Nuclear Metals, Inc., Cambridge, Mass.	Discuss parameters of an extrusion press	P Loewenstein	Yes
	4/28	MIT, Cambridge, Mass.	Interview candidate for employment	--	No
	4/29	High Vacuum Equip. Corp., Hingham, Mass.	Discuss vacuum equipment	JB Merrill	No
	4/30	Natl. Res. Corp., Cambridge, Mass.	" " "	--	No
JM Davidson RE Nightingale FW Woodfield	4/10-11	Phillips Petroleum Co., Idaho Falls, Ida.	Discuss Hanford graphite testing programs in the MTR and ETR	RB Johns	Yes
JW Riches	4/1	Chase Brass & Copper, Waterbury, Conn.	Consultation on zirconium	DK Crampton	No
	4/2	Hunter Douglas, Riverside, Calif.	" " "	RA Quadt	"
	4/3	Harvey Aluminum, Torrance, Calif.	" " "	JR Smith	"
	4/4	Oregon Metallurgical Corp., Portland, Ore.	" " "	WA Aschoff	"

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
PJ Pankaskie	4/21-23	Tube Reducing Corp., Wallington, N. J.	Consultation on zirconium	SN Randall	No
	4/24	Superior Tube Co., Norristown, Pa.	" " "	HW Cooper	No
HP Oakes	4/1	Western Pneumatic, Seattle, Wn.	" " "	C Eckmann	No
	4/2	NTH Products, Inc.	" " "	B Salmon	"
	4/3	Harvey Aluminum,	" " "	JR Smith	"
	4/4	Oregon Metallurgical Corp., Portland, Ore.	" " "	WA Aschoff	"
	4/28	Damascus Tube Co., Greenville, Pa.	" " "	BB Burd	"
	4/29-30	Tube Reducing Corp., Wallington, N. J.	" " "	SN Randall	"
RC Aungst	4/9	Revere Copper Co., Detroit, Mich.	" " "	A Badalucco	"
	4/10	Tube Reducing Corp., Wallington, N. J.	" " "	SN Randall	"
	4/14	Allegheny Ludlum, Watervliet, N.Y.	" " "	RE Rohrabaugh	"
	4/15	Chase Brass & Copper, Waterbury, Conn.	" " "	JR Smith	"
	4/16-17	Tube Reducing Corp., Wallington, N. J.	" " "	WD Goad & SN Randall	"
LD Turner	4/17-18	AIME, Spokane, Wn.	Attend regional meeting	--	"
JA Ayres	4/23	ACS, Tacoma, Wn.	Present talk	--	"
WB Weihermiller	4/15-16	UCRL, Livermore, Calif.	Discuss merits of Sheffield-Pratt-Whitney gaging system	KF Beckman	Yes
	4/30	Phillips Petroleum Co., Idaho Falls, Ida.	Coordinate maching & inspection for MTR fuel elements	MH Bartz	"
TD Chikalla	4/25	B&T Mach. Co., Holland, Mich.	Discuss die casting	J Petter	No
		Kux Co., Chicago, Ill.	" " "	JJ Kux	"

VISITS TO OTHER INSTALLATIONS (CONT)

Name	Dates of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JH Rector	4/9-13	Monarch Machine Co., Sidney, Ohio	Inspect lathe	Mr. Brandenberg	No
		AEC Mach. Tape Control Conf., Detroit, Mich.	Attend conference	--	No
		Gorton Co., Racine, Wisc.	Special lathe	Mr. Klema	No
KG Toyoda	4/1-2	GE, Schenectady	Discuss purchase requisition on CG-661	D Misura	"
LG Merker	4/6	Northwest Copper Co., Portland, Ore.	Discuss hood fabrication	--	"
WS Kelly	4/27-29	Phillips Petroleum Co., Idaho Falls, Ida.	Inspect hot labs & fuel handling assemblies	M Fellman BC Wing R Neidner	Yes
RH Purcell JM Batch	4/28 4/29	AECL, Chalk River, Ontario Canadian GE, Peterborough, Ontario	Consultations on mech. dev. & mech. seal pumps	R Brothers HE Tilbe	Yes No

VISITS TO HANFORD WORKS

Name	Dates of Visit	Company and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
MJ Sinnott	4/8-11	U. of Michigan, Ann Arbor, Mich.	Consultant Agreement 169	FW Albaugh JJ Cadwell EA Evans SH Bush JC Tobin OJ Wick ID Thomas	Yes	300, 306, 326, 325, 328 200W, 231, 234-5
FJ Mhringer	4/28	GEL, Schenectady	Discuss thermal stress cycling tests	KG Toyoda	Yes	100-D, 189, 1707

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
HA Wilhelm P Chiotti	4/23-24	Ames Laboratory Ames, Iowa	Discuss Ames assistance to Hanford program	JJ Cadwell JE Minor JC Tobin WE Roake RS Kemper	Yes	300, 303, 325 326; 100K, 105-KE
DF Babcock JC Woodhouse H Worthington	4/28-29	duPont Company, Atomic Energy Div., Wilmington, Del.	Discuss aspects of uranium fuel element technology	FW Albaugh JJ Cadwell SH Bush	Yes	300, 303, 325, 326, 328
CD Vail	4/2-3	Minneapolis Honeywell, Richland, Wn.	Inspect & service equipment in 326 Bldg.	JM Davidson	No	300, 326
RS Miller	4/15-17	ACF Industries, Washington, DC	Discuss development program on GCTR	FW Woodfield RE Nightingale	Yes	700, 300, 328
A Beckett	4/29	Phillips Chemical, Pasadena, Calif.	Discuss nonmetallic Materials	R Harrington	No	300, 326
WJ Ramsey	4/22-24	UCRL, Livermore,	Discuss Project Whitney & attend Pu Fuels Symposium	OJ Wick FW Albaugh	Yes	300, 325 200W, 231,
AF Voight	4/22-23	Ames Laboratory Ames, Iowa	Attend Pu Fuels Symposium	FW Albaugh	Yes	300, 325
RJ Ackermann M Ader RJ Dunworth KR Ferguson FG Foote RC Goertz HH Hyman JH Kittel S Lawroski WB Lowenstein HO Monson M Novick		ANL, Lemont, Ill.				

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
JG Schnizlein AB Shuck BI Spinrad RK Steunenberg	4/22-23	ANL, Lemont, Ill.	Attend Pu Fuels Symposium	FW Albaugh	Yes	300, 325
EL Anderson WC Bartels GW Courtney RC Dalzell CD Goodman LH Roddis JM Simmons G Wensch		AEC - DRD, Washington, DC				
RB Martin		Oak Ridge Operations Office				
WD Sandburg		Savannah River Operations Office				
B Anderson		Chicago Operations Office				
JB Philipson		Idaho Operations Office				
R Balent R Berman GE Brand CC Woolsey		Atomics Internatl. Canoga Park, Calif.				
BW Dunnington		BMI, Columbus, O.				
LA Matheson ID Venable		Dow Chemical Co., Rocky Flats Plant				
LB Jones		Mound Laboratory, Miamisburg, O.				
MH Barts DR deBoisblanc		Phillips Petroleum Co., Idaho Falls, Ida.				

VISITS TO HANFORD WORKS (CONT)

Name	Dates of Visit	Company and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
RD Baker JA Leary WJ Maraman WD McNeese AN Morgan PJ Peterson FW Schonfield RS Winchester	4/22-23	LASL, Los Alamos, N. M.	Attend Pu Fuels Symposium	FW Albaugh	Yes	300, 325
ED Arnold RE Brooksbank TJ Burnett DE Ferguson JP Hammond DE Horner RE Leuze WH Lewis		ORNL, Oak Ridge, Tenn.				
EE Hayes FW Tober		duPont Company, Savannah River Lab.				

PLUTONIUM RECYCLE PROGRAM

MONTHLY REPORT - APRIL 1958

REACTOR & FUELS RESEARCH & DEVELOPMENT OPERATION

Plutonium Fuels Development

MTR Capsule Irradiations. Examination of the Al-1.65 w/o Pu and the Al-12 w/o Si -1.65 w/o Pu capsules which were irradiated to approximately 60 per cent burn-up of the Pu atoms, is in progress in the Radiometallurgy Laboratory. The alloy cores have been carefully dejacketed and sectioned, and metallographic samples are being prepared.

Al-5,10,15 and 20 w/o Pu and Al-12 w/o Si - 5,10,15 w/o Pu alloy cores have been cast, sampled and machined. The Al-12 w/o Si-20 w/o Pu alloy is being prepared. With the aid of flux depression calculations a function relating flux and specific power generation for the various capsules is being determined by Design Development. This function will allow calculation of heat transfer data needed to establish the irradiation test specifications. Samples will be irradiated in various flux regions so that core temperatures will be equal. Preparation of silicon alloys for MTR irradiations is continuing since this material can probably be adequately reprocessed by pyrometallurgical techniques, thus obviating the need for wet chemical processing.

Flux depression computations for the Zircaloy-clad, high and low density cores of the mixed crystal oxides of PuO_2 - UO_2 for MTR irradiation tests should be available in a few weeks. These results will be used by the Thermal Hydraulics Operation in calculation of the heat transfer data necessary for preparation of the test proposal and specifications.

Ex-Reactor Testing of Al-Pu Alloy Cluster Elements. The corrosion testing of a four-capsule cluster with Zircaloy-3 cladding is continuing in 316 C coolant in ELMO-7 loop. To date, the pickled capsule welds made by the electron-beam process appear better than the non-pickled welds made in the modified evacuable welding chamber by the tungsten-inert gas method.

Metallographic examination is underway on the Zircaloy-clad, four rod cluster which exhibited white corrosion product in the ELMO-7 loop. The cluster has been exposed to 240 to 316 C water for 45 days. This test will indicate the magnitude of the corrosion problem associated with this shipment of Zircaloy-3 tubing.

Cluster Engineering. A new wire wrapping fixture has been designed and is being fabricated. The new model will employ a brass tube milled with a 10-in. pitch helical slot. The fuel tube will be slipped inside this spiral-slotted tube, after which the wire will be stretched in the spiral slot to a tight fit and attached to the end cap by welding. Then the fuel rod will be screwed out of the sleeve leaving a spiralled wire on the rod with a constant 10" pitch.

Pyrometallurgical Techniques. Silicon additions to aluminum-plutonium alloys have fabrication advantages over pure Al-Pu alloy. In addition, work with stand-in

Al-U alloys indicates that the presence of silicon imparts superior corrosion resistance which is useful in the event of a jacket rupture. Advantages are also realized with this material in pyrometallurgical reprocessing methods. Plutonium can be recovered from scrap material containing silicon by extraction processes using molten metals as the extractant, or by chemical conversion to plutonium oxide.

Basic to the development of these techniques is an understanding of the ternary system aluminum-silicon plutonium. Initial studies have been made using thermal analysis to determine various phase regions. For Al-Si eutectic compositions (88.4 w/o Al-11.6 w/o Si), additions of Pu from 3.8 w/o to 11.5 w/o caused an intermetallic compound to begin crystallizing at 590 C. With silicon additions a ternary eutectic with a freezing point of 575 C occurred at 80.6 w/o Al; 12.6 w/o Si, and 6.8 w/o Pu. With Al additions the crystallizing temperature increased, beginning at 605 C in an 82.6 w/o Al; 8.2 w/o Si; 9.2 w/o Pu alloy. Information regarding the Al-Si-Pu ternary is valuable in determining liquating conditions for the concentration of Pu in Al-Si-Pu alloys.

Plutonium Oxide Fuel Materials. Initial ceramic fabrication experience is being obtained employing activated MCW grade UO_2. The effects of basic fabrication variables on density will be determined, including the effect of pressure and l/d ratio on green density; and the effects of time, temperature and degree of vacuum on sintered density. The extent of axial, diametral and volume shrinkage during sintering will also be determined. Sintering in a hydrogen atmosphere will begin as soon as the furnace becomes operable. High density pellets of mixed crystal oxides of plutonium and uranium will be compacted in the near future.

Pu-Al_2 Core Material. The intermetallic compound $PuAl_2$ has potentialities as a fuel material. The compound has a melting point of 1250 C and probably a higher thermal conductivity than PuO_2. Fabrication of $PuAl_2$ - UAl_2 core material by compaction and sintering should be possible. A quantity of metallic plutonium (250 grams) was added to 500 grams of molten aluminum at 850 C. An exothermic reaction resulted which raised the melt temperature above 1000 C. The melt was liquated at 875 C and the composition of the high melting residue is being determined chemically and by X-ray diffraction.

Injection Casting Development. A method for the attachment of Zircaloy thin wall tubing to the injection casting apparatus has been developed. The Zircaloy tubes are flared by a spinning operation and attached by means of a modified flared tube fitting. Prototype equipment for aluminum-plutonium castings has been designed. Fabrication and installation is scheduled for completion this fiscal year.

A mechanical injection casting of aluminum at 1800 psi in 0.5 inch diameter, 7'4" long stainless steel tubing resulted in a density 97% of theoretical. Radiographs still show small blowholes at the upper end and traces of central solidification shrinkage. The advantages of using injection pressures up to 20,000 psi will be evaluated by use of a commercial die casting machine. The Kux Machine Company of Chicago and the B & T Machinery Company of Holland, Michigan, have made preliminary designs of a die block and have submitted rough

estimates of the cost of die fabrication and process evaluation. A contract for this work will be awarded next month for completion during June.

Facilities. Fabrication of a portable vacuum welding chamber, designed for end closures of 0.505 diameter Zircaloy tubing, has been completed. A sixteen foot decontamination hood has been obtained from the 234-5 Building and is being installed for fuel element assembly and decontamination.

Design has been completed on the fuel element canning glove box, rolling mill vacuum glove box, extrusion press glove box, and cryolyte reduction process glove box. The 50 KW motor generator for the cryolite furnace has been moved to 231-Z Building from the 314 Building.

U-Pu Test Pieces for PCTR. The simulated 2000 MWD monitoring slug has been irradiated, disassembled and the pins counted, re-assembled, recanned and returned to the physics group. Casting has begun on the forty 4000 MWD slugs. A new mold design is being fabricated that should decrease the number of misruns due to poor metal distribution into the molds.

UO_2 Fuel Development

Swaged UO_2 Fuel Elements for KER Irradiation. Six four-rod cluster fuel elements were fabricated and delivered to the KER for irradiation at high temperature (270 C) and high pressure (1150 psig) in KER Loop No. 1. Each cluster consists of four 18" long by 0.626" O.D. rods of UO_2 swaged in 0.036" wall thickness stainless steel cladding. The end fittings were provided by the Fuel Element Design Operation. The high density UO_2 powders (packing density 6-7 g/cc) were prepared as described below. The UO_2 contained 1.6 w/o U-235. Densities obtained, by cold swaging, were 83, 86, and 89 per cent of the theoretical. The completed fuel elements were autoclaved at 1200 psi, 350 C, and helium leak tested.

The enriched high-density uranium dioxide powder for swaged fuel elements was prepared from reject uranium metal washers containing 1.6 per cent U-235. Twenty-five pounds of the uranium was reacted with 170 C water by the Corrosion and Coatings Operation. The product was a low bulk density UO_2 powder having a high specific surface area. It was loose-sintered at 1700 C before swaging. This material is referred to as steam-oxidized UO_2, although it is probable that a water phase was in contact with the uranium at the pressure used (100 psi).

Fifty pounds of the enriched uranium metal was converted to uranium dioxide by a chemical process. The metal was dissolved in nitric acid by the Chemical Development Operation. Uranium was precipitated from the resulting solution as uranyl peroxide, which was filtered and dried to a UO_3 hydrate containing 74 per cent uranium. The UO_3 was reduced in hydrogen at 1700 C, resulting in a very dense UO_2 powder referred to as peroxide-UO_2. This material packs to a density of 6.5 g/cc.

Fabrication of KER Fuel Element Cores. Uranium dioxide tubular, or I & E, fuel cores for irradiation in KER-3 loop were fabricated from 1.15 per cent enriched UO_2 by isostatic pressing solid cores, boring out the central holes, sintering to 94 per cent of theoretical density in hydrogen, and grinding to final dimensions. Material was fabricated for four 8-inch fuel elements. The enriched

uranium was obtained in the form of UO_3 containing 1.978 per cent U-235. The UO_3 was reduced with hydrogen to UO_2, ball-milled 48 hours, and blended in a twin-shell intensifier blender with sufficient ball-milled natural UO_2 to provide a final U-235 content of 1.15 per cent.

Fuel Closure Development. Current design of the PRTR Nested Tubular Fuel Element specifies a double-weld closure for each component. Each tubular component consists of two concentric Zircaloy cladding tubes containing UO_2 in the annulus. A Zircaloy hemitoroidal cup will be inserted into each end and the initial closure made by a seam weld at each joint between tube and cup. Sciaky Bros., Inc., are developing the welding technique under terms of a contract with GE. Two samples of their Zircaloy welds have been received for examination. The welds were made without benefit of inert atmosphere and a very light straw color exists at the weld area. Exposure of one as-received specimen and one HNO_3-H_2F_2 pickled specimen, (both samples vapor degreased and water washed) showed no corrosion of the weld area during three days exposure to 750 F saturated steam. Corrosion tests are continuing. Transverse and longitudinal sections of the weld area reveal complete penetration and uniform cast microstructure throughout the nugget area. Certain manipulations of the Sciaky welder will permit forging of each overlapping weld nugget after solidification.

Fuel Element End Fittings. Oregon Metallurgical Corporation, which contracted to make the three sizes of seam-weld cups for the Mark IIB fuel element, has demonstrated some success in this work. The problems of producing the small, deep drawn cup, for closure of the central fuel element rod, have been solved and the cup is being produced. Tooling and drawing techniques for producing the smallest hemitoroidal cup have been developed, and some acceptable pieces have been fabricated. The same techniques will be applied to the production of the larger cup, which is expected to be easier to fabricate.

UO_2 Sintering Studies. Sintering temperatures required to achieve high-density UO_2 fuel elements are markedly decreased by small additions of TiO_2 and Nb_2O_5. The following table illustrates the density improvement achieved by using these additives with PWR-type UO_2. The data indicate that lower UO_2 sintering costs may be possible by the use of such additives.

Powder	Additive	Sintering Temperature	Sintered Density % of Theoretical
Untreated UO_2	None	1600 C	73
Untreated UO_2	0.1 w/o TiO_2	1500 C	90
UO_2 Activated by Ball Milling	None	1600 C	91
Same	0.4 w/o Nb_2O_5	1400 C	90

There has been some evidence that during the sintering of UO_2 containing as little as 0.75 w/o TiO_2, slight swelling or "bloating" of the material would occur. To investigate this effect, UO_2 samples containing 0.1 w/o TiO_2, 0.1 w/o Nb_2O_5, or

0.4 w/o Nb_2O_5, and which had been sintered for four hours at 1500 C, were resintered for twenty hours at 1750 C. This additional, high temperature sintering operation did not cause "bloating" of any of the samples.

Ex-Reactor Tests. Flow studies on the mock-up Mark IIA nested tubular fuel element are being continued in the high temperature, high pressure loop. A stress rupture test on the Zircaloy weld section of a nested tubular fuel element pinned to the stainless steel hanger section by four 3/16" diameter stainless steel pins is being conducted at a temperature of 600 F. At this time, a load of 700 pounds has been applied to the test section without significant change in length or distortion of the pins. This is a load approximately five and one-half times greater than any anticipated in service. The test will continue until rupture or extreme distortion of the test section occurs.

Coolant System Studies

pH Control for "Crud" Reduction in PRTR. Adjustment of the PRTR primary coolant system pH to the range 9.0 to 11.0 was recommended to reduce amounts of "crud" deposited on reactor flow surfaces. On the other hand, the moderator pH should be maintained in the neutral range to prevent excessive corrosion of the aluminum moderator system. Savings in maintenance costs resulting directly from reduction in radiation levels in the system fully justify the slight additional expense required to provide high pH demineralized water in the primary coolant system.

Secondary Coolant Treatment During PRTR Outages. Thorough deoxygenation of PRTR secondary coolant by addition of excess sodium sulfite well before reactor start-up was recommended. Complete oxygen removal during PRTR outages is not necessary, but the presence of oxygen for even short periods of high temperature operation could initiate stress-corrosion cracking of stainless steel if chloride is also present. Addition of excess sodium sulfite for about one hour prior to reactor startup, and continued addition until after reactor shutdown, will reduce oxygen concentrations to safe levels for prevention of stress corrosion.

The Zircaloy-3 clad mockup of the four-rod cluster type PRTR fuel element proposed for KER irradiation has been removed from the ELMO-7 test loop after four months' operation at temperatures up to 316 C. Three-fourths of the welds showed indication of corrosion, exhibiting white ZrO_2. Three of the four rods also had a fairly heavy build-up of the white oxide over 180° sectors of the rods. The fourth rod corroded in irregular areas. Microsections are being made at various points to show the full extent of the corrosion.

The short four-rod cluster PRTR weld test section is still charged with two unpickled Zircaloy-3 rods which exhibit white oxide corrosion product buildup, while the two pickled rods still show no evidence of gross corrosion after two and one-half months' operation between 304 and 316 C. The electron-beam end cap welds are not corroding in either the pickled or unpickled conditions while the heliarc end cap weld is corroding on the unpickled rod only.

Zircaloy Tubing

Zircaloy-2 PRTR Jacket Tubing. Two each of the 1.818" I.D. (#3) and 2.968" I.D. (#5) ribbed tubes for jacketing the Mark IIB nested tubular fuel element were extruded for Nuclear Metals at the Detroit plant of Revere Copper and Brass Company April 9. Because of difficulties with press equipment, only one of the #3's and 1/2 length of one of the #5's were good. These, upon stripping the steel from a short length of each, proved to be dimensionally accurate and the ribs well bonded. The steel will be left on the outside of the main lengths of tubing until after the I.D. has been ball sized and the O.D. of the ribs centerless ground. Four more of each size will be extruded in mid-May after Revere has corrected their press problems.

Initial scoping sketches have been prepared by New Rochelle Tool Company for the "Thermatool" machine to weld ribs to jacket tubing for the Mark IIA nested tubular fuel element. Fabrication has begun on several of the heavier basic parts. Short samples of tubing and strip have been prepared for shipment to New Rochelle for use in designing and adjusting the welding head geometry.

PRTR Process Tubes. Allegheny Ludlum Steel Company is attempting to produce this tube by extrusion followed by several passes through a tube reducer. An initial, three tube pilot order, in which the tubes were tapered without an internal mandrel, was unsuccessful. Two of the tubes broke up during tapering and the third has a bad hook in the end and a questionable internal surface. Extrusions have been made and are being conditioned on a subsequent five tube order, and will receive their initial tapering pass at Tube Reducing Corporation the week of April 28. New tooling has been designed which will provide a supporting mandrel in each of several passes. The tubes will be annealed between passes. The anneal is expected to alleviate the cracking and the mandrel to provide a better inside surface.

Chase Brass and Copper Company has a program for producing the PRTR process tube by extrusion, with the taper to be applied by swaging. The Fenn Manufacturing Company is doing the swaging, and is attempting to sink the material in three steps with no internal mandrel and no intermediate anneals. Results have been disappointing, with wrinkling and slivering of the internal surface and cracking of the walls on the second pass. Annealing between all passes may be the only means of producing an acceptable taper by swaging, and even then the absence of a mandrel will probably cause a questionable inside surface.

Corrosion Studies

Effect of Surface on Aluminum Corrosion. The sometimes anomalous effect of surface treatment on the corrosion of aluminum alloys is not well understood, and several scouting-type studies of surface effects have been conducted by Hanford Laboratories and Fuels Preparation personnel. For example, acid polishing of X-8001 aluminum alloy was more effective in increasing the corrosion resistance of the material in 500 C steam than either mechanical removal of the surface (by milling) or than etching with 50% NaOH.

Another test was conducted by FPD personnel using Hunter Douglas A-1 alloy (same composition as 198X: 1% Ni, 0.1% Ti). Substantial improvement in corrosion resistance was effected by gently melting the surface of the metal with heliarc welding equipment.

Aluminum Alloy Comparisons. Samples of aluminum powder metallurgy alloys M-82 and M-54 provided by the Atomic Power Equipment Department have been screened in refreshed autoclave tests in water at 300 C to 360 C. This cermet material has the primary advantage over the wrought aluminum alloys (such as 2S, X-8001, 198X) of providing greater strength at the high temperatures (300 C) of interest in future reactor applications. At the high temperatures used for the above screening tests the cermets did not stand up corrosion-wise quite as well as X-8001. However, testing will continue at lower temperatures, which are still of interest, and on new types of cermet alloys as they become available.

PRP Fuel Element Test Autoclave. A new autoclave is now available for autoclaving uranium-bearing fuel elements up to 12 feet long at temperatures up to 350 C. The unit has already been operated at 300 C and 2000 psi. Operating cycles are expected to require about four hours to heat to temperature and approximately 24 hours to cool without employing special procedures.

Thermal Hydraulics

PRTR Hazard Calculations. Analyses of events were started for several cases following loss of water from the PRTR:

1. Ruptured bottom tube jumper
2. Ruptured top tube jumper
3. Ruptured top 14 inch header
4. Ruptured bottom 14 inch header

As the first step in the analyses, calculations were performed to determine the rate of water loss as a function of time.

PRTR Instrumentation. Studies were completed for PRTR instrumentation to (1) detect heavy water loss to the ventilating system and (2) control light and heavy water purities.

The moisture detection system suggested is based on recirculating the ventilating air leaving the high leak potential areas (these being the top access, bottom access, and instrument cells) and removing the moisture by chilling. The system suggested is to detect total moisture in excess of the chiller capacity, which is 5 gph.

Instruments were suggested for control of light water purity by determination of pH, electrical conductivity, total water hardness, dissolved oxygen, and silica.

The heavy water purity control consists of pD and conductivity measurements by in-line primary pickup elements and isotopic determination of water samples to determine the D_2O-H_2O purity. While the required frequency of analysis of heavy water-light water purity is low, the cost of equipment for determining such is high. Therefore, it was suggested that this control analysis be made by existing HAPO laboratories using existing spectrometric equipment.

Full Scale Electrical Heated Mockup of Mark II Fuel Element. Design of a process tube to be installed in the vertical test section of the high pressure heat transfer apparatus was completed and fabrication was started.

Design of the electrical heated mockup of the Mark IIA fuel element was completed. Fabrication of this highly complex text section is expected to be complete by June 15.

Design of test sections to determine subcooled boiling burnout data for annular flow at PRTR conditions was completed. Two types of test sections were designed; one type being for a single heated surface with annular flow, and the other for two heated surfaces with an annular flow space between the two surfaces.

Mechanical Equipment Development

Design Test PR-25 - Shroud Tube Collapsing Pressures and Installation. The shroud tube collapse tests were completed and a report is being prepared. The first experimental tests of shroud tube attachment methods were completed. The aluminum tube sheet after the welding tests had warped upward 0.140 inch. Additional tests are being carried out.

Design Test PR-50 - Reactor Piping Seal Testing. The two inch flares on the process tube inlet fitting assembly were thermally cycled 430 times between 300 F and 525 F on ELMO-7. The "screw type" inlet fitting developed a leak after approximately 70 cycles, but the "split ring type" inlet fitting did not develop a leak until approximately 200 cycles had been run. The total leak rate for the two seals was approximately 300 ml per day. The assembly was removed from ELMO-7 and reworked. It will be reinstalled upon the completion of the fabrication of leakage collectors.

The new design of the process tube inlet fitting, employing a bolted flange and an "O" ring, was hydrostatically tested. Good results were obtained with both self-energized and solid"O" rings. The fitting assembly will be thermally cycled as soon as it has been modified to fit on the Mechanical Equipment Development Operation static test facility.

The new design of the inlet gas seal is now being fabricated. This fitting will be statically tested both thermally hot and cold.

The "process tube to nozzle" test assembly has been thermally cycled a total of 609 times on the Mechanical Equipment Development Operation static test facility. No leakage developed in either the delta ring or the flexitallic gasket during the test. Torque requirements for this connection ranged from 800 to 1000 ft.-lbs.

Nozzle cap assembly "A", employing two flexitallic gaskets, has been thermally cycled 839 times on ELMO-7. The leaking gasket on the end originally designed for an "O" ring was replaced after approximately 500 cycles. An examination of the housing during the replacement revealed that the leak had caused no damage. No leakage was evident during the remaining cycles. Nozzle cap assembly "B", utilizing a "Bridgman" seal and a "dome" seal, has been thermally cycled a total of 581 times on the Mechanical Equipment Development Operation static test facility. The leaks which developed during hydrostatic testing after disassembly and reassembly without cleaning stopped after two additional cycles on the tester.

The "outlet gas seal packing" test assembly was modified to permit a better expansion of the packing against the sides of the assembly. A combination of John Crane Superseal No. 4 and No. 177 packings was tested during the month. A gas leak rate of 0.066 cu. ft./hr. at a pressure of 1.3 psig was measured.

Fabrication of process tube assembly "A" is nearing completion. The order was placed with the Marmon Company for the fabrication of the "Conoseal" joints for process tube assembly "B".

Design Test PR-51 - Reactor Piping Structural Integrity. Testing of a simulated inlet jumper was begun during the month. Preliminary data from the strain gauges indicate that the maximum stress is approximately 17,400 psi. This jumper has undergone 10,000 flexing cycles of 1-inch vertical travel and 1/2 inch horizontal travel while at a pressure of 1500 psi. Design and construction of the lower face mock-up, less inlet connections and jumpers, were completed. Design of the upper face mock-up less piping and nozzles was also completed.

Design Test PR-63 - Process Channel Leak Detection Facility. Construction of the major portion of the leak detection facility was completed. Initial helium flow and heat-up tests were started.

Other Activities. Construction of the single tube prototype facility was approximately 59% completed from a financial standpoint. The estimated delivery dates by the vendor for the pumps are August 31 for the Phase I pump and January 31 for the Phase II pump.

The PRTR inlet piping valves arrived during the month. A Hammel-Dahl valve and a Powell valve were delivered to Coolant Systems Development Operation for tests to determine the pressure drop through the valves and the valve leakage rates.

The construction of the tube rupture facility was started and is now approximately 50% complete. Preliminary rupture tests will begin during the latter part of May.

PRTR Design Development

General. Temporary construction was 75% completed; Phase I construction started on April 29. Most of the drawings for the Phase II bid package were approved; Phase III design was 55% completed.

River Structure. The river discharge structure scope is being revised to use a river bank condensing facility with a submerged discharge line into the river, in order to eliminate the trestle extending into the river.

Shielding. Comments have been returned on the top and bottom primary shields, the side shield, and the top secondary shield. Comments have also been transmitted on the top and bottom primary shield specifications.

Fueling Vehicle. General Mills has begun design of the fueling vehicle. Work during April has concentrated on the bridge, carriage, and drive system.

Primary Loop Leakage. A report of the D_2O leakage study was issued, HW-55738, "PRTR Primary Coolant Leak Study", D. J. Foley and J. C. Fox. This study concludes that equipment for recovery of D_2O from the air must be furnished, and describes a recommended system.

Process Tube Assembly. A review of shield and calandria tolerances, together with process tube tolerances, revealed that it will be necessary to position

tubes selectively in each channel of the reactor. Alignment procedures and tools are being worked out. The positioning of process tube flanges will be done by the shield fabricator at the time the calandria and shields are aligned in the fabrication shop.

Fuel Element Load-Out and Shipping. Scoping of the fuel element load-out facility and shipping equipment was started.

Coolant Systems. An investigation of flow pressure losses through the primary cleanup and gamma monitoring system has shown that it will be necessary to provide a by-pass to permit deionization of primary coolant at required rates during the depressurized, shutdown condition.

A light water injection system was scoped to provide a means for preventing the melting of fuel elements and calandria components in the event of a rupture of primary coolant piping. The injection system provides for segregation of light and heavy water valve leakage, and for remote control of injection water flow rate and flow direction. The latter feature will ensure optimum utilization of injection water and minimize flooding of the containment vessel. Injection water will normally be available at 450 psig except during a total electrical power outage, in which case the emergency well pump will supply water at 100 psig and 750 gpm.

At the request of bidders, the bid closing date on the PRTR main heat exchanger was extended to May 15.

An investigation of operating conditions in the main heat exchanger after 30 minutes following reactor shutdown has indicated that tubeside (heavy water) temperatures below 90 F are feasible with natural convection heat transfer to shellside cooling water. After cool-down, the use of untreated process water should present no scaling or corrosion problems, and will permit economies to be realized in both water treatment and pumping power requirements.

Fuel Element Examination Cell. Scoping has proceeded to firm up criteria and a schedule for the PRTR fuel examination cell. Preliminary calculations have indicated that it will be necessary to channel cooling air through the elements, rather than to rely on general flow through the pit, to control gamma heating of the elements. Further study will be required to determine the type and amount of cooling.

Instrumentation and Control. The bid package for the reactor power level automatic controller has been transmitted to the AEC. The controller, together with the chilled neutron flux monitoring instrumentation, will be procured on a combined design and procurement contract.

Dump tests employing the PRTR calandria mock-up in 185-D Building show a rate of moderator dumping which is initially faster, but on the average slower than predicted by calculation. High speed motion pictures taken during dumping indicate that the slow response is due mainly to choking of the bottom gas lines by water, and probably to a lesser extent by air entrainment in the water. Means of eliminating the choking effect and of speeding up the dump rate are under study, and may result in some modification of the dump chamber design. The observed

dump rates, while on the average slower than predicted, are not slow enough to compromise reactor safety.

The calculations of tritium buildup in the heavy water are being revised, on the basis of more definitive calculations of expected flux levels which have since become available. Expected tritium concentrations on the basis of the new calculations are about one-fourth those previously reported.

Analog Studies. New studies were made of reactor operating incidents for the revised PRTR safeguards analysis. These studies included subjecting the simulated reactor to the reactivity transients which have been associated with the worst credible and worst probable incidents, and lesser degrees of these. Results obtained reflected changes in the system and the temperature effect which have been made since the previous work done in December.

Thermal Neutron Flux. Calculation of average and maximum thermal neutron flux values in the PRTR was carried out for both the 2200 M/sec and Maxwellian average velocity conventions. These are denoted by $\hat{\varphi}$ and $\bar{\varphi}$ respectively. Tabulation of values based on 70 MW nominal power obtained are as follows:

	$\bar{\varphi}$ (n/cm^2/sec)	$\hat{\varphi}$ (n/cm^2/sec)
Core-average flux in Moderator	8.66×10^{13}	6.99×10^{13}
Core-average flux in Fuel	5.22×10^{13}	4.21×10^{13}
Max. flux in moderator, H_2O reflector, flattened dist.	1.49×10^{14}	1.20×10^{14}
Max. flux in fuel, H_2O reflector, flattened dist.	8.41×10^{13}	7.20×10^{13}
Max. flux in moderator, D_2O reflector	1.55×10^{14}	1.25×10^{14}
Max. flux in fuel, D_2O reflector	9.35×10^{13}	7.55×10^{13}

The above values are subject to some variation with exposure and loading patterns.

Xenon and Samarium Poisoning. More detailed calculations of Xe^{135} and Sm^{149} poisoning substantiate previous estimates of these quantities. Differences in fission yields between U-235 and Pu-239 fissions were taken into account for I^{135} and Xe^{135}. Total I and Xe yields were taken as 6.1% for U-235 fission and 4.5% for Pu-239 fission. The Sm^{149} precursor, Pm^{149}, was assumed to have the same yield in both cases, this being 1.3%.

Equilibrium poisoning is tabulated as follows:

	$P = \Delta \frac{1}{f}$ Xe^{135}	$P = \Delta \frac{1}{f}$ Sm^{149}	Total $\frac{\Delta k}{k}$
H_2O Reflector			
flat zone (UO_2)	0.030	0.007	0.034
buckled zone (Pu-Al)	0.024	0.008	0.029
D_2O Reflector (85% UO_2, 15% Pu-Al)	0.029	0.007	0.033

A 60 mk excess reactivity allowance is sufficient to allow a poison override time of about two hours after shutdown. Peak poisoning occurs at 10 hours after shutdown and startup is again allowed after about 24 hours. These times may be altered by additional temporary enrichment if desired.

Gamma-Induced Neutron Production in PRTR D_2O After Shutdown. The neutron flux due to γ, n reactions in D_2O ten days after shutdown has been calculated, based on an operational power level of 70 MW. The origin of these reactions is the decay of La^{140} with a 2.5 mev γ. All other isotopes produced in fission in significant amounts either decay with a γ energy below the 2.2 mev threshold for the γ, n reaction in D_2O, or have a half-life much shorter than the La^{140} precursor Ba^{140} which has a half life of 12.8 days. The γ-induced thermal neutron flux 10 days after shutdown was found to be $1.42 \times 10^7 n/cm^2/sec$.

Shielding Studies

Design testing for the flow transducers was begun. A small but serious oil leak developed in one unit. Further testing of this prototype will be suspended until the vendor corrects the problem. The single remaining prototype has had one component failure. The problem was noted and corrected, and testing is proceeding.

Plutonium Fabrication Pilot Plant

Phase I Construction. The construction contractor completed the work scheduled for 60 days on the date scheduled. Work on the underground water lines has been completed. The lines have been chlorinated, and tests for sanitation have been passed. Work on the underground steam and condensate lines is progressing at a satisfactory rate.

Construction work on the Phase I contract is about 70% complete.

The construction site was cleared for the AEC-167 Phase I construction contractor about a week ahead of schedule.

Phase II Design. The design of the building and utilities will be complete as scheduled by May 2, 1958, and a bid package will be submitted to the Commission on or before May 8.

A test was made of the Pyr-a-larm fire detector, to determine whether it would be satisfactory for use in the exhaust ventilation ducts. It was found that the

device could not detect products of combustion after the combustion gases were passed through a CWS filter. Thus the device will not serve in the proposed application.

Phase III Design. Scope interpretations for the radiographic equipment, the degreaser-decontamination system and hood, and the oxide lines are behind schedule because of the emphasis on Phase II design. Work is now actively in progress, and issuance of the latter two is expected early in May.

Phase III Procurement. Procurement of Group 1 and Group 3 equipment is in progress. An order has been placed for the swager. The plants of representative hood fabricators were visited. They expressed favorable opinions on the standard detail design method and suggested changes in the specifications for reduced cost.

Hazards Analysis. A general hazards analysis for the building has been prepared. Specific analysis was also made of the hazards associated with a complete power outage (main power and emergency power). The probability of such an outage is deemed low enough, and the costs of decontamination, etc., after such an incident so variable, that no monetary value can be put on a third power supply. A third power supply is no longer under active consideration.

PHYSICS AND INSTRUMENT RESEARCH AND DEVELOPMENT OPERATION

MONTHLY REPORT

APRIL 1958

FISSIONABLE MATERIALS - 2000 PROGRAM

METALLURGY

Nuclear Safety Consultations

Fuel Preparations Department

A. A study of the nuclear safety of a proposed pallet for handling of 0.96 percent U-235 enriched fuel elements was made. These pallets are larger than those now being used. Criteria for the safe handling of fuel elements in arrays of these boxes were presented to FPD.

B. Nuclear safety in the processing of 1.6 percent fuel elements together with natural uranium in the pickling tank was reviewed. A process work permit was approved to carry out this operation.

C. A preliminary study has been made of the reactivity of water-flooded arrays of 0.95 percent enriched U-235 fuel elements encased in iron tubing. The fuel elements considered were solid rods of 1.34 inches O.D. and I. and E. fuel elements of 1.37 inches O.D. by 0.48 inch I.D. The calculations indicate that a minimum iron tube thickness of about 0.07 inch is required to insure a subcritical system.

   Special iron tubing has been received and the buckling will be measured for several different lattices with 1.34-inch diameter fuel elements positioned in this tubing. These measurements will provide a check on the calculated results.

Fuels Development Operation (HLO)

At the request of theCeramic Fuels Development Operation, a study was made of the nuclear safety in the manufacture of UO_2 fuel elements from UO_3 powder (eight percent U-235 enrichment). Criteria to insure nuclear safety in this operation as well as suggested types of shipping containers and methods of off-site shipment were presented. A talk on nuclear safety in the processing of enriched fuels was also given to this group.

REACTOR

STUDIES RELATED TO PRESENT PRODUCTION PILES

Exposure and Temperature Coefficient with Synthetic Slugs

The PCTR experiments necessary for the determination of the 2000 MWD/T Pu-enriched, natural-uranium total temperature coefficient have been completed.

Analysis of this data, and the previously obtained 1000 MWD/T data, is in progress.

The metal temperature coefficient experiments were repeated this month with a new slug oven design. The previously used mica insulation was replaced with alumina. Although this oven failed during the experiment due to heater shorts, the results of the analysis of the data obtained are encouraging. Because the mica binder in the first ovens outgassed, the cooling and heating experiments yielded different results. In the latest alumina insulated experiments the heating and cooling data agree. Minor modifications of the present heater design should eliminate shorting and should allow the completion of the metal temperature coefficient experiments. Although the final error analyses have not been completed on these experiments, it is of some interest to note that the approximate metal temperature coefficient of k_{∞} of $-2.75 \times 10^{-5}/^{\circ}C$ agrees with K-pile startup data. The estimated precision of these preliminary results is $\pm 1 \times 10^{-5}/^{\circ}C$.

End Effects in k_{∞} Measurements in the PCTR

A first order calculation has been performed using the perturbed thermal neutron flux and the unperturbed thermal adjoint flux distributions in a $7\frac{1}{2}$-inch graphite natural uranium lattice to evaluate the error in a measured k_{∞} caused by cutting a lattice cell perpendicular to the axis of symmetry and removing a central section of the cell. Such a cut allows streaming from the cell boundaries to the middle of the cell at the interfaces. This first order calculation indicates that this error was such as to cause a measured k_{excess} to be about two percent too large, as compared with an earlier zero order calculation of about five percent too large. A further experiment will be necessary to estimate the size of this error when the fuel at the interface is covered with an aluminum end cap.

Lattice Neutron Temperature Study

Work continued on normalizing the fission foils that are to be used in the lattice neutron temperature experiment. The counting equipment is now complete so that two foils can be counted simultaneously.

Thermal Neutron Flux in a Medium with a Temperature Discontinuity

Work began on the OMNICODE program for the numerical solution of the partial differential equation by J. L. Powell's iterative method.

A paper on the analytical solution of this problem was written and presented at the Gatlinburg Conference on Neutron Thermalization.

Nuclear Safety Consulting

At the request of the Process and Reactor Development Operation a review of a preliminary draft of a 100 Area nuclear safety document for handling enriched fuels was made. Suggested changes for this document were presented.

STUDIES RELATED TO FUTURE PRODUCTION PILES

Lattice Measurements for Cluster Fuel Elements

A series of measurements has been started in the small graphite exponential piles (4 ft. x 4 ft. or 4 ft. x 5 ft.) using clusters of natural uranium. The clusters are composed of seven cylindrical elements, 0.5 inch in diameter, supported by polyethylene spacers in an hexagonal array with one rod down the center. This assembly corresponds to one with which some measurements have previously been made in the PCTR.

The material bucklings will be determined for the lattice spacings 5 3/16, 6 3/16, 7 3/16, 8 3/8, and 10 3/8 inches with air or water coolant at each spacing. The material buckling with MIPB coolant will be determined for lattices of 6 3/16 and 8 3/8 inches.

Measurements have been completed in the 5 3/16-inch lattice with both air and water coolants. However, the buckling values are not yet available.

Development of Methods of Calculating Reactor Parameters

A. Fuel Isotopic Concentrations

The simplified formulations of isotope concentrations vs. exposure, which have been reported in recent months, have neglected the radial distribution of the flux. An approach is being investigated in which these simplified relations are treated as local exposure conditions, thereby permitting a radial variation of the temperature of the Maxwellian component of the flux. The parameters in the Tripartite cross sections thus depend on radius. A means of specifying the neutron temperature as a function of radius is being sought.

B. Machine Computational Programs

The OMNICODE program for evaluation of an integral encountered in the cosine weighting correction to isotopic concentration calculations is now conditionally ready for data.

Flow charting and programming have been completed on a program for least squares fitting of exponential pile transverse flux data to a cosine curve to determine the extrapolation length.

Instrumentation

Work continued on an improved pyrometer which will take a temperature measurement in three seconds as compared with the sixty seconds required by the present model. A report is being written on the principles and methods of pyrometry. The report includes a description of a color pyrometer built by the optical shop. The accuracy and calibration of this instrument are described.

Some sample magnetic core storage elements were obtained for testing in connection with the investigation of storage devices. If the samples appear satisfactory, a purchase order will be placed for a sufficient number of magnetic core

memory planes to test data storage, handling, and presentation techniques.

A search was started on problems and methods concerning the detection and measurement of radioisotopes in 100 Area processes. The results of this investigation will indicate the feasibility of considering new or improved techniques.

STUDIES RELATED TO SEPARATIONS PLANTS

Measurement of k_{∞} for Uranyl Nitrate H_2O Mixtures

A preliminary analysis of the data for determining k_{∞} of enriched uranyl nitrate-water mixtures indicates the maximum k_{∞} to occur for H/U atomic ratios less than 12. Previous measurements were taken with H/U ratios of 12, 14, 16, and with enrichments in the range of 2.1 percent to 2.3 percent. The analysis shows the need of experimental data at smaller H/U ratios if the maximum k_{∞} is to be determined; measurements are now in progress with H/U ratios of 8 and 10.

Nuclear Safety Specifications for Enriched Uranium in the 1.25% - 2% Range

A series of exponential measurements were completed with 1.6 percent enriched I. and E. fuel elements in water moderated lattices. The fuel elements, which were 1.39 inches in O.D., with a 0.464-inch I.D., were contained in type 3S aluminum tubing which was 1.50 inches in O.D., with a 0.049-inch wall thickness. The buckling has now been determined for ten different cases. At each of five different lattice spacings, measurements were taken with the hollow slug core wet and also dry. The buckling values measured this month are listed as follows:

Buckling for 1.6 Percent Enriched Hollow Fuel Elements

Separation Between Rods	H_2O/U (by Volume)	Buckling (10^{-6} cm.$^{-2}$)
2.0 inches	1.25	6033
2.4 inches	2.37	6136
2.6 inches	3.01	4937

Since the critical mass of the uranium can be estimated from the exponential measurements, the uranium will now be used in multiplication measurements to check experimental procedures preparatory to the near critical experiments which are planned with three percent enriched uranium in connection with the reprocessing of power reactor fuels.

Criticality Studies in Support of Processing Power Reactor Fuels

Data on the criticality of heterogeneous systems with three percent enriched uranium is to be obtained from subcritical multiplication measurements in reactor assemblies with adequate controls and safety mechanisms to insure against supercriticality. The fuel rod assemblies will be positioned in a water-filled stainless-steel tank which is four feet in diameter and five feet in height; a quick dump system for the water has been built into this reactor tank.

Both lucite and aluminum tubing has been received for encasing the three percent enriched uranium.

The first measurements will be done with 1.6 percent enriched uranium, since an estimate of the critical mass for this material is known from the exponential measurements. It will thus be possible to check the control instrumentation and to investigate the reliability of the experimental procedures with a known material prior to the measurements with the three percent enriched uranium.

Nuclear Safety, Critical Mass Consultations

Nuclear Safety in 234-5 Building Processing

A. A review of the criticality problems in the fabrication of Model No. Pit 65 in the machining hood was made. Recommendations were presented to Research and Engineering (CPD) to insure nuclear safety of this operation.

B. A study was made of the nuclear safety of a plutonium fluoride powder recycle pan and powder recycle hopper addition to the plutonium oxalate calciner in Hood 9B Operations (Continuous Tasks I - II). Suggested alternatives as well as recommendations were made to Research and Engineering (CPD).

Neutron Age Measurements

The equipment for these measurements is being reassembled to repeat the measurements in water. A different type of mounting for the source is being developed in order to circumvent another mishap in handling of the type which necessitated the repetition of these measurements. A modification has also been made to the gas flow proportional counters to seal off the counting volume from the active foil to avoid water contamination in the counters. Some time was spent in editing the Geneva Conference paper on neutron age.

Mass Spectrometer for Plutonium Analyses

The primary mechanical components of the spectrometer are being aligned and assembled. Modification of Room 4-A as a mass spectrometer laboratory has been started.

REACTOR DEVELOPMENT - 4000 PROGRAM

STUDIES RELATED TO THE PLUTONIUM RECYCLE PROGRAM

D_2O - UO_2 Lattice Measurements

Measurements of k_∞ for a plutonium spiked lattice (one Pu spike column for every six UO_2 columns) were made with two different distributions of copper poison over the plutonium and neighboring UO_2 fuel. The perturbing effect of the copper poison differed in the two experiments by a factor of three; yet the values of k_∞ inferred from the two experiments were exactly the same. This gives added confidence to the multiplication factor obtained.

The k_{∞} for 19-rod clusters of uranium oxide, with air coolant, in a D_2O moderated, eight-inch triangular lattice has been redetermined. The central test cell had an actual fuel length of 33 1/2 inches without "end buffer" cells and was, therefore, identical to all the surrounding buffer rods. This measurement was necessarily run during the course of the plutonium spike measurements reported last month.

The value of k_{∞} obtained using this full length column was identical to the k_{∞} of 1.060 previously determined(1) when the 15 3/4-inch test section with end buffers was used.

This result indicates that any flux perturbation due to the presence of the end caps and end supports is either negligible or such as to be just cancelled out by neutron streaming effects when the full length test column is used. Neutron streaming from the large, central-cell calandria opening may occur when the full length test column is removed (and the "dummy" vessel is inserted) since there are no end buffers to prevent it.

Since the chances are small that these two effects are such as to exactly cancel, the reproducibility of this previously obtained value gives additional confidence in the values of k_{∞} obtained with liquid moderators.

The calandria with a nine-inch lattice spacing has been fabricated and delivered. Measurements of k_{∞} and f for 19-rod clusters of either UO_2 or UO_2 - PuAl mixtures will begin this month.

Resonance Escape Theory

The corrected value of resonance integral reported last month has been used to revise the resonance escape probabilities which had previously been calculated for various lattices of interest.

Theoretical PCTR Studies

A method is being formulated for calculating the resonance escape probability in an infinite lattice of supercells. Each supercell consists of a central cell with a fuel element of type B surrounded by six cells with fuel elements of type A in a hexagonal array. This problem arises in connection with plutonium spike measurements in the PCTR. The formulation involves three parameters: The relative resonance capture probabilities in type A and type B elements, the relative resonance capture probabilities in originating and nearest neighbor elements, and the relative number of fissions in type A and type B elements. Expressions are being sought for these parameters in terms of quantities measured in the PCTR.

Instrumentation

Further discussion meetings were held with members of Advance Engineering on noble gas monitoring and on the characteristics of gm tube detectors for slug rupture detection.

The detail design work on the 5X viewer was continued.

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(1) Physics Research Quarterly Report, April, May, June, 1957, HW-51983.

A discussion was held with members of the Radiometallurgy Laboratory Operation regarding the requirements and limitations of the profilometer. A method of automatically recording diameter and warp was demonstrated.

CROSS SECTION MEASUREMENTS PROGRAM

Subthreshold Fission - Np-237

Fission cross section measurements have been continued in the energy region below six ev. Resonances have been observed at 0.49, 1.55, and 1.9 ev. The total cross section resonances at 2.0 and 2.7 ev are not clearly seen in the fission results probably because of poor statistical precision and poor resolution. Reasonably good upper limits to the fission contribution of these resonances can be made, however.

Subthreshold Fission - Am-241

Fission resonances have been observed at 0.3 ev, 1.5 ev and what is probably a doublet at 0.53 and 0.58 ev. The four resonances reported in total cross section measurements from two to five ev are not seen in fission. The statistical precision of the data is sufficiently good to put upper limits on the fission widths of these resonances which are quite small.

U-235 Fission Cross Section

Measurements have been completed to obtain the relative U-235 weights of fission foils used for absolute fission cross section measurements at Harwell and Hanford. The ratio of weights was determined by comparison fission counting in a spatially flat thermal neutron beam from the TTR. Corrections were applied for absorption between the foils, relative solid angle and fissions not counted. The best value for the relative weights was 1.075 ± 0.004. The ratio of the weight values used in the absolute fission cross sections was 1.051 ± 0.014. The difference in the ratios is not significant in explaining the difference in the measured fission cross sections of about 13 percent.

Three-Crystal Spectrometer

Acceptance of the spectrometer with exceptions has been informally approved. The outstanding exception is the beam shutter step plug which is very unreliable in operation. Provisions have been made to fabricate a new piece and install it during a shutdown at a later date. A preliminary survey has been made of the efficiency of the spectrometer shielding when the primary neutron beam is stopped in the first axis shielding as it is for scattering measurements. The results showed no significant increase in the room background when the collimators through the shielding were five degrees or more from the straight through position. Readings were also made with the primary beam brought through the shielding to test the beam catcher. The beam catcher performance was very satisfactory and room background was at a conveniently low level. Two beryllium crystals have been ordered to try with this spectrometer as monochromating crystals.

Time-of-Flight

A five-inch RCA7170 photomultiplier with a plastic scintillator was tested for

resolution and efficiency as a fast neutron detector with the time-of-flight equipment. A factor of 10 in efficiency was obtained without loss of time resolution. A preliminary effort was successful in obtaining a photographic display of pulse height versus time-of-flight. The display is three dimensional in that the density of points is proportional to the number of pulses. This technique may have important application to the determination of absolute counter efficiency. Instrumentation was completed to utilize pulse height selection with the chronotron. Work continued on the design of a new beam deflection oscillator for the Van de Graaff and the testing of different tubes as amplifiers for the chronotron loops.

TEST REACTOR OPERATION

Operation of the PCTR continued on a one to three shift basis during the month. There was one unscheduled shutdown during the month due to an electronic failure.

Measurements were completed on the second group of simulated high exposure slugs (2000 MWD). One series of measurements was nearly completed using slightly enriched UN hydrate.

Four improved design control rods were installed, making a total of seven rods replaced. A spare count rate meter was received during the month. Spare instruments are now on hand for all units of the control and safety system. Special graphite bars were machined during the month to permit loading a 37 1/2-inch cube test cell into the PCTR. Significant improvements in flux matching will thus be made possible for the scheduled 9 1/2-inch PRTR lattice experiments.

A study was made to evaluate alternatives to the present method of storing the 37 1/2-inch long driver rods for the PCTR in a single vertical row. (PCTR - 305-B Building). The storage rack is composed of two sections positioned one above the other. It was suggested that these two sections placed side by side at a one foot center-to-center distance would be safe. In fact, an infinite array of these racks on one foot centers would be safe.

Plans for the 305-B addition are being prepared by the architect-engineer and are scheduled for completion early in May. Construction is scheduled to start in the middle of June and be completed by October 1.

Several reactor runs were made in the TTR for the fission foil chamber-multichannel analyzer work being done by Experimental Nuclear Physics personnel. There were two unscheduled shutdowns during the month. One was caused by a faulty bypass switch, which was replaced. The other scram resulted from Channel 3 trip being set too low.

BIOLOGY AND MEDICINE - 6000 PROGRAM

BIOPHYSICS RESEARCH

Atmospheric Physics

Experimental determinations of the transport and diffusion of airborne materials emanating from the 100 Areas and moving across various sections of the Wahluke Slope were continued. Continuous point sources at the ground level were used

and crosswind measurements of airborne concentrations near the ground and at distances up to 4.5 miles from the source were obtained.

Pertinent information from all of the Slope experiments is summarized in the following table:

Exp. No.	Wind Vel. (mph)	Temp. Diff. 3'-200' (°F)	Dist. from Source (mi)	Ave. Time (hrs.)	Max. Ave. Conc. x 10^8 (m^{-3})	Source Site	Slope of ln X vs. ln x
1	NW22	-2.1	3	3-1/2	5	100-H	-
2	SSW23	-2.0	2	2-3/4	10	100-B	-1.18
			8	2-3/4	2	100-B	
3	SW18	-1.1	2	3-1/2	(1.2)	100-B	-
			8	3-1/2	(0.4)	100-B	
4	W12	-1.3	1.2	2-1/4	5	WB	-1.14
			4.5	2-1/4	1.1	WB	
5	SW13	-4.0	1.7	3	0.8	100-D	-1.88
			4.2	3	0.2	100-D	

Experiment 5 represents the most extremely unstable condition tested to date, and it is particularly interesting to note the enhanced value of the slope of ln X vs. ln x, where X is the concentration and x is the distance from the source. The enhanced diffusion rate represented by this slope probably reflects the presence of large, organized convective cells which essentially produce vertical meander of the plume. Plans were laid for a continuation of these experiments in order to define transport and diffusion capacities and variabilities for a much wider range of meteorological conditions.

Special summaries of observed winds over the Wahluke Slope and the 100 Areas were compiled for presentation to the AEC Advisory Committee on Reactor Safeguards. These data, combined with Hanford diffusion measurements, comprise the most extensive data available for the hazards evaluation on the Slope.

DOSIMETRY

A sample of talc from our rock shield was analyzed at MIT and found to contain 4 to 8 x 10^{-15} curie of radium per gram of talc. This is consistent with estimates made from background measurements in the shield.

Two plutonium puncture cases were examined in the rock shield. The first was found to have 0.076 ± 0.008 μc in his thumb. After surgical removal of a piece of flesh, there remained 0.0047 • 0.0006 μc. It is felt that some of this is surface contamination; the subject will be re-examined after the wound has healed. The excised tissue was found to contain 0.057 ± 0.006 μc of plutonium. Later the plutonium was separated chemically from this tissue and alpha counted; 0.037 μc, 65% of the above value, was found. The second

case was found to have less than 0.001 μc of plutonium. Some specks taken from his wound were counted and found to contain 0.00014 ± 0.00004 μc or 310 dpm. This sample was also measured by alpha counting and found to contain 187 dpm

Double moderator measurements of the $Be^9(d,n)B^{10}$ reaction are in progress to check time-of-flight results, to complete published data on the reaction, and to obtain angular distribution data.

INSTRUMENTATION

Circuitry development was continued on the experimental, transistorized, scintillation alpha, beta, gamma Hand and Shoe Counter. This instrument can replace the Four-Fold and Five-Fold Counters. It will be approximately one-half the size of a Four-Fold.

The vacuum tube (Model II) combined alpha, beta, gamma Hand and Shoe Counter which can replace both the Four-Fold and Five-Fold Counters has now operated successfully in general building usage for ten weeks with a total down time of about 15 minutes for calibration adjustments. No repair work has been necessary.

Minor high-voltage circuitry corrections were incorporated in the experimental transistorized neutron count-rate meters employing a thin ZnS - B^{10} crystal for scintillation detection. The circuitry changes permit operation in higher level gamma fields while retaining the moderated Ra-Be neutron sensitivity of 150 c/m per $n/cm^2/sec$. The second instrument of the same type which was loaned to UCRL was returned after successful operation. Two enriched (55%) B^{10} - ZnS crystals were ordered for further experimentation with the aim of obtaining more neutron sensitivity.

The two prototype scintillation transistorized gamma-energy analyzers have been fabricated and are now being tested, adjusted, and de-bugged.

The robot monitoring magnetic sensing device experimental work was completed after the development of a transistorized phase-sensing device to obtain directional sensing.

Investigation of special neutron problems showed that some of the indicated levels of fast neutrons in certain plants were far too high because of the inadvertent reading of much slow neutron flux. This problem can be rectified using a cadmium shield over the fast neutron detector.

The experimental work on the sensitive alpha air monitoring system, which will alarm on a 60 mpc level of airborne plutonium concentration in 20 minutes, has been completed and the system was tested successfully during the month. The system compares the rate-of-rise of the radon-thoron background activity to the rate-of-rise of the airborne plutonium activity. Fabrication will start soon on a prototype.

Some investigation work is being carried out to obtain 3.0-volt input operation for the single transistor high-voltage supply which normally operates at 8.0 volts input. Efficiencies obtained so far at 3.0 volts input are in the order of 40 to 45%, converting 3.0 volts DC input to 900 to 1000 VDC output.

The AEC has evaluated bids for the radiotelemetering repeater stations and, because of irregularities in bid procedure, have decided to issue a new bid request for the repeater station.

The zinc sulfide particle detector for the Atmospheric Physics Operation has been assembled and tested satisfactorily. Linear particle detection range tested is from 100 to 19,000 particles per filter paper.

The Dog Counter System for Biology was completely assembled and tested with known sources. Operation was quite successful. The system will adequately locate and determine the type and magnitude of various isotopes in vivo. Detection limit sensitivites were found to be 0.5 to 1.0 μc Pu^{239} and 0.08 to 0.1 μc Ru^{103} in vivo. Sr^{90} detection limit via bremsstrahlung detection was found to be about 3.0 μc through 2 inches of water. Actual experimentation using live dogs with known amounts of Pu^{239} in the lungs were carried out. It was found to be possible to detect 0.5 μc of Pu^{239} in the lungs.

An investigation of methods of photographing oscilloscope traces for pulse height analysis (energy analysis) work was started. A recording densitometer is being fabricated to permit film reading from photocell scanning procedures. This system, if the resolution is satisfactory, will permit the use of a scope camera to obtain pulse height analysis data and subsequent energy analysis without the use of expensive pulse height analyzers.

Evaluation tests were continued on the transistorized scintillation slow and fast neutron meter.

Evaluation tests were completed on three prototype Victoreen G-M's built to HAPO specifications. A total of 100 are on order.

G-M battery aging tests were completed and several types of mercury batteries were tested under load. It is thought that many of such batteries obtained by Stores are already quite old.

All evaluation and testing work on the sensitive (0-0.5 mr/hr first range) scintillation dose-rate meter was completed. The rebuilt prototype will now be field demonstrated and tested.

One commercial transistorized G-M was evaluated. The instrument lacked a loudspeaker, was far too insensitive, and had generally poor fabrication qualities.

A single probe alpha, beta, gamma detection and aural indicating instrument is being fabricated for the Calibrations Operation. This will permit simultaneous radiation checking of portable instruments for alpha, beta, and gamma contamination. The probe is a scintillation-type employing alternate strips of ZnS and bioplastic for alpha and beta-gamma detection simultaneously.

WASHINGTON DESIGNATED PROGRAMS

The construction of the mass spectrometer for this program proceeded satisfactorily simultaneously with the construction of the mass spectrometer for plutonium analyses.

CUSTOMER WORK

Analog Computing

A remote read-out system for the digital voltmeter was installed in the computer console. This unit will aid in reducing calibration and check-out time.

The computer was shut down for a two-day period in order to oil and adjust the large number of stepping relays. While the machine was down other minor troubles were corrected.

The majority of this month's running time was for two phases of the PRTR program. Another set of hazards studies was completed and additional runs were made on the gas and water system.

Two special time-transport delay circuits were developed and tested for use with the NPR heat exchanger program. This circuit will be used on the next series of runs.

Although work orders have not been issued for the following problems, they have been discussed and appear feasible for computer programs. It is expected that authorization for the work will be given during the month of May.

a. NPR pressurizer problem - CEO
b. Slug heat transfer - IPD
c. Thorium burnup - HLO

Weather Forecasting and Meteorology Service

Type of Forecast	Number Made	% Reliability
8-Hour Production	90	81.0
24-Hour General	60	84.8
Special	152	86.8

April temperatures averaged 2.5 degrees below normal and precipitation totaled 0.28 inch above normal. This was the fourth consecutive month of above-normal precipitation and brought the January-April total to 4.32 inches, which is nearly 70 percent of normal for the entire year.

Optical Service

Tests were made to determine the quality of four large lead glass windows received from Corning for possible use as 100 Area viewing windows. These were returned to Corning when the tests showed that they were not low reflection coated. Four lucite windows were also tested and found unacceptable.

The design of the Redox periscope heads was modified to provide for more reliable change of power.

The routine optical shop work included the fabrication of mirror holders for use in photographing welding arc phenomena, completing the modification of a

105-F Area access hole periscope, the repair of two three-power periscope heads for Redox, the aluminizing of four mirrors, the servicing of two crane periscope heads for U-Bldg. periscopes, the reconditioning of darkened lenses for Purex periscopes, and the fabrication of modifications to the arc image furnace.

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
P. M. Wood W. J. Dodson	4/17-18	American Car & Foundry Washington, D. C. Kaiser Engineers Idaho Falls, Idaho	Discuss development program on Gas Cooled Test Reactor.	PF Gast JE Faulkner RE Heineman DS Selengut	No	300: 305-B 326 328
J. L. Powell	4/21-25	Univ. of Oregon Eugene, Oregon	Consultation	JE Faulkner	Yes	300: 305-B 303
T. J. Burnett	4/24	Oak Ridge Nat'l Lab. Oak Ridge, Tenn.	Discuss instrumentation.	RA Harvey	No	300: 329

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
J. E. Faulkner	4/2-7	Cal. Tech. and UCLA Pasadena, Calif.	Recruiting	--	No
	4/8	Atomics International Canoga Park, Calif.	Discuss reactor physics work.	MC Walske WA Horning LA Laubenstein	Yes
W. C. Roesch	4/3-4 4/17-18	Univ. of Washington Seattle, Wash.	Teach AEC Fellows.	--	No
I. T. Myers	4/10-11 4/24-25	Univ. of Washington Seattle, Wash.	Teach AEC Fellows.	--	No
E. D. Clayton	4/14	Univ. of Colorado Boulder, Colo.	Present invited lecture - University Relations Program.	AB Weaver	No
G. R. Hilst	4/15	Univ. of Washington Seattle, Wash.	Confer on meteorological problems.	PE Church	No

VISITS TO OTHER INSTALLATIONS (Continued)

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D. A. Kottwitz	4/28-30	Oak Ridge Nat'l Lab. Gatlinburg, Tenn.	Attend Neutron Thermalization Conference.	--	No
D. S. Selengut	4/28-30	Oak Ridge Nat'l Lab. Gatlinburg, Tenn.	Attend Neutron Thermalization Conference	--	No
	5/1	Aircraft Nuclear Propulsion Cincinnati, Ohio	Technical Liaison.	John Krase RM Cohen	Yes
	5/2	Univ. of Michigan Ann Arbor, Mich.	University Relations Program Seminar.	Profs. Gomberg & Osborn	No
P. F. Gast	4/28-30	Oak Ridge Nat'l Lab. Gatlinburg, Tenn.	Attend Neutron Thermalization Conference.	--	No
	5/1-2	Advisory Committee on Reactor Physics Gatlinburg, Tenn.	Attend Meeting.	RA Charpie	No
W. C. Roesch	4/28-30	Div. of Military Application, AEC Washington, D. C.	Project Tutor Panel Meeting.	AD Starbird	Yes
	5/1-2	Nat'l Bur. of Stds. Washington, D. C.	Discuss dosimetry at NBS.	HO Wyckoff	No
H. V. Larson	4/28-29	Columbia Univ. New York, N. Y.	Discuss neutron dosimetry.	Wm. Gross	No
	5/1-3	Am. Inst. Physical Society Washington, D. C.	Present paper.	--	No

Chemical Research & Development

ORGANIZATION AND PERSONNEL

Effective April 1, 1958 the Engineering Development Planning Operation was transferred to the Programming Operation.

RESEARCH AND DEVELOPMENT

FISSIONABLE MATERIALS - 2000 PROGRAM

IRRADIATION PROCESSES

Decontamination of Mild Steel Reactor Components

Reagents were evaluated for decontaminating test coupons exposed in the KER-1 loop coolant at 100-260 C and at pH 10. Arithmetic gross gamma D.F.'s of about 90 were obtained using a modification of a proprietary process developed by the Turco Corporation for cleaning jet engines. The modified process involves successive treatments with the proprietary Turco compound (Turco 4501), a $NaOH-KMnO_4$ solution, and a 10 g/l $Na_2S_2O_5$ solution.

Disposal of Decontaminating Reagents

Based on data collected during the cleaning operation of the piping of 105-H, in which Turco 4306-B was used for a decontaminating agent, recommendations were made to IPD for the disposal to the Columbia River of a similar solution to be used on the 105-KE reactor. Because the 105-KE cleaning operation is to be carried out in May, when river flow is large and dilution is near a maximum, no river pollution problems are anticipated. However, as an added safeguard, it was recommended that the spent solution be released to the river at a slow rate. Samples will be taken during the operation to study river pollution and inter-area effects.

Uranium Oxidation Experiments

The oxidation rate of uranium in air at 780 C was measured with time as the variable. A parabolic rate of oxidation was observed during the first 20 minutes, at which time the specimen was about one-third consumed. A 10 fold increase in air flow did not effect the reaction rate appreciably. However, after 20 minutes the reaction rate accelerated and the data became somewhat erratic. The oxidation rate was fastest at the higher air flow. This observed change in oxidation rate is thought to be caused by an increase in the surface area resulting from the oxidation which occurs during the first twenty minutes.

Fuel Rupture Monitors

Plans which would provide for direct discharge of reactor effluent to the river have emphasized the need for sensitive rupture detection instruments and a careful evaluation of the present rupture monitors. A review was made of some past ruptures to obtain representative estimates of the uranium loss from diagrams and photographs of the ruptured elements. This loss in turn was compared to estimates made from fission product analyses of the reactor coolant water samples taken during the

rupture. In the general case more rupture debris was lost than could be accounted for by the rupture monitoring data taken during the rupture. This observation suggests that sampling of the cooling water header was not representative or that a significant loss of uranium occurred in a manner undetected by the monitor. Further analysis of rupture-monitor sensitivity will be made.

Analytical Services

"Spectrochemical Determination of Strontium and Cesium in Water," (HW-55543) was issued. Detection limits are 5 and 0.5 part(s) per billion. Precision is ± 10 per cent. Similar measurements apply to 13 metals in water.

The gas chromatograph was used to measure ortho terphenyl and biphenyl in binary mixtures. Instrument modification was required to operate at 275 C. The chromatograph was also used to identify complex hydrocarbons in off-gas from irradiated plastics.

$Xe^{133,135}$ and $I^{131,133}$ were found at high concentrations in KAPL - 120 loop cooling water. The data indicated fuel element cladding failure which was confirmed later by inspection.

SEPARATION PROCESSES

Feed Preparation

Annular "E" Metal Dissolver. Test charging of an "E" metal dissolver mock-up, based on design SK-2-7180, was completed. Steel "stand-in" slugs were dumped from a standard slug bucket. Maximum and minimum slug heights of 29 inches and 19 inches were observed when the slugs were dumped equally from each side of the distributor cone. Dumps from only one side of the cone produced maximum and minimum slug heights of 40 inches and 11 inches. Random versus stacked placement of the slugs within the buckets had no significant effect on the resulting distribution pattern in the dissolver.

Continuous Dissolution. Dissolution rates in the pilot scale continuous dissolver have been increased to values equivalent to 1.4 tons/day/ton of heel with a product composition of 2.0 M UNH and 0.2 M HNO_3. Hydrogen concentration in the off-gases has ranged from 5 to 70 per cent of the lower explosive limit.

Dissolution of Dingot Metal. Small concentrations of $(NH_4)_2SiF_6$ markedly increase the instantaneous dissolution rates of both ingot and dingot metal in HNO_3-UNH solutions. The dissolution rate of dingot metal in 1.0-6.0 M HNO_3, 1.0 M UNH, 0.005 - 0.0075 M $(NH_4)_2SiF_6$ solutions at boiling temperatures equals or exceeds the rate for ingot metal in the absence of added $(NH_4)_2SiF_6$. The effects of these concentrations of $SiF_6^=$ on stainless steel corrosion and solvent extraction performance are under investigation.

End-grain attack of nitric acid on uranium metal has been shown to be a result of both fabrication methods and the presence of carbon in the metal. Two dingot uranium alloys were alpha rolled (640 C) to about 75 per cent reduction in cross sectional area and beta heat treated (730 C for 15 minutes, water quenched). One alloy contained 284 and 1360, and the other 1103 and 110 ppm carbon and silicon,

respectively. The low carbon alloy exhibited only moderate end-grain attack, whereas the high carbon alloy experienced severe end-grain attack. Only moderate end-grain attack occurred on the high carbon alloy in the as-cast condition. However, the dissolution rate of both alloys was greater in the as-cast plus beta heat treated than in the alpha rolled plus beta heat treated condition, i.e., the absence of end-grain attack was associated with an increase in dissolution rate.

Solvent Extraction

Coated Pulsed Column Plates. The coalescence of an organic phase by stainless steel sieve plates "whirlclad" (coated in a fluidized bed) with linear polyethylene and hot pressed between two heated platens of a laboratory press was found to be inferior to that of solid linear polyethylene sieve plates.

Production of U(IV). This program concerns application of the light-catalyzed reduction of U(VI) to U(IV) in nitrate media by formic acid or formaldehyde. A U(IV) solution has utility as a plutonium reductant in the Purex process.

The highest reduction efficiency obtained to date, 22 per cent, was achieved by five hours irradiation with light from a G.E. 275 watt R.S. sunlamp of a solution at 20 C containing 0.2 M UNH and 0.05 M formaldehyde at pH 0.5. The process at 50 C reduced uranium at about 80 per cent of the rate at 20 C. Substitution of 0.1 M formic acid for the 0.05 M formaldehyde resulted in a slower reduction rate. Studies of the effect of acidity on reduction rate indicated pH 0.5 to be optimum in the pH range 1.0 to 0.05 at 20 C and in the absence of a nitrite suppressor.

Flurex Process

Flurex Process development studies during the month may be summarized as follows:

1. Batch contact uranium distribution ratios indicate the feasibility of cation exchange recovery of uranium from Flurex catholyte bleed solutions. Column experiments with Dowex 50 x 8 resin are in progress.

2. Particle settling rate data indicate that about 80-90 per cent of the Flurex product (NH_4UF_5) can be removed by decantation in the initial liquid-solid separation step.

3. Leakage rates of sulfate ion from Flurex catholyte solutions across a Permutit 3142 cation membrane to the feed compartment are extremely low and are not of significance with respect to current efficiency for uranium transport.

4. Studies of the washing of Flurex product show that this compound peptizes readily. Peptization is avoided and low uranium losses are obtained with 0.1 M $NH_4F.HF$ wash solutions. Sulfate contamination of NH_4UF_5 precipitated in a sulfate-containing catholyte is reduced to about 0.02 per cent by weight by moderate washing with 0.1 M $NH_4F.HF$. Excessive wash volumes are required to reduce sulfate contamination to 0.001 per cent.

5. Product yields under typical Flurex Process conditions are decreased about five per cent when a full-wave rectified (pulsating) direct current, the usual output of industrial units, is substituted for a filtered (continuous) direct current. Anodic dissolution rates of SS 304 L are increased slightly.

Purex

Batch extraction-scrub studies aimed at elucidating the "irreversible" fission product extraction which limits Purex HA column gamma decontamination to about 10^4 continued. No improvement in zirconium-niobium scrubbing performance was noted when an aqueous feed was pretreated by exposure to highly-degraded Shell E-2342 in an attempt to remove fission products which might be complexed by diluent degradation products. Exposure of the aqueous feed to degraded Shell E-2342 followed by exhaustive washing with fresh diluent, extraction with 30 per cent TBP in Soltrol, and five batch scrubs of the organic extract resulted in a typical increasing distribution coefficient for zirconium-niobium in the scrub steps, from 0.08 in the first scrub step to 4 in the fifth. Over-all zirconium-niobium decontamination in this experiment was, therefore, worse than normally obtained in the absence of the treatment with degraded diluent.

Improved zirconium-niobium scrubbing was observed when an organic extract (30 per cent TBP in Soltrol) was allowed to age at room temperature before scrubbing. Zirconium-niobium distribution coefficients in the first scrubbing operation were 0.18, 0.08, and 0.018 when the organic extract was aged for 2, 21, and 144 hours, respectively.

Anion Exchange Processes

Purex Anion Resin Stability. The capacity was determined for a sample of Permutit SK removed from the Purex continuous anion exchange unit after 41 days operation. The capacity of this resin was the same as that of new resin within experimental error. A slight increase in fines was noted.

Plutonium Recovery From A Simplified Purex Type Partition Cycle. A flowsheet was tested for the separation of plutonium from uranium and fission products in 1BXP. Solvent extraction was carried out in the full level miniature mixer-settler equipment. The plutonium product from the solvent extraction equipment was fed to a fixed bed of Permutit SK resin at a column temperature of 60 C. "Complete" decontamination was obtained for all fission products except niobium. The niobium decontamination factor for the complete process from dissolver solution to plutonium product was 4×10^7.

These results indicate the technical feasibility of replacing the Purex 1BS, 2A, and 2B columns with a single cycle of anion exchange.

Resin Movement, Higgins Contactor. A program aimed at defining the fluid and resin flow patterns in a moving bed, semi-continuous contactor has been initiated. Currently, a "slide valve" resin sampler and "trombone" fluid samplers are being employed.

Resin movement is being traced by establishing steady state conditions with a yellow resin and then adding a plug of green resin. The rate and location of appearance

of the green resin downstream from the addition point will be used to define distribution characteristics. Preliminary results indicate that the resin definitely does not flow in a "plug" or piston fashion.

Pyrochemical Processing

The distribution of uranium between potassium-aluminum chloride ($KAlCl_4$) and aluminum has been established in experiments in which the equilibrium was approached from both sides. Writing the simplified equation for the reaction as

$$UCl_3 + Al \underset{\longleftarrow}{\overset{KAlCl_4}{\longrightarrow}} U + AlCl_3$$

a value for the equilibrium constant,

$$K = \frac{[U][AlCl_3]}{[UCl_3][Al]},$$

of between 2 and 2.5 at 725 C is believed valid. For experimental conditions of local interest, about 88 per cent of the uranium is found in the aluminum phase.

Analytical Services

Nitrogen dioxide in dissolver off-gas is being measured in two ways. Corrosion caused by NO_2 prevents its direct mass spectrographic assay along with N_2O and NO. NO_2 is frozen out (-67 C) of the mixture. A measure of NO_2 comes from comparing pressures of the mixture before and after NO_2 freeze-out. Usually needed is the more accurate method of taking up the frozen NO_2 in water and titrating with standard base.

Plutonium X-rays (0.018 Mev) appear important in the Z-plant gamma personnel exposure study. A "thin" (1 mm) crystal is being used with a gamma spectrometer-counter arrangement for quantitative counting and absorption measurements. Higher energy plutonium gamma is thereby excluded. Radiochemical services supporting the study have expanded to cover the 0.018 Mev - 4 Mev range. Growth and absorption are being considered. In plutonium fluoride, for example, Na^{22} formed by an (α,n) reaction was observed.

Isotopic analysis of test well samples was made more efficient. One-half an employee was released for other work. Strontium and cesium determinations were shortened by using the distillation heels from ruthenium determinations. (Samples require ruthenium measurements regularly.) Previously, separate distillations were made to decontaminate cesium and strontium with respect to ruthenium.

WASTE TREATMENT

Calcination of Purex Waste

Calcination studies on acidic Purex 1WW were carried out both with "cold" synthetic and with 1WW spiked solutions. The former were used in three-inch screw calciner

runs aimed at determining possible temperature limits or other operating limitations (applicable to continuous units such as fluidized beds) and to prepare material for heat transfer measurements. Laboratory scale batch calcination studies with tracer solution studied the effects of temperature of calcination and of atmosphere on the volatilization and leaching of fission products.

Three different runs in the screw calciner at temperatures of 270 C, 340 C, and 440 C had to be terminated because of scale formation which jammed the agitator. In addition, approximately half of the solids formed were carried out with the gaseous reaction products and collected in the water scrubber. A fourth run (440 C) in which the starting bed was selectively sized sand showed improvement from an operating standpoint, and the addition of phosphate in a fifth run largely eliminated dusting.

The fission product volatilization-leaching studies covered the temperature range 200 C to 900 C and three atmospheres: air, air saturated with formaldehyde, and steam. Ruthenium evolution was greatest with steam and least with formaldehyde. With air, it showed a minimum at about 700 C. Cesium evolution was negligible at all temperatures, at least up to 900 C. The fraction of each fission product leached by water was constant up to about 700 C but decreased somewhat above this point.

Submerged Combustion

Several samples of simulated Purex coating waste were concentrated a factor of four in small scale submerged combustion experiments. When the wastes had been concentrated a factor of two, some foaming was noted.

Corrosion of Purex Underground Waste Storage Tanks

Cursory experiments were performed to determine the effect of local "hot spots" on the bottoms of the waste storage tanks on corrosion of the mild steel linings. Stressed and unstressed mild steel coupons exposed at 500 F to molten salts prepared from synthetic Purex waste solution showed no indication of stress corrosion cracking after 625 exposure hours. Corrosion was slight and general.

Observation Wells

Samples of ground water from a well near the 216-A-8 crib were found to contain Co^{60} at a concentration of 1.95×10^{-6} uc/cc. This represents the first appearance of Co^{60} in the ground water near this crib and tends to indicate that cobalt in the boiling tank condensates is present as a non-exchangeable complex ion. No other significant changes in ground water contamination or measured water levels were found here. Additional scintillation probe measurements indicated downward migration of measurable gamma activity totaling 10 to 90 feet in various wells near the BC cribs.

A well being drilled approximately 50 feet SE of 216-BC-5 crib encountered significant contamination in the upper zones of the sediments drilled. Contamination was detected at a 15-foot depth and increased as the well was deepened. The maximum reading with portable monitoring instruments was obtained from samples collected at the 65 and 70 foot depth, one-pint samples giving 28 mr/hr.

Special Geological Studies

The Corps of Engineers, Seattle, again began exploration at the Ben Franklin Dam site to determine the feasibility of that structure. Three core drill holes will be drilled to determine foundation conditions there. The core is being made available to us for study. The Corps began exploration with the first of two test holes, 38 inches in diameter, adjacent to the 105-F and 105-H Buildings. The holes will permit visual inspection of the materials underlying the reactor buildings and permit better evaluation of the problems that will develop as the ground water table rises there under the influence of the proposed Ben Franklin Dam.

Disposal to the Ground

Laboratory data, relating to the Redox process condensate crib (216-S-7) were analyzed. It was found that the crib's capacity for effectively adsorbing radioisotopes of concern may not be exhausted for several more years. This information, along with a predicted capacity for the proposed new crib and the need to neutralize the waste to pH 8 - 11 to obtain the most favorable conditions for Cs and Sr removal, was transmitted to the Facilities Planning Operation, Chemical Processing Department.

HW-54599, "A History and Discussion of Specific Retention Disposal of Radioactive Liquid Wastes in the 200 Areas," was revised for release to the Civilian Application Program.

Laboratory tests were initiated to study problems associated with the 216-WR cribs. These cribs received waste from the U-Plant totaling 194 million gallons and having an average Sr^{90} concentration of 10^{-3} uc/cc. Since June, 1957, the cribs received very low level condensates from the UO_3 plant only. The elution effect of this clean condensate on the fission products stored on the soils beneath the cribs will be evaluated.

Tests were performed to evaluate the influence of calcium ion in Purex process condensates on the retention of Sr^{90} from these wastes by soils. A bed of limestone chips is now used to neutralize these condensates before they are discharged to the 216-A-5 crib. Comparison tests showed a soil column capacity for strontium retention from unneutralized waste nearly three times that for wastes neutralized with calcium carbonate. Similar tests of wastes neutralized with sodium hydroxide are in progress.

Laboratory soil column tests with a sample of CAW (Recuplex) waste, normally discharged to the 216-Z-10 crib indicated a very low retention of Pu by soils. The sample tested may not have been typical of the waste stream since it was found to have a pH of -0.2, while the waste handling procedure specifies neutralization to a pH of 2.5 before discharge. Previous laboratory work indicated poor retention of Pu by soils from solutions having a pH less than 2.0. Further tests will be conducted to identify with greater assurance the cause of the poor Pu removal from these wastes.

Gelling of Wastes

Soil samples, taken at various depths immediately below the test disposal gel bed, were analyzed for moisture content and alpha activity.

Based on the alpha analyses, the moisture lost from the gel wetted the soil to a depth of about 3 times the depth of the gel. This compares to a penetration of 5 times the gel bed depth as observed in the laboratory. The difference is attributed to plugging of the soil by the gel which minimized moisture loss.

It is concluded that gelling of coating wastes and disposal into prepared pits has the advantage over disposal by specific retention only in that Al is removed essentially completely and fission products in large part. These might, in some cases, be important considerations however. To make the gels more completely retentive, either the gels would have to be "tailored" to meet the demand or another process step, such as calcining or drying the gelled waste, would have to be included.

TRANSURANIC ELEMENT AND FISSION PRODUCT RECOVERY

Cesium Recovery

A "tracer level" run (spiked with ca. 200 ml of Purex HAW) to test equipment and decontamination procedures was completed successfully in the Multicurie cell. Remote decontamination of equipment and cell after the run was very good with most items reduced to background ($\leq$10 mr/hr). Cesium recovery with the cesium zinc ferrocyanide flowsheet was only fair. Eight per cent of the cesium was lost to the ferric hydroxide precipitate, despite three precipitate washes, and 20 per cent was not precipitated with ferrocyanide, probably due to a too low pH (1.3). The next run, to test adequacy of shielding, will be at ten per cent full-level as soon as 1WW solution can be obtained from the Purex plant.

Neptunium Recovery

Recent analyses show that essentially all of the neptunium reaching the Purex 2D column in late February and March has been partitioning into the 2DW waste stream. In view of this behavior and recycle of this stream in the Purex Phase II flowsheet, work on anion exchange removal of neptunium from 3WB has been initiated. Initial results appear very promising. In other work, use of oxalate complexing in 1B to partition neptunium with the plutonium followed by cerium(IV) oxidation to insure extraction in 2A was rejected because the cerium was found to cause a six fold increase in the rate of concentrator attack. However, masking the oxalate with ferric ion was found to be effective and may afford a satisfactory process provided the relative neptunium-plutonium nitrite oxidation kinetics are favorable.

ANALYTICAL AND INSTRUMENTAL CHEMISTRY

X-Ray Analysis

Preliminary experiments were performed to evaluate the use of a non-destructive X-ray method for determining the thickness of aluminum cladding on MTR type fuel plates. Using the attenuation, by the cladding, of the characteristic X-ray of the uranium induced by 60 Kv X-rays, it was possible to determine the thickness of 20 mil cladding over 10 w/o uranium-aluminum to ± 0.6 mil using a 30 second counting period and a working area of approximately 0.55 square centimeters. A similar procedure can be used for Plutonium bearing fuel.

Spectrographic Analysis of Plutonium

A brief study was made of the use of tri-iso-octyl amine as an extractant for plutonium for the determination of the impurities in plutonium by spectrography. Most of the key elements studied, namely Ni, Al, Cr, Cu, Mn, and Mg, remain in the aqueous phase during amine extraction of plutonium from nitrate solutions, and adequate spectrographic calibration curves are obtainable. However, iron impurity is extracted to some extent and, accordingly, the method would not be an improvement over the Cupferron or TTA methods.

Spectrographic Analysis by Micro Spark

The use of spectrographic analysis techniques for microscopic areas on planar metal samples would be valuable for metallurgical research in studying the composition of micro inclusions and diffusion layers in metals. The published techniques for micro spark work were reviewed, and laboratory tests were made using existing equipment and specially shaped silver and tungsten electrodes. By these methods, an effective sparking area of about 40 mils on planar metallic specimens was obtained. Much better techniques have been used successfully in other laboratories with special excitation and sample stage apparatus. It was found that a sample sparking area of about two mils is obtainable with apparati which could be fabricated locally.

Neptunium Determinations

The isolation of neptunium by a simple anion exchange resin method is being studied. A method has been developed which gives encouraging results for neptunium-uranium separations, and there is some promise of successful neptunium-plutonium separations as well. Neptunium is reduced to the plus four oxidation state by semicarbazide in 8 M HNO_3 and placed on a Dowex 1, X-4 column. Uranium is not held by the column. Thorium (UX_1) is eluted by 12 M HCl and plutonium by reduction with hydroiodic acid in hydrochloric acid. The neptunium is finally eluted with dilute hydrochloric acid, yielding a relatively pure neptunium solution with very simple techniques. Pending completion of development, the method may be considerably more economical to apply than the TTA methods.

EQUIPMENT AND MATERIALS

Bearing Test Program

The load carrying capacity of aluminum oxide bearings treated with a high melting point wax appears to be superior to untreated oxide bearings. Tests bearings, two Coors Porcelain Company and one Linde product were impregnated with Paraflint R. G. (melting point 100 C). These bearings, run against journals of like but unimpregnated materials, could be loaded a factor of two higher than untreated oxide bearings before bearing wear was indicated.

Transfer Equipment

After pumping 65 per cent nitric acid at typical process conditions for approximately 6,000 hours the Johnston Splined Shaft Pump No. 2 was removed from service and Coors ceramic (aluminum oxide) bearings and journals were installed. Inspection of the

pump at the termination of the above test indicated very little wear of the graphite bearings and hardened 17-4 PH stainless steel journals. Graphite bearing diametrical wear varied from 3.7 to 9.4 mils while the journal showed a maximum wear of 1.7 mils.

In cooperation with Construction Engineering Operation, three organic jets to be installed in the Purex Plant during the May shutdown were given shakedown tests. Jet performance agreed closely with that predicted by the Vendor.

Non-Metallic Materials Testing

Homalite 101, a transparent sheet material manufactured by the Homalite Corporation, was tested by static immersion at room temperature. This material swelled 1 per cent in hexone and 10 per cent in trichloroethylene but was unaffected by concentrated nitric acid, concentrated caustic and Purex HAX.

PROCESS CONTROL DEVELOPMENT

Assistance on Process Control Instrumentation

Gamma scintillation monitors on the Purex IBP, and 2EU streams were placed in service this month. A gamma monitor is also ready for operation on the HSP stream. The Purex 100 (G-5) sampling system failed to circulate sample through the gamma monitor on that stream. A prototype of the sample system has been installed in the 321 Building No. 1 tank farm. This prototype system satisfactorily circulates organic solutions to a height two feet above that required for the plant 100 sample system. Observations of the prototype sampler indicate that air leakage may be the cause of the difficulty with the plant sampler.

Purex HA Column Densimeter

Testing of the prototype densimeter is complete and a design drawing (SK-2-2951) of the float, and guide assembly to be installed in the Purex HA Column has been issued. Final tests with the system pressurized indicated that the static pressure at the column feed point will actually improve the float stability. Operational characteristics established in the semi-works runs are as follows: density range 0.95 to 1.00, repeatability ± 0.0013 density units or ± 0.75 gram uranium per liter, at pulse frequencies between 50 and 104 cycles per minute.

Flowmeters

A Kates "Flow Regulator" is being evaluated for possible use in semi-works operation. The regulator under test has a flow range of 0.02 to 0.2 gallon per minute. After 300 hours operation in the 0.2 gallon per minute range, it appears to control to within ± 5 per cent.

Neutron Detector

A second experimental pipeline neutron monitor was installed on the 234-5 task I supernate recycle line. This unit incorporates major changes in geometry and shielding from the original unit. The boron trifluoride counting tubes are cast

directly in the paraffin moderator. The background moderator and/or reflector was changed from one inch of borated paraffin to 7-1/2 inches of paraffin plus 1/16 inch of cadmium. An improvement in signal to background ratio of 100 was realized with this geometry and shielding arrangement.

NON-PRODUCTION FUELS REPROCESSING

Feed Preparation

Mechanical Processing. During the month studies were continued on various types of saw blades for the cutting of simulated non-production fuel elements. Studies were performed on abrasive blades (silicon carbide), diamond blades and both saw-tooth and U-tooth friction blades. Studies have indicated that the diamond blades and the U-tooth blades would give satisfactory service in the cutting of simulated fuels. In life tests the U-tooth friction blade has made more than 400 cuts of simulated fuel elements (each element consists of a bundle of nine half-inch diameter stainless steel tubes filled with a ceramic stand-in for UO_2) without excessive blade wear. In similar tests, diamond blades have demonstrated satisfactory performance for greater than 200 cuts. Tests on the diamond blade were discontinued after 200 cuts but inspection at that time revealed very little wearing (approximately six mils) on the cutting surface of the blade.

Tests were made at the Williams Patent Crusher Company plant in St. Louis on a pulverizer (king-size hogmill) being evaluated for use in mechanically disintegrating fuel elements. These tests showed that simulated fuel elements could be reduced to steel shrapnel (roughly 1/2 inch by 1/2 inch) and fragmented powder in such a mill. However, the tests also indicated that fuel elements should be first reduced in size to approximately 25-pound pieces to permit efficient operation of the pulverizer.

Darex. Fabrication and installation of the Darex prototype have continued. The only major equipment piece not completely fabricated is the titanium condenser. The over-all Darex installation is about 60 per cent complete.

Zirflex. Tests on unoxidized Zircaloy-2 and 3 show no significant differences in the dissolution characteristics.

Oxidized Zircaloy-2 (3 days in air at 400 C) was 99.99 per cent dissolved in four hours in boiling 5.5 M NH_4F and 0.5 M NH_4NO_3. However, a flaky gray residue of oxide film was present in the solution.

Exposure of unoxidized sheets of Zircaloy-3 and pieces of sintered UO_2 in a dissolver solution of the above composition resulted in complete dissolution of the Zircaloy in two hours and a 0.04 per cent dissolution of the uranium.

The effect of dissolved uranium(IV) on rate of attack of sintered UO_2 by 6 M NH_4F-0.5 M NH_4NO_3 was studied. The rate is lower by a factor of about 10 when the solution is saturated with uranium(IV). This indicates that less UO_2 core material should convert to the uranium(IV) fluoride during the Zircaloy-2 decladding operation than was estimated previously from results of experiments with uranium metal.

[redacted]

Dissolution of UO_2 in HNO_3

Initial rates of dissolution as low as 0.1 and 0.4 g/hr,cm^2 were observed in boiling 8 and 12 molar nitric acid, respectively. As non-uniform attack resulted in increasing the surface area, the reaction rate increased. Acid consumption to terminal acidities greater than 2.4 molar nitric acid was in the range of 2.4 to 2.8 moles of HNO_3 per mole of UO_2 dissolved.

Dissolution of Metallic Uranium in HNO_3-HF

The rate of dissolution of uranium metal in 1 molar nitric acid containing 0.2 to 4.0 molar hydrofluoric acid follows the equation:

$$\text{Dissolution rate (grams/hour/cm}^2) = 0.27\ (M_{HF})^{-1.3}$$

The rate of dissolution is second order with respect to nitric acid concentration in the range 0.5 to 2.0 molar nitric acid when the initial hydrofluoric acid concentration is fixed at 0.5 molar.

Corrosion Studies

Hastelloy-F. Corrosion and dissolution rates in nitric-hydrofluoric acid solutions as determined in recently completed Teflon equipment are appreciably higher than rates previously determined in glass equipment. In Teflon equipment, 304-L stainless steel dissolves at about six mils/hr in 2 M HNO_3-2 M HF solution at 85 C. Vacuum melted Hastelloy-F corrodes in this solution at rates of 10 mils/mo at 85 C and 25 mils/mo at boiling. As stainless steel dissolution products build up in the solution, the 304 L dissolution rate decreases. For example, when the solution contains 25 grams of stainless steel per liter, the dissolution rate is about 0.3 mil/hr. A similar, although not as marked, decrease in the corrosion rate for Hastelloy-F occurs as stainless steel dissolution products accumulate in the solution.

Vacuum melted Hastelloy-F weld metal has an unsatisfactorily high corrosion rate (>100 mils/month) in nitric-hydrofluoric acid solutions. Heat treatment at 1900 F (recommended temperature) had no beneficial effect. Cold-worked welds and Hastelloy-F welded with Haynes 25 filler rod are currently being evaluated for corrosion resistance.

Preliminary data indicate nitrogen is the major component (85 mole per cent) of the off-gas produced from the dissolution of stainless steel in 2 M HNO_3-2 M HF solution. Oxides of nitrogen, oxygen, and hydrogen are present to the extent of nine, four, and two mole per cent, respectively.

Stress Corrosion Cracking of A-55 Titanium. Investigation of the corrosion resistance of hard-faced titanium to 65 weight per cent nitric acid (hard surfaced in cyanide bath) showed stress corrosion cracking adjacent to numbers placed on the samples with a Vibra-tool and with an arc pencil. Metallurgical examination showed the cracks propagated only through the hard surface. No cracking was observed on non-surfaced A-55 titanium marked with arc pencil, Vibra-tool, and metal stamp after exposure to 65 weight per cent nitric acid and to dilute aqua regia. Cracking of

the oxide film was observed on titanium specimens heat treated at 2000 F for one minute, air cooled, and exposed to dilute aqua regia. The oxide film remained intact when exposed to 65 weight per cent nitric acid.

Criticality Studies

Homogeneous UNH System. The preparation and delivery of the enriched homogeneous uranyl nitrate for the third and final portion of the full-scale phase of the PCTR criticality experiment have been completed. The shipment consisted of two 500-lb batches of uranyl nitrate with an 8 hydrogen to uranium atomic ratio and enriched to 2.10 per cent and 2.30 per cent U-235, respectively; and one 40-lb batch with an 8 H/U atomic ratio at 2.20 per cent U-235. In addition, two 40-lb batches with a 10 H/U atomic ratio and enriched to 2.10 per cent and 2.30 per cent U-235, respectively, were prepared.

REACTOR DEVELOPMENT - 4000 PROGRAM

Reprocessing of PRP Fuels by Amine Extraction

Additional experiments have been done in an attempt to clean up used amine extractant. Since the extracted activity is primarily zirconium-niobium, a series of complexing agents were tried. These included sodium sulfate, sodium oxalate, sodium citrate, versene, ammonium fluoride, and sulfuric acid. Filtration through silica gel was also tried. None of these treatments were as effective as dilute sodium hydroxide, which gives a gross gamma E_g^o of about 0.7.

Non-Rigid Fuel Cores

Three samples of uranium dioxide-bismuth slurries containing 20 w/o uranium were prepared by both the in situ and magnesium gettering methods. One such sample retained its fluidity for over 200 hours at 600 C, being shaken after 64, 128, and 203 hours at that temperature. It was then allowed to stand for 92 hours, at which time the furnace was cooled and the capsule analyzed. Analyses of six segments starting at the top disclosed uranium concentrations of 22.2, 25.5, 22.0, 21.1, 19.3, and 10.9 w/o uranium (weighted average 19.9 w/o uranium). The appearance was good. No oxide was observed at the top, although some patches of free oxide were visible on sectioning. The stability of the slurry is quite remarkable and very possibly broadens the feasibility of its use as a reactor component.

Trans-Plutonium Isotopes

A theoretical study of the production of trans-plutonium isotopes in plutonium fuels under recycle, such as in the operation of the PRT reactor, was made with the cooperation of personnel of the Physics and Instrument Research and Development Operation. Exposure and recycle conditions based upon proposed PRTR operating plans were selected, and a Goodyear analog computer was used to solve the equations. Curves were plotted giving yields versus years of exposure and number of cycles for five plutonium isotopes and 15 trans-plutonium isotopes including californium-252.

[redacted]

BIOLOGY AND MEDICINE - 6000 PROGRAM

Dosimetry Studies

Preliminary laboratory development was completed on a plutonium bioassay procedure to allow analyses of on-site samples. The procedure has a yield of 85 ± four per cent and utilizes small area electrodeposition and nuclear track counting techniques to obtain high sensitivity. The sensitivity and suitability for routine application will be tested by the Bioassay Laboratory when modified electrodeposition cells and nuclear track counting microscopes are obtained.

Spectrophotometric procedures were developed for phosphate and uranium in aqueous solutions which allow the detection of 0.1 ppm in a 10 cm cell. These procedures will be used in studies to determine the source of the parent isotopes which are activated in the reactor cooling water to give P^{32}, Np^{239}, and the fission products. The spectra from the common ions which might interfere in the measurements were also measured.

Continuing studies of the chemical form of P^{32} containing ions in reactor effluent water have shown that the efficiency of the ion exchange method of separating the phosphate ions is affected by the presence of carrier phosphates. When a carrier containing a mixture of ortho-, pyro-, and more condensed phosphates is added to reactor effluent water prior to application of the ion exchange separation, most (about 88 per cent) of the P^{32} appears as the orthophosphate. Without carrier the orthophosphate value was reported in February to be about two to three per cent. Further study is required before these results can be explained in terms of the chemical form of P^{32} in reactor effluent water since the differences observed may be due to the ion exchanger, changes resulting from the addition of carrier, or other variables.

Geology and Hydrology

The Standard Oil Company of California abandoned their stratigraphic test well after penetrating 10,665 feet of basalt. The basalts, more than twice as thick as previously known, and the absence of significant breaks in the series to that depth, apparently precludes the economical disposal of wastes beneath the basalts.

Further research on unsaturated flow indicates a relationship between the moisture content function that must be incorporated into the basic Darcy flow equation and the range of pore sizes available in the porous medium. The experimental data tended to establish uniform pore size for well graded sand of relatively uniform shape but a wide range of pore sizes for typical Hanford soils.

Fluorescein dye was detected in a third observation well being sampled as part of the current ground water tracer test. The appearance of the dye occurred 67 days after the start of the test, indicating a maximum average velocity of 335 ft/day.

A water stage recorder installed in a well near Gable Mountain indicated a sharp fluctuation in the ground water table at 7:00 a.m. on April 7, 1958. This fluctuation appeared to correlate with a reported major earthquake in Alaska.

Soil Chemistry and Geochemistry

During an experiment to study the capacity of a calcite bed for removing radiostrontium from synthetic high-salt waste, thirty liters of the waste solution were passed through a 34 cc bed of crushed limestone without detectable breakthrough of strontium. The apatite formed by this reaction was analyzed to indicate an actual formula of:

$$\left[Ca_{9.35}Na_{1.07}\right]\ \left[(PO_4)_{5.46}\ (CO_3)_{1.36}\right]\ (OH)_{0.67}\cdot(H_2O)_{1.33}$$

Tests showed that Sr^{90} removal by calcite was significantly reduced at phosphate ion concentrations below 5×10^{-4} M.

The natural pollucite mineral was found to contain 0.01 to 0.1 per cent sodium ion. The hydrated sodium ion being the same size as the normally unhydrated cesium ion, it is replaced by cesium in exchange reactions. The sodium ion was shown to be the only exchangeable ion in natural pollucite. The reaction is significantly specific for cesium removal. For a Cs^{137} solution of 2×10^{-3} ppm, concentrations of K of 40 ppm, Rb of 86 ppm and Na of 1000 ppm are required to measurably affect Cs removal.

Sixteen other zeolites were also examined to determine their ability to remove Cs from solution. Six of the zeolites tested showed high exchange capacities for cesium and two were found to have unusually high selectivity for cesium in the presence of other alkalies.

Ground Water Investigations

Laboratory soil column experiments designed to study the influence of soil column length and diameter on crib evaluation tests are in progress. Six of the 21 planned experiments were completed but the results do not yet justify drawing conclusions regarding this effect.

Tests with an electrolytic technique for providing controlled feed to laboratory soil columns were discontinued. The apparatus was found to be extremely sensitive to atmospheric pressure changes, flow variations as large as 100 per cent resulting from natural, diurnal atmospheric pressure changes.

Field Apparatus Development

Laboratory equipment for permeability measurement was fabricated, installed and given preliminary tests. An initial experiment indicated that soil permeability as measured in the laboratory was about 10 per cent of that from a field determination made through pumping tests. Several possible causative factors were recognized. Valid permeability measurements permit ground water velocities to be computed when the water gradient is known.

L. P. Bupp

Manager
Chemical Research & Development

LP Bupp:bp

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
A. Friedman	4/14/	AEC Division of Reasearch Washington, D.C.	Research Programs in CR&D	LP Bupp	Yes
D. L. Horrocks	4/10-11/	Argonne National Lab Lemont, Illinois	Discuss radiochemistry methods.	RJ Brouns FP Brauer JM Nielsen LJ Kirby	Yes
J. R. Craig	4/16/	AEC Washington, D.C.	Discussed Washington Designated Programs	RJ Brouns FP Brauer	Yes
T. Parsons	4/29/	Radiation Laboratory Berkeley, California	Discussed transuranic element recovery.	WH Reas	Yes
E. Anderson	4/21/	AEC Division of Reactor Dept. Washington, D.C.	Non-Production Fuel Reprocessing Program and fission product recovery.	LP Bupp OF Hill	Yes
J. E. Machurek	4/22/	AEC Office of Industrial Development Washington, D.C.	Fission Product Facility.	OF Hill RJ Sloat	Yes
T. Parsons	4/29/	University of Calif. Radiation Laboratory Berkeley, California	Transplutonium isotope production.	AM Platt	Yes
J. G. Schnizlein	4/22/	Argonne National Lab. Lemont, Illinois	Consultation on uranium oxidation studies.	RK Hilliard	No
G. R. Quimby J. E. Jeffrey L. F. Maranville	4/1/	Rayonier Incorporated Olympic Research Shelton, Washington	Discuss radiochemical methods, instruments.	LC Schwendiman	No
R. Schreurs	4/28/	E. E. Johnson, Inc. St. Paul, Minn.	Discuss well screen requirements at Hanford.	DJ 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
C. S. Content J. R. Jensen	4/15/	Bechtel Corporation San Francisco, Calif.	Discuss geological & hydrological research at Hanford that might be of value in their dam studies on the Lewis & Columbia Rivers.	RE Brown DJ Brown WH Bierschenk JR Raymond	No
J. H. Mackin L. Pierce	4/13/	University of Wash. Seattle, Washington	Discuss geology of Pasco Basin area, particularly the Ringold-Touchet-fluviatile-Palouse formation relationship.	RE Brown JR Raymond	No
H. H. Waldron	4/13/	USGS Seattle, Washington	Discuss geology of Pasco Basin area, particularly the Ringold-Touchet-fluviatile-Palouse formation relationship.	RE Brown JR Raymond	No
A. S. Cary R. H. Gedney W. L. Shannon	4/16/	Corps of Engineers Seattle, Washington Shannon & Wilson Soil Mechanics & Foundation Engineers Seattle, Washington	Discuss foundation problems to develop 100-F & 100-H Areas as a result of the proposed Ben Franklin Dam.	RE Brown	No
W. H. Gardner	4/25/	Washington State Coll. Pullman, Washington	Discuss with PP Rowe his experimental equipment, procedures, and experimental results, in his work for PhD degree.	PP Rowe	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
C. I. Alexander	4/1-3/	Magnolia Petroleum Co. Dallas, Texas	Inspection of facilities and discussion of waste disposal. American Petroleum Institute.	LP Bupp DW Pearce	Yes
J. O. Blomeke W. deLaguna E. G. Struxness		Oak Ridge National Lab. Oak Ridge, Tennessee			
W. G. Belter J. A. Lieberman		AEC Washington, D.C.			
G. Herzog		The Texas Company Bellaire, Texas			
T. V. Moore		Standard Oil Company New York, New York			
W. S. Morris		East Texas Salt Water Disposal Company Kilgore, Texas			
E. W. Roedder		USGS Washington, D.C.			
C. V. Theis		USGS Albuquerque, New Mexico			
J. W. Watkins		U.S. Bureau of Mines Bartlesville, Oklahoma			
M. Williams		Humble Oil Company Houston, Texas			

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
A. F. Voigt	4/21-23/	Ames Laboratory Ames, Iowa	Attend Plutonium Fuel Technology Symposium	LP Bupp WH Reas	Yes
R. J. Ackermann M. Ader R. J. Dunworth K. R. Ferguson F. G. Foote R. C. Goertz H. H. Hyman J. H. Kittel S. Lawroski W. B. Lowenstein H. O. Monson M. Novick J. G. Schnizlein A. B. Shuck B. I. Spinrad R. K. Steunenberg		Argonne National Lab. Lemont, Illinois			
E. L. Anderson W. C. Bartels G. W. Courtney R. C. Dalzell C. D. Goodman L. H. Roddis J. M. Simmons G. Wensch		Atomic Energy Commission Division of Reactor Development Washington, D.C.			
R. B. Martin		Oak Ridge Operations Office Oak Ridge, Tennessee			
W. D. Sandburg		Savannah River Operations Office Aiken, South Carolina			

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
B. Anderson	4/21-23/	Chicago Operations Office Lemont, Illinois	Attend Plutonium Fuel Technology Symposium.	LP Bupp WH Reas	Yes
J. B. Philipson		Idaho Operations Office Idaho Falls, Idaho			
R. Balent R. Berman G. E. Brand C. C. Woolsey		Atomics International Canoga Park, California			
B. W. Dunnington		Battelle Memorial Institute Columbus, Ohio			
L. A. Matheson I. D. Venable		Dow Chemical Company Denver, Colorado			
R. D. Baker J. A. Leary W. J. Maraman W. D. McNeese A. N. Morgan P. J. Peterson F. W. Schonfield R. S. Winchester		Los Alamos Scientific Lab. Los Alamos, New Mexico			
L. B. Jones		Mound Laboratory Miamisburg, Ohio			
E. D. Arnold R. E. Brooksbank T. J. Burnett D. E. Ferguson J. P. Hammond D. E. Horner R. E. Leuze W. H. Lewis		Oak Ridge National Laboratory Oak Ridge, Tennessee			

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented and Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data
M. H. Barts D. R. deBoisblanc	4/21-23/	Phillips Petroleum Co. Idaho Falls, Idaho	Attend Plutonium Fuel Technology Symposium	LP Bupp WH Reas	Yes
E. E. Hayes F. W. Tober		Savannah River Laboratory Aiken, South Carolina			
W. J. Ramsey		University of California Radiation Laboratory Berkeley, California			

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. E. Brown	4/16/	Corps of Engineers Bonneville Dam, Oregon	Discuss usage of Corps of Engineers river model in study of possible effect of Ben Franklin Dam on Hanford reactor operation. Also preliminary discussions on reactor foundation problems.	RH Gedney	No
	4/28/	Corps of Engineers Ice Harbor Dam, Wash.	Discuss mutual geological problems with Corps of Engineers geologist at Ice Harbor.	M Eversaul	No
W. H. Bierschenk	4/16-19/	1958 Pacific Northwest Regional Conf. Spokane, Washington	Present paper "Hydrological Research in the Ground Disposal of Radioactive Wastes"	JJ Quinlan	No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
C. W. Thomas	4/14-17/	National ACS Meeting San Francisco, Calif.	Present Paper		No
	4/18/	U.S. Naval Radiological Defense Lab. San Francisco, Calif.	Discuss Analytical Procedures	J. Mackin HV Weiss P. Zigman	Yes
H. A. Treibs	4/14-17/	National ACS Meeting San Francisco, Calif.	Present Paper		No
	4/18/	U.S. Naval Radiological Defense Lab.	Discuss counting procedures	J. Mackin P. Zigman HV Weiss DF Covell	Yes
W. W. Schulz	4/14-18/	National ACS Meeting San Francisco, Calif.	Present Paper		No
R. E. Burns	4/14-15/	Iowa State College Ames, Iowa	PhD Recruiting Trip		No
	4/17-18/	University of Michigan Ann Arbor, Michigan	PhD Recruiting Trip		No
	4/21/	Haynes-Stellite Corp. Kokomo, Indiana	Confer on Hastelloy-F properties & availability.		No
	4/22/	Battelle Memorial Inst. Columbus, Ohio	Discuss corrosion of metals.	P Miller C Peterson E White F Fink	Yes
	4/23/	Bettis Plant Pittsburgh, Ohio	Discuss film formation and decontamination of mild steel.	B Schultz WT Lindsay P Brown R Lloyd	Yes

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. E. Burns	4/22-25/	Oak Ridge National Lab. Oak Ridge, Tennessee	Problems on non-production fuels reprocessing uranium conversion.	RE Blanco IR Higgins	Yes
V. P. Kelly	4/23/	Mallinckrodt Chemical St. Louis, Missouri	Inspect pulverizing equipment used in processing uranium, size reduction of uranium chips, and other mechanical processing equipment.	KJ Caplan	Yes
	4/22&24/	William Patent Crusher & Pulverizing Company St. Louis, Missouri	Observe the test pulverizing of simulated fuel elements assembly.	E Jueckstock	No
L. L. Burger	4/14-18/	National ACS Meeting San Francisco, Calif.	Attended Meeting		No
	4/21/	Stanford Research Inst. Menlo Park, California	Discuss radiation chemistry.	EM Kinderman	No
	4/22/	Vallecitos Laboratory Pleasanton, California	Discuss radiation chemistry.	S Jones DH Ahmann	No
H. T. Hahn	4/14-17/	National ACS Meeting San Francisco, Calif.	Present paper.		No
	4/17/	Aeroprojects, Inc. (Talked with him at ACS meeting)	Discussed application of ultrasonics to liquid metal slurries.	M Bromberg	No
	4/18/	APED San Jose, California	Discussed electromagnetic pumps and associated metering equipment.	B Voorhees G Collins I Gregg	No
J. R. Morrey	4/14-18/	National ACS Meeting San Francisco, Calif.	Present paper.		No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
R. W. Perkins	4/14-17/	National ACS Meeting San Francisco, Calif.	Attended meeting.		No
	4/18/	U.S. Radiological Defense Laboratory San Francisco, Calif.	Discussed gamma-ray spectrometric counting techniques and radiochemical procedures.	D McDonald	No
J. L. Ryan E. J. Wheelwright	4/14-17/	National ACS Meeting San Francisco, Calif.	JL Ryan presented paper prepared by both.		No
	4/18/	Vallecitos Laboratory Pleasanton, California	Discussed proposal project for resin radiation stability tests.	RW Coyle	No
J. L. Swanson	4/14-18/	National ACS Meeting San Francisco, Calif.	Presented paper.		No

BIOLOGY OPERATION

A. Organization and Personnel

No major or significant items relating to personnel changes or activities occurred during April 1958.

B. TECHNICAL ACTIVITIES

FISSIONABLE MATERIALS - 2000 PROGRAM

BIOLOGICAL MONITORING

Atmospheric Contamination

Concentrations of I^{131} in thyroid glands of jack rabbits were about five times those observed a year ago. Values were as follow:

Collection Site	uc/g thyroid Average	Maximum	Trend Factor
Four Miles S.W. of Redox	1×10^{-2}	3×10^{-2}	• 5
Wahluke Slopes	1×10^{-2}	1×10^{-2}	•17
Prosser Barricade	7×10^{-3}	1×10^{-2}	• 2

Concentrations of fission products in rabbit liver and feces were 2 and 25 times greater, respectively, than one year ago. These increased levels presumably resulted from atmospheric contamination originating at the recent Russian nuclear tests. Values were as follow:

Sample Type	Average µc/g	Monthly trend
Feces	5×10^{-4}	• 17
Bone	4×10^{-4}	• 4
Muscle	3×10^{-5}	• 3
Liver	1×10^{-5}	-

Columbia River Contamination

The contamination levels for beta emitters in representative organisms from the river were as follow:

Sample Type	Collection Site	µc/g wet wt. tissue Average	Maximum	Monthly Trend
Minnows (entire)	Hanford	7×10^{-4}	3×10^{-3}	-
Minnows (entire)	McNary	4×10^{-4}	7×10^{-4}	
Whitefish flesh	Ringold	3×10^{-4}	7×10^{-4}	

[redacted]

Concentrations of P^{32} in 77 Canada goose eggs collected during the current nesting survey were three times greater in shell and albumen than last year. Values for yolk remained the same. Concentrations were as follow:

Egg Component	$\mu c\ P^{32}/g$
Shell	3×10^{-4}
Albumen	3×10^{-5}
Yolk	1×10^{-4}

Effect of Reactor Effluent on Aquatic Organisms

Reactor effluent, which was varied in concentration from 3 to 6.2 per cent to simulate the magnitude of fluctuation which results from power production at Priest Rapids Dam, caused a slight but significant increase in mortality of young Chinook salmon. The result was not significantly different from that caused by continuous exposure to four per cent effluent, however.

Young Chinook salmon exposed to four per cent strength effluent from special Tube No. 4963 of the KE reactor had a significantly higher mortality than the fish exposed to a like concentration of the gross effluent. The process water in the special tube is at a lower pH than that of the rest of the reactor.

BIOLOGY AND MEDICINE - 6000 PROGRAM

METABOLISM, TOXICITY, AND TRANSFER OF RADIOACTIVE MATERIALS

Reactor Effluent Radioisotopes

The distribution of several reactor effluent radioisotopes was determined in rats 20 hours after intragastric administration of 10 ml of 30 times concentrated reactor effluent water. Isotopes detected included Na^{24} and P^{32} which were present in highest concentration in bone; Cr^{51}, Cu^{64}, and Np^{239} which were present in highest concentration in kidney; and Zn^{65}, As^{76}, and Mo^{99} which were present in highest concentration in liver.

Phosphorus

Eggs have been obtained from a rainbow trout which had been receiving 0.006 µc P^{32} per gram of body weight per day. These eggs are being incubated to determine if radiation damage is discernible. It is hoped that eggs can be obtained from additional fish to improve the reliability of the results.

Zinc

Zn^{65} is concentrated approximately equally in barley grown on Ephrata soil and on Cinebar soil. Yield from Ephrata was about nine times higher than from Cinebar soil but the total amount of Zn^{65} was likewise nine times more, so that the concentration in the plant tissue was the same. This appears to show that there is, in the initial stage, little or no difference in zinc fixation between these two soils.

[redacted]

Strontium

Strontium-90 was made up as crystalline material of the following eight different compounds: $SrCl_2$, $Sr(NO_3)_2$, $SrCO_3$, $SrSO_4$, $SrHPO_4$, $Sr(OH)_2$, SrF_2, and SrC_2O_4. These were added to Cinebar soil in amounts to produce a contamination of 10 μc Sr^{90}/100 g soil with the Sr carrier at 100 μg/g. These soils were then used in Neubauer culture with barley. Concentration factors were those normally observed for the chloride and nitrate, but about 20-fold lower for carbonate, sulphate, phosphate, hydroxide, fluoride and oxalate. These results indicate that the maximum depression of Sr^{90} uptake obtainable by precipitation will be about 20. It is presumed that with time these insoluble compounds will gradually become more available. Rates to establish equilibrium will be obtained in pot culture experiments.

Preliminary results are available through the 50th day of feeding from the experiment studying the effects of dietary calcium on chronic deposition and retention in rats of Sr^{90} and Ca^{45}. After 50 days, the OR varies from 0.08 on the 0.03 per cent calcium diet to 0.38 on the 2.0 per cent calcium diet. Over the approximately 65-fold range in dietary calcium, the deposition and retention of Sr^{90} varies over a fourfold range and the deposition and retention of Ca^{45} varies over a 17-fold range.

An experiment was initiated to determine the effects of dietary calcium level on the retention of a single intraperitoneal dose of Sr^{90} and Ca^{45}.

The uptake and excretion pattern of orally administered Sr^{90} in three miniature pigs during a 15-day period was studied. Blood, urine and feces samples were collected at predetermined intervals after dosing. Samples of all tissues and the total skeleton were collected at post mortem and were submitted for radiochemical analysis.

Results relative to the concentration of Sr^{90} in the blood at different times after single dosing indicated that the maximum concentration of Sr^{90} in the blood was reached during the first ten hours after dosing, then steadily declined to pre-dosing levels by the sixth day.

A study to determine the effects of different levels of dietary calcium in the diet of the ewe on Sr^{90} absorption and tissue retention in ewe and turnover of Sr^{90} to suckling lambs was initiated. Nine ewes with lambs were separated into three groups and fed 200 μc $Sr^{90}Y^{90}$ and 200 μc Ca^{45} per day for ten days. Dietary calcium of each group was as follows: normal calcium, 1.25 x normal and 1.50 x normal. Blood and milk samples from the ewes were obtained daily, as were blood samples from the lambs. Ewes and lambs will be sacrificed at the end of ten days for tissue analysis.

Iodine

Some sheep and pigs are continuing to receive I^{131} daily. Only a few measurements of effects are being taken for this study which will continue during the animals' lifetimes to determine long-term effects. Principal observations include thyroidal I^{131} metabolism and histopathology.

[redacted]

Cesium

The concentrations of Cs^{137} in the water and organisms from the pond which were spiked with the isotope last June were essentially the same as during the previous month. Concentration factors of Cs^{137} in sunfish from the pond ranged from 1,000 for liver to 3,000 for muscle.

Plutonium

Preliminary studies of the toxicity of $CaNa_3$ DTPA were completed. Six rats were employed in each group at dose levels of 2,500, 2,000, 1,500, 1,000 and 500 mg/kg, administered intraperitoneally. At the highest dose level, three out of the six rats exhibited hardened gastrointestinal tracts and a white, hard deposit on certain of the viscera. Spleens appeared darker than normal. One rat at the 2,000 mg/kg level exhibited the same effects. Rats at the two highest dose levels lost weight during the experiment and showed a decreased urine and fecal output.

In tests of additional chelating agents, ethylene bis(α-imino-o-hydroxyphenylacetic acid) (EHPA), was shown to be almost as effective as DTPA in preventing bone deposition of plutonium, more effective in promoting fecal excretion of plutonium, but considerably less effective in stimulating urinary output. EHPA has the disadvantage of being quite insoluble at physiological pH and is considerably more toxic than DTPA.

Fallout

Eight stations were established in the State of Washington for studies of the effects of environmental factors upon accumulation of radioactive materials from fallout in the natural biota. The stations are located in areas of widely varied environmental conditions.

Gastrointestinal Radiation Injury

Twelve rats were each administered intragastrically 500 mg of $Pu^{239}O_2$. These animals were sacrificed after 3, 6 and 9 days and will be studied for extent of histological damage to the intestinal tract.

Additional experiments were performed to study the effect of partial shielding of portions of the exteriorized intestine. Results are not yet available.

Radioactive Particles

Five hundred days after inhalation of 0.2 μc $Ru^{106}O_2$, 39 mice were killed for pathology and radiochemical studies. Preliminary data show a high concentration of Ru^{106} in the ovaries, adrenals, lungs and spleen. No gross pathology was observed. Other mice have completed six months of daily exposure to $Sr^{90}SO_4$ aerosol and are being retained for clinical and longevity studies.

A whole-body monitor for dogs has been completed by Instrument Research and Development Operation. The instrument will be used initially to study the deposition and retention of inhaled plutonium.

Relative Biological Effectiveness

P^{32} recently obtained from Oak Ridge in carrier-free form appears to be giving dose values which are reasonably in agreement with calculated values. Dose evaluation by the Chemical Research Operation indicated that 97 per cent of the theoretically possible dose was absorbed within the culture volume. RBE values for tritium were 0.9 and 1 for the last series. Data for calculating mutation and biochemical RBE's are not yet available.

It now appears feasible to determine loss of phosphorus containing compounds resulting from radiation damage as a measure of radiation effects. This test may be suitable for use in RBE tests.

Research Services

Approximately 300 pathology slides were examined and results recorded for Aquatic Biology.

As a result of work at the Experimental Animal Farm on decontamination of pig skin (HW 44526), Aeroplast has been approved by the Radiological Development Operation for skin decontamination use by non-medical personnel.

H A Kornberg
Manager
BIOLOGY OPERATION

HA Kornberg:es

C. Offsite Vists and HLO Visitors

Name	Dates of Visit	Company of Organization Represented and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data	Areas and Buildings Visited
VISITORS TO HAPO						
George Hazzard	4/1/58	GE Research Lab, Schenectady, N.Y.	Inspect facilities	Kornberg Warner	No	100-F,108-F 141-M,146-FR
12 members	4/3/58	American Petroleum Institute Committee	Waste disposal	Kornberg Foster Clarke	No	100-F, 141-M 146-FR
179 personnel and guests	4/5/58	Employees and guests	Biology Open House	-	-	100-F, 108-F, 141-M, 146-FR
Joe Morden	4/15/58	GE Schenectady Public Relations	Tour Biology	Thompson Kornberg	-	100-F, 108-F
Members (25)	4/21/58	Plutonium Fuel Technology Conference	Tour Biology	Kornberg Clarke Foster	-	100-F, 141-M 146-FR
Dr. R.F. Daubenmire	4/23	Washington State College, Pullman	Ecological research	Hanson	-	100-F, 146-F
S. E. Hazlet	4/29/58	Dean, Graduate School, WSC, Pullman	Discuss post-graduate programs.	Kornberg	-	100-F, 108-F 141-M, 146-FR
VISITS TO OTHER INSTALLATIONS						
HA Kornberg	4/8/58	Yakima County Medical Association, Sunnyside	Give lecture.	DA Northrop Exec. Secretary	-	-
LA George	4/9-21/58	Cornell Univ., Ithaca, N.Y., Armed Forces Inst. of Path., Wash. D.C. U. of Utah Rad. Lab., Salt Lake City, Utah	Discuss mutual research problems. (Present a paper at Soc.Exptl.Biol. in Philadelphia.)	Comar & Wasserman Col. Skold Rehfeld & Mays	-	-
DE Warner	4/24-25	USNRDL, San Francisco	Inspect vivarium and laboratories	Tompkins, Covell, Shell	-	-
VH Smith	4/19-26	UCRL, USNRDL, San Francisco	Discuss radio-biology and attend ACS meetings.	Tompkins, Gong, Garrison, Durben	-	-
RC Thompson	4/30	Seattle, Wash.	Address ASME	-	-	-
JJ Davis and RC Pendleton	4/21-24/58	Ozette, Wash. and other sites west of Cascades	Establish collection sites.	-	-	-
RT O'Brien	4/26-5/2	Argonne National Lab., Lemont, Ill. and Chicago	Present paper at Soc. of Am. Bacteriologists and discuss research.	EL Powers and staff		-

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D. Lectures

a. Papers presented at meetings

George, L.A., "Comparative Effects of Beta Irradiation on Rabbit, Sheep and Swine Skin," Meeting of the Federation of American Societies for Experimental Biology, Philadelphia, Pennsylvania, April 16, 1958.

O'Brien, R.T., "Radiation Sensitivity of Cytochrome Deficient Yeast," Society of American Bacteriologists, Chicago, Illinois, April 28, 1958.

Thompson, R.C., "The Hazard of Radioactive Fallout from Weapons Testing," American Society of Mechanical Engineers, Seattle, Washington, April 30, 1958.

Kornberg, H.A., "Radiation Biology at Hanford", Yakima County Medical Association, Sunnyside, Washington, April 8, 1958.

b. Seminars

April 9, 1958 - J. E. Ballou, "Zinc-65 Metabolism in Rats"

V. H. Smith, "Removal of Internally Deposited Pu"

April 23, 1958 - R. C. Thompson, "The Hazard of Radioactive Fallout from Weapons Testing"

April 28, 1958 - R. Borasky, "Modern Research in Biology", Mid-Columbia Science Fair Association

E. Publications

HW Publications

None

Open Literature

Bair, W.J. and F.P. Hungate, "Synergistic Action of EDTA and Radiation on Yeast," Science 127, 813 (1958).

[redacted]

[redacted]

HW-55905

OPERATIONS RESEARCH AND SYNTHESIS OPERATION MONTHLY REPORT

April, 1958

ORGANIZATION AND PERSONNEL

Jane A. Figg joined the Experimental Statistics function as a Statistician on April 1, 1958.

OPERATIONS RESEARCH ACTIVITY

Economic Studies

Four meetings of the task force to develop methods for the evaluation of long range capital expenditure programs were held during April. The two programs which are to be compared and the type of detailed description necessary to their comparison were agreed upon. The preparation of appropriate production statistics for these programs has been started.

Work on the construction of an input-output response simulation model is proceeding in two directions: (1) the construction and study of small highly aggregated models which will serve to pilot the construction of a larger and more detailed model and (2) the collection and assembly of past production data in a form amenable to statistical examination in order to determine appropriate structural assumptions.

CPD Control Study

Work during the month was primarily concerned with completing the description and definition, both numerically and logically, of the present system in preparation for an interim report to be issued in May. During the course of this work, it is becoming apparent that timely analysis and interpretation of present control data is burdensome, due at least partially to the difficulties in manually extracting required information from the large number of records available. The possible use of machine methods will be further investigated.

Other

Work on the study of operator coverage at electrical substations has been delayed pending the receipt of further information from both the Utilities Operation and the Irradiation Processing Department.

STATISTICAL AND MATHEMATICAL ACTIVITIES IN SUPPORT OF THE RESEARCH PROGRAM

2000 Program - Metallurgy

Further statistical assistance was given in connection with corrosion experiments on aluminum alloys.

[redacted]

Production Tests - Irrad. Proc. Dept. and Fuels Prep. Dept.

Continued consultation has been afforded responsible personnel in connection with appropriate changes in the reporting of profilometer measurements of irradiated fuel elements so as to establish a greater degree of consistency in the data reported.

An analysis is being made of distortion data from production test PT-634, and additional data from production test IP-19A were analyzed during the month.

General - Irradiation Processing Department

Methods of solutions for a set of simultaneous linear differential equations and the corresponding characteristic equations were discussed with interested personnel.

A method of determining the ratio between two constants which occur in a Fourier series expansion whose coefficients are linear combinations of Bessel functions was found, and a problem on the rearrangement, integration, and summation of an infinite series of functions was solved.

General - Chemical Processing Department

Data on the corrosion of stainless steel by nitric acid have been tabulated in preparation for an extensive analysis of the effect of differences between alloys, physical geometries, and suppliers on corrosion attack.

Work on the feasibility of using the computer as an aid in controlling final product was continued. Work on the calibration of the C-2 tank has been completed.

Assistance was given in designing an experiment to compare the durability of different types of gloves and in determining methods of obtaining confidence limits for the average exposure of personnel in certain work areas.

Two different integrals involving Bessel functions were investigated. One integral was evaluated and the second reduced to tabular form.

OTHER STATISTICAL AND MATHEMATICAL ACTIVITIES

Activities for Other Operations

Consultation with the task force on SS accountability was continued. A production test specifying how the appropriate experimentation will be conducted was agreed upon. Assistance was also given in the interpretation of correlation coefficients between various combinations of book physical inventory differences, removals, receipts and inventories. These interpretations are difficult due to the functional dependence of the items being correlated.

Assistance was provided in the design of a questionnaire to evaluate the effectiveness of the Asiatic Flu program conducted last fall.

Activities within HLO

Statistical analyses in connection with absenteeism and minor injury data were completed. In addition, further statistical consultation was provided in connection with error rates of an office machine operator.

Discussions were held concerning possible statistical assistance in the prediction of crib capacities. A problem in the design of a lead cask to be used in transporting radioactive materials was solved. Evaluation of routine standard and referee data from the analytical laboratories was continued.

Discussions were held concerning an experimental program to determine the precision of the current neutron dosimetry program, and a sequential statistical design was suggested for carrying out experimentation to determine the optimum location of future sampling positions.

Work on a mathematical model describing the environ deposition of radioactive material from Hanford sources was continued.

OFFSITE VISITS

C. A. Bennett presented a paper on the "Application of Learning Curves to Industrial Problems" to the 6th Pacific Northwest Quality Control Conference, Seattle, Washington on April 12, 1958.

Carl C. Bennett

C. A. Bennett, Manager
OPERATIONS RESEARCH & SYNTHESIS

CAB:jbk

RADIATION PROTECTION OPERATION MONTHLY REPORT-APRIL, 1958

A. ORGANIZATION AND PERSONNEL

The function of the Consulting Radiological Scientist was transferred from the Radiation Protection Operation to the newly organized Programming Operation on April 1, 1958.

J. W. Healy and Margaret M. Wood transferred to the Programming Operation on April 1 and April 7, 1958, respectively. F. L. (Irene) Peters transferred to Chemical Research and Development on April 14, 1958. Betty S. Hamrick terminated April 11, 1958. J. M. Selby terminated April 25, 1958. Patricia O. Lemler began leave of absence on April 7, 1958.

Force Summary	3-31-58	4-30-58
Exempt	41	40
Nonexempt	125	120
Total	166	160

B. ACTIVITIES

Three cases of plutonium deposition were confirmed as a result of special bioassay sampling following known radiation incidents. Two of the cases appeared to result in negligible deposition of plutonium. The more serious case was reported last month. It involved a puncture injury associated with skin contamination. Preliminary bioassay results on this case indicate plutonium deposition not in excess of 0.01 μc. One case of personnel exposure in excess of permissible limits occurred when a Purex process operator was splashed with process solution during maintenance work on sampling equipment. The maximum estimated dose was 2.5 rads including 0.09 r to the arm.

A review of the trends of accumulated external exposures received by employees in 1958 indicates an upward trend in some areas. In some selected groups (75 to 100 people) in the reactor areas, the last 12 months dose is increasing at the rate of about 40 mr per employee per month. Only prompt and effective measurements will avoid a substantial number of plant employees exceeding 3 r per year in 1958.

The average weekly emission of I^{131} from Separations facilities was 9.2 curies. The average weekly emission rate for the 12-month period ending in April is 8.0 curies. Substantial fallout from nuclear bomb tests made the analysis of I^{131} on vegetation difficult. In nearby residential areas the average I^{131} deposition (from all sources) on vegetation was about 70% of the Hanford working limit of 1×10^{-5} μc/gram. Iodine deposition on vegetation samples in Portland and Spokane averaged about 150% of the Hanford working limit; presumably from fallout. Fallout of nuclear debris also caused a five-fold increase in deposition on vegetation of fission products other than I^{131}.

Analysis of Columbia River water at 100-F area and Pasco were normal for this time of the year.

On April 14 a slug caught fire in the rear-face area of the 100-KE reactor. The resultant discharge of about 0.05 curie to the atmosphere caused ground contamination in a narrow band extending several miles southeast of 100-K area.

Experimental operation of the prototype film-badge processing machine was successful. Work is in progress to add the planned attachments, such as automatic badge feeding mechanism and failsafe control improvements, to the machine.

Initial data obtained using modified badges with cadmium shields for slow-neutron monitoring verified Los Alamos observations. Exposure of 20 millirems of thermal neutrons resulted in a useful density difference of 0.01 in optical density units. The testing has been limited to the range of 20 to 100 millirems until a suitable slow-neutron source, free from excessive gamma radiation is available. The planned procurement of a PuF_4 source should remedy this situation. Minor design changes were made for modification of the plastic badge to contain two packets of film and a cadmium absorber. Bid invitations for these badges were prepared. The use of X-ray for coding NTA film was found to be satisfactory with a slight adjustment in energy and dose as compared to its normal use for coding beta-gamma film. This technique will be an improvement over the current manual method of scribing identifications on the film itself.

The new bioassay sample flask containers arrived and were accepted. Work progressed on the fabrication of low-level pencil reading devices. Preliminary data on the application of this pulse technique for reading slow-neutron pencils looks favorable. Work continued on the modification and evaluation of continuous impactor air sampler equipment. Calculations were made on the capabilities of the present radiometallurgy facilities for examination of plutonium fuel elements.

The modification of the portable BF_3 to be used in conjunction with the recently developed (Radiological Physics Operation) double moderator approached completion. The remaining work consists largely of fabrication of suitable calibration equipment and development of procedures.

A preliminary analytical procedure was received from Chemical Development Operation. This procedure will permit analysis of plutonium in a small volume of urine by plating the plutonium on an 8 sq. mm. area. The current practice is electro-plating the plutonium on a 44 sq. mm. area. Necessary equipment is being ordered or modified to permit full testing of this procedure in the bioassay laboratory.

Radiation Monitoring and Calibration services were provided for customers without incident.

Contributions were made by several staff members for the Hanford presentation at the Public Hearings on Waste Disposal.

C. EMPLOYEE RELATIONS

There were three medical treatment injuries for a frequency of 1.11. No security violations occurred during the month.

Three suggestions were submitted by Radiation Protection Operation Operation personnel. Three suggestions were received for evaluation.

No new developments occurred in current negotiations with the regional monitors.

D. SIGNIFICANT REPORTS

HW-25457 - Radiation Protection Standards. One standard, RPS 7.2, Radioactive Liquid Waste Disposal, was reissued with updating changes.

The following papers were prepared for presentation at the Health Physics Society meeting in San Francisco in June, 1958.

"Electronic Data Processing and Radiation Exposure Records" by I. C. Nelson.

"A Pulse Reading Method for Condenser Ion Chamber" by F. L. Rising.

"A Film Technique for Measuring the Exposure Dose from Plutonium" by E. C. Watson.

"Radiological Protection Considerations for a Plutonium Fuel Element Fabrication Pilot Plant" by A. J. Stevens.

The following documents were issued during the month.

HW-55171 "Waste Disposal Monitoring Activities Summary, February 1958" by R. M. Bernard.

HW-55724 "Regional Monitoring Activities, March 1958" by Regional Monitoring personnel.

HW-55843 "Investigation of Eastman Personal Monitoring Type II Film for Potential Use at HAPO" by W. V. Baumgartner.

HW-55907 "Monthly Report - April 1958, Radiation Monitoring Operation" by A. J. Stevens.

[redacted]

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization tion Represented & Address	Reason for Visit	HW Personnel Contacted	Access to Restricted Data	Areas and Buildings
T. J. Burnett	4/24/58	Oak Ridge Nat'l. Lab. Oak Ridge, Tennessee	To review Hanford practices and designs on the badge and badge processing and the electronic data processing of exposure records.	RL Junkins LJ Defferding IC Nelson HA Meloeny RH Wilson	NO	329, 3706 3705:300 747:700
			Discuss stack monitoring	JK Soldat	NO	

VISITS TO OTHER INSTALLATIONS

B. G. Lindberg	4/11/58	2700th EOD Squadron Hill Air Force Base, Ogden, Utah	Confer on equipment and procedures in work of mutual interest.	Maj. AI Fisher	YES
B. G. Lindberg	4/14 - 18/58	Sandia Corp., Task Group 57, Project 74 Camp Mercury, Nevada	Participate in alpha monitoring field exercise and conference at Nevada Test Site, as representative of one nationally-designated emergency monitoring team.	Mr. RE Butler	YES

REGIONAL MONITORING - RESULTS (March 23 - April 20)

Sample Type and Location	Activity Type	Monthly Average	Units*	Trend** Factor
Drinking Water				
100-F Area	Isotopic	1.1	% MPC_{GI}	+2
Separations Areas	Total Beta	7.4×10^{-7}	µc/cc	-2
Pasco	Isotopic	0.3	% MPC_{GI}	--
Kennewick	Isotopic	0.7	% MPC_{GI}	--
Richland	Total Beta	3.3×10^{-8}	µc/cc	--
Columbia River Water				
Above 100-B Area	Total Beta	4.1×10^{-8}	µc/cc	--
100-F Area	Isotopic	7.3	% MPC_{GI}	+2
Hanford Ferry	Total Beta	6.0×10^{-5}	µc/cc	--
Pasco	Isotopic	1.4	% MPC_{GI}	--
McNary Dam	Total Beta	1.2×10^{-6}	µc/cc	--
Vancouver, Washington	Total Beta	3.7×10^{-7}	µc/cc	--
Waste Water				
Outlying Test Wells	Total Beta	$< 2.0 \times 10^{-7}$ (max.)	µc/cc	-2
Reactor Effluent Retention Basins to River	Total Beta	~~160~~ 27,600 *	curies/day	--
Atmosphere				
Gross Dose Rate -				
Separations Areas	Beta-gamma	1.2	mrad/day	--
Residential Areas	Beta-gamma	1.3	mrad/day	+2
I-131 Separations Areas	I-131	9.7×10^{-13}	µc/cc	--
I-131 Separations Stacks	I-131	9.2	curies/week	-2
Active Particles - Project	--	4.6	ptle/100 m^3	+7
Active Particles - Environs	--	7.6	ptle/100 m^3	+13
Vegetation				
Separations	I-131	1.8×10^{-5}	µc/gm	+2
Residential	I-131	6.8×10^{-6}	µc/gm	+4
Eastern Washington and Oregon	I-131	1.5×10^{-5}	µc/gm	+10
Fission Products less I-131 - Wash., Ore.	Beta	2.6×10^{-4}	µc/gm	+5

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

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

* Correction made per DE Document Correction Receipt dated 6-13-58 RJ

RADIATION MONITORING	Hanford Laboratories	Minor & Major Construction	Others	April	1958 to Date
Special Work Permits	1367	63	526	1956	7883
Routine and Special Surveys	1322	37	306	1665	6189
Air Samples	2249	6	239	2494	9353
Skin Contaminations	7	0	1	8	21
*Class II Radiation Incidents	0	0	0	0	0
**Class II Radiation Incidents	0	0	1	1	6*

EXPOSURE EVALUATION AND RECORDS

Gamma Pencils	Pencils Processed	Paired Readings 100-280 mr	Paired Readings Over 280 mr	Lost Readings
April	43,290	40	3	3
1958 to Date	193,542	158	24	14

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)
April	21,966	747	20	2	51	3.20	9.11
1958 to Date	87,796	3,341	104	30	184	3.27	9.55

Slow Neutron Pencils

	Pencils Processed	Paired Readings 4-12 mrem	Paired Readings Over 12 mrem	Lost Readings
April	4,024	66	21	0
1958 to Date	16,186	205	65	6

Fast Neutron Film Badges

	Badges Processed	Readings Above 50 mrem	Lost Readings
April	1,137	0	0
1958 to Date	4,828	8	4

Bioassay	April	1958 to Date
Plutonium: Samples Assayed	1,331	5,288
Results above 2.2×10^{-8} µc/sample	34	158
Fission Product: Samples Assayed	1,368	5,499
Results above 3.1×10^{-5} µc FP/sample	2	11
Uranium: Samples Assayed	321	1,295
Confirmed Plutonium Deposition Cases	3	10[1]

*HLO Radiation Monitoring Customers
**Other Plant Components
[1]Bringing all-time HAPO total to 222
*Correction of March 1958 report

Uranium Analyses	Following Exposure Units of 10^{-9} µc U/cc			Following Period of No Exposure Units of 10^{-9} µc U/cc		
Sample Description	Maximum	Average	Number Samples	Maximum	Average	Number Samples
Fuels Preparation	50.4	9.9	26	13.4	4.2	24
Hanford Laboratories	48.0	6.9	34	33.5	8.1	19
Chemical Processing	30.8	5.6	65	81.2	6.1	55
Chemical Processing*	29.6	8.1	31	37.4	7.0	29
Special Incidents	0	0	0	0	0	0
Random	6.5	2.0	38	0	0	0

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

Thyroid Checks	April	1958 to Date
Checks Taken	6	11
Checks Indicating >0.01 µc	0	0

Hand Checks		
Checks Taken - Alpha	46,192	187,544
- Beta-Gamma	37,731	154,167

CALIBRATIONS

Portable Instruments	Number of Units Calibrated April	1958 to Date
CP Meter	1,032	3,844
Juno	350	1,288
GM	1,431	5,244
Other	247	888
Total	3,060	11,264
Personnel Meters		
Badge Film	1,384	4,768
Pencils	5,168	16,755
Other	283	1,254
Total	6,835	22,777
Miscellaneous Special Services	583	4,195
Total Number of Calibrations	10,478	38,236

A. R. Keene, Manager
RADIATION PROTECTION

ARK:kc

LABORATORY AUXILIARIES OPERATION
MONTHLY REPORT - APRIL, 1958

GENERAL

Safety performance of the Operation was considered satisfactory. There were no major injuries; the minor injury frequency rate was 2.92 per cent.

The absenteeism rate was 4.20 per cent, which is above average experience. The high rate is due to several specific illnesses.

There was one security violation charged to the Operation.

TECHNICAL SHOPS OPERATION

Total productive time for the month was 13,092 hours. The total shop work backlog is 20,634 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 2.6% (466 hours) of the total available hours.

Distribution of time was as follows:	Man Hours	% of Total
Fuels Preparation Department	2763	21.2
Irradiation Processing Department	919	6.9
Chemical Processing Department	1152	8.8
Hanford Laboratories Operation	7862	60.1
Construction Engineering Operation	268	2.0
Miscellaneous	128	1.0

Customer demands for service remained firm with the total backlog of work slightly below the previous month. Requests for emergency service decreased, resulting in a nominal amount of overtime being worked.

Security performance was considered satisfactory with no violations. The number of minor injuries was high (10) compared to an expected annual average of 6 to 8. Increased attention by supervision to causes of minor injuries is being stressed with a corresponding increase in effort toward encouraging employees to faithfully report all injuries.

A symposium on lathe operation conducted by the Monarch Machine Tool Company was attended by the shop engineer. New developments in sintered carbide tools were explored and demonstrations were held on Monarch machines to illustrate the effectiveness of new tool grinding techniques. Information obtained is being passed on to shop personnel.

A Cincinnati universal milling machine has been placed on order with delivery expected prior to 6-15-58. This machine will replace an obsolete piece of equipment and will assist the shops in providing improved customer service.

RADIOGRAPHIC TESTING OPERATION

Activity for the Radiographic Testing Operation continued at a high level for the past month. Continuing the trend of previous months the number of tests performed reached a high point. A total of 5733 tests were made of which 686 were radiographic

exposures (including x-ray and gamma) and 5047 were supplementary tests. The supplementary test work included penetrant, ultrasonic, eddy current, dimensional measurements (micrometric and air gage), densitometry, and stress measurements. The feet of material examined was down somewhat from last month but still totaled 12,280 feet. This footage represented 1,220 pieces examined. Work was done for 14 different organizational components representing most of the operating departments and service operations. A total of 15 reports were issued detailing test findings with conclusions and recommended action. Radiographic Testing Operation was consulted on 15 different occasions for advice and information regarding general testing theory and applications for other than the jobs tabulated in Part II.

A new area of work was engaged in during the past month with the opportunity of making stress measurements on the piping on the front face of the 100-D Reactor. It was desired to determine the extent of possible damage due to a vibrating condition in one of the header pipes. Strain gage measurements were made and the results are being analyzed, taking into consideration the fatigue properties of the pipe material.

Testing Statistics

Component	No. of Tests	Ft. of Weld or Material	No. of Pieces	Description
A. Chemical Processing Department	8	10	1	5" sch 40, SS welded pipe.
B. Construction Engineering Operation	90	157.5	18	100 Area field construction air receiver tanks. Test reactor nozzle cap assembly.
C. Hanford Laboratories Operation	5418	7671	1050	Welding of 303 to 304. UO_2 PUO_2-UO_2 PRTR S.S. and Zr clad, and MTR fuel elements. Irradiated and normal graphite rods, BDF, ribbed Zr Process tubing. Pressure vessel survey 300 A.
D. Relations and Utilities Operation	217	4441.5	151	SS welded pipe. Pole climbers, buckles, snaps, etc.
	5733	12,280	1220	

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FACILITIES ENGINEERING OPERATION

Projects

Following is a summary of project activity:

Number of Authorized Projects at end of month	15
Number of Projects completed during the month	2*
Number of Projects authorized during the month	2**
Total Authorized Funds	$ 4,415,000
Total Estimated Cost of Authorized Projects	$ 8,086,000
Project Proposals in Preparation	4***
Project Proposals submitted to the AEC during the month	2****
Service Engineering during the month (Approximate)	$ 4,875.00
Number of Projects Awaiting AEC Approval	4*#

* CG-664, 350° Flow Loop - 314 Building
CG-672, Monochromatic Neutron Beam Facility - 105-KE-Building

** CAH-794, Geological & Hydrological Wells - FY 1958 (Total funds)
CA-744, Metallurgical Development Facility ($60,000 design funds)
In addition total authorization was given for CA-749, High Level Radiochemistry Facility

*** Increase Electrical Capacity - 328 Building
High Temperature Testing Cell - 327 Building
X-Ray Diffraction Cell - 327 Building
Additions to Separations Development Facilities - 321 Building, CG-779 Rev.1 (The project proposal was submitted to Contract Administration 4-30-58)

**** CAH-794, Geological & Hydrological Wells - FY 1958
CGH-796, Facilities for Isotope Study on Animals

*# CG-731, Rev. 1, Critical Mass Laboratory $ 1,800,000
CG-760, Expansion of the 3745-B Facility 193,000
CGH-790, High Level Radioactive Receiving and Storage Addition 325,000
CGH-796, Facilities for Isotope Study on Animals 49,800
Total Estimated Cost of Projects Awaiting Approval $ 2,367,800

A detailed report of project activity and status is attached.

Engineering Services

Title	Status
Modification of Elevator, 327 Building.	Requests for vendor estimates being made.
Acid System and Acid Dispenser Installation - Bioassay Laboratory, 747 Building.	Appropriation Request and Work Determination for Plant Forces approved. Design complete and work order is being issued for installation.
Lessen Sound Level and Improve Ventilation in Key Punch Room, 3760 Building.	Job complete.
Recommendation for Air Filter on Vacuum System, 325 Building.	Work in progress.
Install Intercom System, 326 Building.	Work in progress.
Resistance Seam Welder, 325 Building.	Work in progress.
Repair Damaged 100-KW Water Heater, HEW-445692 for Code Compliance.	Work in progress.
Electrical Addition - Basement, 325 Building.	Conduit and wire run. Completion pending delivery of Circuit Breaker, expected 5-25-58.
Install Hot Water Heater, 327 Building.	Heater and equipment on order.
Clean Up the West End of the 314 Building.	A fixed price estimate is being obtained from CO to clean up portions of the building east of the melt plant. Material to be excessed or disposed of has been listed.
Service and Outlets, 141-H Building.	Work progressing. Estimated 50% complete.
Provide Ventilation Exhaust from Room 8-2A, 325 Building and Block Existing Supply.	Job complete.
Greenhouse - Roof of 108-F Building.	Engineering load study complete. Job now pending customer's decision.
Development Plan for Biology Operation.	The preliminary plan has been formulated ready for review by the affected group.
Installation of New Hood, Laboratory 14-A, 329 Building.	Appropriation Request AR-58-HL-2-78 approved. Work Order for design will be issued.

1243522

Title	Status
Fabricate and Install XY Manipulator in Metallographic Cell.	Appropriation Request has been approved. Fabrication in shop is underway.
Construct Pig Farrowing House, 100-F Animal Farm.	The Work Order has been signed and Fixed Price for construction has been agreed upon. Construction will start in May.
Lawn Sprinkling System for Aquatic Biology Building, 100-F.	Information is being obtained from vendor's of underground sprinkling systems.
Extend Annunciator System, 1706-KE Building.	Installation plans will be drawn and submitted to 1706-K Engineer for approval.

Design and Drafting Services

An equivalent of 135 drawings were produced during the month excluding graphics work. The work load is very heavy in the central drafting room. The location of FEO drafting personnel other than in the 3706 central drafting room is as follows:

306 Building - 2
327 Building - 1
272-A Building - 2
1707-D Building - 1

Three on-loan employees from CEO are working with our group.

Approximately 12,000 square feet of prints were reproduced during the month.

The following summarizes the major work in the drafting operation:

Title	Status
Cesium Recovery.	Approximately 45% complete.
Swage Loading and Feed Mechanism.	Approximately 75% complete.
Medium Level Chemical Cell, 325 Building.	Work in progress.
Ceramic Fuels - Loading and Handling Mechanism.	Scope 100% complete.
Vacuum Welding Box - 306 Building.	Scope 100% complete - detailing 10%.
Ceramic Fuel Density Test Equipment.	Details 100% complete.
Vacuum Welding Chamber - 326 Building.	Detail 100% complete.
Chuck for Welding Ceramic Elements 325 Building.	Detail 100% complete.

Maintenance and Building Engineering Services

Modification of 3707-C was completed with the exception of the partition installation and associated wiring. Partitions are due late in May. At month's end, SS Accountability moved into the unpartitioned area. Completion is scheduled for late June but the space will be used effectively almost a month and a half in advance.

Erecting of the library stacks was begun at month's end. It is planned to install a row of stacks then transfer the books to it. Then relocate the empty stacks until space is provided for the new stack arrangement.

Plans are being made with FPD to jointly renovate room 313 in 3706 Building. FPD will use half the space for offices. In the other half, HLO will house the Radiological Development laboratory from 325 Building. Ceramic Fuels in turn will occupy the released laboratory in the 325 Building.

A program to revise the building prints to a current basis has been initiated with CEO Drafting. Once the tracings have been corrected, vigorous measures will be taken to maintain their "as built" condition.

An enclosure was designed to shield the southwest stairway of the 326 Building from wind and precipitation. The installation cost is being estimated.

Investigations have been made to devise proper storage and ultimate disposal procedures and facilities for laboratory equipment. Comments from other locations such as the GE Research Laboratory and the General Engineering Laboratory are being studied.

Programs for scheduling and recording maintenance are being studied as possible supplements to the present scheduled preventive maintenance.

The 147-F Pump House was inspected and a plan for correction of existing safety hazards and flooding conditions is being prepared.

A water filter and water softener will be installed in the 306 Building.

Extensions of gas storage facilities will be installed to buildings 325 and 329.

Extension of the existing stairway for roof access on the south side of 306 Building is being investigated. Also, a study is being made to evaluate methods of improving maintenance on the air-conditioning units, 306 Building roof.

Two downdraft hoods from 325 Building are being relocated in room 313, 3706 Building. The problem of adapting existing fans in the 3706 attic to these hoods has been worked out. An ultrasonic generator will also be relocated from 325 to this location.

Engineering survey of HLO Pressure Vessels is 80% complete.

Six pressure vessels in the 189-D Building were inspected by the Third Party Inspector during the month.

Engineering Survey of Liquid Helium requirements for HLO and HAPO. Report is being written.

TECHNICAL INFORMATION OPERATION

Work Volume Statistics

		March	April
Library -			
	Titles Added	152	74
	Volumes Added	291	251
	Books Circulated	1,630	2,737
	Periodicals Circulated	4,393	4,934
	Reference Questions	208	228
Classified Files -			
	Documents routed and discharged	16,868	18,376
	Documents issued	8,431	9,139
	Documents sent offsite	6,224	8,974
	Documents filed	8,653	9,151
	Documents Destroyed	5,751	9,659
Report Reference and Publication -			
	Abstracts	168	192
	Literature Searches	29	29
	Formal Reports Issued	7	8
	Reports released to CAP	37	29

LABORATORIES ADMINISTRATION

Timely revisions were issued to thirteen Organization and Policy Guides. Two O.P.G.'s; No. 05.3.6, Authorization of Work Performed by Other HOO-AEC Contractors, and No. 05.3.8, Authorization of Work by HOO-AEC, were withdrawn because the same subjects are now covered by No. 04.6, Authorization and Performance of Work.

O.P.G. No. 04.6, Authorization and Performance of Work, has been subjected to review and study. Twelve O.P.G's on associated subjects, including work by other A.E.C. contractors, assistance to Hanford; design, test, and engineering procedures, are being considered along with No. 04.6. All of these are being organized into a draft of a manual.

The delegation of authority of September 1, 1956, regarding absences due to military service was incorporated into O.P.G. No. 03.1.10, Employees Entering the Armed Forces and Re-employment of Veterans. Specific delegations of authorities were issued as covered by O.P.G. No. 02.3.1, Approval Authorizations.

Contract No. DDR-5 with Superior Tube Company for Zircaloy tubes was amended.

Consultant Agreement CA-189 with Dr. M. E. Eusminger for services in animal husbandry was processed for approval.

Consultant Agreement CA-185 with Dr. Sidney Marks was reviewed with Manager - Biology. Recommendations on administration are being considered.

Contract No. DDR-24 with Nuclear Metals, Inc. has been closed out.

Requirements for Assistance to Hanford program and KAPL services to Hanford were received from Level 3 Operations. These have been summarized and an authorization letter requesting approval of the A.E.C. has been prepared.

The assignments of vehicles to Hanford Laboratories Operation remained unchanged, however, four reassignments were made within and between Level 3 Operations.

A survey was made within Hanford Laboratories Operation of the need to microfilm vital records other than those already done for Technical Information Operation and Radiation Protection Operation.

Manager
LABORATORY AUXILIARIES

JL Boyd:jcw

UNCLASSIFIED

MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	EST. TOTAL PROJECT COST	AUTHORIZATION INFORMATION AMOUNT / DATE	PROJECT PROGRESS IN PER CENT DESIGN SCHED / DESIGN ACTUAL	PROJECT PROGRESS IN PER CENT CONST. SCHED / CONST. ACTUAL	STARTING DATE DESIGN / CONST.	Directive Comp. Date Design / Constr.	Estimated COMP. DATE DESIGN / CONST.
General Plant Projects - FY 1956									
AEC-2-23X-56-L-2		Reactor & Fuels	$ 127,000	$ 140,000* / 4-4-57	100 / 100	100 / 100	5-23-56 / 12-7-56	- - - / 5-1-58	9-28-56 / 4-30-58**
CG-664	350° C Flow Loop - 314 Building								

REMARKS: Start-up testing is progressing. Minor difficulties are being corrected. This project has been completed. Physical Completion Notice dated April 30, 1958 is being routed for approvals. This project will not again be carried in this report.

Engineer: R. W. Dascenzo

*Includes $350 transferred equipment. **Actual date.

General Plant Projects - FY 1957								
AEC-23-57-N-2		Radiation Protection	$ 150,000	$ 150,000 / 2-4-57	100 / 100	25 / 20	2-18-57 / 3-11-58	- - - / 12-31-58	12-19-57* / 10-31-58
CA-658	Shielded Personnel Monitoring Station - 747 Building								

REMARKS: The concrete floor, foundations and footings for the building are complete. Construction of the concrete block exterior walls and wood framing for the inside partitions are underway. The concrete block walls of the addition are pink and do not match the grey of the existing building. It has not yet been decided whether to leave it as is or to have the entire exterior of the existing building and addition painted one color. A meeting was held among representatives of the AEC, general and sub-contractors, A-E, and G. E. to discuss difficulties confronting the fabricator working on the 7 inch plate. The flame cut edges are extremely hard and difficulty was experienced finding tools sufficiently hard to machine them. Annealing is being considered as one solution. Surface irregularities and holes in the plates were also discussed, and methods of correcting them were established. The difficulties experienced on this steel are not expected to affect the project completion schedule, because delivery of the outer 3 inch steel plates is still governing the completion of cell fabrication. *Actual date.

Engineer: D. S. Jackson

		Chemical Research	$ 80,000	$ 73,000 / 3-12-57	100 / 100	98 / 98	4-23-57 / 9-15-57	6-12-57* / 9-15-58	5-28-57** / 7-1-58
CG-729	Ventilation System Improvements - 222-U Building								

REMARKS: The fixed price contractor has resubmitted his claim of $1,200 for furnishing the filters in the exhaust filter box. The General Electric Company has recommended to the Commission that this claim not be paid, it is felt that this item is covered adequately on the drawings. The CPFF Construction Contractor has removed the obsolete exhaust fans and patched the roof. New grills for the ventilation system have been installed. In order to obtain a proper balance on the ventilation system, it will probably be necessary to replace the outside doors. This would increase the former estimated project cost by $2,500. Plant Forces have done some preliminary work toward balancing the system.

Engineer: A. W. Hervin

*Scheduled date. **Actual date.

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-55902
April, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	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 / Constr.	Estimated COMP. DATE DESIGN / CONST.
CG-733	Plutonium Metallurgy Facility	Reactor & Fuels	$ 295,000	$ 295,000 5-10-57	100 100	96 98	5-14-57 6-10-57	9-25-57* 6-15-58	10-1-57** 5-1-58
	Engineer: J. T. Lloyd	REMARKS: Changing ventilation ductwork in Rooms 16 and 17 was added to the project. This work is in progress. One piece of equipment must be brought in before the last removable door can be can be replaced. The small hood with ductwork and piping located in Cell I has to be removed. Room 38 is now complete. The above per cent complete reflects the additional work. *Scheduled date. **Actual date.							
General Plant Projects - FY 1958 AEC-2-23-58-L		Physics & Instr.	$ 193,000	None to date None	To be est 0	To be est 0	1* 9*	None None	6* 16*
CG-760	Expansion of the 3745-B Facility	REMARKS: The project proposal was resubmitted to the AEC-HOO March 13, 1958 and is under study.							
	Engineer: R. C. Ingersoll	*Months after authorization.							
CA-765	Additions to the 314 Building	Reactor & Fuels	$ 46,000	$ 46,000 11-15-57	100 100	0 0	10-14-57 5-15-58(a)	- - - 11-15-58	3-7-58 11-15-58
		REMARKS: The CPFF Construction Contractor has removed the contaminated machinery platform and barricaded the underground concrete duct.							
	Engineer: A. W. Hervin	(a)Bid opening for the construction work is scheduled for opening May 1, 1958.							
CA-778	Expansion of the 305-B Building	Physics & Instr.	$ 55,000	$ 55,000 12-11-57	N.S. 75	0 0	4-4-58* 6-16-58#	5-15-58 10-15-58	5-7-58# 10-1-58#
		REMARKS: A-E's schedule on Title II was submitted to the Commission April 11, 1958 and approved 4-16-58. Comments on A-E preliminary construction drawings and specifications were sent to the Commission April 15, 1958. A-E expects to complete and submit detailed design for approval the week of April 28.							
	Engineer: R. C. Ingersoll	*Actual date. #A-E's scheduled dates.							
CG-779	Additions to Separations Development Facilities - 321 Building	Chemical Research	$ 28,000	None to date None	0 0	0 0	None None	None None	None None
		REMARKS: The new project proposal has been submitted to Contract Administration.							
	Engineer: J. T. Lloyd								

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	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 / Constr.	Estimated COMP. DATE DESIGN / CONST.
IR-236	321 Building Test Pit Enclosure Engineer: A. W. Hervin	Chemical R & D	$ 19,000	$ 19,000 2-28-58	N.S. 20	0 0	3-3-58 None*	- - - None*	None None
		REMARKS: No further work has been done this month as the army has not released the hutment to the Commission. However, indications are that the hutment may be released the first part of May, 1958. *Dates cannot be established until release of the hutment.							
CAH-794	Geological and Hydrological Wells - FY 1958 Engineer: D. S. Jackson	Chemical Research	$ 49,000	$ 49,000 4-16-58	N.S. 10	0 0	4-7-58 6-23-58	- - - 12-31-58	5-12-58 12-31-58
		REMARKS: Directive AEC-129, dated April 16, 1958 authorized the Engineering Supply Division of AEC-HOO to incur costs in the amount of $49,000 for the performance of this work. General Electric Company received Work Authority CAH-794(1) authorizing us to proceed with the work and to incur costs in the amount of $8,300.							
CA-769	Additions to the 622 Building Engineer: J. T. Lloyd	Physics & Instr.	$ 80,000	None to date None	0 0	0 0	None None	None None	None None
		REMARKS: At the request of the General Electric Company the project proposal was returned from the AEC on April 8, 1958. A restudy of the requirements will be made to determine if the objective can be accomplished by alternate methods.							
Equipment Not Included in Construction Projects - Program Class 2900		Reactor & Fuels	$ 664,000	$ 664,000 9-18-57	33 45	0 0	12-6-56 1-15-59	10-1-58* 8-31-59*	11-1-58 8-31-59
CG-661	Additional Heat Generation Facility - 189-D Building	REMARKS: Design work is continuing on both the electrical and mechanical phases of the work. The vendor, General Electric Company, has submitted twelve large lay-out drawings for approval on the Direct Current Power Supply. Work is progressing on the fabrication of the heat exchanger and it is anticipated that it will be shipped during May, 1958. Due to a discrepancy in the specifications concerning code requirements, the steam condenser will probably not be shipped until July, 1958.							
		REMARKS: (CG-661 Continued) this will not affect the project completion date. *Scheduled dates.							

BM-7300-005 (11-58) AEC-GE RICHLAND, WASH.

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-55905
April, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	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 / CONSTR.	Directive Comp. Date Design / Constr.	Estimated COMP. DATE DESIGN / CONST.
CG-672	Monochromatic Neutron Beam Facility - 105-KE Building Engineer: H. Radow	Physics & Instr.	$ 183,000	$ 195,000 3-7-57	100 100	100 100	5-21-56 11-1-57	- - - 5-1-58	10-29-56* 4-25-58*
		REMARKS: This project has been completed. Physical Completion Notice dated April 30, 1958 is being routed for approvals. This project will not again be carried in this report. *Actual dates.							
CA-681	Hanford Equipment in the ETR Engineer: H. Radow	Reactor & Fuels	$1,200,000	$1,200,000 8-12-57	93** 93**	N.S. 10	9-17-56* 4-7-58*	- - - 12-15-58	7-1-58 1-30-59
		REMARKS: Installation of equipment by Phillips forces started April 7, 1958. A construction schedule has not yet been received, but current unofficial estimate for completion of the 3 x 3 loop is Mid-July. **Modification of the 9 x 9 loop to accommodate larger fuel elements has been approved. Revised design is scheduled for completion on July 1, 1958. *Actual dates.							
CG-682	High Level Cut-Off and Examination Cell - 327 Building Engineer: A. W. Hervin	Reactor & Fuels	$ 430,000	$ 430,000 8-20-57	100 100	8 9	7-18-56* 3-27-58*	- - - 10-1-58	6-26-57* 10-1-58
		REMARKS: The cut-off saw is being run-in by the vendor and shipment is anticipated the first of May. The 14 ton shipping cask has been completed by the vendor and has been shipped. The vendor for the manipulator has received most of his material and sub-assemblies are in progress. The vendor of the meehanite cell has completed all boring except on the one casting which is being replaced. The cell is being assembled and shipment of the castings, except the replacement casting, should occur during the first part of May. Work is progressing on the sliding blocks for the cell. This order is being followed very closely to ascertain that the delivery date does not slip to the point where it would impair completion of the project. Work on the lead glass windows is progressing. The CPFF construction contractor started dismantling the existing lead brick cell April 23, 1958. Approximately 70% of the cell has been removed. The contractor has also erected a plastic shelter around the cell to contain the contaminated dust particles in the immediate cell area, thus permitting normal operation for all other areas in the canyon. Most of the electrical and service lines in the basement, which interfere with the new structural supports for the cell and also support the 14 ton cask track dolly, have been relocated. Framework has been installed in the basement east of the new cell location and will serve as a barrier to prevent contamination spread when the hole is being cut into the existing wet storage basin. *Actual dates.							

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

PROJECT NUMBER	TITLE	USING COMPONENT	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 / Constr.	Estimated COMP. DATE DESIGN / CONST.
CA-695	Radio Telemetering Network Engineer: J. T. Lloyd	Physics & Instr.	$ 98,000	$ 89,000 1-10-57	100 100	15 15	2-22-57 7-25-57	4-15-57* 5-15-58	5-27-57** 1-1-59
		REMARKS: The prototype has been shipped. The AEC has awarded Contract No. 1238, for the repeater station, to the Motorola Company for $2,995. *Scheduled date. **Actual date.							
CG-758	Ceramic Fuels Development Press and Furnace Additions Engineer: R. C. Ingersoll	Reactor & Fuels	$ 175,000*#	$ 200,000 8-1-57	100 100	N.S.* 40	8-22-57 1-20-58	2-1-58** 10-1-58	2-28-58# 10-1-58
		REMARKS: The furnace installation is complete with exceptions involving minor changes in wiring and piping. Bid opening on press installation has been postponed indefinitely pending study and action on locating the press in the 325 Building. *An overall construction schedule has not been established because the second phase construction (press installation) has not been scheduled. **Scheduled date. # Actual date. *#Based on latest cost information.							
CG-785	In-Reactor Studies Equipment - 105-KW Building Engineer: H. Radow	Reactor & Fuels	$ 440,000	$ 15,000* 2-12-58	20 20	0 0	3-10-58 None	None None	6-13-58 None
		REMARKS: Comment drawings on one capsule have been submitted. The instrument panel layout has been resolved, pending contacts with vendors on special instrumentation that may be available. Conceptual sketches on 4 types of capsules have been submitted to design. *For preliminary design and necessary services to submit a revised project proposal for detail design, procurement and construction funds.							
New Construction - FY 1958 CG-731	Critical Mass Laboratory Engineer: R. W. Dascenzo	Physics & Instr.	$1,800,000	None to date None	0 0	0 0	None None	None None	None None
		REMARKS: The local AEC has received a teletype authorizing funds of $175,000 for total design of this project, but to date a directive has not been issued.							
CA-744	Metallurgical Development Facility Engineer: R. W. Dascenzo	Reactor & Fuels	$2,600,000	$ 60,000 4-28-58	0 0	0 0	None est. None	None None	None None
		REMARKS: Directive AEC-133 and Work Authority CA-744(1) have been issued authorizing $60,000 for partial design. The directive and work authority also indicate the project scope is not to exceed $2,600,000 in cost.							

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MONTHLY PROJECT REPORT

HANFORD LABORATORIES OPERATION

HW-55900
April, 1958

PROJECT NUMBER	TITLE	USING COMPONENT	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 / Constr.	Estimated COMP. DATE DESIGN / CONST.
CA-749	High Level Radiochemistry Facility Engineer: R. W. Dascenzo	Chemical Research	$1,070,000	$1,070,000 4-21-58	0* 0*	0 0	7-1-58 9-1-58	- - - 6-30-59	10-30-58 6-30-59
		REMARKS: Work Authority CA-749(3) dated 4-8-58 increased previously authorized GE funds from $20,000 to $23,000 for performance of preliminary design. Directive AEC-112, Mod. 2, dated 4-21-58 authorizing $1,070,000 total project funds has been received. Advance notice for invitation to bid was issued on 4-18-58. The bid package for construction will be prepared by April 30. Bidders have until 6-12-58 to submit bids. *Does not include scoping, preliminary design & bid package by GE.							
	X-Ray Diffraction Cell - 327 Building Engineer: R. W. Dascenzo	Reactor & Fuels	$ 120,000	None to date None	0 0	0 0	None None	None None	None None
		REMARKS: A project proposal for partial design money is being routed for approval.							
	High Temperature Tensile Testing Cell - 327 Building Engineer: R. W. Dascenzo	Reactor & Fuels	$ 140,000	None to date None	0 0	0 0	None None	None None	None None
		REMARKS: A project proposal for partial design money is being routed for approval.							
CGH-790	High Level Radioactive Receiving and Storage Addition Engineer: A. W. Hervin	Reactor & Fuels	$ 325,000	None to date None	0 0	0 0	1* 8*	None None	6* 19*
		REMARKS: The project proposal and data sheet were forwarded to AEC-Washington on April 4, 1958. *Months after approval.							
CGH-796	Facilities for Isotope Study on Animals Engineer: J. T. Lloyd	Biology	$ 49,800	None to date None	0 0	0 0	None None	None None	None None
		REMARKS: The project proposal was submitted to the AEC-HOO on April 18, 1958. It was scheduled for review on April 24, 1958, however, action was deferred one week to allow the Review Board to become more familiar with the proposed work.							

BM-7300-005 (11-56) AEC-GE RICHLAND, WASH.

VISITS TO HANFORD WORKS

Name	Dates of Visits	Company or Organization Represented & Address	Reason for Visit	H.W. Personnel Contacted	Access to Restricted Data	Areas & Buildings Visited
Members of ACS Student Chapters in Eastern Wash. Colleges	4-18-58	Various Colleges	Tour Technical Information Facilities	C. G. Stevenson	No	300 - 3760
S. E. Cumpston	4-28-58	General Electric Co. ANPD Lockland, Ohio	Tour Plant Facilities	O. W. Priebe	No	300 - 325, 326, 327, 328 329

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
O. W. Priebe	4-14 & 4-15-58	ASME Meeting Pittsburgh, Pa.	Attend Plant Engineering and Maintenance Conference	--	No
	4-16 & 4-17-58	General Electric Co. Schenectady, N.Y.	Company Business	Mr. Robb, Mr. Rauu, and Mr. Short	No
	4-18-58	General Electric Co. New York, New York	Company Business	Mr. Clover	No
	4-21-58	Moslar Safe Company Hamilton, Ohio	Review procurement of purchase order H8S-48976, High Level Cut-off Cell	E. M. Burnhagen GE Field Inspector	No
D. S. Jackson	4-23-58	Todd Shipyard Co. Seattle, Washington	Vendor Liaison on Project CA-658	G. Ackerman Mr. Richmond Mr. Kramer	No
J. H. Kelly	4-7-58- 4-14-58	Monarch Machine Tool Co. Sydney, Ohio	To attend a symposium	S.A. Brandenbury Al Albrecht	No
R. L. Scott	4-25 - 4-26-58	Univ. of Washington Seattle, Washington	To participate as HAPO representative at NDT Exposition		No

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visits	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
C. G. Stevenson	4-21 - 4-25-58	National Lead Company Fernald, Ohio	Attend meeting of Technical Information Panel and Library and Control Sub-Committee	Dr. F.L. Cuthbert	Yes

EMPLOYEE RELATIONS OPERATION MONTHLY REPORT

GENERAL

At month's end the staff of the Hanford Laboratories Operation totalled 1119, including 504 exempt and 615 nonexempt employees. Of the total exempt employees there were 438 with college degrees, including 420 technical degrees as follows: BS - 217, MS - 104, PhD - 99. There were 36 nonexempt employees with degrees.

AEC-SPONSORED TRAINING PROGRAMS

Planning of training programs for off-site personnel is progressing according to schedule. Ten professors will participate in the AEC-ASEE Summer Institute starting June 23 while the summer training of 15 AEC Radiological Physics Fellowship students will commence June 16.

PERSONNEL DEVELOPMENT

Three hundred thirty Engineering Personnel Register forms for HLO employees were submitted to Engineering Services. At month's end 19 Technical Graduates and 7 Technician Trainees were on assignment within HLO. Off-program placement of these people is progressing favorably.

TRAINING

Sixty-five HLO employees attended two sessions of Project Cost Estimates; 5 employees attended Engineering Data Processing; 12 commenced Understanding People and 8 started Conference Leading courses.

COMMUNICATIONS

One hundred seventy-nine employees and guests attended the Biology Open House. Seventy-two science students from area colleges toured HLO facilities during April.

HEALTH, SAFETY AND SECURITY

Laboratories personnel worked 195,116 hours during the month with no disabling injuries. Since September 1, 1956, a total of 3,774,606 man-hours have been completed with no disabling injuries. The medical treatment frequency for April was 1.75 as compared with 1.52 during March.

There were 7 security violations during the month, bringing the 1958 total to 19.

EMPLOYMENT

Employment of nonexempt personnel continued steady during the month with 7 requisitions being filled and 5 continuing actively open. There were no force reductions nor reduction notices issued during the month to nonexempt employees.

TECHNICAL PERSONNEL PLACEMENT

Fourteen PhD candidates visited Richland for interviews during April. These interviews resulted in 5 offers being extended. For the recruiting year Sept. 1, 1957 to date there have been 12 PhD acceptances received and 8 offers are currently open. The recruiting of experienced BS/MS personnel continues at a minimum level.

UNION RELATIONS

Regional Monitoring negotiations await further word from the HAMTC following their consideration of the Company's comments in reply to rejection of the Company's last proposal by the IBEW.

The Company and the HAMTC are unable to reach an agreement as to an arbitrator for the Maki case and it now appears that the services of the Federal Mediation and Conciliation Service will be required.

One grievance was received during the month of April and was submitted by an FPD Serviceman claiming a HLO Engineering Assistant performed work which belongs to the Teamsters. The grievance has been discussed at Stage II and an answer will soon be sent to the HAMTC. Total grievances processed during the current calendar year are 13, including 2 non-unit grievances.

SUGGESTIONS

At the April Suggestion Board meeting 5 suggestions were approved for awards totalling $80. For the year to date, 33 suggestions have been adopted and awards totalling $1,090 have been approved.

BENEFIT PLANS PARTICIPATION

Hanford Laboratories' participation in the Employee Benefit Plans is as follows:

Year	Insurance	Pension Plan	Savings & Stock Bonus	Savings Plan
Jan.	99.6	98.4	60.6	7.5
Feb.	99.7	98.5	61.3	8.2
Mar.	99.7	98.6	61.9	8.7
Apr.	99.7	98.6	61.3	7.9

SALARY AND WAGE ADMINISTRATION

Salary and Wage Administration is conducting a study of exempt salary reviews since it is now possible to conduct these reviews on the basis most nearly suitable to individual level 2 components.

Manager
Employee Relations

1240036

VISITS TO OTHER INSTALLATIONS

Name	Date of Visit	Company Visited and Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
D.C. Fleckenstein T. G. Marshall	4/1	General Engineering Laboratory, G.E. Co. Schenectady	Personnel development of professional, semitechnical and all other non-exempt		No
D.C. Fleckenstein T. G. Marshall	4/1	Engineering Services G.E. Co. Schenectady	Advanced engineering and creative engineering program	W. S. Hill	No
D.C. Fleckenstein T. G. Marshall	4/2	P & ER Services Engineering Serv. New York	Salary and wage admin., attitude survey, employee benefits, and engineering personnel register	I. H. Dearnley H. H. Hutchinson	No
D.C. Fleckenstein T. G. Marshall	4/3	P & ER Services Engineering Serv.	Inventory and placement	T. H. Koerner E. D. Rebucci H. W. Gouldthorpe	No

TABLE II. EMPLOYMENT - TECHNICAL PERSONNEL STATUS

I. Employment

Non-Exempt Employment Status	Mar.	April	Non-Exempt Transfer Requests	Mar.	April
Requisitions					
At end of month	11	10	Transfer Requests		
Cancelled	0	1	Active cases at end of month	46	49
Received during month	10	7	Cancelled	2	2
Filled during month	6	7	New during month	2	6
Candidates Considered			Transfers effected	0	1
Total Applications	18	13	Planned Transfers		
Total Transfer Requests from other at HAPO	2	6	Effective during month	3	1
Total Interviewed	0	0			

II. Technical Personnel Placement

Ph.D. Recruiting - HLO - 9/1/57 to date

		VISITS TO RICHLAND				OFFERS*			On
	Cases Considered	Extended	Visited	To Visit	Open Invite.	Extended	Accepted	Open	The Roll
Engineering:									
Chemical	57	22	9	2	0	7	3	1	1
Electrical	26	5	1	1	1	2	0	0	0
Mechanical	32	0	3	3	0	2	0	0	0
Met - Ceramics	55	24	8	3	1	6	0	2	1
Other	6	2	1	1	0	0	0	0	0
Science:									
Chemistry	234	35	17	2	1	11	5	2	4
Physics	230	91	25	13	14	13	2	3	3
Math-Statistics	37	3	0	1	0	0	0	0	1
Other	44	9	3	3	1	2	2	0	2
TOTAL	721	200	67	29	18	43	12	8	12

*Offer totals include 14 Ph.D. open offers as of 9/1/57.

BS/MS Experienced Recruiting - HLO - 9/1/57 to date

		VISITS TO RICHLAND				OFFERS			On
	Cases Considered	Extended	Visited	To Visit	Open Invite.	Extended	Accepted	Open	The Roll
Engineering:									
Chemical	6	2	1	-	-	1	-	-	-
Electrical	9	2	2	-	-	-	-	-	-
Mechanical	11	4	3	-	-	2	-	-	-
Met-Ceramics	8	1	1	-	-	1	1	-	1
Other	16	-	-	-	-	2	1	1	1
Science:									
Chemistry	10	-	-	-	-	-	-	-	2
Physics	5	-	-	-	-	2	-	-	-
Math-Statistics	4	1	1	-	-	1	1	-	1
Other	16	-	-	-	-	-	-	-	-
TOTALS	85	10	8	0	0	9	3	1	5

TABLE III. Exempt Transfer Cases

			March	April	Total
Active cases at beginning of month			31	30	
New cases:	Initiated by employee			2	5
	Initiated by management*		1	3	12
Cases reactivated					
			32	35	
Cases closed:	Transfers:	Within HLO			2
		Within HAPO	1		1
		Other GE			0
	Withdrawn		1	1	3
	Terminated		2	3	6
			28	31	12
Active cases at end of month			28		28

Total cases - January 1, 1958 to date (includes 23 cases initiated prior to and active on 1/1/58) 40

Initiated by employee	15
Initiated by management*	25

*Includes ROF's, transfers proposed by employee's management, and requests from other G. E. departments.

TABLE IV. Union Relations

Grievances Processed - January 1, 1958 to date

Total processed	13	(includes 2 non-unit grievances)
Step I		
Answered satisfactorily*	6	(includes 2 non-unit grievances)
Step II		
Pending Step II discussion	0	
Pending Step II answer	1	
Answered		
Satisfactorily	5	
Pending time limit	1	
Applied for arbitration	1	

* Step I grievances which Council indicated a desire to discuss at Step II not scheduled for discussion within three months are considered settled at Step I.

** Step II grievances in which the Council formally applied for arbitration but for which no further action is taken within three months are considered settled at Step II.

FINANCIAL OPERATION MONTHLY REPORT

Personnel

There were no personnel changes in the Financial Operation during April.

General Accounting Operation

Due to changes in planning, it appears that some of the money allocated Hanford Laboratories for Attendance at Meetings and for Off-Site Courses and Seminars is available for reassignment. Level 3 Managers have been advised.

A special meeting to discuss AEC surveys of SS material procedures and practices was scheduled to be held May 5, 1958. Forecasts of requirements for diversion of SS material inside production channels for the period July 1 through December 31, 1958 were accumulated and transmitted to SS Accountability Operation. The results of AEC Survey 15, Part II were studied and two items affecting HLO are being followed to insure appropriate action is taken.

New reports covering the status of zirconium held for HLO were developed and will be issued monthly in the future.

Arrangements are currently under way with Reactor and Fuels R&D Operation to insure that equipment located at Arco, Idaho will be adequately identified by property tags and carefully accounted for.

The analysis initiated last month to determine the degree of accuracy experienced in estimating the value of equipment acquired on appropriation requests has been up dated and the results based on FY 1957 and FY 1958 closed Appropriation Requests are shown below:

	No. of AR's	Authorized Funds	Actual Cost	(Over) Under	Percentage
Over-Run					
By more than 10% (Supplement Required)	22	104,788	143,883	(39,095)	37.3%
By less than 10%	12	95,120	100,631	(5,511)	5.8%
Under-Run					
By more than 10%	32	155,385	103,979	51,406	33.1%
By less than 10%	20	130,644	127,246	3,398	2.6%
Total Appropriation Requests	86	485,937	475,739	10,198	2.1

Final results of the physical inventory of shop stock material in the custody of Technical Shops Operation disclosed an overage of $528. The overage is due primarily to material being added to inventory without documentation and price increase on slow turning material.

Quarterly inventory reports for the quarter ending March 31, 1958 were received from all HLO custodians of special materials and reconciled with Property Accounting stock control records. All reports were found in agreement with Property Accounting records. A comparison of the Reactor and Other Special Materials,

March 31, 1958 inventory balance ($581,999) with that of December 31, 1957($693,797) shows a decrease of $111,798, principally due to the transfer of zirconium to IPD ($120,959).

In connection with the annual physical inventory of uninstalled cataloged equipment, a Missing Plant and Equipment Report and a Property Disposal Request has been prepared for all HLO missing equipment and a summary report of findings and recommendations prepared and distributed. A comparison of the inventory balance $7,845,266 (8,406 items) with the adjusted book balance $7,905,765 (8,280 items) disclosed a shortage of 126 items valued at $60,499 or 0.77% of missing equipment to adjusted book balance. Unrecorded items added to record during the inventory totaled 1,078 items valued at $480,598.

Verification of the physical inventory count taken by custodial personnel of the 321 Building, Cold Separation Laboratory, installed equipment, continues. Storage location 300 North, 300 West, Room 108, 3706 Building, not inventoried by custodial personnel remains to be taken.

Cost Accounting

During April, the FY 1958 program authorizations of Hanford Laboratories remained firm. However, Level 3, 4 and 5 Operating Budgets were adjusted to reflect the internal reallocations of (1) the Plutonium Recycle Research and Development funds and (2) the program funds required to finance the newly established Programming Operation.

A new Financial Plan for FY 1958 was received and analyzed for comparison with the previous plan and with the amounts currently included in the budget for HLO sponsored programs. No significant variations in HLO programs were found, as all programs were included, in the amounts that had previously been indicated by the AEC. The Financial Plan did reveal an area that will require reconciliation in HLO's allocations from CPD (Separations Processes for Non-Production Fuels). The plan includes a lesser amount for this program than the amount allocated to HLO from CPD.

A new report has been developed by Contract Accounting entitled, "Program Assignment of Workforce". The emphasis is placed on personnel assignments to the various HAPO Research and Development programs so that information pertaining to the level of effort on Research and Development is readily available to management. This report will be issued quarterly and will segregate exempt and non-exempt manpower by program at each quarter-ending date.

A second new report which has been prepared will be called "Status of Procurement Directives, Contracts, and GEH Orders (MTR, Arco)." It will be issued monthly and will include item numbers, customer codes, authorized amount, cost-to-date, and unexpended balances by each authorizing document.

A Safety and Security meeting was held on April 23 by the Financial Operation. A member of the Richland Police Force was the guest speaker on the subject of vacation driving and courtesy on the road. The chairman of the meeting also discussed (1) the proper procedure to follow when an accident or illness occurs to an individual during working hours, (2) General Electric Company's safety performance over the last ten years and (3) the improvement in security performance in Hanford Laboratories Operation this calendar year-to-date as compared to the same period last calendar year.

A meeting was held by the Specialist - Technology Cost to help decide the manner of funding the development and fabrication of a Fish Monitor. The Supervisor, Radiation Protection Instrument R&D Operation, agreed to finance the cost of developing a prototype probe and the Manager, Aquatic Biology Operation, agreed to finance the cost of Technical Shops fabrication and the cost of the necessary commercial equipment. The latter costs to be incurred after the prototype probe has proven to be satisfactory to all parties concerned.

Personnel Accounting Operation

A 1.77% cost-of-living increase, effective 4-28-58 will be reflected in weekly salary checks dated 5-9-58. The resulting annual increase in weekly salaries is estimated to be $44,515. Area differential payments to exempt employees will be increased from $43.18 per month to $43.84 per month which will result in an annual increase in the payroll of approximately $1,000.

Federal and State Tax Summaries were prepared, applicable taxes paid, and required reports submitted, for the first quarter 1958.

Procedures

Work was completed on the system study of personnel records in the Laboratories. A written summary was prepared of the results of the study, and recommendations for procedural improvements were given. A consolidated record office and complete coordination of Financial and Employee Relation personnel records were recommended; clerical work reductions, cost savings, and paperwork improvements are expected advantages of the proposed system. The recommendations are presently under study by the Manager - Employee Relations and the Manager - Finance.

A related summary was made outlining possible areas of improvement in the internal record procedures of Employee Relations. Suggested improvements which were given to afford time and cost savings and clerical work reductions are also being considered by the Manager - Employee Relations.

Further procedural work was accomplished in the development of a detailed record system for use by Facilities Engineering concerning the maintenance of building equipment. A related FPD maintenance record system was studied as it is being converted for handling on electronic data processing equipment. The cost and utility of similar procedures for HLO building records are being evaluated.

Auditing

The Physical Inventories audit report and the Administrative Services audit follow-up were issued. The Property Accounting audit field work is in progress.

Measurements

Meetings with management on the HLO Measurements Program were initiated during the month. Two meetings with Level 3 Managers have been completed to date.

Several meetings have been held with members of Employee Relations to plan for the report on possible employee attitude indicators. Considerably more work is needed for the final report.

One letter giving cost information has resulted from the questionnaire on libraries. We are attempting at present to work up similar HLO figures. A system of Bio-assay unit costs has been developed which promises to have satisfactory utility. However, it is based on the number of personnel at selected sites in the plant and this information concerning such numbers has proved difficult to obtain.

The Performance Appraisal for Hanford Laboratories, completed in December 1957, was reproduced and distributed to Level Three Managers as a result of a suggestion in the recent HLO Climate Review.

Payroll Statistics

Number of HLO Employees Changes During Month	Total	Exempt	Non-Exempt
Employees on Payroll at Beginning of Month	1 120	500	620
Additions and Transfers In	13	8	5
Removals and Transfers Out	(14)	(4)	(10)
Employees on Payroll at End of Month	1 119	504	615

Overtime Payments During Month	April	March
Exempt	$ 5 298	$ 6 786
Non-Exempt	5 466	8 222
	$10 764	$15 008

Gross Payroll Paid During Month		
Exempt	$395 783	$397 715
Non-Exempt	260 345	226 366
	$656 128	$664 081

Participation in Employee Benefit Plans at Month End	No. Participating April	No. Participating March	% Participating April	% Participating March
Pension Plan	1 127	1 124	98.6	98.6
Insurance Plan				
Personal Coverage	1 164	1 164	99.7	99.7
Dependent Coverage	740	732	-	-
U.S. Savings Bonds				
Stock Bonus Plan	686	693	61.3	61.9
Savings Plan	88	97	7.9	8.7

Insurance Claims	April Number	April Amount	March Number	March Amount
Employee Benefits				
Life Insurance	0	$ 0	0	$ 0
Weekly Sickness & Accident	17	946	10	1 020
Comprehensive Medical	61	4 841	56	5 897
Dependent Benefits				
Comprehensive Medical	89	5 849	106	7 403
Total	167	$11 636	172	$14 320

Good Neighbor Fund	April	March
Number Participating	709	714
Percent Participating	63.4	64.1

W. Sale/bk
May 12, 1958

PROGRAMMING OPERATION

A. FISSIONABLE MATERIALS - 2000 PROGRAM

1. CHEMICAL PROCESSING PROGRAM

Flowsheet development and economic study of alternate processing schemes for power, test and propulsion reactor fuels was continued. Proposals concerning the recovery of noble gases from fission product wastes were received from all interested companies. Opinions on economic and technical factors presented in the proposals are now under study in order to prepare recommendations for action.

2. RADIOLOGICAL AND WASTE DISPOSAL PROGRAMS

Preliminary layouts of process and equipment for alternate ultimate waste disposal methods were under development in order to establish comparative construction and operating costs. Consideration of gross fission product packaging and marketing as a factor in this study was also included.

Material was prepared for, and a presentation made to the Reactor Hazards Evaluation Branch of the AEC in Washington, D.C., on April 21 and 22, concerning radiological hazards in the Wahluke Slope area. This information is to be used by the AEC in preparation for a meeting of the Advisory Committee on Reactor Safety soon to be held at Hanford.

A manuscript, "Review of Information of the Maximum Permissible Limits for Thorium" was prepared for presentation by others at the American Industrial Hygiene Association meeting at Atlantic City on April 25. A Geneva Conference paper on high level radioactive waste storage was completed.

B. REACTOR DEVELOPMENT - 4000 PROGRAM

1. PLUTONIUM RECYCLE PROGRAM

Plutonium Recycle Analysis

A study of the effects of process losses on the attainable exposure of uniformly enriched, steady-state recycle fuel was completed. The results confirm previous work, yielding a maximum attainable exposure at process losses of plutonium between three and four per cent per cycle. At high values (1.6%) of U-235 feed enrichment the maxima are very low, indicating little sensitivity to process losses of plutonium over a large range. The highest maxima (as compared to the zero-loss exposure) occur in small (high-leakage) reactors with natural or depleted feed. The problem is now believed to be reasonably well understood in terms of the rates of formation, burnout and discard of the Pu-242 isotope.

A study of the effects on a reactor neutron energy spectrum of replacement of U-235 by equal amounts by weight of plutonium of various isotopic

compositions were started. The results so far obtained indicate that complete replacement of U-235 by plutonium results in the reduction of the thermal portion of the neutron energy spectrum by a factor of about 2. This flux hardening effect is so severe that it is by no means obvious how a self-consistent comparison can be made between the values of U-235 and plutonium in a given reactor. Current efforts on non-recycle reactor cases are devoted to establishing the partial derivatives of the value function with respect to uranium fuel costs, plutonium yield, etc. in an attempt to formulate a simple but complete prescription for the value of plutonium as a U-235 substitute in non-recycle cases.

The computer program for calculating plutonium recycle fuel costs was made ready to operate and was used to calculate the fuel costs for a particular plutonium recycle reactor under some 25 sets of economic conditions. Fuel element fabrication costs and plutonium value were among the economic factors varied to give these sets. Eight different feed enrichments were analyzed for each set of economic parameters to determine the minimum fuel cost in each case. The reactor analyzed was as defined by the following reactor parameters: $k_\infty/\epsilon = 1.10$, $p = \sim 0.9$, $f = \sim 0.9$, moderator temperature = 200 C, and specific power = 10 MW/T. In all, some 200 cases were analyzed. Interpretation of the results is underway.

The computer program for once-through reactor operation was still being prepared for final operation. Test runs indicated some residual flaws in the program that are now being corrected.

PRTR Fuel Processing

A study to compare PRTR fuel processing in the Redox facility and in the Hot Semiworks was completed. Economics were shown to be highly favorable to the Redox method. Discussions were held with members of the Chemical Processing Department concerning Redox use for PRTR fuels, and no serious obstacles became apparent. However, other factors such as flexibility for alternate flowsheet studies, process refinement and scheduling favor the Hot Semiworks alternate.

Geneva Conference Participation

A report, "Plutonium Recycle in Thermal Reactors" was completed and submitted to the AEC. This is to comprise one chapter of the Geneva Book "Advance Concepts in Solid Fuel Reactors." Display material concerning the Plutonium Recycle Program was prepared for the Geneva Conference. A Geneva paper, "The Comparative Economics of Plutonium Fuel Utilization and U-235 Fuel Utilization in Thermal Power Reactors" was prepared during the month. The data in this paper were also presented at the Plutonium Fuels Conference held at Hanford on April 22 and 23.

2. GAS COOLED REACTOR PROGRAM

Discussions were held with representatives of the local and Washington AEC, Kaiser Engineers, ACF Industries, and ORNL concerning possible Hanford participation in research and development work associated with the Gas-

Cooled Graphite-Moderated Power Reactor Program. Agreements were reached on HAPO participation in FY-58 in work on measurement of lattice physics parameters in the PCTR and on the in-reactor chemical reaction between carbon dioxide and graphite at elevated pressures and temperatures. Negotiations were started concerning similar work in subsequent years, it seeming highly probable that mutually satisfactory arrangements can be made.

L H McEwen

Manager - Programming Operation

LH McEwen:dl

[redacted]

VISITS TO HAPO

Name	Dates of Visit	Company Represented and Address	Reason for Visit	HAPO Personnel Contacted	Access to Restricted Data	Bldgs. & Areas Visited
JE Machureck	4/22	AEC-Office of Industrial Development Washington, D.C.	Discuss rare gas processing.	CA Rohrmann ET Merrill	Yes	326, 300
TC Parsons	4/29	U. of California Radiation Laboratory Berkeley, Calif.	To discuss plutonium alloy fabrication, irradiation and trans-uranic element recovery.	CA Rohrmann	No	326, 300
RS Miller	4/15-17	ACF Industries Washington, D.C.	To discuss development program on GCTR.	LH McEwen	Yes	700, 300

VISITS TO OTHER INSTALLATIONS

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JG Bradley	4/21 and 4/23	Mallinckrodt Chem. Works St. Louis, Mo.	Discussions on process and equipment.	KJ Caplan	Yes
	4/22 and 4/24	Williams Patent Crusher & Pulverizer Co. St. Louis, Mo.	To observe and evaluate crushing operations on S.S. clad, power reactor fuel bundles.	E Jeukstock AL Brown	No
ET Merrill	4/3-6	Union Oil Company Fullerton, Calif.	Consultations regarding rare gas recovery.	FL Hartley	No
LH McEwen	4/7-8	Division of Reactor Dev. AEC Washington, D.C.	To discuss R & D on gas reactor coolants.	UM Staebler JM Atwood	Yes
M Lewis	4/1	Los Alamos Scientific Lab. Los Alamos, N.M.	Speak at technical colloquium, "The Use of Pu in Thermal Power Reactors"	Dr. D. Hall	Yes

VISITS TO OTHER INSTALLATIONS (CONT.)

Name	Dates of Visit	Company Visited & Address	Reason for Visit	Personnel Contacted	Access to Restricted Data
JW Healy	3/24 thru 4/5	New Zealand government	Participate in Atoms for Peace Mission	RL Kirk Carol Zabel Arthur Rupp	Yes
JW Healy	4/21	AEC, Reactor Hazards Evaluation Staff Washington, D.C.	Discuss various aspects of Wahluke Slope hazard problem.	CK Beck	Yes
	4/22	AEC, Reactor Hazards Evaluation Staff and Div. of Biology & Medicine Washington, D.C.	" " "	CK Beck CL Dunham	Yes
JW Healy	4/11 & 12	Department of Civil Engineering, State College of Wash.	Attend meeting of Sanitary Engineering Advisory Committee	Dr. GH Dunstan	No

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
H. T. Hahn	Heat Exchange in Liquid Metal Fueled Reactors (HW-55726)
R. G. Wheeler	In-Reactor Strain Cycling Apparatus

H. T. Parker